

# STATUS OF COMMENSAL RODENT-BORNE DISEASES RESEARCH IN INDONESIA

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## ABSTRAK

Rodents yang terdapat di rumah-rumah maupun di lapangan mempunyai peranan penting dalam penyebaran penyakit terhadap manusia dan binatang. Dalam tulisan ini disajikan peninjauan kembali literatur tentang penyakit-penyakit yang ditularkan oleh binatang, seperti : plague, scrub and murine typhus, leptospirosis, schistosomiasis, angiostrongyliasis, yang biaya terdapat di Indonesia.

## INTRODUCTION

The "commensal rodents" are those rodents that live in close proximity with man and his surroundings. There is little information on the distribution and biology of the commensal rodents inhabiting urban areas in Indonesia. Rodent studies by many past workers (to quote a few of the important ones) were focussed in rural areas, and on those rodents with economic pest importance<sup>1-5</sup>, while low priority was given to rodents of public health importance except plague. The only piece of work which mentioned rodents of urban areas was dane<sup>6</sup>. Com-

mensal rodent studies for plague, on the other hand, is a national health problem, and is maintained as one of the priorities in communicable diseases control programmes. Apart from this, there are very little research activities done on commensal rodents and their parasites in relation to public health importance in the country.

This paper reviews literatures on some of the rodent-borne diseases of zoonotic importance based on past and present activities undertaken, and also suggests further research activities on its zoonotic implication leading to preventive measures for future action.

## COMMENSAL RODENTS

The commensal rodents can be divided into domestic and field rodents as shown below.

Domestic		Field	
<i>Rattus norvegicus</i>	Sewage rat	<i>Rattus argentiventer</i>	Ricefield rat
<i>Rattus r. diardii</i>	Roof rat	<i>Rattus tiomanicus</i>	Wood rat
<i>Mus musculus</i>	House mouse	<i>Rattus exulans</i>	Palynesian rat
		<i>Bandicota indica</i>	Bandicoot

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**Domestic rodents:** The Sewage rat, *R. norvegicus* (Berkenhout, 1796), originally a native of northern Eurasia, has spread to cities around the world by commerce. In Indonesia this species is common in all seaport cities. The roof rat, *R. rattus diardii* (Linnaeus, 1785), native in Asia is represented by many subspecies within different regions of Southeast Asia. This species is restricted to human habitations in cities and villages throughout the country. The house mouse, *M. Musculus* Linnaeus, 1766, originally from Eurasia and northern Africa, is now an introduced species throughout the rest of the world. This species is equally as common as *Rattus rattus* and is confined to indoors only in cities, town and villages in the country.

**Field rodents:** The ricefield rat, *R. argentiventer* (Robinson & Kloss, 1916), occurs throughout the major land mass of the Sunda region including Malaysian mainland. It is common in lowland ricefields throughout Indonesia, and is a serious agricultural pest<sup>5</sup>. The wood rat, *R. tiomanicus* (Miller, 1900), with distributional pattern similar to that of *R. argentiventer*, is an important pest in oilpalm estates in Indonesia<sup>5</sup>. The polynesian rat, *R. exulans* (Peale, 1848), is widely distributed throughout Southeast

Asia and the pasific islands. It is a highly adaptable species and is not only found in the fields but also occurs indoors. It is an agricultural pest in Indonesia<sup>5</sup>. The large bandicoot, *Bandicota indica* (Bechstein, 1800), widely distributed throughout the oriental region, is patchily distributed in Indonesia, and has been shown to be a pest in sugar plantation (unpublished data).

### RODENT-BORNE DISEASES

Rodent-borne diseases are classified amongst the zoonotic diseases, i.e. "an infection or an infections disease transmissible under natural conditions from vertebrate animals to man". In Indonesia the more common rodent-borne disease encountered and received attention are plague (bacterial disease), leptospirosis (spirochaetal disease), scrub typhus and murine typhus (rickettsial disease) and angiostrongyliasis and schistosomiasis (helminthic diseases).

Bubonic plague is transmitted to humans by the bite of an infected flea, the handling of infected rat tissues, or contact with the pus from an infected rat (Fig. 1). Scrub typhus is transmitted to humans through the bites of infected larval chiggers in the fields (Fig. 2). Murine typhus,

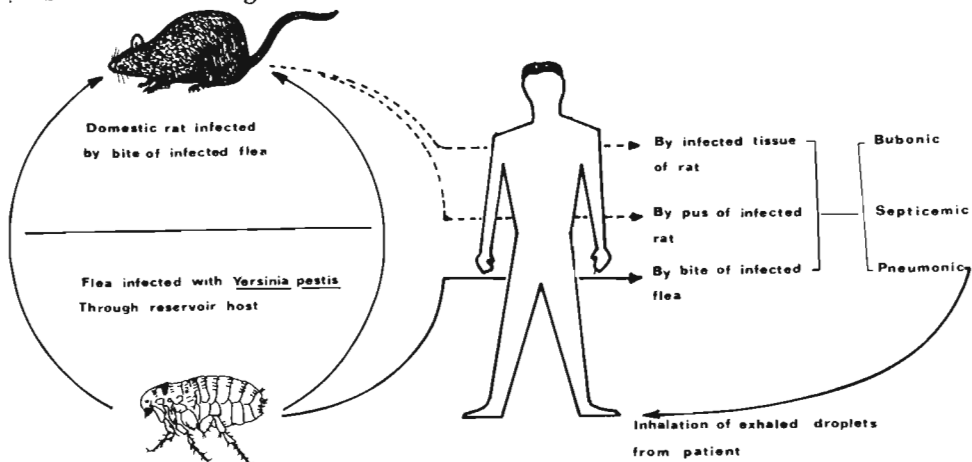


Fig. 1. Transmission cycle of human plague

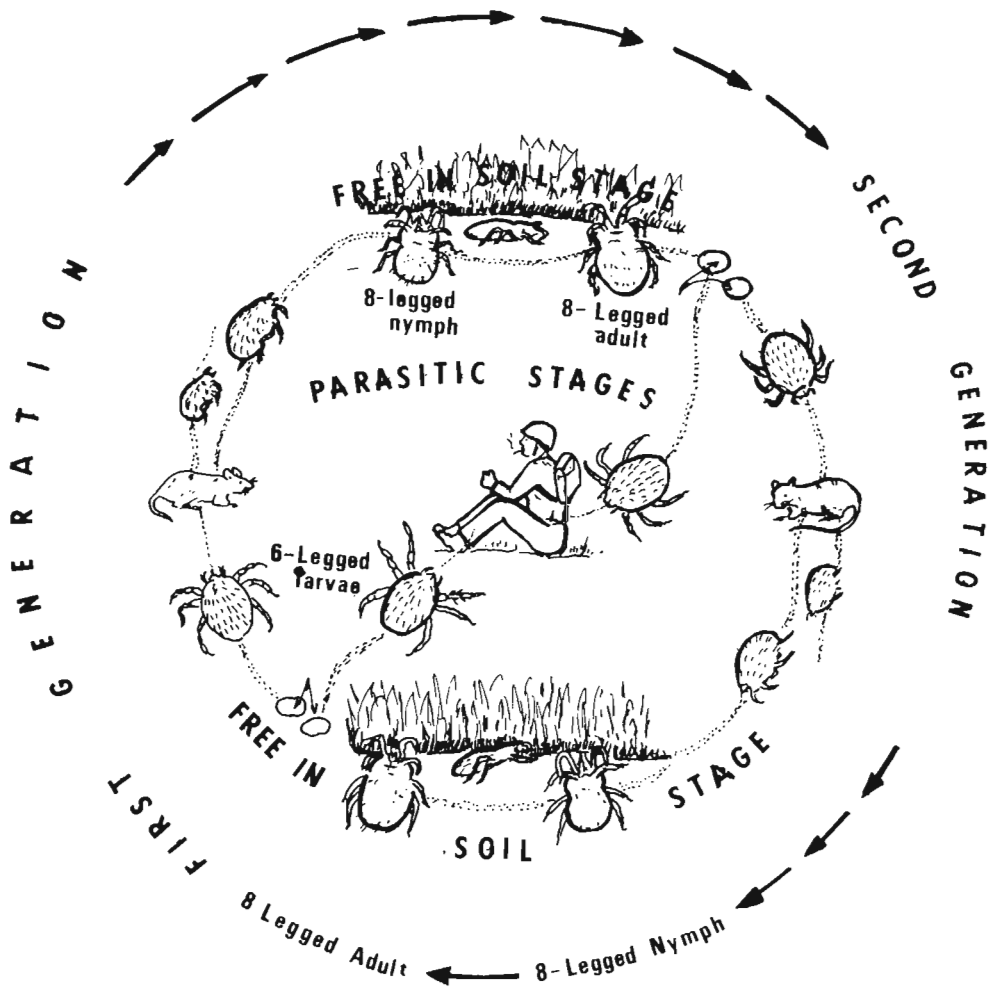


Fig. 2. Live-cycle of Trombiculid mites and its mode of transmission.

also called shop typhus, is found where people and rats occupy the same buildings. Transmission occurs through the faeces, deposited on the skin while the infected flea feeds. The infectious agent (*Rickettsia typhi*) enters through the site of the

bite or any other fresh skin wound (Fig. 3). Leptospirosis is usually a water-borne disease, with infection by contact with water, moist soil or vegetations contaminated with the urine of infected animals.

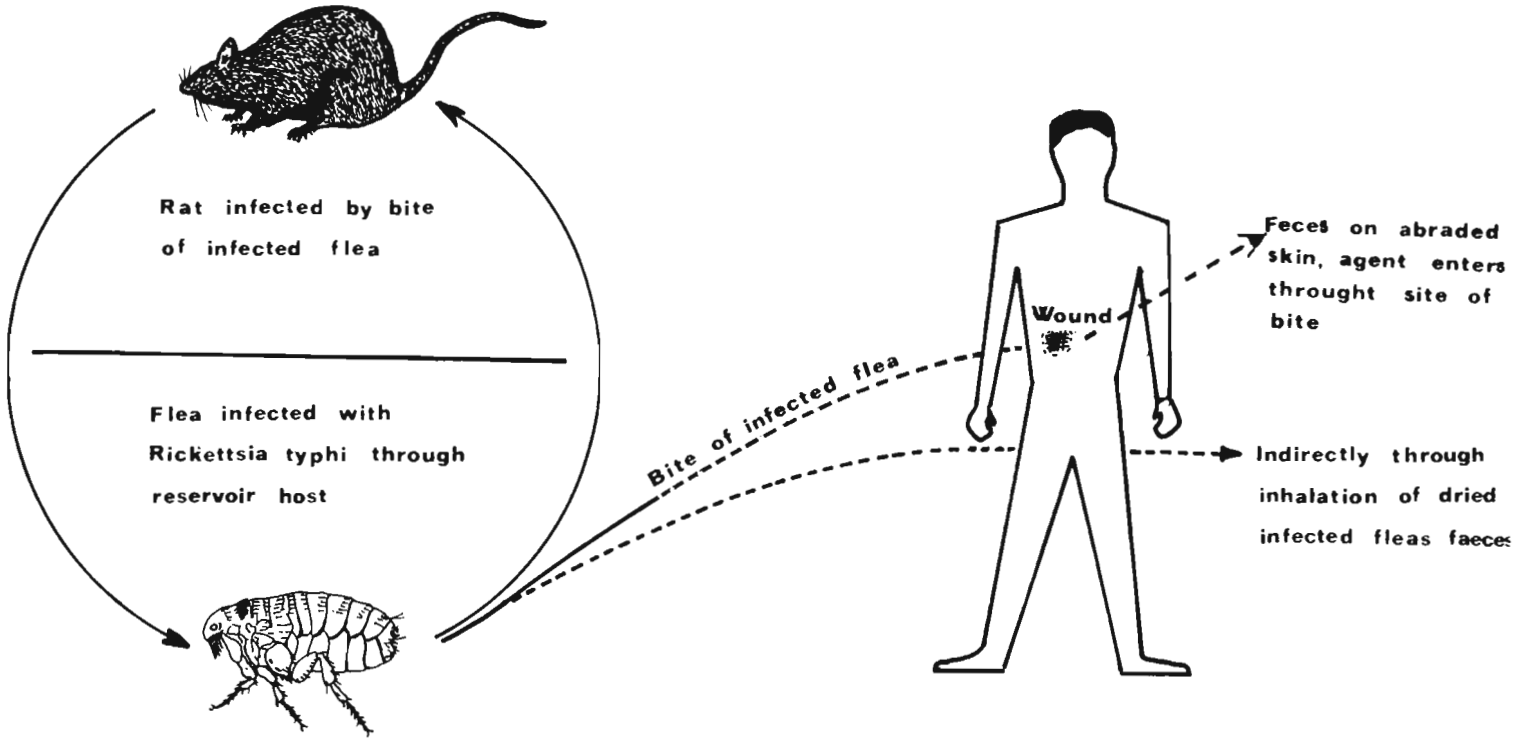


Fig. 3. Life cycle of Murine typhus and its, mode of transmission to man

Penetration is through abraded skin of mucous membranes or from ingestion of food contaminated with the urine of infected rats (Fig. 4). Angiostrongyliasis and schistosomiasis are transmitted to human through molluscan intermediate hosts. With the former parasite, human

contacts is by ingesting insufficiently cooked snails, land crabs and prawns, or through contaminated raw vegetables (Fig. 5). With the latter parasite, infection is from water containing larval forms (cercariae), and these penetrate the skin (Fig. 6).

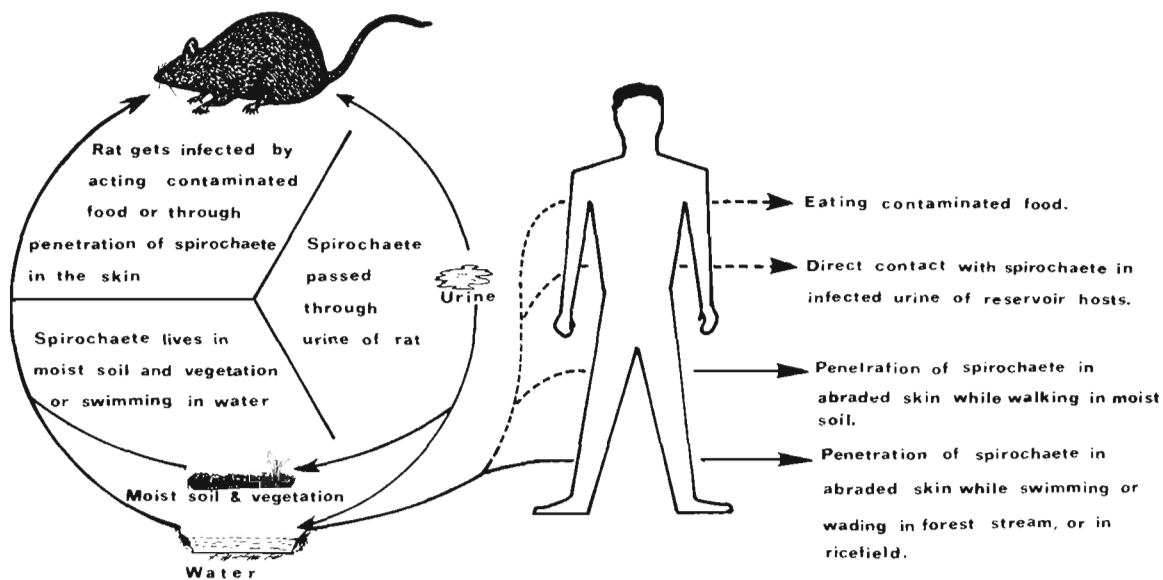


Fig. 4. Life cycle of Leptospirosis and its mode of transmission to man

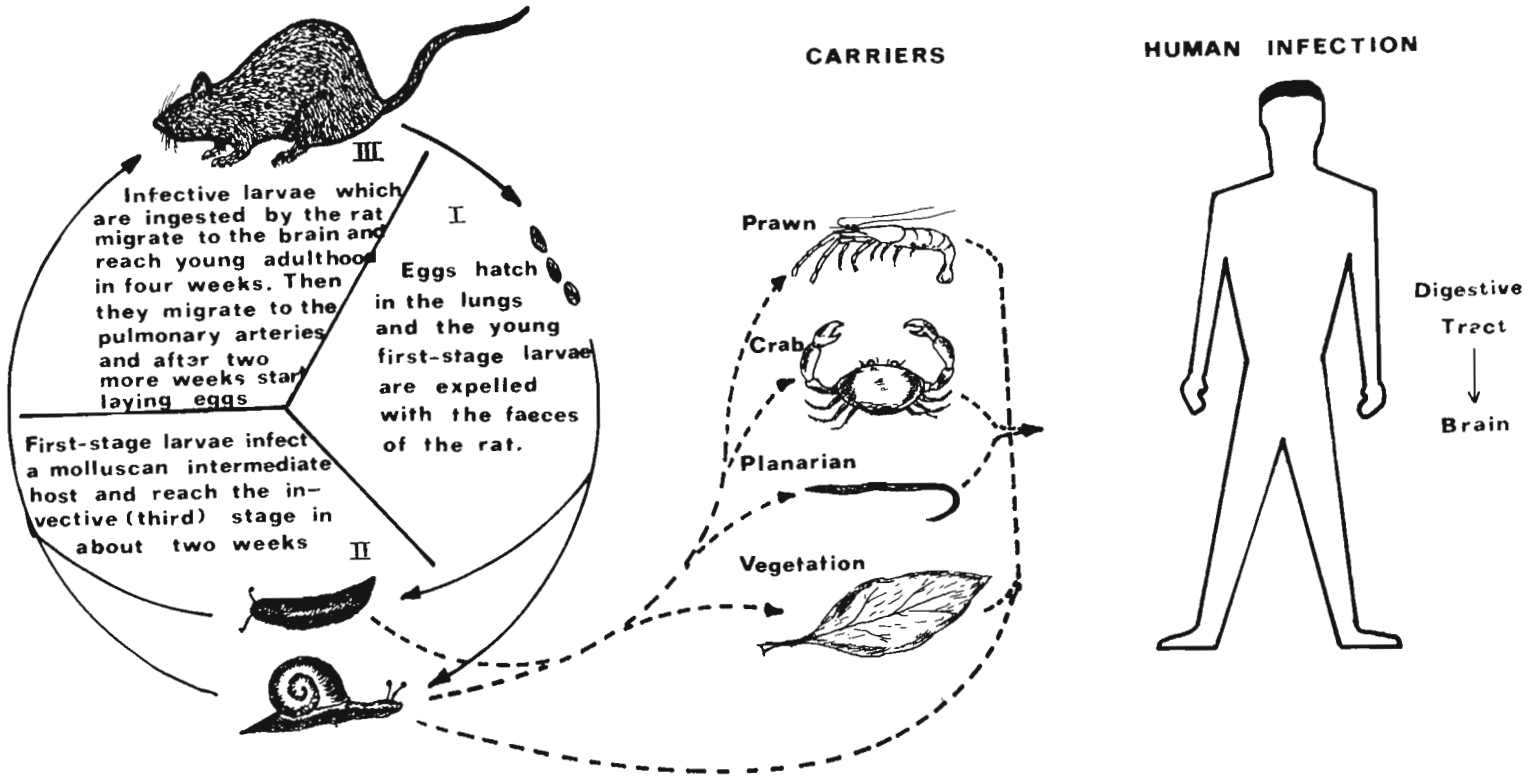


Fig. 5. Life cycle of *Angiostrongylus cantonensis* and its mode of transmission to man.

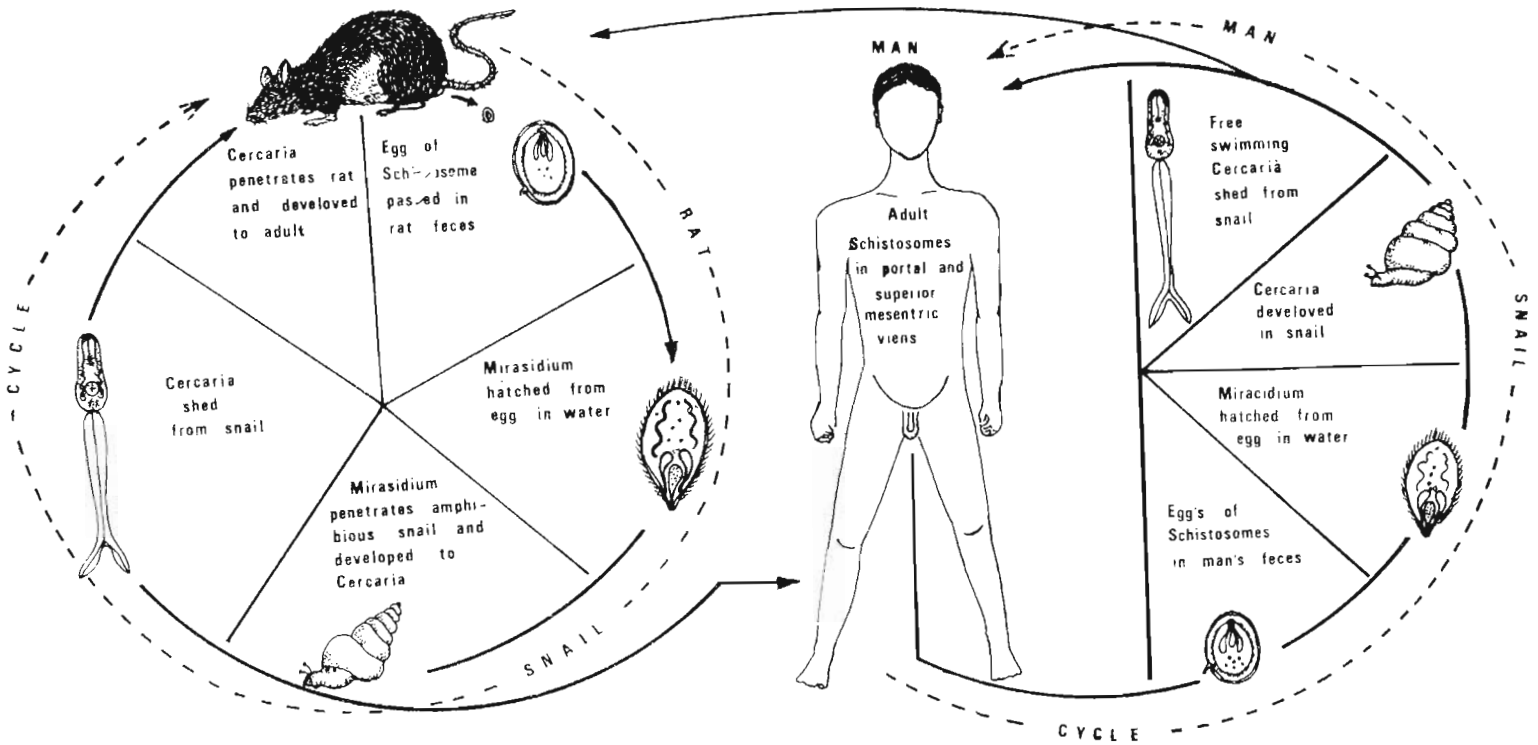


Fig. 6. Life cycle of *Schistosoma japonicum* and its mode of transmission to man

### PAST RESEARCH ACTIVITIES (1892 – 1970)

**Plague:** Plague was brought into Java by infective rats, and/or fleas in cargoes of rice imported into the eastern seaport of Surabaya in November 1910. Additional importations are suspected in the seaports of Semarang in 1916, Cirebon in 1923 and Tegal 1927. Epidemics first were confined to east Java, then the disease spread to southern central Java within a few years (Surakarta in 1915 and Jogjakarta in 1916). Either as multiple invasions westward progression of the original infection, or both, plague reached

western central Java and east central Java in the 1920's. From 1910 to 1920, a total of 240,375 plague deaths were reported in Java<sup>7-12</sup>. In 1922, plague-like cases were reported in Makasar (Sulawesi) and Palembang (Sumatera) but no deaths were recorded. Prevalence of the disease, decreased steadily after the 1930's except for some violent revivals of the infection in central Java in late 1904,s and early 1950's. Further reduction in infected territory and decline in the number of cases continued until, by the late 1950's, plague was restricted to two mountainous zones (Wonogiri and Boyolali) in the Surakarta Recidency (Fig. 7).

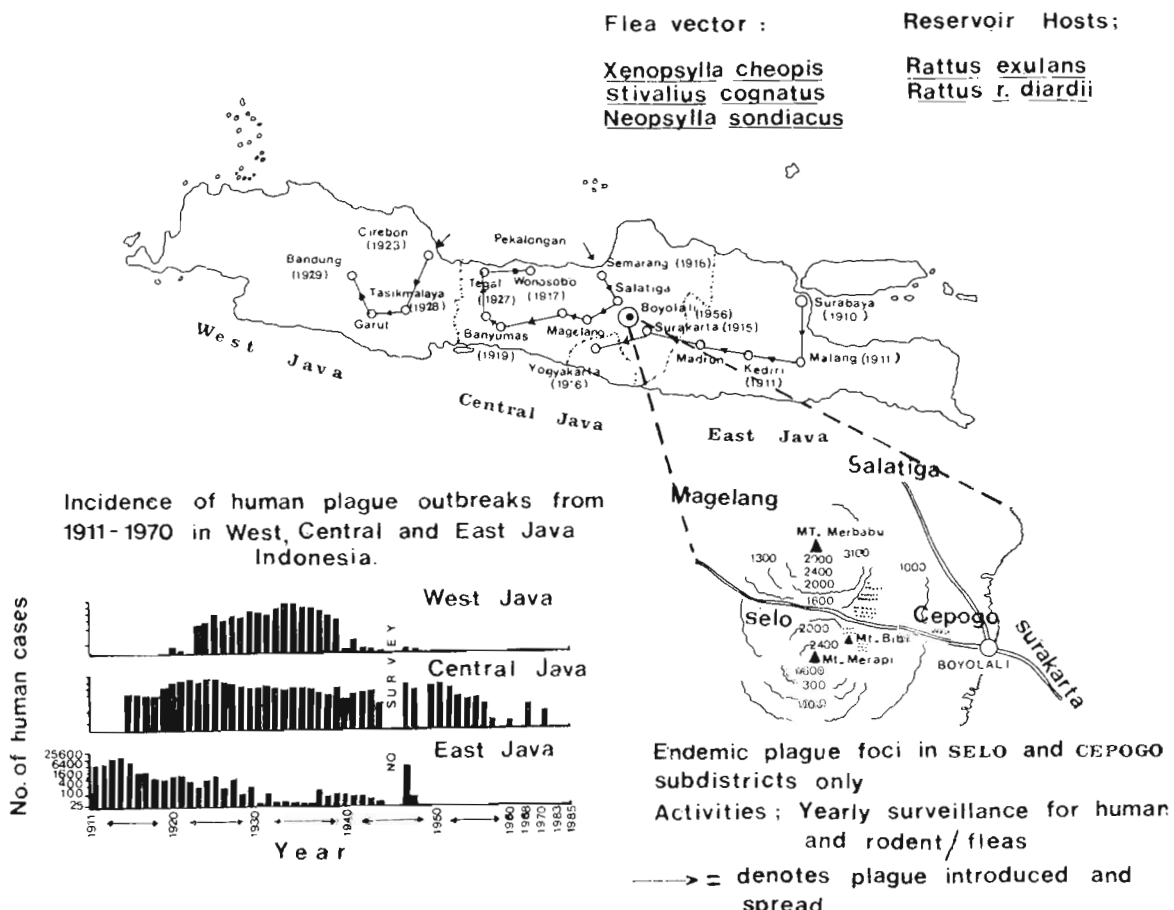


Fig. 7. Human plague distribution in Java

These two foci accounted for more than two-thirds of all recorded human cases of plague on the island<sup>13-14</sup>. The oriental rat flea, *Xenopsylla cheopis*, and the roof rat, *R.r. diardii* were incriminated as the vector and reservoir hosts of plague in Java<sup>13-14, 15-19</sup>.

From 1960 to 1968 no activities of plague surveillance were carried out in Java. However, plague flared up twice more in the Boyolali in two subdistricts of Selo and Cepogo in 1968 (102 cases, 43 deaths) and again in 1970 (10 cases, 2 deaths). During the 1968 outbreak, the Provincial Government in Central Java together with the National Communicable Diseases Control (CDC/Jakarta) and United States Naval Medical Research Unit-2 (NAMRU-2) carried out mass vaccination of the populace and DDT dusting for fleas in houses of the infected areas. Surveillance on human cases and rodent/fleas was subsequent followed up by the Provincial Government.

**Scrub typhus and Murine typhus:** Scrub typhus was first reported in north Sumatera<sup>20</sup>. Later the disease was found in Kalimantan and Irian Jaya<sup>21-24</sup>. Most of these human cases were symptomatic, and some were serologically diagnoses. The aetiological agent, *Rickettsia tsutsugamushi* was isolated from blood of two patients in Jakarta<sup>22</sup>. *R. tsutsugamushi* was also isolated from pools of the vector chigger, *Leptotrombidium (L.) deliense* and *L. (L.) fletcheri*<sup>24</sup>. Murine typhus, on the other hand, was reported in Jakarta through the isolation of the agent, *R. typhi* from domestic rat, *R. norvegicus* and *R.r. diardii*, oriental rat flea, *X. cheopis*, and also from the chigger, *Ascoschoengastia indica*<sup>25-26</sup>. Since then there was no work done on these two diseases until the 1970's.

**Leptospirosis:** Human leptospirosis was first reported from a soldier in Jakarta who showed signs and symptoms of

Weil's disease. Serum of this patient was serologically tested and shown to be positive with the sero-type indentified as *Icterus febrilis*<sup>27</sup>. In subsequent years more human sera were obtained from suspected cases in Jakarta and Surabaya of West and East Java, and serological results showed the same sero-type<sup>28</sup>. (Anonymous, 1895). Serum examination of a suspected person in Jakarta again, and it was positive with sero-type which he named it as *Leptospira icterohaemoglobinura*<sup>29</sup>. Following these positive cases, further surveys found 196 cases in West Java (Jakarta, Sukabumi, and Sindanglaya), 34 in east Java (Surabaya) and 18 in Central Java Semarang<sup>30-33</sup>. In Sumatera (Deli, Senembuh My, Simau, Bangkinang, Bangka & Belitung) 532 cases were found to be serologically positive<sup>29, 34-38</sup>. In East Kalimantan (Singkawang, Tarakan) 35 positive cases were reported<sup>27-29</sup>, and 26 cases in Sulawesi (Makassar)<sup>40</sup>. Among these infected cases, 78 persons died of the disease. During this period, a total of 842 people were found positive with the disease from Java, Sumatera, Kalimantan, and Sulawesi, and with a mortality rate 9.2%. There was no report of cases from other islands in the country. Four *Leptospira* sero-types namely, *L. inchoerohaemo rrahgiae*, *L. bataviae* *L. javanica* and *L. australis* were identified.

Domestic rodents and wild bats were also examined. In West and Central Java (Jakarta, Bogor, Semarang and Ambarawa) 31.4% of 363 *Mus musculus*, 6.7% of 30 *R.r. diardii*, 21.2% of 104 *Rattus r. brevicaudatus* (= *Rattus argentiventer*), 23.6% of 72 *R. roquei* (= *R. tiomanicus*) and 0% of 26 *R.r. diardii* were reported<sup>33, 41-45</sup>. In Sumatera (Pangkalpinang) 19.8% of 111 *Mus musculus* and 6.7% of 89 *R.r. diardii* positives were reported<sup>37</sup>, and in Sulawesi (Makasar) 7% of 350 *Mus mucus* were also reported to be positive<sup>46</sup>.

Rodent leptospirosis studies showed that the infection rates were higher in field rodents with 21.2% of 104 *R. argentiventer* and 23.6% of 72 *R. tiomanicus* infected than in domestic rodents with 14.1% of 824 *M. musculus* and 6.3% *R.r. diardii*. Seven sero-types of leptospira were identified. *R. argentiventer* and *M.*

*musculus* were each found with all the 7 sero-types, and two sero-types were from *R.r. diardii*, and 3 from *R. tiomanicus* (Table 1). Bats of the genus, *Cynopterus* were also examined, and some positive bats were shown to be infected only with sero-type *L. cynopteri*<sup>47-48</sup>.

Tabel 1. Results of Leptospira sero-types found in man and animals spp. by past reserch workers from 1892 to 1964.

Species of host	<i>L. ictero-haemorrhagiae</i>	<i>L. javanica</i>	<i>L. autummalis</i>	<i>L. bataviae</i>	<i>L. schuffneri</i>	<i>L. canicola</i>	<i>L. sarmini</i>	<i>L. benjamin</i>	<i>L. naam</i>	<i>L. potyhosa</i>	<i>L. bovis</i>	<i>L. pyrogenes</i>	<i>L. australis</i>	<i>L. pomona</i>	<i>L. cynopteri</i>	<i>L. mitis</i>	<i>L. wolffi</i>
Primate																	
Man	+	+		+									+				
Domestic rodents																	
<i>Mus musculus</i>	+			+		+				+	+		+	+			
<i>Rattus r. diardii</i>	+			+													
Field rodents																	
<i>Rattus argentiventer</i>	+			+	+		+		+			+		+			
<i>Rattus tiomanicus</i>			+			+		+									
Domestic animals																	
Cat	+	+		+													
Dog	+	+		+		+								+			
Farm animals																	
Swine				+										+		+	+
Goat														+			
Water buffalo												+		+			
Horses	+					+							+	+			
Cattle														+			
Chinoptera																	
Bats															+		

Domestic cats and dogs surveyed in Jakarta (west Java) showed 9.8% of 794 cats examined were positive with antibodies of *L. bataviae*, *L. icterohaemorrhagiae* and *L. javanica*<sup>32, 49-51</sup>. Of 296 dogs examined from Medan (Sumatera), Jakarta (West Java) and Makasar (South Sulawesi), 21.6% were positive with *L. bataviae*, *L. javanica*, *L. icterohaemorrhagiae*, *L. canicola* and *L. pomona*<sup>52-53</sup>.

Farm animals, i.e. swine, sheep, goats, water buffalo, horses, dairy and beef cattle; the sera of these animals were serologically tested with the various leptospira antigens. Positive reactions against *L. pomona* were found in 75% (596 animals) buffalo sera, 52.7% (317) beef cattle, 30.4% (79) swine and 14.5% (586) dairy cattle. One of 33 swine sera showed a reaction against *L. bataviae*, while 2 of the same sera were positive for *L. mitis* and *L. australis* were found in 2 of 20 horses sera, and 1 each of the same sera reacted against *L. canicola*, *L. icterohaemorrhagiae*, *L. pomona* and *L. wolfii*. One of 30 goat sera was positive with *L. pyrogenes*<sup>54</sup>.

Leptospira of 17 serotypes were determined in these studies (Table 1). Among them, the commonest serotypes encountered in man and his commensal and domestic animals were *L. icterohaemorrhagiae*, *L. bataviae*, *L. pomona*, *L. canicola*, *L. javanica* and *L. australis*. The leptospirosis studies carried out by past scientific workers showed that the disease was common in man as well as in wild and domestic animals.

**Schistosomiasis:** This disease was first reported in Indonesia in 1937 following the discovery of a human case in Palu, Central Sulawesi<sup>55</sup>. The patient was a 35 years old male from Tomado in the Lindu Lake area. In the same year, the eggs of *Schistosoma japonicum* were identified in tissue section taken at autop-

sy from the same patient<sup>56</sup>. Based on the finding, a stool survey was conducted in the Lindu Lake area and *S. japonicum* eggs were found in 8% of 234 human samples. Further surveys revealed a prevalence rate of 53% of 468 stool sampled<sup>55</sup>, and resurveyed of the Lindu Lake area found *S. japonicum* infections in 26% 347 people sampled<sup>58</sup>. Adult schistosomes in humans, dogs and wild deer found<sup>59</sup> were considered closely related to the classical form of *S. japonicum*<sup>60</sup>. The identification was only based on the morphology of the adult worms without doing a complete life-cycle study of the parasite, as the intermediate host (snail) had not yet been found at the time. No study on the rodents as potential reservoirs of the parasites was carried out. These historical studies established the identity of the parasite and recognised the public health importance of this disease, endemic to the Lindu Lake areas of Central Sulawesi.

**Angiostrongyliasis:** Human cases of eosinophilic meningoencephalitis, with suspected etiology due to *Angiostrongylus cantonensis*, were reported from North Sumatera<sup>61-62</sup>. Subsequently, adult worms of *A. cantonensis* were recovered in domestic and field rats (*Rattus r. diardii* and *R. argentiventer*) in the same area, further substantiating the suspected etiology in the human cases<sup>63</sup>.

## PRESENT RESEARCH ACTIVITIES (1970 - 1985)

During this period studies on rodent-borne disease were re-initiated by the national scientists in the Health Ecology Research Centre (HERC) of the National Institute of Health Research and Development (NIHRD) and Subdirectorate of Zoonosis of the Communicable Disease Control (CDC) in collaboration with the United States Naval Medical Research Unit-2

(NAMRU-2), WHO Regional Projects on Schistosomiasis (SEARO/IND and on plague 0099), and WHO Interregional Project of Vector Biology and Control Research Unit-2 (VBCRU-2).

**Plague:** Since 1970 no further plague outbreak has occurred in the previously endemic areas on Central Java. However, CDC in collaboration with WHO Regional Project carried out an ecological study

on rodents in relation to the plague transmission cycle from 1972—1974. During this study a detailed vertical host distribution in the plague endemic focus area was mapped (Fig. 8). *R. r. diardii* and *R. exulans* were confirmed in the involvement of the infectious plague cycle, as isolation of the pathogen (*Yersinia pestis*) from the organs of these rodents were made<sup>64</sup>.

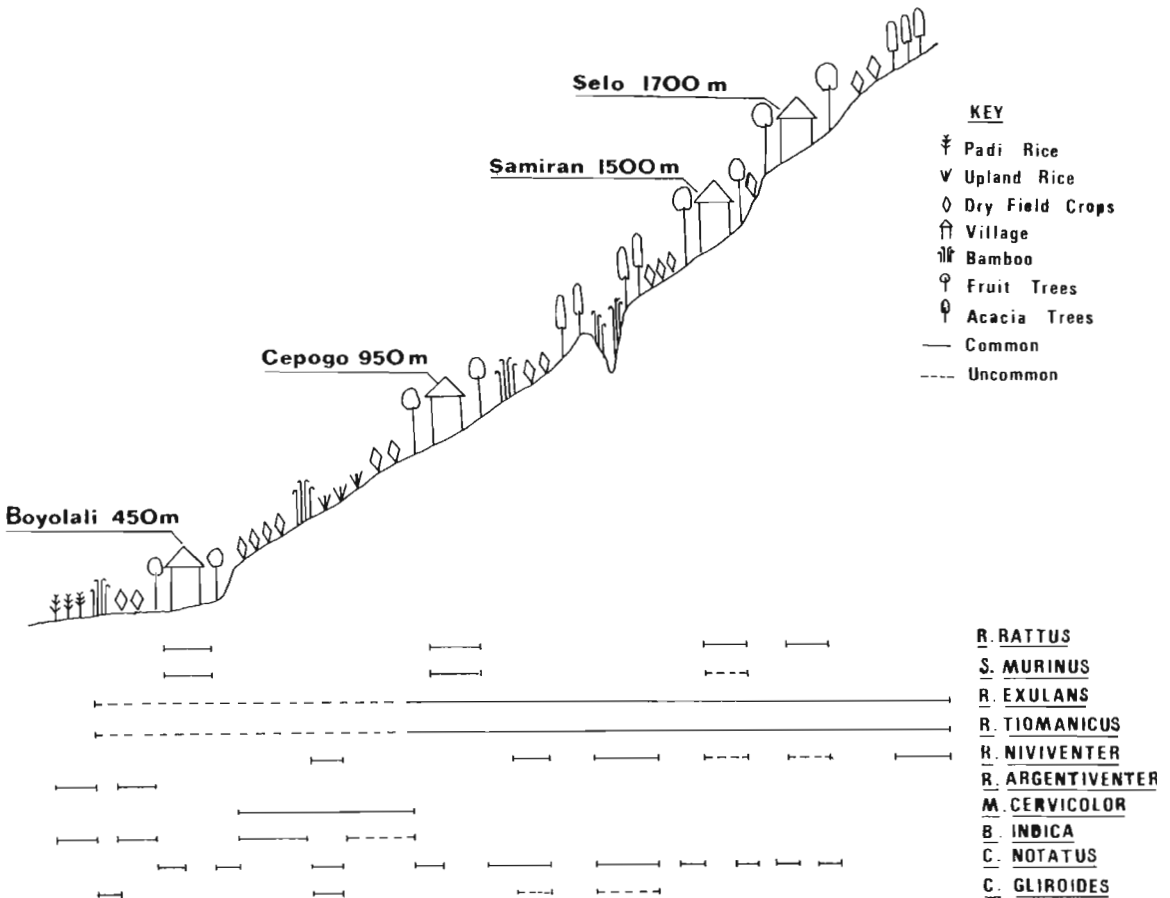


Fig. 8. Host distribution in the Boyolali plague focus, Central Java, Indonesia.

Based on studies on ecological distribution, patterns of movement and the reaction of the plague pathogen in these rats, the field rat, *R. exulans* was found to be resistant to the pathogen, and it was concluded that this species functions as the primary reservoir maintaining plague. The house rat, *R.r. diardii*, on the other hand, was shown to have low resistance or nearly complete susceptibility to the pathogen, thus making it a poor reservoir during inter-epidemic periods. *R.r. diardii*, thus probably functions mainly as an amplifying host for the pathogen during outbreaks<sup>64</sup>.

Past workers incriminated a field flea, *Stivalius cognatus* and an oriental

rat flea, *Xenopsylla cheopis* as vectors of the plague focus area. A third species, *Neopsylla sondaica* was the most common and widespread flea, occurring both in houses and fields at elevations below 1000 metres. Above 1000 metres, *X. cheopis* was confined mainly to houses, *S. cognatus* and *N. sondaica* were the common species in the field at all elevations. Positive isolations of *Y. pestis* were acquired from *S. cognatus* and *X. cheopis* infesting *R. exulans* and *R.r. diardii*<sup>65</sup>. The results of these studies on the dynamics of the plague transmission cycle from sylvatic through peridomestic to domestic habitats are illustrated in Fig. 9 a-c respectively.

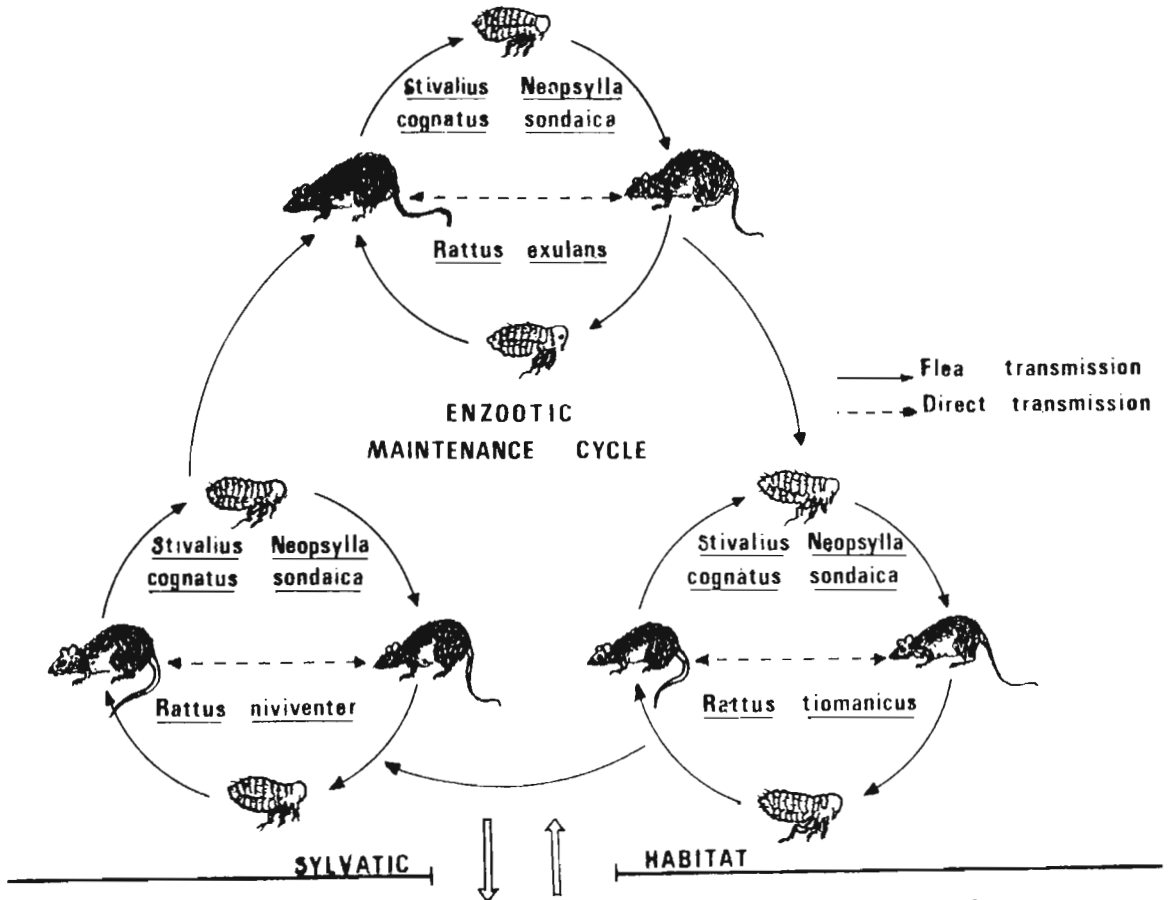


Fig. 9.A. Potential components of the plague transmission cycle in sylvatic habitats.

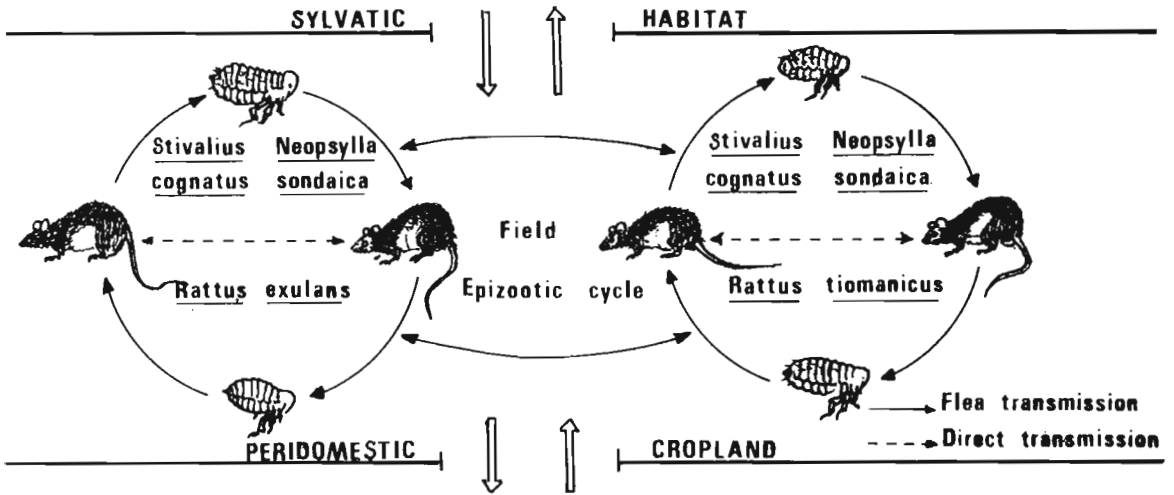


Fig. 9.B. Potential components of the plague transmission cycle in peridomestic habitats.

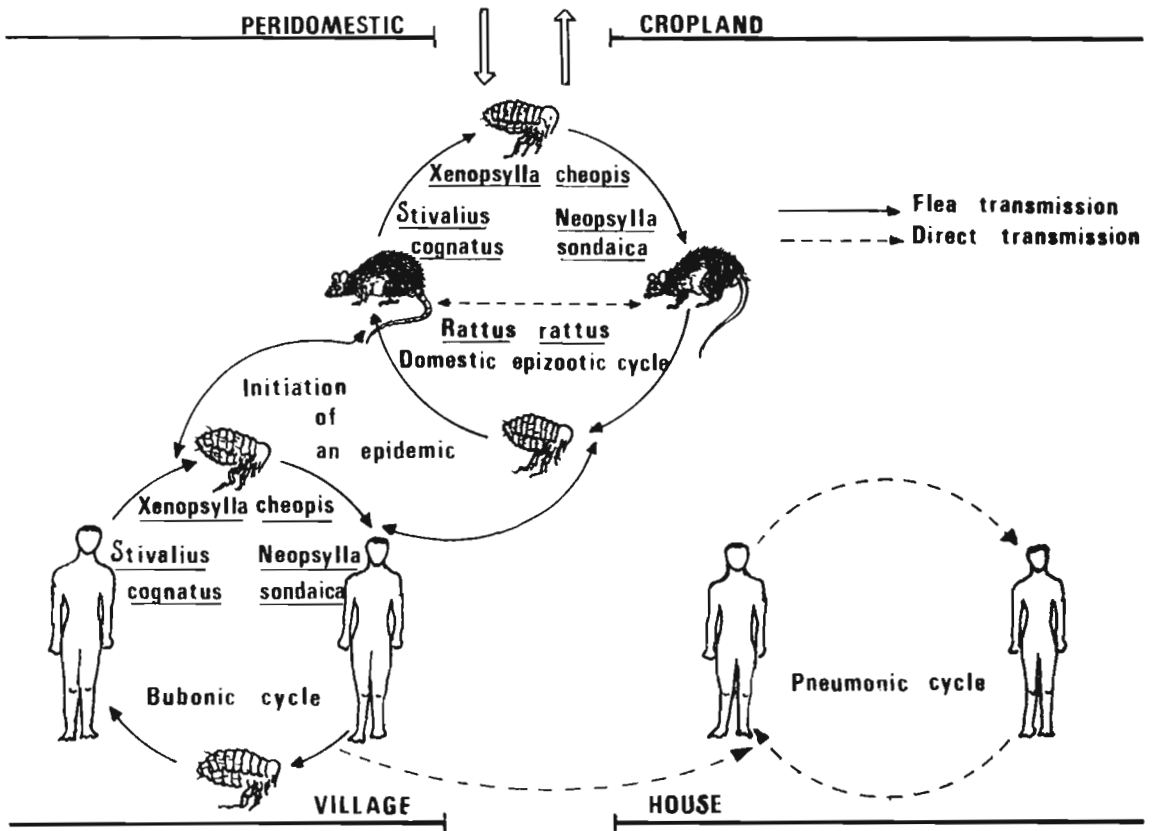


Fig. 9.C. Potential components of the plague transmission cycle in domestic habitats.

In 1978 CDC/Jakarta, CDC/Semarang, HERC/Jakarta and WHO/VBCRU-2 Jakarta jointly conducted a two months survey of the rodents and fleas in the plague focus area. In human domiciles 611 animals (*R.r. diardii*, *R. exulans*, *R. tiomanicus*, *Suncus murinus*) were examined. Of these, 93.3% was the predominant house rat, *R.r. diardii*. In field environs 197 rats (*R. exulans*, *R. tiomanicus*, *R. niviventer*) were examined, and *R. exulans*, comprised 90.9% of the total catch.

Three flea species (*X. cheopis*, *S. cognatus*, *N. sondiaca*) were found infesting these domicile and field mammals. The flea population on animals in human domiciles comprised of 47.9% *X. cheopis*, 51.8% *S. cognatus* and 0.3% *N. sondiaca*, while that in the field environs was 2.2% *X. cheopis*, 80.7% *S. cognatus* and 17.1% *N. sondiaca*. The field flea, *S. cognatus* was shown to be relatively more common in the field than oriental rat flea, *X. cheopis* in human domiciles.

Attempts to isolate plague bacillus from 70 pools of three flea species and 129 pools from the small mammals from both human domiciles and field environs yielded negative results. Serological studies of plague antibody in organs of 120 small mammals also gave negative results<sup>66</sup>. At the same time 197 human sera were tested, and only two were positive with low titres. These two positive were old plague cases from the 1970 outbreak.

During the same period laboratory susceptibility tests with 4% DDT, 0.5% malathion, 1.0% fenitrothion and 0.2% dieldrin against the three flea species were carried out. The field flea, *S. cognatus*, which was highly susceptible to malathion in 1972, was found to be resistant to it, but susceptible to the other three insecticides. The oriental rat flea, *X. cheopis* which was previously found to be highly resistance to DDT, was less resistant, but susceptible to the other

three insecticides tested. The third field flea, *N. sondiaca*, was found highly susceptible to DDT<sup>67</sup>. Prior to this insecticide susceptibility test of fleas in the plague focus area, a field trial of fenitrothion, malathion and DDT against flea from *R.r. diardii* in three villages in West Java was carried out. The field areas had similar ecological biotypes to that of the plague endemic focus area in Central Java. The results revealed that malathion dust at 5% was effective controlling *X. cheopis* up to 15 weeks, while 5% fenitrothion dust effective for 19 weeks, and DDT at 5% was not effective<sup>68</sup>.

In 1982-1983 CDC/Jakarta and CDC/Semarang, assisted by WHO/VBCRU-2, conducted surveillance studies again for a period of 12 months. A total of 411 pools of organs of *R.r. diardii*, *R. exulans* and *S. murinus* from human domiciles and fields were isolated, and one pool of 3 *R.r. diardii* was bipolar positive and gram negative, and this was confirmed as *Y. pestis*. Isolations of 385 pools of fleas, *X. cheopis*, *S. cognatus* and *N. sondiaca*, none were positive. Negative results were also obtained from 74 pools of bats. Serological tests for plague antibody in 1723 sera of rodents species, and 107 sera of dogs, 34 cats and 229 bats also gave negative results.

A total of 32,664 people, comprising of 67.3% adults and 32.7% children of both sexes from 283 subvillages in the plague focus area, were medically examined. Of these 0.14% (47) people showed symptoms of fever, and sera from these fever cases were taken for serological tests, and only one was positive. This one has a low titre of 1:20 who was an old plague case from the 1968 outbreak (Kusharyono et al - unpublished). The results of the survey revealed that although no new human plague case was detected but infection in rats still occurs. In view of the finding of positive isolates in

rats, control measures were carried out against fleas with 10% DDT treated in the subvillages where the positive rats were found. In addition, mass vaccination of the populace in the plague focus area was undertaken.

**Scrub and Murine typhus:** Scrub typhus vector studies were recently intensified. To date 69 species of chiggers have been identified, including 7 *Leptotrombidium* spp. Four of the *Leptotrombidium* spp. were confirmed as vectors of *R. tsutsugamushi*, and of these *L. (L.) deliense* and *L. (L.) fletcheri* were found to be widely distributed. Thirty-three mammalian hosts, comprising of 3 insectivores, 3 primitive primates, 23 murids, 3 squirrels and 1 carnivore were shown to be hosts of *Leptotrombidium* chiggers. Details of this disease are dealt with in a separate paper. Studies of murine typhus in human and rodents were also reinitiated. Seven hundred and twenty-two human sera were collected in different parts of the country and tested using the indirect immunofluorescence technique. Antibodies of murine typhus were found in 10% to 20% of the sera from Java and Sumatera, but less than 2% in sera from islands east of Java<sup>69</sup>. Since 1977 serological studies on rodent murine typhus have been intensified by NIHRD, WHO/VBCRU-2 and the University of Maryland, U.S.A. Preliminary results revealed that murine typhus was quite prevalent in the domestic rats (*R.r. diardii*, *R. norvegicus*) and low in the field rats. The high prevalence of murine typhus antibodies in the domestic rats supports the theory that the infection involves indoor commensal rodents rather than those in their natural outdoor environments (Unpublished data).

**Leptospirosis:** A recent surveillance study was carried out jointly by NAMRU-2 and NIHRD. They examined 186 patients from Jakarta hospital who suffered from fevers of unknown origins. Urine and blood were obtained on admission from all, but second convalescent specimens were obtained from only 138. Fourteen patients died, and 34 were discharged before second specimens could be obtained. Nine patients had evidence of past infection with leptospirosis based on microscopic serum agglutination test titres at dilution of less than 1:400 against serotypes: *L. Hebdomadis* (1 person), *L. grippotyphosa* (1), *L. australis* (1), *L. batavie* (1), *L. icterohaemorrhagiae* (1), *L. pyrogenes* (2) and *L. putoe* (2). The results showed only 2 of 186 febrile hospitalized patients in Jakarta had leptospirosis, one with serotype *L. agrippotyphosa* and the second with *L. batavie* 70

During an epidemic of jaundice, thought to be caused by viral hepatitis, NAMRU-2 and NIHRD did a study at the end of 1967 and early 1968 in the province of South Sumatera. Sera from 259 people were serologically tested. Of these 18.1% were positive. Nine leptospira sero-types were determined, and among these the highest leptospira agglutination titres against these sera were *L. australis*, *L. grippotyphosa*, *L. icterohaemorrhagiae* and *L. hebdomadis* which also were the most common serotypes<sup>71</sup>.

Fifty-three domestic rats (*R. argentiventer* and *R.r. diardii*) were also examined in South Sumatera. Kidney cultures of two were positive, *L. javanica* and *L. batavie* only. River water cultures detected *Leptospira* which were not identified<sup>71</sup>.

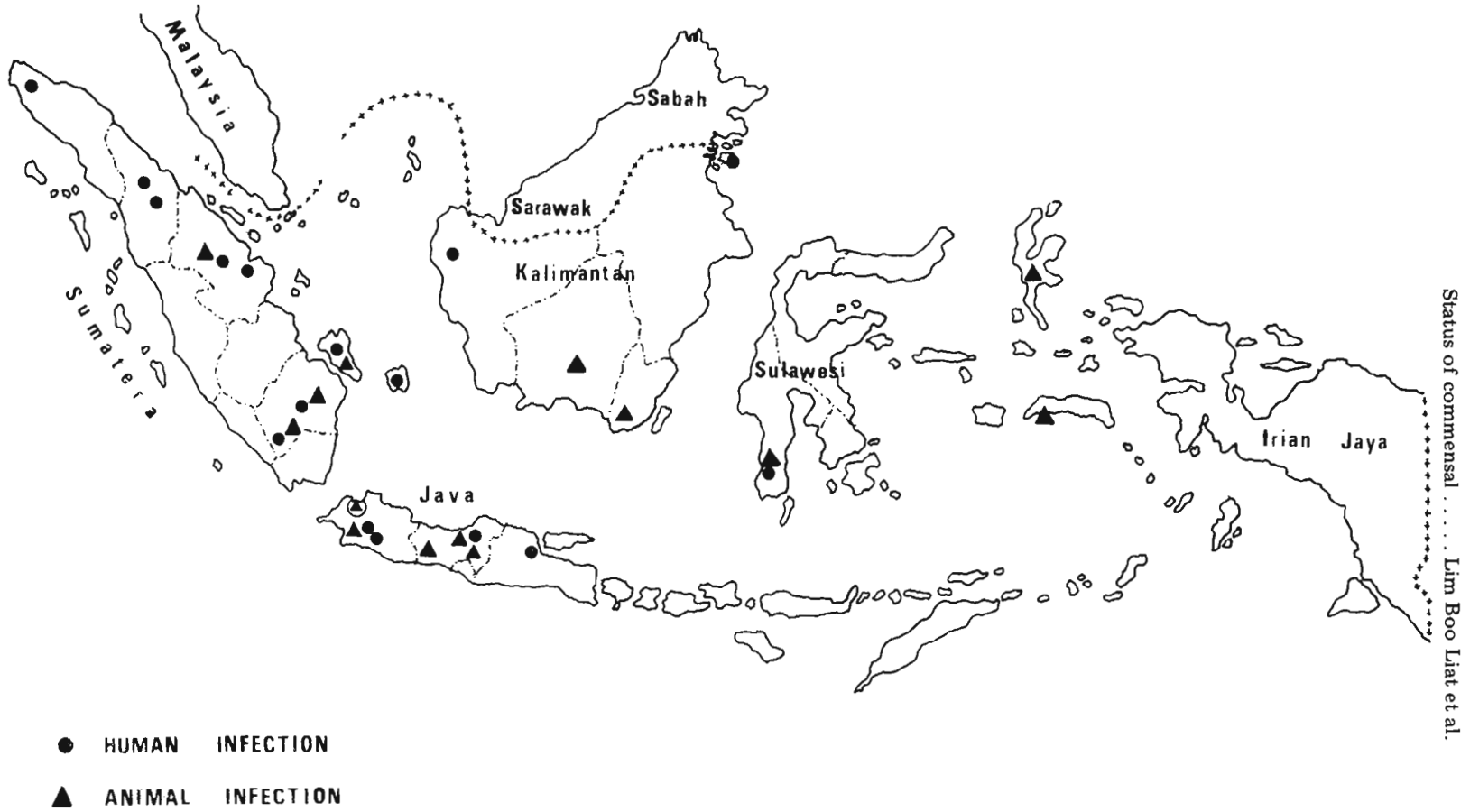


Fig. 10. Distribution of Leptospiriosis of man and animals surveyed in Indonesia (1892 – 1971)

Comprehensive leptospirosis surveys in wild mammals comprising 49 species were examined (Table 2). Most of the infected animals were the domestic rat, *R. norvegicus*; field rat, *R. argentiventer* and *R. exulans*; and 13 leptospira sero-types were determined. These recent studies indicate that Leptospirosis is quite prevalent in Indonesia and is an infection common among the domestic and field rodents<sup>69</sup>. The leptospira serotypes associa-

ted with human disease were more common in the commensal rodents. Infection of sylvatic mammals was usually by Leptospira serotypes of lesser human importance.

A geographical distribution map of Leptospirosis infection in man and animals is presented in Fig. 10.

Tabel 2. Results of attempted isolation and serology of leptospire of animal species in Indonesia (Modified from Table by Van Peenen et al., 1971).

Type of animals	Isolation				Serology			
	Number of spp.	Number tested	Number positive	Serotypes	Number of spp.	Number tested	Number Positive	Serotypes
DOMESTIC RAT								
<i>Rattus norvegicus</i>	1	20	14	bataviae (7); javanica (5); unknown (2).	1	18	3	javanica, bataviae
<i>R.r. diardii</i>	1	96	1	bataviae	1	94	0	I in icterohaemorrhagiae
FIELD RAT								
<i>R. argentiventer</i>	1	18	5	australis	1	76	1	
<i>R. tiomanicus</i>	1	1	0		1	3	0	
<i>R. exulans</i>	1	59	4	javanica	1	49	0	
FOREST RAT	7	85	3 (2)	javanica, canicola	11	136	2 (1)	bataviae
FOREST SQUIRRELS	3	3	0		4	5	1	bataviae
FOREST SHREW	1	5	0		2	7	0	
HOUSE SHREW	1	5	0		1	20	1	javanica
FOREST CARNIVORES	5	11	0		5	14	3 (3)	australis, bankinang, trassovi.
FOREST HERBIVORES	2	2	0		3	4	0	
MONKEY	1	1	0		1	0	0	
BATS	10	48	0		17	171	8 (3)	copenhageni, sejroe, medaneinsis, butembo, cynopteri.
Total	35	383	27		49	597	19	

Note : Figure in parenthesis denotes number of species infected.

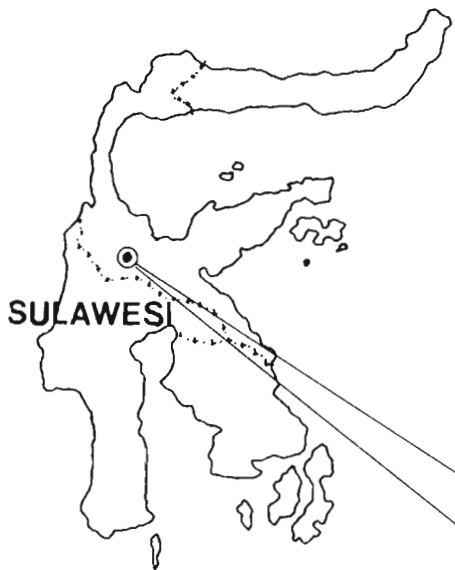
**Schistosomiasis:** Studies of this disease have reactivated. The high prevalence of *S. japonicum* in the human was reconfirmed<sup>72-74</sup>. The molluscan host was found in Lindu valley<sup>75</sup>, and subsequently described as a new subspecies of *Oncomelania*, namely *O. hupensis lindoensis*<sup>76</sup> and the life-cycle was determined<sup>77</sup> (Fig. 6). The finding of this new subspecies of snail led to the discovery of the first focus of *O. hupensis* in paku area. After the discovery of the snail focus, subsequent surveys confirmed another focus of schistosomiasis. Several schistosomiasis studies in Lindu Valley were carried out to determine the density of *O.h. lindoensis*, seasonal variation in snail, infection rate and the type and prevalence of *S. japonicum* in wild and domestic animals<sup>78</sup>.

Animals surveys revealed *S. japonicum* infesting 10 or more mammal species, in addition to man, namely: *R. exulans*, *R. hoffmani*, *R. chrysocomus rallus*, *R. marmosurus*, *R. celebensis*, *Cervus timorensis*, *Sus scrofa*, domestic cat (*Felis cattus*), domestic dogs (*Canis familiaris*) and *Viverra tangalunga*<sup>79</sup>. Mammal surveys have been geared to determine the distribution and infection rates in rodents, principally *R. exulans*, which inhabit the cultivated lowlands of the disease foci in the Lindu area. Routine fecal examinations of wild and domestic animal showed that domestic dogs,

domestic cattle, field and forest rats, wild hoars, wild deer and wild cattle were incriminated in the life-cycle of *S. japonicum* in the foci areas of Lindu valley, Central Sulawesi.

A pilot control project was carried out in Lindu, using mass treatment with Ambilhar (R) at 25 mg kg body weight and snail control by mollusciciding, using Byluscide (R) at dosage rates of 10 - 40 ppm in addition to agroengineering method and environmental sanitation. The results of these control measures, although it had taken some effect, was not significant<sup>78</sup>. In later years, mass treatment with Praziquantel at dosage of 60 mg kg body weight was carried out in Lake Lindu. The results showed significant reduction of prevalence rates from an average of 15% pre-treatment to 2% six months post-treatment<sup>80-81</sup>, and in Napu Valley, the prevalence was reduced to 2.5% post-treatment from a range of 43 to 79 % pre-treatment<sup>82</sup>. It was apparent from these two studies, Praziquantel is now the drug of choice for the treatment of *S. japonicum* in the endemic area.

The past and present studies confirmed and reconfirmed that the disease is endemic in the Lindu valey and Napu valley in Central Sulawesi valley and 11). Control and preventive measures and research activities currently are undertaken by CDC/Jakarta, CDC/Provincial and NIHRD.



SULAWESI

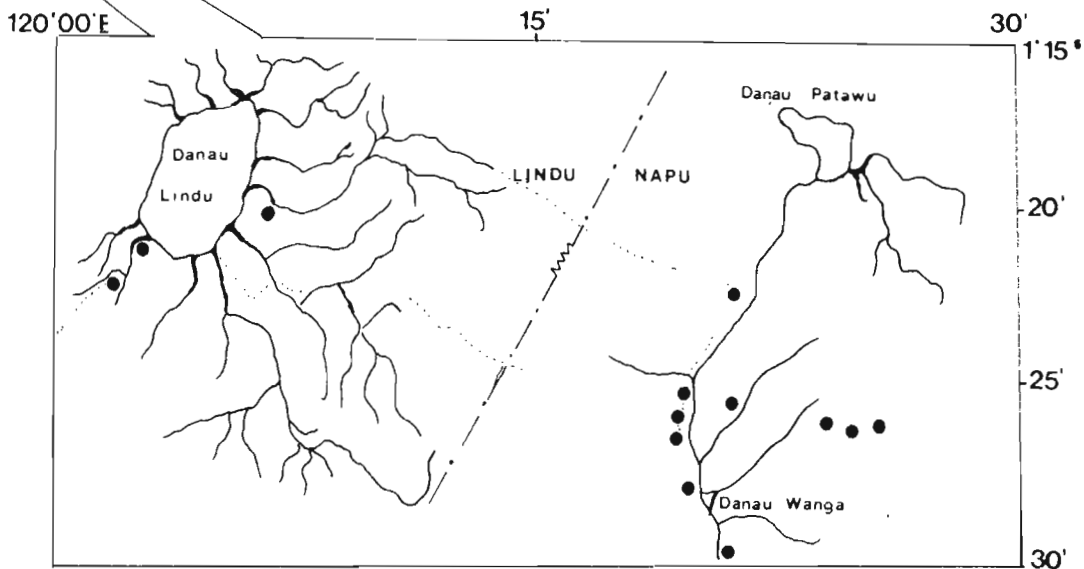


Fig. 11. Endemic area of shistosomiasis in Indonesia

**Angiostrongyliasis:** Following the discovery of *Angiostrongylus cantonensis* in commensal rodents by Kwo & Kwo (1968), another lungworm, *A. malaysiensis* was discovered from *R.r. diardii* in Medan, North Sumatera<sup>83</sup>. Both species of parasites in domestic and field rats at Baturaja Transmigration areas in South Sumatera were found<sup>84</sup>. The latter lungworm may have been implicated in the cases of eosinophilic meningitis<sup>62</sup>. Since 1974 intensive rodent surveys for these parasites in Java and Sumatera were carried out, and results showed that two species of domestic rats (*R.r. diardii*, *R. norvegicus*), four species of field rats (*R. exulans*, *R. tiomanicus*, *R. argentiventer*, *Bandicota indica*) and two species of forest rats (*R. bartelsii*, *R. lepturus*) were reservoir hosts<sup>69, 83, 85-90</sup>.

Three molluscs have so far been incriminated as intermediate hosts of *A. cantonensis*. They are the African giant snail (*Achatina fulica*), the veronicellid slug (*Laevicaulis alte*), and the large freshwater operculate (*Piala scutata*). These molluscs were confirmed as the maintaining hosts of *A. cantonensis*<sup>91</sup>. With the finding of the molluscan intermediate host led to the study of the life cycle of this parasite (Fig. 5).

The first and only confirmed cases of angiostrongyliasis in Indonesia was recently reported<sup>92</sup>. *A. cantonensis* was recovered intact from the interior chamber of the left eye of a 23 year-old woman from Semarang, Central Java.

The distribution of *A. cantonensis* and *A. malaysiensis* in Indonesia is shown in Fig. 12.

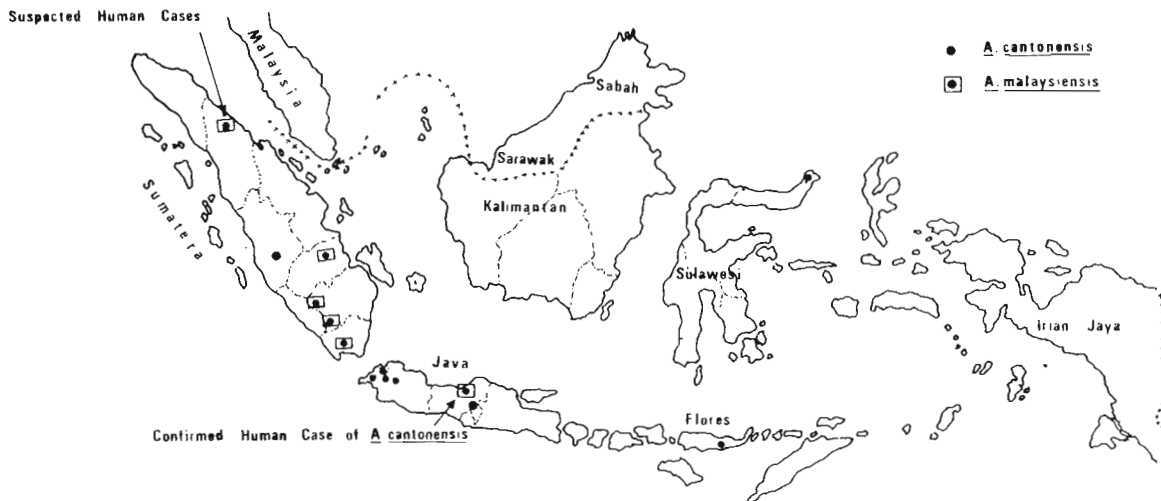


Fig. 12. Geographic distribution of *Angiostrongylus cantonensis* and *Angiostrongylus malaysiensis* in Indonesia.

## FUTURE RESEARCH ACTIVITIES

### BACTERIAL DISEASE

**Plague:** Since 1970 there has been no human plague outbreak, however, research and surveillance activities after 1970 in the plague focus areas, found positive isolation of *Yersinia pestis* in the field rodents, *R. exulans*, and its fleas, *S. cognatus* in 1973. Positive isolation of the plague bacillus was again obtained from the house rats, *R.r. diardii* in 1983. All these positive animals were isolated cases which were found in restricted subvillages in plague focus areas. In the human surveillance, 3 positive cases were found in 1978 and 1983 who were old plague cases in the 1968 and 1970 plague outbreaks, and no new cases were detected. The presence of the plague agent being occasionally encountered in the house and field rats indicates that plague still persists in the rat reservoir hosts in the plague focus areas, thus surveillance studies need to be continued as follows:

1. Animal surveillance: CDC/Jakarta and the Provincial Government in Central Java will continue rodent and domestic and wild animal surveillance. Animals there will be trapped, and together with its fleas will be processed for serological and isolation studies of plague bacillus.

2. Rat falls: The look out for dead rats can be arranged by community participation through the Public Health Services in the focus areas. The observation should be carried out by the Chief and his villages, they should report them to the Health Centres there and the latter in turn should report to the Regency and Provincial government and subsequently notified the CDC/Jakarta.

3. Flea susceptibility test: Susceptibility to impregnated papers of DDT, Malathion and fenitrothion of rodent fleas should be carried out to assess the resis-

tancy or susceptibility to these insecticides. This can be carried out during the period when animal surveillance is being conducted.

4. Human surveillance: Passive human surveillance should be carried out in Selo and Cepogo subdistricts by the Health centres there.

5. Rodent and flea survey other than the plague focus areas: Spot surveys in some previous known plague endemic areas in West Java (Ciweday, Gunung Cireme) and East Java (Gunung Bromo) should be carried out once a year.

**Leptospirosis:** It was apparent from the past and present research surveillance activities that the disease in man and infections in animals are widespread throughout Indonesia. The infection has been shown to be very common among the commensal and domestic animals in Indonesia, and serotypes found in them are more commonly associated with human disease, while infection of sylvatic mammals is usually by *Leptospira* serotypes of lesser human importance. The high prevalence of infection of man's animals and his associated wild animals, suggests that more surveys of this disease in man should be carried out although that the disease has not cause any dramatic incidence since its discovery in 1892 in Indonesia.

1. Animal surveillance: During rodent activities undertaken by either CDC/Jakarta or NIHRD/Jakarta in relation to other diseases, or by Port Authorities, sample of these rodents should be made for leptospirosis investigation.

2. Human surveillance: Examination of hospital patients with fever of unknown origin (FUO) and those suspected with viral hepatitis may serve to uncover more leptospirosis cases.

3. The bulk of the work carried out during the past and present activities were

concentrated in four main islands of Indonesia, i.e. Java, Sumatera, Kalimantan, and Sulawesi. If possible, surveillance work on animals and human should be extended to other islands as well to further map out the distribution and prevalence of this disease to ascertain its public health importance.

**Salmonellosis:** Salmonellosis is an infection of man and animals with organisms of the genus *Salmonella*. It is also commonly known as infections food-poisoning. There are different serotypes of *Salmonella* organisms infect a variety of domestic animals, poultry, wildlife and rodents. Two of these serotypes *S. enteritidis* and *S. typhimurium* are common infections to commensal rats and mice. In Indonesia domestic rodents (*R.r. diardii*, *R. norvegicus* and *Mus musculus*) are potential reservoir hosts of these organisms. The organisms are excreted in their droppings and urine and the disease is transmitted to man when rat contaminated food is eaten. Food poisoning is a common hazard in man throughout the world and is no exception in Indonesia. The close-association of these domestic rodents with man probably may warrant some caution on this disease.

## RICKETTSIAL DISEASES

**Scrub typhus and murine typhus:** Scrub typhus or tsutsugamushi disease is dealt with in its respective section. Murine typhus studies by past and present activities indicate that the disease, although uncommon in human, but infection to domestic rats (*R. norvegicus*, *Mus musculus* and *R.r. diardii*) were shown to be more common than what used to think otherwise. Efforts should be made to find out more about the epidemiology of this disease, and surveillance of anti-

bodies or *R. mooseri* in rodent hosts to map out the distribution and prevalence of infection in these rodent hosts. This work can be carried out together with existing rodent activities undertaken on plague, scrub typhus and rodent control programmes by the NIHRD, CDC/Jakarta, and Port Authority in the country.

## HELMINTHIC DISEASES

**Schistosomiasis:** Under the working group for filariasis and schistosomiasis (Pokja Filariasis and Schistosomiasis), headed by Dr. M. Sudomo of HERC, NIHRD in Indonesia, follow-up research activities to be carried out jointly with NIHRD/CDC/University, Jakarta are as follows:

1. Research on the transmission dynamics of schistosomiasis of man, and animal reservoir hosts in the endemic areas.

2. Laboratory studies on the molluscan host, *Oncomelania hupensis lindoesis* to assess the life-span of the snail, and pathogenicity in various animal hosts (wild and laboratory-bred).

3. The modified Karto technique for stool examination at present is still not very efficient to determine the infected cases, thus it is essential to investigate the most effective and practical method and also more effective serological techniques for diagnosis in mass survey of schistosomiasis.

4. The endemic area in Central Sulawesi is extensive (35,000 ha). A small part is cultivated, and the snail intermediate hosts are found in the cultivated area as well as in the forest. Compare to endemic area in other countries, Lindu and Napu valleys are unique, because relative extensive area is inhabited by only about 7000 people. In such an endemic area snail control is not practicable and even impossible. Praziquantel is the choi-

ce drug shown to be very effective for mass treatment in the area. Thus, control measures in the endemic area could be achieved by persistent treatment with the drug coupled with health education and simple environmental changes, such as sanitation and hygiene, minor physical changes in habits, etc.

5. Sample of schisto- cases, with or without hepato-splenomegaly should be examined physically and serologically, before and after treatment, to see whether the treatment can give improvement to the health of the patients.

6. Immunological study to characterize the humoral state of infected persons, serum IgG and IgM should be measured in a sample of schisto-cases pre- and post treatment. Changes in these parameters can be correlated with the clinical picture as well as with changes in egg output. For the characterization on cell-mediated immune response, blood for lymphocyte transformation should be drawn from a sample of cases with or without hepatosplenomegaly.

7. Further identification of the parasite species by isoenzyme genetic studies, kartotype and karo-systematic and electron microscopic studies of the *S. japonicum* in the endemic area are needed to assess whether there is any strain differences between the Indonesian and other Asian strains.

*Schistosomia incognitum* is a parasite common among the commensal rodent in Indonesia<sup>79</sup>. This parasite has been shown to infect rodents in the schistosomiasis endemic area in Central Sulawesi. In one instance *S. incognitum* was found in copala with *S. japonicum* in *R. exulans*<sup>79</sup>. Further research on the possible of hybridisation between those two worm species is essential to (1) whether the hybrid is pathogenic to man or animal,

an (2) if found not pathogenic to man it may be interesting to investigate the possible antagonisms between *S. incognitum* and *S. japonicum* for a possible biological control method.

**Angiostrongyliasis:** The rat lungworm, *Angiostrongylus cantonensis* and *A. malaysiensis*, etiological agent of human eosinophilic meningitis are primarily parasites of rodents. Human infection is accidental. The fact that only a single authentic human case caused by one of these worms reported since its discovery of these parasite in 1968, indicates that this disease is not a public health importance; the parasites and its geographical distribution in Indonesia are considered as parasites of medical importance only.

Other helminths such as, cestodes *Hymenolepis nana* and *H. diminuta*, trematodes *Echinostoma ilocanum*, *E. malayanum*, and *E. lindoense*, and nematodes *Trichinella spiralis* are common infections of domestic and field rodents<sup>93</sup>. Most of these parasites are also known to be pathogenic to man<sup>57, 94-98</sup>. Rodents do not play an important role in the direct transmission of these parasites to man. Like Angiostrongyliasis, they are parasites of medical importance only. However search for these parasites in commensal rodents should be carried out in connection with other rodent studies to find out the prevalence of infections.

## CONCLUSION

Rodents play an important part in the spread of many diseases of man and domestic animals. Among rodents species, the "commensal rodents" which live in close proximity with human environments, pose a greater threat to man of the diseases they carry. All the seven commensal rodent species found in Indonesia, are also widely distributed to neighbouring Southeast Asian countries<sup>99</sup>.

Of the seven species, *Rattus norvegicus*, *R.r. diardii* and *Mus musculus* live inside houses of human habitations, and the other four, *R. argentiventer*, *R. tiomanicus*, *R. exulans* and *Bandicota* are field rodents adjacent to human environs. Among these field rodents, *R. exulans* sometimes invades domain of human habitations also.

Diseases carried by these commensal rodent can be broadly classified into bacterial, rickettsial and helminthic diseases. Plague and leptospirosis are the two common infections among the bacterial diseases which were very thoroughly investigated in Indonesia. The field rat, *R. exulans* was incriminated as the foremost important reservoir host in the plague foci area, and *R.r. diardii*, an amplying host of human domiciles. The flea parasites of these hosts, *Xenopsylla cheopis* and *Stivalius cognatus* were confirmed as the plague vectors<sup>64-65</sup>. For leptospirosis, the house rodents involved were *Mus musculus*, *R.r. diardii* and *R. norvegicus*; the field rodents were *R. argentiventer* and *R. tiomanicus*. In addition to involvement of rodents, cats and dogs were also found to be important reservoir hosts of this bacterial disease. *Leptospira* of 17 serotypes were isolated from these houses and field rodents, including cats, dog, and human.

Another common bacterial disease is Salmonellosis where house rodents are potential source of transmission. They are *R. norvegicus*, *R.r. diardii* and *Mus musculus*. There are different serotypes of *Salmonella* organisms typed, two of these *S. enteritidis* and *S. typhimurium* are common infections to these house rodents.

Rickettsial disease, like scrub and murine typhus, the former disease involves field rodents only. They are *R. argentiventer*, *R. tiomanicus*, *R. exulans* and *Bandicota indica*. In addition, numerous

forest rodent species are also hosts of scrub typhus. These rodents harbour seven scrub typhus *Leptotrombidium* potential vectors, and among these two, *L. (L) deliense* and *L. (L) fletcheri*, were incriminated as vectors. For murine typhus, house rodents, *R. norvegicus* and *R.r. diardii* were involved as reservoir hosts only. The vector of murine typhus is the oriental rat flea, *Xenopsylla cheopis* commonly infested these rodents.

Field and house rats are also common reservoir hosts of some of the helminthic disease<sup>100</sup>. Schistosomiasis, endemic in Central Sulawesi, forest and field rodents, are reservoir hosts of the parasite *Schistosoma japonicum*. The field rodent, *R. exulans* is the primary reservoir host among the different rodent hosts incriminated. Snail, *Oncomelania hupensis lindoensis* is the intermediate host of the parasite. In the case of *S. incognitum*, a parasite of rodents, the field rat, *R. exulans* is the important hosts. For *Angiostrongyliasis*, 8 rodent species were reservoir hosts of the parasites, *Angiostrongylus cantonensis* and *A. malaysiensis*. Among the rodent reservoir hosts, two house rats, *R.r. diardii* and *R. norvegicus*, and 4 field rats, *R. exulans*, *R. tiomanicus*, *R. argentiventer* and *Bandicota indica* are important reservoir hosts of these parasites. The intermediate hosts are terrestrial and fresh water molluscs. Other helminths such as, cestodes *Hymenolepis nana* and *H. diminuta*, trematodes *Echinostoma ilocanum*, *E. malayanum* and *E. lindoense* and nematode *Trichinella spiralis* are common infections of house and field rats.

The disease where commensal rodents play a primary role in the transmission to man are plague, leptospirosis, murine and scrub typhus, and angiostrongyliasis. Those that play a tertiary role are diseases such as, salmonellosis, hymenolepsiasis, echinostomiasis and trichinellosis.

Commensal rodents are also involved in some viral diseases. The houses rats *R. norvegicus* and *R. rattus* are known to be reservoir hosts of haemorrhagic fever with renal syndrome and rat-bite fever. Both these viral diseases are uncommon in Indonesia.

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