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AEDES COMMUNIS NEVADENSIS, A NEW SUBSPECIES OF MOSQUITO FROM WESTERN NORTH AMERICA (DIPTERA:CULICIDAE)

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Several investigators have suggested that *Aedes communis* (De Geer) in the Americas is composed of more than one species. Hocking *et al.* (1950) reported that there were large and small forms at Churchill, Manitoba; the ratio of lengths of proboscis to wing were different in both males and females of the two forms and it was suggested that they were probably different species. Hocking (1954) reported later that the smaller form was completely autogenous, that he never observed it sucking blood, and that it obtained nourishment for egg production by autolysis of the flight muscles. In Canada, Beckel (1954) found a difference in number of anterolateral and posterolateral mesonotal setae between the large and small forms of *A. communis.* Although Vockeroth (1954) also mentioned that in northern Canada *A. communis* may never feed on blood, many investigators reported this species to be a severe pest in many parts of North America, including the following: Alaska (Jenkins, 1948), Ontario and Quebec (Jenkins and Knight, 1950, 1952), Minnesota (Barr, 1958), northwestern United States (Stage *et al.*, 1952), Utah (Nielsen and Rees, 1961), California (Bohart, 1950; Carpenter, 1962), Nevada (Chapman, 1961), and many others. These differences in feeding habits, type and degree

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of autogeny, and adult morphological measurements lend credence to the possibility that more than one form is involved.

About 40 years ago Dyar erected the following species: *A. altiusculus* from Washington (Dyar, 1917b), *A. masamae* from Oregon (Dyar, 1920); and *A. tahoensis* from California (Dyar, 1916, 1917a). These and *A. lazarensis* Felt and Young, were later synonymized with *A. communis* (De Geer). All reported differences in *A. communis* were concerned with the adults; no important differences were noted for other stages.

Our study was occasioned by the finding that larvae of *A. communis* from eastern and western Nevada not only were in different habitats but were easily separable morphologically. We reasoned that an intensive study of all stages of these populations might disclose additional differences.

MATERIALS AND METHODS

The aberrant larvae were first noticed in collections from Lamoille Canyon in the Ruby Mountains of eastern Nevada and are described as a new subspecies in this paper. Populations with larvae of this type, hereafter termed the "atypical form," were noted from other areas as well, but the bulk of the observations were of the population of this locality. These specimens were compared with material from other areas, chiefly Minnesota ("eastern form") and California and western Nevada ("western form").

Chaetotactic analyses of larvae and pupae of the three forms were made by the chaetotactic system of Barr and Myers (1962). For the analyses, 31 larvae and 31 pupae of each form were utilized. The collection data for the larvae are: *atypical,* Lamoille Canyon, Elko Co., Nevada, May 27, 1960; *western,* Glenbrook, Douglas Co., Nevada, March 22, 1960; *eastern,* Virginia, St. Louis Co., Minnesota, May 17 and 18, 1953, and Itasca State Park, Clearwater Co., Minnesota, May 17, 1954 and May 5, 1957. Similar data for the pupae are: *atypical* (21 ♂, 10 ♀), Lamoille Canyon, May 26, 1960; *western,* 17 (12 ♂, 5 ♀) from Glenbrook, Nev., March 21, 1960, and 14 (10 ♂, 4 ♀) from Echo Summit, El Dorado Co., Calif., May 30, 1960; *eastern,* Virginia, Minn., 14 (8 ♂, 6 ♀) collected April 22, 1963, and 17 (5 ♂, 12 ♀) taken May 17, 1963.

Larval analyses were made by the senior author and pupal analyses by the junior author. They were done somewhat differently because of the geographical separation of the authors at the time. It is unlikely, however, that these differences affected the analyses significantly.

Larvae were examined with an ordinary light microscope at magnifications of 150 or 645 diameters. The setae utilized are shown in Figure 1. The branches of one seta of each pair were counted. Pupal exuviae were examined with a Zeiss phase-contrast microscope at 200 to 320 diameters and both setae of a pair examined. All pupal setae were examined. An attempt was made to exclude no values in the pupa since more highly branched setae are more often doubtful; the exclusion of doubtful values would have thus systematically biased the results.

The results were tabulated and a mean and standard error of the mean calculated for the number of branches of each seta.

TABLE 1.—Probability of differences in comparison of mean values of 119 setae of the three forms (31 larvae of each) of *Aedes communis.*

Comparison	Number of differences with specified probabilities			
	>.05	<.05	<.01	Total
Western x atypical	79	17	23	119
Eastern x atypical	80	14	25	119
Western x eastern	72	12	35	119

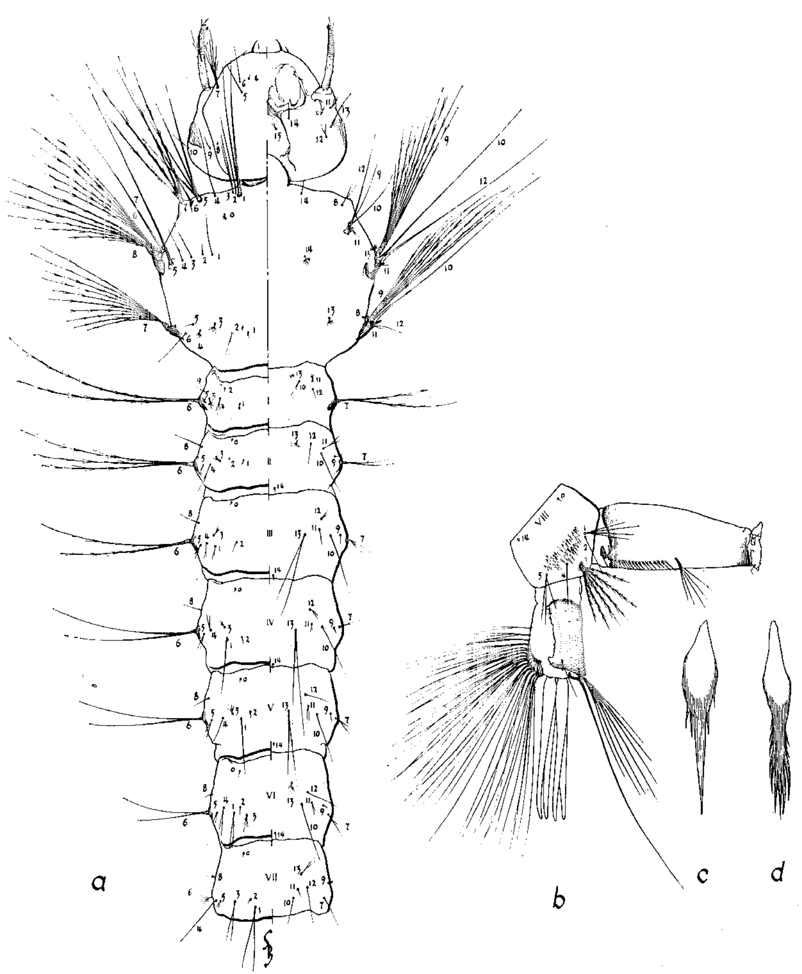

Fig. 1.—Fourth instar larva of *Aedes communis nevadensis* n. subsp.; *a,* anterior portion, dorsal aspect on left, ventral on right; *b,* terminalia, left lateral aspect; *c,* comb scale; *d,* comb scale of *A. c. communis* for comparison.

The branching of each seta of each form was then compared by using a "t" test. A standard error of the difference for each seta was estimated by the square root of the sum of the squared standard errors of the two setae. Finally the similarity among forms was shown by means of correlation coefficients. For this purpose the mean values for the setae of one form were correlated with the mean values of the setae of another. Significance of difference between the correlation coefficients (r values) was tested after conversion to "z" values (Fisher and Yates, 1953).

Observations

Larva. A total of 119 setae were examined on each larva. Comparisons of

TABLE 2.—Correlation coefficients of larval characteristics of the three forms of *Aedes communis.*

Correlation	R	P	Z
Western x eastern	0.9924	<0.01	2.792
Atypical x western	.9909	<.01	2.693
Atypical x eastern	.9884	<.01	2.566

the larvae of the three forms are shown in Table 1. From these results it would appear that the western form is most similar to the atypical form and least similar to the eastern form. The atypical form seems to occupy an intermediate position.

When the similarity of the forms was tested by correlation coefficients (Table 2), it was found that each of the forms was highly correlated with the others and there were no significant differences among the correlation coefficients.

The following key will separate the fourth instar larvae of these 3 forms:

1. Comb scales with weak subapical spinules less than half as long as strong median spine..........atypical form
1. Comb scales with apex rounded and fringed with subequal spinules...... 2
2. VIII-3 with 10 or more branches; V-3, IV-5, I-5, V-5 with fewer than 4 branches ....western form
2. VIII-3 with fewer than 10 branches; V-3, IV-5, I-5, and V-5 with 4 or more branches................eastern form

PUPA. Exuviae were first examined to determine whether qualitative differences in pigmentation, in the shape and size of the respiratory trumpets, or in the shape or denticulation of the paddles could be found among the forms. No such differences were found in the 93 exuviae mentioned above or in numerous other pupae from the same localities. A complete chaetotactic analysis on the 93 selected exuviae was then made.

A total of 98 setae were studied in each of the three forms (Fig. 2). Two of the setae (VII-9 and VIII-9) were evaluated in terms of principal branches as well as in terms of terminal branches. The results of these comparisons are shown in Table 3. These results argue that the eastern form is more like both the western and atypical forms than the western and atypical are like each other; the eastern form would therefore be intermediate between the other two. If only setae which differ at 1 percent are considered, the three forms appear to be approximately equidistant.

A different kind of analysis was also done to determine which was the more central form. Each seta was placed in a group of the following kind w=e>a, e<w=a, etc. (western=eastern and both greater than atypical, eastern less than western and atypical which are equal, etc.). When these results were tabulated, 42 setae indicated that eastern was the intermediate form, 38 that atypical was intermediate, and 35 that western was intermediate. (The numbers do not total 100 because w=e>a indicates only that atypical is the extreme form; either eastern or western could be intermediate.) In this analysis also the eastern form appears to resemble the other two forms more than they resemble each other.

Finally, each form was compared with the others by means of correlation co-

TABLE 3.—Probability of difference in comparisons of mean values of 100 setae in each of the three "forms" (31 pupae of each) of *Aedes communis.*

Comparison	Number of differences with specified probabilities			
	>.05	<.05	<.01	Total
Western x atypical	48	15	37	100
Eastern x atypical	55	9	36	100
Western x eastern	55	7	38	100

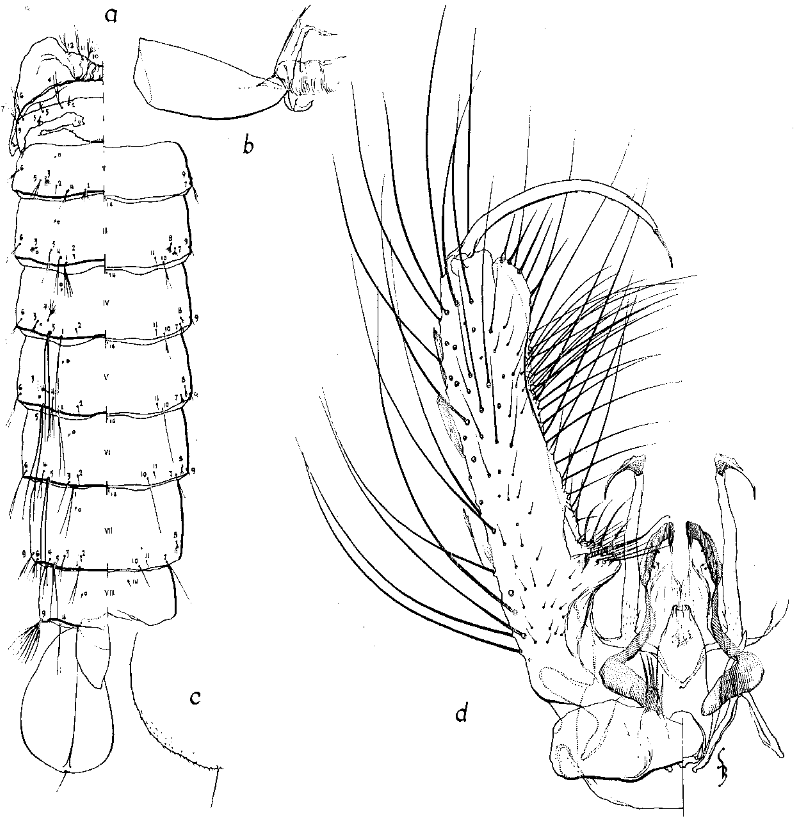

FIG. 2.—Pupa and male genitalia of *Aedes communis nevadensis* n. subsp.; *a*, metathorax and abdomen of pupa, dorsal aspect on left, ventral on right; *b*, left respiratory trumpet; *c*, outer margin of left paddle; *d*, male genitalia, ninth tergum removed on right side.

TABLE 4.—Correlation of average branching of pupal setae in each of the three forms of *Aedes communis.*

Correlation	Forms	R	P	Z
a	Western x eastern	.9304	<.01	1.658
b	Atypical x western	.9551	<.01	1.892
c	Atypical x eastern	.9853	<.01	2.455

efficients as was done for the larvae. The results are shown in Table 4. All of the correlation coefficients were highly significant.

The correlation coefficients were then transformed to "z" values (Table 4) to test the significance of differences between them (Table 5). The last two lines of

TABLE 5.—Significance of difference of correlations between the three forms of pupae of *Aedes communis.*

Comparison	T	P
a x b	1.61	>.05
b x c	3.88	<.01
a x c	5.50	<.01

the table show that the atypical form is more similar to the eastern than to the western form, and the eastern is more similar to the atypical than to the western form.

By the following key, the reader will, with some difficulty, be able to distinguish most pupal exuviae of the three forms we examined:

1. VII-5 usually triple or better; IV-1 usually triple or better; IV-8 usually with 5 or more branches; CT-4 usually with 3 or fewer branches; V-1 frequently with 3 or more branches, rarely single.................western form
1. VII-5 usually double or single; IV-1 usually single or double; IV-8 usually with 4 or fewer branches; CT-4 usually with 4 or more branches; V-1 rarely with 3 or more branches, frequently single.................... 2
2. VII-1 usually double or better; V-6 frequently with 3 or more branches, rarely single; III-3 usually with 6 or more branches; II-6 usually triple or better; CT-2 usually single or double; I-6 usually triple or better; CT-10 frequently with 9 or more branches, rarely with fewer than 7......atypical form
2. VII-1 usually single; V-6 rarely with 3 or more branches, frequently single; III-3 usually with 5 or fewer branches; II-6 usually double or single; CT-2 usually triple or better; I-6 usually double or single; CT-10 rarely with 9 or more branches, frequently with fewer than 7.................eastern form

Adult. The male and female adults of the eastern, western and atypical forms appear to be indistinguishable.

Eggs. Eggs were laid by field engorged females of the atypical form from eastern Nevada and the western form from western Nevada. These eggs were prepared for examination according to the technique of Craig (1955). Both the senior writer and Dr. Craig (personal correspondence) found no differences in the chorionic marking of the eggs of the two forms. In the laboratory, autogeny was noted in the western but not in the atypical form.

Larval Ecology. The aquatic stages of the western form in Nevada were found only in shaded habitats such as woodland pools, overflow pools, and stream beds; they were never found in completely open areas. This association of *communis* larvae with shaded sites was also reported by Bohart (1950) and Carpenter (1962) in California and is generally true of the eastern form as well.

Although the aquatic stages of the atypical form were observed in both open and shaded habitats, they were most commonly found in open overflow meadow pools adjacent to mountain streams; in such pools it was generally the sole or dominant species. When the atypical form occurred in shaded pools, *Aedes pullatus* (Coq.) and *A. increpitus* Dyar were the dominant species.

The atypical form is thus found in a different habitat than the other two forms. We have examined large numbers of larvae from all over the range of *A. communis* in North America and find that all "atypical" larvae can be distinguished and that these larvae occur only in a geographically circumscribed area from which the "typical" form is generally unknown. For these reasons we believe that the atypical form should be recognized nomenclatorially. We have examined larvae from the general areas from which Dyar described *A. altiusculus, masamae,* and *tahoensis* and found none which agree with the presently described larvae. We therefore designate our atypical form *Aedes communis nevadensis* subsp. n. In the event that this form is subsequently found to exist sympatrically with the typical form without intergradation it should be accorded full specific rank.

The holotype female and associated larval and pupal exuviae were collected June 12, 1962, in Lamoille Canyon, Elko Co., in the Ruby Mountains of eastern Nevada. The series has been deposited in the U. S. National Museum (No. 65968) along with a series of paratypes from the same locality. Brief descriptions of the larvae, pupae, and adults are given below.

Adult Female. Similar to that of *A. c. communis.* Palps and proboscis dark.

Torus with pale scales. Vertex with golden and dark brown recumbent scales and dark upright scales. Vertical bristles dark. Thoracic integument dark. Considerable variation of the mesonotal markings; pattern frequently indistinct, the color varying from golden to dark brown. Prescutellar area and lobes of scutellum with pale scales. Supraalar and scutellar bristles coppery. Pleural scaling whitish; no hypostigmal scale patch. Sternopleural scaling extending to anterior margin of sclerite. Postcoxal scale patch absent. Sternopleural and lower mesepimeral bristles pale. Mesepimeral scales extending to ventral margin of sclerite. Wing scales dark except for patches of pale scales on bases of costa and remigium. Tips of halteres pale-scaled. Mixed pale and dark scaling on dorsal aspect of femora. Femora apex with pale knee spot; considerable pale scaling on legs, especially on venter of tibia and proximal tarsomeres. Tarsal claws as in *c. communis*. Abdominal terga with dark brown scaling; basal whitish bands of moderate width on segments 2–7; tergum 1 mostly pale. Venter of abdomen mostly white scaled; dark apical patches laterally at apices of segments.

ADULT MALE. The male genitalia of *c. nevadensis* are shown in Figure 2d and are inseparable from that of *c. communis*.

PUPA. The chaetotaxy of *c. nevadensis* is shown in Figure 2a, b, c. No clear-cut differences were found between it and *c. communis*.

FOURTH INSTAR LARVA. The fourth instar larva of *c. nevadensis* is shown in Figure 1a, b. The shape of the comb scale readily separates it from larvae of *c. communis*. A comb scale of *c. nevadensis* (Figure 1c) possesses subapical spinules which are less than half as long as the strong median spine. Occasional specimens have comb scales with 2–3 large median spines. The typical *c. communis* comb scale has the apex rounded and fringed with subequal spinules as shown in Figure 1d. The comb of *c. nevadensis* contains significantly fewer comb scales (40) than the eastern and western forms (average of 57 and 62, respectively).

DISTRIBUTION. *Aedes communis* is Holarctic and occurs in forested areas of the United States in Maine, Massachusetts, New York, New Jersey, New Hampshire, Pennsylvania, Michigan, Wisconsin, Minnesota, Colorado, Montana, Wyoming, Oregon, Washington, Utah, California, Alaska, and all of the Canadian provinces (Carpenter and LaCasse, 1955). It is also recorded from Idaho (Stage *et al.*, 1952) and Nevada (Chapman, 1959).

During the course of these investigations the writers have studied larvae from all of the Western States in which *communis* occurs. We have seen *c. nevadensis* material only from northern and southwestern Wyoming, eastern Nevada, and many areas in Utah. All larvae examined from Colorado, Montana, Oregon, California, Washington, Idaho, western Nevada, and central and eastern Wyoming were *c. communis*. Larvae from Oregon, Washington, and Idaho have comb scales most similar to *c. nevadensis* but differ in that their comb scales are less obvious and generally possess a number of almost subequal spinules. Both subspecies occur in at least two States, Nevada and Wyoming. In Nevada *c. communis* occurs in the Sierra Nevada Mountains in the western portion of the State and *c. nevadensis* appears in the far-removed Ruby Mountains in the eastern portion; hence there is no opportunity for intermingling of the subspecies. The subspecies occur within less than 100 miles of each other in northwestern Wyoming.

DISCUSSION

An intensive study of northern Teton County in Yellowstone National Park in Wyoming should reveal intermingling of the subspecies, if it occurs. All of the larvae examined from the University of Wyoming had rounded comb scales and were *c. communis*. Owen and Gerhardt (1957) mentioned that *communis* larvae have broadly rounded comb scales, which indicates that they never encountered *c. nevadensis* in their Wyoming collections. It is evident that *c. nevadensis* was not seen by Rempel (1950) in western Canada since he depicts a *communis* larva with rounded comb scales with subequal spinules. The only reference of what we now designate *c. nevadensis* in the literature is a drawing of portions of a larva and the spinelike comb scale of a specimen from Utah labeled *A. communis* by Yamaguti and LaCasse (1951).

The evolutionary relationship of these forms is not apparent. The overall analysis of the larvae suggests that *c. nevadensis* is closer to the western than to the eastern form, but the pupal analysis indicates the reverse. The only certain method of distinguishing *c. nevadensis* is by the comb scales and by this character alone can it be designated the aberrant member of the group. This we believe to be the correct relationship as the naming of the subspecies implies. Although we can separate most eastern and western larvae and pupae examined, we cannot determine how much of this variation is genetic and how much environmental, and, of the genetic variation, how much is normal between populations of a species.

Summary

A new subspecies of *A. communis* is described. It differs from the typical form in the shape of the comb scale and in larval habitat. Differences were not found in adults or eggs, and pupal differences were no greater than those between populations of the typical form.

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NOTES ON THE *CULICOIDES* OF NEW JERSEY [1]

PAUL P. BURBUTIS AND DANIEL M. JOBBINS [2]

High populations of *Culicoides* species occur in areas of New Jersey where large numbers (i.e., 500–700) of white-tailed deer died in 1955 from a fatal virus disease designated by Shope *et al.* (1960) as epizootic hemorrhagic disease (EHD). Preliminary work (Shope *et al.,* 1955) suggested that the virus may be carried by an arthropod rather than transmitted by direct contact. Because the biting midges of the genus *Culicoides* are involved in the transmission of disease agents (Foote & Pratt, 1954) an attempt was made to identify the *Culicoides* fauna in these areas of the State. Cooperative studies were also undertaken in 1956 between the Rutgers Entomology Department, Dr. Shope of the Rockefeller Institute, and the New Jersey Division of Fish and Game. These included attempts at virus transmission by injecting deer with suspensions of wild-caught *Culicoides* specimens (unpublished data) and preliminary transmission experiments (Shope *et al.,* 1960) with the stable fly *(Stomoxys calcitrans)* and mosquitoes *(Culex pipiens* and *Aedes vexans).* While not conclusive, these studies failed to produce any positive evidence of arthropod involvement.

In addition to *Culicoides* spp. being serious nuisance pests there is also the possibility that they are involved in the transmission of the virus causing eastern encephalitis (EE) which occurs almost annually in New Jersey (Burbutis and Jobbins, 1957) among birds. This virus has been isolated from wild-caught *Culicoides* species in the Southeastern United States (Karstad *et al.,* 1957). However, their role as vectors of the virus among birds, horses, or other animals is still not defined.

To date only six species of *Culicoides* have been reported from New Jersey.

RESULTS. Table 1 lists the *Culicoides* species found during this study and the collection localities. All the species reported here were collected during August and September of 1956 by means of conventional New Jersey mosquito light traps. The traps were operated at a height of approximately 5 feet above ground level.

Thirteen species of *Culicoides* were found in these light trap collections. Nine of them, as indicated in the table, are new records for the State. The remain-

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[2] Assistant Professor—University of Delaware and Research Specialist—Rutgers University, respectively. This was a collateral study on an NIH Grant-in-Aid while the senior author was employed at Rutgers Univ., The State Univ. of N. J., 1954–58.