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DISCUSSION TO SEVERAL TAPEWORM SPECIES FROM THE FAMILIES HYMENOLEPIDIDAE, ANOPLOCEPHALIDAE AND DAVAINEIDAE PARASITIZING RODENTS AND MAN

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Abstract

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With the more recent knowledge, the hypothesis by Joyeux and Baer (1929) is consulted: "... most of rarer species of tapeworms occurring in man are probably parasites of other mammals, specially of Rodentia .....". In connection with that, the host specificity in several species from the families Hymenolepididae, Anoplocephalidae and Davaineidae is discussed. So far parasites of rodents are concerned, they are the species *Rodentolepis straminea, R. fraterna, Hymenolepis diminuta, H. pseudodiminuta, H. hibernia* and *Inermicapsifer arvicanthidis*. So far parasites of man are concerned, they are the species *Rodentolepis nana, Hymenolepis flavopunctata* and *Inermicapsifer madagascariensis*. Attention is drawn also to discrepancies in the opinions published on the views of hosts' specificity or of zoogeographical distribution of several species from the family Davaineidae.

Cestoda, Hymenolepididae, Anoplocephalidae, Davaineidae, host specificity, Rodentia, man

In the current medical literature, in university text books and in special literature dealing with the taxonomic appurtenance of cestodes, we often meet with the statement that several tapeworm species from the family Hymenolepididae have as their definitive hosts both man and rodents. This opinion reflects the hypothesis published by Joyeux and Baer (1929) that "…. most of rarer species of tapeworms occurring in man are probably parasites of other mammals, especially of Rodentia ….". Even when later, these authors leave successively their opinion (see below), a more complex view of the respective facts is missing, which would either support or argue against the above hypothesis. Below, the analysis and the opinion of the complicated situation in the systematic-taxonomical status of the above species is presented.

MATERIAL AND METHODS

The material was collected from different hosts and localites.

Hymenolepididae Ariola, 1899

1. *Hymenolepis diminuta* (Rudolphi, 1819); host: *Mus musculus*; locality: Lednice, Czech Republic. 2. *H. pseudodiminuta* Tenora, Asakawa et Kamiya, 1994; hosts: *Apodemus argenteus*, *A. speciosus*; locality: Hokkaido, Japan. 3. *Hymenolepis hibernia* Montgomery J., Montgomery I. et Dunn, 1987; hosts: *Apodemus flavicollis*; locality: Lednice, Czech Republic; *A. sylvaticus*; locality: Hodonín, Czech Republic. 4. *Rodentolepis nana* (von Siebold, 1852); host: man; locality: Nangrahar, Afghanistan. 5. *R. fraterna* (Stiles, 1906); hosts: *Mus musculus*; locality: Hodonín, Lednice, Czech Republic; *M. musculus* var.

alb., locality: Nangrahar, Afghanistan (introduction with laboratory animal from Germany); host: *Rattus norvegicus*; locality: Mutěnice, Czech Republic. 6. *R. straminea* (Goeze, 1782), hosts: *A. flavicollis, A. sylvaticus, A. microps, Microtus arvalis*; localities: Hodonín, Lednice, Mutěnice, Strážnice, Czech Republic; host: *Cricetus cricetus*; locality: Hungary.

Anoplocephalidae Cholodkovsky, 1902

1. *Inermicapsifer arvicanthidis* (Kofend, 1915); host: *Heliophobius argenteocinereus*; locality: Malawi, Africa.

Davaineidae Braun, 1900

The species from the family Davaineidae presented in this study (*Raillietina celebensis, R. demerariensis*, and *R. trinitatae*) were studied from the original descriptions and redescriptions presented in the literature cited.

Preparation

Cestodes, (Hymenolepididae, Anoplocephalidae) were fixed in 4% formaldehyd, stained with acetocarmine, dehydrated in alcohol, cleared in xylene, and mounted in Canada balsam.

RESULTS

Hymenolepididae

The species *R. nana* was described as a parasite of man under the name *Taenia nana*, and into the genus *Hymenolepis* Weinland, 1858, it was transferred by Stiles (1906). The species *H. nana* was transferred and included in other genera as, e.g., *Diplacanthus* Weinland, 1858, *Vampirolepis* Spassky, 1954, *Variolepis* Spassky et Spasskaya, 1954 (Spassky 1954; Yamaguti 1959; Schmidt 1986 and others). At the present, accepted is commonly the inclusion of the species *H. nana* in the genus *Rodentolepis* Spassky, 1954 (Vaucher 1994). It should be presented that Spassky (1954), establishing the genus *Rodentolepis*, complicated somewhat the situation with that he included as younger synonyms of the typical species of the genus *Rodentolepis* (= *R. straminea*) also *H. nana* and *H. fraterna*. This his opinion was traded more frequently in the Russian literature (for more details see Ryzhikov et al. 1978). It was, of course, proved that the species *R. straminea* differs with a number of characters from *R. fraterna* and *R. nana* (Baer and Tenora 1970). We state that tapeworms *R. nana* and *R. fraterna* are species morphologically, anatomically and metrically very similar but biologically distinct. Used other characters than morphological and metrical ones (for a number of features see Kontrimavichus and Smirnova 1991; Špakulová 2002), the validity and independence of both species can be confirmed (cf. Skrjabin and Matevosjan 1948; Baer in Baer and Tenora 1970; Joyeux in Hunkeler 1974; Hunkeler 1974; Tenora 2001, 2002; Macnish et al. 2002 and others). However, this cannot exclude that *R. fraterna* (a parasite of rodents) can be considered, eventually confirmed, to be the ancestor of *R. nana* (a parasite of man) during the evolutionary events of co-speciation.

In contrast to *R. nana*, the species *Taenia diminuta*, described from rats, has changed its generic status only once, namely into *Hymenolepis* Weinland, 1858. Burt (1980) concentrated the highest number of information on the species *H. diminuta* and states that, in the literature in total, 28 its synonyms and 100 hosts' species belonging to the orders Primates, Rodentia, Carnivora and Insectivora are reported. It was proved (e.g., Skrjabin and Matevosjan 1948; Tenora and Murai 1972; Tenora and Baruš 1972; Ryzhikov et al. 1978) that is necessary to remove from the synonyms of the species *H. diminuta* the resurrected species *H. megaloon* (von Linstow, 1901). It is, of course, wholly evident that the synonym of *H. diminuta* is *H. diminutoides* Cholodkowsky, 1913. The complex synonymy and extraordinarily numerous and diverse list of definitive hosts of *H. diminuta* have led the authors Mas-Coma et al. (1980) to the opinion that, under the name *H. diminuta*, a complex of more species is reported in the literature. Moreover, this is completed by the information that, in Spain, *Apodemus sylvaticus* is parasitized by tapeworms morphologically very similar to *H. diminuta* which will be described as a new species. Later on, erroneous determination of tapeworms as *H. diminuta* from *A. sylvaticus* was corrected by Montgomery et al. (1987), who described a new species *Hymenolepis hibernia*. Tenora et al. (1994) corrected the erroneous determination of the material from *Apodemus* spp. in Japan with the description of a new species *H. pseudodiminuta* (its validity was confirmed by Ishih et al. 2003). All above examples document the justification of opinions by Mas-Coma et al. (1980). The analysis of the species complex of the supraspecies *H. diminuta* means the actual problem. It is highly likely that the species *H. diminuta* is not, in all probability, regular parasite of man. This is already suggested by ancien efforts by several authors who reported tapeworms from man, similar to *H. diminuta*, under the names of independent species: *Taenia flavopunctata* Weinland, 1858, *T. flavomaculata* Leuckart, 1863, *T. varesina* Parona, 1884, *T. minima* Grassi, 1886. Other signal suggesting the possibility and evidently reality for excluding the taxon determined hitherto as *H. diminuta* parasitizing the man, and for establishing it as an independent taxon, is a low frequency of its findings. So, e.g., Burt (1980) reports 95 findings in man, and of those only two from Europe (determined only on eggs – England, Poland). Contrary, at the same time, the species *H. diminuta* is a frequent and obligatory parasite in rodents in Europe. The other 93 findings of *H. diminuta* are from the territory outside Europe (these findings show a mozaic occurrence in the human popu-

lation living at a low life level) (Edelman et al. 1965; Burt 1980; Combs and Crompton 1991). The necessity of coming back to the opinion that *H. diminuta* is a parasite of rodents, and not regularly parasit of man, is also suggested by the fact that the above tapeworm species described as n. sp. from man were declared and arranged as synonyms of *H. diminuta* as early as in the ancien past, namely by Blanchard (1891) and Grassi and Rovelli (1892). Later on, this opinion was taken over uncritically not only by the medical praxis but also by other specialists. It can be assumed that the species *T. flavopunctata* is a sibling species of the taxon *H. diminuta* (cf. Tenora 2001, 2002). This suggests that *H. diminuta* (a parasite of rodents), or of very similar species, can be the ancestor of *H. flavopunctata* (a parasite of man). For the exact solution of defined problems, methods of allozyme electroforesis (Beveridge 1998) and modern analyses of biological properties (Brouks 1988, Mongomery et al. 1998, Macnish et al. 2002, Ishih et al. 2003) should be applied. In the case of *H. diminuta* the authors prefere the host and ecological specificity contrary to the morphology and anatomy of the parasite.

The identical problem is in the case of *Mesocestoides variablilis* Mueller, 1927 (parasit of man) and *M. lineatus* (Goeze, 1782) (parasit of Carnivora), compare Coombs and Crompton, (1991), Fuentes et al. (2002), (2003), Tschertkowa and Kosupko, (1978). The similar problem in the case of *Taenia solium* (Goeze, 1782) and *T. asiatica* Eom et Rim, 1993, compare in Hoberg, (2002) and Galan–Puchades and Fuentes, (2000).

Anoplocephalidae

Through a very complex development in the field of taxonomy and systematics, two species have passed, namely *Inermicapsifer arvicanthidis* (Kofend, 1917) and *I. madagascariensis* (Davaine, 1896). Both species (despite of being included in the family Anoplocephalidae) have, except for unarmed scolex, numerous features characterizing the species of the family Davaineidae (uterus development, presence of egg capsules, morphology of eggs, assumed developmental cycle without presence of Oribatidae and others). The species *I. madagascariensis* uses to be considered a species of an unclear systematic status (Matevosjan 1966) and there is no its exceptional inclusion in the genus *Raillietina* (Yamaguti 1959; Kourí et al. 1963; Schmidt 1986; Coombs and Crompton 1991 and others). On a detailed analysis, Tenora et al. (2003) incline to the opinion by Baer (1956), who transferred the species *Taenia madagascariensis* Davaine, 1896 into the genus *Inermicapsifer* Janicki, 1910. The hypothesis submitted by Tenora et al. (2003) assumes the host-specialization of *I. madagascariensis* in man, and that of the species *I. arvicanthidis* in rodents. The species *I. cubensis* Kourí, 1938, a parasite of man in Cuba, is than a synonym of *I. madagascariensis* and does not belong to the genus *Thysanotaenia* Beddard, 1911 where it was included by Spassky (1951). The hypothesis formulated by Tenora et al. (2003) supposes further the original occurrence of *I. madagascariensis* in man in the Ethiopian Region with that the species was brought in West Indiens (within slaveny trade) including Cuba. The species *I. arvicanthidis* is a frequent and obligatory parasite in African rodents only.

Davaineidae

A great amount of obscurities is reported in the case of several species from the family Davaineidae, from the genus *Raillietina* Fuhrmann, 1920. So far parasites of man and rodents are concerned, or of other vertebrates, they are, first of all the species *R*. (*Raillietina*) *celebensis* (Janicki, 1902), *R. (R.) demerariensis* (Daniels, 1895) a *R. (R.) trinitatae* (Cameron et Reesal, 1951). Principal studies on the above species present different opinions both in host specificity and their zoogeographical distribution.

Yamaguti (1959) reports the species *R. (R.) celebensis* as a parasite of rodents from Celebes, Philippines, Formosa, China, Indochina, Siam, Burma, India, Africa and Australia (he reminds of finding of this species as a parasite of rodents and man in the Ethiopian Region); Schmidt (1986), except for finding in man, reports similar data as Yamaguti (1959); Tenora et al. (2003) as a parasite of rodents. Tenora et al. (2003) consider the possibility of including the findings in man, reported under the name *R. celebensis*, in the species *R. (R.) asiatica* (Linstow, 1901). The latter species is described, of course, imperfectly from man in Turkmenia and northern Caucasus, and Matevosjan (1966) includes it in the category „sub judice".

Yamaguti (1959) considers the species *R. (R.) trinitatae* to be the subspecies of the species *R. (R.) demerariensis*, parasitizing agoutis and lappes in Canada. Matevosjan (1966) considers *R. (R.) trinitatae* to be bona species, parasitizing rodents and apes in the Neotropical Region. Schmidt (1986) reports as its host *Cuniculus paca*, *Dasyprocta aguti* a *Proechimys cayennensis* from Trinidad and Venezuela.

Yamaguti (1959) reports the species *R. (R.) demerariensis* among parasites of man in British Guiana and as its host the ape *Alouatta seniculus* in Surinam. Moreover, Yamaguti (1959) includes in the species *R. demerariensis* also *R. (R.) demerariensis* var. *trinitatae* (see above) and *R. (R.) demerariensis* var. *venezolanensis* López-Neyra et Díaz-Ungría 1957, from the host *Coendou melanurus* from the Delta del Orinoco, Venezuela. Matevosjan (1966) and Schmidt (1986) report coincidently man and rodents as hosts in the Neotropical Region (this opinion is near to Baer's, 1940 comcept).

More than one century, the controversy lasts about the systematic-taxonomical status, about host and zoogeographical distribution of the species reported under the *Raillietina* (R.) *madagascariensis* (Daniels, 1895). Tenora et al. (2003), according to the opinions by Baer (1956), consider this species to be the member of the genus *Inermicapsifer* (see above the family Anoplocephalidae). For solution of the relation between *I. madagascariensis* and *Raillietina* sp. Kourí, Basnuevo et Sotolongo, 1963, from Cuba, more detailed data on host and locality are missing in the latter. The taxon *Raillietina* sp. is, of course, only hardly conspecific with *R. (R.) madagascariensis* (= *I. madagascariensis*), from which it differs with presence of hoocklets on scolex.

CONCLUSION

The morphologo-anatomical features are considered to be decisive at systematic-taxonomical assessments of species. Recently, beside the respective features, authors also use the knowledge of molecular biology, ecology and ethology, emphasizing the host specificity, draw attention to biology of species and use the conception of sibling species. Not at least, studies appear applying the knowledge of archeoparasitology. The set of features applied in such way opens new views of validity in several taxa, first of all, in those which have coincident morphologo-anatomical characters, but they parasitize hosts are systematically distant. These problems are analyse and discussed in the present study in several tapeworm species parasitizing rodents and man. The facts compiled weaken the hypothesis by Joyeux and Baer (1929) which assumes that several tapeworm species parasitizing man are also parasites of rodents (compare the last finding of *R. microstoma*, cf. Macnish et al., 2003). In contrast from this assumption, it is clear that previous taxonomical concepts of several species have to be changed. So, e.g., the superspecies *R. straminea* contains a set of independent species of *R. straminea* and *R. fraterna*, which are parasites of rodents, and *R. nana*, a parasite of man. Similarly, the superspecies *Hymenolepis* diminuta is a set of more species, namely *H. diminuta, H. hibernia, H. pseudodiminuta* and *H. megaloon* (maybe even other species), which are parasites of rodents, and with the species *H. flavopunctata* parasitizing man. From the family Anoplocephalidae, the species *Inermicapsifer madagascariensis* is considered to be a parasite of man, and the related species *I. arvicanthidis* is a parasite of African rodents. The study also point out to the fact the genus *Inermicapsifer* corresponds with its characters more to the characteristics of the family Davaineidae than of Anoplocephalidae. The diference in scolex morphology – armed (Davaineidae) and unarmed (Anoplocephalidae) – may not be decisive in diagnosis (compare the family Hymenolepididae). The analysis results also draw attention to the complicated state in taxonomy of several species from the genus *Raillietina*.

Only conceptually and freely, the present study links up with the results of archeoparasitological research presented by Loreille and Bouchet (2003). These authors applied these methods to the analysis of the species *Ascaris suum* and *Ascaris lumbricoides*. On the basis of taxonomical status on selected tapeworm species from the families Hymenolepididae, Anoplocephalidae and Davaineidae (parasitizing man and hosts systematically distant), we state coincidently with these authors that a close collaboration between archeologists, parasitologists, archeoparasitologists, geneticists and paleogeneticists will certainly shed light on the overal history of cestoda, of some species (or of very similar species), parasitizing man and rodents, or man and other hosts. The importace of such results regards to epidemiology will be indisputable.

SOUHRN

Diskuse k několika druhům tasemnic z čeledí Hymenolepididae, Anoplocephalidae a Davaineidae parazitujících u hlodavců a člověka

S novějšími znalostmi je konfrontována hypotéza Joyeuxe a Baera (1929) předpokládající, že mnoho raritních druhů tasemnic zjištěných u člověka jsou pravděpodobně obligátní paraziti jiných savců, zvláště hlodavců. Ve vztahu k této hypotéze je analyzována a diskutována hostitelská specifičnost některých druhů tasemnic z čeledi Hymenolepididae, Anoplocephalidae a Davaineidae. Z analýzy vyplynulo, že parazity hlodavců jsou druhy *Rodentolepis straminea, R. fraterna, Hymenolepis diminuta, H. pseudodiminuta, H. hibernia* a *Inermicapsifer arvicanthidis*. Specializovanými parazity člověka jsou druhy *Rodentolepis nana, Hymenolepis flavopunctata* a *Inermicapsifer madagascariensis*. Je upozorněno také na nesrovnalosti v publikovaných názorech na hostitelskou specifičnost, event. zoogeografické rozšíření některých druhů z čeledi Davaineidae.

tasemnice, Hymenolepididae, Anoplocephalidae, Davaineidae, hostitelská specifičnost, hlodavci, člověk

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