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Copulation and Ovulation in *Anabrus Simplex* Hald.

By C. P. GILLETTE.

The so-called Mormon cricket, *Anabrus simplex*, appeared in great numbers in portions of Routt County, Colorado, the past summer. While studying the habits of this wingless grasshopper, near Eddy, my attention was attracted by the large white masses of a jelly-like material that were attached to the abdomens of the females just beneath the ovipositors. They had also been noticed by the ranchmen who spoke of them as "white sacs" and "blubber." I concluded the phenomenon must be associated in some way with the process of fertilization and began an investigation. By pinching the abdomens of several females having the white masses attached I found they could be removed without breaking or tearing any organ and that they were held in place by the vulva which grasped a small portion or lobe. Several examples of both sexes were then taken at random from the swarm and their abdomens were opened in search of this body but it was not found. I noticed, however, that the seminiferous tubules of the males were filled with a milky white fluid before copula-

tion, and that after copulation they were empty and yellow in color. A male and female *in copula* were then separated, just before the close of the process and before the sperm mass had made its appearance. The male abdomen was then pinched so as to crowd the contents towards the end, and a sperm mass, exactly like those taken from females, was obtained. I therefore concluded that during copulation the males fill these sacs with seminal fluid and then transfer them bodily to the females who seize them by two of the small lobes, Fig. 1 C and D. The females carry these conspicuous white objects about for a time, extracting a portion, at least, of their contents for the fertilization of the ova.

It was noticed that the females bearing these seminal sacs were most numerous about 9 or 10 o'clock in the morning, and that few or none could be found after 1 or 2 in the afternoon.

Mr. W. W. Miles, postmaster at Eddy, told me he and Mrs. Miles noticed these white sacs attached to the females in great numbers on their ranch during the forenoon of June 27th. Mr. Miles also noticed the females depositing eggs July 5th.

While passing through a large swarm of the hoppers at 9 o'clock in the morning of July 29th, it was noticed that fully half of the females were carrying about these sacs, and the males everywhere were noisy with their stridulations. Whether copulation takes place more than once during the egg-laying period of a female, I have been unable to determine with certainty.

Numerous females bearing the sperm sacs were dissected and in all cases there were many eggs present in the ovaries, some with dark firm shells, apparently ready to be deposited, and others soft and yellow and in all stages of maturity from those less than half-grown to those of full size.

There was no indication that the eggs were developing in sets or broods, for they seemed to grade through all stages from those that were small and just developing to those fully mature. Counts made at Eddy on July 27th gave from 10 to 35 apparently mature eggs, and from 34 to 46 immature eggs in ovaries of single females taken with the sperm sacs attached.

As females taken from this swarm a few days previous had, in several cases, over 100 eggs, in one case 133, and as Mr. W. W. Miles saw so many of the sperm sacs attached to the females of the same swarm on June 27th, and as I again saw them so abundant in a neighboring swarm on July 29th, it seems probable that copulation takes place more than once, particularly as the individuals in a swarm develop very closely together. As nearly as could be ascertained, the swarm at Eddy had all been adults since June 25th, and probably for several days prior to that time.

The manner of ovipositing is to bring the tip of the ovipositor well forward beneath the abdomen and insert it in a nearly perpendicular position. Hill sides and hill tops, where the vegetation is scanty and where the bushes are small, seemed to be the favorite places for egg-laying. A clay or adobe soil with many small cracks in the thin surface crust where the ovipositor could be easily inserted was especially used for egg-laying.

The sperm sac measures from 10 to 12 millimeters in diameter when first obtained from the male, and it all appears to view during the last few seconds of the copulatory act. As soon as it appears to view the female begins to run about, dragging the male upon his back behind her until, catching upon some object, he is pulled loose.

The sac, when first received, is suggestive of the brain of a higher vertebrate in form, there being two large lobes corresponding to the cerebral hemispheres and beneath these four smaller lobes corresponding to the quadrigemina somewhat enlarged. The upper pair of these little lobes are somewhat smaller than the others and are pale yellowish in color resembling cartilage. The larger pair are milk-white in color at first, even whiter than the hemispheres, and it is these that are clasped by the vulva of the female. At D of the accompanying plate the two large hemispheres and the two milk-white lobes are all that show, the other pair of lobes being hidden behind the small pair shown.

After being held in the vulva of the female for a short time the small milk-white lobes become gradually translucent and

yellowish in color like the other small pair. For a time there is an opaque white globule at the center of each lobe which gradually diminishes in size, until they are entirely cartilaginous in appearance.

These small lobes are all quite firm to the touch while the two very large ones are soft and easily crushed and torn as the female crawls about.

After two or three hours these masses disappear entirely, but whether the contents are largely taken in by the female or whether she rejects the greater portion after extracting the spermatozoa, I did not determine.

Copulation* began soon after sunrise and continued until near noon in the swarms I visited. I did not witness the beginning of the copulatory process, but in no case did a pair remain in *coitu* more than ten minutes after I noticed them. After about 10 in the morning the chirping of the males almost entirely ceased, except as they were disturbed by some moving object, and then the squeaking noise which they make seemed to be entirely a note of warning, and would cause the members of the swarm to run or jump in all directions for a distance of 20 or 30 feet, and sometimes farther, as if frightened.

The position of the male during copulation was, either curled beneath the female—literally standing on his head—or lying upon his back beneath her and being dragged behind her if she chose to walk about.

EXPLANATION OF PLATE XIX.

Anabrus simplex Hald.—A, adult female; B, a comparatively straight ovipositor; C, sperm mass clasped by vulva of female; D, the sperm mass removed immediately after copulation showing the two small lobes which are seized by the vulva of the female; E, end of male abdomen from above showing clasping organs; F, wings of adult male; G, a cluster of eggs, the upper one coming to the surface. All natural size except E and F, which are twice natural size.

* I am under obligations to Mr. C. L. Marlatt, Acting Chief of the Bureau of Entomology, for having a search made in the library of the Bureau for published observations upon copulation in this genus of Orthoptera. The librarian, Mr. Nathan Banks, found nothing upon the subject. The writer knows of no such observations except those here recorded.



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