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Small ruminant Gongylonema pulchrum infection in the South West Algerian desert: prevalence of a sporadic zoonosis

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Summary

Individual faecal samples were randomly collected from the rectum of goats (n = 120) and sheep (n = 182) bred in four distinct areas of the South West Algerian desert. All the samples were examined by faecal flotation technique. A range of gastro-intestinal parasites was recorded by microscopic examination. Special reference was given to potentially zoonotic nematodes. Typical G. pulchrum eggs were detected as mixed or single infections in 9.3% of the animals (15% of goats and 5.5% of sheep). Goats were statistically (OR=3.04 [1.35-6.83]) more likely to harbor G. pulchrum infections than sheep. Animals older than 1 year of age were more likely to be infected with G. pulchrum than younger ones, but these differences di not reach statistically significant values. Monitoring human infections represents an imperative need of modern society. Anyone working with sheep and goats or sharing the same environment with them and physicians should be aware of gongylonemiasis and other potentially zoonotic nematode infections due to ovicaprines, though considered not life-threatening, sporadic or neglected.

Keywords: Gongylonema pulchrum, shee, goats, zoonotic nematodes

It is well known that one of the main threats facing small ruminant breeding worldwide is parasitism, which is caused by a wide range of protozoa, helminths, and arthropods. Sheep and goats are affected for the most part by the same parasites. Problems associated with parasites, particularly those of the gastrointestinal tract, can cause irreversible damages, death, reduced performance and economic losses (21). In particular, infections caused by different genera of nematodes still today remain one of the main constraints to sheep and goat production both in temperate and tropical countries. Therefore, monitoring and surveillance of parasitic infections in small ruminants, with the final goal of setting up sustainable and effective control strategies, have been investigated (20).

On the other hand, it should be kept well in mind that surveillance of helminth infection in ovicaprines is very important also from a public health point of view, because some gastrointestinal nematodes of sheep and goats can also infect humans causing zoonoses considered sporadic so far. For instance, adult worms of the spirurid nematode *Gongylonema pulchrum* (also known as the 'gullet worm" because of its location in the upper digestive system) are found in burrows in the mucosal lining of the esophagus and rumen of sheep and goats throughout the world. Its transmission cycle is indirect and occurs through accidental ingestion of coprophagus (manure-eating) beetles and cockroaches. Eggs in feces hatch after being eaten by these insects where larvae develop to the infective stage. Sheep and goats ingest the intermediate hosts while grazing, larvae are released in the abomasum and migrate forward to the esophagus where they develop into adults. The infection can occur also in a variety of other domestic and wild mammals (i.e., cattle, camels, pigs, horses, monkeys, cervids, rodents, wild boars, bears, primates) and has been diagnosed even in the oral cavity and tongue of humans in many places around the world (5, 8, 14, 19, 23, 24).

The opportunity to perform a survey in goats and sheep in areas of the Sahara desert prompted us to determine the coprological prevalence and distribution of parasite in ovicaprines of this geographical region. Results are here reported, focusing on whether they may serve as reservoir hosts for zoonotic nematodes with special reference to *G. pulchrum*.

Material and methods

The study area included refugee camps around the oasis town of Tindouf (geographical coordinates: 27° 40' 31.44" N, 8° 7' 42.6" W) in the South West Algerian desert. The camps are located on a plateau at 500 meters above the sea level covering an area of about 100 square kilometers. Inhabitants are distributed into twenty-five municipalities and five administrative provinces, namely Smara, El-Ayoun, Dakhla, Auserd, and 27 de Febrero. The South West Algerian desert is part of the Hammada, which is one of the driest place on earth with rainfall well below 100 mm per year. This is the most hostile to life among three ecosystems of the Sahara, the world's largest desert. There are predominantly expanses of stony ground or barren rock with little vegetation of low foraging value such as *Acacia tortilis*, *Artemisia herba-alba*, *Cotulea cinerea*, *Citrullus colocynthis*, *Euphorbia calyptrata*, *Hammada scoparia*, *Stipa* spp. Temperatures often soar over 50 degrees in summer days and drop to 5 degrees below zero in winter nights.

Almost every family has small ruminants, usually a mixed sheep-goat flock with 5-20 animals in average. During the day, the animals are free to wander in mixed groups of sheep and goats searching for the scarce natural vegetation. Their diet is supplemented with a mash made of water, scraps of human food (vegetables, rice, bread, pasta) and large amounts of paper as fiber source. Only occasionally they receive a small amount of feed. Often sheep and goats graze among the rubbish, eating rags, plastic, and other waste. At sunset, the animals are confined in pens located on the outskirts of tent camps and made with pieces of sheet metal, wire mesh, wooden poles and other waste materials.

In September 2011, a total number of 302 individual faecal samples were collected directly from the rectum of goats (n = 120) and sheep (n = 182) bred in refugee camps. Sampled animals were randomly selected, had different ages, and did not receive any anthelminthic treatment in the previous months. After collection, each sample was placed in a clean plastic container, labeled, taken to the laboratory of the veterinary school of Rabuni within 2-6 hours, and kept at 4°C until parasitological determination was carried out.

Goats examined were hybrids of Sahelian goats while sheep were descendants of Sahel-type sheep, both crossed with local indigenous strains. Fifty-two goats and 48 sheep were from Smara (19 and 13 flocks), 32 goats and 32 sheep from 27 de Febrero (7 and 6 flocks), 16 and 52 from El-Ayoun (4 and 6 flocks), 20 and 50 from Dakhla (2 and 4 flocks). In average, 4 (range 2-10) goats and 6 (range 2-18) sheep were sampled in each flock. One hundred-twenty six sheep and 112 goats were females while 56 only 8 were males, respectively. There were 98 adult (> 1 year-old) and 22 young (≤ 1 year-old) goats as well as 126 adult and 56 young sheep. The age of goats ranged from 3 months to 7 years (mean = 31 months, standard deviation = 18 months) while the age of sheep ranged from 2 weeks to 10 years (mean = 27 months, standard deviation = 14 months). One hundred goats and 156 sheep were asymptomatic while 20 and 26 of them showed diarrhea at the time of sampling, respectively.

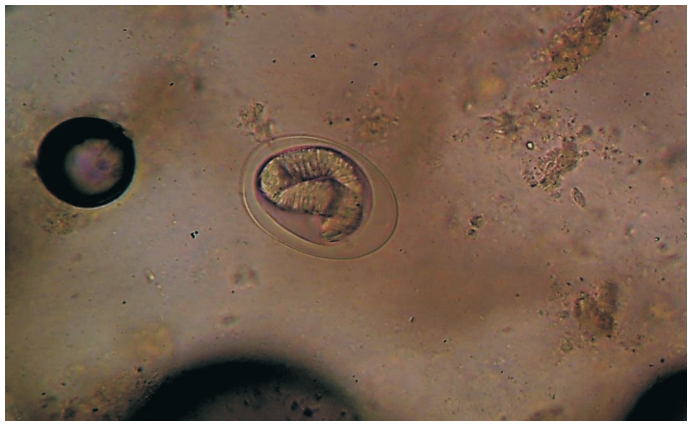

Fig. 1. Fully embryonated egg of *G. pulchrum* in goat faeces (400×)

For faecal analysis, approximately 5 gram faeces were examined by routine flotation technique for the presence of eggs of helminthes, using a saturated sodium chloride solution with a specific gravity of 1.2. Slides were microscopically screened at 100× and 400× magnification (Fig. 1).

Prevalence values were calculated as number of positive animals/number of examined animals × 100 with the corresponding 95% confidence intervals (95% CI). Data collected for each animal included province, species, age, and presence or absence of visible clinical signs at the time of sampling. The age of the sheep and goats was given by the owners. *G. pulchrum* infected animals were stratified by species and age. Differences between groups were compared by the chi-square test. *P* values < 0.025 were considered significant. Odds ratio values with corresponding 95% CI were also calculated as a measure of the risk. Statistical values determined as not significant are not present.

Results and discussion

Results of coprological examination are summarized in Tab. 1.

Fully embryonated, thick-walled, ovoid eggs (n = 25) with transparent and smooth shell, measuring approximately 57.2 ± 7 × 32.6 ± 4.7 μm, were detected in 9.3% (95% CI: 4.65-13.9%) of the samples. Diagnosis of gongylonemiasis can be made by the finding of eggs of the parasite in the faeces of infected hosts but identification of *G. pulchrum* to species level is mainly accomplished by collection of adult worms at necropsy or slaughtering and examination of the morphological features (7, 6, 10, 15). In our study, logistic restraints prevented further investigations such as slaughtering of coprologically positive animals followed by examination of their esophagi for collection and identification of *G. pulchrum* specimens. Nonetheless, the morphological characteristics and sizes of eggs found in this survey are consistent with those previously shown and reported in well-documented studies on gongylonemiasis in different hosts (4, 5, 10, 11, 13, 14). Moreover, *G. pulchrum* can be found worldwide while other *Gongylonema* species infecting ruminants occur only in South Africa (*Gongylonema mönnig*) or their geographical distribution is limited

Tab. 1. Positive number (no.), prevalence (%) and 95% confidence intervals (95% CI) of gastrointestinal parasites in goats and sheep in areas of the South West Algerian desert

Parasites and their associations	Goats (n = 120)			Sheep (n = 182)			Total (n = 302)		
	Positive no.	%	95% CI	Positive no.	%	95% CI	Positive no.	%	95% CI
Eimeria	73	60.8	52.1-69.6%	133	73.0	66.6-79.5%	206	68.2	63-73.4%
Eimeria-G. pulchrum	16	13.3	7.2-19.4%	8	4.4	1.4-7.4%	24	7.9	4.9-11%
Eimeria-GIS*	4	3.3	0.1-6.5%	11	6.0	2.6-9.5%	15	5.0	2.5-7.4%
Eimeria-Strongyloides	11	9.2	4-14.3%	–	–	–	11	3.6	1.5-5.8%
Eimeria-GIS-*Moniezia*	4	3.3	0.1-6.5%	–	–	–	4	1.3	0-2.6%
Eimeria-GIS-*Strongyloides*	2	1.7	0-4%	2	1.1	0-2.6%	4	1.3	0-2.6%
Eimeria-Moniezia	–	–	–	4	2.2	0.1-4.3%	4	1.3	0-2.6%
Eimeria-Skrjabinema	4	3.3	0.1-6.5%	–	–	–	4	1.3	0-2.6%
GIS	2	1.7	0-4%	2	1.1	0-2.6%	4	1.3	0-2.6%
Eimeria-Moniezia-Skrjabinema	–	–	–	2	1.1	0-2.6%	2	0.6	0-1.6%
Eimeria-Moniezia-Strongyloides	2	1.7	0-4%	–	–	–	2	0.6	0-1.6%
Eimeria-Trichuris	–	–	–	2	1.1	0-2.6%	2	0.6	0-1.6%
Eimeria-G. pulchrum-Moniezia	–	–	–	2	1.1	0-2.6%	2	0.6	0-1.6%
G. pulchrum	2	1.7	0-4%	–	–	–	2	0.6	0-1.6%
Total	120	100	100-100%	166	91.2	87.1-95.3%	286	94.7	92.2-97.2%

Explanation: *GIS = Gastrointestinal strongyles

to India, South Africa, and United States (*Gongylonema verrucosum*) (19). Therefore, we concluded that *G. pulchrum* was the species implicated in the present survey.

Prevalence values of *G. pulchrum* in goats and sheep were 15% (95% CI = 8.6-21.4%) and 5.5% (2.2-8.8%), respectively. Positivity rates in single areas were 37.5% (20.7-54.3%), 25% (3.8-46.2%), and 10% (0-23.1%) in goats, or 12.5% (1-24%), 7.7% (0.4--14.9%), and 4% (0-9.4%) in sheep. Previous surveys on *G. pulchrum* in slaughtered goats and sheep reported prevalence values of 32.5% (2) and 2% to 45% (6, 7, 10, 15), respectively.

A statistically significance difference (χ^2 = 7.77, P = 0.0053, OR = 3.04 [1.35-6.83]) was observed in prevalence of *Gongylonema* between goats and sheep.

It is likely that goats are at increased risk of swallowing infected arthropods present in the environment as they are much more voracious eaters than other livestock.

With respect to age, prevalence rates were higher in animals older than one year of age than in younger ones both in goats (16.3% [9-23.6%] vs. 9.1% [0-21.1%]) and in sheep (6.3% [2.1-10.6%] vs. 3.6% [0-8.4%]). However, these differences did not reach statistically significant values. This trend may depend on the animal population examined as a higher number of adults (n = 224) was sampled with respect to young animals (n = 78) in this survey. Nonetheless, other authors showed that the likelihood of swallowing infected arthropods significantly increases with the increase of age in cattle (10).

Only one adult sheep with mixed *G. pulchrum-Eimeria* infection showed signs of diarrhea at the time of sampling but this was probably due to the concurrent eimeriosis. Indeed, although heavy infections cause notable inflammation of the esophagus, animals usually are able to support up to 100 worms in a single esophagus without developing any clinical sign (6). However, though the infection is not considered to be pathogenic and no therapeutic treatment is recommended in ruminants, development of an esophageal squamous cell carcinoma in a 17-year-old, female vari (*Lemur macaco variegates*) was attributed to infection with *G. pulchrum* (3) and, in general, gongylonemiasis seems to have more significant effects on health of primates (3, 4).

Human gonylonemiasis, though reported as sporadic cases, is widely distributed worldwide, including Asian and European countries, Australia, New Zealand, North Africa, and United States (5, 8, 14, 19, 23, 24). Ingestion of infected insects by humans is mostly accidental and unrecognized (24). Only one of the recorded cases in humans has indicated that the infected patient had knowledge of having ingested or inhaled an insect (23). Excluding the voluntary ingestion of insects or parts of them, the factors that put some people at increased risk for infection with *G. pulchrum* still remain unknown. Since larvae emerge spontaneously from infected insects which fall into water, the transmission to humans may occur also through ingestion of water contaminated with the third-stage larvae having emerged from dead intermediate hosts or through consumption of raw vegetables contaminated

by this water (8). Human gongylonemiasis is mainly associated with the complaint of something moving in the oral cavity, including the lips, gums, tongue, cheeks, and palate (5, 8, 14, 24). In some patients, eosinophilia, reflux-like and convulsion-like symptoms as well as migratory creeping sensation in the neck region, throat, and upper part of the digestive tract have also been noted (5, 8, 14, 23). In addition to the immediate physical suffering inflicted by the parasite, gongylonemiasis may exert some degree of psychological distress and be misdiagnosed with delusional parasitosis (5, 14, 24). Treatment for the infections include surgical/manual extraction (5, 24) and dosage of albendazole (5, 14, 23, 24).

With respect to other parasitoses found in this survey, species of the genera *Eimeria*, *Moniezia*, *Skrjabinema*, *Strongyloides*, and *Trichuris* harbored by sheep and goats are specific to herbivorous mammals. Gastrointestinal strongyles (GIS) include a number of species belonging to different genera such as *Haemonchus contortus*, *Ostertagia*, and *Trichostrongylus axei* in the abomasums, *Trichostrongylus*, *Nematodirus*, and *Cooperia* in the small intestine, and others. It is not possible to identify GIS eggs to genus level by faecal examination as the eggs of these parasites are similar in appearance and overlapping in size. In general, GIS of ovicaprines do not pose public health concerns. However, it is important to emphasize that human infections associated with at least seven *Trichostrongylus* species have been reported in Iran (9). *Trichostrongylus colubriformis* has been isolated from humans in France (12) and Laos and (18). Humans become infected by ingesting third stage-infective larvae. The use of fertilizing vegetables with manure from herbivores, especially goats, has been identified as a predisposing factor (22). The majority of human infections are asymptomatic or associated with mild symptoms. Symptomatic individuals may present watery diarrhea, abdominal pain and eosinophilia (17, 22). Nematodes of this genus typically occur in sheep and goats with reported prevalences of 39.6-55% in dry areas of African countries (1, 16). Therefore, *Trichostrongylus* species are likely to occur in the ovicaprime population examined. Since the study areas have many infected sheep and goats which wander almost freely everywhere, the risk of food and water resources being contaminated with animal feces can be high.

Conclusions

Monitoring human infections represents an imperative need of modern society.

Though some nematodes from ovicaprines can be considered as minor, non-life threatening zoonotic agents, their impact on people living in livelihood conditions may be considerable. It is not difficult to speculate that these people probably will have limited access to basic health care. Therefore, it is advisable that anyone working with sheep and goats or sharing the same environment with them (i.e., herders, veterinarians, farmers) as well as physicians are aware of gongylonemiasis and other potentially zoonotic nematode infections due to these animals, though considered sporadic or neglected so far.

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