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Prevalence and intensity of *Nematodirus* sp. and *Eimeria* sp. infections in the domestic goats of St. Katherine's Protectorate (Sinai, Egypt): relations with some ecological and biological factors

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ABSTRACT

The prevalence and intensity of intestinal parasites in the domestic goats at St. Katherine's protectorate and their relation to some ecological and biological factors that might possibly influence parasite load were investigated. Faecal samples from 164 goats, housed in three different sites during two seasons, (Aug-Sept 2001 and Jan-Feb 2002) were examined for egg or oocyst numbers per gram (EPG or OPG) as indices of parasite load. *Nematodirus* sp. (Nematoda) and *Eimeria* sp. (coccidian protozoa) were the dominant intestinal parasites. Only few cases showed high EPG (>200) or OPG (>500) while others showed subclinical levels of infection. Marked seasonal variations were observed, higher in Aug-Sept (dry season) than in Jan-Feb (wet season). There were significant differences among sites, perhaps caused by many factors including site topography, feeding habits, diet or health status. OPG increased dramatically in ungrazed and EPG increased in grazed goats. OPG was affected by sex, age class and female status but this was not the case for EPG. There was a significant correlation between OPG and host size. We conclude that differences in parasite loads are determined by both environmental and biological factors.

KEYWORDS: goats, *Nematodirus, Eimeria*, season, site, food, sex, age.

INTRODUCTION

Goat herding is a traditional activity of all Bedouin tribes and plays an important role in their social and economic life. Herds are not sold because they represent the wealth of a clan or tribe and as such are a valuable resource, playing a wide variety of roles in the Bedouin economy (transport, meat, milk and milk products, wool and wool products, skins). However, the livestock also have many diseases, especially internal and external parasites that affect dramatically their productivity, hence impacting on Bedouin life. Internal and external parasites seriously limit both per capita productivity and the density at which goats can be raised on farms (Blackburn *et al.* 1991; Rahman & Collins 1990; Abebe *et al*. 2000). There have been many goat health-management programmes established worldwide to improve herd productivity through a variety of different mechanisms, such as environmental management and parasite control.

Since parasites can have a wide range of impacts on the ecology of their hosts (in terms of health, behaviour, sexual selection and regulation of host populations), this makes them interesting to examine from the point of view of the ecological factors that determine parasite loads (Vidya & Sukumar 2002). Many factors are known to influence the transmission of parasites: for example, environmental conditions (Rogers & Sommerville 1963), and feeding, movement and defaecation patterns of the host which influence the parasites encountered (Price *et al*. 1988; Lozano 1991). In addition internal conditions of the host (e.g. existing infection [Quinnell *et al*. 1990] and immune response) may affect successful establishment of parasites (Vidya & Sukumar 2002). A certain degree of understanding about the life-cycle of these parasites and the factors affecting them is necessary for effective control using anthelmintics or other means of parasite control (Luginbuhl 1994).

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Recent researches have been directed specifically at studying the influence of ecological factors and the host-parasite relationship on parasite burdens in different mammalian hosts. Sharkhuu (2001) studied the helminths of goats from three geographic zones in Mongolia and pointed to relations between age or season and the intensity of infection. Stancampiano *et al.* (2001) carried out a three-year survey on the output of gastro-intestinal nematode eggs from four Alpine chamois herds in Italy. They found variations in EPG related to the season and an unexpected inverse influence of host density on egg counts. Vidya & Sukumar (2002) studied the effects of ecological factors on intestinal parasite loads in the Asian elephant and found that parasite loads were significantly higher during the dry season than the wet season, but were not different between different places. In addition, no correlation between body condition (assessed visually using morphological criteria) and parasite load in either season was recorded.

Little is known about the prevalence and abundance of parasitic disease among the Bedouin domestic goats of Sinai, and no information is available on influence of the ecological or biological factors. A previous haematological and parasitological survey (Abdel-Nabi *et al.* 2002) was conducted in this area during August-September 2000 on 32 goats from 6 different sites. Accordingly in this study we aim to extend our documentation of parasite populations infecting local goats in the Protectorate, and to shed more light on their prevalence and abundance. We studied the possible influence of some ecological and biological factors, such as site, season, origin, age, sex and female status on parasite load by using faecal analysis. Since the feeding patterns of goats vary among sites and also vary during each season, the influence of feeding habits on parasite loads was considered.

MATERIALS AND METHODS

Two localities of the St. Katherine Protectorate (South Sinai, Egypt) were investigated in this study (Fig. 1). Locality 1 (the central part of the town of St. Katherine) included two sites, El-Quesa (1) and Wadi El-Milgaa (2), both 1600 m above sea level. Locality 2 included only one site, Wadi El-Arbaein (3), 1600-1730 m above sea level, which extends south-east from the town of St. Katherine (see Willmer *et al*. 1994; Gilbert *et al.* 1996). The study was carried out at the Environmental Research Centre of Suez Canal University, on the periphery of the town of St. Katherine.

Goats (n = 164) from the selected sites were surveyed for intestinal parasites at two consecutive times of year: dry (Aug-Sept 2001) and 'wet' season (Jan-Feb 2002). The data collected for each goat included: a) origin (either local [St. Katherine] or brought in from the Nile Delta; b) feeding regime (grazed or non-grazed, the latter fed mainly on dried clover, dry bread and maize); c) age class (young <1 yr, or adult >1 yr); d) sex; e) female status (suckling, pregnant, or neither). Morphometric measurements were recorded during the first survey (n=71), including body length, height and head size. Table 1 summarizes the number of goats considered for each category.

Faecal samples were collected from the goat's rectum into a labelled plastic bag and preserved under refrigeration until examination. Direct examination of a faecal smear followed by a flotation technique (Soulsby, 1982) was used for identification and estimation of egg or oocyst numbers per gram (EPG and OPG). We used saturated sugar solution for recovery of parasite eggs and oocysts, but for accuracy of counting sugar solution was added to the surface of the test tube several times after the first counting until no more were found. The size of *Nematodirus* sp eggs and *Eimeria* sp oocysts in the faecal samples were measured using an ocular micrometer.

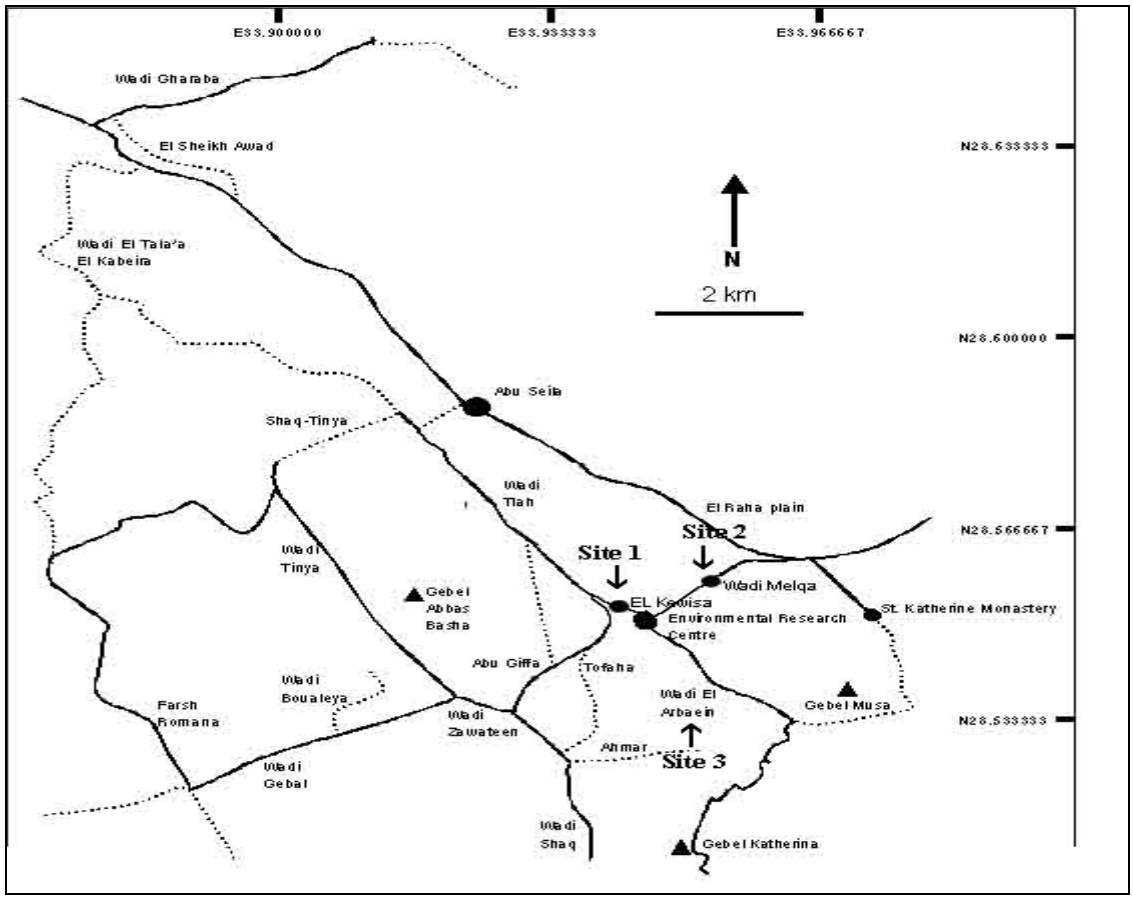

Figure 1: Map of the study area. Most of our samples are concentrated at the centre of the village of St. Katherine. The scale bar = 2 km. GPS references are given in the text and along the vertical and horizontal axes.

All data concerning either EPG or OPG are presented as arithmetic means ± SD. The impact of factors on the intensity of parasitic infection (EPG or OPG) was analyzed statistically using Analysis of Variance. Correlations between some variables were examined using the non-parametric Spearman's rank correlation. All statistical tests were performed using the software package SPSS 11.0

Table 1: Sample sizes for each factor considered.

Factors considered		No. of goats examined
Season	1) Sept 2001	111
	2) Jan 2002	53
Site	1) El-Quesa	63
	2) Wadi Milgaa	43
	3) Wadi El-Arbaein	58
Origin	1) St. Katherine	117
	2) Delta	47
Food	1) Grazed	90
	2) Non-grazed	74
Sex	1) Male	36
	2) Female	128
Age categories	1) Adult	102
	2) Young (< 1 year)	62
Female status	1) Suckling	68
	2) Pregnant	58
	3) neither	38

RESULTS

During two consecutive seasons, a nematode *Nematodirus* sp. and a coccidian *Eimeria* sp. were the dominant intestinal parasites, as indicated by faecal examination. Infection rates (prevalence) of *Nematodirus* among sites are shown in Fig. 2. The summary statistics of total EPG and OPG broken down by each factor are shown in Table 2; the full statistical analyses are given in Table 3. In all goats, both infections were at low levels, considered to be below clinical levels except for a few cases. High egg counts of *Nematodirus* were recorded in four goats from the El-Quesa area (152, 175, 180 and 205 EPG). High oocyst counts of *Eimeria* were recorded in two goats from Wadi El-Milgaa (500 and 520 OPG). The size of *Nematodirus* eggs ranged from 187.5-225 µm in length and 62.5-100 µm in width, but were unusually large in two goats from El-Quesa (250 x 100 µm). Oocyst sizes of *Eimeria* ranged from 18.7-21.8 µm in length and 12.5-15.6 µm in width.

Seasonal variations show higher infections in summer for both parasites. Egg output (EPG) of *Nematodirus* differed significantly among sites: mean EPG values were the highest among goats of El-Quesa. No significant differences were detected among origins, sexes, ages or female status. Although there was only a marginally significant difference in EPG between feeding habits ($p=0.053$), the overall mean values show remarkable differences between grazed and non-grazed goats; however, this is confounded by site differences because most of El-Quesa and El-Arbaein goats are grazed every day (although in different places and for shorter periods in El-Arbaein), but goats of Wadi El-Milgaa do not graze at all but rather have their fodder provided for them. The influence of interactions between factors considered on EPG was analyzed but with no significance.

Intensity of infection with *Eimeria* (OPG) was also significantly different among sites: total OPG was highest among goats of Wadi El-Milgaa. Sex, feeding behaviour, age and female status all had significant effects on OPG, and only goat origin was not significant as a main factor (but there was an interaction with age). Non-grazed goats had higher OPG compared to grazed ones; young goats had higher OPG compared to adults; females were more susceptible than males; and non-suckling and non-pregnant females were also more susceptible.

OPG ($r_s = -0.4$, $n=53$, $p<0.05$) output was correlated with host size, but there was only a weak correlation between EPG and host size.

Statistical analysis of factors that significantly affected total parasite outputs (EPG and OPG) in goats are shown in Table 4.

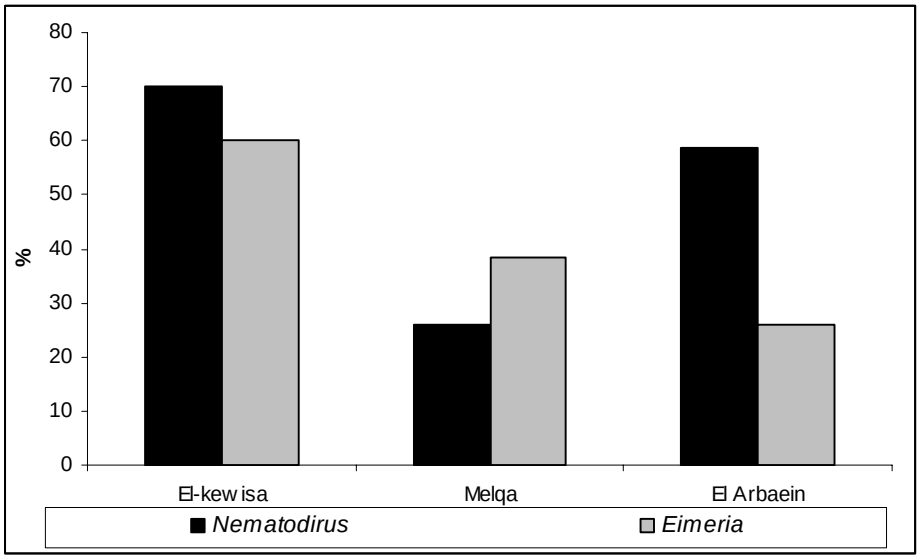

Fig. 2: Rates of infection (%) with *Nematodirus* sp or *Eimeria* sp. among goats from three different sites in the St. Katherine area.

Table 2: Summary statistics for total egg per gram (EPG) of *Nematodirus* sp. and oocyte per gram (OPG) of *Eimeria* sp according to factors considered.

Factor		Mean ± SE (EPG)	Range	Mean ± SE (OPG)	Range
Site	El- Quesa	33.4 ± 6.0	0-205	29.94± 7.2	0-240
	Milgaa	1.8 ± 0.7	0-11	71.8 ± 10.3	0-520
	El-Arbaein	2.5 ± 0.5	0-18	9.9 ± 4.2	0-184
Feeding Habits	Graze	20.0 ± 3.7	0-205	21.0 ± 4.7	0-240
	No graze	2.3 ± 0.8	0-18	48.9 ± 13.9	0-520
Season	Aug-Sept	24.2 ± 2.7	0-205	39.2 ± 8.2	0-520
	Jan-Feb	15.8 ± 4.7	0-131	19.5 ± 3.9	0-240
Origin	S.Katherine	15.9	0-205	28.2 ± 6.3	0-520
	Delta	9.2 ± 1.3	0-75	2.5 ± 2.5	0-15
Age Class	Young	13.5 ± 3.4	0-130	39.2 ± 12.2	0-520
	Adult	11.1 ± 3.4	0-205	16.6 ± 4.3	0-200
Sex	Female	16.4 ± 3.1	0-205	28.8 ± 6.8	0-520
	Male	4.5 ± 2.3	0-27	14.3 ± 7.1	0-106
Female status	Suckle	17.6 ± 5.9	0-205	15.9 ± 5.6	0-500
	Pregnant	5.9 ± 2.4	0-65	12.3 ± 6.5	0-184
	None	15.1 ± 4.5	0-130	36.7 ± 11.4	0-520

Table 3: Statistical analysis of factor affecting faecal egg ouput (EPG) and oocysts output (OPG) of goats during the two season of study.

	SS	DF	Mean Square	F	Sig.
Nematodirus EPG (Aug.-Sept.2001)					
Site	7356.98	2	3678.49	6.17	0.003
Food	3442.96	2	1721.48	2.68	0.073
Nematodirus EPG (Jan.-Feb. 2002)					
Site	15613.45	1	15613.45	20.36	0.0000
Total EPG					
Site	6884.64	2	3442.32	6.42	0.002
Food	3333.08	2	1666.54	2.91	0.058
Eimeria OPG (Aug.-Sept.2001)					
Site	49438.24	2	24719.12	3.72	0.028
Sex	74394.69	1	74394.69	11.9	0.000
Food	49125.2	2	24562.6	3.69	0.029
Age categories	42931.31	1	42931.31	6.38	0.013
Female status	108380.43	3	36126.81	6.04	0.001
Eimeria OPG (Jan.-Feb.2001)					
Site	16357.03	1	16357.03	5.62	0.021
Sex	19440.75	1	19440.75	7.03	0.011
Food	17145.12	1	17145.12	3.77	0.021
Age categories	18747.82	1	18747.82	6.55	0.013

Total OPG					
Site		2	23072.75	4.41	0.014
Origin	26838.55	1	26838.55	6.61	0.012
Food	44971.28	2	22485.64	4.29	0.016
Age categories	62193.82	1	62193.82	15.33	0.0002
Origin * Age categories	124914.1	1	124914.1	30.79	0.0000

Table 4: Statistical analysis of factor affecting Total parasite outputs in goats.

	SS	DF	Mean Square	F	Sig.
Total parasite outputs					
Site	18151.9	1	18151.9	3.897	0.04
Origin	25864.5	1	25864.5	5.553	0.020
Age categories	34117.6	1	34117.6	7.325	0.008
Origin * Age	71341.7	1	71341.7	15.316	0.000

DISCUSSION

Prevalence and intensity of the intestinal parasites, *Nematodirus* sp. and *Eimeria* sp. in domestic goats of St. Katherine and their relation to factors that might potentially influence parasite loads were investigated. A previous haematological and parasitological survey (Abdel-Nabi *et al.* 2002) conducted during Aug-Sept 2000 on 32 goats from six different sites found that 20% of examined goats were infected with *Nematodirus* with a maximum 8 EPG and that 47% of goats were infected with *Eimeria*. However, our study recorded higher prevalence of *Nematodirus* (26 to 70%) with higher EPG values. It is worth mentioning that infection rates with *Eimeria* among goats of Wadi El-Arbaein was 26%, although Abdel-Nabi *et al.* (2002) did not record eimerian infection at all in the same area. Possible differences between our study and the previous one may be due to the efficacy of the technique used for faecal egg and oocyst detection and to the higher number of goat individuals surveyed.

Levels of EPG and OPG were higher in the Aug-Sept survey (dry season). Similar higher intensities of infection in the dry season have been previously recorded (Watve 1992; Stancampiano *et al.* 2001; Vidya & Sukumar 2002) in other mammalian hosts. However, McCulloch *et al*. (1986) found that differential egg counts of *Haemonchus, Trichostrongylus, Ostertagia* and *Nematodirus* worm populations in Angora goats had higher worm populations in wet as opposed to dry conditions. In Mongolia, Sharkhuu (2001) recorded the highest EPG of gastrointestinal helminths in March and the lowest in November. As the survival of most of nematodes eggs or larvae and coccidian parasites is higher under moist conditions (Rogers & Sommerville 1963; Soulsby 1982), transmission through contaminated food is unlikely to give rise to the observed pattern. Vidya & Sukumar (2002) attributed the higher parasite loads in the dry season to various reasons, such as transmission, diet, body condition, and uneven sampling across age classes/ sexes. Not all of these factors can explain our results**.** Our results did not show any significant relation between EPG and sex or age whereas a significant relation was found for OPG**.**

Infection with *Nematodirus* was significantly site-specific since it was highly prevalent among the goats of El-Quesa, with high intensity. The influence of site on

parasite load might be related to many factors, such as site topography or local feeding habits. To clarify how site topography may or may not favor the suitable conditions for survival of infective stages, Vidya & Sukumar (2002) concluded that if the height to which juvenile stages can climb the vegetation is limited, there should be a difference in parasite loads between different habitats. However, further studies are needed on the topography of the selected areas. Feeding habits, on the other hand, might have an effect on parasite burden via the impact of health and diet; healthy animals are probably more resistant to disease than unhealthy ones. Size-related differences found in this study may confirm the later mode. Since *Nematodirus* is transmitted orally by ingesting the infective stage in contaminated food, its high intensity may be caused by highly contaminated grazing sites, the reason why grazed goats show high infection intensities. Neither sex nor age appeared to have significant influence on EPG. Itoh *et al*. (2003) pointed to the absence of sex-related difference in the EPG of the nematode *Strongyloides* spp. infecting dogs.

Eimeria prevalence was significantly affected by many factors: site, food, sex, age and female status. Non-grazed goats had higher OPG compared to grazed ones feeding on wild plants. A greater susceptibility of young goats to infection than adults has been noticed before (Heath & Harris 1991), but Decker *et al*. (2001) found no age- or sex-related differences in rodents. Barnard *et al.* (2002) correlated reduced resistance and thus greater parasite intensities with male bank voles which had significantly larger adrenal glands, testes and seminal vesicles for their age. Consequently the sex-related differences in OPG recorded in this study may be due to the hormonal activity of the host. However, our findings obviously also reflect differences in responses between the two parasites to environmental and biological factors.

Oocyst sizes recorded in this study were smaller than those recorded for other species of goat coccidia (*E. arloingi*, 22-31x17-22µm; *E. fauveri*, 25-33x18-24; *E. ninakohlyakimovae*, 20-28x15-22 µm) (Souslby 1982). *Nematodirus* egg sizes were within the normal ranges reported by Souslby (1982).

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الملخص العربى

معدل إنتشار وكثافة الإصابه بالطفيليات المعوية فى الماعز المحلية لمحمية سانت كاثرين، سيناء، مصر: علاقة الإصابة ببعض العوامل البيئية و البيولوجية

مها فريد سليمان - سامى محمد زلط

قسم علم الحيوان – كلية العلوم – جامعة قناة السويس – الإسماعيلية – مصر

تم دراسه معدل إنتشار وشده الإصابه بالطفيليات المعويه للماعز المحليه في محمية سانت كاثرين، مصر وعلاقتهم ببعض العوامل البيئية والبيولوجيه و التي من المحتمل ان تؤثّر عليهما. تم فحص عينات من براز 164 من الماعز من ثلاثة مواقع مختلفة خلال فصلين من العام (أغسطس - سبتمبر 2001 ، يناير- فبراير2002) و ذلك لتقدير عدد البيض و الأووسيست كدليل على معدل وشده الإصابه بالطفيليات المعويه. واضحت النتائج ان طفيل نيماتودروس وايميريا كانت هى الطفيليات السائدة ولكن مستويات الإصابه كانت معظمها منخفضه فيما عدا عدد قليل من الماعز. أشّارت الدراسه الى وجود علاقه بين التغيرات الموسمية و بين كثافه العدوى و التى بلغت ذروتها فى فصل الصيف. كذلك اشارت الدراسه الى فروق معنويه بين شده الأصابه وأماكن تواجد الماعز فى المحمية والتى قد ترجع الى طبوغرافيه المكان او الى العناصر الغذائيه التى تحصل عليها الماعز و التى قد تنعكس على صحه الماعز ولكن هذه النتائج تحتاج لمزيد من البحث. أوضحت الدراسه كذلك أن الرعى أو عدم الرعى، حجم العائل، الجنس لهم علاقه معنويه بالنسه لشده الإصابه بالـ آيميريا على وجه الخصوص. ولذا فإن الدراسة قد أوضحت مدى تأثير العوامل البيئية والبيولوجية على معدلات الإصابة بالطفيليات المعوية فى المناطق الصحراوية مما يضفى أهمية كبرى على دراسة علاقة الطفيليات ومعدلات الإصابة بالأماكن المختلفة وخصوصاً فى المناطق الصحراوية ذات الصفات الطبوغرافية المتباينة.