

Baylisascaris transfuga: a parasite with zoonotic potential

Mohmad Muzafar Sheikh^{1*}, Hidayatullah Tak², Mustahson F. Fazili², Bilal A. Bhat² and Ishfaq Nazir Wani³

^{1*} Research Scholar, Department of Zoology, University of Kashmir, Kashmir, 190006, India.

² Assistant Professor, Department of Zoology, University of Kashmir, Kashmir, 190006, India.

³ Research Scholar, Department of Zoology, University of Kashmir, Kashmir, 190006, India.

Abstract

Baylisascaris, a genus of Ascaridoid nematodes, comprises of a total 10 species with a wide range of hosts. They have a similar life cycle pattern either direct, through oro-fecal route or indirect, through an intermediate host which is usually a small mammal. *Baylisscais transfuga* is a well known intestinal round worm of all bear species, except spectacled bear. Although *B. procyonis*, is reported to cause fatal neurologic disease in humans and many wildlife species, the work regarding larval migrans of other species including *B. transfuga* is still in infancy. However there is a circumstantial evidence of *Baylisascaris transfuga* causing neural migrans in Japanese macaques that share habitat with American black bear. This is substantiated by experimental work wherein *B. transfuga* has caused larval migrans in rat, rabbit, Mongolian gerbil and chick leading to death in some cases. The work has evoked interest in presenting the existing information on *B. transfuga* for future study. Here we provide a review on morphology, geographic distribution, epidemiology, impact on paratenic host, diagnosis and control of this understudied species.

Keywords: *Baylisascaris transfuga*, larva migrans, bear and zoonosis

was named in honor of Parasitologist H. A. Baylis of the British Museum of Natural History (Sprent, 1968). Sprent (1968) reclassified members *Ascaris* and *Toxascaris* of bear into a new genus *Baylisascaris* on the basis of presence of pericloacal rough patches and subventral postcloacal papillae. Worms of Genus *Baylisascaris* include 10 species; inhabiting a wide range of hosts (Sprent 1968, 1970; Wu et al., 1987; Kazacos 2001; Tokiwa et al. 2014) (table 1).

Table 1. *Baylisascaris* species and their primary hosts

Speices	Primary host(s)
<i>B. transfuga</i>	Bears
<i>B. procyonis</i>	Raccoons
<i>B. potosis</i>	Kinkajous
<i>B. columnaris</i>	Skunks
<i>B. melis</i>	Badgers
<i>B. devosi</i>	Martens, fishers
<i>B. schroederi</i>	Giant pandas
<i>B. ailuri</i>	Red pandas
<i>B. tasmaniensis</i>	Tasmanian devils, quolls
<i>B. laevis</i>	Marmots, ground squirrels

1. Introduction

Baylisascaris transfuga (Rudolphi, 1819), a parasitic intestinal round worm belonging to the family Ascarididae under Order Ascaridida, has been reported in all bear species, excluding spectacled bear (Schaul, 2006; Sapp et al., 2017). The Genus *Baylisascaris* was officially described in 1968 and

Adult worms of *B. transfuga* range in length from 10-25 cm (Moran et al., 1994; Okoshi et al., 1962; Khera, 1951), females being larger than males. They possess cervical alae, absence of an interlabium and striation around the body at the site of the vulva (Okoshi et al., 1962). The spicules in males are short and stout (0.85-1.02 mm long) and covered with small granulations (Khera, 1951). The Males of *Baylisascaris* spp. possess pericloacal

roughened areas known as area rugosa. The cervical alae of adult worms possess cuticular bars which reach the surface of the cuticle (McIntosh, 1939; Sprent 1952, 1970). Labia papillae (dorsal and subventral) are distinctly double. Males also possess pre and post-cloacal groups of papillae on their tails (Kazacos, 2001). Female *Baylisascaris* spp. lays numerous eggs, which are shed with host fecal matter into the environment. Eggs are brown in color, globular with irregular albuminous coat, with dimensions of 66.3-74.7 X 78.3-88.0 µm (Wallach et al., 1983). Pathogenicity in primary host appears low. Embryonated eggs may be ingested by a variety of paratenic hosts where it does not develop into adult worm and causes larval migrans.

2. Life cycle

The complete life cycle of most *Baylisascaris* spp. is unknown (Gutiérrez, 2000). However, the known life cycle of raccoon roundworm, *Baylisascaris procyonis* is used as a model. The adult male and female live in definitive hosts in large intestines; they mate and produce millions of eggs a day which are passed in feces. The eggs mature and are infective in two to four weeks in conducive environment (Shafir et al., 2011). Eggs have been reported to persist under appropriate environment conditions for up to five years (Sapp et al., 2017). When a definitive host accidentally swallows the eggs, they hatch in the intestine, migrate through hepatic portal system entering blood stream. Larvae in blood stream reach lungs where they moult and finally reach intestines, with swallowed mucus of respiratory tract. In paratenic hosts larvae migrate through the tissue, a condition known as ‘larval migrans’ and can invade visceral organs, eyes and brain causing serious damage. Definitive host may also get infected by ingesting the infected paratenic hosts (Fig 1 and Fig 2).

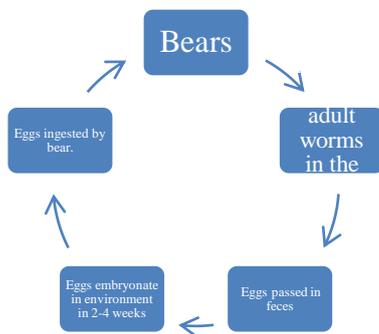


Figure 1 Proposed life cycle (Direct) of *Baylisascaris transfuga* based on *Baylisascaris procyonis* model

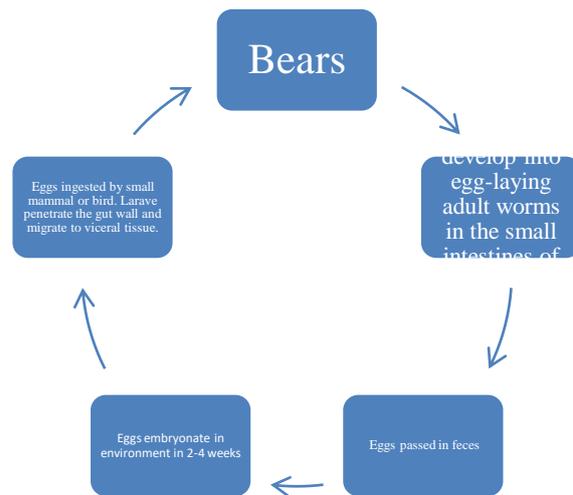


Figure 2 Proposed life cycle (Indirect) of *Baylisascaris transfuga* based on *Baylisascaris procyonis* model.

3. Distribution and Prevalence

The geographic distribution of *Baylisascaris transfuga* is linked to its primary host, bear species. *Baylisascaris* has been reported in grizzly bears in northwestern Canada (Choquette et al., 1968), Canadian Arctic (Gau et al., 1999), black bears in Ontario (Sprent, 1950), Chicago (Jaskoski, 1960), Prague (Jaros, 1966), Alaska (Rausch, 1961), Minnesota (Rogers, 1975), Montana (Worley et al. 1976) Wyoming (Rush, 1932) and southeastern U.S (Crum, 1978). *Baylisascaris transfuga* has also been reported in bears from south-eastern USSR (Oshmarin, 1963), Japan (Okoshi et al, 1962), Caucasus, Baikal, Chukotka, Indonesia, Syria and Tibet (Bromlei, 1965), Croatia (Ambrogi, 2011), Italy (Testini et al. 2011) and Kashmir (Muzafar et al., 2017). The distribution and prevalence of *Baylisascaris transfuga* is presented in table 2.

4. Zoonotic Potential

The serious zoonotic potential of *Baylisascaris columnaris* and *Baylisascaris procyonis* have evoked an interest in the zoonotic potential of other *Baylisascaris* species. *Baylisascaris transfuga* larval migrans has been reported in laboratory studies on various models viz. rat, Mongolian gerbils, rabbits and chickens (Sprent, 1951, 1952, 1953, 1955; Papini, 1996; Sato, 2004 and Schaul, 2006). Experimental paratenic host showed clinical manifestation from visceral larval migrans, ocular larval migrans and neural larval migrans to death

Table 2. Distribution and prevalence of *Baylisascaris transfuga* in bears

S. No	Species	Procedure : No. of samples examined	Location	Prevalence	Refrence
1	Black bear	Necropsy: 55	New York	30.90%	King, 1960
2	Black bear	Necropsy:9	Lake superior	55.55%	Rogers, 1975
3	Black and Grizzly bears	Necropsy: 30 and 70	Montana and Wyoming	80% and 75.5%	Worley et al. 1976
4	Black bear	Coprology/ Necropsy: 168/34	Quebec	23%/18%	Frechette et al, 1977
5	Black bear	Necropsy/Coprology: 29/92	Northern Wisconsin	89%/64.13%	Manville, 1978
6	Black bear	Coprology: 114	Quebec	13%	Frechette et al., 1978
7	Black bear	Necropsy: 53	Southeast U.S	53%	Crum et al., 1978
8	Black bear	Necropsy: 91	Alberta (Canada)	62%	Dies, 1979
9	Black bear	Coprology: 8	Pisgah Forest	50%	Jeness, 1997
10	Grizzly bear	Coprology: 56	Canada	5%	Gau et al, 1999
11	Black bear	Necropsy: 22	Florida	23%	Foster et al, 2004
12	Brown bear	Coprology: 96	Croatia	13%	De Ambrogi et al, 2011
13	Black bear	Necropsy: 130	Dehcho	64.30%	Johnson et al. 2013
14	Black and Brown bears	Necropsy: 40 and 13	Alberta and British Columbia	60% and 53.8%	Catalano et al., 2015
15	Black bear	Coprology: 112	Kashmir Himalaya	47.32%	Sheikh et al. 2017

depending upon the intensity of infection and paratenic host species. Laboratory mice developed mild clinical disease with granulomas in brain. Mongolian gebrils developed malacia and lack of host immune reaction (Sato, 2004). Rabbits displayed a loss of appetite, dyspnea and depression but no neurological signs (Papini, 1996). Chickens did not develop any clinical signs (Papini, 1993). There is no report of larval *Baylisascaris* in humans (Bauer, 2013; Sapp et al., 2017). However there is a circumstantial evidence for larval *Baylisascaris*, a fatal outbreak of neurological larval migrans that erupted in Japanese macaques (*Macaca fuscata*) sharing habitat with American black bear (Sato, 2005).

5. Diagnosis

Diagnosis of adult worm infection in bears is based on identification of eggs in the feces using floatation methods. Imaging techniques such as Computed tomography (CT) and Magnetic resonance imaging (MRI) are useful in detecting damage and atrophy in paratenic host (Huff et al., 1984). Serologic methods like ELISA have also been used (Kazacos, 2016).

6. Prevention and Control

Prevention of *Baylisascaris transfuga* infection in paratenic host depends on preventing ingestion of infective eggs from water and herbage contaminated by bears. Environment which is harnessed by humans for their use should be managed to reduce contamination, like water supply coming from wild habitat should be treated with various disinfectants. Precautionary measures like clean eating habits and routine washing of floor of bear captivity is important when working with bears in captivity. *Baylisascaris transfuga* is not well known by common people, including wildlife biologists, animal care takers and wildlife rehabilitators. So, detailed information of this bear round worm, its mode of transmission and pathology is needed.

Several drugs have been recognized as prophylactic and post infection treatment of ascariasis in definitive hosts (Katz, 1977). Treatment of bears infected with *Baylisascaris transfuga* has been done in captivity. Various anthelmintics have been used but the efficacy is variable. Febendazole, Mebendazole and Dichlorvas have been used but results were not promising (Clark et al., 1969; Moudgil et al., 2014 and Vercruyse et al., 1976).

Anthelmintic baiting can be used to get rid of adult worms in bears, similar to the bait treatment

of *Echinococcus* in foxes in Europe or the use of baits for rabies vaccination of wildlife (Kazacos, 2001). Introduction of plants edible to bears with anthelmintic properties (*Punica* spp, *Ficus* spp, *Trifolium* spp. etc.) should be introduced in bear habitats (Mali et al., 2008).

The clinical efficacy of anthelmintic treatment of larval migrans depends on several factors viz. location of larva, intensity of larval infection and drug pharmacokinetics (Kazacos, 2001). Treatment of low level or early infection appears possible by using larvicidal drugs, such as albendazole (Murray and Kazacos, 2004; Gavin et al., 2005; Kazacos et al., 2013). Levamisole and Ivermectin were used in mice experimentally infected with *Baylisascaris transfuga* eggs. They showed good results when used after three days post infection, after 14 days post infection efficacy decreases (Fu et al., 2011). To treat larval migrans, ivermectin and levamisole anthelmintic drugs have been used, as the former does not cross blood brain barrier whereas later does. (Bennett, 1986; Kazacos, 2001).

7. Conclusion

Population growth and changing socioeconomic conditions have led to ever increasing use of natural resources to meet the demand of human need. Poor hygiene and man's exploitation of wild habitat are responsible for food and water borne zoonoses emerging from wildlife. Human health care strategies are incomplete without considering the health of environment and animals, together they make a 'one health triad'. There is a need for better coordination of medical, veterinary and wildlife sciences and improvement of collaborative approaches to formulate appropriate control strategies for long term health and survival of man. The information on ecology of *Baylisascaris transfuga* is scanty whereas, its life history pattern is unknown. The information on these aspects is therefore, required to suggest mitigation measures for controlling its infection and transmission in animals and humans.

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