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Gastro-intestinal helminth parasites of the common North African gerbil *Meriones shawi* (Duvernoy) in Tunisia: Parasites diversity and habitat anthropization effect

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Abstract. This study presents the first data on helminth fauna of Shaw's jird population from Tunisia. Ten helminth taxa were recovered from the digestive tract and the body cavity of 85 Shaw's jird *Meriones shawi* captured from two localities with different levels of anthropization in Tunisia. Among the helminth species recovered, only three have high prevalences and intensities, namely: *Meggittina aegyptica*, *Gongylonema neoplasticum* and *Raillietina* sp.. Helminth species richness from Mezzouna (less anthropized place) seems to be higher compare to Skhira (highly anthropized place). The nematode *Trichuris gerbilli* is more prevalent in Skhira ($\chi2=10.5$, $p=0.0012$) and the cestodes *Meggittina numida* and *M. aegyptica* are more common in Mezzouna ($\chi2=9.6$, $p=0.0019$; $\chi2=22.01$, $p<0.0001$, respectively). This may be related to the high level of human activities which repulse wild animals, habitat fragmentation through the creation of agricultural parcels and their associated pollution by pesticides that kills insects which are intermediate hosts of helminths and discharges from the phosphate industry observed in Skhira. We add also a check-list of helminths species recorded from *M. Shawi* in all its distribution area.

INTRODUCTION

Helminths are attracting increasing interest as potential indicators of environmental quality and they can be used as bio-indicators for anthropogenic pollution (Sures, 2004; Thomas *et al.*, 2005; Chaisiri *et al.*, 2010). In addition, some helminths are considered as regulators acting on the population dynamics of rodents by reducing the abundance of their hosts (Scott & Dobson, 1989; Hudson *et al.*, 2006). Also, the distribution of parasites with indirect life cycles (such as many helminths) is dependent on the distribution of all hosts in the environment. Any modification of host distribution and habitat will affect parasites diversity (Morand & Guégan, 2008).

For a better understanding of bio-diversity and ecosystem functioning in arid environment, it's important to investigate the parasite diversity and particularly the helminth fauna of rodents because it could be linked to rodent's food habit (i.e. the presence of some helminths with complex life cycles is related to ingestion of the intermediate hosts) (Behnke *et al.*, 2000). The subfamily of Gerbillinae Gray is a rodent clade well adapted to arid climate conditions (Carleton & Musser, 1984).

Some works have investigated the helminths of Gerbillinae in Tunisia and mainly focused on taxonomic purposes. (Bernard, 1963, 1969, 1987; Quentin, 1973, 1978; Jrijer & Neifar, 2014; Jrijer *et al.*, 2015).

Moreover, previous studies interested in parasites of Gerbillinae mainly focused on zoonotic microparasites (rabies & leishmaniasis) (Ghawar *et al.*, 2011; Toumi *et al.* 2012).

Shaw's jird is present in all North African Mediterranean (arid environments) and is considered to be the most common Gerbillinae among the 27 species of rodents in Tunisia (Bernard & Ben Rachid, 1969; Gharaibeh, 1997). Moreover, *M. shawi* is known as a pest of crops that causes considerable damage with many cultures, in particular with corn and barley (Adamou-Djerbaoui *et al.*, 2011). Despite this ubiquity, untiringly, no helminth surveys are available for *M. shawi* in Tunisia. The only surveys available on helminths of Shaw's jird was done by Joyeux & Foley (1930) in their study on helminths of *M. shawi* from Algeria.

Human activities such as industrial pollution, use land for agriculture or use of pesticide, may alter host-parasites relationship by reducing host abundances, densities or diversity but also abiotic factors. Any reduction in densities, abundances (or disparition) in the definitive or intermediate hosts could lead to a decrease in parasite richness in ecosystems (Bush and Reed, 2013). The aim of our study was then to update the parasitological knowledge by carrying out an original survey of helminth diversity in Shaw's jird. The effect of anthropization on parasites diversity and ecosystem functioning is discussed in the light of helminth species richness of *M. shawi* from two anthropized zones.

MATERIALS

Study was conducted during four sampling campaigns between April 2011 and March 2013. Sampling was conducted in two different sites located in central Tunisia (Figure 1). Skhira: (34°21' 00 N, 10°10' 41. E), an area in the coast of Gulf of Gabes, is characterized by industrial phosphate activities surrounded by large lands used for pasture and rain fed agriculture and several

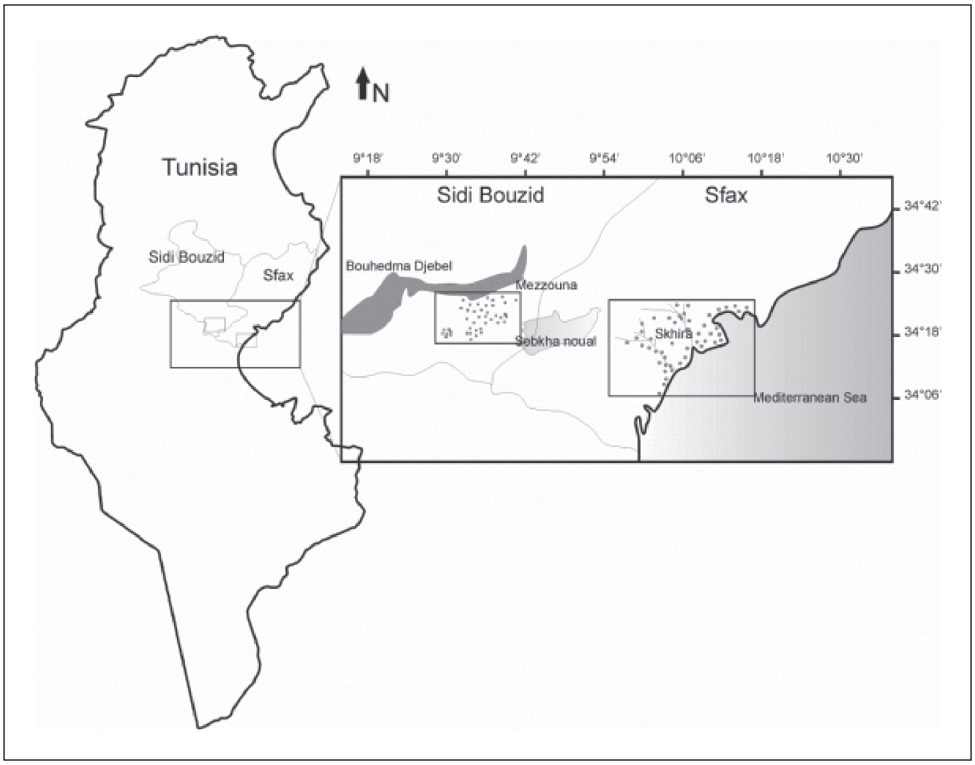

Figure 1. Trapping Locations of Shaw's jird from Tunisia.

wadis that constitute a refuge for many animals. Mezzouna: (34°30' 19 N, 9°43' 47. E), the second studied area, is located sixty kilometres to the west of the coast and characterized by protected steppic area with dominance of gum tree *Acacia tortilis* and wild vegetation despite the proximity of extensive agricultural fields.

Rodents were captured alive in traps placed selectively near burrows showing signs of recent activities and generally under tufts of Chenopodiaceae. Fifty traps were set out and inspected after 24 hours during three days each campaign, each locality. Individuals trapped were brought to laboratory, sacrified, identified using taxonomic keys (Wilson & Reeder, 2005; Aulagnier *et al.*, 2009), sexed, weighed and measured. All this data are used to differentiate *M. Shawi* from *M. Libycus* and *M. crassus* that occur in the same area. The body cavity, liver and gastrointestinal tract (stomach, small intestine, cecum and colon) were investigated for helminths. Nematoda and Acanthocephala collected were fixed in warm alcohol. They were cleared in glycerine and temporary mounted between slide and cover slip. Cestoda collected were fixed in Holland Bouin fixative. They were then stained with semichon's acetic carmine, dehydrated in a graded series of alcohol solutions, cleared in clove oil and mounted in Canada balsam. Identification of helminths are based on Keys to the Cestode Parasites of Vertebrates (Khalil *et al.*, 1994) and CIH Keys to the Nematode Parasites of Vertebrates (Anderson *et al.*, 1974–1983).

Prevalence and mean intensity of infection were calculated as defined by Bush *et al.* (1997). Chi square tests ($\alpha = 0.05$ throughout) was calculated to determine significant differences between the two sites in terms of prevalence of infections.

RESULTS

Ten helminth species were recovered from 85 individuals of *Meriones shawi* trapped in the two localities: 47 in Skhira and 38 in Mazzouna. The helminth community of *M. shawi* from Mazzouna is richer (nine helminth species) compared to Skhira (five helminth species). Overall prevalences of helminth infection in *M. shawi* from the two sites were 66% in Skhira and 74% in Mazzouna (Table 1).

Among the Nematodes, *Gongylonema neoplasticum* (Fibiger et Detlevsen, 1914) was the most prevalent, found in the stomach of 27.5% of *M. shawi* collected (32% in Skhira and 23,7% in Mazzouna) (Table 2). The difference was not significant between the two sites (Table 2). The pinworm *Syphacia obvelata* Yamaguti, 1941 and the whipworm *Trichuris gerbilli* Bernard, 1969 were both found in the cecum of *M. shawi* with different prevalences according to the sites. *Trichuris gerbilli* was more common in Skhira ($\chi2=10.5$, $p=0.0012$). *Acanthochelonema viteae* (Chabaud, 1952) found in 8 % of hosts trapped in Mezzouna and the less prevalent nematode was for *Nippostrongilus* sp. with only 2,1 %.

Four Cestoda species were identified; *Raillietina* sp. was the most prevalent. This cestode species infects 54.2% of individuals trapped (Table 2). Shaw's Jird also harboured two cestoda of the genus *Meggittina* Lynsdale, 1953 (Cyclophyllidea, Catenotaeniidae). *Meggittina aegyptica* (Wolfgang, 1956) was found in the small intestine of individuals trapped in the both sites with prevalence of 2.1 % in Skhira and 29% in Mazzouna. *Meggittina numida* Jrijer & Neifar, 2014 was recorded in 18,4 % of individuals of *M. shawi* from Mazzouna. *Meggittina numida* and *M. aegyptica* were more common in Mezzouna ($\chi2=9.6$, $p=0.0019$; $\chi2=22.01$, $p<0.0001$, respectively).

Moniliformis moniliformis (Bremser, 1811) is the only acanthocephalan parasite found in the intestine with a prevalence of 8% in individuals from Mazzouna (Table 2).

Table 1. Overall prevalence of helminths parasitic *Meriones shawi* from two sites in Tunisia

Sites	Skhira	Mezzouna	Total
Habitat	Anthropized	Wild	
Host collected	47	38	85
Host infected	35	25	60
Prevalence	66%	74%	70%

Table 2. Prevalence and Intensity of helminths parasitic *Meriones shawi* from Tunisia

Helminths species	Organ	Skhira %			Mezzouna %			Chi square tests	P
		Host infected	Intensity	Prevalence	Host infected	Intensity	Prevalence		
Nematode									
Gongylonema.neoplasticum	Stomach	15	2,58	32	9	2,7	23.7	1.2225	0.2689
Syphacia obvelata	caecum		–	–	2	1	5,2	–	–
Trichuris gerbilli	caecum	10	2,12	21,2		–	–	10.5	0.0012*
Nippostrongilus sp.	intestine	1	92	2.1		–	–	0.0348	0.8521
Acanthochelonema viteae	general cavity		–	–	3	1	8	2.2781	0.1312
Cestode									
Raillietina celebensis	intestine		–	–	1	2	2.6	–	–
Meggittina numida	intestine		–	–	7	10	18,4	9.6	0.0019*
Raillietina sp.	intestine	26	37,38	55.3	20	22	52,6	0.0406	0.8402
Meggittina aegyptiaca	intestine	1	15	2.1	11	24,2	29	22.01	<0.0001*
Acanthocephala									
Moniliformis moniliformis	intestine		–	–	3	14	8	3.3088	0.0689

Multiple infections at individual level (3 helminths species or more parasiting the same host individual) were observed in nine cases in *M. shawi* from Mezzouna and in two cases in individuals from Skhira.

DISCUSSION

Helminth parasites of *Meriones shawi* have been studied previously by Joyeux & Foley (1930) in Algeria. Among 66 individuals captured in humid areas from northern Algeria, nine helminth species were recovered including one trematode, five cestodes, and three nematodes. With the exceptions of *Syphacia obvelata*, all taxa observed in the present study was not reported by Joyeux & Foley (1930) (Table 3), which suggests that despite arid conditions, this rodent could harbour a high biodiversity of helminthfauna. Similar helminth species richness in rodents living in arid condition was found by Behnke *et al.* (2000). They found 6 helminths species in spiny mice *Acomys cahirinus* (Desmarest, 1819) from Egypt. The differences of helminth fauna compared to result of Joyeux & Foley could be related to differences in presence/absence and/or abundances of the intermediate hosts between the two localities. Likewise, no trematode species were recorded in our survey maybe related to the original trematode life cycle that mostly, necessitates mollusc intermediate hosts (*Helix aspersa* Müller, 1774 and *Otala punctata* (Müller, 1774)) and moist environment for the development of miracidium, the both being absent or scarce in our areas (Fried *et al.*, 1997).

All ten species varied in mean prevalence with seven of them having low or very low prevalences (Table 2). Parasites with high prevalences were *Raillietina* sp. (54%), *G. neoplasticum* (27%) and *M. aegyptica* (16%). These taxa have been found in other rodent helminth surveys. *M. aegyptica* is considered specific to rodents (Tenora *et al.*, 1980) when *Raillietina* sp. and *G. neoplasticum* have a wide range of mammal hosts (Sawada, 1964; Sato *et al.*, 2005; Eira *et al.*, 2006), including Muridae (*Meriones* spp., *Gerbillus* spp.) and Leporidae (i.e *Oryctolagus cuniculus*) (Eira *et al.*, 2006; Paramasvaran *et al.*, 2009; Ribas, López, Makundi, Leirs, & Bellocq, 2013). Their high prevalence in Shaw's jird may then result from their widespread and generalist nature (Sawada, 1964; Sato *et al.*, 2005; Haukisalmi, 2010).

Syphacia obvelata, *T. gerbilli* and *Nippostrongilus* sp. have all direct transmission while the other helminth species have indirect life cycle, i.e *M. numida*, *R. celebensis*, *A viteae*, and *Moniliformis moniliformis* (Wolfgang, 1956; Sawada, 1964; Quentin, 1978; Bernard, 1987). These last species also showed the lowest prevalence, which may suggest that host individuals did not encounter intermediate hosts frequently. For example, the acanthocephalan *M. moniliformis* exhibits a typical acanthocephalan life cycle, involving a invertebrate (including rodents) as definitive host and a cockroach intermediate host, which is not a common insect in wild arid habitat of *M. shawi* (Moore & Gotelli, 1992). In addition, *Meriones* spp. are mainly granivorous and herbivorous (Bernard & Ben Rachid, 1969; Adamou-Djerbaoui *et al.*, 2013), a diet that do not favour ingestion of possible intermediate hosts like insects.

The helminths community of *M. shawi* in less anthropized place (Mezzouna) is richer (nine helminth species) compared to highly anthropized place (Skhira) (five helminth species), albeit not significant for most helminths species (Table 2).

The high pollution level of the site of Skhira, among many other factors such as coastal climate and agricultural activity, could explain the reduced helminth species richness due to negative impacts of pollutants on hosts, intermediate hosts and parasites. As well, Salamun *et al.* (2012) established that heavy metal pollution strongly negatively impacts free nematode species richness, these latest being very low close the pollution source. A decrease in heavy metals contents in the environment away from the pollution sources was linked with an increase in species richness of nematodes.

Table 3. Checklist of helminths parasites of *Meriones shawi* (Duvernoy)

	Helminths	Locality	References
Digenia	*Brachylaima recurvus* Prokopic & Genov, 1974	Algeria	Joyeux & Foley (1930)
Cestoda	*Catenotaenia oranensis* Joyeux & Foley 1930	Algeria	Joyeux & Foley (1930)
	Hymenolepis fraterna (syn. *H. nana*) Stiles, 1906	Algeria	Joyeux & Foley (1930)
	H. procerca Janick, 1906	Algeria	Joyeux & Foley (1930)
	H. dimunita Weinland, 1858	Algeria Tunisia	Joyeux (1923) Joyeux & Foley (1930)
	H. microstoma Dujardin, 1845	Algeria	Joyeux & Foley (1930)
	Raillietina celebensis Fuhrmann, 1920	Tunisia	Present study
	Meggittina numida Jrijer & Neifar 2014	Tunisia	(Jrijer & Neifar, 2014)
	Raillietina sp.	Tunisia	Present study
	Meggittina aegyptiaca (Wolfgang, 1956)	Tunisia	Present study
	Raillietina trapezoides Janicki, 1904	Tunisia	(Canaris & Gardner, 2003)
	Skrjabinotaenia oranensis Joyeux & Foley, 1930	North Africa	(Canaris & Gardner, 2003)
Nematoda	*Gongylonema brevispiculum* Seurat, 1914	Tunisia	Bernard, 1987
	Trichuris gerbilli Bernard, 1969	Tunisia	Bernard, 1987
	Longistriata seurati Travassos & Darriba, 1929	Algeria	Joyeux & Foley (1930)
	Syphacia obvelata (Rudolphi, 1802)	Algeria Tunisia	Joyeux & Foley (1930), Present study
	Trichuris muris (Schrank, 1788)	Algeria Tunisia	Joyeux & Foley (1930), Present study
	Gongylonema neoplasticum Fibiger & Detlevsen 1914	Tunisia	Bernard, 1987 Present study
	Nippostrongylus sp.	Tunisia	Present study
	Acanthochelonema viteae Seurat, 1914	Tunisia	Bernard, 1987 Present study
Acanthocephala	*Moniliformis moniliformis* (Bremser 1811)	Tunisia	Present study

In addition, helminths may be negatively affected by heavy metals due to their high ability to accumulate heavy metals to a very high degree (Sures, 2004).Likewise, any reduction in the survival of helminth larval or adult stages could lead at the end to reduced abundances and richness of helminths in anthropized environments (Sures, 2004; Salamun *et al.*, 2012).

On the other hand, the study area of Mezzouna still offers a wild natural habitat for the Shaw's jird individuals, with a wide diet range that includes spontaneous natural vegetation and a variety of insect species promoting parasite transmissions across host species that may favour higher helminth species richness (Chen *et al.*, 2008). This mechanism supported the Shaw's jird population trapped here with higher helminth species compared to Skhira (Table 2). The higher rodent population densities encountered in the locality of Mezzouna (author's personal observation) may be linked to a higher diversity of parasite species (Bordes & Morand, 2011).

Additional studies are necessary to identify the fine mechanisms prone to impact the transmission of helminth parasites in this arid environment (Sures *et al.*, 1999; Vidal-Martínez *et al.*, 2010).

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REFERENCES

Adamou-Djerbaoui, M., Djelaila, Y., Labdelli, F. & Adamou, M.S. (2011). Ecologie et infestation de *Meriones shawii* Duvernoy dans la region de Tiaret. *Revue d'Ecologie et Environnement* **7**: 7-14.

Adamou-Djerbaoui, M., Denys, C., Chaba, H., Seid, M.M., Djelaila, Y., Labdelli, F. & Adamou, M.S. (2013). Étude du régime alimentaire d'un rongeur nuisible (*Meriones shawii* Duvernoy, 1842, Mammalia, Rodentia). *Lebanese Science Journal* **14**, 15-32.

Anderson, R.M. & May, R.M. (1978). Regulation and stability of host-parasite population interactions. I. Regulatory processes. *Journal of Animal Ecology* **47**: 219-247.

Anderson, R.C., Chabaud, A.G. and Willmob, 5. (eds) (1974-1983). CIH Keys to the Nematode Parasites of Vertebrates, Vols 1 -10, CAB International.

Aulagnier, S., Haffner, P., Mitchell Jones, A.J., Moutou, F. & Zima, J. (2009). Mammals of Europe, North Africa and the Middle East, ed. *A&C Black Publishers Ltd*, ISBN 9781408113998. 272 pp.

Behnke, J.M., Barnard, C.J., Mason, N., Harris, P.D., Sherif, N.E., Zalat, S. & Gilbert, F.S. (2000). Intestinal helminths of spiny mice (*Acomys cahirinus dimidiatus*) from St Katherine's Protectorate in the Sinai, Egypt. *Journal of Helminthology* **74**: 31-44.

Bernard, J. & Ben Rachid, M.S. (1969). Nematodes parasites du goundi *Ctenodactylus goundi* Rothman. Archives de l'Institut Pasteur de Tunis **46**: 411-422.

Bordes, F. & Morand, S. (2011). The impact of multiple infections on wild animal hosts: a review. *Infection Ecology and Epidemiology*, **1**: 1-10. doi:10.3402/iee.v1i0.7346

Bush, S.E. & Reed, M. (2013). Impact of forest size on parasite biodiversity: implications for conservation of hosts and parasites. *Biodiversity and Conservation*, doi:10.1007/s10531-013-0480-x.

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. doi:10.2307/3284227.

Canaris, A.G. & Gardner, S.L. (2003). Bibliography of helminth species described from african vertebrates 1800-1967. *Faculty Publications from the Harold W. Manter Laboratory of Parasitology.*

Carleton, M.D. & Musser, G.G. (1984). Muroid rodents in Anderson, S. & Jones, J.K., Jr. (eds.). Orders and families of recent mammals of the world. *John Wiley & Sons*, New York, p. 289-379.

Chaisiri, K., Chaeychomsri, W., Herbreteau, V. & Morand, S. (2010). Human-dominated habitats and helminth parasitism in Southeast Asian murids. *Parasitology Researsh*, 931-937. doi:10.1007/s00436-010-1955-2.

Chen, E.R. (1991). Current status of food-borne parasitic zoonoses in Taiwan. *Southeast Asian Journal of Tropical Medicine and Public Health* **22**: 62-4.

Chen, H., Liu, W., Davis, A.J. & Jorda, F. (2008). Network position of hosts in food webs and their parasite diversity. *Oikos* **117**: 1847-1855, doi:10.1111/j.1600-0706.2008.16607.x

Chouba, L. & Mzoughi-aguir, N. (2006). Les metaux traces (cd, pb, hg) et les hydrocarbures totaux dans les sediments superficiels de la frange cotiere du golfe de Gabes). *Bulletin de l'Institut National des Sciences et Techologie de la Mer de Salammbô* **33**: 93-100.

Dufour, B. & Savey, M. (2004). Diversite des zoonoses. definitions et consequences pour la surveillance et la lutte. *Epidémiologie et Santé Animal* **46**: 1-16.

Duplantier, J.M. & Granjon, L. (2009). Les rongeurs de l'Afrique sahélo-soudanienne *Ed. IRD / MNHN*, Collection Faune et Flore Tropicale.

Eira, C., Miquel, J., Vingada, J. & Torres, J. (2006). Natural infection of *Oryctolagus cuniculus* (Lagomorpha , Leporidae) by *Gongylonema neoplasticum* (Nematoda, Gongylonematidae) in Portugal. *Acta Parasitologica* **51**: 119-122. doi:10.2478/s11686-006-0018-4.

Fain, A., Limbos, P., Van Ros, G., De Mulder, P. & Herin, A. (1977). Presence du cestode *Raillietina* (*R.*) *celebensis* (Janicki, 1902) chez un enfant originaire de Tahiti. *Annales de La Societe Belge de Médecine Tropicale* **57**: 137-142.

Fried, B., Schmidt, K.A. & Sorensen, R.E. (1997). *In vivo* and ectopic encystment of *Echinostoma revolutum* and chemical excystation of the metacercairiae. *Journal of Parasitology* **83**: 251-254.

Garaibeh, B.M. (1997). Mammals of Tunisia. Systematics, distribution and zoogeography. A dissertation in Biology. *Texas Tech University*, U.S.A. p. 354.

Ghawar, W., Toumi, A., Snoussi, M.A., Chlif, S., Zâatour, A., Boukthir, A. & Ben Salah, A. (2011). *Leishmania major* infection among *Psammomys obesus* and *Meriones shawi*: reservoirs of zoonotic cutaneous leishmaniasis in Sidi Bouzid (central Tunisia). *Vector-Borne and Zoonotic Diseases* **11**: 1561-1568. doi: 10.1089/vbz.2011.0712.

Haukisalmi, V., Hardman, L.M. & Henttonen, H. (2010). Taxonomic review of cestodes of the genus *Catenotaenia* Janicki, 1904 in Eurasia and molecular phylogeny of the Catenotaeniidae (Cyclophyllidea). *Zootaxa* **33**: 27-28.

Joyeux, C. & Foley, H. (1930). Les helminthes de *Meriones shawi* rozet dans le nord de l'Algérie. *Bulletin de La Société Zoologique de France* **5**: 353-374.

Jrijer, J. & Neifar, L. (2014). *Meggittina numida* n. sp. (Cyclophyllidea: Catenotaeniidae), a parasite of the Shaw's jird *Meriones shawi* (Duvernoy) (Rodentia: Gerbillinae) in Tunisia. *Systematic Parasitology* **88**: 167-174. doi:10.1007/s11230-014-9488-1

Jrijer, J., Bordes, F., Morand, S. & Neifar, L. (2015). A Survey of Nematode Parasites of Small Mammals in Tunisia, North Africa: Diversity of Species and Zoonotic Implications. *Comparative Parasitology* **82**: 204-210.

Khalil,L.F., Jones, A. & Bray, R.A. (1994). Keys to the Cestode Parasites of Vertebrates CAB International.

Mccarthy, J. & Moore, T.A. (2000). Emerging helminth zoonoses. *International Journal for Parasitology* **30**: 1351-1360.

Moore, J. & Gotelli, N.J. (1992). *Moniliformis moniliformis* Increases Cryptic Behaviors in the Cockroach *Supella longipalpa*. *Journal of Parasitology* **78**: 49-53.

Morand, S. & Guégan, J. (2008). How the biodiversity sciences may aid biological tools and ecological engineering Interactions with other drivers of global change. *Revue scientifique et technique (International Office of Epizootics)*, 2008, 27(2), 355-366 How, 27(2), 355-366.

Orihel, T.C. & Eberhard, M.L. (1998). Zoonotic Filariasis. *Clinical Microbiology Reviews* **11**: 366-381.

Paramasvaran, S., Sani, R.A., Hassan, L., Hanjeet, K., Krishnasamy, M., John, J. & Lim, K.H. (2009). Endo-parasite fauna of rodents caught in five wet markets in Kuala Lumpur and its potential zoonotic implications. *Tropical Biomedicine* **26**: 67-72.

Ribas, A., López, S., Makundi, R.H., Leirs, H. & Bellocq, J. (2013). *Trichuris* spp. (Nematoda: Trichuridae) from two rodents, *Mastomys natalensis* and *Gerbilliscus vicinus* in Tanzania. *Journal of Parasitology* **99**: 868-875. doi:10.1645/12-151.1.

Šalamún, P., Renèo, M., Kucanová, E., Brázová, T., Papajová, I., Miklisová, D. & Hanzelová, V. (2012). Nematodes as bioindicators of soil degradation due to heavy metals. *Ecotoxicology* **21**: 2319-2330. doi:10.1007/s10646-012-0988-y.

Sato, H., Une, Y. & Takada, M. (2005). High incidence of the gullet worm, *Gongylonema pulchrum*, in a squirrel monkey colony in a zoological garden in Japan. *Veterinary Parasitology* **127**: 131-137. doi:10.1016/j.vetpar.2004.10.005.

Sawada, I. (1964). On the genus *Raillietina* (I). *Journal of Nara Gakugei University Natural Sciences* **12**: 19-36.

Scott M.E.& Dobson, A.P. (1989). The role of parasites in regulating host abundance. *Parasitol Today* **5**: 176-183.

Sures, B. (2004). Environmental parasitology: relevancy of parasites in monitoring environmental pollution. *Trends in Parasitology* **20**: 170-177. doi:10.1016/j.pt.2004.01.014.

Sures, B., Siddall, R. & Taraschewski, H. (1999). Parasites as accumulation indicators of heavy metal pollution. *Parasitology Today* **15**: 2-6.

Taylor, L.H., Latham, S.M. & Woolhouse, M.E. (2001). Risk factors for human disease emergence. *Philosophical Transactions of the Royal Society of London. Biological Sciences* **356**: 983-989. doi:10.1098/rstb.2001.0888

Tenora, F., Mas-Coma, S., Murai, E. & Feliu, C. (1980). The System of Cestodes of the Suborder Catenotaeniata Spassky, 1963. *Parasitologia Hungarica* **88**: 39-57.

Thomas, F., Renaud, F. & Guégan, J.F.G. (2005). Parasitism and Ecosystems. *Oxford University Press Inc.*, New York, ISBN 0 19, 221.

Toumi, A., Chlif, S., Bettaieb, J., Alaya, N., Ben Boukthir, A., Ahmadi, Z.E. & Ben Salah, A. (2012). Temporal dynamics and impact of climate factors on the incidence of zoonotic cutaneous leishmaniasis in central tunisia. *PLoS Medecine* **6**: 0-7. doi:10.1371/journal.pntd.0001633.

Vidal-Martínez, V.M., Pech, D., Sures, B., Purucker, S.T. & Poulin, R. (2010). Can parasites really reveal environmental impact? *Trends in Parasitology* **26**: 44-51. doi:10.1016/j.pt.2009.11.001.

Wilson, D.E. & Reeder, D.A.M. (2005). Mammals species of the World: a taxonomic and geographic reference. Third edition, *The Johns Hopkins Univ. Press*, Baltimore.

Wilson, M.E., Lorente, C.A, Allen, J.E. & Eberhard, M.L. (2001). *Gongylonema* infection of the mouth in a resident of Cambridge, Massachusetts. *Clinical Infectious Diseases: An Official Publication of the Infectious Diseases Society of America* **32**: 78-80. doi:10.1086/319991.

Wolfgang, R.W. (1956). Helminths parasites of reptiles, birds and mammals in Egypt. *Catenotaenia aegyptica* sp. nov. from myomorph rodents, with additional notes on the genus. *Canadian Journal of Zoology* **34**: 6-20.