Revision of the Amphistomes of European Ruminants

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ABSTRACT. Author analysed the possibility of the European occurrence of the following amphistomes, recovered from different ruminants: Paramphistomum cervi (Zeder, 1790); P. daubneyi Dinnik, 1962; P. gotoi Fukui, 1922; P. ichikawai Fukui, 1922; P. microbothrium Fischoeder, 1901; P. microbothrioides Price et McIntosh, 1944 and Gastrothylax crumenifer (Creplin, 1847). A key to species and a parasite/host check-list are appended.

During the two hundred years of European rumen fluke research, the following species have been reported from different ruminants: Calicophoron ijimai Näsmark, 1937; Cotylophoron cotylophorum (Fischoeder, 1901); Gastrothylax crumenifer (Creplin, 1847); Orthocoelium (= Ceylonocotyle) scoliocoelium (Fischoeder, 1901); Paramphistomum bothriophoron (Braun, 1892); P. cervi (Zeder, 1790); P. clavula Näsmark, 1937; P. daubneyi Dinnik, 1962; P. gotoi Fukui, 1922; P. (Liorchis) hiberniae Willmott, 1950; P. ichikawai Fukui, 1922; P. leydeni Näsmark, 1937; P. microbothrium Fischoeder, 1901; P. microbothrioides Price et McIntosh, 1944 and P. (= Liorchis) scotiae Willmott, 1950.

Depending on the interpretation of the various specific features, their authenticity, the profundity of the investigation, thereby the conception of the validity of the species resulted in divergent opinions concerning European species.

FISCHOEDER (1903), who established the first scientific system of the amphistomes, could differentiate the species with reliable accuracy on the basis of their morphology and organology. LOOSS (1912) focused the attention to the role of the structure of certain organ systems (lymphatic, excretory and reproductive) which played a role in the diagnosis of the species. The classification of amphistomes based on these principles, however, could not be completed by LOOSS. MAPLESTONE (1923) discarded the characteristics proposed by LOOSS (1912) mainly from practical view points and gave preference to easily ascertainable anatomical features. By over-estimating the individual variations of certain organs he initiated subsequent authors for revisory work the influence of which is still detectable.

NÄSMARK (1937) attributed special importance to the histological structure of the muscular organs (pharynx, genital opening, acetabulum) which, seemingly, show much less individual variations than the anatomical ones. Principles elaborated by NÄSMARK (1937) are, no doubt, important contributions to the classification of amphistomes but they are not devoid of critical deliberation in certain details.

Until recently the identification of paramphistomids in systematic works has been generally based on morphological pecularities and little attention paid to the particulars originating from the ontogenic cycle. Although the morphological ground is a fundamental basis of the taxonomy in paramphistomids, too, but the usage of such information as the genetic nature of the parasite/intermediate hosts' interaction as well as the ecological aspects of geographical distribution of these helminths seem to be useful argumentation in the diagnosis. All of these will be taken into account in this paper aiming at the clarification of the available species of the European rumen flukes.

MATERIAL AND METHODS

Samples of the test material were derived from the following countries and hosts: Albania, Bulgaria, Czechoslovakia, Germany, Denmark, England, France, Finland, Greece, Hungary, Ireland, Italy, The Netherlands, Poland, Rumania, the USSR and Yugoslavia mainly from domestic (cattle, sheep, buffalo, goat) and to a lesser extent from wild (roe deer, red deer, fallow deer, rein deer and moose) ruminants. Altogether more than five hundred sections of the different species have been prepared for examination. Besides these, sections of the relevant species of NÄSMARK' s collection and of the collection of the Natural History Museum, Berlin; type specimens of WILLMOTT's species as well as sections of the material of MIHAILOVA et al. were also available.

RESULTS AND DISCUSSION

Having examined the amphistome material and the relevant literature we regard the following species to be valid. Synonyms, listed under the species cover those reported from Europe up to now.

Paramphistomum cervi (Zeder, 1790)

Syns: Paramphistomum (= Liorchis) hiberniae Willmott, 1950
P. leydeni Näsmark, 1937
P. (= Liorchis) scotiae Willmott, 1950

The first description of this species of scientific value was given by FISCHOEDER (1903) and those specific features used in differentiation, the presence of the papillae in the anterior part of the pharynx and the muscular elements in the genital opening were included in his description. P. cervi was characterized histo-morphologically by NÄSMARK (1937) as a species in having Liorchis-type of pharynx, Gracile-type of genital opening and Paramphistomum-type of acetabulum, with his remark that the pharynx has no papillae and the musculature in the genital opening is emterily absent. Yet, these features could be observed in the single slide of P. cervi found in NÄSMARK's collection, whereas the papillae are in the state of movement of the detachment, probably owing to its treatment in water before fixation (Figs. 1-2).

The structure of the genital opening of the type of P. leydeni (Epiclitum) as it was described by NÄSMARK (1937) (Figs. 3-4) can also be brough into connection with the prefixative soaking of specimens. Since, under the influence of water the genital opening enlarges, the radial muscles become loose and thick (Fig. 5), the ability to bind stains decreases and later the radial musculature is difficult to see (Fig. 6). Accordingly, such a procedure before fixation can transform the same type of genital opening into a type with distinct radial muscles (Epiclitum-type of P. leydeni sensu NÄSMARK (1937), (Fig. 5) or an other one without musculature (Gracile-type sensu NÄSMARK (1937), (Fig. 6) as our experiments and observations indicate. The structure of the pharynx of P. leydeni (Fig. 7) was found to be similar to that of P. cervi. Specimens of both P. cervi and P. leydeni found in NÄSMARK' s collection were soaked, proved by the empty and enlarged parenchymal cells (Figs. 1-4).

In our preparations of P. cervi from different hosts it was found that the pharynx was always furnished with papillae (Fig. 8) and the genital opening with radial muscles, more or less developed provided they were not treated in water for a long time (less than four hours) (Fig. 9); thus, these structural elements are normal components of these organs.

WILLMOTT (1950) described two new species - Paramphistomum hiberniae, P. scotiae - found in the test material originated from Ireland, The Netherland and Scotland. Both species have a modified Liorchis-type pharynx, the genital opening of P. hiberniae was designated as Ichikawai- and of P. scotiae as Epiclitum-type. VELITCHKO (1966) having examined WILLMOTT' s original material found that P. hiberniae has the same type of genital opening (Epiclitum) as P. scotiae has and she, contrary to WILLMOTT (1950) designated the pharynx of the former species as pseudo-Liorchis-type. According to WILLMOTT (1950) the modified Liorchis-type pharynx has well-developed middle and exterior circular muscles in the posterior two thirds of the pharynx and inconspicuous ones in the anterior third. In NÄS-

MARK' s (1937) description of the Liorchis-type pharynx essentially the same situation is found. Our observations also agree with NÄSMARK' s (1937) description. Thus, there seems to be no solid ground for the designation of the modified Liorchis-type pharynx.

The pseudo-Liorchis pharynx of VELITCHKO (1966) has no pharyngeal papillae, which is, in our opinion, the consequence of the soaking of these specimens (also supported by the observations of KATKOV et al. (1971). Thus, VELITCHKO (1971) and KATKOV et al. (1971) rightly came to the conclusion that P. hiberniae was a synonym of P. scotiae.

After examining the type specimens of WILLMOTT's (1950) species, the author found that both of them have the same type of genital opening, the Gracile-type (Figs. 10-11), in the sense of the present paper and they are neither Ichikawai- (P. hiberniae WILLMOTT, 1950) nor Epiclitum- (P. scotiae WILLMOTT, 1950; VELITCHKO, 1966) types. (For the sake of the comparision a photograph of the Epiclitum-type of genital opening in P. epiclitum is given: Fig. 12.)

VELITCHKO (1966) created a new genus: Liorchis for WILLMOTT's species and the division of the muscle units in the d.e. circular layer into three groups has been emphasized by her as the main generic character. As to this new type of acetabulum, reference should be made to NÄSMARK's (1937) observation, that the inner circular d.e.1 and v.e. muscles of the Paramphistomum-type acetabulum sometimes lie in anatomically intermediate position to the outer parts of the same and to the circular d.e.2 muscles (p. 322), as for example in P. leydeni (Fig. 13). Having examined ten specimens of Liorchis scotiae, derived from VELITCHKO' s collection, I found that the picture of the d.e. muscle layer indicated by VELITCHKO (1966) was exhibited in two specimens only and, at the same time it is worth of reminding that such an arrangement of the d.e. muscle units was not detectable in WILLMOTT' s preparations either (Fig. 14). Thus, this generic feature did not seem to be consistent and it is rather the consequences of the individual variations or the pre-fixative treatment. Therefore, it is believed that VELITCHKO' s (1966) Liorchis-type acetabulum and genus are entirely within the category outlined by NÄSMARK (1937) under the genus Paramphistomum.

It was pointed out, in his earlier paper of the present author (SEY, 1974) that the anatomical pecularities tabulated by WILLMOTT (1950) were so variable that on the basis of them P. hiberniae and P. scotiae should be regarded as synonyms of P. leydeni. The present findings which were based on a much bigger collection of paramphistomids from different European sources than that of the above cited paper was (Hungarian material only!) reasonably justify nor is P. leydeni a valid species and together with P. hiberniae and P. scotiae they are synonyms of P. cervi.

P. cervi, in the sense of the present paper has been reported from most European countries (see check-list) both from domestic and wild ruminants, except from Belgium, Greece, Iceland, Luxembourg, Malta, Switzerland and the European part of Turkey. The wide distribution of this species in Europe is completely in accordance with the broad distribution of its numerous planorbid intermediate snail hosts (SZIDAT, 1937; GLUZMAN, 1969; KATKOV, 1973; KRANEBURG, 1977; ODENING et al. (1978).

Paramphistomum daubneyi Dinnik, 1962

Syns: Calicophoron ijimai of MIHAILOVA et al. 1974
Cotylophoron cotylophorum of GENTILE et al. 1977
Paramphistomum bothriophoron of MIHAILOVA et al. 1974
P. clavula of MIHAILOVA et al. 1974
P. microbothrium of KOTLÁN, 1958; of several Bulgarian authors (see later)
P. microbothrioides of KOTLÁN, 1958; of ERHARDOVA, 1964

The first European occurrence of this species was reported by VISHNYAKOV et al. (1971) from Bulgaria together with P. microbothrium. Subsequent authors of the above country did not inform on its repeated findings, moreover KAMBUROV (1976) in a symposium lecture held on the species of the European paramphistomids did not mention the status of this species either as a valid or as a synonym of an other species. After examination of a country-wide collection of amphistomes from cattle, buffalo and sheep in Bulgaria SEY and VISHNYAKOV (1976), however, have only found P. daubneyi, and they were of the opinion that the species described under P. microbothrium by different Bulgarian authors (MEREMINSKIĬ and VISHNYAKOV (1969); VISHNYAKOV et al. (1971); GENOV (1971); KORTLÁ et al. (1974);

MIHAILOVA et al. (1974); KAMBUROV and OSSIKOVSKI (1976); VASSILEV and SAMNALIEV (1974, 1978) is identical with P. daubneyi. While P. daubneyi and P. microbothrium are species having close similarities to each other yet, P. daubneyi possesses well-defined specific features of its own.

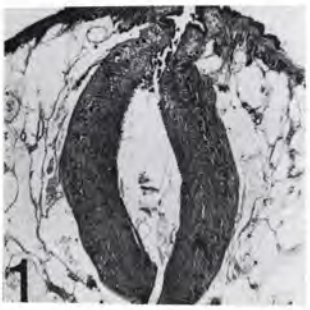
The morphological differences between them were studied by DINNIK (1962), SEY (1974); in their intermediate host specificity by DINNIK (1962), SEY and VISHNYAKOV (1976), SEY and ARRU (1977) and in their stages of the ontogenic cycle by SEY (1979). Results obtained after these examinations are highly suggestive of the European occurrence of P. daubneyi and it seems to be well founded to say that P. microbothrium is found in countries only where its intermediate hosts (bulinid snails) are common. The distribution of Bulinus truncatus in Europe is confined to Corsica, Sardinia, the southern parts of France, Spain and Portugal (PAMPIGLIONE and TOFFOLETTO, 1971).

Of the countries in which the systematic status of the rumen flukes (P. daubneyi, P. microbothrium) is questionable, according to the writer the most detailed examinations have been done in Bulgaria. VASSILEV and SAMNALIEV (1974, 1978) are of the opinion that the species with which they have worked is such a P. microbothrium of which intermediate host, specially in Bulgaria is Lymnaea truncatula. At the same time, the species of the rumen flukes develop in the same intermediate host (L. truncatula) both in Bulgaria and Hungary is regarded by the writer as the same, single species (P. daubneyi) while the Bulgarian authors consider it to be P. microbothrium. Our opinion is based on the following considerations.

DINNIK (1962) experimentally demonstrated in Kenya that L. truncatula did not pick up the miracidium of P. microbothrium (of which regular intermediate hosts are bulinid snails). Infestational experiments carried out in our laboratory, used three hundred young snails of B. truncatus (derived from Sardinia) with miracidia of P. daubneyi (of which regular intermediate host is mainly L. truncatula) showed that none of them picked up the miracidia. These experiments indicate that P. microbothrium develops, obligatorily, in bulinid while P. daubneyi in lymnaeid snails. If the ominous Bulgarian rumen fluke would really be P. microbothrium then the picking up of the infestation would have been expected when miracidia of P. daubneyi (= P. microbothrium by Bulgarian authors) were tested with B. truncatus.

Considering the above mentioned experimental results on the obligatory property that appeared in the specificity of these flukes/intermediate host interaction, the recent advances on the genetic regulation of the intermediate host specificity (RICHARDS and MERRITT, 1972) and taking the modern concept of the species (MAYR, 1971) into account then VASSILEV and SAMNALIEV's (1974, 1978) argumentation does not seem to be acceptable. Namely, the obligatorily different intermediate hosts of the two rumen flukes in question indicate that they are reproductively isolated from each other and thus they have independent gene pool satisfying the concept of the distinc species. Thus, the Bulgarian species "P. microbothrium" should be regarded as P. daubneyi.

Figs. 1-15: Median sagittal sections of the muscular organs of some amphistomes
Figs. 1-2: Pharynx and genital opening of Paramphistomum cervi (Näsmark specimens)
Figs. 3-4: Genital opening of Paramphistomum leydeni (Näsmark's specimens)
Figs. 5-6: Genital opening of Paramphistomum cervi, soaked in water
Fig. 7: Pharynx of Paramphistomum leydeni (Näsmark's specimen)
Figs. 8-9: Pharynx and genital opening of Paramphistomum cervi, showing typical appearance
Figs. 10-11: Genital openings of Paramphistomum hiberniae and Paramphistomum scotiae (Willmott's specimens)
Fig. 12: Genital opening of Paramphistomum epiclitum
Fig. 13: Dorsal half of Paramphistomum cervi with three groups of muscular units in d.e. layer
Fig. 14: Dorsal half of Paramphistomum scotiae (Willmott's specimen)
Fig. 15: Pharynx of Paramphistomum gotoi (Photo: O. Sey)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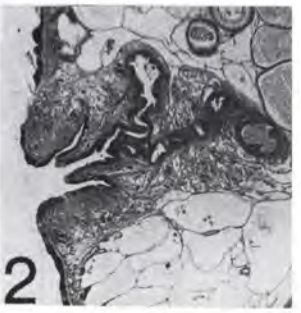
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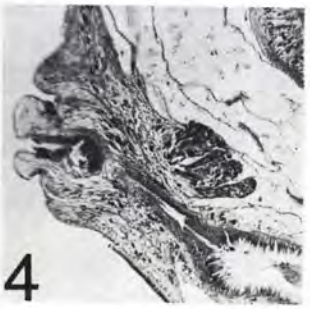
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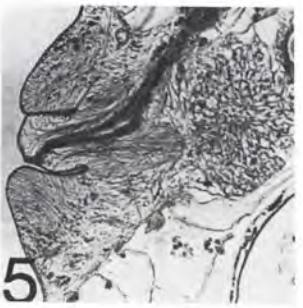
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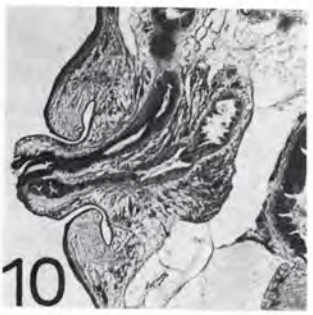
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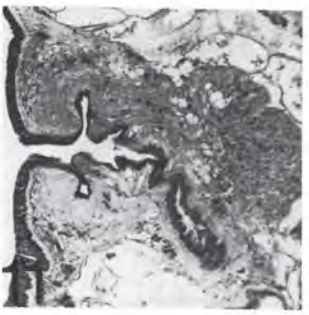
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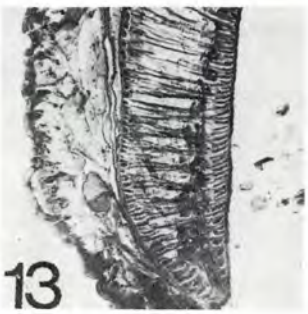
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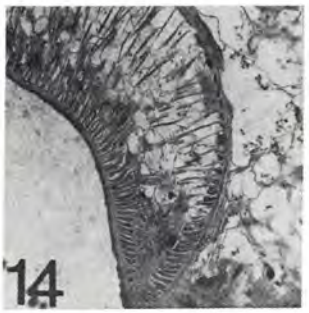
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In the light of these considerations the distribution of P. daubneyi comprises several central and south European countries (see check-list) described under the names either P. daubneyi or P. microbothrium. KAMBUROV's (1976) finding refers to the British occurrence of P. microbothrium (= P. daubneyi) was not included to the check-list due to the absence of the host's record.

Paramphistomum gotoi Fukui, 1922

The presence of this rumen fluke, first described in Asia has only been reported from some European countries (see check-list) up to now.

Both FUKUI (1926, 1929) and the subsequent authors (NÄSMARK, 1937, SEY, 1976, 1978a) have regarded the presence of the large papillae along the inner surface of the anterior part of the pharynx (Fig. 15) to be one of the most important specific features. Test material of this species available which also included samples other than European ones seems to confirm the priority of the diagnostic value of this character.

The intermediate host(s) are not known either in Europe or in Asia.

Paramphistomum ichikawai Fukui, 1922

Syns: Cotylophoron cotylophorum of MAROTEL and GRATECOS, 1938; of GUILHON and PRIOUZEAU, 1945; of POPOV et al. 1967; of EUZEBY, 1973
Orthocoelium (= Ceylonocotyle) scoliocoelium of ERHARDOVA, 1964; of MIHAILOVA et al. 1974

This species was described by FUKUI (1922) in Japan. On the basis of some well-definable features, seen in median sagittal sections (structure of the genital opening, number and arrangement of the d.e.2 muscle units) it is easily discernible from the other European paramphistomids.

Having examined GUILHON and PRIOUZEAU's (1945), as well as EUZEBY's (1973) material labelled as Cotylophoron cotylophorum (both of them were based on MAROTEL and GRATECO's (1938) identification) I found that they proved to be P. ichikawai, consequently, this finding should be regarded as the first one in Europe. Later it was recovered in several other European countries (see check-list). KAMBUROV's (1976) findings refer to the presence of this species in Albania and Bulgaria were not included into the check-list owing to the absence of hosts' records.

In Europe its intermediate hosts are planorbid snails (KATKOV, 1973; SEY, 1978b).

Paramphistomum microbothrium Fischoeder, 1901

Syns: Paramphistomum cervi of BRUMPT, 1936
P. cervi of several Italian authors (in part)

The first European finding of this species was published by NÄSMARK (1937), Italy; later by WILLMOTT (1950), France; more recently it was recovered in several Central European countries. Due to the close similarity of this species to P. daubneyi, a misinterpretation of P. microbothrium might not be excluded. Therefore, the writer asserted the opinion in his earlier papers (SEY, 1974, 1975, 1979) and in the present one (see under P. daubneyi) that P. microbothrium is found in those countries where its intermediate host is common. Accordingly, of the numerous reports referring to the range of P. microbothrium only some South European findings can be regarded to be correct (see check-list).

Paramphistomum microbothrioides Price et McIntosh, 1944

The first reports referring to the European occurrence of this species are KOTLÁN's (1958) and ERHARDOVA's (1964) papers. Later it was pointed out that these findings were based on misidentification (SEY, 1974).

Among the imported cattle of the Holstein-friesian breed, from the USA to Bulgaria KAMBUROV et al. (1977) found a cow excreted paramphistomid eggs. Using L. truncatula as intermediate host they reproduced its life-cycle in lamb and after histological examination it was identified as P. microbothrioides.

In the USA this species develops also in lymnaeid snails (L. humilis, L. cubensis) and its susceptibility to L. truncatula indicates that the circumstances can be suitable for its establishment in Europe, too.

Gastrothylax crumenifer (Creplin, 1847)

In Europe it was recovered by RYBALTOVSKĬ (1957) for the first time in the Moscow abbatoir. Subsequent occurrence was noticed by DAVYDOVA (1959) and NIKITIN (1967) in the Astrakhan district. Studying the life-cycle of this species NIKITIN (1967) found Gyraulus albus to be its intermediate host.

A KEY TO THE SPECIES OF THE EUROPEAN RUMEN FLUKES

1) Ventral pouch absent 2
- Ventral pouch present 5
2) Pharynx Paramphistomum-type 3
- Pharynx Liorchis-type 4
3) A) Genital opening Ichikawai-type ..... P. ichikawai

B) Genital opening Microbothrium-type with moderately developed circular musculature; end parts of caeca lateral; intermediate hosts lymnaeid snail ..... P. daubneyi

C) Genital opening Microbothrium-type with more strongly developed circular musculature; end parts of caeca dorsal; intermediate hosts bulinid snails ..... P. microbothrium

D) Genital opening Microbothrium-type; oesophagus with muscular thickening; acetabulum with 4-14 loosely arranged muscle units in d.e.2. ..... P. microbothrioides

4) Genital opening Gracile-type
A) Pharynx relatively smaller with papillae about 25-30 μ in length ..... P. cervi

B) Pharynx relatively bigger with papillae about 60-75 μ in length ..... P. gotoi

5) Caeca reach anterior part of the testes ..... Gastrothylax crumenifer

PARASITE/HOST CHECK-LIST

(Literature data below include the most important relevant publications of the given countries and arranged in the sense of conclusions of the present paper)

Paramphistomum cervi (Zeder, 1790)

Bos taurus

Albania (MOSKVIN 1958); Bulgaria (KAMBUROV et al. 1976); Czechoslovakia (CHROUST 1964); Denmark (HENRIKSEN and NANSEN 1976); Finland (SEY present paper); France (GUILHON and PRIOUZEAU 1945, EUZEBY 1973); Germany (FISCHOEDER 1903, SZIDAT 1937, GOTTSCHALK 1962, KRANEBURG 1977, ODENING et al. 1978); Hungary (SEY 1974); Italy (BONINI 1963); England (KELLY 1948, WILLMOTT 1950); The Netherlands (SCHOON 1947, WILLMOTT 1950); Norway (HELLE 1973); Poland (ZADURA and NIEC 1952, ANCZYKOWSKI and CHOWANIEC 1955, PATYK 1960, ZDZITOWIECKI et al. 1977); Portugal (LEITAO 1963); Rumania (TUDOR and ANTON 1968, SEY 1978b); Spain (CORDERO DEL CAMPILLO 1975); Sweden (NÄSMARK 1937); the USSR (SKRJABIN and SCHULTS 1937, POPOVA 1950, KRYUKOVA 1957, VELITCHKO 1966); Yugoslavia (BABIIĆ 1966, CANKOVIĆ and BATISTIĆ 1963).

Ovis aries

Albania (MOSKVIN 1958); Bulgaria (GEORGIEV 1956, KAMBUROV et al. 1976); Czechoslovakia (RYSAVÝ and ERHARDOVA 1953); Germany (FISCHOEDER 1903, GOTTSCHALK

1962); Hungary (SEY 1974); Ireland (KELLY 1948); Italy (ARRU and DEINA 1962, 1969, ARRU et al. 1970); Poland (ZDZITOWIECKI et al. 1977); Rumania (OLTEANU and LUNGU 1961, TUDOR and ANTON 1968); Spain (SAIZ MORENO 1963); England (CRAIG and DAVIES 1937); the USSR (VELITCHKO 1968, ANDREIKO 1973); Yugoslavia (AUDI 1946, VUJIĆ 1965).

Capra hircus
Albania (MOSKVIN 1958); Rumania (TUDOR and ANTON 1968); Italy (ARRU and DEINA 1962, DEINA and ARRU 1962, ARRU and DEINA 1969).

Bison bonasus
Poland (DROZDZ 1961); the USSR (MATEVOSYAN 1964)

Alces alces
Poland (ZDZITOWIECKI et al. 1977); Sweden (NILSSON 1971); the USSR (ALEKSANDROVA 1962, VELITCHKO 1968, SEY present paper)

Rangifer tarandus
Finland (SEY present paper)

Cervus elaphus
Austria (KUTZER and HINAIDY 1969); Czechoslovakia (KOTRLY and PÁV 1959, PÁV et al. 1962); Hungary (SEY present paper); Germany (ODENING et al. 1978, GRAUBMANN et al. 1978); Poland (ZADURA 1960, ZDZITOWIECKI et al. 1977); the USSR (ROMASHOV 1963).

Dama dama
Czechoslovakia (KOTRLY and PÁV 1959, PÁV et al. 1962); Hungary (SEY present paper); Poland (ZDZITOWIECKI et al. 1977); USSR (SEY present paper)

Ovis musimon
Austria (KUTZER and HINAIDY 1969); Czechoslovakia (KOTRLY and PÁV 1959, MOTTLE and PÁV 1958, PÁV et al. 1962); the USSR (SEY present paper)

Capreolus capreolus
Czechoslovakia (KOTRLY and PÁV 1959, PÁV et al. 1962); Germany (ODENING et al. 1978, GRAUBMANN et al. 1978); Hungary (SEY present paper); Poland (ZDZITOWIECKI et al. 1977); Sweden (NILSSON 1971); the USSR (KAZLAUSKAS and PUZHAUSKAS 1974); Yugoslavia (RICHTER 1959).

Paramphistomum daubneyi Dinnik, 1962

Bos taurus
Albania (ERHARDOVA 1964, KOTRLÁ et al. 1974); Bulgaria (KOSAROFF and MIHAILOVA 1959, MIHAILOVA et al. 1974, VISHNYAKOV et al. 1971, KOTRLÁ et al. 1974, SEY and VISHNYAKOV 1976, VASSILEV and SAMNALIEV 1978); Czechoslovakia (ERHARDOVA 1964); Greece (SEY present paper); Hungary (KOTLÁN 1958, SEY 1974); Italy (SEY and ARRU 1977); Germany (ODENING et al. 1978); Rumania (SEY 1978); Yugoslavia (VUJIĆ 1965, BABIIĆ 1966).

Bubalus bubalis
Bulgaria (KAMBUROV and OSSIKOVSKI 1976, SEY and VISHNYAKOV 1976); Yugoslavia (PAVLOVIĆ 1975)

Ovis aries
Albania (KOTRLÁ et al. 1974); Bulgaria (KOTRLÁ et al. 1974 MEREMINSKIĬ and VISHNYAKOV 1969, VISHNYAKOV et al. 1971, SEY and VISHNYAKOV 1976); Hungary (SEY 1974); Yugoslavia (LEPOJEV and CVETKOVIĆ 1976).

Cervus elaphus
Yugoslavia (PETROVIĆ et al. 1966)

Capreolus capreolus
Czechoslovakia (SEY present paper); Yugoslavia (PETROVIĆ et al. 1966)

Paramphistomum gotoi Fukui, 1922

Bos taurus
The USSR (STEPANOV 1969); Rumania (SEY 1978a)

Paramphistomum ichikawai Fukui, 1922

Bos taurus
France (MAROTEL and GRATECOS 1938, GUILHON and PRIOUZEAU 1945, EUZEBY 1973); Poland (ZDZITOWIECKI et al. 1977); Hungary (SEY 1974); Rumania (SEY 1978); the USSR (VELITCHKO 1968); Yugoslavia (BABIIĆ 1966)

Bubalus bubalis
Hungary (SEY 1978b)

Ovis aries
Hungary (SEY 1974); the USSR (VELITCHKO 1968); Yugoslavia (VUJIĆ 1965)

Cervus elaphus
Czechoslovakia (ERHARDOVA 1964); Hungary (SEY present paper); Poland (ZDZITOWIECKI et al. 1977)

Paramphistomum microbothrium Fischoeder, 1901

Bos taurus
France (BRUMPT 1936, WILLMOTT 1950); Italy (NÄSMARK 1937, SEY and ARRU 1977); Portugal (CAEIRO 1961, LEITAO 1963)

Ovis aries
Italy (SEY and ARRU 1977)

Capra hircus
Italy (SEY and ARRU 1977)

Paramphistomum microbothrioides Price et McIntosh, 1944

Bos taurus
Bulgaria (KAMBUROV et al. 1977)

Ovis aries (exp.)
Bulgaria (KAMBUROV et al. 1977)

Gastrothylax crumenifer (Creplin, 1847)

Bos taurus
The USSR (RYBALTOVSKIĬ 1957, NIKITIN 1967)

Ovis aries
The USSR (DAVYDOVA 1959, NIKITIN 1967)

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