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# Parasitic helminths of the wild rabbit, *Oryctolagus cuniculus*, in different bioclimatic zones in Tenerife, Canary Islands

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## Abstract

Faunistic and ecological analyses of the wild rabbit helminth fauna were undertaken in Tenerife island (Canary Islands). Rabbits were collected between 1998 and 2000 in seven bioclimatic zones in Tenerife selected by orientation and altitude. Five parasite species were identified, three cestodes (*Taenia pisiformis* (larvae), *Andrya cuniculi* and *Mosgovoyia ctenoides*) and two nematodes (*Trichostrongylus retortaeformis* and *Passalurus ambiguus*). *Taenia pisiformis* presented an irregular distribution with significant differences in prevalences between the zones. *Andrya cuniculi* was only found in two zones and there were no significant differences in prevalence values. *Mosgovoyia ctenoides* presented a wide distribution with significant prevalences, which were higher in northern compared to southern zones. *Trichostrongylus retortaeformis* was absent in the low southern zones of the island. *Passalurus ambiguus* was found in all zones with no significant difference in the prevalence of infection. The differences in prevalences are likely to be explained by abiotic factors in the case of *T. retortaeformis*, and by the absence of definitive and intermediate hosts in the case of *T. pisiformis* and *A. cuniculi*, respectively. All parasite species in Tenerife are common helminths in the Iberian Peninsula, from which their rabbit hosts originated. No significant differences were recorded in the mean intensities of infection of any of the parasite species identified.

## Introduction

The Canary Islands have been a focus for studies of the colonization and the diversification of different organisms. The guanches, aboriginal of the Canary Islands, were conquered by the Spanish Empire in the 15th century and because of that event, the introduced fauna in different Canary Islands exhibit marked European influences mostly from the Iberian Peninsula (Juan *et al.*, 2000). The wild rabbit (*Oryctolagus cuniculus*) was introduced at different colonization times in the islands from Iberia. Parasitic helminths of some terrestrial vertebrates in the Canaries have been reported (Cordero del Campillo *et al.*, 1994) but the only available data on helminths of wild rabbit are reported by Foronda *et al.* (2000). The present study describes the helminth parasites of wild *O. cuniculus* in Tenerife island (Canary archipelago) in different

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bioclimatic zones and the role of humans in introducing rabbit helminths in Tenerife is discussed.

## Materials and methods

The Canary archipelago is located between 13°23′ to 18° 8′ W and 27°37′ to 29°24′ N in the Macaronesia with the islands of Madeira, Azores, Savages and Cape Verde. Tenerife is the largest island of the archipelago (2.034 km$^2$) with the Teide volcano (3.718 m). The weather is strongly influenced by the humid trade winds from the northeast which, in combination with the altitude of the volcanoes and the drier northwest winds blowing at higher levels, produce an inversion zone and marked vegetation belts. For the present study, rabbits were captured between 1998 and 2000 in seven bioclimatic zones in Tenerife related to the aspect and altitude (Las Cañadas del Teide, high and northern, low and northern, high and southeastern, low and southeastern, high and southwestern, and low and southwestern) (fig. 1, table 1).

The abdominal cavity was opened and the contents removed. The liver, mesenteries, pelvic area and body cavity were examined for the presence of parasites. The stomach contents were examined dry (without saline solution) in a large glass Petri dish. The small and large intestines were initially examined directly in sections and their contents sieved through a 100 mesh (125 $\mu$m) sieve. The total number of cestodes and nematodes were counted for each rabbit, and stored in 70% ethanol. Cestodes were stained in Semmichon acetocarmine, dehydrated in alcohol, cleared in xylol and mounted in Canada balsam. Nematodes were cleared in lactophenol. Helminths were identified according to Skrjabin *et al.* (1954), Verster (1969), Beveridge (1978), Tenora *et al.* (1981/82), Tenora & Murai, 1978 and Hugot *et al.* (1983).

Statistical $\chi^2$ and ANOVA tests were used to determine differences in the prevalences and mean intensities of helminth species between climatic zones (Bush *et al.*, 1997). Helminth counts were log transformed to normalize the distribution.

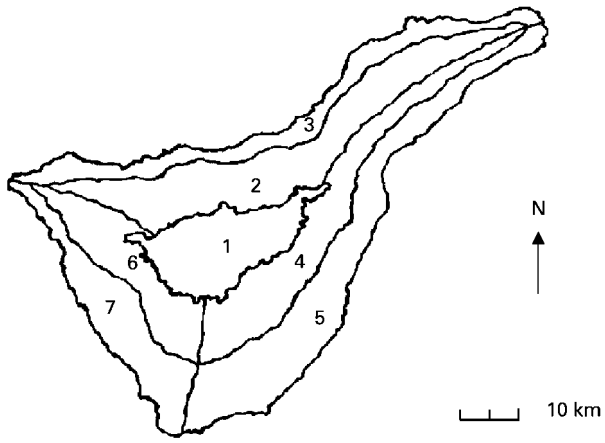


Fig. 1. Localization of the biogeographical zones considered in Tenerife island. 1, Las Cañadas del Teide; 2, high northern; 3, low northern; 4, high south-eastern; 5, low south-eastern; 6, high south-western; 7, low south-western.

## Results

Five helminths species were identified: three species of cestodes, *Taenia pisiformis* (Bloch, 1780) larvae (Taeniidae), *Mosgovoyia ctenoides* (Railliet, 1890) and *Andrya cuniculi* (Blanchard, 1891) (Anoplocephalidae) and two nematode species, *Trichostrongylus retortaeformis* (Zeder, 1800) (Trichostrongylidae) and *Passalurus ambiguus* (Rudolphi, 1819) (Oxyuridae). Values for the prevalence, mean intensity and range of helminth species in the different areas of Tenerife are given in table 2.

The cysticercus of *T. pisiformis* was found in 15% of the rabbits and showed an irregular distribution in the island. This species was absent in Las Cañadas and showed significant differences in prevalences in the southeast from the north ($\chi^2 = 3.9$; $P < 0.05$) and the southwest ($\chi^2 = 4.24$; $P < 0.05$). In the southwestern zones, the prevalence in the high zone was significantly lower than in the low zone ($\chi^2 = 3.99$; $P < 0.05$). *Mosgovoyia ctenoides* is a widely distributed species in Tenerife with a prevalence between 15% and 100%. In the southwestern zone the prevalence of *M. ctenoides* was significantly higher (58%) than in the northern zones (23%) ($\chi^2 = 4.01$; $P < 0.05$). *Andrya cuniculi* was only found in two zones in the island with no significant differences in the prevalence and intensity of infection. *Trichostrongylus retortaeformis* occurred in all zones except the low southern zones of the island. The highest prevalence of *T. retortaeformis* was found in the northern zones and Las Cañadas but there was no significant difference between these sites. The only significant differences in prevalences were found between the high southeasthern zone (10%) compared with the northern zones (61%) ($\chi^2 = 14.6$; $P < 0.05$) and Las Cañadas ($\chi^2 = 20.91$; $P < 0.05$). *Passalurus ambiguus* was found to have similar prevalences in all zones. The results of the ANOVA tests indicated that there were no significant differences in the mean intensities of any of the species in all zones considered.

## Discussion

Rabbits in Tenerife have fewer species of parasites than rabbits found in the Iberian Peninsula from where the wild rabbit stocks of the Canary Islands originated. Sixteen helminth species have been reported in the Iberian wild rabbit (Cordero del Campillo *et al.*, 1994; Blasco *et al.*, 1996; Molina *et al.*, 1998, 1999) and this appears to be the richest helminth fauna found in this host in Europe (Blasco *et al.*, 1996). Only a small number of these species were introduced in Tenerife despite the similarities in the flora and fauna of several island zones within the Mediterranean region (Juan *et al.*, 2000). Helminths parasitizing *O. cuniculus* in Iberia and absent in Tenerife are the digenean *Dicrocoelium dendriticum* (Rudolphi, 1819) Loss, 1899, the anoplocephalid *Cittotaenia denticulata* (Rudolphi, 1804) and the nematodes *Trichuris leporis* (Froelich, 1789) (Trichuridae), *Graphidium strigosum* (Dujardin, 1845) (Trichostrongylidae), *Nematodiroides zembrae* (Bernard, 1965) (Molineidae) and *Dermatoxys hispaniensis* (Simon Vicente, 1969) (Heteroxynematidae). Blasco *et al.* (1996) in a comparative study of two rabbit populations in Spain, found several

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Table 1. Data on altitude and climate in the different climatic regions of Tenerife.

| Region | Altitude (m) | Relative humidity (%) | Mean annual rainfall (mm) | Mean temperature (°C) |
|---|---|---|---|---|
| Las Cañadas del Teide | 2000–2500 | <100 | 504 | 9 |
| High northern | 330–1630 | 400–800 | 786 | 14 |
| Low northern | 0–330 | 200–400 | 354 | 19 |
| High south-eastern | 540–1470 | 400–600 | 298 | 17 |
| Low south-eastern | 0–540 | <300 | 180 | 18 |
| High south-western | 570–1630 | 200–600 | 419 | 15 |
| Low south-western | 0–570 | <400 | 118 | 20 |

qualitative and quantitative differences between the helminth communities of a northern population of *O. cuniculus cuniculus* and a sourthern population of *O. cuniculus algirus*. The southern wild rabbit (*O. c. algirus*) is richer in helminth species than *O. c. cuniculus* due to the presence in southern Spain of three anoplocephalid species (*Leporidotaenia* spp.) not found in *O. c. cuniculus* (Blasco *et al.*, 1996). These anoplocephalid cestodes (*Leporidotaenia wimerosa* (Moniez, 1880), *L. pseudowimerosa* (Tenora *et al.*, 1981–82) and *L. cf. wimerosa* (Moniez, 1880)) are common species parasitizing wild rabbit (*O. c. algirus*) in central and south Iberia (Cordero del Campillo *et al.*, 1994; Blasco *et al.*, 1996) while *L. wimerosa* occasionally occurs in a northern population of *O. c. cuniculus* (Molina *et al.*, 1998). No data are available on the genetical identification of the wild rabbit subspecies present in Tenerife. Repeated introductions of the wild rabbit into the Canary Islands were made from different zones of Iberia where two genetically differentiated lineages (according to restriction data on whole mitochondrial DNA (mtDNA)) are present. The A lineage predominates in the southern and southwestern areas (Andalusia, southern Portugal) while the B lineage is predominant in the northern part of the Peninsula (Biju-Duval *et al.*, 1991; Monnerot *et al.*, 1994; Hardy *et al.*, 1995). The A lineage was tentatively associated with *O. c. algirus* and the B+ lineage with *O. c. cuniculus*, as well as the corresponding nuclear gene pools (Branco *et al.*, 2000). Moreover, it is also possible that several introductions have been made with domestic animals. The absence in Tenerife of several peninsular species found in the wild rabbit could also be due to the absence of the intermediate hosts in Tenerife. Data on life cycles of anoplocephalid cestodes parasitizing Iberian *O. cuniculus* are available for

Table 2. The prevalences (P%) and mean intensity (MI) of infection and range (in parentheses) of five helminth species in *Oryctolagus cuniculus* in the different bioclimatic zones in Tenerife.

| Region | *Taenia pisiformis* P(%) MI ± SD (range) | *Andrya cuniculi* P(%) MI ± SD (range) | *Mosgovoyia ctenoides* P(%) MI ± SD (range) | *Trichostrongylus retortaeformis* P(%) MI ± SD (range) | *Passalurus ambiguus* P(%) MI ± SD (range) |
|---|---|---|---|---|---|
| Las Cañadas del Teide | 0 | 31 | 15 | 61 | 38 |
| n = 13 | – | 3.2 ± 0.6 (1–8) | 1 ± 0 (1) | 46.1 ± 21.4 (2–180) | 554.8 ± 1123.4 (2–2560) |
| High northern | 11 | 18 | 23 | 68 | 52 |
| n = 44 | 24.0 ± 44.0 (1–90) | 3.7 ± 5.4 (1–17) | 1.2 ± 0.4 (1–2) | 79.5 ± 124.6 (1–500) | 650.9 ± 977.7 (2–3620) |
| Low northern | 50 | 0 | 25 | 75 | 75 |
| n = 4 | 6.5 ± 0.7 (6–7) | – | 1 ± 0 (1) | 66.0 ± 56.6 (26–106) | 300.0 ± 210 (3–300) |
| High south-eastern | 29 | 0 | 29 | 43 | 57 |
| n = 7 | 12.5 ± 16.3 (1–24) | – | 1.5 ± 0.7 (1–2) | 12.0 ± 8.5 (3–20) | 1475.0 ± 1528.1 (200–2750) |
| Low south-eastern | 8 | 0 | 29 | 0 | 42 |
| n = 24 | 13.5 ± 16.3 (2–25) | – | 1.2 ± 0.4 (1–2) | – | 603.1 ± 934.4 (1–2260) |
| High south western | 50 | 0 | 50 | 30 | 30 |
| n = 10 | 3.0 ± 3.1 (1–8) | – | 1.7 ± 0.6 (1–2) | 57.5 ± 21.9 (42–73) | 1350 ± 950.3 (6–1350) |
| Low south western | 0* | 0* | 100* | 0* | 50* |
| n = 2 | – | – | 1.3 ± 0.6 (1–2) | – | 2 ± 0 (2) |
| General | 15 | 12 | 28 | 45 | 47 |
| n = 104 | 11 ± 22.4 (1–90) | 3.5 ± 4.6 (1–17) | 1.2 ± 0.4 (1–2) | 67 ± 104.8 (1–500) | 660 ± 925.8 (1–3620) |

n, Number of hosts studied.
*Data are not representative due to the low 'n'.

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*M. ctenoides* and *C. denticulata* (Rudolphi, 1804). Both species use the same oribatid mites as intermediate hosts (Denegri, 1991, 1993). At present, it is not possible to explain the presence in Tenerife of *M. ctenoides* and the absence of *C. denticulata*, as these two species are overdispersed in Iberia parasitizing the A and B lineages of *O. cuniculus* (Blasco *et al.*, 1996; Molina *et al.*, 1998). No data are available on the life cycle of *Leporidotaenia* spp. and the absence of this cestode from Tenerife is difficult to explain because the A Iberian rabbit lineage is likely to be present in the island.

The five helminth species detected in the Tenerife wild rabbit are common species found in different surveys of this host in Europe. The presence of the larval stage of *T. pisiformis* depends on the presence of the definitive carnivore hosts, mostly Canoidea. In continental Europe, foxes (*Vulpes vulpes*) are the most common definitive hosts of *T. pisiformis* but dogs and cats are also infected in Iberia (Cordero del Campillo *et al.*, 1994). No other mammal carnivores other than dogs (*Canis familiaris)* and cats (*Felis catus*) live in the Canaries and dogs have been reported as definitive hosts of *T. pisiformis* in Tenerife (Valladares *et al.*, 1985). There are significant differences in the presence of *T. pisiformis* in the wild rabbit in the different zones considered. The low prevalence of adult *T. pisiformis* and the irregular distribution of this species in Tenerife was explained by the use of dogs for hunting in rural zones where *T. pisiformis* is found (Valladares *et al.*, 1985). In the Iberian Peninsula, the distribution of *T. pisiformis* is also irregular. Blasco *et al.* (1996) found significant differences in the prevalence of *T. pisiformis* between the northern and southern populations of Iberian *O. cuniculus* and Molina *et al.* (1998) had not detected this larval cestode in a study of *O. c. cuniculus* in Navarra (north of Spain).

*Mosgovoyia ctenoides* is the most prevalent cestode species detected in the general helminth fauna in Tenerife. This anoplocephalid is a frequent species in continental Europe parasitizing *O. cuniculus* but *M. ctenoides* is absent from the British Isles where *Mosgovoyia pectinata* (Goeze, 1782) is the most common species reported (Boag & Iason, 1986; Boag, 1988; Boag & Fowler, 1988; Butler, 1994; Allan *et al.*, 1999). In the Iberian Peninsula both species are present in Leporidae (*O. cuniculus* and *Lepus* spp.) but *M. ctenoides* parasitizes *O. cuniculus* and *M. pectinata* is only found in hares (*L. europaeus* and *L. granatensis*) (Cordero del Campillo *et al.*, 1994). No lagomorph species other than the rabbit lives in the Canaries and so the absence of *M. pectinata* in these islands is not surprising. *Andrya cuniculi* was found in Tenerife but at a lower prevalence than *M. ctenoides*. Data on *A. cuniculi* in Iberia (Blasco *et al.*, 1996; Molina *et al.*, 1998) reveals a similar pattern of irregular distribution. *Andrya cuniculi* was only found in Tenerife in the high altitude zones. A possible explanation could be the distribution of the intermediate hosts of *A. cuniculi*, although the life cycle is unknown.

The nematode species *T. retortaeformis* and *P. ambiguus* are two of the more frequent parasite species in Palearctic leporids (Blasco *et al.*, 1996). *Trichostrongylus retortaeformis* is a geohelminth species and its presence is conditioned by bioclimatic factors (Prasad, 1959) and also by host immune mechanisms (Michel, 1952, 1953). The absence of *T. retortaeformis* in the low southern zones could be due to the temperature and humidity effects. The low southern zones are differentiated from the other zones in Tenerife by having the most hot and dry climate during the year, and this could explain the absence of *T. retortaeformis* in southern Tenerife. The significant differences observed between the high southwestern and northern zones and Las Cañadas could be due to the high temperate with low humidity (similar to that in the high southeastern zone) contrasting with levels of rainfall in the northern zones. *Passalurus ambiguus* is an ageohelminth species with direct transmission and is influenced less by abiotic factors (Kharichkova, 1946) but, nevertheless, host age or acquired resistance influences levels of infection (Allan *et al.*, 1999). In the present study, host age is unknown and hence precise conclusions cannot be drawn.

In the Macaronesian islands the only studies on the helminth parasites of *O. cuniculus* were undertaken in the islands of Terceira and Flores in the Azores archipelago (Casanova *et al.*, 1996), the island of Madeira (Blasco *et al.*, 1996) and the island of Tenerife (Foronda *et al.*, 2000). Casanova *et al.* (1996) reported five helminth species, all of which, except *Nematodirus* sp., were found in the present study. One unique species of nematode, *Dermatoxys hispaniensis*, was cited in Madeira (Blasco *et al.*, 1996) and the helminth fauna reported by Foronda *et al.* (2000) in Tenerife was similar to that in the present study except for the absence of *T. pisiformis*. The fauna and flora of the Canary Islands are related to that in the Azores which has affinities with the Mediterranean region. In the Azores, as in the Canary Islands, the rabbit was introduced at different times by the Portuguese and Spanish after the first half of the 15th century. The helminth fauna of *O. cuniculus* in the Azores and Canary Islands is similar to that recorded in other studies on insular helminths in this host in Zembra island (north Africa) (Bernard, 1965) and also to that reported by Boag (1987) in the Isle of Coll, UK.

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## References

**Allan, J.C., Craig, P.S., Sherington, M.T., Rogan, M.T., Storey, D.M., Heath, S. & Iball, K.** (1999) Helminth parasites of the wild rabbit *Oryctolagus cuniculus* near Malham Tarn, Yorkshire, UK. *Journal of Helminthology* **73**, 289–294.

**Bernard, J.** (1965) Contribution à la connaissance de la faune parasitaire de lìle de Zembra. I. Parasites du lapin, *Oryctolagus cuniculus* L. *Archives de l'Institut Pasteur de Tunis* **42**, 205–223.

**Beveridge, I.** (1978) A taxonomic revision of the genera *Cittotaenia* Riehm, 1881, *Ctenotaenia* Railliet, 1893, *Mosgovoyia* Spassky, 1951 and *Pseudocittotaenia* Tenora, 1976 (Cestoda: Anoplocephalidae). *Mémoires du Muséum d'Histoire Naturelle, série A, Zoologie* **107**, 64.

**Biju-Duval, C., Ennafaa, H., Dennebouy, N., Monnerot, M., Mingotte, F., Soriguer, R., El Gaied, A., El Hili, A. & Mounolou, J.C.** (1991) Mitochondrial DNA evolution in lagomorphs: origin of systematic heteroplasmy, organization of diversity in European rabbits. *Journal of Molecular Evolution* **33**, 92–102.

**Blasco, S., Torres, J., Feliu, C., Casanova, J.C., Miquel, J. & Moreno, S.** (1996) The helminth fauna of *Oryctolagus cuniculus* (Linnaeus, 1758) in the Iberian Peninsula. Faunistic and ecological considerations. *Parasite* **4**, 327–333.

**Boag, B.** (1987) The helminths parasites of the wild rabbit *Oryctolagus cuniculus* and the brown hare *Lepus capensis* from the Isle of Coll, Scotland. *Journal of Zoology* **2126**, 352–355.

**Boag, B.** (1988) Observations of the seasonal incidence of myxomatosis and its interactions with helminth parasites in the European rabbit (*Oryctolagus cuniculus*). *Journal of Wildlife Diseases* **24**, 450–455.

**Boag, B. & Fowler, P.A.** (1988) The prevalence of helminth parasites from the hedgehog *Erinaceus europaeus* in Great Britain. *Journal of Zoology* **215**, 379–382.

**Boag, B. & Iason, G.** (1986) The occurrence and abundance of helminth parasites of the mountain hare *Lepus timidus* (L.) and the wild rabbit *Oryctolagus cuniculus* (L.) in Aberdeenshire, Scotland. *Journal of Helminthology* **60**, 92–98.

**Branco, M., Ferrand, N. & Monnerot, M.** (2000) Phylogeography of the European rabbit (*Oryctolagus cuniculus*) in the Iberian Peninsula inferred from RFLP analysis of the cytochrome *b* gene. *Heredity* **85**, 307–317.

**Bush, A.O., Lafferty, K.D., Lotz, J.M. & Shostak, A.W.** (1997) Parasitology meets ecology on its own terms: Margolis *et al.* revisited. *Journal of Parasitology* **83**, 575–583.

**Butler, F.T.** (1994) Arthropod and helminth parasites from rabbits *Oryctolagus cuniculus* in south-west Ireland. *Irish Naturalists Journal* **24**, 292–295.

**Casanova, J.C., Miquel, J., Fons, R., Molina, X., Feliu, C., Mathias, M.L., Torres, J., Libois, R., Santos-Reis, M., Collares-Pereira, M. & Marchand, B.** (1996) On the helminth fauna of wild mammals (Rodentia, Insectivora and Lagomorpha) in Azores Archipelago (Portugal). *Vie et Milieu* **46**, 253–259.

**Cordero del Campillo, M., Castañón, L. & Reguera, A.** (1994) *Índice-catálogo de Zooparásitos Ibéricos*. 650 pp. 2nd edn. Secretariado de Publicaciones, Universidad de León, Spain.

**Denegri, G.M.** (1991) *Definition of Scientific Research Programme in Parasitology: about the biology of tapeworms in the Anoplocephalidae family.* Thesis in Philosophy of Science, Department of Philosophy, La Plata University, 1–64.

**Denegri, G.M.** (1993) Review of oribatid mites as intermediate hosts of tapeworms of the Anoplocephalidae. *Experimental and Applied Acarology* **17**, 567–580.

**Foronda, P., Del Castillo, A., Piñero, J. & Casanova, J.C.** (2000) Helminths and virus infections of wild rabbit in Tenerife (Canary archipel). *Acta Parasitologica* **45**, 176.

**Hardy, C., Callou, C., Vigne, J.D., Casane, D., Dennebouy, N., Mounolou, J.C. & Monnerot, M.** (1995) Rabbit mitochondrial DNA diversity from prehistoric to modern times. *Journal of Molecular Evolution* **40**, 227–237.

**Hugot, J.P., Bain, O. & Cassone, J.** (1983) Sur le genere *Passalurus* (Oxyuridae: Nematoda) parasite de Leporidés. *Systematic Parasitology* **25**, 1065–1075.

**Juan, C., Emerson, B.C., Oromí, P. & Hewitt, G.M.** (2000) Colonization and diversification: towards a phylogeographic synthesis for the Canary Islands. *Tree* **15**, 104–109.

**Kharichkova, M.V.** (1946) A study of the biology of *Passalurus ambiguus* (Rud., 1819). Collected Papers in Helminthology dedicated to K.I. Skrjabin in his 40th year of scientific education administration. *Archiev*, 274–279.

**Michel, J.F.** (1952) Self cure infections of *Trichostrongylus retortaeformis* and its causation. *Nature* **169**, 881.

**Michel, J.F.** (1953) Phenomenon of protection in infections of *Trichostrongylus retortaeformis*. *Nature* **173**, 312.

**Molina, X., Casanova, J.C., Feliu, C. & Castién, E.** (1998) Studies of wild rabbit (*Oryctolagus cuniculus*) populations in Navarra (Spain). III. Qualitative and quantitative composition of the rabbit parasitic helminthofauna. *Gibier Faune Sauvage Game Wildlife* **15**, 123–133.

**Molina, X., Casanova, J.C. & Feliu, C.** (1999) Influence of host weight, sex and reproductive status on helminth parasites of the wild rabbit, *Oryctolagus cuniculus*, in Navarra, Spain. *Journal of Helminthology* **73**, 221–225.

**Monnerot, M., Casane, D., Hardy, C. & Vigne, J.D.** (1994) Evolution of *Oryctolagus*: relationships within the Lagomorpha system and access to population history by ancient DNA. *Polish Ecological Studies* **20**, 543–551.

**Prasad, D.** (1959) The effect of temperature and humidity on the free-living stages of *Trichostrongylus retortaeformis*. *Canadian Journal of Zoology* **37**, 305–316.

**Skrjabin, K.I., Shikhobalova, N.P. & Schluz, R.S.** (1954) Trichostrongylids of animals and man. *In* Skrjabin, K.I. (*Ed.*) *Essentials of nematodology,* Vol. III, 704 pp. Israel Program for Scientific Translations, Jerusalem.

**Tenora, F. & Murai, E.** (1978) Anoplocephalidae (Cestoda) parasites of Leporidae and Sciuridae in Europe. *Acta Zoologica Academiae Scientiarum Hungaricae* **24**, 415–429.

**Tenora, F., Murai, E., Valero, A. & Cutillas, C.** (1981/82) *Anoplocephaloides pseudowimerosa* sp. n. and other Anoplocephalidae (Cestoda) parasites of *Oryctolagus cuniculus* (Leporidae) in Spain. *Parasitologia Hungarica* **14**, 73–77.

**Valladares, B., Gijón, H. & López-Román, R.** (1985) Estudio epidemiológico del parasitismo intestinal del perro (*Canis familiaris*), en la isla de Tenerife. *Revista Ibérica de Parasitología* **45**, 41–48.

**Verster, A.** (1969) A taxonomic revision of the genus *Taenia* Linneaus, 1758 s. str. *Onderstepoort Journal of Veterinary Research* **36**, 3–58.

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