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GASTROINTESTINAL HELMINTHS AND LUNGWORMS OF FRENCH DAIRY GOATS: PREVALENCE AND GEOGRAPHICAL DISTRIBUTION IN POITOU-CHARENTES

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ABSTRACT

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A study was conducted on 81 dairy-goat farms in western France. Faecal samples were collected once and 31 culled goats were necropsied in order to assess their gastrointestinal and respiratory helminth species, their prevalences and the intensities of infection as well as their geographical distribution in six subregions of the surveyed area. Fifteen species of helminth were recovered. The most frequent were *Muellerius capillaris*, *Trichostrongylus colubriformis* and *Teladorsagia circumcincta* with a prevalence more than 90%. The two latter species represented respectively 50.9% and 30.2% of the total worm burden of the digestive tract. Other prevalent species were *Haemonchus contortus*, *Strongyloides papillosus*, *Trichuris* spp., *Moniezia* spp. and *Dicrocoelium lanceolatum*. The occurrence of *Dicrocoelium lanceolatum* was related to the presence of calcareous or alkaline soils and restricted to the south of the surveyed area. No area at particular risk was defined for the other helminth infections, probably because of the relative homogeneity in climatic and topographic conditions of the six agricultural regions.

Keywords: epidemiology, goats, helminths, intestine, *Ostertagia*, principal component analysis, stomach, *Teladorsagia*, *Trichostrongylus*

INTRODUCTION

The major goat-producing areas in France are the Centre, Rhône-Alpes and the Poitou-Charentes regions. The latter, located in the western part of the country, in the vicinity of the Atlantic coast, includes more than a third of the French goat population and 65% of the industrial dairy production.

From a previous study on dairy-goat farms in Touraine, it was reported that animals on farms of low productivity were more heavily infected by internal parasites than herds with high productivity. Milk production and the number of kids sold per goat were negatively correlated to *Muellerius* and digestive tract strongyle infections, respectively (Cabaret *et al.*, 1984).

Information about the helminth fauna of goats in France is relatively limited (Raynaud, 1977; Brunet, 1981) especially concerning the Poitou-Charentes area (Kerboeuf and Godu, 1981). Furthermore, the geographical distribution of the helminths of domestic ruminants, even on a limited scale, is characterized by important faunistic variations (Cabaret, 1986). The assessment of areas of high risk is of particular interest in a given region to allow adaptation of control measures.

The aim of this study was to define the prevalence of gastrointestinal and respiratory helminths in dairy goats on pastures in Poitou-Charentes. An attempt was made to establish the geographical distribution of these parasites in six agricultural regions.

MATERIALS AND METHODS

Eighty-one commercial dairy-goat farms in the Poitou-Charentes region (département des Deux-Sèvres), equally distributed in six agricultural regions defined by climatological and soil characteristics (Table I), were studied between July and September 1991. The whole area has an oceanic and thus a temperate climate with winter rainfall, the wettest month being November and the driest July. All the farms used grazing on limited pastures for 7–9 months of the year, the animals being kept indoors for the other months. The average number of adult goats ranged from 32 to 62. The stocking rate was not assessed. The anthelminthic treatments per year varied from 2 to 10, and were performed mainly with benzimidazole compounds – i.e. oxfendazole, fenbendazole, febantel (80%) and ivermectin (12%). The goats were purebred (French Alpine or Saanen) or cross-bred.

TABLE I
Characteristics of the six agricultural regions in Deux-Sèvres (Poitou-Charentes)

	Mean temperatures (°C) (av. min–max)	Annual rainfall (mm)	Geology[a]
Bocage	11.4 (5.9–18)	940	SGR
Gâtine	11.4 (5.3–17.5)	1327	SGR
Entre Plaine et Gâtine	11.4 (5.8–18.9)	1152	SGR+JL
Plaine de Niort-Brioux	12.2 (6.3–18.7)	1000	JL
Plateau Mellois	12.1 (6.1–18.6)	881	A+JL
Plaine de La Mothe-Lezay	12.3 (6.0–19.3)	956	JL

[a]SGR, schist and grantite; JL, jurassic limestone; A, alluvial

TABLE II
Helminth species encountered in dairy goats and general prevalence (necropsy or coproscopical examination)

Species	Prevalence
Haemonchus contortus	37.1 ± 16.3
Ostertagia ostertagi	14.3 ± 11.8
Teladorsagia circumcincta	91.4 ± 9.5
Teladorsagia trifurcata	51.4 ± 16.9
Trichostrongylus colubriformis	94.3 ± 7.8
Trichostrongylus vitrinus	5.7 ± 7.8
Oesophagostomum venulosum	22.9 ± 14.2
Skrjabinema ovis	40.0 ± 16.6
Trichuris ovis	5.7 ± 7.8
Capillaria spp.[a]	6.0 ± 5.3
Strongyloides papillosus[a]	36.0 ± 10.7
Muellerius capillaris[a]	95.5 ± 4.6
Moniezia spp.[a]	29.8 ± 10.2
Dicrocoelium lanceolatum	20.0 ± 13.5
Fasciola hepatica	5.7 ± 7.8

[a]Coproscopical examination

TABLE III
Worm burdens for digestive-tract nematodes in 31 necropsied dairy goats

Species	Mean intensity of infection	Range
Haemonchus contortus	862 ± 290	93 – 3224
Ostertagia ostertagi	529 ± 404	18 – 2130
Teladorsagia circumcincta	4864 ± 1540	60 – 43616
Teladorsagia trifurcata	686 ± 200	41 – 2784
Trichostrongylus colubriformis	6724 ± 1427	20 – 30880
Trichostrongylus vitrinus	820 ± 680	141 – 1500
Oesophagostomum venulosum	580 ± 322	20 – 2720
Skrjabinema ovis	447 ± 165	20 – 1800
Trichuris ovis	30 ± 9	20 – 39

TABLE IV
Faecal egg and larval counts from goats in six agricultural regions of Poitou-Charentes

	Bocage	Gâtine	Entre Plaine et Gâtine	Plaine de Niort-Brioux	Plateau Mellois	Plaine de La Mothe-Lezay
Digestive tract strongyles	715 (264)[a]	349 (94)	760 (234)	359 (111)	973 (177)	465 (132)
Trichuris spp.	26 (15)	23 (6)	7 (-)	39 (27)	0 (-)	10 (2)
Strongyloides spp.	14 (5)	22 (8)	7 (-)	20 (6)	39 (11)	27 (8)
Capillaria spp.	0 (-)	11 (4)	7 (-)	11 (4)	0 (-)	0 (-)
Muellerius capillaris (larvae/g)	68 (27)	158 (60)	100 (36)	220 (72)	227 (58)	38 (8)
Moniezia spp.	15 (8)	30 (23)	18 (7)	17 (7)	58 (25)	49 (24)
Dicrocoelium lanceolatum	0 (-)	0 (-)	7 (-)	24 (12)	7 (0)	17 (7)

[a]Confidence interval at $p < 0.05$ in parenthesis

Fresh faecal samples were collected once from the ground in order to assess the prevalence and intensity of parasitism in adult goats. The McMaster technique was performed on all samples using potassium iodomercurate solution ($d = 1.44$) with two additional flotation slides per sample to give a sensitivity of 15 eggs per gram of faeces (Raynaud, 1970). The faecal samples were also examined for lungworm larvae by the Baermann technique.

Five or six culled goats from the farms surveyed in each region were slaughtered. None had been drenched for at least one month. The livers were examined according to the method of Reinecke (1984). Worm counts were conducted on 1/20 aliquots of abomasum and large intestine contents. For the small intestine, only the first 4 metres were examined as these contain more than 97% of the trichostrongyle population (Rahman and Collins, 1990); the rest was examined macroscopically for tape worms. The species composition was determined by identification of random samples of at least 50 male worms from each organ.

The mean intensity (total number of worms recovered/number of infected goats) and the prevalence (number of infected hosts/number of surveyed goats) were calculated.

For each species recovered from necropsied goats, the frequency (number of worms of one particular species/total number of worms recovered) was established for each goat and was used in principal component analysis (PCA) according to Lebart *et al.* (1982); the data were standardized as (actual values – mean value for the variable)/standard error for the variable; the data were arranged in columns (variables : species of worms) and rows (individual data) (Hoste and Cabaret, 1992).

RESULTS

Species encountered and general pattern

Fifteen species were recovered (Table II). The most prevalent species of gastro-intestinal nematodes were *Trichostrongylus colubriformis*, *Teladorsagia circumcincta* and *T. trifurcata* (94.3%, 91.4% and 51.4%, respectively). The mean intensities of infection (Table III) had a similar pattern as the two largest mean burdens (6724 and 4864) were of *T. colubriformis* and *T. circumcincta*. These species represented respectively 50.9% and 30.2% of the total worm burden. The average frequency of *Teladorsagia trifurcata* (number of *T. trifurcata*/number of *Teladorsagia* spp.) was 7.3%. Results obtained from coproscopical examinations at a flock level showed a very high prevalence of *Muellerius capillaris* infection (95.5%). This was the only lungworm found.

Egg or larval excretions ranged from 349 to 973 eggs/g for digestive tract strongyles and 38 to 227 larvae/g for *Muellerius capillaris* (Table IV). The other helminths had low egg outputs below 60 eggs per g.

In principal component analysis, axes 1 and 2 represented 43.1% of the variability. The major correlations concerned *Ostertagia ostertagi* and *Trichuris ovis* on axis 1 and *Teladorsagia circumcincta* on axis 2. The graph in Figure 1 indicates a close relationship for two pairs of parasites: *Teladorsagia circumcincta/T. trifurcata* and *Ostertagia ostertagi/Trichuris ovis*. However, a strong negative relationship was observed between *Trichostrongylus colubriformis* and *Teladorsagia* spp. The distribution of the animals did not show any particular grouping according to their subregion of origin.

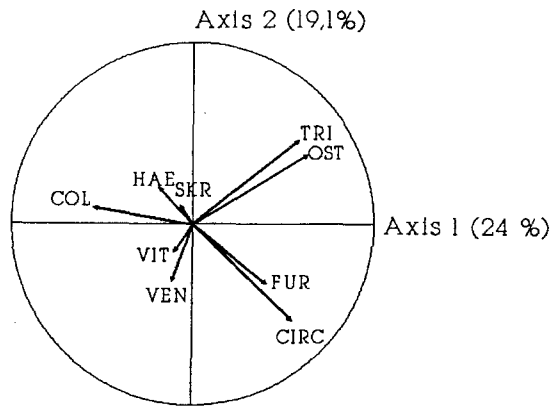
Geographical distribution

The following helminths were present in all subregions with only limited ranges of variation: *Haemonchus contortus*, *Teladorsagia circumcincta* and *T. trifurcata*, *Trichostrongylus colubriformis*, *Strongyloides papillosus*, *Skrjabinema ovis*, *Muellerius capillaris* and *Moniezia* spp. The other nematodes showed a heterogeneous distribution but identification of areas at particular risk was not possible. *Fasciola hepatica* eggs were not encountered in the samples, but two slaughtered goats coming from subregions 2 and 5 had very slight liver fluke burdens (1 and 4 respectively). Both coproscopical examinations and necropsy showed that *Dicrocoelium lanceolatum* infection was restricted to the south of the area surveyed.

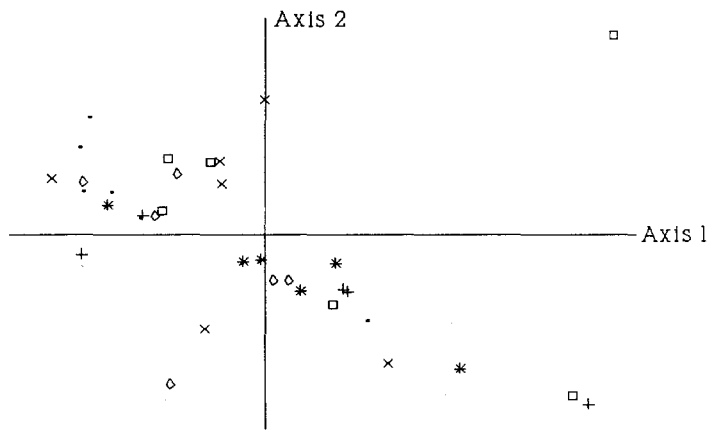
DISCUSSION

The most frequent species in Deux-Sèvres were *Muellerius capillaris*, *Trichostrongylus colubriformis*, *Teladorsagia circumcincta* and *T. trifurcata*. This pattern is in general agreement with data of Kerboeuf and Godu (1981) in Deux-Sèvres and with Cabaret *et al.* (1984) in Touraine. These authors also emphasized the low worm burdens recovered from the large intestine except for *Skrjabinema ovis*. More surprising was the moderate prevalence of *Haemonchus contortus* (37%) in our study, carried out

during the hot summer months which are usually considered to be the most favourable period in France (Kerboeuf, 1984). However haemonchosis is recognized as occurring mainly in areas of summer rainfall (Michel, 1967). In France, the optimal conditions of temperature and rainfall for the transmission of *H. contortus* seem to be restricted to years with mild springs and wet summers (Gruner *et al.*, 1978). Nevertheless, this species may be an important factor affecting the health of goats in



(a)



(b)

Figure 1. The interactions in principal component analysis between nine species of digestive-tract nematodes from French dairy goats in Poitou-Charentes. Figure 1a is the projection of the nine variables (species of worms) and Figure 1b the projection of the 31 individuals (necropsied goats) with their agricultural region of origin on the main plan (axes 1 and 2). The first axis concerns OST-TRI and the second axis CIRC. CIRC, *Teladorsagia circumcincta*; FUR, *T. trifurcata*; HAE, *Haemonchus contortus*; OST, *Ostertagia ostertagi*; COL, *Trichostrongylus colubriformis*; VIT, *T. vitrinus*; SKR, *Skrjabinema ovis*; TRI, *Trichuris ovis*; VEN, *Oesophagostomum venulosum*. Agricultural regions: 1, □; 2, *; 3, ×; 4, ◊; 5, .; 6, +

this area as almost 10% of the necropsied goats had worm burdens above the pathogenic level defined by Reinecke (1984).

Trichostrongylus was mainly represented by *T. colubriformis* and a few specimens of *T. vitrinus*. *T. axei* and *T. capricola* seemed to be absent. The small number of helminth species in our study contrasts with results from Spain (Tarazona, 1984a,b) and from the Italian Alps (Genchi *et al.*, 1984a,b). This has also been observed in goats in Touraine for ten years (Cabaret, unpublished data) and may result from the frequent use of anthelminthics. The *Ostertagia ostertagi* found were probably of bovine origin (Bisset, 1980). Goats and cattle do not usually graze together in the survey area but are occasionally present on the same plots at different times, so permitting cross-transmission. The absence of *Cooperia* spp. and *Nematodirus* spp. may be associated with their relatively strong host specificity for cattle and sheep respectively (Bisset, 1980; Kerboeuf, 1984). The mean egg or larval output levels for digestive and respiratory strongyles recorded were relatively high, as Cabaret *et al.* (1984) reported that faecal counts of over 400 eggs/g or 60 larvae/g were indicative of heavy infections in dairy-goat farms.

The opposing distribution of *T. colubriformis* and *Teladorsagia* spp. found is consistent with the results obtained by Coop *et al.* (1986) with *T. vitrinus* and *T. circumcincta* in lambs and by Kloosterman *et al.* (1984) with *O. ostertagi* and *Cooperia oncophora* in calves. Nevertheless, the general negative interaction of *Teladorsagia* spp. with other genera described by Hoste and Cabaret (1992) was not obvious in this study. The close relationship between *O. ostertagi* and *Trichuris ovis* is in contrast to the general pattern assessed by Barger (1984) in lambs where stronger correlations occurred between genera parasitizing the same organ. Conversely such a correlation was evident for the two species or morphs of *Teladorsagia*.

Geographical variations in helminth fauna can be established at different levels: state, large regions or restricted areas. Climatic and geological factors can be considered as the most helpful parameters for assessing the risk level for helminth fauna in a large region (Cabaret, 1986). In Deux-Sèvres the relative homogeneity in temperature, rainfall and topography (altitude less than 272 m) between the six agricultural regions is probably responsible for the absence of any major fluctuations in the geographical distribution of the main helminth species. These results are quite different from those recorded by Gruner and Cabaret (1985) in sheep raised in French Mediterranean areas where prevalences of *Haemonchus contortus*, *Trichostrongylus axei* and small lungworms showed great variations between the three subareas studied. On the other hand, an abattoir survey conducted in 13 departements located in south-east France failed to demonstrate any particular distribution for small lungworms in sheep (Brunet *et al.*, 1985). The same authors studying the distribution of *Dicrocoelium lanceolatum* observed a higher prevalence in the Alpine areas. This fluke was the only parasite showing a marked heterogeneous distribution in Deux-Sèvres.

The link existing between the occurrence of *D. lanceolatum* and the presence of alkaline soils is probably correlated with the existence of suitable biotopes for the intermediate hosts, especially for the terrestrial snails. Further investigations would be needed to assess accurately the risk areas for *D. lanceolatum* using soil maps and vegetation characteristics as has been done for lungworms and liver fluke (Wright and Swire, 1984; Cabaret and Galkin-Cabaret, 1985).

The scarcity of *Fasciola hepatica* in our study did not permit us to distinguish any particular agricultural region of risk for this helminth. Goats are infrequently infected with liver fluke (Leathers *et al.*, 1982), although they are very susceptible to it (Redington *et al.*, 1986).

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