

THE DISTRIBUTION OF SOME PLAGUE-IMPORTANT RODENTS AND FLEAS IN WESTERN CANADA

(Mammalia: Rodentia, and Insecta: Siphonaptera)¹

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FOREWORD.—In 1938, surveys of some of the commoner species of rodents occurring in British Columbia and Alberta were initiated, with a view to determining whether sylvatic (=bubonic) plague had become introduced to those two provinces. Gibbons (1939) stated: "Most of the observers are of the opinion that the west coast of North America became infected in the course of the plague pandemic of 1894 which originated in Hong Kong and reached America at least by 1900. Wild rodents probably became infected through contact with domestic rats and the infection spread until it is now present in nine of the western states, including Washington, Idaho and Montana, which border on the provinces of British Columbia and Alberta. The history of the progress of the infection northward and eastward through the western sections of the United States forces us to consider that the infection may have extended to Canada, or if not, may be expected to do so within the next few years."

Accordingly, surveys were organized by the Health Departments of these two western provinces, under the direction and advice of the Dominion Department of Pensions and National Health and the Livestock Insect Laboratory, of the Division of Entomology, at Kamloops, B.C. During the first season (1938), tissue and flea specimens were tested at the George Williams Hooper Foundation in San Francisco. In 1939, and subsequently, the tests were conducted at the newly constructed Laboratory of Hygiene at Kamloops.

In 1938 the attention of the Alberta crew was drawn to the case of a mink farmer of Stanmore, Alberta, who had died the previous year of an acute septic-

aemia resulting from an injury to his finger incurred while skinning a mink. This mink, with a number of others, had died following the use of ground squirrels (*Citellus r. richardsonii* (Sabine)) from a nearby area, as food. In 1939, *Pasteurella pestis* was demonstrated in ground squirrels and their fleas, from this particular locality, and the infection was found to be present over at least four townships, embracing an area of 144 square miles (Gibbons and Humphreys, 1941).

In 1941, plague was demonstrated in *Citellus r. richardsonii* in Divide County, North Dakota (Public Health Reports, 1942) immediately south of the Saskatchewan border. In 1942, a survey of southern Saskatchewan, based on the system used in British Columbia and Alberta, was instituted by the Health Department of that province and carried out under the supervision of the writer.

In 1943, the Royal Canadian Army Medical Corps conducted an investigation of the ground squirrels and rats occurring in the vicinity of military camps in the provinces of Alberta, Saskatchewan and Manitoba.

As a result of all these surveys, considerable data have been accumulated on the distribution of important rodents and fleas and form the subject matter of the present paper.

GENERAL CONSIDERATIONS.—Western Canada has been, and is, exposed to two principal avenues whereby plague might be introduced: (1) through the spreading of the disease from infected ground squirrel or other native rodent colonies in the adjoining states of Washington, Idaho, Montana and North Dakota, where it is known to be established (as has already occurred in Alberta), and (2) through the introduction of plague-infected rats, conveyed by shipboard from foreign lands

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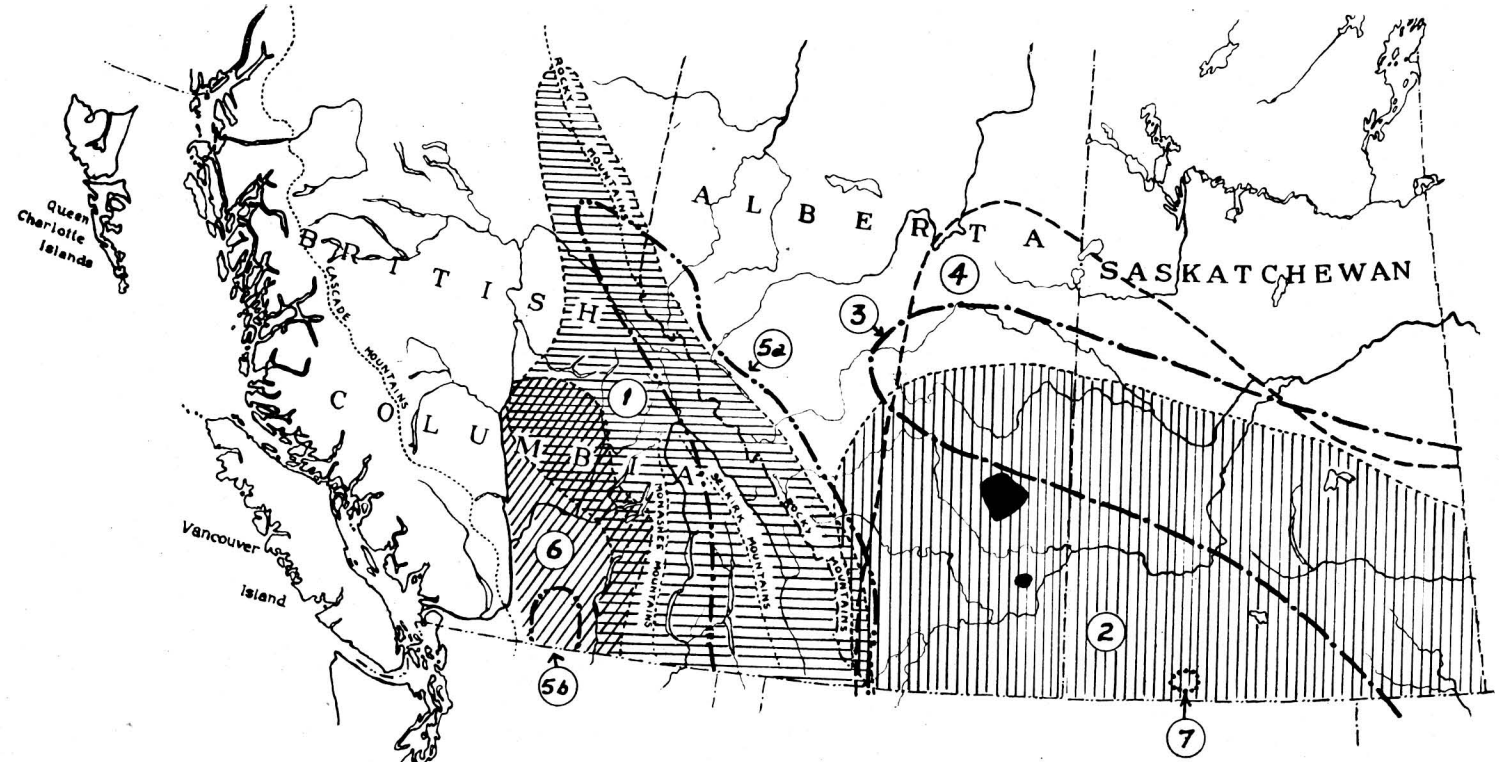











Fig. 1.—HOLLAND

The approximate distribution of some native rodents in Western Canada. (Rodent distribution partly from Howell (1938) and partly from records at the Kamloops Laboratory. Plague areas from literature references: Brown and Roy 1943; Gibbons and Humphreys 1941; Public Health Reports 1943).

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|---|--------------------------------|---|-----------------------------|---|---------------------------------------|
|  | <i>Citellus c. columbianus</i> |  | <i>C. 13-l. 13-lineatus</i> |  | <i>Marmota f. avara</i> |
|  | <i>C. r. richardsonii</i> |  | <i>C. lateralis tesorum</i> |  | <i>Cynomys l. ludovic.</i> |
|  | <i>C. franklinii</i> |  | <i>C. saturatus</i> |  | Known Plague infected areas (approx.) |

to our Pacific seaports, all of which are heavily infested with rats, the natural carriers of plague.

Also to be considered is the possibility of infected rats being brought north by train from such cities as San Francisco, Tacoma and Seattle, where plague has been recorded in these rodents. Again, there is the possibility of the disease spreading from infected prairie ground squirrels to the rat populations in certain southern towns and cities.

However, the present article is concerned primarily with the distribution of the potential carriers and vectors of plague, as revealed by the results of the surveys of British Columbia, Alberta and Saskatchewan. Not sufficient data are available, as yet, for a detailed account of the situation in Manitoba.

While a fair number of rodents of both native and introduced species have been incriminated with regard to plague transmission in the United States, investigations in Canada have been restricted to comparatively few forms, such mammals as the tree squirrels (*Tamiasciurus* spp.), flying squirrels (*Glaucomys* spp.) woodrats (*Neotoma* spp.) and mice (*Peromyscus*, *Microtus*, *Mus*, etc.) being ignored, or collected only as opportunity offered. However, much attention was given to ground squirrels of several species (particularly two), introduced European and Asiatic rats, and, to a much lesser extent, marmots, prairie dogs and chipmunks.

Distribution of the Rodents

A. INDIGENOUS SPECIES.—Fig. 1.

(1) Columbian ground squirrel, *Citellus columbianus columbianus* (Ord).

The range of the Columbian ground squirrel covers a large area in southeastern British Columbia, and fringes the southwest boundary of Alberta. It is, in fact, rather closely confined to the Rocky, Selkirk and Monashee mountain systems, with their related foothills and valleys. Habitat types vary from open fields in the bottomlands to alpine meadows at 7,000 to 8,000 feet altitude. According to local reports it is only in comparatively recent years that

these ground squirrels have been seen in any numbers west of the North Thompson River. They occur now as far west as Lac la Hache and 150 Mile House along the Cariboo Highway, and are very common in the Horsefly Lake region. In the Columbia and Kootenay valleys they frequently occur in large colonies, and in some areas constitute a serious agricultural menace.

Southward, these rodents extend into Washington, Oregon, Idaho and Montana. Eskey and Haas (1940) reported plague in this species, from tissue samples and fleas collected at Wallowa Country, Oregon.

(2) Richardson ground squirrel, *Citellus richardsonii richardsonii* (Sabine).

This mammal, locally known as the "prairie gopher" is the commonest and most conspicuous rodent of the great plains of Alberta, Saskatchewan and Manitoba. Aside from its potentialities as a disease carrier, its depredations to crops and interference with irrigation combine to make it an economic problem of prime importance. Its distribution, and the areas where plague infection has been demonstrated are shown on Plate 1.

In the United States, plague has been shown in this rodent in Beaverhead County, Montana (Eskey and Haas) and Divide County, North Dakota (Public Health Reports, 1942). The status of this mammal in Canada has recently been treated by Brown and Roy (1943).

(3) Franklin ground squirrel, *Citellus franklinii* (Sabine).

This rodent, sometimes known as the "gray gopher," "brush gopher" or "bushy-tail" is widespread across the prairie provinces, but is chiefly confined to the lightly treed areas, rather than on the open plains. In the United States, it is found in North and South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Illinois and Indiana.

Very few specimens of this mammal have been collected by the Canadian survey crews, principally because plague investigations have been conducted chiefly in the

extreme south of the prairie, while the Franklin ground squirrel is more abundant farther north.

(4) Thirteen-lined ground squirrel, *Citellus tridecemlineatus tridecemlineatus* (Mitchill).

This ground squirrel, usually known locally as the "striped gopher," is much more widespread in the prairie provinces than *C. r. richardsonii*, but in the areas covered by the survey crews, has not proved to be common. Only a few specimens have been collected, in scattered localities, in Alberta and Saskatchewan. *C. t. tridecemlineatus* and related subspecies occur all through the central United States.

(5) Mantled ground squirrels, *Citellus (Callospermophilus)* spp.

Plague has been demonstrated in ground squirrels of the subgenus *Callospermophilus* in several counties of California (Eskey and Haas). Flea species present were *Diamanus montanus* (Baker), *Oropsylla idahoensis* (Baker) and *Monopsyllus eumolpi* (Rothschild), the last two of which occur commonly in Western Canada on a number of hosts.

The dusky mantled ground squirrel, *Citellus saturatus* (Rhoads) is found in the east Cascades, in the extreme south of British Columbia. Hollister's mantled ground squirrel, *C. lateralis tescorum* (Hollister) is found in the Rocky and Selkirk mountain regions. Neither species has been collected in any great numbers by the survey crews.

(6) Pallid yellow-bellied marmot, *Marmota flaviventris avara* (Bangs).

The yellow-bellied marmots or "groundhogs" are confined chiefly to the "Interior Dry Belt" of British Columbia, in some localities of which they may occur in considerable numbers, especially if large rock piles are available for protection. *M. f. avara* is found in the Fraser Valley as far south as Hope, and extends to the north as far as Williams Lake. It ranges southward through the Okanagan Valley into Washington, Oregon and northern Nevada. Related subspecies are found in

all the western and Pacific States, with the possible exception of Arizona. Fair numbers of *M. f. avara* have been collected by the British Columbia survey crews, and also a few individuals of *M. caligata* ssp., the hoary marmot, in areas at high altitude.

Plague has been demonstrated in marmots (probably *M. flaviventris nosophora* Howell) in Montana and Wyoming (Eskey and Haas).

(7) Black-tailed prairie-dog, *Cynomys ludovicianus ludovicianus* (Ord).

Prairie-dogs are known from one locality in Canada, in a coulee bottom, thirteen miles southeast of Val Marie, in southern Saskatchewan, where a single large colony exists. The Saskatchewan survey crew has collected a number of these mammals.

In the United States, plague has been demonstrated in *Cynomys parvidens* Allen (Garfield County, Utah), *C. leucurus* Merriam (Uinta County, Wyo.) and *C. gunnisoni zuniensis* Hollister in New Mexico and Arizona (Eskey and Haas).

(8) Chipmunks, *Eutamias* spp.

Chipmunks of many species and subspecies occur in Western Canada. A small number (mostly *E. amoenus affinis* (Allen), and *E. amoenus luteiventris* (Allen)) were collected by the British Columbia crew. While these rodents occur in Alberta and Saskatchewan (mostly *E. minimus borealis* (Allen)), very few were collected due to the fact that they occur principally in the lightly treed areas, whereas the bulk of the survey work was carried out on the open prairie.

Plague was recovered from *Eutamias* spp. in various localities in California and Nevada (Eskey and Haas).

B. INTRODUCED SPECIES.

(9) Norway rat, *Rattus norvegicus* (Erxleben).

The Norway rat, house rat or sewer rat, a native of the Old World, was introduced to North America in the middle of the 18th Century. Since that time, the original stock has multiplied and spread, and also there have been successive in-

vations of seaport towns of rats from poorly tended vessels docking there. This undesirable rodent has followed man to nearly all corners of the globe and, once established in any locality, is very difficult to eradicate. Plague is a natural disease of this and related species, and the fleas of rats are ideally adapted to the dissemination of this disease, partly because of their peculiar physiology, which renders them readily infective, and partly because of their readiness to bite man. These facts, coupled with the rats' tendencies to become established around domestic households, make the rat and rat flea situation a public health menace of grave concern.

In Western Canada, rats are localized to a certain extent. Apparently they occur in most, if not all, seaport towns from Vancouver to Prince Rupert, as well as on Vancouver, Queen Charlotte, and doubtless other islands. They are found commonly in the lower Fraser Valley, around Chilliwack, Hope, Harrison Bay, Agassiz, etc.

They occur in garbage dumps, warehouses, waterfront docks, in lanes in the residential areas where they feed on garden refuse and garbage from poorly tended tins, around stables, restaurants, abattoirs, in houses, grain elevators, and in fact, any place where an easy living may be obtained.

In the Interior of British Columbia they seem to be rare, and this apparently holds good for most of Alberta also, although we have records from Calgary.

Southern Manitoba is apparently well populated, and Saskatchewan, while virtually free of rats a few decades ago, now shows a steady increase in numbers of these rodents, and a very definite spreading westwards and northwards. The Sanitation Division of the Provincial Health Department has prepared an interesting map, showing the influx and advances of rats, year by year.

Southern cities, such as Regina and Moose Jaw, are now heavily infested, as also is Saskatoon. In Estevan, rats and Richardson ground squirrels were noted in large numbers in the same garbage

dump, and this only ten miles or less from the plague focus in North Dakota! Furthermore, ground squirrel fleas (*Oropsylla rupestris* (Jordan)) were recovered from the rats. Here then is the ideal opportunity for the rats to pick up the infection from the ground squirrels!

(10) Black rat, *Rattus rattus rattus* (Linnaeus).

The black rat, a smaller and longer-tailed species is comparatively rare in this country, only a few specimens having been collected, and these usually in waterfront warehouses at the coast. It apparently has to give way before the more powerful Norway rat. They both carry the same species of fleas, but *R. r. rattus* is not now common enough to constitute a serious problem.

(11) Roof rat, *Rattus rattus alexandrinus* (Geoffroy).

This rodent, like the black rat, is comparatively rare, and known only from the coast areas.

Distribution of the Fleas

These rodents have been found to be infested with a wide variety of fleas of which fifteen species were fairly common to very common, and which are of varying importance as potential plague vectors. Their relationship to the rodent hosts is summarized in Table I.

A. INDIGENOUS SPECIES.

(1) *Monopsyllus eumolpi* (Rothschild).

M. eumolpi is a common and regular parasite of western chipmunks (genus *Eutamias*) and is found wherever these mammals occur. In British Columbia it is quite frequently collected on the Columbian ground squirrel when habitat association offers the opportunity. It has been proved to transmit plague experimentally in the laboratory (Eskey and Haas). We have several records of this insect biting man.

TABLE I
Species of Fleas Found, and Relationship to Rodent Hosts

	Hosts								
	Rattus spp.	Citellus c. columbianus	Citellus r. richardsonii	Citellus franklinii	Citellus 13-lineatus	Callospermophilus spp.	Marmota flaviventris avara	Cynomys l. ludovicianus	Eutamias spp.
Indigenous Species									
1. <i>Monopsyllus eumolpi</i> . . .		*							†
2. <i>Neopsylla inopina</i>		†			*				
3. <i>Opisocrostis bruneri</i> . . .			*	†	*				
4. <i>Opisocrostis labis</i>			†	*				*	
5. <i>Opiso. t. tuberculatus</i> . . .		†	†	*	*				
6. <i>Oropsylla idahoensis</i> . . .		†				†			
7. <i>Oropsylla rupestris</i> *			†	*?	*?			*	
8. <i>Rectofrontia fraterna</i> . . .			†	*	*				
9. <i>Thrassis acamantis</i> *							†		
10. <i>Thrassis bacchi</i>			*	*	†				
11. <i>Thrassis petiolatus</i>		†							
Introduced Species									
12. <i>Ctenocephalides canis</i> . . . *									
13. <i>Ctenocephalides felis</i> . . . *									
14. <i>Nosopsyllus fasciatus</i> . . . †									
15. <i>Xenopsylla cheopis</i> †									

† True or typical parasites of the host concerned.

* Frequent records, but relationship due to habitat association.

(2) *Neopsylla inopina* (Rothschild).

N. inopina is a true ground squirrel flea and as it is blind it may be chiefly confined to the nests and burrows of the host. It is common on *Citellus r. richardsonii* in Alberta and Saskatchewan, and occurs on *C. c. columbianus* in the extreme southeast of British Columbia. It has not been demonstrated to be a potential plague vector—nor has it been recorded infesting man's person.

(3) *Opisocrostis bruneri* (Baker).

This flea, recently demonstrated to be an efficient plague carrier (Prince, 1943) also occurs on ground squirrels. While sometimes taken on *Citellus richardsonii* and *Citellus 13-lineatus*, it is more usually found on the Franklin ground squirrel.

(4) *Opisocrostis labis* (Jordan and Rothschild).

O. labis is a true parasite of *C. richardsonii* and is widespread and common on the Canadian prairie. It has been shown to transmit plague (Eskey and Haas). This

species does not occur on British Columbia ground squirrels.

(5) *Opisocrostis t. tuberculatus* (Baker).

This, like the above species occurs on the ground squirrels of Alberta and Saskatchewan, and is capable of transmitting plague (Eskey and Haas). It is found also on *C. c. columbianus* in the Kootenay district of British Columbia.

(6) *Oropsylla idahoensis* (Baker).

This species is very common on the Mantled ground squirrel (*Callospermophilus*) and also is one of the two common and regular siphonapterous parasites of *Citellus c. columbianus*. In Canada it seems confined to British Columbia and the foothills of Alberta. According to the experiments of Eskey and Haas (1940), it seems resistant to plague infection.

(7) *Oropsylla rupestris* (Jordan).

This is the commonest flea of *Citellus r. richardsonii*, and its range is probably coincident with the distribution of that rodent. It has been taken on rats (R.

norvegicus) where the two rodent hosts are in contact (as in southern Saskatchewan). As it is capable of transmitting plague (Eskey and Haas) it is probably one of the most potentially dangerous of our native fleas, as it offers the possibility of this disease spreading from the native ground squirrels back to the rat population of the southern prairie. Although we have no records, it almost certainly occurs also on the Franklin and 13-lined ground squirrels where the ranges of these mammals overlap that of the Richardson ground squirrel.

(8) *Rectofrontia fraterna* (Baker).

R. fraterna is a small blind flea that occurs on fair numbers on ground squirrels and other rodents east of the Rockies. Like *N. inopina* it may be chiefly a nest flea, and like that species it has not been incriminated with disease transmission. It also occurs (rarely) in British Columbia, on a variety of hosts.

(9) *Thrassis acamantis* (Rothschild).

While on rare occasions this species is taken on other hosts, it is an extremely common parasite of the yellow-bellied marmot (*M. flaviventris avara*) and occurs throughout the range of this rodent in British Columbia. It has been shown to be infective under laboratory conditions (Eskey and Haas).

(10) *Thrassis bacchi* (Rothschild).

T. bacchi occurs on all the prairie ground squirrels, especially *C. 13-lineatus*, but seems to be rather rare in Canada. It is of potential significance as a plague carrier (Prince, 1943).

(11) *Thrassis petiolatus* (Baker)

T. petiolatus is an extremely common parasite of *Citellus c. columbianus* in British Columbia. Like the other common flea of this rodent (*Oropsylla idahoensis*) it is resistant to plague transmission (Eskey and Haas). In view of the fact that the two most common fleas of this rodent are not readily infected, the Columbian ground squirrel is very likely not of so much potential significance as the Richardson

ground squirrel, as the latter carries at least five species of plague-important fleas.

B. INTRODUCED SPECIES.

(12) *Ctenocephalides canis* (Curtis).

(13) *Ctenocephalides felis* (Bouche).

These two fleas are widespread in their distribution, and commonly infest domestic pets, particularly cats, dogs and rabbits. Heavy infestations frequently occur in households, and as both these species feed readily on man, they are often a serious domestic problem.

Large numbers of these fleas sometimes occur on the rats in certain garbage dumps in Vancouver.

(14) *Nosopsyllus fasciatus* (Bosc d'Antic).

This, the European rat flea, is well established in Canada and is probably coincident in its distribution with *Rattus norvegicus*. Though not as highly significant as the next species, this flea is of definite importance as a possible disseminator of plague.

(15) *Xenopsylla cheopis* (Rothschild).

X. cheopis, the Indian rat flea or "plague flea," occurs more commonly in tropical than temperate regions. However, it does become well established in these latitudes and wherever it occurs its presence is a matter of gravest concern, as it is the most important of the flea vectors of plague.

The possibility of its occurrence in Vancouver was first suggested by Spencer (1937), and in 1938 specimens were recognized by the writer (1940). This constituted the first Canadian record. In 1941 Holland discussed the status of this flea in the coastal area in British Columbia. It was found that a significant percentage of the rat fleas in the Vancouver city garbage dump was of this species. It was also recorded from New Westminster. Continued surveys since that time have shown *X. cheopis* to be widely distributed throughout the residential area of Vancouver, where the spread of its rodent host is undoubtedly assisted by the carelessness of the residents with reference to garbage

disposal. *X. cheopis* also is known at North Vancouver and Sechelt.

Summary and Discussion

The distribution and status of eleven kinds of rodents and fifteen species of fleas are briefly discussed with reference to the possible dissemination of plague in Western Canada. Both the mammals and their parasites vary considerably as to their infectivity. The host specificity, and relative tendencies of fleas to bite humans are of importance from a public health standpoint.

Undoubtedly there are other mammals in our fauna that might be considered as possible carriers of this disease, and also there are undoubtedly many other species of fleas capable of transmitting plague from host to host, or from host to man. Records at the Kamloops laboratory include at least fourteen species of fleas present in Western Canada which will bite man readily. The plague-disseminating propensities of most of these are not as yet known.

Mice of various genera have not been

studied extensively in Canada with reference to plague, but, in the United States, the white-footed mouse (*Peromyscus* spp.) has been incriminated to a limited extent (Eskey and Haas). The potentialities of some of these smaller rodents should not be overlooked.

Birds, especially hawks and owls, which prey upon mice and ground squirrels are also a possible factor in the spread of infection (Jellison, 1939). Small carnivores such as weasels might be considered in a like manner.

At the present time, concentrated eradication measures are being taken against the rat population by various civic health authorities. Also should be mentioned, the very creditable effort at ground squirrel control in the vicinity of the known plague foci of Alberta, which has been conducted by the Health Department of that Province. It is to be hoped that these measures, and the continued careful surveying of native and introduced rodents and their fleas, will achieve the desired result of holding sylvatic plague in check to the point where it does not affect Canadian health and welfare.

LITERATURE CITED

- Brown, J. H. and G. D. Roy. 1943. The Richardson ground squirrel, *Citellus richardsonii* Sabine, in southern Alberta: its importance and control. *Sci. Agric.* 24 (4): 176-197.
- Eskey, C. R. and V. H. Haas. 1940. Plague in the Western part of the United States. U.S.P.H.S., Pub. Hlth. Bul. 254: 1-83.
- Gibbons, R. J. 1939. Survey of Rocky Mountain spotted fever and sylvatic plague in Western Canada during 1938. *Can. Publ. Hlth. Journ.*, April 1939. 4 pp.
- Gibbons, R. J. and F. A. Humphreys. 1941. Plague surveys in Western Canada. *Can. Publ. Hlth. Journ.*, Jan. 1941: 24-28.
- Holland, G. P. 1940. New records of Siphonaptera for British Columbia. *Ent. Soc. Brit. Col., Proc.* 36: 11-12.
- Holland, G. P. 1941. A survey of the rat fleas of the southern British Columbia coast with relation to plague studies. *Ent. Soc. Brit. Col., Proc.* 37: 1-5.
- Howell, A. H. 1938. Revision of the North American ground squirrels. *N. Amer. Fauna.* 56: 1-256.
- Jellison, W. L. 1939. The role of certain birds in the epidemiology of plague. *Pub. Hlth. Repts.* 54 (19): 792-798.
- Prince, F. M. 1943. Report on the fleas *Opisocrostitis bruneri* (Baker) and *Thrassis bacchi* (Roths.) as vectors of plague. *Pub. Hlth. Repts.* 58(27):1013-1016.
- (Public Health Reports). 1942. Plague infection reported in the United States during 1941. 57(24): 903-905.
- (Public Health Reports). 1943. Positive plague and tularemia specimens reported in Canada during 1942. 58(16):646.
- Spencer, G. J. 1937. The menace of rat parasites in Vancouver in 1936. *Ent. Soc. Brit. Col., Proc.* 33: 44-45.