YERSINIOSIS IN WILDLIFE AND ITS PUBLIC HEALTH IMPLICATIONS 1

Author: MAIR, N. S.

Source: Journal of Wildlife Diseases, 9(1) : 64-71

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-9.1.64

YERSINIOSIS IN WILDLIFE AND ITS PUBLIC HEALTH IMPLICATIONS[1]

N. S. MAIR, Public Health Laboratory Service, Groby Road Hospital, Groby Road, Leicester, LE3 9QE, England

Abstract: Yersiniosis is a disease of man and other animals due to *Yersinia pseudotuberculosis* (syn. *Pasteurella pseudotuberculosis)* and *Y. enterocolitica.* The majority of human and animal infections have been recorded in Europe, but in recent years the disease has been recognized more frequently in North America, Asia and Australia. In the United Kingdom *Y. pseudotuberculosis* infection has been found in 6 species of wild mammals and in 21 species of wild birds. Principal reservoirs of infection are rodents and birds. Human infection with *Y. pseudotuberculosis* is probably acquired by direct or indirect contact with animals. *Yersinia enterocolitica* infection is less widespread in wild animals but more prevalent in human beings than the corresponding *Y. pseudotuberculosis* infection. Its epidemiology remains obscure.

INTRODUCTION

The term pseudotuberculosis has sometimes led to confusion because of its use in veterinary pathology to describe not only the lesions due to *Yersinia pseudotuberculosis* (syn. *Pasteurella pseudotuberculosis)* but also to those caused in sheep by *Corynebacterium pseudotuberculosis ovis,* in cattle by *Mycobacterium paratuberculosis* and in mice by *Corynebacterium murium.* With the introduction of the new genus Yersinia which includes *Y. pseudotuberculosis* and *Y. enterocolitica,* both producing similar lesions, the designation yersiniosis is to be preferred to the older name pseudotuberculosis.

Y.pseudotuberculosis is found in a wide variety of animals. The disease has been recorded in farm animals and domestic pets (cattle, horse, sheep, goat, pig, cat, dog, guinea-pig, hamster and rabbit), in commercially - reared fur - bearers (chinchilla, mink and coypu), in wild mammals (hare, rat, mouse, fox, vole, deer, marmot, beaver, hedgehog etc.), and in mammals in zoological gardens (monkey, puma, kangaroo, agouti etc.). Epizootics have been reported in sheep and wild fur-bearers.

Infection is widespread in domestic and wild birds. Serious epizootics have been reported periodically in turkeys, ducks, feral wood pigeons, stock doves, and in aviaries of canaries and finches. Sporadic infection has been recorded in more than 50 species.

Cold-blooded vertebrates are rarely infected. Only three cases (a python and two Greek tortoises in zoological gardens) have been reported.

Infection with *Y. enterocolitica* has been observed mainly in mammals. Outbreaks have been reported in hares, chinchillas and captive monkeys, and sporadic infection in dogs, pigs, sheep, guinea-pigs, rabbits and cattle.

Human and animal infection with *Y. pseudotuberculosis* is essentially of European origin. The disease is rarely reported in the Mediterranean littoral. No human or animal case has been reported from Spain, and in neighbouring Portugal the infection has been found only in imported guinea-pigs and monkeys. In Italy, as in Greece, only one human case has been recorded. The disease is unknown in the Near- and Middle-East. With the exception of Algeria and Morocco, the African

[1] Paper presented at the Second International Conference on Wildlife Diseases, University of Sussex, England, 1971.

continent appears to be free of infection. *Y. pseudotuberculosis* has never been isolated in south-east Asia, and India can claim only one human case, in 1952. In recent years infection has been observed in Japan, Australia and New Zealand.[10]

In North America sporadic isolations from domestic and wild animals have been reported[9] and human cases have been recognized in California, Washington, New York, Louisiana and Alberta.[8,10]

An interesting hypothesis[19] has been put forward to explain the European origin of the disease. It has been observed that the limits of yersiniosis in Europe coincide, more or less, with the boundaries reached by plague during the second pandemic. Since acquired resistance to infection with *Y. pseudotuberculosis* is known to protect against plague, it is suggested that the emergence of the enzootic of *Y. pseudotuberculosis* (possibly as a variant of *Y. pestis)* may have contributed to the extinction of the pandemic, and further, its subsequent establishment as an endemic disease may have prevented the implantation of plague in Europe during the third, and last, pandemic. The appearance of *Y. pseudotuberculosis* in other parts of the world is attributed to the importation of infected animals from Europe.

Y. enterocolitica has a wider geographical distribution than *Y. pseudotuberculosis.* It is found not only in Europe but also in North and South America, the Congo and South Africa. The highest concentration of human and animal cases has been found in France, Belgium, Sweden and Finland.

In this account yersinia infections of British free-living wild mammals and birds are described, and their epidemiology and effect on the animal and human population are discussed.

YERSINIOSIS IN BRITAIN

Since 1961, strains of *Y. pseudotuberculosis* have been submitted to the Leicester public health laboratory for confirmation and serologic typing. Between January 1961 and June 1971, 321 strains of animal origin were received from veterinary investigation centers and zoological gardens. During the same period 160 human infections were diagnosed at the laboratory from clinical material, mainly sera, submitted by public health and hospital laboratories. Of the 321 strains of animal origin representing 72 different species, 101 were isolated from wild animals living in captivity, 79 from farm animals and domestic pets, 73 from experimental animals, and 68 from free-living wild animals. Of the latter, 28 strains were isolated from six species of mammals, and 40 strains from 21 species of birds. The sources of the strains isolated from free-living wild animals are shown in Table 1.

Up to the present, strains of *Y. enterocolitica* have been isolated from the pig, the dog and the bush-baby in this country, but none from free-living wild animals.

YERSINIOSIS IN FREE-LIVING WILD MAMMALS

Acute yersiniosis takes the form of a fulminating septicaemia, death resulting in one to three days with intestinal congestion the only lesion. In the subacute and chronic forms, the disease is characterized by loss of weight over a period of days or weeks, increasing listlessness, severe diarrhea, respiratory distress, muscular weakness and incoordination.

Hares

Of wild animals, hares are probably most liable to yersiniosis. In France and Germany *Y. pseudotuberculosis* accounts for more leporine deaths than any other bacterial cause, having been isolated from as high as 60 per cent in some areas. In 1937, when a few cases of tularemia were reported in some European countries, large numbers of carcasses of wild animals were examined in Britain and a high percentage of hares were found to be infected with *Y. pseudotuberculosis.*[11] Sporadic infection has been reported in the brown hare, *Lepus europaeus*[3,18] and in the Scottish blue or mountain hare, *Lepus timidus scoticus.*[14]

Hares appear to be equally susceptible to *Y. enterocolitica* infection. In a recent survey conducted in Belgium, 14 per cent of hares were found to be carriers.[7]

TABLE 1. Isolations of **Y. pseudotuberculosis** from free-living wild animals in Britain 1961-1971.

Mammals	No. of isolations
Coypu *(Myocastor coypus)*	8
Brown Hare *(Lepus europaeus)*	7
Mouse *(Mus musculus)*	6
Rabbit *(Oryctolagus cuniculus)*	5
Fox *(Vulpes vulpes)*	1
Field Vole *(Microtis agrestis)*	1
Birds	
Blackbird *(Turdus merula)*	1
Eider *(Somateria mollisima)*	1
Fieldfare *(Turdus pilaris)*	1
Great Tit *(Parus major)*	1
Greenfinch *(Chloris chloris)*	4
Green Woodpecker *(Picus viridis)*	1
Hedge Sparrow *(Prunella modularis)*	1
Hoopoe *(Upupa epops)*	1
House Martin *(Delichon urbica)*	5
Magpie *(Pica pica)*	1
Oystercatcher *(Haematopus ostralagus)*	1
Partridge *(Perdix perdix)*	3
Pheasant *(Phasianus colchicus)*	2
Pied Wagtail *(Motacilla alba)*	1
Redwing *(Turdus musicus)*	1
Swallow *(Hirundo rustica)*	1
Swift *(Apus apus)*	1
Stock Dove *(Columba oenas)*	1
Tree Sparrow *(Passer montanus)*	1
Wood Pigeon *(Columba palumbus)*	10
Wren *(Troglodytes troglodytes)*	1
	68

Coypus

Continental workers have reported yersiniosis mainly in farm-bred coypus.[5,20,23,25] In Britain, the Coypu Centre at Norwich recorded an incidence of 1 per cent in 3,000 coypus live-trapped or otherwise caught and killed in Norfolk and Suffolk over a 6-year period.[2]

Foxes

There are few reports of yersiniosis in wild foxes. Only one other case has been recorded in Britain.[1] The fox reported here was one of many found dead near the Scottish border in Northumberland. At first it was thought that the animal had been the victim of a toxic pesticide

[2] NEWSON, R. M. 1964. Personal communication. (Cited by MAIR, N. S. Pseudotuberculosis in Free-living Wild Animals in Diseases in Free-living Wild Animals. Symposia of the Zoological Society of London. Number 24. Academic Press, London, 1969.)

but at autopsy necrotic nodules, from which *Y. pseudotuberculosis* was isolated, were found in all the viscera.

Rabbits

The literature contains few reports of infection in wild rabbits.

Other free-living mammals

On the Continent the disease has also been observed in roe-deer *(Capreolus capreolus)*, mink *(Mustela lutreola)*, marten *(Martes martes)*, mole *(Talpa europaea)*, hedgehog *(Erinaceus europaeus)* and marmot *(Marmota marmota)*. In North America the organism has been isolated from the muskrat *(Ondatra zibethica)* and beaver *(Castor canadensis)*,[12] and from the black-tailed jack rabbit *(Lepus californicus)*, white-tailed antelope squirrel *(Citellus lecurus)*, and eastern cottontail *(Sylvilagus floridanus)*.[9]

YERSINIOSIS IN WILD BIRDS

Yersiniosis is of much greater importance in birds than in mammals. The disease is usually fatal in birds and often takes a percute course with catarrhal or nodular lesions of the duodenum. The acute and subacute forms of the disease are characterized by diarrhea and lameness or stiffness of gait.

Besides the species recorded here, other British wild birds in which the disease has been reported include the coot *(Fulica atra)*, chough *(Pyrrhocorax pyrrhocorax)*, goldfinch *(Carduelis carduelis)*, jackdaw *(Corvus monedula)*, pied flycatcher *(Muscipapa hypoleuca)*, puffin *(Fratercula arctica)*, rook *(Corvuns frugilegus)*, starling *(Sturnus vulgaris)*, skylark *(Alauda arvensis)*, sparrowhawk *(Accipiter nisus)*, song thrush *(Turdus ericetorum)*, swallow *(Hirundo rustica)* and willow warbler *(Phylloscopus trochilis)*.[14,15]

Other wild birds

On the Continent the disease has also been reported in the owl *(Strix aluca)* and swan *(Cygnus olor)*, and in the United States in common grackles *(Quiscalus quiscula)*.[4]

RESERVOIRS OF YERSINIOSIS

The principal reservoirs of *Y. pseudotuberculosis* are rodents and birds. Rats and mice are resistant to experimental and natural disease, and for this reason play an important epidemiologic role in the spread of infection. Observers in the Soviet Union have noted the absence of lesions in rats and mice from which the organism has been isolated. These findings in nature have been confirmed by experimental results: administration *per os* of a culture of *Y. pseudotuberculosis* to the rat or mouse does not produce any visible lesions but results in excretion of the organism in the feces and urine over a period of several weeks. Hares, common voles *(Microtus arvalis)* and water voles *(Arvicola terrestis)* also are known to serve as reservoirs. In fact, almost all susceptible animals may become carriers of *Y. pseudotuberculosis*. Latent infection may become manifest under conditions of stress, such as exist in the winter months when animals, particularly free-living species, are exposed to cold and starvation. The seasonal influence on the occurrence of the disease is shown in Table 2. Of 239 cases of yersiniosis in animals, 153 (64 per cent) occurred in the period December to March, the coldest months of the year in Britain.

TRANSMISSION TO OTHER ANIMALS

Wood pigeons, which are often grossly affected, have been known to introduce *Y. pseudotuberculosis* repeatedly into guinea-pig colonies by way of the animals' greenfood. The pigeons void huge numbers of viable organisms in their excreta as they feed on green crops such as kale, cabbage and brussel sprouts, which may become heavily contaminated. In cold weather the organisms survive in the fecal deposits on plants for several days.[21]

It is probable that contaminated feeds are also a source of infection for farm animals and that much of the disease in animals in zoological gardens is caused by pollution of food stores and food and water containers by rodents and birds. In a recent study at the Bristol Zoo, six out of fourteen mice trapped in a bird house,

TABLE 2. Monthly distribution of yersiniosis in man and other animals in Britain 1961-1971.

	Man	Other Animals
January	34	51 (16)
February	11	41 (12)
March	20	40 (8)
April	25	18 (3)
May	12	15 (6)
June	3	6 (1)
July	6	13 (6)
August	5	4 (0)
September	5	7 (0)
October	8	7 (0)
November	10	16 (6)
December	7	21 (4)
	146	239 (62)

Free-living animals in parenthesis

which had suffered heavy losses from yersiniosis, were found to be carriers of *Y. pseudotuberculosis.*

Predators such as domestic cats are infected directly by rodents and birds, and may thus constitute an important link between the natural reservoir and man.[17]

The role of insect vectors remains uncertain. It has been shown that the rat flea *(Xenopsylla cheopis)* remains a carrier of *Y. pseudotuberculosis* for up to 35 days after feeding on an infected guinea-pig but without the capability of transmitting the infection to a susceptible guinea-pig.[2] *Y. pseudotuberculosis* has also been isolated from ixodid ticks collected from cows in the outskirts of Leningrad.[21] It has been suggested that insectivorous birds and mammals may acquire the disease from insects which have fed on the droppings of infected rodents and birds.

TRANSMISSION TO MAN

Yersiniosis runs a different course in man as compared to animals. In contrast to the generalized fatal disease in animals, human yersiniosis is localized, as a rule, to the mesenteric lymph nodes and usually runs a benign course. Clinically, the disease mimics acute appendicitis, but when the terminal ileum and cecum are involved also, the condition may be mistaken for regional ileitis or malignant disease. Other manifestations include erythema nodosum, arthritis, septicaemia and enterocolitis, the latter being the most predominant form of *Y. entercolitica* infection.

It is probable, but by no means certain, that infection with *Y. pseudotuberculosis* is acquired by direct or indirect contact with animals. The role of animals as a source of human infection is suggested by the following observations. Human and animal strains of *Y. pseudotuberculosis* have the same cultural, biochemical and pathogenic characteristics. The majority of animal strains belong to serologic type I, the type most prevalent in Europe, and found most frequently in man.[16] Both the animal and human disease reach their peak about the same time of the year (see Table 2). In some rural areas where there is a high incidence of animal infection there is a correspondingly high incidence in humans. Many patients both in urban

and rural areas provide a history of contact with animals.

Numerous reports have been published in which human infection has followed the death of a family pet such as a hamster, guinea-pig, rabbit or cat, but the organism has rarely been isolated from the animal probably because of the long interval between the death of the animal and the onset of the patient's symptoms.

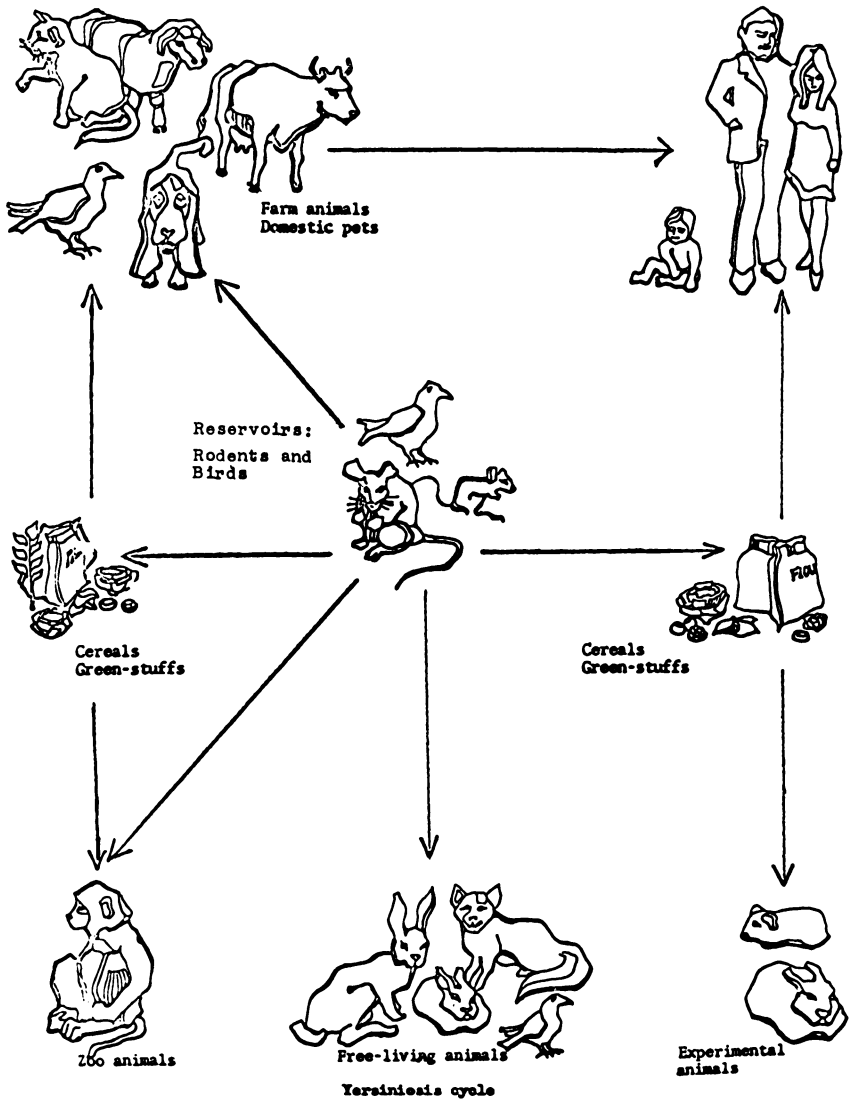

FIG. 1. Yersiniosis cycle illustrating transmission of disease from natural reservoirs to man and other animals.

Paul and Weltmann[22] reported the case of a labourer who died of *Y. pseudotuberculosis* septicemia eight days after working in a garden where the soil had been fouled by the excreta of a cat suffering from diarrhea. The cat was later killed and necropsy revealed signs of enteritis and nodules in the liver and spleen from which the same strain of *Y. pseudotuberculosis* was isolated. Daniels[9] isolated *Y. pseudotuberculosis* type I from the feces of a 25-year-old man suffering from acute mesenteric lymphadenitis and from the excreta of his pet canary.

Further evidence has been provided by numerous observations in which antibodies have been found in animals in close proximity to the patient. High agglutinin titres have been recorded in cows, cats, dogs and rabbits. Macaulay *et al.*[13] demonstrated agglutinins to the infecting organism in the serum of a dog belonging to a man who had died of yersinious septicaemia. The dog had bitten the patient some days before the onset of his illness.

The suggested mode of spread of *Y. pseudotuberculosis* from animal reservoirs to other animals and man is illustrated in the figure.

The epidemiology of *Y. enterocolitica* infections remains obscure. Healthy carriers have been detected in the cat, cow, dog, hare and pig; similar serologic types have been demonstrated in pigs and humans, but it has not been possible to establish a link between the disease in animals and the disease in man.

PREVENTION AND CONTROL

No effective preventive measures are known. The application of normal hygienic measures to prevent food-borne infection and the recognition that domestic pets constitute a hazard, particularly to young children, may go some way towards diminishing the incidence of yersiniosis. A measure of protection may be provided by the systematic eradication of rats and mice, and the prevention of access to food supplies by rodents and birds.

Infection may be introduced into hitherto yersiniosis-free areas and countries by the importation of animals for restocking hunting reserves, for breeding purposes, and for laboratory experiments. The need for surveillance is obvious, but this may be rendered ineffective by the presence of latent infection in apparently healthy animals.

Many aspects of the pathology and epidemiology remain to be determined. It is clear that infection is much more widespread than the literature indicates, and that it should be looked for in man and other animals where it is still unknown. This calls for an interdisciplinary approach involving laboratory workers, physicians, sanitarians, epidemiologists, veterinarians and members of wildlife services.

Acknowledgements

The author wishes to thank Miss C. M. Ansell for permission to publish details of the *Y. pseudotuberculosis* isolations at the Bristol Zoo.

LITERATURE CITED

1. BLACKMORE, D. K. 1964. A survey of diseases in British wild foxes *(Vulpes vulpes)*. Vet. Rec. 76: 527-533.
2. BLANC, G., and M. BALTAZARD. 1944. Contribution à l'étude du comportement des microbes pathogènes chez les insects hématophages: la mémoire. Archs. Inst. Pasteur Maroc. 3: 21-49.
3. CLAPHAM, P. A. 1953. Pseudotuberculosis among stock-doves in Hampshire. Nature, Lond. 172: 353.
4. CLARK, G. M., and L. N. LOCKE. 1962. Observations on pseudotuberculosis in common grackles. Avian Dis. 6: 506-510.

5. CLAUSSEN, L. 1934. Uber Bakteriämie durch das Bacterium pseudotuberculosis rodentium bei der Biberatte. Dtsch. tierärztl. Wschr. 42: 243-247.
6. DANIELS, J. J. H. M. 1961. Enteral infection with *Pasteurella pseudotuberculosis*. Isolation of the organism from human faeces. Brit. med. J. 2: 997-998.
7. DUBOIS, P., L. FIEVEZ, and A. GRANVILLE. 1971. Le lièvre, porteur asymptomatique de *Yersinia enterocolitica*. Méd. et Mal. infect. 1: 227-228.
8. HNATKO, S. I., and A. E. RODIN. 1963. *Pasteurella pseudotuberculosis* infection in Man. Canad. Med. Ass. J. 88: 1108-1112.
9. HUBBERT, W. T. 1972. Yersiniosis in mammals and birds in the United States: Case reports and review. Amer. J. Trop. Med. Hyg. 21: 458-463.
10. HUBBERT, W. T., C. W. PETENYI, L. A. GLASGOW, C. T. UYEDA, and C. W. CREIGHTON. 1971. *Yersinia pseudotuberculosis* infection in the United States, Septicaemia, Appendicitis and Mesenteric Lymphadenitis. Amer. J. Trop. Med. Hyg. 20: 679-684.
11. JAMIESON, S., and M. A. SOLTYS. 1947. Infectious Epididymo-orchitis of Rams Associated with Pasteurella pseudotuberculosis. Vet. Rec. 59: 351-353.
12. LANGFORD, E. V. 1972. *Pasteurella pseudotuberculosis* infections in Western Canada. Can. vet. J. 13: 85-87.
13. MACAULAY, J. D., J. A. C. WILSON, J D. ABBOT, and N. S. MAIR. 1967. Fatal case of *Pasteurella pseudotuberculosis* infection associated with hepatic cirrhosis. Brit. med. J. 2: 553-554.
14. MACDONALD, J. W. 1962. Mortality in wild birds with some observations on bird weights. Bird Study. 9: 147-167.
15. MACDONALD, J. W. 1965. Mortality in wild birds. Bird Study. 12: 181-195.
16. MAIR, N. S. 1965. Sources and serological classification of 177 strains of *Pasteurella pseudotuberculosis* isolated in Great Britain. J. Path. Bact. 90: 275-278.
17. MAIR, N. S., J. F. HARBOURNE, M. T. GREENWOOD, and G. WHITE. 1967. *Pasteurella pseudotuberculosis* infection in the Cat: two cases. Vet. Rec. 81: 461-462.
18. McDIARMID, A. 1962. Diseases of free-living wild animals. F.A.O. agric. stud. No. 57.
19. MOLLARET, H. H. 1967. L'infection à bacille de Malassez et Vignal. W.H.O./ Zoon/67, 99.
20. OUDAR, J., and L. JOUBERT. 1961. Trois nouveaux cas de pseudotuberculose à "Cillopasteurella pseudotuberculosis" chez le ragondin *(Myocastor coypus Molina)*. Bull. Soc. Sci. vet. Lyon. 63: 313-318.
21. PATERSON, J. S., and R. COOK. 1963. A method for the recovery of *Pasteurella pseudotuberculosis* from faeces. J. Path. Bact. 85: 241-242.
22. PAUL, O., and O. WELTMANN. 1934. Pseudotuberkulose beim Menschen. Wien. klin. Wschr. 1934: 603-604.
23. PILET, C., L. VALETTE, C. LABIE, and M. FONTAINE. 1958. Pseudotuberculose dans un élevage de Myocastors. Bull. Acad. vet. Fr. 31: 299-303.
24. UL'YANOVA, N. I. 1961. The natural focal occurrence of pseudotuberculosis. J. Microbiol. Epidem. Immunobiol. 32: 2268-2273. (Translated from Russian.)
25. ZSCHOKKE, W., and E. SAXER. 1932. Beobachtungen bei Pelztierkrankungen Ein Fall von Pseudotuberkulose beim Sumfbiber (Nutria). Schweizer Arch. Tierheilk. 74: 446-450.

Received for publication April 27, 1972