

# Small Mammals in Relation to Korean Hemorrhagic Fever

a preliminary report

Edwin L. TYSON

(Smithsonian Institution, Washington, D.C., U.S.A.)

韓國出血熱과 關聯되는 小哺乳動物에 對하여 (豫報)

에드윈·엘·타이슨

(美國 스미소니안 研究所)

(Received April 11, 1967)

## 摘 要

韓國出血熱患者의 發生이 報告된 5個軍事施設內 및 그 周邊의 小哺乳動物에 對한 調查結果, 사람과 극히 關聯성이 많은 動物이 *Mus musculus* 이어서, 이 動物이 다른 動物들보다 出血熱과 關聯이 깊으리라고 추측된다. *Rattus rattus* 는 村落과 農家에 흔하지만, 軍事施設內에는 많지 않았다. 두 種의 땅쥐, *Crocidura lasiura* 와 *C. suaveolens* 는 흔하지 않았으나, 出血熱患者와 접촉이 많은 경우가 가끔 있었다. 다른 小哺乳動物들은 대단히 드물거나 人跡이 드문 곳에 살고 있었다.

## INTRODUCTION

Following the epidemic of Korean Hemorrhagic Fever (KHF) among United Nations troops during the years of 1952~53, the disease has remained endemic in the general area of the first outbreaks, the Chorwon valley about sixty miles northeast of Seoul. The disease organism has gradually spread in a southwesterly direction, and in December 1966 a patient was reported in Seoul and in January 1967 one was reported near Osan, about thirty miles south of Seoul. If this southward trend continues the disease may become epidemic in some of the more highly populated areas such as Seoul and the rich agricultural lands to the south. For this reason, if for no other, the causative agent must be isolated, the vectors (if any) and reservoirs must be determined and control methods must be established.

Previous studies on the epidemiology of KHF have been of short duration and have been hampered by frequent changes in personnel, resulting in no conclusive evidence concerning vectors or reservoirs. However, some interesting and perhaps significant observations have been made. First, KHF appears to be primarily but not entirely a disease of military compounds, both American and Korean; and second, to become infected it does not appear necessary for a person to go out into the fields or forests or even to visit a local village or farm house. These two observations suggest that something more closely related to military camps than to the locality in general increases the probability of human infection. With these observations in mind, and the fact that most hemorrhagic fevers are associated with rodents, this short term project was designed to (1) determine differences in small mammal populations in areas visited by KHF patients during the last two weeks prior to getting sick in surrounding areas, (2) determine differences between mammal populations in the villages and the military compounds, (3) determine the differences in small mammal populations in areas frequented by man and areas seldom visited, (4) become acquainted with small mammals of the area including their habitats and abundance, and (5) get some idea as to how to proceed with a more comprehensive study of the relationship between small mammals and the KHF organism.

### METHOD

The general study method was to trap small mammals in areas visited by U.S. Army KHF patients the two weeks prior to their getting sick. In addition, adjacent areas not visited by patients were trapped in a similar manner. Trapping was done between 28 November, 1966 and 2 March, 1967. For this short study, five patients were chosen after interviews determined that they had not often been to any or many places outside the military compound on which they were stationed. Of these, three men had remained on their camps or on vehicles between camps, one had visited a single farm house just outside the gate of his camp, and one lived in the village with his wife. In addition, one camp was selected in the area south of the demilitarized zone from which no patient had been reported and where the general aspect of the vegetation was quite different from the other five areas, and also there were no rice paddies or other agricultural features and there were no houses except military structures. Near the camps, five groups of several farm houses or small village houses were studied, four in the vicinity of Munsan (20 miles north of Seoul) and one near Changong-ni (35 miles north of Seoul).

Field procedures were quite simple. Trapping was done in any area in which it could be determined that a patient had visited and in adjacent but similar areas. In addition, traps were set out in surrounding grassy and brushy areas. At all places worked, traps were set at any place at which it looked as if a rodent might be caught. Commonly, from 97 to 250 traps were used each night of trapping. Museum Special snap traps, Sherman traps were most frequently used. From time to time, a live trap suitable for *Rattus rattus* was employed. Traps were usually baited with peanut butter alone or in combination with bacon grease and rolled oats.

Identification of specimens was checked by personnel of the U.S. Army, 5th Preventative Medicine Laboratory, Camp Nabors. Nomenclature follows that of Jones and Johnson (1960, 1965). Transportation and all field assistants were provided by the lab at Camp Nabors through the assistance of the U.S. Army Medical Command, 406th Medical Laboratory, Japan. Primary support was provided by Contract No. F 44620-67-C-0013, from the Air Force Office of Scientific Research entitled "Ecological Study in Korea".

### RESULTS AND DISCUSSION

Table 1 summarizes results of all small mammals caught during the study, which includes 233 individuals of seven species of rodents and two shrews. By separating these into three categories: (1) areas visited by patients, (2) areas not visited by patients and (3) local Korean dwelling houses, some idea of relative abundance of species found in each place can be seen. However, it must be pointed out that trapping effort was not equal in all three areas, therefore, the relative abundance of species in each column studied separately is more meaningful. Most of our traps were not suitable for *Rattus rattus* and their abundance as compared to the other species is probably not representative. This discrepancy was much more obvious at the Korean dwellings where *Rattus* was extremely common and other species tended to live outside the houses under straw or winter fuel heaps.

Tables 2 and 3 show the percent of times mammal were captured by type of area and presence and absence of patient activity. Numbers of traps used at each site are not listed because no effort was made to set traps in any systematic manner so as to be able to compare trap sites. Note that the presence of *Mus musculus* in areas frequented by KHF patients was over 50 percent except in the one farm house where a patient visited, yet in places not visited this mouse was also common. *Mus* was caught outside of the house of the patient that lived in the village. In areas south of the demilitarized zone and near Osan not one single *Mus* was captured in 250 and 160 traps respectively. Note that *Clethrionomys rufocanus* and *Micromys minutus* were not captured in areas habitually visited by man and they were rare in other areas. The two shrews, *Crocidura lasiura* and *C. suaveolens* were relatively most common in areas visited by patients. *Rattus rattus* was by far the most common rodent in the village or farm houses and was only found on military compounds when the rat control bait stations were not kept baited. *Apodemus agrarius* was extremely common in grassy areas, yet this mouse seldom visited areas frequented by man. *Microtus fortis*, a semidiurnal rat, was common in colonies near camps but was not actually in areas frequented by people.

**Table 1.** Number of small mammals captured in ten nights of trapping in endemic hemorrhagic fever areas.

Species	Area visited by patients	Area not visited by patients	Korean dwellings	Total
<i>Mus musculus</i>	59	35	14	108
<i>Apodemus agrarius</i>	3	60	6	69
<i>Rattus rattus</i>	3	3	10	16
<i>Microtus fortis</i>	1	11	0	12
<i>Crocidura lasiura</i>	3	8	0	11
<i>Crocidura suaveolens</i>	4	5	1	10
<i>Cricetulus triton</i>	1	2	0	3
<i>Micromys minutus</i>	0	3	0	3
<i>Clethrionomys rufocanus</i>	0	1	0	1
Totals	74	128	31	233

**Table 2.** Percentage of places in which species was captured in areas frequented by hemorrhagic fever patients.

Type area	No. of areas trapped	Species*								
		1	2	3	4	5	6	7	8	9
Food service	9	56	0	33	X	11	22	X	X	X
Barracks	6	67	X	X	X	17	17	X	X	X
Work area	8	50	13	13	13	X	X	0	X	X
Village house	3	67	X	33	X	X	X	X	X	X
Farm house	1	0	100	0	X	X	0	100	X	X
Supply room	1	100	X	X	X	X	X	X	X	X

\* 1. *Mus musculus*    2. *Apodemus agrarius*    3. *Rattus rattus*    4. *Microtus fortis*    5. *Crocidura lasiura*  
 6. *Crocidura suaveolens*    7. *Cricetulus triton*    8. *Micromys minutus*    9. *Clethrionomys rufocanus*

O Species caught in this type area.

X Species not caught in this type area.

**Table 3.** Percentage of places in which species was captured in areas not frequented by hemorrhagic fever patients.

Type area	No. areas trapped	Species*								
		1	2	3	4	5	6	7	8	9
Food service	4	50	25	0	X	25	0	X	X	X
Barracks	26	23	X	X	X	6	12	X	X	X
Work area	9	56	11	0	X	X	X	11	X	X
Grassy areas	12	25	42	17	25	8	18	X	X	X
Brushy areas	4	25	25	0	25	25	25	25	50	25
Village houses	2	50	X	50	X	X	X	X	X	X
Farm houses	14	57	21	29	X	X	7	0	X	X
Supply room	1	0	X	X	X	X	X	X	X	X
Fence line	4	100	50	X	50	50	X	X	X	X
Bunkers	2	50	50	X	X	50	X	X	X	X
Water point	1	X	100	X	X	X	X	X	X	X

\* All subscripts as in Table 2

## DISCUSSION BY SPECIES

*Mus musculus*.....This ubiquitous mouse was caught in every type area worked except the one water point. It was found more commonly in all types of military structures than all other small mammals combined. Because of its commonness and close association with man, it has all the attributes of a suitable carrier host for the causative agent of KHF. Based on conversations with many people in the army compounds and the farm houses, *Mus* behavioral pattern coincides with the fall increase in KHF patients. It appears that *Mus* is as much if not more a field mouse in the warm months of the year, living commonly along the rice paddy dikes and in the nearby grass. When the rice is harvested and the people begin cutting and raking the straw for winter fuel, the mouse is left without its usual home so it must move to other places. The most logical places are the army camps and the Korean homes, however, *Rattus* is already established in the native houses and *Mus* appears unable to survive in the same house. Therefore, *Mus*

invades the military compounds where it is not necessary to compete with *Rattus*.

*Apodemus agrarius*.....This mouse is as common in the fields as *Mus* in and around houses. On only one occasion was it captured in a building, but it is often caught near buildings. In general, even though common, *Apodemus* is probably not a good reservoir host for transmitting the causative agent of KHF to man because they are uncommon in areas frequented by man.

*Rattus rattus*.....This cosmopolitan rat was abundant at and in all Korean houses at which work was done. On the other hand, it was very uncommon on the military compounds where control bait stations were kept up to date. *Rattus* was rare out in the fields and forests. This rat is probably not the host for the KHF organism, if so, the disease would be more common in villages and farms than on the army compounds.

*Microtus fortis*.....This semidiurnal rat was common in most areas of tall grass and less common in short grass. It was not found in areas frequented by man, therefore, it is unlikely to be associated in any way with KHF.

*Crocidura lasiura*.....This shrew was caught almost as many times in areas frequented by KHF patients as in similar areas not visited. However, they occur infrequently, and for this reason they are unlikely to constitute a good reservoir host for the disease agent.

*Crocidura suaveolens*.....This small shrew was captured more often in mess halls and barracks than *C. lasiura*, yet it is relatively rare, and probably is not a reliable reservoir host for the agent of KHF.

*Cricetulus triton*.....This uncommon hamster was caught at the farm house visited by a KHF patient, otherwise, was not found in close association with man.

*Micromys minutus*.....This small semi-boreal mouse is a rare inhabitant of brushy woodlands and does not frequently come into contact with man.

*Clethrionomys rufocanus*.....This small woodland rat is rare in the western lowlands of Korea where KHF has been endemic, therefore it is unlikely to constitute a health hazard to man.

### CONCLUSIONS

The most obvious conclusions that can be drawn from this report is that we do not have enough data, taken in a systematic way, to predict with any degree of confidence which small mammal, if any, is most likely to be associated with the causative agent of KHF. *Mus musculus*, however, does live in areas commonly frequented by man and is present in most other places, therefore, *Mus* is the most likely suspect species. *Rattus rattus* is common in the villages but not in the military compounds where KHF is most prevalent. The two species of shrews, *Crocidura lasiura* and *C. suaveolens* often live in close association with man in the barracks and mess halls but they are infrequently found. *Apodemus agrarius* and *Microtus fortis* are common in grassy and light brushy areas, however, they do not often come in contact with man. Other species are uncommon or rare and probably do not constitute health hazards to man.

### ABSTRACT

A cursory study of small mammals on and near five military compounds where Korean Hemorrhagic Fever patients had been reported indicated that *Mus musculus* was more closely associated with man than all other mammals combined. Therefore, there is a greater probability that *Mus musculus* is associated with the disease than any other species. *Rattus rattus* was common in villages and farm houses but was not abundant on military compounds. The two shrews, *Crocidura lasiura* and *C. suaveolens* were uncommon, but they were often found in close association with hemorrhagic fever patients. Other small mammals were rare or lived in such places as to come in contact with man rarely.

### REFERENCES

- Jones, J.K., and D.H. Johnson 1960. Review of the insectivores of Korea. *Univ. Kansas Publ., Mus. Nat. Hist.* 9, 549.  
 \_\_\_\_\_, 1965. Synopsis of the lagomorphs and rodents of Korea. *Univ. Kansas Publ., Mus. Nat. Hist.* 16, 357.