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# SIPHONAPTERA

## A STUDY OF THE SPECIES INFESTING WILD HARES AND RABBITS OF NORTH AMERICA NORTH OF MEXICO

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# SIPHONAPTERA: A STUDY OF THE SPECIES INFESTING WILD HARES AND RABBITS OF NORTH AMERICA NORTH OF MEXICO [1]

The material embodied in this paper represents the results of a study undertaken for the purpose of bringing together available data pertaining to the distribution and host relationships of the species of Siphonaptera that infest the Leporidae (hares and rabbits) of North America, north of Mexico. Much of the information presented is new. This has been obtained partly through correspondence, but mostly from materials collected incident to field studies of tick-transmitted diseases by the Rocky Mountain Laboratory. A brief section giving pertinent information relating to the hares and rabbits of the region concerned precedes the flea data.

The writer expresses his appreciation to the many persons who aided in the study. Special acknowledgments are due to Dr. Wm. A. Riley, under whose direction this study was initiated; to Assistant Parasitologist Wm. L. Jellison, of the Rocky Mountain Laboratory, for specimens, data, and other assistance; and to Mr. B. J. Collins, formerly of the Division of Zoology of the National Institute of Health, for specimens and advice in taxonomic problems. A quantity of materials made available by the University of Michigan Museum of Zoology has been the source of new host and locality records for several species.

## CLASSIFICATION OF HOSTS

In North America north of Mexico the family Leporidae, according to Miller (1924), is represented by 3 genera and 63 species and subspecies exclusive of the introduced European hare, *L. europaeus europaeus; Lepus* with 32 species and subspecies; *Sylvilagus* with 30 species and subspecies, and *Brachylagus* with one species. The principal generic characters together with lists of host species are given below.

Submitted for publication December, 1939.

[1] Contribution from the Rocky Mountain Laboratory (Hamilton, Mont.), of the Division of Infectious Diseases, National Institute of Health, and the Division of Entomology and Economic Zoology, University of Minnesota. A portion of the data on which this paper is based was contained in a thesis submitted June 1937 to the Faculty of the Graduate School of the University of Minnesota.

**Lepus** Linnaeus

The varying hares and jackrabbits; characterized by their relatively large size, long ears and long hind legs. Young born clothed with hair and with their eyes open.

| *Species* | *Common names* |
|---|---|
| *L. americanus* Erxleben | Varying hares. |
| *L. washingtonii* Baird | |
| *L. bairdii* Hayden | |
| *L. townsendii* Bachman | White-tailed jack rabbits. |
| *L. californicus* Gray | Black-tailed jack rabbits. |
| *L. alleni* Mearns | Antelope jack rabbit. |
| *L. gaillardi* Mearns | Gaillard jack rabbit. |
| *L. arcticus* Ross | Arctic hares. |
| *L. othus* Merriam | |
| *L. poadromus* Merriam | |
| *L. groenlandicus* Rhodes | |

**Sylvilagus** Gray

The cottontails, brush rabbits, marsh and swamp rabbits; smaller than *Lepus*, ears and hind legs relatively shorter. Young born naked and with their eyes closed.

| *Species* | *Common names* |
|---|---|
| *S. floridanus* (Allen) | Eastern cottontails. |
| *S. cognatus* Nelson | |
| *S. robustus* (Bailey) | |
| *S. transitionalis* (Bangs) | New England cottontail. |
| *S. nuttalii* (Bachman) | Rocky Mountain cottontails. |
| *S. audubonii* (Baird) | Western cottontails. |
| *S. bachmani* (Waterhouse) | Pacific Coast brush rabbits. |
| *S. palustris* (Bachman) | Marsh rabbits. |
| *S. aquaticus* (Bachman) | Swamp rabbits. |

**Brachylagus** Miller

Pigmy rabbits; resemble the cottontails but smaller, tail very short, hind foot less than 70 mm. in length (Pratt, 1935).

| *Species* | *Common name* |
|---|---|
| *B. idahoensis* (Merriam) | Pigmy rabbit. |

## HOST DISTRIBUTION

The family Leporidae is represented by one or more species in nearly all parts of North America. On the basis of available information the approximate ranges of certain species or groups are shown on maps 1 to 4. Definite distributional data are lacking for some species and consequently it appeared inadvisable to attempt to map their ranges. However, the maps, together with the following statements, will serve to indicate the distribution of Leporidae in a general way.

The varying hares (map 1) inhabit the major portion of Alaska and Canada. In the United States they occur in some portion of each state in the northern tier and in regions of high elevation their range extends considerably farther to the south.

The arctic hares occur north of the range of the varying hares in Canada, and along the west and north coastal regions of Alaska. The species *Lepus groenlandicus* is found along the coastal regions of Greenland and according to Seton (1929), it is also found on the arctic islands north of the 74° parallel.

The jack rabbits occur in much of the United States west of the Mississippi River (map 2.) In Canada (Seton, 1. c.) they are found in southern Alberta, southern Saskatchewan, southwestern Manitoba, and south central British Columbia.

The range of the cottontails is principally south of that of the varying hares and includes a large portion of the United States (map 3). The swamp and marsh rabbits are restricted to the southeastern United States while the brush rabbit is limited to the Pacific Coast region south of the Columbia River (map 4).

The known range of the pigmy rabbit is about as follows: Sagebrush plains of southeastern Washington, eastern Oregon, extreme northeastern California, central and northern Nevada, northern Utah, southern and eastern Idaho, and southwestern Montana.

## TREATMENT OF THE SIPHONAPTERA

Wild rabbits and hares in North America are normal hosts for nine species and subspecies of fleas representing three genera. According to Ewing (1929) these genera are included in the families Pulicidae and Dolichopsyllidae. The species and subspecies are: *Cediopsylla simplex* (Baker) 1895, *Cediopsylla inaequalis inaequalis* (Baker) 1895, *Cediopsylla inaequalis interrupta* Jordan 1925, *Hoplopsyllus glacialis glacialis* (Tasch.) 1880, *Hoplopsyllus glacialis lynx* (Baker) 1904, *Hoplopsyllus affinis* (Baker) 1904, *Hoplopsyllus foxi* Ewing 1924, *Odontopsyllus multispinosus* (Baker) 1898, and *Odontopsyllus dentatus* (Baker) 1904.

### KEY TO THE FAMILIES, GENERA AND SPECIES

1. Thorax not reduced, the three thoracic tergites together being longer than the first abdominal tergite; frontal region of head not separated from occiput by a suture. Abdominal tergites 2 to 7 with a single row of bristles ..... Pulicidae (2)
   As above but abdominal tergites 2 to 7 with at least 2 rows of bristles ..... Dolichopsyllidae (6)
2. With a row or patch of spinelets on inner surface of the hind coxae; eyes and pronotal comb present; genal comb of 3 to 8 spines, comb more nearly vertical than horizontal ..... *Cediopsylla* (3)
   As above but genal comb absent ..... *Hoplopsyllus* (4)

3. Genal comb usually 6 to 8 spines; upper spine set close to eye _ *C. simplex*
   Genal comb usually 4 to 7 spines; upper spine widely separated from eye. Bristles on ventral margin of male clasper evenly spaced _____ *C. inaequalis inaequalis*
   As above but bristles on ventral margin of male clasper divided into a proximal group of 4 to 6 and a distal group of 2 or 3 *C. inaequalis interrupta*
4. Spined process of male clasper not more than twice as long as broad (Plate 2, fig. J); spermatheca of female as in Plate 2, fig. G _____ *H. affinis*
   Spined process of male clasper more than twice as long as broad; spermatheca of female not as above _____ (5)
5. Spined process of male clasper four times as long as broad, not greatly exceeding length of bristled process (plate 2, fig. I); female spermatheca (plate 2, fig. F) relatively large, anterior margin smoothly rounded _____ *H. glacialis glacialis* [2]
   *H. glacialis lynx* [2]
   Spined process of male clasper very slender and about twice the length of bristled process (Plate 2, fig. H); female spermatheca as in Plate 2, fig. E _____ *H. foxi*
6. Genal comb absent; head with frontal tubercle; eyes well developed; a patch of spinelets on inner surface of hind coxae, pronotal comb with more than 30 spines _____ *Odontopsyllus multispinosus*
   As above, but pronotal comb with about 24 spines _____ *O. dentatus*

Individual host animals were often found infested with two and occasionally with three of the above species. In cases where such multiple infestations occurred the species present always belonged to different genera except in an area which included parts of Washington, Oregon, and Idaho where the ranges of *Cediopsylla inaequalis inaequalis* and *C. inaequalis interrupta* overlap. For each species of rabbit flea Table I shows the other species that have been found associated with it as co-parasites in multiple infestations.

Rabbits are occasionally found that are infested with limited numbers of fleas which normally infest other animals, especially rodents. This is to be expected when the temporary parasitic habit of fleas is taken into account. Many species were represented among the stray fleas thus found. In the Western United States, species that have ground squirrels as their normal hosts are the ones most frequently encountered. *Hoplopsyllus anomalus* (Baker) and *Diamanus montanus* (Baker), the two common fleas of the California ground squirrel, *Citellus beecheyi*, and its near relatives, are occasionally found in small numbers. These two species of fleas are recognized vectors of sylvatic plague in ground squirrel populations and even their occasional occurrence on rabbits may be significant. Eskey (1939) has recently reported the finding of wild rabbits infected with plague.

[2] These two subspecies are morphologically very similar. On the basis of the very few specimens of *glacialis glacialis* available to the writer for examination, the only difference between it and *glacialis lynx* appears to be size, the former being considerably larger. *H. glacialis glacialis* is here regarded as being restricted to the *Lepus arcticus* group and its predators, with *H. glacialis lynx* restricted to the *Lepus americanus* group and its predators, principally *Lynx* sp. (Kohls, 1939).

**Table 1.—*For each species of rabbit flea is shown: (1) its co-parasites [+][1], (2) the species that may possibly be co-parasites [ ? ], (3) the species that never occur as co-parasites with it [−].***

| Species | Co-parasite | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | C. simplex | C. in. inaequalis | C. in. interrupta | H. gl. glacialis | H. gl. lynx | H. affinis | H. foxi | O. multispinosus | O. dentatus |
| C. simplex | | − | − | − | ? | + | − | + | − |
| C. inaequalis inaequalis | − | | + | − | + | + | − | − | + |
| C. inaequalis interrupta | − | + | | − | ? | + | + | − | + |
| H. gl. glacialis | − | − | − | | − | − | − | − | − |
| H. gl. lynx | ? | + | ? | − | | − | − | ? | + |
| H. affinis | + | + | + | − | − | | − | + | + |
| H. foxi | − | − | + | − | − | − | | − | + |
| O. multispinosus | + | − | − | − | ? | + | − | | − |
| O. dentatus | − | + | + | − | + | + | + | − | |

[1] Never more than one species of a genus in a given area except in the case of *C. inaequalis inaequalis* and *C. inaequalis interrupta*, the ranges of which overlap in part.

Two species of fleas, *Pulex irritans* L. and *Echidnophaga gallinacea* (West.), which until rather recently were commonly regarded as parasites of man and domesticated animals, were found to occur on wild hares and rabbits rather frequently in certain parts of the United States.

Shaftesbury (1934) reported the collection of *P. irritans* from wild rabbits in North Carolina and Ward (1933) listed it as *P. dugesii* from *Lepus californicus* and *Sylvilagus floridanus* in central Oklahoma. To the foregoing States I add the following: Arizona (Pima and Santa Cruz Counties); California (Colusa, Kings, and Orange Counties); Montana (Madison and Petroleum Counties); Texas (Jeff Davis and Kleberg Counties); and Wyoming (Albany, Hot Springs, Medicine Bow, and Natrona Counties).

The stick-tight flea, *Echidnophaga gallinacea*, is widely distributed in the United States, particularly throughout the southern part. While its normal hosts are domestic fowls, it has also been reported (Stewart, 1932) from a wide variety of domestic and wild mammalian and avian hosts. Thus far, however, it appears to be unreported from wild hares and rabbits. I have seen specimens from these hosts from the following localities: Arizona (Cochise County); California (Kern and Fresno Counties); Florida (Alachua County); Texas (Donley and Kleberg Counties).

## SPECIES DATA

### **Cediopsylla** Jordan

1925. *Cediopsylla* Jordan, Nov. Zool. *32:* 103.

All species of this New World genus infest hares and rabbits. Two, *C. simplex* (Baker) and *C. inaequalis inaequalis* (Baker), and one subspecies *C. inaequalis interrupta* Jordan, occur in North America. The South American representative of the genus is *C. spillmani* Jordan 1930, known from Ecuador (Pichincha) on *Sylvilagus ecaudatus*.

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**Cediopsylla simplex** (Baker)

Plate I, figure A.

1895. *Pulex inaequalis* var. *simplex* Baker, Can. Ent. *27*: 164.
1904. *Ctenocephalus simplex* (Baker), Baker, Proc. U. S. Nat'l. Mus. *27*: 384, 385, 439.
1905. *Spilopsyllus simplex* (Baker), Baker, Proc. U. S. Nat'l. Mus. *29*: 131, 145.
1925. *Cediopsylla simplex* (Baker), Jordan, Nov. Zool. *32*: 103.

**Previous records.**—Baker (1895) described the species from specimens collected in Michigan from "*Lepus*" (*Sylvilagus*?), and in 1904 reported it from Iowa. Recorded from *Sylvilagus floridanus mearnsi*, Ithaca, N. Y., by M. A. Stewart (1928) and from "cottontail," Lyon Lake, Rensselaer County, N. Y., by Jordan (1929). Bred from nest of *S. floridanus mallurus*, East Falls Church, Va. (Jordan, 1928). Reported by Ward (1933) on *S. floridanus* from central Oklahoma. Shaftesbury (1934) listed it from nine counties in North Carolina and stated that the United States National Museum has records from rabbits from Michigan, Iowa, Massachusetts, Georgia, and Tennessee. Harkema (1936) found 78.04 percent of 41 cottontails, *S. floridanus mallurus*, in Durham County, N. C., infested with this flea and referred to it as the common rabbit flea of the eastern United States. Jordan (1937) listed it from Massachusetts on *S. floridanus transitionalis*.

**New records.**—Alabama. *Sylvilagus aquaticus*—Montgomery County; April 23, 1934, 1♂ (R. E. Butler). *Sylvilagus* sp.—Houston County; Dothan, February 17, 1934, 1♀ (W. U. McCullough).

Arkansas. *Sylvilagus* sp.—Boone County; Harrison, June 7, 1938 (7 hosts) 9♂; 10♀: Washington County; Fayetteville, June 6, 1938 (2 hosts) 5♂, 1♀.

Florida. *Sylvilagus floridanus mallurus*—Alachua County; Gainesville, March 13, 1937, 4♂, 1♀ (Professor H. B. Sherman).

Iowa. *Sylvilagus floridanus mearnsii*—Story County; Ames, April, 1935, 17♂, 55♀; May, 1933, 3♂, 3♀ (records through courtesy of Irving Fox).

Illinois. *Sylvilagus floridanus* subsp.—Mercer County; Keithsburg, June 9, 1932, 2 specimens (Ross and Mohr); data from Professor Carl Mohr, correspondence 1935.

Kansas. Reported by Professor Roger C. Smith from "rabbit," Manhattan (correspondence 1935).

Michigan. *Lepus americanus americanus*—Charlevoix County; Boyne Falls, July 3, 1923, 1♂, 5♀; July 5, 1923, 4♂, 3♀. *Sylvilagus floridanus mearnsii*—Berrien County; Harbart, July 14, 1927, 5♂, 4♀: Charlevoix County; Boyne Falls, July 4, 1923, 1♂, 1♀: Washtenaw County; Portage Lake, May 20, 1920, 1♂, 19♀; Ann Arbor, December 24, 1920, 2♂, 1♀.

Minnesota. In the collection of the University Department of Entomology and Economic Zoology there are (1937) specimens as follows: "woodhare," St. Anthony Park, 1895; varying hare and cottontail, Lake Alexandria, 1931; cottontail, Dunniville, 1935. There are also several specimens lacking either host or locality data.

Mississippi. Reported by Professor E. W. Stafford, A. & M. College (correspondence 1935) to occur on "rabbits." I have seen specimens through the courtesy of Mr. J. W. Ward. Locality data were lacking.

Missouri. *Sylvilagus* sp.—Barry County; Viola and Cassville, June 8, 1938 (11 hosts) 11♂, 20♀.

Nebraska. Among fleas sent me by Professor Myron H. Swenk was found a specimen collected from "rabbit," Roca, October 31, 1915.

North Dakota. *Sylvilagus floridanus* subsp.—Cass County; Sheldon, May 29, 1935, 2♂, 3♀; Kindred, January 30, 1937, 2♂, 1♀ (J. A. Munro).

Oklahoma. "Jack rabbit"—Noble County; Perry, May 22, 1929, 5♂, 30♀ (C. E. Sanborn). "Cottontail"—Johnston County; Tishimingo, May 11, 1929, 1♂, 1♀, (Sanborn & Stiles).

South Dakota. *Sylvilagus floridanus similis*—Brookings County; Brookings, April 15, 1936, 1♀. *Sylvilagus* sp.—Brookings County; Brookings, June 6, 1920, 2♂, 4♀. Materials from this State were furnished by Professor D. E. Harriman.

Texas. *Sylvilagus* sp.—Liberty County; Cleveland, August 16, 1937, 1♂, 2♀: Brazos County; Bryan, May 28, 1938, 1♀. *Sylvilagus aquaticus*—Brazos County; Bryan, May 29, 1938 (2 hosts) 10♂, 5♀: Liberty County; Cleveland, May 11, 1938 (2 hosts) 8♂, 12♀.

**Cediopsylla inaequalis inaequalis** (Baker)

Plate I, figure B.

1895. *Pulex inaequalis* Baker, Can. Ent. *27:* 163, 164.
1904. *Ctenocephalus inaequalis* (Baker), Baker, Proc. U. S. Nat'l. Mus. *27:* 384, 385, 439.
1905. *Spilopsyllus inaequalis* (Baker), Baker, Proc. U. S. Nat'l. Mus. *29:* 131, 145.
1925. *Cediopsylla inaequalis inaequalis* (Baker), Jordan, Nov. Zool. *32:* 103.

Considerable variation occurs in the taxonomic characters, particularly in the number of spines in the genal comb, the number and arrangement of the bristles on the abdominal segments and also in the number of bristles on the ventral margin of the male clasper. These latter bristles vary from about 8 to 15, and in typical specimens they are evenly spaced along the margin. However, specimens have been found in which some irregularity in spacing occurs, suggesting intergradation with the subspecies *interrupta* in which these bristles are definitely separated into a proximal group of 4 to 6 and a distal group of 2 or 3. In fact in some instances, especially in specimens from the

region of Burns (Harney County), and Lake View (Lake County), Oreg., subspecific assignments have been made with some degree of uncertainty.

Typical representatives of the two subspecies as well as what appear to be intergrades are sometimes encountered on the same individual host. The females appear to be indistinguishable and in areas where males of both subspecies occur subspecific assignment of the females is impossible. Among the hundreds of male specimens examined from Montana, Colorado, and a lesser number from Wyoming, only two were found, one from western Montana and the other from Colorado, that approach the *interrupta* form, and both were in large series of typical *inaequalis*. On the other hand all Oregon specimens from west of the Cascade Mountains and all California specimens, with the exception of two records from Alpine and Lassen Counties representing one male specimen each, were typical *interrupta*. Records and specimens from the intervening region of Nevada and Utah are too few to justify any statement in regard to overlapping in those areas. Both subspecies were represented in collections from Yakima and Franklin Counties in Washington. Only *interrupta* was found in a collection of 35 males from one host at Shoshone Falls (Twin Falls County), Idaho while further west at Mayfield (Ada County) a mixture was present.

In the following detailed listing of records, in the collections in which males of both subspecies were found the females are assigned to the predominating subspecies in the collection.

**Previous records.**—The species was described from specimens collected from cottontails and jack rabbits, Grand Canyon, Ariz Baker (1904) recorded it from *Lepus* sp., Arboles, Colo., and without mention of host from Moscow, Idaho. Mitzmain (1909) listed it from California but Jordan (1925) established the subspecies *interrupta* for the form to which Mitzmain undoubtedly referred. Dunn and Parker (1923) found it on *Sylvilagus nuttallii*, *Lepus bairdii*, and *Lepus townsendii*, all from the Bitterroot Valley, western Montana. McCampbell (1926) recorded the species from Logan, Weld, and Morgan Counties, Colo., on *Lepus californicus melanotus*. In Utah, Stanford (1931) found it on *Lepus californicus deserticola*, Salina, and on *Sylvilagus* sp., Salina Canyon. Although Ward (1934) reported the occurrence of this species in central Oklahoma on *Sylvilagus floridanus*, a representative series of his specimens submitted to me contained only *C. simplex*.

**New records.**—Arizona. "Rabbit"—Coconino County; July 10, 1935, 2♂, 1♀. *Sylvilagus audubonii cedrophilus*—Apache County; Concho, July 12, 1924, 1♀.

California. *Lepus* sp. (jack rabbit)—Lassen County; Wendel, May 23, 1933, 1♂: Alpine County; Markleeville, July 7, 1936, 1♂.

Colorado. *Lepus californicus melanotus*—Washington County; Akron, June 20, 1925, 2♀. *Lepus townsendii* subsp.—Conejos County; Antonito, August 8 to September 8, 1931 (7 hosts) 25♂, 42♀; May 18, 1932, 14♂, 23♀; June 17, 1932, 9♂, 12♀; June 23, 1932, 2♀; June 24, 1932, 4♂, 7♀; June 24, 1932, 3♂, 1♀; July 21, 1932, 1♀; July 29, 1932, 2♀; August 11, 1932 (3 hosts) 3♂, 8♀; August 17, 1932, 1♀. *Sylvilagus audubonii baileyi*—Adams County; Fort Morgan, August 14, 1924, 1♂: Weld County; Hudson, August 11, 1924, 1♀. *Sylvilagus audubonii warreni*—Costilla County; Blanca, August 7, 1925, 8♂, 15♀. *Sylvilagus nuttallii pinetis*—Chaffee County; Buena Vista, June 27, 1925, 9♂, 50♀. *Sylvilagus nuttallii* subsp.—Conejos County; Antonito, August 8 to September 8, 1931, (30 hosts) 159♂, 320♀; June 23, 1932, 16♂, 13♀; July 21, 1932, 1♀: Archuleta County; Pagosa Springs, September 7, 1931, 2♂, 6♀. *Sylvilagus* sp.—Costilla County; Garland, August 4, 1925, 7♂, 5♀: Larimer County; Fish Creek, June 16, 1938, 9♂, 11♀.

Idaho. *Lepus* sp. (jack rabbits)—Ada County; Mayfield, June 26, 1932, 2♂; July 2, 1932, 1♂; April 23, 1933, 1♂, 1♀; April 28, 1933, 1♂. *Sylvilagus nuttallii* subsp.—Ada County; Mayfield, August 22, 1932, 3♂; April 25, 1933, 3♂. *Brachylagus idahoensis*—Ada County; Mayfield, July 9, 1932, 1♀; August 24, 1932, 1♀; September 9, 1932, 2♂, 6♀.

Montana. *Lepus bairdii*—Ravalli County; March 10, 1930, 1♂; August 9, 1932, 1♂; July 26, 1932, 8♂, 7♀. *Lepus townsendii* subsp.—Carter County; Alzada, June 2, 1935 (4 hosts), 9♂, 11♀; June 4, 1935, 3♂, 1♀: Custer County; Miles City, June 6, 1935 (2 hosts), 3♂, 1♀: Ravalli County; June 27, 1931, 2♀; September 25, 1931, 2♂, 2♀; January 7, 1934, 1♀; January 16, 1934, 1♂, 1♀; January 25, 1934, 2♀; October 30, 1934 (3 hosts) 7♂, 10♀; January 18, 1936 (2 hosts), 4♂, 1♀: Wheatland County; Harlowton, April 28, 1934, 1♂, 2♀. *Lepus californicus deserticola*—Beaverhead County; Dillon, April 19, 1936, 6♂, 6♀; Armstead, November 2, 1936 (16 hosts), 18♂, 31♀. *Sylvilagus nuttallii* subsp.—Beaverhead County; Dillon, July 8, 1936, 4♂, 1♀; August 11, 1936, 4♂, 8♀; August 26, 1936, 4♂, 5♀; September 8, 1936, 6♂, 11♀; November 2, 1936 (3 hosts), 29♂, 51♀; November 3, 1936 (8 hosts), 54♂, 81♀: Carter County; Albion, June 3, 1935 (3 hosts), 15♂, 24♀: Custer County; Calabar, August 1, 1930, 3♂, 7♀; Miles City, June 6, 1935, 34♂, 77♀: Fergus County; September 23, 1931, 2♂, 8♀: Ravalli County; July 16, 1929, 147 specimens; November 16, 1929, 8♂, 19♀; July 6, 1931, 1♀; August 16, 1931, 2♀; September 15, 1931, 1♂, 6♀; September 15, 1931, 2♂; September 16, 1931, 2♂, 5♀; June 8, 1932, 3♀; June 20, 1932, 18 specimens; July 8, 1932, 12♂, 13♀; July 22, 1932, 3♂, July 22, 1932, 1♀; August 23, 1932, 2♂, 5♀; January 25, 1934, 26♂, 32♀; February 7, 1934, 1♂, 7♀; October 30, 1934, 3♂, 10♀; September 17, 1935, 8♂, 16♀; January 18, 1936, 1♂,

9♀; January 18, 1936, 3♂, 1♀; January 24, 1936, 87♂, 98♀. *Brachylagus idahoensis*—Beaverhead County; Bannock, July 8, 1936, 5♂, 23♀.

Nebraska. *Sylvilagus* sp.—Scotts Bluff County; Scotts Bluff, May 25, 1933, 3♂, 10♀.

Nevada. *Lepus* sp. (jack rabbits)—Elko County; Wells, April 17, 1932, 1♀; April 19, 1932, 4♂, 1♀.

New Mexico. *Lepus californicus* subsp.—Bernalillo County; July 12, 1935 (2 hosts), 1♂, 1♀; July 19, 1935 (3 hosts) 1♂, 7♀; July 25, 1935, 1♀; August 1, 1935, 1♀; Torrance County; May 29, 1935, 2♀. *Sylvilagus audubonii cedrophilus*—Catron County; Quemado, July 14, 1924, 2♂, 8♀; July 15, 1924, 12♂, 6♀; Datil, July 16, 1924, 7♂, 11♀. *Sylvilagus* sp.—Bernalillo County; July 11, 1935, 1♂, 1♀; Torrance County; May 29, 1935, 16♂, 9♀; Mount Monzano, July 20, 1924 (2 hosts), 1♂, 3♀.

Oregon. *Lepus* sp. (jack rabbits)—Harney County; Burns, July 20, 1932, 1♂; July 30, 1932, 1♂; September 2, 1932, 1♂; May 8, 1933 (3 hosts), 1♂, 4♀; May 9, 1933, 1♂: Lake County; Lakeview, May 20, 1933 (5 hosts), 12♂, 8♀; May 19, 1933, 1♂. *Sylvilagus nuttallii nuttallii*—Baker County; Baker, June 20, 1922, 2♂, 7♀. *Sylvilagus* sp.—Harney County; Burns, July 19, 1932 (3 hosts) 2♂, 2♀; July 25, 1932 (2 hosts), 3♂, 2♀; August 31, 1932, 2♂; May 6, 1933, 18 specimens: Lake County; Lakeview, May 19, 1933, 2♂. *Brachylagus idahoensis*—Harney County; Burns, August 30, 1932 (2 hosts), 6♂, 12♀; August 27, 1935, 1♂, 2♀.

Washington. *Lepus* sp. (jack rabbits)—Yakima County; Yakima, 20 miles south, June 18, 1934 (2 hosts) 1♂, 2♀. *Sylvilagus nuttallii* subsp.—Yakima County; Moxee City, June 20, 1934, 1♂.

Wyoming. *Lepus townsendii campanius*—Albany County; Laramie, July 25, 1931, 1♂, 5♀; March 22, 1936, 1♂, 3♀. *Lepus* sp. (jack rabbit)—Albany County; James Lake, November 28, 1935, 1♀; Laramie, June 23, 1938, 1♀: Carbon County; Medicine Bow, April 11, 1936, 5♀, 8♂. *Sylvilagus nuttallii grangeri*—Albany County; Hutton Lake, July 21, 1931, 1♂, 1♀; Laramie, December 24, 1935, 6♂, 11♀; January, 1936, 6♂, 18♀; February, 1936, 14♂, 19♀; March 7, 1936, 2♂, 9♀: Carbon County; Fort Steele, October 20, 1922, 3♂, 8♀; Rawlins, October 24, 1922 (3 hosts) 12♂, 21♀. *Sylvilagus audubonii baileyi*—Fremont County; Riverton, March 29, 1932, 1♂, 5♀: Albany County; Laramie, January, 1936, 4♂, 3♀: Sweetwater County; Eden Valley, January 12, 1936, 5♂, 13♀. *Sylvilagus* sp.—Albany County; Roger Canyon, May 30, 1933, 2♂, 2♀; Laramie, March 20, 1936, 40♂, 65♀; Hattie Lake, May 18, 1938, 16♂, 8♀; Laramie, June 3, 1938, 3♂, 3♀: Carbon County; Medicine Bow, April 1, 1936, 52♂, 102♀; July 1, 1938, 6♂, 10♀: Sweetwater County; Rock Springs, July 22, 1938 (2 hosts) 5♂, 17♀: Laramie County; Chugwater Creek, May 16, 1938 (2 hosts) 5♂, 8♀.

A number of the Wyoming specimens were furnished by James R. Simon, University of Wyoming. In addition to the above materials, I have seen Wyoming specimens in the collection of the University of Minnesota as follows: "Rabbit," Albany County, 1918; "rabbit", Carbon County, August 6, 1925; "cottontail rabbit," Red Butte, February 22, 1921; and from *Lepus townsendii*, Sand Creek, May 29, 1931.

**Cediopsylla inaequalis interrupta** Jordan

1925. *Cediopsylla inaequalis interrupta* Jordan, Nov. Zool. *32:* 103.

See discussion under *Cediopsylla inaequalis inaequalis*, page 7.

Previous records.—Jordan referred to this subspecies a series of specimens from California hosts as follows: Palo Alto, on fox (ex coll. Stanford University); San Francisco, on *Lepus bachmani;* Claremont, on *Lepus*. Probably Mitzmain's record (1909) of the occurrence of *C. inaequalis* in California refers to this subspecies.

**New records.**—California. *Lepus californicus* subsp.—Los Angeles County; March 28, 1932, 8♂, 4♀: San Benito County; Hollister, March 22, 1932, 1♀: Riverside County; Banning, May 18, 1935, 1♀; May 29, 1935, 30♂, 78♀. *Lepus* sp. (jack rabbits)—Shasta County; Redding, May 29, 1933, 1♂; May 31, 1933, 1♀. *Sylvilagus audubonii* subsp.—Kern County; Kernville, June 1, 1936, 2♀; June 4, 1936, 29♂, 28♀: Monterey County; Hastings Natural History Reservation, July 13, 1938, 1♂, 1♀; November 5, 1938, 1♀: Tulare County; Fairview, June 3, 1936, 2♂, 1♀: San Luis Obispo County; Santa Margarita, June 17, 1936, 2♀: Ventura County; Fillmore, June 13, 1936, 1♀; February 3, 1937, 10♂, 30♀: San Diego County; Vista, February 8, 1937 (3 hosts) 1♂, 3♀. *Sylvilagus bachmani* subsp.—Monterey County; Hastings Natural History Reservation, April 25, 1939, 1♂; Soledad, August 30, 1922, 1♀: Riverside County; Banning, June 7, 1935, 1♀: San Diego County; La Jolla, October 9, 1922, 1♀; Vista, May 12, 1936, 1♂; May 13, 1936, 22♂, 47♀: Ventura County; Fillmore, May 22, 1936, 2♀: Santa Cruz County; Los Gatos, June 22, 1936, 2♂, 2♀: San Luis Obispo County; Morro, October 9, 1922 (2 hosts) 2♂, 6♀.

Idaho. *Lepus* sp. (jack rabbits)—Ada County; Mayfield, June 26, 1932, 1♂; April 28, 1933 (2 hosts) 3♂. *Sylvilagus nuttallii* subsp.—Ada County; Mayfield, June 25, 1932, 1♂, 1♀; April 25, 1933, 5♂, 12♀: Twin Falls County; Twin Falls, April 22, 1938, 35♂, 34♀.

Oregon. *Lepus* sp. (jack rabbits)—Douglas County; September 19, 1935, 6♂, 5♀: Harney County; April 9, 1933, 1♂: Umatilla County; Echo, March 28, 1936, 1♂ (W. J. Chamberlain); April 8, 1936, 1♂, 1♀ (W. J. Chamberlain): Linn County; Lyons, April 17, 1936, 2♂, 2♀: Josephine County; April 18, 1936, 2♂, 1♀. "Rabbit"—

Benton County; Philomath, January 24, 1932, 1 ♂, 1 ♀ (N. P. Larson). *Sylvilagus nuttallii nuttallii*—Baker County; Baker, June 20, 1922, 2 ♂: Morrow County; Heppner, April 13, 1932, 4 ♂, 32 ♀: Umatilla County; Echo, April 17, 1936, 30 ♂, 70 ♀ (estimated total of 300–400 fleas by A. V. Meyers); April 24, 1936, 15 ♂, 56 ♀ (A. V. Meyers). *Sylvilagus bachmani ubericolor*—Benton County; Corvallis, April 19, 1932, 1 ♂, 3 ♀: Josephine County; August 8, 1935, 2 ♀: Tillamook County; Blaine, August 3, 1922, 9 ♂, 10 ♀; August 7, 1922, 6 ♂, 10 ♀. *Sylvilagus* sp.—Douglas County; August 21, 1935, 1 ♀: Josephine County; May 9, 1935, 1 ♂; June 28, 1935, 2 ♀: Curry County; July 17, 1935, 1 ♀; July 24, 1935, 2 ♂, 1 ♀: Lake County; Lakeview, May 19, 1933, 15 ♂, 19 ♀. *Brachylagus idahoensis*—Harney County; Burns, May 11, 1933, 14 ♂, 14 ♀.

WASHINGTON. *Lepus washingtonii washingtonii*—Lewis County; Alpha, July 28, 1922 (3 hosts) 13 ♂, 21 ♀. *Sylvilagus nuttallii nuttallii*—Yakima County; Moxee City, June 20, 1934, 1 ♂. Franklin County; Pasco, June 3, 1939, 1 ♂: Walla Walla County; Wallula. May 21, 1922, 10 ♂, 12 ♀.

### DISCUSSION OF SPECIES OF CEDIOPSYLLA

Listed above are all locality and host records known to the writer of *Cediopsylla simplex*, *C. inaequalis inaequalis* and *C. inaequalis interrupta* from rabbits. The locality records are shown on map 5. In those States for which definite locality records were lacking a spot denoting the presence of the species is placed centrally.

The map shows that the genus has not been recorded from Alaska or Canada but suggests that it is probably represented in all parts of the United States except possibly southern Arizona, southern New Mexico, and western Texas where no species of this genus have been encountered in spite of considerable collecting in various localities.

*Cediopsylla simplex* was found to be generally distributed throughout the eastern half of the United States. The limit of its western extension appears to lie near the 100th meridian, this line also marking the approximate eastern limit of *C. inaequalis inaequalis*. The data at hand do not indicate that there is any overlapping of the two species but more intensive collecting is needed in North and South Dakota, Nebraska, Western Kansas, and the Oklahoma and Texas Panhandles in order to be certain that this is actually the case.

*C. inaequalis inaequalis* is essentially a species of the western Great Plains, the Rocky Mountain, and Great Basin areas. Its range as now known extends eastward to extreme northeast Colorado, south to central New Mexico, west to the Sierra Nevada near Lake Tahoe in California and north as far as Moscow, Idaho. In a triangular region limited by Twin Falls, Idaho, and Lake County, Oreg., on the south, and Yakima County, Wash., on the north, it shares its range

with the subspecies *C. inaequalis interrupta*, the two often being collected from the same host animal.

*C. inaequalis interrupta* occurs in California west of the Sierra Nevada from San Diego County on the south and northward through Oregon to Lewis County, Wash. As noted above, it shares a part of its eastern range in Washington, Oregon, and Idaho with *C. inaequalis inaequalis*.

The factors determining the distributional limits of the species of *Cediopsylla* are entirely unknown. But host relationships are not concerned, since in no case is parasite species distribution coextensive with that of a host species or genus. Nor can it be conceived that geographical barriers play any significant part. More likely, the answer will be found in climatological factors, and in this connection it is of interest to note that the ranges of *C. simplex* and *C. inaequalis inaequalis* as now known approach each other in the region along the 20-inch isohyetal line.

### **Hoplopsyllus** Baker

1905. *Hoplopsyllus* Baker, Proc. U. S. Nat'l. Mus. *29:* 130.

Five species and subspecies of this genus are known from North America. Four infest hares and rabbits: *H. glacialis glacialis* (Tasch.) 1880, *H. gl. lynx* (Baker) 1904, *H. affinis* (Baker) 1904 and *H. foxi* Ewing 1924. The fifth, *H. anomalus* (Baker) 1904, is a common flea of ground squirrels, *Citellus beecheyi* subspp., and certain other rodents of the western United States. Two other species are known from the Western Hemisphere: *H. exoticus* J. & R. 1923 from Panama (Boquete) on *Felis* sp., and *H. andensis* Jordan 1933 from Ecuador (Paramo de Guamani) on *Thomasomys* sp.

#### **Hoplopsyllus glacialis glacialis** (Taschenberg)

1880. *Pulex glacialis* Taschenberg, Die Flöhe, p. 76–77, pl. 3, figs. 17, 17a.
1905. *Hoplopsyllus glacialis* (Tasch.), Baker, Proc. U. S. Nat'l. Mus. *29:* 130, 144.

There are very few records of this species, and in the course of the present studies I have been unable to obtain additional ones. It is known from the Arctic zone only. Taschenberg described it from specimens collected from "*Lepus glacialis*" (=*arcticus*) at the "North Pole." Wahlgren (1903) listed it from the same host species in Greenland. Jordan (1932a), in his review of the fleas known from the Arctic region gave Greenland and Baffinland as its habitat. Its normal host is the Arctic hare, *Lepus arcticus*, but according to Jordan it has also been found on *Lynx*, *Alopex*, and *Felis*.

### Hoplopsyllus glacialis lynx (Baker)

PLATE 2, FIGURES B, F, I

1904. *Pulex lynx* Baker, Proc. U. S. Nat'l. Mus. *27:* 378, 383–384, 437; pl. 10, figs. 7–11; pl. 11, figs. 1–2.
1905. *Hoplopsyllus lynx* (Baker), Baker, Proc. U. S. Nat'l. Mus. *29:* 130, 144.
1925. *Hoplopsyllus glacialis lynx* (Baker), Jordan, Nov. Zool. *32:* 103.

**Previous records.**—Baker described this species from a large series of specimens from *Lynx canadensis* (Moscow, Idaho). Jordan (1929) recorded it from *Lepus americanus* in Maine, from Atlin, British Columbia, on *Lepus americanus macfarlani* (1932b) and from New Brunswick (1932a). The same author (1937) reported it from New Hampshire on *Lynx canadensis.* Wagner (1936) recorded it in British Columbia from *Lepus americanus* and *Lynx fasciatus.* Philip (1938) collected specimens from varying hares (*L. americanus*) in Alaska at the following places: Circle Hot Springs, Circle, Rapids, Gulkana, and Chitina.

**New records.**—ALASKA. *Lepus americanus*—Killey River, Kenai Peninsula, September 26, 1938, 3♂, 3♀ (Jack Warwick). *Lynx* sp.—Dahl River, Yukon, December 25, 1935, 9♂, 20♀.

MONTANA. *Lepus bairdii*—Ravalli County; March 10, 1930, 4♂, 12♀; July 14, 1930, 2♂, 1♀; September 22, 1930, 3♂; July 21, 1932, 1♂. *Lynx canadensis*—Ravalli County; March 26, 1937, 66♂, 99♀. *Sciurus hudsonicus*—Ravalli County; September 11, 1932, 1♂, 1♀. *Canis latrans*—Ravalli County; October 19, 1935, 1♀. The last two records are undoubtedly cases of straying.

OREGON. *Lepus washingtonii klamathensis*—Klamath County; Fort Klamath, August 17, 1922 (3 hosts) 4♀.

Because of the paucity of existing records of this flea and the attendant uncertainty of its true host, collections from all known hosts are listed.

The type host is the lynx, *Lynx canadensis.* Baker (1904), noting the similarity of the species to *H. affinis* (type host "a small *Lepus*"), stated that it was "something of an anomaly to find two so closely related species on such different hosts." He doubted that its occurrence on the lynx was accidental, since a large series of specimens had been collected. The subsequent records show that varying hares may well be the true host of the species. Its presence in large numbers on the lynx can be readily accounted for by the fact that these hares are its chief article of diet (Seton, 1929). Ample opportunity is thus afforded for the transfer of fleas from prey to predator. However, it is quite probable that the flea has become so adapted as to be able to subsist on the lynx in addition to the varying hare.

**Hoplopsyllus affinis** (Baker)

PLATE 2, FIGURES C, D, G, J

1904. *Pulex affinis* Baker, Proc. U. S. Nat'l. Mus. *27:* 378, 382–383, 435.
1905. *Hoplopsyllus affinis* (Baker), Baker, Proc. U. S. Nat'l. Mus. *29:* 130, 144.

**Previous records.**—Baker described this flea from specimens taken "on small *Lepus*," Grand Canyon, Ariz. Mitzmain (1909) recorded it from *Sylvilagus bachmani*, San Francisco County, Calif. This record undoubtedly applies to *H. foxi* Ewing 1924, instead of to *H. affinis*. Hall (1912) listed it from *Sylvilagus audubonii baileyi*, Colorado Springs, Colorado. Listed by Dunn and Parker (1923) from Ravalli County, Mont., on *Sylvilagus nuttallii* (1 flea) and erroneously from varying hares, *Lepus bairdii*. Reported from *Lepus californicus melanotus* from Weld, Logan, and Morgan Counties, Colo. (McCampbell 1926). Listed from Salina, Utah, on *Lepus californicus deserticola* and from Henry Mountains, Utah, on *Sylvilagus audubonii warreni* by Stanford (1931). Vorhies and Taylor (1933) recorded the species from Santa Cruz County, Ariz., on *Lepus alleni* and *Lepus californicus eremicus*.

**New records.**—ARIZONA. *Lepus alleni*—Santa Cruz County; Santa Rita Mountains, May 4, 1933, 3♂, 1♀. *Lepus californicus* subsp.—(2 hosts) Santa Cruz County; Santa Rita Mountains, May 4, 1933, 1♂, 1♀; May 5, 1933 (2 hosts) 1♂, 2♀; May 8, 1933, 1♂: Cochise County; Cave Creek, May 15, 1933, 2♀. *Lepus californicus texianus*—Navajo County; Winslow, July 24, 1924, 1♂, 2♀. *Sylvilagus sp.*—Santa Cruz County; Santa Rita Mountains, May 4, 1933 (4 hosts) 43♂, 54♀; May 7, 1933, 9♂, 14♀: Pima County; Sells, May 10, 1933, 1♂, 3♀: Cochise County; Cave Creek, May 15, 1933 (3 hosts) 13♂, 23♀. *Sylvilagus audubonii cedrophilus*—Apache County; Concho, July 24, 1924, 1♀: Coconino County; Canyon Diablo, July 8, 1924, 3♂, 3♀.

COLORADO. *Lepus townsendii* subsp.—Conejos County; Antonito, August 8 to September 8, 1931, 7 hosts infested with 7♂, 5♀; May 18, 1932, 1♀; June 23, 1932 (2 hosts) 1♂, 2♀; June 24, 1932 (2 hosts) 6♂, 4♀; July 29, 1932, 8♂, 6♀; August 11, 1932 (3 hosts) 3♂, 2♀. *Sylvilagus nuttallii* subsp.—Conejos County; Antonito, August 8 to September 8, 1931, 30 hosts infested with 35♂, 52♀; June 23, 1932, 2♀; July 21, 1932, 4♂, 9♀: Archuleta County; Pagosa Springs, September 7, 1931, 3♂, 2♀. *Sylvilagus audubonii baileyi*—Adams County; Fort Morgan, August 11, 1924 (2 hosts) 4♀: Weld County; Hudson, August 11, 1924, 4♂, 10♀. *Sylvilagus audubonii warreni*—Costilla County; Blanca, August 4, 1925 (2 hosts) 2♂, 5♀.

FLORIDA. "Rabbit"—Miami; a single male specimen loaned by Mr. B. J. Collins.

IDAHO. During the period from June to September 1932, a total of 247 jack rabbits, *L. californicus* and *L. townsendii*, 11 cottontails, *S. nuttallii*, and 4 pigmy rabbits, *B. idahoensis*, all from Ada County, were examined without finding this species. From April 21 to May 2, 1933, 27 jack rabbits and 3 cottontails were examined in the same area. A single female was found on a jack rabbit.

IOWA. *Sylvilagus floridanus mearnsii*—Story County; Ames, May 1934, 1♂, 2♀ (R. L. Roudabush). In dwelling, Sioux County; Hawarden, May 1938, 1♂, 1♀ examined by writer (house reported to be badly infested, C. J. Drake).

KANSAS. Reported by Professor Roger C. Smith, Kansas State College (correspondence 1935) from "rabbit," Manhattan.

MINNESOTA. *Lepus americanus*—Cass County; Pine River, August 27, 1931, a series.

MONTANA. *Lepus bairdii*—Ravalli County; July 15, 1929, 1♀. (Only record from this host.) *Lepus townsendii*—Ravalli County; a single male specimen among the fleas collected from 10 hosts at various dates: Carter County; Albion, June 1935 (4 hosts examined) 3♀. *Sylvilagus nuttallii*—Ravalli County; September 16, 1931, 1♂; June 8, 1932, 1♀; June 1932, 1♂; July 8, 1932, 1♂; July 18, 1932, 6♂, 7♀; July 22, 1932, 1♂, 3♀; August 23, 1932, 1♀; February 7, 1934, 9♂, 28♀; January 24, 1936, 9♂, 14♀: Beaverhead County; Dillon, August 26, 1936, 3♂, 4♀; November 3, 1936 (7 hosts) 25♂, 47♀. *Sylvilagus* sp.—Custer County; Calabar, August 1, 1930, 5♂, 7♀ (F. A. Morton).

NEBRASKA. "Rabbit"—Roca, 1915, 1 specimen (Dr. Myron Swenk). *Sylvilagus* sp.—Scotts Bluff; May 25, 1933, 6♂, 2♀.

NEW MEXICO. *Lepus californicus* subsp.—Bernalillo County; July 12, 1935, 1♀; July 15, 1935, 6♀; July 18, 1935 (2 hosts) 5♀; July 19, 1935, 1♀; July 23, 1935, 1♂, 1♀; July 25, 1935, 1♀; July 30, 1935, 4♀; August 1, 1935, 3♀: Dona Ana County; Las Cruces, May 20, 1933 (4 hosts) 7♂, 5♀: Torrance County; May 29, 1935 (2 hosts) 1♂, 5♀; June 18, 1935, 1♀; June 21, 1935, 3♀. *Sylvilagus* sp.—Bernalillo County; June 27, 1935 (2 hosts) 15♂, 8♀; July 2, 1935 (2 hosts) 4♂, 6♀; July 8, 1935, 3♂, 1♀; July 9, 1935 (5 hosts) 21♂, 44♀; July 11, 1935 (2 hosts) 6♂, 14♀; July 15, 1935, 14♂, 31♀; July 18, 1935 (2 hosts) 18♂, 47♀; July 23, 1935 (2 hosts) 15♂, 10♀; July 29, 1935 (2 hosts) 7♂, 20♀; July 30, 1935 (2 hosts) 7♂, 7♀. *Sylvilagus audubonii cedrophilus*—Catron County; Quemado, July 14, 1924 (2 hosts) 5♂, 7♀. *Sylvilagus audubonii minor*—Otero County; Alamogordo, July 4, 1929, 1♂, 9♀.

NORTH DAKOTA. *Sylvilagus floridanus* subsp.—Cass County; Sheldon, May 29, 1935, 2♂, 3♀; Kindred, January 30, 1937, 10♂, 9♀ (J. A. Munro).

OKLAHOMA. *Lepus* sp. (jackrabbit)—Noble County; Perry, May 22, 1929, 1♀ (C. E. Sanborn). *Sylvilagus* sp.—Johnston County;

Tishimingo, May 11, 1929 (2 hosts) 1♂, 4♀ (Sanborn and Stiles): Noble County; Perry, May 23, 1929, 1♀ (C. E. Sanborn).

South Dakota. *Lepus townsendii campanius*—Brookings County; Brookings, October 28, 1935, 2♂, 14♀; December 17, 1935, 2♂, 1♀. *Sylvilagus floridanus similis*—Brookings County; Brookings, April 15, 1936, 1♀, October 24, 1936, 7♂, 1♀. *Sylvilagus* sp.—Brookings County; Brookings, June 6, 1920, 5♂, 1♀. All specimens from this State were received from Dr. H. E. Herriman, South Dakota State College; part of the lot was from the collection of Prof. H. C. Severin.

Texas. *Lepus californicus* subsp.—Donley County; Hedley, October 23, 1935, 1♂; Jeff Davis County; Davis Mountains, April 28, 1938 (2 hosts) 4♂, 5♀: Kleberg County; Kingsville, May 25, 1938, 1♂ (J. C. Brown); December 20, 1938, 11♂, 9♀ (J. C. Brown). *Sylvilagus* sp.—Cameron County; Brownsville, May 4, 1938, 12♂, 8♀: Brazos County; College Station, May 28, 1938 (2 hosts) 3♂, 7♀: Donley County; Hedley, October 23, 1935 (2 hosts) 23♂, 26♀: Gray County; Pampa, August 19, 1937 (2 hosts) 2♂, 9♀: Jeff Davis County; Davis Mountains, April 28, 1938 (4 hosts) 45♂, 67♀: Kleberg County; Kingsville, May 27, 1938, 4♂, 9♀ (J. C. Brown); December 3, 1938, 2♀ (J. C. Brown). *Sylvilagus aquaticus*—Brazos County; Bryan, May 29, 1938 (2 hosts) 2♀: Liberty County; Cleveland, May 13, 1938, 4♂, 4♀.

Wyoming. *Lepus* sp.—Laramie County; Cheyenne, 39 miles north, July 16, 1938, 1♂.

#### **Hoplopsyllus foxi** Ewing

Plate 2, Figures A, E, H

1924. *Hoplopsyllus foxi* Ewing, Parasitology *16:* 350–351, pl. 14, fig. 4.
1926. *Hoplopsyllus powersi* Fox, Pan-Pacific Ent. *2:* 184, text figs. 8, 11.
1926. *Hoplopsyllus minutus* Fox, Pan-Pacific Ent. *2:* 185, text figs. 6, 10.
1939. *Hoplopsyllus foxi* Ewing, Kohls, Publ. Hlth. Rpts. *54:* 2019–2020 = *H. powersi* Fox 1926, = *H. minutus* Fox 1926.

**Previous records.**—The species was described from a male (holotype) taken from *Sylvilagus bachmani*, San Francisco, Calif., 1908. *H. powersi* and *H. minutus* were described from specimens taken from the same host species, Los Angeles, 1925, and San Francisco, 1908, respectively.

**New records.**—California. *Lepus californicus californicus*—Monterey County; Soledad, August 30, 1922, 2♂, 9♀: San Luis Obispo County; Morro, September 10, 1922, 25♂, 29♀: Santa Cruz County; Corralitos, July 15, 1920, 2♂. *Lepus californicus richardsonii*—Fresno County; Lanare, June 8, 1924 (2 hosts) 1♂, 3♀: Kings County; Lemoore, September 29, 1922, 1♀: Monterey County; San Antonio Mission, September 3, 1922 (2 hosts) 1♂, 5♀. *Lepus californicus* subsp.—Mendocino County; Willits, July 16, 1936, 1♀:

Riverside County; Banning, May 29, 1935, 3♂, 4♀: San Benito County; Hollister, March 22, 1932, 4♂, 3♀. *Lepus* sp. (jack rabbits) —Shasta County; Redding, May 28, 1933 (5 hosts) 19♂, 49♀; May 29, 1933 (9 hosts) 17♂, 34♀; May 31, 1933 (2 hosts) 4♂, 13♀: Lassen County; Wendel, May 31, 1933, 1♂, 1♀. *Sylvilagus audubonii sanctidiegi*—San Diego County; La Jolla, October 10, 1922 (4 hosts) 23♂, 36♀. *Sylvilagus audubonii vallicola*—Monterey County; San Antonio Mission, September 5, 1922, 1♀. *Sylvilagus audubonii* subsp.—Kern County; Kernville, June 4, 1936, 1♂, 1♀: Monterey County; Hastings Natural History Reservation, July 24, 1938, 1♂: San Diego County; Vista, February 8, 1937 (3 hosts) 6♂, 13♀: Ventura County; Fillmore, June 10, 1936, 5♂, 7♀; June 13, 1936, 1♂, 4♀. *Sylvilagus bachmani bachmani*—San Luis Obispo County; Morro, September 10, 1922, 12♂, 23♀: Santa Cruz County; Corralitos, July 8, 1920, 1♂. *Sylvilagus bachmani cinerascens*—San Diego County; La Jolla, October 9, 1922 (4 hosts) 24♂, 51♀. *Sylvilagus bachmani mariposae*—Calaveras County; San Andreas, September 19, 1922 (2 hosts) 4♀. *Sylvilagus bachmani* subsp.—Monterey County; Hastings Natural History Reservation, April 25, 1939, 2♂, 1♀; Soledad, August 30, 1922, 7♂, 7♀: Riverside County; Banning, June 8, 1935, 1♀: San Diego County; Vista, May 12, 1936, 1♂, 10♀: San Luis Obispo County; Santa Margarita, June 19, 1936, 1♂, 1♀: Santa Cruz County; Los Gatos, June 22, 1936, 2♂, 2♀: Ventura County; Fillmore, May 22, 1936, 5♂, 5♀.

OREGON. *Lepus californicus* subsp.—Jackson County; Rogue River, August 19, 1935, 7♀: Josephine County; Grants Pass, May 1, 1935, 4♂, 12♀; June 12, 1935, 4♂, 4♀; June 17, 1935, 13♂, 7♀; July 20, 1935, 2♂, 1♀; August 4, 1935 (2 hosts), 9♂, 40♀; April 17, 1936, 14♂, 24♀; April 18, 1936, 2♂, 14♀. *Sylvilagus* sp.—Josephine County; Galice, May 5, 1935, 3♂, 26♀; May 9, 1935, 7♂, 23♀.

### DISCUSSION OF SPECIES OF HOPLOPSYLLUS

Regions where *Hoplopsyllus affinis* and *H. foxi* have been collected are shown on map 6, and *H. glacialis lynx* on map 7. The distribution of *H. glacialis glacialis* has already been discussed (p. 13).

*H. affinis* was not present in several collections of fleas from Alaska examined by the writer, nor has it been reported from that region or from Canada. As for the United States, I have obtained but one record east of the Mississippi River; Miami, Fla. Shaftesbury (1934) did not find it in North Carolina and Harkema (1936) made no reference to this flea among material collected from 41 cottontails in the same State. Probably the species occurs sparingly in parts of the eastern United States, but as yet no records have appeared in the literature.

On the other hand, *H. affinis* is common west of the Mississippi River as evidenced by the many records of its collection. Present data suggest that its western limit in the north is western Idaho. Its scarcity here has already been pointed out. Extensive collecting farther west in the regions of Burns (Harney County) and Lakeview (Lake County), Oreg., failed to reveal its presence. Jellison (Rocky Mountain Laboratory) in 1932 examined 12 jack rabbits and 2 cottontails from Elko, Nye, Churchill, and White Pine Counties in Nevada and *H. affinis* was not among the few fleas collected. In southern Arizona and southern New Mexico, however, it is apparently the only true rabbit flea present.

That this species may be very scarce in areas well within its distributional range is illustrated by Wyoming data. A single male was found in collections totaling over 500 fleas from about 40 jack rabbits and cottontails, principally from the southeastern section of the State. The host was taken July 16, 1938, on Horse Creek, 39 miles north of Cheyenne. This is the only known record of the species from the State.

*Hoplopsyllus foxi* was found to occur primarily west of the Sierra Nevada in California and west of the Cascade Mountains in Oregon and is known only from these two States. The northern limit of its distribution is unknown, but it was not found in a small collection of fleas from cottontails near Corvallis, Benton County, Oreg., nor was it found east of the Cascade Mountains in that State. It is of interest to note that its range corresponds in the main with that of *Cediopsylla inaequalis interrupta*. These two species are the common rabbit fleas of that region.

*Hoplopsyllus glacialis lynx* appears to be essentially limited to the varying hares and their predators. There is a single record of its occurrence on the pine squirrel, *Sciurus hudsonicus*, in Ravalli County, Mont. The fact that it has been found in such widely separated regions as Alaska, New Brunswick, and Oregon suggests that it will be found on varying hares in the intervening areas.

### **Odontopsyllus** Baker

1905. *Odontopsyllus* Baker, Proc. U. S. Nat'l. Mus. *29:* 129, 131, 145.

Two species of this genus occur in North America: *O. multispinosus* (Baker) and *O. dentatus* (Baker), both of which infest hares and rabbits. The species are readily distinguished by the number of spines in the pronotal comb, *multispinosus* having more than 30 and *dentatus* about 24.

**Odontopsyllus multispinosus** (Baker)

PLATE 3, FIGURES A, B, D

1898. *Pulex multispinosus* Baker, Jour. New York Ent. Soc. *6:* 54.
1904. *Ceratophyllus multispinosus* (Baker), Baker, Proc. U. S. Nat'l. Mus. *27:* 386, 389–390, 445; pl. 12, figs. 1–5.
1905. *Odontopsyllus multispinosus* (Baker), Baker, Proc. U. S. Nat'l. Mus. *29:* 129, 131.

**Previous records.**—The species was described by Baker from one male collected from *Sylvilagus floridanus mallurus* (="*Lepus sylvaticus*"), Raleigh, N. C., and was redescribed by him (1904) from specimens from the same host species and locality. Collected from nest of *S. floridanus mallurus*, East Falls Church, Va. (Jordan 1928). Recorded by Ward (1934) from *Lepus californicus* in central Oklahoma. Listed by Shaftesbury (1934) from *S. floridanus mallurus* collected in 1899, Raleigh, N. C., and from *Sylvilagus* sp. in Guilford, Orange, and Yadkin Counties, N. C., 1931 and 1932. Further records from this State (Durham County) are given by Harkema (1936), the host being *S. floridanus mallurus*.

Regarding its occurrence, Shaftesbury stated: "The few specimens recorded at the National Museum are from North Carolina, Maryland, and Massachusetts and all are from varieties of cottontail rabbits."

**New records.**—CONNECTICUT. *Lepus americanus*—Woodbridge, September 4, 1933, 1♂, 1♀.

IOWA. *Sylvilagus floridanus mearnsii*—Story County; Ames, May 1933, 2♂, 2♀; April 1935, 2♀; November 1936, 2♂, 2♀ (R. L. Roudabush; records through courtesy of Irving Fox).

MINNESOTA. Three specimens in the University collection (1937) labelled: "Hastings; host, cottontail."

**Odontopsyllus dentatus** (Baker)

PLATE 3, FIGURES C, E

1904. *Ceratophyllus dentatus* Baker, Proc. U. S. Nat'l. Mus. *27:* 386, 390, 441.
1905. *Odontopsyllus dentatus* (Baker), Baker, Proc. U. S. Nat'l. Mus. *29:* 131, 145.
1923. *Odontopsyllus spenceri* Dunn, Dunn and Parker, Publ. Hlth. Rpts. *38* (47): 2765–2766, 2775.

Dunn (Dunn and Parker, 1923) described *O. spenceri* from specimens collected from varying hares, Ravalli County, Mont., stating that the species differed from *O. dentatus* "by having more bristles in the upper genal row and on the dorsal surface of the ninth sternite." Commenting on the validity of *O. spenceri*, Collins (correspondence 1935) stated: "The type of *O. spenceri* agrees in practically all details with the type of *O. dentatus* * * * The material examined, including a series in the National Museum shows that there is variation in the number of these bristles, even in specimens from the same locality.

We consider *O. spenceri* to be the same as *O. dentatus*." The present writer concurs in this opinion.

**Previous records.**—The original description was of a single male specimen collected from *Lynx canadensis* at Moscow, Idaho. Baker regarded its occurrence on this host as "purely accidental" and subsequent records as listed below substantiate this opinion. Listed by Dunn and Parker (1923) as *O. spenceri* from *Sylvilagus nuttallii* and *Lepus bairdii*, Ravalli County, Mont.

**New records.**—California. *Lepus californicus* subsp.—Lassen County; Wendel, May 23, 1933, 1♂, 1♀; May 25, 1933, 2♀: Los Angeles County; March 28, 1932, 8♂, 4♀: Riverside County; Banning, May 29, 1935, 1♀: San Benito County; Hollister, March 22, 1932, 3♂, 1♀. *Sylvilagus audubonii* subsp.—San Diego County; Vista, February 8, 1937, 3♂: Ventura County; Fillmore, February 3, 1937, 2♂, 4♀. *Sylvilagus bachmani* subsp.—Monterey County; Hastings Natural History Reservation, April 25, 1939, 1♂, 1♀.

Colorado. *Lepus townsendii* subsp.—Conejos County; Antonito, May 18, 1932, 7♂, 15♀; June 17, 1932, 8♂, 11♀; June 24, 1932, 1♂; July 21, 1932, 1♂. In the same area during the period of August 8 to September 8, 1931, 34 *Sylvilagus nuttallii* were examined and no specimens of this species were found. *Sylvilagus* sp.—Larimer County; June 16, 1938, 1♀.

Idaho. *Lepus* sp. (jack rabbits)—Ada County; Mayfield, June 26, 1932 (2 hosts) 3♀; April 22, 1932, 1♀; April 23, 1933, 1♂, 3♀; April 28, 1933 (5 hosts) 6♂, 5♀; April 29, 1933, 1♂; May 2, 1933 (3 hosts) 2♂, 2♀. *Sylvilagus nuttallii* subsp.—Ada County; Mayfield, April 21, 1933, 1♂, 1♀; April 28, 1933, 1♀. The above Idaho records were obtained through examination of 247 jack rabbits, *L. californicus* and *L. townsendii*, 11 cottontails, *S. nuttallii*, and 4 pigmy rabbits, *B. idahoensis*, over the period of June to September 1932, and in the same area from April 21 to May 2, 1933, 27 jack rabbits and 3 cottontails were examined.

Montana. *Lepus californicus deserticola*—Beaverhead County; Dillon, April 19, 1936, 1♂, 1♀. *Lepus townsendii campanius*—Custer County; Miles City, June 6, 1935 (2 hosts) 1♂, 2♀: Ravalli County; January 16, 1934, 2♂; January 25, 1934, 1♀; October 30, 1934 (2 hosts) 3♂, 3♀; January 18, 1936, 2♂: Wheatland County; Harlowton, April 28, 1934, 1♂, 3♀. *Sylvilagus nuttallii* subsp.—Beaverhead County; November 2, 1936, 1♀; November 3, 1936 (3 hosts) 2♂, 2♀: Custer County; Miles City, June 6, 1935, 2♀: Ravalli County; July 16, 1929, 5 specimens; September 15, 1931, 1♀; July 8, 1932, 1♀; January 25, 1934, 6♂, 4♀; February 7, 1934, 2♂, 4♀; October 30, 1934, 1♂, 6♀; January 24, 1936, 2♂, 1♀.

NEVADA. *Lepus* sp. (jack rabbits)—Elko County; Wells, April 19, 1932, 4♂: Nye County; April 14, 1932, 1♂, April 15, 1932, 1♂.

OREGON. *Lepus* sp. (jack rabbits)—Josephine County; Grants Pass, May 1, 1935, 1♂; April 18, 1936, 2♀: Lake County; Lakeview, May 16, 1933, 4♂, 1♀; May 17, 1933, 1♂, 1♀; May 19, 1933 (2 hosts) 1♂, 1♀; May 20, 1933 (4 hosts) 4♂, 7♀: Linn County; Lyons, April 17, 1936, 1♀ (Dr. W. J. Chamberlain): Umatilla County; Echo, April 8, 1936, 1♂, 2♀ (Dr. W. J. Chamberlain). *Sylvilagus* sp.—Benton County; Corvallis, April 19, 1932, 2♀: Curry County; June 27, 1935, 1♀: Harney County; Burns, May 6, 1933 (2 hosts) 5♂, 3♀: Josephine County; Galice, June 27, 1935, 2♀: Lake County; Lakeview, May 19, 1933 (2 hosts) 17 specimens: Umatilla County; Echo, April 17, 1936, 1♂, 4♀ (Dr. W. J. Chamberlain); April 24, 1936, 2♂ (Dr. W. J. Chamberlain).

WYOMING. *Lepus* sp. (jack rabbits)—Carbon County; Medicine Bow, April 11, 1936, 1♂, 1♀. *Sylvilagus nuttallii grangeri*—Albany County; Laramie, December 24, 1935, 1♂. *Sylvilagus audubonii baileyi*—Albany County; Laramie, January 1936, 1♂. *Sylvilagus* sp.—Carbon County; Medicine Bow, April 1, 1936, 12♂, 1♀; Sweetwater County; Rock Springs, July 22, 1938, 1♀. The writer is indebted to Mr. James R. Simon, University of Wyoming, for all of the above Wyoming records, except the last.

### DISCUSSION OF SPECIES OF ODONTOPSYLLUS

The localities where the species of *Odontopsyllus* have been collected are shown on map 8. In the States of Maryland and Massachusetts, for which definite locality data were lacking, the spot indicating the presence of the species is centrally placed. This genus, like *Cediopsylla*, is of general occurrence throughout the United States but unreported for Canada and Alaska.

While distributional data regarding *O. multispinosus* are scant, the species is apparently restricted to the eastern half of the United States. The extreme western record is from central Oklahoma, and the species is known from only two other inland States—Iowa and Minnesota. Shaftesbury (1934) and Harkema (1936) reported its occurrence in North Carolina. No records are available for the Gulf States, but judging from replies to inquiries by correspondence, no attention has been given to fleas occurring on rabbits in that region. The species will probably be found here as well as throughout the Eastern and Great Lakes States.

*O. dentatus* is the western representative of the genus. The known distribution extends from California eastward to eastern Montana and Wyoming and south to southern Colorado. It was not seen in extensive collections of rabbit fleas from New Mexico and Arizona but it may be expected to occur in the extreme northern parts of these

States. Numerous records have been obtained from California and Oregon. With more intensive collecting, this species will undoubtedly be found in Utah and Washington.

It is of interest to note that *Odontopsyllus multispinosus* and *Cediopsylla simplex* occupy much the same range, while the ranges of *O. dentatus* and *C. inaequalis*, including its subspecies *interrupta*, are likewise almost identical.

PARASITE AND HOST LIST

1. **Cediopsylla simplex** (Baker):
   - *Lepus* sp. (jack rabbit).
   - *Lepus* sp. (varying hare).
   - *Lepus americanus americanus.*
   - *Sylvilagus* sp.
   - *Sylvilagus aquaticus.*
   - *Sylvilagus floridanus* subsp.
   - *Sylvilagus floridanus mallurus.*
   - *Sylvilagus floridanus mearnsii.*
   - *Sylvilagus floridanus similis.*
   - *Sylvilagus transitionalis.*

2. **Cediopsylla inaequalis inaequalis** (Baker):
   - *Brachylagus idahoensis.*
   - *Lepus* sp. (jack rabbit).
   - *Lepus bairdii* subsp.
   - *Lepus californicus* subsp.
   - *Lepus californicus deserticola.*
   - *Lepus californicus melanotus.*
   - *Lepus townsendii* subsp.
   - *Lepus townsendii campanius.*
   - *Sylvilagus* sp.
   - *Sylvilagus audubonii baileyi.*
   - *Sylvilagus audubonii cedrophilus.*
   - *Sylvilagus audubonii warreni.*
   - *Sylvilagus nuttallii grangeri.*
   - *Sylvilagus nuttalliii nuttallii.*
   - *Sylvilaqus nuttallii pinetis.*

3. **Cediopsylla inaequalis interrupta** Jordan:
   - *Brachylagus idahoensis.*
   - *Lepus* sp. (jack rabbit).
   - *Lepus californicus* subsp.
   - *Lepus washingtonii washingtonii.*
   - *Sylvilagus* sp.
   - *Sylvilagus audubonii* subsp.
   - *Sylvilagus bachmani* subsp.
   - *Sylvilagus bachmani ubericolor.*
   - *Sylvilagus nuttallii* subsp.
   - *Sylvilagus nuttallii nuttallii.*

4. **Hoplopsyllus glacialis glacialis** (Tasch.):
   - *Lepus* sp. (Arctic hare).

5. **Hoplopsyllus glacialis lynx** (Baker):
   *Lepus americanus* subsp.
   *Lepus americanus macfarlani.*
   *Lepus bairdii* subsp.
   *Lepus washingtonii klamathensis.*
   *Lynx* sp.
   *Lynx canadensis.*
   *Lynx fasciatus.*
6. **Hoplopsyllus affinis** (Baker):
   *Lepus* sp. (jack rabbit).
   *Lepus americanus* subsp.
   *Lepus alleni.*
   *Lepus bairdii* subsp.
   *Lepus californicus* subsp.
   *Lepus californicus deserticola.*
   *Lepus californicus eremicus.*
   *Lepus californicus melanotus.*
   *Lepus californicus texianus.*
   *Lepus townsendii* subsp.
   *Lepus townsendii campanius.*
   *Sylvilagus* sp.
   *Sylvilagus aquaticus.*
   *Sylvilagus audubonii baileyi.*
   *Sylvilagus audubonii cedrophilus.*
   *Sylvilagus audubonii minor.*
   *Sylvilagus audubonii warreni.*
   *Sylvilagus floridanus mearnsii.*
   *Sylvilagus floridanus similis.*
   *Sylvilagus nuttallii* subsp.
7. **Hoplopsyllus foxi** Ewing:
   *Lepus* sp. (jack rabbit).
   *Lepus californicus californicus.*
   *Lepus californicus richardsonii.*
   *Sylvilagus* sp.
   *Sylvilagus audubonii* subsp.
   *Sylvilagus audubonii sanctidiegi.*
   *Sylvilagus audubonii vallicola.*
   *Sylvilagus bachmani bachmani.*
   *Sylvilagus bachmani cinerascens.*
   *Sylvilagus bachmani mariposae.*
8. **Odontopsyllus multispinosus** (Baker):
   *Lepus americanus* subsp.
   *Lepus californicus* subsp.
   *Sylvilagus* sp.
   *Sylvilagus floridanus mallurus.*
   *Sylvilagus floridanus mearnsii.*
9. **Odontopsyllus dentatus** (Baker):
   *Lepus* sp. (jack rabbit).
   *Lepus bairdii* subsp.
   *Lepus californicus deserticola.*
   *Lepus townsendii campanius.*
   *Sylvilagus* sp.
   *Sylvilagus audubonii* subsp.
   *Sylvilagus audubonii baileyi.*

*Sylvilagus bachmani* subsp.
*Sylvilagus nuttallii* subsp.
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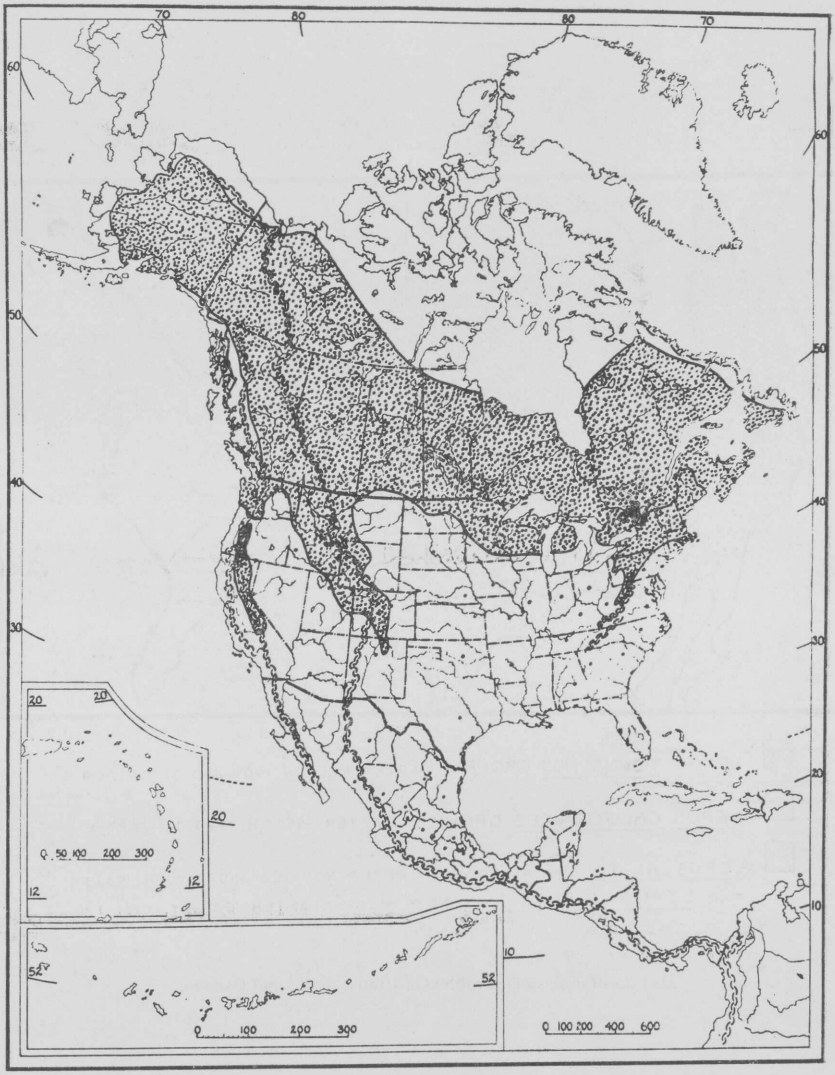
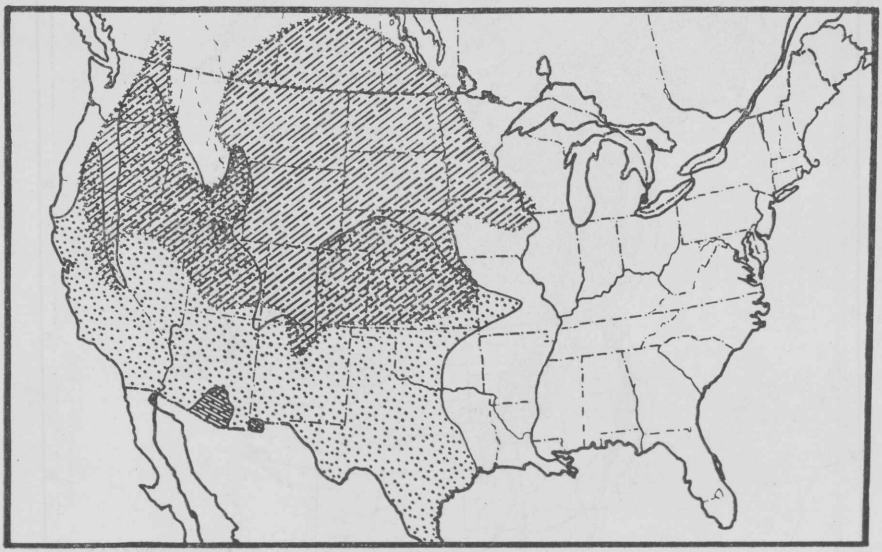
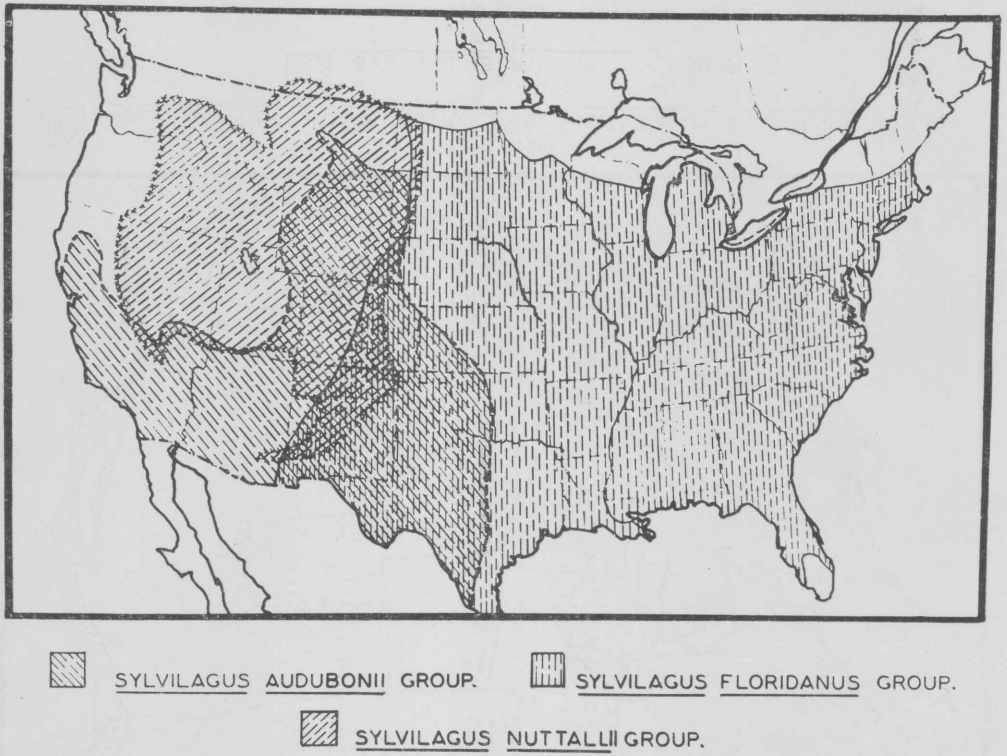


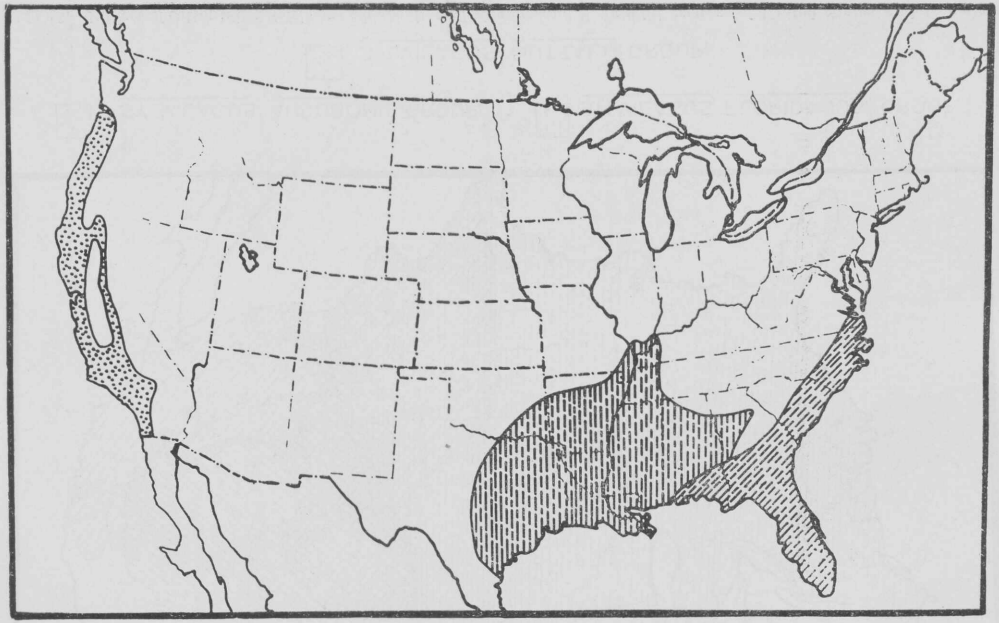

MAP 1.—Range of varying hares of Alaska, Canada, and United States. (After Seton 1929 in part.)




MAP 2.—Ranges of jack rabbits of United States and Canada.

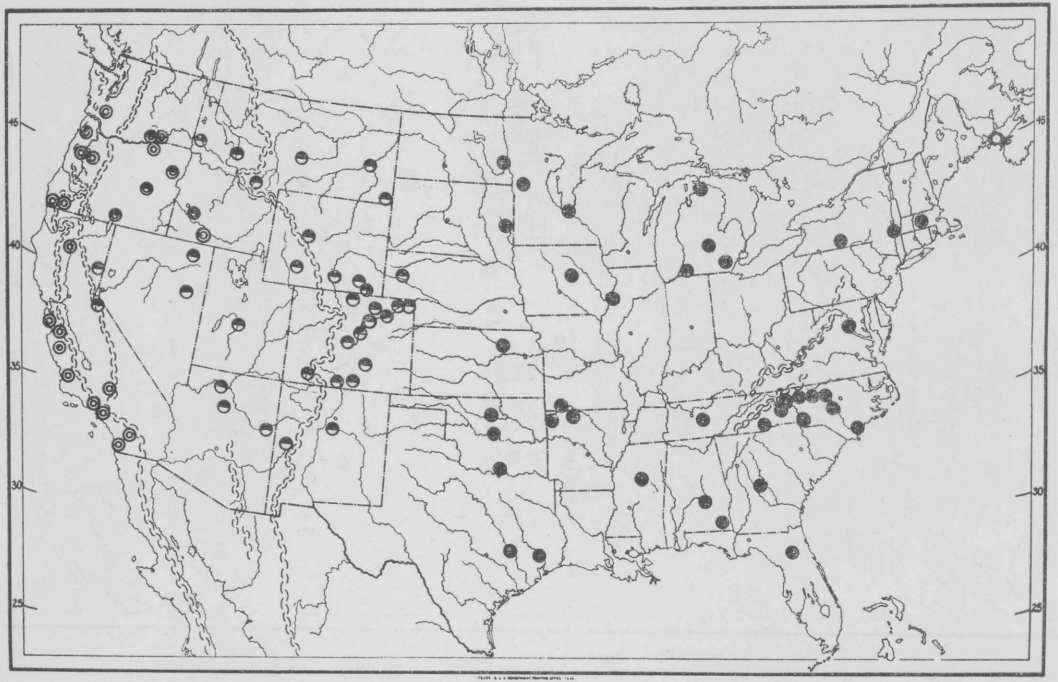



MAP 3.—Ranges of cottontails: *Sylvilagus audubonii*, *S. floridanus*, and *S. nuttallii* groups, of United States and Canada. (After Seton, 1929.)



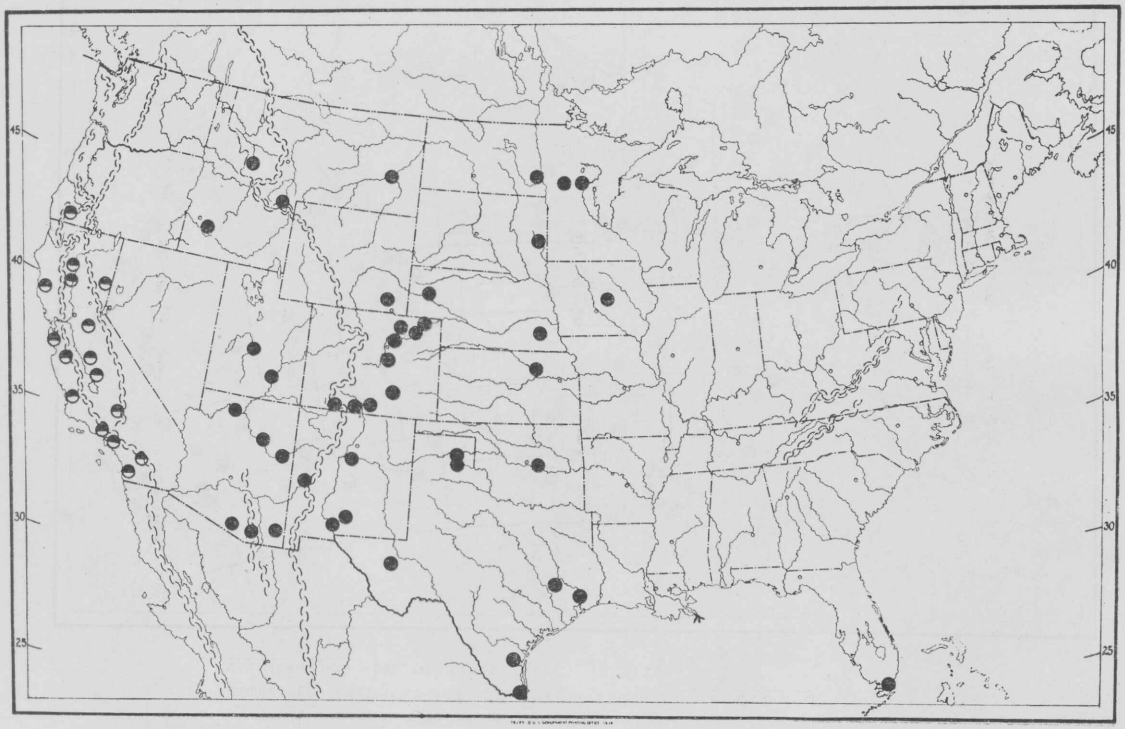

MAP 4.—Range of brush rabbits, *Sylvilagus bachmani* group; swamp rabbits, *S. aquaticus* group, and marsh rabbits, *S. palustris* United States. (After Seton 1929 in part.)

SHOWING LOCALITIES WHERE CEDIOPSYLLA SIMPLEX (BAKER) [●], C. INAEQUALIS INAEQUALIS (BAKER) [◓] AND C. I. INTERRUPTA JORDAN [◎] HAVE BEEN COLLECTED. [◓] INDICATES LOCALITIES WHERE BOTH C. I. INAEQUALIS AND C. I. INTERRUPTA WERE COLLECTED.

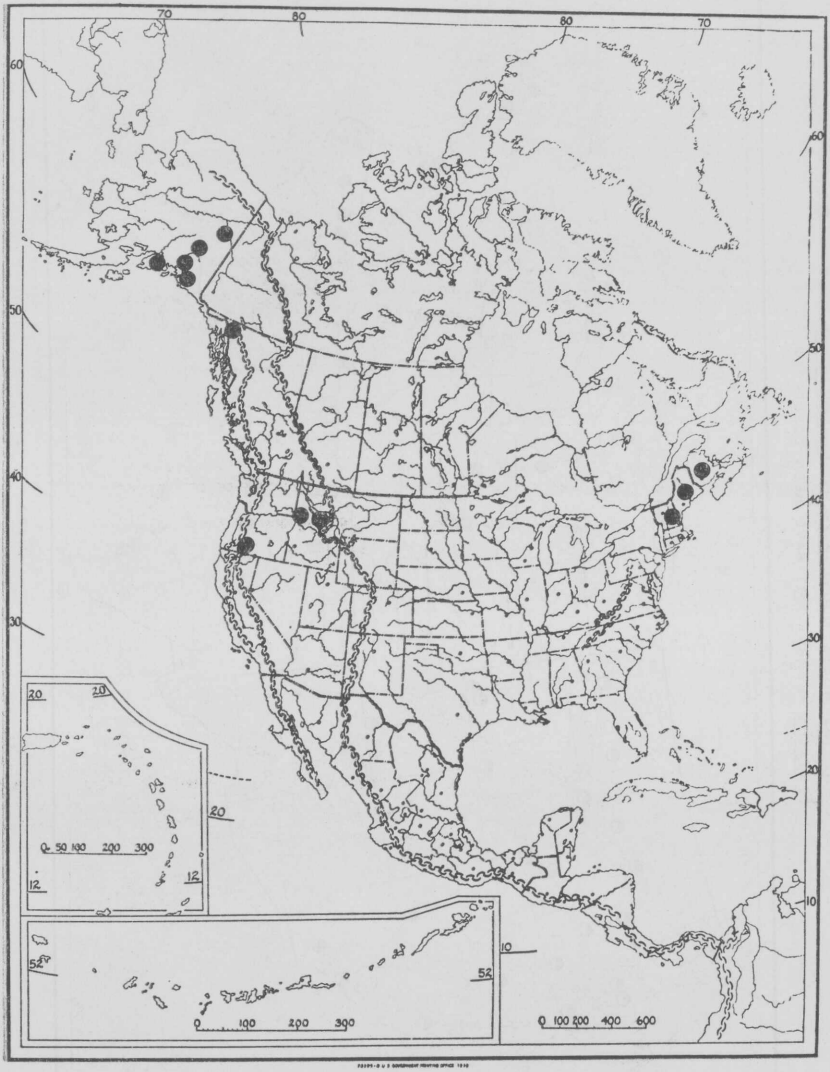



MAP 5.

SHOWING LOCALITIES WHERE HOPLOPSYLLUS AFFINIS (BAKER) [●] AND H. FOXI EWING [◓] HAVE BEEN COLLECTED.

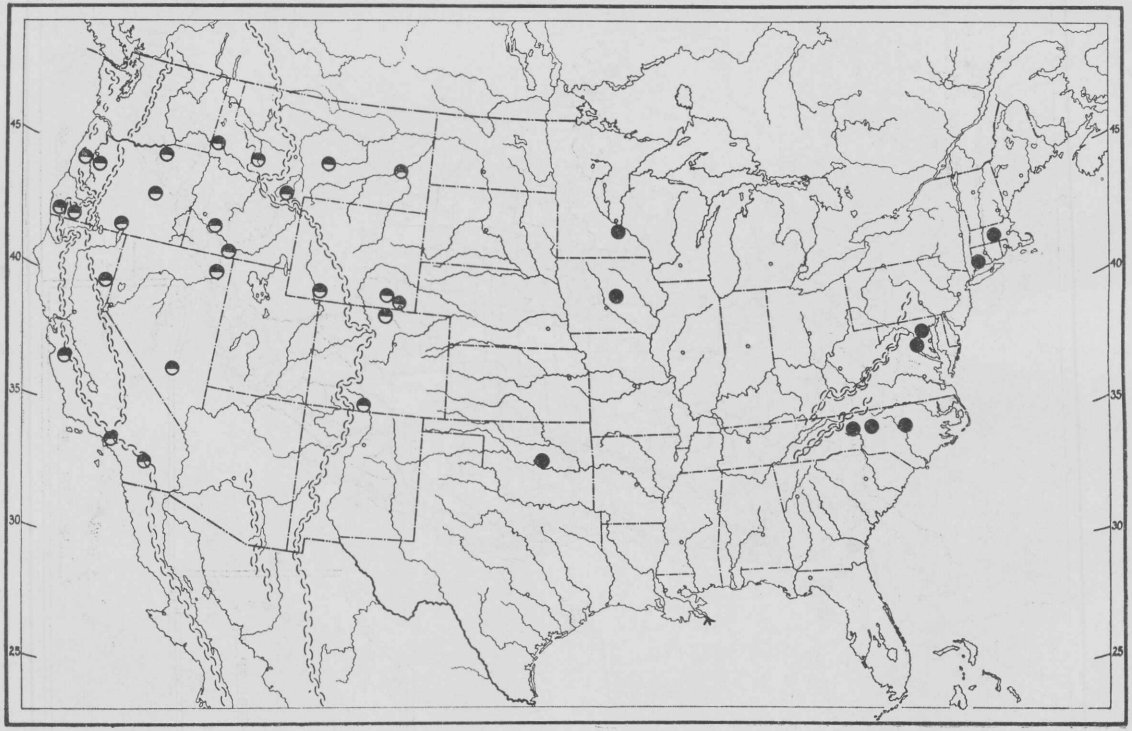



MAP 6.




MAP 7.—Showing localities where *Hoplopsyllus glacialis lynx* (Baker) has been collected.

SHOWING LOCALITIES WHERE ODONTOPSYLLUS MULTISPINOSUS (BAKER) [●] AND
O. DENTATUS (BAKER) [◓] HAVE BEEN COLLECTED.

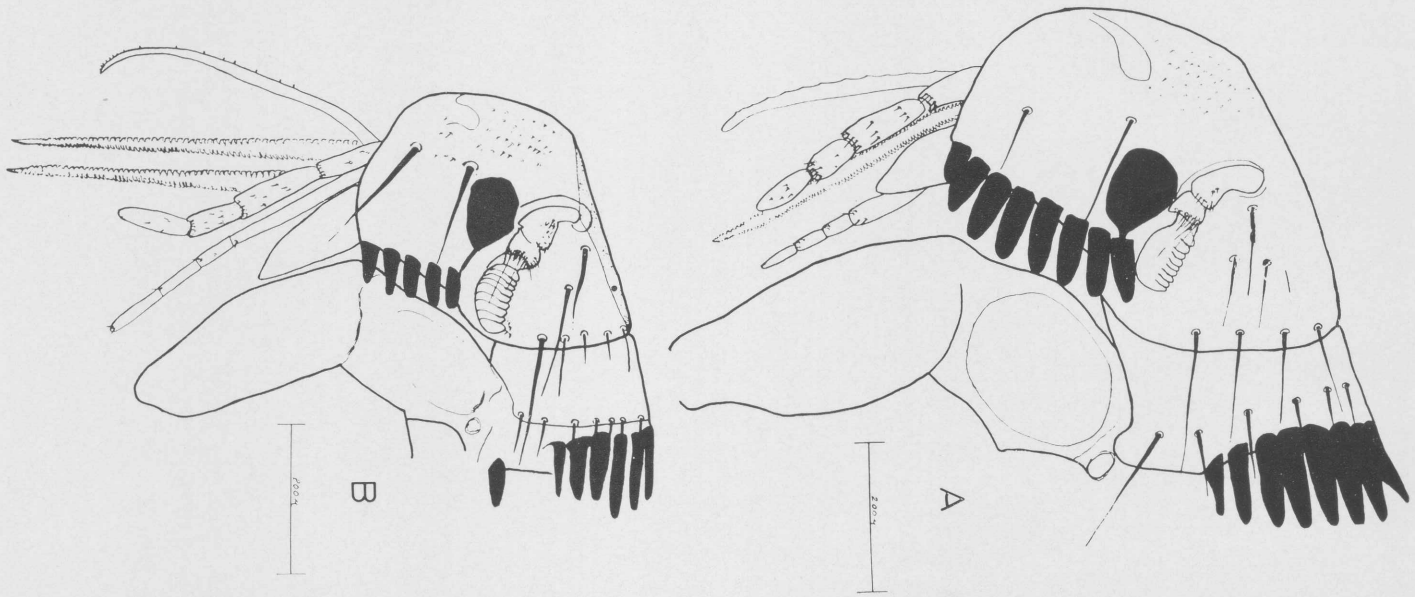



MAP 8.

PLATE 1

A. *Cediopsylla simplex* (Baker). Head.

B. *Cediopsylla inaequalis inaequalis* (Baker). Head.


B
200 µ
A
200 µ

## Plate 2

A. *Hoplopsyllus foxi* Ewing. Seventh sternite of female.

B. *Hoplopsyllus glacialis lynx* (Baker). Seventh sternite of female.

C. *Hoplopsyllus affinis* (Baker). Seventh sternite of female.

D. *Hoplopsyllus affinis* (Baker). Head of male.

E. *Hoplopsyllus foxi* Ewing. Spermatheca.

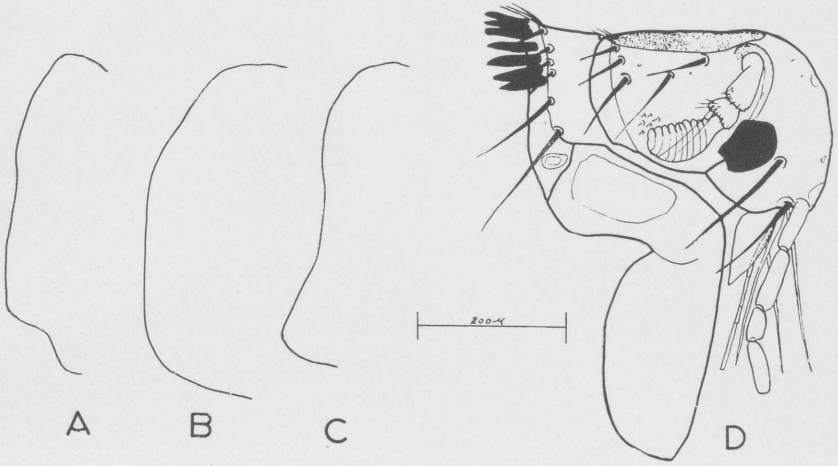
F. *Hoplopsyllus glacialis lynx* (Baker). Spermatheca.

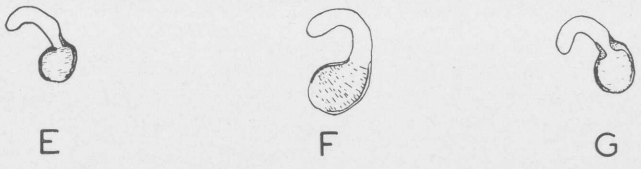
G. *Hoplopsyllus affinis* (Baker). Spermatheca.

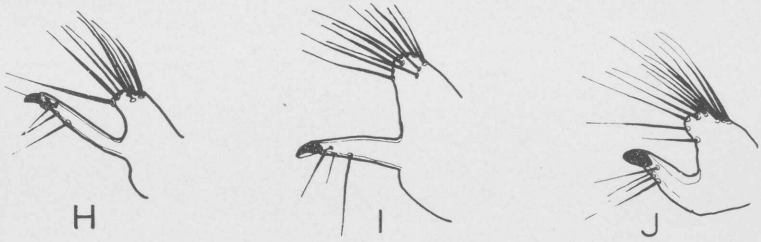
H. *Hoplopsyllus foxi* Ewing. Spined and bristled processes of male clasper.

I. *Hoplopsyllus glacialis lynx* (Baker). Spined and bristled processes of male clasper.

J. *Hoplopsyllus affinis* (Baker). Spined and bristled processes of male clasper.


200μ
A
B
C
D


E
F
G


H
I
J

## Plate 3

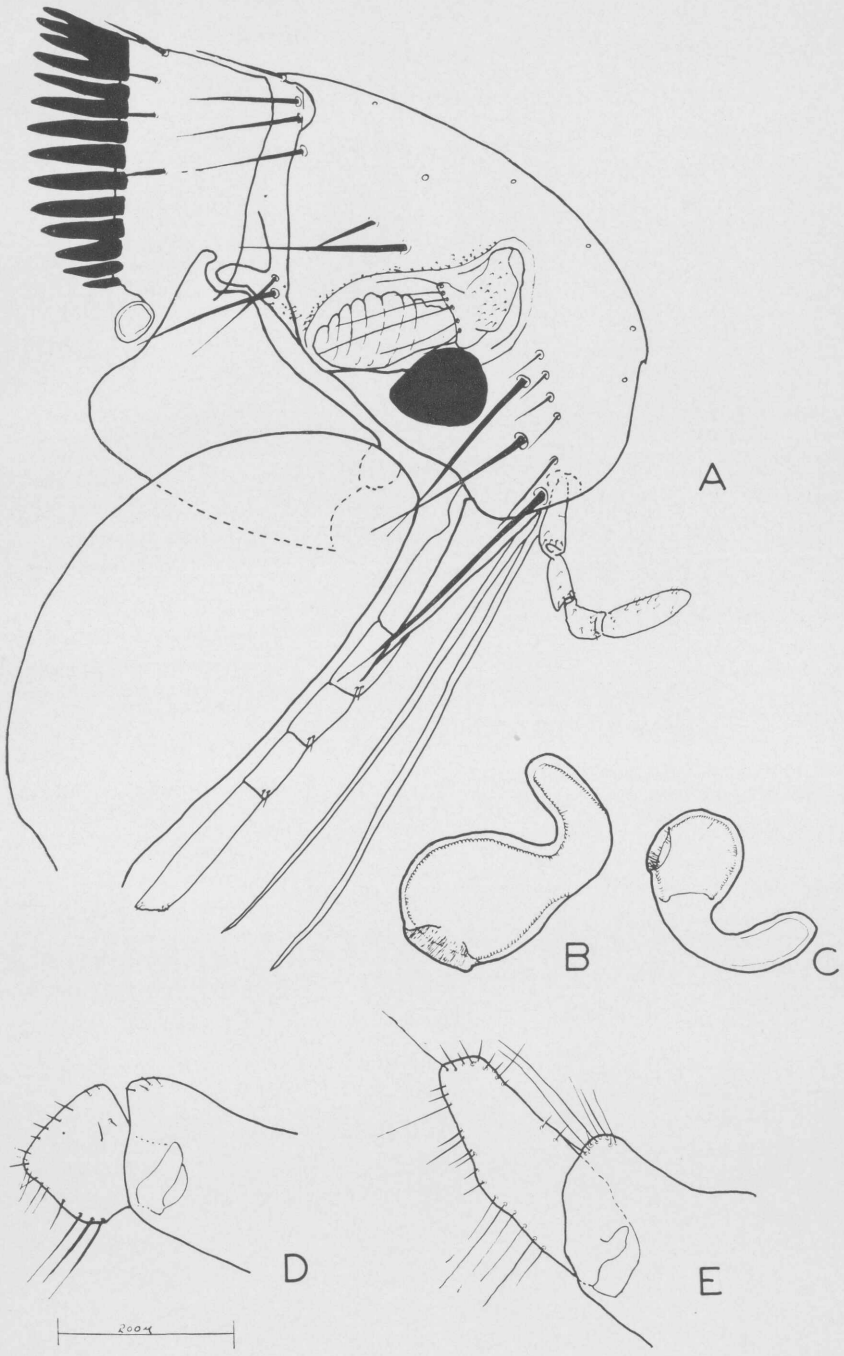
A. *Odontopsyllus multispinosus* (Baker). Head, female.

B. *Odontopsyllus multispinosus* (Baker). Spermatheca.

C. *Odontopsyllus dentatus* (Baker). Spermatheca.

D. *Odontopsyllus multispinosus* (Baker). Movable and immovable processes of male clasper.

E. *Odontopsyllus dentatus* (Baker). Movable and immovable processes of male clasper.


A
B
C
D
E
200μ