

MOSQUITO DISTRIBUTION IN ALASKA WITH ESPECIAL REFERENCE TO A NEW TYPE OF LIFE CYCLE

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The most important and best known family of Alaskan insects is the Culicidae, or mosquitoes. Northern mosquito investigations since World War II have provided enough insight into the Alaskan distribution, if not yet furnishing an adequate check list, to be of interest to other entomologists and even make contributions to biogeography. In this paper it is proposed to compare in a general way arctic, subarctic, and temperate zone mosquito faunas. Disregarding several rare species and those of uncertain occurrence as well as transition elements which tend to obscure zonal distinctions, lists of the mosquitoes of Umiat, Anchorage, and Juneau have been chosen to represent their respective zones. This procedure introduces a considerable error of omission, but it does not seem either to misrepresent zones or to affect the chief conclusions. Unfortunately, we cannot yet draw up complete lists of arctic, subarctic, or temperate zone Alaskan insects.

At first glance, today's list of Alaskan mosquitoes²—about 24 species belonging to the worldwide genera *Aedes*, *Culiseta*, *Culex*, and *Anopheles*—appears commonplace enough to resemble another State check list. Nothing could be farther from the truth, however, for when these species are viewed with a biological bias they are seen to constitute an extraordinary assemblage of cold-tolerant forms, a rigorous selection biota, having a good deal in common biologically. It is evident that

Alaskan mosquitoes manifest only one of four types of life cycles represented by mosquito biologies in temperate United States or Europe, and that the biologies of three-quarters of the species belong to this one type of cycle which therefore thoroughly predominates in Alaska. The type of life cycle of the remaining several species is a new one (Frohne, 1953) characteristic of the subarctic. Thus not only has the northern environment selected species similarly qualified to survive the winter and to take full advantage of the short summer, but it has even developed, by a kind of convergent adaptation, a second type of strictly northern life cycle for the several other species whose phylogenies required them to hibernates in a different life-history stage. Furthermore, when the three zonal lists of mosquitoes are presently contrasted, it will be noted that only the dominant type of life cycle occurs in the arctic list, and that the other type, starting from a subarctic origin, becomes relatively less important in temperate southeastern Alaska.

Trees are an important part of the environment to mosquitoes, and their distribution is also an important biological difference between the three life zones. The convenient custom of mosquito workers of designating species which are apparently limited to forests as "woods" species, and those of treeless country as "tundra" or "prairie" species, is followed here. Admittedly, nevertheless, only better distribution data and careful life-history studies showing how trees may be necessary, perhaps for mating activities or for hibernation of "woods" mosquitoes, can establish the validity or erroneousness of these handy, speculative designations.

TYPES OF CYCLE.—Four kinds of mosquito life cycles have been recognized, (Bates, 1949) depending chiefly on the number of broods per year and the stage

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²*Aedes aboriginis*, *cataphylla*, *cinereus*, *communis*, *diantacus*, *excrucians*, *fitchii*, *flavescens*, *hexodontus*, *impiger*, *intrudens*, *nearcticus*, *nigripes*, *poniops*, *pseudodiantacus*, *pullatus*, *punctodes*, *punctor*; *Anopheles* ? *occidentalis*; *Culex territans*; *Culiseta alaskaensis*, *impatiens*, *incidens*, *maccrackenae* ?, and *morsitans*.

in which the inclement season (winter or dry season) is passed. Each type, originally proposed by Wesenberg-Lund, has been named by Bates after a typical, representative species. Thus, in the one named for the almost cosmopolitan house mosquito—the *Culex pipiens* type of life cycle—there are an indefinite number of broods a season, and it is the inseminated females which hibernate. This type of cycle does not occur among Alaskan mosquitoes. As a matter of fact, no Alaskan mosquitoes appear to have more than a single annual brood. Three-fourths, probably eighteen, of the Territory's species belong to the *Aedes cinereus* type of life cycle, which is single-brooded, with hibernation in the egg. Disregarding a peculiar species of *Culiseta* (which may possibly hibernate in the larval stage in Alaska as it does in Europe), since we do not know the facts, the remaining species (about 5) cannot be accommodated in any of the long recognized types of life cycle. Every Alaskan is familiar with some of these common mosquitoes, which include the large biters of early spring. One of them is a winter mosquito, frequently encountered by snowshoers on the trails about Juneau, flying in the sunshine and resting on the snow in January and February. It was the detailed study of two species of this group by entomologists of the Arctic Health Research Center which led to the definition and naming of this new type of cycle—the *Culiseta impatiens* type of life cycle. Before discussing the distribution of Alaskan mosquitoes according to type of cycle it is desirable to characterize the two cycles of Alaskan mosquitoes.

Aedes cinereus TYPE OF CYCLE. *Aedes cinereus* itself and about 17 congeners are the well-known, vicious biters of June and July in Central Alaska. Most of them are smaller kinds than the big *Culiseta* pests of April and May which they replace, but their numbers are legion. They begin biting just after they have finished mating, usually in characteristic swarms. They seek blood in order to develop the eggs, which they soon lay individually in

the dry basins of vernal snow-melt pools. The eggs develop embryos at once, but they do not hatch, even if inadvertently flooded. Instead, they lie quiescent over the winter until with the melting snows of the following spring, they hatch in a characteristic order or succession according to species. Thus the earliest abundant one, *Aedes communis*, is typical of cold melt holes of partly ice-bound pools, while a late one, *Aedes pionips*, occurs especially in lukewarm pools a month or more later. *Aedes cinereus* is intermediate. Regardless of minor differences of hatching habits and of habitat, the adults emerge about a month afterwards. They mate, soon bite, and oviposit to complete the cycle. Thus, *Aedes cinereus* and all other Alaskan *Aedes* species pass 8-10 months of their individual lives of about a year as embryonated eggs, and they produce one annual brood.

Culiseta impatiens TYPE OF CYCLE. Besides *Culiseta impatiens*, *C. alaskaënsis*, (Frohne, 1954) has been shown to pass through a closely similar life cycle, and it is necessary to assume from larval dipping records and other evidence that the local species of *Culex* and *Anopheles* also manifest similar life cycles. The eggs of *C. impatiens* are laid in May or June in boat-shaped rafts of a hundred or more eggs directly on the water of permanent ponds and bog pools. After 5 days they hatch and rush through their larval and pupal development to the winged stage in less than a month. Mating is probably always without the formalities of male swarms, and the males die soon afterwards. The inseminated females are restless and without bloodlust during their first summer. They seek out resting places where they may remain dormant as long as 9 or 10 months. In southeastern Alaska, however, they come forth impatiently on sunny days of winter. In March, April or May they seek blood, mature the eggs in about two weeks, oviposit, and so complete the cycle. Part of a female's activities belong to her first summer, another kind of behavior to her second summer, and she is likely to live

more than a year as an adult insect. The occurrence of two types of females with quite dissimilar habits led to disagreements as to biting behavior of these species until the life histories were worked out. Of the other mosquitoes with this cycle, the Alaskan *Anopheles* similarly bite only after hibernation, but the *Culex* do not bite man. In fact, nothing is known of the biting habits of *Culex territans* in Alaska. The essential features of the *Culiseta impatiens* type of life cycle are single-broodedness and hibernation by the inseminated female.

ARCTIC MOSQUITOES. Knight (1948), to whom we owe the list of Umiat mosquitoes, reported three species and evidence for the occurrence of one or two more there. Mosquitoes are exceedingly abundant and troublesome at Umiat. The known species are *Aedes punctor*, *communis*, and *nearcticus*. The suspected additional ones are closely related *Aedes* species such as *A. nigripes*. All of these belong to the *Aedes cinereus* type of cycle. Even though *punctor* and *communis* occur in forests farther south, all these arctic forms must be considered "tundra" species, for trees in the usual sense do not occur about Umiat. Some or perhaps all of them are great migrants here. Their dispersal with the wind has been observed by others and ourselves in the strange light of arctic evening. This phenomenon of dispersion has been called upon to explain the short duration of mosquito abatement when about 30 square miles around Umiat were sprayed with DDT concentrate by aircraft. It may be a result of the almost continuous sunlight of the flight period that these arctic mosquitoes manifest no noticeable periodicity in biting and perhaps of other activities. The mosquito biting season in this part of the arctic is less than a month per year, but it is possibly the most severe in the world during this short period.

SUBARCTIC MOSQUITOES. The Anchorage area has a larger and better known mosquito fauna.¹ There occur as least four species with the *Culiseta impatiens* and twelve with the *Aedes cinereus* types

of cycle. (The cycle of *Culiseta morsitans* is in doubt.) Two of the former group of species, unfortunately, are bad pests of the early springtime. This results in extending the mosquito biting season, which lasts about four months. The latter group includes some "woods" mosquitoes, a salt-marsh contingent, of which *Aedes punctodes* is most important, and several kinds which avoid trees. Their adult habitats are neither tundra nor prairie. One of these "non-woods" species which breeds only in brackish water in Alaska, so far as is known, is *Aedes flavescens*. The adults of *flavescens* do not leave the open salt meadows. Of even greater practical importance is the behavior of biting females of certain "woods" species which are not merely reluctant to leave the cover of the trees but actually do not molest people living in large clearings. The same species, in the main, do not disperse far from their breeding areas, although "far" may mean more than a mile. Unfortunately, away from the coast and further north such fortunate habits, or the species manifesting them, are less prominent when evident at all.

TEMPERATE ZONE ALASKAN MOSQUITOES. Any attempt to explain biogeography of southeastern Alaska should take into account the recent recession of the ice cap there and the comparative isolation still caused by sea, ice, and mountain barriers. However, radiocarbon dating, (Berrill, 1953), shows no such great age difference from the north temperate United States as one might expect. Much of Maine was still covered by the last continental glacier for about a thousand years after the bog on upper Montana Creek near Juneau melted and began accumulating peat about 5,000 years ago as Heusser (1952) has determined. But this geologically short period operated in conjunction with sea and mountain barriers and lengthy if mild winters in southeastern Alaska, and

¹ *Aedes cataphylla*, *cinereus*, *communis*, *dian-taenus*, *exerucians*, *fitchii*, *flavescens*, *impiger*, *intrudens*, *pionips*, *punctor*, *punctodes*; *Anopheles* ? *occidentalis*; *Culex territans*; *Culiseta alaskensis*, *impatiens*, and *morsitans*.

the combination of impediments has apparently kept many organisms out to this day. Some mosquitoes, e.g. *Culiseta alaskaënsis* and *Aedes excrucians*, have apparently penetrated into the region only at points like Haines and Wrangell where major rivers provide an avenue from the interior. However, along the coast and perhaps by island-jumping came two mosquitoes, *Culiseta incidens* and *maccrackenae*? which are otherwise typical United States West Coast temperate forms. A further factor is the cool summer climate of southeastern Alaska. The region is relegated to the temperate zone in recognition of its mild winters, despite its cool summer climate, as a glance at July and January isotherm maps for North America makes obvious.

Viewed in the light of the preceding paragraph it is not surprising that the Juneau list of mosquitoes,¹ representing southeastern, i.e. temperate Alaska, resembles the arctic and subarctic Alaskan lists more than it would a stateside temperate zone list of mosquitoes. At Juneau eight species with the *Aedes cinereus* type of cycle and two with the *Culiseta impatiens* occur. There are no mosquitoes which produce more than a single annual brood though the mosquito biting season is very long, over five months. The absence of *Culex* and *Anopheles* suggests the arctic list. It is probably too cool in summer about Juneau, as at Umiat, for the sun-loving malaria mosquito. The maritime influence is apparent in the predominance as a pest of *Aedes punctodes*, a salt-marsh species. This species probably immigrated from the subarctic along the coast. As has been noted for some subarctic coastal

mosquitoes (*Aedes*), those of southeastern Alaska are probably all "woods" species which disperse relatively short distances and leave the shelter of the forest reluctantly.

SUMMARY AND CONCLUSION. A preliminary check list of 24 Alaskan mosquitoes, and three partial lists representing arctic, subarctic, and temperate life zones of the Territory are presented. After viewing these lists of species according to their biologies—types of life cycles—it is concluded that Alaskan mosquitoes as a whole are an extraordinary selection biota. Only two types of life cycle, both manifestly adaptations to the northern climate, occur. One of these, which is especially characteristic of the subarctic, is new. All Alaskan mosquitoes are single-brooded. They may be classified as to type of life cycle by the stage, egg or inseminated female, which hibernates. Biological differences among the representative species lists of the three zones are discussed. Of practical importance is the length of the mosquito biting season, less than a month in the arctic, about 4 months in the subarctic, and more than 5 months in temperate Alaska.

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¹ *Aedes aboriginis*, *cinereus*, *communis*, *impiger*, *pionips*, *pullatus*, *punctodes*, *puncator*; *Culiseta impatiens*, *incidens*, *morsitans*.