

AN INVESTIGATION INTO THE EFFECTS OF CONIFER PLANTING ON THE TERRESTRIAL INVERTEBRATE FAUNA OF PORTO SANTO

By Helen J. READ¹ & C. P. WHEATER²

ABSTRACT. Invertebrates were sampled from three different habitats (nine sites in all) during the summers of 1984 and 1986. The three habitats were; mature conifer plantations, young conifer plantations and open grassland. Differences in the number of taxa, number of individuals and diversities between the habitats were investigated. Differences between the sampling sites (within the habitats) and between the sampling occasions were also considered.

Lower numbers of taxa and individuals were found in the two coniferous areas than the grassland sites. No differences were found between the diversities, number of taxa or number of individuals on the two sampling occasions, but the taxon arrays were different. The influence of these changes on the invertebrate populations are discussed, with reference to an endemic species.

INTRODUCTION

The island of Porto Santo was probably originally forested, as was most of Madeira (Krejci-Graf 1961). The indigenous forest was presumably of hard woods and consisted of a mixture of species. Today the island is principally grassland, providing rough and seasonal grazing. The rainfall is low and for much of the year negligible. Despite the unpromising nature of the island today,

¹Towerwood, Park Lane, Burnham Beeches, Buckinghamshire, UK

²Dept. of Environmental and Geographic Sciences, Manchester Metropolitan University, Manchester, UK

Porto Santo is rich in endemic invertebrates eg. snails, millipedes and spiders, which appear to have adapted for survival on the dry grassland. In recent years tree planting has been carried out over much of the Madeiran archipelago and Porto Santo is no exception. The species used in the drier regions is mainly *Pinus alepensis* Mill.. Pico do Castelo was terraced and planted some time ago and is now abandoned. The trees are mature whilst the ground cover is mixed and of mostly exotic species. On the west side of the island recent terracing and planting of locally propagated trees has resulted in more extensive plantations of young conifers. These presumably stabilize the soil and help to reduce erosion as well as providing a timber crop for the future.

Conifer plantations are widely known to support low diversities of invertebrates (Peterken 1981) as are introduced tree species (Southwood 1961). Coniferous trees generally support fewer species than deciduous (Kennedy & Southwood 1984) however Rymer (1981) points out that consideration of monoculture pine plantations as wildlife habitats should be made in comparison to that which it replaces. Hence as a replacement to intensive agriculture it may be beneficial, whereas clearance of native forest would be detrimental

The current investigation was made in order to examine the effects of the conifer planting on the terrestrial invertebrates on Porto Santo.

SITE DESCRIPTIONS (Table 1)

Mature woodland - Pico do Castelo.

Sites 1, 2, and 3 were all situated on the slopes of Pico do Castelo, one of the highest points on the island (437 m). Mature conifers predominate. The terracing was rather dilapidated and in places odd specimens of *Cupressus sempervirens horizontalis* L., *Erica arborea* L. and *Quercus ilex* L. were found.

Young plantations.

Sites 4, 5, and 6 were all on the west side of the island where the more recent planting had taken place. the trees were in definite rows and were 0.75 - 1.5 m high in 1984 and up to 2.5 m high in 1986. The ground layer was quite varied including grasses and composites.

TABLE 1 Physical and vegetation characteristics of the sites

MATURE CONIFER SITES

- Site 1 WNW of Pico do Castelo, some holm oak present, conifers about 7m high with a mean of 1.79m between them. 75% bare ground on a slope of 60 degrees.
- Site 2 SSE of Pico do Castelo, conifers about 15m high with a mean of 1.14m between them. 85% bare ground on a slope of 50 degrees.
- Site 3 South of Pico do Castelo, conifers about 5-7m high with a mean of 1.46m between them. 10% bare ground on a slope of 15 degrees.

IMMATURE CONIFER SITES

- Site 4 On the west coast opposite Ilheu do Ferro, conifers about 1.5m high with a mean of 3.0m between them. Ground cover of dry grasses and herbs on a slope of 25 degrees.
- Site 5 On the west coast opposite Ilheu do Ferro, conifers about 2m high with a mean of 3.0m between them. Ground cover of dry grasses and herbs on a slope of 20 degrees.
- Site 6 On the west coast opposite Ilheu do Baixo, conifers about 0.7m high with a mean of 1.2m between them. Ground cover of dry herbs on a slope of 25 degrees.

GRASSLAND SITES

- Site 7 Facing Ana Ferreira, ground cover of dry grasses (20-25cm high) and littered with rocks on a slope of 10 degrees.
- Site 8 South of Pico do Castelo, ground cover of dry grasses (maximum of 30cm high) and littered with rocks on a slope of 10 degrees.
- Site 9 East of site 8 near sewage works, ground cover of dry grasses and stones making up terracing on a slope of 25 degrees.
-

Grassland.

Sites 7, 8, and 9 were grassland, composed of mixed grasses and herbs and were very dry on both sampling occasions. Site 7 was close to Pico do Ana Ferreira, sites 8 and 9 were east of Villa Baleira. These sites are grazed by cows and goats and have numerous stones amongst the dry grasses.

METHODS

Animals were collected using standardised 30 minute searches of ground vegetation and under logs and stones. The sites were examined in early September in 1984 and late August in 1986. The animals found were classified as far as order and the number of each counted.

Shannon-Wiener diversity indices (H'), the number of taxa and the number of individuals were examined in relation to vegetation type. The differences in taxon array were investigated using chi-squared tests. Other relationships (differences between the years and differences between the three major vegetation types) were examined using non-parametric analyses of variance (Meddis 1984).

RESULTS

A breakdown of the taxa found at each site for each of the two sampling periods can be seen in Table 2. In both 1984 and 1986 significant differences were found between the taxon arrays for the three types of areas (mature conifers, young conifers and grassland) (1984: $\chi^2 = 328.66$, d.f. = 12, $p < 0.0001$, 1986: $\chi^2 = 2414.34$, d.f. = 12, $p < 0.0001$). Similar analyses of the three types of sites taken individually showed significant differences in taxon array between the two dates of sampling ($\chi^2 > 318.56$, d.f. = 6, $p < 0.0001$).

A non-parametric analysis of variance was used to examine any differences between the diversities, numbers of animals and numbers of taxa found in each year of sampling, taking into account the different areas sampled. No significant differences were found (Table 3). A similar analysis showed significant differences in the number of taxa and number of individuals found in each area taking into account the different years sampled (Table 4). No such significant differences were found for the diversity data.

TABLE 2 Taxa found during searches. Upper left figures refer to 1984, lower right figures refer to 1986

TAXA	Mature Conifers			Immature Conifers			Grasslands		
	1	2	3	1	2	3	1	2	3
Mollusca Pulmonata	6 11	22 14	224 86	169 179	4 159	2 243	597 731	375 407	411 204
Crustacea Isopoda	7	2							
Chelicerata Araneae	2	7	2	3	1	14 2	7 5	10 3	7 6
Chelicerata Acarina			2						
Myriapoda Diplopoda	24 2	46 2	234 99	6	64	1	11 17	10 10	553 245
Myriapoda Chilopoda	2		1						
Insecta Thysanura	14			2 2	24	6	11 4	43 6	2 3
Insecta Orthoptera						20	6 2	9	
Insecta Hemi/Heteroptera							2	4	1
Insecta Formicidae	24 450	55	4 3	6 6	4 166	6 3	5 4	7 6	1 13
Insecta Coleoptera	1		33 34	2 1	12 1	8	10 24	57 23	105 871
Diversity (H')	1.28 0.28	0.74 0.90	0.93 1.18	0.48 0.23	0.78 0.95	1.14 0.38	0.43 0.36	0.96 0.53	0.99 0.97
No. of Taxa	4 7	3 4	4 7	6 4	4 6	4 6	8 7	7 7	6 7
No. of Individuals	68 475	70 79	495 227	188 188	84 352	42 263	649 787	511 459	1079 1343

DISCUSSION

No significant differences were found between the taxon diversities, number of taxa or number of individuals found on the two sampling occasions, but the taxon array did alter. Similar differences in array were found between the areas sampled within each year. Whilst this might be expected with developing vegetation types such as the two coniferous areas, it is perhaps more surprising in the grassland area. However, the presence of large aggregations of aestivating Coleoptera in 1986 may help to explain at least part of this. Differences between the years in terms of grazing pressure and climatic conditions may also have contributed.

TABLE 3. Non parametric analysis of variance of taxa found during the two sampling dates, taking into account the different areas sampled

	Diversities	Number of Taxa	No. Individuals
Mean Rank 1984	4.1	2.9	2.8
Mean Rank 1986	2.9	4.1	4.2
H statistic ($\equiv \chi^2$)	1.92	2.03	2.31
D.F.	1	1	1
p	0.16 (ns)	0.15 (ns)	0.12 (ns)

The significant differences found between the number of taxa and number of individuals at the different sites indicate more change between areas of similar vegetation type than within them. The mean rank of each points towards similar lower numbers of taxa and individuals being found in the two coniferous areas compared to the grassland sites. This confirms the suspicion that coniferous plantations support a more impoverished invertebrate population despite the increased structural diversity of the vegetation.

Certain taxa are restricted to certain vegetation types (Isopods to mature woodland, Orthoptera and Heteroptera to grassland). With others polarisation appears to occur, for example with Diplopoda and Coleoptera, and to a lesser

extent Pulmonata, and Thysanura in 1984 and Araneae in 1986. All have least abundance in the immature woodland. Such distributions are probably influenced by the relatively short amount of time since this habitat was planted.

Also of interest is the influence of habitat on one of the most striking endemic species *Isohogna maderiana* (Walckenaer). This animal seems to be fairly widely distributed on Porto Santo. During these studies the species was found to be most common in the grassland sites 8 individuals in 1984 and 4 individuals in 1986; less common in the immature coniferous sites 8 individuals in 1984 and 1 individual in 1986; and absent from the more mature coniferous woodlands on either sampling occasion.

TABLE 4. Non parametric analysis of variance of taxa found in each area, taking into account the different sampling dates

	Diversities	Number of Taxa	NO. Individuals
Mean Rank Mature Conifers	5.7	3.9	3.7
Mean Rank Imm. Conifers	4.3	3.7	3.5
Mean Rank Grasslands	5.0	7.4	7.8
H statistic ($\equiv \chi^2$)	0.71	8.15	9.64
D.F.	2	2	2
p	>0.05 (ns)	0.016 (*)	0.008 (**)

CONCLUSIONS

This study has tended to confirm the view that the planting of introduced conifers in plantations is in general detrimental to the fauna of the island of Porto Santo. The grassland areas may at first sight appear very unpromising habitats, particularly in the drier periods, but the number of invertebrates can, at times, be quite surprising. An example of this is that in two of the grassland sites in 1984 and one in 1986 every stone was found to have at least one animal under it, and stones were by no means scarce. The same thing could

not be said of any of the plantation sites. Despite grassland not being the natural vegetation of the island it has a distinct and unique invertebrate fauna associated with it. Perhaps the most concerning aspect of the afforestation programme is the effect on certain endemic species, particularly *Isohogna maderiana*. The expansion of coniferous forests on the island will undoubtedly result in a decrease in the population of this striking animal. It should be noted however, that for the snail fauna, the existence of woodland of any type may provide a refuge for indigenous forest species.

REFERENCES

KENNEDY, C.E.J. & T.R.E. SOUTHWOOD:

1984. The number of species of insects associated with British trees: A re-analysis. *J. Anim. Ecol.* 53:455-478.

KREJCI-GRAF, K.:

1961. Vulkaninseln und Inselvulkane 4. Porto Santo. *Natur Volk* 91:33-38.

MEDDIS, R.:

1984. *Statistics using ranks: a unified approach*. Blackwell, Oxford.

PETERKEN, G.F.:

1981. *Woodland conservation and management*. Chapman & Hall. London.

SOUTHWOOD, T.R.E.:

1961. The number of species of insect associated with various trees. *J. Anim. Ecol.* 30:1-8

RYMER, L.:

1981. Pine plantations in Australia as a habitat for native animals. *Environmental Conservation* 8(1):95-96.