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(Review article)

The species of *Paragonimus* in Latin America

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SUMMARY

Six species of *Paragonimus* are presently known in Latin America. They include the following : *P. mexicanus*, *P. peruvianus*, *P. amazonicus*, *P. inca*, *P. ecuadoriensis*, and *P. caliensis*. Among them, *P. peruvianus* has been recognized as a synonym of *P. mexicanus* by Miyazaki himself, the discoverer of *P. peruvianus*. Furthermore, *P. ecuadoriensis* is suggestive of a synonym of *P. mexicanus* by Miyazaki. I also regard *P. amazonicus*, *P. inca* and *P. caliensis* as dependent species. I entertain a strong suspicion that these are synonymous with *P. mexicanus*. Therefore, *P. mexicanus* is the only species that distinctly inhabits Latin America. In the classification, in particular *Paragonimus*, we have to recognize the variations in the same species.

Key words : *Paragonimus*, taxonomy, Latin America

INTRODUCTION

The lung fluke, *Paragonimus rudis*[1], was first reported in Mat Grosso, Brazil, in 1828 by Diesing. However, the correct species name was unable to be determined based on its initial simple description. There after, the following 6 new *Paragonimus* species have been reported from Latin America : *P. mexicanus*[2], *P. peruvianus*[3], *P. amazonicus*[4] and *P. inca*[5] by Miyazaki *et al.*, *P. ecuadoriensis*[6] by Voelker and Arzube, and *P. caliensis*[7] by Little. Among them, *P. peruvianus* has been recognized as a synonym of *P. mexicanus* by Miyazaki[8] himself, the discoverer of *P. peruvianus*. Furthermore, *P. ecuadoriensis* is suggestive of a synonym of *P. mexicanus*[8]. I regard *P. amazonicus*, *P. inca*, and *P. caliensis* as synonyms of *P. mexicanus*.

DESCRIPTION OF *PARAGONIMUS* SPECIES IN LATIN AMERICA

P. rudis[1] was reported by Diesing from the otter in Mat Grosso, Brazil, in 1850. However, nobody can confirm the correct species name based on his article because of its simple description at that time. Thereafter, Voelker *et al.*[9] and Tongu *et al.*[10] have searched for *P. rudis* in Mat Grosso where the *Paragonimus* was firstly caught in 1828. However, they were unable to find any *Paragonimus* metacercariae or adults.

Afterward, new species of *Paragonimus* were reported in Latin America, such as *P. caliensis*[7] from Colombia, *P. mexicanus*[2] from Colima in Mexico, *P. peruvianus*[3] from Peru, *P. amazonicus*[4] from Tingo Maria in Peru, *P. inca*[5] from Peru, and *P. ecuadoriensis*[6] from Ecuador. Among them, only *P. mexicanus*[2] is known as a widely distributed species in Latin America. These species have been identified by trivial morphological features of the adult worms except for *P. caliensis* because of undiscovered cercaria or metacercaria.

The metacercaria of *P. caliensis*[7] were reported by Little. However, it could not be distinguished from *P. mexicanus* by its morphological features mentioned in his report except for the number of

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flame-cells. Miyazaki and Hendricks[11] classified *P. peruvianus* or *P. caliensis* mainly by the position of the tip of the excretory bladder in the metacercarial stage from Panama. However, Brenes[12] made an objection to this criterion. He claimed that *P. peruvianus* was a synonym for *P. mexicanus*. Miyazaki[8] later agreed with his opinion. Other researchers have also asserted that *P. peruvianus* and *P. mexicanus* were one and the same species.

The cercaria of the Latin American *Paragonimus* were first reported by Ito *et al.*[13] and Malek *et al.*[14] Ito *et al.* found the microcercous cercaria naturally infected in *Aroapyrgus alleei* from Colima, Mexico, and they identified this cercaria as *P. mexicanus*. On the other hand, Malek *et al.* reported the cercaria of *P. peruvianus* from *A. colombiensis* experimentally infected with the miracidium of *P. peruvianus*. These two species of cercariae were different with respect to the presence of a pseudo sucker and the number of penetration gland cells. However, the adult worm of *P. mexicanus* and *P. peruvianus* had been recognized as the same species at present. Thereupon, Ibanez[15] revived the name of *P. peruvianus* based on the difference in the cercarial and the adult stage. However, I[16] disagreed with his opinion. I concluded that the cercaria reported by Malek *et al.*[14] as *P. peruvianus* was the true cercaria of *P. mexicanus*.

DISCUSSION

Although Miyazaki[3] established the new species, *Paragonimus peruvianus*, in 1969, Brenes *et al.*[12] raised an objection to his classification. In 1979 Miyazaki[8] corrected the name of *Paragonimus peruvianus* as a synonym of *P. mexicanus* by himself. Ibanez[15] then claimed to revive the name of *P. peruvianus* mainly based on the morphological differences between the cercaria. He emphasized the differences in the testis, seminal vesicle, spermatheca, Laurer's canal, and egg size between the adult *P. mexicanus* and *P. peruvianus*. However, these differences, particularly in the adult worm, were regarded as variations in the same species. The true cercaria[16] of *P. mexicanus* is the cercaria reported as a cercaria of *P. peruvianus* by Malek *et al.*[14]. Therefore, the name of *P. peruvianus* revived by Ibanez[15] is a synonym of *P. mexicanus*.

Voelker and Arzube[6] introduced a new species, *P. ecuadoriensis*, from Ecuador due to the differences between *P. peruvianus*. They asserted that the branches of the ovary and testis were different in the adult worm. However, Miyazaki[8] anticipated that this *Paragonimus* was the same species as *P. mexicanus*. I regard that these differences in the adult worm are also variations in the same species. *P. ecuadoriensis* is also a synonym of *P. mexicanus*.

Little[7] reported a new species, *P. caliensis*, from Colombia. The cercaria of this species had 96 flame-cells. The flame-cell formula was distinctly different from that of *P. mexicanus* with 60 flame-cells. However, it was difficult to identify these 2 species in the egg stage. Moreover, the differences in the branch of the ovaries and shape of the spines on the body surface are slightly different in individual worms or worm regions in the adult worm. Based on his description, I can not separate *P. caliensis* from *P. mexicanus* by morphological features except for the difference in the flame-cell formula of the metacercarial stage. It is unthinkable that he correctly counted more than 60 flame-cells in the metacercarial stage. Probably this species will be a synonym of *P. mexicanus*. Miyazaki and Grados[17] identified only one *Paragonimus* from Peru as *P. caliensis*. They claimed that there were differences in the branches of the testis and ovary, shape of the spines, and slight differences in the oral sucker in the adult worm. However, these differences in the adult worm are regarded as variations in the same species. These are not appropriate criteria for taxonomy. If we can observe a complete flame-cell formula, for example, in the metacercarial stage, we can get a better criterion for the classification of the *Paragonimus* species. On the whole, it is impossible to correctly determine a flame-cell formula in the *Paragonimus* cercarial or metacercarial stages having a total number of 60

flame-cells or more. Therefore, Miyazaki has never reported the flame-cell formula in his articles concerning the *Paragonimus* species. Thereafter, there was no report on this *Paragonimus* species from Latin America. Based on these facts, I have some doubt about the total number of 96 flame-cells reported by Little[7] and the presence of this species.

Miyazaki *et al.*[4] collected 4 adult worms of *Paragonimus* from an opossum in Peru. They identified these *Paragonimus* as a new species, *Paragonimus amazonicus*, by the slender body characteristic. The only morphological criteria is the slender body of the adult worm. However, it is difficult to identify this species as being different from *Paragonimus mexicanus* except for the slender body. In general, the metacercariae or adult worms of *P. mexicanus* often expand and contract in physiological saline solution. Moreover, this new *Paragonimus* species was classified based on only 4 adult worms. Nobody has reported this *Paragonimus* species from Latin America there after. I also have some doubt about the presence of this species.

Miyazaki *et al.*[5] collected 27 adult worms of *Paragonimus* in all from opossums in Peru. Among them, only 8 were identified as *P. amazonicus* and 19 were considered the new species, *P. inca*, based on the difference in the ovary branch. However, this was a slight difference, but only variety in the same species. After that nobody has reported these species from Latin America. There is no possibility that this is a new separate species of *Paragonimus*. Based on these facts, *P. mexicanus* is the only species widely inhabited in Latin America.

For the taxonomy of *Paragonimus* species, they employ a slight criteria, and lack a dynamic point of view. In general, the branch of the ovary and the shape of the spine of trematoda increase the complication of its structure as the worms grow older. For the taxonomy of metacercaria, Miyazaki[11] employed the distance of the excretory bladder as a criterion of metacercaria. The excretory bladder in metacercaria is a flexible organ. Therefore, this organ is inappropriate for the taxonomy of the *Paragonimus* metacercaria. For the classification of *Paragonimus*, in particular, we have to recognize the variations in the same species.

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（総　説）

ラテンアメリカにおける肺吸虫の種類

頓宮廉正

抄　　録

現在までにラテンアメリカの肺吸虫は *P. mexicanus*，*P. peruvianus*，*P. amazonicus*，*P. inca*，*P. ecuadoriensis*，*P. caliensis* の6種が報告されてきたが，そのうち *P. peruvianus* は命名者である宮崎自身によって *P. mexicanus* のシノニムと訂正された。さらに *P. ecuadoriensis* も *P. mexicanus* のシノニムであると示唆されている。*P. amazonicus*，*P. inca*，*P. caliensis* もその分類には些細な形態上の違いを取り上げており，著者は *P. mexicanus* のシノニムの可能性が強いと考えている。したがって、現在のラテンアメリカに明確に分布している肺吸虫種は *P. mexicanus* 1種のみである。肺吸虫の分類においては特に種内の変異を認めるべきである。

キーワード：肺吸虫，分類，ラテンアメリカ

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