

ECOLOGICAL OBSERVATIONS AND RECENT RECORDS ON MOSQUITOES OF SAN DIEGO AND IMPERIAL COUNTIES, CALIFORNIA

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Public interest in mosquitoes has steadily grown in recent years due to the increased number of military personnel returning from foreign fields with mosquito-borne diseases. Communities are becoming aware of the need for information on the mosquitoes of their respective areas, and since no material has been published recently on the mosquitoes of San Diego and Imperial Counties it is felt this paper will be of particular interest at this time for these localities. While this paper does not deal with medical phases of mosquito-borne diseases, it contains pertinent data on the distribution and abundance of the various species which will have value for further studies of mosquito-borne diseases in Southern California.

For example, many disease vectors are known to be present in the area. Hammon and Reeves (1) showed *Culex tarsalis*, a common species in San Diego and Imperial Counties, could serve as a reservoir for the virus of St. Louis and western equine encephalitis, and is able to transmit the infection. They have shown that experimentally in the laboratory the following species found in the above mentioned counties are capable of transmitting St. Louis encephalitis, *Culex quinquefasciatus*, *Culex pipiens*, *Aedes vexans*, *Culiseta incidens*, and *Culiseta inornata*. Hammon and Reeves demonstrated that western equine encephalomyelitis can be transmitted experimentally also by *Aedes vexans*, *Aedes dorsalis*, *Culiseta incidens*, *Culiseta inornata*, and *Culex tarsalis*. These are species considered in this paper.

The established vector of malaria in Southern California is *Anopheles maculipennis freeborni* (2). Laboratory infection

of Filariasis, *Wuchereria bancrofti*, was accomplished in San Diego with two species of mosquitoes. These were *Culex erythrothorax* and *Culex quinquefasciatus* (3).

The major part of these observations was confined to an area approximately within a thirty-mile radius of San Diego City; however, occasional collecting trips were taken to representative breeding habitats over the entire county. Several field trips were made into Imperial County, and data from these collections are included.

San Diego County is an area of 4,200 square miles, and is unusual because of the great extremes of climatic conditions within its borders. One can leave the mild coastal climate and in one day travel by automobile through altitudes as high as 6,300 feet, thence descend to desert areas which are almost below sea level. These three features, a coastal strip, a mountainous region, and a desert, present a wide variety of habitats in which mosquitoes may breed. The annual average temperature in San Diego City is a maximum of 71.9° F. and a minimum of 55.1° F. The average total yearly rainfall is 10 inches. Cuyamaca Peak is the highest elevation above sea level, having an altitude of 6,515 feet. The average yearly snowfall for Cuyamaca State Park is 38.2 inches. The annual average temperatures in the park are: maximum of 48.7° F., a minimum of 41.0° F. Weather records for Carrizo Desert are similar to the town of Imperial, yearly average rainfall 3.65 inches, yearly average maximum temperature 88.3° F., and minimum of (= 55.0°) F. The area in the immediate vicinity of San Diego City receives most of its pre-

precipitation in the months of January, February and March. Temporary pools formed from rainwater often remain until June or July; therefore breeding of mosquitoes is heavy at such times. The most permanent stream of the county is the San Luis Rey River. The San Diego River and the Sweetwater River flow about ten months yearly, usually being intermittent in the months of July and August.

At the present time many canyons draining into the coastal strip of the county which usually were dry in the summer months have fast flowing streams throughout the year. This condition is the result of the many military reservations which empty treated sewage and waste water into them. Such water creates habitats for several species of mosquitoes.

Twenty-three species are considered in this report. One species, *Uranotaenia anhydor* Dyar, because of its rareness, is given particular attention. Most of the determinations were checked by W. C. Reeves, Ph.D., George Williams Hooper Foundation, who also kindly read and criticized this paper; some by Alan Stone, Ph.D., National Museum. Their initials are placed with the species they identified as it is described. For their help the writer is very thankful. Appreciation is here expressed to Lt. Commander G. R. Underwood, MC, USNR, through whom this work was made possible while the writer was assigned to a Navy Epidemiology Team.

Anopheles maculipennis freeborni Aitken

HABITAT AND DISTRIBUTION: This species has been collected over the entire county, from the coldest stream or lake to hot springs in Carrizo Desert (Caliente Hot Springs). It favors clean, clear water, with or without algal mats; it, however, is generally collected from the grassy edges of shallow water. Often it has been taken from the following: lakes and reservoirs, permanent ponds and pools, borrow pits with either clear banks or vegetated banks, hoof prints, small depressions containing seepage water, springs, streams, and high tide pools.

LARVAL ASSOCIATES: *Anopheles pseudopunctipennis franciscanus*, *Uranotaenia anhydor*, *Culiseta inornata*, *Culex thriambus*, and *Culex tarsalis*.

ABUNDANCE: Common. Sometimes abundant. Most common between September and June.

SPECIFIC DATA: Has been found breeding in high tide pools with a concentration of salt 2660 ppm. (expressed in total chlorides).

Anopheles maculipennis occidentalis Dyar & Knab
(Det. W.C.R.)

HABITAT AND DISTRIBUTION: Adults of this species have been collected from Sorrento Canyon and in the gorge area at the headwaters of San Luis Rey River. Female specimens from the former were examined by Reeves. These two habitats are quite different, the former being a marshy area in the mouth of a canyon at sea level; the latter a clear mountainous stream of rapids and waterfalls. Breeding here occurred in the feather edges of comparatively still water at the borders of the stream.

LARVAL ASSOCIATES: Not known here.

ABUNDANCE: Adults were occasionally collected with *Anopheles maculipennis freeborni* in the two locations from which it has been found; however, they may be common in other places in the county as yet not discovered.

SPECIFIC DATA: The writer believes, as far as literature has been available to him, this to be the southern-most West Coast record for *Anopheles maculipennis occidentalis*. (5)

Anopheles punctipennis Say

HABITAT AND DISTRIBUTION: This mosquito was reported from Camp Pendleton, Oceanside, California, by J. M. Hutzler, Ensign, H-V(S), USNR, on September 25, 1943. The writer has searched for it numerous times throughout San Diego County, but has failed to find adults or larvae.

ABUNDANCE: Rare.

Anopheles pseudopunctipennis franciscanus
Theobald
(Det. W.C.R.)

HABITAT AND DISTRIBUTION: This species may be found in this county throughout the year in most bodies of comparatively clean, still water, be it a pond, pool, lake or stream. It prefers algal mats, yet will occur in unvegetated water. Like *Anopheles maculipennis freeborni*, it has been found in cold water in the mountains as well as warm water in the desert. Many times it is directly associated with *A. m. freeborni*; but will also at times be found breeding alone.

LARVAL ASSOCIATES: *Anopheles maculipennis freeborni*, *Culex tarsalis*, *Culex thriambus* and *Culiseta inornata*.

ABUNDANCE: Common to abundant. The most common anopheline, found throughout the entire county.

SPECIFIC DATA: On several occasions *Anopheles pseudopunctipennis* has been collected from high tide pools, and in one particular instance bred in a saline pool of 8900 ppm concentration of total chlorides. This was at Ream Air Field, near the Mexican border south of San Diego. Associated with this species was *Culex tarsalis*. Saline, high tide pools of less concentration located at the mouth of Sorrento Canyon also contained *Anopheles pseudopunctipennis*.

Culex apicalis Adams
(Det. W.C.R.)

HABITAT AND DISTRIBUTION: This species is found in densely vegetated pools or ponds in the warmer months; it is frequently found in open sunlit pools having much aquatic vegetation during the cooler months. It is most common in the fall. *Culex apicalis* prefers clean water, and is often collected from springs or the small pools formed by them.

LARVAL ASSOCIATES: *Culex thriambus*, *Culex restuans*, *Culex tarsalis*, *Culiseta macrackenae*, *Culex erythrothorax*, and *Anopheles maculipennis freeborni*. Often it is found breeding alone.

ABUNDANCE: Uncommon.

Culex erythrothorax Dyar
(Det. W.C.R.)

HABITAT AND DISTRIBUTION: Wherever marshy areas exist, mainly stream, bottomland marshes with slow flowing pools running through tule and grassy beds, this species breeds heavily. It may be taken in isolated pools; however, the marsh suits it best. It will tolerate mild sewage contamination.

LARVAL ASSOCIATES: *Culex thriambus*, *Culex restuans*, *Culex tarsalis* and sometimes *Anopheles maculipennis freeborni*.

ABUNDANCE: Abundant in marshes, rare elsewhere. Occasional in winter season, breeds well all summer.

SPECIFIC DATA: Is attracted to light traps readily. Bites viciously in bright sunlight, as well as at dark.

Culex pipiens Linnaeus
(Det. W.C.R.)

HABITAT AND DISTRIBUTION: This species is commonly collected from street drains, artificial containers, and in the many pools or puddles of water frequently found about human habitations. During the hot summer months breeding is most common in street drains filled with water from excessive lawn and garden irrigation. It may be taken from foul water at times.

LARVAL ASSOCIATES: It is often found with *Culex quinquefasciatus*, with which it is said to interbreed on the West Coast. *Culex tarsalis* and *Culex stigmatosoma* may be found with it in untreated sewage outlet pools in canyons below some residential districts of outlying areas from San Diego City.

ABUNDANCE: Abundant in warmer months, occasionally found during the cooler seasons.

Culex quinquefasciatus Say
(Det. W.C.R.)

HABITAT AND DISTRIBUTION: Occurs around human habitations, in artificial containers, sewers and drains, and is occasionally associated with *Culex pipiens*.

LARVAL ASSOCIATES: *Culex stigmatosoma* and *Culex pipiens*.

ABUNDANCE: Common. Abundant at times.

Culex restuans Theobald
(Det. W.C.R.)

HABITAT AND DISTRIBUTION: This species is not common, but when found is often associated with *Culex thriambus*. It has been collected from small pools and shallow depressions, such as seepage water in hoof prints. It is occasionally found in hoof prints in marshes used for cattle grazing.

LARVAL ASSOCIATES: *Culex thriambus* and *Culiseta inornata*.

ABUNDANCE: Uncommon.

Culex stigmatosoma Dyar
(Det. W.C.R.)

HABITAT AND DISTRIBUTION: This common stagnant or foul water breeder is found at sewage plants, in street drains, in polluted water from farms, especially dairies, and occasionally in clean water adjacent to a polluted pool where this species is breeding.

LARVAL ASSOCIATES: *Culex tarsalis* and sometimes *Culex pipiens* or *Culex quinquefasciatus*.

ABUNDANCE: Common to abundant.

Culex tarsalis Coquillett

HABITAT AND DISTRIBUTION: Although *Culex tarsalis* is commonly accepted as a foul water breeder in San Diego County, it is taken from some different habitats. In the mountains it is often found in clear cold water where no pollution exists, and in the desert it can be observed breeding in abandoned irrigation ditches containing seepage water.

LARVAL ASSOCIATES: In the desert it has been found with *Aedes vexans*, *Psorophora confinis*, *Aedes*



Fig. 1. A typical breeding pool for *Culex quinquefasciatus*, *Culex pipiens* or *Culex stigmatosoma*. Origin of water was an overflow from a swimming pool shower.

dorsalis, and *Anopheles pseudopunctipennis*. *Culex stigmatosoma*, *Culex pipiens* and *Culex quinquefasciatus* are its closest associates in foul water, whereas in clear cool water it may be found with *Culex erythrorhox* and *Culiseta inornata*.

SPECIFIC DATA: It has been found breeding in water with a saline concentration of 8900 ppm, expressed in total chlorides.

Culex thriambus Dyar
(Det. W.C.R.)

HABITAT AND DISTRIBUTION: Generally this species is collected from marshes, or marshy ponds. It never has been taken from large bodies of water, or from flowing streams. It prefers small quiet pools, hoof prints or depressions filled with seepage water and does not breed in foul water. It, however, is often taken from tea-colored water having a high concentration of organic substances. This species is a cool season breeder, for the most part.

LARVAL ASSOCIATES: *Culiseta maccrackenae*, *Culex restuans*. Often with *Culiseta inornata* or *Culiseta incidens*.

ABUNDANCE: Fairly common.

Culiseta incidens Thomson
(Det. W.C.R.)

HABITAT AND DISTRIBUTION: The writer has found this species breeding only in warm months generally with *Culex tarsalis*, and being replaced in the same pools during the colder months by *Culiseta inornata*. *Culiseta incidens* is often collected from artificial containers about residences.

LARVAL ASSOCIATES: *Culex tarsalis*.

ABUNDANCE: Not too common, probably best described as occasionally found in San Diego County.

Culiseta inornata Williston
(Det. W.C.R.)

HABITAT AND DISTRIBUTION: This is a common mosquito throughout the entire county and breeds in various types of habitats. It has been found in slightly foul water. It is most commonly found in the cooler months, when it is the dominant species; and often the only species in some pools. *Culiseta inornata* breeds in small ponds and breeds heavier in the cooler months. It has been collected at sea level and at altitudes as high as 4500 feet. **LARVAL ASSOCIATES:** *Culiseta maccrackenae*, *Culex tarsalis*, *Culex erythrorhox* and at times with *Anopheles maculipennis freeborni*.

Culiseta maccrackenae Dyar & Knab
(Det. W.C.R.)

HABITAT AND DISTRIBUTION: The writer has found this species in San Diego County at sea level and at the high altitudes. Adults have been collected in Sorrento Canyon, whereas larvae have been taken from the following places: a marsh in the San Luis Rey River near Bonsall, in the same river near its headwaters where the stream is a series of rapids, in springs almost at the top of Mt. Palomar, and in meadow pools in the Cuyamaca section of the Laguna Mountains. It has

been collected from such places in the summer and in fall, and was quite common, being the dominant species in certain pools.

LARVAL ASSOCIATES: *Culiseta incidens* and *Culex apicalis*.

SPECIFIC DATA: Although the larvae of this mosquito have not been collected in pools at sea level or at least at lower altitudes than Highland Valley (altitude of 1350 feet), it is quite interesting to find adults at such places as a barn collection station near the mouth of Sorrento Canyon, a few feet above sea level.

Aedes dorsalis Meigen
(Det. W.C.R.)

HABITAT AND DISTRIBUTION: This species has been encountered in only one place in San Diego County. The location was a high tide pool on the grounds of Ream Air Field, near the Mexican border south of San Diego. Although many attempts have been made to find other breeding places of this species, particularly along the coast in high tide pools, none has been found. Larvae have been collected from irrigation ditches in Imperial County breeding with *Aedes vexans*. (See *Aedes vexans* data.)

LARVAL ASSOCIATES: *Aedes vexans* in the desert. In high tide saline pools, concentration of 8900 ppm (total chlorides), it was followed by a brood of *Culex tarsalis* and *Anopheles pseudopunctipennis franciscanus*.

SPECIFIC DATA: As far as this writer is informed (4) (5) this is the southern-most record of this species for the West Coast. The record of its breeding in the desert with *Aedes vexans* is unusual.

Aedes increpitus Dyar
(Det. W.C.R.)

HABITAT AND DISTRIBUTION: Only one record is established by this writer for this mosquito; however, it undoubtedly occurs in other places in San Diego County which have not been encountered. The larvae of this species were found in a sunken rain pool at the base of a sycamore tree in San Clemente Canyon.

LARVAL ASSOCIATES: None.

ABUNDANCE: Rare.

Aedes squamiger Coquillett
(Det. W.C.R.)

HABITAT AND DISTRIBUTION: The adults of this species have been collected from Presidio Park in the city of San Diego, and from a barn collecting station near the mouth of Sorrento Canyon. Larvae have been found in only one location, that being a high tide pool beside Route 101 highway on Mission Bay in San Diego. They have not been found breeding with *Aedes taeniorhynchus*, but have followed a brood of this species in the same pool.

LARVAL ASSOCIATES: None. Probably does occur with *Aedes taeniorhynchus* in this area.

ABUNDANCE: Uncommon.

Aedes taeniorhynchus Wiedemann

(Det. W.C.R.)

HABITAT AND DISTRIBUTION: The common high tide breeder of the coastal section of San Diego County. Has proven to be a nuisance in a residential section near its breeding grounds, and adults have been found at Green's Farm, Camp Elliot, which is between eight and ten aerial miles distant from the brackish pools where they breed.

LARVAL ASSOCIATES: Probably *Aedes squamiger*, but no data has been collected.

ABUNDANCE: Abundant, a year round breeder, very prolific in the summer.

Aedes varipalpus Coquillett

(Det. W.C.R.)

HABITAT AND DISTRIBUTION: This is the tree-hole breeder of the country. It has been collected from the water caught in trees following the first winter rain. Very common in sycamore trees which have suitable holes for retaining water. The pH of several samples of water read around 8.04.

LARVAL ASSOCIATES: None. *Orthopodomyia signifera* (Coquillett) found breeding with this species by Reeves, Riverside County, California, may occur with it, however, none have been observed. (6)

ABUNDANCE: Abundant in winter and spring seasons.

Aedes vexans Meigen

(Det. W.C.R.)

HABITAT AND DISTRIBUTION: On September 28, 1944, both larvae and adults of *Aedes vexans* were collected in Imperial County near El Centro. The larvae were collected from abandoned roadside irrigation ditches into which water frequently overflowed from the adjacent waterways. The temperature of the water during the collection was 37° C. and all the pools were grassy, without algal mats. Adults were common around residences, bit viciously at dusk, and were readily caught in light traps. *Aedes dorsalis* larvae were collected from the same ditches.

LARVAL ASSOCIATES: *Psorophora confinnis*, *Culex tarsalis*, *Aedes vexans*, and *Anopheles pseudopunctipennis franciscanus*.

ABUNDANCE: Abundant.

SPECIFIC DATA: The species is generally considered a flood water breeder which prefers wooded area pools, particularly shady. It, therefore, is quite unusual to find this species in warm water in the desert. (4)

Psorophora confinnis Lynch-Arribalzaga

(Det. W.C.R.)

HABITAT AND DISTRIBUTION: This species prefers roadside ditches, abandoned irrigation ditches, or overflow puddles on roads. The writer has found it only in the desert, a heavy breeder in the area of Imperial County near El Centro City. It is easily caught by a light trap.

LARVAL ASSOCIATES: *Culex tarsalis*, *Aedes vexans*, *Anopheles pseudopunctipennis franciscanus*.

ABUNDANCE: Abundant in the desert.



Fig. 2. Roadside pool in Imperial County in which *Psorophora confinnis* was found breeding. Origin of water is overflow from field irrigation.

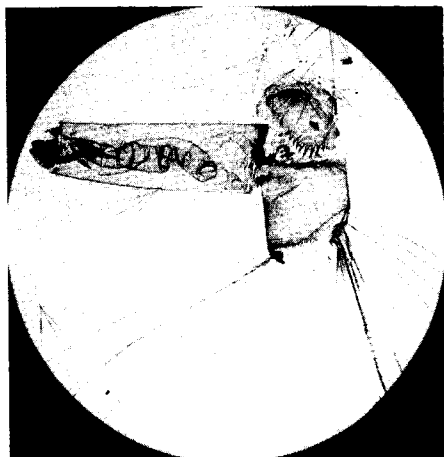


Fig. 3. Posterior segments of *Uranotaenia anhydor* Dyar larva. A photomicrograph.

Uranotaenia anhydor Dyar

(Det. W.C.R. & A.S.)

On September 15, 1944, one third instar larva of *Uranotaenia anhydor* was collected from a grass-tule marsh in the river bed of the San Luis Rey River, four miles upstream from Bonsall, California. The single larva was taken from

hoof prints in a grassy area where cattle were grazing and was associated with two other species, *Culex thriambus* and *Anopheles maculipennis freeborni*. The former species was common, where the latter was but an occasional collection in the marsh. Although at the time no larva were taken, *Culex erythrothorax* adults were caught on the wing in this location.

Dyar reported: "A single larva was obtained in a swamp full of reeds (Sweetwater Junction, San Diego County, June 1906), associated with *Anopheles occidentalis (maculipennis)*, *Anopheles pseudopunctipennis*, *Culex tarsalis*, and *Culex erythrothorax*." (7)

The breeding water was tea colored, was but a few inches deep in the hoof prints, and the bottom was of a muck-sand composition, typical to most marshes of stream bottomlands of southern California. *Gambusia affinis*, the top minnow was abundant in the larger pools of the stream; yet rarely were observed in hoof prints where most of the breeding existed.

In the laboratory Charles S. Richards, a co-worker of the writer, observed the single larva

of *Uranotaenia anhydor* to be predaceous on other larvae; therefore two third instar *Culiseta macrackenae* were placed with the larva and soon appeared to be eaten by it, although they were considerably larger in size. Other persons* observed this action; however, doubt remains in their minds whether or not it was an act of predaceousness. It is possible that something killed the larva on which the *Uranotaenia anhydor* fed; the larva merely feeding on the parts of the dead organisms. Predaceous mosquito larvae generally eat their prey whole; therefore this condition, if an example of a predator, is indeed a new conception or method of a mosquito larvae preying on others. Following two days of feeding the specimen pupated; however two days later was found dead in the container. The larval skin was mounted in a chloral hydrate preparation and final identification was made from it.

In his publication "Mosquitoes of California" (4), Freeborn stated the following about this species:

*Lt. O. K. Scott, MC, USNR, and writer.



Fig. 4. Marsh in San Luis Rey River near Bonsall, California, where the author collected the single larva of *Uranotaenia anhydor* Dyar.

"This species was named *anhydor* by Dyar on account of the fact that, when he attempted to collect more specimens, he found that the pool which had yielded the single type larva had dried. The species is extremely rare. Dyar has bred the adults from larvae collected in a pond at Old Town, San Diego (May, 1916). The original name was proposed for a single larva taken by Dyar and Caudell (Sweetwater Junction, San Diego Co., June 1905) which died before pupating. The writer was fortunate in seeing a single female taken at Camp Kearney (near San Diego) in May, 1918. This specimen was taken in a large packing box placed near a fresh-water crew for the purpose of affording a collection point in the otherwise barren terrain. It was in perfect condition and gave indication of having emerged but a short time before capture."

The marsh from which this species was collected was revisited six times later, but no other specimens were found. This record is only the fourth time *Uranotaenia anhydor* has been collected, all being within San Diego County.

DESCRIPTION OF SPECIMEN FROM LARVAL SKIN..

Length 5 mm. Head elliptical, bulging at the eyes, as long as wide, front prominent; antennae small, slightly thickened at base, scarcely spinous; upper head hair ?*, the lower a single coarse spine-like hair; anteantennal tuft multiple, well developed. Lateral abdominal hairs long and coarse on first and second segments, fine, multiple and short on succeeding ones; subdorsal hairs ?.* Air tube about three or slightly more times as long as wide, very slight taper; pecten of 16 evenly spaced brush-like, feathered, teeth in one room; the other row with 18 teeth. Air tube with a black basal ring, single large tuft at middle just beyond pecten. Anal segment ringed by a plate, slightly longer than wide, the chitinous plate excavated to hold a short ventral brush, spinous along its posterior margin; dorsal tufts of three long divided hairs on each side; ventral brush long, but not extending far onto side of segment, confined to the barred area; anal gills (number of?*) not as long as anal segment. Lateral plate of eight (8) segment, comb of nine (9) sharp, thorn-like teeth on its posterior border, those near the center longer than the others. Teeth with fine lateral feathering.

Determination of species was made by Dr. Alan Stone, National Museum, and Dr. W. C. Reeves, Hooper Foundation.

*Not discernable on specimen.

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The library of San Diego Natural History Museum was available to the writer during the course of this study through the courtesy of Clinton G. Abbott, Director.