

MATING SWARMS OF MALES OF THE MOSQUITO, *Aedes punctator* (KIRBY), IN ALASKA

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INTRODUCTION. Close observation of seventy-four swarms of male *Aedes punctator* mosquitoes near Auke Bay, Alaska, in 1952 leads us to question the general validity of the conclusion of Nielsen and Greve (1950) that mating and swarming of mosquitoes are unrelated phenomena which normally take place at quite different times. While they observed "several millions of mosquitoes" in swarms during seven seasons they saw only three copulations. Calling attention to the high density of mosquitoes on the ground, they further state that copulation occurs there in the morning or in the air in the afternoon, when there are no swarms of males. However, reviews of the mosquito literature (Howard, Dyar, and Knab, 1913; Wesenberg-Lund, 1920; and Bates, 1949) show virtual unanimity for the thesis that the male swarm is the chief locus for copulation, and that it even provides the essential stimulus. To be sure, many authors comment on the scarcity of mating pairs in the swarms they observed. No workers other than Nielsen and Greve appear to have proposed an explanation for male swarms other than that they are mating swarms. The Danish workers, however, throw out the suggestion "that swarming serves to prevent inbreeding by mixing males from different breeding places." Very recently Nielsen and Nielsen, as reported by Provost (1952), have studied male swarms of *Aedes taeniorhynchus*, the females of which are celebrated migrants. In this instance mixing of males from different breeding places would appear to be superfluous. The Nielsens saw no mating in connection with the swarms they observed near Fort Pierce, Florida. Provost, however, reports mating in the swarms of the same species at Sanibel Island, Florida.

The present observations in Alaska do not solve the conflict altogether, but they do show that very high rates of copulation amounting to hundreds or even thousands per evening may occur even in swarms of one of the species studied so assiduously by the Danes. Predation on the swarming male mosquitoes by swarming males of a dance fly, *Rhamphomyia* sp., is also described.

CIRCUMSTANCES. The data were obtained by direct observation, usually with the observer lying flat on the back nearly under the swarm so as to see the mosquitoes against the light of the sunset. The advantage of this position, which was discovered by chance when resting from the arduousness of reclaiming a garden plot, is partly due to the Tyndall effect. The location, a glade in the Tongass National Forest about 15 miles northwest of Juneau, Alaska, sloped westward. While the lay of the land favored evening swarming and observations, morning swarms did not occur.

JUNE SWARMS. The earliest swarms were noted on June 6 at 22:30.† The species was *Aedes punctator*, which is considered to be a forest mosquito, and it is presumed that glades in the gloomy wilderness of western hemlock and Sitka spruce such as the garden clearing are its normal swarming sites. The mosquitoes of the June swarms, however, had doubtless bred in an extensive, open, brackish marsh nearly a mile away in the tidal delta of the Mendenhall River. The actual breeding areas of *punctator* there were shallow depressions in a zone 50-100 yards wide in which a form of the species with reduced, budlike gills occurs at high densities. The eggs hatched from mid-April to mid-May as the melting snow and the tides flooded different areas on the

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† Pacific Standard Time.

flats. Large larvae teemed there the latter half of May, and the first pupae were dipped May 19. During the succeeding two weeks the adults emerging on this open salt marsh migrated into the woods behind.

Large numbers of adults of both sexes appeared June 4 in the tall, dead grass of the garden clearing, and all the June observations were made there. During a vain search for mating activities the following evening the first *Aedes* bite of the season was recorded. Although dissections were not made, it is reasonable to suppose that the clouds of females flying near the ground and showing virtually no blood lust were predominantly composed of virgins until after mid-June. Nevertheless, the number of females seeking blood grew by leaps and bounds during the following week. Counts made on June 11 gave a landing rate of 60-80 (Blanton *et al.*, 1950). Unfortunately the higher rates of the succeeding 10 days, when there was much mating at male swarms, could not be determined by this method; there were too many mosquitoes. The average age of the females, i.e., the proportion of virgins, is possibly the chief difference, other than size of male swarms, between the June swarms in which high rates of copulation were observed, and the July-August swarms where almost no matings were seen. There were ordinarily three swarms each "swarming" evening. They formed at precisely the same locations in the clearing from about 20:30 to about 22:30 on June 6, 10-12, 14-20.

The swarms of June 6 and 10 were large, but unfortunately were not closely observed. No matings were seen. On June 11, however, a casual observation at about 20:45 showed that mating was taking place constantly at high rates at all three swarms. The rates fluctuated between about 25 and 150 matings per minute. Our representative figures give approximations of the order of magnitude of the rate; they were estimated after many trial counts for different periods counting slowly by threes for a minute. The swarms became very large, in num-

bers of participants, and dense. Not less than several thousand males were in attendance at each. The din of the high-pitched hum could be heard about 40 feet away. When broken up by passing the net through the "core," a swarm reformed within 5-15 seconds. On June 12, the following evening, the same frenzied swarming and copulating took place. No observation could be made June 13, and all subsequent June swarms were smaller, and the average copulation rates, which were easily determined, were only a few per minute or practically zero June 21 and 22.

JULY-AUGUST SWARMS. Three weeks after swarming had ceased in the garden clearing, two swarms of mosquito males were discovered about a tenth of a mile away near the shore of Auke Bay. The new swarming sites differed from the earlier ones in the garden clearing in that they occurred under a canopy of branches, and the mosquitoes circled closer to the ground. It was conjectured that another species, then emerging in large numbers, presumably with different swarming requirements was the subject. However, all the genitalia mounts sampled over the ensuing 5 weeks again involved *Aedes punctator*, the species observed in June. In the new swarming loci 36 swarms were observed July 12-15, 17, 19-25, 27-30, August 1-14. They were looser swarms with less than about 75 males participating at once, and the soundness of the term "swarm" for as few as 1-2 males, as suggested by Nielsen and Greve (1950), became apparent from observing the smallest. Swarms formed between 20:30 and 21:00 on clear evenings, but on dark, cloudy nights they sometimes appeared as early as 19:45. They terminated with the sunset about 22:30 in mid-July and progressively earlier until it was about 21:30 in mid-August. Temperatures at which this midsummer swarming occurred averaged about 15 degrees C., ranging from 13 to 18 degrees C. On two evenings following days of heavy rain there was no swarming, but neither was there any on the evening of July 31, one of the bright-

est, warmest days of the year. There were swarms during light drizzles August 2 and 7 and despite a wind of several miles per hour a few other evenings. The summer dipping records showing relatively few *punctor* larvae in the latter half of July and in August suggest the males may have been on the average older than those of the June swarms. It is also not unlikely that relatively few virgin females were on the wing, especially in August.

Whatever the reasons, there was very little mating seen in connection with the July-August swarms. In one and three-quarter hours of attentive watching on July 12, however, two instances were seen, and each of us saw what appeared to be copulating pairs a few times in the succeeding 5 weeks. There may have been low rates proportional to the small size of the swarms which we overlooked. For, unfortunately, the time interval during which a pair of mosquitoes might be clearly visible was short in comparison with the same period for the June swarms. There appears to be no good reason to doubt that mating was of rare occurrence in the summer swarms, nevertheless.

COPULATION. Mating pairs were seen chiefly in the June swarms, only a very few being seen for a part of their nuptial flight in July-August swarms. No instance of mating independent of swarming was found. Thus in our experience the factors favorable to mating are those causing swarming. Representative weather conditions under which swarming occurred ranged from fair and calm to drizzly and windy. The air temperature at the bottom of the swarm where mating pairs initially grappled ranged from 8 to 16 degrees C. However, the very large swarms of June 11 and 12 which had the highest mating rates followed warm, sunny, calm days. The greatest activity of the adults of this species similarly appeared to be at about 15 degrees C.

The act of copulation averaged about half a minute, ranging from $\frac{1}{4}$ to $1\frac{1}{2}$ minutes. After coming together venter to venter in the lower part of the swarm pairs ascended out of it to a height of

15-50 feet. Ascent became descent when one partner, probably the male, stopped flying and released the claw holds. Pairs came down a variable distance still joined end to end before the terminalia were disengaged and the partners separated. Possibly some reached the ground *in coitu*. This nuptial flight was so regularly observed for all pairs that it would seem unlikely that mating could occur in the species without it (Séguy, 1950). Pairs caught in the net before ascending separated at once. Within the swarm pairs were usually assailed by supernumerary males. Above it, they were frequently seized by male dance flies (cf. following paragraph). Male mosquitoes occasionally grappled momentarily with one another.

DANCE FLY SWARMS. The males of *Rhamphomyia* sp., a species of dance fly (Empididae) swarmed directly above the June male mosquito swarms and preyed upon the males and also on mosquito pairs near the top of the mosquito swarms. These dance flies, first observed June 14, increased in numbers to form conspicuous, loose swarms of about 50 flies each during the week following, while the mosquito swarms became smaller each evening. At first the aggregations of male dance flies over the mosquito swarms were viewed as being there primarily to secure prey, presumably for offering to prospective mates. However, the dance fly males continued swarming after the termination of the mosquito swarming late in June so that it is more reasonable to suppose that the predation was incidental to swarming for some other purpose, presumably mating. The dance flies captured mated pairs of mosquitoes, seemingly preferring them to individual males. They did not depart from their swarming to catch female mosquitoes which were present in high densities in the proximity of the observers. A single instance in which two dance flies engaged at close quarters was regarded as copulation, but this must be viewed as doubtful. It may have been a case of cannibalism involving two males. No females of the dance flies were included in net

collections. Dance flies did not appear in connection with the July-August swarms.

SUMMARY AND CONCLUSIONS. Seventy-four swarms of *Aedes punctor* males were observed: (A) in June; and (B) in July-August.

(A) The June series of 38 swarms was characterized by large concentrations of hundreds or even thousands of males flying in 3 loci of an open clearing, copulating at the rate of 1-10 per minute or rarely at very high rates estimated at about 150 per minute. A nuptial flight occurred.

(B) The July-August series of 36 small swarms of less than about 75 males each took place evening after evening in two loci under overhanging branches. Very few instances of copulation were seen.

It is concluded that for *Aedes punctor* in Alaska swarming is a behavior closely connected with copulation, i.e., swarms of males are *mating swarms*, but that males form small swarms later in the season which are largely without function since few or no copulations then occur there.

Males of a dance fly (Empididae), *Rhamphomyia* sp., formed swarms above the June mosquito swarms. They also preyed on the mosquito males and pairs.

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NOTES ON MOSQUITOES IN NORTH AMERICA: II

COLLECTIONS AT MILITARY INSTALLATIONS IN INDIANA DURING 1944 AND 1945

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Hart (1944) published records of twenty-four species of mosquitoes found in Indiana. Christensen and Harmston (1944) published a preliminary list of the mosquitoes of Indiana which includes all the species found by Hart and records for five additional species.

This paper includes collection records of twenty-one species of mosquitoes taken during 1944 and 1945 at five military installations located in Indiana. Two species, *Aedes* (*Aedes*) *cinereus* Meigen and *Culex* (*Culex*) *salinarius* Coquillett, were not reported by either Hart (1944) or Christensen and Harmston (1944). The mosquitoes were collected by Army Medical Service personnel assigned to the

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