Endoparasites (helminths and coccidians) in the hedgehogs *Atelerix algirus* and *Paraechinus aethiopicus* from Algeria

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The study of endoparasites (helminths and coccidians) in the Algerian (*Atelerix algirus*) and desert (*Paraechinus aethiopicus*) hedgehogs was performed between July 2008 and October 2009. The helminth species found included two cestodes, *Mathevotaenia erinacei* (Anoplocephalidae) and an unidentified cestode larva in the mesentery, eight species of nematodes: *Aonchotheca erinacei* (Trichuridae) in the intestine, spirurids (Spiruridae) in the intestine, *Crenosoma striatum* (Crenosomatidae) in the lungs, *Gongylonema mucronatum* (Gongylonematidae) in the oesophagus, *Physaloptera clausa* (Physalopteridae) in the stomach, *Physaloptera* sp. larvae (Physalopteridae) in the mesentery, *Pterygodermatites plagiostoma* (Rictulariidae) in the stomach, *Spirura rytipleurites seurati* (Spiruridae) in the intestine; and two acanthocephalans, *Moniliformis moniliformis* (Moniliformidae) in the intestine and larvae of an unknown acanthocephalan species in the mesentery. The general prevalence was high in both hosts, 92% in *Atelerix algirus* and 94.12% in *Paraechinus aethiopicus*. *Physaloptera clausa* was the most prevalent species (64.0% in *Atelerix algirus* and 64.7% in *Paraechinus aethiopicus*). Polyparasitism of helminths was 68% in *Atelerix algirus* and 52.9% in *Paraechinus aethiopicus*. Two coccidian species were detected in both hedgehogs, *Isospora* sp. and *Eimeria* sp. We provide the first complete parasitological data from Africa for these two hedgehogs.

Key words: helminths, coccidians, *Atelerix algirus, Paraechinus aethiopicus,* Algeria.

INTRODUCTION

Two hedgehogs inhabit Algeria, *Atelerix algirus* (Lereboullet, 1842) and *Paraechinus aethiopicus* (Ehrenberg, 1833). The natural range of the Algerian hedgehog, *A. algirus*, encompasses North Africa, but this species has also been introduced by humans into several island groups such as Malta, the Balearic Islands and the Canary Islands, as well as the Mediterranean coastal strip of peninsular Spain (Mitchell-Jones *et al.* 1999; Alcover 2002; Aulagnier *et al.* 2008). On the other hand, the desert hedgehog, *P. aethiopicus*, occurs in the south of the Atlas Mountains from Morocco southward to Mauritania and then eastwards through Algeria, Tunisia, Libya, Sudan and northern Ethiopia as far as Somalia (Corbet 1978; Aulagnier & Thévenot 1986; Corbet 1988). These two species of hedgehogs coexist on the high plains of Algeria (Kowalski & Rzebik-Kowalska 1991).

Few faunistic or ecological studies of the helminths or coccidians in erinaceids exist, the exception being the European genus *Erinaceus.* To date, studies of helminths have mainly focused on the western hedgehog, *Erinaceus europaeus* Linnaeus, 1758, throughout its distribution in Spain (Feliu *et al.* 2001), Italy (Poglayen *et al.* 2003), Germany (Laux 1987) and Britain (Gaglio *et al.* 2010). In addition, the helminths of the conspecific *Erinaceus concolor* Martin, 1838 have recently been studied by Cirak *et al.* (2010) in Turkey. The only two complete helminthological studies of African hedgehogs are of *Atelerix albiventris* (Wagner, 1841) in Nigeria (Okaeme & Osakwe 1988) and Kenya (Gregory 1981). Previous helminthological data regarding the two hedgehog species discussed in

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the present study are limited to the work by Esteban *et al.* (1987) on *A. algirus* from a population introduced into the Balearic Islands; no data exist for the helminth parasites of *P. aethiopicus.* Despite the fact that much data on the coccidian of European hedgehogs exist (Reeve 1994), no information is currently available for these two African hedgehogs (see the review by Duszynski *et al.* 1999).

The aims of the present study were to provide the first descriptive data of the helminth fauna of a native population of *Atelerix algirus,* as well as the first helminthological data on *Paraechinus aethiopicus.* In addition, we present data regarding the coccidians of both species.

MATERIALS & METHODS

The study of the helminth and coccidian parasites of both hedgehogs was conducted during the period July 2008 – October 2009. Fieldwork was conducted at several sampling sites in three main areas: Hodna (M'sila) (35°40′00″N, 4°31′00″E), Bordj-Bou-Arreridj (36°04′30″N, 4°46′30″E) and Algiers Beni-Messous (36°46′57″N, 2°58′29″E) (Fig. 1). Twenty-five individuals of *Atelerix algirus* (9 males, 15 females and 1 of unknown sex) and 17 individuals of *Paraechinus aethiopicus* (5 males, 10 females and 2 of unknown sex) were caught by hand at night (achievable due to these species' nocturnal activity) or retrieved as fresh road-kills. All hosts were identified to species level using morphological criteria (Aulagnier & Thévenot 1986; Reeve 1994; Aulagnier *et al.* 2008). In the laboratory, each animal was weighed, measured and sexed. The dissection and preservation of the viscera in ethanol 70% was performed in the Ecology Laboratory of the University of M'sila in Algeria. The material was then transported to Barcelona University's Parasitology Laboratory, where the full helminthological process (dissection, identification, etc.) was performed. Nematodes and acanthocephalans were studied using Amman lactophenol wet mounts in depression slides. Cestodes were stained with chlorhydric carmine, dehydrated and permanently mounted in Canada balsam.

Fresh individual faecal samples were preserved in vials with 2.5% (w/v) potassium dichromate ($K_2Cr_2O_7$) in the field and were subsequently analysed in Barcelona University's Parasitology Laboratory. For coccidian detection all samples were examined under microscopes after flotation using a $ZnSO_4$ solution (s.g. 1.28).

RESULTS

The analysis of the hedgehog hosts enabled us to recover 1695 helminths, with a mean of 52.9 worms per host in *Atelerix algirus* and 21.8 in *Paraechinus aethiopicus.*

Helminth species included two cestodes: *Mathevotaenia erinacei* Meggen, 1920 (Anoplocephalinae) and unidentified cestode larvae found in the mesentery; eight nematodes: *Aonchotheca erinacei* Rudolphi, 1819 (Trichuridae), *Spirura rytipleurites seurati* Chabaud, 1954 (Spiruridae) and unidentified spirurids in the intestine, *Crenosoma striatum* (Zeder, 1800) (Crenosomatidae) in the lungs, *Gongylonema mucronatum* Seurat, 1916 (Gongylonematidae) in the oesophagus, unidentified *Physaloptera* sp. larvae in the mesentery, *Physaloptera clausa* (Rudolphi, 1819) (Physalopteridae) and *Pterygodermatites plagiostoma* Wedl, 1861 (Rictulariidae) in the stomach; and two acanthocephalans, *Moniliformis moniliformis* (Bremser, 1811) (Moniliformidae) in the intestine and unidentified acanthocephalan larvae in the mesentery. Data on prevalences, mean abundance, S.D. (standard deviation), mean intensity and range for all the helminth species found in both hedgehogs are given in Table 1.

The general prevalence was high in both hosts: 92.0% in *Atelerix algirus* and 94.1% in *Paraechinus aethiopicus,* with *Physaloptera clausa* the most prevalent helminth in both species (64.0% in *Atelerix algirus* and 64.7% in *Paraechinus aethiopicus*).

In both species the dominant group of helminths was nematodes, and *Gongylonema mucronatum, Physaloptera clausa, Physaloptera* sp. larvae and *Pterygodermatites plagiostoma* were found in both species. In addition, *Atelerix algirus* also hosted *Aonchotheca erinacei, Crenosoma striatum* and *Spirura rytipleurites,* while *Paraechinus aethiopicus* hosted the undetermined Spirurida; other than *Pterygodermatites plagiostoma,* the prevalence of these nematodes was low in both species (35.29% in *Atelerix vs* 4% in *Paraechinus*). *Atelerix algirus* was parasitized by two species of cestodes (*Cestoda* sp. larvae and *Mathevotaenia erinacei*), while *Paraechinus aethiopicus* was not parasitized by any cestode. The same species of acanthocephalans were recorded in both hosts (*Acanthocephala* sp. larvae and *Moniliformis moniliformis*), with similar prevalences, but in low abundances. For the *Acanthocephala* sp., the prevalence of *Moniliformis moniliformis* was the third highest for both species of hedgehogs, with 32% and 29.41% for *Atelerix algirus* and *Paraechinus aethiopicus,* respectively.

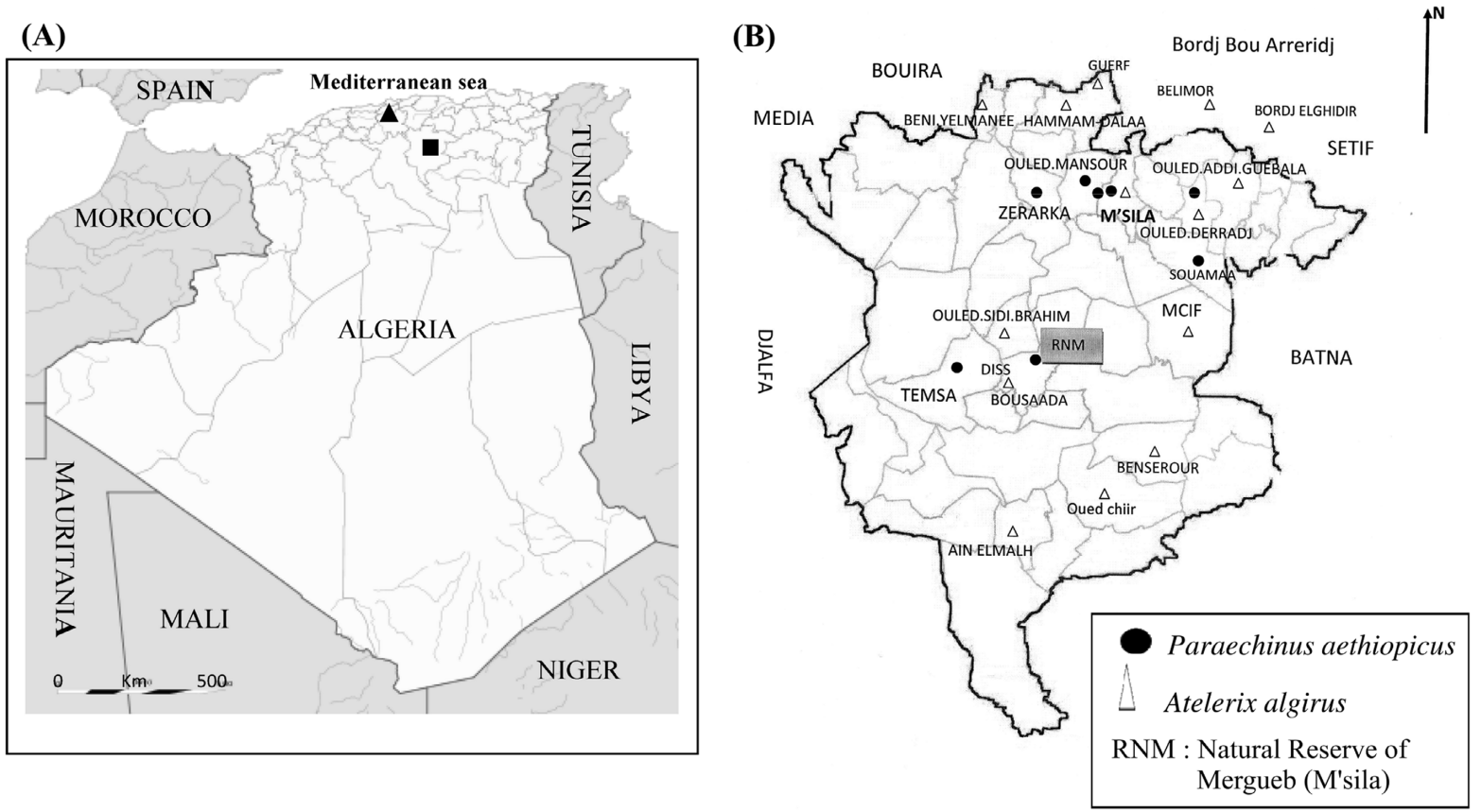

Fig. 1. **A**, Map showing the study area of endoparasites of hedgehogs in Algeria: (▲) Beni-Messous (coccidian study site), (■) M'sila and Bordj-Bouarreridj (helminth study site). **B**, Details of sampling sites for hedgehogs in the helminthological study.

Table 1. Prevalences of helminths detected in hedgehogs in Algeria.

Helminth species	*Atelerix algirus* (*n* = 25)					*Paraechinus athiopicus* (*n* = 17)				
	Prevalence (%)	Mean abundance	S.D.	Mean intensity	Range	Prevalence (%)	Mean abundance	S.D.	Mean intensity	Range
Cestoda										
Mathevotaenia erinacei	8.00	2.60	12.39	32.5	3–62	0	0	0	0	0
Cestoda sp. larvae	4.00	8.20	41	205	205–205	0	0	0	0	0
Nematoda										
Aonchotheca erinacei	4.00	3.00	15	75.00	75–75	0	0	0	0	0
Spiruridae gen. sp.	0	0.00	0	0	0	5.88	0.29	1.21	5.00	5–5
Crenosoma striatum	4.00	0.28	1.40	7	7–7	0	0	0	0	0
Gongylonema mucronatum	36.00	1.56	2.53	4.33	3–10	17.65	0.9	2.55	5.00	1–10
Physaloptera clausa	64.00	5.32	15.46	8.31	1–77	64.71	8.1	13.74	12.45	1–52
Physaloptera sp. larvae	36.00	10.60	26.54	29.44	1–101	11.76	6.82	22.34	58.00	26–90
Pterygodermatites plagiostoma	4.00	0.20	1.02	5.00	5–5	35.29	4.35	9.66	12.33	2–37
Spirura rytipleurites	24.00	3.76	10.00	15.67	1–39	0	0.0	0	0	0
Acanthocephala										
Acanthocephala sp. larvae	20	8.4	28.28	42	2–102	17.65	0.82	2.32	4.67	1–9
Moniliformis moniliformis	32.00	9.04	28.55	28.25	1–89	29.41	0.6	1.28	2.00	1–5

In terms of abundance, the larval stages of *Physaloptera* were most abundant (10.6%) in *Atelerix algirus*, while *Physaloptera clausa* was the most abundant (8.1%) in *Paraechinus aethiopicus*. The highest intensity (75 specimens) was of *Aonchotheca erinacei* in *Atelerix algirus* and *Physaloptera* sp. larvae (58) in *Paraechinus aethiopicus*.

Polyparasitism (Fig. 2) is frequent in both hosts (68% in *Atelerix algirus* and 52.9% in *Paraechinus aethiopicus*). In *Atelerix algirus* the nematode *Physaloptera clausa* was the most common species in the associations (76.47%), followed by *Moniliformis moniliformis* and *Physaloptera* sp. larvae (47.06%). The most common associations were of three helminths (41.18%). Acanthocephalans were always found associated with other helminth species. In *Paraechinus aethiopicus*, *Physaloptera clausa* was also the most common species in helminth associations (77.78%), followed by *Pterygodermatites plagiostoma* and *Moniliformis moniliformis* (55.56%). The most common associations (22.2%) were of two species. Acanthocephalans were found associated with other helminth species in 55.56% of cases.

Two coccidian species were detected: *Isospora* sp. (5.5% in *Atelerix algirus* and 4.5% in *Paraechinus aethiopicus*) and *Eimeria* sp. (16.7% in *Atelerix algirus* and 9.1% in *Paraechinus aethiopicus*). At present no data exists regarding coccidian parasitization of these erinaceid species. Our material is too limited to perform an accurate study of these coccidian species and more, well-preserved material is needed to clarify whether or not they are new to science.

DISCUSSION

We provide here the first helminthological data on two African hedgehog species, specifically *Atelerix algirus* and *Paraechinus aethiopicus* from Algeria. Helminth species richness (n = 13) in *Atelerix algirus* is higher than that reported by Esteban *et al.* (1987), who studied hedgehogs in the Balearic Islands and reported eight species of helminths in 87 Algerian hedgehogs. Despite the fact that our study used a smaller sample (n = 25), species richness was higher (13 *vs* 8). This lack of richness in the Balearic Islands could be explained by its anthropogenic origin, as previous studies of helminths in introduced populations have also revealed lower species richness (reviewed by Torchin *et al.* 2003). For example, in small mammals, Lopez-Darias *et al.* (2008) reported only half the number of helminth species

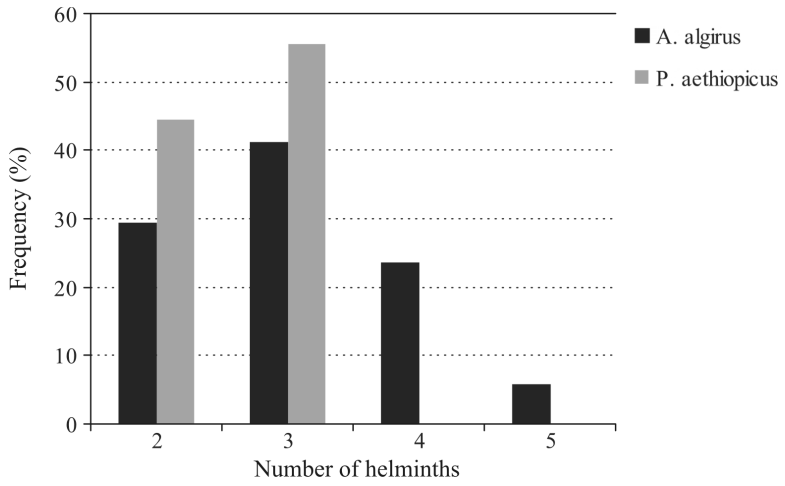

Fig. 2. The frequency (%) of parasitized hedgehogs harbouring two or more helminths.

in the Barbary ground squirrel (*Atlantoxerus getulus* Linnaeus, 1758) in the introduced population on the island of Fuerteventura compared to its native population in Morocco. No previous data regarding the helminth richness of *Paraechinus aethiopicus* is available for comparison. The single previous complete study of helminths in an African hedgehog was performed on *Atelerix albiventris* and reported nine helminth species (Okaeme & Osakwe 1988). The studies of Kaikabo *et al.* (2006, 2007) on *Atelerix albiventris* are not comparable since they were focused on parasitism shared with cattle.

The dominant helminth in both hedgehogs was *Physaloptera clausa* (64.0% in *Atelerix algirus* and 64.7% in *Paraechinus aethiopicus*), an heteroxenous parasite that requires insects as intermediate hosts (Anderson 1992). A high prevalence of 93.18% for *Physaloptera dispar* was reported by Esteban *et al.* (1987) in *Atelerix algirus* on Formentera (Balearic Islands). Okaeme & Osakwe (1988) also found *Physaloptera dispar* to be the most prevalent nematode (24%) in *Atelerix albiventris* from Nigeria, while in the study of Gregory (1981) this species was also the most prevalent nematode (77%) in Kenya. Cirak *et al.* (2010) reported *Physaloptera clausa* as the dominant species (72.2%) in *Erinaceus concolor* from Turkey. *Physaloptera clausa* were reported in *Erinaceus europaeus* by Poglayen *et al.* (2003) from Sardinia with a low prevalence of 3%, but was absent from Sicily and the Emilia Romagna region; in peninsular Spain this species has been reported at an even lower prevalence of 0.8% (Feliu *et al.* 2001). These divergences could be explained by dietary habits related to the proportion of insects ingested, which are probably eaten more often in drier habitats in Algeria and the Balearic Islands than on the Iberian Peninsula or in Italy.

The lungworm *Crenosoma striatum* can produce respiratory dry coughing, breathing difficulties and weight loss (Reeve 1994) and often co-occurs with the bacterial infection by *Bordetella bronchiseptica* (Gregory 1985; Keymer et *al.* 1991). In European hedgehogs it is often associated with tracheitis, catarrhal rhinitis and may lead to bronchopneumonia (Saupe & Poduschka 1985). In the United Kingdom Majeed *et al.* (1989) found 56.6% of *Erinaceus europaeus* harboured this nematode. Likewise, Feliu *et al.* (2001) reported that 62.4% of *Erinaceus europaeus* in the Iberian Peninsula were hosts to *Crenosoma striatum.* Poglayen *et al.* (2003) detected a 47% prevalence of this lungworm in Sardinia, 77% in Sicily and 73.5% in the Emilia Romagna region (peninsular Italy). On the Balearic Islands, it has been detected on Mallorca and Menorca, but not on Cabrera, Ibiza or Formentera (prevalences are not reported). High prevalences were found in Turkey (55.5%) and in Britain (71%) by Gaglio *et al.* (2010). In the present study, prevalences were lower (4% in *Atelerix algirus* and none in *Paraechinus aethiopicus*). This result could be related to the scarcity of intermediate hosts (molluscs) in semi-desert areas such as our study area and is supported by the fact that the helminths found in the present study have an indirect life cycle and use insects and snails as intermediate hosts.

The finding of *Moniliformis moniliformis* is of human health interest, as this species can cause

disease (acanthocephaliasis) in humans (Goldsmith *et al.* 1974; Ikeh *et al.* 1992; Anosike *et al.* 2000).

Other studies have also occasionally reported that hedgehogs are infected by coccidian species. The best studied species is *Erinaceus europaeus,* in which several coccidian species have been recorded from a number of different areas (*Eimeria ostertagi* Yakimoff & Gousseff, 1936, *Eimeria perardi* Yakimoff & Gousseff, 1936, *Isospora erinacei* Yakimoff & Gousseff, 1936, *Isospora schmaltzi* Yakimoff & Gousseff, 1936 and *Isospora rastegaievae* Yakimoff & Matikaschwili, 1933) (see the revision by Duszynski *et al.* 1999 and Beck 2007). *Eimeria auritus* Mirza, 1970 was described from Iraq in *Hemiechinus auritus* (Gmelin, 1770) (see Mirza 1975), while Abdel-Wasae & El Garhy (2009) described *Eimeria yeminii* Abdel-Wasae & El Garhy, 2009 from the same hedgehog species in Yemen. Therefore, the finding of oocysts of unidentified *Eimeria* and *Isospora* species in hedgehogs surveyed in Algeria represents the first information regarding the presence of coccidian parasites in both *Atelerix algirus* and *Paraechinus aethiopicus.* However, a more complete study of the coccidian species found in hedgehogs from Algeria should be performed in the future in order to clarify whether they represent new species or are just new hosts for recognised species.

Future studies are also required on the parasites of other African species of hedgehogs that to date have not been not properly surveyed or studied.

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REFERENCES

ABDEL-WASAE, B.M. & EL GARHY, M. 2009. Incidence and prevalence of *Eimeria* infection among the hedgehog, *Hemiechinus auritus* in Yemen. *Journal of the Egyptian Society of Parasitology* **39**: 723–729.

ALCOVER, J.A. 2002. *Atelerix algirus* Lereboullet, 1842. In: *Atlas de los Mamiferos terrestres de España*, (eds) L.J. Palomo & I.J. Gisbert, pp. 58–61. Dirección General de Conservación de la Naturaleza-SECEM-SECUM, Madrid.

ANDERSON, R.C. 1992. Nematodes Parasites of Vertebrates. Their Development and Transmission. 2nd Edición. pp. 347–350. Editorial CAB International. Wallingford, Oxon OX10 8DE, U.K.

ANOSIKE, J.C., NJOKU, A.J., NWOKE, B.E.B., OKORO, O.U., OKERE, A.N., UKAGA, C.N. & ADIMONYE R.N. 2000. Human infections with *Moniliformis moniliformis* (Bremser 1811) Travassos 1915 in south-eastern Nigeria. *Annals of Tropical Medicine and Parasitology* **94**: 837–838.

AULAGNIER, S., HAFFNER, P., MITCHELL-JONES, A.J., MOUTOU, F. & ZIMA, J. 2008. *Guide des mammifères d'Europe, d'Afrique du Nord et du Moyen-Orient.* Delachaux et Niestlé S.A., Paris.

AULAGNIER, S. & THEVENOT, M. 1986. Catalogue des mammiféres sauvages du Maroc. *Travaux de L'Institut Scientifique, Série Zoologie,* n° 41, Rabat, Morocco.

BECK, W. 2007. Endoparasiten beim Igel. *Wiener Klinische Wochenschrift* **119**: 40–44.

CIRAK, V., SENLIK, B., AYDOGDU, A., SELVER, M. & AKYOL, V. 2010. Helminth parasites found in hedgehogs (*Erinaceus concolor*) from Turkey. *Preventive Veterinary Medicine* **97**: 64–66.

CORBET, G.B. 1978. *The Mammals of the Palaearctic Region: A Taxonomic Review.* British Museum (Natural History), London, U.K.

CORBET, G.B. 1988. The family Erinaceidae: a synthesis of its taxonomy, phylogeny, ecology and zoogeography. *Mammal Review* **18**: 117–172.

DUSZYNSKI, D.W., UPTON, S.J. & COUCH, L. 1999. Coccidia of the World. Online at: www.biology.unm.edu/biology/coccidia/insectiv.html

ESTEBAN, J.G., GALAN-PUCHADES, M.T., BARGUES, M.D., VALERO, M.A. & MAS-COMA, S. 1987. Sobre la helmintofauna del erizo moruno, *Erinaceus (Aethechinus) algirus* (Lereboullet, 1842) (Insectivore: Erinaceidae), en el Archipélago Balear (Islas Gimnésicas y Pitiusas). In: *Mammíferos y Helmintos,* (eds) V. Sans-Coma, S. Mas-Coma & J. Gosábez, pp. 163–166. Ketres, Barcelona.

FELIU, C., BLASCO, S., TORRES, J., MIQUEL, J. & CASANOVA, J.C. 2001. On the helminthfauna of *Erinaceus europaeus* Linnaeus 1758 (Insectivora, Erinaceidae) in the Iberian Peninsula. *Revista Ibérica de Parasitologia* **61**: 31–37.

GAGLIO, G., ALLEN, S., BOWDEN, L., BRYANT, M. & MORGAN, E.R. 2010. Parasites of European hedgehogs (*Erinaceus europaeus*) in Britain: epidemiological study and coprological test evaluation. *European Journal of Wildlife Research* **56**: 839–844.

GOLDSMITH, J.M., SMITH, M.E. & FLEMING, F. 1974. Human infection with *Moniliformis* sp. in Rhodesia. *Annals of Tropical Medicine and Parasitology* **68**: 363–364.

GREGORY, M.V. 1981. Diseases and parasites of the Central African hedgehog *Erinaceus albiventris* Wagner. *Zoologische Beiträge* **27**: 205–213.

GREGORY, M.V. 1985. Hedgehogs. In: *B.S.A.V.A. Manual of Exotic Pets,* (eds) J. Cooper, M.F. Hutchinson, O.F. Jackson & R.J. Maurice, pp. 54–58. British Small Animal Veterinary Association, Cheltenham.

IKEH, E.I., ANOSIKE, J.C. & OKON, E. 1992. Acanthocephalan infection in man in northern Nigeria. *Journal of Helminthology* **66**: 241–242.

KAIKABO, A.A., KALSHINGI, H.A., SADDIQ, M.D., MUAZU, A., GASHUA, I.B. & SULEIMAN, A.B. 2007. Detection of helminth parasites of ruminants in hedgehog *Atelerix albiventris. Nigerian Journal of Parasitology* **28**: 129–130.

KAIKABO, A., MUSTAPHA, A., ALI, M. & YARORO, I. 2006. Observations on the helminth parasites of West African nocturnal hedgehog (*Atelerix albiventris*) in

the semi-arid northern Nigeria. *Animal Production Research Advances* **2**: 172–174.

KOWALSKI, K. & RZEBIK-KOWALSKA, B. 1991. *Mammals of Algeria.* Ossolineum Publishing House, Wroclaw, Poland.

LAUX, A. 1987. Extent and intensity of endoparasitic infection in the hedgehog. *Angewandte Parasitologie* **28**: 137–141.

LÓPEZ-DARIAS, M., RIBAS, A. & FELIU, C. 2008. Helminth parasites in native and invasive mammal populations: comparative study on the Barbary ground squirrel *Atlantoxerus getulus* L. (Rodentia, Sciuridae) in Morocco and the Canary Islands. *Acta Parasitologica* **53**: 296–301.

MAJEED, S.K., MORRIS, P.A. & COOPER J.E. 1989. Occurrence of the lungworms *Capillaria* and *Crenosoma* spp. in British hedgehogs (*Erinaceus europaeus*). *Journal of Comparative Pathology* **100**: 27–36.

MIRZA, M.Y. 1975. Three new species of coccidia (Sporozoa: Eimeriidae). *Bulletin of the Natural History Research Center, University of Baghdad* **6**: 1–13.

MITCHELL-JONES, A.J., AMORI, G., BOGDANOWICZ, W., KRYŠTUFEK, B., REIJNDERS, P.J.H., SPITZENBERGER, F., STUBBE, M., THISSEN, J.B.M., VOHRALÍK, V. & ZIMA, J. 1999. *Atlas of European Mammals.* Academic Press, London.

OKAEME, A.N. & OSAKWE, M.E. 1988. Gastrointestinal helminths and food of the African hedgehog *Atelerix albiventris* (Wagna) in Kainji Lake area of Nigeria. *African Journal of Ecology* **26**: 239–241.

POGLAYEN, G., GIANNETTO, S., BRIANTI, E., SCALA, A., GARIPPA, G., CAPELLI, G., SCARAVELLI, D. & REVEE, N.J. 2003. Helminths found in hedgehogs (*Erinaceus europaeus*) in three areas of Italy. *Veterinary Record* **152**: 22–24.

RIBAS, A. & CASANOVA, J.C. 2006. Acanthocephalans. In: *Micromammals and Macroparasites: From Evolutionary Ecology to Management,* (eds) S. Morand, B.R. Krasnov & R. Poulin, pp. 81–87. Springer-Verlag, Tokyo.

REEVE, N. 1994. *Hedgehogs.* T. & A.D. Poyser Natural History, London.

SAUPE, E. & PODUSCHKA ,W. 1985. Igel. In: Krankheiten der Heimtiere, K. Gabrisch and P. Zwart (eds), pp. 75–96. Schlutersche, Hanover.

TORCHIN, M. E., LAFFERTY, K.D., DOBSON, A.P., McKENZIE, V.J. & KURIS, A.M. 2003. Introduced species and their missing parasites. *Nature* **421**: 628–630.

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