

An overview of the host spectrum and distribution of *Calodium hepaticum* (syn. *Capillaria hepatica*): part 1—Muroidea

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Abstract *Calodium hepaticum* (syn. *Capillaria hepatica*) is a worldwide-distributed species of zoonotic nematodes with a high affinity to the liver. Several rodent species of the superfamily Muroidea serve as main hosts for this pathogen. *C. hepaticum* has been found in Muroidean hosts in more than 60 countries in Europe; North, Central, and South America; Asia; Africa; and Oceania. *C. hepaticum* was documented in more than 90 Muroidean rodent species (Murinae, Deomyiinae, Arvicolinae, Neotominae, Cricetinae, Sigmodontinae, Gerbillinae, and Cricetomyiinae). Globally, the Norway rat (*Rattus norvegicus*) seems to be the main host species for this nematode. However, locally high prevalences (above 50 %) have also been observed in several other synanthropic (commensal and non-commensal) Muroidea species (e.g., *Rattus tanezumi*, *Ondatra zibethicus*, *Apodemus sylvaticus*). This review gives an overview of the distribution and host spectrum of *C. hepaticum* in Muroidea host species.

Introduction

Calodium hepaticum (syn. *Capillaria hepatica*) is a zoonotic nematode parasite distributed worldwide. Adults of this nematode parasitize the liver of mammals and lay their eggs into the liver parenchyma causing hepatic capillariasis. The eggs are only released into the environment with the death of the host. The main hosts of this parasite are rodents of the superfamily Muroidea (Schmidt 2001). Furthermore, this parasite has been documented in numerous other mammalian species including more than 70 human cases (reviewed in Fuehrer et al. 2011; Fuehrer 2013). Hepatic capillariasis is diagnosed

through necroscopy or biopsy only, because with hepatic infections eggs are not shed into the environment with the feces.

This review focuses on the Muroidea host spectrum and its geographic distribution in those hosts only. Information about the pathogenesis, ecology, and host spectrum in humans and other mammals is given elsewhere (e.g., Fuehrer et al. 2011; Fuehrer 2013; Schmidt 2001).

For data evaluation, the systematic search was based on electronic databases (Scopus, PubMed, Google Scholar) and previous summaries (e.g., Schmidt 2001). The search terms *Capillaria hepatica*, *Calodium hepaticum*, *Hepaticola hepatica*, *Trichocephalus hepaticus*, and hepatic capillariasis were used. An attempt was made to include only those studies where the scientific names of the host and parasite were given clearly. Furthermore, spurious infections (= pseudoparasitism) were differentiated as far as possible from hepatic capillariasis. A short overview of spurious *C. hepaticum* infections in animals is given in Fuehrer (2013).

Taxonomy

C. hepaticum is a nematode out of the family Capillaridae (order Trichocephalida). Moravec (1982) categorized *C. hepaticum* in the genus *Calodium*. However, the name *C. hepaticum* is rarely used, and most researchers use the term *Capillaria hepatica*. Further synonyms are *Trichocephalus hepaticus* (Bancroft, 1893) and *Hepaticola hepatica* (Hall 1916) (Fuehrer et al. 2011).

The taxonomy of the family Capillaridae is disputed and pending. In the past, most species were included in the genus *Capillaria*. Recently, a molecular phylogenetic study revealed that Capillaridae can be clearly separated from Trichuridae (Guardone et al. 2013). However, the former genus *Capillaria* consists of a complex group of parasites including several

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parasites of carnivores and rodents of the genera *Calodium*, *Eucoleus*, *Capillaria*, *Paracapillaria*, *Pearsonema*, and *Aonchotheca* (Guardone et al. 2013). Three species are of zoonotic importance, namely *Paracapillaria philippinensis* (syn. *Capillaria philippinensis*), *Eucoleus aerophila* (syn. *Capillaria aerophila*), and *C. hepaticum* (syn. *C. hepatica*).

Life cycle

The life cycle of *C. hepaticum* is a direct one with a high affinity to the liver. After the ingestion of embryonated eggs, larvae hatch in the area of the caecum and invade the liver via the portal vein system. Adult worms parasitize in the liver of its mammalian hosts where the females lay eggs into the liver parenchyma after mating. The life span of adult worms is short (18–60 days post infection in mice) (Juncker-Voss et al. 2000; Schmidt 2001). The eggs develop in the host's liver to the eight-cell stage only. Unembryonated eggs are only released into the environment with the death of the host only (decay of host; excretion in feces of carnivores and omnivores or after cannibalism). Depending on the environmental conditions (e.g., humidity, temperature), eggs embryonate within 5–8 weeks. Laboratory studies revealed that embryonated eggs are viable for 25 months (reviewed in Juncker-Voss et al. 2000). The life cycle is closed when embryonated eggs are ingested from a mammalian host. The ingestion of non-embryonated eggs leads to pseudoparasitosis (= spurious infections) where the non-embryonated eggs are re-released with the feces and lead to mild symptoms only (reviewed in Fuehrer et al. 2011).

Muroidea host spectrum

The mammalian superfamily Muroidea consists of rodents with a worldwide distribution (with the exception of Antarctica) including animals like rats, true mice, gerbils, and hamsters. Recent molecular phylogenetic studies classified the superfamily into 6 families, 19 subfamilies, around 280 genera, and over 1,300 species (e.g., Stepan et al. 2004).

The host spectrum of *C. hepaticum* in Muroidea hosts (and in other mammals) indicates very low host specificity. More than 90 species of at least 44 genera of the superfamily Muroidea (Murinae, Arvicolinae, Neotominae, Cricetinae, Sigmodontinae, Gerbilinae, and Cricetomyiinae) are known as hosts of this parasite (Table 1). Of these, more than 55 species are rodents of the subfamily Murinae including the Norway rat (*Rattus norvegicus*), Black rat (*Rattus rattus*), and house mouse (*Mus musculus*). Prevalences above 50 % are regularly documented in Norway rats (*R. norvegicus*) and Tanezumi rats (*R. tanezumi*), and rarely in house mice (*M. musculus*), long-tailed field mice (*Apodemus sylvaticus*),

muskrats (*Ondatra zibethicus*), and bank voles (*Myodes glareolus*). All of these species are known as (commensal or non-commensal) synanthropic species. Human hepatic capillariosis cases are associated with poor hygienic conditions and the presence of rodents (e.g., rats) (Fuehrer et al. 2011). Davis (1951) reported that *C. hepaticum* is significantly less prevalent in decreasing rat populations than in stationary or increasing populations. A study conducted in Michigan (USA) with deer mice revealed that parasite prevalences are correlated negatively with heterozygosity when the effects of population density were held constant (Meagher 1998). Meagher further hypothesizes that inbred populations are more susceptible to parasite infestations. Differences in the prevalences of *C. hepaticum* in different rodent host species are thought to be associated with different living and nutritional habits (Schmidt et al. 1998). Several authors report that *C. hepaticum* occurs in localized foci of the examined study areas (e.g., Reperant and Deplazes 2005; Stojčević et al. 2002). Furthermore, cannibalism may be an important egg-releasing mechanism and is an important source of infection in burrows. On the other hand, predation seems to be responsible for scattered foci of infection (Farhang-Azad 1977a, b; Stojčević et al. 2002). Decomposition is thought to be a less important egg-releasing mechanism. Environmental conditions (humidity and temperature) are also associated with the distribution of these pathogens (e.g., Resendes et al. 2009). The pathogenicity of *C. hepaticum* in Muroidea hosts is considered low, although experimental infections of rats and mice have been demonstrated to lead to hepatic failure and the death of the host (the host survival rate is reduced by 5–10 %) (Singleton and Chambers 1996). However, individual variations of the host's inflammatory reaction to the parasite have been reported. Furthermore, hypersensitivity is associated with repeated infections (Borucinska and Nielsen 1993).

Hepatic capillariosis—geographic distribution in Muroidea hosts

C. hepaticum has been found in Muroidean hosts in more than 60 countries in Europe; North, Central, and South America; Asia; Africa; and Oceania. *R. norvegicus* is the rodent species with the highest prevalences worldwide. In Europe, North America, South America, and Asia, several studies reported prevalences above 50 % in Norway rats (e.g., Easterbrook et al. 2007). Also other murid host species can present high prevalences in certain regions. In Asia, the nematode was found in prevalences above 50 % in the common species *R. tanezumi* and the white bellied rat (*Niviventer fulvoscens*) (e.g., Yuan et al. 2000; Zhou et al. 1998). Furthermore, the muskrat (*O. zibethicus*) seems to be an important host of *C. hepaticum* in North America (Borucinska and Nielsen 1993). In the UK, high prevalences of this parasite were observed in long-tailed

Table 1 *Calodium hepaticum* in Muroidea

Classification	Species	Prevalence (%)	Country/region	References
Muridae				
Murinae	Norway rat (<i>Rattus norvegicus</i>)			
		82 % (of 86)	USA	Childs et al. (1988); Shorb (1931); Wantland et al. (1956)
		75 % (of 845)	USA (Connecticut)	Conlogue et al. (1979)
		75 % (of 845)	USA (Maryland—Baltimore area and zoo)	Farhang-Azad (1977a)
		87.9 % (176/201)	USA (Maryland—Baltimore Zoo)	Farhang-Azad (1977b)
			USA (Maryland, Baltimore)	Easterbrook et al. (2007)
			USA (New York)	Herman (1939)
		85.6 %	USA (Maryland)	Luttermoser (1936)
		94.1 % (of 1,460)	USA (Maryland)	Davis (1951)
			USA (North Carolina)	Harkema (1936)
			USA (District of Columbia)	Price and Chitwood (1931); Cram (1928)
			USA (Pennsylvania and Rhode Island)	Winfield (1933)
			USA (California)	Hall (1916)
			Canada (Quebec)	Firlotte (1948)
		Spurious infection 6 % (of 150)	Puerto Rico	Leon de (1964)
			Venezuela	Vogelsang and Espin (1949)
		20.1 % (51/254)	Colombia	Duque et al. (2012)
			Brazil	Araújo (1967); Galvão (1981); Chieffi et al. (1981); Ferreira and Andrade (1993)
			Brazil (Bahia)	Ferreira and Andrade (1993)
		54.1 % (13/24)	Brazil (Belém)	Moreira et al. (2013)
		30 %	Argentina (Buenos Aires)	Hancke (2011)
		33.3 % (5/15)	Chile	Torres and Gonzáles (1972); Rojas et al. (1971)
		1 case	England	Simmons and Walkey (1971)
		1 case	England (zoo)	Redrobe and Patterson-Kane (2005)
		A: 90.4 % (38/42) B + C: none of 38	England	Owen (1976)
		23 % (n=44)	England	Webster and MacDonald (1995)
		60 % (of 29)	Portugal (Azores)	Roque (1989)
		20 % (of 20)	Portugal (Azores)	Cruz (2006)
		62.5 % (of 73)	Portugal	Roque et al. (1984)
		42 % (21/50)	Portugal Lisbon Zoo	Crespo (2012)
		20 %	Spain	

Table 1 (continued)

Classification	Species	Prevalence (%)	Country/region	References
				Mascato et al. (1993); Feliu et al. (1985); Castro (1944); Gallego Berenguer (1959)
			France	Davoust et al. (1997)
			Italy	Perugia (1893)
		80 % (of 28)	Italy	Vanni (1938); Vanni (1947)
		30 % (of 100)	Italy (Pisa)	Ghelardoni (1966)
		30 % (of 50)	Italy	Casarsa and Ghelardoni (1965)
		36 % (17/49)	Italy (Milano)	Ceruti et al. (2001)
		54.55 % (of 143)	Italy (Sicily)	Milazzo et al. (2010b)
		74.6 %	Austria	Rydlo (1966)
		1 case	Austria	Frank (1977)
			Switzerland	Hörning (1966)
		16.4 % (of 864)	Belgium	Cotteleer et al. (1982)
			Former CSSR	Mituch (1960)
		100 % (26/26)	Hungary (zoo)	Mészáros and Kemenes (1973)
		1.95 % (6/307)	Croatia	Stojčević et al. (2002)
		10.9 % (of 147)	Serbia (Belgrad)	Kataranovski et al. (2010)
			Turkey	Merdivenci (1970)
			Kazakhstan	Plesščev and Kozlov (1978)
			Japan	Shimatani (1961); Sato and Shimatani (1960); Iwaki et al. (1993); Ito et al. (1996); Yagisawa (1978)
		52.7 % (1,272/2,222)	Japan (Osaka)	Momma (1930)
		90 %	Philippines	Tubangui (1931)
		60/138 (42 %)	Thailand	Chaiyabutr (1979)
		12.5 % (of 16)	Thailand	Namue and Wongsawad (1997)
			Malaysia	Liat et al. (1977); Sinniah et al. (1979)
			China	Lagrange (1924)
		30.4 %	China (Soochow)	Wu (1930)
		7.1 %	China (Canton)	Chen (1933)
		61.9 %	China (Hubei Province)	Zhou et al. (1991)
		66.7 %	China (Yunnan Province)	Zhou et al. (1998)
		1 case	China (Yunnan Province)	Xiong et al. (1999)
		77 %	China (Yunnan Province)	Shen et al. (2003)
		66.7 %	China (Fujian Province)	Yuan et al. (2000)

Table 1 (continued)

Classification	Species	Prevalence (%)	Country/region	References
		12.3 %	China (Fujian Province)	Xue et al. (1998)
		46.2 %	China (Fujian Province)	Zhang et al. (2003)
		25.8 %	China (Henan Province)	Lin et al. (2007)
		25.83 % (109/422)	China (Henan)	Wang et al. (2013)
		36.7 %	Taiwan	Yang and Lu (2000)
		54.9 %	Taiwan	Tung et al. (2009)
		62.5 % (20/32)	Taiwan	Tung et al. (2013)
		36 %	South Korea (Seoul)	Nakamura and Kobashi (1955)
		88 % (286/325)	South Korea (Seoul)	Seo et al. (1964)
		38.1 % (of 1,000)	South Korea (Seoul)	Min (1979)
		12.1 % (of 33)	South Korea (Pochun and Chungpyong)	Seo et al. (1968)
		23.6 % (21/89)	South Korea (Gangwon Province)	Yi et al. (2010)
		25.9 % (11/43)	South Korea (Chunchon)	Seong et al. (1995)
		13.04 % (of 23)	Iran	Pakdel et al. (2013)
		28 %	Australia (Queensland)	Singleton et al. (1991)
			Egypt	El-Nassery et al. (1991)
			Tunisia	Mishra and Gonzalez (1975)
			New Zealand	Roberts (1990)
		5 %	Australia (Queensland)	Singleton et al. (1991)
		25–30 %	Federated States of Micronesia (Pohnpei)	Storer (1962)
			Bangladesh	Bhuiyan et al. (1995)
			India	Chahota et al. (1997); Kumar et al. (1985); Somvanshi et al. (1995); Chahota et al. (1997); Bhattacharya et al. (1998)
		29.54 % (of 88)	India	Malsawmtluangi and Tandon (2009)
		2.32 % (1/43)	India	Sharma et al. (2012)
		Spurious infection		
		88.3 %	India	Patel et al. (2004)
		7.3 % (of 3,190)	Pakistan	Ahmad et al. (2011)
		20 % (1/5)	Iran	Pakdel et al. (2013)
		7.4 % (2/27)	Thailand	Chaiyabutr (1979)
		4.54 % (of 22)	Thailand	Namue and Wongsawad (1997)
		28.6 %	Taiwan	Tung et al. (2009)
		18.2 % (2/11)	Taiwan	Tung et al. (2013)
			Japan	Sato and Shimatani (1960); Shimatani (1961)
	Black rat (<i>Rattus rattus</i>)			

Table 1 (continued)

Classification	Species	Prevalence (%)	Country/region	References
			Turkey	Mertivenci (1970)
		3.1 % (2/65)	Israel	Wilamowski et al. (2002)
			Spain	Feliu et al. (1985); Castro (1944); Gallego Berenguer (1959)
			Portugal (Azores)	Casanova et al. (1996); Roque (1989)
			France	Davoust et al. (1997)
		34.2 % (of 37)	Italy (Sicily)	Milazzo et al. (2010a)
			Switzerland	Hörning (1966)
			USA	Layne (1970)
			Brazil	Chieffi et al. 1981
			Brazil (Bahia)	Ferreira and Andrade (1993)
		69.8 % (30/43)	Brazil (São Paulo)	Almeida-Silva et al. (2011)
		38.4 % (10/26)	Brazil (Belém)	Moreira et al. (2013)
			Egypt	El-Nassery et al. (1991)
		6.2 % (19/308)	Ethiopia	Farhang-Azad and Schlitter (1978)
			Democratic Republic of the Congo	Dubois (1933)
		5.8 % (6/103)	Nigeria	Onyenwe et al. (2009)
	<i>Rattus</i> spp. (<i>R. norvegicus</i> and/or <i>R. rattus</i>)	100 % (of 12)	Philippines	Claveira et al. (2005)
		34 %	Japan (Southern Anami Islands)	Kamiya et al. (1968)
		44 % (of 82)	France	Davoust et al. (1997)
		21.6 %	Malaysia	Paramasvaran et al. (2009)
	<i>Rattus</i> spp. (<i>Rattus rattus diardii</i> , <i>R. norvegicus</i> , and <i>R. exulans</i>)	11.9 %	France—Lyon Zoo	Apéry (2012)
	<i>Rattus</i> sp.	13 %	France—Vincennes Zoo	Apéry (2012)
	<i>Rattus rattus sladeni</i>	38.8 %	China (Yunnan Province)	Shen et al. (2003)
		33 % (1/3)	China (Yunnan Province)	Xiong et al. (1999)
	Polynesian rat (<i>Rattus exulans</i>)		New Zealand	Roberts (1990)
			Indonesia	Brown et al. (1975b)
			Malaysia	Liat et al. (1977); Sinniah et al. (1979)
			Malaysia	Syad-Arnez and Mohd Zain (2006)
	Sikkim rat (<i>Rattus andamanensis</i>)	37.5 %	Bangladesh	Fuehrer et al. (2012)
	Rice-field rat (<i>Rattus argentiventer</i>)	8.3 % (1/12)	Indonesia	Brown et al. (1975b)
			Malaysia	Mulkit and Cheong (1971); Liat et al. (1977); Sinniah et al. (1979)
	Lesser rice-field rat (<i>Rattus losea</i>)	5.4 %	Taiwan	Yang and Lu (2000)
		38.9 %	China (Fujian Province)	Yuan et al. (2000)

Table 1 (continued)

Classification	Species	Prevalence (%)	Country/region	References
	Hoffmann's rat (<i>Rattus hoffmanni</i>)		Indonesia	Brown et al. (1975b)
	Opossum rat (<i>Rattus marmosurus</i>)		Indonesia	Brown et al. (1975b)
	Tanezumi rat (<i>Rattus tanezumi</i>)		Indonesia	Brown et al. (1975b); Wioreno (1978)
			Malaysia	Liat et al. (1977); Sinniah et al. (1979)
	<i>Rattus flavipectus</i> (syn. for <i>Rattus tanezumi</i>)	12.9 % (20/155)	China (Henan)	Wang et al. (2013)
		12.9 %	China (Henan Province)	Lin et al. (2007)
		61.9 %	China (Hubei Province)	Zhou et al. (1991)
		65.1 %	China (Yunnan Province)	Zhou et al. (1998)
		49.4 % (of 881)	China (Yunnan Province)	Xiong et al. (1999)
		77.5 %	China (Yunnan Province)	Shen et al. (2003)
		44.3 %	China (Fujian Province)	Yuan et al. (2000)
		13.1 %	China (Fujian Province)	Xue et al. (1998)
		66.7 %	China (Fujian Province)	Zhang et al. (2003)
	Malayan field rat (<i>Rattus tiomanicus</i>)		Malaysia	Mulkit and Cheong (1971); Liat et al. (1977); Sinniah et al. (1979)
	Ammandale's rat (<i>Rattus ammandalei</i>)	44.4 %	Malaysia	Syad-Armez and Mohd Zain (2006)
	Himalayan field rat (<i>Rattus nitidus</i>)	40.1 %	Malaysia	Liat et al. (1977); Sinniah et al. (1979)
	Bush rat (<i>Rattus fuscipes</i>)		India	Malsawmtluangi and Tandon (2009)
			Australia	Singleton et al. (1991); Spratt and Singleton (1986)
	Müller's giant Sunda rat (<i>Sundamys muelleri</i>)		Malaysia	Liat et al. (1977)
		33.3 %	Malaysia	Syad-Armez and Mohd Zain (2006)
	Greater bandicoot rat (<i>Bandicota indica</i>)	11.5 %	Malaysia	Liat et al. (1977)
			Taiwan	Yang and Lu (2000)
	Lesser bandicoot rat (<i>Bandicota bengalensis</i>)		Sri Lanka	Dissanaike and Paramanathan (1961)
			Bangladesh	Bhuiyan et al. (1995)
			India	Pasricha et al. (1941)
		33.3 % (6/18)	India	Singla et al. (2013)
	Bower's white-toothed rat (<i>Berymys bowersi</i>)	16.6 %	Malaysia	Liat et al. (1977)
			India	Malsawmtluangi and Tandon (2009)
	Kenneth's white-toothed rat (<i>Berymys mackenziei</i>)	31.8 %	India	Malsawmtluangi and Tandon (2009)
	Gray tree rat (<i>Lenothrix canus</i>)		Malaysia	Liat et al. (1977)
	White-bellied rat (<i>Niviventer niviventer</i>)		Indonesia	Brown et al. (1975b)
	Chestnut white-bellied rat (<i>Niviventer fulvescens</i>)	40 %	Malaysia	Liat et al. (1977)
		55.6 %	India	Malsawmtluangi and Tandon (2009)
			China (Fujian Province)	Yuan et al. (2000)

Table 1 (continued)

Classification	Species	Prevalence (%)	Country/region	References
	Dark-tailed tree rat (<i>Niviventer cremoriventer</i>)		Malaysia	Mulkit and Cheong (1971)
	Chinese white-bellied rat (<i>Niviventer confucianus</i>)	30 %	China (Fujian Province)	Yuan et al. (2000)
	<i>Rattus nivivente</i> (sug. syn. for <i>Niviventer</i> sp.)	6.12 % (3/49)	China (Henan)	Wang et al. (2013)
	Edwards's long-tailed giant rat (<i>Leopoldamys edwardsi</i>)		Indonesia	Brown et al. (1975b)
	Long-tailed giant rat (<i>Leopoldamys sabanus</i>)		Malaysia	Liat et al. (1977)
			Indonesia	Brown et al. (1975b)
			Malaysia	Mulkit and Cheong (1971); Liat et al. (1977)
	Bartels's spiny rat (<i>Maxomys bartelsii</i>)		Indonesia	Brown et al. (1975b); Wioreno (1978)
	Hellwald's spiny rat (<i>Maxomys hellwaldii</i>)		Indonesia	Brown et al. (1975b)
	Rajah spiny rat (<i>Maxomys rajah</i>)		Malaysia	Mulkit and Cheong (1971); Liat et al. (1977)
	Musschenbroek's spiny rat (<i>Maxomys musschenbroekii</i>)	30.6 %	Malaysia	Syed-Armez and Mohd Zain 2006
			Indonesia	Brown et al. (1975b)
	Whitehead's spiny rat (<i>Maxomys whiteheadi</i>)		Malaysia	Mulkit and Cheong (1971); Liat et al. (1977)
	Red spiny rat (<i>Maxomys surifer</i>)	25 %	Malaysia	Syed-Armez and Mohd Zain 2006
			Malaysia	Liat et al. (1977)
	Fawn-footed mosaic-tailed rat (<i>Melomys cervinipes</i>)	30.4 %	Malaysia	(Syed-Armez and Mohd Zain 2006)
			Australia	Singleton et al. (1991); Spratt and Singleton (1986)
	Giant white-tailed rat (<i>Uromys caudimaculatus</i>)	24 %	Australia	Singleton et al. (1991)
	Kaiser's rock rat (<i>Aethomys kaiseri</i>)		Rwanda	Fain (1955)
	Hinde's rock rat (<i>Aethomys hindei</i>)		Democratic Republic of the Congo	Fain (1953)
	Peters's striped mouse (<i>Hybomys univittatus</i>)		Democratic Republic of the Congo	Schweitz (1956)
	African grass rat (<i>Arvicanthis niloticus</i>)		Democratic Republic of the Congo	Fain (1953)
	African marsh rat (<i>Dasyomys incomtus</i>)		Democratic Republic of the Congo	Fain (1953); Schweitz (1956)
	House mouse (<i>Mus musculus</i>)	6.2 %	Spain	Mascato et al. (1993); Felu et al. (1985); Castro (1944); Gallego Berenguer (1959)
		2.6 % (1/39)	Israel	Wilamowski et al. (2002)
		9.1 % (of 22)	Russia	Romašov (1983)
			Russia	Romašov (1996)
			Kazakhstan	Pleščev and Kozlov (1978)
			Turkey	Merdivenci (1970)
		47.4 %	Austria	Juncker et al. (1998)

Table 1 (continued)

Classification	Species	Prevalence (%)	Country/region	References
		42.7 % (of 166)	Austria (Vienna—zoo)	Juncker-Voss et al. (2000)
		80 % (of 5)	Switzerland	Hörning (1966)
		5.5 % (of 37)	Italy	Vanni (1947)
		21.2 % (of 52)	Italy (Sicily)	Milazzo et al. (2010a)
		19.6 % (10/51)	Portugal (Azores)	Casanova et al. (1996)
		40.2 % (of 92)	Portugal (Azores)	Resendes et al. (2009)
		22 % (11/50)	Portugal Lisbon Zoo	Pereira (2009)
			USA	Crespo (2012)
			USA (Maryland)	Childs et al. (1988)
			USA (Pennsylvania)	Luttermoser (1938)
		0.9 % (of 110)	Iran	Doran (1955)
		4.6 % (of 410)	Pakistan	Pakdel et al. (2013)
		2.1 % (1/47)	Bangladesh	Ahmad et al. (2011)
			Bangladesh	Fuehrer et al. (2012)
		19.1 %	Bangladesh	Bhuiyan et al. (1995)
		21.1 %	China (Hubei Province)	Zhou et al. (1991)
		4.6 %	China (Yunnan Province)	Zhou et al. (1998)
		10 %	China (Fujian Province)	Xue et al. (1998)
		10 % (13/130)	China (Henan Province)	Lin et al. (2007)
			China (Henan)	Wang et al. (2013)
			Australia (Queensland)	Singleton et al. (1991)
			Australia release study	Singleton and Chambers (1996)
	Long-tailed field mouse (<i>Apodemus sylvaticus</i>)	2/17	Austria	Frank (1977)
			Switzerland	Hörning (1966)
		7 % (of 99)	Switzerland (Geneva Canton)	Reperant and Deplazes (2005)
			Belgium	Bernard (1961)
			Former UDSSR	Pavlov (1955)
			Spain	Feliu et al. (1984, 1985, 1987); Mas-Coma and Feliu (1977); Prokopič and Tenora (1975)
			England	Baylis (1931)
		75 % (of 58)	England	Canning et al. (1973)
		100 %	St. Kilda, UK	Berry and Tricker (1969)
		18 % (2/11)	UK Shetland Islands	Wilson et al. (1998)
			Wales	Lewis (1968)
			Slovakia	Mituch (1966/1970)

Table 1 (continued)

Classification	Species	Prevalence (%)	Country/region	References
	Yellow-necked mouse (<i>Apodemus flavicollis</i>)	5.93 % (of 135)	Bulgaria	Genov (1984); Prokopič and Genov (1974)
			Russia	Romašov (1996)
			Georgia	Kirschenblat (1948)
			Armenia	Kirakosjan et al. (1963)
			Middle Asia	Tokobaev (1976)
			Russia	Romašov (1978, 1996)
			Russia	Romašov (1983)
			Bulgaria	Genov (1984); Prokopič and Genov (1974)
		2 cases	Serbia	Čabrilo et al. (2013)
			Slovakia	Mituch (1960); Mituch (1966/1970)
			Former CSSR	Erhardová (1956); Erhardová and Ryšavy (1955); Prokopič and Genov (1974); Tenora (1963)
		8.5 % (24/284)	Germany (Saxony-Anhalt)	Schmidt (2001)
		6 cases	Denmark	Tenora et al. (1991)
	<i>Apodemus</i> spp.	1.5 % (of 96)	France (forested area near Dijon)	Scandola et al. (2013)
			Iran	Mobedi and Arfaa (1971)
	Broad-toothed field mouse (<i>Apodemus mystacinus</i>)		Georgia	Kirschenblat (1948)
	Striped field mouse (<i>Apodemus agrarius</i>)	3.37 % (of 297)	Russia	Romašov (1978)
		0.2 %	Russia	Romašov (1983)
			Russia (Southern West Siberia)	Chechulin et al. (2011)
			Former UDSSR	Pavlov (1955)
			Russia (Novosibirsk Region)	Koval'chuk and Bonina (1981)
		4.27 % (5/117)	China (Henan)	Wang et al. (2013)
	Small Japanese field mouse (<i>Apodemus argenteus</i>)		Japan	Chabaud et al. (1963); Ishimoto (1974); Iwaki et al. (1993)
	Korean field mouse (<i>Apodemus peninsulae</i>)		Japan	Iwaki et al. (1993)
	Large Japanese field mouse (<i>Apodemus spectosus</i>)		Japan	Iwaki et al. (1993)
	Typical striped grass mouse (<i>Lemniscomys striatus</i>)		Democratic Republic of the Congo	Fain (1953)
	Southern multimammate mouse (<i>Mastomys coucha</i>)		Democratic Republic of the Congo	Fain (1953); Schwetz (1956)
	Natal multimammate mouse (<i>Mastomys natalensis</i>)		Ghana	Paperna et al. (1970)
			South Africa	Cochrane et al. (1957)
	Jackson's soft-furred mouse (<i>Praomys jacksoni</i>)		Democratic Republic of the Congo	Fain (1953)
	Tropical Vlei rat (<i>Otomys tropicalis</i>)		Democratic Republic of the Congo	Fain (1953)

Table 1 (continued)

Classification	Species	Prevalence (%)	Country/region	References
Deomyinae	Creek groove-toothed swamp rat (<i>Pelomys fallax</i>)		Democratic Republic of the Congo	Schwetz (1956)
	Bell groove-toothed swamp rat (<i>Pelomys campanae</i>)		Guinea	Joyeux et al. (1928)
	Target rat (<i>Stochomys longicaudatus</i>)		Democratic Republic of the Congo	Schwetz (1956)
	Ethiopian white-footed mouse (<i>Stenocephalemys albipes</i>)	0.5 % (1/212)	Ethiopia	Farhang-Azad and Schlitter (1978)
	Yellow-spotted brush-furred rat (<i>Lophuromys flavopunctatus</i>)		Democratic Republic of the Congo	Schwetz (1956)
Cricetidae	Southern African spiny mouse (<i>Acomys spinosissimus</i>)		Zimbabwe	Sandground (1933)
	Bank vole (<i>Myodes glareolus</i>)			
Arvicolinae			Russia	Romašov (1978, 1996)
		37.36 % (of 1,159)	Russia	Romašov (1983)
		1.4 %	Russia (Southern West Siberia)	Chechulin et al. (2011)
		75 % (of 57)	Former UDSSR	Pavlov (1955)
		27.6 % (of 29)	England	Canning et al. (1973)
		15.1 % (22/146)	France (forested area near Dijon)	Scandola et al. (2013)
		5.2 % (of 58)	Germany (Saxony-Anhalt)	Schmidt et al. (1998); Schmidt (2001)
			Switzerland (Geneva Canton)	Reperant and Deplazes (2005)
			Slovakia	Mituch (1960)
		5.4 % (of 115)	Czech Republic	Rupeš (1964)
	Northern red-backed vole (<i>Myodes rutilus</i>)		Former UDSSR	Pavlov (1955)
		1 %	Russia (Southern West Siberia)	Chechulin et al. (2011)
	Southern red-backed vole (<i>Myodes gapperi</i>)		USA	Fisher (1963)
		9.5 % (28/294)	USA	Solomon and Handley (1971)
		2.8 %	Canada (Alonquin Park)	Freeman and Wright (1960)
	Grey red-backed vole (<i>Myodes rufocanus</i>)		Japan	Chabaud et al. (1963); Ishimoto (1974); Iwaki et al. (1993)
	Northern mole vole (<i>Ellobius talpinus</i>)		Former UDSSR	Pavlov (1955)
Zaisan mole vole (<i>Ellobius tancrei</i>)		???	Mentioned in Tinnin et al. (2011)	
Siberian brown lemming (<i>Lemmus sibiricus</i>)		Former UDSSR	Morozov (1956)	
		USA	Rausch (1961)	
Southern bog lemming (<i>Synaptomys cooperi</i>)		Canada (Alonquin Park)	Freeman and Wright (1960)	
Muskkrat (<i>Ondatra zibethicus</i>)		Canada (Alonquin Park)	Freeman and Wright (1960)	
		Canada (Ontario)	Price (1931)	
	Laboratory infection studies	USA	Borucinska et al. (1997)	
	77 % (184/270)	USA (Pennsylvania and Connecticut)	Borucinska et al. (1993)	

Table 1 (continued)

Classification	Species	Prevalence (%)	Country/region	References
		17 % (of 104)	USA (Louisiana)	Penn (1952)
			USA (Maine)	Meiers and Reilly (1950)
			USA (Michigan)	Ameel (1942)
			Russia	Romašov (1995, 1996)
			Former CSSR	Tenora and Zavadil (1967)
		4.21 % (of 1,140)	Belgium	Cotteleer et al. (1982)
		1 case (of 440)	Great Britain	Warwick (1937)
	Field vole (<i>Microtus agrestis</i>)	3 cases (of 5)	Austria	Frank (1977)
		16.67 % (of 6)	Russia	Romašov (1983)
			Russia	Romašov (1978, 1996)
		4.5 %	Russia (Southern West Siberia)	Chechulin et al. (2011)
	Common vole (<i>Microtus arvalis</i>)	0.9 % (3/318)	Austria	Fuehrer et al. (2010)
		4 cases (of 4)	Austria	Frank (1977)
		20.69 % (of 29)	Russia	Romašov (1983)
			Russia	Romašov (1996)
			USA	Fisher (1963)
	Rock vole (<i>Microtus chrotorrhinus</i>)		Canada	Freeman and Wright (1960); Lubinsky et al. (1971)
			Canada	Lubinsky et al. (1971)
	Meadow vole (<i>Microtus pennsylvanicus</i>)	9.4 % (of 769)	Canada (Alonquin Park)	Freeman and Wright (1960)
			Former UDSSR	Morozov (1956)
	Tundra vole (<i>Microtus oeconomus</i>)	3.4 %	Russia (Southern West Siberia)	Chechulin et al. (2011)
			Canada	Freeman and Wright (1960)
			Kyrgyzstan	Tokobaev (1960)
	Narrow-headed vole (<i>Microtus gregalis</i>)	1 case	England (zoo)	Redrobe and Patterson-Kane (2005)
	Günther's vole (<i>Microtus guentheri</i>)	1.1 % (1/98)	Austria	Fuehrer et al. (2010)
	Water vole (<i>Arvicola terrestris</i>)	10.4 %	Russia	(Chechulin 1989); Romašov (1978, 1996)
		28.57 % (of 42)	Russia (Southern West Siberia)	Chechulin et al. (2011)
			Russia	Romašov (1983)
			Switzerland	Hörning (1966)
		0.2 % (of 466)	Switzerland (Geneva Canton)	Reperant and Deplazes (2005)
		2 cases	England (zoo)	Redrobe and Patterson-Kane (2005)
	European snow vole (<i>Chionomys nivalis</i>)		Former UDSSR	Pavlov (1955)
			Former UDSSR	Kirschenblatt (1938)
	Brandt's vole (<i>Lasiopodomys brandtii</i>)		China (Inner Mongolia)	Wan et al. (2007a)
Neotominae	Eastern wood rat (<i>Neotoma floridana</i>)	47.1 % (16/34)	USA	Solomon and Handley (1971)

Table 1 (continued)

Classification	Species	Prevalence (%)	Country/region	References
	Bushy-tailed woodrat (<i>Neotoma cinerea</i>)		USA	Rausch (1961)
	Cotton mouse (<i>Peromyscus gossypinus</i>)		USA	Layne (1968, 1970); Layne and Winegarner (1971)
	White-footed mouse (<i>Peromyscus leucopus</i>)	2.9 % (7/239)	USA	Solomon and Handley (1971)
	Deer mouse (<i>Peromyscus maniculatus</i>)	10.2 % (73/713)	USA	Solomon and Handley (1971)
			USA (lab experiments)	Meagher (1998)
			Canada	Lubinsky (1957); Lubinsky et al. (1971); Freeman and Wright (1960); Freeman (1958); Wright (1961); Herman (1981)
	Florida mouse (<i>Peromyscus floridanus</i>)		Canada (Alberta)	Lubinsky (1956)
			USA	Rausch (1961); Layne (1968, 1970); Layne and Winegarner (1971)
		12.7 % (21/723)	USA (Florida)	Layne and Griffio Jr (1961)
			USA	King and Stanton (1974)
	<i>Reithrodontomys</i> sp.		Former UDSSR	Pavlov (1955)
Cricetinae	Gray dwarf hamster (<i>Cricetulus migratorius</i>)		Austria	Frank (1977)
	European hamster (<i>Cricetus cricetus</i>)		China (Henan)	Wang et al. (2013)
	Greater long-tailed hamster (<i>Tscherskia triton</i>)		China (Inner Mongolia)	Wan et al. (2007a, b)
	Campbell's dwarf hamster (<i>Phodopus campbelli</i>)		Venezuela	Vogelsang and Espin (1949)
Sigmodontinae	Northern grass mouse (<i>Necomys urichi</i>)		USA	Luttermoser (1937); Layne (1968, 1970)
	Hispid cotton rat (<i>Sigmodon hispidus</i>)		USA (Texas)	Read (1949)
		Freshwater marshes: 30 % (43/142); salt water marshes	USA (Florida)	Kinsella (1974)
		12 % (4/34); upland habitats		
		5 % (1/22)		
Gerbillinae	Savanna gerbil (<i>Gerbilliscus validus</i>)		Democratic Republic of the Congo	Fain (1953)
	Bushveld gerbil (<i>Gerbilliscus leucogaster</i>)		Democratic Republic of the Congo	Schwetz (1956)
	Persian jird (<i>Meriones persicus</i>)		Democratic Republic of the Congo	Schwetz (1956)
			Armenia	Kirakosjan et al. (1963)
		6.9 % (11/160)	Iran	Kia et al. (2010)
Cricetomyinae	Emin's pouched rat (<i>Cricetomys emini</i>)	17.7 %	Democratic Republic of the Congo	Malekani (1990, 1994)
	Gambian pouched rat (<i>Cricetomys gambianus</i>)	30.8 %	Rwanda	Fain (1955)
			Democratic Republic of the Congo	Malekani (1990, 1994)
			Nigeria	Chineme and Ibrahim (1984)

field mice (*A. sylvaticus*) and the bank vole (*M. glareolus*) (Canning et al. 1973).

Conclusions

C. hepaticum is a worldwide-distributed parasite with rodents of the superfamily Muroidea as main hosts. *C. hepaticum* has been described in more than 90 rodent species. Murinae and Arvicolinae are the hosts with the highest prevalences of this parasite. The Norway rat seems to be the most important host species with reported prevalences above 50 % on several continents. However, a high percentage of the studies dealt with Norway rats only, and not with less common murid rodents. Especially synanthropic (commensal and non-commensal) Murinae and Arvicolinae seem to be the most affected hosts.

However, the diagnosis of this pathogen is limited to liver biopsies and necroscopy and so the true prevalence in Muroidea and other mammals remains unclear. At spurious infections, care should be taken to exclude mix-ups with other Trichuridae and Capillaridae shedding eggs of almost similar morphology (e.g., Bork-Mimm and Rinder 2011; Di Cesare et al. 2011; Stuart et al. 2013; Traversa et al. 2011). Novel (molecular) diagnostic tools for proper (molecular) species classification are of urgent need.

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References

- Ahmad MS, Maqbool A, Mahmood-ul-Hassan M, Mushtaq-ul-Hassan M, Anjum AA (2011) *Capillaria hepatica* (Nematode) in rodents of the Lahore Metropolis Corporation—Pakistan. *J Anim Plant Sci* 21(4):787–793
- de Almeida-Silva MJF, del Fava C, Potenza M, Reis F, de Carvalho Campos AE (2011) Diagnosis of *Capillaria hepatica* in *Rattus rattus* by histopathology. Proceedings of the Seventh International Conference on Urban Pests. Instituto Biológico, São Paulo, SP, Brazil
- Ameel D (1942) Two larval cestodes from the muskrat. *Trans. Amer. Microsc. Soc.* 69: 267–271. In: Lubinsky G (1956) On the probable presence of parasitic liver cirrhoses in Canada. *Can J Comp Med Vet Sci.* 20, 457–465
- Apéry S (2012) La capillarose hépatique dans quatre parcs zoologiques en France. Thèse. Doctorat Vétérinaire. La Faculté de Médecine de Créteil. École Nationale Vétérinaire D'Alfort. pp. 104

- Araújo P (1967) Helminthos de *Rattus norvegicus* (Berkenhout, 1769) da cidade de São Paulo. *Rev. Fac. Farm. Bioquím. Universidade de São Paulo* (5)1:141–159.
- Baylis HA (1931) On the structure and relationships of the nematode *Capillaria (Hepaticola) hepatica* (BANCROFT). *Parasitology* 23, 533–543. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Bernard J (1961) Liste de nematodes parasites des micromammifères de la fauna Belge. *Ann. Parasitol. Hum. Comp.* 36: 775–784. In: Asakawa M, Tenora F (1996) A checklist of nematode parasites of the genus *Apodemus* (Murinae: Rodentia) throughout the world excluding Japan. *J. Rakuno Gakuen Univ* 20 (2): 181–213
- Berry RJ, Tricker BJK (1969) Competition and extinction. The mice of Foula, with notes on those of Fair Isle and St Kilda. *J Zool.* 158: 247–265. In: Lloyd S, Elwood CM, Smith KC (2002) *Capillaria hepatica (Calodium hepaticum)* infection in a British dog. *Vet Rec.* 151(14):419–20
- Bhattacharya D, Sikdar A, Sarma U, Ghosh AK, Biswas G (1998) Concurrent infection of *Capillaria hepatica* and *Cysticercus fasciolaris* in rat (*Rattus rattus*)—a preliminary note. *Indian Vet J* 75(5):486
- Bhuiyan AI, Ahmed TA, Khanum H (1995) Endoparasitic helminths of rats and mice from Tangail area. *Bangladesh J Sci Res* 13(1):75–80
- Borucinska JD, van Kruiningen HJ, Cairra JN, Garmendia AE (1997) Clinicopathological features and histopathology of experimental hepatic capillariasis in muskrats (*Ondatra zibethicus*). *J Wildl Dis* 29(3):518–20
- Bork-Mimm S, Rinder H (2011) High prevalence of *Capillaria plica* infections in red foxes (*Vulpes vulpes*) in Southern Germany. *Parasitol Res* 108(4):1063–7. doi:10.1007/s00436-010-2196-0
- Borucinska JD, Nielsen SW (1993) Hepatic capillariasis in muskrats (*Ondatra zibethicus*). *J Wildl Dis* 29:518–520
- Brown RJ, Carney WP, van Peenen PFD, Cross JH, Saroso JS (1975) Capillariasis in wild rats of Indonesia. *Southeast Asian J Trop Med Pub Hlth* 6:219–222
- Čabrilo B, Jovanović V, Budinski Ivana, Blagojević Jelena, Vujošević M, Bjelić-Čabrilo O (2013) First report of *Capillaria hepatica* (Bancroft, 1893) in *Apodemus flavicollis* in Serbia. Third International Epizootiology Days and Serbian Epizootiology Days 2013. Abstract. 178.
- Canning EU, Cox FEG, Croll NA, Lyons KM (1973) The natural history of Slapton Ley Nature Reserve: VI studies on the parasites. *Field Studies* 3, 681–718. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Casanova JC, Miquel J, Fons R, Molina X, Feliu C, Mathias ML, Torres J, Libois R, Santos-Reis M, Collares-Pereira M, Marchand B (1996) On the helminthofauna of wild mammals (Rodentia, Insectivora and Lagomorpha) in Azores Archipelago (Portugal). *Vie et Milieu* 46(3/4): 253–259. In: Crespo APMAM (2012) Controlo de pragas no jardim zoológico de Lisboa particular relevância para o controlo de roedores e sua infeção parasitária. Dissertação de Mestrado em Segurança Alimentar. Faculdade de Medicina Veterinária. Universidade Técnica de Lisboa. pp. 174
- Casarsa L, Ghelardoni E (1965) Prime ricerche sulla diffusione della *Capillaria hepatica* (BANCROFT 1893) nei ratti delle chiaviche (*Rattus norvegicus*) della provincia di Pisa. *Annali della Facoltà di Medicina Veterinaria di Torino* 15, 203–205. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland.

- PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Castro JG (1944) Contribucion al estudio del parasitismo por helmintos o sus fases larvianas de diversos muridos capturados en Granada. *Revista iberica de parasitologia* 4, 38–60. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Ceruti R, Sonzogni O, Origgi F, Vezzoli F, Cammarata S, Giusti AM, Scanziani E (2001) *Capillaria hepatica* infection in wild brown rats (*Rattus norvegicus*) from the urban area of Milan, Italy. *J Vet Med B Infect Dis Vet Public Health* 48(3):235–40
- Chabaud AG, Rausch RL, Dessel MC (1963) Nématodes parasites de rongeurs et insectivores Japonais. *B Soc Zool Fr*, 88, 489–512. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Chahota R, Asrani RK, Katoch RC, Jithendran KP (1997) Hepatic capillariasis in a wild rat (*Rattus rattus*). *Journal of Veterinary Parasitology* 11(1):87–90
- Chaiyabutr N (1979) Hepatic capillariasis in *Rattus norvegicus*. *J Sci Soc Thailand* 5:48–50
- Chechulin AI (1989) Structure of the helminth fauna of the water rat during the period of its mass multiplication in northern Baraba. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Chechulin AI, Kapenko SV, Panov VV (2011) Ecology of *Hepaticola hepatica* infection in rodents in Southern West Siberia. *Contemporary Problems of Ecology* 4(4):423–427
- Chen HT (1933) A preliminary report on a survey of animal parasites of Canton, China, rats. *Lingnan Sc. Jour.* 12(1): 65–74. In: Seo BS, Rim HJ, Lee CW, Yoon JS (1964) Studies on the parasitic helminths of Korea: II. Parasites of the rat, *Rattus norvegicus* Erxl. In Seoul, with the description of *Capillaria hepatica* (Bancroft, 1893) Travassos, (1915). *Kisaengchunghak Chapchi.* 2(1):55–62
- Chieffi PP, Dias RMDS, Mangini ACS, Grispino DMA, Pacheco MAD (1981) *Capillaria hepatica* (Bancroft, 1893) em murídeos capturados no município de São Paulo SP. *Brasil Rev Inst Med Trop São Paulo* 23(4):143–146
- Childs JE, Glass GE, Korch GW (1988) The comparative epizootiology of *Capillaria hepatica* (Nematoda) in urban rodents from different habitats of Baltimore, Maryland. *Can J Zool* 66: 2769–2775. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Chineme CN, Ibrahim MA (1984) Hepatic capillariasis in African giant rats (*Cricetomys gambianus* WATERHOUSE). *J Wildl Dis* 20:341–342
- Claveria FG, Causapin J, de Guzman MA, Toledo MG, Salibay C (2005) Parasite biodiversity in *Rattus* spp caught in wet markets. *Southeast Asian J Trop Med Public Health* 36(Suppl 4):146–8
- Cochrane JC, Sagorin L, Wilcocks MG (1957) *Capillaria hepatica* infection in man; a syndrome of extreme eosinophilia, hepatomegaly and hyperglobulinaemia. *S Afr Med J* 31(30):751–755
- Conlogue G, Foreyt W, Adess M, Levine H (1979) *Capillaria hepatica* (Bancroft) in select rat populations of Hartford, Connecticut, with possible public health implications. *J Parasitol* 65(1):105–8
- Cotteleer C, Famerée L, van den Abbeele O (1982) Les Parasites de l'appareil digestif du surmulot (*Rattus norvegicus*) et du rat musqué (*Ondatra zibethica*) en Belgique. Incidence sanitaire pour l'homme et les animaux domestiques. *Schweiz Arch Tierh.* 124: 447–455. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Cram EB (1928) A note on parasites of rats (*Rattus norvegicus* and *Rattus norvegicus albus*). *J. Parasit.* 15: 72. In: Lubinsky G (1956) On the probable presence of parasitic liver cirrhoses in Canada. *Can J Comp Med Vet Sci.* 20: 457–465
- Crespo APMAM (2012) Controlo de pragas no jardim zoológico de Lisboa particular relevância para o controlo de roedores e sua infeção parasitária. Dissertação de Mestrado em Segurança Alimentar. Faculdade de Medicina Veterinária. Universidade Técnica de Lisboa. pp. 174
- Cruz JSP (2006) Fatores de variação da fauna helmintológica em populações de roedores da ilha de São Miguel (Açores). *Atas del X Congreso Ibérico de Parasitologia (CIP 10)*, P 71, Madrid: Servicio de Publicaciones, Universidad Complutense de Madrid. ISBN 978-84-96704-04-6. In: Crespo APMAM (2012) Controlo de pragas no jardim zoológico de Lisboa particular relevância para o controlo de roedores e sua infeção parasitária. Dissertação de Mestrado em Segurança Alimentar. Faculdade de Medicina Veterinária. Universidade Técnica de Lisboa. pp. 174
- Davis DE (1951) The relation between the level of population and the prevalence of *Leptospira*, *Salmonella* and *Capillaria* in Norway rats. *Ecology* 32(3):465–468
- Davoust B, Boni M, Branquet D, Ducos de Lahitte J, Martet G (1997) Recherche de trois infestations parasitaires chez des rats capturés à Marseille: évaluation du risque zoonosique. *B Acad Nat Med Paris* 181: 887–897. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Di Cesare A, Castagna G, Meloni S, Milillo P, Latrofa S, Otranto D, Traversa D (2011) Canine and feline infections by cardiopulmonary nematodes in central and southern Italy. *Parasitol Res* 109(Suppl 1): S87–96. doi:10.1007/s00436-011-2405-5
- Dissanaike AS, Paramanathan DC (1961) On *Capillaria hepatica* infection in the Ceylon bandicoot (*Bandicota malabarica*). *The Ceylon Veterinary journal* 9: 9–11. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Doran D (1955) A catalogue of the protozoa and helminths of North American rodents. III. Nematoda. *Amer. Midland Nat.* 53 : 162–175. In: Lubinsky G (1956) On the probable presence of parasitic liver cirrhoses in Canada. *Can J Comp Med Vet Sci.* 20: 457–465
- Dubois A (1933) Sur l'existence de *Hepaticola hepatica* au Congo belge. *Ann Soc Belg Med Tr.* 13, 259–260. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Duque BA, Aranzazu D, Agudelo-Flórez P, Londoño AF, Quiroz VH, Rodas JD (2012) *Rattus norvegicus* as an indicator of circulation of *Capillaria hepatica* and *Taenia taeniaeformis* on a groceries trade center of Medellín, Colombia. *Biomedica.* 32(4):510–8. doi: 10.1590/S0120-41572012000400006. Spanish.
- Easterbrook JD, Kaplan JB, Vanasco NB, Reeves WK, Purcell RH, Kosoy MY, Glass GE, Watson J, Klein SL (2007) A survey of zoonotic pathogens carried by Norway rats in Baltimore, Maryland, USA. *Epidemiol Infect* 135(7):1192–9
- El-Nassery SF, El-Gebali WM, Oweiss NY (1991) *Capillaria hepatica*: an experimental study of infection in white mice. *J Egypt Soc Parasitol* 21:467–478

- Erhardová B (1956) Parasitičti červi nasich mysovitych hlodavcu II. Českolov. Parasitol. 3: 49–66. In: Asakawa M, Tenora F (1996) A checklist of nematode parasites of the genus *Apodemus* (Murinae: Rodentia) throughout the world excluding Japan. J. Rakuno Gakuen Univ 20 (2): 181–213
- Erhardová B, Ryšavy B (1955) Příspěvek k poznání cizopasných červů našich myši a hrabošů. Zoologické a entomologické listy 4: 71–90. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Fain A (1953) Observations sur *Hepaticola hepatica* (BANCROFT, 1893) Hall 1916 au Congo, Belge. Ann Soc Belg Med Tr 33:107–117
- Fain A (1955) Deux nouveaux hôtes pour *Hepaticola hepatica* (BANCROFT) au Ruanda-Urundi. Rev Zool Bot Afr 51:11–12
- Farhang-Azad A (1977a) Ecology of *Capillaria hepatica* (Bancroft 1893) (Nematoda). I. Dynamics of infection among Norway rat populations of the Baltimore Zoo, Baltimore, Maryland. J Parasitol 63:117–122
- Farhang-Azad A (1977b) Ecology of *Capillaria hepatica* (BANCROFT 1893) (Nematoda). II. Egg-Releasing mechanisms and transmission. J Parasitol 63:701–706
- Farhang-Azad A, Schlitter DA (1978) *Capillaria hepatica* in small mammals collected from Shoa Province, Ethiopia. J Wildl Dis 14: 358–361
- Feliu C, Mas-Coma S, Gallego J (1984) Contribution al conocimiento de la Helmintofauna de micromamíferos ibéricos. VIII. Nuevos datos sobre parásitos de *Apodemus sylvaticus* LINNAEUS, 1758 (Rodentia: Muridae). Revista Iberica de Parasitología 44, 109–128. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Feliu C, Mas-Coma S, Gallego J (1985) Coneixements actuals sobre l'helmintofauna paràsita dels múrids (Rodentia) a Catalunya. Butlletí de la Institució Catalana d'Historia Natural, Filial de l'Institut d'Estudis Catalans 50: 255–261. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Feliu C, Gracenea M, Torregrosa M (1987) Ecological evaluation of the helminth parasites of *Apodemus sylvaticus* (Rodentia: Muridae) in the Spanish Eastern Pyrenees. In: Asakawa M, Tenora F (1996) A checklist of nematode parasites of the genus *Apodemus* (Murinae: Rodentia) throughout the world excluding Japan. J. Rakuno Gakuen Univ 20(2): 181–213
- Ferreira LA, Andrade ZA (1993) *Capillaria hepatica*: a cause of septal fibrosis of the liver. Mem I Oswaldo Cruz 88:441–447
- Firlotte WA (1948) A survey of the parasites of the brown Norway rat. Cand J Comp Med 12:187–191
- Fisher RL (1963) *Capillaria hepatica* from the rock vole in New York. Journal of parasitology 49, 450. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Frank C (1977) Kleinsäugerhelminthen im Neusiedlerseegebiet. Angewandte Parasitologie 18:206–216
- Freeman RS (1958) On the epizootiology of *Capillaria hepatica* (BANCROFT, 1893) in Algonquin Park, Ontario. J Parasitol 44: 33. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Freeman RS, Wright KA (1960) Factors concerned with the epizootiology of *Capillaria hepatica* (BANCROFT, 1893) (Nematoda) in a population of *Peromyscus maniculatus* in Algonquin Park, Canada. J Parasitol 46:373–382
- Führer HP, Schneider R, Walochnik J, Auer H (2010) Extraintestinal helminths of the common vole (*Microtus arvalis*) and the water vole (*Arvicola terrestris*) in Western Austria (Vorarlberg). Parasitol Res 106(4):1001–4. doi:10.1007/s00436-010-1753-x
- Fuehrer HP, Igel P, Auer H (2011) *Capillaria hepatica* in man—an overview of hepatic capillariosis and spurious infections. Parasitol Res 109(4):969–79. doi:10.1007/s00436-011-2494-1
- Fuehrer HP, Baumann TA, Riedl J, Treiber M, Igel P, Swoboda P, Joachim A, Noedl H (2012) Endoparasites of rodents from the Chittagong Hill Tracts in Southeastern Bangladesh. Wien Klin Wochenschr 124(Suppl 3):27–30. doi:10.1007/s00508-012-0237-7
- Fuehrer HP (2013) An overview on the host spectrum and distribution of *Calodium hepaticum* (syn. *Capillaria hepatica*): part 2—Mammalia (excluding Muroidea). Parasitol Res. (accepted)
- Gallego Berenguer J (1959) Parasitismo vermidiano de los múridos españoles. Revista de sanidad e higiene publica 33, 169–208. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Galvão VA (1981) Estudos sobre *Capillaria hepatica*: uma avaliação do seu papel patogênico para o homem. Mem Inst Oswaldo Cruz 76(4): 415–433
- Genov T (1984) Helminths of insectivores and rodents in Bulgaria. Publishing House of the Bulgarian Academy of Sciences, Sofia, Bulgaria: pp 348. In: Asakawa M, Tenora F (1996) A checklist of nematode parasites of the genus *Apodemus* (Murinae: Rodentia) throughout the world excluding Japan. J. Rakuno Gakuen Univ 20 (2): 181–213
- Ghelardoni E (1966) Infestione da *Capillaria hepatica* (BANCROFT, 1893) nei muridi della provincia di Pisa. Ann Fac Medic Vet di Parma 18: 91–100. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Guardone L, Deplazes P, Macchioni F, Magi M, Mathis A (2013) Ribosomal and mitochondrial DNA analysis of Trichuridae nematodes of carnivores and small mammals. Vet Parasitol. doi:10.1016/j.vetpar.2013.06.022
- Hall MC (1916) Nematode parasites of mammals of the orders Rodentia, Lagomorpha and Hyracoidea. Proc US Natl Mus 50:1–258
- Hancke D (2011) Endoparasitos de *Rattus norvegicus* en un ambiente urbano marginal de la ciudad de Buenos Aires. Mastozool Neotrop 18(1):147–148
- Harkema R (1936) The parasites of some North Carolina rodents. Ecol Monogr. 6: 153–232. In: Lubinsky G (1956) On the probable presence of parasitic liver cirrhoses in Canada. Can J Comp Med Vet Sci. 20: 457–465
- Herman CM (1939) A parasitological survey of wild rats in New York Zoological Park. Zoologica 24: 305–308. In: Lubinsky G (1956) On the probable presence of parasitic liver cirrhoses in Canada. Can J Comp Med Vet Sci. 20: 457–465
- Herman TB (1981) *Capillaria hepatica* (Nematoda) in insular populations of deer mouse *Peromyscus maniculatus*: Cannibalism or competition for carcasses? Can J Zool. 59: 776–784. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Hörning B (1966) Die Helminthenfauna der Nagetiere (Rodentia, Siphonocentia) der Paläarkt, unter Berücksichtigung ihrer Faunistik und ihrer Übertragungsmöglichkeiten auf den Menschen

- und auf Haustiere. Bern, Univ., Veterinärmed. Fakultät, Habil.Schr. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Ishimoto Y (1974) Studies on helminths of voles in Hokkaido. I. Taxonomical study. Jpn J Vet Res. 22: 1–12. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Ito A, Okamoto M, Kariwa H, Ishiguro T, Hashimoto A, Nakao M (1996) Antibody responses against *Echinococcus multilocularis* antigens in naturally infected *Rattus norvegicus*. J Helminthol. 70: 355–357. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Iwaki T, Hatakeyama S, Nonaka N, Miyaji S, Yokohata Y, Okamoto M, Ooi HK, Oku Y, Kamiya M (1993) Survey on larval *Echinococcus multilocularis* and other hepatic helminths in rodents and insectivores in Hokkaido, Japan, from 1985 to 1992. Jpn J Parasitol. 42: 502–506. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Joyeux C, Gendre E, Baer JG (1928) Recherches sur les Helminthes de l'Afrique occidentale française. Coll. Soc. Path. Exot., Monographie II, Paris, Masson. In: Justine JL (1989) Liste des *Capillaria* (Nematoda, Capillariinae) parasites de Mammifères africains. Bull. Mus. Natn. Hist. Nat. Paris, 11(4): 755–762
- Juncker M, Küber-Heiss A, Prosl H (1998) Zum Vorkommen von *Capillaria hepatica* bei Hausmäusen (*Mus musculus*) in Österreich. Mitt Österr Ges Tropenmed Parasitol 20:137–142
- Juncker-Voss M, Prosl H, Lussy H, Enzenberg U, Auer H, Nowotny N (2000) Serological detection of *Capillaria hepatica* by indirect immunofluorescence assay. J Clin Microbiol 38(1):431–3, Review
- Kamiya M, Chinzei H, Sasa M (1968) A survey on helminth parasites of rats in southern Amamai, Japan. Jap. J. Parasit. 17(5): 74–82. In: Seo BS, Rim HJ, Yoon JJ, Koo BY, Hong NT (1968) Studies on the parasitic helminths of Korea III. Nematodes and cestodes of rodents. Korean J Parasitol. 6(3): 123–131
- Kataranovski M, Zolotarevski L, Belij S, Mirkov I, Stošić J, Popov A, Kataranovski D (2010) First record of *Calodium hepaticum* and *Taenia taeniaeformis* liver infection in wild Norway rats (*Rattus norvegicus*) in Serbia. Arch Biol Sci Belgrade 62(2):431–440
- Kia E, Shahryary-Rad E, Mohebal M, Mahmoudi M, Mobedi I, Zahabiun F, Zarei Z, Miahipoor A, Mowlavi G, Akhavan A, Vatandoost H (2010) Endoparasites of rodents and their zoonotic importance in Germi, Dashte-Mogan, Ardabil Province, Iran. Iran J Parasitol 5(4):15–20
- King GL, Stanton G (1974) Modification of the epizootiology of *Capillaria hepatica* by the host type infected. Bulletin of the Georgia Academy of Science 32: 3. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Kinsella JM (1974) Comparison of helminth parasites of the Cotton Rat, *Sigmodon hispidus*, from several habitats in Florida. Am Mus Novit 2540:1–11
- Kirakosjan MO, Lusararjan VS, Davtjan GG, Sakanjan AB (1963) K obnaruženiju novych chozjaev dlja *Capillaria hepatica* v Armenii. Izvestija Akademii Nauk Armjankoj SSR / Biologiceskie nauki 16: 95–97
- Kirschenblat ID (1948) Материалы гел минтофауне грызунов Грузии. Trud. Trud. Zool. Inst. Georg. 8: 317–339. In: Asakawa M, Tenora F (1996) A checklist of nematode parasites of the genus *Apodemus* (Murinae: Rodentia) throughout the world excluding Japan. J. Rakuno Gakuen Univ 20 (2): 181–213
- Kirschenblatt JD (1938) Die Gesetzmässigkeiten der Dynamik der Parasitenfauna bei den maeseähnlichen Nagetieren (Muriden) in Transkaukasien. Diss. Univ. Leningrad: pp. 5–92
- Koval'chuk ES, Bonina OM (1981) A focus *Hepaticola hepatica* infection in the Barabin lowlands. In: Asakawa M, Tenora F (1996) A checklist of nematode parasites of the genus *Apodemus* (Murinae: Rodentia) throughout the world excluding Japan. J. Rakuno Gakuen Univ 20(2): 181–213
- Kumar V, Brandt J, Mortelmans J (1985) Hepatic capillariasis may simulate the syndrome of visceral larva migrans, an analysis. Ann Soc Belg Med Trp. 65: 101–104. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Lagrange ME (1924) Sur un Trichocéphalidé du ratt á Sanghai, *Hepaticola hepatica* HALL, 1916. B Soc Pathol Exot. 17: 658–659. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Layne JN (1968) Host and ecological relationships of the parasitic helminth *Capillaria hepatica* in Florida mammals. Zoologica 53: 107–123. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Layne JN, Griffio JV Jr (1961) Incidence of *Capillaria hepatica* in populations of the Florida deer mouse. *Peromyscus floridanus*. J Parasitol 47:31–37
- Layne JN (1970) New host records of *Capillaria hepatica* in Florida. Fla Sci. 33: 18–22. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Layne JN, Winegarner CE (1971) Occurrence of *Capillaria hepatica* (Nematoda: Trichuridae) in the spotted skunk in Florida. J Wildl Dis 7(4):256–7
- Leon de DD (1964) Helminth parasites of rats in San Juan, Puerto Rico. J Parasitol. 50: 478–479. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Lewis JW (1968) Studies on the helminth parasites of the long-tailed field mouse, *Apodemus sylvaticus sylvaticus*, from Wales. J Zool. 154: 287–312. In: Lloyd S, Elwood CM, Smith KC (2002) *Capillaria hepatica* (*Calodium hepaticum*) infection in a British dog. Vet Rec. 151(14):419–20
- Liat LB, Fong YL, Krishnasamy M (1977) *Capillaria hepatica* infection of wild rodents in Peninsular Malaysia. Southeast Asian J Trop Med Public Health 8: 354–358. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Lin XM, Xu BL, Zhao XD, Li H, Huang Q, Deng Y, Hao ZY, Zhang AM (2007) Epidemiological investigation on *Capillaria hepatica* infection among little animal in Henan Province. Zhongguo Jishengchoubing Fangzhi Zazhi 2: 44–46. In: Li CD, Yang HL, Wang Y (2010) *Capillaria hepatica* in China. World J Gastroenterol. 16(6):698–702

- Lubinsky G (1956) On the probable presence of parasitic liver cirrhoses in Canada. *Can J Comp Med Vet Sci* 20:457–465
- Lubinsky G (1957) List of helminths from Alberta rodents. *Can J Zool.* 35: 623–627. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Lubinsky G, Jacobsen BR, Baron RW (1971) Wildlife foci of *Capillaria hepatica* infections in Manitoba. *Can J Zool.* 49: 1201–1202. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Luttermoser GW (1936) A helminthological survey of Baltimore house rats (*Rattus norvegicus*). *Amer. J. Hyg.* 24(2): 350–360. In: Seo BS, Rim HJ, Lee CW, Yoon JS (1964) Studies on the parasitic helminths of Korea: II. Parasites of the rat, *Rattus norvegicus* Erxl. In Seoul, with the description of *Capillaria hepatica* (Bancroft, 1893) Travassos, (1915). *Kisaengchunghak Chapchi.* 2(1):55–62
- Luttermoser GW (1937) Resistance of rats and mice to infection with *Capillaria hepatica*. (American Society of Parasitologists, Program and abstracts of the thirteenth annual meeting). *J. Parasitol.* 23: 547–574. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Luttermoser GW (1938) An experimental study of *Capillaria hepatica* in the rat and the mouse. *The Am J Hyg* 27:321–340
- Malekani M (1990) Studies on hepatic capillariasis and on the genus *Meggittina* (Cestoda) of *Cricetomys* spp.,—some of the edible rodents in Zaire. Antwerp: Prince Leopold Institute of Tropical Medicine (M.Sc. Thesis): pp136.
- Malekani M, Kumar V, Pandey VS (1994) Hepatic capillariasis in edible *Cricetomys* spp. (Rodentia: Cricetidae) in Zaire and its possible public health implication. *Ann Trop Med Parasit* 88:569–572
- Malsawmtluangi C, Tandon V (2009) Helminth parasite spectrum in rodent hosts from bamboo growing areas of Mizoram, North-east India. *J Parasit Dis* 33(1–2):28–35. doi:10.1007/s12639-009-0004-5
- Mascato FA, Rey J, Bos J, Peris D, Paniagua E, Blanco P (1993) Parasitos Capillariinae (Nematoda) de algunas especies de micromamíferos gallegos. *NACC-Biología* 4:111–120
- Mas-Coma S, Feliu C (1977) Contribucion al conocimiento de la helmintofauna de micromamíferos Ibericos. IV. Parasitos de *Apodemus sylvaticus* LINNAEUS, 1758 (Rodentia, Muridae). *Revista iberica de parasitologia* 37:301–317
- Meagher S (1998) Physiological responses of deer mice (*Peromyscus maniculatus*) to infection with *Capillaria hepatica* (Nematoda). *J Parasitol* 84:1112–1118
- Merdivenci A (1970) Türkiye'de *Hepaticola hepatica* infeksiyonlari ve parazitlerin gelismesi üzerine bazi deneyler. Istanbul Ueniversitesi Tip Fakueltesi mecmuasi 32: 423–436. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Mészáros J, Kemenes F (1973) *Capillaria hepatica* verursachte Hepatitis bei einem Biber (*Castor fiber*). *Parasitol Hung* 6:33–40
- Meyers MC, Reilly JR (1950) Parasites of muskrats in Maine. *Amer Midland Nat* 44:467–477
- Milazzo C, Cagnin M, Di Bella C, Geraci F, Ribas A (2010a) Helminth fauna of commensal rodents, *Mus musculus* (Linnaeus, 1758) and *Rattus rattus* (Linnaeus, 1758) (Rodentia, Muridae) in Sicily (Italy). *Rev Ibero-Latinoam Parasitol* 69(2):194–198
- Milazzo C, Ribas A, Casanova JC, Cagnin M, Geraci F, Di Bella C (2010b) Helminths of the brown rat (*Rattus norvegicus*) (Berkenhout, 1769) in the city of Palermo, Italy. *Helminthologia* 47(4):238–240
- Min HK (1979) Prevalence of *Capillaria hepatica* among house rat in Seoul. *Korean J Parasitol* 17(2):93–97
- Mishra GS, Gonzalez JP (1975) Bilan d'une etude sur les endoparasites du rat, *Rattus norvegicus* Berkenhout, 1769, à Tunis. *Archs Inst. Pasteur Tunis*, 52: 71–87. In: Justine JL (1989) Liste des *Capillaria* (Nematoda, Capillariinae) parasites de Mammifères africains. *Bull. Mus. Natn. Hist. Nat. Paris*, 11(4): 755–762
- Mituch J (1960) Zur Verbreitung der Helminthen bei der Nordischen Ratte (*Rattus norvegicus* ERXL.) in der Slowakei. *Helminthologia* 2: 114–132. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Mituch J (1966/1970) Helminthofauna drobných cicavcov a mäsožravcov TANAP. In Report of Helminthological Institute Slovak Academy of Sciences, Košice: 85–117. In: Asakawa M, Tenora F (1996) A checklist of nematode parasites of the genus *Apodemus* (Murinae: Rodentia) throughout the world excluding Japan. *J. Rakuno Gakuen Univ* 20 (2): 181–213
- Mobedi II, Arfaa F (1971) Probable role of ground beetles in the transmission of *Capillaria hepatica*. *J. Parasitol.* 57: 1144–1145. In: Asakawa M, Tenora F (1996) A checklist of nematode parasites of the genus *Apodemus* (Murinae: Rodentia) throughout the world excluding Japan. *J. Rakuno Gakuen Univ* 20 (2): 181–213
- Momma K (1930) Notes on modes of rat infestation with *Hepaticola hepatica*. *Ann. Trop. Med. and Parasitol.* 24(1): 109–113. In: Seo BS, Rim HJ, Lee CW, Yoon JS (1964) Studies on the parasitic helminths of Korea: II. Parasites of the rat, *Rattus norvegicus* Erxl. In Seoul, with the description of *Capillaria hepatica* (Bancroft, 1893) Travassos, (1915). *Kisaengchunghak Chapchi.* 2(1):55–62
- Moravec F (1982) Proposal of a new systematic arrangement of nematodes of the family Capillariidae. *Folia Parasitol (Praha)* 29(2):119–32
- Moreira VLC, Giese EG, da Silva DCB, de Vasconcelos Melo FT, Furtado AP, Maldonado A Jr, dos Santos JN (2013) *Calodium hepaticum* (Nematoda: Capillariidae) in synanthropic rodents (*Rattus norvegicus* and *Rattus rattus*) in Eastern Amazonia. *Rev Bras Parasitol Vet Jaboticabal* 22(2):265–269
- Morozow JUF (1956) K poznaniju gel'mintofauny gryzunov i nasekomojadnyh SSSR i opyt ee ekologo-geografeskogo analiza. *Diss. biol. Wiss.* In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Mulkit S, Cheong CH (1971) On a collection of nematode parasites from Malayan rats. *Southeast Asian J Trop Med Public Health* 2: 516–522. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Nakamura K, Kobashi S (1935) Die Arten der Ratten in Chosen (insbesondere in Keijo und Jinsen) und die bei ihnen gefundenen Ekto- sowie Entoparasiten. *Jour. Chosen Med. Assoc.* 25(5): 183–184. In: Seo BS, Rim HJ, Lee CW, Yoon JS (1964) Studies on the parasitic helminths of Korea: II. Parasites of the rat, *Rattus norvegicus* Erxl. In Seoul, With the description of *Capillaria hepatica* (Bancroft, 1893) Travassos, (1915). *Kisaengchunghak Chapchi.* 2(1):55–62
- Namue C, Wongsawad C (1997) A survey of helminth infection in rats (*Rattus spp*) from Chiang Mai Mount. *Southeast Asian. J Trop Med Public Health* 28(Suppl 1):179–83
- Onyenwe IW, Ihedioha JI, Ezeme RI (2009) Prevalence of zoonotic helminths in local house rats (*Rattus rattus*) in Nsukka, Eastern Nigeria. *Animal Research International* 6(3):1040–1044

- Owen D (1976) Some parasites and other organisms of wild rodents in the vicinity of an SPF unit. *Lab Anim* 10(3):271–8
- Pakdel N, Naem S, Rezaei F, Chalehchaleh AA (2013) A survey of helminth infection in mice (*Mus musculus*) and rats (*Rattus norvegicus* and *Rattus rattus*) in Kermanshah, Iran. *Vet Res Forum* 4(2):105–109
- Paperna I, Furman DP, Rothstein N (1970) The parasite fauna of rodents from urban and suburban areas of Accra-Tema, South Ghana. *Revue Zool. Bot. Afr.* 81: 330–336. In: Justine JL (1989) Liste des *Capillaria* (Nematoda, Capillariidae) parasites de Mammifères africains. *Bull. Mus. Natn. Hist. Nat. Paris*, 11(4): 755–762
- Paramasvaran S, Sani RA, Hassan L, Hanjeet K, Krishnasamy M, John J, Santhana R, Sumarni MG, Lim KH (2009) Endo-parasite fauna of rodents caught in five wet markets in Kuala Lumpur and its potential zoonotic implications. *Trop Biomed* 26(1):67–72
- Pasricha CL, Panja G, Bhaduri NV (1941) *Capillaria hepatica* in a wild rat in Calcutta. *Ind Med Gaz.* 76, 475–476. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität, Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Patel AK, Bhattachaiya D, Chattopadhyay UK, Bera AK, Sikdar A (2004) Capillariasis in rats: prevalence and pathological evaluation. *J. Vet. Parasitol.* 111: 89–90. In: Goswami R (2012) Studies on comparative hemato-biochemical profile in certain spontaneously occurring helminths in wild and laboratory rats. PhD Thesis, Mahatma Jyotiba Rohilkhand University Bareilly (U.P.), India. pp 219.
- Pavlov AV (1955) Biologija nematody *Hepaticola hepatica* i osobnosti epizootologii vyzivaemogo eju zabolobanija pu,nych zverej. Moskau, Avtorref. dis. kand. biol. nauk. 27. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität, Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Penn GH (1952) Parasitology survey of Louisiana muskrats. *J Parasitol.* 28: 348–349. In: Borucinska JD, Nielsen SW (1993) Hepatic capillariasis in muskrats (*Ondatra zibethicus*). *J Wildl Dis.* 29, 518–520
- Pereira VMM (2009) Estudo da helmintofauna de *Mus musculus* (Rodentia) em São Miguel (Açores): fatores indutores de diversidade e potencial zoonótico. Dissertação de Mestrado em Biologia Humana e Ambiente. Lisboa: Faculdade de Ciências—Universidade de Lisboa. In: Crespo APMAM (2012) Controlo de pragas no jardim zoológico de Lisboa particular relevância para o controlo de roedores e sua infeção parasitária. Dissertação de Mestrado em Segurança Alimentar. Faculdade de Medicina Veterinária. Universidade Técnica de Lisboa. pp. 174
- Perugia A (1893) Sul Trichosoma del fegato dei Muridi. *Atti della Societa Ligustica di Scienze Naturali e Geografiche* 4: 206–210. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität, Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Pleščev VS, Kozlov AN (1978) Gel'mintofauna sinantropnyh gryzunov celinogradskoj oblasti. Materialy naučnyh konferencij vsesojuznogo obščestva gel'mintologov 30: 135–139. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität, Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Price EW (1931) *Hepaticola hepatica* in liver of *Ondatra zibethica*. *J Parasitol.* 18: 44–56. In: Borucinska JD, Nielsen SW (1993) Hepatic capillariasis in muskrats (*Ondatra zibethicus*). *J Wildl Dis.* 29: 518–520
- Price EW and Chitwood BG (1931) Incidence of internal parasites in wild rats in Washington, D.C. *J. Parasit.* 18:51. In: Lubinsky G (1956) On the probable presence of parasitic liver cirrhoses in Canada. *Can J Comp Med Vet Sci.* 20: 457–465
- Prokopič J, Genov T (1974) Distribution of helminths in micromammals (Insectivora and Rodentia) under different ecological and geographical conditions. *Studie ČSAV.* 9: 1–159. In: Asakawa M, Tenora F (1996) A checklist of nematode parasites of the genus *Apodemus* (Murinae: Rodentia) throughout the world excluding Japan. *J. Rakuno Gakuen Univ* 20 (2): 181–213
- Prokopič J, Tenora F (1975) Contribution to the knowledge of helminth fauna of small mammals in Spain. *Vestnik Československe Spolecnosti Zoologicke* 39: 60–67. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität, Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Rausch R (1961) Notes on the occurrence of *Capillaria hepatica* (BANCROFT, 1893). *P Helm Soc Wash.* 28: 17–18. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität, Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Read CP (1949) Studies on North American helminths of the genus *Capillaria* ZEDER, 1800 (Nematoda): I. Capillariids from mammals. *J Parasitol* 35:223–230
- Redrobe SP, Patterson-Kane JC (2005) *Calodium hepaticum* (syn. *Capillaria hepatica*) in captive rodents in a zoological garden. *J Comp Pathol* 133(1):73–6
- Reperant LA, Deplazes P (2005) Cluster of *Capillaria hepatica* infections in non-commensal rodents from the canton of Geneva, Switzerland. *Parasitol Res* 96(5):340–2
- Resendes AR, Amaral AF, Rodrigues A, Almeria S (2009) Prevalence of *Calodium hepaticum* (Syn. *Capillaria hepatica*) in house mice (*Mus musculus*) in the Azores archipelago. *Vet Parasitol* 160(3–4): 340–3. doi:10.1016/j.vetpar.2008.11.001
- Roberts M (1990) The ecological parasitology of the Polynesian rat (*Rattus exulans*) on Tiritiri Matangi Island. Unpublished Ph.D. thesis. University of Auckland, Auckland, New Zealand. In: McKenna PB (1997) Checklist of helminth parasites of terrestrial mammals in New Zealand. *New Zeal J Zool.* 24:277–90.
- Rojas A, Villarroel F, Diaz F, Rubio P, Schenone H (1971) Investigación de triquinosis y capillariasis hepática en *Rattus norvegicus* del Matadero Municipal de Santiago (Chile). *Bol Chil Parasitol.* 26: 65–66. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität, Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Romašov BV (1978) Biotopičeskoe raspredelenie nematody *Hepaticola hepatica* (Capillariidae) i sezonnaja dinamika zaražennosti eju melkich mlekopitaju,čich voronežskogo zapovednika. Materialy naučnyh konferencij vsesojuznogo obščestva gel'mintologov 30: 139–147. In: Asakawa M, Tenora F (1996) A checklist of nematode parasites of the genus *Apodemus* (Murinae: Rodentia) throughout the world excluding Japan. *J. Rakuno Gakuen Univ* 20 (2): 181–213
- Romašov BV (1983) Osobnosti žiznennogo cikla *Hepaticola hepatica* (Nematoda, Capillariidae). In: Parazitologičeskie issledovanija v zapovednikach (Sbornik Naučnyh Trudov Central'naja naučno-issledovatel'skaja laboratorija ochotnič'ego chozjajstva i zapovednikov) Moskau, S. 49–58.
- Romašov BV (1995) Ekologija parazitičeskoj nematody *Calodium hepaticum* (Nematoda: Capillariidae) Voronežskij Biosfernnyj Zapovednik. Sostojanie i problemy ekosistem srednego podon'ja. Trudy biologiceskoj učebno-naučnoj bazy Voronežskogo gosudarstvennogo universiteta "Venevitinovo" 7, 44–50. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität, Veterinärmedizinische Fakultät, Leipzig: 145pp.

- Romašov BV (1996) Ecological connections in life cycle *Capillaria hepatica* (BANCROFT, 1893) (Nematoda: Trichocephalida). Abstracts VII European Multicolloquium of Parasitology (EMOP VII) 1996. *Parassitologia* 38, 20. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Roque MM, Mendonça MM, Marcos MV, Lopes FJ (1984) Endoparasitas encontrados no rato cinzento (*Rattus norvegicus* Berk.) da zona de Lisboa. *Revista Portuguesa de Doenças Infecciosas* 7(2): 101–109. In: Crespo APMAM (2012) Controlo de pragas no jardim zoológico de Lisboa particular relevância para o controlo de roedores e sua infeção parasitária. Dissertação de Mestrado em Segurança Alimentar. Faculdade de Medicina Veterinária. Universidade Técnica de Lisboa. pp. 174
- Roque MM (1989) Fauna helmintológica de vertebrados terrestres da Ilha de S. Miguel (Açores). Dissertação de Doutoramento em Biologia. Universidade dos Açores. In: Crespo APMAM (2012) Controlo de pragas no jardim zoológico de Lisboa particular relevância para o controlo de roedores e sua infeção parasitária. Dissertação de Mestrado em Segurança Alimentar. Faculdade de Medicina Veterinária. Universidade Técnica de Lisboa. pp. 174
- Rupeš V (1964) Parazitičti červi u *Apodemus flavicollis* a *Clethrionomys glareolus* z okolí Prahy. *Československá parazitologie* 11: 335–338. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Rydlo M (1966): Beitrag zur Kenntnis der Parasitenfauna der Wanderratte *Rattus norvegicus* (BERKENHOUT, 1769).- Wien, Univ., Philosoph. Fak., Diss.
- Sandground JH (1933) Parasitic nematodes from East Africa and Southern Rhodesia. *Bull Mus Comp Zool Harvard Univ.* 75: 263–293. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Sato A, Shimatani T (1960) Studies on *Capillaria hepatica*. I. Incidence of *C. hepatica* of house rats Kyoto and Maizuru cities, Kyoto Prefecture. *Medicine and biology* 57: 181–183. (Japanese) In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Scandola P, de Biasi C, Davoust B, Marié JL (2013) Prevalence of *Capillaria hepatica* in non-commensal rodents from a forest area near Dijon, France. *Parasitol Res* 112(7):2741–4. doi:10.1007/s00436-013-3369-4
- Schmidt S, Haupt W, Ribbeck R (1998) *Capillaria hepatica* – ein seltener Zoonose-Erreger. Vorkommen bei Mäusen Mitt Österr Ges Tropenmed Parasitol 20:131–136
- Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Schwetz J (1956) Role of wild rats and domestic rats (*Rattus rattus*) in schistosomiasis of man. *T Roy Soc Trop Med H.* 50: 275–282. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Seo BS, Rim HJ, Lee CW, Yoon JS (1964) Studies on the parasitic helminths of Korea: II. Parasites of the rat, *Rattus norvegicus* Exrl. In Seoul, with the description of *Capillaria hepatica* (Bancroft, 1893) Travassos, (1915). *Kisaengchunghak Chapchi.* 2(1):55–62
- Seo BS, Rim HJ, Yoon JJ, Koo BY, Hong NT (1968) Studies on the parasitic helminths of Korea III. Nematodes and cestodes of rodents. *Korean J Parasitol* 6(3):123–131
- Seong JK, Huh S, Lee JS, Oh YS (1995) Helminths in *Rattus norvegicus* captured in Chunchon, Korea. *Korean J Parasitol* 33:235–237
- Sharma D, Joshi S, Vatsya S, Yadav CL (2012) Prevalence of gastrointestinal helminth infections in rodents of Tarai region of Uttarakhand. *J Parasit Dis.* 1–4.
- Shen LJ, Luo ZY, Li W, Li ZH, Gao C, Yang WB, Li LY, Qian TJ (2003) Investigation on rats infected with *Capillaria hepatica* in Dali. *Zhongguo Jishengchoubing Fangzhi Zazhi* 16: 296–298. In: Li CD, Yang HL, Wang Y (2010) *Capillaria hepatica* in China. *World J Gastroenterol.* 16(6):698–702
- Shimatani T (1961) Studies on the ecology of *Capillaria hepatica* eggs. *Journal of Kyoto Prefectural Medical University* 69: 1063–1083. Japanese. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Shorb DA (1931) Experimental infestation of white rats with *Hepaticola hepatica*. *J Parasitol.* 17: 151–154. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Simmons DJC, Walkey M (1971) *Capillaria* and *Hymenolepis* in a wild rat: hazards to barrier-maintained laboratory animals. *Lab Anim* 5:49–55
- Singla N, Singla LD, Gupta K, Sood NK (2013) Pathological alterations in natural cases of *Capillaria hepatica* infection alone and in concurrence with *Cysticercus fasciolaris* in *Bandicota bengalensis*. *J Parasit Dis* 37(1):16–20
- Singleton GR, Spratt DM, Barker SC, Dodgson PF (1991) The geographic distribution and host range of *Capillaria hepatica* (BANCROFT) (Nematoda) in Australia. *Int J Parasitol* 21:945–957
- Singleton GR, Chambers LK (1996) A manipulative field experiment to examine the effect of *Capillaria hepatica* (Nematoda) on wild mouse populations in southern Australia. *Int J Parasitol* 26:383–398
- Sinniah B, Singh M, Anuar K (1979) Preliminary survey of *Capillaria hepatica* (BANCROFT, 1893) in Malaysia. *J Helminthol* 53:147–152
- Solomon GB, Handley CO (1971) *Capillaria hepatica* (Bancroft, 1893) in Appalachian mammals. *J Parasitol* 57(5):1142–4
- Somvanshi R, Bhattacharya D, Laha R, Rangarao GSC (1995) Spontaneous *Capillaria hepatica* infestation in wild rats (*Rattus rattus*). *Indian J Vet Pathol.* 19, 44–45. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Spratt DM, Singleton GR (1986) Studies on the life cycle, infectivity and clinical effects of *Capillaria hepatica* (BANCROFT) (Nematoda) in mice, *Mus musculus*. *Aust J Zool.* 34: 663–675. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Stephan S, Adkins R, Anderson J (2004) Phylogeny and divergence-date estimates of rapid radiations in muroid rodents based on multiple nuclear genes. *Syst Biol* 53(4):533–53
- Stojčević D, Marinculić A, Mihaljević Ž (2002) Prevalence of *Capillaria hepatica* in Norway rats (*Rattus norvegicus*) in Croatia. *Vet arhiv* 72(3):141–149
- Storer TJ (1962) Pacific island rat ecology. Bernice P. Bishop Museum, Honolulu Bull. 225, 274pp. In: Farhang-Azad A, Schlitter DA (1978) *Capillaria hepatica* in small mammals collected from Shoa Province, Ethiopia. *J Wildl Dis.* 14: 358–361

- Stuart P, Golden O, Zintl A, de Waal T, Mulcahy G, McCarthy E, Lawton C (2013) A coprological survey of parasites of wild carnivores in Ireland. *Parasitol Res* 112(10):3587–93. doi:10.1007/s00436-013-3544-7
- Syed-Arnez ASK, Mohd Zain SN (2006) A study on wild rats and their endoparasite fauna from the Endau Rompin National Park, Johor. *Malaysian Journal of Science* 25(2):19–39
- Tenora F (1963) Review of parasitic worms in rodents of the genus *Apodemus* in Czechoslovakia. *Zool. Listy. Brno.* 12: 331–336. In: Asakawa M, Tenora F (1996) A checklist of nematode parasites of the genus *Apodemus* (Murinae: Rodentia) throughout the world excluding Japan. *J. Rakuno Gakuen Univ* 20 (2): 181–213
- Tenora F, Zavadil R (1967) A contribution to the evaluation of capillariid nematodes found in rodents in Czechoslovakia. *Acta Universitatis Agriculturae* 15: 357–368. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig: 145pp.
- Tenora F, Andreassen O, Hindsbo O, Loda J (1991) Helminths of small rodents in Denmark. *Helminthologia* 28:151–154
- Tinnin DS, Ganzorig S, Gardner SL (2011) Helminths of small mammals (Erinaceomorpha, Soricomorpha, Chiroptera, Rodentia, and Lagomorpha) of Mongolia. Faculty Publications from the Harold W. Manter Laboratory of Parasitology. pp. 669
- Tokobaev MM (1960) Gel'mintofauna gryzunov Kirgizii. *Trudy Gel'mintologifeskoy Laboratorii* 10: 235–247. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Tokobaev MM (1976) Gel'minty dikich mlekopitajuscich Srednej. Asii. Izd. "ILIN", Frunze: pp. 179. In: Asakawa M, Tenora F (1996) A checklist of nematode parasites of the genus *Apodemus* (Murinae: Rodentia) throughout the world excluding Japan. *J. Rakuno Gakuen Univ* 20 (2): 181–213
- Torres P, Gonzalez H (1972) Capilariasis hepatica en Valdivia, primera comprobacion en Chile. *Arch Med Veterinaria Vol* 4(2):30–32
- Traversa D, Di Cesare A, Lia RP, Castagna G, Meloni S, Heine J, Strube K, Milillo P, Otranto D, Meckes O, Schaper R (2011) New insights into morphological and biological features of *Capillaria aerophila* (Trichocephalida, Trichuridae). *Parasitol Res* 109(Suppl 1):S97–104. doi:10.1007/s00436-011-2406-4
- Tubangui MA (1931) Worm parasites of the brown rat (*Mus norvegicus*) in the Philippine Islands, with special reference to those forms that may be transmitted to human beings. *The Philipp J Sci* 46:637–687
- Tung KC, Hsiao FC, Yang CH, Chou CC, Lee WM, Wang KS, Lai CH (2009) Surveillance of endoparasitic infections and the first report of *Physaloptera* sp. and *Sarcocystis* spp. in farm rodents and shrews in central Taiwan. *J Vet Med Sci* 71(1):43–7
- Tung KC, Hsiao FC, Wang KS, Yang CH, Lai CH (2013) Study of the endoparasitic fauna of commensal rats and shrews caught in traditional wet markets in Taichung City, Taiwan. *J. Microbiol Immunol Infect* 46(2):85–8. doi:10.1016/j.jmii.2012.01.012
- Vanni V (1938) Sul potere cirrogino delle uova di *Capillaria hepatica*. *Annali d'Igiene* 48: 529–531. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Vanni V (1947) Sobre algunas metaplasias producidas por helmintos. *Archivos de la Sociedad de Biología de Montevideo* 14: 11–13. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Vogelsang EG, Espin J (1949) Dos nuevos huespedes para *Capillaria hepatica* (BANCROFT, 1893) TRAVASSOS 1915; nutria (*Myopotamus coypus*) y el raton mochilero (*Akodon venezuelensis*). *Revista de medicina veterinaria y parasitología* 8: 73–78. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Wan X, Liu W, Zhao T, Jing Y, Guo P, Shi Y, Wang G (2007a) Relationship between the infective characters of *Capillaria hepatica* and the body mass of the Brandt's vole (*Lasiopodomys brandtii*). *Acta Theriol Sin* 27(2):165–169
- Wan XR, Jing Y, Wang GH, Sa RH, Lou JP, Guan QG, Yu C, Du SY (2007b) Relationship between *Phodopus campbelli* age and population density and *Capillaria hepatica* infective rate. *Chinese J Ecology* 26(4):515–518
- Wang Z, Lin X, Wang Y, Cui J (2013) The emerging but neglected hepatic capillariasis in China. *Asian Pac J Trop Biomed* 3(2):146–7. doi:10.1016/S2221-1691(13)60039-8
- Wantland WW, Kemple HM, Beers GR, Dye KE (1956) *Cysticercus fasciolaris* and *Capillaria hepatica* in *Rattus norvegicus*. *Trans Ill Acad Sci.* 49, 177–181. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Warwick T (1937) The occurrence of disease among muskrats (*Ondatra zibethica*) in Great Britain during 1934. *J Anim Ecol.* 6: 112–114. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Webster JP, Macdonald DW (1995) Parasites of wild brown rats (*Rattus norvegicus*) on UK farms. *Parasitology* 111:247–255
- Wilamowski A, Moran S, Greenburg Z (2002) Commensal rodents and their parasites in Israel. In Proceedings of the 4th international conference on urban pests. Charleston, South Carolina, USA. 103–112.
- Wilson K, Eady P, del Nevo AJ (1998) Origin of an insular population of the wood mouse based on parasitological evidence. *J Wildl Dis* 34(1):150–4
- Winfield GF (1933) Quantitative experimental studies on the rat nematode, *Heterakis spumosa* Schneider. *Amer. J. Hyg.* 17: 168–228. In: Lubinsky G (1956) On the probable presence of parasitic liver cirrhoses in Canada. *Can J Comp Med Vet Sci.* 20: 457–465
- Wirreno W (1978) Nematode parasites of rats in West Java, Indonesia. *Southeast Asian J Trop Med Public Health* 9: 520–525. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Wright KA (1961) Observations on the life cycle of *Capillaria hepatica* (BANCROFT, 1893) with a description of the adult. *Can J Zool.* 38: 167–182. In: Schmidt S (2001) Untersuchungen zum Vorkommen von *Capillaria hepatica* und Metazestoden der Cyclophyllida bei Wildmäusen in Deutschland. PhD Thesis, Universität., Veterinärmedizinische Fakultät, Leipzig:145pp.
- Wu X (1930) A study of the common rat and its parasites. *Lignan Sc. Jour.* 9: 51–64. In: Seo BS, Rim HJ, Lee CW, Yoon JS (1964) Studies on the parasitic helminths of Korea: II. Parasites of the rat, *Rattus norvegicus* Erxl. In Seoul, with the description of *Capillaria hepatica* (Bancroft, 1893) Travassos, (1915). *Kisaengchunghak Chapchi.* 2(1):55–62
- Xiong MT, Rong YG, Xiong W, Xiong MT, Yang GR, Wu X (1999) Investigation of small mammals with *Capillaria hepatica* in Weishan County. *Endemic Diseases Bulletin* 14(3):58–60
- Xue YS, Wu CH, Huang MS, Li RH (1998) Investigation on rats infected with *Capillaria hepatica* in Fuqing. *Haixia Yufang Yixue Zazhi* 4:

- 31–32. In: Li CD, Yang HL, Wang Y (2010) *Capillaria hepatica* in China. World J Gastroenterol. 16(6):698–702
- Yagisawa M (1978) Studies on zoonotic helminths from mammals in Northern Honshu, Japan. Hirosaki Medical Journal 2(30): 239–284
- Yang ZH, Lu KH (2000) Survey of *Angiostrongylus cantonensis* and *Capillaria hepatica* in field rodents in Taiwan. Taiwan J Vet Med Anim Husband 70:51–57
- Yi JY, Kim YH, Kim HC, Hahn TW, Jeong H, Choi CU, Woo GH, Kim YB, Han JH, Yoon BI (2010) Prevalence of hepatic parasites in Korean wild rats (*Rattus norvegicus*) and their association with pulmonary arteriolar medial hypertrophy. Vet Pathol 47(2):292–7. doi:10.1177/0300985809359306
- Yuan GL, Li XY, Chen WJ (2000) Investigation on *Rattus losea* infected with *Capillaria hepatica* in Ningde. Zhongguo Meijie Shengwuxue Ji Kongzhi Zazhi 11: 301–302. In: Li CD, Yang HL, Wang Y (2010) *Capillaria hepatica* in China. World J Gastroenterol. 16(6):698–702
- Zhang LY, Huang JY, Yang FZ (2003) Investigate on rats infected with *Capillaria hepatica* in Jiangle. Zhongguo Jishengchoubing Fangzhi Zazhi 16: 19–20. In: Li CD, Yang HL, Wang Y (2010) *Capillaria hepatica* in China. World J Gastroenterol. 16(6):698–702
- Zhou XM, Zhang GF, Li C, Li FH, Yin ZH, Yang JL, Su P (1998) Investigation on rats infected with *Capillaria hepatica* in Kunming. Zhongguo Renshou Gonghuanbing Zazhi 14: 33. In: Li CD, Yang HL, Wang Y (2010) *Capillaria hepatica* in China. World J Gastroenterol. 16(6):698–702
- Zhou ZL, Wu HY, Mao XP, Fang ZM (1991) Investigate the infection rate of *Capillaria hepatica* on rats. Zhongguo Bingyuan Shengwuxue Zazhi 4: 225. In: Li CD, Yang HL, Wang Y (2010) *Capillaria hepatica* in China. World J Gastroenterol. 16(6):698–702