Notable seasonal variation observed in the morphology of the reindeer rumen fluke *(Paramphistomum leydeni)* in Finland

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Abstract: Although numerous *Paramphistomum* species have been described from the rumen and reticulum of domestic and wild ruminants, information about rumen flukes in reindeer is sparse and their nomenclature is somewhat conflicting. Rumen fluke of reindeer is usually referred to as *P. cervi,* but *P. leydeni* and *Cotylophoron skriabini* are also mentioned in the literature. Here, the surface structures and internal anatomy of rumen flukes from reindeer, as seen by scanning electron microscopy (SEM) and in histological sections under light microscopy, are presented. The aim of the study was to find morphological information to enable identification of rumen flukes in reindeer to species level. In addition, the morphology of rumen flukes collected in winter (winter flukes) was compared with that of flukes collected in summer (summer flukes). Key morphological findings were as follows: the acetabulum of the rumen flukes was of paramphistomum type, the pharynx of liorchis type, and the genital atrium of leydeni type. Both winter and summer flukes shared these morphological features. Based on these findings, it was concluded that rumen flukes of reindeer in Finland belonged to the species *P. leydeni*. Significant morphological variation was observed when winter and summer flukes were compared. The winter fluke was smaller in size, possessed immature gonads (testes, ovary, uterus), and immature accessory genital glands (Mehlis' gland, vitelline follicles), and had barely discernible tegumental papillae. These data indicate that winter rumen flukes represent an immature stage of *P. leydeni* and summer flukes the mature stage of the same species. Further, these findings suggest that the rumen flukes of reindeer during wintertime in Finland have a slowed or inhibited lifecycle.

Key words: Paramphistomatidae, *Rangifer tarandus tarandus*, scanning electron microscopy, Trematoda.

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Introduction

The family Paramphistomatidae established by Fischoeder (1901) belongs to the trematodes (flukes) of the order Digenea. These are pear-shaped worms, circular in transverse section, and characterized by having two distinct suckers, one of which is for attachment and the other is a mouth. The oral sucker consists of a muscular pharynx, which is the beginning of the bifurcated caecum (alimentary canal). The posterior sucker (acetabulum) is situated at the posterior end of rumen flukes and is well developed. The flukes are hermaphroditic, and the genital pore is located ventromedially in the anterior third, serving as a common opening for male and female sex organs. All internal organs are embedded in a parenchyma. Paramphistomes require an aquatic snail as an intermediate host and the pre-parasitic stages of the lifecycle (miracidia and stages in the snail) are very similar to those of liver flukes (*Fasciola hepatica*). However, the exact lifecycle of rumen flukes of reindeer is unknown.

Although numerous *Paramphistomum* species have been described from the rumen and reticulum of domestic and wild ruminants, information about rumen flukes in reindeer is sparse. Winigradowa (1932) reported *Paramphistomum cervi* as an autopsy finding in a reindeer. Nikolaevski (1953), Miskewich

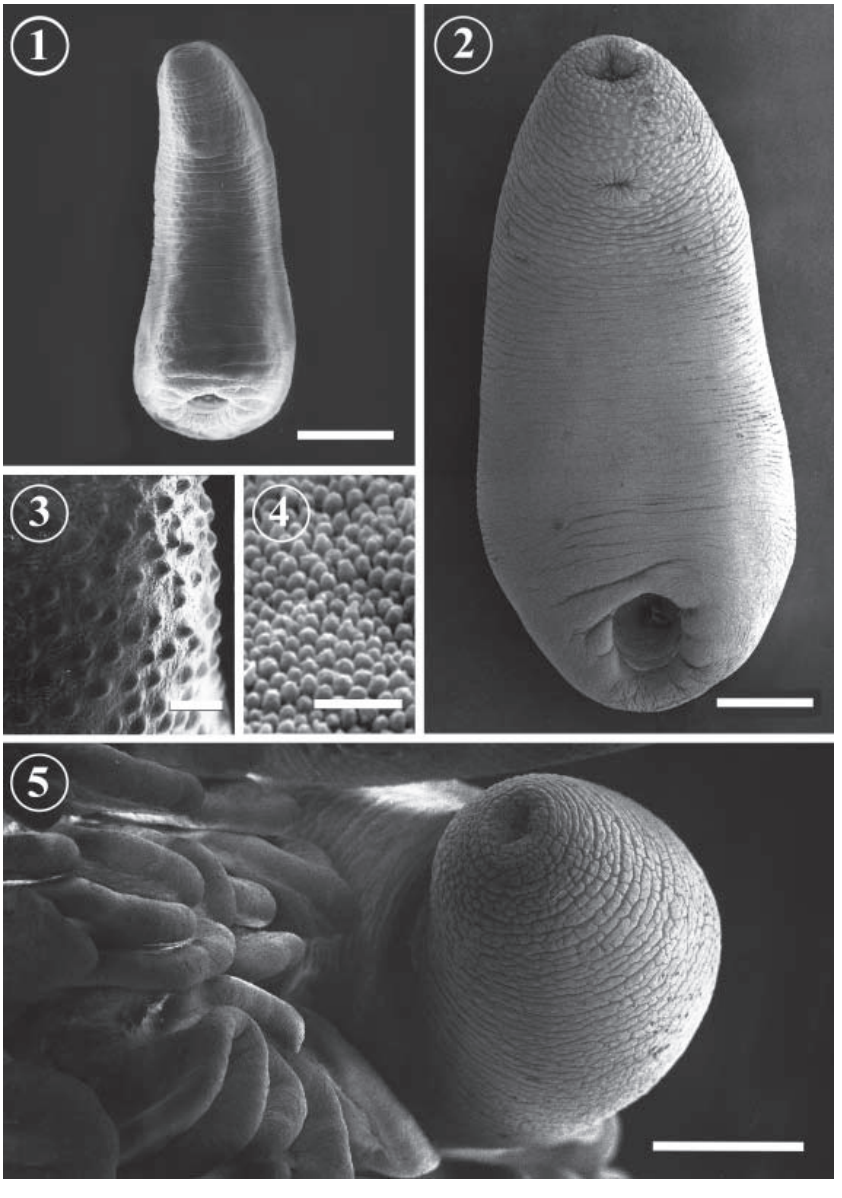


Fig. 1. Morphology of *Paramphistomum leydeni* as seen during the winter (winter fluke) under SEM to show less prominent tegumental papillae. Scale bar = 1 mm.

Fig. 2. Morphology of *P. leydeni* as seen during the summer (summer fluke) under SEM to show well-defined papillae at the anterior end. Scale bar = 1 mm.

Fig. 3. Papillae at the anterior end of the summer fluke as seen under SEM. Scale bar = 100 µm.

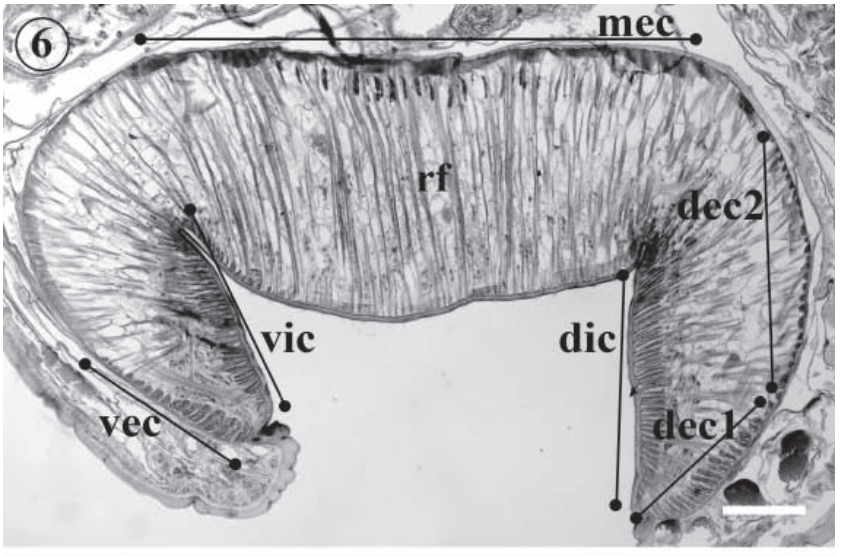
Fig. 4. High-magnification SEM of the surface of the winter fluke showing a carpet of tiny spherical papillae. Scale bar = 1 µm.

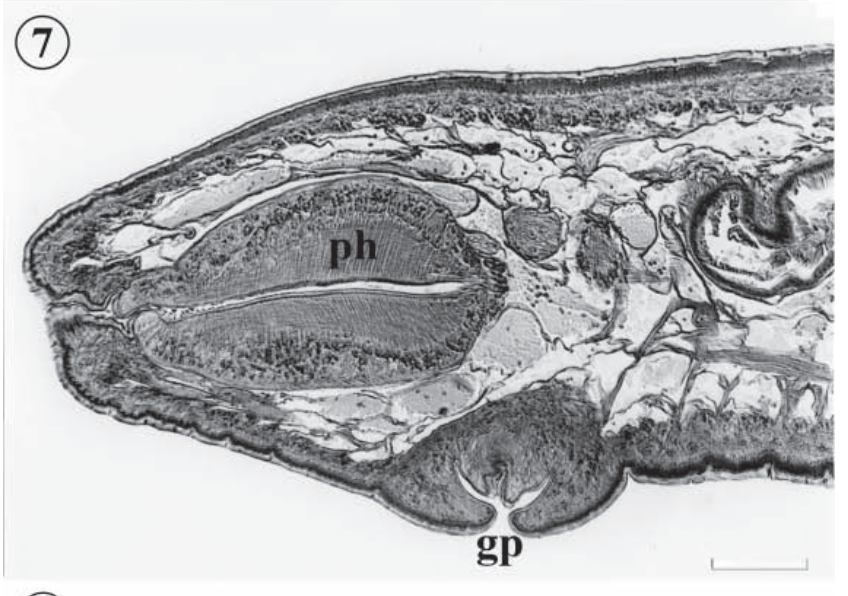
Fig. 5. SEM micrograph showing a winter fluke attached to a rumen villus of a reindeer. Scale bar = 1 mm.

(1967), Sey (1980), and Dieterich (1981) have also described *P. cervi* as a parasite of reindeer. Another Paramphistomatidae fluke mentioned in the literature as occurring in reindeer is *Cotylophoron skriabini* (Miskewich, 1958), that according to Eduardo (1982b) is synonymous with *Paraphistomum leydeni*. In a textbook dealing with reindeer healthcare (Rehbinder & Nikander, 1999), the reindeer rumen fluke is referred to as *P. leydeni*. Other than these citations, apparently no literature exists on rumen flukes in reindeer.

The taxonomy of paramphistosomes is complex (Soulsby, 1982). Identification of these flukes was originally based on morphological criteria established by Näsmark (1937). These criteria were later revised by Eduardo (1982a). Identification is based on the morphology of the acetabulum, pharynx, terminal genitalium, tegumental papillae, and internal organs of flukes.

We employed histological, light microscopy (LM), and scanning electron microscopy (SEM) techniques to identify the reindeer rumen fluke, *Paramphistomum* sp., to species level. In addition, we compared the morphology of rumen flukes sampled during the winter (winter flukes) with that of flukes obtained during the summer (summer flukes). The morphological differences between these flukes are so marked that they could easily be misinterpreted as different species by someone unaware of the seasonal variation in reindeer rumen flukes.





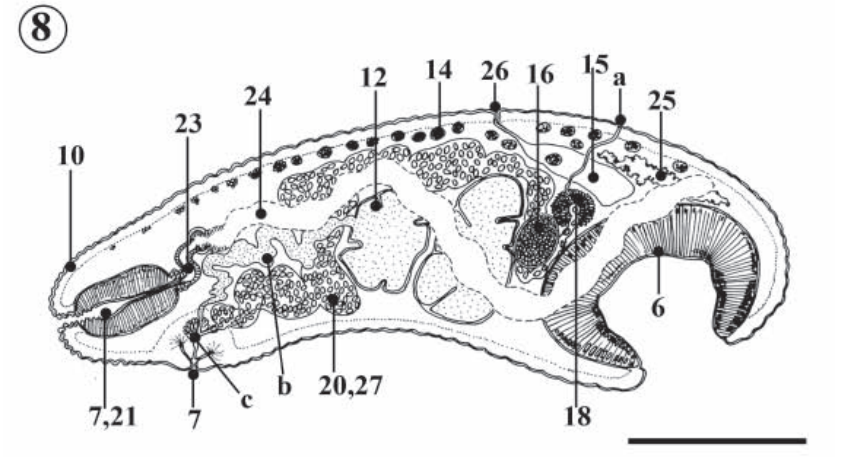
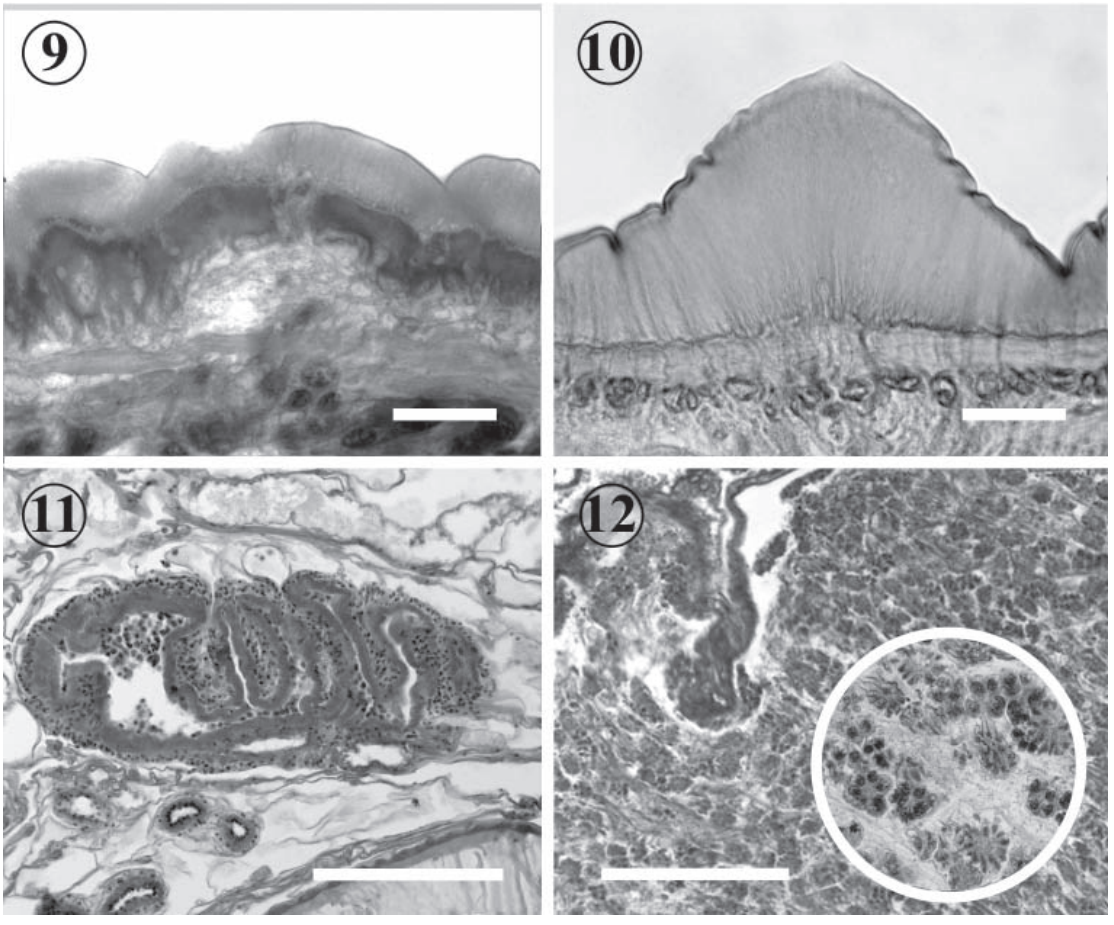


Fig. 6. LM micrograph showing a sagittal section of the subterminal acetabulum of paramphistomum type. Key to muscle abbreviations: vec = ventral exterior circular muscle series, vic = ventral interior circular muscle series, dic = dorsal interior circular muscle series, dec1, dec2 = dorsal exterior circular muscle series 1 and 2, rf = radial muscle fibers, and mec = median circular muscle series. Scale bar = 200 µm.

Fig. 7. LM micrograph showing a sagittal section of the anterior end of the fluke with a pharynx (ph) of liorchis type and a terminal genitalium of leydeni type: gp = genital pore. Scale bar = 200 µm.

Fig. 8. Diagrammatic presentation of the sagittal view of *P. leydeni*. The areas indicated with numbers are depicted in the figures with corresponding numbers. Laurer's canal (a), vas deferens (b), and prostate gland (c) are not presented in the figures. Scale bar = 2 mm.



Figs. 9 – 10. Histological section of the tegument from the anterior end of the rumen fluke. Fig. 9 shows the wavy and thin tegumental syncytium of a uniform thickness in the winter fluke. Fig. 10 shows the corresponding area in the summer fluke. The syncytium is thick, forming a conical nonciliated papilla at the anterior end. Scale bar = 20 µm.

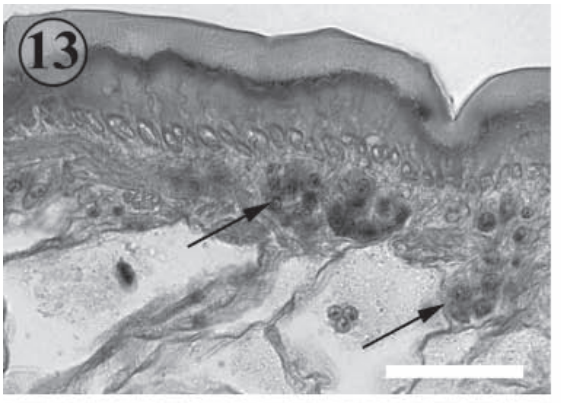
Figs. 11 – 12. LM micrographs showing the seasonal variation in the testes of a reindeer rumen fluke. Fig. 11 depicts the immature testis of the winter fluke. It possesses deeply folded capsule and dark-stained primordial germ cells. Fig. 12 shows part of the testis of a mature summer fluke. The capsule forms only a few septa. The insert shows the stages of spermatogenesis and mature spermatozoa. Scale bar = 200 µm.

Figs. 13 – 14. LM micrographs showing seasonal variation observed in the vitelline cells and follicles of a reindeer rumen fluke. Fig. 13 shows clusters of intensively stained vitellin cells (arrows) in the parenchyma beneath the tegumental cells of the winter fluke. Fig. 14 shows a part of the mature vitellin follicle of the summer fluke with immature and mature cells containing shell globules. Scale bar = 200 µm.

Figs. 15 – 16. LM micrographs showing seasonal variation observed in the ovaries of reindeer rumen flukes. The immature ovary (arrow), Mehlis' gland (mg), and excretory vesicle (ev) of the winter fluke are seen in the same micrograph (Fig. 15). Fig. 16 shows the corresponding area during summer. Only part of the ovary with mature oocytes is depicted. Scale bar 200 = µm.

Figs. 17 – 18. LM micrographs showing seasonal variation observed in Mehlis' gland of the reindeer rumen fluke. Fig. 17 shows the small Mehlis' gland of the winter fluke (arrow) with the vitellin duct (vd) and sections of the uterus (u). Fig. 18 shows an active Mehlis' gland forming an egg in the summer fluke. Eggs (e) can be observed within the lumen of Mehlis' gland and adjacent to the gland. Scale bar = 200 µm.

Figs. 19 – 20. LM micrographs showing seasonal variation observed in the uterus of the reindeer rumen fluke. Fig. 19 shows the winding immature uterus (arrows) of the winter fluke. Fig. 20 depicts the uterus during the summer. Scale bar = 200 µm.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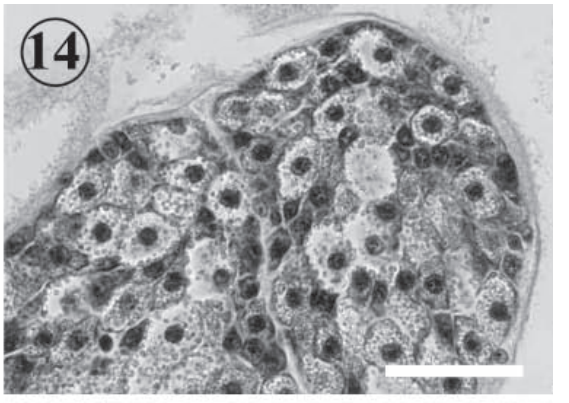
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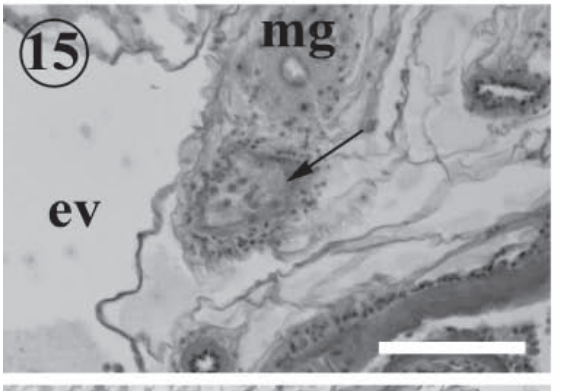
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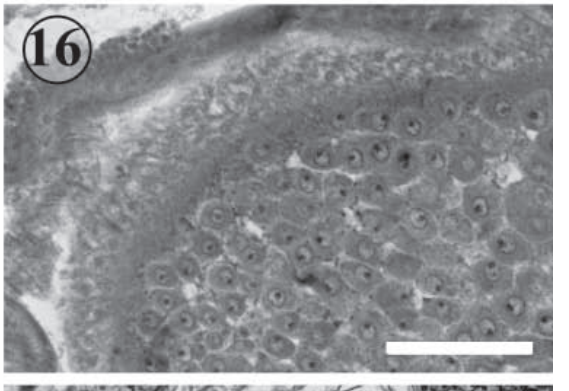
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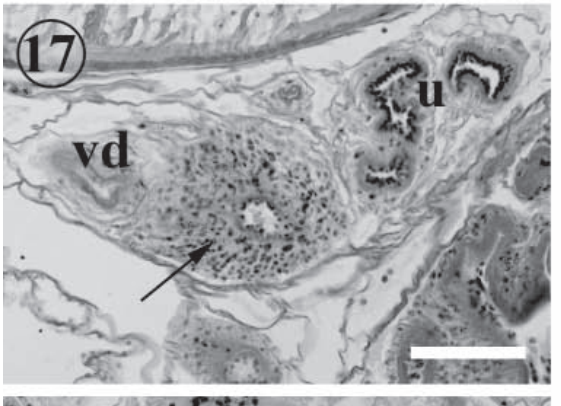
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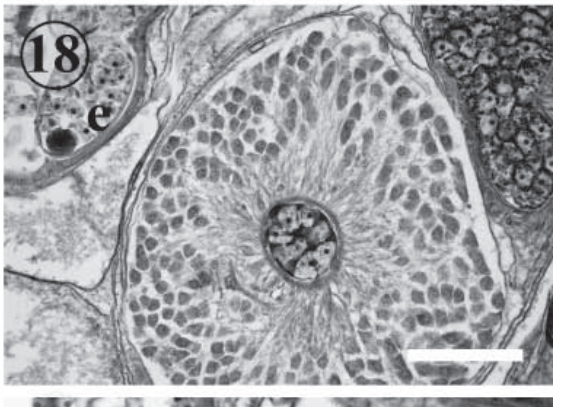
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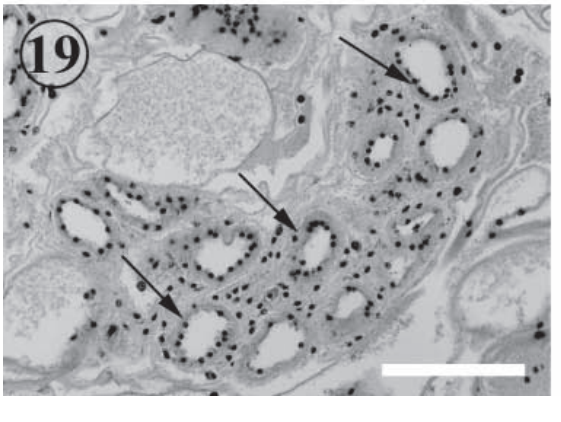
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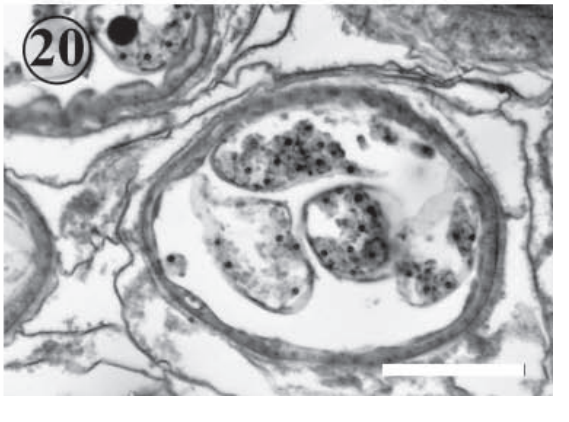
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Material and methods

The material originated from reindeer in Finnish Lapland (Enontekiö, Kaamanen, Vuotso, and Savukoski). Winter fluke specimens were collected in December – January from slaughtered animals by emptying the rumen, washing it gently, and then inspecting the ruminoreticular fold for flukes. During the summer (May – August), samples were more difficult to obtain, but flukes could be found in, for instance, road casualties and single animals euthanised due to severe injuries. The fluke-collecting procedure was the same as mentioned above.

The flukes were fixed in a phosphate buffer containing formaldehyde (10%), paraformaldehyde (2%), and glutaraldehyde (0.1%). After storage in 70% alcohol, the samples were dehydrated through a series of increasing concentrations of ethanol (70%, 80%, 90%, 96%, and 100%). Samples intended for light microscopy were embedded in paraffin and vertical longitudinal sections of the flukes were routinely processed for histology. Altogether about 2500 histological sections of rumen flukes were examined.

In specimens prepared for SEM studies, the alcohol series was followed by drying using a critical point dryer (Bal-Tec, CPD 030). Dried samples were mounted on aluminium stubs, coated with platinum (Agar Sputter Coater), and examined under a Zeiss DSM 926 scanning electron microscope at the Electron Microscopy Unit of the Institute of Biotechnology, University of Helsinki. To reveal internal structures, some paraffin-embedded flukes were sectioned into slices with a surgical blade. The paraffin was removed in xylene, and the specimens were transferred to 100% ethanol, dried, and processed similar to the other SEM specimens.

The maximum length and diameter of 50 rumen flukes collected in the winter were recorded and corresponding measurements were obtained for summer flukes. Internal structures were measured from histological sections for 10 winter and 10 summer flukes using light microscope with calibrated ocular micrometer.

To further investigate differences between winter and summer flukes, 50 winter flukes were pooled, dried at room temperature on a Petri dish, and weighed. The result was compared with that obtained for 50 similarly processed summer flukes.

Results

The morphometrics of reindeer rumen flukes are summarized in Table 1, with the morphological details shown in figures. Reindeer rumen flukes were conical red flukes that were usually found as a colony in the rumen attached to papillae on the reticular side of the ruminoreticular fold. In the winter, the red colour of the flukes was not as intense as in the summer. Detaching the rumen fluke from the papilla revealed an atrophic, club-shaped papilla.

The SEM study of the surface of winter and summer flukes showed that the anterior third of their bodies were covered by distinct papillae. The winter flukes possessed cobblestone-like flat papillae (Figs. 1 and 5). The corresponding papillae of summer flukes were well-developed, dome-shaped, and arranged in circular rows (Figs. 2 and 3). High magnification SEM of the surface of winter and summer flukes revealed that the entire tegument was covered by a carpet of tiny spherical papillae of 0.15-0.20 µm in diameter (Fig. 4).

The weight of 50 winter flukes was 0.123 g, while summer flukes weighed 0.330 g. The dried winter flukes were red brown and the summer flukes were very dark brown.

The muscles of the acetabulum (Fig. 6) observed in median sagittal sections were as follows: dorsal exterior (dec1 and dec2), dorsal interior (dic), ventral exterior (vec1 and vec2), and ventral interior (vic) muscles.

Fig. 21. SEM micrograph showing the pharynx of *P. leydeni* during winter with different types of papillae. The oral papillae (seen on the right) are tall and usually branched. The aboral papillae are unsplit and short, covering the dorsal and ventral surfaces of the pharynx. The lateral part of the pharynx is without papillae. Scale bar = 50 µm.

Fig. 22. Close-up SEM micrograph showing the details of the oral papillae with split tips. Scale bar = 10 µm.

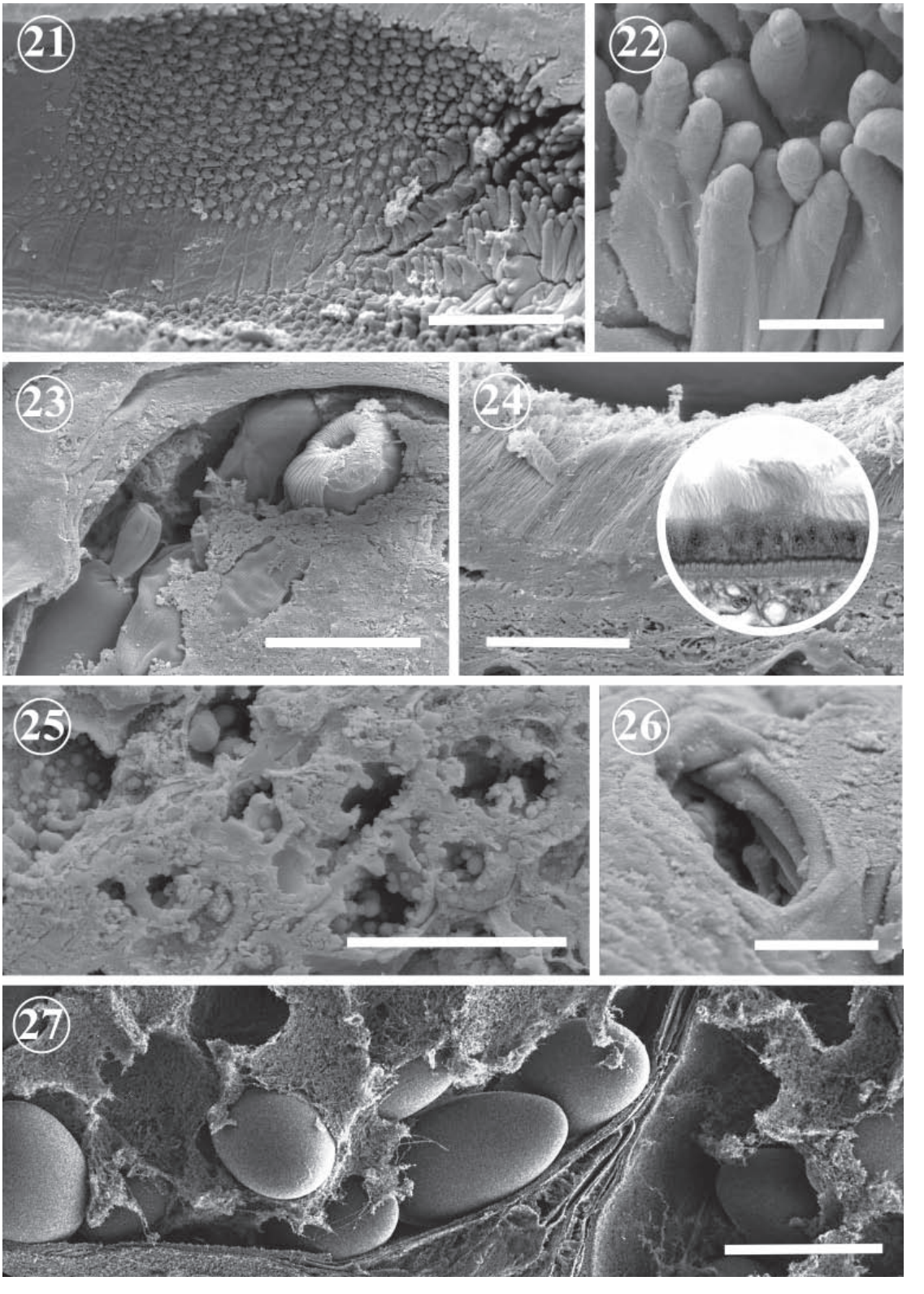
Fig. 23. SEM micrograph showing the lumen of the esophagus of the winter fluke. The esophagus is filled with ingesta consisting mainly of protozoa. The wall of the esophagus is smooth and nonciliated. Scale bar = 50 µm.

Fig. 24. SEM micrograph showing the wall of the caecum covered by a thick carpet of microcilia. The corresponding area as seen in LM in the insert. Scale bar = 20 µm.

Fig. 25. SEM micrograph showing the lymph system network. Numerous vesicular globular structures of various sizes can be observed within the channels. Scale bar = 20 µm.

Fig. 26. Ostium of the excretory canal on the dorsal side of the fluke. Scale bar = 10 µm.

Fig. 27. Mature uterus filled with eggs in some kind of fibrous "package material". In summer, the uterine wall is thin, probably because of pressure from the eggs. The operculum, which is typical for fluke eggs, is hardly visible. Scale bar = 100 µm.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Between the dorsal exterior and ventral exterior muscle were irregular median circular (mec) series and a few oblique (of) but well-developed radial muscle fibers (rf). The exterior longitudinal fibers were distinct but few. The numbers of muscle fibers in the acetabulum of ten flukes were as follows: dec1: range13 - 20 (mean 16); dec2: 19 - 29 (25); dic: 35 - 43 (39); vic: 39 - 54 (47); vec: 13 - 20 (15); and mec: 18 – 25 (22).

The terminal genitalium with its opening (Fig. 7) was located at the level of the anterior part of the esophagus, about 1.2 mm from the anterior end in the winter fluke. The terminal genitalium possessed only a few muscle fibers. The genital papilla was thick and covered by ventral folds without sphincter muscles or a ventral atrium. Radial fibers were well developed.

The pharynx (Fig. 7) possessed well-developed exterior and middle circular muscle fibers. Neither anterior nor posterior sphincter muscle fibers were observed in the histological sections. The SEM showed that the dorsal and ventral areas of the pharynx were covered with stout conical papillae (Fig. 21). The oral part possessed lip-like structures, and in the pharynx long papillae, often with split tips of 2-4 branches were present (Fig. 22). The lateral and aboral areas of the pharynx lacked papillae. The esophagus was usually bent dorsally, but a straight esophagus was observed in one winter fluke in sagittal histological sections. Ingested protozoa and trematode eggs were frequently seen within the esophagus (Fig. 23) and caeca. The paired caeca were present on both dorsolateral sides of the body, undulating dorsoventrally. At the anterior margin of the acetabulum, the blind end of the caeca curved medially without meeting. The wall of the intestine was thick and possessed longitudinal and circular muscle fibers. The epithelium consisted of a single layer of columnar epithelial cells that were covered by an uninterrupted carpet of microvilli. These microvilli were as tall as the epithelial cells themselves (Fig. 24).

The testes were situated in the posterior two-thirds of the body, anterior to the acetabulum. They were lobed, situated in tandem, and surrounded by a capsule with distinct septae. In winter flukes, the testes were very small with a thick, folded capsule, and they contained immature spermatogonial cells (Fig. 11). In summer flukes, the testes were large, containing various stages of spermatozoa (Fig. 12). Occasionally, strong septae divided the testis into separate lobes.

The immature vitellin cells of winter flukes were located in small clusters peripherally under the tegument (Fig. 13). In summer flukes, the vitellin glands were in active phase and were thus filled with shell globules (Fig. 14). The vitellin glands occupied the peripheral parts of the parenchyma dorsally, laterally, and ventrolaterally. These glands were observed within the parenchyma, starting from the middle part of the acetabulum and extending to the posterior part of the pharynx.

The immature ovary of winter flukes was very small. It was located posterior to the testis and middorsally to the acetabulum. It was small and densely packed with immature oocytes, small cells with scant cytoplasm, and an intensively stained nucleus (Fig. 15). Summer flukes possessed a large ovary that was surrounded by a capsule and packed with mature oocytes characterized by a large nucleus with a distinct nucleolus (Fig. 16).

Mehlis' gland was situated immediately posterior to the ovary and testis. In winter flukes, it consisted of a small oval cluster of cells around a canal (Fig. 17). The Mehlis' gland of summer flukes had a spherical and glandular appearance. Recently formed eggs packed

Table 1. Seasonal changes in morphology of rumen flukes (*Paramphistomum leydeni*) from reindeer in Finland. Specimens collected in winter (December-January) are referred to as winter flukes and specimens collected in summer (May-August) as summer flukes.

	Winter flukes Range (mean)	*Summer flukes* Range (mean)
Maximum length (*n*=50)	38 – 63 mm (49 mm)	78 – 116 mm (92 mm)
Maximum width (*n*=50)	18 – 26 mm (22 mm)	28 – 37 mm (34 mm)
Acetabulum (diameter) (*n*=10)	1.46 – 1.80 mm (1.59 mm)	1.80 – 2.00 mm (1.96 mm)
Pharynx (length) (*n*=10)	0.62 – 0.90 mm (0.73 mm)	0.76 – 0.83 mm (0.80 mm)
Esophagus (length) (*n*=10)	0.55 – 0.70 mm (0.60 mm)	0.62 – 0.76 mm (0.65 mm)
Testis (diameter) (*n*=10)	0.20 – 0.50 mm	1.00 – 1.50 mm
Ovary (maximum width) (*n*=10)	(0.14 mm)	(0.80 mm)
Mehlis' gland (diameter) (*n*=10)	(0.20 mm)	(0.35 mm)

with vitelline cells were frequently observed within the centrally located lumen of the Mehlis' gland.

The uterus arose from the Mehlis' gland and ended in the genital pore. In the winter fluke, the uterus was a relatively thin winding tube located on the dorsal side above the testis (Fig. 19). In the mature summer fluke, the uterus was full of eggs, taking up virtually all of the unoccupied space of the parenchyma (Figs. 20 and 27). The eggs were surrounded by a fibrous matrix.

Laurer's canal was observed as another thin tube, originating from the Mehlis' gland and opening along the dorsolateral surface of the fluke. About 0.7 mm anterior to this opening was the excretory pore (Fig. 26). It was located mid-dorsally 3.8 - 3.9 mm from the posterior end of the fluke. The excretory vesicle was located dorsally to the acetabulum. Dorsally and posterior to the excretory vesicle, a network of tubular and alveolar structures was present. These structures were considered as a part of the lymph system. Numerous vesicular globules of varying size were observed on the walls of these structures (Fig. 25).

Discussion

Identification of the Paramphistomidae is based on the system introduced by Näsmark (1937). He classified the acetabulum, terminal genitalia, and pharynx into different structural types. His classification of acetabular types is principally based on the arrangement of the muscle fibers. According to Näsmark (1937), 12 different acetabulum types can be distinguished.

If the acetabulum is not huge, and it possesses a single vec group, and the dec2 units are smaller in size but greater in number than the dec1 units, the acetabulum is of paramphistomum type (Näsmark, 1937; Eduardo, 1982a).

All of these morphological criteria were met by the rumen flukes examined by us. Although the numbers of muscle fibers were not entirely within the limits set by Eduardo (1982a), it can be concluded that the rumen flukes of the reindeer in Finland possess an acetabulum of paramphistomum type.

Näsmark (1937) described 21 different types of genital openings in Paramphistomidae. The location of the genital opening and the presence or absence of the sphincter muscles in the genital atrium and papilla are of diagnostic interest. Eduardo (1982a) added a 22nd type to the list of types of terminal genital openings. This latest addition, namely the leydeni type, is characterized by a genital pore located at the level of the pharynx, a thick genital papilla, and well-developed radial fibers. This description is consistent with the morphology of the genital opening observed by us in reindeer rumen flukes. Thus, it can be concluded that the present reindeer rumen flukes have a genital opening of the leydeni type. According to the literature, the genital atrium of *P. cervi* is located at the level of the posterior part of the esophagus (Willmoth, 1950), which is more posterior than in flukes studied by us.

Differentiation of pharynx types is based on the presence or absence of the pharyngeal bulb and pharyngeal sacs. The arrangement of muscle fibers is also of diagnostic importance (Näsmark, 1937; Eduardo, 1982a). The pharynx of our specimens was characterized by having weakly developed interior circular muscle fibers, in contrast to the middle circular fibers, exterior circular fibers, interior longitudinal fibers, and radial fibers, all of which were well developed. Exterior longitudinal fibers were few and were all situated close to the wall. Neither anterior nor posterior sphincters were observed. Clearly defined lips and long papillae were present in the anterior part of the pharynx (Eduardo, 1982b). These findings are typical of the pharynx of liorchis type (Eduardo, 1982b).

A notable variation was observed in the length and diameter of the muscular part of the pharynx, suggesting that the pharynx is able to stretch and contract and may also move forward and simultaneously stretch the esophagus. The straight esophagus observed in one specimen was considered evidence of this. The mobility of the lips and pharynx is understandable as rumen flukes obtain protozoa and other nutrients from the rumen. A flexible oral opening and pharynx are needed not only for feeding, but also because material not taken up by the intestine is periodically regurgitated and discharged from the intestine and the pharynx (Mehlhorn, 2001).

Key morphological findings were the following: the acetabulum of the reindeer rumen fluke was of paramphistomum type, the pharynx of liorchis type, and the genital atrium of leydeni type. According to Eduardo (1982b), only two valid species share these morphological features, namely *Paramphistomum leydeni* and *P. hiberniae*. The latter species possesses small deeply lobed testes and a different distribution of vitelline follicles than *P. leydeni* and the rumen flukes our study. Both winter and summer flukes shared these morphological features, thus the reindeer rumen fluke in Finland is *P. leydeni*.

The history of *P. leydeni* dates back to the collections of the Rijksmuseum in Leiden, the Netherlands, as their collections included specimens labelled *P. cervi* but which were, according to Näsmark (1937), morphologically in an intermediate position between *P. epiclitum* and *P. cervi*. This species was named *P. leydeni* (Näsmark, 1937). Odening (1983) has objected

to the differences between *P. cervi* and *P. leydeni* presented by Eduardo (1982b). According to Eduardo the body surface of *P. cervi* is lacking tegumental papillae, which are present on the tegument of *P. leydeni*. In addition, the genital opening of *P. cervi* is of gracile type, whereas *P. leydeni* has the genital opening of leydeni type (Eduardo, 1982b).

Odening (1983) emphasized that based on the histological evidence the absence of tegumental papillae observed in *P. cervi* is just a normal morphological variation seen in one species. He regarded *P. leydeni* as a well established synonym of *P. cervi* (Odening, 1983).

Our observations support the findings by Eduardo that *P. leydeni* and *P. cervi* possess enough morphological differences to justify their consideration as separate species. However, it can be concluded that the taxonomy and classification of paramphistomes remain as a conversation piece until the techniques based on molecular biology have been fully employed for identification of *Paramphistomum* species.

Our study clearly showed that there is significant variation in the morphology of the reindeer rumen flukes collected during the winter and summer. When the flukes are studied their age and the possibility of seasonal morphological variation should be kept in the mind. For example, the immature winter flukes possessed almost negligible papillae on the tegument, which could be readily observed only with the aid of the SEM. This finding can be easily misinterpreted as the absence of papillae, which is a morphological feature of *P. cervi*. Lankester (1979) observed that rumen flukes, presumably *P. cervi,* in moose in Canada were small and immature in winter (November – March) while the specimens collected in summer (July – August) were all mature. He supposed that the moose probably achieves the infection during the summer, the maturation takes place in the following spring and early summer and the mature flukes die in the next autumn after breeding. The annual lifecycle of the reindeer rumen fluke may be similar in Finland. *P. leydeni* as a typical digenean trematode has an indirect lifecycle and it needs a snail as an intermediate host. In the cold climate of Lapland the intermediate host is active only during the short period of summer and the rumen flukes should be able to synchronize their maturity and breeding with the availability of the snails in nature. Similar examples of biological adjustment aiming at the successful completion of the lifecycle of the fluke have been reported in paraphistomes occurring in warmer climates as well. Gupta *et al*. (1984) observed synchronization between the maturation and egg laying of *P. cervi* in sheep and the emergence of its intermediate host snail (*Indoplanorbis exustus*) from its hibernation in India.

The immaturity and the delayed maturation in *P. leydeni* collected during the winter could be easily confirmed in histological sections of the flukes. Our morphological observations were in accordance with that of *P. cervi* studied by Gupta and his co-workers (Gupta *et al*., 1986; 1987). All the reproductive organs were smaller in the winter flukes than their counterparts in the samples collected during the summer. For instance, the ovary of the winter fluke was very small, no mature spermatozoa could be observed within the testes, the vitellin cells were observed only as small clusters of the cells beneath the tegument and Mehlis' gland was inactive. The most striking difference was seen when the uteri were compared. The small tubes that could be observed scattered in the parenchyma of the immature winter flukes were packed with eggs in the mature summer flukes. In fact, the uterus of the summer flukes occupied the majority of the parenchymal volume. Other internal organs (e.g. intestine and lymphatic vesicles) were somewhat similar in the winter flukes and in the summer flukes. Thus, it can be concluded that the maturation of the reproductive organs is the most important contributor to the 170% increase of dry weight observed between immature and mature flukes in the present study.

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Poron pötsimadon *(Paramphistomum leydeni)* morfologiassa esiintyy selvää vuodenaikaisvaihtelua

Abstract in Finnish / Yhteenveto: Pötsimatoja *(Paramphistomum* spp.) löytyy monien villien ja kotieläiminä pidettävien märehtijöiden pötsistä tai verkkomahasta. Poron pötsimadosta on saatavilla varsin niukasti tietoa, ja lähteestä riippuen poron pötsimadon esitetään yleensä kuuluvan *Paraphistomum cervi* -lajiin. *P. leydeni* ja *Cotylophoron skriabini* ovat muita poron pötsimadon yhteydessä kirjallisuudessa esiintyviä lajinimiä. Tässä tutkimuksessa pyrittiin saamaan lisävalaistusta poron pötsimatojen taksonomiaan tunnistamalla Suomessa poroilta kerättyjä pötsimatoja lajitasolle. Tutkimuksessa käytettiin pötsimadoista tehtyjen kudosleikkeiden mikroskooppisen tutkimuksen sekä pyyhkäisyelektronimikroskoopin tarjoamia mahdollisuuksia. Lisäksi tutkimuksessa verrattiin poron pötsistä talviteurastuksen yhteydessä kerättyjen matojen rakennetta kesällä kuolleiden tai lopetettujen porojen pötsistä saatuihin matoihin. Sekä talvella että kesällä poimitut madot - huolimatta huomattavasta morfologisesta vaihtelusta "talvi- ja kesämatojen" välillä - kuuluivat *Paramphistomum leydeni* -lajiin. Talvella kerätyt madot olivat selvästi pienikokoisempia, niiden ulkopinta oli vain niukasti nystyinen ja niiden sukuelimet apuelimineen olivat kehittymättömät verrattaessa niitä kesällä poimittujen matojen vastaaviin rakenteisiin. Tutkimuksen tulokset viittaavat siihen, että talvella poron pötsissä esiintyvät pienikokoiset pötsimadot ovat keskenkasvuisia *P. leydeni* -pötsimatoja ja että Suomessa pötsimadon kehittyminen on talvisaikaan pysähdyksissä tai hyvin hidasta.

Renens vomflundran *(Paramphistomum leydeni*) uppvisar en tydlig morfologisk årstidsvariation.

Abstract in Swedish / Sammandrag: Vomflundror *(Paramphistomum* spp.) förekommer i vommen hos vilda och tama idisslare. Uppgifter om renens vomflundror är sparsamma och de presenteras i allmänhet som *Paramphistomum cervi. P. leydeni* och *Cotylophoron skriabini* är andra i litteraturen nämnda artnamn för renens vomflundror. I denna undersökning strävade man till att få information om renens vomflundrors taxonomi genom att identifiera vomflundror som insamlats från renar i Finland.

I undersökningen studerades vävnadssnitt av vomflundror med ljusmikroskop och scanningelektronmikroskopets möjligheter utnyttjades också. Därtill gjordes en morfologisk jämförelse av vomflundror som insamlats under renslakten på vintern med vomflundror som härstammade från renar som dött eller avlivats under sommaren. Trots betydande morfologiska variationer mellan de vomflundror som insamlades på vintern och de som erhölls på sommaren var det fråga om en och samma art, *Paramphistomum leydeni*. "Vinter" vomflundrorna var betydligt mindre, ytan var obetydligt knottrig och könsorganen med tillhörande strukturer var outvecklade i jämförelse med motsvarande strukturer hos "sommar" vomflundrorna. Undersökningen ger en antydan om att de på vintern i renens vom förekommande små vomflundrorna är unga *P. leydeni* vomflundror och att de utvecklas mycket långsamt eller rentav tillfälligt avstannar i sin utveckling på vintern i Finland.