AN OVERVIEW OF NEMATODES INFECTING URBAN AND WILD RATS (MURIDAE) IN MALAYSIA

PARAMASVARAN S.[1], SANI R.A.[2], KRISHNASAMY M.[1], AMAL NASIR M.[1], HASSAN L.[2], MOHD ZAIN S.N.[3], JEFFERY J.[3], SANTHANA RAJ L.[1], LATIFA I.[1], ABDUL AZIZ[4], VELLAYAN S.[5] AND SELVANESAN S.[6]

1 Institute for Medical Research, Jalan Pahang, 50588 Kuala Lumpur, Malaysia
2 Faculty of Veterinary Medicine, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
3 Institute of Biological Sciences, University of Malaya, 50603 Kuala Lumpur, Malaysia
4 Faculty of Medical Parasitology, University Malaya, 50603 Kuala Lumpur, Malaysia
5 Faculty of Medicine, University Technology MARA, 40450 Shah Alam, Selangor, Malaysia
6 National Public Health Laboratory, Ministry of Health, Sungai Buloh, Selangor, Malaysia
Corresponding author e-mail: param@imr.gov.my

ABSTRACT. Rodents particularly those belonging to the Muridae family in Malaysia have been well studied because of their medical and economic importance. Much of the work on rodents has been focusing on the identification of endo and ecto parasites. Parasites in rats (Murids) particularly helminthes belonging to the Nematoda family have been described by many workers for more than a century. This paper is an attempt to compile 50 papers on rodent nematodes that has been published in various scientific journals over the last 100 years in Malaysia. It is hoped that this literature overview on rodent nematodes will come useful as a reference material for the budding parasitologist and biology scientist.

Keywords: rodents, Muridae, Malaysia, wild, urban, rats, parasites, zoonotic, helminths overview

INTRODUCTION

Rodents are a key mammalian group and found in many environments throughout the world. They constitute more than 42% of the known mammalian species [1]. The Order Rodentia is divided into three major groups: the Sciuromorpha (squirrel-shaped), Myomorpha (mouse-shaped) and Hystrichomorpha (porcupine-shaped).

Commensal rats and mice are members of the rodent family Muridae, part of the Myomorpha group. Rodents belonging to the family Muridae are extremely successful and dominant species in most regions of the world largely due to their ability to adapt and then exploit new situations rapidly [1].

The genus Rattus consists of nearly 200 sub-species that can be further grouped into 20 species in Malaysia. Most of the members of this genus are forest or island forms and the number of rodent species that can be found in urban and agricultural habitats may comprise of about 12 species.

Rattus rattus diardii and *Rattus norvegicus* are the two most successful species in adapting to all kinds of environment and found widespread in the world [2].

All Malayan rats are nocturnal [3]. They form an important and diverse group in towns, cultivated land and forest, extending from the shore to the mountain peaks and from ground level to the forest. Different species of rodents tend to be selective in their habitat, when these habitats are destroyed or disturbed either through agricultural intensification, deforestation, or urbanisation it can bring about changes in rodent species diversity [4, 5]. This will invariably facilitate the emergence and transmission of rodent-borne zoonotic pathogens.

The endoparasite fauna of wild terrestrial rats from primary forest habitats in Peninsular Malaysia has been well recorded. Prior studies have provided insights into the rats' habitat and behaviour and changes to the rats surrounding are often reflected in the endoprasites diversity and population.

AN OVERVIEW OF RODENT NEMATODES

The earliest reports of nematodes from Malaysian murids and other animals were provided by Alessandrini [6] and Adams [7], who described parasites which are mostly from domestic animals. The nematode parasites identified from the rodent host were *Syphacia obvelata*, *Cyclodontostomum purivisi* and *Heterakis* sp. from the large intestine of rats caught in Raub. They also recorded another species of *Ancylostoma malayenum* [6] from a rat in Seremban and an oxyurid (*Oxyurid syphacia obvelata*) in rats from Taiping and Pahang. There was a long lapse of interest following which a batch of worms from murids from Pulau Jarak were identified by Buckely (quoted in Audy *et al.* [8]) to contain a strongyloid. This worm was subsequently described by Yeh [9] as *Hepatojarakies malayae*, representing a new species and genus.

The nematodes *Capillaria hepatica*, *Rictularia tani* and *Nippostrongylus* sp. were also recognised in the same collection. A larger collection of parasites were examined from other parts of Malaysia around this time and it included worms from murids. These murid worms were examined by Sandosham [10, 11, 12]) under the four major helminth groups in which the incidence of infection was recorded. Subsequently, nematode parasites from unidentified house rats were identified by Hall [13]. They were *Strongyloides ratti*, *Angiostrongylus cantonensis*, *Nippostrongylus muris* and *Gongylonema neoplasticum*. Four other undetermined species of Capillaria, Syphacia, Protospirura and Mastophorus were also mentioned.

A number of unnamed filarial worms were reported from rats. The first was said to be a new genus of filarial heart worm belonging to the Subfamily Splendiodfilarinae which was isolated from *Rattus sabanus*, *Rattus whitheadi*

and *Rattus muelleri* by Sivanandam *et al.* [14]. They also found another filarial worm from the heart, lung and the liver of *Rattus sabanus*. The fourth species was recovered by Sandosham and Sivanandam [15] also from the heart of *Rattus sabanus*. Several years later, additional two species, *Breinlia booliati* [16] and *Dunnifilaria ramachandrani* were recovered from *Rattus sabanus* [17].

In 1963, Balasingham [18] redescribed the hookworms of *Cyclodontomum purvasi* from Malayan giant rats. Very few people have described the major groups of helminths in Malaysia during this time. Miyazaki and Dunn [19] reported *Gnathostoma malaysiae* from *Rattus surifer.* First Sandosham [12] introduced to a major group without the species identification. Dunn *et al.* [20] later described helminths of rats from Pulau Tioman and Pulau Tikus islands. The groups are nematodes, cestodes and trematodes. The helminths identified were *Raillietina* sp., *Hymenolepis diminuta*, *Rodentolepis* sp. (*H. nana*), *Leipertrema* sp. *Zonorchis* sp., *Strongyloides ratti*, *Globocephalus* sp., *Cyclodontostomum purvisi*, *Nippostroglus brasiliensis*, *Angiostrongylus* (*cantonensis*) *malayasensis*, *Syphacia muris*, *Gnathostoma* sp. *Physoloptra* sp. and some filarial species and a pentostomid *Armillifer* (*proceplus*) *moniliformis*.

Mayers and Kuntz [21] described a few nematode parasites from common rodents in Sabah. The rodent nematodes were identified as *Gongylonema orientale* may be (neoplasticum), *Heterakis spumosa*, *Nippostrongylus braziliensis*, *Rictularia (Whartani) tani*, *Protospirura muris.* Later Ow Yang [22], Mulkit and Cheong [23], Lim *et al.* [24], Bhaibulaya and Cross [25] described many Muridae parasites mostly that of nematodes. Bhaibulaya and Cross [25] described a new species of nematode named *Angiostrongylus malaysiensis*. Leong *et al.* [26] and Inder *et al.* [27] completed the description of the following nematodes, *G. neoplasticum*, *S. ratti*, *Trichuria muris*, *Heterakis spumosa*, *Syphacia* sp., *Subulura andersoni*, *H. malaya*, *Enterobius* sp., *Physaloptera* sp., *A. malaysiensis*, *S. ratti*, *Subulura* sp., and *H. diminuta*, *Dipylidium caninum*, *Taenia taeniaeformis*, *Moniliformis dubius*, and *Armilifer moniliformis*.

In the 1970s many reports were on the same finding. Durette-Desset [28] has renamed (*N. muris*) to *N. brasiliensis* from Malaysian rats, this Nippostrongylus is common among all kinds of Malayan rats. Bhaibulaya and Cross [25] redescribed *Angiostrongylus cantonensis* and called it *A. malaysiensis*, a new species. Lim [29] noted the presence of this nematode in three commensal and three forest rat species in Tuaran, Sabah. Ow-Yang [22] and Mulkit and Cheong [23] examined nematode parasites from feral rats which have potential for human transmission.

The feral rats were *Rattus argentiventer*, *Rattus rattus jarak*, *Rattus rattus rumpia*, *Rattus bowersi*, *Rattus canus*, *Rattus cremoventer*, *Rattus jalorensis*, *Rattus muellerai*, *Rattus rajah*, *Rattus sabanus* and *Rattus*

whiteheadi. The following nematode parasites were examined from the above rodent host examination. *A. (cantonensis) malayensis*, *Breinlia* sp., *C. hepatica*, *C. purvesi*, *Globocephales connorfilii*, *G. neoplasticum*, *H. malayaee*, *N. brazilliensis*, *Physaloptera* sp., *P. mastophorous* spp., *R. tani*, *S. ratti*, *S. andersoni*, *S. muris* and *T. crassicauda*. Subsequently several people carried out surveys and identified several groups of rodent endo-parasites but little work was done to confirm the morphology of the parasites. Varughese [30] was the first person to describe the complete life cycle of a rodent hookworm, *Cyclodontostomum purvisi* from Malaysian giant rats.

Quentin and Krishnasamy [31] have reported a new species *Spirura malayensis* from *Tupaia glis* from Ulu Gombak Forest Reserve. Lim *et al.* [32] and Sinniah *et al.* [33] reported the liver worm *Capillaria hepatica* as one of the common nematodes species among rodents in Malaysia. Subsequently, Khairul [34] reported that the Acantocephala, *Moniliformis moniliformis* to be common among house rats in Penang, Malaysia. Sinniah [35] found *Angiostrongylus cantonensis (malaysiensis)* followed by *Strongyloides ratti* being the most prevalent nematode infections in 8 rat species in Peninsular Malaysia. Krishnasamy *et al.* [36] studied the wood rat (*Rattus tiomanicus*) helminth fauna and described the common helminth groups – nematodes, cestodes and trematodes.

Following this Ambu *et al.* [37] carried out a survey in Pantai Bengkoka, and described several rodents' nematodes and cestodes. At the same time Singh *et al.* [38] attempted to isolate *Trichinella* sp. from rodents caught in the wild but, was not successful. Lynda and Krishnasamy [39] reported a new genus and species of nematode *Malayometastrongylus diardinematus* from a house rat *Rattus r. diardii* near Ulu Yam, Rawang.

Singh *et al.* [40] during wildlife expedition to Ulu Endau, Johor recovered some parasites from four species of rats which belong to the following groups: nematodes, cestodes, trematodes and pentastomids. Ho and Krishnasamy [41] conducted a survey at Taman Negara National Park and reported infections of endo-parasites as common among the small mammals including the rodents. Later in 1993, Krishnasamy *et al.* [42] described a rare nematode parasite Gnathostoma malaysiae from a forest dwelling rodent *Rattus rajah*. Three years later, Ambu *et al.* [43] conducted a survey at an Orang Asli settlement in Selangor to assess the potential health risk of rodent parasites. In his findings he reported nematodes and cestodes as the dominant group of helminths and trematode as rare.

Mohd Zain and Arnez [44, 45], conducted extensive studies of the parasite fauna at Endau-Rompin National Park and recovered 8 rat species of which 5 were new records and a total of 20 new records of endoparasites including 9 plural species of Trichostronyloidea parasites (*Heligmonoides bulbosus*, *Malaystrongylus odontospicularis*, *Macrostrongylus ratti*,

Maxomystrongylus sp., *Nippostrongylus brasiliensis*, Orientostrongylus sp., *Paraheligmonelloides* sp., *Rattustrongylus odontoconus* and *Rattustrongylus rotundoconus*). Their study also noted an emergence of commensal rats and cosmopolitan endoparasites suggesting impact of increasing human activities in the park.

Mohd Zain [46] surveyed 2 islands on the Straits of Malacca to understand the effects of island biogeography on the diversity of rodent host and their parasites. However, both islands were disturbed habitats with only commensal rats recovered and low helminth community.

Paramasvaran *et al.* [47, 48, 49] reported several species of nematodes recovered from rodents from urban, rice field, forest and coastal habitats in the states of Selangor and Negeri Sembilan. It was shown for the first time statistically there was significant association of helminth infections and the habitats in which the rodents live.

As for the filarial parasites there were not many reports. Singh and Cheng [16], Mak and Lim [49] described the filarial worm *Breinlia booliati* from rat. In the same year Mullin and Balasingam [17] reported *Dunnifilaria ramachandrani* from *Rattus sabanus* which is at present suspected to be zoonotic.

CONCLUSION

There have been no major changes in the fauna of the nematodes described over the last 100 years in the rodents. However with the global climatic changes that we are experiencing now, the rodent ecology may be altered giving rise to the proliferation and formation of new rodent foci and its parasites. If the rodent population increases there will be concomitant increased risk of maintaining zoonotic infection. Considering the rat-man proximity this situation may pose considerable threat to human and animal health in the future. .

REFERENCES

1. Singleton G.R., Lyn Hinds, Charley Krebs and Dave Spratt (2003). Rats, mice and people: interwoven relationship. Rodent Biology Management. ACIAR Monograph No. 96, 564 pp
2. Roberts T.J. (1977). Mammals of Pakistan. 1st edition London: Ernest Benn.258-261.
3. Medway L. (1969 & 1983). The wild mammals of Malaya (Peninsular Malaysia and Singapore). 2nd Edition, Oxford University, Oxford University Press 1969, Oxford, London.
4. Walsh J.F., Molyneux D.H. and Birley M.H. (1993). Deforestation effects on vector borne diseases. Journal Parasitology. 106:55-75
5. RatZooMan (2006). Rats and human health in Africa: Proceedings of an international workshop on rodent-borne diseases and the RatZooMan research project. May 3-6, Malelane, Republic of South Africa.
6. Alessandrini G. (1905). Su di alumini univariae parasite dell uome e li altri Vertebarate. Boll. Soc. Zool. Itel; 14:23-48.
7. Adams (1933). Report on a collection of nematodes from the Federated Malay States, Journal of Tropical Medical Parasitology; 27:1-13
8. Audy J.R., Harrisons J.L. and Wyatt Smith, (1950). A survey of Jarak Island, Straits of Malacca, Bulletin Raffles Museum; 23:230-261.
9. Yeh L.S. (1955). A new bursate nematode *Hepatojarakies malayae* new species from the liver of Rattus rattus jarak on Pulau Jarak Straits of Malacca. Journal of Helminthology; 29:44-48.
10. Sandosham A., (1954). A Malaysian parasites – Preliminary note on the incidence of worm infection in common hosts. Studies of the Institute Medical Research, Malaya (1953); 26: 23-28.

11. Sandosham A. (1955). A checklist of helminth parasites of man in Malaya with brief notes on their incidences. Proceedings Alum. Association of Malaya; 8:258-265.
12. Sandosham A. (1957). Infection of animals by major groups of helminthes: An intrim tabulations studies. Institute Medical Research. FMS, Malaysian Parasites XXXII, Malaya 1957; No 28: 403-408
13. Hall M.C. (1916). Nematode parasites of mammals of the orders Rodentia, Lagomorpha and Hyracoidea. Proceedings U.S. Natural Museum; 50:1-258.
14. Sivanandam S., Sandosham A.A. and Wong M.M. (1965). Filarial worms in heart, lung and liver of forest rats. Medical Journal of Malaya; 20:64-65
15. Sandosham A.A. and Sivanandan S. (1966). A new filarial worm in the heart of a forest rat (Rattus sabanus). Ibid; 20:399-340.
16. Singh M.S. and Cheng H.B. (1973). *Breinlia booliati* sp. n. (Filaroidea: Onchocercidae), a filarial of a Malayan forest rat, *Rattus sabanus*. Journal of Helminthology; 47(2):127-133.
17. Mullin S.W. and Balasingam S. (1973). *Dunnifilaria ramachandrani*, gen. n.,sp. n. (Nematoda: Filariodea) from the Long Tailed Giant Rat (*Rattus sabanus*) in Malaysia. Proceeding of the Helminthological Society of Washington; 40(1): 47-49.
18. Balasingam E. (1963). Redescription of *Cyclodontomum purvasi* Adams. A hookworm parasite in Malayan giant rats. Canadian Journal of Zoology; 41:237
19. Miyazaki I. and Dunn F.L. (1965). *Gnathostoma malaysiae* sp. from rats on Tioman Island, Malaysia (Nematoda: Gnathostomid) Journal of Parasitology; 51: 382-384.
20. Dunn F.L., Lim B. and Yap L.P. (1968). Endoparasite patterns in mammals of the Malayan Rain Forest. Journal Ecology; 49 :1180-1184
21. Mayers B.L. and Kuntz R.E. (1969). Nematode parasites of mammals Oermopter, Primates, Pholidota, Rodentia-carnivora. Canadian Journal of Zoology; 47:419-421.
22. Ow Yang C.K. (1971). Studies on the nematode parasites of Malaysian rodents. The Rhabdiasidae, Trichuridae and Oxyuridae. Journal of Helminthology; Vol. XLV, Nos. 2/3:93-109.
23. Mulkit S. and Cheong C.H. (1971). On the collection of nematode parasites from Malaysian rats. Southeast Asian Journal of Tropical Medicine and Public Health; 2:516-521.
24. Lim B.L., Ramachandran C.P. and Krishnasamy M. (1974). Helminth infections among small mammals in Penang Island, Peninsular Malaysia. Federation of Museums Journal; 19: 57-65.
25. Bhaibulaya M. and Cross J.H. (1971). *Angiostrongylus malayensis* (Nematoda: Metastrongylidae). A new species of rat lung-worm from Malaysia. Southeast Asian Journal of Tropical Medicine and Public Health; 2:527-533.
26. Leong T.S., Lim B.L., Yap Loy Fong and Krishnasamy M. (1979). Parasite fauna of the house rat *Rattus rattus diardii* in Kuala Lumpur and nearby villages. Southeast Asian Journal of Tropical Medicine and Public Health; Vol. 10 No.1:122-126.
27. Inder Singh and Krishnasamy M. and Ho Tse Ming (1987). Collection of small vertebrates and their endoparasites from Ulu Endau, johor, Malaysia. Malaysian Heritage and Scientific Expedition of Endau Rompin. Malaysian. Nature Journal. 41:349-356
28. Durette-Desset M.C. (1970). Le genre Nippostronylus Laue 1923. (Nematode-Heligmosomadie). Annales de Parasitolgie Humaine of Compare, Extraiz Tomce XIV: 1970 ; 45: 515-821
29. Lim B.L. (1976). *Angiostrongylus malaysiensis* from Tuaran, Sabah, with reference to the distribution of the parasite in Malaysia. Southeast Asian Journal of Tropical Medicine and Public Health; 7:384-389.
30. Varughese G. (1973). Studies on the life cycle and the developmental morphology of *Cyclodontostomum purvisi* (Adams, 1933). A hookworm parasite of Malayan Giant Rats. Southeast Asian Journal of Tropical Medicine and Public Health; 4:78
31. Quentin J.C. and Krishnasamy M. (1975). Nematodes Spirura parasites des Tupaia et du Nycticeable en Malaisie. Annales de Parasitologie (Paris); T50, No. 6:795-812.
32. Lim B.L., Yap L.F. and Krishnasamy M. (1977). *Capillaria hepatica* infection of wild rodents in Peninsula Malaysia. Southeast Asian Journal of Tropical Medicine and Public Health; Vol. 8 No.3:354-358.
33. Sinniah B., Manmohan Singh and Khairul A. (1979). Preliminary survey of *Capillaria hepatica* (Bancroft, 1893) in Malaysia. Journal of Helminthology; 53:147-152.
34. Khairul A. (1977). *Moniliformis moniliformis* Bremser (*Moniliformis dubius*, Mayer) and its prevalence in *Rattus* spp. in Penang, Malaysia. Medical Journal Malaysia; Vol. XXXII, No 2: 111.
35. Sinniah B. (1979). Parasite of some rodents in Malaysia. Southeast Asian Journal of Tropical Medicine and Public Health; 10 (1): 115-121.
36. Krishnasamy M., Inder Singh K., Ambu S., Ramachandran P. (1980). Seasonal prevalence of the helminth fauna of the Wood Rat *Rattus tiomanicus* (Miller) in West Malaysia. Folia Parasitologica (Praha); 27:231-235.
37. Ambu S., Lim P.K.C., Mak J.W., Kan S., Krishnasamy M., Liew L.M. and Tangon E. (1984a). A survey of animals in Pantai Bengkoka Peninsula Malaysia, for zoonotic diseases. Journal of Malaysian Society of Health; Vol. 4 No. 1: 42-47.
38. Singh K.T., Krishnasamy M. and Ambu S. (1984). Examination of animals for *Trichinella* sp. in Peninsula Malaysia. Journal of Malaysian Society of Health; 4:55-59.

39. Lynda M.G. and Krishnasamy M. (1986). *Malayometastrongylus diardinematus* n. g., n. sp. (Metastrongyloidea: Angiostrogylidae) from *Rattus rattus diardii* in Malaysia and redescription of *Thaistrongylus harinasutai* Ohbayashi, Kamiya and Bhaibulaya, 1979. Systematic Parasitology; 8:107-115
40. Singh K.I, Krishanasamy M. and Ho T.M. (1987). Collection of small vertebrates and their endoparasites from Ulu Endau, Johor, Malaysia. Malaysian Heritage and Scientific Expedition Endau Rompin. Malaysian Nature Journal; 41: 349-356.
41. Ho T.M. and Krishnasamay M. (1991). Ectoparasitic Acari and endoparasites of small mammals in Taman Negara. A special issue to commemorate the Golden jubilee of Taman Negara 1939-1989. Journal of Wildlife and Parks; Vol. 10: 54-61
42. Krishnasamy M., Palmier J.R, Oothuman P. and John Jeffery (1993). Host tissue reactions to *Gnathostoma malayensis* (Nematoda: Gnathostomidae) in *Rattus surifer* Miller; Southeast Asian Journal of Tropical Med. Public Health; Vol. 24 No 3: 489-493.
43. Ambu S., Krishnasamy M., Ramachandran P. and Ramos R. (1996). Helminth infections of rodents in Orang Asli settlement in Selangor, Malaysia – possible health risks. Tropical Biomedicine; 13: 23-127.
44. Mohd Zain S.N. and Syed Arnez A.S.K. (2005). Parasitofauna of the wild rat population at Selai, Endau-Rompin National Park, Johor, Malaysia. In The Forest and Biodiversity of Selai, Endau-Rompin (Eds. H. Mohamed @ M. Zakaria-Ismail. University Malaya Press: 215-218.
45. Syed Arnez A.S.K. and Mohd Zain S.N. (2006). A studies on wild rats and their endoparasite fauna from the Endau-Rompin National Park, Johor. Malaysian Journal of Science; 25(2): 19-39.
46. Mohd Zain S.N. (2008). Endoparasites of rodents in two islands of the Straits of Malacca. Malaysian Journal of Science; 27(3): 123-127.
47. Paramasvaran S., Krishnasamy M., Lee H.L., John Jeffery, Lokman Hakim, Naseem Bibi Malik, Rehana A.S. and Santhana Raj (2005). Helminth infections in small mammals from Ulu Gombak Forest Reserve and the risk to human health. Tropical Biomedicine; 22 (2):191-194.
48. Paramasvaran S., Sani R.A., Krishnasamy M., Hanjeet Kaur, John Jeffery, Santhana Raj, Sumarni M.G., Lim K.H. (2009). Endo-parasites of rodents from five wet markets in Kuala Lumpur and its potential zoonotic implications. Tropical Biomedicine; 26(1):67-72
49. Paramasvaran S. (2009). Ecto and Endo-parasites in rodents and shrews from four habitats in Selangor and Negeri Sembilan, Malaysia. Masters of Science Thesis University Putra Malaysia
50. Mak J.W. and Lim B.L. (1974). New host of *Breinlia booliat* in wild rats from Sarawak with further observations on its morphology. Southeast Asian Tropical Journal of Medicine and Public Health; 5:22-28.

ACKNOWLEDGEMENTS. We thank the Director-General of Health, Malaysia, for his permission to publish this paper. We also would like to thank the Director of the Institute for Medical Research, and the Head of Medical Research Resource Center, IMR, for the support and encouragement in writing this paper. We also like to put on record our thanks and gratitude to Dr Lee Han Lim for his valuable advice in preparing this manuscript.