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Review Article

Review and update of paramphistomosis

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Summary

Despite records of ruminal paramphistomes in Argentina dating back to the beginning of the XX century, in the last decade cases have increased in number with evidence of spreading to new geographical areas. This fact led us to carry out some studies in the last few years in order to enhance the poor availability of reports in South America, some of which are actually performed in our group. This paper reviews the characteristics of the life cycles and some aspects of the disease both at world and local level, and updates the latest paramphistome reports in domestic ruminants of Argentina.

Keywords: *Paramphistomum*; ruminants; intermediate host

Introduction

Paramphistomosis is defined as the parasitosis found in domestic and wild ruminants caused by trematoda that in general belong to the family Paramphistomidae (although there are others such as Balanorchiidae or Gastrothylacidae), which in their early stage are located in the small intestine and abomasums, from where they move to the rumen to finally lodge as adult trematodes. In much the same way as *Fasciola hepatica*, these digeneans require the presence of a snail in its habitat to complete the first stage of the life cycle. Although their pathogenicity is still controversial, there are worldwide descriptions of sporadic outbreaks reporting deaths or undetermined losses with or without clinical symptoms.

In Argentina the disease has not been studied in depth, but over the last few years there has been an increasing recording of cases, mainly in the northeast Mesopotamia (sited between the Paraná and Uruguay rivers) (Bulman *et al.*, 2002; Raccioppi *et al.*, 1995). Recently as well, several cases have been detected in the Province of Buenos Aires in the temperate climate central-east of Argentina (Sanchez *et al.*, 2005), with descriptions originated in necropsies and EPG's, marking thus an important increase to the original endemic area. The correct identification of these specimens is necessary for interpretation of their true importance as well as their potential for causing new clinical cases.

Taxonomy

The classification is highly dynamic and the recent molecular studies tend to reduce orders and to regroup these into minor taxa as superfamilies. However, families remain as the most constant taxa. At present the order Echinostomida (included in subclass Digenea) contains the superfamily Paramphistomoidea (Olson *et al.*, 2003) which includes the families Paramphistomidae and Gastrothylacidae, containing the majority of the known paramphistomes of ruminants. Paramphistomidae is divided into two subfamilies, whereby the subfamily Paramphistominae is represented by the genera *Paramphistomum, Cotylophoron, Calicophoron, Explanatum, Gigantocotyle* and *Ugandocycle.* The family Gastrothylacidae contains the genera *Fischoederius, Carmyerius, Gastrothylax* and *Velazquezotrema.*

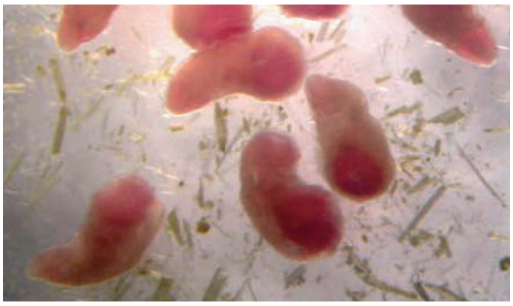

Fig. 1. Mature *Paramphistomum sp.* from ovine rumen.

Not in the Paramphistomoidea, the family Balanorchiidae (with *Balanorchis anastrophus* as the only species present) is located within the superfamily Cladorchoidea.

In Argentina, *Balanorchis anastrophus* has been described since 1917 (originally classified as *Verdunia tricoronata*) (Lahille & Joan, 1917), and in 1995 Racioppi *et al.,* described *Cotylophoron cotylophorum*, but the classification is now under review, and refocused towards the genus *Paramphistomum* (Sanabria *et al*., 2006) (Fig. 1).

Life cycle development

Within the intermediate host (IH): The external phase in the life cycle of *Paramphistomum spp* is similar to that of *Fasciola hepatica.* Eggs are shed in the digestive tract and eliminated with the faeces of the definite host. They must fall in water where at 28 ºC and after 17 days, hatching of miracidia capable of infecting snails takes place (Lengy, 1960). The production of miracidia can be delayed by adverse environmental conditions such as lower temperatures. Among the freshwater snails, the IH of paramphistomids belong to the families Lymnaeidae and Planorbidae. Neighbouring countries as Brazil and Uruguay may have planorbid snails as intermediates hosts of *Paramphistomum* spp. (Silva Santos *et al.*, 1986; Paiva, 1994). In Mexico *Lymnaea* species takes this role (Castro Trejo *et al.*, 1990).
In Argentina, *Lymnaea viatrix* (Venturini, 1978) (Fig. 2) and *L. columella* (Prepelitchi et al, 2003) have been described as intermediate hosts of *Fasciola hepatica,* and several species of the genus *Drepanotrema* and *Biomphalaria* are also present in the local snail population (Rumi *et al.*, 1997). At the moment, *L. viatrix* seems to be more receptive intermediate host to *Paramphistomum sp.* (Sanabria *et al*., 2005), although role of planorbids has not been discarded, since there are enough evidence around the world of their participation as intermediate hosts of these paramphistomids in ruminants (Sey, 1991).

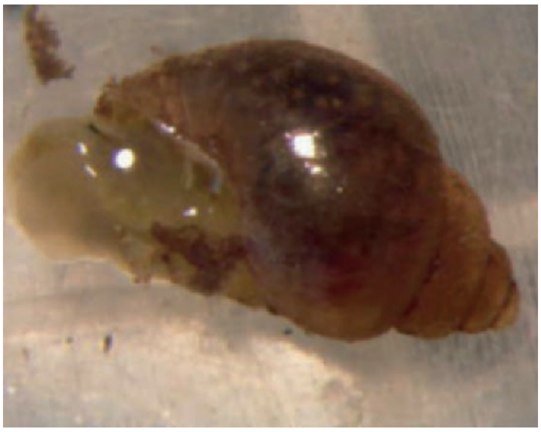

Fig. 2. *Lymnaea viatrix* snail.

The miracidiae penetrate the snail shell, shedding their ciliated coat and develop to sporocysts containing germinal cells. In 1 to 2 weeks, the sporocysts give rise to rediae (Horak, 1971), which have a pharynx and ceca, and a great phagocytic capacity. They can also form secondary new generations of young rediae, and these in turn may produce more generations of the same phase all leading to the following phase of cercariae, or alternatively, develop to cercariae directly.
The cercariae emerge from their rediae and undergo a maturation period of approximately 10 days, within the snail. These cercariae have pigmentation and 2 eye spots, and in this phase, a typical feature of ruminal paramphistomids, the crossing of the main excretory vessels (Durie 1951, 1956; Yamaguti, 1958; Sey, 1991) (Fig. 3).

Fig. 3. *Paramphistomum sp.* cercariae showing characteristic main excretory vessels disposition.

Once the cercariae leave the snail and reach water again, they move until reaching subaquatic vegetation, to which they adhere and begin to develop a cysts leading to metacercaria, constituting the infective phase for ruminants when ingested. The process of cyst formation takes about 20 minutes (Horak, 1971), and the resulting metacercaria are able to survive for at least 29 days if a humid environmental temperature persists (Horak, 1962). The prepatent period in the intermediate host was 37 days at 28 °C (Lengy, 1960), but could present variations mainly related to temperature and humidity, the genus of the snail host as well snail - parasite interactions, such as a defensive response of the snail and evasive mechanisms of the parasite to that response. In our experience, under controlled laboratory conditions, the prepatence in *L. viatrix* was of 62 days at 22 º C (Sanabria *et al*., 2005).
Within the definite host (DH): When the metacercaria are ingested and reaches the anterior part of small intestine the immature flukes are shed and remain attached to the intestine wall feeding cellular detritus. Once they have developed sufficiently, they migrate towards the rumen, where the parasites will reach the adult stage, remaining there and living on ruminal fluid. The prepatent period described for *Paramphistomum microbothrium* by Horak (1967) was of 56 days in cattle, 69 days in goats and 71 days in sheep. On this basis, in small ruminants, maturation and migration is apparently slower than in bovines (Horak, 1971).
There is a reason to believe in a more favourable

host/parasite relationship in cattle compared with sheep and goats, at least with *P. microbothrium.* This is also the case of the size reached by the adult specimen, and cattle show a greater tolerance towards relatively large loads.

Pathology and pathogenesis

The occurrence of the disease depends both on the individual vulnerability and the species susceptibility, as well as on the number of the ingested metacercaria. The susceptible categories mainly include young animals, as adults develop immunity easily for longer periods. However, adult cattle and sheep without previous exposure may produce clinical or subclinical conditions after the ingestion of high doses of metacercariae (Boray, 1959; Horak, 1971).

It is evident that clinical outbreaks are associated to a high intake of metacercariae from grass, and this fact is related to a high rate of infection of the intermediate host. The amount of metacercariae capable of producing clinical signs is variable according to different experiments, but is much higher compared with doses employed to produce infection with *F. hepatica*.

Doses of 5000 metacercariae of *C. cotylophorum* produced clinical signs at 116 days after dosage in a lamb, and death after day 124 post infection (Varma, 1961).

Burdens of 40000 flukes gave rise to clinical signs and death in sheep, although field infections given by 2000 flukes were associated with the cause of death (Horak, 1971).

In the small intestine, young parasites adhere by their acetabulum, generating a "sucker effect". This effect is associated at the successively detachment of the acetabulum in act to produce a forward migration, and multiplied by the number of flukes present. As a result, they leave injured areas that are equal to the size of the acetabulum, with exposition to vascular strata and the loss of electrolytes and proteins producing anorexia, foetid diarrhoea, and loss of corporal condition. Anaemia is unusual.

Protein loss generates a generalized oedema (hydrothorax, hydropericardium, ascites, lung oedema).

In Argentina, *B. anastrophus* (Schiffo *et al.*, 1974) has been attributed to be the cause of a death case in cattle, and an outbreak of Paramphistomosis has also been incriminated in Uruguay (Rimbaud & Diana, 1991). However, at least in Argentina, it is infrequent to find relevant cases. Most probably death and clinical disease are sporadic in endemic areas and signs of enteritis and weight loss associated to other factors, often suggest the presence of other diseases.

Epizootiology

Since this parasite infection is conditioned, like the rest of the Digenea to the coexistence of favorable temperature, humidity and presence of IH, paramphistomosis has been described in low and easily flooded lands, rice growing areas and natural grass pastures with slow running water, as well as in the area of lakes and marshlands.

Snails reproduce during the warm and rainy months, when their number increases and become easily infected with *Paramphistomum* miracidia. Afterwards, once the cycle in the IH is completed, the metacercariae spread over the pasture, where they may survive for several months.

If they survive dry periods, the pasture area will tend to narrow to wetland environments, and it is possible that the animal contamination rates will increase. Thus it has been described in endemic regions such as Australia (Rolfe *et al.*, 1991). In temperate zones, climatic contrasts may be more reduced or there may be special situations that merit being studied, which is the case in the more recent reports in Argentina. There is reason enough to expect a cyclic development similar to that of *Fasciola hepatica* regarding the climatic dependence, perhaps within higher ranges of temperature. The authors are presently studying the variables that determine the behaviour of the genus described in the temperate areas of Argentina, but the first conclusions tend towards a seasonal nature, when larger egg counts in cattle and sheep faecal material are observed in late spring and summer, which would be linked to larger infections near the end of the fall.

Diagnosis

The filtration technique with sieves and sedimentation (Happich & Boray, 1969) is the most accurate to identify eggs in faeces, producing clearer evidence in the sediment of the sample under study. Eggs are similar in shape to those of *Fasciola hepatica* but slightly larger (160 – 180 μ), and transparent in aspect. In order to distinguish the differences between eggs more clearly, it is advisable to use contrast stains such as methylene blue or methyl green, instead of Lugol.

It is to be taken into account that in animals with acute symptoms without previous exposure it is highly probable not to find eggs or only very few, and this may be in association to massive infestation with young flukes and to the fact that the prepatent period is relatively long. Among the differential diagnosis, the presence of enterotoxic weeds (eg. *Baccharis coridifolia*), enterotoxaemia in lambs, parasitic gastroenteritis, paratuberculosis and other diseases that include in their symptoms both weight loss and diarrhoea have to be included. The aforementioned cases should be related to the geographical characteristics of the area where the necessary IH snail species are present.

Control

Under this perspective, as an integrated control measure, the distribution of grazing paddocks is established according to their geographical features, combined with the anthelmintic therapy and the study of other epidemiological variables such as the infection prevalence in the IH. On farms where this is possible, herd rotation can be carried out according to the prepatency and the possibilities of egg contamination. Adult animals are less susceptible, so they could be grazed in infected paddocks and then moved to

Table 1: Trematodicide drugs evaluated against amphistomes of cattle and sheep, adapted from Rolfe & Boray, 1987. (*): Not evaluated

Drug	Dose mg/kg	Species	% Efficacy against mature flukes	% Efficacy against immature flukes
Albendazole	20	Sheep	0	13-99
Closantel	7,5	Cattle	0	0
Fenbendazole	4,4	Sheep	0	*
Hexaclorophene	20	Cattle	100	99,5
Niclosamide	160	Cattle	*	91,1
Niclosamide	100	Sheep	0	99,8
Nitroxynil	10	Sheep	0	0
Oxiclozanide/Levamisole	18,7/9,4	Cattle	100	99,9
Resorantel	6,5	Sheep	100	95
Triclabendazole	100	Sheep	0	44,9

higher pastures when the prepatent period has been completed. The need of treatment must be carefully evaluated, as outbreaks with pathogenic signs are unusual, and the only presence of adults in the rumen in necropsies is no evidence of a disease outbreak.

The employment of molluscicides (copper sulphate, sodium pentachlorophenate) may be used as with *Fasciola hepatica*, but in general is not applicable due the ecological impact. The fencing off of problematic paddocks or limited areas within these would be the most appropriate choice, although scarcely used. In regard to treatments, there is little information about the effectiveness of different drugs and besides, those that control immature stages may have little or no effect at all on adults and vice-versa. In all the cases, recommendations are based on a few isolated tests, where results are sometimes contradictory. In Table 1, the effectiveness of some drugs on paramphistomids is summarized (Rolfe & Boray, 1987), mainly emphasizing on those more available in Argentina.

We suggest the need of evaluation of molecules available in the region that shows reciprocal activity both in the small intestine and rumen.

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