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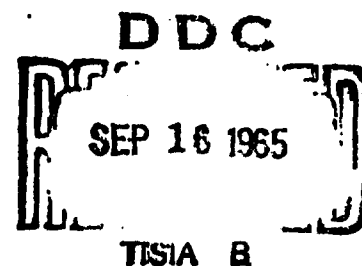
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ALASKAN HEMATOPHAGOUS INSECTS, THEIR FEEDING
HABITS AND POTENTIAL AS VECTORS OF
PATHOGENIC ORGANISMS

I: THE SIPHONAPTERA OF ALASKA

Cluff E. Hopla

May 1965

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ARCTIC AEROMEDICAL LABORATORY

AEROSPACE MEDICAL DIVISION
AIR FORCE SYSTEMS COMMAND
FORT WAINWRIGHT, ALASKA

SECURITY

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ALASKAN HEMATOPHAGOUS INSECTS, THEIR FEEDING HABITS AND POTENTIAL AS VECTORS OF PATHOGENIC ORGANISMS

I: THE SIPHONAPTERA OF ALASKA

Cluff E. Hopla

FOREWORD

This technical report constitutes Part I of the final report on contract AF 41(657)-333 (Project 8241, Task 824101) with the University of Oklahoma Research Institute, Norman, Oklahoma. The report covers work done from June 1960 through May 1964. Part II will be "The Feeding Habits and Colonization of Subarctic Mosquitoes." Air Force program monitor is Robert Becker, ALRA, Arctic Aeromedical Laboratory.

This technical report has been reviewed and is approved.

HORACE F. DRURY
Director of Research

ABSTRACT

Fifty-one species and subspecies of fleas are currently known in Alaska; 37 species normally occur on mammals, and 14 are associated with birds. With the possible exception of one or two species, none are restricted to the political entity, Alaska. From a study of geography, paleozoology, morphology and taxonomy, the fleas of Alaskan mammals are reported to be derived from three principal faunas. The largest group apparently arose from Eurasia as the mammals migrated across the Bering Land Bridge during the glacial periods of the Pleistocene epoch and earlier. These animals found refuge in a large nonglaciated area of interior Alaska and the Yukon Territory. These fleas are now common to both the Nearctic and Palearctic regions, their hosts generally being Holarctic in distribution. The second group of fleas are Nearctic in origin and have migrated northward along with their hosts as the Pleistocene glaciers receded. A number of the genera in this second group are restricted exclusively to the Nearctic region; however, certain genera are also represented in Eurasia. A third group of fleas arose from the Pacific Northwest. These fleas, like the second group, have spread northward as the Pleistocene glaciers receded. Fleas of this third group now occupy a narrow strip of land, mostly west of the Coast and Alaska Ranges. A study of host associations reveals that distribution of the fleas is not concordant with that of the preferred hosts. For example, of six species associated with microtine rodents in the taiga, only two have followed the same hosts into the vast tundra region to the north. Fleas originally thought to be restricted to the Arctic regions are now known to have adapted to hosts within the taiga, albeit the distribution is not an extensive one. These distribution patterns indicate that the Siphonaptera are subject to ecological factors and pressures over and above those which affect the distribution of the mammals and birds upon which they depend for their existence. Additional knowledge is urgently needed in order to understand the biology of the flea, especially in the subarctic and Arctic areas of the world. The data collected thus far indicate that most fleas in the taiga have one or possibly two generations a year. By late winter and early spring, Malaraeus penicilliger dissimilis (Jordan, 1938) is frequently the only species encountered upon the microtine rodents. During July, August, September and October, the small mammals are most abundant. Simultaneously, the flea infestation rates upon the mammals increase, and the number of different species encountered also becomes more varied.

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INTRODUCTION

A study of the flea fauna in arctic and subarctic America is of considerable interest because, unlike the other ectoparasites of warm-blooded animals, the larval form of the flea is free-living; therefore the larval adjustment to the environment must be considerably greater than, for example, that of the louse or perhaps even that of the adult flea. An investigation of seasonal variations in population should furnish data on the adaptations of the boreal fleas to the environment.

It has been postulated by mammalogists (118, 10, 104) that a considerable portion of the boreal mammalian stock in North America is of Eurasian origin. An investigation of the siphonapterous fauna should shed additional light upon this intriguing concept. Such information is particularly important in understanding some of the zoonoses that occur in the Nearctic region. It seems likely that certain of these diseases were introduced by the animals and their ectoparasites as they established new beachheads on the North American continent. Thus, a zoogeographic investigation of the flea fauna of Alaska ought to contribute to our understanding of the origin and spread of these diseases.

Data for this study have been accumulated over a period of several years, beginning in 1955. Significantly, a direct study of the Siphonaptera was never the issue. Part of the information was gathered while collecting mammals for possible recovery of tularemia organisms and other etiological agents pathogenic to man. Recently, data were gathered while working on the feeding habits of mosquitoes and other hemophagous arthropods.

A taxonomic approach has been utilized, in part, during the course of this investigation, and while it was not the ultimate or primary goal, it was decided to add all species that have been reported from Alaska and its adjacent islands, even though I had not collected them myself, so that a thorough coverage of the known fauna could be completed. It will be noted that my own collecting efforts were largely confined to the fleas of the Rodentia, with the exception of the Hirundinidae.

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II

REVIEW OF LITERATURE

In many ways, the current study has been blessed by a paucity of literature dealing directly with Alaskan Siphonaptera, thereby avoiding the confusion generated by some of the earlier American workers who did not fully appreciate this group of insects. Jellison and Kohls (79) listed 17 species of fleas and their hosts. Hubbard, in 1943 and 1947 (69, 70), essentially repeated Jellison and Kohls. However, in 1960 Hubbard (72) presented a short paper based on a "packet" of fleas presented to him by Murray Johnson. Some of the records in this last study are of dubious validity, as the collection data on the slides frequently do not agree with that presented in publication.

In 1961 Holland (58) presented a paper in the Pacific Science Congress dealing with the faunal affinities of the Alaskan Siphonaptera and added an annotated list of species. Holland's list indicated 46 species, an interesting comparison with that of Jellison and Kohls (79). Two other excellent general works by Holland (45, 56) have considerable bearing upon the present study. The first one, "Siphonaptera of Canada," is perhaps the most important publication dealing with Nearctic Siphonaptera. While the second publication was not the first to call attention to the circumpolar distribution of northern fleas, no other article so lucidly explains this concept. The discussion dealing with the origins of the flea stocks is particularly informative.

Literature dealing with original descriptions of a particular species will be reviewed under the species accounts.

III

CLIMATE AND GEOGRAPHY

Climate has an indirect effect upon the terrestrial vertebrate hosts and a direct one upon at least the larval flea. The indirect effects upon the host, including the amount and kind of food that is available and the protective cover, largely determine the distribution of the terrestrial mammals. The larval flea, on the other hand, is dependent upon the temperature of the host's nest. The body heat of the host animal, as well as the amount of time the host spends in the nest, no doubt contribute significantly to the microenvironment of the nest. When the flea is not on the host, then it is directly influenced by the nest environment.

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The topography of Alaska exerts a strong effect upon the climate. The coastal mountains of the Alaska Range are the highest and some of the most massive mountains in western North America, and they stand directly in the path of warm moist air masses coming in from the Gulf of Alaska. Partly as a result of this, the amount of precipitation in the northern area is considerably lower than in southeastern Alaska. The Brooks Range in northern Alaska is lower, less massive and faces the cold Arctic Ocean rather than the warmer Gulf of Alaska. The intermontane area between these two ranges of mountains is characterized by broad valleys or lowlands, through which are interspersed small chains of mountains. For example, the Yukon Flats and the Tanana Valley are, for the most part, between 400 and 600 feet in elevation and are drained by the Yukon River and its tributaries. The principal drainage systems within Alaska are shown in Figure 1.

In the light of the above discussion, climatic factors important to the host and the fleas should not only prove interesting but also provide a better background for understanding the zoogeography of the flea. Various investigators have developed concepts attempting to relate such vegetation and animal factors. For the purpose of this discussion, the work of Dice (15), Figure 2, and that of Hopkins et al (62), Figure 3, are pertinent. These two studies were concerned with different problems, yet it is interesting to observe that the latter authors' "Zone of Continuous Permafrost" closely parallels Dice's Eskimoan Biotic Province; the "Zone of Discontinuous Permafrost" corresponds largely with the Hudsonian Biotic Province; and the "Zone of No Permafrost" is nearly congruous with the Sitkan Biotic Province. Figure 3 more accurately reveals the distribution of the tundra and the taiga.

Eskimoan Biotic Province

This unique area is characterized by the nearly universal presence of permafrost. The soil thaws in the summer to a depth of 6 inches to 4 feet, depending upon surface material, vegetation cover and exposure. The permafrost is perhaps the dominant ecological feature of the Eskimoan Biotic Province, thereby producing an entirely different flora and fauna, for without it, the arctic slope would indeed be a desert. Thienemann (142) first postulated the importance of permafrost in the conservation of moisture within the Arctic.

The vegetation collectively is termed tundra and lies beyond the limit of tree growth, although tall willows, alders and scattered poplars grow along the channels of the large streams in the southern part of the region. Tundra vegetation consists primarily of dwarf shrubs, grasses, sedges, lichens and herbaceous plants. The term tundra is applied to a wide variety of vegetation types and is not a good indicator of presence or absence of permafrost. Unless the type of tundra is specified, it simply means the absence of trees. For example, alpine tundra is considerably different from the tundra found on the

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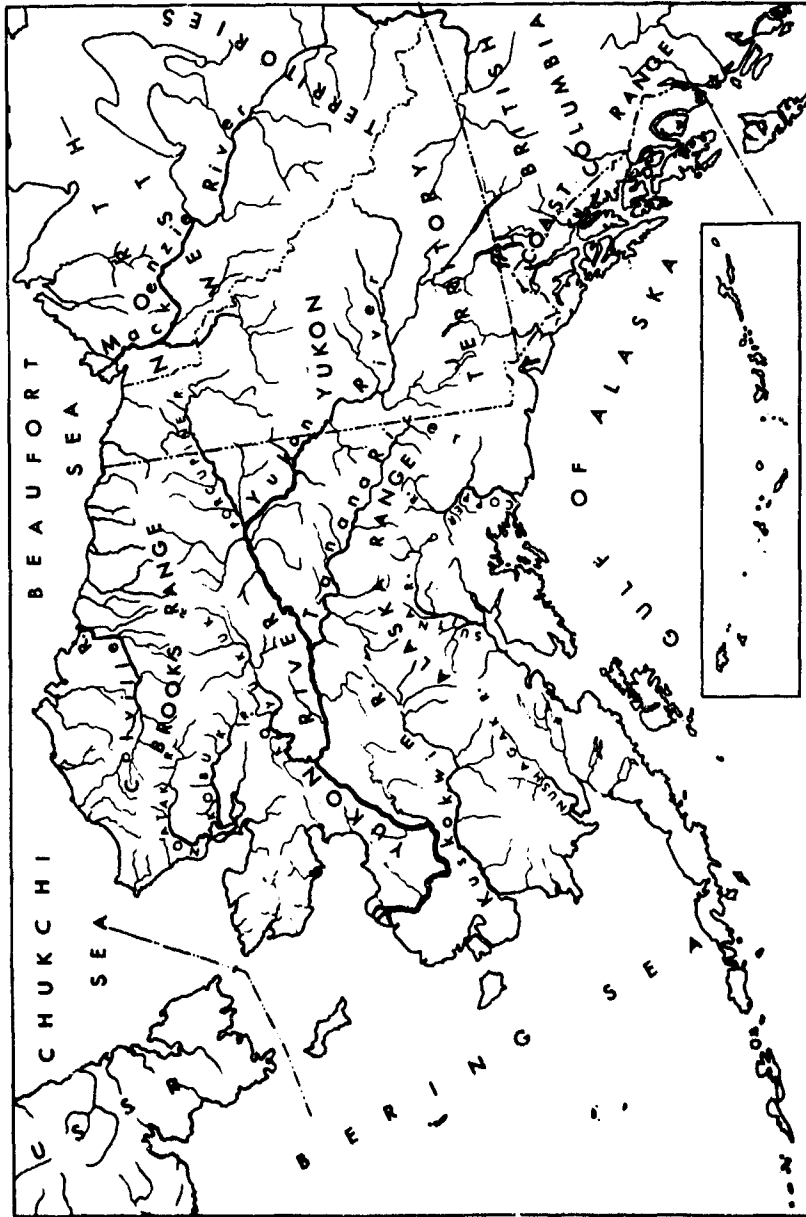
FIGURE 1

Principal Drainage Systems in Alaska

With the exception of the Colville River and its tributaries, most of the rivers flow approximately in a west-southwesterly direction.

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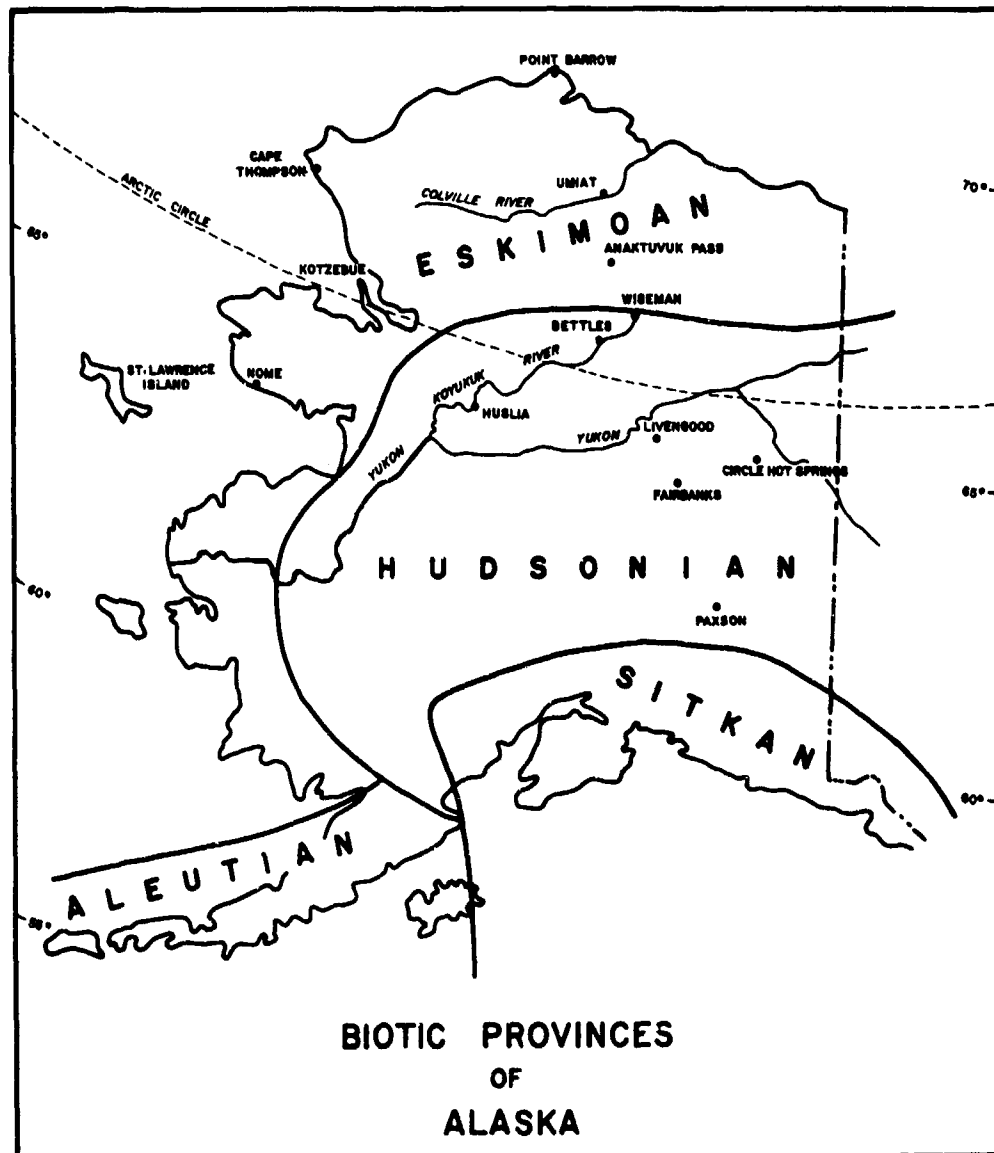
FIGURE 2

The Biotic Provinces of Alaska (after Dice, 15)
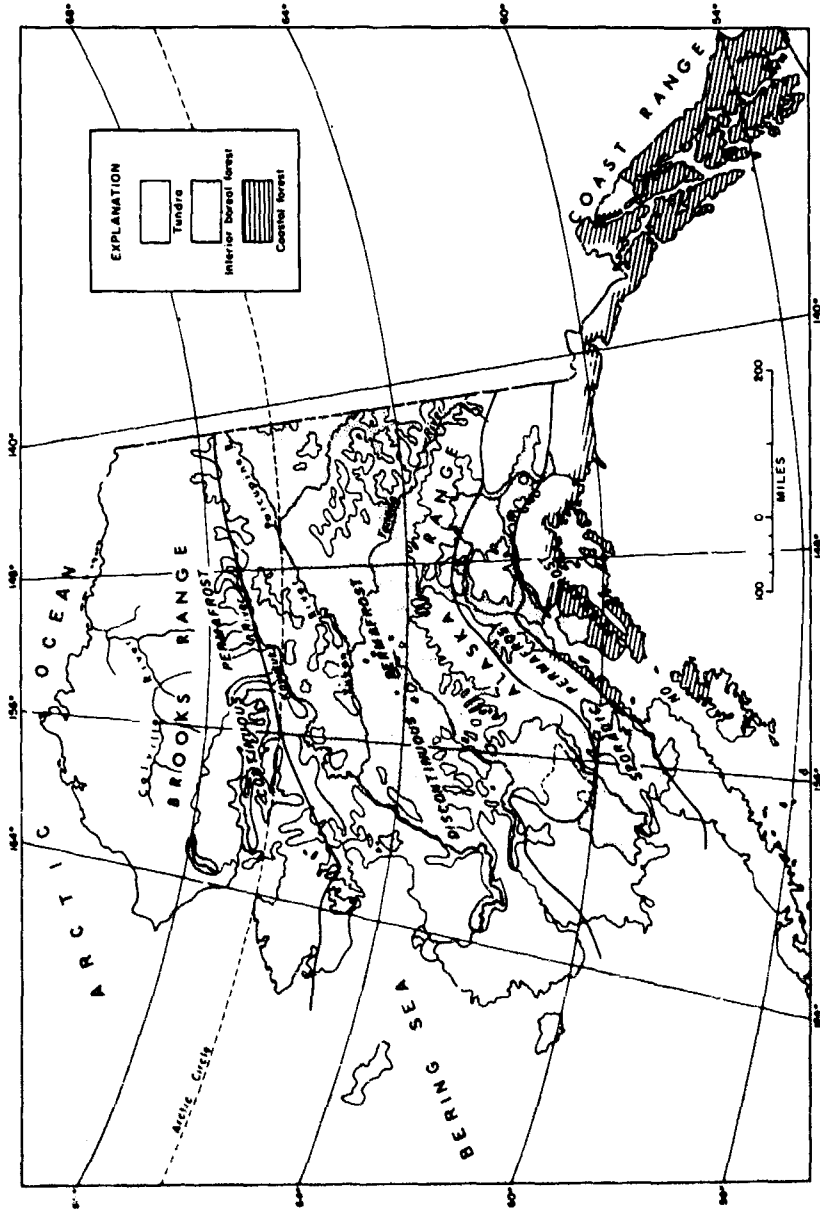
FIGURE 3

The Distribution of Treeless and Forested Areas in Alaska

The treeless areas consist mainly of tundra but also include glaciers and exposed bedrock (after R. S. Sigafoos, 124).

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arctic slope beyond the Brooks Range or tree line. Areas of tundra vegetation are interspersed with forested areas throughout most of Alaska, and both tundra and forests occur in all of the permafrost zones, as well as in the zones of no permafrost (note Figure 3).

Mammals frequently encountered and more or less characteristic of this biotic province follow. Some of these mammals are found to the south in the taiga, and thus they can not be truly characteristic of the province. Others, such as hoary marmot (Marmota caligata) and the arctic ground squirrel (Spermophilus undulatus), are "characteristic" of the upland "tundra" throughout the montane areas to the south. For further accounts of arctic mammals, the reader is referred to Rausch (118), Bee and Hall (4) and Hall and Kelson (39).

The aforementioned list of mammals in the Eskimoan Biotic Province includes: Sorex arcticus (arctic shrew), Sorex cinereus (masked shrew), Lepus othus (Alaskan hare), Marmota caligata (hoary marmot), Spermophilus undulatus (arctic ground squirrel), Clethrionomys rutilus (red-backed vole), Dicrostonyx groenlandicus (collar lemming), Lemmus trimucronatus (brown lemming), Microtus miurus (singing vole), Microtus oeconomus (arctic vole), Alopex lagopus (arctic fox), Canis lupus (gray wolf), Vulpes fulva (red fox), Ursus horribilis (grizzly bear), Gulo luscus (wolverine), Mustela erminea (ermine), Mustela rixosa (least weasel), Alces alces (moose), Rangifer tarandus (caribou), Ovis dalli (Dall's sheep).

As an example of the climate, let us consider Umiat. While Umiat is farther inland than Point Barrow, the climate is not remarkably different. The annual mean temperature at Umiat is 10° F, and the recorded extremes are 79° and -57° F. Mean annual precipitation is 5.4 inches, half of it represented by rainfall during the months of July, August and September. Annual snowfall is approximately 33 inches. Wind is a prevalent feature in this area and causes considerable drifting of the powdery snow that falls during the long, cold winter.

Hudsonian Biotic Province

This area is limited in the north at the tree line (spruce forests) on the south slope of the Brooks Range, in the south by the north slope of the Coast Range and by altitude on various mountain systems in between. To most ecologists, this area is included in the "taiga." However, the taiga also includes the Canadian Biotic Province, which does not occur in Alaska; therefore, the application of the term in this discussion is more restricted than usual. The Hudsonian is essentially transcontinental, stretching from Newfoundland to western Alaska, but is prevented from reaching the coastline by a narrow strip of the tundra (Eskimoan Biotic Province), as illustrated in Figures 2 and 3. It reaches the Pacific Ocean only in a narrow strip at Cook Inlet.

On the south slope of the Brooks Range, the Hudsonian has many finger-like processes extending up into the low, protected valleys; likewise, it is penetrated by tundra along the mountain ridges at the higher elevations, as can be observed in Figure 3. This is the "Zone of Discontinuous Permafrost," and the climate is characterized as a cold continental one (i. e., short, warm summers and long, cold winters). A large part of our study was conducted in the Tanana Valley, which is typified by data obtained in the Fairbanks environs (a mean annual temperature of 26.1° F, with extremes of 99° and -66° F). The mean annual precipitation is 11.7 inches, 60% of which falls as rain, during the period from May to September. The mean annual snowfall is 67 inches. The Tanana Valley has been subjected to considerable ecological disturbance. At first this was due to the gold mining operations, followed by attempts at homesteading for agricultural purposes and the production of rough lumber used in construction and housing needs. Military bases within the area have also changed the landscape. It is difficult to find virgin stands of timber because much of it has been burned over since the arrival of the prospectors about the turn of the century. However, some stands of white spruce that are 2 1/2 feet in diameter can be found along the margins of streams.

Dr. Allan Mick has informed me that the temperature of the soil varies considerably once the original cover is disturbed. For example, many of the plots in the experimental farm at the University of Alaska have shown a warming of 20° F since the ground was first cleared. Such a temperature change should have a remarkable effect upon the Siphonapterous fauna, and it is believed that we have information to substantiate this point. The expansion of the highway system in Alaska is aiding the distribution of certain mammals, particularly the arctic ground squirrel (Spermophilus undulatus).

The vegetation on undisturbed ground now consists of white spruce, paper birch, willow, balsam poplar and some larch, growing in pure and mixed stands along rivers, sloughs, lakes and minor drainage courses. Birch, aspen and white spruce grow on bedrock slopes, hills and burned-over areas on glacial outwash plains. Dense, black spruce forest covers undisturbed areas on outwash plains. Upland valleys are covered by muskeg ("tundra" of some authors), consisting of sedges, grasses, dwarf birch, small heaths or stands of stunted black spruce, willows and alder. As one becomes familiar with the area, one notes that stands of tall willows and isolated pure stands of balsam poplar on flood plains indicate the presence of unfrozen ground. Areas overgrown by black spruce are likely to be underlain by permafrost at a shallow depth. Throughout much of Alaska, the forests are limited to the slopes at lower altitudes and to the better drained parts of the valley floor.

Characteristic plants are: black spruce (Picea mariana), white spruce (Picea glauca), paper birch (Betula papyrifera), tamarack or larch (Larix laricina), balsam poplar (Populus balsamifera, aspen (Populus tremuloides),

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willows (Salix spp.), alders (Alnus incana), dwarf birch (Betula glandulosa), blueberries (Vaccinium), Labrador tea (Ledum groenlandicum), horsetail (Equisetum), "niggerheads" (Eriophorium vaginatum) and cotton grass (Eriophorium scheuchxeri). Low-bush cranberry frequently is abundant on well-drained slopes, particularly in mixed birch-spruce forests.

The animals encountered in the Hudsonian Biotic Province are not all characteristic of the taiga. Indeed, few mammals are confined solely to any one biotic province, although when occurring in more than one they are not of equal abundance in both areas. For example, this is particularly true of the red-backed vole (Clethrionomys rutilus) and the wolverine (Gulo luscus), the former typically a taiga mammal but with a broad distribution in the tundra. The latter is a tundra representative which occurs in lesser numbers in the taiga. Again I have listed certain animals, for example the arctic ground squirrel (Spermophilus undulatus osgoodi and Spermophilus undulatus plesius) as well as the pika (Ochotona collaris) and the marmot (Marmota caligata), which are usually associated with the upland areas, the last two being largely confined to talus slopes. Spermophilus u. osgoodi is particularly difficult to classify from this standpoint because it will occur in the lowlands, for example, along the Steese Highway from Central to Circle. In the Circle Hot Springs area it has been observed in the aspen-spruce association. However, by far the greater preponderance of the population in the lowlands is in cleared areas, thereby conforming in part to the major portion of the animal's range above timberline.

Thus, the following list of mammals is provisional, and I do not mean to imply that they are strictly taiga representatives: Sorex arcticus (arctic shrew), Sorex cinereus (masked shrew), Microsorex hoyi (pigmy shrew), Lepus americanus (varying hare), Ochotona collaris (collared pika), Glaucomys sabrinus (flying squirrel), Marmota caligata (hoary marmot), Marmota monax (woodchuck), Spermophilus undulatus osgoodi (arctic ground squirrel), Spermophilus undulatus plesius (arctic ground squirrel), Tamiasciurus hudsonicus (red squirrel), Castor canadensis (beaver), Clethrionomys rutilus (red-backed vole), Lemmus trimucronatus (brown lemming), Microtus oeconomus (arctic vole), Microtus pennsylvanicus (meadow vole), Ondatra zibethicus (muskrat), Zapus hudsonius (jumping mouse), Erethizo. dorsatum (porcupine), Canis lupus (gray wolf), Vulpes fulva (red fox), Lynx canadensis (lynx), Ursus horribilis (grizzly bear), Ursus americanus (black bear), Gulo luscus (wolverine), Martes americana (marten), Mustela erminea (ermine), Mustela rixosa (least weasel), Mustela vison (mink), Alces alces (moose), Rangifer tarandus (caribou).

Sitkan Biotic Province

This occupies most of what is known as the "panhandle" or southeastern Alaska. The climate is characterized as being a cool but equable one. For instance, January is usually the coldest month, and the temperature is

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seldom lower than 32° F; July is the hottest month, and the average temperature is 57.5° F. The maximum recorded temperature of 96° F and a minimum of -8° F have been recorded at Ketchikan. The temperature is surprisingly uniform for such a long, relatively north-south strip of land. For example, during January the average temperature at Juneau is 27° F, while the hottest month, July, has an average temperature of 56.6° F, with a range of from -15° to 89° F. The precipitation, however, is more variable. The average annual precipitation at Ketchikan is 150.89 inches, with May, June and July being the driest months. Juneau has an average annual precipitation of 83.25 inches, with a similar dry spell. Average snowfall approximates 100 inches annually.

This area was extensively glaciated during the Pleistocene, and many large glaciers still occur. Timberline ranges between 1,000 and 2,000 feet as a general rule, but may vary from 500 to 3,000 feet. The Sitkan Province is extremely mountainous; much of it is broken by the sea into chains of mountainous islands, which in turn are separated by tide-swept channels. The boundaries for the Sitkan Biotic Province are somewhat arbitrary; however, it is generally limited to the heavy coastal coniferous forest which extends from near Kodiak Island southeastward to the southern tip of Alaska. In an eastward direction, the boundary between the Sitkan and Hudsonian province is placed along the top of the Coast Range. (In early studies this range included what are now known as St. Elias Mountains and the Coast Mountains).

The most important or characteristic trees in the heavily forested areas at the lower elevations are: Chamaecyparis nootkatensis (Alaskan cedar), Tsuga heterophylla (western hemlock), Tsuga mertensiana (mountain hemlock), Picae sitchensis (Sitka spruce), Salix spp. (willow) and Populus tricocarpa (black cottonwood).

Some of the characteristic mammals are: Sorex obscurus (dusky shrew), Sorex palustris (water shrew), Myotis lucifugus lucifugus (little brown myotis), Spermophilus undulatus (arctic ground squirrel), Tamiasciurus hudsonicus (red squirrel), Peromyscus maniculatus (deer mouse), Phenacomys intermedius (mountain phenacomys), Microtus longicaudus (long-tailed vole), Microtus oeconomus macfarlani (tundra vole), Erethizon dorsatum (porcupine), Ursus horribilis (Alaskan brown bear), Mustela vison (mink), Mustela erminea (ermine), Alces alces (moose), Dama hemionus (black-tailed deer).

The mammals and arthropod fauna of the southeastern portion of Alaska have been largely overlooked in the studies during the past 20 or so years, due to a greater emphasis placed on arctic and subarctic ecology. This area has not been studied insofar as any of my programs are concerned; however, the change in the mammal fauna is indeed extremely interesting, and while the Siphonapterous records are sketchy at best, they also indicate a fauna

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entirely unlike that known in the other two biotic provinces. Insofar as zoonoses are concerned, I believe this biotic province offers at least as rich an area for investigation as that of the Arctic and subarctic regions. It is hoped that someone at some future time will be able to make a comprehensive study in this area.

IV

PALEOZOOLOGY

It is virtually impossible to understand the Siphonapterous fauna of Alaska without having some understanding or appreciation of the events that have happened in the geological past. The mammalian stocks now found in boreal North America appear to have originated from two principal sources. Many genera and even species are shared in common with Eurasia, while a smaller number of species have a continuous distribution from below the known southern limits of the ice sheets during the Pleistocene and as yet are not shared by Eurasia. Other refugia have been postulated to the west, but their contributions to boreal fauna are thought to be so minor for the purposes of this study that they are not worthy of discussion here. According to Darlington (13), intense interchange between Eurasia and North America took place in early Eocene, late Eocene, early Oligocene, late Miocene, middle to late Pliocene and Pleistocene. The fossil evidence earlier than the Pleistocene is relatively sketchy; therefore, this review will be largely confined to this epoch. According to Flint (26), the fluctuation in the mean annual temperature of the temperate latitudes during the Pleistocene epoch seems to have been no more than 10° C. During glacial ages, the mean annual temperature was roughly 8 degrees colder than now, and during the interglacial ages, it was roughly 21 degrees warmer than now.

Probably the principal arctic refugium within which plants and animals with sufficient adaptability survived the glacial ages of the Pleistocene epoch lay in the large nonglaciated areas al Alaska and the adjacent parts of Yukon Territory. In addition, repopulation of the arctic flora must have taken place to a considerable extent from the belt of country lying south of the limits of glaciation. Evidence to date makes it seem likely that the subarctic forests generally reached close to the southern margin of the ice sheet and that the intervening belt of tundra was narrow. Along the Arctic coast between Point Barrow and the Mackenzie River there are evidences of previous tree growth, indicating a considerably warmer climate during interglacial time than is now known.

The Bering Strait is both narrow and shallow. It could have become a land mass at one or more times as a result of a moderate lowering of sea

level, such as is postulated to have occurred during each glacial age when water was abstracted from the sea to build the great terrestrial glaciers. A second concept indicates that a slight warping of the earth's crust in Alaska and Siberia could have converted this shallow strait into land (Flint, 26). However the land bridge may have been formed, there seems little doubt that it existed and that over it moved a varied fauna into boreal North America. Moore (104), has indicated that there could have been a westward migration from North America into Eurasia but that the preponderance of movement was an easterly one. The Arctic region, therefore, was a corridor through which Asiatic mammals entered the New World.

Emiliani (20) thinks it is fairly well established that throughout the Tertiary period the climate was more moderate than at present. Even in the Pleistocene, the interglacial stages had fairly moderate climates. The reader is referred to Deevey (14) for further information concerning this point.

Likely, temperature per se was not directly a selective mechanism in the interchange of mammalian species between Eurasia and North America. The vegetative cover postulated for the Bering land bridge would suffice for most of the small mammals. For example, Hopkins (61) considered the paleobotanical evidence sufficient to postulate that during the latest glacial period of the Pleistocene, the land bridge was covered with tundra but not trees. Hopkins further states that a comparison of the vegetation in Alaska and Siberia suggests that the Bering land bridge never supported trees during any part of the Pleistocene. This concept is most easily accepted if one can assume that the summers were too short and too cold to support forest vegetation. The recent work by Pruitt (114) bears considerably upon the concept of small mammal migration across the land bridge. In this most significant work, it was learned that the temperature beneath the snow cover was no lower than 16 to 20° F, although air temperature above the snow could be in the -50 or -60° F range. Once a layer of snow attains a depth of 19 cm, a "thermal blanket" is formed. A depth less than this is not effective in protecting the voles and other small rodents. Therefore, adaption to the cold is not as critical as many people have previously suggested. However, a sufficient cover of vegetation would be needed to hold the snow and to prevent it from drifting. The larger mammals would be able to cross without severe difficulty, as indeed some forms are thought to do at the present time.

In a discussion such as this, certain concepts must be assumed as valid. Physiological evolution no doubt proceeds more rapidly than does morphological evolution. An excellent example of this is the porcupine, which is of South American origin but has reached into southeastern Alaska and is indeed characteristic throughout the Hudsonian Biotic Province. Secondly, not all mammals have evolved at the same rate, but close relationships should indicate recent crossings, and distant relationships, an early isolation of the two stocks. A third important assumption is that mammal habits have

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not changed markedly since the time their ancestors had the opportunity to cross the land bridge. As stated by Burt (10), if this latter assumption is not valid, then we have no way of interpreting many of the phenomena of the past.

I have assumed that the area which contains the greater number of species within the genus was likely the original source of distribution, particularly if this is supported by fossil evidence. It is realized that this is not entirely valid but seems to be as acceptable as any other theory that has been presented. As an example of this, there are 12 Eurasian species of pika and 2 in North America. The genus Ochotona is fossilized in the Pliocene and Pleistocene of Eurasia and is known only in the Pleistocene of North America at the present time. Indeed, there appears evidence that one of the North American species (Ochotona collaris) is no more than a subspecies of the Eurasian one. Pikas now live in talus slopes near timberline. However, Anthony (1) reported them within the spruce forest 2 miles from the nearest rock slide. From personal observations in the Uinta Mountains in Utah, I know they will migrate a considerable distance (1.5 miles) through spruce forest. This appears to me to happen when the population density is so great that they utilize small talus slopes which they do not inhabit otherwise. For the first ancestral crossing (middle Tertiary) when climates were more moderate (10), a change in habits of these lagomorphs would have been necessary. In the Pleistocene, environmental conditions similar to present day pika habitats would have been more likely. Therefore, Burt (10) concludes that our present stocks were largely of Pleistocene derivation. On the other hand, certain of the Eurasian pikas, particularly those of eastern Siberia, live in tundra areas, mingling considerably with the arctic ground squirrel population.

In view of the above discussion, one would expect that the ground squirrels, marmots and voles that are on opposing sides of the Bering Strait at the present time would be closely related, if not the same species. One finds that this actually holds true. The ground squirrel, Spermophilus undulatus, and the arctic vole, Microtus oeconomus, are generally accepted as a single species. The marmots occur in montane elevations on each side of the Strait and are considered by Ellerman and Morrison-Scott (19) and by Rausch (118) to belong to a single species; yet Hall and Kelson (39) have retained Marmota caligata as a distinct species (perhaps on a sentimental basis).

Other mammals thought to be shared in common with Eurasia, in addition to the mammals mentioned above, are: Sorex arcticus, Ochotona collaris, Lepus othus, Clethrionomys rutilus, Microtus miurus, Lemmus trimucronatus, Dicrostonyx groenlandicus, Canis lupus, Thalarctos maritimus, Felis lynx, Alopex lagopus, Mustela erminea and Mustela rixosa.

Burt (10) lists 30 genera out of the 68 occurring in the western North America as being shared with Eurasia. It is interesting that the highly successful family Muridae in Eurasia apparently was unable to cross the Bering land bridge. Equally interesting is the fact that the Hesperomyini spp., a highly successful tribe of New World Cricetinae, were unable to become a part of the westward migration across this bridge into Eurasia. The Hesperomyini spp. are relatively "recent" inhabitants of the boreal region, and nowhere within this region are they a dominant form.

Our discussion, so far, has largely dealt with those forms which are shared with Eurasia, with only the briefest mention of the flora and fauna from south of the Pleistocene ice sheet, which invaded the area to the north as the ice sheet retreated. While the following discussion is primarily concerned with mammals, it goes without saying the mammals were dependent upon the vegetation which preceded them north. Space and time does not permit a lengthy discussion; therefore, only certain examples will be chosen.

Perhaps one of the most characteristic mammals of the taiga is the red squirrel Tamiasciurus hudsonicus. There is, I believe, rather general agreement that Tamiasciurini is of New World origin. The only other known relative is the Sciurotamias davidianus in China, which shows markedly strong generic differences. The ecological niches of these two genera are not equivalent, since the Sciurotamias is a rock squirrel. Westward, rather than eastward, migration of this group is most likely and must have occurred a long time ago, possibly in early Pliocene or earlier (104). While Tamiasciurus hudsonicus is the dominant arboreal squirrel in the northern region, it does not reach the Pacific Coast within the lower 48 states; the western coast is inhabited by another species, Tamiasciurus douglasii, which occurs east of the Rocky Mountains in California, Oregon, Washington and British Columbia. However, T. hudsonicus, not T. douglasii, does occupy the islands of southeastern Alaska. Currently, the most southeastern record of T. hudsonicus in North America is in the Smoky Mountains of Tennessee.

Microtus pennsylvanicus occurs throughout most of the taiga in Alaska. I have never encountered it in large numbers, nor as universally as Microtus oeconomus, which I consider to be the dominant microtine in Alaska. Be that as it may, I think that M. pennsylvanicus was pushed south by the advancing ice sheets during Pleistocene, thence reinvading the north as conditions permitted. Insofar as I know, there is no evidence to indicate that M. pennsylvanicus survived the glacial periods of the Pleistocene in the Alaskan-Yukon refugium. It now enjoys the widest geographic distribution of any species of the subgenus Microtus in North America. However, contrary to Hall and Cockrum (38), M. pennsylvanicus does not have nearly as large a distribution as M. oeconomus in the Old World, even without considering the distribution of the latter in boreal North America. Ellerman (18) indicated that M. pennsylvanicus and the Eurasian Microtus agrestis are closely

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related. Ellerman and Morrison-Scott (19) go a step further and suggest these two forms are conspecific. Intuitively, I doubt the soundness of the latter concept; I do not know the right of the matter.

The porcupine, Erethizon dorsatum, did not occur in North America until after the Panama land connection with South America. Geologically speaking, this was a short time ago — about Blancan time (1_6). (According to Hibbard, 42, Blancan time is considered as transitional between Pliocene and Pleistocene.) The spread of this animal in a northerly direction is truly remarkable. It is relatively common throughout the taiga in Alaska and has accomplished this without noticeable external modification of features. As mentioned earlier, it is an excellent example of physiological adaptation occurring more rapidly than morphological adaptation.

Of the Zapodidae, Zapus hudsonius is the only representative in the taiga of Alaska. Burt (10) indicates late crossings of stocks from Eurasia. However, inasmuch as Z. hudsonius does not occur throughout the taiga, I believe that it has migrated north as conditions became favorable, after the retreat of the Wisconsian ice sheet. In the Tanana Valley, I have found it most numerous in the ecologically disturbed areas where the growth of such plants as lambs-quarter, raspberries, fireweed and grasses (Calamagrostis canadensis) occur. While Zapus is fossorial, it is only weakly so; thus friable soil is important to the distribution of this animal. The fact that it hibernates has no doubt contributed to its successful invasion of the North. Later, reference will be made to this animal when discussing the flea, Megabothris quirini.

Earlier, the giant ground squirrels were discussed with particular reference to Marmota caligata, indicating it was conspecific with the Eurasian counterpart. Marmota monax is an example of an earlier Eurasian (middle Tertiary) stock with subsequent isolation. M. monax likely was forced south by the ice sheets of the Pleistocene and has since migrated north. At the present time, it is doubtful whether it occurs north beyond Tanana Valley. The distribution of M. monax is remarkably similar to the previous example, Z. hudsonius.

While the paleontological record of the mammalian hosts is incomplete, a study of the flea phylogeny is even more difficult. One fossil species, Palaeopylla klebsiana Dampf, was described from Baltic amber; unfortunately, this specimen is no longer available for study. P. klebsiana apparently is closely related to other members of the genus, which is remarkable because Palaeopylla is now considered a specialized, rather than a primitive, genus. The flea fauna currently known throughout the world actually consists of a remnant or survived population. Many of the mammalian orders known to be important flea hosts, such as Insectivora and Lagomorpha, have more extinct than extant genera.

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A study of the Alaskan flea fauna is intriguing in relation to the mammal stocks originating in Eurasia and from south of the Pleistocene ice sheets. The host associations of Siphonaptera are difficult to understand, at best, and with the heterogeneity of mammalian stocks, some interesting problems are to be resolved in this study.

V

MORPHOLOGY

The following account is not intended as a classic treatise upon siphonapteran morphology; instead it is a treatment of the salient morphological features of taxonomic usefulness. For the most part, I have adopted the terminology of Hopkins and Rothschild (64), which in turn is essentially that of Jordan (91). Plates I through IV, which illustrate some of the morphological features described, are placed at the end of Section V.

Head

The head of the flea is highly specialized, and most of its features are peculiar to the Siphonaptera. The head and body of the flea are compressed laterally. Topographically, the head can be divided into a preantennal (frons) and postantennal (occiput) region by the antennal fossae. Frequently there is an interantennal suture running over the dorsum of the head between the pair of antennae. Morphologically, the preantennal region is said to be composed of three sclerites: the frons, clypeus and gena. Since these sclerites are no longer separated by sutures, their identity has been obscured, although Snodgrass (134), in his classical study of flea morphology, revealed that much of what is called "frons" is indeed the clypeus and that the so-called "frontal tubercle" is in reality the clypeal tubercle. However, I will use the terms in the topographic sense that one observes in studying cleared specimens, for this is the type of specimen on which much of our reliance in taxonomy has been placed.

Preantennal regions. The frons (Fr.) occupies the dorsal portion of the preantennal region ventral to and including the frontal tubercle (Fr. Tub.). The genal area (G.) refers to the ventral portion of the head from below the frontal tubercle and the eye (if present) running underneath the eye posteriorly to the anterior margin of the antennal fossa. The genal process (G. P.) is a posterior prolongation of the gena.

The function of the frontal tubercle is not known, although it has been suggested (see Holland, 45, p. 39) that it serves to rupture the pupal skin. Snodgrass (134) does not see how this can be its function. At any rate, it is not always present, and Jordan (89) demonstrated that in certain species of two families — the Ischnopsyllidae (bat fleas) and the Vermipsyllidae (carnivore fleas) — the frontal tubercle is indeed deciduous.

The paired eyes, according to Snodgrass, are ventrally displaced ocelli. This would not agree with Wagner (151), but according to Hanstrom (40), the

compound eyes and their brain centers are gone. Compound eyes, if present, likely would not be anterior to the antenna. The eye may be large and heavily pigmented, reduced, vestigial or absent, depending upon the particular flea involved. The cuticular cup may be variously shaped; for example, in the eye of Amphipsylla (Plate II, G) it appears to be notched or sinuate. As a rule, the eyes of the fleas associated with burrowing mammals are usually reduced, vestigial or absent, whereas those of the fleas that spend considerable time upon the hosts are likely to be large and heavily pigmented. However, one should not speculate too much upon this particular point because there are many exceptions to the general rule. Sufficient knowledge is not available to properly interpret the adaptation of fleas from this standpoint at the present time.

In the past, much confusion has existed concerning the mouth parts. Now, however, there appears to be general agreement. The unpaired epipharynx was previously termed the hypopharynx or the labrum. The epipharyngial derivation of this structure has been shown both by Snodgrass (134) and by Wenk (152). The other two piercing stylets are the lacinae — paired of the maxillae (L.). These were formerly confused with mandibles, which are absent in the adult fleas. Both the development of the lacinae and the number of teeth present on them differ in various genera, the greatest development occurring in the Pulicoidea. The stipes (Sti.) of the maxillae are frequently called the maxillary lobes (82) and bear the maxillary palps (Max. P.), which are always four-segmented. The remaining external mouth parts consist of the paired labial palps, which as a rule are approximately as long as the lacinae. Since they vary in length and apparent segmentation, the labial palps are often used in the taxonomy of various genera and species. The hypopharynx, labium and labrum either are obscured by the forementioned mouth parts or are located within the head and are not taxonomically significant.

Antennae. The antennae of fleas lie protected in the antennal fossae. They are attached lateral of the frons, and each appendage consists of a basal scape (Sc.), an intermediate pedicle (Ped.) and a terminal clava (Clv.), which supposedly represents the flagellum on an elongate antenna. The clava or "club" consists of nine "segments" and is attached to the pedicle by a narrow petiole. The shape of the clava varies with different genera, and at times the segmentation appears fused; but an examination of the posterior margins will generally reveal the true nature of the segments. The posterior margin may at times be so deeply indented as to appear lobulated. Usually, the pedicle will have a row of bristles along its distal border, and their length is an aid in separating certain groups of fleas, as is the symmetry of the clava.

The antennae of fleas are short, but with the exception of the Pulicoidea, those of the male are longer than those of the female. In Hoplopsyllus Baker (Pulicidae), the genal process continues around the antennal fossae, uniting with the postoccipital ridge. The antennal fossae are then said to be closed. However, in the Ceratophylloidea usually the antenna of the male is longer,

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extending onto the prosternosome. In fact, the dorsal or upper portion of the prosternosome is somewhat scooped out for reception of the antennae in the Ceratophyllidae; and in Mioctenopsylla Rothschild and Monopsyllus Kolenati in particular, an extreme morphological adaptation is found. Within the Ceratophylloidea, the genal process ends at the anterior margin of the antennal fossae, leaving the fossae or grooves "open."

Most male fleas, especially the Ceratophylloidae, are capable of erecting the antennae at will, and frequently the antennae are found in this position when processing specimens for microscopic examination. Erection is allowed by the fact that although the scape is articulated at its base in the upper angle of the antennal fossae, it is angulated beyond the articulation in such a fashion that when the antenna is erected, it clears the projecting upper margin of the fossa. With the possible exception of the Pulicoidea, male fleas are thought to use the antennae as clasping organs during copulation. Lundblad (99) and particularly Holland (54) leave little doubt that these organs function in this capacity in the species which they studied. Unfortunately, most observations to date have been limited to the genus Ceratophyllus Curtis.

Chaetotaxy of head. The development of setae on the pre- and postantennal regions is of significant taxonomic value. The head contains a number of well-developed setae, which may occur singly or in rows. A seta located near the eye is termed an "ocular seta." If this particular seta is one of a row, that group is known as the "ocular row." A row of setae located above this (anterior) is called the "frontal row." In certain genera, such as Ctenophyllus Wagner and Peromyscopsylla I Fox, certain setae are thickened and heavily pigmented (spiniforms) near the anterior margin of the head. In several genera, particularly those of the family Hystrichopsyllidae and Leptopsyllidae, the setae are arranged in rows in the postantennal region. In addition to the setae, the head contains pits of various sizes, some of which contain minute hairs.

Frequently, a row of strong spines is encountered on the lower margin of the head (posterior), as demonstrated in Plate II. This row of modified spines is known as the genal ctenidium (G. Ct.). While not a conspicuous characteristic of most Alaskan genera of fleas, nontheless the genal ctenidium is a striking modification when it does occur. The spines (teeth) may be arranged horizontally, obliquely or vertically, or the ctenidium may consist of not more than two spines, with one overlapping the other, as in Epitedia (Plate II, F). In the bat fleas (Ischnopsyllidae) the modified spines occur anterior to the oral cavity, forming what is known as a preoral ctenidium (Po. Ct.); (see Plate II, E.).

Internally, the head has various devices for strengthening the head capsule, the most important of which is the tentorium. Considerable confusion has been generated by certain workers in the past, due largely to an

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inadequate understanding of the tentorium's various modifications from one family to another. Inasmuch as parts of the tentorium have been used by taxonomists, it is hoped that the following brief discussion will clarify some of the misconceptions and enable the new student in the study of Siphonaptera to gain some idea of its phylogenetic significance.

The main part of the tentorium consists of a bar or bridge that crosses the foramen magnum. The "bridge" arises laterally from the postoccipital ridge and is formed by the confluence of two opposing tubular ingrowths from the postoccipital sulcus, the pits of which do not show externally because of the narrowness of the postoccipital ridge. The tentorium also includes a pair of longitudinal bars; when fully developed, these bars extend forward in the head, between the antennal fossae, and curve laterally to where they attach on the genal areas in front of the fossae and before the eyes (if the latter are present). Snodgrass (134) concludes that these bars are in reality the dorsal arms of the tentorium and that their lateral positions can be correlated with the ventrolateral displacement of the ocelli. In many of the ceratophyline species they are incomplete, often merely vestiges and as such probably are not used for the attachment of the antennal muscles. When the dorsal or so-called anterior arms are absent or vestigial, a transverse bar, the trabecula centralis (T. C.), is developed through the middle of the head and can be seen usually above the eye toward the anterior margin of the antennal fossae. In some other groups of fleas, the upper ends of the antennal fossae are fused on the interantennal ridge on the dorsal wall of the head; in others, the walls of the antennal fossae touch each other; and in others, the walls of the antennal fossae are united.

Thorax

The thorax of the siphonaptera is compact, and the legs have been adapted as an effective substitute for the wings, which these insects have lost. The distinctive features of the thorax are adaptations to the saltatorial habit. Therefore, the thorax in this group of insects differs markedly from that in flying insects. The hind legs and the metathorax are the most highly modified for jumping, although they are not always the largest.

The various thoracic segments are united by conjunctival membranes, and additional security is gained from the vincula, or link-plates — connective sclerites resembling the cervical plates that link the head and prothorax. According to Snodgrass, the vincula lie laterally in the conjunctiva, each articulating anteriorly with the pleuron of the segment in front and posteriorly with the notum of the segment behind. The vincula between the prothorax and the mesothorax contain the first pair of spiracles. No muscles are attached to the first link-plates, but a relatively large muscle from the mesocoxa is inserted on each plate of the second pair of vincula.

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As stated earlier, I have followed Jordan's terminology, and it is indeed regrettable that his points of view and those of Snodgrass are not reconciled with reference to this region of the flea's anatomy. For a more detailed discussion of some important differences in point of view, the reader is referred to Johnson (82).

Prothorax. The prothorax includes two principal plates: the notum and the composite sternopleural plate. The notum is relatively simple, being overlapped by the head flange at the anterior border and, in turn, overlapping the mesothorax. Apically, the pronotum may bear a ctenidium or comb which varies in both the number and length of spines. For example, the spines are short and pale in Mioctenopsylla Rothschild and actually absent in Chaetopsylla Kohaut (Vermipsyllidae). Frequently, this ctenidium is absent in Pulicoidea, but it is present in the lone Alaskan representative of this superfamily. The function of the pronotal ctenidium and, for that matter, of the cephalic ones, is not known. It is speculated that they offer additional protection to vital areas of the body. Be that as it may, however, the "non-combed" fleas are virtually absent in the boreal fauna.

The composite pleurosternal plate, termed the prosternosome, lies horizontally below the notum and supports the foreleg on its anterior margin. There is no line or separation between the component parts, but in some cases a ridge is found to run lengthwise to the pleuron, likely separating an episternal area above it from an epimeral area below it. The cervical sclerites articulate with the episternal margins near the lower anterior angle of the notum. The first pair of vincula are attached to the posterior margins of the prosternosome. In the ceratophyllid fleas this border has a concavity for the reception of the vinculum and, at least in the genus Malaraeus, has a small flange external to the concavity which partially covers the link-plate. In Mioctenopsylla Rothschild and Monopsyllus Kolenati, the episternum has a depression for the reception of the antennae that is greater than that of most other ceratophyllid fleas. Johnson (82) places considerable emphasis upon the proepimeronal flange, indicating that the flange is reduced in the more highly modified fleas.

Mesothorax. The mesonotum of the mesothorax is relatively uncomplicated. The lower margins of the notum are closely connected with the pleuron and slightly overlapped by the mesopleuron (mesosternosome) ventrally.

The pleural rod (Pl. Ro.) usually separates the anterior mesepisternum from the posterior mesepimeron. The pleural rod is not a true ridge, being completely free from the surface except for a dorsal connection on the upper margin and a ventral one at the coxal articulation. Primitively, the pleural rod is bifurcate dorsally in most fleas. The Ceratophylloidea have retained the latter characteristic to some degree, except for the highly specialized Anomiopsyllinae (Johnson, 82). This same author stressed the importance of

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the external oblique break of the mesocoxa as showing the trend toward completeness in advanced or highly modified forms.

Metathorax. The metanotum resembles the mesonotum in size and appearance. It has a flange which overlaps the first tergum. Both the notum and the pleuron are reinforced with internal ridges, to absorb the upward and forward thrusts of the legs against the body. In view of the size and development of the hind leg, it is assumed that this appendage furnishes the principal source of power in leaping.

In some fleas, the notal ridge appears to be joined with the pleural ridge of the metasternosome (Plate I, C and D), although it actually terminates at the upper end of the pleural ridge in what is called the pleural arch (Plate I, A and B). Holland (45), along with others, has implied that the pleural ridge (Pl. Ri.) functions as a ball-and-socket joint with the pleural arch (Pl. A.). As seen from the outside in the cleared specimens used for taxonomic purposes, this indeed is the impression one obtains. However, Snodgrass (134) reports that the two are so closely united that efforts to separate them cause a break with the "head of the ridge still within the arch." Snodgrass reasons that the function of this articulation is to secure a solid union along the notal and pleural ridges — not for control of movement. When the pleural arch is absent (Plate I, D) there is usually an enlargement of the abdomen coincident with some reduction of the legs, and these species of fleas are known as "crawlers" rather than "jumpers," in contrast to the fleas which have the well-developed pleural arch.

Anterior to the pleural ridge is the metasternum (Mts.); posterior to it is the metepimeron (Mte.). The Pleural ridge usually occurs in typical form and is never partially detached from the surface of the pleural wall, as is the pleural rod on the mesothorax. The metasternum is relatively small, at least in comparison to the metepimeron. Typically, the metepimeron is a large plate with a relatively wide posterior flange. It extends upward to, and somewhat behind, the metanotum, overlapping the ventral margin of the first tergum (T.I.) and, in the case of Malareus, the basoventral margin of Tergum II. Ventrally, the metepimeron overlaps the base of the metacoxa and laterally supplants the first abdominal sternite, which has no sclerotization of its own. The third spiracle is located midway near the dorsal margin of this sclerite. In certain genera, such as Rhadinopsylla Jordan and Rothschild (Plate VII, b), the metepimeron possesses an intriguing structure, the striarium (Str.). The function of the striarium is not known, although various students of the Siphonaptera have postulated that it is part of a stridulating mechanism. It may well be an area which aids the antennae as clasping organs during copulation.

The metepisternum (Mtes.) is one of the most highly controversial sclerites of the thorax. The followers of Jordan (91) agree that in the mesosternosome the mesepisternum is divided by an oblique ridge, the area below it being a part of the mesosternum and that above it the mesepisternum.

According to Jordan (see Hopkins and Rothschild 64, 65), this is best exemplified in certain of the Ischnopsyllidae and in certain representatives of other families. Using this information, by analogy Jordan believed that in the metathorax, the detached portion was the metepisternum and the area below it, the metasternum. Snodgrass (134) and Johnson (82), among others, do not agree with this interpretation. According to them, the sclerite in question is an integral part of the metanotal plate and is known as the lateral metanotal area.

In cleared specimens, the metepisternum appears to bear a small and distinct flange that overlaps the pleuron below it, including a portion of the "head" of the pleural ridge. In Malaraeus, the metepisternum can be followed upward into the flange of the metanotum. Johnson states that internally the sclerite is clearly attached to the notum, not the pleuron.

Hopkins and Rothschild (65) are convinced that Snodgrass did not study sufficient material, and they point out that he omitted the Ischnopsyllidae upon which Jordan placed considerable emphasis for his interpretation of the metepisternum. It is indeed regretable that this was not done, for then perhaps the controversy would have been settled. This must be resolved, for in my opinion, the sclerite in question is of considerable phylogenetic significance.

Legs. The Siphonaptera have three pairs of legs, those of the metathorax being greatly enlarged. The coxae are large and well developed, and certain of them contain characteristics of considerable phylogenetic and taxonomic importance. The absence of the outer internal ridge of the mesocoxa is of family significance, not being found in the Pulicoidae but present in the Ceratophylloidae. The metacoxa (Mtcox.) at times possesses setae along the mesal surface in addition to those on the apical margin, and the distribution of these in a basoapical direction is of considerable generic value, as is the presence of patches of spiniform setae. The trochanters are well developed but are small and of little or no interest in taxonomy. The femora, like the coxae, are large and well developed. Jordan (86) utilized the chaetotaxy of the forecoxae in his extensive revision of the genus Ceratophyllus Curtis, by placing in Group A those species that possessed not more than one seta on the mesal surface (Orchopeas Jordan, Opisodasys Jordan and Tarsopsylla Wagner). The tibia is moderately well developed elongate and possesses a variety of spines and setae of varying degrees of taxonomic use. In Peromyscopsylla I. Fox, the dorsal margin has a "false" comb of short, stout bristles. This particular pattern is characteristic of other members of Leptopsyllidae. The apical margin of the tibia is developed into what Jordan terms a tooth, which is characteristic of Ceratophylloidae but not of Pulicoidae. The tarsus is five-segmented, the fifth segment being the one most used because of the various modifications of the chaetotaxy in several genera. However, the first segment of the tarsus is of significance in at least one genus (Tarsopsylla Wagner), since it is longer than the next three

segments combined. The arrangement of the lateral plantar bristles has been used extensively; typically, they consist of five or six pairs. In certain instances, the basal pair is shifted medially, i.e., Orchopeas Jordan (Plate XXVIII, H) or the third pair may have migrated medially, as in Dasypsyllus Baker (Plate XXI, F). At times the number is reduced to less than four, as is characteristic of the genus Hoplopsyllus Baker, and this genus is also characteristic for the other pulicids and vermipsyllids known to me.

The tarsus terminates in a pair of claws or ungues. Considering the variety of hosts, with the difference in texture among various furs and feathers, the claws are remarkably uniform and offer little or nothing by way of taxonomic significance.

Abdominal Segments

The abdomen is now generally considered to consist of 10 segments, although in the past, several workers, among them Wagner (149) and Kessel (94), have proposed 11 or 12 segments. The concept of 10 segments at least conforms to that of other holometabolous insects.

Pregenital segments. The first seven abdominal segments are considered to be unmodified, and Snodgrass used the term pregenital segments in describing them as a group. This definition is not entirely true insofar as the seventh segment is concerned, but on the other hand, it is not nearly as modified as those immediately following it. Each of the first seven segments consists of a tergum and a sternum, with the sternum being overlapped by its dorsal counterpart. It must be recalled that sternum I is unsclerotized and is overlapped by the metepimeron of the metathorax, whereas sternum II is larger than other unmodified sternites and departs from the general pattern by overlapping its dorsal counterpart.

A distinctive feature of terga I-VI is the possible occurrence of apical spinelets, which are thought to represent vestigial ctenidia. The number of rows of bristles on each tergum is also of some family significance, taxonomically speaking, although these rows are not nearly so important by modern standards as presumed by earlier workers. Johnson (82) used the form of the first tergite phragma as a generic and family character. Stenoponia Jordan and Rothschild, a genus largely confined to more southerly latitudes than that of Alaska, possesses a true ctenidium on terga I-II, and the following three terga have an extensive series of apical spinelets. Myodopsylla Jordan and Rothschild, a genus of bat fleas found in southeastern Alaska, evidently lost the ctenidia on the abdominal terga and has since developed "false" ctenidia on these same segments. These false ctenidia consist of apical, closely grouped, heavy setae. Another genus of bat flea, Nycteridopsylla Oudemans, possesses a comb on tergum VII.

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A point of some confusion on first working with this group of insects is the fact that the tergites and sternites that are in contact with the actual body cavity form a relatively small part of the plate. A thin sutural line occurs in the middle of each segment, from which the long spines arise. The posterior extension beyond this point is a free flange which overlaps the succeeding segment. The flange covers much of the succeeding tergal and sternal plate; it extends far downward from the sides of each tergum and upward from each sternum. Therefore, the broadly overlapping dorsal and lateral parts of the terga and sterna are these flanges. Instances have been known where the mid-sutural line was mistaken for the apical edge!

Near the apical margin of tergum VII in most fleas, particularly those known thus far in Alaska except Vermipsyllidae, are a group of large setae (varying from one to five in number, depending upon the genus) known as antepygidial setae. The real function of these setae is not known, although some have speculated that they protect the pygidium, whose real function is also not known. Insofar as Alaskan genera are known, these setae are always present, although they vary considerably as to size and number among the various genera. Occasionally the apical margin in this segment will be produced into a caudal process between the antepygidial bristles, as in Corrodopsylla Wagner (Plate IX, E).

With the exception of sternites II and VII, the pregenital segments offer little information of taxonomic significance. Sternum II frequently has a patch of small setae near the basal margin, which has been used to separate genera but is of no significance in the Alaskan fauna at the present time. Sternum VII (apparent sixth sternite) has been used extensively. Most of the characteristics are concerned with the modification of the posterior border contour. If a lateral sinus (L. S.) does not occur on this margin, it is said to be entire. When it is present, the lateral sinus divides the posterior margin into a dorsal or upper lobe (U. L.) and a ventral or lower lobe (L. L.). The angulation of these may be of some help in certain closely related species of a particular genus. If the area of the sternite below the ventral lobe (forming the floor of the abdomen) is undercut, the specimen then possesses a ventral sinus (V. S.). The apex of sternum VII has not been used taxonomically, but its profile does differ markedly among several genera. The characteristics described are of value at specific and subspecific levels only. Unfortunately, the contour of the posterior margin of this sternite may be extremely variable within a given species, as shown in Plate XXIII, G, for Malaraeus penicilliger dissimilis (Jordan, 1938). Holland has also reported in 1951 and 1952, on such variation in this and other species, particularly Ceratophyllus petrochelidoni Wagner, 1936, and Megabothris groenlandicus (Wahlgren, 1903). Speculation by various authors indicates that modification of the posterior contour of sternum VII is possibly an aid in copulation.

Genital segments. The eighth, ninth and tenth segments constitute what are known as the genital segments of Siphonaptera. In the male, the

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modification at times is so great as almost to appear beyond the point of usefulness or credibility. The bizarre arrangement of these highly modified segments has obscured the importance of certain others, which are not nearly so spectacular in appearance but are of fundamental importance. This has been particularly true with respect to the understanding of the higher taxa within the order. The female segments are not spectacular; however, they offer important clues in the evolution of the group, as well as furnishing a reasonable amount of information with regard to family relationships.

Male genitalia. The tergite and sternite of segment eight in male fleas are variously modified and, from the standpoint of phylogenetic relationships or suprageneric taxa, are of inestimable value. Tergum VIII is large in the Ceratophyllidae, almost completely enclosing the other genital setments. On the other hand, sternum VIII is considerably reduced in this family. Plate III (A and B) shows the relative size of the tergite and sternite, as well as their position relative to tergum IX. As a general rule, when the eighth tergum is large, there will be an equal reduction in its ventral counterpart. The same concept holds true when the reverse situation occurs: when the sternum is tremendously enlarged, the tergite will be reduced. In the Leptopsyllidae, the sternum is somewhat larger than in the previous family, but the tergite is still a relatively large one. On this basis, Holland (45) removed Peromyscopsylla from the Hystrichopsyllidae and placed it within a subfamily in Ceratophyllidae. The Hystrichopsyllidae carry the enlargement of the sternum a little further, with some reduction of the tergum. In the Pulicidae, the modification of the eighth segment is essentially the reverse of what has been discussed for the Ceratophyllidae. Here the tergum is greatly reduced, and the sternum is enlarged so that it essentially insheathes the other genital segments. In the bat fleas (Ischnopsyllidae), the tergum and sternum are essentially unmodified, closely resembling those of the Vermipsyllidae. However, with the aid of strong marginal setae, they are able to provide adequate protection for the genital segments. The apical membranous lobe of sternum VIII is very characteristic for some species, especially in Ceratophyllidae. Unfortunately, it is a delicate structure and can be shown only when considerable care has been given to the preparation of study specimens. I have illustrated it for several species of this family.

The ninth segment has undergone a fantastic modification, and it has been utilized extensively as an aid in separating fleas at the species level; it also is of significance in the family concept. Considerable difference of opinion exists concerning the ninth segment (see Hopkins and Rothschild, 65, pp. 39-40). Essentially, I follow Jordan in that I consider all of the clasper and its processes to be a part of tergum IX. With this concept in mind, tergum IX is then one of the larger male genital sclerites. In many species of fleas the tergum of the male is produced anteriorly into a dorsal apodeme (Apt. IX), which extends anterolaterally in front of and around the pygidium and just under the spiracular fossae on tergum VIII. The manubrium (Man.)

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is generally accepted as the ventral apodeme. The central part of this seg-
ment is the body of the clasper (B. Cl.), which is produced caudad into a
fixed process (F. P.) and a movable process (M. P.). In the Ceratophylloidea,
the movable process articulates mesally with the clasper on the posterior
margin, in what is called the acetabulum (Ac.). In the Pulicidae, there may
be several fixed processes, the homologies of which are not clearly
understood.

Sternum IX has been said to be L-shaped, V-shaped or boomerang-shaped.
From these descriptive terms it is obvious that sternum IX varies from one
group to another, but it nevertheless follows essentially a basic pattern. I
have followed Smit (132) in the terminology of this sclerite. The basal part
of the sternum (which is attached inside the body) is the proximal arm (P. A.),
and the posterior half (which usually runs dorsal and posteriorly) is the
distal arm (D. A.). The terminal portion of the distal arm is called the
apical lobe (A. L. St. IX). The apical lobe is considerably varied in chaeto-
taxy and structure and is helpful in separating closely related species. I
have found it particularly useful in Ceratophyllus Curtis (Plate XV, H.).
Sternum IX is fused at approximately the mid-point, the proximal and distal
arms then being separated from their counterpart on the opposite side. The
tendon of sternum IX arises on the distal arm and projects into the body
cavity at a point about the midway (junction of the two arms) of the sternite.
This structure has been of considerable aid in establishing family relation-
ships.

Between sternum VIII and sternum IX is the intersegmental lobe or mem-
brane (Its. L.) which is of various shapes. Wagner (151) believed it to have
some functional role in copulation. This membrane or lobe is usually
revealed only in well-prepared slides; therefore, its possibilities as a taxo-
nomic structure have been overlooked, particularly in cursory studies.

The intromittent organ (aedeagus) is a vastly complex structure. The
principal works dealing with this organ are those by Snodgrass (134), Johnson
(82) and especially Traub (147). These workers have done much to elucidate
the morphology and the significance of this structure in the higher categories
of Siphonaptera. Traub and Johnson have utilized it extensively in dealing
with species, and the reader is advised to consult their papers for further
details.

The 10th segment of fleas has the broad dorsal portion (tergum) mostly
occupied by the pygidium ("little rump") or sensilium. As mentioned earlier,
the function of the pygidium is not known, but following the usual concept in
entomological jargon, we ascribe "some sensory function" to it. The distal
part of the 10th segment terminates in an anus-bearing womb, which is fre-
quently produced into what are known as the dorsal anal lobe and the ventral
anal lobe. In the male flea, this segment is almost is almost surrounded

(at least closely embraced) by tergum IX. The structure called the pygidium is well defined, of various shapes and sizes. On the surface, it is densely clothed with small spicules and hairy structures known as trichobothria. In the males of Vermipsyllidae and Hystrichopsyllidae, the ventral anal lobe (sternum X) at first glance appears to be an integral part of tergum IX, which of course it is not.

Female genital segments. Tergum VIII is an extremely large scle e, covering or obscuring most of tergum IX (when present) and sternites VIII and IX, as well as a part of segment X. The spiracular fossa for this segment has migrated to a dorsal position just in front of the pygidium. Sternum VIII is very reduced (Plate IV, A) and appears to help form the floor of the vagina. It is overlapped by both sternum VII and tergum VIII. The ninth sternite frequently serves to form the dorsal wall of the vagina and is completely or almost completely overlapped by the eighth tergite. The 10th segment, as in the male, produces the anal cone. The pygidium occupies essentially the same position as in the male, although its various sizes and shapes are best studied in the female. The posterior part of the tenth segment, as in the male produces the anal cone. The pygidium occupies essentially the same position as in the male, although its various sizes and shapes are best studied in the female. The posterior part of the tenth segment (tergum) ends in a process known as the anal stylet (An. Sty.), which is present in all females except those belonging to the Vermipsyllidae; this structure does not occur in the male flea.

The ninth tergite is largely absent, at least as a well-developed sclerite, in most female fleas. It is absent in the Ceratophyllidae, Leptopsyllidae and Ischnopsyllidae but present in the Hystrichopsyllidae. Johnson (82) regarded tergum IX of the female flea as perhaps the most important of the modified female segments from the taxonomic and evolutionary standpoint. This observation by Johnson has been little appreciated until relatively recently.

Female reproductive tract. The following discussion is limited entirely to the structures that are related in getting the sperm from the male flea into the spermatheca for storage. No discussion of the ovaries or other soft parts of the female reproductive system is offered.

As mentioned earlier, the female genital tract opens externally at the entrance of the vagina, which is protected by various well-developed setae. The ventral wall of the vagina lies approximately along the dorsal margin of the eighth sternum, the dorsal wall appearing to be limited largely by the ventral wall of the ninth sternum. This tract extends cephalad to about the base of sternum VIII, whence it turns rather abruptly in a dorsal direction and is known as the duct of the bursa copulatrix (D. B. C.). The duct of the bursa copulatrix is frequently a heavily chitinized tube that leads into the

bursa copulatrix (B. C.), from which arise two ducts. One of these is known as the blind duct (B. D.), and the other, the duct of the spermatheca (D. S.), which enters the spermatheca in the cribriform area. Most modern fleas have a single spermatheca; however the presence of the blind duct and the fact that certain genera within the family Hystrichopsyllidae presently have two spermathecae have led to speculation that primitive fleas likely had two such structures. The regions of the spermatheca have been called by various names, and it is difficult to keep all of the synonymous terms in mind. The basal portion of the spermatheca (that directly attached to the duct) is known as the bulga (B.) and the apical portion, as the hilla (H.). Previously, these regions have been most commonly known as the head and tail, respectively. Frequently, the hilla terminates in a chitinous papilla (Pa.). The shape of the spermatheca has been used extensively in female taxonomy, as has the shape and amount of chitinization in the bursa copulatrix, especially at the species level. The bursa copulatrix is by no means always a simple structure, as can be verified by an examination of it in certain species of Monopsyllus.

Spiracles

Most fleas (all Alaskan forms) have 10 pairs of spiracles, 2 of which are located on the thorax and 8 on the abdomen. Several workers have indicated that the thorax has three pairs, but the third one, located on the dorsal portion of the metepimeron in most fleas, is abdominal in character rather than thoracic, even as to the method of closure. The point in discussion is a moot one, inasmuch as the metepimeron is an extremely enlarged metathoracic plate, largely replacing the first abdominal segment and with a subsequent reduction of the second tergite as well.

The first pair of spiracles is located in the vincula that link the prothorax and mesothorax. An occlusor muscle is found within the outer cavity of the vinculum, and this inserts on a small membranous area at the outer surface; the contraction of the muscle apparently draws in the membrane, and if not completely closing the spiracular aperture, at least it narrows the orifice considerably.

The second thoracic spiracle is closely associated with the vincula between the mesothorax and the metathorax. This pair of spiracles is located in the conjunctival membrane just ventral to the vincula. The external aperture may consist of a thickened rim, but usually it is elevated on a small papilla. A small muscle which originates ventrally in the papilla is inserted at the distal end of the trachea. According to Wigglesworth (153), "when this muscle contracts, the trachea is drawn inward and the tip of the papilla occludes the external opening."

The abdominal spiracles are consistently different from the thoracic ones, particularly in the structure of the closing apparatus. Also, the abdominal spiracles are sunken into cuticular pits or grooves on the body wall. The external portion (Plate IV, D), is known as the spiracular fossa (S. F.), and ventral to this is the ostium of the spiracle (Osp.). The ostium leads into a short tubular atrium (Atr.), the wall of which has heavy chitinous rings, heavier than the taenidia in the trachea proper. The atrium is connected to the trachea by a thin-walled section which is constricted midway and, according to Snodgrass, is devoid of taenidial rings. At the constriction is what I call a tracheal rod (Rd.), which is a bow-shaped chitinous rod on one side with a muscle attached to the ends of the bow. When this muscle contracts, the rod pinches the trachea, thereby closing it.

Frequently, the shape and sculpturing of the spiracular fossae are significantly different on the first three abdominal segments than on the remaining five. The eighth abdominal spiracle has moved from a lateral position on tergum VIII to a dorsal one and is located just anterior to the pygidium. Plate IV shows various modifications in size and shape which frequently are a diagnostic aid at the generic level. The shape of the spiracular fossae on the usual abdominal segments (IV-VII) has at times the same value at the specific level. This holds particularly true within the genera Catallagia and Ceratophyllus.

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PLATE I

GENERAL ANATOMY

Malaraeus penicilliger dissimilis (Jordan, 1938).

Figure A: Head and Prothorax   Figure B: Meso- and Metathorax

Ant. = Antenna
    Sc. = Scape
    Ped. = Pedicle
    Clv. = Clava
Ant. F. = Antennal Fossa
E. = Eye
Ep. = Epipharynx
Fr. = Frons
Fr. Tub. = Frontal Tubercle
G. = Gena
G. P. = Genal Process
L. = Lacina
La. P. = Labial Palps
Max. P. = Maxillary Palps
Oc. C. = Occiput
Prn. = Pronotum
Prn. Ct. = Pronotal Ctenidium
Vc. = Vinculum (Link-plate 1)
Prst. = Prosternosome
Prcox. = Procoxa (Fore Coxa)
Sti. = Stipes
T. C. = Trabecula Centralis

Msn. = Mesonotum
Mcox. = Mesocoxa
Mse. = Mesepimeron
Mses. = Mesepisternum
    Pl. Ro. = Pleural Rod
Mtn. = Metanotum
    Mtcox. = Metacoxa
    Mte. = Metepimeron
    Mtes. = Metepisternum
    Mts. = Metasternum
    Pl. A. = Pleural Arch.
    Pl. Ri. = Pleural Ridge
    Pvt. = Proventriculus
St. II. = Sternum II
T. I. = Tergum I
T. II. = Tergum II
Tr. = Trochanter
Ap. Sp. = Apical Spinelets

Ceratophyllus riparius Jordan and Rothschild, 1920

Figure C: Metathorax showing strong development of pleural arch

Ceratophyllus arcuegens Holland, 1952

Figure D: Metathorax showing absence of pleural arch

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PLATE I

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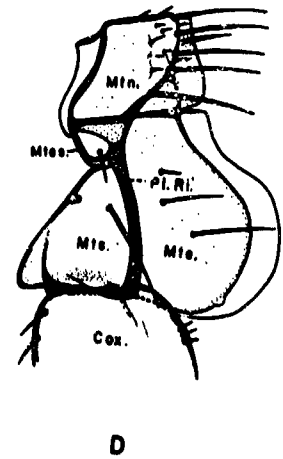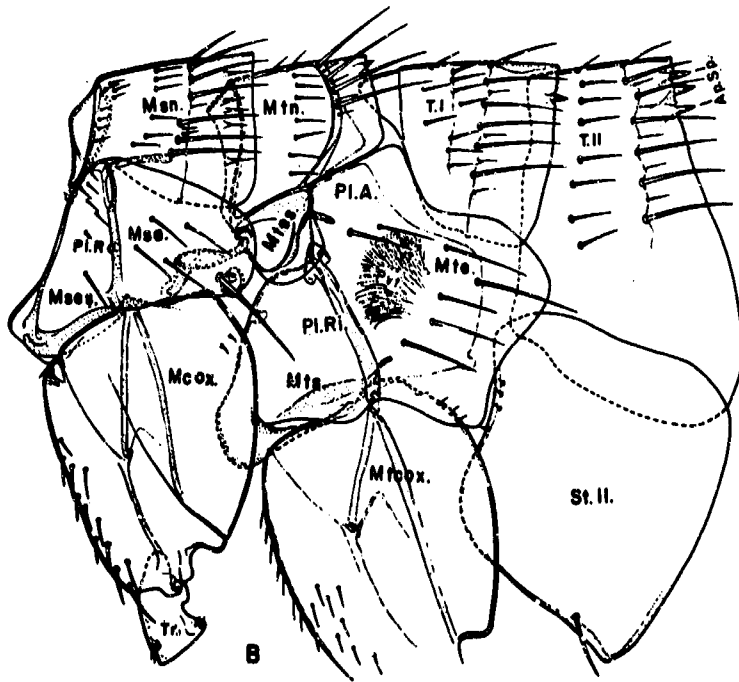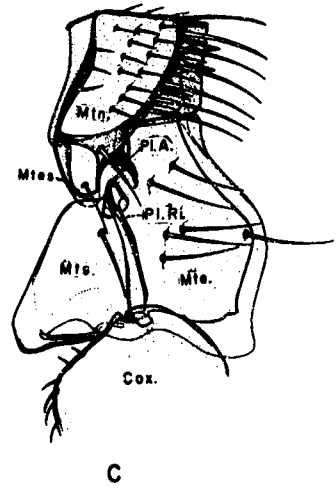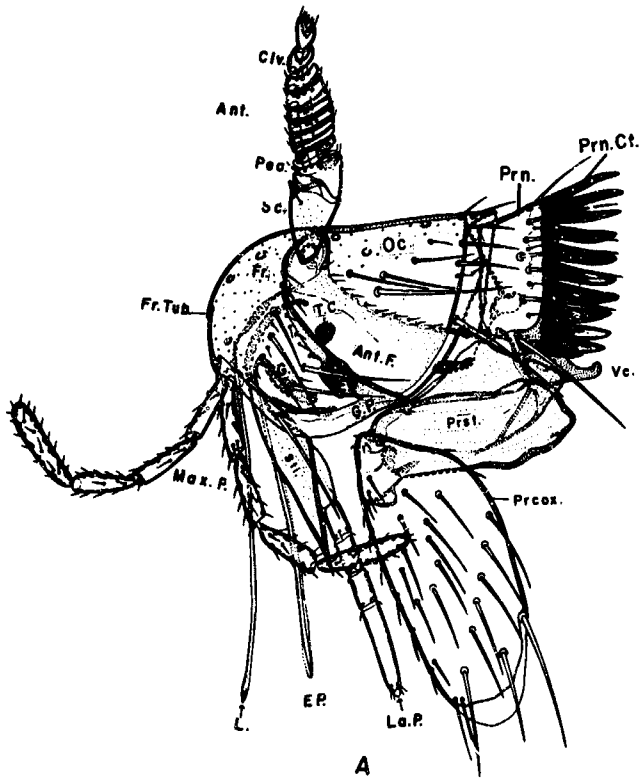
PLATE II

GENERAL MORPHOLOGY

Various Modifications in Cephalic and Prothoracic Structures

Figure A: Nearctopsylla brooksi (Rothschild, 1904). Female.

  G. Ct. = Genal Ctenidium

Figure B: Chaetopsylla floridensis Fox, 1939. Male

Figure C: Corrodopsylla curvata curvata (Rothschild, 1915).

  Ia. S. = Interantennal Suture.

Figures D and G: Amphipsylla marikovskii ewingi Fox, 1940.

  G = Enlarged view of eye.

Figure E: Myodopsylla gentilis Jordan and Rothschild, 1921.

  Po. Ct. = Preoral Ctenidium

Figure F: Epitedia wenmanni (Rothschild, 1904).

PLATE II

A

B

la.S.

C

G

D
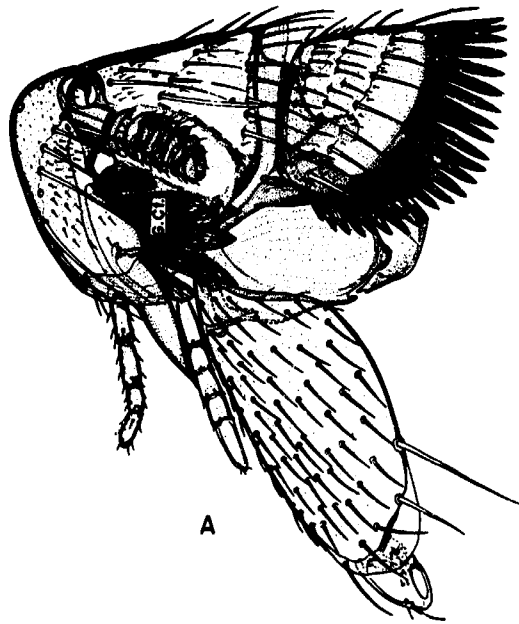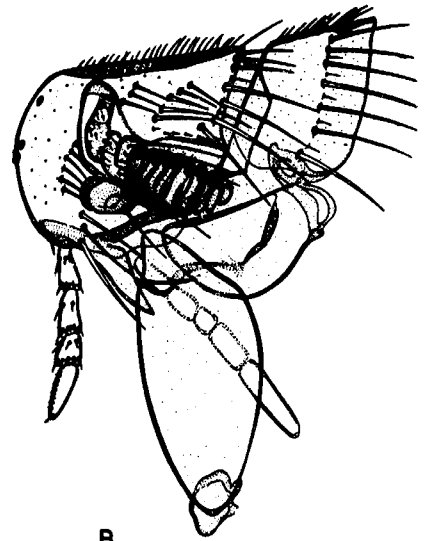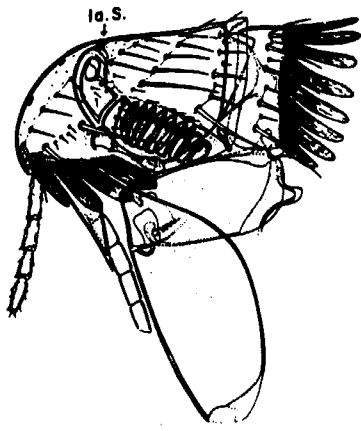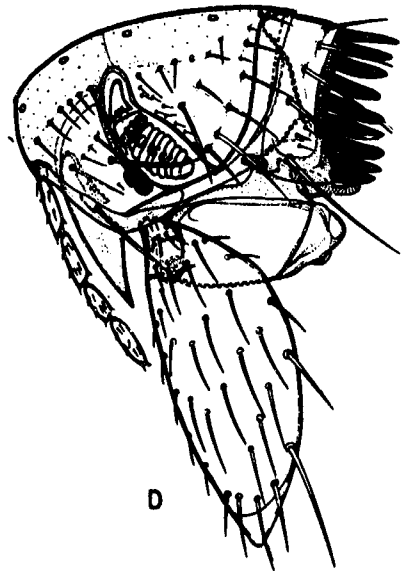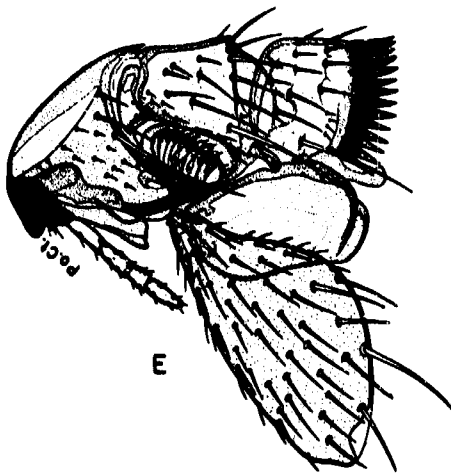
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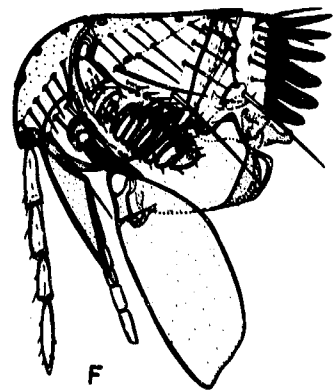
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PLATE III

GENERAL MORPHOLOGY

(Figures A - D: Modified Genital Segments, Male)

Malaraeus penicilliger dissimilis (Jordan, 1938)

  Figure A: Tergum VIII and Tergum IX (Clasper)

   Ac. = Acetabulum
   Ac. B. = Acetabular Bristles
   Apt. IX. = Dorsal Apodeme of Tergum IX
   B. Cl. = Body of Clasper
   F. P. = Fixed Process
   M. P. = Movable Process
   Man. = Manubrium
   Spf. S. = Spiniform Setae

  Figure B: Sternum IX (St. IX)

   A. L. St. IX. = Apical Lobe, Sternum IX
   D. A. = Distal Arm
   P. A. = Proximal Arm
   St. VIII = Sternum VIII
   A. M. L. = Apical Membranous Lobe
   Its. L. = Intersegmental Membrane
   Ten. St. IX. = Tendon, Sternum IX

  Figure C: Aedeagal Crochet

  Figure D: Enlarged View of Apical Lobe of Sternum IX

Malaraeus penicilliger dissimilis (Jordan, 1938)

  Figure E: Metathoracic Leg

   Cox. = Coxa
   Fe. = Femur
   Ti. = Tibia
   Tr. = Trochanter

  Figure F: Tarsus

   Ta. 1 = Tarsal Segment 1
   Ta. 2 = Tarsal Segment 2
   Ta. 3 = Tarsal Segment 3
   Ta. 4 = Tarsal Segment 4
   Ta. 5 = Tarsal Segment 5

  Figure H: Enlarged View of Tarsal Segment V

   L. P. B. = Lateral Plantar Bristles

Tarsopsylla oc.odecimdentata coloradensis (Baker, 1895) Male

  Figure G: Metatarsus Showing Elongation of the First Segment

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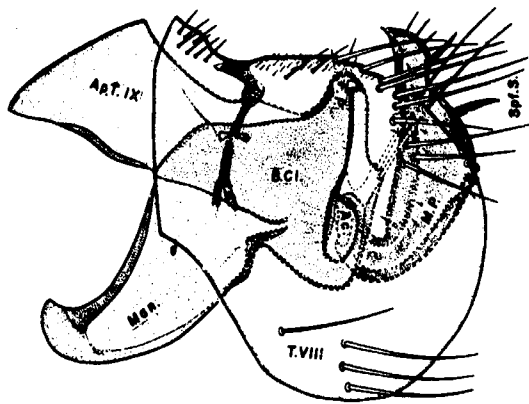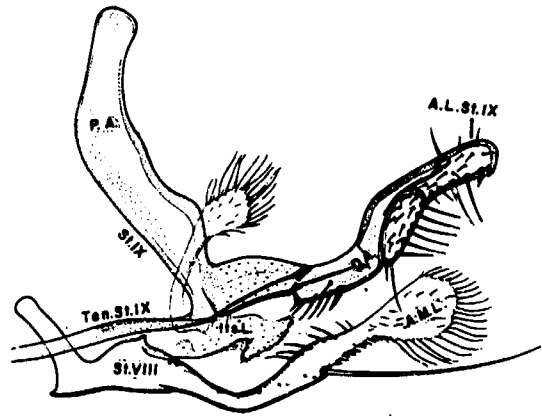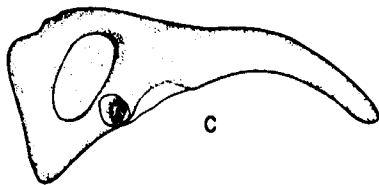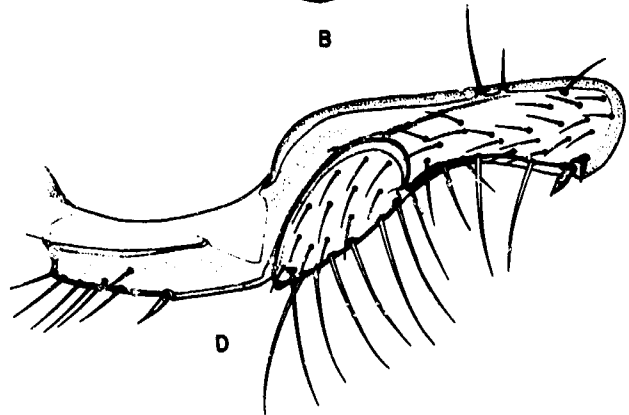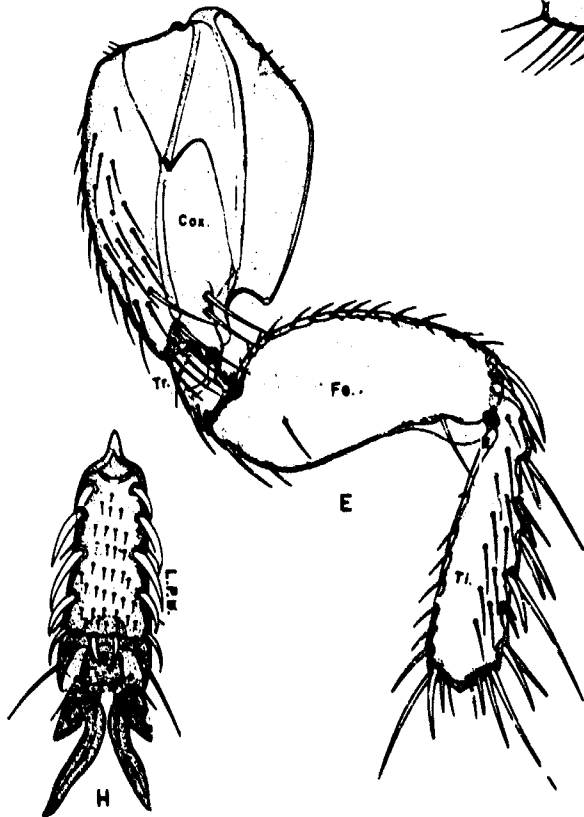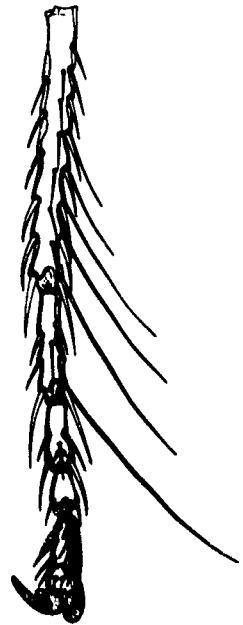
PLATE III

PLATE IV

GENERAL MORPHOLOGY

Malaraeus penicilliger dissimilis (Jordan, 1938)

Figure A: Modified Genital Segments, Female

T. VII. = Tergum VII
        A. Pyg. = Antepygidal Bristles
T. VIII. = Tergum VIII
An. Sty. = Anal Stylet (Tenth Tergite)
Spermatheca
   B. = Bulga (Head)
   H. = Hilla (Tail)
   Pa. = Papilla
B. C. = Bursa Copulatrix
B. D. = Blind Duct
D. B. C. = Duct of Bursa Copulatrix
D. S. = Duct of Spermatheca
Vg. = Vagina
S. VI = Sternum VI
S. VII = Sternum VII
   L. L. = Ventral (Lower) Lobe
   L. S. = Lateral Sinus
   U. L. = Dorsal (Upper) Lobe
   V. S. = Ventral Sinus
V. A. L. = Ventral Anal Lobe
S. VIII = Sternum VIII
S. IX = Sternum IX
Segment X
   An. Sty. = Anal Stylet
   V. A. L. = Ventral Anal Lobe

Figure E: V. A. L. = Ventral Anal Lobe

Catallagia dacenkoi fulleri Holland, 1951

Figure B: Convex Pygidium and Enlarged Spiracular Fossa (S. F.)

Pyg. = Pygidium

Megabothris calcarifer gregsoni Holland, 1950

Figure C: Illustrating Concave Pygidium and Enlarged Spiracular Fossa (S. F.)

Figure F: Anal Stylet

Hystrichopsylla occidentalis Holland, 1949

Figure D: Left Spiracle, Female

Atr. = Atrium
Osp. = Spiracular Ostium
Rd. = Tracheal Rod
Tra. = Trachea

PLATE IV
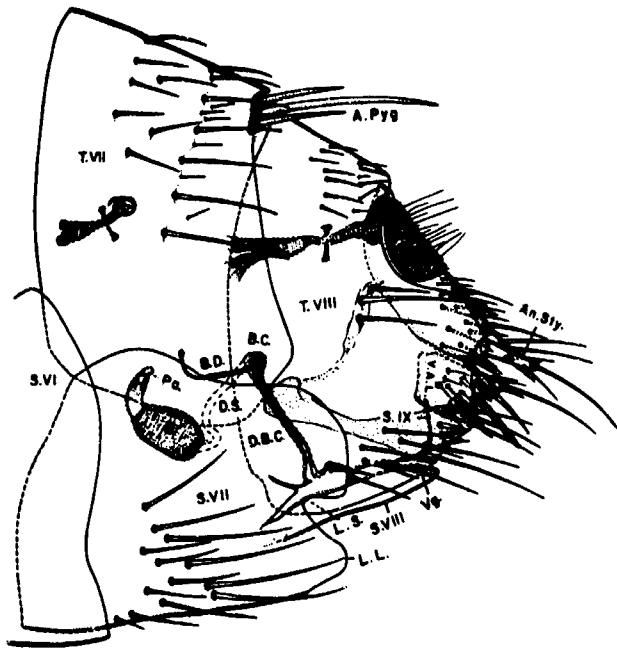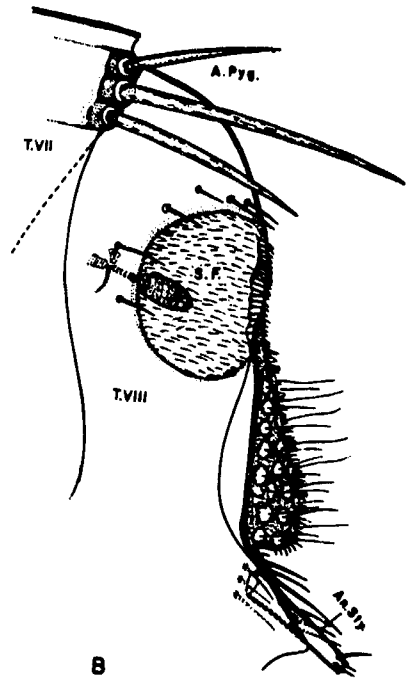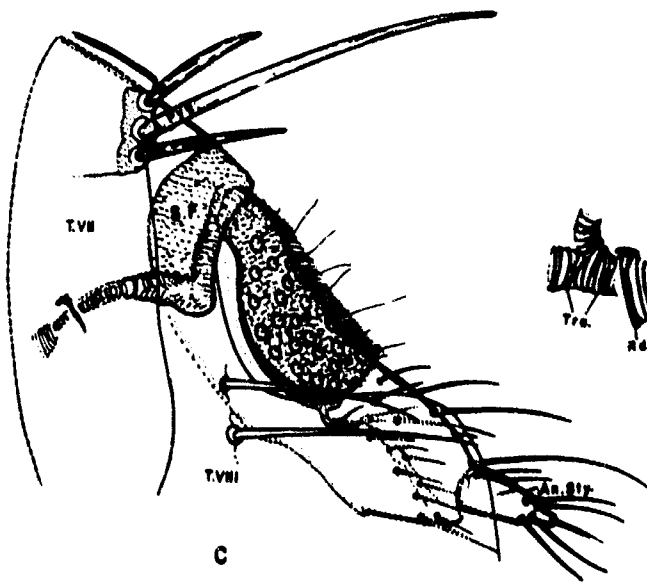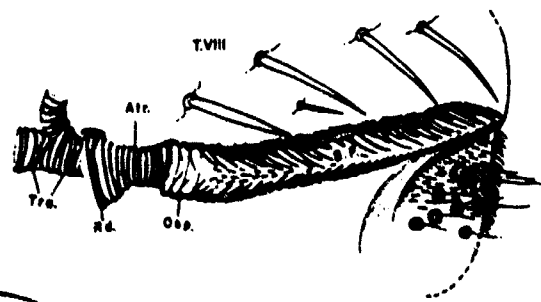
COLLECTION AND PREPARATION OF FLEAS FOR STUDY

One of the most critical aspects of a siphonapterous study is the method used to obtain specimens. This is particularly true if one is interested in host associations and other factors pertaining to the ecology of fleas. Few valid collections have been made, especially in North America, that permit one fully to appreciate the host relationships for most of the Nearctic Siphonaptera. Since my interest in the study of Alaskan Siphonaptera centered around the natural history and zoogeography of the fleas, it was especially important to be as meticulous as possible when collecting specimens.

Many methods for studying the population density of a particular species of mammal have been published. One of the most popular is termed "trap night," which simply indicates one trap for a 24-hour period. If 300 traps are set during this period, then "300 trap nights" would be reported. Theoretically, in this procedure the specimens are removed from the trap only once during the 24-hour period. The sagacity of such a procedure is questionable when one is interested in ectoparasites because many of the fleas will have departed from the host within that period of time.

Certain workers, Stark and Kinney (139) for example, indicate that the yield of ectoparasites is enhanced by using live traps. However, because of the bulk and extra time required in using these traps, they were not feasible for this study. Therefore, reliance was placed upon snap traps, and a schedule was maintained of running them every 4 hours. In rare instances it was possible to run the traps every 2 hours, but these occasions were few indeed and did not seem to increase the yield of fleas appreciably over the 4-hour interval. It is believed that by running the snap traps in the interval stated, the recovery of fleas was nearly as large as if live traps had been used. This is not merely an estimate, because at one time a small series of samples was run in comparison with live traps, and it was noted that if the live traps were run only every 8 hours, the yield of ectoparasites did not compare favorably with the snap traps run at 4-hour intervals. Attempts to get the live animal out of the trap causes agitation on the part of the animal, and certain species of fleas will depart readily during this process. Ideally, a trap is needed which is fatal to the rodent and "bags" it all in one operation!

Each species of flea seems to vary in the persistence with which it remains with the dead host. For example, we found that Peromyscopsylla o. longiloba (Jordan, 1939) would leave the host very readily. On the other hand, Malaraeus p. dissimilis (Jordan, 1938) would remain with the host over a comparatively long period of time. This was not the case with Catallagia dacenkoi fulleri Holland, 1951. Two specimens in the series of Amphipsylla marikovskii ewingi Fox, 1940, were secured by locating them after they had

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jumped from the host. In this instance, we were close enough to the trap to hear it snap and to remove the host within a matter of two or three minutes. Their abrupt departure leads me to believe that this is one of the reasons why A. m. ewingi has been so uncommon in collections.

With the traps being inspected at least six times during the 24-hour period, I have not attempted to give population estimates of the mammals because my figures would not be compatible with any previous publication dealing with the subject. For example, in some instances one trap night would record seven specimens, which in common practice would be the number reported in as many trap nights.

Each mammal was placed in a paper bag of appropriate size, which was folded from the top and stapled. A field number and the time of day were written on each bag (Figure 4). The field number consists of four paired digits: the first pair indicating the collection number for the day the second pair, the day of the month; the third pair, the month of the year; and the fourth pair, the year of the century. A letter always followed the last pair of digits: "A" indicating animal, "B" indicating burrow and "N" indicating nest. The paper bag with the animal inside it was then placed in a polyethylene sack, the free end of which was twisted and tied into a knot. If there was not sufficient time to examine the animals for ectoparasites immediately they were stored at a cool temperature in the field. This was not difficult in Alaska, because at most of the study sites a pit dug to the depth of 2 1/2 to 3 feet would reach permafrost. The specimens could be stored in this way and hauled back to the laboratory at the end of the field expedition, after which they could be kept for indefinite periods by placing them in a freezer. This procedure was followed more often than not, because pressure of other work made it necessary to secure the ectoparasites from the hosts at odd moments.

Ectoparasites were recovered from the host by placing the bagged animals in a "killing jar," which usually was a metal can of approximately 5-gallon capacity, and exposing them to chloroform fumes for several minutes. This was a routine procedure, because certain of the fleas, i.e., Tarsopsylla o. coloradensis (Baker, 1895), could withstand several weeks of storage in a freezer without apparent harm. After this treatment the animal was first removed from the plastic sack, which was inspected to ascertain if any fleas had escaped from the paper container. Then the paper bag was torn open carefully to make certain no fleas were adhering to any of the folds or seams. The field number was recorded in the record book, and the bag was discarded. The animal was "brushed" over a white surface, usually an enameled pan, and the ectoparasites stored in vials containing 70% alcohol. If the mammal was infested with ectoparasites, it was given a catalogue number. To make sure that there was no mixing of records, both the field number and catalogue number were written on a small paper tag that was inserted within the vial with the specimens. Figure 5 shows a completed

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FIGURE 4

Illustration of Field Numbering and Method of "Bagging"
Mammals for the Recovery of Ectoparasites

Host No: 05090861-A   **Cat. No.** 272

Host   <u>Microtus oeconomus</u>

Locality: Study area, Arctic Circle Hot Springs,
        Alaska

Date:

Collector: Dan Hopla

Remarks: Trap # 12, set in run along bank of Hot
        Springs Creek. Partially covered or
        protected by clump of <u>Calamagrostis</u> sp.
        Area well drained at trap setting but moist
        10 ft. away.
        Taken at 0500 hrs.

Ectoparasites
 Siphonoptera: 17 fleas
    <u>Catallagia dacenkoi fulleri</u> Holland, 1951
       02 males, 05 females = 07
    <u>Malaraeus penicilliger dissimilis</u> (Jordan, 1938)
       02 males, 01 female = 03
    <u>Megabothris calcarifer gregsoni</u> Holland, 1950
       02 males, 02 females = 04
    <u>Peromyscopsylla ostsibirica longiloba</u> (Jordan, 1939)
       02 males, 10 female = 03

Acarina: 00 - none

Phthiraptera: 03

Remarks:
    NaOH, 1700 hrs., 3-XI-61: 17 mounted in clarite.

FIGURE 5

Field Data Sheet

Only the section down to "Ectoparasites" is recorded in
in the field.

catalogue of field data sheets. It should be understood that only the upper
portion of the sheet was filled out (down to ectoparasites) at this time. In
the event that the animal did not have ectoparasites, the blank space for the
catalogue number was filled in with a dash (-). It has been my feeling that it
is just as important to know the number of animals that are not infested as it
is to know those that are.

While the mammals themselves are a source for obtaining fleas, there
are times when the nest or the burrow will yield a greater number of speci-
mens than the host. Whenever a rodent nest was encountered, traps were set
around it to ascertain which species was using it. Usually the nests were
placed in a paper bag, which was immediately placed in a plastic sack. The
material was taken back to the laboratory and allowed to sit for two or three
days before being placed in modified Berlese funnels (Figure 6). The funnels
were scrubbed meticulously after running a nest to prevent any cross-
contamination from fleas that might be clinging to a particle of debris near
the bottom of the funnel.

Another method of obtaining fleas that usually produces good results is
"swabbing" burrows of animals, such as the arctic ground squirrel (Spermo-
philus undulatus). This has been a standard operational procedure by various
workers within the U.S. Public Health Service and elsewhere for some years.
The swabbing of burrows was not given an extensive trial in Alaska because
we always encountered negative results. Be that as it may, swabbing burrows
is known to be a very effective means of obtaining fleas. It is accomplished
by using a square yard of Canton flannel attached to the end of a flexible cable
which is inserted into the burrow. The fleas become entangled in the cloth
and can be removed with forceps. I have found this method particularly effec-
tive when working with such burrowing animals as the black-tailed prairie dog
(Cynomys ludovicianus) in the southwestern United States. (At times we got
as many as 200 or more fleas from within the first 3 feet of the entrance,
although when the animal had been trapped previously, we usually would not
remove more than about half a dozen specimens.)

Throughout this study, I have used the terminology of Hall and Kelson
(39) for the scientific names of the mammals and Gabrielson and Lincoln (31)
for the avian host names. When in doubt as to what a particular species was,
the skulls were saved and sometimes study specimens prepared. These were
identified almost entirely by Dr. William O. Pruitt; however, Dr. Brian P.
Glass, Oklahoma State University, Stillwater, Okla., identified certain of
the Sorcidae.

In preparing fleas for microscopic study, numerous variations of a basic
technique have been reported by several authors (see Holland, 45, and Smit,
132). The procedure which follows was most successful under my working
conditions.
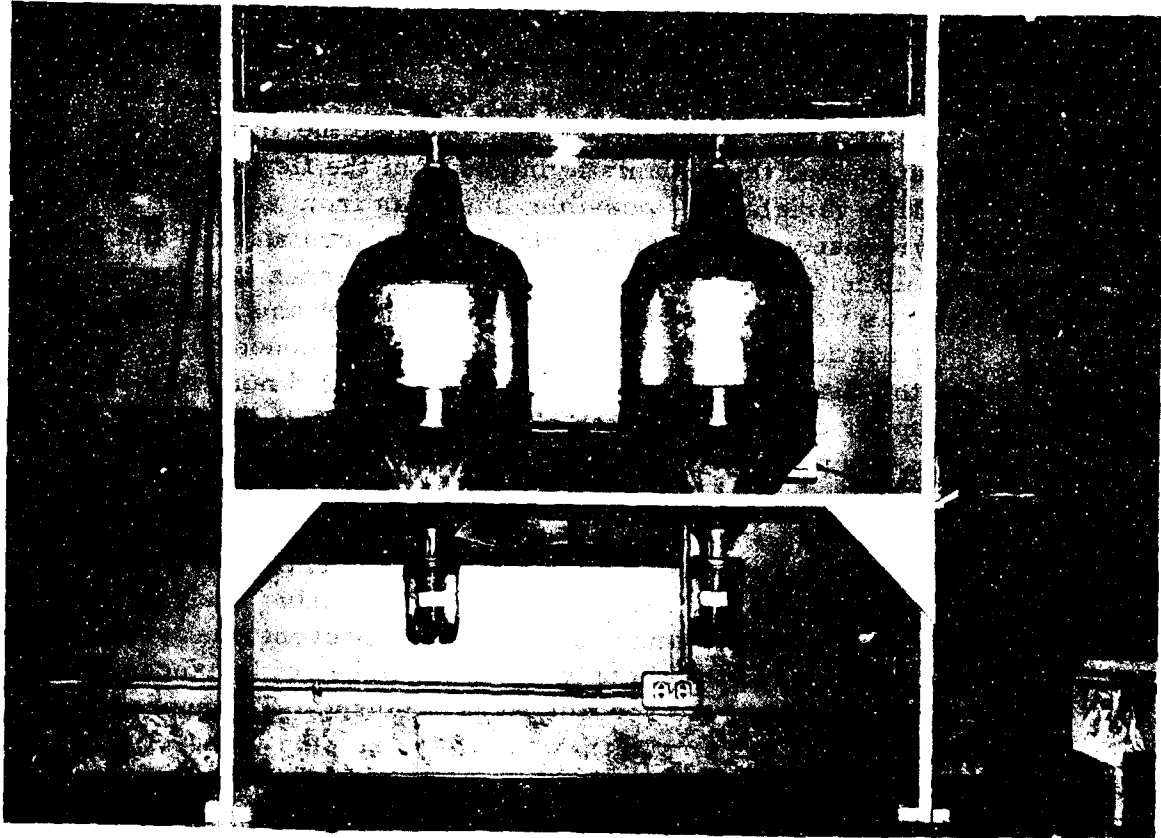
Modified Berlese Funnels Used to Recover Fleas from the Nests of Various Mammals and Birds.
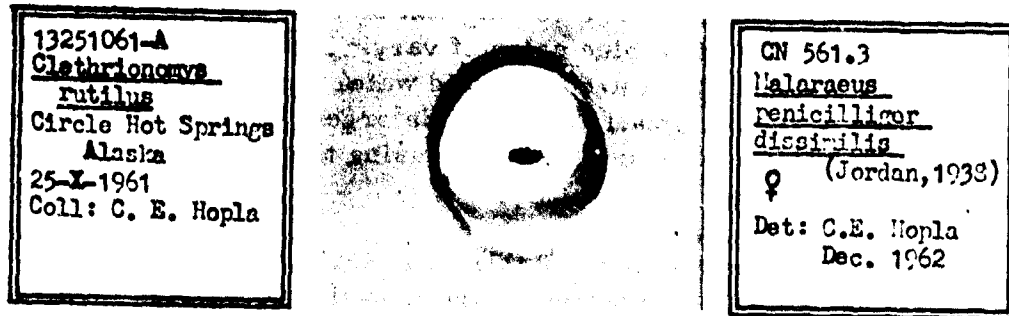
Data Recorded on Slide; Note Host Information Occurs on the Lefthand Side.

FIGURE 6

Fleas were removed from the vials and placed directly in 10% potassium hydroxide. Dry specimens of fleas were processed the same way, eventually obtaining excellent mounts for study. Fleas cannot be left in the caustic solution for a standardized period of time, because the duration is determined by temperature and the melanistic intensity of the flea. In an effort to eliminate as many variables as possible, the fleas from each collection were placed in Syracuse watch glasses which were in turn stacked and placed in a small "Boekel" incubator. The Syracuse watch glasses had ground glass upper edges as well as ground grooves on their bottoms, which prevented or at least cut down the evaporation of the higher concentrations of alcohol in which the fleas were later processed. The field number was recorded on the upper edge of the watch glass, and a slip of paper with the catalogue number was placed directly in the potassium hydroxide solution. This was done in an attempt to prevent any mixing of fleas, which might confuse the host records. Probably more errors in host associations have been made from the time fleas are placed in the bleach until they are mounted on the slides and labeled than in any other phase of securing study specimens. Every effort was made to check and double-check to prevent this from happening, and we we:e pleased that in only a small number of instances did we have to discard fleas because the records were confused. The uppermost watch glass (in a stack of six or eight), was always an empty one, and a small red tag was placed in it when the specimens were in KOH; a yellow one, when in the first water rinse; a green tag, for 70% alcohol (2 hours); blue, for 95% alcohol (2 hours); white, for 100% alcohol (15 minutes); and orange, when the specimens were being cleared in either oil of cloves or oil of wintergreen. The fleas were given a xylol rinse just before being placed on slides.

The yellow tag used during the water rinsing is of additional value, because a drop of the water will cause the yellow to turn to pink if even a slight trace of KOH remains. The red tag can be used for the same purpose, the KOH changing the red to a blue color of varying intensity, depending upon the strength of the solution.. I used distilled water during the rinsing procedure, to which I added a small amount of detergent (Tween 80). The detergent lowered the surface tension, thereby causing the fleas to sink and obtain a more thorough rinsing.

In the last water rinse (second or third), I straightened out the legs as much as possible, especially the meso- and metathoracic ones. (Sometimes little or nothing can be done with the prothoracic legs, although it is wise to attempt to straighten them if possible, particularly within the genera Orchopeas Jordan, Opisodasys Jordan and Tarsopsylla Wagner.) At this time, if a large amount of material remained in the abdominal cavity, the basal abdominal sternite (sternum II) was disassociated from its postero-ventral attachment and the material gently forced out. Frequently the basal sternum returned back into position after such an operation so that it was difficult to tell that it had been manipulated. All hair and traces of cotton or

other debris were removed from around the mouth parts and legs at this time. I generally was not concerned about hair from the host during the KOH processing, because many times this was destroyed or softened so much by the KOH that it would become disassociated from the flea during rinsing in water. While not germane to the study of Siphonaptera, I cannot help commenting upon the interesting hair structural pattern of the host that was revealed during the stay in KOH. Frequently one could tell the host by the hair pattern.

Much has been written about the various merits of different essential oils in the clearing process. I have used only two, oil of wintergreen and oil of cloves, that I deem meritorious. There are certain advantages to each, but in general I think that fleas can be left in oil of wintergreen for a longer period of time than in oil of cloves, without producing excessive brittleness in the specimen.

There is no standard method for placing a flea on the slide. However, as an aid to illustration it works best to have the flea mounted on its right side, the head thus pointed to the right and the feet away from the technician. When the specimens are subsequently studied under the compound microscope, the head is to the left and illustrations can be made exactly as the flea lies, rather than having to reverse the slide and study through the thickness of the slide, which is a marked handicap if the high dry objective is used. When working with a large series of specimens, the more pains taken in centering the flea under the cover slip, the better. As a standard process, 13 mm cover slips were used for all but the larger fleas, such as those belonging to the genus Oropsylla, Chaetopsylla; for these, 15 mm cover slips were used.

Various types of mounting media have been used. I have had excellent success with original stocks of Clarite, but this is no longer available. I have secured from various sources old stocks of Clarite that were dissolved in a variety of solvents other than xylene or toluene, and these have not proved satisfactory. I have tested HSR (Harleco Synthetic Resin), but after 4 or 5 years I have noted a tendency for excessive yellowing. Thus, I have reverted to the more standard medium, Canada balsam. The more refined, paper-strained balsam now available appears to be working very well, and I am not encountering the problem of excessive yellowing that was so characteristic of older slides when earlier types of balsam were used. Also, material mounted in balsam can be remounted a number of years later with little or no damage to the specimen, which is something that cannot be said for most of the modern synthetic resins.

I found it most convenient to use precleaned slides with a ground glass area at one end. The catalogue number was recorded on the ground glass with pencil, and the initials of the technician and the abbreviation for the mounting medium were recorded in the lower left- and righthand corners

respectively. After the slides had been dried, the specimens were examined under a compound scope, and the genus and species name was abbreviated by using a standard series of initials secured from Robert Traub. With this information available, the first label was placed on the left side and the host data recorded. The second or "species" label for the flea was placed directly over the ground glass portion, or righthand side, of the slide. If any of the data previously penciled on the ground glass needed to be checked after the labels were in place, it could easily be read by holding the slide over a mirror. Figure 6 shows a slide with all labeling completed.

List of Collectors

The following is a list of collectors. If an individual name did not appear more than twice, no initials are given; instead, the name will appear in full for that particular citation.

Carl, E. A.	E. A. C.	Hufman, L. L.	L. L. H
Couser, R. D.	R. D. C.	Jellison, W. L.	W. L. J.
Cracraft, J. L.	J. L. C.	Mitchell, C. J.	C. J. M.
Emerson, T.	T. E.	Molchan, M.	M. M.
Engleman, J. H.	J. H. E.	Neiland, K. A.	K. A. N.
Geary, J. M.	J. M. G.	Pruitt, W. O.	W. O. P.
Gill, G.	G. G.	Rausch, R.	R. R.
Hopla, C. E.	C. E. H.	Springer, H.	H. S.
Hopla, D.	D. H.	Van Velzen, W. T.	W. T. V.
Hopla, R. E.	R. E. H.	Viereck, E. G.	E. G. V.

List of Collections

R. T. =	Personal collection of Robert Traub
C. N. C. =	Canadian National Collection
U. S. N. M. =	U. S. National Museum

VII

TAXONOMY

The discussion which follows is a brief history of taxonomic concepts, with particular regard to the suprageneric taxa. I hope this presentation will also provide a better understanding of the characteristics used for classification at the generic and specific levels. One cannot consider the Alaskan fauna as a separate entity unto itself; first, because there are few species which are unique to this political area, and second, because only by utilizing information gained from global studies can proper interpretation be given to the localized fauna. The reader is referred to an extremely important

article by Holland (59) for a more detailed explanation of the family relation-ships; equally important are his comments concerning subspeciation.

Two of the most conspicuous morphological landmarks of the flea are:
(1) the presence or absence of the genal comb and (2) the degree of develop-ment of the interantennal suture. This suture may be so strongly developed that the dorsal outline of the head is broken, with the frons appearing to overlap the occiput (fracticipit), or it may be reduced or absent (integricipit). In any case, the presence or absence of the pronotal ctenidium did not make nearly as profound an impression upon the earlier workers as that of the previously mentioned structures.

Taschenberg (141) was the first to divide the fleas into two families, recognizing only Pulicidae and Sarcopsyllidae (=Tungidae). The earliest formal attempt to break Pulicidae into a subfamily concept was by Tiraboschi (146), who based his distinction upon the presence or absence of the genal comb. Oudemans (106, 107) was intrigued with the development of the inter-antennal suture and placed enormous importance upon it. He based his divi-sion of fleas into two suborders: those possessing the suture were called Fracticipita, and those lacking it were Integricipita. The known species were small in number (approximately 300 species, many of which were not known to him), and by coincidence the fleas with a genal comb appeared to be Fracticipita and those without the genal comb were, by Oudemans' definition, Integricipita. Oudemans also developed the concept that the flea with the higher number of bristles, combs, spines and setae represented the most primitive type. While Jordan (90) pointed out that most of Oudemans' concepts were Lamarkian, they have not been entirely discarded by certain of the modern students.

The classification of Oudemans was accepted readily, particularly by North American workers, long after new knowledge indicated it was not tenable. C. Fox (47) mentioned some of the difficulties with Oudemans' concept but essentially conformed to his classification. Ewing (23, 24) also followed Oudemans' classification insofar as suborders were concerned but reduced the number of known families from 18 to 6, on a seemingly arbitrary basis. The result was a family classification that was unusual, to say the least, scrambling the family concept almost beyond credibility. For example, Ewing placed Anomiopsyllus under Pulicidae simply because of the single row of setae on the abdominal terga, which as Holland (59) states, is a "character that is fundamental to the Pulicidae and secondary to Anomiop-syllus and others."

In 1933 Jordan published a significant paper in which the genus Cerato-phyllus was divided into 16 genera, all of which are still acceptable, although the placement of genera in families has undergone some change. Showing an unusual amount of insight, Jordan based his revision upon characters that at first glance seem insignificant, yet have proved to be fundamental. He

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based the division upon the setal pattern of the forefemora and the mid- and hindcoxae. Ioff and Scalon (74) did not follow Jordan, preferring to keep many of his generic names as sub-genera within Ceratophyllus. Nonetheless, the above-mentioned publication is an invaluable aid in studying boreal fleas. Wagner (151) discarded the artificial classification of Oudemans insofar as the suborders were concerned but utilized the interantennal character in dividing the families. Wagner's system was, however, a more "natural" classification than any previously published. I. Fox (29) returned to Oudemans' and Ewing's classification in his study of the flea fauna of the eastern United States. This chaotic situation was further perpetuated by Ewing and Fox in 1943. Essentially, they ignored the advances made by both Jordan and Wagner and repeated Ewing's effort of 1929 (23, 24). Hubbard (70) mentioned some of the nonconformities in the previous authors' works but proceeded to follow them, ending up with a fusion of Oudemans' and Ewing's concepts for the suprageneric taxa and Jordan's generic classification for the ceratophyllids. Hubbard developed a number of definitions of genera that neither conformed nor belonged to the family definitions, thereby removing considerable value from his comprehensive compilation of the fleas in western North America.

Within the past 15 years, a number of modern students, largely independent of one another, came to the conclusion that the interantennal suture and the genal combs were not highly significant phylogenetic characters. Currently, the interantennal suture is not employed higher than the generic level, and there is some question as to its reliability even there. For example, Jordan (86) described a new genus Cratynius, known only from the female which was integricipit; later, Traub (148) described Johnsonaepsylla, known only from the male which was fracticipit. In 1955, Hopkins and Traub realized that Johnsonaepsylla was a synonym of Cratynius Jordan! The latter is an extreme example, but it does show that the interantennal suture is not valid in certain fleas even at the species level.

In 1948 Jordan published a most significant paper dealing with suprageneric taxa, basing his concepts upon a previous publication by him (90), in which he stated that the modifications of the fleas are so distributed that the higher taxa can be defined and distinguished only by a combination of characters, any of which may appear outside the taxon defined. In other words, the combination is the vital characteristic of the taxon, not the sporadic occurrence of exceptional characters. As hindsight, it is apparent that most of the earlier workers expended their energies upon the latter concept and therefore never approached Jordan's insight to the fundamental concepts of the order. Essentially, Jordan's classification is followed by most workers at the present time.

Jordan divided the order into the Pulicoidae and Ceratophylloidae. The former superfamily was split into the Pulicidae and Tungidae; the remaining sixteen families were placed under the Ceratophylloidae, the most significant

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change being the separation of the leptopsyllids from Hystrichopsyllidae and the amphipsyllids from the Ceratopyllidae. He placed Leptopsyllidae and Amphipsyllidae next to each other without explanation, although Hopkins and Traub (67) believed that he considered them closely related. Johnson (82) has since created a third superfamily, the Malacopsylloidae, which appears to have been well received by other colleagues. Holland was of the opinion that the leptopsyllid fleas belonged with the Ceratophyllidae, since they share the following characteristics with them: the presence of apical spinelets on the metanotum, an apodemal rod on sternum IX, and a flat pygidium, all of which are considered phyletically significant. Traub (147) confirmed the ceratophyllid affinities of the leptopsyllid series by his study of the phallosome, noting, among other things, that the crochets were large and freely movable. The first in a series of "catalogues" by Hopkins and Rothschild in 1953 was a particularly important landmark, since among other things, they summarized many of Jordan's phyletic concepts. Hopkins and Traub (67) proposed that the Leptopsyllidae contain two subfamilies, the Amphipsyllinae and the Leptopsyllinae; this has been well received and largely completed the current trend of re-evaluating the family concepts.

Check List of the Siphonaptera of Alaska

PULICIDAE

SPILOPSYLLINAE

Hoplopsyllus glacialis lynx (Baker, 1904)

HYSTRICHOPSYLLIDAE

HYSTRICHOPSYLLINAE

Hystrichopsylla occidentalis Holland, 1949

RHADINOPSYLLINAE

Rhadinopsylla sp.
Nearctopsylla brooksi (Rothschild, 1904)
Nearctopsylla hyrtaci (Rothschild, 1904)

CTENOPHTHALMINAE

Corrodopsylla curvata curvata (Rothschild, 1915)

NEOPSYLLINAE

Catallagia dacenkoi fulleri Holland, 1951
Catallagia charlottensis (Baker, 1898)
Delotelis hollandi Smit, 1952
Epitedia wenmanni (Rothschild, 1904)

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ISCHNOPSYLLIDAE

Myodopsylla gentilis, Jordan and Rothschild, 1921

LEPTOPSYLLIDAE

LEPTOPSYLLINAE

Peromyscopsylla ostsibirica longiloba (Jordan, 1939)

AMPHIPSYLLINAE

Amphipsylla sibirica pollionis (Rothschild, 1905)
Amphipsylla marikovskii ewingi Fox, 1940
Ctenophyllus armatus terribilis (Rothschild, 1903)

CERATOPHYLLIDAE

CERATOPHYLLINAE

Ceratophyllus arcuegens Holland, 1952
Ceratophyllus riparius Jordan and Rothschild, 1920
Ceratophyllus idius Jordan and Rothschild, 1920
Ceratophyllus scopulorum Holland, 1952
Ceratophyllus celsus celsus Jordan, 1926
Ceratophyllus garei Rothschild, 1902
Ceratophyllus diffinis Jordan, 1925
Ceratophyllus balati Rosicky, 1955
Ceratophyllus gallinae (Shrank, 1803)
Ceratophyllus niger Fox, 1908
Ceratophyllus vagabundus vagabundus (Boheman, 1866)
Ceratophyllus lunatus tundrensis Holland, 1944
Dasypsyllus stejnegeri (Jordan, 1929)
Dasypsyllus gallinulae perpinnatus (Baker, 1904)
Mioctenopsylla traubi Holland and Jellison, 1952
Mioctenopsylla arctica hadweni (Ewing, 1927)
Malaraeus penicilliger dissimilis (Jordan, 1938)
Megabothris calcarifer gregsoni Holland, 1950
Megabothris abantis (Rothschild, 1905)
Megabothris groenlandicus (Wahlgren, 1903)
Megabothris quirini (Rothschild, 1905)
Monopsyllus tolli (Wagner, 1901)
Monopsyllus vison (Baker, 1904)
Monopsyllus ciliatus protinus (Jordan, 1929)
Orchopeas caedens caedens (Jordan, 1925)
Orchopeas caedens durus (Jordan, 1929)
Opisodasys pseudarctomys (Baker, 1904)
Opisodasys keeni (Baker, 1896)

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CERATOPHYLLINAE (cont'd)

Tarsopsylla octodecimdentata coloradensis (Baker, 1895)
Oropsylla alaskensis (Baker, 1904)
Oropsylla idahoensis (Baker, 1904)
Oropsylla arctomys (Baker, 1904)
Thrassis pristinus Stark, 1957
Amphalius necopinus (Jordan, 1925)

VERMIPSYLLIDAE

Chaetopsylla floridensis Fox, 1939
Chaetopsylla tuberculaticeps ursi (Rothschild, 1902)

Keys and Drawings

Insofar as I know, the keys presented on the following pages are the first ones prepared specifically for Alaskan Siphonaptera. Keys to the families are not presented, but they are described in the text. A simple dichotomous key has been prepared for the genera and species. In those genera which are monotypic (in Alaska), the species name is included in the generic key; otherwise the species within the genus are not separated until that genus is discussed in the text.

The drawings were prepared with the aid of a microprojector, and originally it was planned that all the species would be drawn on the same scale. The clasper of the male and sternum VII of the female were drawn at 100x and projected 27 inches. The enlarged drawing of the spermatheca was 250x and projected 27 inches. With the smaller species, the lower magnification did not prove practical, and a second drawing of the clasper and sternum IX of the male at the higher power was included. Admittedly, this is a duplication of effort, but the smaller drawing was retained for a general impression of comparative size.

Time and space does not permit a detailed description of each species; however, the review of literature for each one is believed complete. With keys and drawings and a rather adequate description of the genera, the terse comments at the specific level of salient points should prove adequate for most purposes.

Generic Key - Alaskan Siphonaptera

1. Without either pronotal or genal ctenidia. Chaetopsylla   page 229
   With a genal or pronotal ctenidium or both   2

2. Genal ctenidium present   3
   Genal ctenidium absent   9

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3. Apex of stipes truncate; spines of genal ctenidium also
truncate. Myodopsylla gentilis   page 94
Apex of stipes or genal spines never truncate   4

4. Pronotal ctenidium curved anteroventrally; spines of genal
ctenidium spatulate. Nearctopsylla   page 70
Pronotal ctenidium straight; spines of genal ctenidium
slender   5

5. Genal ctenidium consisting of two spines   6
Genal ctenidium of more than two spines   7

6. The two genal spines overlapping, with acuminate apices;
head not bearing heavy spiniforms. Epitedia   page 88
The genal spines not overlapping, with rounded apices; head
with spiniforms near dorso-anterior angle. Peromyscopsylla
o. longiloba   page 95

7. Fifth tarsal segment with five pairs of plantar bristles,
four pairs lateral, basal pair medially displaced; genal
ctenidium horizontal with four spines per side. Corrodopsylla
c. curvata.   page 74
Fifth tarsal segment with all five pairs of plantar bristles
lateral; genal ctenidium of more than four spines per side
and not horizontal.   8

8. Pronotal ctenidium consisting of not more than 12 spines per
side, Mte. with striarium; total body length less than 3 mm.
Rhadinopsylla   page 68
Pronotal ctenidium consisting of 16 or more spines per side,
Mte. lacking striarium; total body length 3 mm or greater
Hystrichopsylla occidentalis   page 66

9. Abdominal terga with one row of bristles. Hoplopsyllus g.
lynx   page 58.
Abdominal terga with at least two rows of bristles   10

10. Occiput with at most one oblique row of bristles in addition
to the submargir 1 row; sternum VIII markedly reduced
in male   14
Occiput with two rows of oblique bristles in addition to the
submarginal row; sternum VIII large, not more than modestly
reduced   11

11. Hind coxa with a patch of spiniforms on mesal surface   12
Hind coxa lacking spiniforms on mesal surface   13

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12. Preantennal region (frons) with three rows of bristles.
    Delotelis hollandi   page 88
    Preantennal region with but two rows of bristles. Catallagia page 80

13. Preantennal region with a row of spiniforms; distal arm of
    ninth sternum poorly developed. Ctenophyllus terribilis   page 110
    Preantennal region lacking row of spiniforms; distal arm of
    ninth sternum not poorly developed. Amphipsylla   page 99

14. One or no lateral setae on mesal surface of outer side of
    profemur   15
    A number of lateral setae on mesal surface of outer side of
    profemur   17

15. Basal segment (segment I) of metatarsus longer than segments
    II to IV; associated with Tamiasciurus. Tarsopsylla o.
    coloradensis   page 208
    Basal segment of metatarsus shorter than the next three
    (segments II-IV)   16

16. MP of male with three to four spiniforms directed upward; female
    with ventral margin of anal sternum angulate from near middle to
    apex; stylet not curved. Orchopeas caedens   page 193
    MP of male with two to three black spiniforms directed ventrally
    or posteriorly; female with ventral margin of anal sternum not
    angulate (as above) but tapering gradually from base to apex;
    stylet somewhat curved. Opisodasys   page 201

17. Pronotal ctenidium with 12 or more spines per side   18
    Pronotal ctenidium with less than 12 spines per side   21

18. Fifth tarsal segment with third pair of lateral plantar bristles
    shifted medially; preantennal region of head with three rows of
    bristles. Dasypsyllus   page 148
    All plantar bristles aligned along lateral margin of fifth tarsal
    segment; preantennal region with less than three rows of
    bristles   19

19. Spines of pronotal ctenidium large and dark   20
    Spines of pronotal ctenidium very short and pale.
    Mioctenopsylla   page 152

20. Labial palps reaching apex of trochanter, MP of male with a
    long ventroposterior arm; Stylet of female with one apical and
    numerous subapical setae; Ochotona usual host. Amphalius r.
    necopinus   page 225
    Labial palps never reaching apex of procoxae or trochanters,
    MP of male without such an arm; stylet of female with a single
    apical and two subapical bristles. Ceratophyllus   page 112

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21. Anterior inner surface of mesa- and metacoxa with thin setae
    from base to apex in addition to those fringing the anterior
    margin   22
    Anterior inner surface of basal portion of mesa- and
    metacoxa lacking these thin setae, except for those fringing
    the anterior margin   23

22. Eighth sternum slender with long apical bristles; bulga of
    spermatheca pyriform or oblong, not subglobular or round.
    Oropsylla   page 210
    Eighth sternum relatively short and broad, bearing many
    setae; some preapical; bulga of spermatheca broader than
    long (round or subglobular). Thrassis pristinus   page 224

23. Spiracle of eighth tergum much enlarged. Megabothris   page 165
    Spiracle of eighth tergum small (usual size)   24

24. Greatest diameter of eye less than distance from its ventral
    margin to sclerotized portion of genal lobe (associated with
    Cricetid rodents). Malaraeus p. dissimilis   page 157
    Greatest diameter of eye more than distance from its ventral
    margin to sclerotized portion of genal lobe (primary hosts
    Ochotona and Tamiasciurus). Monopsyllus   page 180

VIII

Family PULICIDAE Stephens, 1829

Eyes large and well-pigmented. Genal and pronotal ctenidia present or absent; if present, usually vertical. Trabecula centralis not apparent; antennal fossae closed. Mesonotum without pseudosetae under collar. Metanotum and abdominal terga without apical spinelets. Outer internal ridge absent on mesocoxae, present on metacoxae. Each abdominal tergum with one row of bristles. Outer surface of apical end of hind tibia not produced into a "tooth." Lateral plantar bristles usually not exceeding four pairs.

Clasper of male often with two movable processes. Sternum IX of male lacking tendon. Sternum VIII much enlarged, covering most of the other genital segments; tergum IX markedly reduced.

Female with one spermatheca. Anal stylet present. Tergum IX not apparent.

Subfamily Spilopsyllinae Oudemans, 1909

Genal and pronotal combs present or absent; if genal ctenidium present, of a vertical form. Mouth parts may be modified for firm attachment to host. Interantennal suture well-developed. Clava of antenna symmetrical. Mesopleural rod present. Male always with a single blunt spiniform bristle at apex of the ventral projection of fixed process. Female tergum VIII divided dorsally.

HOPLOPSYLLUS Baker, 1905

Hoplopsyllus Baker, 1905. Proc. U. S. Nat'l. Mus., 29:128, 130, 144.

With the exception of the genotype (Hoplopsyllus anomalus Baker, 1904, ex Spermophilus), all other members of the genus are found on hares and rabbits. This genus is circumpolar in distribution, extending as far south as Peru in South America.

Separable from all other pulicids by the presence of a pronotal ctenidium and absence of a genal ctenidium. Pronotal ctenidium not extending along entire lateral margin of prothorax; a pale lobe projects posteriorly below ctenidium. Frons not angulate. A pale flange projecting posteriorly from anterior margin of antennal fossae and covering a portion of the clava. Lacinae and hypopharynx normal, not modified for permanent attachment to host as in Cediopsylla Jordan. All tarsi segments V with four pairs of plantar bristles.

Male: Fixed process of clasper divided into a broad dorsal lobe with numerous bristles at apex; ventral lobe slender, "spout-like," and a much enlarged spiniform at apex. Movable process single, arising from clasper proper. Second movable process absent.

Female: Frons somewhat more sloping than that of male. Spermatheca single, hilla not projecting into bulga. Posterior margin of sternum VII somewhat variable, usually slightly concave and without a ventral sinus.

<center>Hoplopsyllus glacialis lynx (Baker, 1904)
(Plate V, A, B, C, D, E, F, G; Map 1)</center>

Pulex lynx Baker, 1904. Proc. U. S. Nat'l. Mus., 27:378, 383-384, 437.

Hoplopsyllus lynx (Baker). Baker, 1905, Proc. U. S. Nat'l. Mus 27:130,
144. Fox, 1914, Hygenic Lab. Bull., 97:25. Fox 1940, p. 15, Pl. IV,
figs. 11, 1e. Hubbard, 1940, Pac. Univ. Bull., 37(4). Hubbard, 1941,
Pac. Univ. Bull., 37(8):8.

Hoplopsyllus glacialis lynx (Baker). Jordan, 1925, Nov. Zool., 32:103.
Jordan, 1929, Nov. Zool., 35:175. Jordan, 1932, Fauna Arctica, 6:16.
Jordan, 1932, Nov. Zool., 38:253. Wagner, 1936, Can. Ent., 68:194-
195. Jordan, 1937, Nov. Zool., 40:283. Philip, 1938, Jour. Parasit.,
24:483, 485. Kohls, 1939, Pub. Health Rept., 54:2019. Jellison and
Kohls, 1939, Pub. Health Rept., 54:2021. Mail and Holland, 1939, Proc.
Sixth Pac. Sci. Cong., 5:126. Kohls, 1940, Nat'l. Inst. Health Bull.,
175:14, Pl. 2, figs. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Jellison,
Kohls, and Mills, 1943, Misc. Publ., Montana St. Bd. Ent., 2:4, 8, 9,
19. Ewing and Fox, 1943, U. S. Dept. Agri. Misc. Publ., 500:107.
Hubbard, 1947, pp. 70-71, fig. 12. Holland, 1949, Proc. Ent. Soc. Br.
Columbia, 45:8. Holland, 1949, Siphonaptera of Canada, p. 63, figs.
Geary, Arctic Aeromed. Lab. Rept., 1:1-37. Hopkins and Rothschild,
1953, Cata. Rothschild Coll., 1:187-189, figs. 177. Gill, 1954, Arctic
Aeromed. Lab. Rept., 2. Brown, 1955, Canad. Ent. 87:362-365. Hol-
land 1956, Proc. Tenth Internat. Cong. Ent., 1:645-658. Geary, 1959,
Cornell Exper. Stat. Mem., 355, figs. 85-87. Jellison 1959, Annual
Rev. Ent., 4:389-414. Miller, 1962, Jour. Parasit., 48(5):751. Hol-
land, 1963, Bishop Mus. Press, 45-63. Holland, 1964, Ann. Rev. Ent.,
9:123-146.

Hoplopsyllus glacialis lynx (Baker, 1904) is the sole representative of the family and genus in Alaska, although it is possible that Hoplopsyllus glacialis glacialis (Taschenberg, 1880) will be found to infest Lepus othus (tundra hare), which inhabits the tundra regions in much of Alaska. These two subspecies are not separable except by host information and by the fact that H. g. glacialis is usually the larger specimen. Intuitively, I feel that if

<center>58</center>

a large series of each were examined, they would completely intergrade insofar as this characteristic is concerned.

Hoplopsyllus g. lynx is found principally upon two hosts, the varying hare (Lepus americanus) and its chief predator, the lynx (Lynx canadensis). I am of the opinion that this flea is able to maintain a breeding population upon the last host; since fleas more often than not are stragglers or strays upon the predator, it is somewhat unique in this respect.

TABLE I

Host Associations of
Hoplopsyllus glacialis lynx (Baker)

Host	Total No. Fleas	No. Positive Specimens Collected	Average/Host
Castor canadensis	03	01	
Lepus americanus	285	25	11.4
Lynx canadensis	25	03	8.3
Martes americana actuosa	01	01	
Spermophilus undulatus	01	01	
Vulpes fulva	02	01	

This particular flea will feed upon man with little hesitation. In talking with a number of old trappers, I have found that they have frequently become infested with these fleas while skinning the lynx and have remained infested for several days. According to the trappers, the bites are very annoying.

It is of interest that this is about the only flea I have encountered in Alaska that will bite man with any readiness, although I have never known them to search for the human host except when man intimately handles either the lynx or the varying hare. It is perhaps significant that personnel at the Arctic Health Research Center, under the direction of Dr. Robert Rausch, have isolated an organism closely related to the plague organism from the varying hare in the Anchorage area.

The last statement is of rather profound importance because, if true, it could possibly change historical concepts concerning the relation of plague in North America. I think that it is entirely possible that plague existed in North America long before the coming of the white man, particularly before the outbreak that occurred in San Francisco in the late 1800's. I postulate that plague moved across the Bering land bridge with the Eurasian stocks of mammals.

Map 1 illustrates the distribution of H. g. lynx in Alaska; it is probably conservative. However, 150 varying hares were collected in the Koyukuk drainage system, none of which had fleas at that time. A considerably smaller number (35) taken at Noorvik were also free of flea infestation. In 1956 similar results were obtained in hares collected at Noatak.

Within the Tanana Valley I have found the fleas present on hares at all times of the year, but the heaviest infestations were noted during the early spring. This coincided with the peak of activity of the adult rabbit tick, Haemaphysalis leporis-palustris.

Records

Alcan Hwy., M. P. 1393, Alaska

Lepus americanus
30-VI-62, 1M (R. D. C.)
30-VI-62, 1M (R. D. C.)

American Creek, Eagle, Alaska

Martes americana actuosa
8-I-62, 1M (M. M.)

Central, Alaska

Lepus americanus
22-VI-53, 13M, 22F
23-VI-53, 8M, 9F

Circle Hot Springs, Alaska

Lepus americanus
9-VIII-61, 1M (C. E. H.)
25-X-61, 2M, 5F (C. E. H.)
23-VI-53, 15M, 26F (J. M. G.)
18-VIII-53, 5M, 7F (J. M. G.)
18-VIII-53, 7M, 9F (J. M. G.)
18-VIII-53, 5M, 9F (J. M. G.)
18-VIII-53, 2M (J. M. G.)
20-VIII-53, 1M, 1F (J. M. G.)
20-VIII-53, 1M, 1F
20-VIII-53, 9M, 25F (J. M. G.)
20-VIII-53, 5M, 9F (J. M. G.)
10-VI-55, 1F (C. E. H.)
9-VI-56, 15M, 26F (C. E. H.)

Elliott Hwy., M. P. 6, Alaska

Lepus americanus
11-VII-61, 1F (C. E. H.)

Ferry, Alaska, M. P. 370, ARR

Lepus americanus
20-VII-63, 2F (H. S.)

Lynx canadensis

30-X-63, 4M, 7F (H. S.)
22-X-63, 1M, 2F (C. Bridenbaugh)

Ft. Yukon, Alaska

Lepus americanus
18-VII-53, 1F

Lynx
26-X-35, 2M, 2F (H. W. Terhune)
USNM

Snowshoe Rabbit
26-X-35, 2M, 2F (H. W. Terhune)
USNM

Cross Fox
26-X-35, 1M (H. W. Terhune) USNM

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Olnes, Alaska

   Lepus americanus
      17-IV-53, 1F (J. M. G.)

Paxson Lake, Alaska

   Castor canadensis
      -I-59, 1M, 2F (L. L. H.)

   Lynx canadensis
      -11-59, 3M, 8F (L. L. H.)

   Vulpes fulva
      6-I-58, 2F (L. L. H.)

Rich. Hwy., Shaw Creek, Alaska

   Lepus americanus
      18-V-52, 1M (J. M. G.)

Steese Hwy., M. P. 60, Alaska

   Lepus americanus
      19-VI-53, 1M

Valdez Hwy., Blueberry Lake, M. P. 23, Alaska

   Spermophilus undulatus
      1-VI-62, 1F (H. S.)

Wilbur Creek, Alaska

   Lepus americanus
      12-VIII-56, 12M, 12F (C, E. H.)

Livengood, Alaska

   Lepus americanus
      14-V-53, 4M, 9F

PLATE V

Hoplopsyllus glacialis lynx (Baker, 1904)

Figure A: Clasper

Figure B: Sternum IX

Figure C: Apical lobe, sternum IX

Figure D: Clasper - enlarged view

Figure E: Abnormal spiniform bristle of fixed process

Figure F: Sternum VII, showing variation of posterior margin

Figure G: Spermatheca

PLATE V
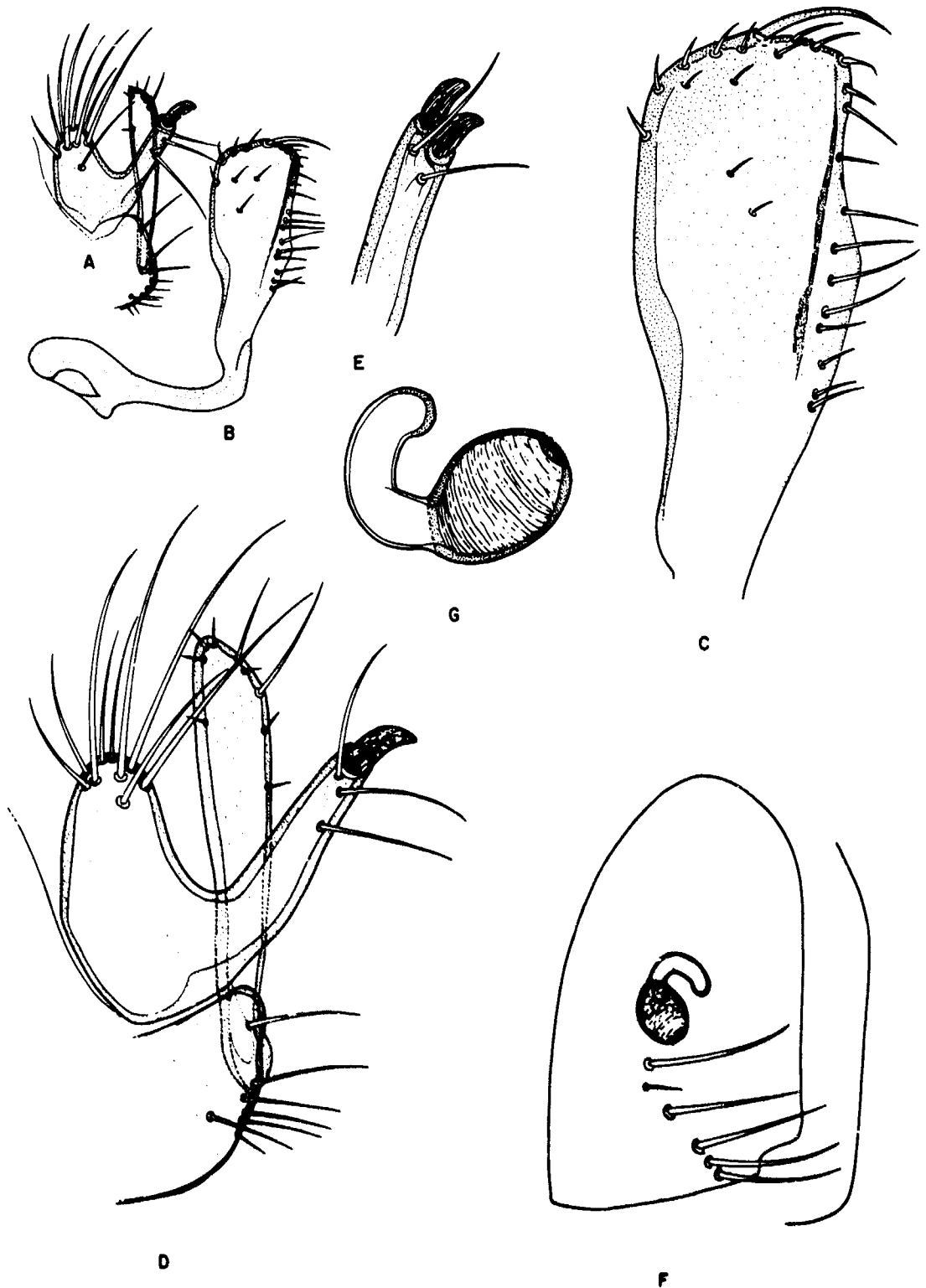
MAP 1

Distribution of <u>Hoplopsyllus</u> <u>glacialis</u> <u>lynx</u> (Baker)

The present distribution records in Alaska are not concordant with the distribution of the two principal hosts, <u>Lepus</u> <u>americanus</u> <u>americanus</u> Erxleben and <u>Lynx</u> <u>canadensis</u> <u>canadensis</u> Kerr.
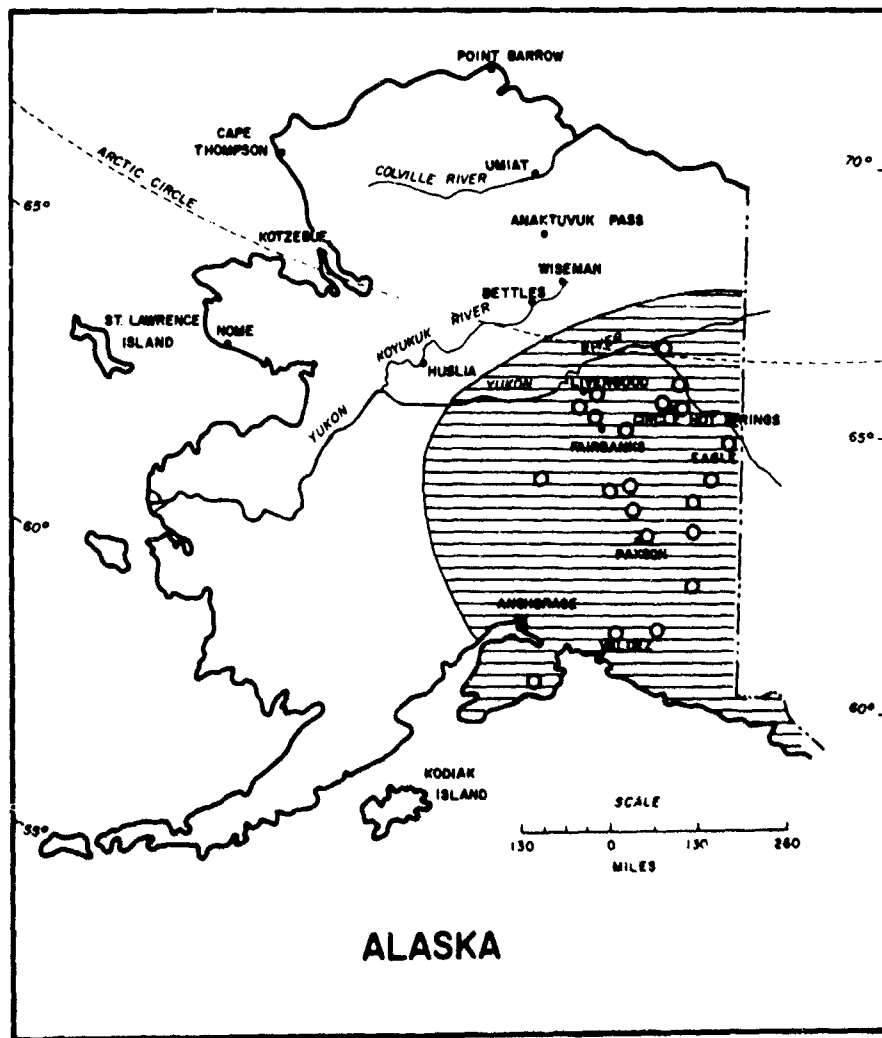
▦ ○ <u>Hoplopsyllus</u> <u>glacialis</u> <u>lynx</u> (Baker).

Family HYSTRICHOPSYLLIDAE Tiraboschi, 1904

Eyes absent or present; if present, reduced. Arch of tentorium (dorsal arm) visible in genal area except in those species with vertical ctenidium. Antennal fossae usually open. Pronotal ctenidium most often present. Apical spinelets absent on metanotum but present on anterior abdominal terga. Abdominal terga usually with two or more rows of setae.

Male with tergum VIII virtually unmodified — not expanded. Sternum VIII moderately expanded without apical membranous lobe. Clasper without acetabular setae. Sternum IX without tendon. Crochets short, projecting only slightly from end chamber.

Female with pygidium more or less convex. Anal stylet present, usually with one long apical bristle and one or two small subapical ones. May have two spermathecae. Tergum IX present.

Subfamily Hystrichopsyllinae Tiraboschi, 1904

Pronotum with at least two rows of bristles. Spiracle of metepimeron pointed. Plantar bristles of segment V of all tarsi lateral. Antepygidial bristles usually three in number. Spiracular fossae of tergum VIII long and tubular. Female frequently with two spermathecae.

HYSTRICHOPSYLLA Tachenberg, 1880

Hystrichopsylla Taschenberg, 1880. Die Flöhe, p. 83.

Genal and pronotal ctenidium present with genal ctenidium consisting of five or more subequal teeth on each side. Eye vestigial. Tentorial arms and trabecula centralis present. Labial palps five-segmented. Tarsi V of all legs with five pairs of lateral plantar bristles. Metepimeron lacking a well-developed striarium. Metepisternum present, well-developed. Three rows of bristles on at least some of the abdominal terga. Sternum VIII of male with a somewhat expanded apical portion. Sternum IX with distal arm bearing pigmented spines. Female with two spermathecae.

Hystrichopsylla Taschenberg is of large size, all species measuring at least 3 mm, with the female somewhat larger than the male. Parasitic on a wide variety of Rodentia. Holarctic in distribution, as yet not reported south beyond North America.

Represented in Alaska by one species and apparently limited within the southeastern portion of this state.

Hystrichopsylla occidentalis Holland, 1949
(Plate IV, D; Plate VI, A, B, C, D, E)

Hystrichopsylla occidentalis. Holland, 1949, Siphonaptera of Canada, pp. 76-
77, Pl. 10, figs. 47-49. Holland, 1957, Can. Ent., 89:309-324, figs
Holland, 1956 (1958), Proc. Tenth Internat. Cong. Ent., 1:645-658.
Holland, 1963, Bishop Mus. Press.

According to Holland (1957), Hystrichopsylla occidentalis is the smallest
species belonging to this genus in the Nearctic region. It is easily separ-
able, in both sexes, from other species within the genus by the larger number
of spines in the genal ctenidium (usually eight, although Holland reports a
variation of from seven to eleven). The distal arm of sternum IX is almost
square-tipped and bears a long series of short, pigmented spines, not
arranged in pairs as in other species. The female's posterior margin of
sternum VII is somewhat variable, being truncate, sometimes with a broad
shallow lateral sinus, or as figured.

H. occidentalis occurs from Alaska to California on small rodents, par-
ticularly Clethrionomys and Microtus, in damp coniferous forests. In the
southern part of its range, it is usually found at higher altitudes. Holland
(58) believes that H. occidentalis is a postglacial migrant to Alaska from
the south. Data indicates that it is presently limited to the southeastern part
of the state.

The following distribution records are from Gregson (1949) and Holland
(1959): Valdez (Gregson), Clethrionomys rutilus, 8-12-VII-1948, 1M
(Gregson).

Holland lists the following Alaskan localities with no other information
given except the number of fleas: Anchorage, 1M, 4F; Juneau, 2M; Peters
Creek, 1F; Prince of Wales Island, 1F; Skwentna, 1M; Seward, 2F.

Subfamily Rhadinopsyllinae Wagner, 1930

Antennae short, not reaching prosternosome; segments of clava partially
fused, appearing to be reduced to six to eight rings. Genal ctenidium pres-
ent. Labial palps five-segmented. Pleural ridge of mesothorax not
complete. Apical spinelets on abdominal terga I through V.

Outer internal ridge of hind coxae not reaching subapical sinus at poste-
rior margin. Striarium when present located on metepimeron. Males lack-
ing spiniforms on modified genital segments. Female with only one
spermatheca.

PLATE VI
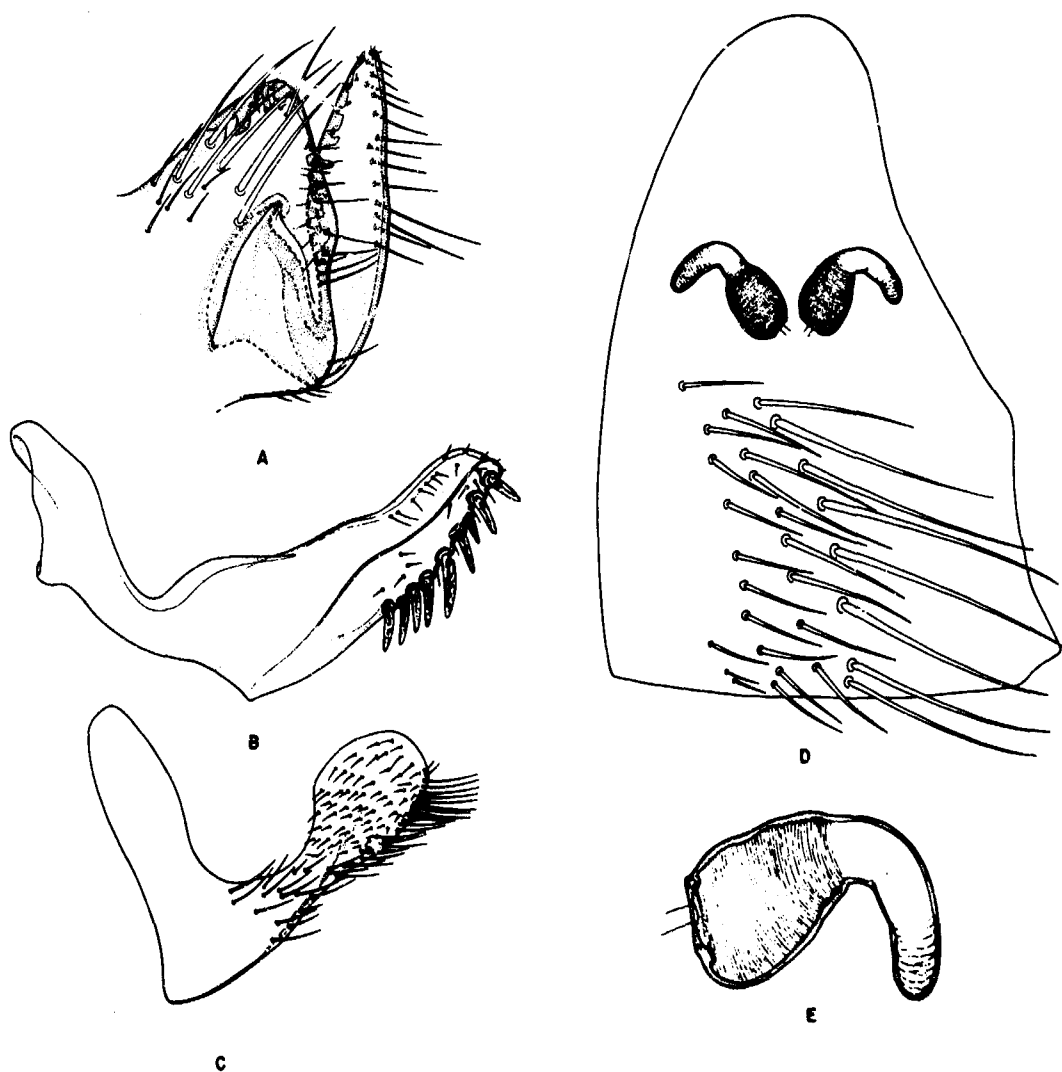
Hystrichopsylla occidentalis Holland, 1949

Figure A: Clasper

Figure B: Sternum IX, male

Figure C: Sternum VIII, male

Figure D: Sternum VII, female

Figure E: Spermatheca, female

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RHADINOPSYLLA Jordan and Rothschild, 1912

Rhadinopsylla Jordan and Rothschild, 1912. Nov. Zool. 40:367.

Genal and pronotal ctenidium present with genal ctenidium consisting of three to six acuminate spines on each side; spines longer in middle of row. Labial palps five-segmented; apical segment with a fine-hooked seta. Apical spinelets present on anterior abdominal terga. Male lacking antepygidial bristles. Metacoxae with a patch of spinelets on mesal surface. Lateral plantar bristles of variable number and pattern.

PLATE VII

Rhadinopsylla sp.

Figure A: Head and prothorax of female

Figure B: Metathorax and tergum I

Figure C: Sternum VII

Figure D: Spermatheca

Figure E: Modified segments of male

Clasper (Man., F. P., and M. P.)

Sternum VIII

Tergum IX

RHADINOPSYLLA sp.

The species figured in Plate VII is unknown to me. Preliminary checks of other species indicate that, of the present known forms, it is nearest to Rhadinopsylla alphabetica, Jameson and Sakaguti, 1959. Specific description will have to await further detailed study. As the host records indicate, it apparently is associated with mustelids. I realize there is cause for some question about such a statement, since so few specimens are available and since the weasel could have picked them up from his prey. However, a rather extensive series of both Microtus and Clethrionomys, as well as Tamiasciurus, have been collected in the general vicinity of Eagle, without recovering specimens of Rhadinopsylla.

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PLATE VII

A

D

C

B

E
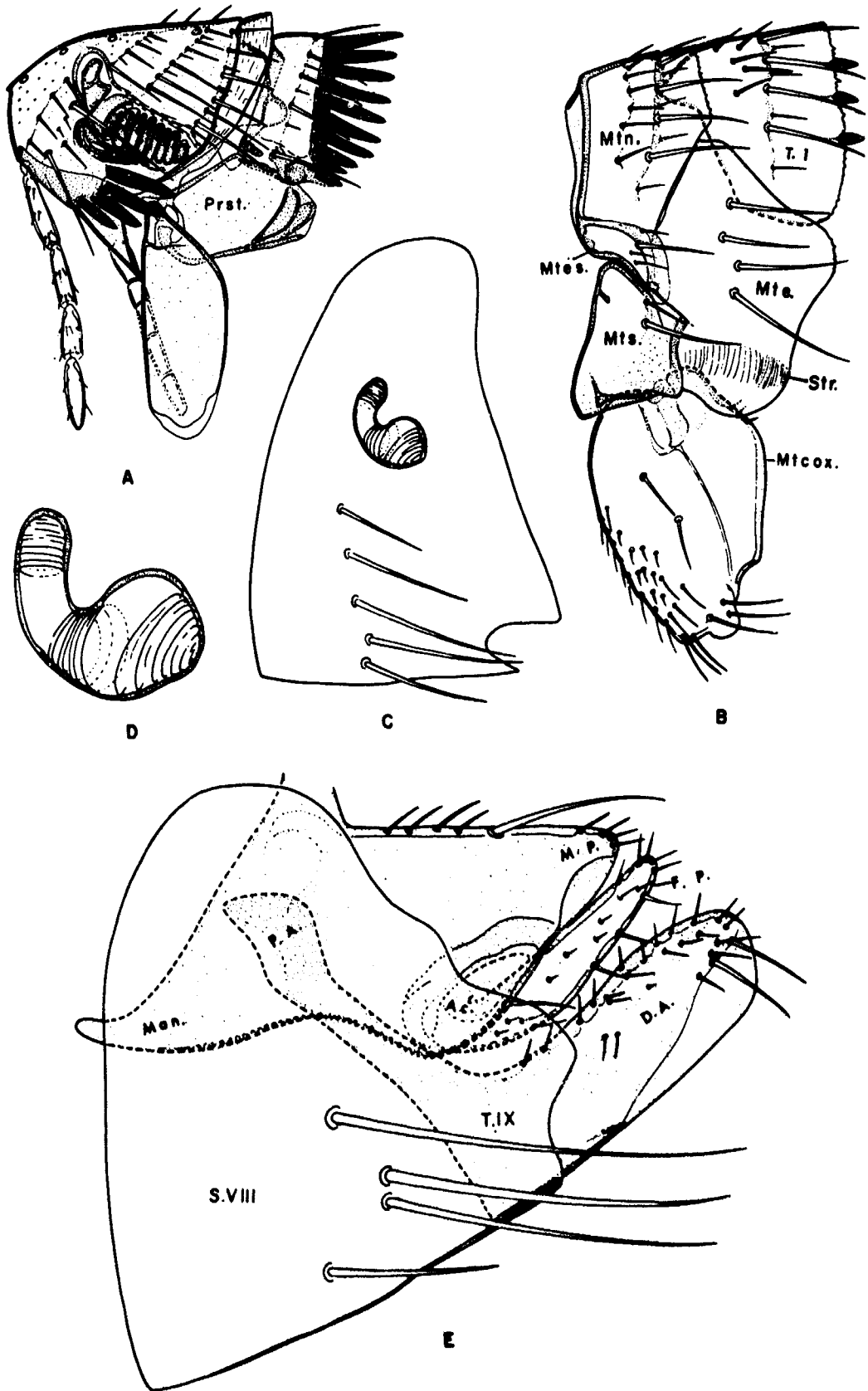
Rhadinopsylla sp. (cont'd)

Records

American Creek, Eagle, Alaska

    <u>Martes americana actuosa</u>
      -XI-61, 1M, 4F (M. M.)

    <u>Mustela erminea</u>
      -XI-61, 1M (M. M.)

Eagle Environs, Alaska

    <u>Mustela erminea</u>
      11-XII-62, 1M (M. M.)

Fairbanks Environs, Alaska

    <u>Clethrionomys rutilus</u>
      30-IX-61, 1F (W. O. P.)[*]

  * Collector not certain host
    record reliable

NEARCTOPSYLLA Rothschild, 1915

<u>Nearctopsylla</u> Rothschild, 1915. Nov. Zool., 307.

Genal and pronotal ctenidium present; genal ctenidium of five spatulate spines arranged more or less in a vertical row. Frontal tubercle absent. Fifth tarsal segment of pro- and mesotarsae with five pairs of lateral plantar bristles; metatarsus with but four pairs. Male with one antepygidial bristle; female with two.

On basis of known data, species of this genus are rare in Alaska. This is a Nearctic genus, confined principally to members of the family Mustelidae.

Key to Alaskan Species of <u>Nearctopsylla</u>

<u>Males</u>

    Anterior and posterior margins of M. P. parallel, apex
    relatively flat   <u>hyrtaci</u>

    Anterior margin of M. P. straight, posterior margin
    convex   <u>brooksi</u>

<u>Females</u>

    Pronotum and mesonotum each with more than one row of
    bristles. Pronotal ctenidium consisting of 18-20 spines
    per side   <u>brooksi</u>

Pronotum and mesonotum each with one row of bristles.
Pronotal ctenidium consisting of 12-14 spines per side   hyrtaci

Nearctopsylla brooksi (Rothschild, 1915)
(Plate II, A; Plate VIII, A, B, C, D; Map 2)

Ctenopsyllus brooksi. Rothschild, 1904. Nov. Zool., 11:649-650, Pl. 15, figs. 86, 88; Pl. 16, fig. 89.

Nearctopsylla brooksi. Rothschild, 1915. Nov. Zool., 22:307. Fox, 1925, Ins. and Dis. of Man, p. 129. Mail and Holland, 1939, Proc. Sixth Pac. Sci. Cong., 5:126. Eskey and Haas, 1940, Pub. Health Bull., 254:29-74. Hubbard, 1940, Pac. Univ. Bull., 37:(1). Ewing and Fox, 1943, p. 94. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Jellison, Kohls, and Mills, 1943, p. 10. Hubbard, 1947, Fleas West. N. America, p. 371, fig. 229. Holland, 1949, Proc. Ent. Soc. Br. Columbia, 45:10. Holland, 1949, Siphonaptera of Canada, p. 105, figs. 140, 141, 143, 142. Holland and Jameson, 1950, Can. Ent., 81:250. Geary, 1953, Arctic Aeromed. Lab. Rept., 37 pp. Holland, 1956 (1958), Proc. Tenth Internat. Cong. Ent., 1:645-658. Stark, 1958, Siphonaptera of Utah, p. 79. Hopkins and Rothschild, 1962, Cata. Rothschild Coll., 3:415-417, figs 752-755.

Nearctopsylla brooksi can be told from all other known species of the genus by its relatively large size, which usually exceeds 4mm. The subgeneric characters of the pronotum and the mesonotum, each with three irregular rows of bristles, and the large pseudosetae, which are present around the collar or flange of the metanotum, are additional aids in separating it from other species. While the genus is Holarctic, this particular species has no close relatives in eastern Asia. Its distribution extends from Utah westward and northward to southeastern Alaska. The only Alaskan record that is available to me is the one by John Geary (1951), which was reported from Mustela erminea, taken at Summit Lake, November 30, 1950, one female.

Nearctopsylla (Beringiopsylla) hyrtaci (Rothschild, 1904)
(Plate VIII, E, F, G, H).

Ctenopsyllus hyrtaci Rothschild, 1904. Nov. Zool., 11:652.

Nearctopsylla hyrtaci (Rothschild). Rothschild, 1915, Nov. Zool., 22:307. Mail and Holland, 1939, Proc. Sixth Pac. Sci. Cong. 5:126. Hubbard, 1940, Pac. Univ. Bull., 37(1):1-4. Hubbard, 1940, Pac. Univ. Bull., 37(2):1, 12. Ewing and Fox, 1943, U. S. Dept. Agr. Mis. Publ., 500:94. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Hubbard, 1947, Fleas West. N. Amer., pp. 370-371, fig. 228. Holland, 1949, Proc. Ent. Soc. Br. Columbia, 45:10. Holland, 1949, Siphonaptera of Canada, p. 107, figs. 142, 145-146. Holland and Jameson, 1950, Cand. Ent., 81:250-253.

PLATE VIII

Nearctopsylla brooksi (Rothschild, 1904)

    Figure A: Clasper of male

    Figure B: Sternum IX of male

    Figure C: Spermatheca

    Figure D: Sternum VII of female

Nearctopsylla hyrtaci (Rothschild, 1904)

    Figure E: Clasper of male

    Figure F: Sternum IX of male

    Figure G: Sternum VII of female

    Figure H: Spermatheca

PLATE VIII

A

E

G

C

F

D

B

H
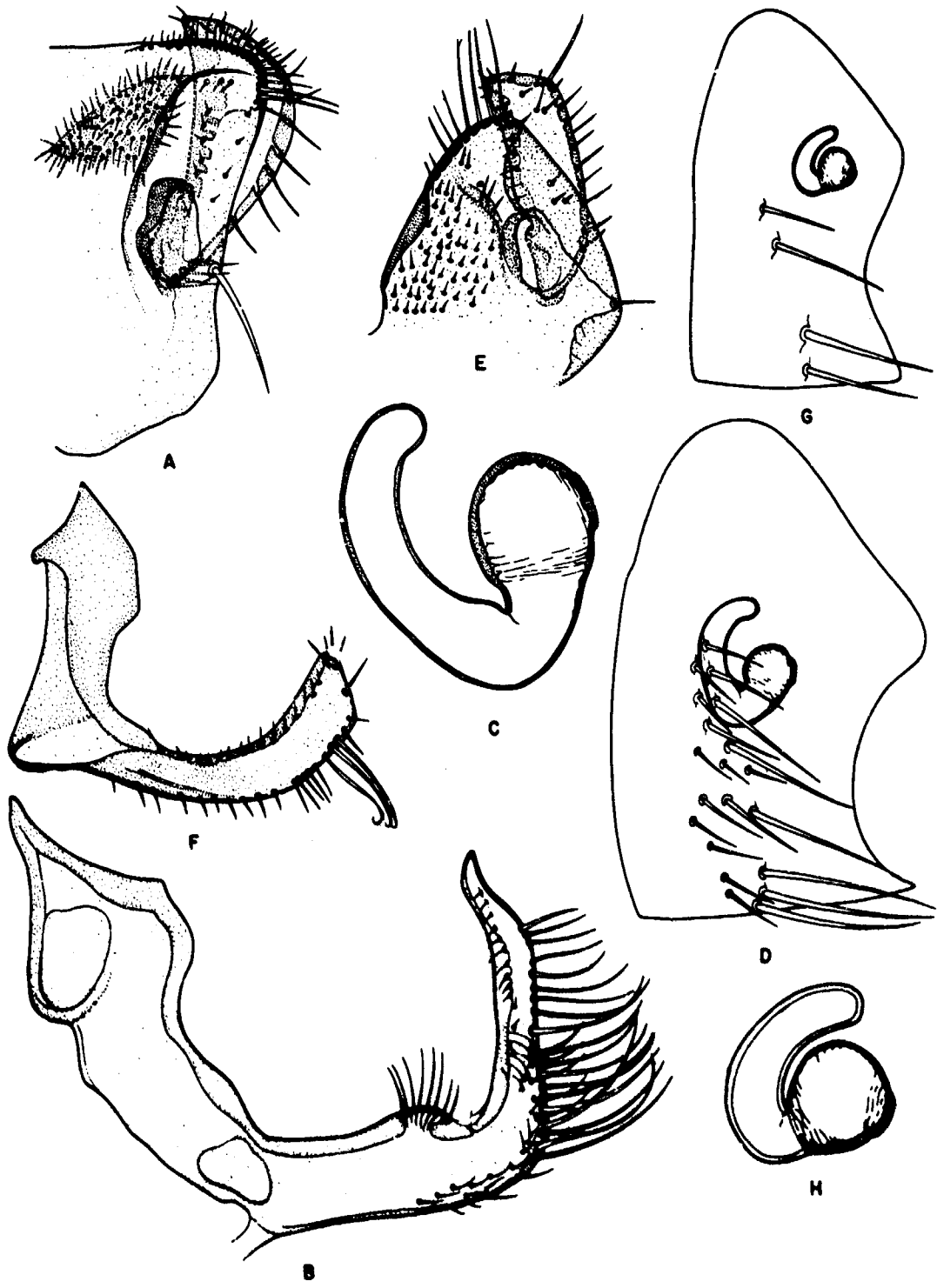
Kohls, 1950, Jour. Parasit., 36:85. Tipton and Allred, 1951, Great
Basin Naturalist, 11:105-114. Wiseman, 1955, Univ. Wyo. Publ.,
19:28 pp. Holland, 1956 (1958), Proc. Tenth Internat. Cong. Ent., 1:645-
658. Stark, 1959, Siphonaptera of Utah, 79. Hopkins and Rothschild,
1962, Cata. Rothschild Coll; 3:pp. 429-430, figs. 786-788. Holland,
1963, Bishop Mus. Press, 45-63, figs. 1-9.

Nearctopsylla hyrtaci is a much smaller species than the N. brooksi but,
like it, is also found on mustelids and occasionally on shrews, particularly
the water shrew, Sorex palustris. I have no records of Nearctopsylla
hyrtaci; however, Holland (1963) states that its distribution is similar to that
of N. brooksi, thus indicating that it occurs in southeastern Alaska.

Subfamily Ctenophthalminae Rothschild, 1915

Genal ctenidium ventral and nearly horizontal, consisting of three or
more teeth. Genal process clearly visible posterior to ctenidium. Pronotal
comb present. Metacoxa lacking spiniforms on inner surface. Striarium
lacking. Normally infesting Insectivora in Alaska.

CORRODOPSYLLA Wagner, 1929

Corrodopsylla Wagner, 1929, Konowia, 8:317 (used as a subgenus)

Corrodopsylla Wagner. Wagner, 1936, Canad. Ent., 86(9):205 (raised
to generic status).

Genal ctenidium of four pressed blunt spines. Genal process evident
beyond last spine. Four pairs of lateral plantar bristles, one basal pair
medially displaced on all tarsi V. Tergum VII with paired dorsal lobes pro-
jecting between antepygidial bristles. Preferred hosts: Insectivora. A
Holarctic genus.

This is a relatively small flea, approximately 2 mm in length. It is not
routine in collection records in Alaska.

Corrodopsylla curvata curvata (Rothschild, 1915)
(Plate II, C; Plate IX, A, B, C, D, E: Map 2)

Doratopsylla curvata Rothschild, 1915. Ectoparasites, 1:25-27, figs. 28-29.
Ewing, 1925, Jour. Parasit., 12:43-46. Jordan, 1929, Nov. Zool.,
35:172. Wagner, 1929, Konowia, 8:317. Ewing, 1929, Man. Ext. Par.,
p. 158. Fox, 1940, Fleas East. U.S., pp. 94-95, pl. XXVI, figs. 133,
136, 138. Hubbard, 1940, Pac. Univ. Bull. 37(2):5, 12. Fuller, 1943,
Jour. New York Ent. Soc., 51:10. Hubbard, 1943, Pac. Univ. Bull.,
39:1-12. Jellison, Kohls, and Mills, 1943, Misc. Publ. Mont. Bd. Ent.,

2:3, 6. Hubbard, 1947, Fleas West. N. Amer., p. 346, fig 212. Knipping, Morgan, Dicke, Wisc. Acad. Sci., Arts and Letters, 40:199-206.

Corrodopsylla curvata curvata (Rothschild). Wagner, 1936, Can. Ent., 68:
205. Mail and Holland, 1939, Proc. Sixth Pac. Sci. Cong., 5:125.
Ewing and Fox, 1943, U.S. Dept. Agri. Misc. Publ., 500, p. 81, fig 8C.
Brown, 1944, Ann. Ent. Soc. Amer., 37:208. Holland, 1949, Proc.
Ent. Soc. Br. Columbia, 45:9. Holland, 1949, Siphonaptera of Canada,
p. 95, figs. 111-113. Weber, 1950, Trans. Amer. Ent. Soc., 76:202.
Traub, 1950, Fieldiana Zool. Mem., 1:84, pl. 48, figs. 7, 8, 9, 10.
Sturm, 1953, Jour. New York Ent. Soc., 61:139-140. Brown, 1955,
Canad. Ent., 87:362-365. Benton and Krug, 1956, N. Y. Mus. and Sci.
Serv. Bull., No. 353. Burbutis, 1956, N. J. Exp. Sta. Bull. p. 782.
Rapp and Gates, 1957, Jour. Kansas Ent. Soc., 30:50-53. Bacon and
Drake, 1958, Jour. Parasit., 44:446. Holland, 1956 (1958), Proc.
Tenth Internat. Cong. Ent., 1:645-658. Geary, 1959, Cornell Exp. Sta.
Mem., 355, figs. 63-65. Stark, 1958, Siphonaptera of Utah, p. 81.
Benton and Cerwonka, 1960, Am. Mid. Nat., 63:383-391. Gabbut,
1961, Ecology, 42:518-525. Holland, 1963, Bishop Mus. Press, pp.
45-63.

Corrodopsylla c. curvata is not a common flea, at least in my experience in Alaska. Holland states (58) that its distribution is similar to that of Epitedia wenmanni. I will have more to say about Epitedia later; however, on the basis of available records, I must state that C. curvata is much more commonly encountered. I do not mean to imply that C. curvata is a common species, for I have many times more negative than positive records from shrews. The best that can be said of its distribution for now is that this flea is of sporadic occurrence and is essentially confined to shrews.

It is interesting that Corrodopsylla c. curvata remains so restricted to the shrews. Frequently, these animals are trapped in the runs of Microtus, yet there has been very little crossing over to this host.

TABLE II

Host Associations of
Corrodopsylla c. curvata (Rothschild)

Host	Total No. Fleas	No. Positive Specimens Collected	Average/ Host
Clethrionomys rutilus	03	01	
Microtus oeconomus	02	02	
Microtus pennsylvanicus	01	01	
Sorex	16	06	2.7

It is also associated with the habitat of Clethrionomys but, again, remains steadfast to the shrews. I believe this flea is confined to the taiga because I have failed to collect it from shrews taken in the tundra. (It is dangerous to generalize when I have so few positive records from the shrews taken in the taiga, in comparison to the negative ones, but I have trapped approximately 250 shrews in tundra regions, and none of them have been infested with fleas.)

Records

Circle Hot Springs, Alaska

Microtus pennsylvanicus
11-IX-61, 1M (C. E. H.)

Microsorex hoyi
17-VI-60, 5M, 2F (C. E. H.)

Sorex
9-VIII-61, 1F (C. E. H.)

Fairbanks, Alaska

Microtus oeconomus
18-VIII-60, 1F (C. J. M.)

30 Mi. S. W. Ft. Yukon, Alaska

Clethrionomys rutilus
2-VII-62, 1M, 2F (J. L. C.)

Minto Flats, Alaska

Microtus
15-VIII-61, 1F (J. H. E.)

Sorex
18-VIII-61, 1M (J. H. E.)

Olnes, Alaska

Sorex
7-VIII-59, 1M (C. E. H.)

5 Mi. S. W. Rex, Alaska

Sorex
31-VIII-63, 4M, 1F (H. S.)

Rich. Hwy. M. P. 179, Alaska

Sorex
24-V-62, 1M (C. E. H.)

MAP 2

Distribution of Corrodopsylia curvata curvata (Rothschild)
and Nearctopsylla brooksi (Rothschild)

The former species is restricted to various species of shrews
(Soricidae) and does not appear to be nearly so widely distributed as its
hosts.

ALASKA
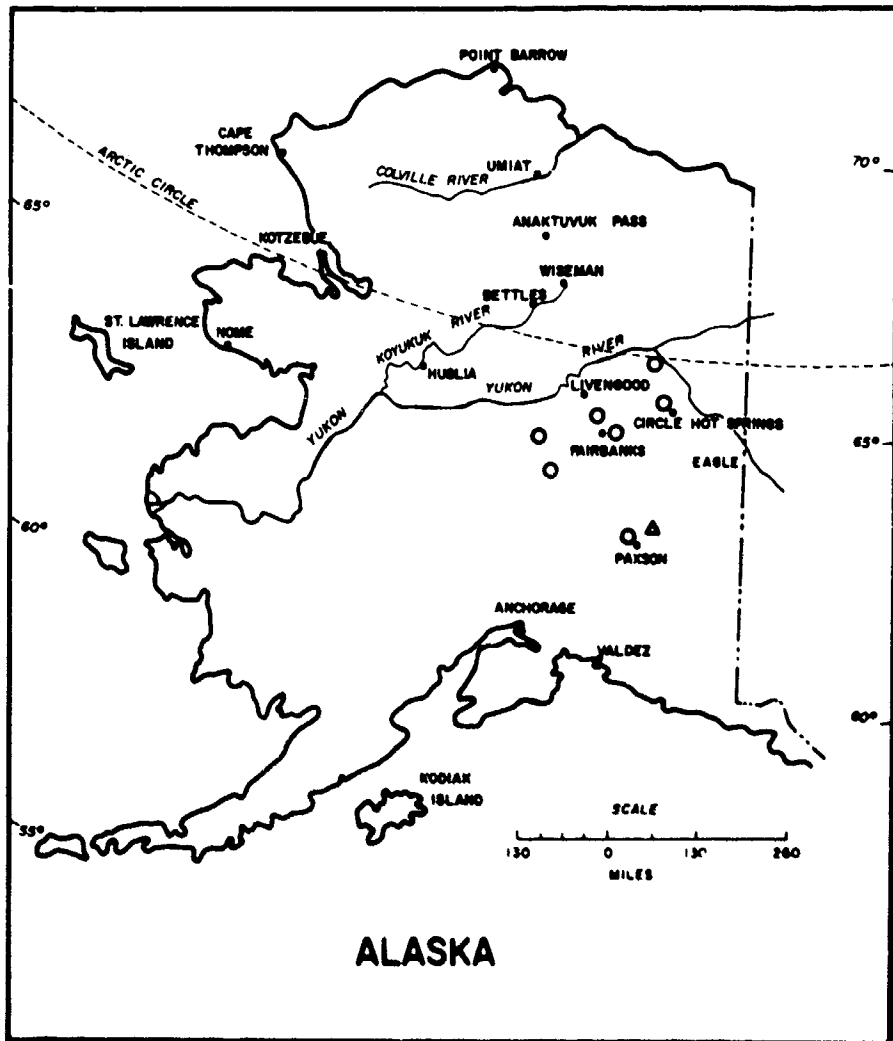
△   Nearctopsylla brooksi (Rothschild).

○   Corrodopsylla curvata curvata (Rothschild).

PLATE IX

<u>Corrodopsylla</u> <u>c.</u> <u>curvata</u> (Rothschild, 1915)

    Figure A: Clasper of male

    Figure B: Sternum IX of male

    Figure C: Sternum VII of female

    Figure D: Spermatheca

    Figure E: Antepygidial setae and caudal
                    process of tergum VII, male

<u>Myodopsylla</u> <u>gentilis</u> Jordan and Rothschild, 1921

    Figure F: Clasper of male

    Figure G: Movable process of male

    Figure H: Sternum IX and clasper of male

    Figure I: Spermatheca

    Figure J: Sternum VII of female

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PLATE IX
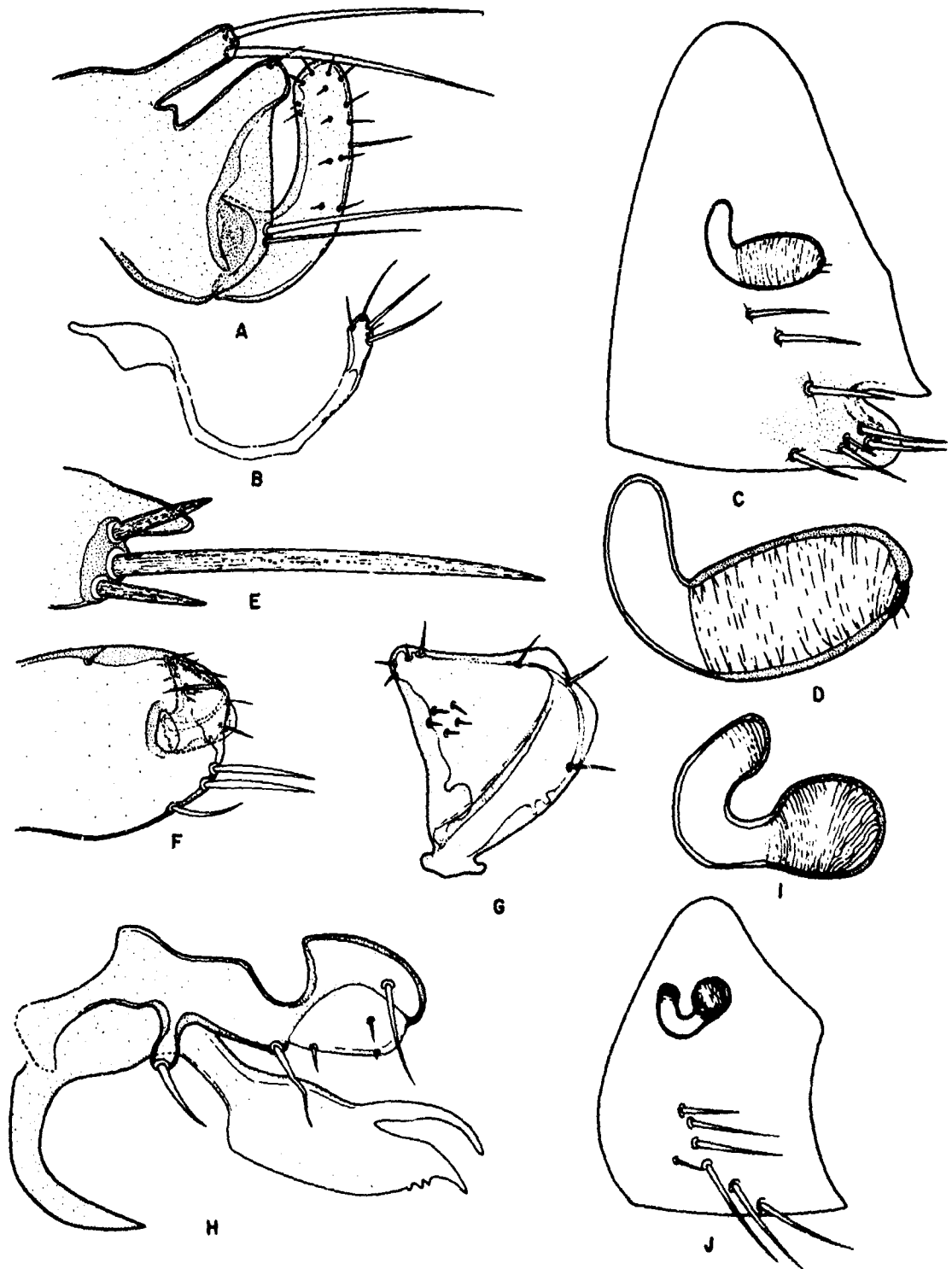
Subfamily Neopsyllinae Oudeman, 1909

Genal comb, when present, consisting of two overlapping spines. Pronotal ctenidium present or absent. Clava of antennae of nine segments, not partially fused. Pleural ridge and arch well-developed. Inner surface of metacoxa with a row or patch of spiniform setae. Distal arm of sternum IX with heavy pigmented setae. Female with one spermathera. Striarium, when present, located on basal abdominal (sternum II) segment.

CATALLAGIA Rothschild, 1915

Catallagia Rothschild, 1915. Ectoparasites, 1:41.

Genal ctenidium absent, but with pronotal ctenidium. Frontal tubercle prominent. Preantennal region with two rows of setae; occiput with three rows of bristles. Eye vestigial. Spiracular fossae of tergum VIII enlarged. Hilla projecting into bulga.

Two species of this genus are encountered in Alaska. One is confined to the southeastern region; the other one is known throughout the remaining area of Alaska but does not apparently enter into the southeastern portion. Appears very much like Epitedia, with the exception of the absence of the genal comb.

Key to the Alaskan species of Catallagia

Males

Eighth sternum of male divided into two lobes; distal arm of ninth sternum usually armed with four-five sub-equal, short, pigmented spiniforms	charlottensis
Eighth sternum of male not divided into two lobes, but sinuous laterally; posterior arm of sternum IX with row of eight such spiniforms on ventral surface	dacenkoi fulleri

Females

Spiracles of unmodified terga large; fossa forming an ovoid chamber, inner surface of its wall armed with numerous minute spines	dacenkoi fulleri
Spiracle of unmodified terga smaller; fossa V-shaped, inner surface of its wall with relatively few spines	charlottensis

Catallagia dacenkoi fulleri Holland, 1951
(Plate IV, D; Plate X, A,B,C,D,E,F,G,H,I; Map 3)

Catallagia dacenkoi fulleri. Holland, 1951, Canad. Ent., 83:156-160, figs.
1-7. Geary, 1953, Arct. Aeromed. Rep., 1:1-37. Holland, 1956 (1958),
Proc. Tenth Internat. Cong. Ent., 1:645-658. Hubbard, 1960, Ent. News,
71:245-247. Hopkins and Rothschild, 1962, Cata. Rothschild Coll., 3:258-
259, figs. 454-457. Holland, 1964, Ann. Rev. Ent., 9:123-146. Holland,
1963, Bishop Mus. Press, 45-63.

Catallagia dacenkoi fulleri Holland, 1951

At the present time, it is easy to distinguish C. d. fulleri Holland, 1951,
from C. charlottensis by the pertinent characters listed in the key. Inasmuch
as these are the only species of the genus to occur in Alaska, further descrip-
tion should not be necessary. C. d. fulleri inhabits the taiga of Alaska and is
associated with the microtine rodents. As indicated in Table III, it is dif-
ficult to decide whether Clethrionomys rutilus or Microtus oeconomus is the
preferred host. It is interesting to note that one of the largest number of
fleas for one collection was found on Microtus pennsylvanicus, a postglacial
migrant to the area. A close survey of the collection records will indicate
stragglers upon other hosts. An analysis of the monthly records indicates
that this flea does not become very abundant until July and then forms a
goodly portion of the flea fauna until early December.

It is closely related to three other Palearctic species, fetisovi, Vovchin-
skaja, ioffi Scalon and striata Scalon. Holland (58) indicates that this flea
occurs through western Yukon up to the Mackenzie River, thence following
the tree line in a narrow belt from Great Slave Lake to Lake Athabaska and
into northern Manitoba, where it stops at Hudson Bay.

TABLE III

Host Associations of
Catallagia dacenkoi fulleri Holland

Host	Total No. Fleas	No. Positive Specimens Collected	Average/host
Clethrionomys rutilus	69	42	1.4
Microtus oeconomus	70	36	1.9
Microtus pennsylvanicus	50	11	4.5
Sorex sp.	01	01	
Spermophilus undulatus	01	01	
Tamiasciurus hudsonicus	02	02	
Zapus hudsonius	01	01	

In 1948, Hubbard described a species *Catallagia motei,* which had as its most distinguishing characteristic a vestigial spermatheca. I have noticed a similar condition in occasional specimens of *C. d. fulleri* and believe that Hubbard's specimens were simply a demonstration of the same phenomenon.

PLATE X

Catallagia dacenkoi fulleri Holland, 1951

Figure A: Clasper of male

Figure B: Sternum IX of male

Figure C: Sternum VIII of male (partial)

Figure D: Distal arm of sternum IX

Figure E: Movable process of male

Figure F: Sternum VIII of male, entire

Figure G: Spermatheca

Figure H: Sternum VII of female

Figure I: Spiracle VI, abdominal segment, female

Catallagia charlottensis (Baker, 1898)

Figure J: Clasper of male

Figure K: Sternum VIII of male

Figure L: Sternum IX of male

Figure M: Distal arm of sternum XI

Figure N: Sternum VII of female

Figure O: Spermatheca

Figure P: Spiracle VI, abdominal segment, female

PLATE X
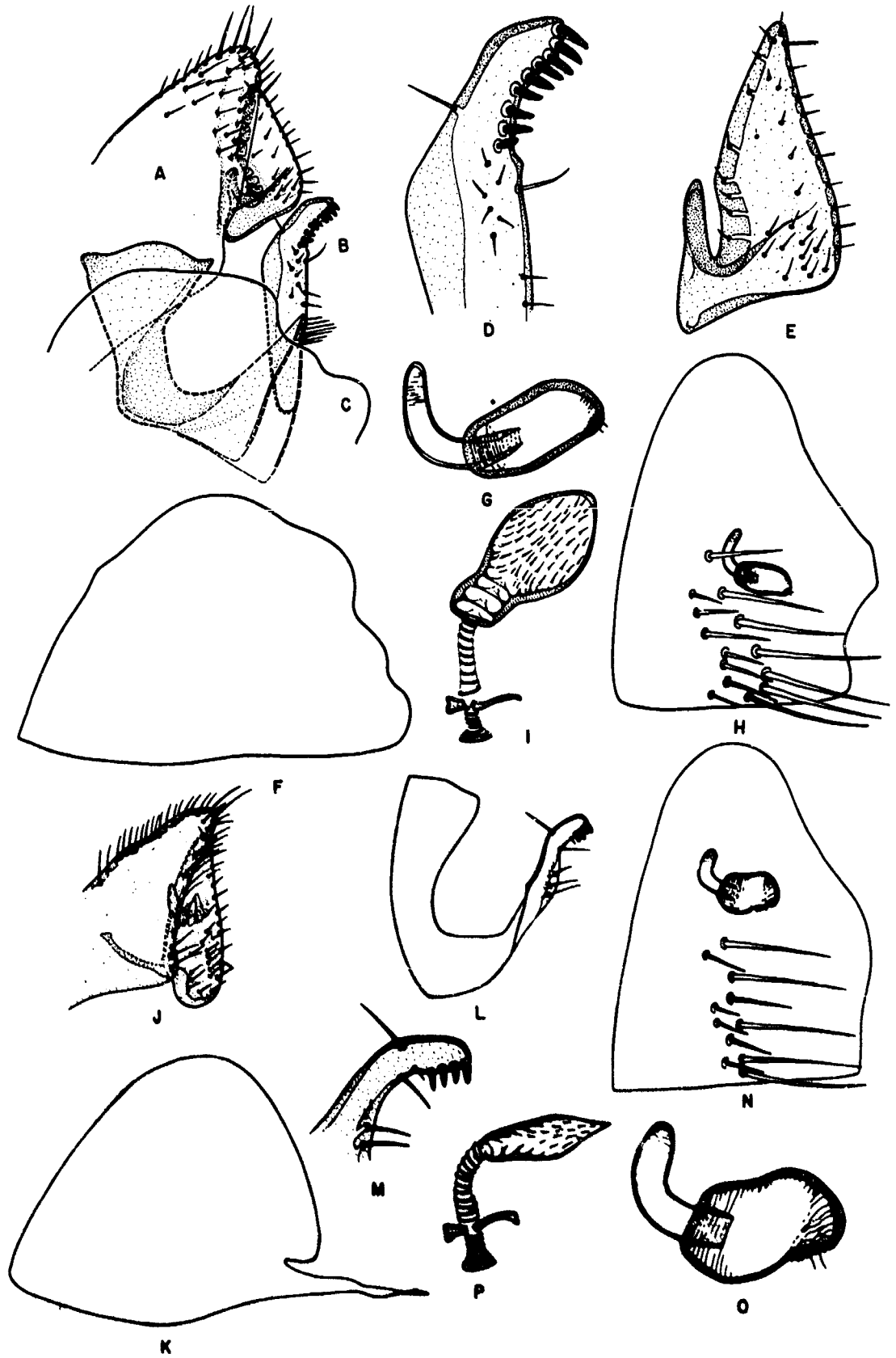
MAP 3

Distribution of Catallagia dacenkoi fulleri Holland and Epitedia wenmanni (Rothschild)

Both species are restricted to the taiga; however, the latter species is encountered only infrequently.

ALASKA

☰ ○ Catallagia dacenkoi fulleri Holland.

▥ △ Epitedia wenmanni (Rothschild).

Records

Bettles Village, Alaska

Microtus oeconomus
15-VIII-61, 1M, 3F (R. D. C.) (N)
15-VIII-61, 1M (R.D.C.)(N)

Circle Hot Springs, Alaska

Clethrionomys rutilus

9-VIII-61, 1F (C. E. H.)
10-VIII-61, 2M (C. E. H.)
11-IX-61, 1F (C. E. H.)
12-IX-61, 1M, 3F (C. E. H.)
12-IX-61, 1F (C. E. H.)
13-IX-61, 2M, 2F (C. E. H.)
13-IX-61, 2M (C. E. H.)
23-X-61, 1F (C. E. H.)
23-X-61, 1M, 1F (C. E. H.)
24-X-61, 1M, 3F (C. E. H.)
24-X-61, 1M (C. E. H.)
24-X-61, 2F (C. E. H.)
24-X-61, 1F (C. E. H.)
24-X-61, 1F (C. E. H.)
24-X-61, 1M (C. E. H.)
24-X-61, 1F (C. E. H.)
24-X-61, 1F (C. E. H.)
24-X-61, 1F (C. E. H.)
25-X-61, 1F (C. E. H.)
25-X-61, 1M (C. E. H.)
25-X-61, 1M (C. E. H.)
25-X-61, 1F (C. E. H.)
25-X-61, 1M, 2F (C. E. H.)
26-X-61, 1M (C. E. H.)
26-X-61, 2M, 3F (C. E. H.)
24-VIII-59, 1F (C. E. H.)

Microtus oeconomus

8-VIII-61, 1F (C. E. H.)
9-VIII-61, 2M, 5F (C. E. H.)
9-VIII-61, 1M (C. E. H.)
9-VIII-61, 1M (C. E. H.)
9-VIII-61, 1M (C. E. H.)
9-VIII-61, 1F (C. E. H.)

Microtus oeconomus (cont'd)
9-VIII-61, 3F (C. E. H.)
10-VIII-61, 1M, 1F (C. E. H.)
10-VIII-61, 1M, 2F (C. E. H.)(N)
10-VIII-61, 1F (C. E. H.) (N)
11-IX-61, 1M, 1F (C. E. H.)
11-IX-61, 1M (C. E. H.)
11-IX-61, 1F (C. E. H.)
12-IX-61, 1M, 1F (C. E. H.)
12-IX-61, 1F (C. E. H.)
12-IX-61, 1M, 6F (C. E. H.)
12-IX-61, 3F (C. E. H.)
13-IX-61, 2F (C. E. H.)
13-IX-61, 1M (C. E. H.)
13-IX-61, 1M, 2F (C. E. H.)
24-X-61, 2F (C. E. H.)
24-X-61, 2F (C. E. H.)
24-X-61, 2M, 1F (C. E. H.)
24-X-61, 2M, 4F (C. E. H.)
24-X-61, 1F (C. E. H.)
24-X-61, 1F (C. E. H.)
26-X-61, 1M (C. E. H.)
11-VI-62, 1F (C. E. H.)
12-VI-62, 1M (C. E. H.)
25-VIII-59, 1M (C. E. H.)
25-VIII-59, 4M, 3F (C. E. H.)(N)

Microtus pennsylvanicus

11-IX-61, 1M (C. E. H.)
11-IX-61, 1F (C. E. H.)
11-IX-61, 2M, 4F (C. E. H.)
12-IX-61, 4F (C. E. H.)
12-IX-61, 1F (C. E. H.)
12-IX-61, 1F (C. E. H.)
12-IX-61, 1F (C. E. H.)
12-IX-61, 1F (C. E. H.)
13-IX-61, 3F (C. E. H.)
24-X-61, 3M (C. E. H.)
25-X-61, 18M, 10F (C. E. H.)

Microtus

14-IX-61, 1F (C. E. H.)(N)
14-IX-61, 1M (C. E. H.)(N)

Circle Hot Springs, Alaska (cont'd)

Sorex sp.
12-IX-61, 1F (C.E.H.)

Tamiasciurus hudsonicus
14-IC-61, 1M (C.E.H.)
14-IX-61, (C.E.H.)(N)
25-VIII-59, 1M (C.E.H.)(N)

Eagle, Alaska

Clethrionomys rutilus
10-VIII-62, 2M, 3F (M.M.)

Eagle Creek, Eagle Summit environs

Clethrionomys rutilus
8-IX-61, 1F (W.T.V.)

Elliott Hwy., M.P. 10, Olnes, Alaska

Microtus oeconomus
10-VIII-60, 1M (C.J.M.)

Fairbanks, Alaska

Clethrionomys rutilus
26-IX-60, 1F (W.O.P.)
26-IX-60, 1F (W.O.P.)
1-X-59, 2F W.O.P.)
17-VIII-60, 1M (C.J.M.)
19-VIII-60, 1F (C.J.M.)
19-VIII-60, 2M (C.J.M.)
20-VIII-60, 1F (C.J.M.)
21-VIII-60, 1M (C.J.M.)
24-VIII-60, 1F (C.J.M.)
24-VIII-60, 1F (C.J.M.)
30-IX-6C, 3F (C.D.K.)

Microtus oeconomus
17-VIII-60, 1F (C.J.M.)
17-VIII-60, 1F (C.J.M.)
20-VIII-60, 1M (C.J.M.)
22-VIII-60, 1F (C.J.M.)

Fairbanks environs, Alaska

Clethrionomys rutilus
9-IX-61, 7M, 11F (C.E.H.)

Ft. Wainwright, Alaska

Zapus hudsonius
10-IX-61, 1M (W.T.V.)

Ft. Yukon, Alaska

Microtus oeconomus
12-IX-58, 1M, 1F (M.Johnson)
                          USNM
10-IX-58, 1M, 1F (M.Johnson)
                          USNM

Hudson Stuck, Fort Yukon, Alaska

Microtus oeconomus
3-VIII-57, 1M (C.E.H.)

Minto Flats, Alaska

Clethrionomys rutilus
12-VIII-61, 1F (J.H.E.)

Mt. McKinley Nat'l Park, Alaska

Clethrionomys rutilus
10-IX-58, 3M, 1F(M.Johnson)
                          USNM
Sorex obscurus
10-IX-58, 1M (M.Johnson)USNM

Nolan Creek, Alaska

Microtus oeconomus
12-VIII-59, 1M, 3F (C.E.H.)

Olnes, Alaska

Clethrionomys rutilus
31-VII-56, 1F (C.E.H.)

Richardson Hwy., M.P. 178, Alaska   Richardson Hwy., M.P. 204.5, Alaska

Clethrionomys rutilus
   18-VIII-61, 1F (C.E.H.)
   18-VIII-61, 1F (C.E.H.)

Spermophilus undulatus
   17-VIII-61, 1M (C.E.H.)

Takotna, Alaska

Microtus oeconomus
   18-VIII-61, 1F (C.E.H.)

Short-tailed mouse
   11-VI-35, 1F (A.H.T.)

Catallagia charlottensis (Baker, 1898)
(Plate X, J, K, L, M, N, O, P)

Typholopsylla charlottensis Baker, 1898. Jour. N.Y. Ent. Soc., 6:56.

Ceratophyllus charlottensis (Baker). Baker, 1904, Proc. U.S. Nat'l Mus.,
    27:386, 390-391, 441. Rothschild, 1905, Nov. Zool. 12:174.

Odontopsyllus charlottensis (Baker). Baker, 1905, Proc. U.S. Mus., 29:131,
    145. Harvey, 1907, Bull. Br. Col. Ent. Soc., 7:1. C. Fox, 1909, Ent.
    News, 20:11. C. Fox, 1914, Hyg. Lab. Bull. No. 97:24, 25, pl. 13.

Catallagia charlottensis (Baker). Rothschild, 1915, Ectoparasites, 1:43. Dunn
    and Parker, 1923, Pub. Health Rept., 38:2770, 2775. Ewing, 1924,
    Parasit., 16:345, 346. Ewing, 1929, Proc. Biol. Soc. Wash., 42:125-
    127. Wagner, 1930, Magazin de Parasitol., 1:142. Wagner, 1936, Can.
    Ent., 68:202-203. Mail and Holland, 1939, Proc. Sixth Pac. Sci. Cong.,
    5:126. Hubbard, 1940, Pac. Univ. Bull., 37(3) with figs. Hubbard,
    1940, Pac. Univ. Bull., 37(4). Hubbard, 1941, Pac. Univ. Bull., 37
    (9A):4. Svihla, 1941, Univ. Wash. Pub. Biol., 12:17. Ewing and Fox,
    1943, U.S. Dept. Agr. Misc. Publ., 500:27, fig. 5C. Hubbard, 1943,
    Pac. Univ. Bull., 39:1-12. Brown, 1944, Ann. Ent. Soc. Amer., 37:
    208. Hubbard, 1947, Fleas West. N. Amer., pp. 285-287, fig. 160.
    Holland, 1949, Proc. Ent. Soc. Br. Col., 45:8. Holland, 1949, p. 81,
    figs. 59-62. Walters and Roth., 1950, Jour. Mammal., 31:292. Holland
    1956 (1958), Proc. Tenth Internat. Cong. Ent., 1:645-658. Holland,
    1960, Canad. Ent., 92:768-790. Hopkins and Rothschild, 1962, Cata.
    Rothschild Coll., 3:275-277, figs. 448, 484-486. Holland, 1963,
    Bishop Mus. Pres, pp. 45-63.

Catallagia charlottensis is restricted to the southeastern part of Alaska,
the distribution being very similar to that of Hystrichopsylla occidentalis. In
its more southern distribution — in British Columbia, Washington, Oregon
and California — this flea is usually associated with the genus Peromyscus,
a Nearctic genus of cricetid rodents. It is interesting to observe that this
member of a Holarctic genus has no close relatives in Eurasia, indicating that
its derivation must have been made from a stock which crossed the Bering
land bridge at a relatively early date.

DELOTELIS Jordan, 1937

Delotelis Jordan, 1937. Nov. Zool., 40:267.

Preantennal region with three rows of setae. Genal ctenidium lacking; pronotal ctenidium present and consisting of six to seven spines on a side. Spiracular fossae of tergum VIII enlarged. Sternum VIII of male with heavy ventral fringe of setae. Distal arm of sternum IX with modified pigmented subapical setae. Striarium well-developed. Subapical bristles on mesal surface of hind coxa spiniform. Pattern of plantar bristles variable.

This is a Nearctic genus, of which two species are known, being found mainly upon the microtine rodents. Hopkins and Rothschild (66), indicate that the scarcity of fleas belonging to this genus in collections is probably due to their being nest fleas.

Delotelis hollandi Smit, 1952
(Plate XI, A, B, C, D, E)

Delotelis hollandi Smit, 1952. Ent. Soc. Wash., 54:269-273, fig. Smit, 1953, Ent. Berich., 14:393-400, fig. 6. Holland, 1956 (1958), Proc. Tenth Internat. Cong. Ent., 1:645-658. Jameson and Brennan, 1957, Ecol. Mono., 27:45-54. Hopkins and Rothschild, 1962, Cata. Rothschild Coll., 3:283-285, figs. 495-496, 498, 500, 502. Holland, 1963, Bishop Mus. Press, 45-63.

Delotelis hollandi Smit apparently is a rare flea of microtine rodents and is restricted to the Nearctic region. It is known from the northwestern United States, British Columbia and southeastern Alaska. In the original description by Smit, the statement is made that "additional specimens from Alaska not included in the type series."

D. hollandi apparently has a distribution similar to the previous species, C. charlottensis; it is confined to the southeastern portion of Alaska, indicating that it is adapted to a relatively moist climate rather than the relatively dry one encountered in interior Alaska.

EPITEDIA Jordan, 1938

Epitedia Jordan, 1938. Nov. Zool., 41:124.

This genus morphologically resembles Catallagia except for the presence of the two overlapping spines of the genal ctenidium. Preantennal region with two rows of bristles; occiput with three rows. Frontal tubercle present (resembling a notch). Pro- and mesotarsi with four lateral pairs and a basal, medially placed pair of plantar bristles. Metatarsus with only four lateral bristles. A row of spiniforms on metacoxa.

This genus is represented in Alaska by one species, which has apparently exceeded the distribution of its normal hosts. This is a Nearctic genus, found principally upon cricetid rodents.

Epitedia wenmanni (Rothschild, 1904)
(Plate XI, F, G, H, I, J, K; Map 3)

Ctenophthalmus wenmanni Rothschild, 1904. Nov. Zool., 11:642-643.
   Stewart, 1928, Cornell Univ. Mem., 101:869.

Neopsylla wenmanni (Rothschild). Jordan and Rothschild, 1915, Ectopara-
   sites, 1:32, 39. Dunn and Parker, 1923, Pub. Health Rept., 38:2770-
   2775. Jordan, 1928, Nov. Zool., 34:186, 187. Jordan, 1929, Nov.
   Zool., 35:172-175, 177. Stanford, 1931, Proc. Utah Acad. Sci., 1931:
   153. Jordan, 1923, Nov. Zool., 39:62. Stewart, 1933, Jour. N.Y.
   Ent. Soc., 41:261. Shaftesbury, 1934, Jour. E. Mitchell Sci. Soc.,
   49:257. Jordan, 1937, Nov. Zool., 40:285. Mail and Holland, 1939,
   Proc. Sixth Pac. Sci. Cong., 5:126. Eskey and Haas, 1940, Pub.
   Health Bull. 254:29-74.

Neopsylla similis Chapin 1919. Bull. Brook. Ent. Soc., 14:50, 58-59.
   Stewart, 1928, Cornell Univ. Memoir, 101:869. Wagner, 1930,
   Magazin de Parasitol., 1:141.

Epitedia wenmanni (Rothschild). Jordan, 1938, Nov. Zool., 41:124. Hubbard,
   1940, Pac. Univ. Bull., 37(4):1-4. Fox, 1940, p. 96-98. pl. I and
   XXVII, figs. 139, 142, 144. Hubbard, 1940, Pac. Univ. Bull., 37(2):
   5, 10, 12, with figs. Augustson, 1941, Bull. South. Calif. Acad. Sci.
   40(3):154. Bell and Chalgren, 1943, Jour. Wildlife Mngmt., 7:275,
   276. Ewing and Fox, 1943, U.S. Dept. Agri. Misc. Publ., 500:79.
   Fuller, 1943, Bull. Brook. Ent. Soc., 38:21. Fuller, 1943, Jour.
   N.Y. Ent. Soc., 51:10. Hubbard, 1943, Pac. Univ. Bull., 39:1-12.
   Jellison, Kohls, and Mills, 1943, Misc. Publ. Mont. Bd. Ent., 2:3,
   12, 13, 18. Wilson, 1943, Jour. Mammal., 24:102. Jameson, 1943,
   Jour. Mammal., 24:194-197. Stanford, 1944, Proc. Utah Acad. Sci.,
   Arts and Letters, 19 and 20:174. Brown, 1944, Ann. Ent. Soc. Amer.,
   37:209. MacCreary, 1945, Jour. Econ. Ent., 38:127. Wilson, 1945,
   Jour. Mammal., 26:200. Hubbard, Fleas West. N. Amer., pp. 310-
   312, fig. 184. Holland, 1949, Proc. Ent. Soc. Br. Col., 45:9. Hol-
   land, 1949, Siphonaptera of Canada, p. 85, figs. 75-77. Hubbard,
   1949, Bull. South. Calif. Acad. Sci., 48:126. Link, 1949, Am. Jour.
   Trop. Med., 29:498. Jameson, 1950, Jour. Mammal., 31:142. Knip-
   ping, Morgan, and Dicke, Wisc. Acad. Sci. Arts and Letters, 40:199-
   206. Tipton, 1950, p. 63. Allred, 1952, Great Basin Nat., 12:67-75.
   Ecke and Johnson, 1952, Pub. Health Serv. Pub. 210, Pub. Health

Mono., 6:36. Beck, et al., 1953, Proc. Utah Acad. Sci. Arts and Letters, 30:43-52. Cummings, 1954, Jour. N. Y. Ent. Soc., 62:161-165. Layne, 1954, Ecol. Mono., 24:227-267. Beck, 1955, Brigham Young Univ. Sci. Bull. Biol. Sci., 1:64. Benton, 1955, Jour. Parasit., 41: 491-495, figs. Brown, 1955, Can. Ent., 87:362-365. Burbutis and Mangold, 1955, N. J. Agr., 37:13-14. Judd, 1955, Jour. Parasit., 41:441-442. Wiseman, 1955, Univ. Wyo. Pub., 19:1-28. Burbutis,

PLATE XI

Delotelis hollandi Smit, 1952.

Figure A: Clasper of male

Figure B: Sternum IX of male

Figure C: Distal Arm of sternum IX, apical lobe

Figure D: Sternum of female

Figure E: Spermatheca

Epitedia wenmanni (Rothschild, 1904)

Figure F: Clasper of male

Figure G: Sternum IX of male

Figure H: Distal arm of sternum IX, apical lobe

Figure I: Sternum VIII of male

Figure J: Sternum VII of female

Figure K: Spermatheca

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PLATE XI
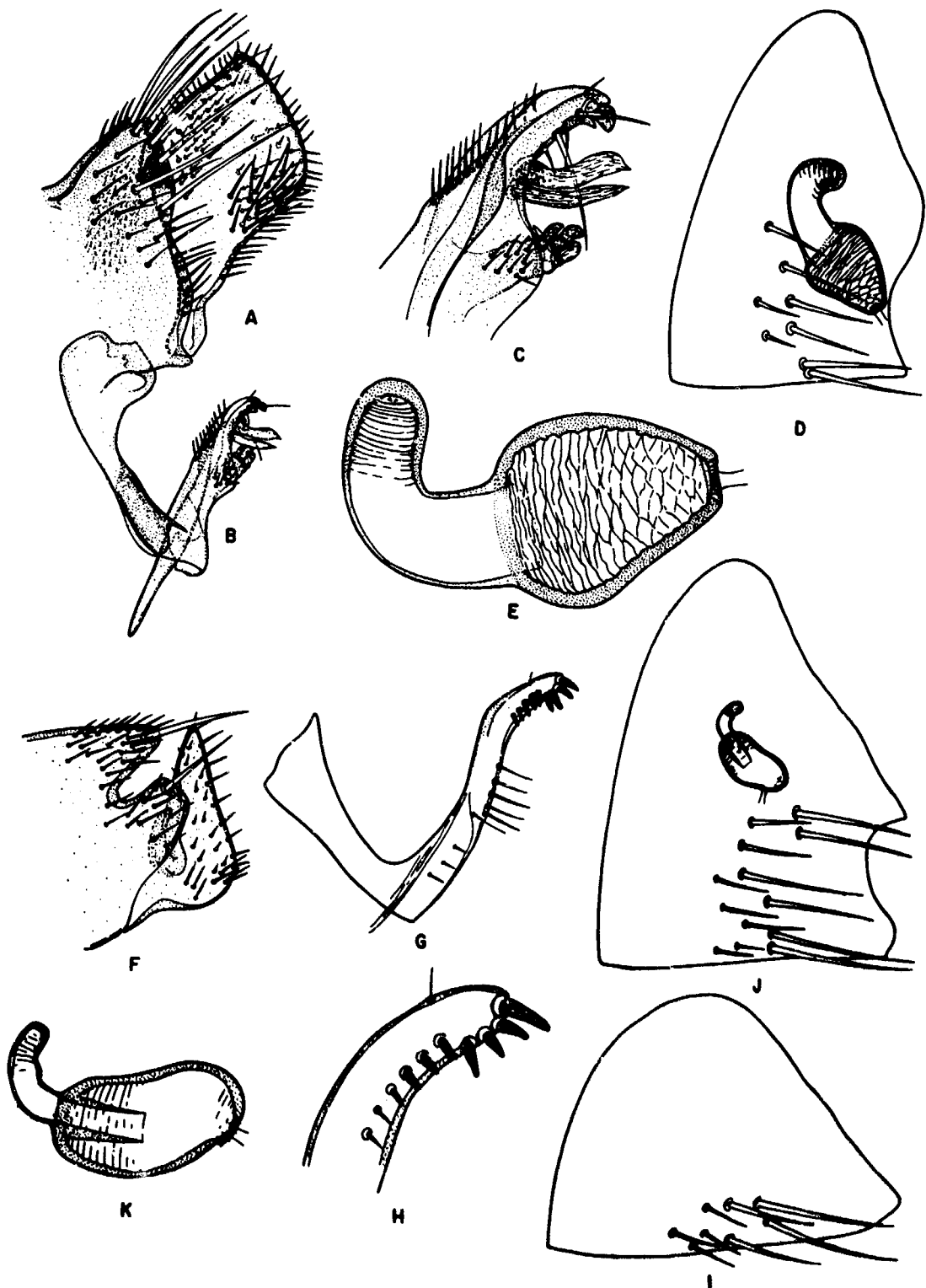
1956, N. J. Exp. Sta. Bull., p. 782. Burbutis and Mangold, 1956, Jour. Wildlife Mngmt., 20:217-218. Holland, 1956 (1958), Proc. Tenth Internat. Cong. Ent., 1:645-658. Rainey, 1956, Univ. Kansas Pub. Mus. Nat. Hist., 8:535-646. Howell, 1957, Jour. Parasit., 43: 566-573. Jameson and Brenna, 1957, Ecol. Mono., 27:45-54. Rapp and Gates, 1957, Jour. Kansas Ent. Soc., 30:50-53. Wilson, 1957, Jour. Mammal., 38:281-282. Layne, 1958, Chic. Acad. Sci., Nat. Hist. Misc., p. 162 (March). Stannard and Pietsch, 1958, Ill. Nat. Hist. Surv. Div. Biol. Notes 38. Geary, 1959, Cornell Exp. Sta. Mem. 355, figs. Haas and Dickie, 1959, Wisc. Acad. Sci., Arts and Letters, 48:125-133. Stark, 1958, Siphonaptera of Utah, 91, figs. Benton and Cerwonka, 1960, Am. Mid. Nat., 63:383-391. Hubbard, 1960, Ent. News, 71:245-247. Gabbutt, 1961, Ecology, 42:518-525. Hopkins and Rothschild, 1962, Cata. Rothschild Coll., 3:246-249, figs. 410, 434-436. Holland, 1963, Bishop Mus. Press, 45-63.

Epitedia wenmanni is ordinarily a common nest flea of Peromyscus and Neotoma further to the south. When the records were first reported by Hubbard (72), I thought they were questionable, since I did not encounter this flea even though I had taken a large series of rodents in the Fort Yukon area and even though the habitats which I worked so extensively in the Circle Hot Springs environs were similar to those in the Fort Yukon area. However, I have seen other specimens, through the courtesy of G. P. Holland at the Canadian National Collection, that were made by Rausch and his coworkers, which indicate that indeed this flea does occur within Alaska. This is surprising, inasmuch as the flea has a more northern distribution than that of its host — a unique situation among the Siphonaptera. Hubbard's reported record from Kivalina is an incredible one. If this is true, E. wenmanni has one of the broadest distributions known for any flea within the Nearctic region, coming from the subtropics into the tundra regions of North America. I doubt the validity of this record.

The extreme northern populations of E. wenmanni seem to be smaller than specimens I know in the southwestern United States. The record reported by me for Eagle I consider to be a dubious one, believing that this specimen was retained within the teeth of a comb previously used in brushing mammals in the southwestern United States.

Epitedia is a Nearctic genus, and although closely related to Catallagia, has no close counterpart in the Palearctic region.

E. wenmanni is thought to be important in the epidemiology of plague in native rodents; however, its occurrence is so sporadic within Alaska that I seriously doubt it would be of major importance in the forseeable future.

The distribution records below were made possible through the courtesy of Dr. G. P. Holland, Canadian National Collection; remaining records are from the U. S. National Museum and are a part of those reported by Hubbard (72).

American Creek, Eagle, Alaska

   Mustela erminea, -XI-61, 1M (M. M.)

38 mi. NW of Chitina, Alaska

   Microtus oeconomus, 8-X-55, 1F (R. Rausch) CNC

Fort Yukon, Alaska

   Microtus oeconomus, 10-IX-58, 1M, 2F (M. Johnson) USNM
                       2-V-58, 2M (F. S. L. Williamson) CNC

Kivalina, Alaska

   Mustela rixosa eskimo, 10-IX-59, 1F (M. Johnson) USNM

Richardson Hwy., M. P. 96 1/2, Alaska

   Microtus pennsylvanicus, 8-X-55, 1M (R. Rausch) CNC

X

Family ISCHNOPSYLLIDAE Wahlgren, 1907

   Distinguishable from all other fleas by the type of genal ctenidium, which
consists of two spines located preorally at the extreme ventroanterior margin
of the head. Frontal tubercle present, may be deciduous. Head fracticipit.
Eyes vestigial. Pronotal comb always present. Combs of pseudosetae always
present under collar (flange) of mesonotum. Metanotum with apical spine-
lets. Apical spinelets present on anterior abdominal terga, frequently
modified as false ctenidia.

   Male with tergum VIII enlarged; sternum VIII reduced, usually somewhat
modified. Sternum IX with tendon originating at base of distal arm. Crochet
large and movable.

   Female with tergum IX lacking free margins posteriorly and ventrally.
One spermatheca present. Dorsal margin of pygidium relatively straight.

MYODOPSYLLA Jordan and Rothschild, 1911

<u>Myodopsylla</u> Jordan and Rothschild, 1911. Nov. Zool., 18:88.

Frons with a large, clear, unsclerotized area. Spines of preoral ctenidium truncate. Stipes truncate. All thoracic and abdominal combs (except that of the pronotum) vestigial, replaced with false combs, which are formed by closely grouped setae. Antepygidial bristle single and unmodified.

This is a Holarctic genus which also occurs in the Neotropical region.

<u>Myodopsylla</u> <u>gentilis</u> Jordan and Rothschild, 1921
(Plate II, E; Plate IX, F, G, H, I, J)

<u>Myodopsylla</u> <u>gentilis</u>, Jordan and Rothschild, 1921. Ectoparasites, 1:152. Ewing, 1929, Man. Ext. Par., p. 158. Mail and Holland, 1939, Proc. Sixth Pac. Sci. Cong., 5:126. Hubbard, 1940, Pac. Univ. Bull., 37(4). Svihla, 1941, Univ. Wash. Pub. Biol., 12(2):18. Augustson, 1943, Bull. South. Calif. Acad. Sci., 42(2):86. Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Publ. No. 500:101. Jellison, Kohls, and Mills, 1943, Misc. Publ. Mont. Bd. Ent., 2:4, 8. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Stanford, 1944, Proc. Utah Acad. Sci., Arts and Letters, 19-20:175. Macy, 1947, Amer. Mid. Nat., 37:375-378. Hubbard, 1947, Fleas West. N. Amer., 374-375, fig. 231. Holland, 1949, Proc. Ent. Soc. Br. Columbia, 45:13. Holland, 1949, Siphonaptera of Can., pp. 180-181, figs. 339, 341-342. Hubbard, 1949, Bull. South. Calif. Acad. Sci., 48:125. Eads and Menzies, 1949, Texas Jour. Sci., 1(4):33-39. Eads, 1950, Texas State Health Dept. Bull., pp. 59-60, figs. Tipton, 1950, Master's Thesis, Brig. Young Univ., p. 64. Wiseman, 1955, Univ. Wyo. Publ., 19:1-28. Holdenried, et al., 1951, Ecol. Mono., 21:1-18. Augustson and Wood, 1953, Bull. South Calif. Acad. Sci., 52:48-56. Hopkins and Rothschild, 1956, 2: 249-251, figs. and Pl. Smit, 1958, Proc. Ent. Soc. Wash., 60:175-177. Stark, 1958, Siphonaptera of Utah, p. 108, fig. 12. Holland, 1963, Bishop Mus. Press, 45-63.

Records of <u>Myodopsylla</u> <u>gentilis</u> Jordan and Rothschild, 1921, are exceedingly rare in Alaska. Holland (58) indicates one Alaskan record, and the only other one that I know about is from <u>Myotis</u> <u>lucifugus</u> (LeConte), taken at Peter's Creek (elevation 300 feet, 20 miles northeast of Anchorage) in July of 1948, by J. R. Alcorn. Since this is approaching the northern limits of distribution for the host, it is not too surprising to find that its siphonapterous parasites are difficult to obtain.

This particular species of bat flea occurs on a wide variety of bats in western North America; the most eastward record is one reported in Colorado

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XI

Family LEPTOPSYLLIDAE Rothschild, 1915

Genal comb present or absent. Arch of tentorium always visible in front of eye. Uppermost bristle of ocular row at or near the margin of antennal fossa and above the level of upper margin of eye. Antennae short. Pronotal ctenidium present. Apical spinelets present on metanotum and anterior terga.

Male with sternum VIII never more than moderately reduced. Tergum VIII moderately enlarged. Sternum IX with tendon arising on distal arm. Crochets usually large, articulated and movable. Acetabular setae of clasper absent.

Female with tergum IX lacking free margins. Pygidium straight or slightly concave in lateral profile.

Subfamily Leptopsyllinae Rothschild, 1915

Genal comb present (except in Cratynius female). Head fracticipit. Clava of male not reaching prosternosome; antennal fossae closed. Frons frequently with spiniform setae. Metatibia with dorsolateral row of comb-like bristles. Sternepisternal ridge of mesothorax sclerotized throughout its length. Male with connection between crochet of phallosome and distal arm of sternum IX intimate. Represented by one genus in the Alaskan fauna.

PEROMYSCOPSYLLA I. Fox, 1939

Peromyscopsylla I. Fox, 1939. Proc. Ent. Soc. Wash., 41:47.

Interantennal suture well-developed. Frontal tubercle distinct, but reduced. Anterior margin of frons with a row of bristles, of which two to four are usually spiniform. Eye reduced, but well-pigmented. Tentorial arm visible anterior to eye. Labial palp five-segmented. Genal ctenidium of two posteriorly directed spines, one above the other but not overlapping. Tarsi V with four lateral plantar bristles and one basal submedian pair.

A Holarctic genus, with more representatives in North America than Eurasia. Johnson and Traub (84), in their revision of the genus, list 20 species and subspecies.

Peromyscopsylla ostsibirica longiloba (Jordan, 1939)
(Plate XII, A, B, C, D, E; Map 4)

Leptopsylla hamifer longiloba Jordan, 1939. Novit. Zool., 41:319-320, fig. 270. Ewing and Fox, 1943, U. S. Dept. Agr. Misc. Publ. No. 500:91. Hubbard, 1947, Fleas of West. N. Amer., pp. 337-338, fig. 199.

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Peromyscopsylla longiloba (Jordan). Geary, 1953, Arctic Aeromed. Lab.
  Rept. 1:1-37.

Peromyscopsylla ostsibirica longiloba (Jordan). Johnson and Traub, 1954,
  Smithsonian Misc. Coll., 23: Nov. 1954, figs. 83-86, 119. Gill, 1954,
  Arctic Aeromed. Lab. Rept., 2:1-50. Holland, 1956 (1958), Proc.
  Tenth Internat. Cong. Ent., 1:645-658. Hubbard, 1960, Ent. News,
  71:245-247. Holland, 1963, Bishop Mus. Press, pp 45-63. Holland,
  1964, Ann. Rev. Ent., 9:123-146.

Peromyscopsylla ostsibirica longiloba (Jordan, 1939) was described from
a female specimen removed from Microtus at One Mile Camp, Valdez Creek
Trail, Alaska. At that time it was considered a subspecies of Peromyscop-
sylla hamifer, and this concept remained in effect until Johnson and Traub
(84) realized its true affinities with Peromyscopsylla ostsibirica Scalon.
P. o. longiloba is close, if not identical, to P. ostsibirica Scalon, which
according to Ioff and Scalon (74), occurs in the forest regions of Irkutskoblast,
in Transbaikalia, Yakutia, Khabarovsk and Primorsk regions, and also in
Korea in the east. These authors indicate that P. ostsibirica parasitizes
"wood voles" (Clethrionomys) and other small forest animals in Europe and
Asia, and that the flea is usually more abundant in the autumn. The latter
statement agrees with my observations in Alaska, for it is usually the latter
part of July before P. o. longiloba is encountered more than sporadically.
In looking at the figures in Table IV it is apparent that this particular species
of flea is more closely associated with Microtus oeconomus than with Cleth-
rionomys rutilus. This statement holds true so long as we keep in mind that
this flea is restricted to the taiga, although its host is not. In checking past
records, something like 1,300 M. oeconomus have been taken in the tundra
regions above and beyond tree line, and no specimens of Peromyscopsylla
were obtained.

TABLE IV

Host Associations of
Peromyscopsylla ostsibirica longiloba (Jordan)

Host	Total No. Fleas	No. Positive Specimens Collected	Average/Host
Clethrionomys rutilus	42	25	1.7
Felis domesticus	01	01	
Glaucomys sabrinus	01	01	
Martes americana	01	01	
Microtus oeconomus	259	88	2.9
Microtus pennsylvanicus	01	01	
Rattus norvegicus	01	01	
Tamiasciurus hudsonicus	03	02	

Records

Allakaket, Alaska

   Clethrionomys rutilus
     5-VIII-55, 1M (C. E. H.)

   Microtus oeconomus
     9-VIII-55, 7M, 5F (C. E. H.)

   Tamiasciurus hudsonicus
     7-VIII-55, 1F (C. E. H.)

American Creek, Eagle Environs, Alaska

   Martes americana actuosa
     -XI-61, 1F (M. M.)

Circle Hot Springs, Alaska

   Clethrionomys rutilus
     9-VIII-61, 1M (C. E. H.)
     9-VIII-61, 1M (C. E. H.)
     12-IX-61, 1M (C. E. H.)
     12-IX-61, 1F (C. E. H.)
     12-IX-61, 1M, 3F (C. E. H.)

   Microtus oeconomus
     8-VIII-61, 1M, 2F (C. E. H.)
     8-VIII-61, 1M (C. E. H.)
     8-VIII-61, 4M, 10F (C. E. H.)
     8-VIII-61, 3M (C. E. H.)
     8-VIII-61, 2F (C. E. H.)
     9-VIII-61, 1M (C. E. H.)
     9-VIII-61, 4M (C. E. H.)
     9-VIII-61, 1M (C. E. H.)
     9-VIII-61, 2M, 1F (C. E. H.)
     9-VIII-61, 1M (C. E. H.)
     9-VIII-61, 3F (C. E. H.)
     9-VIII-61, 2M (C. E. H.)
     9-VIII-61, 1F (C. E. H.)
     9-VIII-61, 1M (C. E. H.)
     9-VIII-61, 2M, 2F (C. E. H.)
     9-VIII-61, 1M (C. E. H.)
     9-VIII-61, 2M, 1F (C. E. H.)
     9-VIII-61, 1F (C. E. H.)
     9-VIII-61, 1M (C. E. H.)

Microtus oeconomus (cont'd)

   9-VIII-61, 1M, 1F (C. E. H.)
   9-VIII-61, 1M, 4F (C. E. H.)
   9-VIII-61, 1M, 3F (C. E. H.)
   10-VIII-61, 1F (C. E. H.)
   10-VIII-61, 1M, 1F (C. E. H.)
   10-VIII-61, 1M, 1F (C. E. H.)
   10-VIII-61, 1M (C. E. H.)
   10-VIII-61, 1M (C. E. H.
   10-VIII-61, 2M, 3F (R. D. C.)
   10-VIII-61, 1F (C. E. H.)
   11-IX-61, 1M, 2F (C. E. H.) (N)
   11-IX-61, 1F (C. E. H.)
   12-IX-61, 1M, 3F (C. E. H.)
   12-IX-61, 2M, 1F (C. E. H.)
   12-IX-61, 1M (C. E. H.)
   12-IX-61, 3F (C. E. H.)
   12-IX-61, 1M, 2F (C. E. H.)
   12-IX-61, 2M (C. E. H.)
   12-IX-61, 2F (C. E. H.)
   12-IX-61, 1F (C. E. H.)
   12-IX-61, 1F (C. E. H.)
   12-IX-61, 1? (C. E. H.)
   12-IX-61, 2F (C. E. H.)
   12-IX-61, 1M, 2F (C. E. H.)
   12-IX-61, 4M, 2F (C. E. H.)
   12-IX-61, 5M, 4F (C. E. H.)
   13-IX-61, 2M, 1F (C. E. H.)
   25-X-61, 1M (C. E. H.)
   24-VIII-59, 2M, 1F (C. E. H.)
   24-VIII-59, 1M, 1F (C. E. H.)
   24-VIII-59, 2M, 3F (C. E. H.)
   25-VIII-59, 2M (C. E. H.)
   25-VIII-59, 3M, 2F (C. E. H.)
   25-VIII-59, 2M, 7F (C. E. H.)
   25-VIII-59, 6M, 10F (C. E. H.)

Microtus pennsylvanicus
   12-IX-61, 1F (C. E. H.)

Tamiasciurus hudsonicus
   25-VIII-59, 1M, 1F (C. E. H.)

Denali Hwy., M. P. 12, Alaska

Microtus oeconomus
28-VIII-61, 1F (J. H. E.)
28-VIII-61, 1F (J. H. E.)

Elliott Hwy., M. P. 10, Alaska

Microtus oeconomus
10-VIII-60, 2F (C. J. M.)

Fairbanks, Alaska

Clethrionomys rutilus
20-IX-59, 1F (W. O. P.)
16-VIII-62, 1F (J. H. E.)
18-VIII-62, 1M (J. H. E.)
13-VIII-62, 2M (J. L. C.)
17-VIII-60, 1M (C. J. M.)
30-IX-60, 3F (C. D. K.)

Glaucomys sabrinus
22-XII-59, 1F (J. F. A.)

Microtus oeconomus
18-VIII-62, 1M, 1F (J. H. E.)
20-VIII-62, 2F (D. M. H.)
10-VIII-62, 1F (J. L. C.)
9-VIII-62, 1M (J. L. C.)
16-VIII-60, 1M (C. J. M.)
17-VIII-60, 1M, 2F (C. J. M.)
17-VIII-60, 1F (C. J. M.)
19-VIII-60, 1M (C. J. M.)
19-VIII-60, 1M (C. J. M.)
20-VIII-60, 1M (C. J. M.)
20-VIII-60, 3F (C. J. M.)
21-VIII-60, 1M (C. J. M.)
22-VIII-60, 1M, 1F (C. J. M.)

Fairbanks, Brock Road, Alaska

Clethrionomys rutilus
20-VII-61, 1? (C. E. H.)

Microtus oeconomus
20-VII-61, 1F (C. E. H.)

Fairbanks environs, Alaska

Felis domesticus
3-X-61, 1F (G. T.)

Ft. Wainwright, Alaska

Clethrionomys rutilus
6-IX-61, 1M (C. E. H.)
6-IX-61, 1M, 1F (C. E. H.)
21-IX-61, 1M, 4F (C. E. H.)
21-IX-61, 1M, 1F (C. E. H.)
20-VIII-62, 2M (J. E.)

Microtus oeconomus
7-IX-61, 2F (C. E. H.)

Rattus norvegicus
25-IX-53, 2M (G. G.)

Ft. Yukon, Alaska

Microtus oeconomus
3-VIII-57, 2M, 2F (C. E. H.)
3-VIII-57, 2F (C. E. H.)
2-VIII-58, 1M (C. E. H.)
8-IX-58, 1M, 1F (J. Johnson)USNM

Nolan Creek, Alaska

Microtus
12-VIII-59, 2M, 10F (C. E. H.)

Paxson Lake, Alaska

Clethrionomys rutilus
4-XI-59, 1F (L. L. H.)

Rich. Hwy., M. P. 178, Alaska

Clethrionomys rutilus
17-VIII-61, 1F (C. E. H.)
18-VIII-61, 1M (C. E. H.)
18-VIII-61, 1M (C. E. H.)
18-VIII-61, 1M, 1F (C. E. H.)

Rich. Hwy., M. P. 178, Alaska (cont'd)

Microtus oeconomus
   17-VIII-61, 3M (C. E. H.)
   17-VIII-61, 2F (C. E. H.)
   17-VIII-61, 1M, 1F (C. E. H.)
   17-VIII-61, 4M, 6F (C. E. H.)
   17-VIII-61, 2M, 2F (C. E. H.)
   17-VIII-61, 4F (C. E. H.)
   18-VIII-61, 1M, 1F (C.E. H.)
   18-VIII-61, 1M, 1F (C.E. H.)
   18-VIII-61, 1M, 2F (C. E. H.)
   18-VIII-61, 1M (C. E. H.)
   18-VIII-61, 3M, 1F (C. E. H.)

Wilbur Creek, Alaska

Microtus oeconomus
   30-VI-57, 1F (C. E. H.)
   1-VII-57, 2F (C. E. H.)
   29-VII-57, 3M, 5F (C. E. H.)

Subfamily Amphipsyllinae Dampf, 1945

Genal comb present or absent (lacking in Alaskan species). Eye usually present, frequently reduced or sinuate. Sternepisternal ridge of mesothorax sclerotized posteriorly or not at all. Head nearly always integricipit. Male with no connection between crochet of phallosome and distal arm of sternum IX as in Leptopsyllinae.

AMPHIPSYLLA Wagner, 1908

Amphipsylla Wagner, 1908. Mitteil. d. Kaukasisch. Mus., 4:196.

Pre- and postantennal regions of the head with three rows of setae each. Eyes moderately pigmented, but sinuate. Labial palps shorter than forecoxa. Tentorial arms conspicuous in front of eye. Mesocoxa lacking spinelets on mesal surface. Genal ctenidium absent; pronotal ctenidium present. Basal pair of plantar bristles on tarsi V shifted ventrally. Movable process of clasper with pigmented spines.

A Holarctic genus, of which three species have been described in the Nearctic Region. Associated with microtine rodents.

PLATE XII

Peromyscopsylla ostsibirica longiloba (Jordan, 1939).

        Figure A: Clasper of male

        Figure B: Sternum IX of male

        Figure C: Sternum VIII of male

        Figure D: Sternum VII of female

        Figure E: Spermatheca

Ctenophyllus armatus terribilis (Rothschild, 1903)

        Figure F: Clasper of male

        Figure G: Sternum IX of male

        Figure H. Sternum VIII of male

        Figure I: Sternum VII of female

        Figure J: Spermatheca

        Figure K: Bursa copulatrix

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PLATE XII
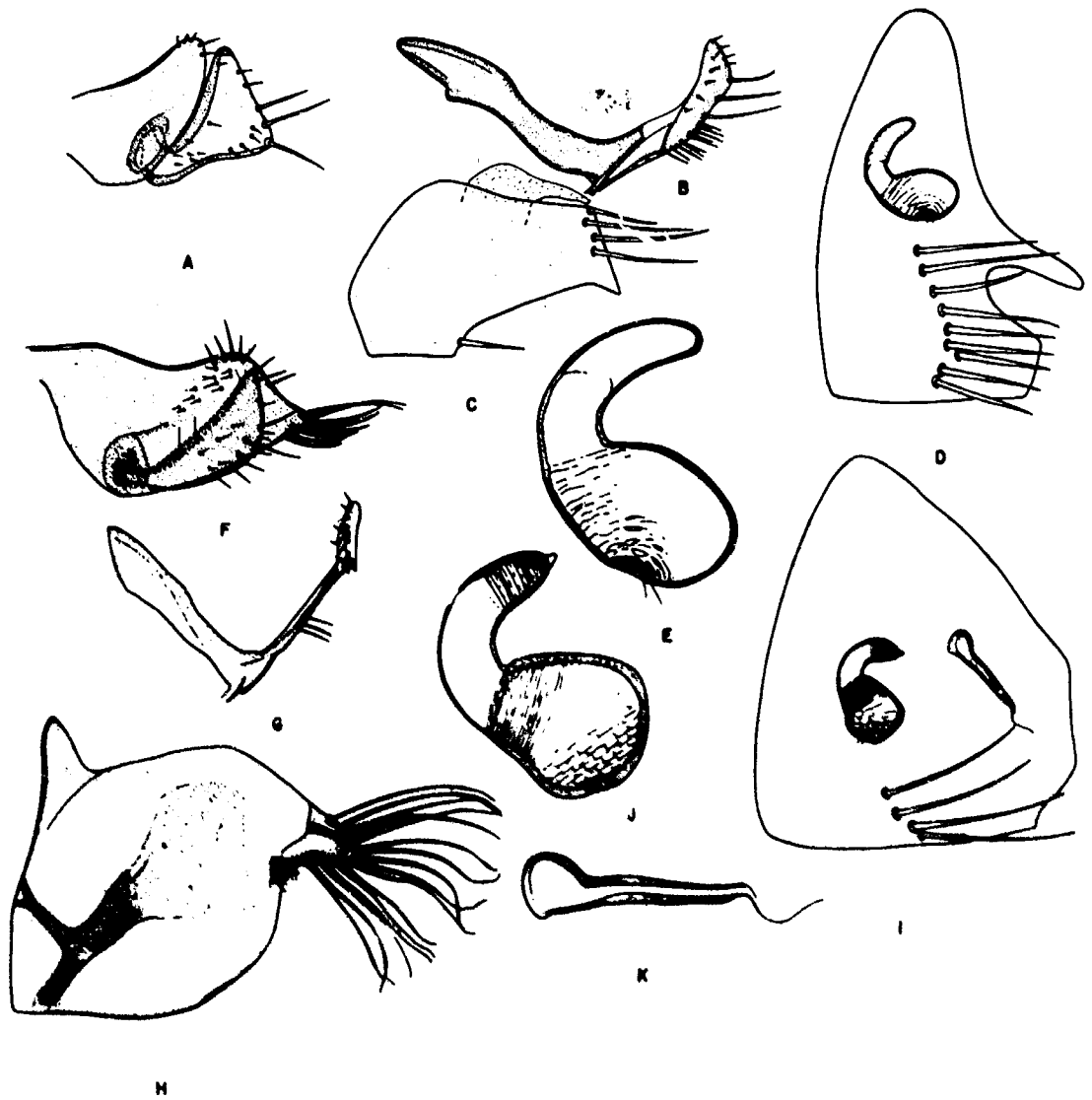
MAP 4

Distribution of Peromyscopsylla ostsibirica longiloba (Jordan), Amphipsylla marikovskii ewingi I. Fox, and Amphipsylla sibirica pollionis (Rothschild).

The absence of the second species in the central portion of the taiga is questionable at the present time.
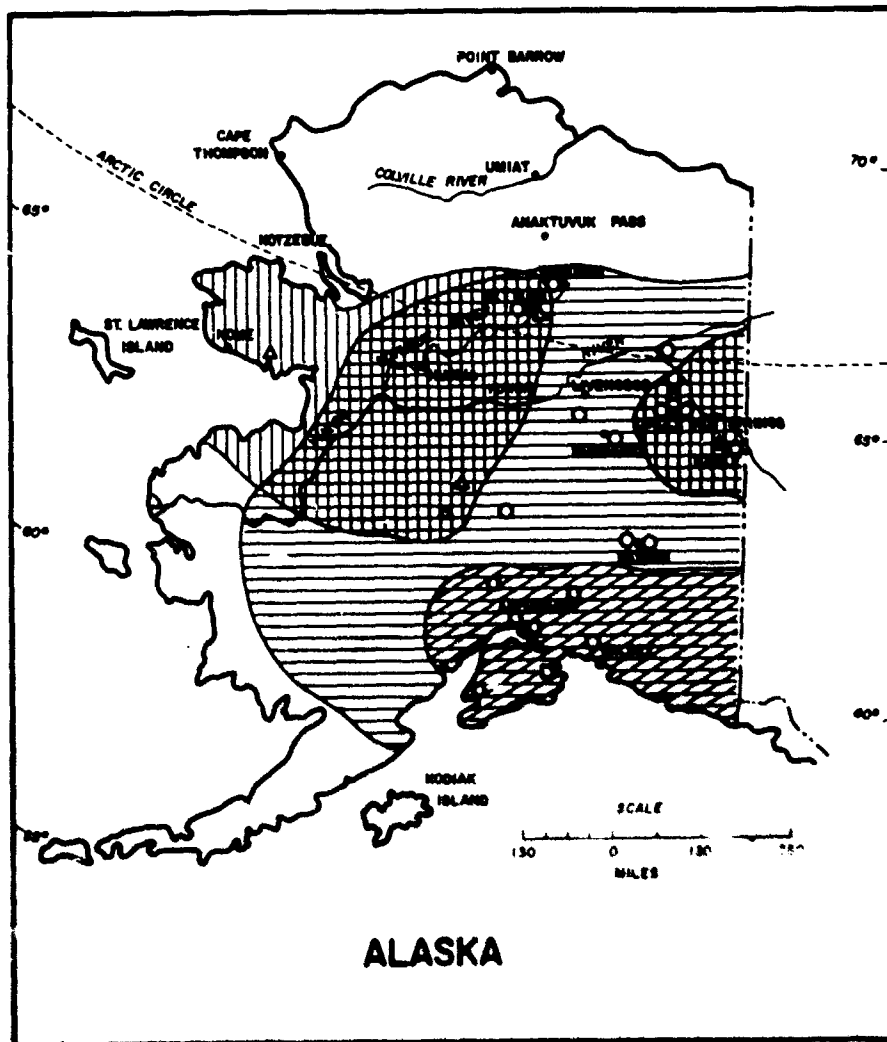
ALASKA

▤ ○ Peromyscopsylla ostsibirica longiloba (Jordan).

▨ ▢ Amphipsylla sibirica pollionis (Rothschild).

▥ △ Amphipsylla marikovskii ewingi Fox.

Key to Alaskan species of Amphipsylla

Males

Posterior margin of M. P. with three-five strong bristles interspaced between two widely separated spiniforms   markovskii ewingi

Posterior margin of M. P. with spiniforms closer together, usually not more than three weak bristles between them   sibirica pollionis

Females

Bursa copulatrix with an apical, small sclerotization

sibirica pollionis

Bursa copu'.trix without apical sclerotization   marikovskii ewingi

Amphipsylla marikovskii ewingi Fox, 1940
(Plate II, D, G; Plate XIV, A, B, C, D, E, F, G; Map 4)

Amphipsylla marikovskii ewingi Fox, 1940. Proc. Ent. Soc. Wash., 42:64-65, pl. IX, fig. 1. Ewing and Fox, 1943, U. S. Dept. Agri. Misc. Publ., No. 500:31. Hubbard, 1947, Fleas West. N. Amer., pp 261-262, figs. Holland, 1956 (1958), Proc. Tenth Internat. Cong. Ent., 1:645-658. Holland, 1963, Bishop Mus. Press, pp 45-63.

Amphipsylla marikovskii ewingi I. Fox, 1940 is closely related to the following species, A. s. pollionis. The principal difference used to separate the males of these two species relies upon the number of small setae arranged between the two stout bristles on the movable process. However, this is not a consistent difference; in the collection of Robert Traub, I have seen a male that had been identified by G. P. Holland as A. pollionis, which has sufficient numbers of these small setae to be classified as ewingi. The female of A. m. ewingi lacks the heavily sclerotized plate on the bursa copulatrix; it is there but is so lightly sclerotized that it is not immediately obvious.

In looking at the distribution plotted on Map 4, I have indicated two discrete populations for this species. I am not at all certain that this is valid, because A. m. ewingi should occur in the Fairbanks-Livengood environs. However, consistent trapping over the years in this area, yielding large numbers of hosts in various kinds of habitats, has not yet shown that it is present.

As with the previous species, sufficient data are not available to make a clear judgement of host associations, although it is evident that A. M. ewingi is closely associated with the microtine rodents. It would be interesting to

see if it would prefer Clethrionomys to Microtus when a large series eventually has been taken. This flea will depart instantly when the host is captured in a snap trap, and I suspect this is one of the reasons that A. M. ewingi has been of uncommon occurrence in collections.

TABLE V

Host Associations of
Amphipsylla marikovskii ewingi Fox

Host	Total No. Fleas	No. Positive Specimens Collected	Average/Host
Clethrionomys rutilus	03	03	01
Microtus oeconomus	07	06	1.2
Microtus pennsylvanicus	02	01	
Mustela vison	01	01	
Tamiasciurus hudsonicus	01	01	

Records

American Creek (Eagle environs), Alaska

Mustela vison
24-XI-61, 1? (M.M.)

Bettles Village, Alaska

Microtus oeconomus
15-VIII-61, 1M (R. D. C.)(N)

Circle Hot Springs, Alaska

Clethrionomys rutilus
25-VIII-59, 2M, 1F (C.E. H.)
24-X-61, 1F (C. E. H.)

Microtus oeconomus
9-VIII-61, 1M (C. E.H.)
12-IX-61, 1M (C. E. H.)
12-IX-61, 1F (C. E. H.)
24-X-61, 1M (C. E. H.)
24-X-61, 1F (C. E. H.)

Microtus pennsylvanicus
24-X-61, 1M, 1F (C. E. H.)

Tamiasciurus hudsonicus
25-VIII-59, 1M (C.E. H.)(N)

Eagle, Alaska

Clethrionomys rutilus
3-VII-62, 1F (M. M.)

Golovin Bay, Alaska

Short-tailed mouse
7-V-31, 1M (E. C. Cushing) USNM
22-XII-30, 1M (A. H. Twitchell) USNM
5-IX-31, 1M (A. H. Twitchell) USNM

Hooper Bay, Alaska

Microtus oeconomus
2-II-57, 2M, 2F (R. Rausch) CNC

Nome, Alaska   Takotna, Alaska

   Microtus oeconomus   Microtus operarius operarius
      19-20-IX-57, 2F (F. H. Fray) CNC   29-V-32, 1M (A. H. Twitchell)
                                                                          USNM
Ophir, Alaska   15-XII-34, 2F (A. H. Twitchell)
                                                                          USNM

   Microtus
      20-II-33, 3F (J. E. Shelbuger) USNM

                   Amphipsylla sibirica pollionis (Rothschild, 1905)
                      (Plate XIII, A, B, C, D, E, F, G, H, I; Map 4)

Ceratophyllus pollionis Rothschild, 1905. Nov. Zool., 12:171-172. Baker,
        1905, Proc. U. S. Nat'l. Mus., 29:133, 150.

Amphipsylla pollionis (Rothschild). Jordan and Rothschild, 1913, Zoologist,
        1913:405-406. Hubbard, 1943, Pac. Univ. Bull., 39:1-12.

Amphipsylla sibirica pollionis (Rothschild). Wagner, 1936, Can. Ent., 68:
        195. Mail and Holland, 1939, Proc. Sixth Pac. Sci. Cong., 5:125.
        Fox, 1940, Proc. Ent. Soc. Wash., 42:64-65. (A. ewingi n. sp.
        described from Alaska). Ewing and Fox, U. S. Dept. Agr. Misc. Publ.,
        No. 500:31. Brown, 1944, Ann. Ent. Soc. Amer., 37:206. Hubbard,
        1947, Fleas West. N. Amer., p. 262-263, figs. Holland, 1949,
        Siphonaptera Can., p. 108, figs. Holland, 1956 (1958), Proc. Tenth
        Internat. Cong. Ent., 1:645-658. Holland, 1964, Ann. Rev. Ent.,
        9:123-146. Holland, 1963, Bishop Mus. Press, pp. 45-63.

     Amphipsylla sibirica pollionis (Rothschild, 1905) is one of two Nearctic
representatives of Amphipsylla sibirica, which occurs across northern
Europe and Asia and has been separated into several subspecies. The
southernmost records of A. s. pollionis in the Nearctic region are in the
lower Alpine areas of the Rocky Mountains at Banff, Canada. Some records
occur in central Canada, and then A. s. pollionis is not encountered again
except for an isolated population in northern Labrador. In 1954, Hubbard
described another subspecies, Amphipsylla s. washingtona, taken from the
dry sagebrush lands in the state of Washington, where the only host records
are from the palid vole, Lagurus curtatus.

     In view of the sharp ecological differences of habitats of these two respec-
tive subspecies, Holland (59) is inclined to regard A. washingtona as a full
species, with the implication of marked physiological differences between
the two.

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In Alaska, the records of A. s. pollionis are not sufficient to make a judgement as to host specificity. On the basis of available evidence, it is safe only to state that it is associated with the microtine rodents.

A major revision of the genus Amphipsylla is needed. Actually, pollionis is not too far removed from Amphipsylla marikovskii ewingi, the females being practically inseparable except for the characteristic of the heavier chitinous plate on the bursa copulatrix (which was called to my attention by G. P. Holland).

PLATE XIII

Amphipsylla sibirica pollionis (Rothschild, 1905)

Figure A: Clasper of male (scale drawing)

Figure B: Clasper of male (enlarged drawing)

Figure C: Sternum IX of male (scale drawing)

Figure D: Sternum IX of male (enlarged drawing)

Figure E: Sternum VIII of male

Figure F: Sternum VII of female

Figure G: Spermatheca

Figure H and I: Bursa copulatrix female

PLATE XIII
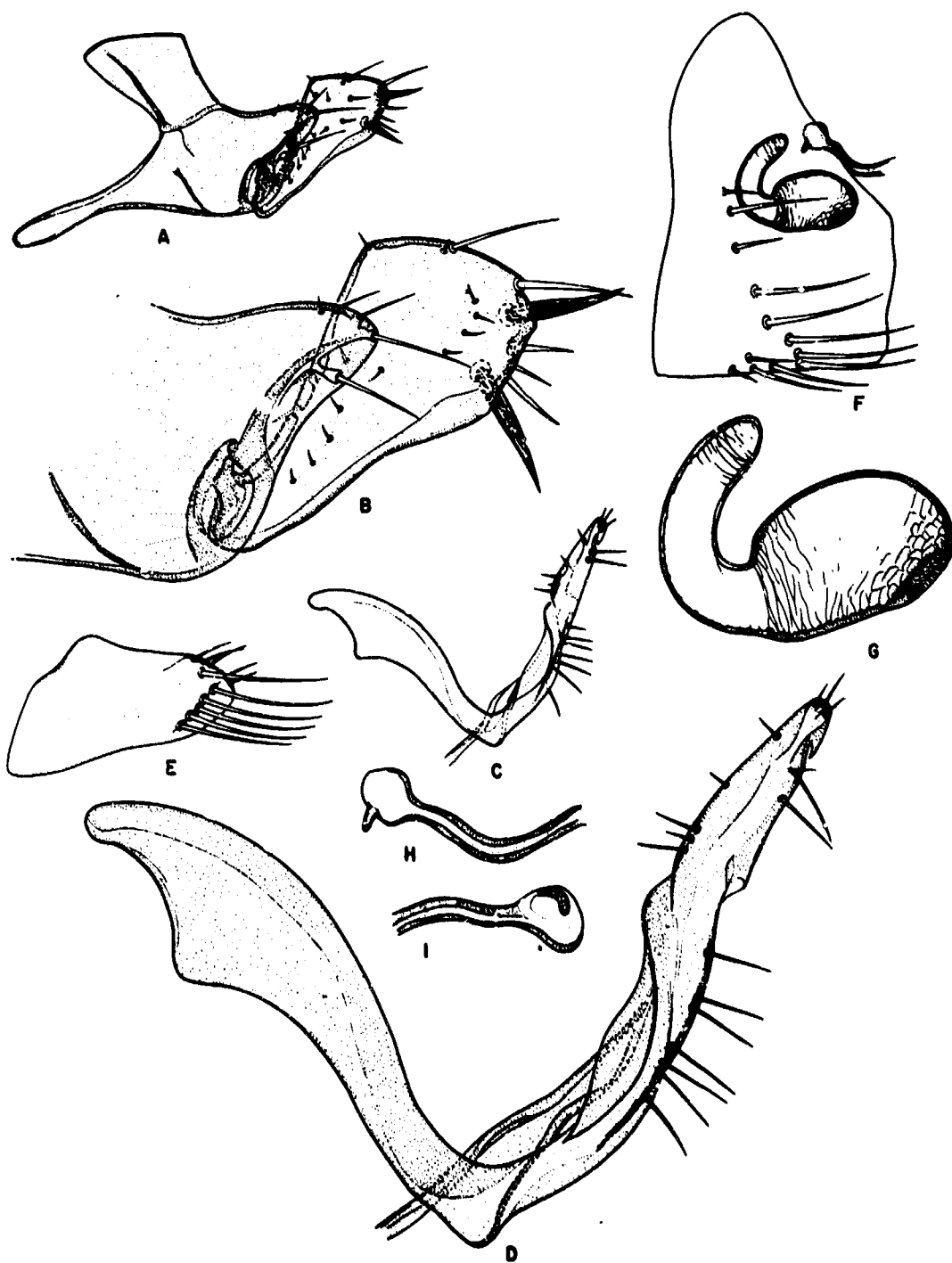
PLATE XIV

Amphipsylla marikovskii ewingi I. Fox, 1940

Figure A: Clasper of male

Figure B: Movable process, (enlarged drawing)

Figure C: Sternum IX of male

Figure D: Sternum VIII of male.

Figure E: Sternum VII of female

Figure F: Spermatheca

Figure G: Bursa copulatrix

PLATE XIV

A

B

C

D

E

F

G
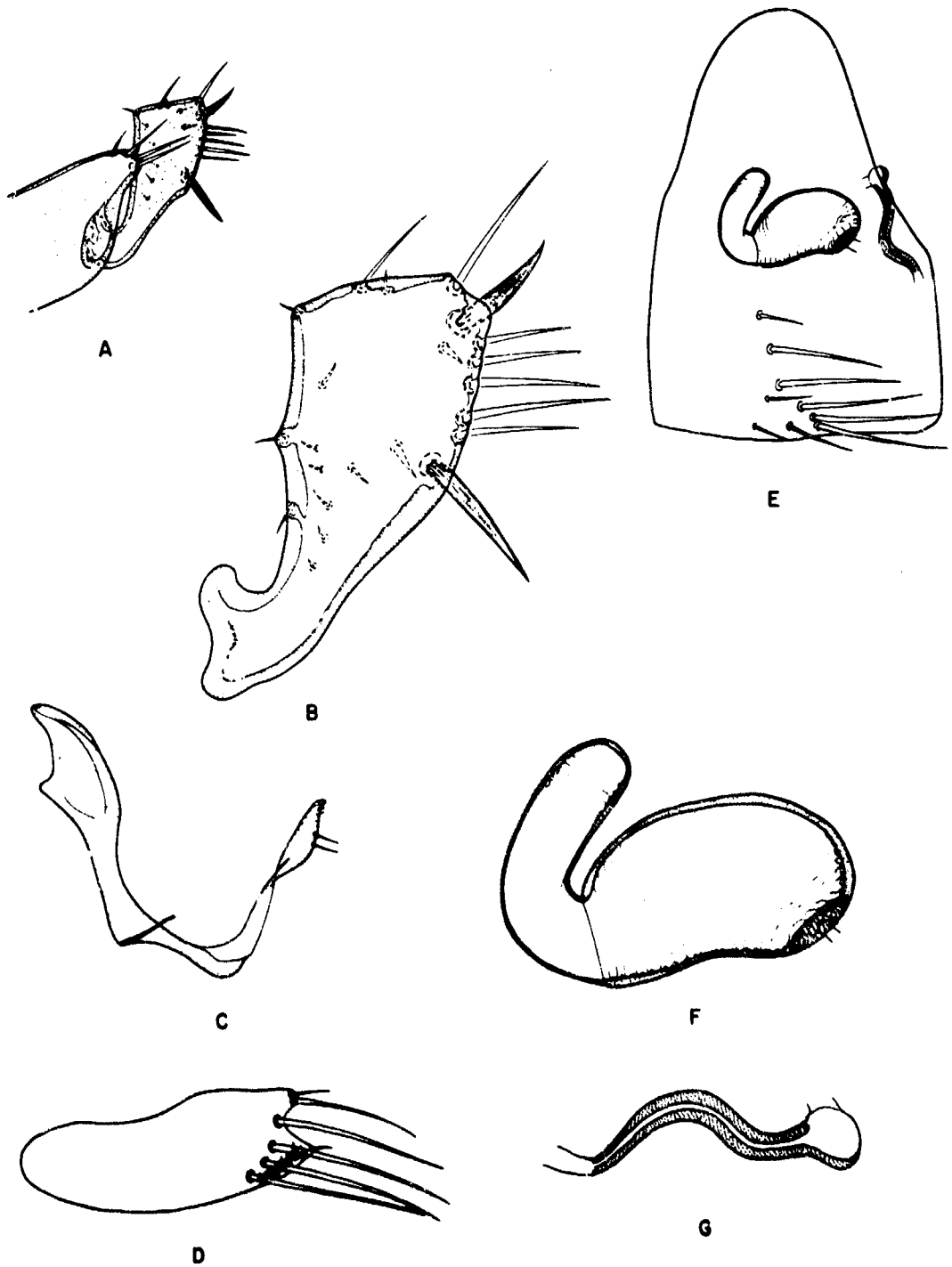
Records

Anchorage, Alaska

    Lemming
       15-IV-48, 1M, 4F   CNC

Glen Hwy , M.P. 86, Alaska

    Microtus pennsylvanicus
       8-X-58, 1F (R. Rausch) CNC

Homer, Alaska

    Microtus oeconomus
       26-III-55, 1M (R. Rausch) CNC

Peters Creek, 20 Mi. N.W. Anchorage, Alaska

    Clethrionomys rutilus
       5-I-52, 1F (R. Rausch) CNC

Seward Hwy. at Tudor Rd., Alaska

    Microtus pennsylvanicus
       7-XI-57, 1M (R. Rausch) CNC

Skwentna, Alaska

    Microtus sp.,
       3-XI-51, 1F (R. Rausch) CNC

CTENOPHYLLUS Wagner, 1927

Ctenophyllus Wagner, 1927. Konowia, 6:108, 112.

Pre- and postantennal regions each with three rows of setae. Most anterior row of frons with heavy spiniforms; mesal surface of hindcoxa with patch of thin hairs. Tarsi V with five lateral plantar bristles. Sternum VIII of male large, broad and reinforced on each side by a Y-shaped thickening of chitin. Apical process of sternum VIII with a tuft of long setae. Sternum IX of male with distal arm slender. Spermatheca with a broad bulga, rather distinctly separated from the hilla.

This is a Holarctic genus, and as with the Amphalius Jordan, is closely restricted to the pika (Ochotona). Southern limits of distribution within the Nearctic distribution are Arizona and California, at higher mountain elevations.

Ctenophyllus terribilis (Rothschild, 1903)
(Plate XII, F, G, H, I, J, K; Map 13)

Ceratophyllus terribilis Rothschild, 1903. Nov. Zool., 10:317-318. Baker, 1905, Proc. U.S. Nat. Mus., 29:134-151.

Ctenophyllus terribilis (Rothschild). Jordan, 1933, Nov. Zool., 39:70-71. Wagner, 1936, Can. Ent., 68:195. Mail and Holland, 1939, Proc. Sixth Pac. Sci. Cong., 5:125. Holland, 1940, Proc. Ent. Soc. Br. Columbia, No. 36. Hubbard, 1940, Pac. Univ. Bull., 37(4). Eskey and Haas, 1940, Publ. Health Bull., No. 354:29-74. Svihla, 1941, Univ. Wash. Pub. Biol., 12(2):13. Jellison, 1941, Pub. Health Rep.,

56:3-8, fig. 1. Hubbard, 1941, Pac. Univ. Bull., 37(8):6-8, figs. Jellison, Kohls, and Mills, 1943, Misc. Publ. Mont. Ba Ent., 2:3, 20. Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Publ., 500:72, fig 6A. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Stanford, 1944, Proc. Utah Acad. Sci. Arts and Letters, 19 and 20:174. Brown, 1944, Ann. Ent. Soc. Am., 37:308. Hubbard, 1947, Fleas West. N. Amer., pp. 270-272, fig. 152. Holland, 1949, Proc. Ent. Soc. Br. Columbia, 45:10. Hubbard, 1949, Bull. South. Calif. Acad. Sci. 48- 6. Holland 1949, Siphonaptera Can., pp. 109-110. figs. 158-161. Eads, 1949, Jour. Econ. Ent., 42-144. Tipton, 1950, Masters Thesis, Brig. Young Univ., p. 63. Morla, 1955, Texas Rep. Biol. and Med., 13: 3-125. Wiseman, 1955, Univ. Wyo. Publ., 19:28 pp. Holdenried and Morl n, 1956, Am. Midl. Na ., 55:369-381. Holland, 1956 (1958), Proc. Tenth Internat. Cong. En ., 1:645-658. Stark, 1958, Siphonaptera o Utah, p. 116. Holland, 196 Bishop Mus. Press, 45-63.

Ctenophyllus terribilis (Rothschild, 1903) is represented in the Nearctic region by only this one species. The distribution in the Nearctic egion is disjunctive, coinciding with the two species of Ochotona recognized by Hall and Kelson (39). Holland has mentioned that these two populations may have resulted from northern survival in a refugium and southern survival below the Pleistocene ice sheets, with partial postglacial reinvasion. Holland considers that no apparent speciation has occurred in the two long-separated populations of C. terribilis.

This flea departs readily from the host, and unless the investigator is careful, most or all of the specimens are lost before the animal is properly secured in a bag. Rausch (119) has reported the distribution of the collared pika (Ochotona collaris) in Alaska. It is likely that C. terribilis occupies essentially the same range as its host. However, one can find colonies of pika where one fails to find the pika infested with fleas, despite meticulous precautions in collecting them. I do not understand this phenomenon but have found it frustratingly true in Alaska. The next year, they may be abundant upon the pika when taken in the same colony at the identical time of the year.

Records

Dry Creek, Alaska

Ochotona collaris
19-VI-62, 2F (E.V.)
25-VI-62, 4M, 8F (E.V.)

Spermophilus undulatus
15-VI-62, 1F (E.V.)
27-VII-62, 1F (E.V.)

Helmet Mountain, Alaska

Ochotona collaris
12-IV-53, 1M, 1F (G.G.)
17-VIII-61, 1M (C.E.H.)

Dan's Valley, Helmet Mountain, Alaska
Ochotona collaris
28-VIII-61, 3M, 1F (W.T.V.)

Dan's Valley, Helmet Mt. (cont'd)   Emerson's Gulch, Helmet Mt.

Ochotona collaris   Ochotona collaris
    28-VIII-61, 1M, 2F (W.T.V.)   27-VII-62, 1F (J. L. C.)
    28-VIII-61, 7F (J. H. E.)
    28-VIII-61, 2M (W.T.V.)   Paxson, Alaska
    2-VII-60, 1M, 1F (C. E. H.)
                                         Pika, 12-IX-53, 1M 3F (G. G.)

XII

Family CERATOPHYLLIDAE Dampf, 1908

Dorsal arm of tentorium usually poorly developed, if at all; not visible in genal area. Trabecula centralis present. Three bristles in ocular row, ocular bristle in front of eye. Eye well-developed (except within subfamily Foxellinae). Antenna long, clava of male reaching prosternosome; antennal fossa open. Genal ctenidium absent. Pronotal ctenidium usually present. Pleural ridge and pleural arch of metathorax usually well-developed. Apical spinelets present on metanotum and anterior abdominal terga. Metacoxa lacking patch of spiniforms on mesal surface.

Males with tergum VIII greatly expanded and almost covering all other genital segments. Sternum VIII enormously reduced. Sternum IX with tendon attached to distal arm. Clasper with acetabulum and usually with acetabular bristles. Distal arm of sternum IX divided into apical and basal lobes. Crochets large, articulated and movable.

Female with tergum IX unsclerotized. Anal stylet present and of various forms. Pygidium flat or concave when viewed from a lateral aspect. One spermatheca present.

The subfamily concept within the Ceratophyllidae is difficult to present because there are no sharp breaks between the groups, as in the Hystrichopsyllidae. The one exception is the Dolichopsyllinae, which is well defined. However, it is represented by one species, Dolichopsyllus stylosus, which is restricted along with its relict host, Aplodontia, to the Northwest Pacific region. The remaining genera are now placed in Ceratophyllinae and Foxellinae. Only the Ceratophyllinae occur in Alaska, and a description of the family is entirely adequate for this subfamily.

XIII

Family CERATOPHYLLIDAE, Genus CERATOPHYLLUS Curtis, 1832

Ceratophyllus Curtis, 1832. British Ent., 9:147.

Genal ctenidium absent; pronotal ctenidium of 24 or more spines. Eye well-developed and pigmented. Labial palps not exceeding forecoxae. A

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Females

1. MPM without pleural arch   arcuegens

    MPM with pleural arch   2

2. Abdominal spiracles of terga II-VII not circular, but appearing
    doubled-over   3

    Spiracles of at least segments V-VII circular in outline   4

3. Three or more rows of setae on each abdominal tergum;
    associated with mustelids   lunatus tundrensis

    Two rows of setae on each tergum, a basal row of short setae
    and an apical row of long setae; associated with birds
                               vagabundus vagabundus

4. Bulga of spermatheca approximately twice as broad as hilla   5

    Bulga narrow, only slightly broader than hilla   6

5. Two-three rows of short bristles on dorsal portion of tergum
    VIII, anterior to spiracle   gallinae

    Not more than three-four such bristles, forming at best an
    indistinct row   balati

6. Posterior margin of sternum VII without a lateral sinus   7

    Posterior margin of sternum VII with a lateral sinus   9

7. Dorsal wall of bulga of spermatheca slightly concave, ventral
    wall strongly convex. Outline of sternum VII as figured   garei

    Bulga not shaped as above, sides subparallel   8

8. Approximately 30 lateral and marginal setae on ventral part
    of tergum VIII   celsus

    Not more than 20 such setae on ventral margin of tergum VIII   niger

9. Sternum VII with a distinct dorsal lobe, lateral sinus shallow
    with ventral lobe usually poorly developed; blind duct not
    sclerotized   diffinis

Sternum VII with lateral sinus short and deep; posterior dorsal
and ventral lobes well-developed. Blind duct strongly
sclerotized, at least in proximal portion   10

10. Posterior dorsal lobe of sternum VII acute, usually longer than
    ventral lobe. Lateral sinus deep. Small ventral sinus present
    between ventral lobes. Bulga thick-walled, hilla with papilla
                                                                idius

    Posterior dorsal lobe of sternum VII obtuse; ventral sinus
    lacking   11

11. Posterior ventral lobe of sternum VII short, the area bordering
    anterior margin of sinus sclerotized, posterior dorsal lobe
    long   scopulorum

    Posterior ventral lobe long, usually exceeding dorsal lobe in
    length; anterior margin of lateral sinus at best weakly
    sclerotized   riparius

Ceratophyllus arcuegens Holland, 1952
(Plate XV, A, B, C, D, E, F; Map 6)

Ceratophyllus arcuegens Holland, 1952. Canad. Ent., 84:297-308, figs.
    8-15.

Ceratophyllus arcuegens Holland, 1952, is reported for the first time in
Alaska. While many species of this genus are especially difficult to dis-
tinguish from one another, this particular species is easily recognized (in
Alaska) in both sexes by the lack of the "head" on the metapleural ridge. In
the male, the shape of the movable process and crochet are equally
characteristic.

This flea is likely to be found rather commonly in the nests of the cliff
swallow (Petrochelidon pyrrhonota), although only one specimen has been
recovered. We obtained large series of specimens of Ceratophyllus
scopulorum Holland, in the same series of nests but were not properly pre-
pared for collecting C. arcuegens. In his original description of this species
in 1952, Holland indicated that it was a crawler rather than a jumper. In
removing nests from the gables of old dwellings in Livengood, there were
literally hundreds of fleas that crawled into cracks and crevices of the old
boards, from whence we could not secure them. Judging from their move-
ments, I rather suspect that these were, for the most part, C. arcuegens.

Apparently this flea overwinters in the nests of the cliff swallows within
the pupal cocoon. Additional remarks concerning such a possibility will be

found under the discussions of <u>Ceratophyllus riparius</u> Jordan and Rothschild and <u>Ceratophyllus scopulorum</u> Holland.

No comments can be made upon the o· ⸱r-all distribution of this species because, except for the material included in the original description, this is the first time that it has been encountered. Intuitively, I believe that this flea is restricted to the cliff swallow in the northern part of the Nearctic region.

Records

Steese Hwy., M.P. 128, Central, Alaska
  <u>Petrochelidon pyrrhonota</u>
    10-VIII-61, 1M (C.E.H.)(N)

<u>Ceratophyllus riparius</u> Jordan and Rothschild, 1920
(Plate XV, G, H, I, J, K, L, M; Map 5)

<u>Ceratophyllus riparius</u> Jordan and Rothschild, 1920. Ectoparasites, 1:71-73, figs. 67-69. Stewart, 1928, Cornell Univ. Memoirs, 101:869. Jordan, 1929, Nov. Zool., 35:91. Stewart, 1933, Jour. N.Y. Ent. Soc., 61: 256. Wagner, 1936, Can. Ent., 68:201. Ioff, 1936, Zeit. Parasit., 9:73-124. Fox, 1940, Fleas East. U.S., p. 55, pl. XIII, figs. 66, 67. Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Publ. No. 500:71. Fuller, 1943, Bull. Brook. Ent. Soc., 38:20. Fuller, 1943, Jour. N.Y. Ent. Soc., 51:6. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Jellison, Kohls, and Mills, 1943, Misc. Publ. Mont. Bd. Ent., 2:3, 7. Hubbard, 1947, Fleas West. N. Amer., pp 251-252, fig. 135. Holland, 1949, Proc. Ent. Soc. Br. Columbia, 45:12. Holland, 1949, Siphonaptera of Canada, pp. 149-150, figs. 249, 259-260. Knipping, Morgan and Dicke, 1950, Wisc. Acad. Sci. Arts and Letters, 40:199-206. Holland, 1951, Canad. Ent., 83:281-289. Geary, 1953, Arctic Aeromed. Lab. Rept., 1:1-37. Burbutis, 1956, N.J. Agr. Exp. Sta. Bull. p. 782. Geary, 1959, Cornell Exp. Sta. Memoir 355, figs 119, 124. Benton and Shatrau, 1962, Can. Ent., 94:743-745, fig. I. Holland, 1963, Bishop Mus. Press, pp. 45-63.

<u>Ceratophyllus riparius</u> Jordan and Rothschild, 1920, was originally described from specimens taken out of the nests of the bank swallow (<u>Riparia riparia</u> Linnaeus) at Milwaukee, Wisconsin, and Rosslyn, Virginia. The characteristics used in the key for separating <u>Ceratophyllus riparius</u> from the rest of the Alaskan species of this genus have been remarkably consistent. The "ball-shaped" basal portion of the apical lobe of sternum IX in the male is unlike any other morphological feature in the remaining Alaskan species. The outline of the posterior margin of the seventh sternum in the female has been remarkably consistent and is sufficiently different from any of the others

bearing a lateral sinus that little or no confusion should result. There is one record in the National Museum that is somewhat disturbing, inasmuch as the five females were labelled Ceratophyllus petrochelidoni. I am reasonably confident that these females are C. riparius and have so indicated. The question that is difficult to resolve, in my mind, is the fact that they supposedly came from a cliff swallow nest. In the event that I should be proven wrong, this then will be the only record of Ceratophyllus petrochelidoni known in Alaska.

C. riparius is restricted almost entirely to the bank swallow, Riparia riparia, but it does not have nearly as wide a distribution as that reported for the host. Apparently, it is confined to the northern half of the United States, from the east coast to the west, and northward into Canada to the "tree line." My observations in Alaska indicate that it is essentially limited to the taiga, although, again, I have rather frail evidence of the bank swallow nests occurring in the tundra (Eskimoan Biotic Province). Ioff and Scalon (74) reported that it occurs in eastern Asia where, at that time, it was known only within the radius of eastern Transbaikalia. However, Holland (58) states that it is known from several localities in Europe and Asia, as well as from much of North America. Insofar as I know, these are the first reported records for C. riparius in Alaska.

Many of the bank swallow colonies are infested with C. riparius to the virtual exclusion of any other species. However, I have found C. celsus celsus Jordan making up a minor part of the population. I would not be surprised if eventually someone reports Ceratophyllus idius from the bank swallow nest, unless they are aware that other swallows sometimes live in the colony with them. For example, I have known two or three colonies in the Fairbanks environs that had five or six pairs of the violet-green swallow using burrows that apparently had been dug out by the bank swallow. The kingfisher will also utilize the same bank, and while I have not taken any fleas from burrows of this particular bird, I have had individuals in Alaska tell me that the burrow of the kingfisher was teeming with fleas.

Table VI shows the difference in the relative abundance of the two fleas, Ceratophyllus riparius Jordan and Rothschild and Ceratophyllus celsus Jordan, in the bank swallow burrows and nests within Alaska. Three of the 80 nests or burrows worked contained over a thousand specimens of fleas.

The habits of C. riparius adults are unlike those of any flea with which I have worked, since they apparently are positively phototropic. I have noticed on numerous occasions that the fleas are often found in large numbers near the entrance of the burrow, particularly late in the summer after the swallows have migrated southward. I paid little or no attention to this because the concentration of fleas seemed to increase as we approached the nest proper. However, on bringing these into the laboratory and placing the nests within the modified Berlese funnels, we had to tape the reflectors to the funnels in

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order to prevent the fleas escaping. If no light was used directly over the funnel while organizing the collecting bottles, etc., not nearly so great a problem was encountered, but with the light on, there was virtually a mass migration of these fleas up the side of the funnel. I cannot help but think that this bears on the large number of fleas sometimes encountered at the entrance of the burrow.

TABLE VI

FLEAS ASSOCIATED IN THE NESTS OF THE BANK SWALLOW, RIPARIA RIPARIA, IN CENTRAL ALASKA

(These Data Represent Random Burrow Samplings From Several
Different Colonies; Therefore, Chance Did Not Favor
Either Species Being Collected.)

Host	Total No. Fleas	No. Positive Specimens Collected	Average/Nest
Ceratophyllus c. celsus	37	07	5.3
Ceratophyllus riparius	13,940	80	174.2

The life history of this flea is not unlike that reported by Bates and Rothschild (3) for Ceratophyllus styx. C. riparius has but one generation a year in Alaska. The fleas that are produced during the breeding season usually remain within the pupal cocoon, unless there is some disturbance of the burrow system during the remaining warmer months of the year. We have sampled burrows throughout the winter season, and I have found that the extreme ambient temperature of the air is somewhat more drastic than that found within the burrows. The lowest temperature that I have recorded in the burrow system was a -35° F when the air temperature was a -55° F; this apparently had no adverse effect upon the flea. The nest samples secured at this time had to be retained two to three days at room temperature before the fleas became active. In April and May we were getting as large a number from the burrows before the arrival or return of the swallows as we did any time during the previous summer. C. riparius feeds upon the adult swallows when they return and also upon the nestling birds. However, this flea is almost entirely a burrow or nest flea. Having captured some 300 swallows in mist nets and placing them in polyethelene bags to which a "chloroform pad" was added, no fleas were recovered. All colonies and most burrows from which some of these swallows came were known to be infested.

There is apparently some difference in the behavior of Riparia riparia in Alaska from that recorded by Bates and Rothschild (3). These authors

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indicated that the bank swallow in England did not use the burrows from the previous year, except possibly for a cursory examination; their concept was that either the fleas jump from the entrance of the burrow onto the swallows as they hover in front of the bank or the fleas themselves migrate along the walls of the cliff into the new burrows. I cannot discuss the problem of migration in fleas from one burrow to another in Alaska, because I do not have sufficient data. We have some general information that leads me to believe that the migration is not nearly so considerable with C. riparius as with C. styx. We did deposit a large number of fleas at the base of a cliff. In watching them for several hours, we did not gain much of an impression one way or another so far as vertical migration was concerned. However, this is not too important in the ability of C. riparius to find a host in Alaska because the bank swallow does use the burrows over a period of several years.

I have records over a four-year period for one colony immediately adjacent to Fairbanks. Heinrich Springer and I have watched the swallows enter these burrows in the spring and have learned that they do some excavations in the old burrows before using them for nesting. New burrows will average approximately 2 1/2 feet in depth, whereas these older burrows are closer to 4 1/2 feet deep.

The soil throughout the Tanana Valley consists largely of windblown glacial sands, which are very fine and lack much by way of cohesiveness. During the "breakup" in the spring, much of this loess crumbles, and new burrows have to be established if the swallows are to continue using a particular site.

I am somewhat at a loss to explain how completely new colonies become infested with fleas, but I presume that additional studies will prove certain of my present concepts untenable. Probably when the swallows first arrive in the spring they may carry fleas with them from one burrow to another as they make a cursory inspection.

In an attempt to learn something of the behavior and survival ability of C. riparius, approximately 2,500 adults were placed in a large glass cylinder 24 inches high by 16 inches in diameter. The bottom was covered with 1/2 inch of sand and a tightly woven cloth secured at the top. These were retained in a cold room at a temperature of 45° F and a relative humidity of 70%. The fleas were placed in the cold room in September and, when brought out into a warmer temperature, were still found to be very active in March. At this time two young chickens, approximately 2 weeks old, were placed into the cylinder, and it was found that the fleas readily infested their bodies, several of them taking a blood meal. Indirect evidence indicates that the feeding period can last as long as 1 1/2 hours. Eggs were secured and some larvae obtained, although I was unable to carry them completely through the life cycle. On the basis of the evidence available, I am not at all certain as to

how many feedings the adult flea would require on the normal host. The bulk of those which obtained one fairly good blood meal from the chickens refused to feed again when placed on this host. I have retained C. riparius at 60° F for as long as 18 months with little or no mortality, as long as the relative humidity ranged between 70 and 80%.

Records

Chena Hot Springs Road, Alaska

  Riparia riparia
    2-VIII-61, 33M, 25F (J. H. E.)(N)
    2-VIII-61, 69M, 730F (J. H. E.)(N)
    12-V-62, 110M, 130F (C. E. H.)(N)

Chena Hot Springs Road, M. P. 8, Alaska

  Riparia riparia
    2-VIII-61, 468M, 647F (J.H. E.)(N)
    2-VIII-61, 322M, 535F (J.H. E.)(N)
    2-VIII-61, 5M, 2F (J. H. E.)(N)
    2-VIII-61, 231M, 334F (J.H. E.)(N)
    2-VIII-61, 252M, 210F (J.H. E.)(N)
    2-VIII-61, 46M, 101F (J. H. E.)(N)
    2-VIII-61, 96M, 115F (J. H. E.)(N)
    2-VIII-61, 1M, 1F (J. H. E.)(N)
    2-VIII-61, 562M, 518F (J. H. E.)(N)
    2-VIII-61, 114M, 216F (J.H. E.)(N)
    2-VIII-61, 1F (J. H. E.)(N)
    2-VIII-61, 59M, 75F (J. H. E.)(N)
    2-VIII-61, 12M, 31F (J. H. E.)(N)
    27-IX-61, 32M, 57F (C. E. H.)(N)
    27-IX-61, 489M, 468F (C. E. H.)(N)
    27-IX-61, 5M, 8F (C. E. H.)(N)
    27-IX-61, 109M, 273F (C. E. H.)(N)
    27-IX-61, 5M, 7F (C. E. H.)(N)
    27-IX-61, 32M, 57F (C. E. H.)(N)
    27-IX-61, 393M, 495F (C. E. H.)(N)
    27-IX-61, 4M, 8F (C. E. H.)(N)
    27-IX-61, 30M, 50F (W. T. V.)(N)
    27-IX-61, 32M, 24F (W. T. V.)(N)
    27-IX-61, 105M, 141F (W. T. V.)(N)
    27-IX-61, 23M, 32F (W. T. V.)(N)
    22-III-62, 152M, 196F (C. E. H.)(N)
    12-V-62, 1F (C. E. H.)(N)
    12-V-62, 45M, 74F (C. E. H.)(N)
    12-V-62, 2M, 6F (C. E. H.)(N)

12-V-62, 60M, 98F (C. E. H.)(N)
12-V-62, 30M, 27F (C. E. H.)(N)
18-VIII-62, 420M, 476F (J. H. E.) (N)
18-VIII-62, 16M, 15F (J. H. E.) (N)
18-VIII-62, 9M, 3F (J. H. E.)(B)
18-VIII-62, 484M, 630F (J. H. E.) (N)
26-X-62, 4M, 5F (H. S.)(N)

Circle Hot Springs, Alaska

  Microtus oeconomus
    11-VI-62, 1M 650F (C. E. H.)(A)

  Tamiasciurus hudsonicus
    10-VIII-61, 1M (C. E. H.)(N)
    14-IX-61, 2F (C. E. H.)(N)

Fairbanks, Alaska

  Riparia riparia
    28-IX-61, 1F (W. T. V.)(N)
    28-IX-61, 62M, 53F (W. T. V.) (N)
    28-IX-61, 34M, 53F (W. T. V.) (N)
    28-IX-61, 1M, 1F (W. T. V.)(N)
    28-IX-61, 2M, 1F (W. T. V.)(N)
    22-III-62, 14M, 26F (C. E. H.) (N)
    22-III-62, 15M, 11F (C. E. H.) (N)
    22-III-62, 89M, 133F (C. E. H.) (N)
    22-III-62, 2M, 4F (C. E. H.)(N)
    22-III-62, 8M, 18F (C. E. H.)(N)

Fairbanks environs, Alaska

    Riparia riparia
        28-IX-61, 8M, 8F (W. T. V.)(N)
        28-IX-61, 1M, 1F (W. T. V.)(N)
        28-IX-61, 1F (W. T. V.)(N)
        28-IX-61, 4M, 4F (W. T. V.)(N)

Fort Wainwright, Alaska

    Riparia riparia
        1-IX-61, 5M, 4F (C. E. H.)(N)
        29-IX-61, 1F (C. E. H.)(N)
        18-VIII-62, 23M, 27F (J. H. E.)(N)

Potter, Alaska

    Riparia riparia
        12-VI-56, 1M 1F (L. J. P.)(N)
        12-VI-61, 1M, 14F (L. J. P.)
                   USNM (B)

Rich. Hwy., Alaska, M. P. 178

    Riparia riparia
        18-VIII-61, 2F (C. E. H.)(N)
        18-VIII-61, 4F (C. E. H.)(N)

Rich. Hwy., Alaska, M. P. 320

    Riparia riparia
        17-VI-62, 5M, 14F (C. E. H.)(N)
        17-VI-62, 35M, 62F (C. E. H.)(N)
        17-VI-62, 11M, 20F (D. H.)(N)

Rich. Hwy., Alaska, M. P. 321

    Riparia riparia
        17-VI-62, 6F (H. S.)(N)

60 Mi. E. Tok, Alaska

    (slides labeled Ceratophyllus petrochelidoni) ex cliff swallow nest
      14-VII-48, 5F (R. I. Sailer) USNM

Steese Hwy., Alaska, M. P. 132. 5

    Riparia riparia
        10-VIII-61, 5M, 17F (C. E. H.)(N)
        10-VIII-61, 1M, 1F (C. E. H.)(N)
        10-VIII-61, 2M, 3F (C. E. H.)(N)
        10-VIII-61, 4F (C. E. H.)(N)
        10-VIII-61, 33M, 30F (C. E. H.)
                          (N)
        10-VIII-61, 3M, 21F (C. E. H.)(N)
        10-VIII-61, 45M, 44F (C. E. H.)
                          (N)
        10-VIII-61, 1M, 5F (C. E. H.)(N)
        10-VIII-61, 59M, 66F (C. E. H.)
                      ·   (N)
        10-VIII-61, 27M, 72F (C. E. H.)
                          (N)
        10-VIII-61, 14M, 12F (C. E. H.)
                          (N)

Steese Hwy., Alaska, M. P. 148

    Riparia riparia
        10-VIII-61, 18M, 10F (C. E. H.)
                          (N)

Steese Hwy., Alaska, M. P. 148. 5

    Riparia riparia
        10-VIII-61, 89M, 72F (C. E. H.)
                          (N)
        10-VIII-61, 89M, 106F(C. E. H.)
                          (N)
        13-IX-61, 2M, 10F (W. T. V.)(N)
        13-IX-61, 24M, 41F (W. T. V.)(N)
        13-IX-61, 3F (W. T. V.)(N)

3 Mi. N. Tetlin Junction, Alaska

    Riparia riparia
        6-VIII-61, 2M, 8F (H. S.)(N)

MAP 5

Distribution of Ceratophyllus riparius Jordan and Rothschild
and Ceratophyllus celsus celsus Jordan

Both species are associated with the bank swallow, Riparia riparia
(Linnaeus).

ALASKA
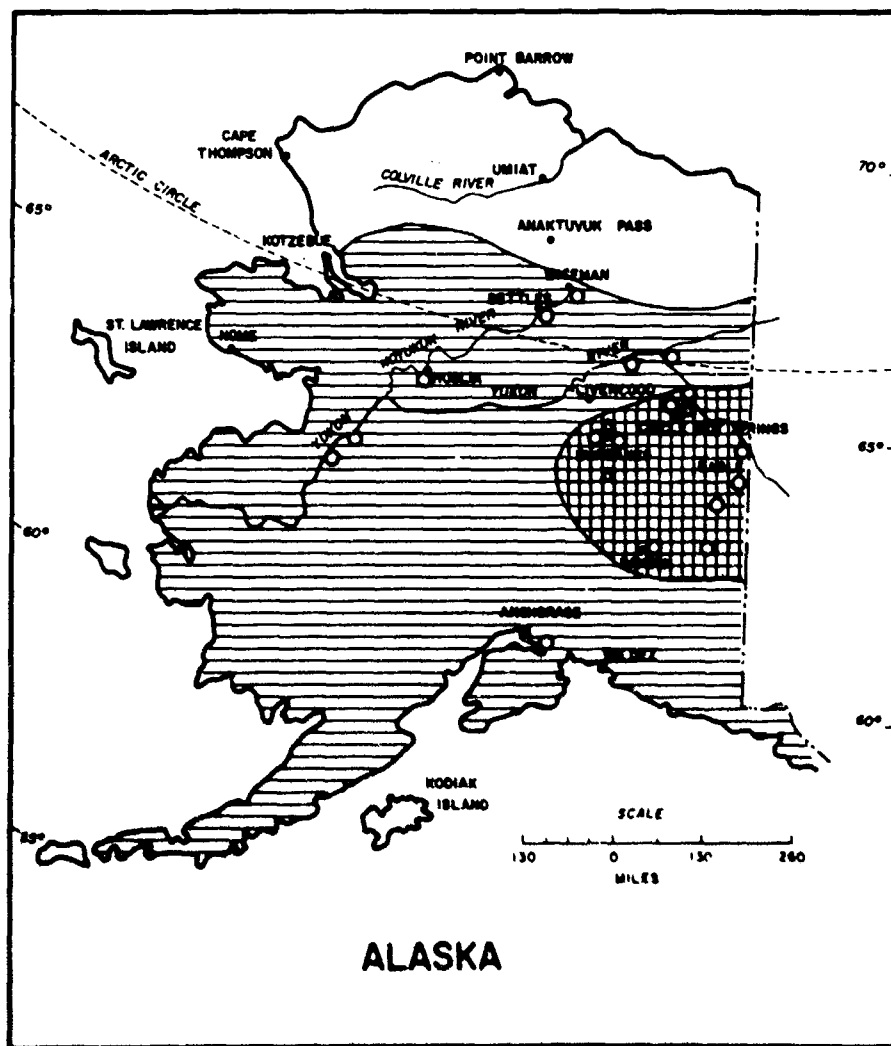
▤ ○ Ceratophyllus riparius Jordan & Rothschild.

Ⅲ △ Ceratophyllus celsus celsus Jordan.

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PLATE XV

Ceratophyllus arcuegens Holland, 1952

      Figure A: Clasper of male

      Figure B: Sternum IX of male

      Figure C: Sternum VIII of male

      Figure D: Crochet of male (aedeagous)

      Figure E: Sternum VII of female

      Figure F: Spermatheca

Ceratophyllus riparius Jordan and Rothschild, 1920

      Figure G: Clasper of male

      Figure H: Sternum IX of male

      Figure I: Sternum VIII of male

      Figure J: Crochet

      Figure K: Movable process illustrating variation

      Figure L: Sternum VII of female

      Figure M: Spermatheca
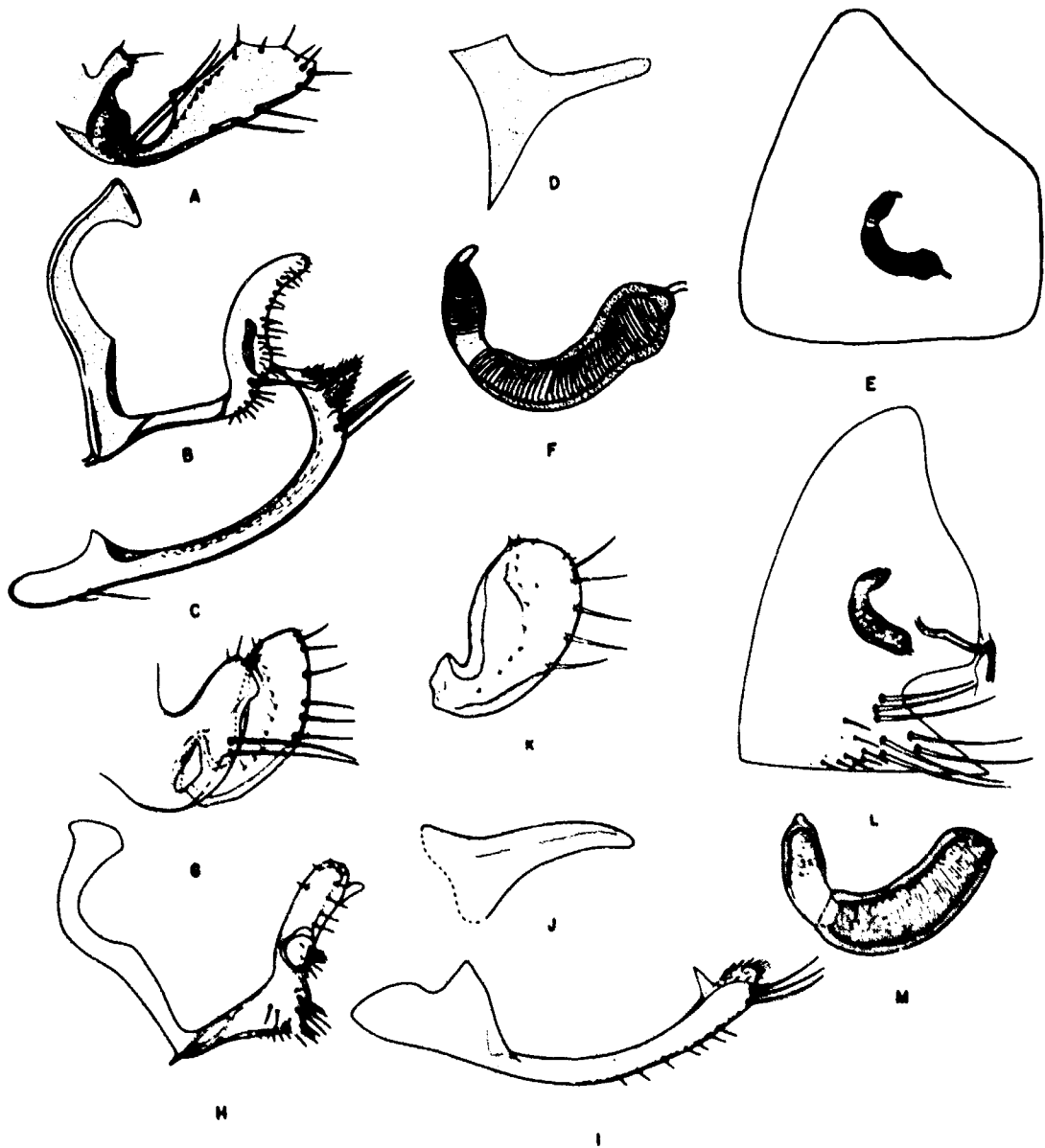
PLATE XV

FIGURE 7

Bank Swallow, _Riparia riparia_ (Linnaeus), Fairbanks
Environs

Some of these burrows have been used each breeding
season for 4 years; average depth of such a burrow
is 42 inches.

Ceratophyllus idius Jordan and Rothschild, 1920
(Plate XVI, A, B, C, D, E, F; Map 6)

Ceratophyllus idius Jordan and Rothschild, 1920. Ectoparasites, 1:73-76,
figs. 70-72. Jordan, 1928, Nov. Zool., 34:183. Jordan, 1929, Nov.
Zool., 35:89-92. Jordan, 1937, Nov. Zool., 40:285. Fox, 1940, Fleas
East. U.S., pp. 51-52, pl. I: pl. XII, figs. 60, 61. Hubbard, 1940,
Pac. Univ. Bull., 37(4):1-4. Ewing and Fox 1943, U.S.Dept. Agr.
Misc. Publ. No. 500:70. Fuller, 1943, Jour. New York Ent. Soc.,
51:6. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Hubbard, 1947,
Fleas West. N. Amer., p. 252, fig. Holland, 1949, Proc. Ent.
Soc. Br. Col., 45:11. Holland, 1949, Siphonaptera Canada, p. 148,
figs. 252-253. Holland, 1951, Canad. Ent., 83:281-289. Holland, 1955,
Trans. Roy. Ent. Soc. London, 107:233-248. Burbutis, 1956, New
Jersey Agr. Exp. Sta. Bull. 782. ᴊmit, 1958, Proc. U.S. Nat'l. Mus.,
108:No. 3394:51-57. Geary, 1959, Cornell Exper. Sta. Memoir 355,
figs. 2, 166, 177, 123. Benton and Shatrau, 1962, Can. Ent., 94-743-
745. Holland, 1963, Bishop Mus. Press, 45-63.

Ceratophyllus idius Jordan and Rothschild, 1920, is a flea usually asso-
ciated with the tree swallow (Iridoprocne bicolor). The following record,
which is the first time C. idius has been recorded for Alaska (insofar as I
know), is from the violet-green swallow, Tachycineta thalassina lepida.
The violet-green swallow is relatively abundant in Alaska, and I consider it
to have habits similar to those of the purple martin further to the south.
Many of the old prospectors have a birdhouse erected on a long pole in a
clearing, in which violet-green swallows nest.

The record listed from Fairbanks is without question a valid one and
does not allow for a chance that the nesting site previously might have been
used by the tree swallow. This can be stated affirmatively because the bird-
house was erected that summer and was used only by this breeding pair of
swallows. When the nest was first secured, no adult fleas were seen, but
an examination of some of the fine nesting material indicated the presence
of a good number of flea larvae. The nest material was retained in the bag
for an additional 3-week period and then run through the Berlese funnel,
resulting in the recovery of 76 specimens.

I regard the record of the one male from Microtus oeconomus to be a
very accidental sort of thing. While I believe the female of C. idius is
reasonably distinctive among Alaskan members of the genus, I am open to
some criticism for classifying the one female from the nest of Riparia
riparia as such, with no male flea being represented.

Records

Circle Hot Springs, Alaska

Microtus oeconomus, 11-VI-62, 1M (C. E. H.)

Fairbanks, Alaska

Tachycineta thalassina lepida, 9-VII-61, 26M, 50F (C. E. H.)(N)

Rich. Hwy., M.P. 321, Alaska

Riparia riparia, 17-VI-62, 1F (C. E. H.)(N)

Ceratophyllus scopulorum Holland, 1952
(Plate XVI, G, H, I, J, K, L; Map 6)

Ceratophyllus scopulorum Holland, 1952. Canad. Ent., 84:297-308, figs.
1-7. Benton and Shatrau, 1962, Can. Ent., 94:743-745.

Ceratophyllus scopulorum Holland, 1952, is probably as abundant as any other flea in the nests of the cliff swallow, Petrochelidon pyrrhonota. As with C. riparius, this flea overwinters in the nest of its host. Specimens secured late in the summer after the swallows have departed are extremely teneral, and it is my concept that if the nests had not been disturbed, these fleas would have remained within the pupal cocoons. I soon learned that it was better to retain the bagged nests in the laboratory for some weeks to allow a hardening of the exoskeleton before attempting to prepare slides for study purposes.

The two records listed from Riparia riparia could well be contaminations from the Berlese funnels that were used to secure the specimens. As stated in the section dealing with the collection of fleas, we cleaned the funnels meticulously after each use, but it is entirely possible that a flea could have been overlooked and not removed from the funnel despite our washing and brushing. I consider the cliff swallow to be the true host for this flea, as it is no doubt for Ceratophyllus arcuegens Holland. In a personal communication with G. P. Holland, he indicated that according to his Canadian records, C. arcuegens usually occurred with more abundance in the nest of the cliff swallow than did C. scopulorum. Our records to date would indicate the reverse situation to be true.

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MAP 6

Distribution of <u>Ceratophyllus</u> <u>arcuegens</u> Holland, <u>Ceratophyllus</u>
<u>garei</u> Rothschild, <u>Ceratophyllus</u> <u>idius</u> Jordan and Rothschild,
<u>Ceratophyllus</u> <u>scopulorum</u> Holland, <u>Ceratophyllus</u> <u>lunatus</u>
<u>tundrensis</u> Holland

(Due to the lack of extensive records for any one species,
the probable distributions are not shaded.)
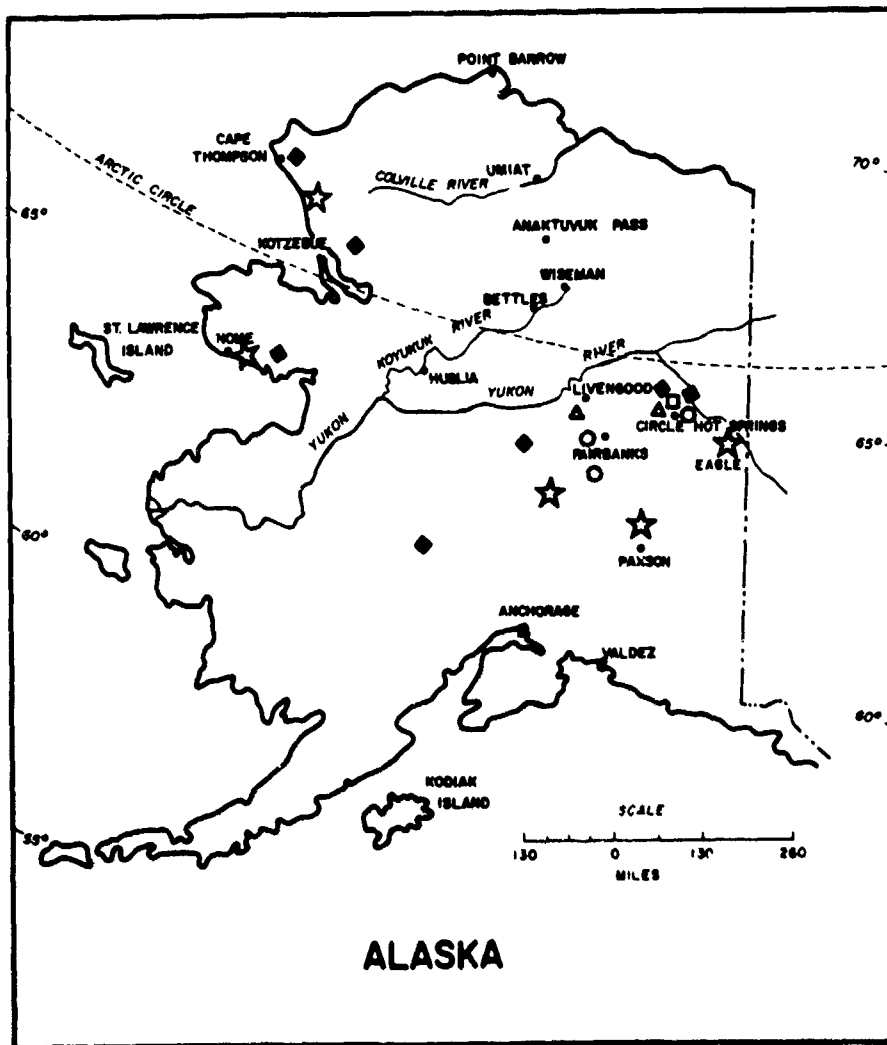
ALASKA

☐   <u>Ceratophyllus</u> <u>arcuegens</u> Holland.

■   <u>Ceratophyllus</u> <u>garei</u> Rothschild.

○   <u>Ceratophyllus</u> <u>idius</u> Jordan & Rothschild.

△   <u>Ceratophyllus</u> <u>scopulorum</u> Holland.

☆   <u>Ceratophyllus</u> <u>lunatus</u> <u>tundrensis</u> Holland.

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PLATE XVI

Ceratophyllus idius Jordan and Rothschild, 1920

      Figure A: Clasper of male

      Figure B: Sternum IX of male

      Figure C: Sternum VIII of male

      Figure D: Crochet

      Figure E: Sternum VII of female

      Figure F: Spermatheca

Ceratophyllus scopulorum Holland, 1952

      Figure G: Clasper of male

      Figure H: Sternum IX of male

      Figure I: Sternum VIII of male

      Figure J: Crochet

      Figure K: Sternum VII of female

      Figure L: Spermatheca

PLATE XVI
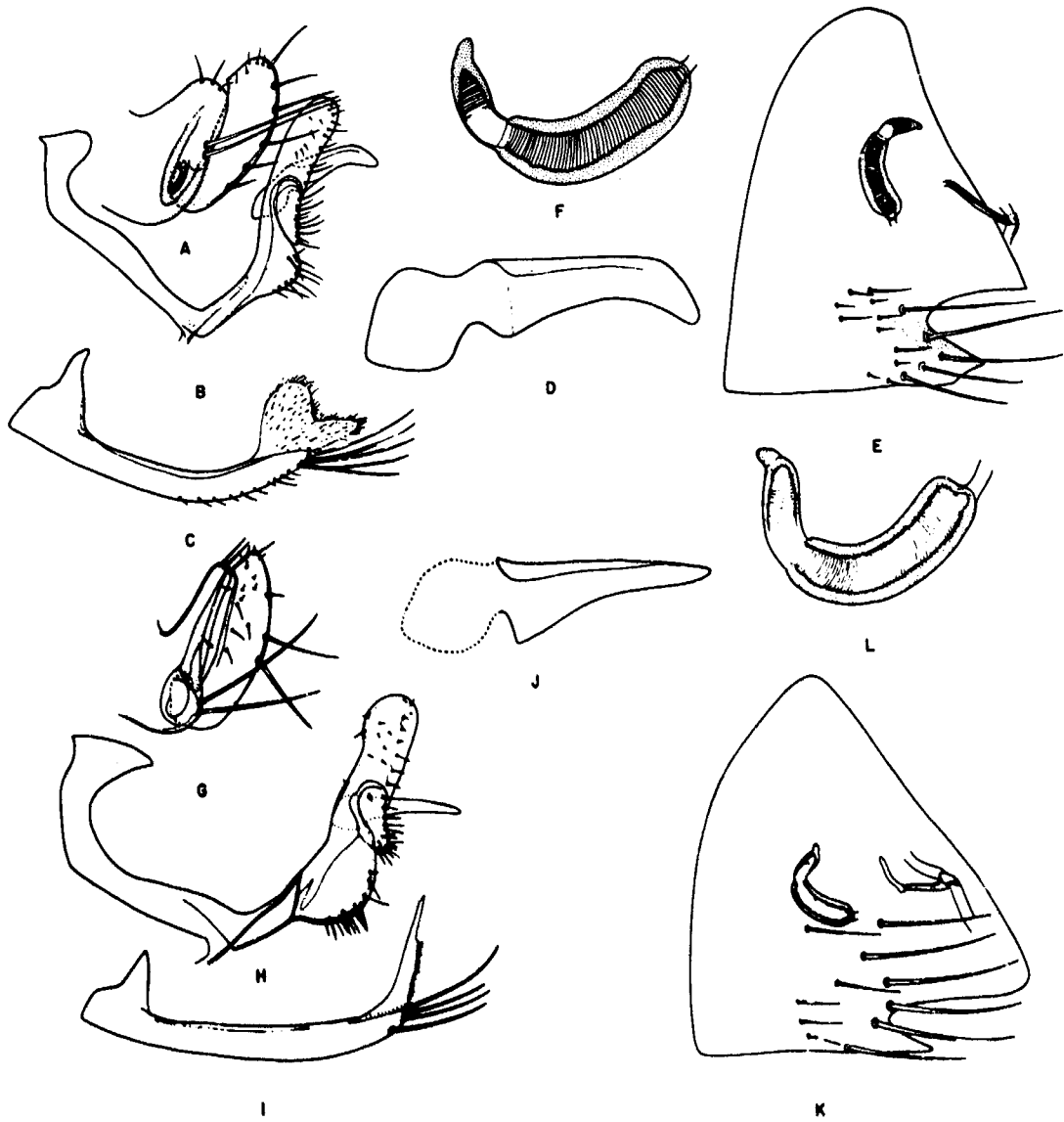
This is a new flea record for Alaska.

Elliott Hwy., M. P. 70 (Livengood), Alaska

Petrochelidon pyrrhonota, 26-VII-61, 12M, 12F (C. E. H.)(N)
26-VII-61, 4M, 23F (C. E. H.)(N)
26-VII-61, 5M, 5F (C. E. H.)(N)
26-VII-61, 3M, 1F (C. E. H.)(N)
26-VII-61, 2M, 7F (C. E. H.)(N)
26-VII-61, 4M, 5F (C. E. H.)(N)
26-VII-61, 7M, 19F (C. E. H.)(N)

Rich. Hwy., M. P. 321, Alaska

Riparia riparia, 17-VI-62, 1M (C. E. H.)(N)

Steese Hwy., Alaska, M. P. 128, Central environs

Petrochelidon pyrrhonota, 10-VIII-61, 7M, 9F (C. E. H.)(N)
10-VIII-61, 1M (C. E. H.)(N)

Steese Hwy., Alaska, M. P. 148. 5

Riparia riparia, 13-IX-61, 1M, 1F (W. T. V.)(N)

Ceratophyllus celsus celsus Jordan, 1926
(Plate XVII, A, B, C, D, E, F; Map 5)

Ceratophyllus celsus Jordan, 1926. Nov. Zool., 33:387-388, text fig 4.
Jordan, 1929, Nov. Zool., 35:89-92. Fox, 1940, pp 49-50, Pl. XII,
figs. 56, 57. Fuller, 1943, Jour. N. Y. Ent. Soc., 51:5. Hubbard,
1943, Pac. Univ. Bull., 39:1-12. Baerg, 1944, The Auk, 61:414.
Burbutus, 1956, N. J. Agr. Exp. Sta. Bull., 782.

Ceratophyllus celsus celsus Jordan, 1933. Nov. Zool., 39:75. Holland,
1941, Proc. Ent. Soc. British Columbia, 37:12. Ewing and Fox, 1943,
p. 68. Jellison, Kohls, and Mills, 1943, pp. 3, 7. Hubbard, p. 250,
with figs. Holland, 1949, Proc. Ent. Soc. British Columbia, 45:11.
Holland, 1949, Siphonaptera of Canada, p. 147, with figs. Rapp and
Gates, 1957, Jour. Kansas Ent. Soc., 30:50-53. Geary, 1959, Cornell
Exp. Sta. Mem., 355, figs. 118, 122. Stark, 1959, Siphonaptera of
Utah, p. 197, with fig. 124, a, b.

Ceratophyllus celsus celsus Jordan, 1933, was originally described
from Colymbus grisegena (now Podiceps) taken at Okanagan Falls, British
Columbia. The true host for this flea is Riparia riparia, although recently
some material has been taken from the nests of the cliff swallow (Petro-
chelidon) in Utah. Unlike C. riparius, this species apparently is confined

to the Nearctic region; it is not listed by Ioff and Scalon (74) in their comprehensive treatment of the fleas of eastern Siberia.

I have some records for Alaska, but to my knowledge no records have previously been published. Holland (58) lists it as being present in Alaska but cites neither localities nor hosts. As the collection records indicate, this flea is not nearly so common in Alaska as C. riparius.

Records

Fairbanks Environs, Alaska

Riparia riparia, 28-IX-61, 1F (W.T.V.)(N)
28-IX-61, 7M, 3F (W.T.V.)(N)
28-IX-61, 1M (W.T.V.)(N)

Rich. Hwy., M.P. 320, Alaska

Riparia riparia, 17-VI-62, 1M, 1F (C.E.H.)(N)
17-VI-62, 10M, 17F (C.E.H.)(N)

Steese Hwy., M.P. 132.5, Alaska

Riparia riparia, 10-VIII-61, 2M, 2F (C.E.H.)(N)
10-VIII-61, 2M (C.E.H.)(N)

PLATE XVII

Ceratophyllus c. celsus Jordan, 1926.

      Figure A: Clasper of male

      Figure B: Sternum IX of male

      Figure C: Sternum VIII of male

      Figure D: Sternum VII of female

      Figure E: Spermatheca

      Figure F: Crochet

Ceratophyllus garei Rothschild, 1902

      Figure G: Clasper of male

      Figure H: Sternum IX of male

      Figure I: Sternum VIII of male

      Figure J: Crochet

      Figure K: Spermatheca

      Figure L: Sternum VII of female

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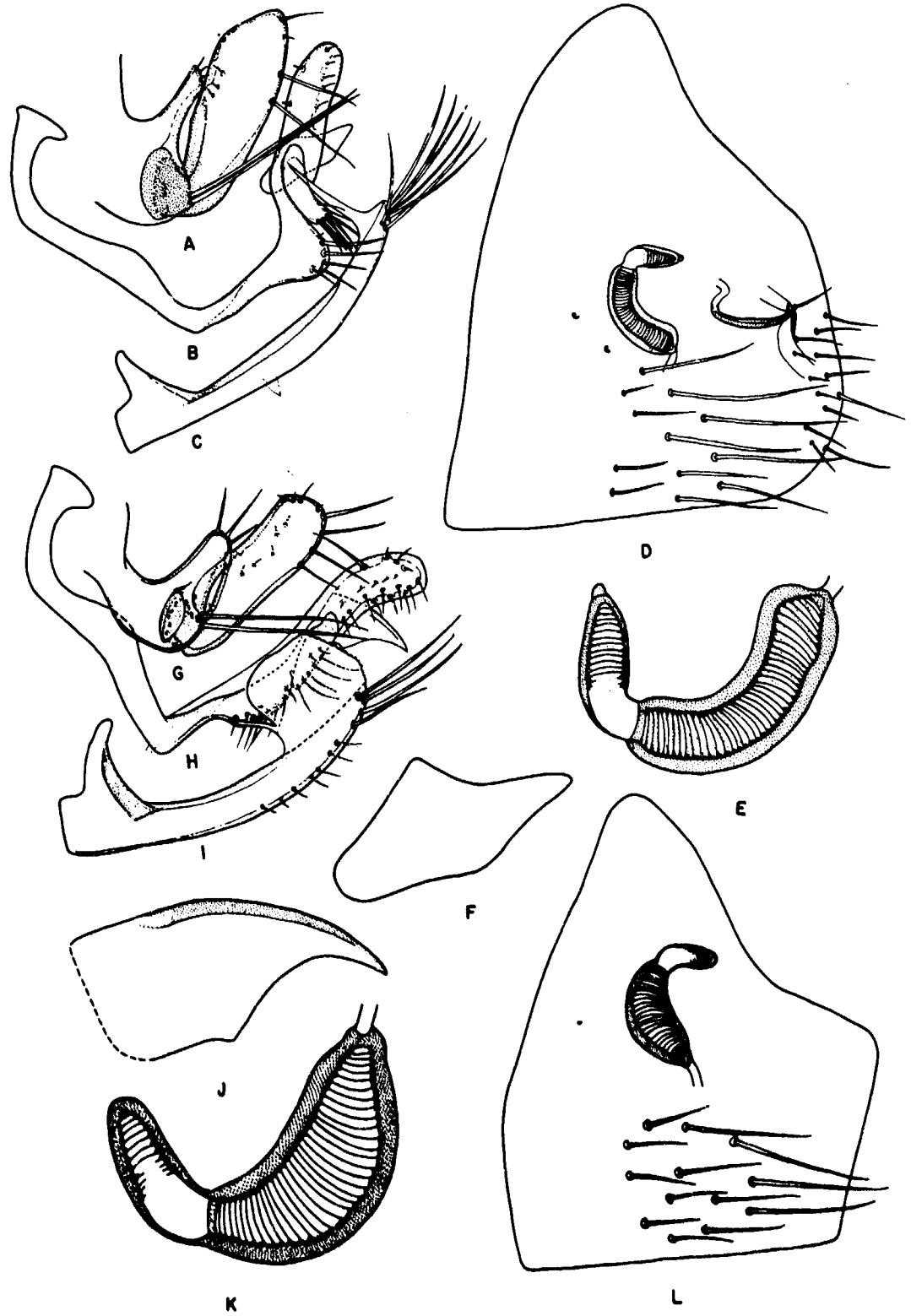
PLATE XVII

Ceratophyllus garei Rothschild, 1902
(Plate XVII, G, H, I, J, K, L; Map 6)

Ceratophyllus garei Rothschild, 1902. Ent. Mo. Mag., 2nd Series, 13:255, figs. 1-3. Jordan and Rothschild, 1920, Ectoparasites, 1:69. Jordan, 1929, Nov. Zool., 35:89-92. Philip, 1938, Jour. Parasit., 24:486. Ioff, 1936, Zeit. f. Parasiten., 9:73-124. Jellison and Kohls, 1939, Publ. Health Rept., 54:2021. Mail and Holland, 1939, Proc. Sixth Pac. Sci. Cong., 5:127. Ewing and Fox, 1943, U. S. Dept. Agr. Misc. Publ. No. 500:69, fig. 7E. Hubbard, 1943, Pac. Univ. Bull., 39:1-2. Jellison, Kohls, and Mills, 1943, Misc. Publ. Mont. Bd. Ent., 2:3, 7. McClure, 1943. Brown, 1944, Ann. Ent. Soc. Amer., 37:208. Hubbard, 1947, Fleas West. N. Amer., p. 253, fig. 137. Rothschild (Miriam), 1948, Entomologist, 81:84-94. Holland, 1949, Proc. Ent. Soc. Br. Col., 45:11. Holland, 1949, Siphonaptera Canada, p. 148, figs. 250-251. Hubbard, 1949, Bull. South. Calif. Acad. Sci., 48:126. Knipping, Morgan, and Dicke, 1950, Wisc. Acad. Sci. Arts and Letters, 40:199-206. Holland, 1951, Canad. Ent., 83:281-289. Cross and Knowlton, 1953, Bull. Brooklyn Ent. Soc., June 1953, p. 73. Rothschild, 1955, Trans. Roy. Ent. Soc. London, 107:195-317. Smit, 1958, Proc. U. S. Nat. Mus., 108:No. 3394. Stark, 1958, Siphonaptera of Utah, p. 197, fig. 123. Hubbard, 1960, Ent. News, 71:245-247. Holland, 1963, Bishop Mus. Press, pp. 45-63

Ceratophyllus utahensis Chapin, 1919. Bull. Brook. Ent. Soc., 14:60-62.

Ceratophyllus quebecensis Fox. Fox, 1940, Proc. Ent. Soc. Wash,, 42:65-66, figs. 3, 4. Ewing and Fox, 1943, U. S. Dept. Agr. Misc. Publ. No. 500:71.

Ceratophyllus garei Rothschild, 1902, is a widely distributed Holarctic bird flea that is associated with ground nesting birds, particularly in damp places. There are numerous records from aquatic and shore birds, as well as the ground-nesting passerine forms.

Ioff and Scalon (74) indicate that this flea is occasionally found on such rodents as the susliks, squirrels and field mice, as well as in their nests. While I have only a few records from Alaska, they are from widely distributed localities. No special effort was made to collect them; however, I feel certain that an enormous number of them could have been obtained in the duck breeding areas of Minto Flats. The one record from man is interesting in that it was a biting record, and the individual complained of the severity of the bite for some days afterward. The individual concerned had been banding Zonotrichia leucophrys, (the white-crowned sparrow) and one of the fleas apparently transferred to him. This flea did not hesitate in attempting to secure a blood meal. While this is only an isolated incident, it probably gives some clue as to the reason for the broad host range of this particular species and has no doubt contributed to its wide distribution in the northern hemisphere.

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C. garei males can be readily separated from all other members of the genus known to occur in Alaska by the shape of the apical membranous lobe of sternum VIII. No other Alaskan flea has this type of modification on this sternite.

Records

Cape Thompson, Alaska

    Passerculus sandwichensis
      20-VII-61, 1F (C.T.H.)KCE

Circle Hot Springs, Alaska

    Clethrionomys rutilus
      10-VIII-61, 1M (C.E.H.)

Golovin, Alaska

    Chestnut-collared longspur
      20-V-31, 1F (E.C.Cushing)

Minto Lakes, Alaska

    Homo sapiens
      24-VIII-61, 1F (W.T.V.)

Minto Lakes, Alaska, (cont'd)

    Passerculus sandwichensis
      10-VIII-61, 1M (W.T.V.)

    Zonotrichia leucophrus
      15-VIII-61, 1F (W.T.V.)

Noatak River, Alaska

    Passerella iliaca
      7-VII-61, 1F KCE

Steese Hwy., M.P. 126, Alaska

    Lepus americanus
      16-VI-62, 1F (J.L.C.)

Ceratophyllus diffinis Jordan, 1925
(Plate XVIII, A, B, C, D, E, F.)

Ceratophyllus diffinis Jordan, 1925. Nov. Zool., 32:111-112, fig. 44. Jordan, 1928, Nov. Zool., 34:182, fig. 7. Jordan, 1929, Nov. Zool., 35:89-92. Jordan, 1937, Nov. Zool., 40:263. Fox, 1940, Fleas of East. U.S., pp. 50-51, pl. XII, figs. 58, 59. Ewing and Fox, U.S. Dept. Agr. Misc. Publ., No. 500:68. Fuller, 1943, Jour. New York Ent. Soc., 51:5. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Hubbard, 1947, Fleas of West. N. Amer., pp. 253-254, fig. 138. Holland, 1949, Proc. Ent. Soc. Br. Col., 45:11. Holland, 1949, Siphonaptera of Canada, p. 147, figs. 248-249. Holland, 1951, Canad. Ent., 83:281-289. Brown, 1955, Canad. Ent., 87:362-365. Burbutis, 1956, N.J. Agr. Exp. Sta. Bull., 782. Geary, 1959, Cornell Exp. Sta. Mem., 355, figs. 120, 125. Benton and Shatrau, 1962, Can. Ent., 94:743-745. Holland, 1963, Bishop Mus. Press, pp. 45-63.

PLATE XVIII

Ceratophyllus diffinis Jordan, 1925

    Figure A: Clasper of male

    Figure B: Sternum IX of male

    Figure C: Sternum VIII of male

    Figure D: Crochet

    Figure E: Sternum VII of female

    Figure F: Spermatheca

Ceratophyllus balati Rosicky, 1955

   Figure G: Clasper of male

    Figure H: Sternum IX of male

    Figure I: Sternum VIII of male

    Figure J: Crochet

    Figure K: Sternum VII of female

    Figure L: Spermatheca

PLATE XVIII

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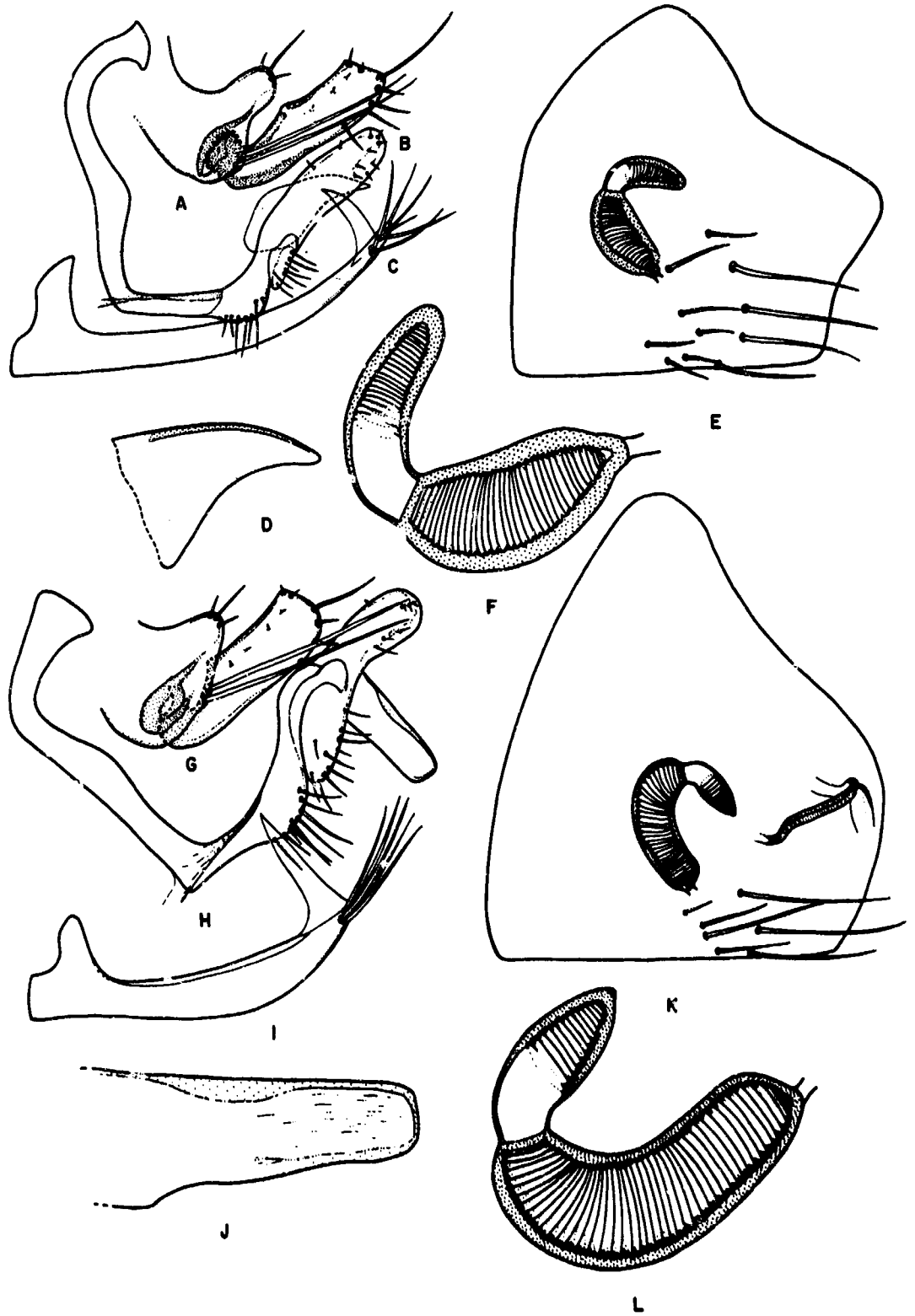
Ceratophyllus rilevi Liu, 1935. Ann. Ent. Soc. Amer., 28:123-124.

Ceratophyllus diffinis Jordan, 1925, is reported to be closely related to the previous species, C. garei. However, it is strictly a Nearctic form, though rather widely distributed in this area, being associated with drier types of nest habitats. It is found on a wide variety of birds belonging to the orders Galiformes and Passeriformes.

I have no records for Alaska, and none are known in the literature. Holland lists it in his paper dealing with the fleas of Alaska but cites neither locality nor host records.

<div align="center">

Ceratophyllus balati Rosicky, 1955
(Plate XVIII, G, H, I, J, K, L.)

</div>

Ceratophyllus balati Rosicky, 1955. Die Aphanipterofauna der Hohen Tatra mit Anmerkungen über die Höhenverteilung der Flöhe in diesem Gebirge (in Czech with German summary). Zool. Ent. Listy, 4:365-383, 8 figs. Holland, 1960, Canad. Ent., 92:787-793. Holland, 1963, Bishop Mus. Press, pp. 45-63.

Ceratophyllus balati Rosicky, 1955, was described from the High Tatara Mountains in Czechoslovakia and has since been found in the Swiss Alps. There are records from Mile 84, Haines Highway, Yukon Territory, Canada, and from a water pipi's nest taken at Anaktuvuk Pass, Alaska.

The male of this species is separable from all other known species of the genus by the large, truncate crochet. The female is not easily separable from C. gallinae, but the setal pattern on the dorsal margin of tergum VIII holds well in the specimens which I have studied.

<div align="center">

Ceratophyllus gallinae (Schrank, 1803)
(Plate XIX, A, B, C, D, E, F.)

</div>

Pulex gallinae Schrank, 1803. Fauna Boica 3:195.

Pulex avium Taschenberg, 1880. Die Flöhe, p. 70-73. Baker, 1895, Can. Ent., 27:108-111. Osborn, 1896, U.S. Dept. Agr., Div. Ent. Bull., 5(n.s.), p. 147. Rothschild, 1900, Nov. Zool., 7:539.

Ceratophyllus gallinae (Schrank). Wagner, 1898, Horae Soc. Ent. Ross., 31:559. Rothschild, 1900, Nov. Zool., 7:540-541, figs. 1, 2, 6, 10, 13, 17, 19. Baker, 1904, Proc. U.S. Nat'l Mus., 27:442-443. Baker, 1905, Proc. U.S. Nat'l Mus., 29:129, 148. Harvey, 1907, Bull. Brit. Col. Ent. Soc., No. 7. Jordan and Rothschild, 1920, Ectoparasites, 1:70. Ewing, 1924, Parasit., 16:342-343, 344. Stewart, 1927, Jour. Ec. Ent., 20:132-134. Britton, 1928, Jour. Econ. Ent. 21:437. Jordan,

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<u>Ceratophyllus</u> <u>gallinae</u> (Schrank). (cont'd)

> 1928, Nov. Zool., 34:182. Jordan, 1929, Nov. Zool., 35:89-92, 171. Ewing, 1929, Man. Ext. Par., p. 158, 171-172. Stewart, 1933, Jour. N.Y. Ent. Soc., 41:255. Ioff, 1936, Zeit. f. Parasiten., 9:73-124. Fox, Fleas East. U.S., pp. 52-54, pl. XIII, figs. 62,·63. Ewing and Fox, 1943, p. 69. Fuller, 1943, Jour. New York Ent. Soc., 51:5. Miller, 1946, Pest Control and Sanitation, Home and Garden, p. 8. Holland, 1949, Siphonaptera of Canada, pp. 147-148, figs. 248-249. Holland, 1949, Proc. Ent. Soc. Br. Col., 45:13. Knipping, Morgan, and Dicke, Wisc. Acad. Sci., Arts and Letters, 40:199-206. Holland, 1951, Canad. Ent., 83:281-289. Smit, 1953, Entomologische Berichte, 14:393-400. Sturm, 1953, Jour. N.Y. Ent. Soc., 61:139-140. Layne, 1954, Ecol. Mono., 24:227-267. Shaw and Hovey, 1954, Jour. Econ. Ent., 47:942-943. Burbutis and Hansen, 1955, J.N.Y. Ent. Soc., 63: 103-106. Burbutis, 1956, N.J. Exp. Sta. Bull., 782. Bolam and Burtt, 1956, Brit. Med. J., 1:1130-1133. Smit, 1958, Proc. U.S. Nat'l Mus., 108:1958 (No. 3394). Geary, 1959, Ann. Rev. Ent., 4: 389-414. Benton and Cerwonka, 1960, Am. Mid. Nat., 63:383-391. Smit, 1960, Ent. Soc. Wash., 62:262-284. Benton and Shatrau, 1962, Can. Ent., 94:743-745. Hopkins and Rothschild, 1962, Parasit., 52: 113-132. Holland, 1963, Bishop Mus. Press, pp. 45-63.

<u>Ceratophyllus</u> <u>gibsoni</u> Fox. Fox, 1914, Hyg. Lab. Bull., 97:15, fig. 4-5.

<u>Ceratophyllus</u> <u>gallinae</u> (Schrank, 1803) is a widely distributed species in the Old World, where several subspecies are recognized. It is reported to be a natural parasite of passerine birds and is also a pest of the domestic fowls in Europe. It is well distributed in eastern and central North America, where it generally is supposed to have been introduced in recent times from Europe. Holland recently obtained specimens from western Alaska but states that the records are too meager to appraise their subspecific status. I have no records to report.

<u>Ceratophyllus</u> <u>niger</u> <u>niger</u> C. Fox, 1908
(Plate XIX, G, H, I, J, K, L)

<u>Ceratophyllus</u> <u>niger</u> Fox, 1908. Ent. News, 19:434-435. Fox, 1909, Ent. News, 20:11. Mitzmain, 1909, Can. Ent., 41:200. Fox,1914, Hyg. Lab. Bull., No. 97. 24, 25. Jordan and Rothschild, 1920, Ecto-parasites, 1:70-71. Ewing, 1924, Parasit., 16:341, 343, 344. Fox, 1925, Ins. and Dis. of Man., p. 141. Hirst, 1926, Cylon Jour. Sci., 1:261. Stewart, 1928, Cornell University Memoir, 101:869. Ewing, 1929, Man. Ext. Par., p. 172. Jordan, 1929, Nov. Zool., 35:89-92. Stewart, 1933, Jour. N.Y. Ent. Soc., 41:254. Wagner, 1936, Can. Ent., 68:200-201. Philip, 1938, Jour. Parasit., 24:486. Jellison and Kohls, 1939, Pub. Health Rep., 54:2021. Mail and Holland, 1939,

Ceratophyllus niger Fox, 1908. (con'td)

     Proc. Sixth Pac. Sci. Cong. 5:125. Fox, Fleas, East. U.S., pp. 54-55. Hubbard, 1940, Pac. Univ. Bull., 37(4). Svihla, 1941, Univ. Wash. Pub. Biol., 12(2):13. Augustson, 1941, Bull South. Calif. Acad. Sci., 40(3):150. Ewing and Fox, 1943, p. 70. Jellison, Kohls, and Mills, 1943, Misc. Publ. Mont. Bd. Ent., 2:3, 7. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Brown, 1944, Ann. Ent. Soc. Amer., 37:208. Hubbard, 1947, Fleas of West. N. Amer., pp. 248-250, fig. 131. Holland, Proc. Ent. Soc. Br. Col., 45:11. Holland, 1949, Siphonaptera of Canada, p. 149, figs. 243, 254-255. Holland, 1951, Canad. Ent., 83:281-289. Hopkins and Rothschild, 1953, Cata. Rothschild Coll., 1:27, fig. 13. Bigeland, 1955, Can. Jour. Comp. Med. Vet. Sci., 19, p. 90. Holland, 1955, Trans. Roy. Ent. Soc. London, 107:233-248. Wiseman, Univ. Wyo. Publ., 19: 28pp. Eads, 1956, Jour. Parasit., 42:73-75. Murray, 1957, Am. Jour. Trop. Med. and Hyg., 6:1068-1086. Smit, 1958, Proc. U.S. Nat. Mus., 108, No. 3394, figs. 3 and 4. Stark, 1958, Siphonaptera of Utah, p. 199, fig. 122. Holland, 1963, Bishop Mus. Press, pp. 45-63.

Ceratophyllus abantis Rothschild. Mitmain, 1908, Ent. News, 19:382.

Pulex avium Taschenberg, 1880. Ewing, 1913, Oreg. Agr. Coll. Bull., 92,   Ext. Ser. 2, No. 5, p. 14.

     Ceratophyllus niger C. Fox, 1908, is represented by one or two records in Alaska according to Holland (58). While related to C. gallinae, it apparently is limited in distribution to the western Nearctic. It is reported on a variety of land and sea birds, including gulls and cormorants.

     The following records are taken from Jellison and Kohls (79): Herring gull (Larus argentatus), Skillak Lake, June 25, 1937, 54 males, 87 females, collected and reared from three nests.

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Ceratophyllus vagabundus vagabundus (Boheman, 1866)
(Plate XX, A, B, C, D, E, F)

</center>

Pulex vagabunda Boheman, 1866. Ofvers. of K. Vet. Akad. Forh., 22:567.   Baker, 1904, Proc. U.S. Nat'l Mus., 27:468.

Ceratophyllus vagabundus (Boheman). Baker, 1905, Proc. U.S. Nat'l. Mus.,   29:152. Jordan, 1932, Fauna Arctica, 6:17. Philip, 1938, Jour. Parasit., 24:486. Ioff, 1936, Zeit. f. Parasiten., 9:73-124. Philip, 1938, Jour. Parasit., 24:486. Jellison and Kohls, 1939, Pub. Health Repts., 54:2021. Ewing and Fox, 1943, p. 71. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Hubbard, 1947, p. 255. Holland, 1951, Canad. Ent., 83:281-289, figs. 3-4. Smit, 1957, Roy. Ent. Soc. Lond., 1(16): 78. Holland, 1963, Bishop Mus. Press, pp. 45-63.

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Ceratophyllus vagabundus vagabundus (Boheman, 1866), is a circumpolar species widely distributed in northern Europe and Asia, including Spitzbergen. In North America it occurs in Alaska and the northern portion of Canada, frequently in truly arctic terrain, and mostly on gulls (Laridae). Jellison and Kohls (79) reported it from the fledglings and nest of the golden eagle (Aquila chrysaetos) taken at Bear Creek, near Rapids, July 15, 1937.

Ceratophyllus tundrensis Holland, 1944
(Plate XX, G, H, I, J, K, L, M, N, O; Map 6)

Ceratophyllus tundrensis Holland, 1944. Canad. Ent., 76:242-243, pl. XVII, figs. 1, 2, 3. Hubbard, 1947, Fleas of West. N. Amer., p. 254-258, fig. Holland, 1949, Siphonaptera of Canada, p. 150, figs. 261, 262. Hubbard, 1960, Ent. News, 71:245-247.

Ceratophyllus lunatus tundrensis Holland, 1951. Canad. Ent., 83:281-289. Geary, 1953, Aeromed. Lab. Rep., 37 pp. Holland, 1956 (1958), Proc. Tenth Internat. Cong. Ent., 1:645-658. Holland, 1963, Bishop Mus. Press, pp. 45-63.

Ceratophyllus lunatus tendrensis Holland, 1944, is a Holarctic species, apparently confined to the mustelids. This is the only species of its genus that is not known to consistently parasitize birds. Holland is of the feeling that this species is limited to only the Arctic region in the New World, but the records listed from Paxson, American Creek and Healy do not warrant this conclusion.

C. lunatus tundrensis is a striking ceratophyllid with no close relatives and should not be confused with other known species. More records of this species are sorely needed before the true extent of its distribution pattern can be properly interpreted. On the basis of the records now available, it is confined to the boreal region of North America.

Records

American Creek, Eagle environs, Alaska

Mustela erminea, -XI-61, 4M, 3F (M.M.)

Ferry, Alaska

Mustela erminea, 20-X-63, 1F (H.S.)

Paxson Lake, Alaska

Mustela erminea, 5-IV-60, 1F (L.L.H.)

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PLATE XIX

<u>Ceratophyllus</u> <u>gallinae</u> (Schrank, 1803)

    Figure A: Clasper of male

    Figure B: Sternum IX of male

    Figure C: Sternum VIII of male

    Figure D: Crochet

    Figure E: Sternum VII of female

    Figure F: Spermatheca

<u>Ceratophyllus</u> <u>niger</u> <u>niger</u> Fox, 1908

    Figure G: Clasper of male

    Figure H: Sternum IX of male

    Figure I: Sternum VIII of male

    Figure J: Crochet

    Figure K: Sternum VII of female

    Figure L: Spermatheca

PLATE XIX

PLATE XX

Ceratophyllus v. vagabundus (Boheman, 1866)

    Figure A: Clasper of male

    Figure B: Sternum IX of male

    Figure C: Sternum VIII of male

    Figure D: Crochet

    Figure E: Sternum VII of female

    Figure F: Spermatheca

Ceratophyllus lunatus tundrensis Holland, 1944

    Figure G: Clasper of male (scale drawing)
    Figure H: Sternum IX of male

    Figure I: Sternum VIII of male

    Figure J: Spiracle, third abdominal segment

    Figure K: Clasper of male (enlarged drawing)

    Figure L: Crochet of male

    Figure M: Sternum VII of female

    Figure N: Spermatheca, normal

    Figure O: Spermatheca, abnormal

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PLATE XX
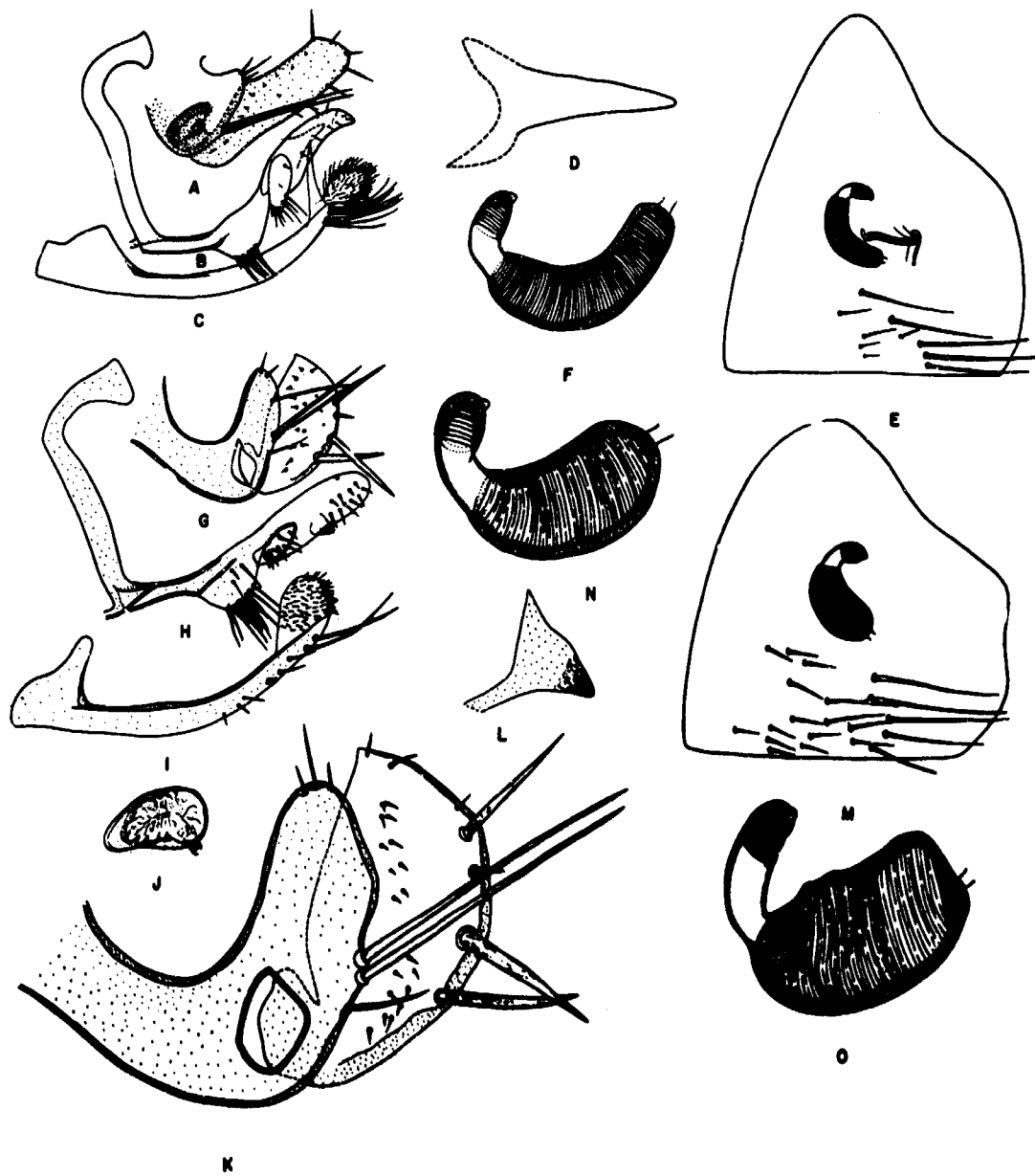
XIV

Family CERATOPHYLLIDAE, Genera DASYPSYLLUS, MIOCTENOPSYLLA, MALARAEUS, and MEGABOTHRIS

DASYPSYLLUS Baker, 1905

Dasypsyllus Baker, 1905. U.S. Nat. Mus. Proc., 29:129, 146

Pre- and postantennal regions with three rows of setae. Pronotal ctenidium of 40 or more spines. Eye large and well-pigmented. A number of small setae on outer surface of fore femur. Six pairs of plantar bristles on all tarsi V, third pair shifted mesally and replaced by dense setae on lateral margin. Sixth pair (apical) shifted mesally between fifth pair.

This Holarctic genus is widely distributed; while primarily a parasite of birds, the records indicate that it is indeed promiscuous in feeding habits, having been reported from burrowing rodents.

Key to the Alaskan species of Dasypsyllus

Males

   Apicodorsal margin of MP forming almost a right angle, posterior
   margin irregular. Sternum VIII vestigial   gallinulae perpinnatus

   Apex of MP narrow and rounded; sternum VIII not vestigial   stejnegeri

Females

   Posterior dorsal lobe of sternum VII broad and square, sinus deep
   and "V" shaped, lower lobe long and blunt   gallinulae perpinnatus

   Posterior dorsal lobe of sternum VII acuminate, sinus small,
   lower lobe large and broadly rounded   stejnegeri

Dasypsyllus stejnegeri (Jordan, 1929)
(Plate XXI, A, B, C, D, E, F')

Ceratophyllus stejnegeri Jordan, 1929. Nov. Zool., 35:26-27, figs 22, 23.

Dasypsyllus stejnegeri (Jordan). Holland, 1949, Proc. Ent. Soc. Br. Colum.
45:12. Holland, 1949, Siphonaptera of Canada, p. 150, footnote.
Holland, 1951, Can. Ent., 83:281-289, with figs. Holland, 1963,
Bishop Mus. Press, pp. 45-63.

Dasypsyllus stejnegeri (Jordan, 1929) is a flea of land birds, particularly sparrows and thrushes. Originally it was believed to be restricted to the coasts of eastern North America and eastern Siberia. Holland (58) indicates that it is now known from the Bering Islands, Siberia (opposite Kamchatka) and from St. Paul Island in the Pribilof group, as well as along the coastal areas of Alaska, and in 1949, Holland reported specimens from Queen Charlotte Islands. Recently, Smit (133) has recorded this flea from the Falkland Islands on thrushes. The erratic distribution is difficult to comprehend, but Smit indicates that Dasypsyllus is chiefly of South American origin, and it may well be that the northern populations of D. stejnegeri constitute stragglers from migrating bird populations. Considerable information remains to be obtained in the future before we can fully appreciate the host relationships and distribution of this particular species.

The specimens of D. stejnegeri in the National Museum were obtained in 1882 during an expedition in the Commander Islands, but were not described by Jordan until 1929.

Records

Bering Island, Alaska

Host unknown, 1892-93, 1M, 1F (S. Stejneger) USNM

Dasypsyllus gallinulae perpinnatus (Baker, 1904)
(Plate XXI, G, H, I, J, K)

Ceratophyllus perpinnatus Baker, 1904. Proc. U.S. Natl. Mus., 27:386, 391-392, 445, figs. 1-6.

Dasypsyllus perpinnatus (Baker). Baker, 1905, Proc. U.S. Natl. Mus., 29: 129, 146. Fox, 1914, Hyg. Lab. Bull. No. 97:24, 25. Wagner, 1927, Konowia, 6:106, footnote = Ceratophyllus gallinulae (Dale).

Ceratophyllus gallinulae (Dale). Jordan and Rothschild, 1920, Ectoparasites, 1:69.

Ceratophyllus gallinulae perpinnatus Baker. Jordan, 1926, Nov. Zool., 33: 386. Jordan, 1929, Nov. Zool., 35:89-92.

Dasypsyllus gallinulae perpinnatus (Baker). Wagner, 1936, Can. Ent., 68: 201. Hubbard, 1940, Pac. Univ. Bull., 37(4). Svihla, 1941, Univ. Wash. Publ. Biol., 12(2):13. Ewing and Fox, U.S. Dept. Agr. Misc. Publ., 500:30, fig. 5D. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Hubbard, 1947, Fleas West. N. Amer., pp. 258-260, fig. 144. Holland, 1949, Siphonaptera of Canada, pp. 150-151, figs. 263-266. Traub, 1950, Fieldianan, Zool. Me., 1:104, fig. Holland, 1951, Can. Ent.,

PLATE XXI

Dasypsyllus gallinulae perpinnatus (Baker, 1904)

    Figure A: Clasper of male

    Figure B: Sternum IX of male

    Figure C: Sternum VIII of male

    Figure D: Sternum VII of female

    Figure E: Spermatheca

    Figure F: Segment V of hind tarsus

Dasypsyllus stejnegeri (Jordan, 1929)

    Figure G: Clasper of male

    Figure H: Sternum IX of male

    Figure I: Sternum XIII of male

    Figure J: Sternum VII of female

    Figure K: Spermatheca

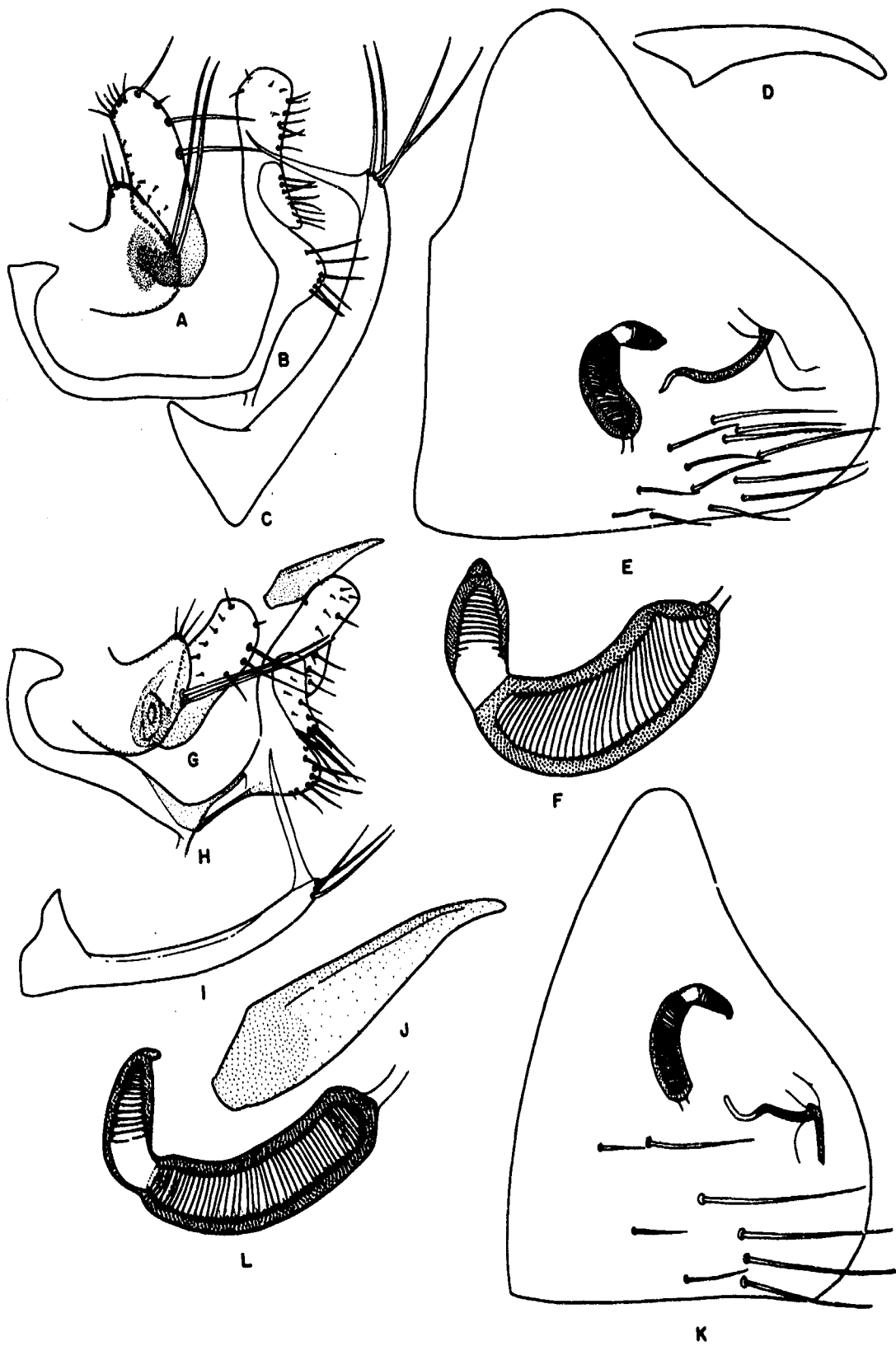# PLATE XXI
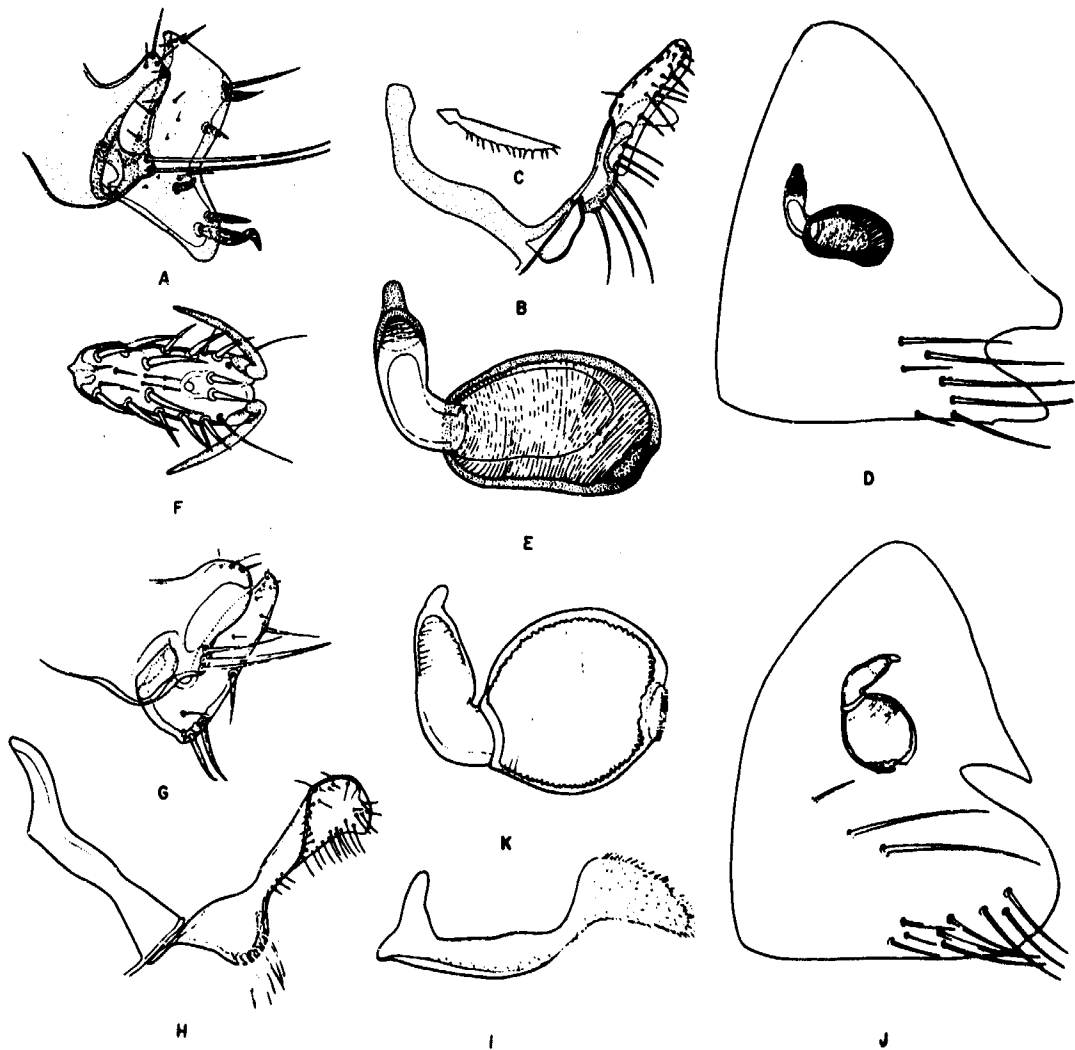
Dasypsyllus gallinulae perpinnatus (Baker). (cont'd)

83:281-289. Holdenried, Evans, and Longanecker, 1951, Ecol. Mono., 21:1-18. Murray, 1957, Am. J. Trop. Med. and Hyg., 6:1068-1086. Smit, 1957, Roy. Ent. Soc. Lond., 1(16):61. Holland, 1963, Bishop Mus. Press, pp. 45-63.

Dasypsyllus gallinulae perpinnatus (Baker, 1904) is a relatively common bird flea occurring in the nests of numerous Passeriformes. Thus far, the only known records are from southern Alaska through British Columbia and south into the western United States. The nominate subspecies is reported to be common in western Europe but has scattered records from the Himalayas, the Philippine Islands and Malaya, as well as some records in eastern Russia.

The records known from the northern regions are relatively sporadic, and recent information with regard to this species by Traub (personal communication) indicates that sufficient knowledge is still not available to properly interpret its distribution.

I have no records to report for Alaska, nor am I aware of any bona fide ones existing in the literature.

MIOCTENOPSYLLA Rothschild, 1922

Mioctenopsylla Rothschild, 1922. Rept. Norwegian Exp. Nov. Zemlya, 1921, No. 4.

Genal ctenidium absent; pronotal ctenidium present and consisting of approximately 34 spines, which are extremely short and pale. Frontal tubercle small. Eyes large and well-pigmented. Preantennal region with two rows, and a third incomplete row, of bristles. Abdominal terga with denticulate dorsal margins; abdominal sterna with numerous minute punctations. Meso- and metacoxa narrow.

This is a Holarctic genus, but little is known of its host associations or distributions. It is anticipated that future studies will result in a considerable amount of information concerning the members of this genus.

Key to the Alaskan Species of Mioctenopsylla

Males

1. FP short, expanded apically, thumb-like apex of MP conical   traubi

2. FP proportionately longer, only slightly expanded. Apex of MP relatively flat   arctica hadweni

<u>Females</u>

1. Posterior margin of seventh sternum with round dorsal lobe, sinus deep "C" shaped, ventral lobe acuminate. Hilla of spermatheca at best weakly papillate   <u>arctica</u> <u>hadweni</u>

2. Posterior margin of Sternum VII relatively straight, not sinuate; usually no apparent dorsal or ventral lobe. Hilla with a well-developed papilla   <u>traubi</u>

<div align="center">

<u>Mioctenopsylla</u> <u>arctica</u> <u>hadweni</u> (Ewing, 1927)
(Plate XXII, A, B, C, D, E)

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<u>Amphipsylla</u> <u>hadweni</u> Ewing, 1929. Proc. Biol. Soc. Wash., 40:89-90.

<u>Boreopsyllus</u> <u>hadweni</u> (Ewing). Ewing, 1929, Man. Ext. Parasit., pp. 201-202.

<u>Mioctenopsylla</u> <u>arctica</u> Rothschild. Jordan, 1932, Fauna Arctica, 6:118. Jellison and Kohls, 1939, Pub. Health Rept., 54:2022. Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Publ., No. 500:44, fig. 5B. Hubbard, Pac. Univ. Bull., 39:1-12. Hubbard, 1947, Fleas West. N. Amer., pp. 194-196, fig. 97.

<u>Mioctenopsylla</u> <u>arctica</u> <u>hadweni</u> (Ewing). Holland and Jellison, 1952. Can. Ent., 84:374-379. Holland, 1963, Bishop Mus. Press, pp. 45-63.

    <u>Mioctenopsylla</u> <u>arctica</u> <u>hadweni</u> (Ewing, 1927) has had a brief but rather chaotic history taxonomically. The genus <u>Mioctenopsylla</u> was originally established by Rothschild in 1922 to accommodate an unusual flea collected from the nest of the kittiwake, <u>Rissa</u> <u>tridactyla</u>, during the Norwegian expedition to Novaya Zemlya in 1921. The species was named <u>Mioctenopsylla</u> <u>artica</u>. Later, Ewing obtained some specimens that were collected in Alaska and described them as <u>Amphipsylla</u> <u>hadweni</u>; later he erected a new genus, <u>Boreopsyllus</u>, and placed it there. Jordan later synonymized this flea with <u>Mioctenopsylla</u> <u>arctica</u> (1932), and this concept was followed until Holland and Jellison (60) re-evaluated the genus. On the basis of a large series of specimens obtained from the nests of kittiwakes on St. Paul Island of the Pribilof group, they reinstated <u>hadweni</u> to the status of a subspecies. Insofar as I know, no additional collections have been reported since the last paper by Holland and Jellison (60) in 1952. I have no new records to report.

<u>Records</u>

Puffin Island, Kotzebue Sound, Alaska

<u>Xama sabini</u>, 6-VIII-20, 1F (H. Hadwen) USNM

St. Paul Island, Alaska

Kittiwake Nest, 24-VIII-51, 4M, 4F (W. L. J.) USNM

PLATE XXII

<u>Mioctenopsylla arctica hadweni</u> (Ewing, 1927)

Figure A: Clasper of male

Figure B: Sternum IX of male

Figure C: Sternum VIII of male

Figure D: Sternum VII

Figure E: Spermatheca

<u>Mioctenopsylla traubi</u> Holland and Jellison, 1952

Figure F: Clasper of male

Figure G: Sternum IX of male.

Figure H: Sternum VIII of male

Figure I: Sternum VII of female

Figure J: Spermatheca

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PLATE XXII

Mioctenopsylla traubi Holland and Jellison, 1952
(Plate XXII, F, G, H, I, J)

Mioctenopsylla traubi Holland and Jellison, 1952. Can. Ent., 84:374-379, figs. 3, 4F, G, 5, 6-9. Holland, 1963, Bishop Mus. Press, pp 45-63.

Mioctenopsylla traubi Holland and Jellison, 1952, like the former species is restricted to the nests of kittiwakes. However, information is relatively meager concerning this particular species, and it seems likely that other shore and/or aquatic birds in the area might well be infested with this flea. With the new interest in the migratory studies of birds, it is hoped that ornithologists and other workers associated with such studies will make a serious effort to obtain fleas from the birds in the Bering Sea Islands and along the coast of Alaska. Such records would be extremely valuable in helping to understand the distribution and host associations of *Mioctenopsylla* spp.

MALAREUS Jordan, 1933

Malareus Jordan, 1933. Nov. Zool., 39:76.

Eye distinctly reduced, its longest diameter shorter than the distance from eye to apex of angle of the strongly chitinized portion of the genal lobe. Occiput, with two to four medium bristles. Pedicle of antenna with short bristles in male, reaching beyond middle of clava, usually shorter in female. Tergum VIII with light traces of spiculose area in the mesal surface of the dorsal margin. Sternum VIII reduced or long and narrow, bearing a long apical bristle and a fringed membranous apical lobe. Anal stylet of female without dorsolateral bristles. Bulga of spermatheca broad, more or less barrel-shaped, usually slightly concave ventrally. Hilla not projecting into bulga.

This is a Holarctic genus, with approximately equal representation in number of species on both sides of the Bering Sea.

Malareus and the succeeding two genera, *Monopsyllus* Kolenati and *Megabothris* Jordan, have been the subject of considerable controversy. Holland (45, p. 151-153) presents an excellent review of the problem. It is particularly difficult to separate all species of *Malareus* from *Monopsyllus*, since one has to rely almost entirely upon the eye character. It is quite separable from *Megabothris* by the fact that spiracular fossa of tergum VIII is much enlarged in that genus, whereas in *Monopsyllus* the spiracular fossa is of "normal" size.

Several species are represented further south in the Nearctic region; however, at the present time only one is known in Alaska, and it has a broad distribution.

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<center>Malaraeus penicilliger dissimilis (Jordan, 1938)</center>
<center>(Plate XXIII, A, B, C, D, E, F, G, H; Map 7)</center>

Malareus penicilliger dissimilis Jordan, 1938. Nov. Zool., 41:119-120, figs. 65, 66a, b. Jellison and Kohls, 1939, Pub. Health Rept., 54:2022. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Holland, 1944, Can. Ent., 76:246, Pl. XVIII, fig. 10. Hubbard, 1947, Fleas West. N. Amer., pp. 204-206, fig. 102. Holland, 1949, Siphonaptera of Canada, pp. 154-155, figs. 273-275, 277. Holland, 1949, Proc. Ent. Soc. Br. Columbia 45:12 (subsp., probably dissimilis Jordan). Holland, 1952, Can. Ent., 84:303-304, figs. 18, 19. Geary, 1953, Aeromed. Lab. Rept., 37 pp. Holland, 1956 (1958), Proc. Tenth Internat. Cong. Ent., 1:645-658. Hubbard, 1960, Ent. News, 71:245-247.

Malaraeus penicilliger Grube. Mail and Holland, 1939, Proc. Sixth Pac. Sci. Cong., 5:126. Hubbard, 1943, Pac. Univ. Bull., 39:1-12.

Trichopsylla (Trichopsylla) penicilliger dissimilis (Jordan). Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Publ., No. 500:63.

Ceratophyllus penicilliger (Grube). Snodgrass, 1946, Smithsonian Misc. Coll., 104:55.

Amalaraeus penicilliger dissimilis (Jordan). Holland, 1963, Bishop Mus. Press, pp. 45-63.

Malaraeus penicilliger dissimilis (Jordan, 1938) is the flea most commonly encountered when working with microtine rodents in Alaska. The species is widely distributed in Eurasia, known from England to Lapland and thence eastward to eastern Siberia and Japan. It has been divided into several subspecies in Eurasia, and two are known in the Nearctic region. M. p. dissimilis was described from material collected by William L. Jellison, taken from Clethrionomys and Microtus at Fairbanks, in July, 1937. Holland (58) considers the distribution of this flea to be concordant with the red-backed vole, Clethrionomys rutilus Pallas. M. p. dissimilis has also been recorded from Kamchatka, leaving little question that it originally stemmed from Eurasia. The other subspecies known to occur is Malaraeus penicilliger athabascae Holland, which occupies the northern fringes of another red-backed vole, Clethrionomys gapperi (Vigors) in Canada, its range extending southward into the Rockies as far as Banff, Canada. As illustrated in Map 7, I have indicated that this particular flea occurs throughout Alaska except for the southeastern part. I have no direct information to indicate that it is not present in the southeastern part, but judging from the remainder of the flea fauna and the ecology of that area, I think it would be unlikely that this flea is there.

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PLATE XXIII

Malaraeus penicilliger dissimilis (Jordan, 1938)

Figure A: Clasper of male

Figure B: Sternum IX of male

Figure C: Sternum VIII of male

Figure D: Crochet

Figure E: Sternum VII of female

Figure F: Spermatheca

Figure G: Variation of female sternum VII. All specimens are from a collection from St. Lawrence Island

Figure H: Sternum variation of sternum VII from same specimens

PLATE XXIII

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Map 7

Distribution of <u>Malaraeus</u> <u>penicilliger</u> <u>dissimilis</u> (Jordan)

    This species is one of the most widely dispersed fleas within Alaska; it is associated with several microtine rodents.

ALASKA

▤ ○   <u>Malaraeus penicilliger dissimilis</u> (Jordan).
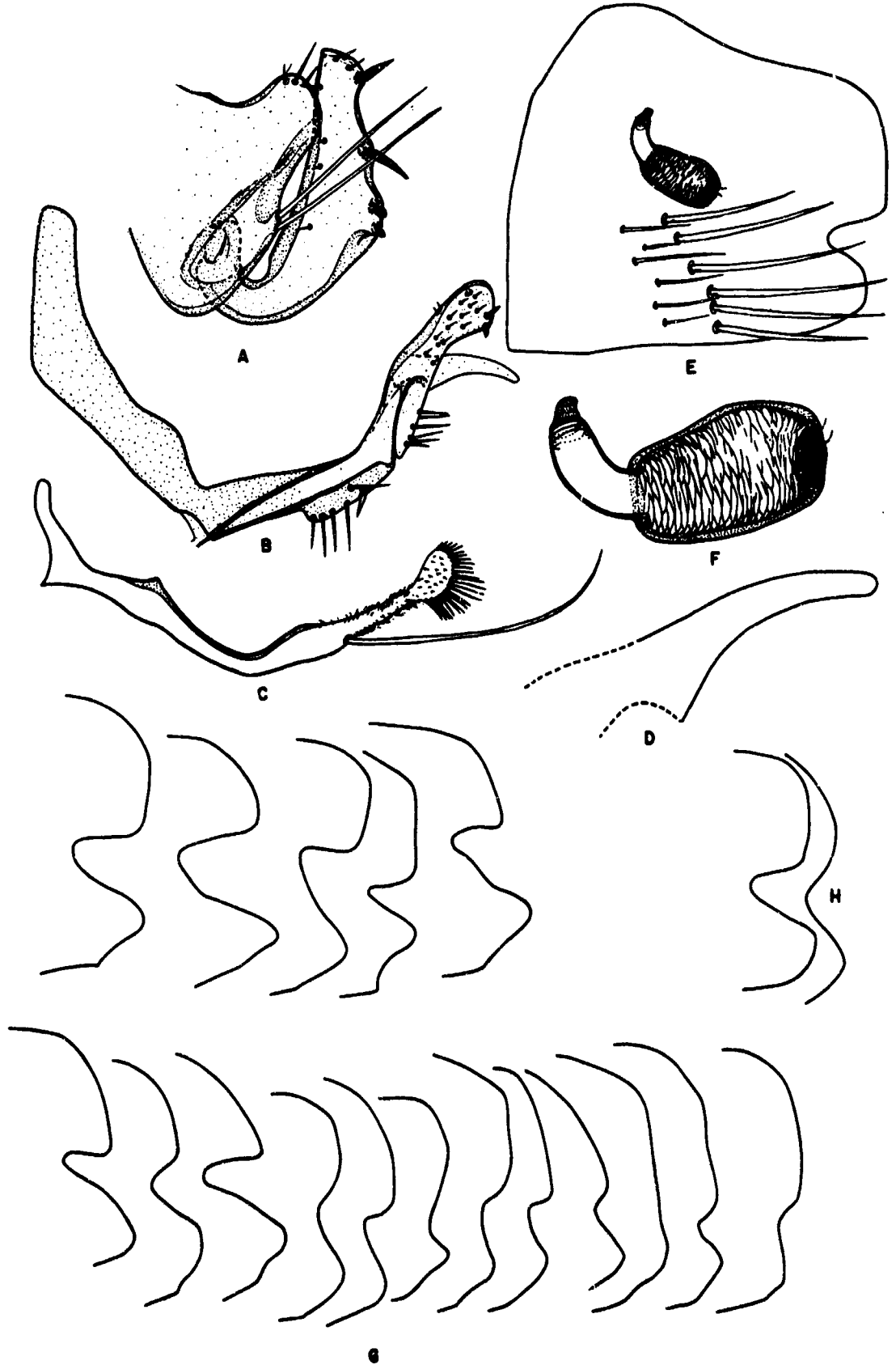
I know of no other flea in the interior of Alaska that retains as stable a population throughout the year as does M. p. dissimilis. By February, and particularly late in the winter (April), it is about the only flea that I have encountered on the microtine rodents in the Fairbanks area. During May, at breakup time, this is the only flea that I have secured from either the nests or the host animals. At this time of the year the rodent population is extremely low, and it is with considerable effort that one gets a reasonably good number of samples. I have encountered far more negative flea records on the host at this time of the year than at any other time. One is grateful for whatever ectoparasites are encountered!

TABLE VII

Host Associations of
Malaraeus penicilliger dissimilis (Jordan)

Host	Total No. Fleas	No. Positive Specimens Collected	Average/Host
Castor canadensis	01	01	
Clethrionomys rutilus	162	75	2.2
Lepus americanus	02	01	
Martes americana	14	01	
Microtus oeconomus	125	59	2.1
Rattus norvegicus	01	01	
Tamiasciurus hudsonicus	03	02	
Vulpes fulva	01	01	

I believe that M. p. dissimilis is as dependent upon Microtus oeconomus as it is upon the red-backed vole, Clethrionomys rutilus. Clethrionomys rutilus is in reality a taiga microtine, and while it does extend into the northern tundra regions, it is not nearly so conspicuous a member of the rodent population. On the Arctic slope (north of the Brooks Range), I have very seldom encountered Clethrionomys. There, Microtus is far more abundant, although I have taken Malaraeus at Umiat and some distance on down the Colville River. On St. Lawrence Island, my records indicate association with Microtus oeconomus only. Holland (58) reported that it was associated with Lemmus sibiricus on Nunivak Island.

The posterior margin of sternum VII in the female is variable, as figured. It can be anywhere from complete (without a sinus) to fully indented with a ventral sinus. It is fortunate that other closely related forms do not occur in Alaska.

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Records

Allakaket, Alaska

  Clethrionomys rutilus
    5-VIII-55, 2F (C. E. H.)

  Microtus oeconomus
    9-VIII-55, 1F (C. E. H.)

American Creek, Eagle, Alaska

  Martes americana actuosa
    -XI-61, 5M, 9F (M. M.)

Anaktuvuk Pass, Alaska

  Microtus oeconomus gilmorei
    27-VII-59, 1M (C. E. H.)

Baldwin Peninsula, Alaska

  Microtus oeconomus
    6-VII-60, 1F (W. O. P)
    6-VII-60, 1M, 1F (W. O. P.)
    7-VII-60, 1M, 2F (W. O. P.)

Chena H. S. Road, M. P. 8, Alaska

  Riparia riparia
    12-V-62, 1M (C. E. H.)(N)

Circle Hot Springs, Alaska

  Clethrionomys rutilus
    8-VIII-61, 1F (C. E. H.)
    9-VIII-61, 3M (C. E. H.)
    9-VIII-61, 1M, 2F (C. E. H.)
    11-IX-61, 1M (C. E. H.)
    12-IX-61, 3F (C. E. H.)
    11-IX-61, 1M (C. E. H.)
    23-VII-61, 1F (C. E. H.)
    23-X-61, 1M (C. E. H.)
    23-X-61, 1F (C. E. H.)
    23-X-61, 1F (C. E. H.)
    23-X-61, 1M (C. E. H.)
    23-X-61, 1F (C. E. H.)

24-X-61, 2M, 1F (C. E. H.)
24-X-61, 1M, 2F (C. E. H.)
24-X-61, 1M, 2F (C. E. H.)
24-X-61, 2M, 1F (C. E. H.)
24-X-61, 1M (C. E. H.)
24-X-61, 1F (C. E. H.)
25-X-61, 1M (C. E. H.)
25-X-61, 1F (C. E. H.)
25-X-61, 1F (C. E. H.)
25-X-61, 1M (C. E. H.)
25-X-61, 3F (C. E. H.)
25-X-61, 1M, 2F (C. E. H.)
25-X-61, 1M (C. E. H.)
25-X-61, 1M, 4F (C. E. H.)
25-X-61, 1M (C. E. H.)
26-X-61, 2M, 3F (C. E. H.)
26-X-61, 5M, 2F (C. E. H.)
26-X-61, 2F (C. E. H.)
26-X-61, 11M, 3F (C. E. H.)
26-X-61, 4M, 6F (C. E. H.)
24-VIII-59, 1M (C. E. H.)
25-VIII-59, 1M, 1F (C. E. H.)

Microtus
  10-VIII-61, 5M, 12F (C. E. H)(N)
  14-IX-61, 1M (C. E. H.)(N)

Microtus oeconomus
  9-VIII-61, 2M, 1F (C. E. H.)
  9-VIII-61, 1F (C. E. H.)
  9-VIII-61, 1M, 1F (C. E. H.)
  9-VIII-61, 1M, 1F (C. E. H.)
  9-VIII-61, 1M (C. E. H.)
  9-VIII-61, 1F (C. E. H.)
  9-VIII-61, 1M, 2F (C. E. H.)
  9-VIII-61, 1M, 2F (C. E. H.)
  9-VIII-61, 1M (C. E. H.)
  9-VIII-61, 1F (C. E. H.)
  10-VIII-61, 3M, 2F (C. E. H.)
  10-VIII-61, 1M (C. E. H.)
  13-IX-61, 1F (C. E. H.)
  11-IX-61, 1M (C. E. H.)
  13-IX-61, 1M, 1F (C. E. H.)
  13-IX-61, 1M (C. E. H.)
  11-VI-62, 1M (C. E. H.)

Circle Hot Springs, Alaska (cont'd)

Microtus oeconomus
24-VIII-59, 1F (C. E. H.)
25-VIII-59, 1M (C. E. H.)

Microtus pennsylvanicus
14-IX-61, 1M (C. E. H.)

Tamiasciurus hudsonicus
9-VIII-61, 1M (R. D. C.)

College, Alaska

Clethrionomys rutilus
28-XI-61, 1F (W. O. P.)
- - 58, 2F (A. W. J.)

Denali Hwy., M. P. 12, Alaska

Microtus oeconomus
28-VIII-61, 1F (J. H. E.)
28-VIII-61. 1F (J. H. E.)

Dry Creek, Alaska

Tamiasciurus hudsonicus
4-VII-62, 1M, 1F (E. V.)

Eagle, Alaska

Clethrionomys rutilus
19-VI-62, 1F (M. M.)
10-VIII-62, 1M (M. M.)
3-VII-62, 1M (M. M.)

Microtus oeconomus
20-VI-62, 1F (M.M.)
20-VI-62, 1F (M. M.)

Fairbanks, Alaska

Clethrionomys rutilus
27-IX-60, 2F (W. O. P.)
1-X-59, 1F (W. O. P.)
19-V-62, 1M (C. E. H.)
18-VIII-62, 1M, 1F (J. H. E.)

19-VIII-62, 1M (J. H. E.)
13-VIII-62, 1F (J. L. C.)
10-VI-60, 1F (C. E. H.)
12-VII-60, 1F (C. E. H.)
16-VIII-60, 1F (C. J. M.)
17-VIII-60, 2F (C. J. M.)
18-VIII-60, 2F (C. J. M.)
19-VIII-60, 2F (C. J M.)
30-IX-60, 1F (C. D. K.)
Clethrionomys
9-IX-61, 1M, 3F (C. E. H.)(N)

Microtus oeconomus
4-V-62, 1M, 1F (C. E. H.)
18-VIII-62, 1F (J. H. E.)
6-VI-60, 1M (C. E. H.)
15-VII-60, 1M (C. E. H.)
16-VII-60, 1M, 1F (C. E. H.)
17-VIII-60, 1M (C. J. M.)
19-VIII-60, 1F (C. J. M.)
19-VIII-60, 1F (C. J. M.)
19-VIII-60, 1F (C. J. M.)
20-VIII-60, 1M (C. J. M.)
20-VIII-60, 1F (C. J. M.)

Fairbanks environs, Alaska

Clethrionomys rutilus
29-IX-59, 1F (R. B.)
18-IX-61, 2M, 2F (J. S.)
21-VI-62, 1F (J. L. C.)
22-VI-62, 2M, 3F (C. E. H.)
23-VI-62, 1M (R. E. H.)
20-VIII-62, 1F (J. H. E.)
1-X-59, 1F (W. O. P.)

Ft. Wainwright, Alaska

Clethrionomys rutilus
11-V-62, 4F (C. E. H.)(N)

Clethrionomys dawsoni
20-IV-53, 1F

Microtus oeconomus
7-IX-61, 1M, 1F (C. E. H.)
22-IV-62, 1M (C. E. H.)
5-V-62, 1F (C. E. H.)(N)

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Ft. Wainwright, Alaska (cont'd)

Rattus norvegicus
25-IX-53, 1M (G. Gill)

Ft. Yukon, Alaska

Clethrionomys rutilus
3-VIII-57, 1F (C. E. H.)
8-VIII-57, 1F (C. E. H.)

Golovin Bay, Alaska

Short-tailed mouse
9-V-31, 1F (A. H. Twitchell)
USNM

Hudson Stuck, Ft. Yukon, Alaska

Microtus oeconomus
3-VIII-57, 1F (C. E. H.)

Huslia, Alaska

Clethrionomys rutilus
21-VI-56, 1M (C. E. H.)
23-VI-57, 1M, 1F (C. E. H.)

Microtus oeconomus
21-VI-57, 1F (C. E. H.)
24-VI-57, 1F (C. E. H.)

Kivalina, Alaska

Microtus oeconomus
7-IX-59, 2M (M. Johnson) USNM

Levelock, Alaska

Clethrionomys rutilus
31-V-61, 3M (K. A. N.) KCE

Livengood, Alaska

Lepus americanus
14-V-53, 2F (G. G.)

Olnes, Alaska

Clethrionomys rutilus
30-VII-56, 1F (C. E. H.)
31-VII-56, 4F (C. E. H.)

Paxson Lake, Alaska

Castor canadensis
-I-59, 1F (L. L. H.)

Clethrionomys rutilus
4-XI-59, 1F (L. L. H.)

Microtus oeconomus
27-VI-60, 1F (C. E. H.)
29-VI-60, 1F (C. E. H.)
1-VII-60, 1M (C. E. H.)

Vulpes fulva
30-IX-61, 1F (L. L. H.)

Paxson Lake environs, Alaska

Clethrionomys rutilus
2-XI-60, 2F (L. L. H.)
2-XI-60, 1F (L. L. H.)

Rich. Hwy. , Alaska

Clethrionomys rutilus
1-VII-60, 1F (C. E. H.)

Rich. Hwy., M. P. 178, Alaska

Clethrionomys rutilus
18-VIII-61, 2M, 2F (C. E. H.)
18-VIII-61, 1M (C. E. H.)
18-VIII-61, 1M, 1F (C. E. H.)

Microtus oeconomus
17-VIII-61, 3M, 2F (C. E. H.)
17-VIII-61, 1F (C. E. H.)
17-VIII-61, 1M (C. E. H.)
17-VIII-61, 2F (C. E. H.)
18-VIII-61, 2M, 2F (C. E. H.)
18-VIII-61, 1M (C. E. H.)

Rich. Hwy., M.P. 179, Alaska   Takotna, Alaska

Microtus oeconomus
   11-X-61, 1M (C. E. H.)
   24-V-62, 1F (C. E. H.)
   25-V-62, 1M (C. E. H.)

Microtus operarius operarius
   29-V-32, 1F (A. H. Twitchell)USNM

Short-tailed mouse
   11-VI-35, 2M, 1F (A. H. T.)

St. Lawrence Island, Alaska

Umiat, Alaska

Citellus undulatus
   4-VIII-56, 1M, 1F (T. G. Metcalf)
                     USNM

Microtus oeconomus
   17-VII-62, 1M, 1F (C. E. H.)
   17-VI-47, 1F (L. A. Jachowski)
                         Traub

Microtus oeconomus
   0-VII-63, 4M, 33F (R. R.)
   22-VII-56, 6M, 22F (T. G.
        Metcalf) USNM

Wilbur Creek, Alaska

Clethrionomys rutilus
   30-VII-57, 3M, 3F (C. E. H.)

Microtus oeconomus
   29-VII-57, 2M, 1F (C. E. H.)

MEGABOTHRIS Jordan, 1933

Megabothris Jordan, 1933. Nov. Zool., 39:77.

    Spiracular fossae of tergum VIII much enlarged (Plate IV, C). Eye large and well-pigmented. Movable process of clasper with dark spiniforms. Bulga much larger and broader than hilla. Alaskan forms normally associated with Cricetidae.

    Megabothris Jordan is Holarctic in distribution, with four species known to occur in Alaska. Insofar as I know, none of them attempt to feed upon man. The relationship of the species in the maintenance of plague is unknown.

<div align="center">Key to the Alaskan species of Megabothris</div>

Males

1. MP with posteroapical projection, armed with two short spiniforms; long pigmented seta at lower angle   calcarifer gregsoni

   MP without such posteroapical projection and not armed with two blunt spiniforms   2

2. Lower angle of MP armed with one blunt spiniform set close to
   a long pigmented bristle   groenlandicus

3. Seta at lower angle of MP long, heavily pigmented; remaining
   setae slender and not heavily pigmented; posterior margin of
   MP markedly concave   quirini

   Long, pointed seta and two pigmented spiniforms evenly spaced
   on MP; posterior margin at most slightly concave   abantis

Females

1. Posterior margin of sternum VII with dorsal and ventral lobes
   acuminate, separated by a broad shallow sinus   calcarifer gregsoni

   Posterior margin of sternum VII lacking evident dorsal and
   ventral lobes; lateral sinus absent   2

2. Posterior margin of seventh sternum with a ventral sinus   abantis

   Posterior margin of seventh sternum without ventral sinus   3

3. Dorsal lobe of sternum VII high, with slope to apex of sternum
   slightly concave   groenlandicus

   Dorsal lobe low, angle to apex almost 45 degrees   quirini

Megabothris calcarifer gregsoni Holland, 1950
(Plate IV, C; Plate XXIV, A, B, C, D, E, F; Map 8)

Megabothris calcarifer gregsoni Holland, 1950, Can. Ent., 82:132-133,
   figs. 7, 8. Geary, 1953, Arctic Aeromed. Lab. Rep., 37 pp. Gill,
   1954, Arctic Aeromed. Lab. Rept., 50 pp. Holland, 1956 (1958, Proc.
   Tenth Internat. Cong. Ent., 1:645-658. Hubbard, 1960, Ent. News,
   71:245-247. Holland, 1963, Bishop Mus. Press, pp. 45-63. Holland,
   1964, Ann. Rev. Ent., 9:123-146.

Megabothris calcarifer gregsoni Holland enjoys as wide a distribution
in Alaska as does the previous species, M. p. dissimilis. This is a
Holarctic species, and gregsoni is very close, if not identical, to the
nominate form. The distribution of the host, Microtus oeconomus, is much
broader in Eurasia than it is in North America, indicating that the popula-
tions now in North America must have crossed the Bering land bridge.

From what records are available to me, I believe this species is more
abundant in the Arctic slope than is Malaraeus penicilliger dissimilis.
Again, we do not have enough information of a quantitative nature to truly

establish the abundance. However, the distribution map indicates more northern records than I have for Malaraeus; there should have been equal opportunity for both species to have been collected.

TABLE VIII

Host Associations of
Megabothris calcarifer gregsoni Holland

Host	Total No. Fleas	No. Positive Specimens Collected	Average/Host
Clethrionomys rutilus	27	16	1.7
Dicrostonyx groenlandicus	01	01	
Lepus americanus	01	01	
Microtus miurus	01	01	
Microtus oeconomus	139	75	1.8
Microtus pennsylvanicus	03	02	
Riparia riparia	02	01	
Sorex sp.	06	03	
Tamiasciurus hudsonicus	01	01	

Records

Allakaket, Alaska

Clethrionomys rutilus
5-VIII-55, 1F (C.E.H.)

Microtus oeconomus
9-VIII-55, 1M, 5F (C.E.H.)

Anaktuvuk Pass, Alaska

Microtus oeconomus gilmorei
15-VII-57, 1M, 1F (C.E.H.)

Angmakrog Mountain, Alaska

Microtus miurus
24-VIII-60, 1F (W.O.P.)

Baldwin Peninsula, Alaska

Clethrionomys rutilus
9-VII-60, 1M (W.O.P.)

Microtus oeconomus
6-VII-60, 1M, 1F (W.O.P.)
5-VII-60, 1M, 1F (W.O.P.)
7-VII-60, 2F (W.O.P.)
7-VII-60, 1M (W.O.P.)
7-VII-60, 1M, 1F (W.O.P.)

Bettles Village, Alaska

Microtus
15-VIII-61, 1M, 1F (R.D.C.)(N)

Tamiasciurus hudsonicus
23-VII-55, 1M (C.E.H.)

Chena Road, Alaska, M.P. 8

Riparia riparia
12-V-62, 2F (C.E.H.)

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Elliott Hwy., Alaska, M.P. 10

Microtus oeconomus
10-VIII-60, 1F (C.J.M.)

Fairbanks, Alaska

Clethrionomys rutilus
20-VIII-60, 1F (C.J.M.)

Microtus oeconomus
17-VIII-60, 1F (C.J.M.)
17-VIII-60, 1M (C.J.M.)
18-VIII-60, 1F (C.J.M.)
19-VIII-60, 1F (C.J.M.)
19-VIII-60, 1F (C.J.M.)
19-VIII-60, 1M, 2F (C.J.M.)
20-VIII-60, 2M (C.J.M.)

Fairbanks environs, Alaska

Clethrionomys
9-IX-61, 2F (C.E.H.)

Microtus oeconomus
27-VII-61, 1M, 1F (C.E.H.)
23-VI-62, 1F (C.E.H.)(N)

Circle Hot Springs, Alaska

Clethrionomys
24-VIII-59, 1F (C.E.H.)

Clethrionomys rutilus
10-VIII-61, 1F (C.E.H.)
11-IX-61, 1M (C.E.H.)
12-IX-61, 1M, 4F (C.E.H.)
12-IX-61, 1M (C.E.H.)
13-IX-61, 1M (C.E.H.)
25-VIII-59, 1M (C.E.H.)

Lepus americanus
23-V-53, 1F (G.G.)

Microtus oeconomus
8-VIII-61, 1F (C.E.H.)
8-VIII-61, 3F (C.E.H.)

8-VIII-61, 1M, 3F (C.E.H.)
8-VIII-61, 1F, (C.E.H.)
8-VIII-61, 3F (C.E.H.)
9-VIII-61, 1M (C.E.H.)
9-VIII-61, 2F (C.E.H.)
9-VIII-61, 2M, 2F (C.E.H.)
9-VIII-61, 1F (C.E.H.)
9-VIII-61, 1M (C.E.H.)
9-VIII-61, 1F (C.E.H.)
9-VIII-61, 1F (C.E.H.)
10-VIII-61, 1F (C.E.H.)
10-VIII-61, 1F (C.E.H.)
10-VIII-61, 1F (C.E.H.)(N)
11-IX-61, 1F (C.E.H.)(N)
11-IX-61, 1F (C.E.H.)
11-IX-61, 1F (C.E.H.)
12-IX-61, 1F (C.E.H.)
12-IX-61, 1F (C.E.H.)
12-IX-61, 1M (C.E.H.)
12-IX-61, 1M (C.E.H.)
12-IX-61, 1F (C.E.H.)
12-IX-61, 1F (C.E.H.)
13-IX-61, 1M (C.E.H.)
13-IX-61, 1M (C.E.H.)
24-VIII-59, 2M (C.E.H.)
25-VIII-59, 1M, 1F (C.E.H.)
25-VIII-59, 3F (C.E.H.)

Microtus pennsylvanicus
11-IX-61, 1M, 1F (C.E.H.)
13-IX-61, 1M (C.E.H.)

Microtus
10-VIII-61, 1M, 2F (C.E.H.)(N)
14-IX-61, 2M, 1F (C.E.H.)(N)

Ft. Wainwright, Alaska

Clethrionomys rutilus
11-V-62, 1M, 1F (C.E.H.)

Huslia, Alaska

Clethrionomys rutilus
23-VI-57, 3F (C.E.H.)
23-VI-57, 1M (C.E.H.)
23-VI-57, 1M, 2F (C.E.H.)

Huslia, Alaska (cont'd)

Microtus oeconomus
  3-VI-57, 1M, 3F (C.E.H.)
  21-VI-57, 1M, 4F (C.E.H.)
  21-VI-57, 1M (C.E.H.)
  21-VI-57, 1F (C.E.H.)
  21-VI-57, 1F (C.E.H.)
  23-VI-57, 2M, 2F (C.E.H.)
  23-VI-57, 1M, 2F (C.E.H.)
  23-VI-57, 2F (C.E.H.)
  24-VI-57, 1M, 2F (C.E.H.)
  24-VI-57, 1M, 1F (C.E.H.)
  25-VI-57, 2F (C.E.H.)
  25-VIII-57, 1M (C.E.H.)

Kivalina, Alaska

Mustela rixosa eskimo
  10-IX-59, 1M (M.Johnson)USNM

Minto Flats, Alaska

Microtus oeconomus
  13-VIII-61, 2M (J.H.E.)
  15-VIII-61, 1F (J.H.E.)

Sorex cinereus
  16-VIII-61, 1M, 2F (J.H.E.)
  15-VIII-61, 1M (J.H.E.)

Mt. McKinley Nat'l Park, Alaska

Clethrionomys rutilus
  12-IX-58, 1M (M.Johnson)USNM

Nolan Creek, Alaska

Microtus
  12-VIII-59, 1M, 1F (C.E.H.)

Ocean Point, Colville, Alaska

Microtus oeconomus
  24-VII-62, 1M, 3F (C.E.H.)

Ogotoruk Creek, Alaska

Dicrostonyx groenlandicus
  16-VII-60, 1F (W.O.P.)
  2-VIII-60, 1F (W.O.P.)

Microtus oeconomus
  22-VII-59, 1F (W.O.P.)

Sorex
  17-VIII-60, 1M, 1F (W.O.P.)

Ogotoruk Valley, Cape Thompson

Microtus oeconomus
  19-VIII-59, 1F (W.O.P.)

Olnes, Alaska

Clethrionomys rutilus
  30-VII-56, 1F (C.E.H.)
  31-VII-56, 1M (C.E.H.)

Paxson, Alaska

Microtus oeconomus
  1-VII-60, 1M (C.E.H.)

Paxson Lake, Alaska

Microtus oeconomus
  28-VI-60, 1F (C.E.H.)
  30-VI-60, 1F (C.E.H.)
  1-VII-60, 1M, 3F (C.E.H.)

Paxson Lake environs, Alaska

Clethrionomys rutilus
  2-XI-60, 1M, 2F (L.L.H.)

Rich. Hwy., Alaska

M.P. 178
  Microtus oeconomus
    17-VIII-61, 1M (C.E.H.)

Rich. Hwy., Alaska (cont'd)

    M. P. 179
      Microtus oeconomus
        24-V-62, 1F (C. E. H.)
        25-V-62, 1F (C. E. H.)
        29-VI-60, 3M, 1F (C. E. H.)

Umiat, Alaska

    Microtus oeconomus
      6-VI-47, 1F (L. A. Jachowski) Traub

Wilbur Creek, Alaska

    Microtus oeconomus
      29-VII-57, 2F (C. E. H.)

Wiseman, Alaska

    Microtus
      14-VII-57, 1F (C. E. H.)
      16-VII-57, 1F (C. E. H.)

PLATE XXIV

Megabothris calcarifer gregsoni Holland, 1950

    Figure A: Clasper of male, including dorsal margin of tergum VIII

    Figure B: Sternum IX of male

    Figure C: Sternum VIII of male

    Figure D: Crochet

    Figure E: Sternum VII of female

    Figure F: Spermatheca

Megabothris abantis (Rothschild, 1905)

    Figure G: Clasper of male

    Figure H: Sternum IX of male

    Figure I: Sternum VIII of male

    Figure J: Crochet

    Figure K: Sternum VII of female

    Figure L: Spermatheca

PLATE XXIV
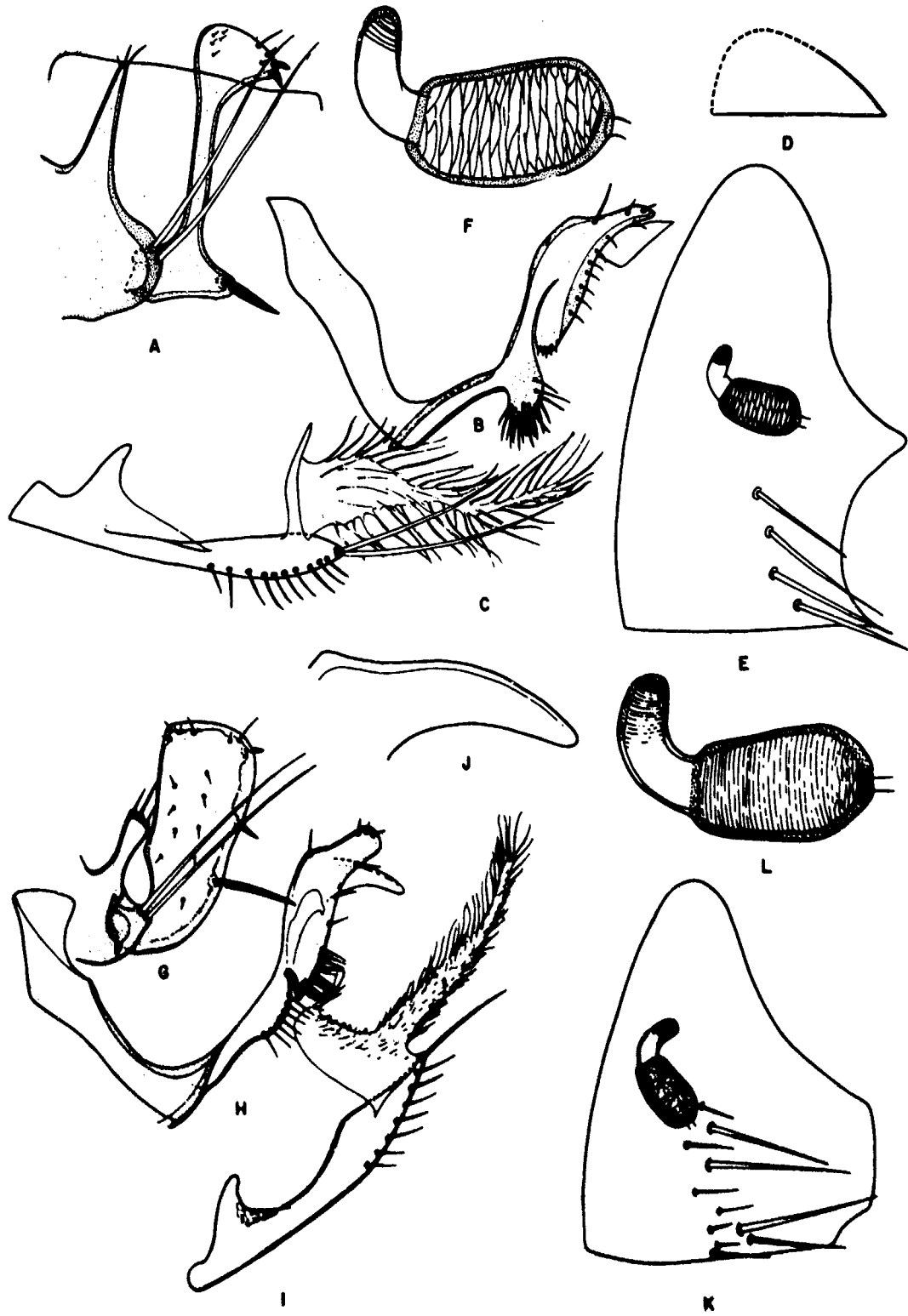
MAP 8

Distribution of Megabothris calcarifer gregsoni Holland,
Megabothris groenlandicus (Wahlgren), Megabothris quirini
(Rothschild), and Megabothris abantis (Rothschild).

The distribution of the last species is not shaded because
of insufficient knowledge of host associations and distribution
on my part.

ALASKA
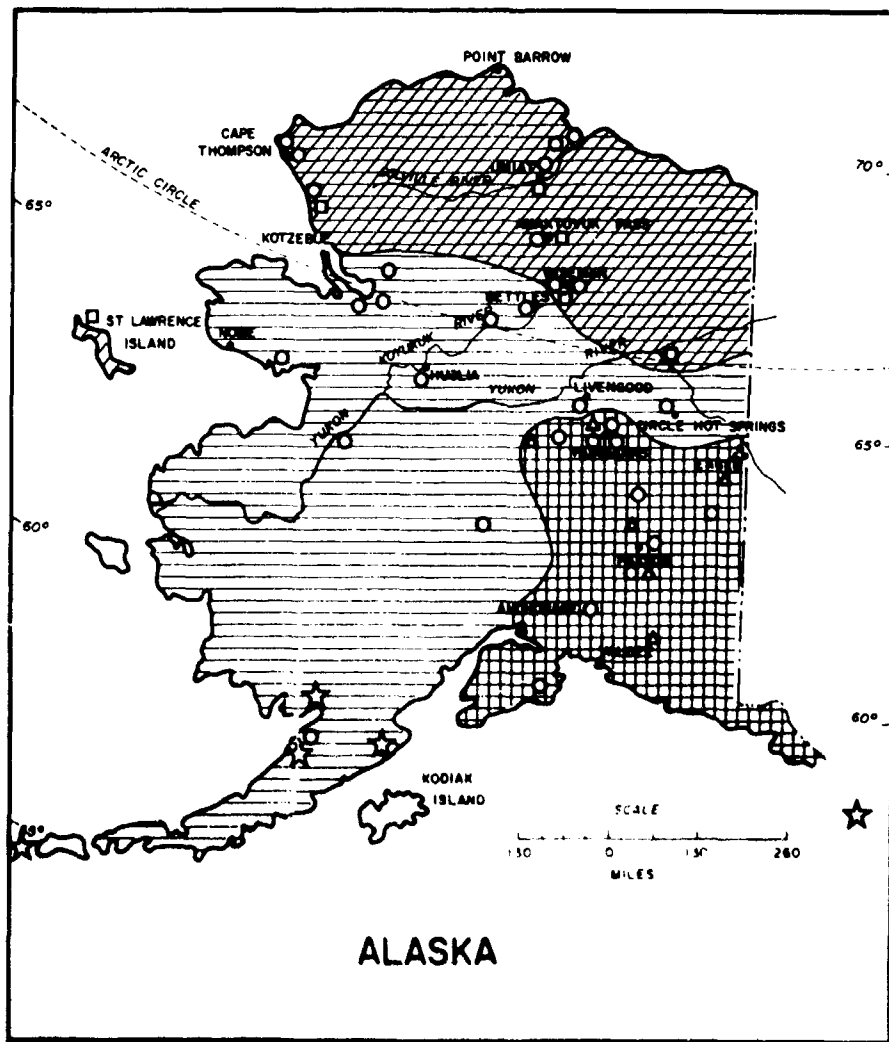
★   Megabothris abantis (Rothschild).

▤ ○   Megabothris calcarifer gregsoni Holland.

▨ □   Megabothris groenlandicus (Wahlgren).

▥ △   Megabothris quirini (Rothschild).

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Megabothris abantis (Rothschild, 1905)
(Plate XXIV, G, H, I, J, K, L; Map 8)

Ceratophyllus abantis Rothschild, 1905. Nov. Zool., 12:164-165. Mitzmain,
1908, Ent. News, 19:382. Wagner, 1930, Magazin de Parasitol.,1:108.

Paradoxopsyllus abantis (Rothschild). Stewart, 1930, Can. Ent., 62:152.

Megabothris abantis (Rothschild). Jordan, 1933, Nov. Zool., 39:77. Wagner,
Can. Ent., 68:201. Svihla, 1941, Univ. Wash. Pub. Biol., 12(2):13.
Augustson, 1942, Bull. South. Calif. Acad. Sci., 40(3):151. Good, 1942,
Jour. Kansas Ent. Soc., 15(1):7-9, fig. 1. Holland, 1942, Can. Ent.,
Sept. 1942, p. 158. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Jel-
lison, Kohls, and Mills, 1943, pp. 4, 8, 10-13, 15-17, 19-20. Prince,
1943, Pub. Health Rept., 58:700-708. Stanford, 1944, Proc. Utah
Acad. Sci. Arts and Letters, 19 and 20:175. Holland, 1949, Sipho-
naptera of Canada, pp. 158-159. Tipton, 1950, Masters Thesis, Brig-
ham Young Univ., p. 64. Allred, 1952, Great Basin Nat., 12:67-75.
Ecke and Johnson, 1952, Pub. Hlt. Serv. Pub., No. 210, Pub. Hlt.
Mono. No. 6, 1-36. Pollitzer, 1952, Bull. WHO, 7:231-342. Pollitzer,
1952, Bull. WHO, 7:318-322, Annex 1. Burroughs, 1953, Parasitol.,
43:35-48. Augustson, 1955, Bull. So. Calif. Acad. Sci., 54:36-39.
Beck, 1955, Brig. Young Univ. Sci. Bull. Biol. Series, 1, 64 pp.
Morlan, 1955, Tex. Rep. Biol. Med., 13:93-125. Wiseman, 1955,
Univ. Wyo. Pub., 19, 28 pp. Kartman and Prince, 1956, Amer. Jour.
Med. Hyg., 5:1058-1070. Schiller and Rausch, 1956, Arctic, 9:191-
201. Jameson and Brennan, 1957, Ecol. Mono., 27:45-54. Holland,
1956 (1958), Proc. Tenth Internat. Cong. Ent., 1:645-658. Parker and
Howell, 1959, Jour. Parasit., 45:597-604. Stark, 1958, Siphonaptera
of Utah, pp. 23, 195, fig. 120. Barnes and Kartman, 1960, Jour. Hyg.,
Cambridge, 58:347-355. Holland, 1963, Bishop Mus. Press, pp. 45-63.

Megabothris adversus Wagner, 1936. Zeitsch. f. parasitenk., 8:654-657.
Mail and Holland, 1939, Proc. Sixth Pac. Sci. Cong., 5:126. Hubbard,
1943, Pac. Univ. Bull., 39:1-12. Hubbard, 1947, Fleas of West. N.
Amer., p. 219.

Trichopsylla (Trichopsylla) adversa (Wagner). Ewing and Fox, 1943, U.S.
Dept. Agr. Misc. Publ., No. 500:57.

Trichopsylla (Trichopsylla) abantis (Rothschild). Ewing and Fox, 1943,
U.S. Dept. Agr. Misc. Pub., No. 500:57.

Megabothris abantis (Rothschild, 1905) is restricted to the southern
portion of Alaska, particularly the coastal margin. The record at Levelock
is the most northern one, and apparently this species is relatively common
out to the Aleutian Chain. According to Holland (58), it occurs on Umnak
Island on lemmings.

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This flea is a postglacial migrant from the south with no close relatives in the boreal region. It is a flea that is common in the western part of the United States, being known from as far eastward as Colorado.

Records

Levelock, Alaska

Clethrionomys rutilus, 31-V-60, 1M, 2F (K.A.N.) KCE

Megabothris groenlandicus (Wahlgren, 1903)
(Plate XXV, A, B, C, D, E, F; Map 8)

Ceratophyllus groenlandicus Wahlgren, 1903. Arkiv. for Zool., 1:183.
Jordan, 1932, Fauna Arctica, 6:118.

Megabothris groenlandicus (Wahlgren). Jordan, 1933, Nov. Zool., 39:77.
Holland, 1944, Can. Ent., 76:244, 246, pl. XVII, XVIII, figs. 6, 7.
Holland, 1949, Siphonaptera of Canada, p. 161, Fig. 287. Holland,
Can. Ent., 84:65-73, figs. 1-3. Holland, 1956, (1958), Proc. Tenth
Internat. Cong. Ent., 1:645-658. Hubbard, 1960, Ent. News, 71:245-
247. Holland, 1963, Bishop Mus. Press, pp. 45-63.

Trichopsylla (Trichopsylla) groenlandica (Wahlgren). Ewing and Fox, 1943,
U.S. Dept. Agr. Misc. Publ., No. 500:61.

Megabothris groenlandicus (Wahlgren, 1903) is considered to be a true Nearctic lemming flea occurring rore frequently upon Dicrostonyx spp. (collared lemming) than any other animal. This is not strictly confined to the northern tundra regions, being found in the taiga upon Microtus oeconomus. Strangely enough, I have no records from the lemmings in Alaska, nearly all of my specimens being from Microtus oeconomus and within the taiga in areas where lemmings now are not known to occur. I have had the unfortunate experience to be on the Arctic slope after the lemming populations have crashed and therefore had little or no opportunity to collect fleas from them.

TABLE IX

Host Associations of
Megabothris groenlandicus (Wahlgren)

Host	Total No. Fleas	No. Positive Specimens Collected	Average/Host
Clethrionomys rutilus	01	01	
Microtus oeconomus	34	16	2.1

Although lemmings are likely conspecific with the Nearctic species which occur in the boreal portions of Europe and Asia, M. groenlandicus is not known from the Palearctic regions. Holland has indicated for some time that this species is much more closely related to Megabothris quirini (Rothschild) than perhaps any other member of the genus. He has indicated that it is probably allopatric to groenlandicus.

Records

Anaktuvuk Pass, Alaska

Microtus oeconomus
27-VII-59, 1M, 3F (C. E. H.)
15-VII-57, 1F (C. E. H.)

Ft. Yukon, Alaska

Clethrionomys rutilus
3-VIII-57, 3M, 1F (C. E. H.)

Microtus oeconomus
10-IX-58, 1M, 1F (M. Johnson)
USNM

Hudson Stuck, Ft. Yukon, Alaska

Microtus oeconomus
3-VIII-57, 2M (C. E. H.)

Kivalina, Alaska

Microtus oeconomus
10-IX-59, 1M (M. Johnson)USNM

Mustela rixosa eskimo
10-IX-59, 1M, 1F (M. Johnson)
USNM

Nolan Creek, Alaska

Microtus oeconomus
12-VIII-59, 1M, 1F (C. E. H.)

Umiat, Alaska

Microtus oeconomus
17-VII-62, 2F (C. E. H.)
17-VII-62, 2M, 3F (C. E. H.)

Wiseman, Alaska

Microtus oeconomus
14-VII-57, 2M (C. E. H.)
15-VII-57, 1M, 3F (C. E. H.)
15-VII-57, 2F (C. E. H.)
16-VII-57, 1F (C. E. H.)
16-VII-57, 1F (C. E. H.)
16-VII-57, 2F (C. E. H.)
16-VII-57, 1M, 2F (C. E. H.)
16-VII-57, 1F (C. E. H.)
16-VII-57, 1F (C. E. H.)
16-VII-57, 2M (C. E. H.)

Megabothris quirini (Rothschild, 1905)
(Plate XXV, G, H, I, J, K, L; Map 8)

Ceratophyllus quirini Rothschild, 1905. Nov. Zool., 12:163-164. Wagner, 1930, Magazin de Parasitol., 1:108. Stewart, 1933, Jour. New York Ent. Soc., 61:256.

Ceratophyllus querini [sic]Rothschild. Jordan, 1929, Nov. Zool., 35:171. Jordan, 1932, Nov. Zool., 38:253. Philip, 1938, Jour. Parasit., 24: 486.

Megabothris quirini (Rothschild). Jordan, 1933, Nov. Zool., 39:77. Jordan, 1937, Nov. Zool., 40:284. Mail and Holland, 1939, Proc. Sixth Pac. Sci. Cong., 5:126. Jellison and Kohls, 1939, Pub. Health Rept., 54: 2022. Fox, 1940, p. 70, pl. XVII, fig. 87; pl. XVIII, figs. 90, 94. Hubbard, 1940, Pac. Univ. Bull., 37:(4). Hubbard, 1941, Pac. Univ. Bull., 37(9A):1. Fuller, 1943, Jour. New York Ent. Soc., 51:8. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Hubbard, 1947, Fleas of West. N. Amer., pp. 211-213, fig. 107. Holland, 1949, Proc. Ent. Soc. Br. Columbia, 45:12. Holland, 1949, Siphonaptera of Canada, pp. 163-164, figs. 276, 291-292. Knipping, Morgan and Dicke, 1950, Wisc. Acad. Sci. Arts and Letters, 40:199-206. Geary, 1953, Arctic Aeromed. Lab. Rept. Judd, 1955, Jour. Parasit., 41:441-442. Wiseman, 1955, Univ. Wyo. Pub., 19, 28 pp. Benton and Krug,, 1956, N. Y. State Mus. Sci. Serv. Bull., 353. Holland, 1956 (1958), Proc. Tenth Internat. Cong. Ent., 1:645-658. Geary, 1959, Cornell Exper. Stat. Mem., 355, figs. Benton and Cerwonka, 1960, Amer. Mid. Nat., 63: 383-391. Holland, 1963, Bishop Mus. Press, pp. 45-63.

Trichopsylla (Trichopsylla) quirini (Rothschild). Ewing and Fox, 1943, U. S. Dept. Agr. Misc. Publ., No. 500:63. Brown, 1944, Ann. Ent. Soc. Amer., 37:211.

Megabothris quirini (Rothschild, 1905) is a flea that has migrated into the boreal regions from the south following the retreat of the Pleistocene glaciers. It occurs on a variety of microtines, particularly the zapodid rodents, but is commonly thought to be more closely associated with Zapus hudsonius than any other one rodent. Although Zapus hudsonius probably occurs throughout most of the Tanana Valley in central Alaska, I have failed to find it a good source of fleas. Approximately two dozen specimens have been taken, and only one of these was infested with a single flea, Catallagia dacenkoi fulleri.

From the records that I have, this flea is almost equally associated with Clethrionomys rutilus and Microtus oeconomus. By way of seasonal incidence, it seems to occur more commonly in the early summer than it does late in the fall. I believe that the northern distribution of this species is somewhat greater than what Holland (58) indicates. A particularly interesting observation is that of the several hundred rodents trapped over a period of several years in the Circle Hot Springs area, this flea was never taken, yet a short distance away, in Eagle, it apparently is a relatively common flea.

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TABLE X

Host Associations of
Megabothris quirini (Rothschild)

Host	Total No. Fleas	No. Positive Specimens Collected	Average/Host
Clethrionomys rutilus	34	21	1.6
Microtus oeconomus	14	12	1.2
Microtus pennsylvanicus	01	01	
Mustela erminea	01	01	

Records

College, Alaska

  Clethrionomys rutilus
    -58, 6M, 5F (A.W.J.)

Eagle, Alaska

  Clethrionomys rutilus
    19-VI-62, 2F (M.M.)
    23-VI-62, 1M, 1F (M.M.)
    20-VI-62, 2F (M.M.)
    19-VI-62, 1F (M.M.)
    19-VI-62, 2F (M.M.)
    26-VI-62, 1F (M.M.)
    26-VI-62, 1F (M.M.)
    3-VII-62, 1M, 1F (M.M.)
    10-VIII-62, 2M (M.M.)

  Microtus oeconomus
    20-VI-62, 2F (M.M.)
    22-VI-62, 1F (M.M.)
    12-VII-62, 1F (M.M.)
    12-VII-62, 1M (M.M.)

Fairbanks, Alaska

  Clethrionomys rutilus
    12·VII-60, 1M (C.E.H.)
    19-VIII-60, 1F (C.J.M.)

19-VIII-60, 1F (C.J.M.)
20-VIII-60, 1F (C.J.M.)
24-VIII-60, 1M (C.J.M.)
18-VIII-60, 2F (C.J.M.)
20-VIII-60, 1M (C.J.M.)
20-VIII-60, 1M

Fairbanks environs, Alaska

  Clethrionomys
    9-IX-61, 1F (C.E.H.)(N)

  Clethrionomys rutilus
    20-VII-61, 2M, 3F (C.E.H.)

  Microtus oeconomus
    19-VI-62, 1F (R.E.H.)

  Microtus pennsylvanicus
    15-IX-61, 1M (W.O.P.)

  Mustela erminea
    9-VII-62, 1F (R.D.C.)

Minto Flats, Alaska

  Microtus oeconomus
    13-VIII-61, 1M (J.H.E.)

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Olnes, Alaska

  Clethrionomys rutilus
    31-VII-56, 1F (C.E.H.)

Paxson Lake, Alaska

  Clethrionomys rutilus
    30-VI-60, 2F (C.J.M.)

Paxson Lake environs, Alaska

  Clethrionomys rutilus
    2-XI-60, 1F (C.E.H.)
    21-V-61, 1F (L.L.H.)

Rich. Hwy., Paxson Lake

  Clethrionomys rutilus
    1-VII-60, 1F (C.E.H.)

Rich. Hwy., M.P. 178

  Microtus oeconomus
    17-VIII-61, 1F (C.E.H.)

Rich. Hwy., M.P. 179

  Microtus oeconomus
    11-X-61, 1M (C.E.H.)
    9-VI-60, 1M (C.J.M.)
    2-VII-60, 2F (C.E.H.)

PLATE XXV

Megabothris groenlandicus (Wahlgren, 1903)

    Figure A: Clasper of male

    Figure B: Sternum IX of male

    Figure C: Sternum VIII of male

    Figure D: Crochet

    Figure E: Sternum VII and variation

    Figure F: Spermatheca

Megabothris quirini (Rothschild, 1905)

    Figure G: Clasper of male

    Figure H: Sternum IX of male

    Figure I: Sternum VIII of male

    Figure J: Crochet

    Figure K: Sternum VII of female

    Figure L: Spermatheca

PLATE XXV
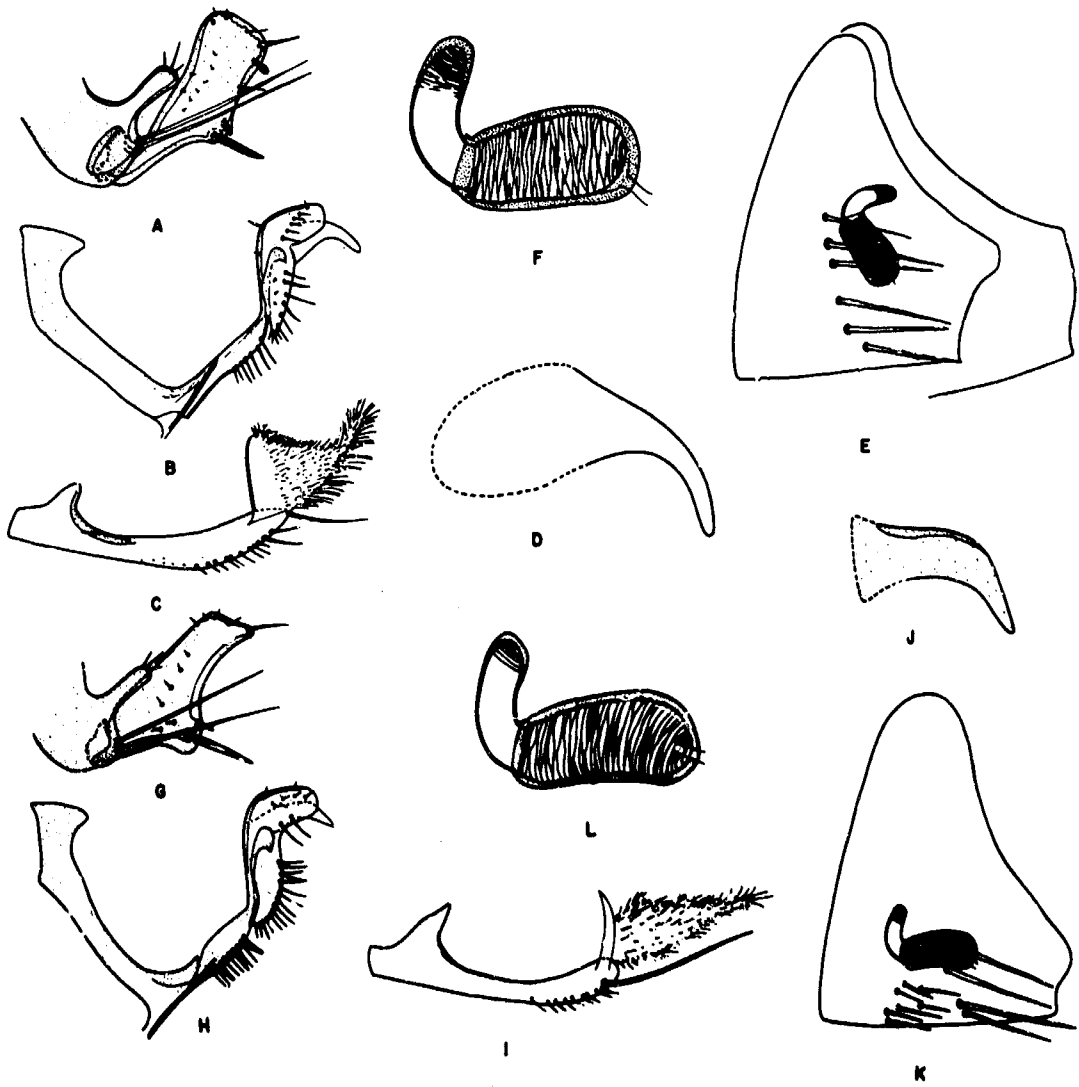
XV

Family CERATOPHYLLIDAE, Genera MONOPSYLLUS, ORCHOPEAS, OPISODASYS, TARSOPSYLLA, OROPSYLLA, THRASSIS and AMPHALIUS

MONOPSYLLUS Kolenati, 1856

Monopsyllus Kolenati, 1856. Wien. Ent. Monatschr., 1(33):65.

Eye large and well-pigmented; longest diameter always longer than distance of eye from angle of strongly chitinized genal lobe (except exilis males). Pronotal ctenidium of no more than 24 spines, usually 18-20. Five pairs of plantar bristles, basal pair moved somewhat mesally. Spiracular fossae of tergum VIII normal, not enlarged as in Megabothris. Distal arm of sternum IX with mesal process or notch for reception of crochet. Spermatheca with bulga longer than wide, otherwise variable in shape. Hilla at times longer and broader than bulga.

There is considerable disagreement concerning the status of this genus. Johnson (83, p. 1, 2) discusses this problem thoroughly in her revision of Monopsyllus.

Holland (45) states that most members of Monopsyllus will bite man readily; however, this is not the case with the common species in Alaska. The fleas of this genus are usually restricted to the Cricetidae and Sciuridae in the Nearctic region. A Holarctic genus.

Key to the Alaskan species of Monopsyllus

Males

1. Apex of MP strongly produced dorsoanteriorly; penis rods coiled | tolli

   Apex of MP not produced anteriorly; penis rods never coiled | 2

2. Apex of MP produced posteroapically; posteroapical bristles spiniform | ciliatus protinus

   Apex of MP not produced posteroapically, roughly rectangular in outline; posteroapical bristles not spiniform | vison

Females

1. Sternum VII usually with ventral portion forming a square lobe; spermatheca with bulga and hilla approximately of equal length | vison

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Females (cont'd)

    Sternum VII and spermatheca not as above   2

2. Posterior margin of sternum VII with upper lobe well-rounded,
     sinus deep and rounded; hilla less than half as long as bulga   tolli

     Posterior margin of sternum VII with upper lobe acuminate,
     sinus triangular, hilla longer than bulga   ciliatus protinus

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Monopsyllus vison (Baker, 1904)
(Plate XXVI, A, B, C, D, E, F; Map 9)

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Ceratophyllus vison Baker, 1904. Proc. U.S. Nat'l. Mus., 27:408-410, 448.
    Stewart, 1928, Cornell Univ. Mem., 101:869. Jordan, 1929, Nov.
    Zool., 35:35. Jordan, 1929, Nov. Zool., 35:170. Wagner, 1929,
    Konowia, 8:311-315. Stewart, 1933, Jour. N.Y. Ent. Soc., 41:256.
    Stewart, 1933, Jour. N.Y. Ent. Soc., 61:256. Ioff, 1936, Zeit,
    Parasit., 9:73-124.

Ceratophyllus lucidus Baker, 1904. Proc. U.S. Nat'l. Mus., 27:388, 410-
    411, 444. Dunn and Parker, 1923, Pub. Health Rept., 38:2773, 2775.

Monopsyllus vison (Baker). Jordan, 1933, Nov. Zool., 39:78. Wagner, 1936,
    Can. Ent., 68:199-200. Philip, 1938, Jour. Parasit., 24:486. Jel-
    lison and Kohls, 1939, Pub. Health Rept., 54:2022. Mail and Holland,
    1939, Proc. Sixth Pac. Sci. Cong., 5:126. Eskey and Haas, 1940,
    Pub. Health Bull., 254:29-74. Hubbard, 1940, Pac. Univ. Bull., 37
    (4):1-4. Hubbard, 1942, Pac. Univ. Bull., 38:(4):1-13. Hubbard,
    1943, Pac. Univ. Bull., 39:1-12. McClure, 1943, Ecol. Mono., 13:
    1-35. Jellison, Kohls, and Mills, 1943, Misc. Publ. Mont. Bd. Ent.,
    2:4, 8, 12, 19, 20. Stanford, 1944, Proc. Utah Acad. Sci. Arts and
    Letters, 175:19-20. Hubbard, 1947, Fleas West. N. Amer., pp. 234-
    236, fig. 121. Holland, 1949, Proc. Ent. Soc. Br. Columbia, 45:12.
    Link, Am. Jour. Trop. Med., 29:498. Holland, 1949, pp. 168-170,
    figs. Knipping, Morgan and Dicke, 1950, Wisc. Acad. Sci. Arts and
    Letters, 40:199. Holland, 1950, Proc. Ent. Soc. Br. Col., 46:5-13.
    Ecke and Johnson, 1952, Pub. Health Serv. Pub., No. 210, Pub.
    Health Mono. 6, 36 pp. Bacon, 1953, Wash. Agr. Exp. Sta. Tech.
    Bull., 40 pp. Geary, 1953, Arctic Aeromed. Lab. Rept., 37 pp. Gill,
    1954, Arctic Aeromed. Rept., 2:50 pp. Layne, 1954, Ecol. Mono.,
    24:227-267. Brown, 1955, Can. Ent., 87:362-365. Judd, 1955, Jour.
    Parasit., 41:441-442. Morlan, 1955, Tex. Rep. Biol. and Med., 13:
    93-125. Wiseman, 1955, Univ. Wyo. Pub., 19: 28 pp. Benton and
    Krug, 1956, N.Y. State Mus. Sci. Serv. Bull., 353. Burbutis, 1956,
    N.J. Agr. Exp. Sta. Bull., 782. Holdenried and Morlan, 1956, Am.

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Mid. Nat., 55:369-381. Schiller and Rausch, 1956, Arctic, 9:191-201. DeVos, 1957, J. Mammal., 38:412. Holland, 1956 (1958, Proc. Tenth Internat. Cong. Ent., 1:645-658. Stark, 1958, Siphonaptera of Utah, p. 191. Geary, 1959, Cornell Exp. Sta. Mem., 355, figs. Benton and Cerwonka, 1960, Am. Mid. Nat., 63:383-391. Johnson, 1961, U.S. Dept. Agr. Tech. Bull., 1277:11-12, figs. 10-18. Holland, 1963, Bishop Mus. Press, pp. 45-63.

Megabothris vison (Baker). Fox, 1940, Fleas East. United States, pp. 72-73. figs. 95, 98-99. Fuller, 1943, Bull. Brook. Ent. Soc., 51:8.

Trichopsylla (Trichopsylla) vison (Baker). Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Publ., No. 500:64. Brown, 1944, Ann. Ent. Soc. Am., 37:211. Snodgrass, 1946, Smithsonian Misc. Coll., 104:1-89, pl. 13, 17, 21.

Monopsyllus vison (Baker, 1904) is a widely distributed Nearctic species associated with the red squirrel, Tamiasciurus hudsonicus (Erxleben). The records extend from the Smoky Mountains of Tennessee northward through the coniferous forests of Canada and westward and north into Alaska. However, in western Canada it stops at the Coast Mountains and is replaced by Monopsyllus ciliatus protinus (Jordan).

TABLE XI

Host Associations of
Monopsyllus vison (Baker)

Host	Total No. Fleas	No. Positive Specimens Collected	Average/Host
Clethrionomys rutilus	12	04	03
Lepus americanus	01	01	
Martes americana	01	01	
Microtus oeconomus	03	01	
Mustela erminea	01	01	
Petrochelidon pyrrhonota	01	01	
Spermophilus undulatus	03	01	
Tamiasciurus hudsonicus	725	108	6.7
Ursus horribilis	01	01	

M. vison is apparently more restricted to the red squirrels than is the other flea commonly encountered upon this animal, Orchopeas caedens (Jordan). I have almost no records from mustelids, whereas the latter species seems to have the same relationship with the mustelids that the lynx does with H. g. lynx.

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Dry Creek, Alaska

    Spermophilus undulatus
      28-VI-62, 3M (E.G.V.)

    Tamiasciurus hudsonicus
      16-VI-62, 5M, 5F (E.G.V.)
      25-VI-62, 4M, 2F (E.G.V.)
      29-VI-62, 4M, 3F (E.G.V.)
      4-VII-62, 3M, 3F (E.G.V.)
      4-VII-62, 5M, 6F (E.G.V.)

Eagle, Alaska

    Tamiasciurus hudsonicus
      10-VIII-62, 1M (M.M.)

Eagle City, Alaska

    Tamiasciurus hudsonicus
      13-VII-62, 2M, 3F (C.E.H.)
      14-VII-62, 1M, 1F (C.E.H.)
      14-VII-62, 2M, 3F (C.E.H.)
      14-VII-62, 1M, 1F (C.E.H.)

Elliott Hwy., Alaska

    Tamiasciurus hudsonicus
      28-IX-53, 1F

Fairbanks, Alaska

    Microtus oeconomus
      5-V-62, 1M, 2F (C.E.H.)

    Mustela erminea
      21-IX-61, 1M (C.E.H.)
      22-IX-61, 1F (W.O.P.)(N)

    Tamiasciurus hudsonicus
      15-VII-61, 1F (J.H.E.)
      20-VII-61, 1M, 4F (J.H.E.)
      3-VII-61, 3M, 14F (W.O.P.)
      4-VII-61, 3M, 5F (W.O.P.)
      12-VII-61, 2F (W.O.P.)
      1-VIII-61, 1M, 5F (W.O.P.)
      1-VIII-61, 3M, 3F (W.O.P.)

      2-VIII-61, 3M, 6F (W.O.P.)
      2-VIII-61, 1M, 1F (W.O.P.)
      8-VII-61, 3F (W.O.P.)
      24-VI-61, 2F (W.O.P.)
      25-VI-61, (W.O.P.)
      16-VII-61, 1M (W.O.P.)
      17-VI-61, 2F (W.O.P.)
      22-IV-62, 2M, 3F (W.O.P.)
      12-IV-62, 6M, 10F (W.O.P.)
      12-IV-62, 1F (W.O.P.)
      7-VI-60, 1M, 2F (C.E.H.)

Fairbanks environs, Alaska

    Lepus americanus
      6-VI-62, 1F (J.L.C.)

    Tamiasciurus hudsonicus
      5-V-62, 1M, 2F (C.E.H.)
      25-VI-62, 4F (W.O.P.)
      1-IV-62, 1M (W.O.P.)
      9-VII-62, 1M (C.E.H.)
      18-VI-62, 2M, 1F (J.L.C.)
      16-VI-56, 1M, 1F (C.E.H.)
      16-VI-56, 1M (C.E.H.)
      16-VI-56, 10M, 7F (C.E.H.)
      16-VI-56, 4M, 1F (C.E.H.)
      16-VI-56, 2M, 1F (C.E.H.)
      7-VIII-59, 1M, 1F (C.E.H.)
      7-VIII-59, 1M (C.E.H.)

Ft. Yukon, Alaska

    Clethrionomys rutilus
      3-VIII-57, 2F (C.E.H.)

40 Mi. S.W. Ft. Yukon, Alaska

    Tamiasciurus hudsonicus
      28-VI-62, 9M, 7F (J.L.C.)
      28-VI-62, 1M (J.L.C.)
      27-VI-62, 3M (J.L.C.)
      27-VI-62, 12M, 12F (J.L.C.)
      27-VI-62, 1F (J.L.C.)
      27-VI-62, 5M, 4F (J.L.C.)
      27-VI-62, 4F (J.L.C.)
      27-VI-62, 4F (J.L.C.)

Johnson (83), in her revision of Monopsyllus, stated that this was a remarkably stable species and that she was unable to find any indication of subspeciation despite its relatively wide range. It is interesting that the closest Asiatic counterpart of the red squirrel, Sciurotamias davidianus, has no fleas that appear to be related to the Nearctic forms.

Records

Allakaket, Alaska

    Clethrionomys rutilus
      5-VIII-55, 3M, 5F (C. E. H.)

    Tamiasciurus hudsonicus
      7-VIII-55, 9M, 2F (C. E. H.)

American Creek, Eagle, Alaska

    Martes americana actuosa
      -XI-61, 1M (M. M.)

Bettles Village, Alaska

    Tamiasciurus hudsonicus
      23-VII-55, 9M, 13F (C. E. H.)
      18-VIII-59, 3M, 5F (C. E. H.)

Central, Alaska

    Tamiasciurus hudsonicus
      15-VI-60, 1M, 7F (C. E. H.)

Circle Hot Springs, Alaska

    Clethrionomys rutilus
      9-VIII-61, 1F (C. E. H.)

    Tamiasciurus hudsonicus
      23-VIII-59, 5M, 20F (C. E. H.)
      25-VIII-59, 1M, 1F (C. E. H.)
      10-VIII-61, 5F (R. D. C.)
      10-VIII-61, 2M, 2F (C. E. H.)(N)
      10-VIII-61, 24M, 16F (C. E. H.)(N)
      10-VIII-61, 21M, 33F (C. E. H.)(N)
      10-VIII-61, 28M, 39F (C. E. H.)(N)
      10-IX-61, 3M, 1F (R. S.)
      14-IX-61, 3M (C. E. H.)

14-IX-61, 38M, 68F (C. E. H)(N)
14-IX-61, 2F (C. E. H.)(N)
14-IX-61, 2M, 4F (C. E. H.)(N)
26-X-61, 1M, 1F (C. E. H.)
26-X-61, 1F (C. E. H.)
26-X-61, 3M, 2F (C. E. H.)(N)
26-X-61, 8M, 8F (C. E. H.)(N)
9-VI-55, 12M, 27F (C. E. H.)
4-VII-56, 3M, 2F (C. E. H.)
4-VII-56, 1F (C. E. H.)
24-VIII-59, 4M, 4F (C. E. H.)
25-VIII-59, 8M, 4F (C. E. H.)
25-VIII-59, 10M, 8F (C. E. H.)
25-VIII-59, 4M (C. E. H.)
25-VIII-59, 1M (C. E. H.)
25-VIII-59, 2M, 5F (C. E. H.)
26-X-61, 1F (C. E. H.)
25-VIII-59, 2M, 5F (C. E. H.)
25-VIII-59, 5M, 7F (C. E. H.)
25-VIII-59, 17M, 16F (C. E. H.)
25-VIII-59, 2F (C. E. H.)
15-VI-60, 5M, 3F (C. E. H.)
18-VI-60, 3M, 12F (C. E. H.)
18-VI-60, 8M, 11F (C. E. H.)
25-X-61, 1M (C. E. H.)

College, Alaska

    Tamiasciurus hudsonicus
      -59, 1M (C. D. K.)
      22-IX-52, 1M (B. Z.)

Denali Hwy., M. P. 1, Alaska

Tamiasciurus hudsonicus
    11-X-61, 1M (C. E. H.)

27-VI-62, 1F. (J. L.C.)
26-VI-62, 7M, 11F (J. L. C.)
25-VI-62, 4M (J. L.C.)
25-VI-62, 3M, 7F (J. L. C.)
25-VI-62, 1M, 4F (J. L. C.)
25-VI-62, 5M (J. L. C.)

Hughes, Alaska

Tamiasciurus hudsonicus
2-VIII-55, 2M, 4F (C. E. H.)

Huslia, Alaska

Tamiasciurus hudsonicus
22-VI-57, 5M, 6F (C. E. H.)

Lake Bolio, Alaska

Tamiasciurus hudsonicus
25-VI-56, 5M, 8F (C. E. H.)
1-VI-60, 3M (C. E. H.)

Livengood, Alaska

Petrochelidon pyrrhonota
26-VII-61, 1M (C. E. H.)

Tamiasciurus hudsonicus
14-IV-53, 19M, 22F (C. J.M.)
15-V-53, 1M

Minto, Alaska

Tamiasciurus hudsonicus
9-VIII-56, 2M (C. E.H.)

Nolan Creek, Alaska

Tamiasciurus hudsonicus
12-VIII-59, 1M, 7F (C.E.H.)

Olnes, Alaska

Clethrionomys rutilus
31-VII-56, 1M (C. E. H.)

Tamiasciurus hudsonicus
18-IV-53, 1M, 6F
18-IV-53, 1M, 5F
17-VI-56, 1F (C. E. H.)
24-VI-56, 2M, 3F (C. E. H.)
28-VII-56, 2M (C. E. H.)

Paxson Lake, Alaska

Tamiasciurus hudsonicus
27-VIII-52, 1M (L. L. H.)

Ursus horribilis
14-VI-55, 1F (L. L. H.)

Rampart River, 2 mi. , 77, Alaska

Northern Red Squirrel
14-VI-12, 2F (A. H. Twitchell)
USNM

Steel Creek Road, 12 Mi. , Alaska

Tamiasciurus hudsonicus
31-III-53, 1M, 2F

Takotna, Alaska

Red Squirrel
19-V-32, 2F (A. H. Twitchell)
USNM

Wilbur Creek, Alaska

Tamiasciurus hudsonicus
19-VIII-56, 3F (C. E. H.)
10-VIII-56, 3M, 2F (C. E. H.)
13-VIII-56, 5M (C. E. H.)
30-VI-56, 1M, 1F (C. E. H.)
30-VI-57, 2M, 2F (C. E. H.)
30-VI-57, 4M, 5F (C. E. H.)

PLATE XXVI

Monopsyllus vison (Baker, 1904)

Figure A: Clasper of male

Figure B: Sternum IX of male

Figure C: Sternum VIII of male

Figure D: Crochet

Figure E: Sternum VII of female

Figure F: Spermatheca

Monopsyllus tolli (Wagner, 1901)

Figure G: Clasper of male

Figure H: Sternum IX of male

Figure I: Sternum VIII of male

Figure J: Crochet

Figure K: Sternum VII of female

Figure L: Spermatheca

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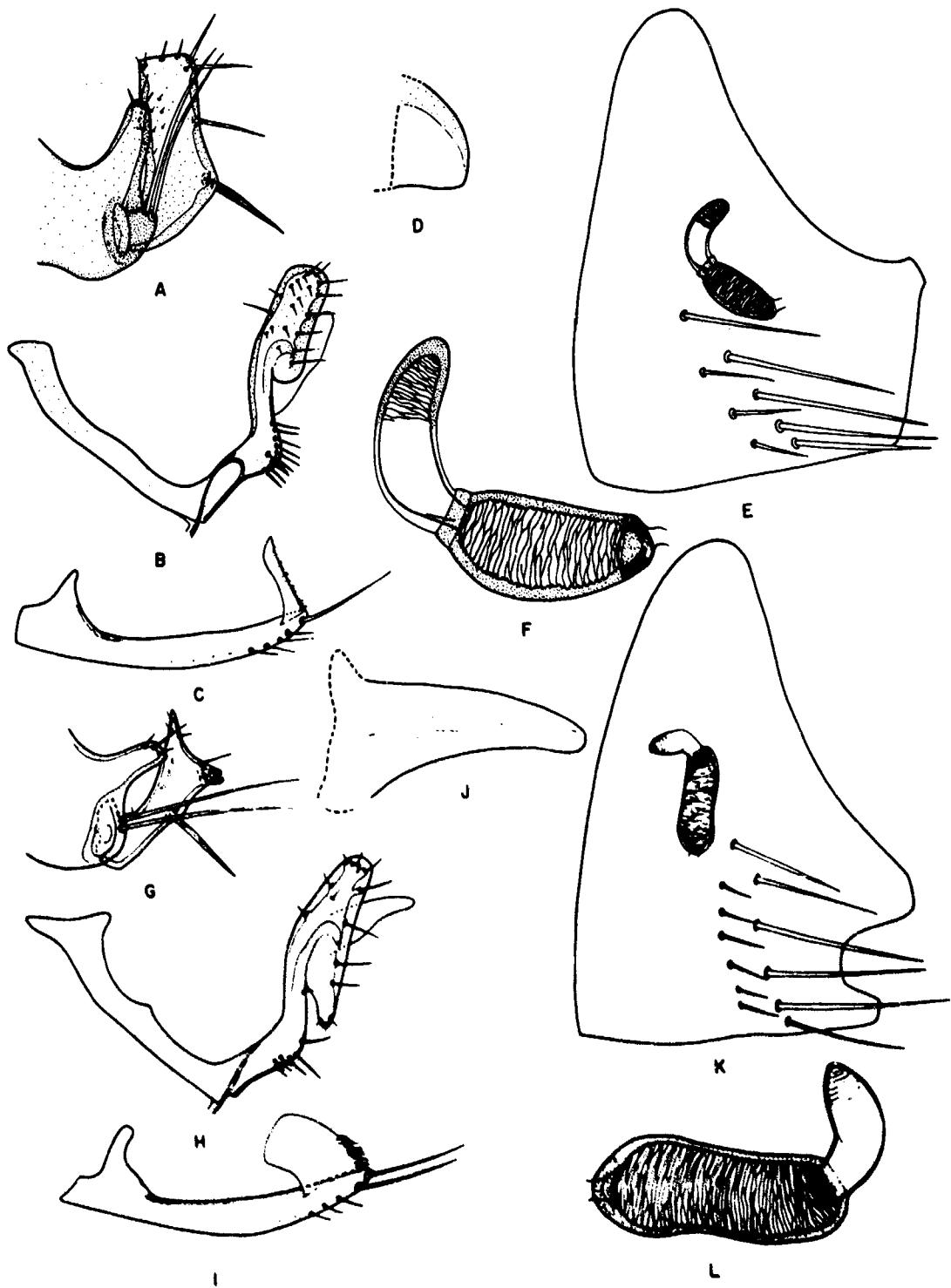
PLATE XXVI

<center>Monopsyllus tolli (Wagner, 1901)</center>
<center>(Plate XXVI, G, H, I, J, K, L)</center>

Ceratophyllus tolli Wagner, 1901. Soc. Ent. Ross. Horae, 35:17-79, 1 pl.,
fig. 8. Baker, 1904, U.S. Nat'l. Mus. Proc., 27:447. Wagner, 1930,
Kat. Aphanipt., p. 9. Holland, 1952, Can. Ent., 84:197-308, figs. 20-
25. Johnson, 1961, U.S. Dept. Agr. Tech. Bull., No. 1277:27-29,
figs. 55-65. Holland, 1963, Bishop Mus. Press, pp. 45-63.

Megabothris toli. Wagner, 1934, Konowia, 13:262.

Monopsyllus (Amonopsyllus) toli. Wagner, 1938, Konowia, 17:9.

Ceratophyllus (Monopsyllus) toli. Ioff, 1936, Ztschr. f. Parasitenk., 9:96,
figs. 3, 13, 34, 44. Ioff and Skalon, 1954, Handb. Ident. Fleas, p. 76,
figs. 148A, B.

Monopsyllus anadyrus Jordan. Jordan, 1937, Nov. Zool., 40:283-291, figs.
72-73. Wagner, 1938, Konowia, 17:9.

   Monopsyllus tolli (Wagner, 1901) is a rare species usually occurring
upon various species of Ochotona. In the Nearctic region it is known from
two localities thus far. The one Alaskan record is from ptarmigan collected
at the Worthington Glacier. In the Canadian National Collection there is also
material from the Yukon Territory collected by A.W.F. Banfield, ex
Ochotona collaris (Nelson).

<center>Monopsyllus ciliatus protinus (Jordan, 1929)</center>
<center>(Plate XXVII, A, B, C, D, E, F; Map 9)</center>

Ceratophyllus ciliatus protinus Jordan, 1929. Nov. Zool., 35:34.

Monopsyllus ciliatus protinus (Jordan). Wagner, 1936, Can. Ent., 68:200.
Jellison and Kohls, 1939, Pub. Health Rept., 54:2022. Mail and Holland,
1939, Proc. Sixth Pac. Sci. Cong., 5:126. Hubbard, 1940, Pac. Univ.
Bull., 37(4):1-4. Hubbard, 1941, Pac. Univ. Bull., 37(8):5-7. Hubbard,
1941, Pac. Univ. Bull., 37(9A):3. Svihla, 1941, Univ. Wash. Pub.
Biol., 12:(2):14. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Holland,
1949, Proc. Ent. Soc. Br. Col., 45:12. Holland, 1949, Siphonaptera of
Canada, pp. 165-166, figs. 295-296. Holland, 1956 (1958), Proc. Tenth
Internat. Cong. Ent., 1:645-658. Johnson, 1961, U.S. Dept. Agr. Tech.
Bull., 1277; fig. 49. Holland, 1963, Bishop Mus. Press, pp. 45-63.

Trichopsylla (Trichopsylla) ciliata protina (Jordan). Ewing and Fox, 1943,
U.S. Dept. Agr. Misc. Publ., No. 500:59.

<center>188</center>

Monopsyllus ciliatus protinus (Jordan, 1929) is confined to southeastern Alaska and is a Pacific Coast species occurring mostly on the squirrel, Tamiasciurus douglasii (Bachman). According to Johnson, this subspecies of ciliatus has been collected in numbers from both Tamiasciurus and Utamias species; it now normally occurs on both of these genera, although originally it may have been associated only with Tamiasciurus.

According to Johnson's records, M. c. protinus occurs in a north-south direction from Seward, Juneau and Salmon Creek, Alaska, through British Columbia, on through the western half of Washington and Oregon, and into northern California. Without question, this species is a postglacial migrant from a Pacific Northwest refugium that has entered into Alaska after the retreat of the last glacial period.

<div align="center">

Records

</div>

Ketchikan, Alaska

    Mustela vison, -I-62, 5F (P. Garceau) KCE

<div align="center">

ORCHOPEAS Jordan, 1933

</div>

Orchopeas Jordan, 1933. Nov. Zool., 39:71.

Frontal tubercle small. Eye well-developed. Outer surface of procoxae with one or no lateral bristle (apart from the ventrolateral ones). Sternum VIII of male narrow, with a long, apical, membranous lobe. Distal arm of Sternum IX well-developed; ventral portion of apical lobe with heavy spiniform. Movable process narrow at base, abruptly expanded near midline ("ham-shaped"). Four or more short, pigmented spiniforms around posterior margin. Spermatheca usually barrel-shaped. Bulga longer than wide, hilla usually papillate. Ventral margin of sternum X distinctly angulate near middle. Anal stylet not noticeably curved.

Orchopeas is confined to the Nearctic region. While males are quite readily identified, the females form a rather homogeneous group, many of their characteristics overlapping. Subspeciation throughout this genus is poorly understood. This is partly a result of individuals attempting clasification without fully understanding the concept of subspeciation, particularly as it applies to the Siphonaptera. A general revision of the genus is sorely needed.

Several species within the genus have been found naturally infected with plague organisms; however, the role of these fleas in the maintenance of plague is inadequately understood. Available evidence indicates that some species are significant, particularly those associated with wood rats and their nests.

<div align="center">

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</div>

PLATE XXVII

Monopsyllus ciliatus protinus (Jordan, 1929)

       Figure A: Clasper of male

       Figure B: Sternum IX of male and crochet

       Figure C: Sternum VIII of male

       Figure D: Crochet

       Figure E: Sternum VII

       Figure F: Spermatheca

Tarsopsylla octodecimdentata coloradensis (Baker, 1895)

       Figure G: Clasper of male

       Figure H: Sternum IX of male

       Figure I: Sternum VIII of male

       Figure J: Sternum VII of female

       Figure K: Spermatheca

PLATE XXVII
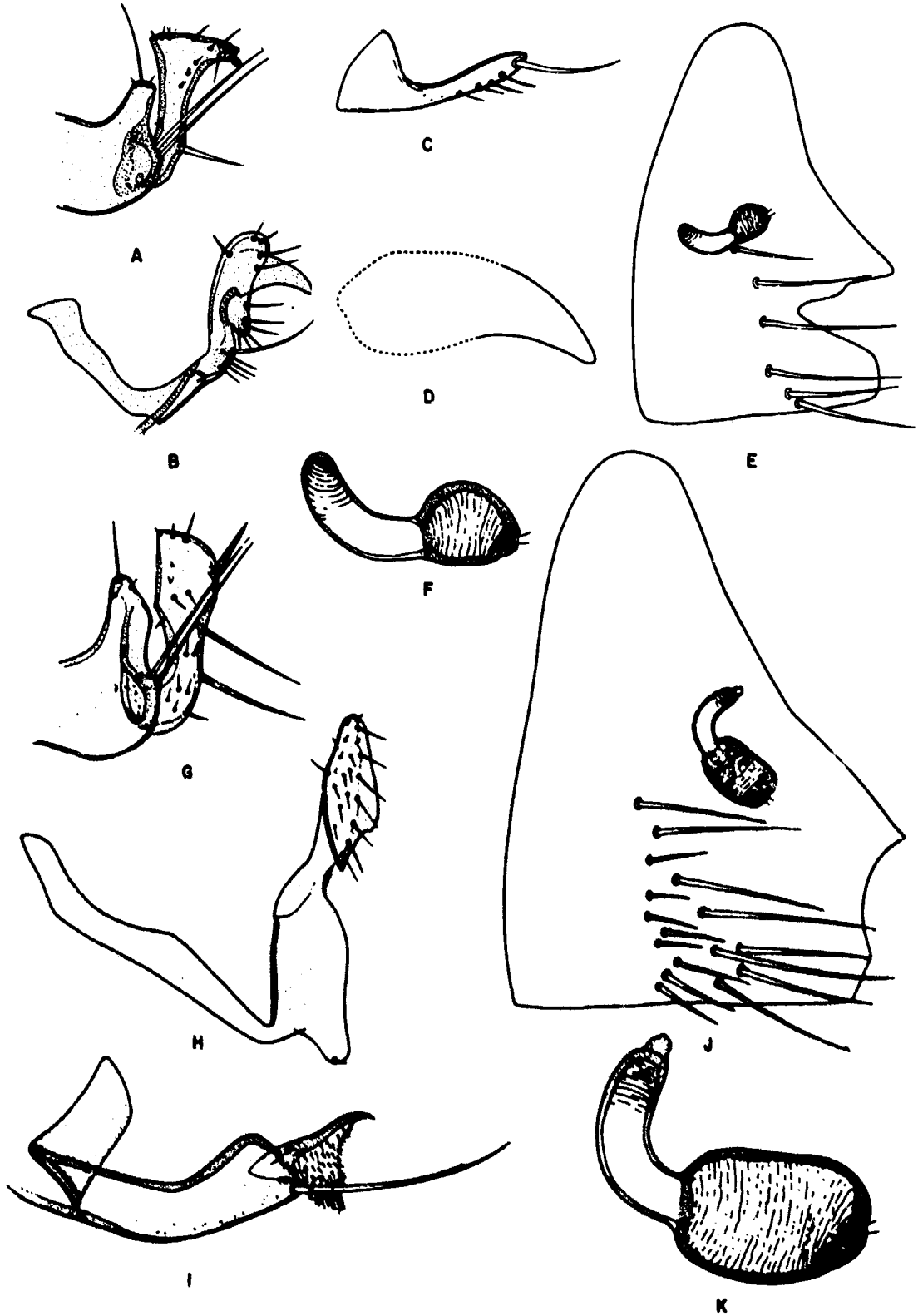
Map 9

Distribution of <u>Monopsyllus</u> <u>vison</u> (Baker) and <u>Monopsyllus</u>
<u>ciliatus</u> <u>protinus</u> (Jordan).

Both species are associated with <u>Tamiasciurus</u> <u>hudsonicus</u>
(Erxleben), although the second species is associated with <u>T.</u>
<u>douglasii</u> (Bachman) in the Pacific Northwest.

ALASKA
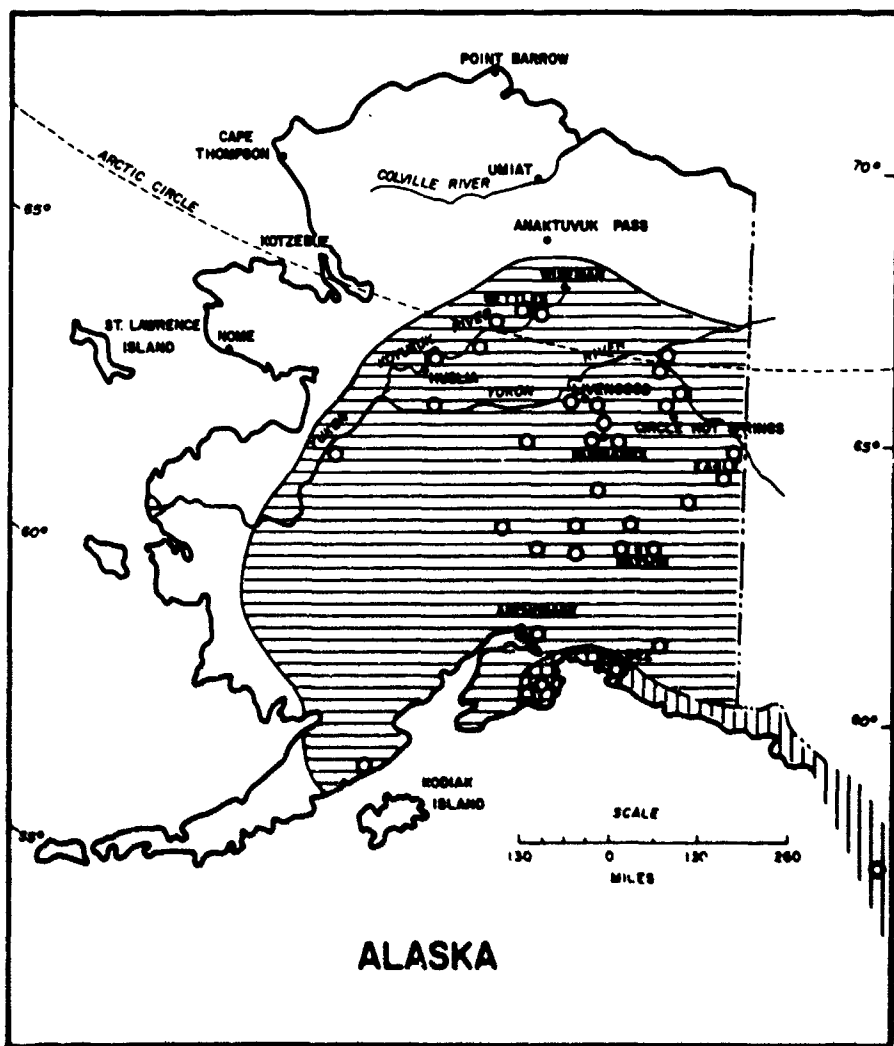
▥	☐	<u>Monopsyllus</u> <u>ciliatus</u> <u>protinus</u> (Jordan).
▤	○	<u>Monopsyllus</u> <u>vison</u> (Baker).

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<div align="center">Orchopeas caedens caedens (Jordan, 1925)</div>
<div align="center">(Plate XXVIII, I, J, K; Map 10)</div>

Ceratophyllus caedens Jordan, 1925. Nov. Zool., 32:104-105. Jordan,
  1929, Nov. Zool., 35:29-30. Stanford, 1931, Proc. Utah Acad. Sci.,
  1931:153. Stewart, 1933, Jour. N.Y. Ent. Soc. 41:257.

Orchopeas caedens (Jordan). Jordan, 1933, Nov. Zool., 39:71-72. Wood,
  1936, Univ. Calif. Publ. in Zool., 41:134. Philip, 1938, Jour. Parasit.,
  24:486. Jellison and Kohls, 1939, Pub. Health Rept., 54:2022. Mail
  and Holland, 1939, Proc. Sixth Pac. Sci. Cong. 5:126. Eskey and Haas,
  1940, Pub. Health Bull., No. 254:29-74. Fox, 1940, Fleas East.
  United States, p. 62, pl. XVI, figs. 80-82. Hubbard, 1940, Pac. Univ.
  Bull., 37(4). Augustson, 1943, Bull. So. Calif. Acad. Sci., 42:80.
  Hatt, 1943, Jour. Mammal., 24:311-345. Ewing and Fox, 1943, U.S.
  Dept. Agr. Misc. Publ., 500: p. 33. Fuller, 1943, Jour. N.Y. Ent.
  Soc., 51:7. Jellison, Kohls and Mills, 1943, Misc. Publ. Mont. Bd.
  Ent., 2:5, 9-10, 15, 19. Hubbard, 1943, Pac. Univ. Bull., 39:1-12.
  Stanford, 1944, Proc. Utah Acad. Sci. Arts and Letters, 19-20:176.
  Brown, 1944, Ann. Ent. Soc. Amer., 37:209. Hubbard, 1947, Fleas
  West N. Amer., pp. 102-104, fig. 35. Holland, 1949, Proc. Ent. Soc.
  Br. Col., 45:11. Holland, 1949, Siphonaptera of Canada, pp. 136-138,
  figs. 221-223, 225. Knipping, Morgan, and Dicke, 1950, Wisc. Acad.
  Sci. Arts and Letters, 40:199-206. Tipton, Masters Thesis, Brig.
  Young Univ., p. 64. Ecke and Johnson, 1952, Pub. Health Serv. Publ.,
  No. 210. Cross and Knowlton, 1953, Bull. Brooklyn Ent. Soc., June,
  1953, p. 73. Geary, 1953, Arctic Aeromed. Lab. Rept., Nov., 1953,
  37 pp. Augustson, 1955, So. Calif. Acad. Sci., 54:36-39. Judd, 1955,
  Jour. Parasit., 41:441-442. Morlan, 1955, Tex. Rep. Biol. and Med.,
  13:93-125. Wiseman, 1955, Univ. Wyo. Publ., 19: 28pp. Holdenried
  and Morlan, 1956, Amer. Midl. Nat., 55:369-381. Holland, 1956 (1958)
  Proc. Tenth Internat. Cong. Ent., 1:645-658. Stark, 1958, Siphonaptera
  of Utah, p. 167, fig. 106. Gabbutt, 1961, Ecology, 42:518-525.

  Orchopeas caedens caedens (Jordan, 1925) is a poorly understood
subspecies. It can be separated from Orchopeas caedens durus (Jordan,
1929), only by the sclerotization immediately anterior to the lateral sinus of
sternum VII in the female. This subspecies occurs upon the red squirrel,
T. hudsonicus, as does O. c. durus. It seems somewhat incongruous for
two subspecies to be occurring in the same area upon the same host.

<div align="center">Records</div>

Eagle City, Alaska

  Tamiasciurus hudsonicus, 14-VII-62, 3F (C.E.H.)
                          14-VII-62, 2F (C.E.H.)

<div align="center">193</div>

PLATE XXVIII

Orchopeas caedens durus (Jordan, 1929)

      Figure A: Clasper of male

      Figure B: Sternum IX of male

      Figure C: Distal arm of sternum IX, apical lobe

      Figure D: Sternum VIII of male

      Figure E: Sternum VII and variation

      Figure F: Spermatheca

      Figure G: Ventral anal lobe

      Figure H: Hind tarsus, segment V of female

Orchopeas caedens caedens (Jordan, 1925)

      Figure I: Sternum VII of female

      Figure J: Variation in posterior margin of sternum VII

      Figure K: Spermatheca

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PLATE XXVIII

Map 10

Distribution of <u>Orchopeas</u> <u>caedens</u> <u>caedens</u> (Jordan) and
<u>Orchopeas</u> <u>caedens</u> <u>durus</u> (Jordan).

These are two poorly understood subspecies. The
nominate form is known presently in Alaska from one
record.

ALASKA

△ <u>Orchopeas</u> <u>caedens</u> <u>caedens</u> (Jordan).

▤ ◯ <u>Orchopeas</u> <u>caedens</u> <u>durus</u> (Jordan).
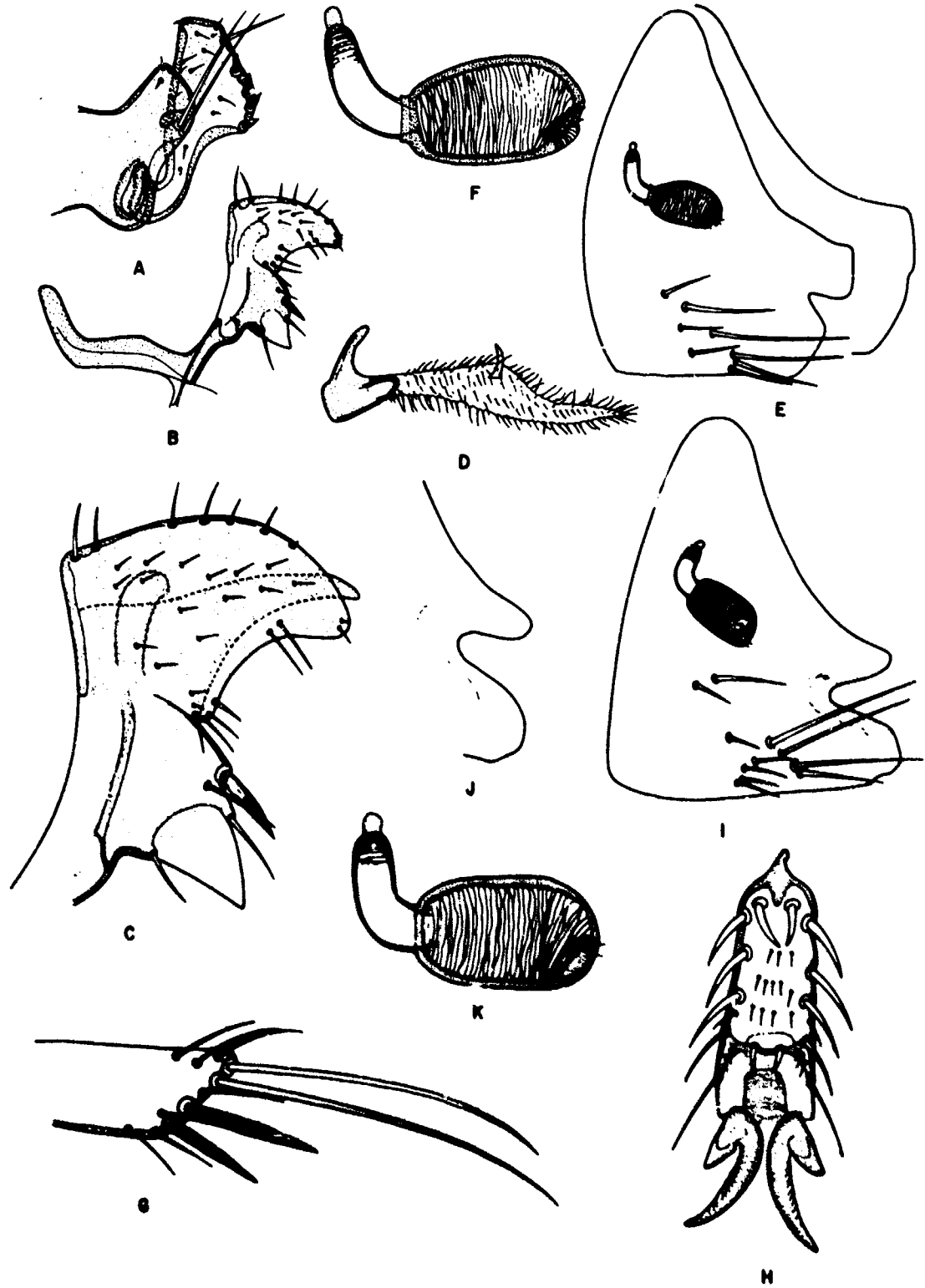
Orchopeas caedens durus (Jordan 1929)
(Plate XXVIII, A, B, C, D, E, F, G, H; Map 10)

Ceratophyllus caedens durus Jordan, 1929. Nov. Zool., 35:29-30. Jordan
1929, Nov. Zool., 35:170. Jordan, 1932, Nov. Zool., 38:253.

Orchopeas caedens durus (Jordan). Jordan, 1933, Nov. Zool., 39:71.
Spencer, 1936, Proc. B.C. Ent. Soc., Br. Col., 1935:13. Wagner,
1936, Can. Ent., 68:199. Jordan, 1937, Nov. Zool., 40:284. Jellison
and Kohls, 1939, Pub. Health Rept., 54:2022. Hubbard, 1940, Pac.
Univ. Bull., 37(4). Svihla, 1941, Univ. Wash. Pub. Biol., 12(2):15.
Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Hubbard, 1947, Fleas West,
N. Amer., p. 105, fig. 36. Holland, 1949, Proc. Ent. Soc. Br. Col.,
45:11. holland, 1949, Siphonaptera of Canada, pp. 138-139, fig. 224a-i.
Geary, 1953, Arctic Aeromed. Lab. Rept., 1, 37 pp. Gill, 1954,
Arctic Aeromed. Lab. Rept., 2, 50 pp. Lane, 1954, Ecol. Mono., 24:
227-267. Benton, 1955, Jour, N.Y. Ent. Soc., 63:139-140. Brown,
1955, Canad. Ent., 87:362-365. Benton and Krug, 1956, N.Y. State
Mus. and Sci. Serv. Bull., 353. Schiller and Rausch, 1956, Arctic, 9:
191-201. Geary, 1959, Cornell Exp. Sta. Memoir, 355, figs. 110, 115.
Benton and Cerwonka, 1960, Am. Midl. Nat., 63:383-391. Holland,
1963, Bishop Mus. Press, pp. 45-63.

Orchopeas caedens durus (Jordan, 1929) is a widely distributed subspecies
upon the red squirrel, T. hudsonicus. The distribution of the subspecies
durus is apparently concordant with that of M. vison.

With regards to host range, I believe that O. c. durus has a much broader
spectrum than the other flea commonly encountered upon the red squirrel,
Monopsyllus vison (Baker). They both occur in about equal numbers upon
T. hudsonicus, although the average listed in Table XI for M. vison is
slightly higher, by about one flea per animal, than that of O. c. durus
(Table XII). On the other hand, I believe that Mustela erminea and Mustela
vison are at least acceptable secondary hosts for this species. If the
ermine has fleas, almost invariably some of them will be O. c. durus. There
does not seem to be the same crossing over on the weasel, for example, with
the Oropsylla fleas of the arctic ground squirrel. I think there is an equal
opportunity for this to happen.

In a small, not too well-controlled experiment, an ermine was
"de-fleaed," placed in a cage, and furnished with nest material from an
old Tamiasciurus nest that had been in a Berlese funnel for several days. I
am reasonably certain that there were no live adult or larval fleas in this
nest material. For six weeks, the weasel was fed on red squirrels which
were shot and then placed in the pen with it. From a good sampling of the
squirrels in this region, we knew that M. vison and O. c. durus occurred

in about equal numbers on the squirrels. Inasmuch as M. vison is larger and darker, it was more conspicuous at first. However, the ermine died at the end of the six-week period, and the nest material was run through a Berlese funnel. Only one specimen of Monopsyllus was recovered, whereas 150 adults of O. c. durus were obtained. Approximately 350 larvae were obtained, which were ascertained as belonging to the genus Orchopeas. While this was not a large or well-controlled experiment, it is believed that the results are self-evident, even though some of the larvae must have been produced by eggs developed while the flea was on the squirrel and laid immediately after being placed on the ermine. Beyond October, I have not found durus to be present in the nests of the red squirrel that occur above the ground until the latter part of April.

TABLE XII

Host Associations of
Orchopeas caedens durus (Jordan)

Host	Total No. Fleas	No. Positive Specimens Collected	Average/Host
Acanthis flammea	02	01	
Canis lupus	01	01	
Castor canadensis	01	01	
Clethrionomys rutilus	01	01	
Glaucomys sabrinus	01	01	
Homo sapiens	01	01	
Lepus americanus	01	01	
Martes americana	03	03	
Mustela erminea	63	14	4.5
Mustela vison	43	07	6.1
Petrochelidon pyrrhonota	01	01	
Riparia riparia	01	01	
Spermophilus undulatus	03	01	
Tamiasciurus hudsonicus	455	90	5.1

Records

Allakaket, Alaska

Tamiasciurus hudsonicus
7-VIII-55, 8M, 6F (C. E. H.)

Berry Creek, near Dot Lake, Alaska

Mustela erminea
25-I-62, 1M, 1F (M. M.)

Bettles Village, Alaska

Tamiasciurus hudsonicus
23-VII-55, 2F (C. E. H.)
16-17-18-VIII-59, 2M 9F (C. E. H.)

Circle Hot Springs, Alaska

Lepus americanus
25-X-61, 1M (C. E. H.)

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Circle Hot Springs, (cont'd)

Tamiasciurus hudsonicus
9-VI-55, 1M (C. E. H.)
9-VI-55, 1M (C. E. H.)
4-VII-56, 1M (C. E. H.)
25-VIII-59, 1F (C. E. H.)
25-VIII-59, 5F (C. E. H.)
25-VIII-59, 5M, 3F (C.E.H.)
25-VIII-59, 2M, 10F (C. E. H.)
24-VIII-59, 3M, 7F (C.E. H.)
23-VIII-59, 5M, 7F (C.E.H.)
25-VIII-59, 7M, 13F (C. E. H.)
25-VIII-59, 2F (C. E. H.)
25-VIII-59, 1M (C. E. H.)
25-VIII-59, 4M, 4F (C.E. H.)
26-X-61, 12F (C.E. H.)
26-X-61, 37M, 77F (C.E. H.)
26-X-61, 73M, 99F (C.E. H.)
26-X-61, 5M, 3F (C. E. H.)
26-X-61, 11M, 32F (C. E. H.)
26-X-61, 15M, 28F (C.E. H.)
25-X-61, 2M, 3F (C. E. H.)
25-X-61, 6F (C. E. H.)
14-IX-61, 1M, 1F (C. E. H.)
14-IX-61, 13M, 18F (C. E. H.)
14-IX-61, 10M, 8F (C. E. H.)
14-IX-61, 3M, 1F (R. S.)
10-VIII-61, 6M, 7F (C.E. H.)
25-VIII-59, 2M, 1F (C.E.H.)
10-VIII-61, 1M, 2F (R.D.C.)
10-VIII-61, 66M, 80F (C. E. H.)
10-VIII-61, 7M, 9F (C.E. H.)
10-VIII-61, 1M (C. E. H.)
9-VIII-61, 1F (R.D.C.)

Denali Highway, M. P. 1, Alaska

Tamiasciurus hudsonicus
11-X-61, 1M, 3F (C. E. H.)
11-X-61, 2M, 1F (C. E. H.)
11-X-61, 1M, 6F (C. E. H.)

Denali Highway, M. P. 10, Alaska

Mustela erminea
26-VIII-61, 1M (C. E. H.)

Dry Creek, Alaska

Tamiasciurus hudsonicus
4-VII-62, 3F (E. G. V.)
4-VII-62, 6F (E. G. V.)
29-VI-62, 1M, 5F (E. G. V.)
25-VI-62, 1F (E. G. V.)
16-VI-62, 8F (E. G. V.)

Eagle, Alaska

Canis lupus
14-XII-62, 1F (M. M.)

Martes americana
14-XII-62, 2M, 1F (M. M.)

Mustela erminea
14-XII-62, 1M, 2F (M. M.)

Tamiasciurus hudsonicus
13-VII-62, 2M, 1F (C. E. H.)
14-VII-62, 2M, 4F (C. E. H.)
14-VII-62, 1M, 4F (C. E. H.)
10-VIII-62, 1F (M. M.)

Eagle environs, Alaska

Martes americana actuosa
-XI-61, 48M, 53F, 20 part.(M. M.)

Mustela erminea
-XI-62, 3M, 1F (M. M.)
11-XII-62, 1F (M. M.)

Tamiasciurus hudsonicus
11-XII-62, 1F (M. M.)

Elliott Highway, Alaska

Tamiasciurus hudsonicus
28-IX-53, 3M, 1F

Fairbanks, Alaska

Acanthis flammea
1962, 2F (J. Okedara)

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Fairbanks, Alaska (cont'd)

Clethrionomys rutilus
20-IX-59, 1F (W.O.P.)

Glaucomys sabrinus
25-IX-60, 1F (W.O.P.)

Homo sapiens
25-IX-61, 1F (C.E.H.)

Mustela erminea
21-IX-61, 5M, 16F (C.E.H.)
15-XII-59, 2M (L. Schene)
15-XII-59, 2M (L. Schene)
22-IX-61, 2F (W.O.P.)
9-VII-62, 1F (R.D.C.)

Tamiasciurus hudsonicus
3-VII-61, 2M, 2F (W.O.P.)
4-VII-61, 2F (W.O.P.)
12-VII-61, 2M (W.O.P.)
1-VIII-61, 1F (W.O.P.)
2-VIII-61, 3F (W.O.P.)
2-VIII-61, 1M, 1F (W.O.P.)
2-VIII-61, 3M, 8F (W.O.P.)
24-VI-61, 1M, 2F (W.O.P.)
25-VI-61, 1F (W.O.P.)
5-IV-62, 2F (W.O.P.)
12-IV-62, 1F (W.O.P.)
12-IV-62, 2M, 2F (W.O.P.)
25-IX-59, 1F (Vogelsang)
7-VIII-59, 1F (C.E.H.)
30-X-61, 1M (C.J. Studley)
15-XII-59, 1M (L. Schene)
25-IX-59, 1F (Vogelsang)
15-XII-59, 1M (L. Schene)
7-VIII-59, 2M (C.E.H.)
7-VIII-59, 3F (C.E.H.)
7-VIII-59, 1F (C.E.H.)
20-VII-61, 2M, 2F (J.H.E.)
20-VII-61, 3M (J.H.E.)
8-VII-61, 1M, 3F (W.O.P.)
6-IV-62, 1M, 6F (W.O.P.)
16-XI-61, 1M, 2F (W.O.P.)
9-VII-62, 2M, 6F (C.E.H.)
9-IX-61, 2F (C.E.H.)

16-VI-56, 1M (C.E.H.)
16-VI-56, 2F (C.E.H.)
16-VI-56, 1F (C.E.H.)
18-VI-62, 2F (J.L.C.)

Ferry, Alaska

Mustela erminea
20-X-63, 1M (H.S.)

Fort Yukon, Alaska

Citellus undulatus
3-VIII-57, 1M, 2F (C.E.H.)

Cross Fox
26-X-35, 2F (H.W. Terhune) USNM

40 Mi. S.W. Ft. Yukon, Alaska

Tamiasciurus hudsonicus
26-VI-62, 4F (J.C.)
27-VI-62, 1M, 2F (J.C.)

Gulkana River, Alaska

Beaver
-II-53, 1F (L., L.H.)

Hughes, Alaska

Tamiasciurus hudsonicus
2-VIII-55, 1M, 11F (C.E.H.)

Huslia, Alaska

Tamiasciurus hudsonicus
22-VI-57, 4M, 8F (C.E.H.)

Livengood, Alaska

Petrochelidon pyrrhonota
26-VII-61, 1F (C.E.H.)

Tamiasciurus hudsonicus
15-V-53, 1F
15-V-53, 1F

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Minto, Alaska

Tamiasciurus hudsonicus
   8-VIII-57, 2M (C. E. H.)
   9-VIII-56, 1M (C. E. H.)

Nolan Creek, Alaska

Tamiasciurus hudsonicus
   12-VIII-59, 3F (C. E. H.)

Olnes, Alaska

Tamiasciurus hudsonicus
   13-II-53, 3M, 3F
   18-IV-53, 1M, 2F
   18-IV-53, 1M, 6F

Paxson, Alaska

Marten
   15-I-53, 1F (L. L. H.)

Mustela
   20-XII-53, 2F (L. L. H.)
   5-XII-53, 3F (L. L. H.)
   13-XII-53, 1M, 4F (L. L. H.)
   -XII-53, 1M, 3F (L. L. H.)

Weasel
   5-XI-53, 2F (L.L. H.)
   21-IX-52, 1M, 2F (L.L. H.)

Paxson Lake, Alaska

Martes americana actuosa
   19-XI-61, 1M (L. L. H.)

Mustela erminea
   5-VI-60, 2M, 6F (L. L.H.)
   6-XII-55, 1M, 4F (L. L. H.)
   25-XI-55, 1M, 7F (L. L. H.)

Mustela vison
   18-XI-55, 6M, 7F (L. L. H.)
   10-XII-55, 3F (L. L.H.)

Tamiasciurus hudsonicus
   22-XI-52, 1F (L. L. H.)
   27-VIII-52, 3F (L. L. H.)
   20-XI-61, 5M, 3F (L. L. H.)

Richardson Hwy, M. P. 320, Alaska

Riparia riparia
   17-VI-62, 1M (C. E. H.)

Seward, Alaska

Pine Squirrel
   18-20-VI-37, 1M, 1F USNM

Steel Creek Road, 12 Mi., Alaska

Tamiasciurus hudsonicus
   31-III-53, 2F

Wilbur Creek, Alaska

Tamiasciurus hudsonicus
   10-VIII-56, 2M (C. E. H.)
   10-VIII-56, 6M, 6F (C.E. H.)
   11-VIII-56, 10M, 9F (C. E. H.)
   30-VI-57, 3F (C. E. H.)
   30-VI-57, 1F (C. E. H.)
   24-IX-61, 2M, 3F (C. E. H.)

OPISODASYS Jordan, 1933

Opisodasys Jordan, 1933. Nov. Zool., 39:72.

   Frontal tubercle small. Eye well-developed. Anterior margin of head usually strongly curved, more so than in most other Ceratophyllinae. Labial palps extending slightly beyond the apex of procoxa. Movable process with

two to three dark spiniforms. Ventral portion of the apical lobe of sternum IX without spiniforms. Sternum X in female rounded ventrally, not angular as in Orchopeas. Anal stylet long and cur ed. Bulga of spermatheca oblong, convex dorsally but concave ventrally.

Opisodasys is a Nearctic genus and can be divided into two groups on the basis of host preferences. The two species occurring in Alaska represent these two groups; Opisodasys keeni is associated with the cricetid rodents in southeastern Alaska, whereas Opisodasys pseudarctomys is restricted to Glaucomys and Tamiasciurus throughout the rest of Alaska.

Key to Alaskan species of Opisodasys

Males

Posterior margin of MP of clasper concave, posteroapical projection with a heavy pigmented spiniform; posterobasal area with two short spiniforms. Associated with Glaucomys sp. pseudarctomys

Posterior margin of MP relatively straight, apical spiniform slender, two short spiniforms on lower half. Associated with cricetid rodents keeni

Females

Mesonotum with four or fewer rows of setae. Dorsal wall of bulga relatively straight pseudarctomys

Mesonotum with more than four rows of setae, dorsal wall of bulga convex keeni

Opisodasys pseudarctomys (Baker, 1904)
(Plate XXIX, A, B, C, D, E, F, G; Map 11)

Ceratophyllus pseudarctomys Baker, 1904. Proc. U.S. Nat'l. Mus., 27:387, 399-400, 446. Stewart, 1928, Cornell Univ. Memoir 101:869. Jordan, 1929, Nov. Zool., 35:28. Jordan, 1933, Nov. Zool., 39:72. Jellison, 1939, Jour. Parasit., 25:415-416, pl. I-III. Fox, 1940, pp. 57-58, pl. XIV, figs. 68-69, 72. Holland, 1941, Proc. Ent. Soc. Br. Col., 37:11-12. Dampf, 1942, Rev. Brasil Biol., 2(4):506-507, figs. 10-11. Rio de Janeiro, D. F. Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Publ., No. 500:37. Fuller, 1943, Bull. Brook. Ent. Soc., 38:20. Fuller, 1943, Jour. N.Y. Ent. Soc., 51:6. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Jameson, 1943, Can. Ent., 75:177. Snodgrass, 1946, Smith. Misc. Coll., 104:1-89, pl. 1-5, 7-9, 12-14, 18-19. Hubbard, 1947, Fleas West. N. Amer., pp. 112-113, fig. 42. Holland, 1949, Proc. Ent. Soc. Br. Col., 45:11. Holland, 1949, Siphonaptera of Canada, p. 139, figs.

216-217. Tipton, 1950, Masters Thesis, Brig. Young Univ., p. 63. Cross and Knowlton, 1953, Bull. Brooklyn Ent. Soc., p. 73. (June). Geary, 1953, Arctic Aeromed Lab. Rept., 37pp. Tibbetts, 1953, Jour. Econ. Ent., 46:530. Benton and Krug, 1956, N. Y. State Mus. and Sci. Serv. Bull., 353 (Sept.). Burbutis, 1956, N. J. Agr. Exp. Sta. Bull., 782. Holland, 1956 (1958), Tenth Internat. Cong. Ent., 1:645-658. Geary, 1959, Cornell Exp. Sta. Mem. 355, figs. Benton and Cerwonka, 1960, Am. Midl. Nat., 63:383-391. Holland, 1963, Bishop Mus. Press, pp. 45-63.

Ceratophyllus acasti Rothschild. Rothschild, 1905, Nov. Zool., 12:168-170. Dunn and Parker, 1923, Pub. Health Rept., 38:2771, 2775.

Ceratophyllus pseudarctomys acasti Rothschild. Baker, 1905, Proc. U. S. Nat'l. Mus., 29:150. Wagner, 1929, Konowia, 8:311-315. Stewart, 1933, Jour. N. Y. Ent. Soc., 61:256.

Opisodasys pseudarctomys acasti (Baker). Harkema, 1936, Ecol. Mon., 6: 214.

Opisodasys pseudarctomys (Baker, 1904), is associated with the flying squirrel, Glaucomys sabrinus (Shaw), from the Atlantic Coast states north into Canada and west into British Columbia, although apparently not west of the Coast Mountains. I believe that it is essentially a nest flea; therefore, one seldom finds large numbers of this flea upon the host. For example, I had a nest sent to me from Michigan by T. Wayne Porter some years ago, and on running this nest through a Berlese funnel, collected 175 adults. Unfortunately, I was unable to secure nests of the flying squirrels in Alaska, although the animal itself is a relatively common one in the central portion of this state. Frequently the flying squirrel will be completely free of siphonapterous ectoparasites.

I regard both O. pseudarctomys and its host as postglacial migrants into the boreal region of North America.

Records

Fairbanks environs, Alaska

Glaucomys sabrinus, 26-IX-60, 1F (J. F. A.)
                    25-IX-60, 2F (W. O. P.)
                    22-XII-59, 1F (W. O. P.)

PLATE XXIX

Opisodasys pseudarctomys (Baker, 1904)

Figure A: Clasper of male

Figure B: Sternum IX of male

Figure C: Sternum VIII of male

Figure D: Crochet

Figure E: Anal stylet of female

Figure F: Sternum VII of female

Figure G: Spermatheca

Opisodasys keeni (Baker, 1896)

Figure H: Clasper of male

Figure I: Clasper of male, enlarged drawing

Figure J: Sternum IX, scale drawing

Figure K: Sternum IX, enlarged drawing

Figure L: Sternum VII of female

Figure M: Spermatheca

PLATE XXIX
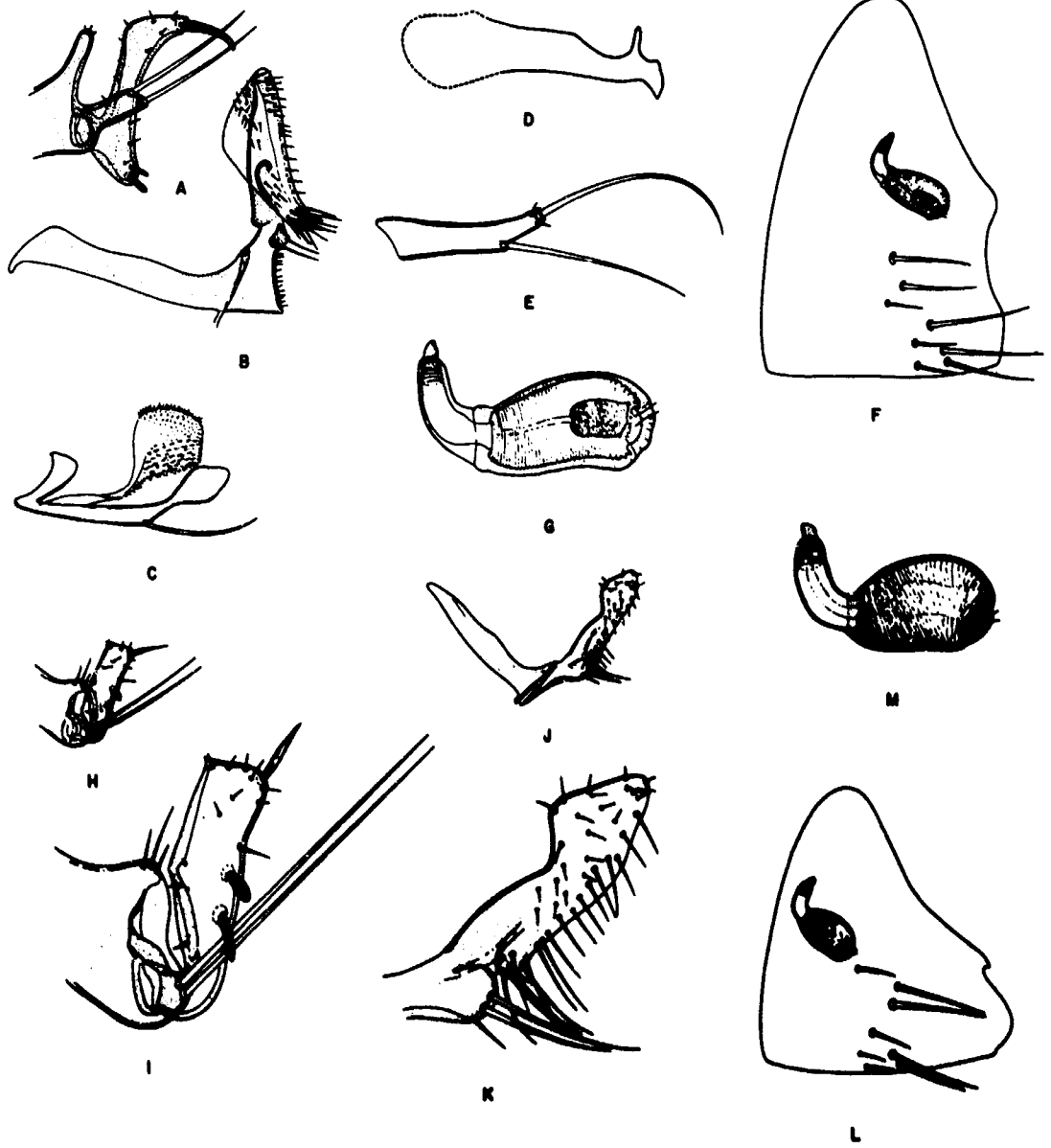
Map XI

Distribution of <u>Opisodasys pseudarctomys</u> (Baker) and
<u>Tarsopsylla octodecimdentata coloradensis</u> (Baker).

The former species is associated with the <u>Glaucomys</u>
<u>sabrinus</u> (Shaw), the latter with <u>Tamiasciurus hudsonicus</u>
(Erxleben).

ALASKA
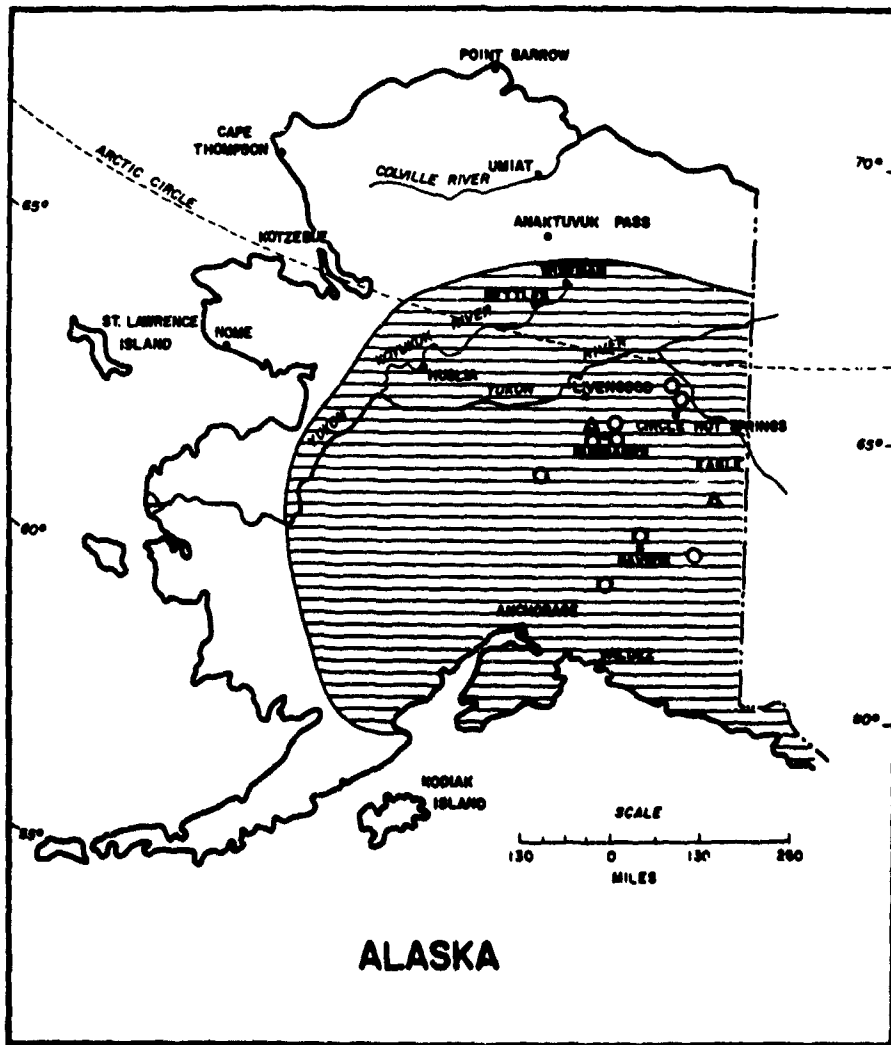
△   <u>Opisodasys</u> <u>pseudarctomys</u> (Baker).

▤   ○ <u>Tarsopsylla</u> <u>octodecimdentata</u> <u>coloradensis</u> (Baker).

Opisodasys keeni (Baker, 1896)
(Plate XXIX, H, I, J, K, L, M)

Pulex keeni Baker, 1896. Can. Ent., 28:234.

Ceratophyllus keeni (Baker). Baker, 1904, Proc. U.S. Nat'l Mus., 27:400, 444. Fox, 1914, Hyg. Lab. Bull., No. 97:25.

Opisodasys keeni (Baker). Jordan, 1933, Nov. Zool., 39:72. Spencer, 1936, Proc. Br. Col. Ent. Soc., 1935: 13. Wagner, 1936, Can. Ent., 68:198-199. Ioff, 1936, Zeit. Parasiten., 9:73-124. Jellison, 1939, Jour. Parasit., 25:416, pl. I-III. Mail and Holland, 1939, Proc. Sixth Pac. Sci. Cong., 5:126. Eskey and Haas, 1940, Pub. Health Bull., 254:29-74. Hubbard, 1940, Pac. Univ. Bull., 37(4)1:4. Augustson, 1941, Bull South. Calif. Acad. Sci., 40(3):153. Hubbard, 1941, Pac. Univ. Bull., 37(9A): 3-4. Svihla, 1941, Univ. Wash. Pub. Biol., 12(2):15. Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Pub., No. 500. Jellison, Kohls, and Mills, 1943, Misc. Publ. Mont. Bd. Ent., 2:5, 16. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Stanford, 1944, Proc. Utah Acad. Sci. Arts and Letters, 19-20:176. Hubbard, 1947, pp. 110-112, figs. Holland, 1949, Proc. Ent. Soc. Br. Col., 45:11. Hubbard, 1949, Bull. South. Calif. Acad. Sci., 48:117. Holland, 1949, Siphonaptera of Canada, pp. 132-133, figs. Tipton, 1950, Masters Thesis, Brig. Young Univ., p. 64. Ecke and Johnson, 1952, Pub. Health Serv. Pub. 210, Pub. Health Mono., 6:36 pp. Beck et al., 1953, Proc. Utah Acad. Sci. Arts and Letters, 30:43-52. Jameson and Brennan, 1957, Ecol. Mono., 27:45-50. Holland, 1956 (1958), Proc. Tenth Internat. Cong. Ent., 1:645-658. Holland, 1963, Bishop Mus. Press, pp. 45-63. Parker and Howell, 1959, Jour. Parasit., 45:597-604. Stark, 1958, Siphonaptera of Utah, p. 173.

Opisodasys keeni (Baker, 1896) is a parasite which occurs throughout the western half of the United States, usually upon mice belonging to the genus Peromyscus. In Alaska it is confined to the southeastern portion and apparently is associated with P. sitkensis Merriam.

Like the preceding species, this is a postglacial migrant into southeastern Alaska, apparently coming from a Pacific Northwest refugium.

TARSOPSYLLA Wagner, 1927

Tarsopsylla Wagner, 1927. Konowia, 6:108, 110.

Frontal tubercle absent. Eye well-developed. Agreeing with the preceding two genera, Orchopeas and Opisodasys, in possessing but one lateral seta on the outer surface of the profemur. Segment I of metatarsus longer than length of segments II-IV combined. Apical spinelets on anterior abdominal terga. Mesodorsal area of tergum VIII with spiculose area. Movable

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process of clasper long, with three well-developed marginal setae. Sternum VIII with one long apical seta and a short apical membranous lobe that is densely ciliated; anterior margin of membrane heavily chitinized. Antepygidial bristles variable (3-4). Bulga of spermatheca longer than wide, but shorter than hilla. Hilla papillate. Sternum IX with ventral portion of the distal arm broadly expanded; wider than apical lobe.

Tarsopsylla Wagner is a Holarctic genus; it is currently believed that the Nearctic form is no more than subspecifically distinct from its Eurasian counterpart (Holland, 56). Arboreal sciurids of various genera appear to be the true hosts for this flea.

Tarsopsylla octodecimdentata coloradensis (Baker, 1895)
(Plate III, G; Plate XXVII, G, H, I, J, K; Map 11)

Pulex coloradensis Baker, 1895. Can. Ent., 27:110-112.

Ceratophyllus coloradensis (Baker). Wagner, 1898, Horae Soc. Ent. Ross., 31:560. 1904, Proc. U.S. Nat'l. Mus., 27:388, 417, 441.

Tarsopsylla coloradensis (Baker). Jordan, 1933, Nov. Zool., 39:72. Spencer, 1936, Proc. Br. Col. Ent. Soc., 1935:13. Wagner, 1936, Can. Ent., 68:199. Mail and Holland, 1939, Proc. Sixth Pac. Sci. Cong., 5:127. Holland, 1941, Proc. Ent. Soc. Br. Col., No. 37:11. Ewing and Fox, 1943, U.S. Dept. Agr. Misc. Pub. No., 500:3, fig. 6B. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Hubbard, 1947, Fleas West. N. America, pp. 263-264. fig. 148. Holland, 1949, Proc. Ent., Soc. Br. Col., 45:11. Holland, 1949, Siphonaptera of Canada, pp. 143-144, figs. 235-239. Pratt and Lane, 1950, Proc. Ent. Soc. Wash., 52:305-307. Ecke and Johnson, 1952, Pub. Health Serv. Pub., No. 210, Pub. Health Mono. 6, Part 1: 36 pp. Geary, 1953, Arctic Aeromed. Lab. Rept., pp. 1-37 (Nov.). Gill, Arctic Aeromed. Lab. Rept., 2:1-50. Morlan, 1955, Tex. Rep. Biol. and Med., 13:93-125. Holdenried and Morlan, 1956, Am. Mid. Nat., 55:369-381.

Opisodasys jellisoni. Fox, 1941, Ent. News, 52:45-47, figs. 1-3. Hubbard, 1947, Fleas West. N. America, p. 112, fig. 41.

Orchopeas jellisoni Fox. Hubbard, 1943, Pac. Univ. Bull., 39:1-12.

Tarsopsylla octodecimdentata coloradensis (Baker). Holland, 1956 (1958), Proc. Tenth Internat. Cong. Ent., 1:645-658. Holland, 1963, Bishop Mus. Press, pp. 45-63.

Tarsopsylla octodecimdentata coloradensis (Baker, 1895) is a Holarctic species, the nominate form occurring in the Palearctic in the nests of Sciurus vulgaris Linnaeus. In the Nearctic region, the favorite host is

<u>Tamiasciurus</u> <u>hudsonicus</u>, and it is occasionally found upon the flying squirrel, <u>Glaucomys</u> <u>sabrinus.</u> Smit (132) states that the nominate form, being a nest flea, is found on its host only in small numbers. From my studies in Alaska I agree about the sparcity of the flea upon the host, but I am not certain I can agree that it is found in the nests in large numbers. Of a relatively large series of nests taken throughout the central portion of Alaska, I have failed to secure more than an occasional specimen from the nest. I do not quite understand how to interpret this, without carrying out further studies. On the basis of present evidence, it is amazing that this flea is able to maintain an adequate population for survival with such small numbers both on the host and in the nest.

<u>T. o. coloradensis</u> is apparently adapted better for cold weather than most of the boreal fleas. In storing mammal specimens in refrigerators for some weeks, it is not uncommon to find this flea still viable once the specimens have been returned to room temperature . I secured one nest of <u>T. hudsonicus</u> in January at a temperature of -45° F and only recovered two adult fleas, both of which were <u>T. o. coloradensis.</u>

The biology of this interesting flea should be studied further. It may well be that the fleas are found in underground nests during the winter. Contrary to popular opinion, when the temperature is below -30° F., one seldom sees the red squirrel above ground. It has tunnels underneath the snow and also is more fossorial than its counterparts to the south. When the temperature is extremely low in Alaska during the winter, one can go for as much as two weeks without either hearing or seeing these animals. I know for a fact that they are not available in the nests that are located in the trees at this time.

Records

Berry Creek, Dot Lake, Alaska

   <u>Mustela erminea</u>
     25-I-62, 1M (M. M.)

Fairbanks environs, Alaska

   <u>Clethrionomys rutilus</u>
     27-IX-60, 1M (W. O. P.)

   <u>Glaucomys sabrinus</u>
     22-12-59, 1M (J. F. A.)

   <u>Tamiasciurus hudsonicus</u>
     5-IV-62, 1M (W. O. P.)
     7-VIII-59, 1F (C. E. H.)

     7-VIII-59, 1F (C. E. H.)
     7-VIII-59, 1M (C. E. H.)

Ferry, Alaska

   <u>Mustela erminea</u>
     20-X-63, 1M, 1F (H. S.)

Ft. Wainwright, Alaska

   <u>Glaucomys sabrinus</u>
     6-IX-61, 2M, 1F (C. E. H.)

   <u>Tamiasciurus hudsonicus</u>
     17-II-62, 1F (D. H.)(N)

Denali Hwy., M. P. 1, Alaska   Paxson, Alaska

Tamiasciurus hudsonicus   Mink
11-X-61, 1F (C. E. H.)   14-IX-53, 1F

OROPSYLLA Wagner and Ioff, 1926

Oropsylla Wagner and Ioff, 1926. Revue de Microbiol. et d'epidemiol., 5:86.

Labial palps long, exceeding the combined length of the procoxae and trochanters. Frontal tubercle small. Eyes large and well-pigmented. Inner surface of meso- and metacoxae with setae from base to apex, in addition to those on margin. Basal abdominal sternite without a patch of setae as in Opisocrostis. Sternum VIII of male long and narrow, with long setae, but without apical membranous lobe. Movable process clavate, with setae; lacking spiniforms. Males with one long and one minute antepygidial bristle. Females with bulga ovate to pyriform, depending upon the species. Hilla strongly papillate. Sternum VII never deeply sinuate.

At the present time, there are three species of this Holarctic genus known to occur in Alaska. One species is probably conspecific with its Eurasian counterpart, and the other one is not more than subspecifically distinct (at best) from its Nearctic counterpart, which occurs in the lower half of British Columbia south to Arizona. A third species has apparently migrated north with the ground hog since the recession of the Pleistocene ice sheets, and it appears identical in all respects to specimens occurring in the eastern United States. Members of the genus are largely restricted to the burrowing Sciuridae.

Key to the Alaskan species of Oropsylla

Males

1. Only one acetabular bristle on each side of clasper   arctomys
   Two acetabular bristles on each side of clasper

2. MP of clasper medium-sized, anterior margin relatively
   straight with a subapical conical projection   alaskensis

   MP of clasper short, with an obtuse angle extending down-
   ward from anteroapical margin to half the length of clasper;
   without a subapical projection   idahoensis

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<u>Females</u>

1. Outline of sternum VII below posterior dorsal lobe sinuate,
   hilla and bulga of equal length   <u>arctomys</u>

   Outline of sternum VII below posterior dorsal lobe straight,
   hilla definitely longer than the bulga   2

2. Posterior margin of sternum VII typically long, dorsal lobe
   forming a wide obtuse angle; bulga of spermatheca pyriform
                                                                    <u>alaskensis</u>

   Posterior margin of sternum VII typically short, dorsal lobe
   usually without marked angle; bulga of spermatheca subglobular
   to globular   <u>idahoensis</u>

<div align="center">

<u>Oropsylla alaskensis</u> (Baker, 1904)
(Plate XXX, A, B, C, D, E, F; Map 12)

</div>

<u>Ceratophyllus alaskensis</u> Baker, 1904. Proc. U.S. Nat'l Mus., 27:387,
   394-395, 440.

<u>Oropsylla alaskensis</u> (Baker). Wagner, 1929, Konowia, 8:313. Jordan, 1933,
   Nov. Zool., 39:74. Ioff, 1936, Zeit. Parasit., 9:73-124. Jellison and
   Kohls, 1939, Pub. Health Rept., 54:2022. Ewing and Fox, 1943, U.S.
   Dept. Agr. Misc. Pub., No. 500:49. Hubbard, 1943, Pac. Univ. Bull.,
   39:1-12. Holland, 1944, Can. Ent., 76:246, pl. XVIII, fig. 8, 9. Jel-
   lison, 1945, Jour. Parasit., 31:88-97, pl. 1 and 2. Hubbard, 1947,
   Fleas West. N. Amer., p. 169, figs. Holland, 1949, Siphonaptera of
   Canada, p. 114, figs. 174-175. Geary, 1953, Arctic Aeromed. Lab.
   Rept., No. 1, 37 pp. Holland, 1956 (1958), Proc. Tenth Internat. Cong.
   Ent., 1:645-658. Ioff and Scalon, 1956, Handbook for Fleas East.
   Siberia, p. 65, figs. 41, 109, 111. Holland, 1963, Bishop Mus. Press
   pp. 54-63.

   <u>Oropsylla alaskensis</u> (Baker, 1904) is a parasite of the arctic ground
squirrel, <u>Spermophilus undulatus</u> Pallas. The distribution of the ground
squirrel in the Palearctic region is far more extensive than that known in
the New World. The taxonomy of the genus <u>Spermophilus</u> within the New
World has undergone some rather drastic changes of concept in recent years,
and there is far from complete agreement as to what the various subspecies
of this squirrel should be. This flea is associated with its host on both sides
of the Bering Sea and therefore has a larger distribution than other
boreal fleas.

   Holland states that <u>O. alaskensis</u> is restricted to those parts of the range
of its host that are truly arctic; I can concur that it occurs in the truly

<div align="center">211</div>

arctic portions of Alaska, but I have also found it in the taiga. Some of the subspecies of the arctic ground squirrel, such as Spermophilus undulatus osgoodi, Merriam, occurring in the central-eastern part of Alaska (in the vicinity of Fort Yukon and Circle Hot Springs), are found in cleared areas within the taiga at low elevations and are infested with this flea. The collections made for me by Eleanor Viereck at Dry Creek are the most southerly ones yet reported and are critical ones, since certain of the ground squirrels harbored both O. idahoensis and the species presently under discussion. Insofar as I know, this is the first time such a "meeting ground" has been reported in the distribution of these two species. It is not unlike the situation that occurs in British Columbia, where according to Holland (45, p. 134) Opisodasys pseudarctomys occurs in the same area and (at times) upon the same specimens of the host as O. vesperalis.

TABLE XIII

Host Associations of
Oropsylla alaskensis (Baker)

Host	Total No. Fleas	No. Positive Specimens Collected	Average/Host
Spermophilus undulatus	360	39	9.2

I think the diagrams often drawn to represent the distribution of the arctic ground squirrel throughout Alaska are in need of revision. I have seen arctic ground squirrels along the Koyukuk River valley; for example, in Hughes during July of 1955. Also, I know that they occur near the tops of the mountains in the area of Kaltag along the Yukon River.

The records obtained for me by Ernest Carl at Ogotoruk Creek are of special significance, since a number of these specimens were taken within 15 minutes to an hour after they first appeared outside their burrow from hibernation. The number of fleas encountered after emerging from hibernation is greater than any I have seen at any other time. Dissection of these females did not show the presence of well-developed eggs. Generally, I have not found eggs to appear in the females before about the middle of June in specimens dissected from Fort Yukon and the Circle Hot Springs area. I have found this to be essentially true for the next species, O. idahoensis, which were collected at mile post 8 of the Denali Highway.

Records

Circle Hot Springs, Alaska   10-VI-55, 2M, 1F (C.E.H.)
                                      13-VI-60, 1M (D.T.)
  Spermophilus undulatus
    9-VIII-61, 1F (R.D.C.)

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Colville River (Bluff), Alaska

Spermophilus undulatus
2-VII-62, 1M (C. E. H.)
20-VII-62, 1M, 1F (C. E. H.)

Colville River, Ocean Point, Alaska

Spermophilus undulatus
21-VII-62, 3F (C. E. H.)

Colville River Delta, Alaska

Spermophilus undulatus
29-VII-62, 1F (C. E. H.)

Dry Creek, Alaska

Spermophilus undulatus
4-VII-62, 2M, 7F (E. G. V.)
20-VII-62, 1F (E. G. V.)
20-VII-62, 1M, 1F (E. G. V.)
20-VII-62, 1M, 3F (E. G. V.)
27-VII-62, 1M, 1F (E. G. V.)

Ft. Yukon, Alaska

Spermophilus undulatus
29-VII-57, 1M, 1F (C. E. H.)
3-VIII-57, 1M (C. E. H.)

40 Mi. S W. Ft. Yukon, Alaska

Spermophilus undulatus
28-VI-62, 4M, 1F (J. L. C.)

Golovin, Alaska

Alaskan squirrel
23-V-31, 1M (E. Cushing)USNM

Itkillik River, Alaska

Spermophilus undulatus
24-VII-62, 1M (C. E. H.)

Long. 141, Lat. 69° 20'

Host unknown
12-22-VIII-12, 1M, 2F USNM

Long. 141, Lat. 69° 10'

Host unknown
14-17-VIII-12, 1M, 1F (J. M.
Jessup) USNM

Nolan Creek, Alaska

Spermophilus undulatus
14-VIII-59, 2F (C. E. H.)

Wiseman, Alaska

Spermophilus undulatus
17-VII-57, 3F (C. E. H.)
17-VII-57, 1M, 3F (T. E.)
17-VII-57, 1M, 1F (C. E. H.)

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PLATE XXX

Oropsylla alaskensis (Baker, 1904)

Figure A: Clasper of male

Figure B: Sternum IX of male and crochet

Figure C: Sternum VIII of male

Figure D: Crochet

Figure E: Sternum VII of female

Figure F: Spermatheca

Oropsylla idahoensis (Baker, 1904)

Figure G: Clasper of male

Figure H: Sternum IX of male and crochet

Figure I: Sternum VIII of male

Figure J: Crochet

Figure K: Sternum VII of female

Figure L: Spermatheca

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PLATE XXX
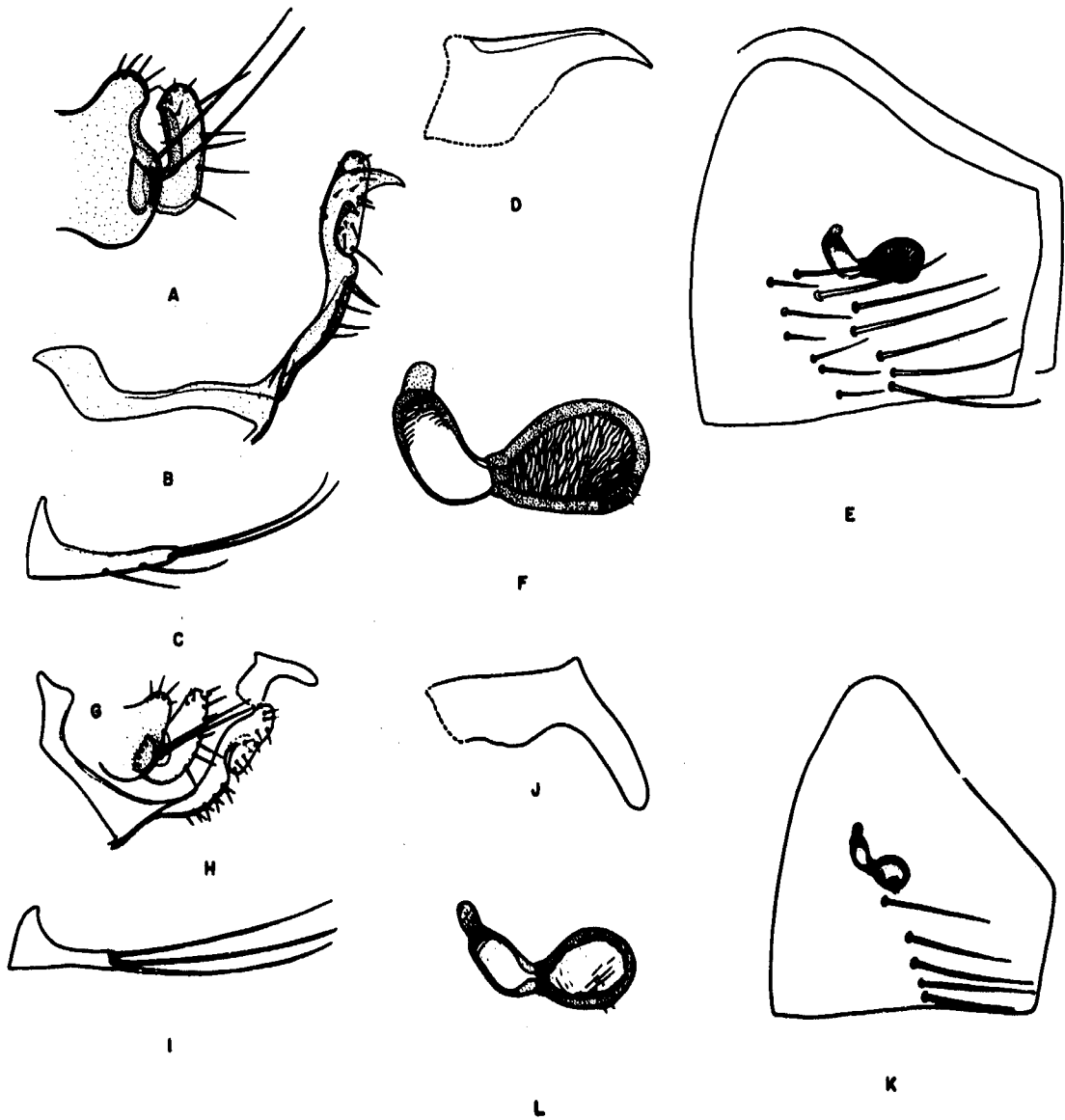
Map 12

Distribution of <u>Oropsylla alaskensis</u> (Baker), <u>Oropsylla</u>
<u>arctomys</u> (Baker), and <u>Oropsylla</u> idahoensis (Baker).

The distribution of <u>O.</u> arctomys was not shown, due
to a lack of data.
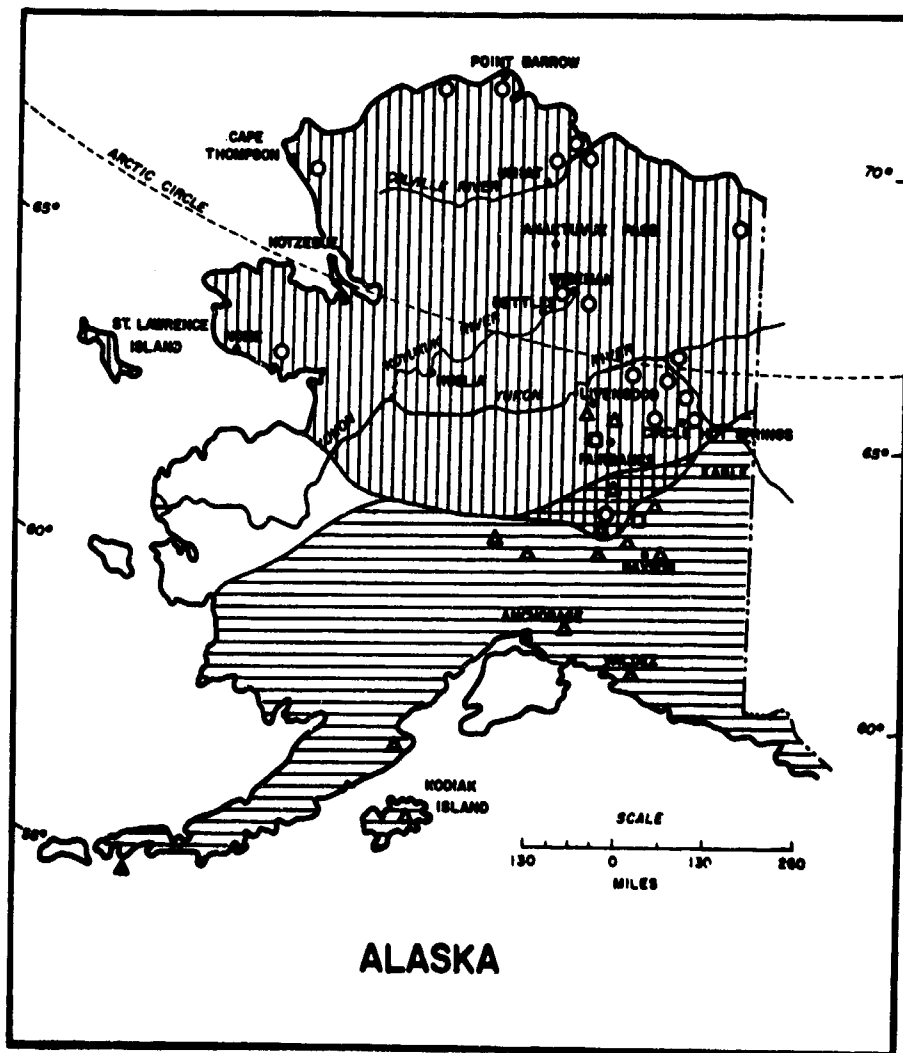
ALASKA

▥	○	<u>Oropsylla alaskensis</u> (Baker).
	□	<u>Oropsylla arctomys</u> (Baker).
▤	△	<u>Oropsylla idahoensis</u> (Baker).

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Oropsylla idahoensis (Baker, 1904)
(Plate XXX, G, H, I, J, K, L; Map 12)

Ceratophyllus idahoensis Baker, 1904. Proc. U.S. Nat'l Mus., 27:388, 413-
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Jordan, 1929, Nov. Zool., 35:32.

Ceratophyllus poeantis Rothschild. Rothschild, 1905, Nov. Zool., 12:155-
156. Dunn and Parker, 1923, Pub. Health Rept., 38:2773-2775.

Ceratophyllus bertholfi Fox. Fox, 1927, Trans. Am. Ent. Soc., 53:211-212.

Oropsylla idahoensis (Baker). Wagner, 1929, Konowia, 8:314. Stanford,
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39:74. Ioff, Zeit. Parasiten., 9:73-124. Wagner, 1936, Can. Ent.,
68:198. Eskey, 1938, Pub. Health Rept., 53:49-57. Eskey and Haas,
1939, Pub. Health Rept., 54:1472. Hubbard, 1939, Pac. Univ. Bull.,
39:1-12. Jellison and Kohls, 1939, Pub. Health Rept., 54:2022. Mail
and Holland, 1939, Proc. Sixth Pac. Sci. Cong., 5:126. Eskey and Haas,
1940, Pub. Health Bull., 254. 30-73, figs. 54-55, 58, 61. Hubbard,
1940, Pac. Univ. Bull., 37(8):5. Hubbard, 1940, Pac. Univ. Bull., 37
(7A):2-3. Stewart, 1940, Sobretiro de la Revista Medicine, Tomo XX,
ana XXI:410. Stewart, 1940, Proc. Sixth Pac. Sci. Cong., 4:433, 434,
436. Augustson, 1941, Bull. South. Calif. Acad. Sci., 40(3):153. Hub-
bard, 1941, Pac. Univ. Bull., 37(8):5-6. Svihla, 1941, Univ. Wash.
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40:153-154. Hubbard, 1942, Pac. Univ. Bull., 38:4, figs. Augustson,
1943, Bull. South, Calif. Acad. Sci., 42:82. Ewing and Fox, 1943, U.S.
Dept. Agr. Misc. Publ., No. 500:49, fig. 7D. Jellison, Kohls and Mills,
1943, Misc. Publ. Mont. Bd. Ent., pp. 5-8, 10-13, 15-16, 18-19.
Brown, 1944, Ent. News, 55:17. Holland, 1944, Proc. Ent. Soc. Br.
Col., 41:5-12, table 1. Stanford, 1944, Proc. Utah Acad. Sci., Arts
and Letters, 19 and 20:176. Brown, 1944, Ann. Ent. Soc. Amer., 37:
210. Jellison, 1945, Jour. Parasit., 31:83-97, pl. 1-2. Burroughs,
1947, Jour. Hyg., 45:371-396. Hubbard, 1947, Fleas West. N. Amer.,
pp. 163-166, fig. 79. Meyer, 1947, Annals N.Y. Acad. Sci., 48:460.
Holland, 1949, Proc. Ent. Soc. Br. Col., 45:10. Holland, 1949, Siphon-
aptera of Canada, pp. 115-116, figs. 176-177. Hubbard, 1949, Bull.
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29:499. Hubbard, 1949, Bull. South. Calif. Acad. Sci., 48:118. Eads,
1949, J. Econ. Ent., 42:144. Holland, 1950, Proc. Ent. Soc. Br. Col.,
46:5-13. Tipton, 1950, Masters Thesis, Brig. Young Univ., p. 65.
Allred, 1952, Great Basin Nat., 12:67-75. Ecke and Johnson, 1952, Pub.
Health Serv. Publ., No. 210, Pub. Health Mono. No. 6, 36 pp. Pollitzer,
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Lab. Rept., 1:1-37. Gill, 1954, Arctic Aeromed. Lab. Rept., 2: 50 pp. Beck, 1955, Brig. Young Univ. Sci. Bull., Biol. Series, 1: 64 pp. Morlan, 1955, Tex. Repts. on Biol. and Med., 13:93-125. Tevis, 1955, Am. Mid. Nat., 53:71-78. Wiseman, 1955, Univ. Wyo. Publ., 19:28 pp. Holland, 1956 (1958), Proc. Tenth Internat. Cong. Ent., 1:645-658. Kartman et al., 1958, Annals N. Y. Acad. Sci., 70:668-711. Stark, 1958, Siphonaptera of Utah, p. 145. Parker and Howell, 1959, Jour. Parasit., 45:507-604. Barnes and Kartman, 1960, Jour. Hyg., Cambridge, 58:347-355. Hubbard, 1960, Ent. News, 71:245-247. Holland, 1963, Bishop Mus. Press, pp. 45-63.

O. idahoensis (Baker, 1904) is a Nearctic species that has a disjunct distribution; it occurs in Alaska, where some have thought it forms a weak subspecies, and does not appear again until one reaches the southern part of central British Columbia. From thence it spreads east to Colorado, west into California and south as far as Arizona. The records from Dry Creek and around Delta, Alaska, are to my knowledge the deepest penetrations into the interior of Alaska. There are large portions of the Tanana Valley that apparently have not yet been populated by the ground squirrels.

According to Stark (138), O. idahoensis has repeatedly been found naturally infected with plague organisms in Colorado, New Mexico, Oregon, Montana and Wyoming.

TABLE XIV

Host Associations of
Oropsylla idahoensis (Baker)

Host	Total No. Fleas	No. Positive Specimens Collected	Average/Host
Ochotona collaris	02	02	
Spermophilus undulatus	83	24	3.5
Tamiasciurus hudsonicus	02	01	

In Alaska this flea is apparently restricted to most of the range of Spermophilus undulatus plesius Osgood and another subspecies, S. u. ablusus (Osgood). I have taken plesius in the Paxson area near talus slopes, where it is associated with the collared pika (Ochotona collaris) and the hoary marmot (Marmota caligata). Except for one record, I have no evidence to indicate that O. idahoensis strays commonly upon these other two animals. I was surprised at this, inasmuch as I have frequently encountered the flea upon

Peromyscus spp. in Utah. In fact, in live-trapping a large series of Pero-
myscus in Utah some years ago, we had an accidental laboratory colony of
O. idahoensis built up in the mouse nests and cages to such an extent that
steps had to be taken to curtail the fleas.

Much remains to be done in working out the distribution of this species
and its biology in Alaska. It is hoped that such studies will be endorsed by
someone in the not too distant future.

Records

Cantwell, Alaska

Spermophilus undulatus
7-VI-62, 2M, 3F (H. S.)

Copenhagen Creek, Alaska

Spermophilus undulatus
8-VI-60, 1M KCE

Denali Hwy., M. P. 30, Alaska

Spermophilus undulatus
4-IX-61, 1F (W. T. V.)

Denali Hwy., M. P. 7, Alaska

Spermophilus undulatus
24-V-62, 1M, 8F (C. E. H.)

Denali Hwy., M. P. 8, Alaska

Spermophilus undulatus
27-VII-62, 4M, 5F (J. L. C.)

Denali Hwy., M. P. 10, Alaska

Spermophilus undulatus
24-V-62, 2M, 7F (C. E. H.)

Dan's Valley, Helmet Mt., Alaska

Spermophilus undulatus
2-VII-60, 5M, 5F (C. E. H.)

Dry Creek, Alaska

Spermophilus undulatus
12-VI-62, 1M, 1F (E. G. V.)
16-VI-62, 2F (E. G. V.)
4-VII-62, 1M (E. G. V.)
19-VII-62, 1M, 4F (E. G. V.)
20-VII-62, 1F (E. G. V.)
22-VII-62, 1M (E. G. V.)
27-VII-62, 1F (E. G. V.)
23-VII-62, 4M, 3F (E. G. V.)

Upper Dry Creek, Alaska

Spermophilus undulatus
16-VI-62, 2F (E. G. V.)

Helmet Mt. Alaska

Ochotona collaris
17-VIII-61, 1M (C. E. H.)

Mt. Hayden, Alaska

Ochotona
13-VI-41, 1M (W.)

Mt. McKinley Nat'l Park, Alaska

Spermophilus undulatus ablusus
12-IX-58, 1M, 3F USNM

Olnes, Alaska

Tamiasciurus hudsonicus
17-VI-57, 2F (C. E. H.)

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Rapids, Alaska

Rich. Hwy., M. P. 217, Caster Creek

Spermophilus undulatus
26-IV-53, 1M, 1F (G. G.)
26-IV-53, 1F
15 VII-37, 1F USNM

Spermophilus undulatus
10-VII-59, 2M, 3F (C. E. H.)

Donnelly Dome

Rich. Hwy., M. P. 204. 5, Alaska

Spermophilus undulatus
24-V-62, 1M, 1F (H. B.)
25-V-62, 4M, 3F (H. B.)

Spermophilus undulatus
17-VIII-61, 1M (C. E. H.)

Rich Hwy., M. P. 209, Alaska

Valdez Hwy., M. P. 23, Alaska

Spermophilus undulatus
1-VI-62, 1F (H. S.)

Spermophilus undulatus
17-VIII-61, 1M (C. E. H.)

Rich. Hwy., M. P. ?36, Alaska

Spermophilus undulatus
31-V-62, 1F (H. S.)

Oropsylla arctomys (Baker, 1904)
(Plate XXXI, A, B, C, D, E, F; Map 12)

Ceratophyllus arctomys Baker, 1904. Proc. U. S. Nat'l Mus., 27:388, 411-412, 440. Stewart, 1928, Cornell Univ. Mem., 101:869. Jordan, 1928, Nov. Zool., 34:183.

Oropsylla arctomys (Baker). Jordan, 1933, Nov. Zool., 39:62, 74. Stewart, 1933, Jour. N. Y. Ent. Soc., 41:258. Spencer, 1936, Proc. Br. Col. Ent. Soc., 1935:13. Wagner, 1936, Can. Ent., 68:198. Jordan, 1937, Nov. Zool., 40:284. Philip, 1938, Jour. Parasit., 24:486. Jellison and Kohls, 1939, Pub. Health Rept., 54:20.. Mail and Holland, 1939, Proc. Sixth Pac. Sci. Cong., 5:127. Eskey and Haas, 1940, Pub. Health Bull., 254:73. Fox, 1940, Fleas East U. S., pp. 45-46, figs. 40-41, 43. Fuller, 1942, Ent. News, 53:137. Bell and Chalgren, 1943, Jour. Wildlife Management, 7:275. Ewing and Fox, 1943, U. S. Dept. Agr. Misc. Publ., No. 500:49. Fuller, 1943, Bull. Brook. Ent. Soc., 38:20. Fuller, 1943, Jour. N. Y. Ent. Soc., 51:5. Brown, 1944, Ann. Ent. Soc. Amer., 37: 210. Jellison, 1945, Jour. Parasit., 31:88, 90. Hubbard, 1947, Fleas West. N. Amer., p. 168, fig. 81. Holland, 1949, Siphonaptera of Canada, p. 114, figs. 171-173. Holland, 1949, Proc. Ent. Soc. Br. Col., 45:10. Knipping, Morgan, and Dicke, 1950, Wisc. Acad. Sci. Arts and Letters, 40:199-206. Judd, 1950, Jour. Mammal. 31:358. Gill, 1954, Arctic Aeromed. Lab. Rept., 2:50 pp. Hubbard, 1954, Ent. News, 65:169-176. Wiseman, 1955, Univ. Wyo. Publ., 19:28 pp. Burbutis, 1956, N. J. Exp. Sta. Bull., 782. Holland, 1956 (1958), Proc. Tenth

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Internat. Cong. Ent., 1:645-658. Rapp and Gates, 1957, Jour. Kans. Ent. Soc., 30:50-53. Geary, 1959, Cornell Exp. Sta. Mem., 355, figs. 127-130. Benton and Cerwonka, 1960, Am. Midl. Nat., 63:383-391. Holland, 1963, Bishop Mus. Press, pp. 45-63.

Aetheopsylla septentrionalis Stewart and Holland, 1940. Can. Ent., 72:41-42, text figs. 1-2. Holland, 1941, Proc. Ent. Soc. Br. Col., 37:11. Hubbard, 1943, Pac. Univ. Bull., 39:1-12.

Oropsylla arctomys (Baker, 1904) is usually restricted to the woodchuck, Marmota monax (Linnaeus). The distribution of the flea is concordant with that of the host; O. arctomys has been reported from the eastern states into Canada and across the northern part of the United States, in such areas as Michigan, Wisconsin, Minnesota, Iowa, Nebraska, Wyoming and Montana. As far as I know, two records are now available for this species of flea in Alaska. One was reported by Jellison and Kohls (79), for material collected by C. B. Phillip from Marmota monax at Fairbanks, July 17, 1937. The only other record that I know of is of specimens that are listed later in the account of this species.

I consider O. arctomys and its host to be postglacial migrants into the North. Marmota monax is not a common animal within the interior of Alaska, so apparently it is still in the process of establishing a stable population.

I have taken approximately twelve specimens of Marmota caligata (Eschscholtz) and have yet to find one infested with fleas. Geary (32) had similarly negative results with the marmots that he collected.

Records

Rich. Hwy., M.P. 290, Alaska

Marmota, 27-VII-53, 2M, 6F (L. L. H.)

THRASSIS Jordan, 1933

Thrassis Jordan, 1933. Nov. Zool., 39:72.

Frontal tubercle present. Eye well-developed and pigmented. Five pairs of lateral plantar bristles on all tarsi segments V. Pedicle with long setae in both sexes. Anterior mesal surfaces of meso- and metacoxae with long, thin setae from base to apex in addition to those occurring on the margin. Sternum VIII usually broad, not necessarily long. Movable process variable as to shape, without pigmented spiniforms; frequently directed frontally. Anal stylet of female with two or three relatively long, lateral setae. Bulga of spermatheca subglobular, broader (higher) than long. Hilla longer than bulga and papillate.

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Thrasis is a Nearctic genus usually associated with the burrowing Sciuridae, although a few species have been described from cricetid rodents. Nearly all of the species occur in the western half of the United States, with four extending northward into Canada and one into Alaska. Members of this genus, as a whole, are thought to be of extreme importance in the incidence of plague among native northwestern American rodents. Harold Stark is currently working on a revision of this genus, which should prove of inestimable value.

PLATE XXXI

Oropsylla arctomys (Baker, 1904).

       Figure A: Clasper of male

       Figure B: Sternum IX of male

       Figure C: Sternum VIII of male

       Figure D: Crochet

       Figure E: Sternum VII of female

       Figure F: Spermatheca

Thrassis pristinus Stark, 1957

       Figure G: Clasper of male

       Figure H: Sternum IX of male

       Figure I: Sternum VII of male

       Figure J: Crochet

       Figure K: Sternum VII of female

       Figure L: Spermatheca

PLATE XXXI
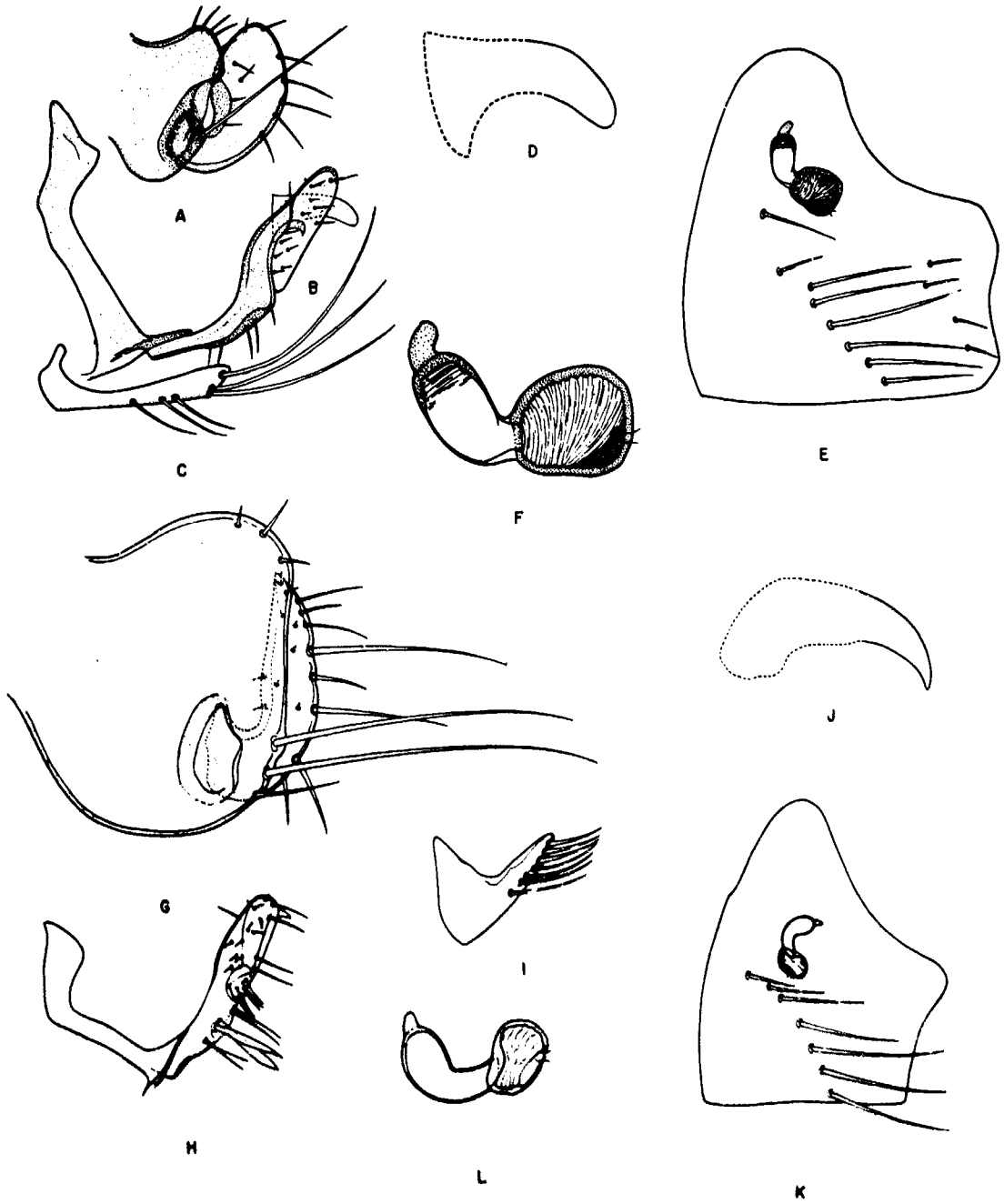
Thrassis pristinus Stark, 1957
(Plate XXXI, G, H, I, J, K, L)

Thrassis pristinus Stark, 1957. Jour. Parasit., 43:332-346. Holland, 1956
     (1958), Proc. Tenth Internat. Cong. Ent., 1:645-665. Holland, 1963,
     Bishop Mus. Press, pp. 45-63.

Thrassis pristinus Stark, 1957, was described from material taken at
Seward, Alaska, from Marmota sp. (likely caligata). Additional material
was secured from Marmota sp., Thompson Pass, Valdez, collected by J.D.
Gregson (1948) and now in the Canadian National Collection.

This is a large Nearctic genus, with only this representative known in
Alaska. While both Geary and myself have had negative records from the
interior of Alaska, I do not consider our collections extensive enough to rule
out the possibility that Thrassis pristinus occurs here. It may well be that it
is confined to southeastern Alaska, where a more equable climate is found.

AMPHALIUS Jordan, 1933

Amphalius Jordan, 1933. Nov. Zool., 39:74.

Labial palps extending beyond procoxa to apex of trochanter. Pronotal
ctenidium of 24 or more spines. Eyes large and well-pigmented. Setae on
mesal surface of meso- and metacoxae from base to apex, in addition to those
occurring on margin. Basal pair of plantar bristles on all tarsi segments V
shifted ventrally. Movable process of clasper with a long, apically dilated
process originating near base and projecting posteroventrally; apical portion
of movable process bearing long spine-like setae. Immovable process narrow.
Sternum VIII with a papilioform membranous apical lobe. Sternum IX with
distal arm broadly expanded; ventral lobe of distal arm with two well-develop-
ed spiniforms. Female with unique spermatheca, without division between
bulga and hilla, roughly "C-shaped." Anal stylet with many bristles on
apical half only.

Amphalius is a Ho.. genus, of which three species are known, two of
which occur in Eurasia and the other one in the mountainous regions of west-
ern North America. I believe the species in Alaska to be conspecific with the
Eurasian form.

Like Ctenophyllus, the members of this genus are restricted to the pika,
Ochotona. They are frequently scarce in collections for many reasons, not the
least of which is the fact that pikas are somewhat difficult to secure. Also,
the pika fleas depart from the host almost instantly upon its death.

Amphalius runatus necopinus (Jordan, 1925)
(Plate XXXII, A, B, C, D, E, F, G, H, I, J; Map 13)

Ceratophyllus necopinus Jordan, 1925. Nov. Zool., 32:110

Amphalius necopinus (Jordan). Jordan, 1933, Nov. Zool., 39:74. Hubbard,
1940, Pac. Univ. Bull., 37(4). Augustson, 1941, Bull. South. Calif.
Acad. Sci., 40(3):150. Holland, 1941, Proc. Ent. Soc. Br. Col., 37:
12. Hubbard, 1941, Pac. Univ. Bull., 37(8):2, figs. Jellison, 1941,
Pub. Health Rept., 56:2341-2349, fig. 1. Ewing and Fox, 1943, p. 54.
Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Jellison, Kohls and
Mills, 1943, Misc. Publ., pp. 2, 20. Brown, 1944, Ann. Ent. Soc.
Amer., 37:207. Hubbard, 1947, pp. 170-172, figs. Holland, 1949, p.
123, figs. Holland, 1949, Proc. Ent. Soc. Br. Col., 45:10. Hubbard,
1949, Bull. South. Calif. Acad. Sci., 48:125. Holland, 1950, Proc. Ent.
Soc. Br. Col., 46:5-13. Tipton, 1950, Masters Thesis, Brig. Young
Univ., p. 62. Geary, 1953, Arctic Aeromed. Lab. Rept., 1, 37 pp.
Morlan, 1955, Tex. Rep. Biol. and Med., 13:93-125. Wiseman, 1955,
Univ. Wyo. Pub., 19:28 pp. Holdenried and Morlan, 1956, Am. Mid.
Nat., 55:369-381. Stark, 1958, Siphonaptera of Utah, p. 200, fig.
47a-b. Holland, 1963, Bishop Mus. Press. pp. 45-63.

Amphalius runatus necopinus (Jordan) Holland, 1956 (1958), Proc. Tenth
Internat. Cong. Ent., 1:645-658.

Amphalius runatus necopinus (Jordan, 1925) is restricted to the collared
pika, Ochotona collaris, in Alaska. Like Ctenophyllus terribilis, this flea
rapidly departs from the host when the latter is killed, and efforts must be
made to place the dead animal in a bag as soon as possible. I consider this
to be a Holarctic species of flea, being not more than subspecifically different
from runatus occurring in eastern Siberia. Ioff and Scalon indicate that A.
runatus is a parasite of the Daurian pika, Ochotona daurica, and that it is
seldom encountered on other species of pika. One other species of Amphalius
is known from Eurasia, A. clarus, which is a parasite of the pikas of the sub-
genus Conothoa. These authors indicate that A. runatus is found at times
upon the susliks, tarbagans and several other rodents. Within the Nearctic
region, the host associations appear to be more restricted.

Holland (56, 58) has commented about the disjunct distribution of the two
species of pika occurring in the Nearctic region. Ochotona collaris is
present in Alaska and part of Canada, and O. princeps is essentially confined
to the higher montane elevations of the Rocky Mountain and Sierra Nevada
ranges. He has postulated that this flea, like C. terribilis, has persisted
unchanged in both the northern and southern populations of the pika. Recently,
in comparing specimens of Amphalius from Utah with those from Alaska,
some rather startling differences were noted in the dorsal arm of sternum IX
and in the crochet. Personal correspondence with various specialists

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indicates this is at least a subspecific difference. Smit (in a personal communication) has further stated that in checking the type specimen from California, there is little difference between the Alaska and California forms. Further investigation is underway, and it will be some time before the status of Amphalius can be determined within the New World.

PLATE XXXII

Amphalius runatus necopinus (Jordan, 1925)

Figure A: Clasper of male, Alaskan form

Fibure B: Sternum IX of male, Alaskan form

Figure C: Crochet, Alaskan form

Figure D: Clasper of male, Utah form

Figure E: Sternum IX of male, Utah form

Figure F: Crochet, Utah form

Figure G: Sternum VIII, entire, Utah form (dorsal view)

Figure H: Anal stylet, female, Alaskan form

Figure I: Sternum VII of female, Alaskan form

Figure J: Spermatheca, Alaskan form

PLATE XXXII
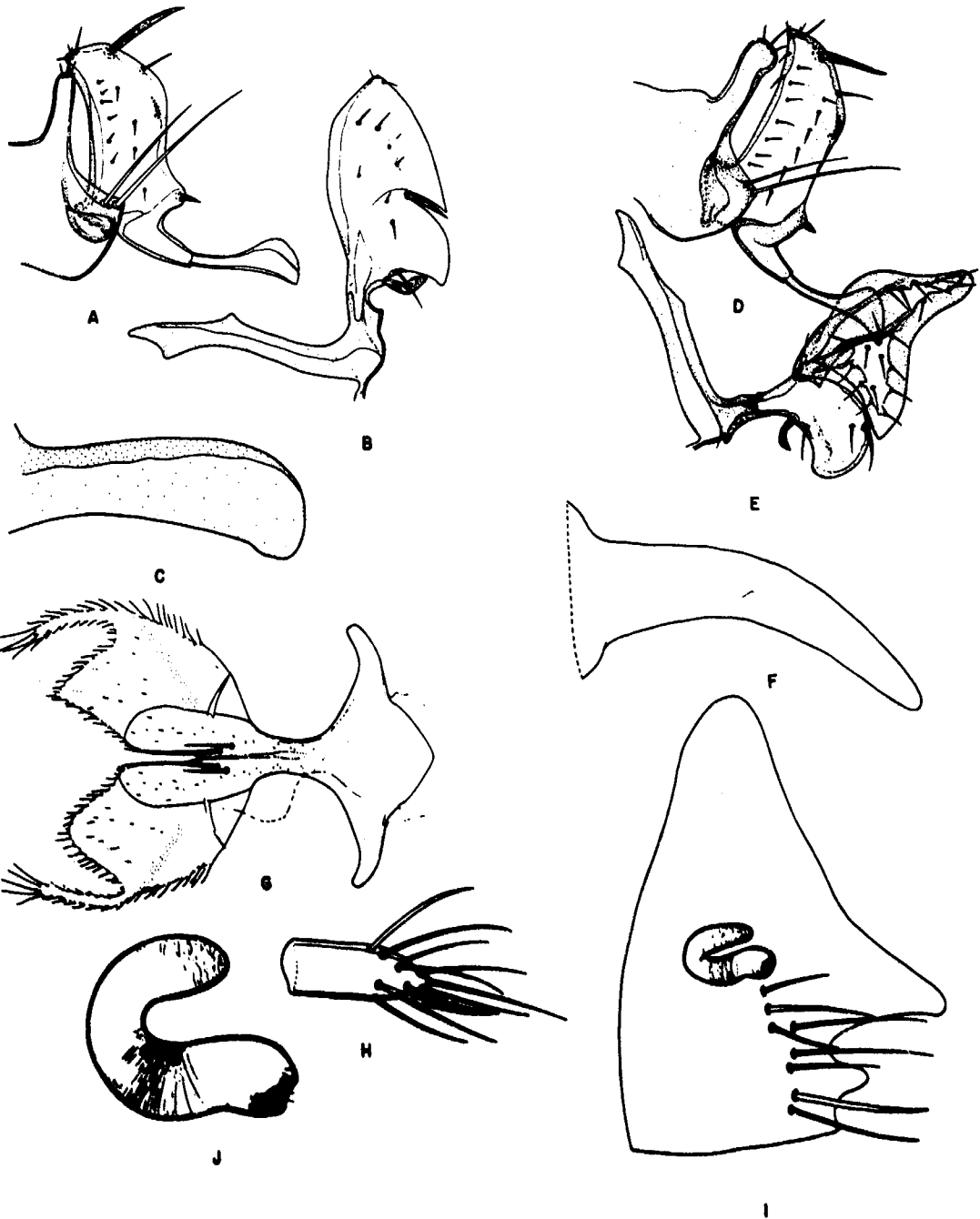
Map 13

Distribution of Amphalius runatus necopinus (Jordan)
and Ctenophyllus armatus terribilis (Rothschild).

    Both species of fleas are associated with Ochotona
collaris (Nelson) and are thought to be concordant with
it in distribution. The shaded area actually represents
the distribution of the two fleas and the host. The dis-
tribution of the fleas is poorly understood at the present
time.
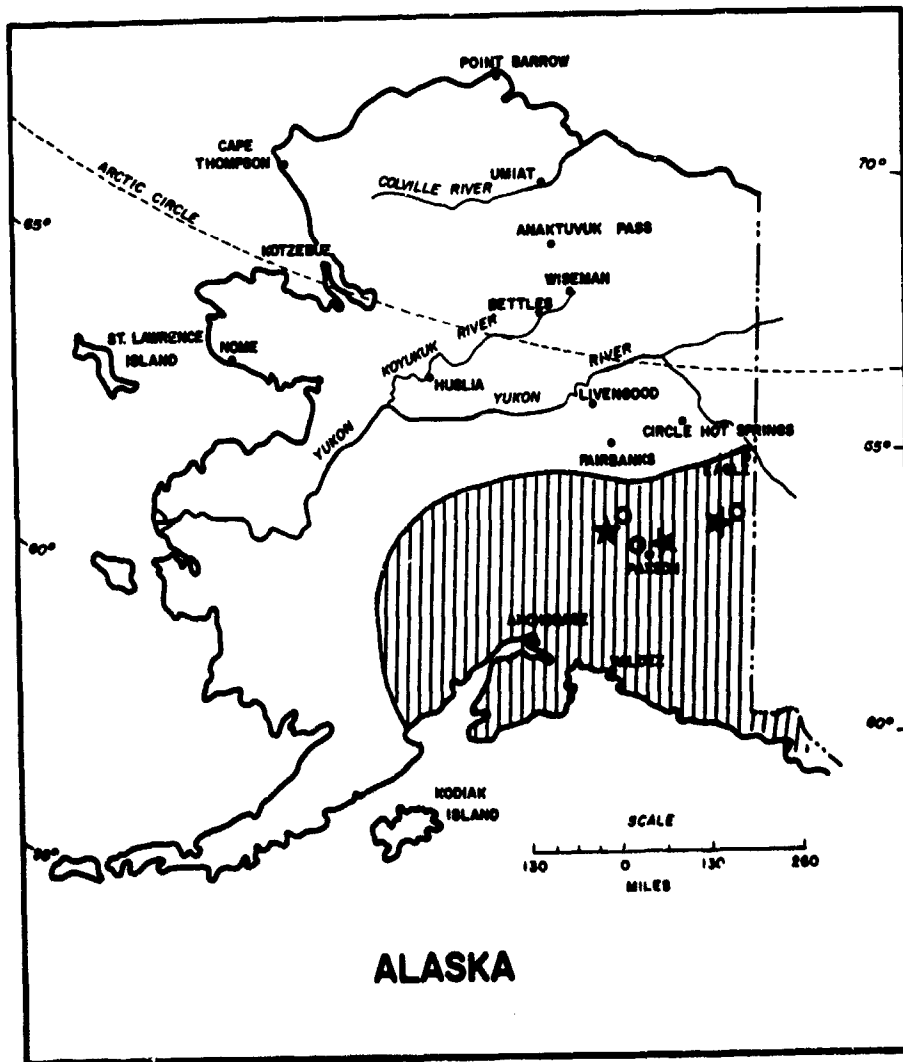
ALASKA

||| ○ **Amphalius runatus necopinus** (Jordan).

★ **Ctenophyllus armatus terribilis** (Rothschild).

Records

Dry Creek, Alaska

 Ochotona collaris
  19-VI-62, 1F (E. G. V.)
  25-VI-62, 4F (E. G. V.)
  21-VII-62, 1F (E. G.V.)

Helmet Mt. Alaska

 Ochotona collaris
  17-VIII-61, 1F (C. E. H.)
  17-VIII-61, 1F (C. E. H.)

Dan's Valley, Helmet Mt. Alaska

 Ochotona collaris
  28-VIII-61, 1M, 1F (W. T.V.)
  28-VIII-61, 1F (J. H. E.)
  28-VIII-61, 1F (W. T. V.)
  2-VII-60, 1M, 4F (W. T. V.)

Emerson's Gulch, Helmet Mt. Alaska

 Ochotona collaris
  27-VII-62, 1M, 2F (J. L. C.)

XVI

Family VERMIPSYLLIDAE Wagner, 1899

Head and pronotum lacking ctenidium. Frontal tubercle present, may be either permanent or deciduous. Antennal fossae open. Metanotum lacking apical spinelets. Antepygidial bristles undifferentiated in both sexes. Metepimeron with long bristles. Segment V of all tarsi bearing four pairs of lateral bristles.

Males with segment VIII essentially unmodified. Sternum IX reduced, without a tendon or spiniform setae.

Females lacking anal stylet, the pygidium wider than long (transverse).

CHAETOPSYLLA Kohaut, 1903

Chaetopsylla Kohaut, 1903. Alatt. Kozlem., 2:37.

Family characteristics given above are quite satisfactory for this genus. Frontal tubercle permanent or deciduous, generally large. Clava of antenna considerably longer than broad, tapering from about midway into a narrow apex. Labial palps variable, usually of five segments and not extending beyond the apex of forecoxae (except in subgenus arctopsylla). Occiput of male with slight concavity and with numerous hairlike setae. Movable process of male without spiniforms. Posterior margin of clasper bearing many long setae, all directed posteriorly. Hilla of spermatheca usually projecting a short distance into the bulga. Sternum VII of female usually small.

Chaetopsylla is of Holarctic distribution. This genus has been the subject of considerable controversy. Johnson (81) partially revised the genus, and Hopkins and Rothschild (65) carried out a major revision of the forms known to them; however, the generic concept is not yet stabilized.

All members of this genus usually occur upon the larger carnivorous mammals. It is generally believed that they require several days of feeding before engorgement is complete. Little is known of their biology, and it is realistic to consider them rare fleas in collections throughout the world.

No information is available as to their possible medical or veterinary importance.

Key to the Alaskan species of Chaetopsylla

Males

MP small, toothlike in shape, articulation in upper 1/3 of
clasper   tuberculaticeps ursi

MP long, sickle-shaped, articulating in ventral half of
clasper   floridensis

Females

Labial palps extending beyond apex of forecoxa; frequently with
two long bristles located immediately below the eye
                                                           tuberculaticeps ursi

Labial palps shorter, not extending to apex of forecoxa; one
bristle located beneath eye   floridensis

Chaetopsylla floridensis I. Fox, 1939
(Plate XXXIII, A, B, C, D, E, F, G, H, I; Map 14)

Trichopsylla floridensis I. Fox, 1939. Proc. Ent. Soc. Wash., 41:45-46.
    Fox, 1940, p. 32, pl. VIII, figs. 34, 36, 39.

Chaetopsylla floridensis Fox. Ewing and Fox, 1943, p. 17. Johnson, 1955,
    Pan Ac. Ent., 31:93-104, figs. Hopkins and Rothschild, 1956, Cat.
    Rothschild Coll., 2:93-96, figs.

Chaetopsylla floridensis I. Fox, 1939, was originally described from two males and two females obtained from leaf mold in Gainesville, Florida. No further records have been reported from this species until now. At first I felt that the flea encountered in Alaska was a somewhat different form than floridensis, but in studying other species at Tring, England, and in discussions with Frans Smit I came to the conclusion that it was. This is a remarkably

disjunct distribution insofar as the records go; however, the mink is actually known from Florida into Alaska, and it may be that this species has simply been overlooked by collectors. On the other hand, this record is almost as incongruous as Epitedia wenmanni (Rothschild), reported by Hubbard from Kivalina; one seldom encounters a flea first in the subtropics and next in the subarctic.

Part of my original confusion existed because rather recent descriptions of the species by Johnson (81) and by Hopkins and Rothschild (65) have both overlooked a large bristle occurring below the eye, as well as the small setae on the mesal surface of tergum VIII. There does seem to be some slight difference in the aedeagus, but at the present time I feel that this is no more than individual variation.

Dr. George P. Holland has kindly sent me his records of this species for Alaska. Thus far it has not been encountered in Canada, but I am certain that it will be in the near future. After all, American Creek is but a relatively short distance from the Canadian border, and fortunately fleas are not bound by political divisions.

A few months ago I received some unidentified specimens from Dr. K. C. Emerson, which extended the distribution into southeastern Alaska and lead me to believe that this flea must be widely distributed throughout Alaska (but within the distribution limits placed upon it by the hosts, the marten and the mink).

Records

Paxson Lake, Alaska

Martes americana actuosa
19-XI-61, 1M, 6F (L. L. H.)

Mustela erminea
6-XII-55, 1M (L. L. H.)

Mustela vison
10-XII-55, 1F (L. L. H.)
18-XI-55, 1M, 1F (L. L. H.)
21-XI-59, 1F (L. L. H.)

American Creek (Eagle environs)

Martes americana actuosa
-II-61, 18M, 22F (M. M.)

Eagle, Alaska

Martes americana
14-XII-62, 1M (M. M.)

Ketchikan, Alaska

Mustela vison
-I-62, 1M, 5F (P. Garceau) USNM

PLATE XXXIII

<u>Chaetopsylla</u> <u>floridensis</u> Fox, 1939

       Figure A: Clasper of male

       Figure B: Aedeagus

       Figure C: Sternum IX of male, Alaskan form

       Figure D: Sternum IX of male, Alaskan form

       Figure E: Sternum VII of female

       Figure F: Spermatheca

       Figure G: Clasper of male, type specimen, Florida

       Figure H: Aedeagus, type specimen, Florida

       Figure I: Sternum VIII, type specimen, Florida

<u>Chaetopsylla</u> <u>tuberculaticeps</u> <u>ursi</u> (Rothschild, 1902)

       Figure J: Clasper of male

       Figure K: Sternum IX of male

       Figure L: Sternum VII of female

       Figure M: Spermatheca, scale drawing

       Figure N: Spermatheca, enlarged drawing

PLATE XXXIII
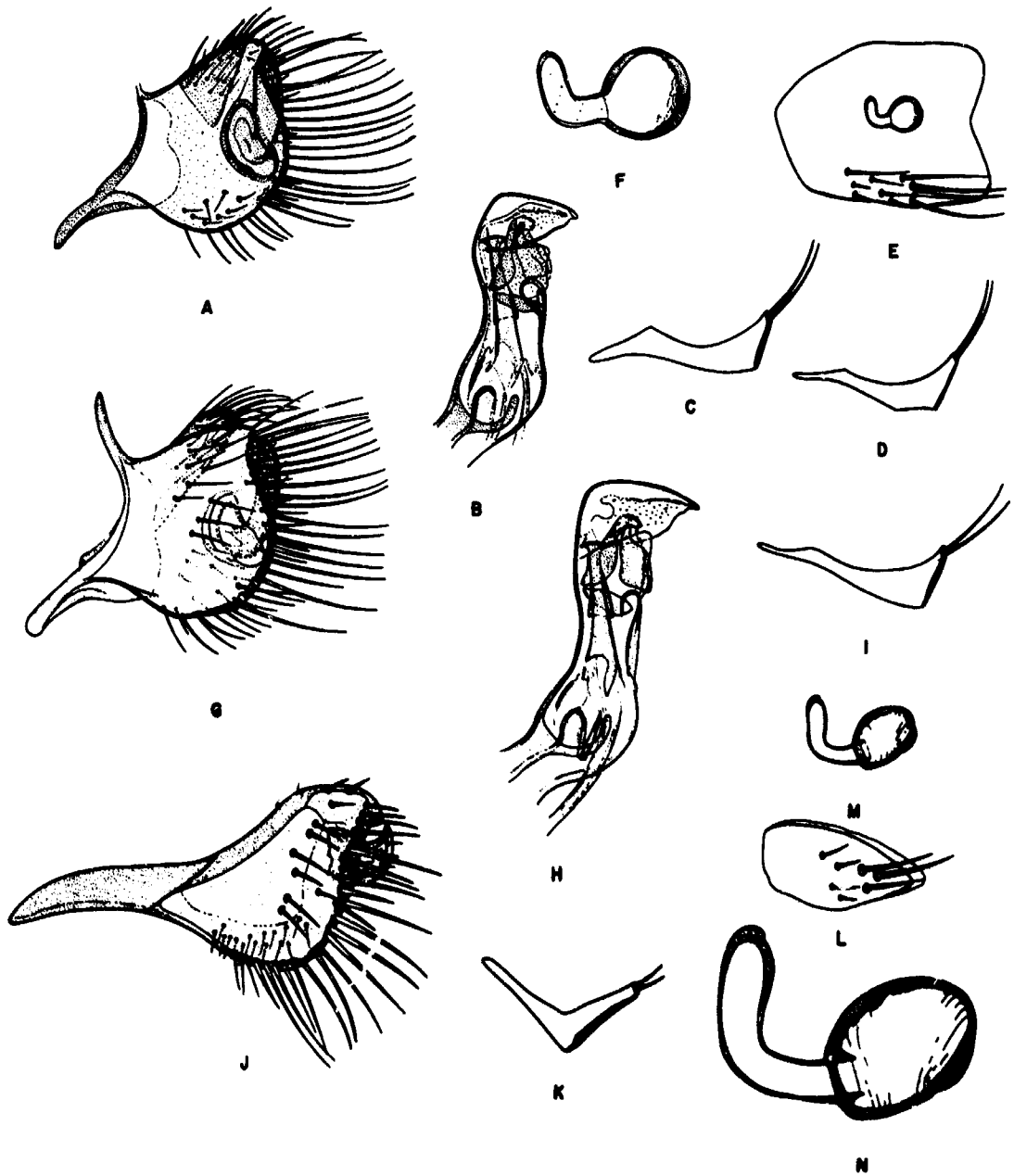
Map 14

Distribution of <u>Chaetopsylla</u> <u>floridensis</u> I. Fox, and <u>Chaetopsylla</u> <u>tuberculaticeps</u> <u>ursi</u> (Rochschild).

Probable distribution was not shown because of insufficient data.

ALASKA
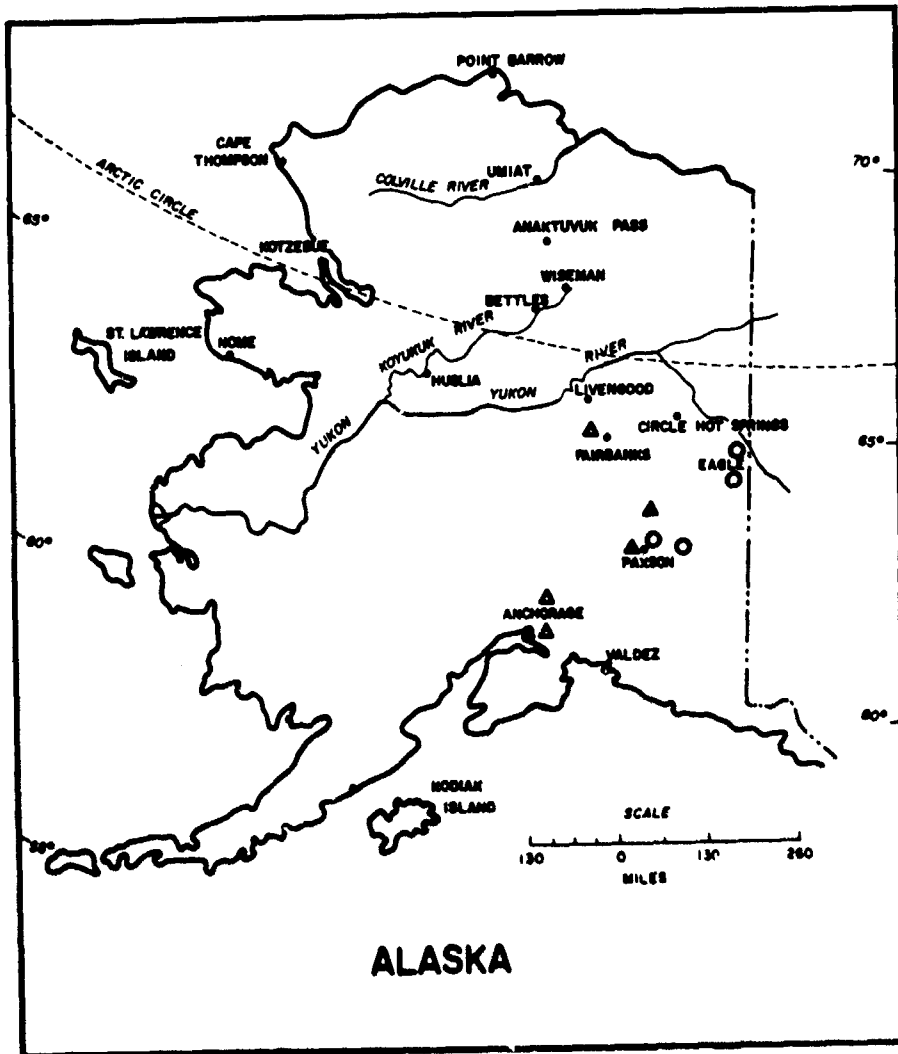
O   <u>**Chaetopsylla**</u> <u>**floridensis**</u> Fox.

△   <u>**Chaetopsylla**</u> <u>**tuberculaticeps**</u> <u>uris</u> (Rothschild).

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Chaetopsylla tuberculaticeps ursi (Rothschild, 1902)
(Plate XXXIII, J, K, L, M, N; Map 14)

Pulex ursi Rothschild, 1902. Ent. Record, 14(3):62-63.

Vermipsylla ursi (Rothschild). Wagner, 1903, Rev. Russe d'Entom., 5:296.

Chaetopsylla ursi (Rothschild). Baker, 1905, Proc. U.S. Nat'l Mus., 29:140.

Arctopsylla tuberculaticeps Bezzi. Wagner, 1930, Katalog der Palaerktischen Aphanipteren, p. 40.

Arctopsylla ursi (Rothschild). Jordan, 1932, Nov. Zool., 38:291. Wagner, 1933, Konowia, 12:89-91. Wagner, 1936, Can. Ent., 68:195. Jellison and Kohls, 1939, Pub. Health Rept., 54:2021. Mail and Holland, 1939, Proc. Sixth Pac. Sci. Cong., 5:125. Jellison, Kohls and Mills, 1943, Misc. Pub. Mont. Bd. Ent., 2:3, 11. Ewing and Fox, 1943, U.S. Dept. Agr. Misc., Pub. No. 500:18, figs. 4D. Hubbard, 1943, Pac. Univ. Bull., 39:1-12. Brown, 1944, Annals Ent. Soc. Amer., 37:207. Snodgrass, 1946, Smithsonian Misc. Coll., 104:1-89, pl. 21. Hubbard, 1947, Fleas West. N. Amer., pp. 88, fig. 23. Holland, 1949, Proc. Ent. Soc. Br. Col., 45:8. Holland, 1949, p. 70, figs. 29-32. Geary, 1953, Res. Rept., Arctic Aeromed. Lab. 37 pp.

Trichopsylla (Arctopsylla) ursi (Rothschild). Holland, 1941, Proc. Ent. Soc. Br. Col., 37:10-11.

Chaetopsylla (Arctopsylla) tuberculaticeps ursi (Rothschild). Hopkins, 1952, Jour. Wash. Acad. Sci., 42:363-365. Hopkins and Rothschild, 1956, 2: 73-75, figs. and plates. Holland, 1956 (1958), Proc. Tenth Internat. Cong. Ent., 1:645-658. Holland, 1963, Bishop Mus. Press, pp. 45-63.

Chaetopsylla tuberculaticeps ursi (Rothschild, 1902) is a Holarctic species occurring on various species of Ursidae. Both Holland and Smit concur that this species is perhaps conspecific with tuberculaticeps of Europe and Asia. Holland (58) indicates that tuberculaticeps is widely distributed in Eurasia, apparently extending from across northern Europe and Asia into the Tien Shan Mountains and northeastward to Kamchatka.

It would be extremely valuable if the licensed big game hunters could be encouraged to seek specimens of this flea, because undoubtedly many new localities could be added to the list. This information, while only of academic importance, would aid greatly in our understanding the distribution and associations of this flea. I do not believe that the flea is confined only to the brown and grizzly bears of Alaska but think that it occurs upon the black bear as well.

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Records

Big Delta, Alaska

Ursus
12-VII-52, 2M (J. M. G.)

Ursus horribilis
12-VII-52, 4M, 6F (J. Geary) CNC

Chickaloon Flats, Alaska

Black Bear
30-V-61, 3F (Atwell) USNM

Fairbanks, Alaska

Ursus
12-VII-52, 2M (J. M. G.)

Paxson Lake, Alaska

Ursus horribilis
14-VI-55, 1F (L. L. H.)

XVII

LIFE HISTORY

Adult fleas are parasitic upon the homeothermic vertebrates and have such morphological modifications as being laterally compressed and wingless, with nearly all the spines and setae pointing posteriorly. All these modifications aid them in their ability to move rapidly and safely upon the host.

Fleas are holometabolous insects, but because they are obligatory parasites, they are dependent upon host occurrence and upon satisfactory ecological requirements for the development of the immature stages, in order to maintain a stable population and/or to expand their distribution. Unfortunately, few studies have been made of the larval requirements, particularly of endemic fleas. In those few instances where such work has been done, usually exotic species have been utilized. The most notable study on biology and life history of a Nearctic flea is that of Poole and Underhill (113), who worked with Megabothris clantoni clantoni Hubbard in Washington. Elbel (17) reported on the comparative morphology of certain flea larvae, among them Orchopeas leucopus (Baker) and Orchopeas sexdentatus (Baker).

The eggs of C. riparius are white, smooth, approximately 1.9 mm in length, and coated with a substance that causes them to adhere loosely to the nest material. In watching various fleas oviposit in the laboratory, I have gained the general impression that eggs of nest-inhabiting species are generally coated with a sticky substance, whereas those of fleas that spend a considerable time upon the host (Pulicoidae) generally lack such a coating. The larvae are mandibulate, apodous, cylindrical and covered with setae. Flea larvae have three instars, the stadium for each instar varying with the species, temperature and relative humidity. For most species, cool

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temperature with adequate humidity will lengthen the life cycle and cause a larger percentage of the fleas to complete development. Most larvae of C. riparius complete development within 5 weeks, at an average temperature of approximately 50° F in the burrow.

Poole and Underhill (113) found that humidity and temperature were of approximately equal importance to larvae development. They found the optimum temperature and humidity for maximum survival and most rapid development of M. c. clantoni to be 90% relative humidity and 28° C. Under such conditions, the life cycle of the flea was found to be 2 1/2 days in the egg stage; first instar, 3 days; second instar, 3 days; third instar, 5 1/2 days; pupa, 5 days; with an 85% survival. Poole and Underhill reported that higher temperatures diminished survival rates, while lower temperatures increased them. These authors concluded that the life cycle from egg to adult for this particular flea varied from 29 to 32 days under controlled conditions.

The larval diet is apparently a varied one, depending upon the species concerned. I do not have adequate information on this for the boreal fleas, having had only partial success in trying to rear C. riparius, M. p. dissimilis and O. caedens durus (Jordan). All three species were carried into the third instar before losing most of the fleas, perhaps for reasons other than that of diet. I fed them ground rat food with powdered beef blood. The late instar larvae of the bank swallow flea brought in from the burrow usually appeared to clear the gut of food before spinning a cocoon; this seems to agree with the findings of Poole and Underhill.

The cocoon consists of a silken thread, and in the case of C. riparius, fine particles of sand are intermixed with this so that the outer surface of the cocoon is completely covered with a coating of fine sand. Measurements of cocoons afte storage in 70% alcohol for one year average 3.1 mm. The time of emergence of the adult flea is highly variable because the adult will remain within the cocoon after metamorphosis is complete. If the cocoon is disturbed (even by blowing upon it) the adult breaks through the cocoon with considerable vigor.

Poole and Underhill (113) reported that the newly emerged adult of M. c. clantoni did not attempt to take a blood meal until approximately 2 days old. My information on the feeding habits of Alaskan fleas is inadequate; however, Megabothris calcarifer gregsoni Holland would feed every other day when kept in vials away from the host except during feeding. The vials were stored at 50° F and 80% relative humidity. M. p. dissimilis (Jordan) fed every day under similar circumstances. Because of the pressure of other work, these observations had to be discontinued at the end of 2 weeks.

Burroughs (9) determined the longevity of a number of female fleas maintained at 20° C and 90-94% relative humidity. He found Oropsylla idahoensis

survived 352 days; Orchopeas sexdentatus, 319 days; Malaraeus telchinum, 182 days; and Megabothris abantis, 477 days. Poole and Underhill found the oviposition of normally fed females to be 5 weeks, but the life span was much longer. I observed that marked M. p. dissimilis survived up to 3 months under laboratory conditions when retained in a terrarium with Microtus oeconomus.

Tiflov and Ioff (145) reported on their work with an extensive series of fleas in Russia. The fleas they studied lived far longer than those studied by any other investigators. They kept them at three different stages of nutrition: (1) unfed, (2) fed once and (3) fed periodically. Two physical environments were selected, and each group of fleas was represented in each environment. The first was a cabinet where the temperature varied from 13° to 24° C. The other was a cellar where the temperature varied from -2° to 15° C. The fleas were kept in tubes of moist sand, and wet cloths were hung in the vicinity to keep the relative humidity at approximately 90%. Daily temperature changes did not exceed more than 1° C. The experiments in the cellar were much more successful than those in the cabinet; therefore, only they will be reported.

In their first series of experiments, unfed fleas were used fresh from the cocoon to ensure that they had not had a previous blood meal. The maximum longevities were as follows: Ctenophthalmus orientalis (Wagner), 396 days; Ctenophthalmus breviatus (Wagner and Ioff), 392 days; Neopsylla setosa (Wagner), 350 days; Ceratophyllus tesquorum (Wagner), 267 days; Oropsylla silantiewi (Wagner), 256 days. In their second series, the fleas were fed only once and kept under the same conditions as the first group. The average longevity was greater, but the maximum dropped from 369 to 353 days. The third group of fleas were fed periodically, usually at monthly intervals, though according to Burroughs (9), there were several lapses of 2 months and once a lapse of 5 months during the winter and spring. The fleas were taken into the laboratory, where at temperatures of from 15° to 24° C, they were given the opportunity to feed for 10-15 minutes on the shaved abdomens of susliks, guinea pigs or white rats. The maximum longevity data obtained in the third experiments were much longer than those previously reported: Neopsylla setosa, 1,725 days; Ctenophthalmus orientalis, 715 days; Ceratophyllus tesquorum, 377 days; Ctenophthalmus breviatus, 342 days; Oropsylla silantiewi, 302 days, Frontopsylla semura, 194 days; Mesopsylla hebes, 42 days; Nosopsyllus fasciatus, 41 days; and Ctenopsylla musculi, 37 days.

At the present time, I do not have sufficient evidence to make unequivocable statements concerning the life history of Alaskan fleas, although I have gained a general impression. For the most part, Alaskan fleas likely have only one generation per year. This should hold true particularly with the avian fleas, like those infesting the various species of swallows. Rodent fleas such as M. p. dissimilis might have a second generation. The larvae

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of those fleas which have not reached the pupal stage by early October apparently are still able to overwinter reasonably well. The few nests secured in late April and early May had large numbers of larvae, virtually all third instar larvae. Adults are scarce in the nests at this time. In one nest, I secured 150 larvae, 223 cocoons and 3 adults. The cocoons were secured by "sifting" the nest material through soil sieves after the nest had been heated in the Berlese funnels for 72 hours. Apparently the fleas succumbed to the excessive heat before they could adjust and escape from the cocoon because, in dissecting them out, all were fully formed and appeared normal.

XVIII

DISTRIBUTION OF ALASKAN FLEAS

In the following presentation I have not included most of the species which I know only from-one or two collection records, nor have I included representatives of Dasypsyllus and Mioctenopsylla, which have largely been known from sporadic collections in the Bering Sea Islands. In other words, my remarks are confined to the species about which I feel sufficient data are available to make an attempt at drawing valid conclusions. I have listed the species according to the Biotic Provinces as discussed in the earlier portion of this work. However, there is one exception in that I have included a separate list of fleas for what is termed "upland tundra." This latter term has been included because certain of the fleas are found only there, and an ecological description of the area does not comply with either the Hudsonian or the Eskimoan Provinces of Dice. I have decided to present the list of species occurring in the different provinces as one unit, so that an individual other than myself may gain an over-all impression with less difficulty than if the species were presented by individual province.

Eskimoan Biotic Province

Ceratophyllus lunatus tundrensis Holland, Malaraeus penicilliger dissimilis (Jordan), Megabothris calcarifer gregsoni Holland, Megabothris groenlandicus (Wahlgren), Oropsylla alaskensis (Baker).

Amphi-Eskimoan - Hudsonian Biotic Provinces

Ceratophyllus lunatus tundrensis Holland, Malaraeus penicilliger dissimilis (Jordan), Megabothris calcarifer gregsoni Holland, Megabothris groenlandicus (Wahlgren), Oropsylla alaskensis (Baker).

Hudsonian Biotic Province

Hoplopsyllus glacialis lynx (Baker), Corrodopsylla c. curvata (Rothschild), Catallagia dacenkoi fulleri Holland, Epitedia wenmanni (Rothschild),

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Peromyscopsylla ostsibirica longiloba (Jordan), Amphipsylla marikovskii ewingi I. Fox, Amphipsylla sibirica pollionis (Rothschild), Ceratophyllus arcuegens Holland, Ceratophyllus riparius Jordan and Rothschild, Ceratophyllus idius Jordan and Rothschild, Ceratophyllus scopulorum Holland, Ceratophyllus celsus celsus Jordan, Ceratophyllus garei Rothschild, Ceratophyllus lunatus tundrensis Holland, Malaraeus penicilliger dissimilis (Jordan), Megabothris calcarifer gregsoni Holland, Megabothris groenlandicus (Wahlgren), Megabothris quirini (Rothschild), Monopsyllus vison (Baker), Orchopeas caedens caedens (Jordan), Orchopeas caedens durus (Jordan), Opisodasys pseudarctomys (Baker), Tarsopsylla octodecimdentata Coloradensis (Baker), Oropsylla alaskensis (Baker), Oropsylla arctomys (Baker), Chaetopsylla floridensis I. Fox, Chaetopsylla tuberculaticeps ursi (Rothschild).

Upland Tundra

Ctenophyllus terribilis (Rothschild), Malaraeus penicilliger dissimilis (Jordan), Megabothris calcarifer gregsoni Holland, Monopsyllus tolli (Wagner), Oropsylla alaskensis (Baker), Oropsylla idahoensis (Baker), Amphalius runatus necopinus (Jordan).

Sitkan Biotic Province

Hystrichopsylla occidentalis Holland, Catallagia dacenkoi fulleri Holland, Delotelis hollandi Smit, Myodopsylla gentilis Jordan and Rothschild, Megabothris abantis (Rothschild), Monopsyllus ciliatus protinus (Jordan), Opisodasys keeni (Baker), Thrassis pristinus Stark, Chaetopsylla floridensis I. Fox, Chaetopsylla tuberculaticeps ursi (Rothschild).

Perhaps one of the most startling facts revealed in the list of fleas by biotic provinces is the observation that the Eskimoan Biotic Province (Arctic of other authors) has no fleas that are entirely restricted to this region. All the Eskimoan species of fleas occur to some extent in the taiga of Hudsonian Province, though admittedly certain species do not occupy nearly so wide an area here as in the Eskimoan region. For example, M. groenlandicus has, for all practical purposes, not been reported south of Fort Yukon. This flea was reasonably abundant in the Wiseman area during the summer of 1959, and in nearly all instances (with one exception) the host within the taiga region has been Microtus oeconomus, indicating that this microtine rodent is an acceptable host for this flea.

With regard to Ceratophyllus l. tundrensis, explanation is difficult because the records known to me in Alaska are mostly from the taiga (subarctic of some authors). This flea has been reported by various individuals from Greenland across to extreme northern Canada. Several of the records from the Palearctic appear also to be from the taiga, which is similar to what I

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have indicated above. It is perhaps too soon to make a final decision with regards to the species; however, I think that C. l. tundrensis is as at home in the taiga as in the Arctic.

Oropsylla alaskensis is monoxenous wit certain subspecies of the arctic ground squirrel, Spermophilus undulatus. Throughout most of its range, this flea is restricted to the tundra in the low Arctic or to the upland tundra. However, in its association with Spermophilus undulatus osgoodi, the flea is found in true taiga conditions from Fort Yukon into the Circle Hot Springs area. Within the tundra of the low Arctic, the largest populations of the squirrels seem to be in the riparian habitats; at times dense populations build up along Colville River and its tributaries, where the banks are high enough to prevent flooding during breakup.

Malaraeus penicilliger dissimilis is one of the most widely distributed fleas in Alaska. Apparently it is equally adapted to members of the genus Clethrionomys or Microtus within the taiga but occurs more frequently on Microtus oeconomus in the northern tundra regions, perhaps in part because Clethrionomys is not as available as a host.

Megabothris calcarifer gregsoni is another widely distributed flea within Alaska. It is of equal abundance on microtine rodents within the taiga, but in the Eskimoan Biotic Province it seems to be more closely associated with oeconomus than with any other one rodent. I have more northerly records for this species than I do for Malaraeus penicilliger but feel no valid conclusion can be arrived at until a more extensive collection has been made.

As indicated earlier, I have never had an opportunity to collect fleas from the various species of lemmings occurring in the arctic tundra. On the occasions I have been there, the populations have been so low that I have failed to secure these animals in spite of setting out several hundred traps. From what records I have of the microtine rodents, I am led to believe that the infestation of fleas in the most northern parts of Alaska is less than that known to the south in the taiga. Insofar as I know, no studies have been done that would make it possible to compare the density of flea populations in these areas. This type of study would have to be a long-range one, due to the cyclic fluctuation of the rodent populations.

Holland (56, 58) has indicated that Hoplopsyllus glacialis glacialis no doubt occurs in the northern tundra regions of Alaska. I know of no published records to this effect but think that Holland is probably correct. I have not listed it in this group because of the lack of information concerning its distribution in Alaska. Indeed, Lepus othus is such an uncommon mammal in the northern tundra regions of Alaska that I have known scientists who have worked in the area for years, yet have not seen a specimen of this animal! With such a scarcity of the host, it would seem a tenuous existence for a flea that is so restricted in its host associations.

The five species of fleas listed as Amphi-Eskimoan-Hudsonian are separated in order to emphasize the point that these species do occur in both areas. In some instances, they apparently have the ability to extend into various types of ecological situations with their hosts, and they provide an interesting contrast to some of the other fleas which appear to be restricted to the same host but are limited only to the Hudsonian.

The list of fleas for the Hudsonian Biotic Province is perhaps conservative. However, such fleas as Ceratophyllus arcuegens and many others of ceratophyllids which are known from just one or two records are not included. Probably they are confined to the birds nesting in the taiga, but this must await further observation. Of the fleas restricted to the taiga, I think that Catallagia dacenkoi fulleri, Peromyscopsylla ostsibirica longiloba, and Amphipsylla marikovskii ewingi are perhaps the most interesting. They are usually associated with the microtine rodents within the taiga but do not extend into the northern tundra regions with them. Those fleas such as Orchopeas caedens and Opisodasys pseudarctomys that are confined to Tamiasciurus and Glaucomys, respectively, are limited by the distribution of their hosts and, therefore, are in an entirely different situation from the aforementioned microtine fleas.

Of some interest is the fact that three species of the genus Oropsylla are known to occur. In view of the previous discussion concerning O. alaskensis, no further comment will be made about this species. Oropsylla arctomys is confined to the woodchuck, and I only know of two records of this animal being infested in Alaska. It is perhaps somewhat presumptive on my part, but I seriously doubt that either the woodchuck or this flea will be found beyond the taiga. Oropsylla idahoensis is for the most part restricted to the upland tundra, and its existence in the taiga is a more or less marginal one.

Two species of Chaetopsylla are known for this region, and both are also known in the Sitkan Biotic Province, which is a rather unusual distribution insofar as Alaskan fleas are concerned. One of them, C. floridensis, is associated with mustelids, and the other C. t. ursi, is associated with various species of Ursidae. I have included several species of the genus Ceratophyllus, most of them being restricted to the Hirundinidae. It may well be that such species as C. riparius may extend a short distance into the arctic tundra regions. However, I anticipate this would only be a "fringing" phenomenon. It would be interesting to see if Ceratophyllus c. celsus is prominent in the nests of the bank swallow in southeastern Alaska. As Holland has stated in several of his publications, the bird fleas of the northern regions are poorly understood, and I suspect that most of the new species to be found within Alaska will be those fleas that parasitize an avian host.

In the earlier part of this work, mention was made of the problem of attempting to associate upland tundra with that of the Arctic Slope, indicating that while in a general sense they appear similar, they are different types of

ecological communities. Four of the eight species of fleas listed for this region are restricted to it for all practical purposes. As to whether this is because flea larvae are adapted to the particular ecological environment offered in the upland tundra, or whether the fleas have become so closely associated with the host that they are unable to adapt to other animals, is not known to me. However, I suspect that this is probably an example of a close association with a particular host. More will be said of this later.

Monopsyllus tolli is also ordinarily associated with pika, although the one Alaskan record is from ptarmigan, presumably in a pika habitat. Oropsylla idahoensis is largely confined to the upland tundra in the southern regions of Alaska, since the squirrel Spermophilus undulatus plesius does not penetrate to any significant depth into the taiga, although another subspecies, S. u. ablusus, does. The rest of the species were discussed earlier and have been encountered in two provinces.

The fleas encountered in the Sitkan Biotic Province are, for the most part, distinctive for this region. Published information on the mammals and other animals of the region are not nearly so conspicuous as those reported for the other areas of Alaska. The occurrence of Chaetopsylla floridensis was somewhat surprising; however, the adjustment of the flea to an environment such as that found in southeastern Alaska (as compared to that of central Alaska) is perhaps no greater than the adjustment of the locality for the type specimens in Florida. Most of the fleas found in the Sitkan Province are known further south in the Pacific Northwest.

XIX

ORIGIN OF ALASKAN FLEAS

The 51 species and subspecies of fleas reported here have been derived from three principal sources. The first group to be discussed is considered as the Transcontinental Group, which have largely pushed north and westward into Alaska as post-Pleistocene immigrants. The second, and largest, group is termed Amphi-Beringian, and the fleas are thought to have been derived from the Palearctic Region. The third, and the smallest, group are the fleas derived from the Pacific Northwest, which are confined to a relatively narrow strip of land in southeastern Alaska. It is realized that several species of bird fleas (Ceratophyllus) could have been included; however I have had experience with only a limited number of these fleas, three of which are included in the following discussion. The reader is referred to Holland (58) for the additional species in this group.

Transcontinental Group

Hoplopsyllus glacialis lynx (Baker), Corrodopsylla curvata curvata (Rothschild), Epitedia wenmanni (Rothschild), Ceratophyllus riparius Jordan and Rothschild, Ceratophyllus idius Jordan and Rothschild, Ceratophyllus scopulorum Holland, Megabothris quirini (Rothschild), Monopsyllus vison (Baker), Orchopeas caedens (Jordan), Opisodasys pseudarctomys (Baker), Oropsylla arctomys (Baker), Chaetopsylla floridensis I. Fox.

H. g. lynx is a common flea on the varying hare in the major portion of this animal's distribution. Miller (102) reported this flea from Vermont, although Geary (33) and Benton (personal communication) have not found it in New York, in spite of the fact that several specimens of the varying hare have been examined. It is perhaps a bit rash to assume that this flea is a post-Pleistocene migrant into the Alaskan area; however, inasmuch as only H. g. profugus Jordan is known in the Palearctic, I consider Hoplopsyllus to have been Nearctic in origin and to have migrated westward in Eurasia sometime during the existence of the Bering land bridge. H. g. profugus was originally described ex Lepus capensis tolai in the Ilijskaya Valley, Kazakhstan. Ioff and Scalon (74) indicate that it is known from the Sayanskii Mountain Range in Tuva, in northwestern and southern Khangaj, and in Taishiri, Mongolia. H. g. lynx has not yet been reported in the extreme southern extensions of the varying hare's range.

C. c. curvata is a widely distributed flea in the Nearctic Region and is restricted to various species of the Soricidae. The genus is represented in the Palearctic Region; however, the closely related species are all Nearctic.

E. wenmanni has an extremely broad distribution in the Nearctic Region and apparently is an example of a flea that exceeds its primary hosts in distribution. Throughout most of its range, this species is confined to the genera Peromyscus and Neotoma. E. wenmanni is known from Mexico into the central region of Alaska. While some species of Peromyscus occur in southeastern Alaska (Sitkan Biotic Province), to date this flea has not been reported there. In the interior of Alaska, it occurs sporadically and seems to be more commonly associated with Microtus oeconomus than any other rodent. Hubbard (72) reported it from as far north as Kivalina, though I feel that this is an incongruous record.

M. quirini probably has returned into the Alaskan area with the northern migration of Microtus pennsylvanicus and Zapus hudsonius. It is found throughout the interior of Alaska, being established in the Tanana Valley and on into the southwestern portion of the state. As Holland has pointed out in several of his publications, this flea bears very close resemblance to Megabothris groenlandicus and can be considered as allotropic to it. I know of no area as yet where the two species overlap within Alaska. Both Monopsyllus vison and Orchopeas caedens are associated with Tamiasciurus. While Monopsyllus is known to occur in the Palearctic Region, Orchopeas is not so represented.

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O. pseudarctomys is associated with Glaucomys and Tamiasciurus and, like Orchopeas, is a New World genus. Both the host and the flea are of Nearctic distribution; however, the flying squirrels as a group have a far greater distribution and evolution in the Palearctic Region than that known in the New World. Frequently, Glaucomys shares a flea, T. o. coloradensis, with Tamiasciurus. This flea is of Old World origin, being primarily a parasite of the squirrel Sciurus vulgaris. It is indeed an interesting associ- ation, because one would expect coloradensis to occur on the Nearctic species of Sciurus. In the event that Glaucomys was of Eurasian origin, it had to migrate at a time when the land bridge across the Bering Strait was favorable for tree growth. If Hopkins (61) is correct in his concepts, this would imply a date earlier than the Pleistocene.

O. arctomys is associated with the woodchuck, Marmota monax through- out its range in the Nearctic. The host is not a common animal in the interior of Alaska, and consequently, there have not been numerous collections of the flea. I think that it is a relatively recent migrant into the boreal region, judging from the rather restricted distribution in Alaska. Little can be said about the distribution and/or origin of C. floridensis at the present time. Collection records show two widely separated regions within North America. With one possible exception, it does not seem to be more closely related to Palearctic forms than those occurring in the Nearctic fauna. However, it is perhaps closer to C. alia Ioff, described from the sable, Martes zibellina. Ioff and Scalon (74) indicate that alia has been found in small numbers on sables in western Siberia, but that the true host and the area of distribution of alia is not known with certainty. I have not had the illustrations of the above- mentioned Russian workers to compare with my material, and it is therefore difficult for me to indicate just how close the relationship may be. Certainly, there are many parallels in the lack of distribution records for these two species of fleas. Future studies may well indicate that alia and floridensis are conspecific.

I have included C. riparius in the Transcontinental group, although it is known to occur in eastern Siberia. However, the distribution in the last- mentioned area is relatively small, and unless specific concepts within the genus Ceratophyllus are changed, I have little choice but to assume that C. riparius is of Nearctic origin. Smit, (131, p. 144) has indicated that perhaps riparius is not more than subspecifically distinct from C. styx. Smit's suggestion is more acceptable to me than the one proposed by Benton and Shatrau (6): that C. riparius and C. styx exemplify one of the relatively rare cases in which the evolution of the parasite has proceeded more rapidly than that of the host. This problem will have to await an extensive study by a competent authority.

Benton and Shatrau (6) reported C. scopulorum from New Brunswick in the nest of both the cliff swallow (Petrochelidon pyrrhonota) and the barn swallow (Hirundo rustica). Previous to these records, C. scopulorum was known only

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from the Northwest and Yukon territories of Canada. These authors indicated that the eastern populations of this flea agreed extremely well with the original description by Holland (51). Alaskan specimens also agreed well with the original description, indicating that this flea is not as pleomorphic as some of the other species within the genus. Benton and Shatrau (6) also reported a large series of C. idius from the nest of the barn swallow and only a few specimens from nests of the tree swallow (Iridoprocne bicolor), a bird that is usually associated with this flea. Fom the description, I cannot tell if the scopulorum and idius cohabited the same nests of the cliff swallow or if they were in different ones.

Amphi-Beringian Group

Catallagia dacenkoi fulleri Holland, Peromyscopsylla ostsibirica longiloba (Jordan), Amphipsylla marikovskii ewingi I. Fox, Amphipsylla sibirica pollionis (Rothschild), Malaraeus penicilliger dissimilis (Jordan), Megabothris calcarifer gregsoni Holland, Ctenophyllus armatus terribilis (Rothschild), Ceratophyllus lunatus tundrensis Holland, Amphalius runatus necopinus (Jordan), Tarsopsylla octodecimdentata coloradensis (Baker), Oropsylla alaskensis (Baker), Chaetopsylla tuberculaticeps ursi (Rothschild).

Several individuals in the past have been interested in the relationship between the boreal Nearctic fleas and those of the Palearctic Region. Most important among these workers have been Wagner (150) and Holland (45, 56, 58). Holland's papers are widely circulated, and the reader is referred to these excellent papers for additional background. Wagner's publication, on the other hand, frequently has been overlooked. Therefore, the following brief review of his concepts is presented. Wagner was instrumental in laying the foundation for this concept in his definition of a "vicariating species" (equivalent to an ecological homologue). For example, Wagner noted that A. s. pollionis, T. coloradensis, C. niger and Chaetopsylla (Arctopsylla) ursi occurred in both the New and Old Worlds. Wagner also mentioned that Corrodopsylla c. curvata and Corrodopsylla birulae Ioff replaced one another in the New and Old World. He suggested that Ctenophyllus terribilis was nearest to C. subarmatus Wagner from Altai, thus being a connecting link between the fauna of British Columbia and of East Asia. Wagner noted that M. vison was near M. sciurorum Schrank, thinking it replaced the latter flea in North America upon the squirrels of the genus Sciurus. Most notable of his comments in this paper were his remarks concerning H. g. lynx, H. g. glacialis and H. g. profugus.

Of the twelve species listed in this group, six have been carried across the Bering land bridge by the microtine rodents, Clethrionomys and Microtus. On the basis of information now available to me, it is literally impossible to discern which animal, Clethrionomys or Microtus, was the primary host of the Nearctic forms. Of the six, only two have a distribution beyond the taiga, these being Malaraeus penicilliger dissimilis and Megabothris calcarifer

gregsoni. Two other genera, Amphalius and Ctenophyllus are each repre-
sented by one species, both of which occur upon the same host, Ochotona
collaris. Preliminary studies have indicated that there is basis to think that
the populations of Amphalius runatus necopinus have evolved into two sub-
species on the two disjunct populations of Ochotona occurring in the Nearctic
Region. Such evidence is not available for Ctenophyllus armatus terribilis.
The fleas belonging to these two genera are believed to be Eurasian in origin
because of the larger number of species occurring in the Palearctic Region at
the present time, and also by the fact that the pikas are distinctly more
diversified as to ecological range and speciation.

T. o. coloradensis is represented in the Old World by the nominate form,
which has an extremely broad distribution with Sciurus vulgaris. In the New
World, T. o. coloradensis is largely restricted to the northern and western
areas of Tamiasciurus, though associated also to some extent with Glaucomys.
No records of this flea have been published for the eastern part of the United
States. Apparently, coloradensis adapted to a new boreal host on coming to
the New World, inasmuch as it is now known to be associated with squirrels
of the genus Tamiasciurus, but not Sciurus.

O. alaskensis is apparently as host-specific in eastern Siberia as it is in
the New World, being confined to Spermophilus undulatus. The fact that this
squirrel flea is apparently inseparable from the Eurasian form speaks for the
relatively recent crossing of these two stocks. Chaetopsylla t. ursi is likely
to be known as conspecific with tuberculaticeps within the near future. The
fact that certain of the hosts are still able to migrate across the Bering Sea
during the winter months would lend considerable weight to such a concept.

Pacific Northwest

Hystrichopsylla occidentalis Holland, Catallagia dacenkoi fulleri Holland,
Delotelis hollandi Smit, Myodopsylla gentilis Jordan and Rothschild, Mega-
bothris abantis (Rothschild), Monopsyllus ciliatus protinus (Jordan), Opiso-
dasys keeni (Baker), Thrassis pristinus Stark.

This group of fleas is essentially analogous to what Holland has called
Cordilleran Group B and Vancouverian Group. I regard these fleas as having
originated from a Pacific Northwest refugium that existed during most, if not
all, of the Pleistocene. Upon the retreat of the Cordilleran glacier, these
fleas have migrated east, south and north from this center but are still
confined, or essentially limited, to the western half of the United States.
Certain of these species, for example, Catallagia charlottensis and Monop-
syllus ciliatus protinus, are not known east of the Coast Mountains (Range)
in British Columbia. Within Alaska, they are confined essentially to the
Sitkan Biotic Province.

HOST ASSOCIATIONS

In many respects, the subject of the host associations of Siphonaptera is fascinating to discuss, but on the other hand, it is a difficult one to resolve. Most of the difficulty stems from the fact that there have not been a sufficient number of adequate ecological and physiological observations on the requirements of the flea. A flea newly emerged from the pupal case must seek out a host; sometimes a particular animal is involved, with certain fleas supposedly undergoing starvation rather than feeding on some other available animal. Probably, in many other instances, the flea will reside on an animal other than the one that suits its particular needs before chance offers the opportunity to transfer to the preferred host. Hopkins (61) established the term "polyhaemophagy" to indicate a flea that could live for some time upon an animal that was not completely favorable to it, indicating that it would take a blood meal but was apparently unable to lay eggs. On the other hand, Hopkins described a flea that was indiscriminate in its requirements as demonstrating "promiscuity." In other words, this is a flea which can reproduce indefinitely on unrelated hosts. In northern mammal populations, particularly the rodents that are extremely cyclic, one is hard pressed to find a logical explanation for the survival of an ectoparasite such as a flea during the period of low density, when the animals literally seem to have vanished from large stretches of the land.

Incongruous as it may seem, the circumstantial evidence used to explain host associations in the past has often been poorly obtained. For example, collecting records did not indicate the number of fleas per host because several specimens of the same species were usually placed in a bag, and when reported, all that was known was the flea and the host, without regard to the numbers involved in either instance. Therefore, decisions concerning host association have been intuitive ones, and when the hosts have been widely separated or unrelated, certain of the early workers with excellent insight have apparently drawn some very valid conclusions.

Monoxenous Siphonaptera

In the following discussion I have used monoxenous in a more restricted sense than has usually been the case in the past. As closely as possible, I have interpreted monoxenous to imply the strict association with one species of mammal or bird. If the flea is monoxenous, then the decision of host association seems apparent; however, at times it takes "considerable doing" to decide that the flea is restricted to one species of animal. For example, I think no one questions that Amphalius runatus necopinus and Ctenophyllus armatus terribilis are restricted to the pika in the Nearctic Region, for they occur so seldom on any other host. This is not because another host is not available, since in one of our study areas near Paxson, the talus slopes are cohabited by Marmota caligata. Spermophilus undulatus pleisus occupies a

large area immediately adjacent to the talus slopes and is itself infested with Oropsylla idahoensis. I have seen pika and squirrel cross paths on several occasions, and if the flea of either animal were indiscriminate as to host, records should bear this out. They do not. Our only problem in the aforementioned examples is to decide not what fleas belong to the hoary marmot, but whether it is infested with fleas! All of my records for the marmot to date have been negative ones. Other workers have had a similar experience in the interior of Alaska when collecting the hoary marmot.

Other examples of monoxenous fleas are found among the Sciuridae, with Oropsylla alaskensis perhaps being the best example. This intimate association seems to be equally valid throughout Eurasia (see Ioff and Scalon, 74, p. 65, who also indicate that O. elana Jordan in Manchuria and O. stejnegeri Jordan in the eastern mountains are probable synonyms). O. idahoensis conforms to this definition in Alaska, being associated with S. u. pleisus and S. u. ablusus in southern Alaska. However, further to the south, it apparently is indiscriminate among various species of spermophiles, and in the laboratory, I know of at least one instance where this flea reproduced very well upon Peromyscus truei. Which flea is associated with ablusus in its northern limits is unknown to me at the present time. During the fall of the year, both species of Oropsylla previously mentioned apparently have an equally good opportunity to become associated with the ermine, as it frequently is trapped coming out of the burrows of the arctic ground squirrel at about the time these squirrels are going into hibernation. The direct relationship between the squirrel and the ermine is unknown at this time, but we have noticed for years that this is the best way of securing the ermine, and yet we have never found one specimen of Oropsylla upon this animal. Monopsyllus vison is almost completely restricted to T. hudsonicus, apparently straying to the ermine and marten only rarely. This is distinctly different behavior from that of O. c. durus, the other flea associated with the red squirrel.

C. riparius is generally regarded as specific for the bank swallow (Riparia riparia), and usually this holds to be the case. However, when the violet-green swallow (Tachycineta thalassina) departs from its usual nesting habitat and occurs in the riparian habitat, comingling as it were with the bank swallow, I am led to believe that C. riparius accepts this new host without hesitation. The same reaction apparently occurs when the kingfisher (Megaceryle alcyon) shares a bank with a colony of these swallows. This implies that C. riparius is not necessarily restricted to one species of swallow, though it is confined to a riparian niche. The bank swallow is by far the most abundant and commonly encountered bird, which has led us to believe that this flea was completely host-specific. Be that as it may, I am of the opinion that if the bank swallows were removed from Alaska, C. riparius would also soon disappear, because the number of other birds living in the riparian habitat likely would not be sufficient to maintain a breeding population of the flea.

Polyxenous Associations

Certain of the fleas placed in this category are closely related to the monoxenous condition discussed above. Two excellent examples are: (1) H. g. lynx with the varying hare (L. americanus) and the lynx (L. canadensis) and (2) O. c. durus with T. hudsonicus and the ermine (M. erminea). The relationship of these two fleas with their hosts bears additional investigation. However, evidence presented earlier indicates that O. c. durus is able to reproduce when confined to the ermine, though it is not known whether it does so as well when on the red squirrel, T. hudsonicus. According to Hopkins' terminology (63), this would be an example of promiscuity rather than poly- haemophagy. I suspect the same applies to H. g. lynx and the predator of the hare, the lynx. Here the matter may be more delicate, particularly if pre- liminary studies by Mead-Briggs and Rudge (101) come to fruition. These last mentioned authors indicate that the rabbit flea, Spilopsyllus cuniculi (Dale) requires a factor from a pregnant rabbit for ovarian maturation. It could possibly be that the varying hare flea is only polyhaemophagous on the lynx. Certainly, this flea will bite man with apparent readiness, as many trappers in the northern regions can testify.

Corrodopsylla c. curvata is primarily associated with members of the family Sorcidae, the exceptions being so uncommon as to be considered rare. There are many examples similar to this — that of C. l. tundrensis and Chaetopsylla floridensis being relevant. The former species has never been taken in a large series at any one time and, with very few exceptions, has been found upon mustelids (Martes and Mustela). C. l. tundrensis is the only species of Ceratophyllus presently not known to occur on birds. However, Hopkins (61) reports that seven specimens of this flea were removed from the nests of Anser leucopsis in Greenland. Almost certainly, this flea is associ- ated with mammals, but it is disquieting that the one collection from a bird nest is the largest series taken. Ch. floridensis has been taken in good series and again appears to be associated with the same two genera, most frequently encountered upon Martes americana and Mustela vison.

Ordinarily, I would have thought that C. scopulorum was a monoxenous species; however, the records by Benton and Shatrau (6) in New Brunswick on the barn swallow indicate that this is not entirely true. Apparently this flea, like C. idius, will be found upon some of the other species of Hirundinidae. In other words, the two species of fleas will be confined to one family of birds. On the other hand, C. garei is an excellent example of a flea that is confined to a particular ecological situation with little regard to the host. This flea breeds in the nest of any number of ground-inhabiting birds, so long as the nesting site is moist.

The occurrence of E. wenmanni in Alaska is most interesting. So far, the few records that are available indicate that this flea has been associated primarily with Microtus. I have considered Clethrionomys to be a replacement

for Peromyscus in the boreal region, and Gabbutt's study (30) would seem to support this concept. It will be interesting to see what the future holds for this species in Alaska. It is not unusual for the host to exceed the distribution of the flea, as for example, the Norway rat and Xenopsylla cheopis. The same phenomenon is known for several New World fleas, of which Polygenis gwyni (C. Fox) is an excellent example. This flea is associated (for the most part) with the cotton rat (Sigmodon hispidus) in the southern United States. However, the cotton rat has extended its northern range, and the flea apparently has not been so successful. Throughout all of Oklahoma and northern Texas, the usual flea associated with the cotton rat is Orchopeas leucopus (Baker), ordinarily a flea of the deer mice. Peromyscus spp.

The examples mentioned in the foregoing paragraph illustrate that fleas are bound, not always just by the distribution of a particular host, but more than likely by ecological requirements. Apparently the flea E. wenmanni is able to adjust to a wider set of ecological conditions than its primary host. This is probably so for many other species of fleas, of which knowledge is bound to be secured in future studies.

With closely related mammals, the host association of the fleas becomes increasingly difficult to understand, particularly if there is a comingling of these mammals in the same habitat, as so frequently happens in Alaska. For example, in the same plot at Circle Hot Springs, it was possible to obtain C. rutilus, M. oeconomus and M. pennsylvanicus. I am not aware that my trapping methods favored any one species of rodent, inasmuch as various types of habitats were selected within an area. Generally, I found Clethrionomys to be more abundant on the drier, well-drained ground and M. oeconomus being predominant in the moist flatlands of the taiga. There was considerable overlap between these two species of microtines; I have never found Microtus pennsylvanicus to exist in large numbers anywhere that I have trapped. M. pennsylvanicus has occurred only sporadically, in small numbers intermixed with M. oeconomus within the taiga. At Circle Hot Springs I have taken both species of Microtus from the same trap in a 24-hour period. Tables XV, XVI and XVII give pertinent information concerning the fleas associated with the microtine rodents.

Of special interest here is the greater frequency of P. o. longiloba upon M. oeconomus and an infestation almost double that of C. rutilus. M. p. dissimilis was encountered slightly more often on C. rutilus, but the average number of fleas per host was not significantly different. Edwards (16) was probably wrong in reporting M. p. dissimilis from Clethrionomys gapperi at Hudson Bay; most likely it was M. p. athabascae Holland. M. c. gregsoni is evidently more closely associated with M. oeconomus, whereas M. quirini appears to show a slight preference for the red-backed vole.

The relationship of C. d. fulleri to M. pennsylvanicus is most interesting, even though the sample is too small to make any sort of a valid

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TABLE XV

Fleas Associated with the
Red-backed Vole, _Clethrionomys_ rutilus

Siphonaptera	Total No. Fleas	No. Positive Specimens Collected	Average/Host
Catallagia d. fulleri	69	42	1.4
Peromyscopsylla o. longiloba	42	25	1.7
Amphipsylla m. ewingi	03	03	1.0
Malaraeus p. dissimilis	162	75	2.2
Megabothris c. gregsoni	27	16	1.7
Megabothris quirini	34	21	1.6

assessment of data. Ordinarily, I would have expected M. quirini to have
been the most common flea associated with this particular mammal. I have
had particularly poor success with attempting to obtain data from the jumping
mouse, Zapus hudsonius. Again, I would have expected M. quirini to have
been relatively common on this rodent; however, as reported earlier, I have
but one flea to report, and that is C. d. fulleri! The high and average
number of fleas per host in relation to C. d. fulleri and the meadow vole is
exaggerated by the fact that 28 out of the 50 fleas were on one specimen.

TABLE XVI

Fleas Associated with the
Arctic or Tundra Vole, _Microtus_ oeconomus

Siphonaptera	Total No. Fleas	No. Positive Specimens Collected	Average/Host
Catallagia d. fulleri	70	36	1.9
Peromyscopsylla o. longiloba	259	88	2.9
Amphipsylla m. ewingi	07	06	1.2
Malaraeus p. dissimilis	125	59	2.1
Megabothris c. gregsoni	139	75	1.8
Megabothris quirini	14	12	1.2

As elsewhere throughout the world, the mammal fleas in Alaska occur
mainly on Rodentia, Lagomorpha, Carnivora, Insectivora and Chiroptera.
Members of the order Artiodactyla in the boreal regions of the New World do

not support fleas, although members of this group are known to be infested in the areas farther to the south. One family within the carnivores is notable for its exception in not having fleas in Alaska; this is the Canidae. With the large number of domestic and semi-domestic dogs within Alaska, it is somewhat startling to learn that they are not infested, which is a remarkable departure from their populations farther south.

TABLE XVI

Fleas Associated with the Meadow Vole, Microtus pennsylvanicus

Siphonaptera	Total No. Fleas	No. Positive Specimens Collected	Average/Host
Catallagia d. fulleri	50	11	4. 5
Peromyscopsylla o. longiloba	01	01	1. 0
Amphipsylla m. ewingi	02	01	2. 0
Malaraeus p. dissimilis	00	00	0. 0
Megabothris c. gregsoni	03	02	1. 5
Megabothris quirini	01	01	1. 0

XXI

MEDICAL IMPORTANCE OF ALASKAN SIPHONAPTERA

Nothing is known of the medical importance of this group of haemophagous insects. Past history has indicated that fleas have largely been important for two diseases, plague and murine typhus, neither of which is known to have occurred in Alaska in historical time. Rausch and coworkers at the Arctic Health Research Center (pers. comm.) reported that they had isolated a gram negative bacterium from a varying hare near Anchorage that was asserted to be Pasteurella pestis. Inasmuch as plague had not been found previously in Alaska, material was sent to the CDCA San Francisco Field Station for confirmation. According to Quan et al (115), their studies showed the Alaskan bacteria to be closely related to pestis in many respects and, on the other hand, to bear some relationships to Pasteurella pseudotuberculosis. The true identity of this organism has probably not yet been established. In many respects, I feel that a more logical explanation of the plague occurring in wild rodents of North America is the concept that plague spread with the Eurasian mammals into the New World during Pleistocene or earlier, rather than assuming it was introduced into the coastal areas of California at the end of the previous century and thence spread into the native animals. I feel that an investigation of this subject in Alaska warrants further study.

Tularemia caused by the organism <u>Bacterium</u> <u>tularense</u> is known to be endemic throughout much of Alaska. In an earlier report to the Arctic Aeromedical Laboratory (68), I discussed the epidemiology of this disease. There is little or nothing in the epidemiology of tularemia as it relates to man that would support a concept that fleas are important vectors. In studies such as this, human infection is not a good yardstick, and the role of fleas as vectors among wild rodents could be far more important than is now recognized. In many respects, the epidemiology of tularemia in Alaska closely resembles that known in Russia. A significant publication by Olsufiev (105) reports that he found many species of fleas could become infected and that some of them transmitted the tularemia organisms among populations of water rats. On the whole, however, Olsufiev did not consider the fleas efficient vectors. Green and Evans (36) found fleas on a varying hare (probably <u>Hoplopsyllus</u> <u>g.</u> <u>lynx</u>) naturally infected with tularemia organisms. The Plague Laboratory in San Francisco has found many species of fleas naturally infected with tularemia organisms when seeking to isolate plague organisms from them.

XXII

SUMMARY

The fleas presently known to be indigenous to Alaska comprise 51 species and subspecies, of which 37 normally occur on mammals and 14 on birds. With one possible exception, all of the fleas are known in other parts of the world, many of them occurring in the Yukon or northern British Columbia and some of them occurring even into the southeastern United States. Approximately half of the species in Alaska occur also in the Old World, being not more than subspecifically distinct. It is interesting to know that of the 25 genera of Alaskan fleas currently known, all but 5 are also known from the Palearctic Region.

The fleas of Alaskan mammals are apparently derived from three principal sources, and their present distribution is thought to represent the postglacial history of this state. The largest group apparently arose from Eurasia as the mammals migrated across the Bering land bridge during the glacial periods and found refuge in a large nonglaciated area of interior Alaska and Yukon territory. These are the fleas that are now known to be common to both the Nearctic and Palearctic Regions, their hosts being generally as Holarctic in distribution. The second group of fleas consists of forms that are mostly Nearctic in origin and have migrated northward on their hosts as the Pleistocene glaciers receded. Within this group are fleas which belong to exclusively Nearctic genera; however, some genera are also represented in Eurasia, though the species within these genera are distantly related. A third group arose from the Pacific Northwest, and in their northward migration now occupy a narrow strip of land, mostly west of the Coast Range.

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There is a general concept that some species of fleas are markedly host-specific, whereas others are not. Be that as it may, it is now well-known that within the host-specific groups, most of the species are not concordant in their distribution with those of the preferred host. A remarkable example of the latter point are the six species associated with the microtine rodents in the taiga. Only two of these species followed the same hosts north into the tundra regions. It is equally interesting that none of the fleas known to occur in the most northern regions of Alaska are restricted to this area, having adapted in some instances to some other host within the taiga. These distribution patterns are basic to our understanding of the flea's biology and indicate that these insects are subject to ecological factors and pressures over and above those which affect the distribution of the mammals and birds upon which they ordinarily depend for their existence. New knowledge is urgently needed on this point in order to understand the biology of the flea and to justify the study of flea distribution; otherwise one would merely record the hosts and assume the flea. One other little-appreciated fact relevant from a study of flea distribution is the importance of these creatures as biological indicators of disease organisms unrelated to them. This implies that frequently a knowledge of the flea fauna in an area can be used as a guide as to what to expect in the way of zoonoses that are transmittable to man but not necessarily by the fleas themselves.

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13. ABSTRACT Fifty-one species and subspecies of fleas are currently known in Alaska; 37 species normally occur on mammals, and 14 are associated with birds. With the possible exception of one or two species, none are restricted to the political entity, Alaska. From a study of geography, paleozoology, morphology and taxonomy, the fleas of Alaskan mammals are reported to be derived from three principal faunas. The largest group apparently arose from Eurasia as the mammals migrated across the Bering Land Bridge during the glacial periods of the Pleistocene epoch and earlier. These animals found refuge in a large non-glaciated area of interior Alaska and the Yukon Territory. These fleas are now common to both the Nearctic and Palearctic regions, their hosts generally being Holarctic in distribution. The second group of fleas are Nearctic in origin and have migrated northward along with their hosts as the Pleistocene glaciers receded. A number of the genera in this second group are restricted exclusively to the Nearctic region; however certain genera are also represented in Eurasia. A third group of fleas arose from the Pacific Northwest. These fleas, like the second group, have spread northward as the Pleistocene glaciers receded. Fleas of this third group now occupy a narrow strip of land, mostly west of the Coast and Alaska Ranges. A study of host associations reveals that distribution of the fleas is not concordant with that of the preferred hosts. For example, of six species associated with microtine rodents in the taiga, only two have followed

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AAL-TR-64-12. ALASKAN HEMATOPHAGOUS INSECTS, THEIR FEEDING
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    I. THE SIPHONAPTERA OF ALASKA.

the same hosts into the vast tundra region to the north. Fleas originally thought
to be restricted to the Arctic regions are now known to have adapted to hosts
within the taiga, albeit the distribution is not an extensive one. These distribu-
tion patterns indicate that the Siphonaptera are subject to ecological factors and
pressures over and above those which affect the distribution of the mammals and
birds upon which they depend for their existence. Additional knowledge is
urgently needed in order to understand the biology of the flea, expecially in the
subarctic and Arctic areas of the world. The data collected thus far indicate
that most fleas in the taiga have one, or possibly two, generations a year. By
late winter and early spring, Malaraeus penicilliger dissimilis (Jordan, 1938)
is frequently the only species encountered upon the microtine rodents. During
July, August, September and October, the small mammals are most abundant.
Simultaneously, the flea infestation rates upon the mammals increase and the
number of different species encountered also becomes more varied.

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