

DISTRIBUTIONAL AND BIOLOGICAL NOTES ON THE TREE HOLE MOSQUITOES OF THE WESTERN UNITED STATES

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In a recent paper (Nielsen *et al.*, 1967) we discussed the present known distribution of tree hole mosquitoes in the western United States and reported on the distribution and biology of six species: *Aedes hendersoni* Cockerell, *Aedes monticola* Belkin and McDonald, *Aedes muelleri* Dyar, *Aedes sierrensis* (Ludlow), *Aedes varipalpus* (Coq.) and *Anopheles barberi* Coq. The present paper presents additional data on tree hole species and includes the current known distribution of the genus *Orthopodomyia* in the western United States. Collections were made by the authors unless otherwise noted and all collections were larval from which associated adults were reared.

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Aedes hendersoni Cockerell. This species is now known to be widely distributed

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along rivers east of the Continental Divide in Colorado, Montana, Wyoming, north-eastern New Mexico and western South Dakota (Nielsen *et al.*, *op. cit.*).

West of the Continental Divide it was known only from localities along the Bitterroot River of Montana north to Missoula and at Nampa, Idaho.

We have now made additional collections which indicate the species occurs extensively along the entire Clark Fork River drainage west of Missoula and also in southwestern Montana, just east of the Continental Divide. The Continental Divide in this region of Montana is relatively low and present distributional data indicate that this may have been the region where *hendersoni* was able to cross the divide and enter the Pacific Coast drainage system.

We now have a collection from the Pecos River in east central New Mexico indicating that the Rio Grande drainage system has also been a pathway of dispersal for this species.

COLLECTION RECORDS—MONTANA: *Granite Co.*, 2 mi. So. Drummond, 3948', VIII-

16-67; Flint Cr., 6 mi. So. of Hall, 4450', VIII-16-67. Jefferson Co., Jefferson River near bridge at Waterloo, 4600', VIII-15-67. Madison Co., Jefferson River at Silver Star, 4650', VIII-15-67.

NEW MEXICO: *Guadalupe Co.*, Puerto de Luna, 4600', III-17-68.

Aedes monticola Belkin and McDonald. This species was previously known to occur only in Arizona (Nielson *et al.*, 1967) where it has a wide distribution across the southeastern area of the state. We now report the species as also occurring in southwestern New Mexico where it was found in cottonwood tree holes associated with *Aedes muelleri*, *Anopheles barberi* and *Orthopodomyia kummi*.

COLLECTION RECORDS—NEW MEXICO: *Hidalgo Co.*, 15 mi. So Animas, 4700', III-19-68.

Aedes muelleri Dyar. This species was previously known to occur only in Arizona and Mexico. We now have collection records from two localities in southwestern New Mexico. One of our collections contained eggs which were present in scrapings of debris obtained from cottonwood and Arizona sycamore tree holes. Both tree holes were dry when the scrapings were removed and larvae hatched on subsequent floodings with distilled water. Breland (1958) had previously hatched eggs of *muelleri* from debris taken from oak tree holes in Texas. He reported that larvae hatched on each of two subsequent floodings with strained pond water and concluded that some of the eggs required more than one flooding before hatching. He observed that hatching was sometimes delayed for several days after flooding. Breland (1957) had noted that dry material collected from tree holes often could be dried and reflooded several times to increase materially the number of larvae recovered.

We divided our scrapings of debris into four containers and subjected them to reflooding and drying over a period of 13 months. We used only distilled water. Water temperatures were not critically controlled, but were maintained within

20° C. ± 4°, a temperature range which was comparable to those we have recorded in tree holes containing larvae during the warmer months of the year. Each container was subjected to four to nine refloodings. The drying time between refloodings varied from 4 to 50 days. Larvae hatched after both the minimum and maximum drying period. A total of 52 larvae hatched. The dates at which hatching occurred and the number of larvae which hatched (in parentheses) were as follows: III-22-67 (5), IV-12-67 (2), IV-20-67 (8), IV-30-67 (1), V-12-67 (6), V-15-67 (3), VI-23-67 (1), VII-13-67 (11), VII-23-67 (2), VIII-2-67 (3), IX-26-67 (2), X-13-67 (1), XI-8-67 (2), I-24-68 (1), II-26-68 (1), III-7-68 (1), III-20-68 (2). The last larva hatched on the ninth reflooding thirteen months after the original collection.

Larvae did not hatch at every flooding. On thirteen refloodings larvae failed to hatch, but in most cases these occurred after the fifth reflooding. Most larvae hatched within 5 hours after flooding, but on several occasions hatching did not occur until several days after flooding, as Breland had noted. On one occasion, IV-20-67, three instars were present at the same time, the last larva hatching more than 2 weeks after the first. Average development times were recorded as follows: First instar, 12-24 hrs.; Second instar, 2-3 days; Third instar, 2-5 days; Fourth instar, 6-14 days; Pupa, 4-7 days. The average development time from hatching to adult was about 25 days with a minimum of 15 days and a maximum of 34 days. Our data indicate that *muelleri* is a species remarkably well adapted to the fluctuating tree hole environment which may remain dry for several months, and where flooding sometimes causes hatching, but produces insufficient water to permit completion of larval development. We have on many occasions obtained both living and dead larvae by flooding what appeared to be a damp or dry tree hole.

COLLECTION RECORDS—NEW MEXICO: *Catron Co.*, Cat Walk Campground, 5 mi.

E. Glenwood, 5250', III-21-67; Reserve, 6225', III-21-67. *Hidalgo Co.*, 15 mi. So. Animas, 4700', III-19-68.

Aedes sierrensis (Ludlow). Nielson *et al.* (*op. cit.*) reported this species from several localities in Idaho and Montana and in one locality in northern Utah. We now report several additional records from Idaho and Montana and eastern Oregon. It appears that the common Pacific Coast tree hole mosquito has a wide distribution in the inland western United States west of the Continental Divide along the Columbia and Snake River systems. The only record which did not conform to this pattern was the relict northern Utah population which is in the Great Basin and more than 250 miles south of the nearest reported Idaho record. The discovery in 1967 of a large population of *sierrensis* along the Snake River near Blackfoot, Idaho, directly north of the Utah population, now leads us to believe that this species entered Utah during Pleistocene times when Lake Bonneville had a drainage into the Snake River at a point near the Blackfoot area. During these wetter Pleistocene times, probably within the last 10,000 years, when much more extensive groves of cottonwood trees are known to have existed along rivers and around Lake Bonneville, *sierrensis* probably had a virtually continuous distribution in northern Utah and throughout the entire Columbia and Snake River drainage systems.

COLLECTION RECORDS—IDAHO: *Bingham Co.*, 5-8 mi. SW Blackfoot, 4500', VIII-14-67. *Bonner Co.*, 1/2 mi. W. Clark's Fork, Lightning Cr., 2100', VIII-17-67.

MONTANA: *Granite Co.*, Flint Cr., 6 mi. So. Hall, 4450', VIII-16-67; 2 mi. So. Drummond, 3948', VIII-16-67. *Missoula Co.*, 27 mi. E. Missoula, 3675', VIII-16-67.

OREGON: *Umatilla Co.*, 2 mi. E. Pendleton, 1068', VIII-18-67.

Anopheles barberi Coq. Nielson *et al.* (*op. cit.*) reported this species to be widely distributed over much of the southern half of Arizona. We have now collected the species in southwestern New Mexico

in cottonwood and Arizona sycamore tree holes. Larvae were associated with *Aedes monticola*, *A. muelleri*, *Orthopodomyia kummi* and *O. signifera*.

COLLECTION RECORDS—NEW MEXICO: *Catron Co.*, Cat Walk Campground, 5 mi. E. Glenwood, 5250', III-21-67; 3 mi. No. Reserve, 6225', III-21-67. *Hidalgo Co.*, 15 mi. So. Animas, 4700', III-19-68.

GENUS ORTHOPODOMYIA

Four species of *Orthopodomyia* Theobald have been reported from the western United States, *Orthopodomyia alba* Baker, *Orthopodomyia californica* Bohart, *Orthopodomyia kummi* Edwards and *Orthopodomyia signifera* (Coq.).

Zavortink (1968) has recently completed a detailed taxonomic study of the genus *Orthopodomyia*. He has found *signifera* to be a highly variable species and can find no reliable larval or adult characters to separate it from *californica*. He therefore has reduced *californica* to synonymy with *signifera*. He has also found that hybridization occurs between *signifera* and *kummi* in some localities where their ranges overlap in southern Arizona. We have included known distributional data on all three species for the western United States exclusive of the Pacific Coast states. Distribution of *signifera* in California is summarized by Chapman (1964), who listed the species as occurring in 17 counties. We have also collected the species in Inyo, San Diego and Ventura Counties.

Adults of *Orthopodomyia* apparently do not feed on man. Zavortink (*op. cit.*) has found that the females of *alba*, *kummi* and *signifera* carry on virtually all of their activity in darkness and that they readily feed on passerine birds. None would feed on his arm. None of the western species has been collected hibernating as adults. Overwintering larvae of all instars have been collected. In the northern limits of their ranges, where tree holes may sometimes freeze solid, it is not known how the species passed the winter.

Orthopodomyia alba Baker. This spe-

cies has been reported from the western United States only in the vicinity of Alcalde, New Mexico (Miller, 1962). We have also collected *alba* along the northern Rio Grande, in the vicinity of Alcalde and Espanola, and along the Pecos River in eastern New Mexico south to Fort Sumner. It is interesting to note that we have collected along the Rio Grande south to Las Cruces and have found *signifera* to be common over most of this area, but we have not taken *alba* south of the Espanola area. In the Pecos River localities *alba* is common, but *signifera* has not been collected.

COLLECTION RECORDS—NEW MEXICO: *De Baca Co.*, Pecos River, Fort Sumner near bridge Hwy 60, 4060', III-17-68. *Guadalupe Co.*, Pecos River near bridge at Puerto de Luna, 4600', III-17-68; Pecos River, 2 mi. So. Santa Rosa, 4610', III-17-68. *Rio Arriba Co.*, Rio Grande River, San Juan Pueblo, 5600', III-17-68.

Orthopodomyia kummi Edwards. This species is a southern form which has been reported from the United States only in southern Arizona (McDonald and Belkin, 1960) in Santa Cruz County.

We now have several additional collection records of this species. It appears to be fairly widespread in the extreme southeastern part of Arizona and southwestern New Mexico. Larvae have been collected in cottonwood, oak, sycamore and willow tree holes and have been found in association with *Aedes monticola*, *Aedes muelleri*, *Aedes purpureipes*, *Anopheles barberi* and *Orthopodomyia signifera*.

COLLECTION RECORDS—ARIZONA: *Cochise Co.*, Chiricahua National Monument, near Mon. Hqs., 5300', XII-24-66; 5 mi. W. Coronado National Memorial, 5600', XII-25-66; Dragoon Mtns., Cochise Stronghold Campground, VIII-26-64, (J. Burger), III-22-66, IX-4-66; Huachuca Mtns., Carr Canyon, IX-5-66; San Pedro River, Hwy 90 bridge, IX-5-66. *Pima Co.*, Madera Canyon, 4800', XII-26-66. *Santa Cruz Co.*, 2-4 mi. SW. Patagonia, VIII-18-64, IX-13-64, I-1-65, VII-25-65 (J. Burger), III-

21-66, IX-5-66; Santa Cruz River, 8 mi. N. Nogales, III-21-66.

NEW MEXICO: *Hidalgo Co.*, 15 mi. So. Animas, 4700', III-19-68.

Orthopodomyia signifera (Coq.). This species was first reported from the western United States by Ludlow (1906) and Reeves (1941), who discussed its presence in California. Bohart (1950) described the California representative as a new species, *O. californica*, principally on the basis of larval differences. Bohart noted the California form as being widely separated geographically from *signifera* which at that time was known to occur west only to Texas and Nebraska. Later the species was reported as occurring in New Mexico (Ferguson and McNeel, 1954) and Arizona (Stone *et al.*, 1965). Richards *et al.* (1956) reported *signifera* from Arizona, but these records were actually *kummi* (McDonald and Belkin, *op. cit.*).

During the past three years our collections in the western United States indicate that *signifera* is one of the commonest tree hole species in Arizona and New Mexico and extends north into southeastern Utah. Larvae have been found associated with all other western tree hole species except *A. kompi*. The species is now known to have a virtually continuous distribution across the southern United States into California. The large amount of material now available has enabled Zavortink (*op. cit.*) to show, as previously noted, that *californica* is not taxonomically distinct from *signifera*.

Excellent discussions on the biology and ecology of *signifera* are contained in publications by Jenkins and Carpenter (1946) and Chapman (*op. cit.*).

COLLECTION RECORDS—ARIZONA: *Cochise Co.*, Chiricahua Nat'l. Monument, near Mon. Hqs., 5300', XII-24-66; 5 mi. W. Coronado Nat'l. Memorial, 5600', XII-25-66; Dragoon Mtns., Cochise Stronghold Campground, VIII-26-64 (J. Burger), III-22-66, IX-4-66; San Pedro River, Hwy 90 bridge, III-22-66, IX-5-66; Road to Portal, 5 mi. and 12 mi. from Hwy 186, IX-6-66.

Cocoino Co., Sedona, Oak Cr., 4240', III-19-66. *Gila Co.*, Globe, 3541', III-22-66; Jones Water Campground, 19 mi. NE. Globe, Hwy 60, IX-2-66. *Maricopa Co.*, 5 mi. So. Wickenburg, 1800', XII-29-65, III-18-66, XII-19-66; Verde River, 26 mi. NE. Phoenix, IX-1-66. *Navajo Co.*, 14 mi. W. Show Low, Mortensen Wash, 6300', VIII-14-66. *Pinal Co.*, Aravaipa Canyon, 11 mi. E. Hwy 77, 2600', XII-21-66. *Yavapai Co.*, Granite Cr., Hwy 89A, 7 mi. NE. Prescott, IX-1-66; Verde River, Hwy 79 bridge, IX-1-66; Wet Beaver Cr., 4 mi. W. Hwy 79, 3700', III-20-66.

NEW MEXICO: *Catron Co.*, Cat Walk Campground, 5 mi. E. Glenwood, 5250', III-21-67; 3 mi. No. Reserve, 6225', III-21-67. *Donana Co.*, Rio Grande River, 1 mi. So. Las Cruces, 3900', III-19-68. *Sandoval Co.*, Rio Grande River, near bridge, Hwy 44, 5280', III-19-67. *Socorro Co.*, Rio Grande River, Escondida, IX-2-66. *Valencia Co.*, Rio Grande River, Las Lunas bridge, Hwy 6, 4800', III-20-67.

UTAH: *San Juan Co.*, San Juan River, Bluff environs, 4500', III-19-67, V-13-67, X-20-67; Canyonlands Nat'l. Park, Salt Cr., V-12-67, X-21-67.

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