Acta Zoologica Academiae Scientiarum Hungaricae 53 (2), pp. 157–167, 2007

PINE FOREST EARTHWORMS FROM CANARY ISLANDS (TENERIFE AND GRAN CANARIA)

TALAVERA, J. A.

Faculty of Education, Module A, University of La Laguna
38206 La Laguna Tenerife, Canary Islands, Spain

Autochthonous pine forests in the Canary Islands are host to a limited number of earthworms, among which the lumbricids are the dominant group in presence and abundance. 13 species have been identified, of which *Allolobophora chlorotica, Aporrectodea rosea bimastoides, Lumbricus rubellus, Microscolex dubius, M. phosphoreus* and *Ocnerodrilus occidentalis* are new records for Gran Canaria, while *Aporrectodea trapezoides* is new for *Pinus canariensis* woodlands from Tenerife. The first original data on the distribution of each species in coniferous forests are also presented, establishing significant faunistic differences; the more southerly dry pine woodlands are typically inhabited by *Aporrectodea rosea bimastoides* and *Microscolex dubius*, while the more humid forests have a fauna richer in species like *Allolobophora chlorotica*, *Lumbricus rubellus*, and *Octodrilus complanatus*, which may be considered good indicators of natural potential forest areas. The high calcium and potassium levels, slightly acidic pH and up to 18.5% organic matter of the studied andosols and/or brown soils appear to influence the earthworm fauna composition and distribution in *Pinus canariensis* forest.

Key words: earthworms fauna, ecology, distribution, pine forest, Canaries

INTRODUCTION

The islands of Tenerife and Gran Canaria possess extensive forests of autochthonous *Pinus canariensis*, situated mainly on the northern (humid pine-forest) and south to south-western slopes (dry pine-forest), at altitudes between 1000 and 1500 m (Fig. 1). Towards the lower end of this range, the forests sometimes appear mixed with wax-myrtle and tree-heath (*Myrica faya, Erica arborea*) – impoverished remnants of evergreen laurel forest in the north, while spurge shrubland communities of *Euphorbia canariensis* and *E. balsamifera* predominate in the south, where rainfall is sparser and soil moisture lower. Growing environmental pressure has caused a reduction in area of these ecosystems and the decrease or disappearance of their fauna, including earthworms that have lived for ages in the pine forests, where fires and uncontrolled felling have endangered their populations (ARCO *et al*. 1987). This has split up the distribution areas of some species, which have had to adapt to various more humanized habitats. It is thus of vital necessity to identify the species currently inhabiting these areas and their ecological requirements, principally pH, moisture and organic matter content. Therefore the priority objective is to report for the first time on the composition, autoecology and distribution of lumbricofauna in autochthonous Canary pine forests, since up to now the information in the existing literature is scarce (COGNETTI 1906, KRAEPELIN 1895) or is restricted to occasional references (BOUCHÉ 1973, TALAVERA 1991, 1992*a*, ZICSI 1969).

MATERIAL AND METHODS

Localities were selected in dry and humid pine forests, either well conserved or degraded and sparse. 23 were sampled in Tenerife (T) and 22 in Gran Canaria (C) mainly during 1999 (Fig. 1). Considerable unpublished material collected already in the 1980's is also incorporated here. A minimum of 3 sites were sampled from each municipal district (see Appendix 1), attempting to include variations in terrain and habitat: stones or pine-needle litter, reservoirs or water channels, forest vehicle track or public recreation zone.

Specimens were collected by spraying 0.6% formalin over areas of 0.5 m^2 and excavation of the ground to 25 cm using a geologist's hammer, then fixed and preserved (TALAVERA 1991). In each municipal district, a minimum of 2 samples of about1kg of soil inhabited by earthworms were taken,

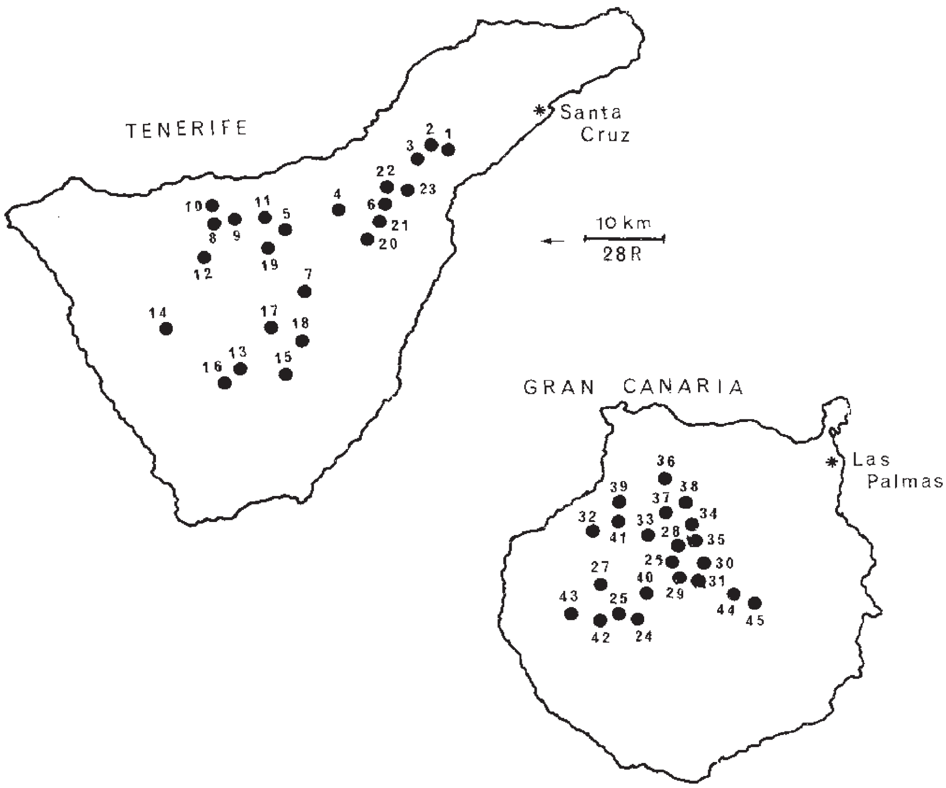

Fig. 1. Maps of Tenerife and Gran Canaria with the sites mentioned in Appendix 1

Table 1. Percentages of total variance explained by the two first axes

	Initial autovalues			Sum of the rotation squares		
Components	Total	% Variance	% Accumulated	Total	% Variance	% Accumulated
1	3.238	26.979	26.979	2.119	17.659	17.659
2	1.931	16.094	43.073	1.934	16.115	33.775

and later analysed for pH (in water), organic matter (OM), total calcium (CA) and potassium (K), according to the techniques of JACKSON (1972). Percentage presence of each species (PP) in the total number of samples and percentage abundance-dominance for the number of individuals (PI) were calculated (Table 2), as described by BOUDOURESQUE (1971). In Figure 2, we represent the projection of the species on a basis defined by axes I and II of the Principal Components (programme 13-SPSS = Statistical Package Social Sciences); the analysis was made from a data matrix that includes the edaphic variables of the 30 soil samples studied, and those species that appeared in more the 10% of them. The percentages of total variance are also included (Table 1).

RESULTS

The results are summarized in Figure 2 and Tables 1 and 2; comments on the 13 species identified are as follows:

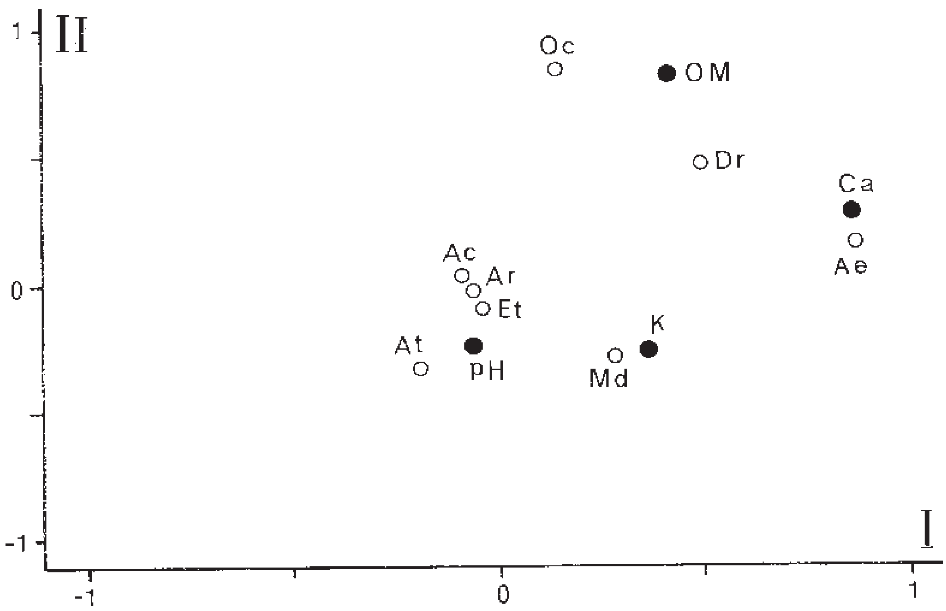

Fig. 2. The projection of the species and edaphic variables: CA = calcium, OM = organic matter, K = potassium, PH = pH in water. Ac = *A. chlorotica*, Ar = *A. rosea bimastoides*, At = *A. trapezoides*, Ae = *A. eiseni*, Dr = *D. rubidus*, Et = *E. tetraedra*, Md = *M. dubius*, Oc = *O. complanatus*

Table 2. Mean and range of edaphic factors, values of presence (PP), abundance (PI), ecological category (CE) for each species, Ac = anecic, En = endogeic, Ep = epigeic.

	PH		Organic matter		Calcium		Potassium		Species		
	mean	range	mean	range	mean	range	mean	range	PP(%)	PI(%)	CE
A. chlorotica	6.56	6.1–6.9	4.70	1.5–6.9	10.30	4.9–14.6	1.10	0.5–1.4	15.55	11.66	En
A. r. bimastoides	6.15	5.9–7.0	5.36	2.0–9.1	10.66	3.4–23.2	2.03	0.4–4.6	31.11	10.00	En
A. trapezoides	6.49	5.9–7.3	4.32	1.5–18.5	9.02	3.4–21.5	1.44	0.4–4.5	60.00	27.00	Ac
A. eiseni	6.38	5.9–7.3	8.68	3.8–18.5	14.62	3.4–23.2	2.08	0.4–4.5	24.44	6.00	Ep
D. cognettii	–	–	–	–	–	–	–	–	2.22	0.50	Ep
D. rubidus	6.50	6.1–7.1	7.12	1.3–18.5	13.70	6.7–21.5	2.84	1.5–4.5	15.55	8.16	Ep
E. fetida	6.40	6.4–6.4	5.70	1.9–9.5	14.20	9.5–18.9	3.60	2.7–4.5	4.44	3.00	En
E. tetraedra	6.42	5.8–6.9	2.08	1.5–3.2	8.44	3.9–14.6	1.24	0.9–1.4	15.55	6.50	Ep
L. rubellus	6.30	6.1–6.9	7.55	1.9–13.1	10.35	3.9–16.8	1.35	1.2–1.5	11.11	2.50	Ep
M. dubius	6.43	5.9–7.1	3.82	1.3–7.6	10.98	3.9–23.2	1.70	0.9–4.6	40.00	17.00	En
M. phosphoreus	6.73	6.1–7.3	4.93	3.8–6.6	9.80	6.7–11.9	2.16	1.4–2.7	6.66	1.50	En
O. complanatus	6.45	6.1–6.8	8.58	2.0–18.5	12.33	3.9–21.5	1.55	0.9–2.4	17.77	5.66	Ac
O. occidentalis	6.95	6.9–7.0	1.95	1.9–2.0	6.10	5.8- 6.4	1.30	1.2–1.4	4.44	0.50	Ep

Allolobophora chlorotica (SAVIGNY, 1826)

Material examined: Nº. 26, 6 ex. Nº. 32, 2 ex. Nº 35, 8 ex. Nº 36, 3 ex. Nº. 37, 9 ex. Nº 38, 29 ex. Nº. 39, 13 ex.

Remarks. Distributed throughout the humid pine-forests on northern slopes containing *Erica–Myrica* relicts, mainly in neutral brown soils with organic material between 1.5 and 6.9%, it occupies third place in dominance in the Gran Canaria pine forests. It prefers high humidity levels.

Allolobophoridella eiseni (LEVISEN, 1884)

Material examined: Nº.1, 5 ex. Nº. 3, 3 ex.. Nº. 4, 1 ex. Nº. 6, 3 ex. Nº. 8, 4 ex. Nº. 9, 4 ex. Nº. 11, 1 ex. Nº. 13, 3 ex. Nº. 19, 3 ex. Nº. 21, 8 ex. Nº. 44, 1 ex.

Remarks. Very common in Tenerife pine-forests but rather rare in those of Gran Canaria, it tends to select habitats near springs in dry pine-forest mixed with leguminous shrubs, or otherwise small reservoirs and water-systems situated in moist pine-forests. It shows a noteworthy presence level and usually chooses soils richer in organic matter and calcium.

Aporrectodea rosea bimastoides (COGNETTI, 1901)

Nº. 3, 4 ex. Nº.7, 4 ex. Nº. 15, 1 ex. Nº. 18, 4ex. Nº.20, 3ex. Nº. 21, 3 ex. Nº.29, 5 ex. Nº. 32, 3 ex. Nº. 36, 1 ex. Nº. 40, 3 ex. Nº. 42, 3 ex. Nº. 43, 8 ex. Nº.44, 11 ex. Nº. 45, 8 ex.

Remarks. With a PP = 31%, this species is the least dominant of the genus. It is associated with the dry pine-forests on the southern and SW slopes of both these islands, found particularly around springs and reservoirs at the points of contact between pine-forest and spurge *(Euphorbia balsamifera)* shrublands. A new record for Gran Canaria, often found in slightly acidic soils with valuable potassium content (up to 4.6%), indicating insufficient rainfall and intense evaporation.

Aporrectodea trapezoides (DUGÈS, 1828)

Material examined: Nº.3, 9 ex. Nº. 5, 7 ex. Nº. 7, 2 ex. Nº. 9, 2 ex. Nº. 11, 5 ex. Nº. 12, 9 ex. Nº. 14, 13 ex. Nº.17, 16 ex. Nº. 18, 7 ex. Nº. 24, 2 ex. Nº. 26, 9 ex. Nº. 27, 6 ex. Nº. 28, 4 ex. Nº. 29, 6 ex. Nº. 30, 5 ex. Nº. 31, 2 ex. Nº. 33, 6 ex. Nº. 34, 3 ex. Nº. 35, 7 ex. Nº. 38, 2 ex. Nº. 39, 7 ex. Nº. 40, 1 ex. Nº. 41, 5 ex. Nº. 42, 2 ex. Nº. 43, 3 ex. Nº. 44, 10 ex. Nº. 45,10 ex.

Remarks. This is the dominant species in pine-forests in both Tenerife (new record) and Gran Canaria. It has a high ecological plasticity and tolerates edaphic variations well (see range in Table 2), both in biotopes exposed to extremely adverse climatic conditions and those highly altered by human settlement.

Dendrobaena cognettii MICHAELSEN, 1903

Material examined: Nº. 9, 3ex.

Remarks. It was found among pine-needle litter and *Myrica–Erica* remnants. This diminutive species seems associated with pine replantations in areas where *Myrica–Erica* is still present.

Dendrodrilus rubidus (SAVIGNY, 1826)

Material examined: Nº.1, 10 ex. Nº.3, 2 ex. Nº. 4, 4 ex. Nº. 9, 18 ex. Nº. 10, 11 ex. Nº. 13, 2 ex. Nº. 16, 2 ex.

Remarks. This species is common in the humus layer of soils characterised by high pine-litter levels, near drinking fountains, taps and leaking water pipes. Its presence is rather limited and it can be considered an averagely dominant species in Tenerife pine-forests (PI = 8.16 %). Its absence in Gran Canaria is striking.

Eisenia fetida (SAVIGNY, 1826)

Material examined: Nº.1, 1 ex. Nº. 10, 17 ex.

Remarks. An unrepresentative species in pine-forest, it does not constitute a stable population and is probably condemned to disappear, as accumulations of plant material and rubbish dumps are controlled or eliminated.

Eiseniella tetraedra (SAVIGNY, 1826)

Material examined: Nº. 6, 2 ex. Nº.14, 2 ex. Nº. 25, 1 ex. Nº.26, 14 ex. Nº. 31, 2 ex. Nº. 34, 4 ex. Nº. 35, 14 ex.

Remarks. A semiaquatic species present on dripping walls of taluses or in valleys with dispersed plantations of *P. canariensis*. Frequent in pine-forest soils with permanent moisture, it prefers the lowest calcium and potassium concentrations.

Lumbricus rubellus HOFFMEISTER, 1843

Material examined: Nº.4, 3 ex. Nº. 6, 1 ex. Nº. 22, 5 ex. Nº. 33, 3 ex. Nº. 34, 3 ex.

Remarks. A new record for Gran Canaria, it is distributed principally in pine-forests situated between 1200 and 1900 m, and also in their replantations overlapping with *Myrica-Erica* vestiges. These data, together with those obtained for laurel forest clearly include *L. rubellus* in the stable fauna of the autochthonous forests in the Canaries. It inhabits andosols and brown soils, rich in organic matter and average pH around 6.3.

Microscolex dubius (FLETCHER, 1887)

Material examined: Nº. 3, 2 ex. Nº. 13, 3 ex. Nº. 15, 7 ex. Nº. 16, 3 ex. Nº. 17, 2 ex. Nº. 19, 6 ex. Nº. 20, 12 ex. Nº. 21, 5 ex. Nº. 24, 7 ex. Nº. 25, 3 ex. Nº. 26, 2 ex. Nº. 28, 2 ex. Nº. 33, 1 ex. Nº. 34, 9 ex. Nº.38, 8 ex. Nº. 39, 7 ex. Nº. 41, 4 ex. Nº. 45, 19 ex.

Remarks. One of the most representative species of the dry pine-forest on southern slopes, it even colonizes high mountain areas with conifers (2150 m a.s.l.). A new record for Gran Canaria, it seems to choose soils with little organic matter, and tolerates calcium variations well. It is the second most dominant species in pine-forest.

Microscolex phosphoreus (DUGÈS, 1837)

Material examined: Nº. 3, 2 ex. Nº. 11, 1 ex. Nº. 39, 6 ex.

Remarks. Rather uncommon in pine-forest, it has a precarious distribution in humid pine-forests; its absence from southern slopes is striking. A new record for Gran Canaria, it seems to tolerate acidic or slightly alkaline soils in forest clearings.

Octodrilus complanatus (DUGÈS, 1828)

Material examined: Nº. 2, 2 ex. Nº. 3, 3 ex. Nº. 4, 7 ex. Nº. 9, 4 ex. Nº. 23, 5 ex. Nº. 32, 2 ex. Nº.34, 3 ex. Nº. 39, 1 ex.

Remarks. This large earthworm is relatively frequent in moist pine-forest in Tenerife, especially between 1100 and 1500 m. a.s.l., particularly where pine-forest coexists with *Myrica-Erica*. In Gran Canaria it has a more restricted distribution, colonizing only moist pine-forests below 1100 m. It prefers soils rich in Ca and organic matter (see Fig. 2).

Ocnerodrilus occidentalis EISEN, 1878

Material examined: Nº.33, 1 ex. Nº. 40, 2 ex.

Remarks. This aquatic species is new for Gran Canaria, where its presence in a water channel within the pine-forest is coincidental and recent.

DISCUSSION

The pine-forests of Tenerife and Gran Canaria may be considered as homogeneous in their fauna, being host to a significant number of epigeic species (*Allolobophoridella eiseni, Dendrobaena cognettii, Dendrodrilus rubidus, Eiseniella tetraedra, Lumbricus rubellus, Ocnerodrilus occidentalis*), which prefer soils with sparse pine-needle litter. The remaining species, except *Aporrectodea trapezoides* and *Octodrilus complanatus*, are endogeic (see Table 2) and seem also to avoid soils rich in this litter; in particular they live near the surface layers of the soil, mainly between two and five cm deep where there is organic matter. These ecological categories were assigned according to LEE (1985) and to a certain degree BRIONES *et al.* (1999). It was also noticed that the rapid decomposition of leaf litter in the more humid zones of *Pinus canariensis* forest favours the abundance and dominance of peregrine taxa like *Aporrectodea rosea bimastoides, A. trapezoides*, and *M. dubius*, while accumulation of litter in soil is a determining factor for the presence of epigeic species, which supports what LAVELLE (1983) pointed out.

Most of these species preferentially inhabit andosols and andic brown soils rich in mutable clays, with phonolites or basalts as materials of origin. From Table 2 it is seen that pine-forest soils present substantial calcium and potassium levels, pH between 5.8 and 7.3 and organic matter percentages between 1.3% and 18.5%. These factors seem to affect their populations unequally, since soils poorer in organic matter with greater acidity and substantial Ca and K levels nearly always yielded the lowest numbers of individuals and narrowest range of species. This is novel information for *Pinus canariensis* forests, since there are only two references in the bibliography (BOUCHÉ 1973, TALAVERA 1988). The first author reports only 2 species for pine-forest in Tenerife (*Aporrectodea caliginosa* subsp., *O. complanatus*) found in silty soils.

Analysis of the main components (Fig. 2) with the descriptive soil variables and the taxonomic presence-abundance reveals an interesting separation into differentiated groups of species. Worthy of note is that constituted by *Allolobophora chlorotica, Ap. rosea bimastoides, Ap. trapezoides* and *E. tetraedra*, which tends moderately towards lightly acid pH; another group includes *D. rubidus* and *O. complanatus*, whose association with high organic matter content is evident on the first axis of the independent variables. Nevertheless, the most significant relationship is seen between *A. eiseni*-calcium and between *M. dubius*-potassium content. In general, the association of soil variables with species abundance is rather weak, indeed, the percentage of total variance explained by the first two axes of the PCA (43.07%, Table 1) suggests that factors other than those studied could have some significant effect on the local distribution of each species (rainfall, sample-site orientation, environmental deterioration).

The southern slopes of the islands studied here are host to few species, among which *Ap. rosea bimastoides* and *M. dubius* tolerate the arid climatic conditions best. In contrast, the more humid northern pine-forests have a richer fauna composition with species that prefer shady zones and low K levels (*A. chlorotica, L. rubellus, O. complanatus*); it is assumed that these species along with *D. cognettii* colonized these pine-forests a long time ago and should be included in the indicator species of the autochthonous vegetation of the Canaries. With the present results it would be a difficult task to distinguish native from introduced earthworms, since both live indifferentiably in apparently virgin habitats and those showing heavy environmental disturbance. This agrees with the comments of ABBOTT (1985) and WOOD (1974) who point out that introduced species (e.g. *Ap. trapezoides, M. phosphoreus*) are commoner where the original vegetation has been replaced by farmed areas or human settlements. This environmental impact of human interference has reduced and fragmented the distribution area of the studied species, altering their original habitats

The presence of exotic species in Canary pine forests is very scarce and is due to fortuitous introductions connected to human activity, e.g. in Gran Canaria *Ocnerodrilus occidentalis* has been introduced in soil transported along with tropical plants, especially avocado and pineapple. It is one of the least dominant peregrine species, found in relatively neutral soils with little organic material (1.95%). Its situation there seems precarious in the island of Hierro where this species appeared only under the fallen pine needles of a residual forest of *Pinus radiata* (TALAVERA 1990); this unusual finding contrasts with that obtained in the coastal zone where it is amply distributed throughout tropical groves from Tenerife (TALAVERA 1992*b*).

Significant differences in fauna composition are to be seen between *Pinus canariensis* and other forests, for example with *Pinus pinaster* (MATO *et al.* 1989), *Pinus uncinata* (ALVAREZ 1977), and *Pinus coulteri* (WOOD et JAMES 1993), this latter having very scarce fauna. TERHIVUO and VALOVIRTA (1978) describe boreal forests in Finland dominated by *Pinus sylvestris*, reporting earthworms like *A. chlorotica, D. rubidus* and *L. rubellus;* such association coincides considerably with the common *Pinus canariensis* forest species, of which lumbricids make up 75%. LEE (1995) provides some results from Australia which confirm the remarkable presence of Lumbricidae found in coniferous forests. Striking faunistic affinities, such as the almost constant presence of *Ap. rosea* and *D. rubidus* in coniferous forest, were good indicators of this type of vegetation. FRAGOSO (1989) reports both species in pine – evergreen-oak woodlands in North America. MRSIC (1987) mentions them for *Piceetum* and *Pinetum mugbi* communities in Yugoslavia. MARTINUCCI and SALA (1979) include them in *Pinus sylvestris* biotopes in Italy, and also reports *E. tetraedra* and *L. rubellus*, which are another two species common in coniferous forest in the Canaries.

*

Acknowledgements – This work was supported by the Consejería Educación y Cultura, Gobierno de Canarias (Research project Nº 33/31 079)

REFERENCES

ABBOTT, I. (1985) Distribution of introduced earthworms in the northern jarrah forest of Western Australia. *Australian Journal of Soil Research* **23**: 263–70.

ALVAREZ, J. (1977) La distribución de las especies de oligoquetos terrícolas en la Jacetania. *Centro Pirenaico de Biologia Experimental* **9**: 121–124.

ARCO, M. J., PÉREZ, P. L. & WILDPRET, W. (1987) Contribución al conocimiento de los pinares de la Isla de Tenerife. *Lazaroa* **7**: 67–84.

BOUCHÉ, M. B. (1973) Observations sur les lombriciens. XI. Prospection de l´île de Tenerife: Lumbricidae et Acanthodrilidae. *Revue d´Ecologie et Biologie du Sol* **10**: 327–336.

BOUDOURESQUE, C. F. (1971) Méthodes d´etude qualitative et quantitative du benthos. *Tethys* (1) **3**: 79–104.

BRIONES, M. J. I., BOL, R., SLEEP, D. & SAMPEDRO, L. (1999) Isotopic ecology of earthworms under grassland and arable cropping systems. *Pedobiologia* **43**: 675–683.

COGNETTI, L. (1906) Contributo alla conoscenza della drilofauna delle isole Canarie. *Bollettino dei Musei di Zoologia ed Anatomia Comparata* (125) **21**: 1–4.

FRAGOSO, C. (1989) Las lombrices de tierra de la reserva "El Cielo": Aspectos ecológicos y sistemáticos. *Biotam* (1) **1:**38–44.

JACKSON, M. L. (1972) *Análisis Químicos de los suelos*. Ed. Omega. Barcelona, 662 pp.

KRAEPELIN, K. (1895) Zoologische Ergebnisse einer Frühjahrs-exkursion nach Madeira und den Canarischen Inseln. *Verhandlungen des naturwissenschaftlichen Vereins Hamburg* **2**: 6–18.

LAVELLE, P. (1983) The structure of earthworms communities. Pp. 449–466. *In* SATCHELL, J. E. (ed.) *Earthworms ecology: From Darwin to vermiculture*. Chapman and Hall, London.

LEE, K. E. (1995) Earthworms and sustainable land use. Pp. 215–234. *In* HENDRIX, P.F. (ed.): *Earthworm ecology and biogeography in North America.* Lewis Publishers, London.

MARTINUCCI, G. B. & SALA G. (1979) Lumbricids and soil types in prealpine and alpine woods. *Bollettino di Zoologia* **46**: 279–297.

MATO, S., TRIGO, D. & DIAZ COSIN, D. J. (1989) Influencia del material de partida del suelo y de los tipos de vegetación sobre las lombrices de tierra. *Anales de Edafología y Agrobiología* **48**: 39–48.

MRSIC, N. (1987) Present state of research on the earthworm fauna (Lumbricidae) of Yugoslavia. Pp. 329–344. BONVICINI PAGLIAI, A. M. & OMODEO, P. (eds): *On earthworms*. Selected Symposia and Monograps U.Z.I., Mucchi, Modena.

TALAVERA, J. A. (1988) Lumbrícidos de las Islas Canarias II. Géneros Octodrilus y Octolasion. *Miscellània Zoològica* **12**: 57–62.

TALAVERA, J. A. (1990) Considerations about Ocnerodrilus occidentalis (Oligochaeta: Ocnerodrilidade) in the Canary Islands). *Bonner zoologische Beiträge*.(1) **41**: 81–87

TALAVERA, J. A. (1991) Lumbrícidos de las Islas Canarias. III. Género Lumbricus Linnaeus, 1758 (Annelida, Oligochaeta). *Boletin de la Real Sociedad Española de Historia Natural* (1–4) **87**: 45–52.

TALAVERA, J. A. (1992*a*) Lumbrícidos de las Islas Canarias IV. Género Eisenia. *Folia Canariensis Academiae Scientiarum* (3–4) **4**: 49–63.

TALAVERA, J. A. (1992*b*) Earthworms of the banana groves from Tenerife (Canary Islands). *Soil Biology Biochemistry* (12) **24**:1369–1375.

TERHIVUO, J. & VALOVIRTA, I. (1978) Habitat spectra of the Lumbricidae (Oligochaeta) in Finland. *Annales Zoologici Fennici* **15**: 202–209.

WOOD, T. G. (1974) The distribution of earthwoms (Megascolecidae) in relation to soils, vegetation and altitude on the slopes of Mt. Kosciusko Australia. *Journal of Animal Ecology* **43**: 87–106.

WOOD, H. B. &, JAMES, S. W. (1993) Native and introduced eartworms from selected chaparral, woodland, and riparian zones in Southern California. *USDA Forest Service General Technical Report PSW-GTR* **142**: 1–20.

ZICSI, A. (1969) Regenwürmer (Lumbricidae) aus Madeira und von den Kanarischen Inseln. *Acta Zoologica Academiae Scientiarum Hungaricae (*1–2) **15**: 243–246.

Revised version received February 23, 2006, accepted January 12, 2007, published May 31, 2007

APPENDIX 1

Collecting sites by municipal district (in bold), with their respective coordinates Universal Transverse Mercator (UTM) and altitude (m asl).

Tenerife

El Rosario: Nº 1, Las Raíces 28RCS6544, 950 m. Nº 2, Montaña Grande 28RCS6445, 1200 m. Nº 3, Las Lagunetas 28RCS6143, 1500 m. **La Orotava**: Nº 4, La Caldera 28RCS5237, 1200 m. Nº 5, Fuente Corchos 28RCS4434, 1800 m. Nº 6, Montaña de Joco 28RCS5638, 1900 m. Nº 7, Los Cañitos 28RCS4827, 2050 m. **Guancha-Icod**: Nº 8, Lomo Rosado 28RCS3836, 1000 m. Nº 9, El Lagar 28RCS3936, 1100 m. Nº 10, Hoya Palomera 28RCS3837, 900 m. Nº 11, Fuente Pedro 28RCS4336, 1500 m. Nº 12, Lomo Alto 28RCS3531, 1700 m. **Isora-Granadilla**: Nº 13, Lomo Topo Negro 28RCS4016, 1600 m. Nº 14, Pinar de Tágara 28RCS3122, 1700 m. Nº 15, Pino del Guirre 28RCS4616, 1150 m. Nº 16, Vilaflor 28RCS3915, 1420 m. **Arico**: Nº 17, Fuente Hediondo 28RCS4422, 2150 m. Nº 18, Fuente Traviesa 28RCS4820, 1300 m. Nº 19, Fuente las Mesas 28RCS4433, 1850 m. **Güimar-Arafo**: Nº 20, Lomo las Lajas 28RCS5834, 1000 m. Nº 21, Las Morras 28RCS5836, 1200 m. Nº 22, Choza La Loca 28RCS5840, 1560 m. Nº 23, Chivisaya 28RCS6039, 1100 m.

Gran Canaria

Tejeda: Nº 24, Pinar Pajonales 28RDR3589, 1000 m. Nº 25, Presa las Niñas 28RDR3489, 1000 m. Nº 26, Cruz de Tejeda 28RDR4197, 1500 m. Nº 27, Barranco de Lima 28RDR3092, 1000 m. **San Mateo**: Nº 28, Los Pechos 28RDR4198, 1700 m. Nº 29, Camino las Nieves 28RDR4294, 1680 m. Nº 30, Monte las Mesas 28RDR4295, 1600 m. Nº 31, Llanos de la Pez 28RDR4394, 1700 m. **Artenara-Valleseco**: Nº 32, Barranco la Hoya, 28RDS2900, 1100 m. Nº 33, Brezos 28RDR3699, 1200 m. Nº 34, Las Montañetas 28RDS4200, 1100 m. Nº 35, Llano Constantino 28RDR4199, 1500 m. **Moya-Guía**: Nº 36, Lomo del Pino 28RDS3806, 950 m. Nº 37, Barranco del Agua 28RDS3901, 1300 m. Nº 38, Fontanales 28RDS4003, 1100 m. **Agaete-La Aldea**: Nº 39, Pinar de Tamadaba 28RDS3203, 1100 m. Nº 40, Andenes Tasarte 28RDR3691, 1200 m. Nº 41, Casas de Tamadaba 28RDS3202, 1300 m. **Mogán-Valsequillo**: Nº 42, Barranco Mulato 28RDR3289, 950 m. Nº 43, Barranco del Medio 28RDR2889, 900 m. Nº 44, Presa Cuevas Blancas 28RDR4693, 1650 m. Nº 45, Roque Grande 28RDR4893, 1200 m.