

GASTROINTESTINAL PARASITES OF SHEEP ON ESTONIAN ISLANDS

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ABSTRACT. Parasites are important production-limiting diseases in livestock farming. Their proper treatment and control requires knowledge of their presence, epidemiology, and diagnostics. We investigated the presence of the GI parasites in pooled herd faecal samples from the islands Saaremaa (n=21), Hiiumaa (n=18), and Vormsi (n=7), collected in 2011–2012. The samples were investigated microscopically after quantitative flotation, acid-fast contrast staining for *Cryptosporidium* oocysts, and direct immunofluorescence for *Giardia* cysts. Findings included nematodes: Strongylida spp. (94.6%), Strongyloides spp. (70.7%), *Trichuris* spp. (9.8%); protozoans: *Eimeria* spp. (94.6%), *Giardia* spp. (69.6%), *Cryptosporidium* spp. (60.9%); cestodes: *Moniezia* spp. (22.8%); and trematodes: *Dicrocoelium* spp. (3.3%). *E. spp.* oocysts and Strongylida eggs were shed in levels that may indicate problems in some herds. The most dominant species of *Eimeria* was the pathogenic *E. ovinoidalis* (64.4%), but the other clinically important species, *E. cranadallis* did not dominate any samples. Based on the presented findings, it appeared that the herds had different parasitic problems needing evidence based treatments for sustainable control.

Keywords: sheep, parasites, protozoa, nematoda, cestoda, trematoda, prevalence.

Introduction

Ovine gastrointestinal (GI) parasites are important pathogens affecting the health of the animals and the income of their farmers (Fitzgerald, 1980; Chartier, Paraud, 2012). Clinical signs of disease, such as diarrhoea, and even mortalities affect mainly young animals (Hansen, Perry, 1994; Chartier, Paraud, 2012). Sub-clinical effects, such as long term weight loss and reduced growth, are probably more important considerations to a modern livestock production aiming for improvement of production through healthier animals (Fitzgerald, 1980; Foreyt, 1990; Taylor, 2009). To achieve such a lasting effect the farmers and veterinarians require knowledge of parasites affecting the sheep, risks affecting the presence of parasites, and methods to detect and treat the infections in a sustainable way (Sargison, 2011; Chartier, Paraud, 2012).

Sheep in the Northern hemisphere are potentially exposed to a wide range of parasites, including gastrointestinal nematodes (GIN), lungworms, tapeworms,

liver flukes, unicellular organisms, and ectoparasites (Domke *et al.*, 2012). There are over 20 different species of GIN of sheep, what can cause clinical or subclinical disease with reduced growth rate, body condition and milk production. Protozoan parasites constitute another group of common and important gastrointestinal causes of disease mainly: *Eimeria*, *Cryptosporidium*, and *Giardia* (Fitzgerald, 1980; Pfister, Flury, 1985; Dittmar *et al.*, 2010; Saratsisa *et al.*, 2011). It has previously been shown that *Eimeria* and *Cryptosporidium* is prevalent in Estonian dairy herds and cause substantial losses to farmers when uncontrolled (Lassen *et al.*, 2009a; Lassen, Østergaard, 2012). Ovines are likely to be similarly affected in Estonia by the clinical and subclinical infections (Sweeny *et al.*, 2011). The most pathogenic *Eimeria* species is considered to be *E. ovinoidalis* (Catchpole *et al.*, 1976; Chartier, Paraud, 2012), and *E. cranadallis* is considered mildly pathogenic in lambs (Catchpole, Gregory, 1985). Other species such as *E. ahsata*, *E. marsica*, *E. bakuensis*, *E. granulosa*, and *E. parva* have been reported to show clinical signs in lambs (Mahrt, Sherrick, 1965; Gregory, Catchpole, 1987; Berriatua *et al.*, 1994; Reeg *et al.*, 2005; Skirnisson, 2007).

Estonian sheep have previously been investigated by Kaarma, and Mägi (2000), Mägi and Kaarma, (2002), and Mägi and Sähk (2004). The investigations examined the population dynamics of strongylids, *Moniezia* and *Eimeria* in the period 1996–2006. Until now the information on sheep parasites on Baltic Sea islands has remained unexplored.

The aim of the current study was to investigate the parasitic situation in the sheep herds on the Estonian islands during two visits in 2011 and 2012 with a focus on identifying the present *Eimeria* species.

Materials and methods

Study population

On the targeted islands, 368 herds of the 559 registered had 9 animals or more and were included in the study (mean: 46, median: 21). The selected herds were distributed as: Saaremaa n=267, Vormsi n=7, Hiiumaa n=94. A minimum sample size of 34 animals was calculated to be sufficient to prove absence of detectable parasitic infections with a minimum expected prevalence of 30%. This calculation was based on 79% sensitivity and 93% specificity of the acid-fast staining method (Quilez *et al.*, 1996). A total of 46 herds agreed to participate and were stratified according to the distribution of herds on the islands as:

Saaremaa n=21, Hiiumaa n=18 and Vormsi n=7. Herd sizes of the sampled farms varied between 9–350 animals (mean: 104, median: 82) and represent the larger herds on the islands.

Sample collection

Selected farms were visited twice (in the spring and autumn) in 2011–2012. Fresh faecal samples were randomly collected into plastic bags on pastures and sheds in the accordance to the number of sheep in the farm (as minimum 20 samples). Samples were kept cool in airtight container until delivery to laboratory within 24–72 hours.

Concentration flotation of parasite eggs

Individual faecal samples were mixed in their bag before pooling into a new plastic bag in masses of $2.15\text{g} \pm 0.60$ STDV. After mixing thoroughly a 4g sub-sample taken for analysis. The quantitative flotation was performed accordingly to modified instructions by Roepstorff and Nansen (1998) using an in-house reading chamber (Henriksen and Korsholm 1984) and sugar-salt flotation medium ($\rho = 1.26 \text{ g/cm}^3$) as previously described (Lassen *et al.*, 2009a).

The sample was screened as 3 vertical rows (0.06 ml) using x200 magnification (Ceti, Topic T light microscope) and findings recorded and counted as oocysts per gram faeces (OPG) or eggs per gram faeces (EPG). *Eimeria* species were determined at x400 magnification according to descriptions of Levine (1985) of the unsporulated oocysts. The each species was counted and the most frequently occurring species was defined as dominant in the sample.

Semi-quantitative estimation of *Cryptosporidium* oocysts

Approximately 0.1 g of faeces was spread as a thin smear on microscopic slides and air dried before fixing in ethanol and staining according to instructions originally described by Henriksen and Pohlenz (1981). Samples were searched for oocysts at x400 using a light microscope. If oocysts were found averages of three random visual areas were taken as the oocyst count and classified as: low (1–5 oocysts per visual area (OVA) = 10^4 – 10^5 oocysts per gram (OPG)), medium (6–25 OVA = 10^5 – 10^6 OPG), and high (>25 OVA = $>10^6$ OPG).

Direct immunofluorescence test for *Giardia* spp.

As for the concentration flotation of parasite eggs four grams of the herd sample was dissolved in 56 ml tap water, resting for 30 min and then filtered through one layer of gauze into a new plastic cup. Ten ml of the mixed solution was transferred to a 14 ml centrifuge tube and the faecal material spun down (263 RCF, 7 min). The supernatant was removed with a pasteur pipette and the pellet resuspended in 5 ml phosphate buffered saline (Roti-Stock 10x PBS, Carl Roth GmBh, Germany) to an approximately 1/10 dilution. After vortexing 20 μl was transferred to a 8 mm wide well on a teflon coated slide. A negative control (PBS) was added on each slide. The slide was completely

dried before fixing the material to the slide for 5 min using ethanol. After drying 25 μl of fluorescent labelled specific antibodies were added (Crypto/Giardia Cel, Cellabs, UK). The slide incubated at 37 °C for 30 minutes in a humidity chamber. Excess reagent was removed by washing in PBS and air dried for 5 min. Mounting fluid was added to each well and a cover glass added. The entire well was examined for presence of fluorescent *Giardia* cysts at x400 magnification using the FITC filter on a Nikon Eclipse 80i microscope.

Statistics

Differences in occurrences of different parasites in the herds on different islands were examined using a chi-square analysis, while a *t*-test was used to estimate differences between years. R version 2.15.2 (The R Foundation for Statistical Computing) was used for the analysis. Prevalences and 95% confidence intervals (CI) were calculated using mid-P using OpenEpi (<http://www.openepi.com>) as were sample sizes.

Results

Distribution of intestinal parasites

The presence of different intestinal parasites is presented in Table 1 and Table 2. *Eimeria*, *Cryptosporidium*, *Giardia*, *Strongylida*, *Strongyloides*, *Moniezia*, and *Trichuris* were found on all islands whereas *Dicrocoelium* eggs were only found on Saaremaa. *Eimeria* and *Strongylida* were found in almost all herds but also *Cryptosporidium*, *Giardia* and *Strongyloides* were observed in the majority of the herds.

Table 1. Prevalences (Mid P exact) of protozoa and cestodes found in sheep herd on Estonian islands in 2011–2012

Table 1. Ainuraksete parasiitide ja paelusside levimus (Mid P exact) Eesti saarte lambakarjades aastatel 2011–2012

	n	<i>Eimeria</i> sp. n, % [95% CI]	<i>Giardia</i> sp. n, % [95% CI]	<i>Crypto-</i> <i>sporidium</i> sp. n, % [95% CI]	<i>Moniezia</i> sp. n, % [95% CI]
All	92	87, 94.6% [83.4;98.0]	64, 69.6% [59.6;78.3]	56, 60.9% [50.6;70.4]	21, 22.8% [15.1;32.2]
Kokku					
Vormsi	14	13, 92.9% [69.5;99.6]	10, 71.4% [44.6;90.2]	12, 85.7% [60.3;97.5]	8, 57.1% [31.2;80.4]
Hiiumaa	36	35, 97.2% [87.1;99.9]	24, 66.7% [50.2;80.5]	26, 72.2% [56.1;85.0]	8, 22.2% [10.9;37.9]
Saaremaa	42	39, 92.9% [81.8;98.2]	30, 71.4% [56.5;83.5]	18, 42.9% [28.6;58.1]	5, 19.1% [9.3;33.0]

Table 2. Prevalences (Mid P exact) of nematodes and trematodes found in sheep herd on Estonian islands in 2011–2012

Table 2. Ainuraksete parasiitide ja paelusside levimus (Mid P exact) Eesti saarte lambakarjades aastatel 2011–2012

	n	<i>Strongylida</i> sp. n, % [95% CI]	<i>Strongy-</i> <i>loides</i> sp. n, % [95% CI]	<i>Trichuris</i> sp. n, % [95% CI]	<i>Dicro-</i> <i>coelium</i> sp. n, % [95% CI]
All	92	87, 94.6% [83.4;98.0]	65, 70.7% [60.8;79.3]	9, 9.8% [4.9;17.2]	3, 3.3% [0.8;8.6]
Kokku					
Vormsi	14	14, 100.0% [80.7;100.0]	12, 85.7% [60.3;97.5]	4, 28.6% [9.8;55.5]	0, 0% [0.0;19.3]
Hiiumaa	36	33, 91.7% [79.0;97.8]	25, 69.4% [53.1;82.8]	2, 5.6% [0.9;17.2]	0, 0% [0.0;8.0]
Saaremaa	42	40, 95.2% [85.2;99.2]	31, 73.8% [59.0;85.4]	3, 7.1% [1.9;18.2]	3, 7.1% [1.9;18.2]

Intensity of parasites in the herds

The presence of parasitic oocysts and eggs in the herds faecal samples ranged 0–10,060 OPG (median: 535, mean: 1,159) for *Eimeria*, 0–1,771 EPG (median: 248, mean: 411) for *Strongylida*, 0–662 EPG (median: 90, mean: 110) for *Strongyloides*, 0–188 EPG (median: 0, mean: 76) for *Moniezia*, 0–188 EPG (median: 0, mean: 9) for *Trichuris*, and 0–94 EPG (median: 0, mean: 3) for *Dicrocoelium*. Semi-quantitative scores for *Cryptosporidium* spp. were distributed as, none: 31.1% (n=39, 29.6–49.4 95% CI), low: 47.8% (n=44, 37.8–58.0 95% CI), medium: 10.9% (n=10, 5.7–18.5 95% CI), and high: 2.2% (n=2, 0.4–7.0 95% CI).

Less cases of *Giardia* spp. was observed in the herds sampled ($p < 0.001$) in 2011 compared to 2012, but the opposite was seen for semi-quantitative intensity scores for *Cryptosporidium* spp. ($p = 0.02$). *Moniezia* eggs counts also dropped between the two years ($p = 0.03$). A large variation was observed in the OPG's of *Eimeria* between herds (Figure 1A), whereas the number of *Strongylida* eggs found in the herds varied a little (Figure 1B). *Strongyloides* eggs were found to vary between herds, but generally at very moderate levels (Figure 1C). Only few herds had evidence of *Moniezia* eggs in larger amounts (Figure 1D).

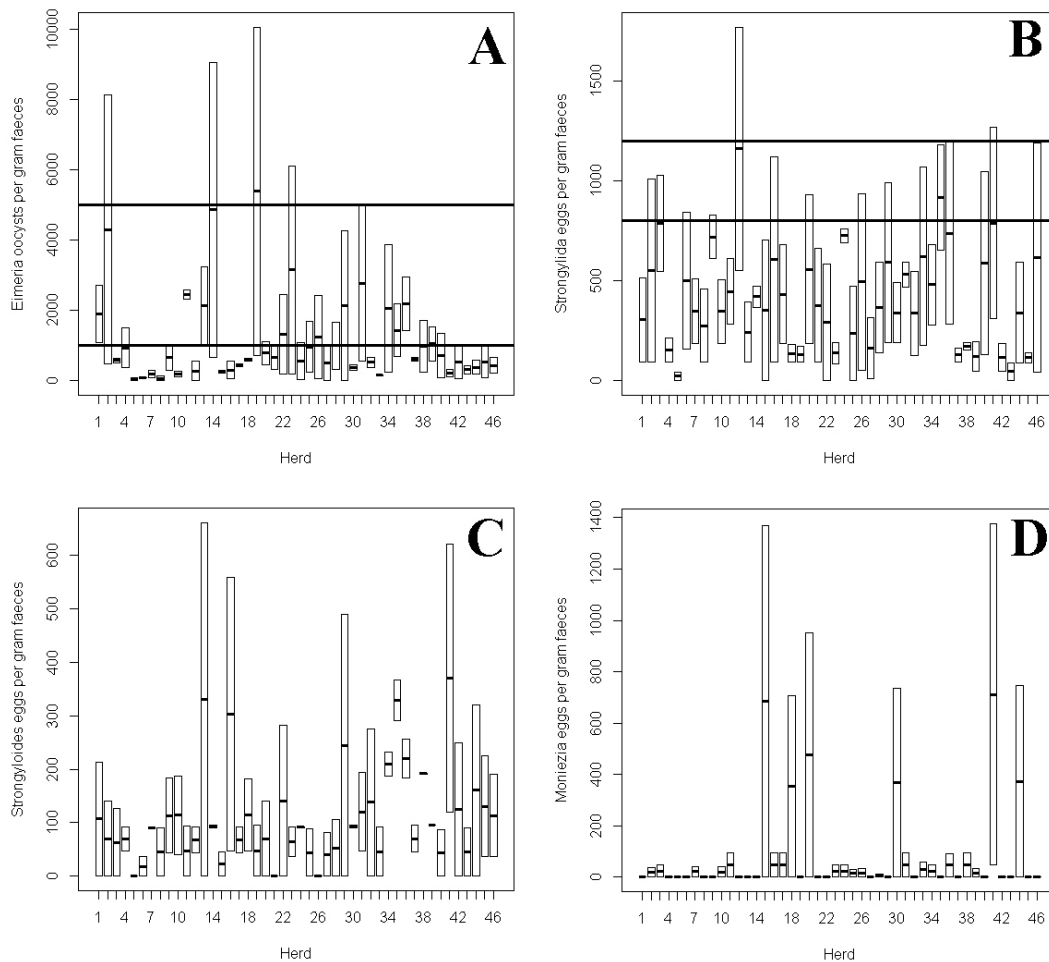


Figure 1. Boxplot of herd averages of oocysts per gram faeces (OPG) *Eimeria* spp. (A), and eggs per gram faeces (EPG) *Strongylida* spp. (B), *Strongyloides* spp. (C), and *Moniezia* spp. (D) found in Estonian sheep from Saaremaa, Hiiumaa and Vormsi between 2011–2012. Vertical bars in figure A and B indicate limits for low to medium (lower bar) and medium to high (upper bar) infection intensities (Hansen, Perry, 1994; Lassen *et al.*, 2009b).

Joonis 1. Karpdiagramm karja keskmise *Eimeria* ootsüstide arvu kohta (A) ja *Strongylida* (B), *Strongyloides*-e (C) ning *Moniezia* (D) munade arvu kohta 1 g-s koproproovis lammastel Saaremaal, Hiiumaal ja Vormsil aastatel 2011–2012. Vertikaaltulbad osades A ja B näitavad madala kuni keskmise (alumine tulp) ja keskmise kuni kõrge (ülemine tulp) nakkusastme ulatust (Hansen, Perry, 1994; Lassen *et al.* 2009b)

Eimeria species distribution

Eleven ovine species of *Eimeria* were identified in the samples (Table 3). For future reference the unsporulated species are presented in Figure 2. *Eimeria ovinoidalis* was found in almost all samples (93.1%) and dominating 64.4% of the samples (Table 3). *Eimeria crandallis* was found in 14.9% of the samples, but did

not dominate in any of them. The 11 identified ovine species were found on all islands with the exception of *E. marsica* that was only found on Saaremaa. Mean oocysts levels were highest in samples where *E. pallida*, *E. parva*, *E. bakuensis*, *E. ovinoidalis*, and *E. granulosa* were dominating. *E. ashata* was only observed dominating in one herd and in low numbers.

Table 3. *Eimeria* species present in Estonian sheep herds on islands Vormsi, Hiiumaa, and Saaremaa sampled in 2011 and 2012. OPG = oocysts per gram faeces

Tabel 3. *Eimeria* prk liigid Vormsi, Hiiumaa ja Saaremaa lambakarjades aastatel 2011 ja 2012. OPG = ootsüside arv 1 g-s koproproovis

<i>Eimeria</i> -positive herds <i>Eimeria-positiivseid karju</i>	All samples <i>Proove kokku</i>				Samples where species is dominating <i>Proovid, kus liigid domineerivad</i>		
	Total <i>Kokku</i>	Vormsi	Hiiumaa	Saaremaa	Frequency <i>Sagedus</i>	OPG	
	n=87	n=13	n=35	n=39	n=87	n=87	n=87
	n, % [95% CI]	n, % [95% CI]	n, % [95% CI]	n, % [95% CI]	N, % [95% CI]	Mean [95% CI]	Min Max
<i>E. pallida</i>	27, 31.0% [22.0; 41.3]	2, 15.4% [2.7; 42.2]	12, 34.3% [20.1; 51.0]	13, 33.3% [20.0; 49.1]	4, 4.6% [1.5; 10.7]	2239 [-182; 4659]	192 3861
<i>E. parva</i>	33, 37.9% [28.2; 48.5]	3, 23.1% [6.2; 50.9]	10, 28.6% [15.5; 45.1]	20, 51.3% [37.8; 66.6]	9, 10.4% [5.2; 18.1]	1815 [-669; 4299]	213 10060
<i>E. marsica</i>	2, 2.3% [0.4; 7.4]	0, 0.0% [0.0; 20.6]	0, 0.0% [0.0; 8.2]	2, 5.1% [0.9; 15.9]	0, 0.0% [0.0; 3.4]	0 [0; 3]	0 0
<i>E. ovinoidalis</i>	81, 93.1% [86.2; 97.2]	12, 92.3% [67.5; 99.6]	34, 97.1% [86.7; 99.9]	35, 89.7% [77.1; 96.7]	56, 64.4% [53.9; 73.9]	991 [657; 1324]	45 6107
<i>E. weybridgensis</i>	29, 33.3% [24.0; 43.7]	9, 69.2% [41.3; 89.4]	7, 20.0% [9.2; 35.6]	13, 33.3% [20.0; 49.1]	0, 0.0% [0.0; 3.4]	0 [0; 3]	0 0
<i>E. crandallis</i>	13, 14.9% [8.6; 23.6]	1, 7.7% [0.4; 32.5]	4, 11.4% [3.8; 25.3]	8, 20.5% [10.0; 35.3]	0, 0.0% [0.0; 3.4]	0 [0; 3]	0 0
<i>E. faurei</i>	25, 28.7% [20.0; 38.9]	6, 46.2% [21.3; 72.6]	7, 20.0% [9.2; 35.6]	12, 30.8% [17.9; 46.4]	3, 3.5% [0.9; 9.1]	617 [-299; 1532]	284 1013
<i>E. granulosa</i>	23, 26.4% [18.0; 36.4]	2, 15.4% [2.7; 42.2]	6, 17.1% [7.3; 32.3]	15, 38.5% [24.3; 54.3]	6, 6.9% [2.8; 13.8]	481 [81; 882]	49 1119
<i>E. bakuensis</i>	44, 50.6% [40.1; 61.0]	7, 53.9% [27.4; 78.7]	16, 45.7% [29.9; 62.2]	21, 53.9% [38.2; 68.9]	8, 9.2% [4.4; 16.7]	1841 [-1114; 4796]	94 9044
<i>E. intricata</i>	4, 4.6% [1.5; 10.7]	1, 7.7% [0.4; 32.5]	1, 2.9% [0.1; 13.3]	2, 5.1% [0.9; 15.9]	0, 0.0% [0.0; 3.4]	0 [0; 3]	0 0
<i>E. ahsata</i>	20, 23.0% [15.1; 32.7]	5, 38.5% [15.7; 65.9]	3, 8.6% [2.2; 21.6]	12, 30.8% [17.9; 46.4]	1, 1.2% [0.1; 5.5]	94 NA	94 94

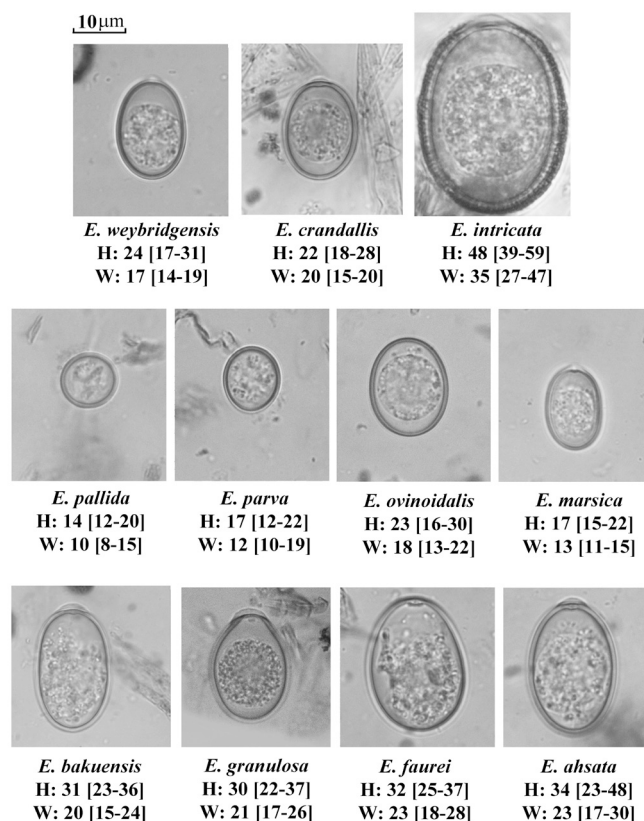


Figure 2. Unsporulated *Eimeria* species found in the investigated sheep. Oocyst dimensions are given as mean height (H) and width (W) and range in brackets (Levine, 1985)

Joonis 2. Uuritud lammastelt leitud *Eimeria* liikide sporuleerumata ootsüstid. Ootsüside mõõtmed: keskmine pikkus (H) ja laius (W) ning vahemik nurksulgudes (Levine, 1985)

Discussion

The study set to investigate the presence of gastrointestinal parasites in sheep herds located on the largest Estonian islands: Saaremaa, Hiiumaa, and Vormsi. The samples investigated have to be considered herd means of the parasitic status as the faeces were randomly collected from unknown animals. Infection intensities of some individual animals are thus likely to be higher than represented here as animals that were not shedding parasite eggs will have diluted samples with high OPG's and EPG's. As a consequence, some herds are likely to be classified as false negatives, and the true prevalences are likely higher than presented. This kept in mind, it is clear that evidence proved the presence of many parasites in the sheep at levels that may indicate possible health problems and losses to the farmers. *Eimeria*, *Cryptosporidium*, *Giardia*, *Strongylida* and *Strongyloides* appeared to be the dominant parasites in the investigated sheep. *Dicrocoelium* spp. was only observed in herds from Saaremaa, but it is possible the low number of eggs normally observed by flotation can have been missed in the pooled herd samples from the other investigated islands. Sedimentation techniques would have to be used for adequately estimate the presence of trematodes in the sheep herds. *Trichuris* spp. seemed to be present, mainly on the island Vormsi, but the evidence did not indicate shedding of eggs in large numbers.

Infection intensities

The average herd EPG's of nematodes not only confirmed the presence but also provided evidence of the general infection intensities. Based on guidelines for sheep by Hansen and Perry (1994) quantitative measurements of mixed nematode infections in young animals can be classified as: 50–800 EPG (light), 801–1200 EPG (moderate), and >1200 EPG (heavy). The handbook highlights the importance of taking into account differences in pathogenicity of the nematodes in different regions of the world when applying these guidelines. Information on the pathogenicity of nematodes relevant to sheep in Estonia such as *Haemonchus*, *Ostertagia*, *Trichostrongylus*, *Nematodirus* a.o., is currently poorly known. In Figure 1 we demonstrated that most herds had a light infection intensity of *Strongylida* but with variations that spanned into medium and high infection intensities. These numbers that are a herd averages are likely to contain some individuals shedding eggs at levels that indicate a severe infection, depending on the species of the parasite, season, and age of the animal. As for *Strongyloides* species, the infection intensities were all in the light category. Generally, *Strongyloides* in sheep (exl. 2–6 weeks old lambs) are not considered pathogenic in this region (Atle Domke, personal communication). It thus seems these parasites represent a smaller problem to the farmers, though a few farms indicated large variations in EPG's (Figure 1C).

Moniezia eggs were generally not shed in large amounts and eggs above a hundred EPG's seemed to

be limited to six herds. Despite a sample prevalence of 22.8% the parasite appeared in different herds (Figure 1D) during the two samplings of the experiment. This is suggesting reservoirs of the parasite (infected soil mites) are present on most farms and may develop into health problems if favourable conditions are present for the parasite and the infection goes unnoticed.

Large variation was observed in OPG's of *Eimeria* herds (Figure 1A). Most herds had either low or medium levels as mean infection intensities. Only one herd consistently had a high excretion of oocysts by the sheep. A few herds indicated a considerable variation which may be driven by the importance of seasonal, presence of young animals, and management changes. *Cryptosporidium* oocysts were very common in herds, but rarely suggesting more than a low infection intensity. It is the first time the presence of *Giardia* is described in Estonian sheep and the results indicate *Giardia* is one of the most common parasitic infections. *Eimeria*, *Cryptosporidium*, and *Giardia*, are all important pathogens of young animals and were observed in >60% of the samples. The three different protozoans share the most common clinical sign in young animals: diarrhoea, but the subclinical infections are more common and costly to the production (Fitzgerald, 1980; Foreyt, 1990). *Cryptosporidium* and *Giardia* are zoonotic pathogens but there is evidence that they may not be an important reservoir for human infections (Ryan *et al.*, 2005), and if so *Cryptosporidium* may be the more important of the two (Robertson, 2009; Robertson *et al.*, 2010). To confirm this for Estonia subgenotyping of strains are needed. *Cryptosporidium* and *Giardia* are often considered together as they share some transmission routes, particularly in water, but depend on the terrain, use of land, chemical elements, and environmental factors (Duris *et al.*, 2013). The decline of *Giardia* while more herds had *Cryptosporidium* oocysts in the studied period may be attributed to different transmission routes in sheep herds. Such factors need identification through carefully planned epidemiological studies. Such studies should take into account that these specific parasites represent underdiagnosed zoonoses, and Estonia has been reporting one of the highest rates of giardiasis per capita in Europe (ECDC, 2011; Estonian Health Board, 2013).

Annual and demographic differences

No apparent difference was noted between herds, years, islands, and EPG's when it comes to the most common nematode groups, *Strongylida* and *Strongyloides*. Protozoan cysts and oocysts varied in their presence to a larger extent. The variation in the herd can be considered as a change of the general parasitic status inside the herd between the two sampling times. Variation in Figure 1 can thus be used to show where there may be a more stable situation (low variation) or a situation where individual animals or the flock shed more parasites in their faeces (large variation). Large

variation in the number of *Eimeria* oocysts in faeces was observed between herds (Figure 1A) indicating large differences in potential problems. *Eimeria* OPG values decreased from 2011 to 2012. Such variations inside a herd may be attributed to annual differences in the climate, such as variations in the weather or management practices. The levels of *Moniezia* spp. eggs decreased from 2011 to 2012, possibly attributed to annual changes in presence of the secondary hosts, oribatid mites, in the pastures (Sinitsin, 1931). In addition, *Moniezia* appears to be a local herd problem, mainly on Vormsi (Table 1), rather than a general one (Figure 1D).

Differences between islands were observed (data not shown) for *Cryptosporidium* spp., *Moniezia* spp. and *Trichuris* spp. but had to be disregarded due to seasonal interference in the sample strategy. In follow up studies samplings would need to be during the same period of time to ensure comparison.

Eimeria species

Eleven species of *Eimeria* were identified (Figure 2). Though the pathogenic species, *E. ovinoidalis*, was clearly dominating in the majority of the samples but not the highest mean OPG's. The highest mean OPG's were dominated by *E. parva*, *E. pallida* and *E. bakuensis* that dominated 4.6%, 10.4%, and 9.2% of the investigated herd samples respectively. *Eimeria pallida* and *E. bakuensis*, that are considered lesser pathogenic species, may play a role in animals shedding high levels of oocysts in some Estonian herds. Other species that have been described to cause clinical symptoms, including *E. crandallis*, were present in the samples but did not dominate in any herds. This indicated that this species do not yet appear to have the conditions needed to be a cause of high OPG's and possibly eimeriosis in sheep herds on Estonian islands. From these observations it appears *E. ovinoidalis* is the predominant *Eimeria* infection in the herds.

Official reports from the Estonian Veterinary and Food Laboratory between 2000–2010 show that a mean of 30 (median: 29, range 0–91) faecal samples are submitted for parasitological investigations there yearly. This almost negligible number of investigations can be interpreted as a low interest in evidence based parasite control. However, it is important to empathize that diagnostic services available to veterinarians who do wish to submit samples have to be up to date to provide sufficient basis for treatment. The veterinarians must have species specific information and precise egg or oocysts counts from the diagnostic analysis to be able to practice evidence based medicine. In the absence of such services, anti-parasitic treatments may either not happen at all, or be non-evidence based. In the latter, the blind or misunderstood practices of medication may develop more permanent problems such as resistance to parasitic drugs as seen in several countries (Domke *et al.*, 2011; Saddiqi *et al.*, 2012).

Conclusions

Faecal samples from Estonian sheep herds on Saaremaa, Hiiumaa, and Vormsi contained *Eimeria*, *Cryptosporidium*, *Giardia*, *Strongylida*, *Strongyloides*, *Moniezia*, and to a lesser extent *Trichuris* and *Dicrocoelium*. *Strongylida* and *Moniezia* species may present local herd problems. *Cryptosporidium* was commonly found in the sheep, but in low numbers. We present the first evidence of *Giardia* being a common parasitic infection in Estonian herds. *Eimeria ovinoidalis* was the most common and pathogenic species found dominating samples, in the contrast to *E. crandallis*, which did not dominate any samples.

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Seedekulglu parasiidid Eesti saarte lammastel

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Kokkuvõte

Käesoleva uurimistöö eesmärgiks oli selgitada lambakarjade parasitoloogilist olukorda Eesti saartel. Seni sellekohased teadusuuringud puudusid.

Lammaste koproproovid koguti ja uuriti aastatel 2011–2012 kokku 46 lambafarmist, neist Saaremaalt 21, Hiiumaalt 18 ja Vormsi saarelt 7 farmist.

Ümarussidest tuvastati strongüliidide (pihtussiliste) nakkus 94,6%-l lambakarjades ja strongüloidide (varbussiliste) nakkus 70,7%-l karjades, piugusse leiti 9,8%-l karjades. Ainuraksetest parasiitidest olid levinumad eimeeriad (94,6%), järgnesid giardiad (69,6%) ja krüptosporiidid ehk peiteoslased (60,9%). Paelussidest leiti monieesiaid 22,8%-l karjades, imiussidest dikrotsööliume ehk väikest ebamaksakaani 3,3%-l karjades.

Kõige rohkem oli 1g koproproovis eimeeriarte ootsüste – 0–10 060 opg (mediaan 535, keskmine 1159), seejärel strongüliidide mune – 0–1771 (mediaan 248, keskmine 411). Selline invasiooni intensiivsus võib tähendada lammaste tervisliku seisundi olulist halvenemist mõnedes karjades.

Kokku määrati lammastel 11 *Eimeria* prk liiki. Suure tõvestavusega liik *E. ovinoidalis* identifitseeriti 93,1%-s uuritud proovides, see oli sageli ka domineeriv liik (64,4%-s proovides). Teine patogeensem liik *E. crandallis* leiti 14,9%-s proovides. Uurimistulemuste põhjal võib väita, et lammaste mao-sooletrakti parasiidid on väga levinud paljudes karjades. See mõjutab loomade tervislikku seisundit (kõhulahtisus, juurdekasvu langus jm.) ja lambakasvatuse tulukust.