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On gastrointestinal nematodes of Mongolian gazelle (*Procapra gutturosa*)

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Summary

The species composition of nematodes found at autopsy of abomasa and small intestines of 24 Mongolian gazelles in Eastern Mongolia is studied. *Orloffia bisonis, Marshallagia mongolica*, *Nematodirus archari, N. andreevi, Trichostrongylus colubriformis, T. probolurus* were registered. *N. archari* and *N. andreevi* were detected in Mongolian gazelle for the first time. All species of gastrointestinal nematodes found in Mongolian gazelles have already been registered in domestic ruminants of Mongolia. The validity of *Orloffia* genus is confirmed based on our own observations and literature data. *Orloffia* is monotypic genus with the only species *O. bisonis* represented by two morphs where "*O. bisonis*" is major and "*O. kasakhstanica*" is minor.

Keywords: Eastern Mongolia; gastrointestinal nematodes; *Procapra gutturosa*

Introduction

Mongolian gazelle *Procapra gutturosa* Pallas, 1777 is an endemic species in Central Asia. In Mongolia and China *P. gutturosa* is the object of licensed hunting (Zhirnov *et al.,* 2005). In the second half of the twentieth century a natural habitat of *P. gutturosa* diminished considerably. In the 1950s Mongolian gazelles were spread on about 2/3 of the territory of Mongolia, on a total area of about 780 000 km^2. To the mid-1970s their natural habitat decreased to its minimum and was estimated as ranging from 81 000 to 170 000 km^2 (Zhirnov *et al.,* 2005). Changes in social and economic conditions in Mongolia in the period of 1989 – 1995 reduced anthropogenic pressures on wild fauna and improved the situation in general (Lushchekina, 1998). Owing to this and some nature conservation measures, the natural habitat of *P. gutturosa* slightly expanded again. Presently it makes about 25 – 30 % of the habitat in 1950s (Lhagvasuren & Milner-Gulland, 1997; Zhirnov *et al.,* 2005).

The estimates of the population size of *P. gutturosa* according to different authors differ considerably due to its mobile mode of life and difficulties in calculation (Zhirnov *et al.,* 2005). A total number of *P. gutturosa* in Mongolia in the 1940s was estimated as 4 – 4.5 mln. Later, the population size decreased and reached its minimum of 1.1 mln in 1975 – 1985, then stabilized and started to increase, but was shrinking again since 1998 (Lhagvasuren, 2000; Zhirnov *et al.,* 2005). According to estimates of Olson *et al.* (2005), Mongolian gazelles may still number one million in Eastern Mongolia. A danger of further decrease of the *P. gutturosa* population size still exists owing to anthropogenic destruction of their habitat, infection diseases, poaching and mass death during harsh winters (Lhagvasuren & Milner-Gulland, 1997; Lhagvasuren, 2000; Kirilyuk & Lushchekina, 2005; Zhirnov *et al.,* 2005; Nyamsuren *et al.,* 2006).

Among factors affecting *P. gutturosa* population size, infectious diseases are of much importance. The death rate from pasteurellosis ranged in different years from several thousand to 140 thousand (Zhirnov *et al.,* 2005). Influenza and foot-and-mouth disease were also recorded as causes of mass death of Mongolian gazelles (Zhirnov *et al.,* 2005; Nyamsuren *et al.,* 2006). It is known that in natural conditions helminth infection usually does not lead to mass mortality (Govorka *et al.,* 1988). However, it can cause a decrease in immunity and in this way contribute to outbreaks of bacterial and virus diseases (Akbaev *et al.,* 1998). In wild ungulates, the damage caused by helminth infections most frequently results in reduction of fertility and survival rate of young animals, and in reduced resistance to severe habitat conditions (Govorka *et al.,* 1988). One of the factors reducing the number of Mongolian gazelles is their mass death during harsh winters (Lhagvasuren, 2000; Zhirnov *et al.,* 2005; Nyamsuren *et al.,* 2006). It was observed that the high intensity of helminth infection results in higher death rate of wild ungu-

lates during harsh winters than those with low infection intensity (Pryeditis, 1979).
Thereby, a study of helminth fauna of Mongolian gazelle is very important for conservation of this species. Considering the possibility of exchange of helminths between wild and domestic ruminants, the study of helminth fauna of Mongolian gazelle is also important for stock-breeding (Sharhuu, 1986; Sharhuu & Sharkhuu, 2004). Data on the helminth fauna of Mongolian gazelle are scarce. First data on helminth fauna of Mongolian gazelle were published in Russian by Danzan (1978) and Sharhuu (1986). A fairly detailed study undertaken by Ganbold (2000) had not been published in international scientific literature. The only report on the helminth fauna of wild and domestic ruminants of Mongolia published in an international journal, is a short review by Sharhuu & Sharkhuu (2004). Gastrointestinal nematodes of ruminants are widespread and notable for considerable species diversity but the taxonomic status of many species is uncertain and needs clarification.

Material and methods

Abomasa and small intestines of Mongolian gazelles were sampled in two sites in Eastern Mongolia (48º10' n.l., 112º30' e.l. and 47º29' n.l., 111º25' e.l.) in July 2006 – 2008 and in October 2008. The samples were collected during licensed hunting, in compliance with licence restrictions on the quantity of gazelles. Special selection by age, sex and body condition of individuals was not carried out during hunting. In total, 24 Mongolian gazelles (16 females and 8 males) were examined. Age of animals was estimated by teeth condition and ranged from 1 to 6 years.
Helminthological procedures on abomasa and small intestines content were carried out according to Ivashkin *et al.* (1971). All killed gazelles were eviscerated and the abomasa and small intestines were processed without separation from each other. For each gazelle we examined first 50 cm of small intestine connected with the abomasum. The abomasum and small intestine were dissected and their content was emptied into a bucket. The mucous tunic was scraped and washed thoroughly with water into the bucket together with abomasum and small intestine content. When the residue has settled the supernatant was decanted. The residue was preserved in 70 % ethanol for later examination.
In the laboratory, nematodes were picked out from the residue using binocular loupe. The whole volume of the residues was examined. Species identification of the nematodes was made using males only because of unreliability of precise diagnostics based on females. Nematodes were cleared with 10 % glycerin in temporary total preparations (Ivashkin *et al.*, 1971). Species identification were based on morphology, specifically on reproductive system peculiarities according to data of Ivashkin *et al.* (1989), Drozdz (1995), Hoberg & Abrams (2001), Kuznetsov (2006). Due to scarcity of data on the morphology of *Nematodirus* spp. (Skrjabin *et. al.*, 1954; Ivashkin *et al.*, 1989), in the present study we used our own keys for this genus (unpublished).

Results and discussion

All examined Mongolian gazelles were infected with nematodes. Rates of infection intensity are presented in Table 1. Total number of all species of gastrointestinal nematodes ranged from 10 to 408 individuals. Infection intensity values were higher in 2006 and 2007 than in 2008.
Orloffia bisonis (Chapin, 1925) was registered in all animals examined. *Orloffia kasakhstanica* (Dikov et Nekipelova, 1963), supposed minor morph of *O. bisonis,* and *Marshallagia mongolica* Schumakovitch, 1938 were also registered in the majority of examined animals. Single individuals of *Nematodirus archari* Sokolova, 1948 and *N. andreevi* Satubaldin, 1954 were found in some animals. Single specimens each of male of *Trichostrongylus colubriformis* (Giles, 1892) and *T. probolurus* (Railliet, 1896) were discovered in two Mongolian gazelles. Number of males of discovered species of nematodes is presented in Table 1.
Literary sources point to the frequent discovery of *O. dahurica* in Mongolian ruminants (Sharhuu, 1986; Sharhuu & Sharkhuu, 2004). Sharhuu (1986) considered *O. dahurica* to be a dominant species of helminths of Mongolian gazelle. A comparison of *O. bisonis* and *O. dahurica* descriptions given by various authors (Skrjabin & Orlov, 1934; Skrjabin *et. al.*, 1954; Ivashkin, 1955; Dikov, 1961; Boev *et al.,* 1963; Karamendin, 1967; Ivashkin *et al.,* 1989; Becklund & Walker, 1967; Lichtenfels & Pilitt, 1991), as well as our own observations, makes us to assume that *O. dahurica* is not a valid species. According to the hypothesis of polymorphism, the existence of major and minor morphs of males of the same species is typical for subfamily Ostertagiinae Lopez-Neyra, 1947 (Drozdz, 1995). According to Drozdz (1995), *O. kasakhstanica* (Dikov et Nekipelova, 1963) is the supposed minor morph for *O. bisonis,* and *O. buriatica* (Konstantinova in Skrjabin et Orloff, 1934) the supposed minor morph for *O. dahurica*.
The comparative analysis of ITS-2 rDNA sequences obtained from samples which were identified based on morphology and morphometry as *Orloffia bisonis, O. kasakhstanica*, *O. dahurica* and *O. buriatica* has shown no significant differences in all sequences studied (Kuznetsov, 2011). Together with the literature data it leads us to the conclusion that the only valid species in the genus *Orloffia* is *Orloffia bisonis,* which males are presented by two morphs where *O. bisonis* is major and *O. kasakhstanica* is minor. Therefore, all mentioned in the literature cases of *O. dahurica* are to be considered as *O. bisonis* which makes *O. bisonis* one of the dominant species of helminths of Mongolian gazelle. At the same time, the level of differences in ITS-2 regions of the members of *Orloffia* and *Ostertagia* genera (Kuznetsov, 2011) does not prove *Orloffia* being not a valid genus but a junior synonym of *Ostertagia* as a number of authors suppose (Becklund & Walker, 1967; Lichtenfels & Pilitt, 1991), but supports the opinion of Drozdz (1995) insisting on the independence of *Orloffia* genus.

Table 1. The intensity of infection of Mongolian gazelles with gastrointestinal nematodes and the list of detected species

Month and year of collection	**Sex of hosts**	**Host age, years**	**Number of detected nematodes**			**Species and number of males (in brackets)**
			Total	Males	Females	
July 2006	♂	4	308	102	206	*O. bisonis* (58)/*O. kasakhstanica* (26), *M. mongolica* (11), *N. archari* (2), *N. andreevi* (4), *T. colubriformis* (1)
	♀	6	227	99	128	*O. bisonis* (58)/*O. kasakhstanica* (18), *M. mongolica* (19), *N. archari* (2), *N. andreevi* (2)
	♀	3	198	58	140	*O. bisonis* (28)/*O. kasakhstanica* (13), *M. mongolica* (17)
	♀	2	152	50	102	*O. bisonis* (30)/*O. kasakhstanica* (14), *M. mongolica* (5), *T. probolurus* (1)
	♀	1	131	57	74	*O. bisonis* (36)/*O. kasakhstanica* (12), *M. mongolica* (3), *N. archari* (1), *N. andreevi* (5)
	♀	1	106	22	84	*O. bisonis* (10)/*O. kasakhstanica* (5), *M. mongolica* (5), *N. archari* (2)
July 2007	♀	5	104	54	50	*O. bisonis* (37)/*O. kasakhstanica* (12), *M. mongolica* (2), *N. archari* (1), *N. andreevi* (2)
	♀	5	248	108	140	*O. bisonis* (84)/*O. kasakhstanica* (17), *N. archari* (2), *N. andreevi* (5)
	♀	4	408	174	234	*O. bisonis* (114)/*O. kasakhstanica* (31), *M. mongolica* (17), *N. archari* (4), *N. andreevi* (8)
	♀	4	224	78	146	*O. bisonis* (62)/*O. kasakhstanica* (13), *N. archari* (1), *N. andreevi* (2)
	♀	3	407	194	213	*O. bisonis* (115)/*O. kasakhstanica* (45), *M. mongolica* (19), *N. archari* (6), *N. andreevi* (9)
July 2008	♂	4	85	21	64	*O. bisonis* (13)/*O. kasakhstanica* (4), *M. mongolica* (1), *N. archari* (1), *N. andreevi* (2)
	♂	3	35	9	26	*O. bisonis* (5)/*O. kasakhstanica* (2), *M. mongolica* (2)
	♀	3	46	14	32	*O. bisonis* (7)/*O. kasakhstanica* (2), *M. mongolica* (5)
	♀	4	10	4	6	*O. bisonis* (3)/*O. kasakhstanica* (1)
	♂	3	15	7	8	*O. bisonis* (5)/*O. kasakhstanica* (2)
	♂	3	44	5	39	*O. bisonis* (3)/*O. kasakhstanica* (1), *M. mongolica* (1)
October 2008	♂	3	68	28	40	*O. bisonis* (16)/*O. kasakhstanica* (5), *M. mongolica* (3), *N. archari* (1), *N. andreevi* (3)
	♀	5	24	4	20	*O. bisonis* (3), *M. mongolica* (1)
	♀	3	38	12	26	*O. bisonis* (7)/*O. kasakhstanica* (5)
	♂	4	18	2	16	*O. bisonis* (2)
	♀	2	35	8	27	*O. bisonis* (5), *M. mongolica* (3)
	♀	4	90	27	63	*O. bisonis* (15)/*O. kasakhstanica* (4), *M. mongolica* (3), *N. archari* (2), *N. andreevi* (3)
	♂	3	13	2	11	*O. bisonis* (2)

The species composition of gastrointestinal nematodes of Mongolian gazelle is very similar to that of domestic ruminants inhabiting this region (Sharhuu & Sharkhuu, 2004; Kuznetsov *et al.*, 2010). It may indicate a significant anthropogenic impact on the population of Mongolian gazelle. The direction of interchange of helminths between wild and domestic ruminants in natural conditions of Mongolia is still not clear. Sharhuu (1986) regarded wild fauna as a source of infection for domestic ruminants. On the contrary, Rykovskyi (1974) and Egorov *et al.* (1997) had shown that in a situation of strong anthropogenic pressure in the European part of Russia, the interchange of helminths was going in a direction from domestic to wild ruminants. Govorka *et al.,* (1988), basing on numerous observations in several regions of Eastern Europe, also came to the conclusion that livestock, as a rule, is a source of infection of helminths, and wild ruminants are the damaged party. Supposedly, the same type of interchange of helminths takes place in Eastern Mongolia. The total number of livestock in Mongolia reaches 35 million (Zhirnov *et al.,* 2005). Such a strong anthropogenic pressure ought to increase parasitic pressure on the wild ruminants.

The number of susceptible hosts is a very important condition that determines the possibility of the circulation of parasites. As it is known, when host population size is low the level of host infestation with parasites may decrease dramatically following by a complete loss of some parasite species. When the host population size starts to recover hosts acquire new species of parasites from phylogenetically and ecologically related species. For example, 36 of the 38 species of helminths found in saiga in Kazakhstan have been found also in domestic livestock (Morgan *et al.,* 2005). Evidently, a similar situation has developed as a result of changes in quantity and natural habitat of Mongolian gazelle. Dominant in Mongolian gazelle, *O. bisonis* and *M. mongolica* were also dominant in goats and sheep in Mongolia (Kuznetsov *et al.*, 2010).

Nematodirus archari and *N. andreevi* were recorded in Mongolian gazelle for the first time. Both species were previously found in domestic goats (Sharhuu & Sharkhuu, 2004). This fact may also indicate increased anthropogenic pressure on the population of Mongolian gazelle.

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References

AKBAEV, M. SH., VODYANOV, A. A., KOSMINKOV, N. E., YATUSEVITCH, A. I., PASHKIN, P. I., VASYLEVITCH, F. I. (1998): *Parasitology and invasive diseases of animals.* Moscow, Russia, Pub. House Kolos, 744 pp.

BECKLUND, W. W., WALKER, M. L. (1967): Redescription of the nematodes *Ostertagia bisonis* Chapin, 1925, of cattle and wild animals, and *Ostertagia mossi* Dikmans, 1931, of deer. *J. Parasitol.,* 53(6): 1273 – 1280

BOEV, S. N., SOKOLOVA, I. B., PANIN, V. YA. (1963): *Helminths of ungulates of Kasakhstan.* Alma-Ata, Kasakhstan, Pub. House of AS of KasSSR, 535 pp.

DANZAN, G. (1978): *Helminths of wild mammals in Mongolian people's republic*. DSc thesis, Russia, Moscow: All-Union K. I. Skryabin Institute for Helminthology

DIKOV, G. I. (1961): A redescription of a nematode parasite of sheep – *Ostertagiella dahurica* (Trichostrongylidae). *Helminthologia,* 3: 85 – 89

DROZDZ, J. (1995): Polymorphism in the Ostertagiinae Lopez-Neyra, 1947 and comments on the systematics of these nematodes. *Syst. Parasitol.* 32(2): 91 – 99

EGOROV, A. N., MAKLAKOVA, L. P., RYKOVSKYI, A. S. (1997): Change in helminths diversity of wild ungulates under conditions of intensive economic usage of hunting areas. In *Ecological and taxonomic diversity of parasites.* Moscow, Russia, Pub. House Nauka, pp. 40 – 43.

GANBOLD, M. (2000): *Helminths of Mongolian gazelle (Procapra gutturosa Pall., 1977) in Eastern Mongolia.* PhD thesis, Mongolia, Ulaanbaatar: Mongolian State University of Education

GOVORKA, YA., MAKLAKOVA, L. P., MITUKH, YA., PELGUNOV, A. N., RYKOVSKYI, A. S., SEMENOVA, M. K., SONIN, M. D., ERKHARDOVA-KOTRLA, B., YURASHEK, V. (1988): *Helminths of wild ungulates in Eastern Europe.* Moscow, Russia, Pub. House Nauka, 208 pp.

HOBERG, E. P., ABRAMS, A. (2001): Synlophe in *Ostertagia* cf. *kasakhstanica* (Nematoda: Ostertagiinae), the minor morphotype of *O. bisonis* from Western North America. *J. Parasitol.,* 87(5): 1181 – 1184

IVASHKIN, V. M. (1955): *Helminths of agricultural animals in Mongolian people's republic*. Moscow, USSR, Pub. House of AS of USSR, 213 pp.

IVASHKIN, V. M., KONTRIMAVICHIUS, V. N., NAZAROVA, N. S. (1971): *Methods of collection and study of helminths of terrestrial mammals.* Moscow, USSR, Pub. House Nauka, 124 pp.

IVASHKIN, V. M., ORIPOV, A. O., SONIN, M. D. (1989): *Keys to helminths of small cattle.* Moscow, USSR, Pub. House Nauka, 256 pp.

KARAMENDIN, O. S. (1967): Morphology and systematic of some Trichostrongylids. *Transactions of Institute of Zoology of KasSSR,* 27: 169 – 181

KIRILYUK, V., LUSHCHEKINA, A. A. (2005): International conference on Mongolian gazelle conservation. *Steppe bulletin,* 17: 17 – 19

KUZNETSOV, D. N. (2006): A method for differentiation of nematodes of subfamily Ostertagiinae. *Transactions of All-Russian K. I. Skryabin Institute for Helminthology*, 43: 271 – 278

KUZNETSOV, D. N. (2011): Taxonomic revision of the genus *Orloffia* (Nematoda: Ostertagiinae) based on an ITS-2 rDNA study. *Biology Bulletin,* 38(6): 608 – 614. DOI: 10.1134/S1062359011060070

KUZNETSOV, D. N., DANZAN, G., BATCHIMEG, M., KHRUSTALEV, A. V. (2010): Nematodes of ruminants from steppe zone of Eastern Mongolia. *Biodiversity and Ecology of Parasites (Transactions of Center for Parasitology of Severtsov's institute of Ecology and Evolution RAS)*, 46: 114 – 116

LHAGVASUREN, B. (2000): *Conservation and analysis of factors affecting the spread and number of Mongolian gazelle (Procapra gutturosa).* PhD thesis, Mongolia, Ulaanbaatar

LHAGVASUREN, B., MILNER-GULLAND, E. J. (1997): The status and management of the Mongolian gazelle *Procapra gutturosa* population. *Oryx,* 31: 127 – 134
LICHTENFELS, J. R., PILITT, P. A. (1991): A redescription of *Ostertagia bisonis* (Nematoda: Trichostrongyloidea) and a key to species of Ostertagiinae with a tapering lateral synlophe from domestic ruminants in North America. *J. Helminthol. Soc. Wash.,* 58(2): 231 – 244
LUSHCHEKINA, A. A. (1998): Current state and perspectives of international cooperation for protection and stable use for the Mongolian gazelle. *Proceedings of RAS. Biology series,* 4: 462 – 466
MORGAN, E. R., SHAIKENOV, B., TORGERSON, P. R., MEDLEY, G. F., MILNER-GULLAND, E. J. (2005): Helminths of saiga antelope in Kazakhstan: implications for conservation and livestock production. *J. Wildl. Dis.,* 41(1): 149 – 162
NYAMSUREN, D., JOLY, D. O., ENKHTUVSHIN, S., ODONKHUU, D., OLSON, K. A., DRAISMA M., KARESH, W. B. (2006): Exposure of Mongolian gazelles (*Procapra gutturosa*) to foot and mouth disease virus. *J. Wildl. Dis.,* 42(1): 154 – 158
OLSON, K., FULLER, T. K., SHALLER, G. B., ODONKHUU, D., MURRAY, M. G. (2005): Estimating the Population density of Mongolian gazelles by driving long-distance transects. *Oryx,* 39: 164 – 169
PRYEDITIS, A. A. (1979): The value of age and sex for the infection by helminths in roes, red deer and elks. In *Theoretical and practical issues of parasitology.* Tartu, pp. 76 – 77
RYKOVSKYI, A. S. (1974): Fauna formation of helminths in wild ungulates in the conditions of cultural landscape in European part of USSR. *Transactions of Helminthological laboratory of Academy of sciences,* 24: 144 – 152
SHARHUU, G. (1986): *Helminths of domestic and wild ruminants and development of measures to combat the main helminthiasis in Mongolian people's republic*. DSc thesis, Russia, Moscow: All-Union K. I. Skryabin Institute for Helminthology
SHARHUU, G., SHARKHUU, T. (2004): The helminth fauna of wild and domestic ruminants in Mongolia – a review. *Eur. J. Wildl. Res.*, 50: 150 – 156. DOI: 10.1007/s10344-004-0050-3
SKRJABIN, K. I., ORLOV, I. V. (1934): *Trichostrongylidoses of ruminants.* USSR, Moscow, Selkhozgiz, 351 pp.
SKRJABIN, K. I., SHIKHOBALOVA, N. P., SHULTS, R. S. (1954): *Essentials of nematodology III. Trichostrongyloids of animals and man.* Moscow, Pub. House of Academy of Sciences USSR, 683 pp.
ZHIRNOV, L. V., GUNIN, P. D., ADIYA, YA., BAZHA, S. N. (2005): *The Conservation Strategy for Wild-hoofed Animals of Mongolia (Biological Resources and Natural Conditions of Mongolia: proceedings of the Joint Russian-Mongolian Complex Biological Expedition RAS and MAS; Vol. 45)*. Russia, Moscow, pp. 74 – 104

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