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A POPULATION OF URANOTAENIA ANHYDOR FROM DEATH VALLEY, WITH DESCRIPTIONS OF ALL STAGES AND DISCUSSION OF THE COMPLEX (DIPTERA, CULICIDAE)[1]

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INTRODUCTION

Uranotaenia anhydor Dyar, 1907 is regarded as one of the rarer North American mosquitoes. The original description was based on a single larva collected by Dyar and Caudell on June 2, 1906 in a swamp full of reeds at Sweetwater Junction (now part of National City), near San Diego, Calif. Subsequently, Dyar reared a series of adults of both sexes from larvae collected in Old Town, San Diego (Howard, Dyar and Knab, 1917, 4: 1041–1042), Freeborn (1926: 350) reported a single female from Camp Kearney (near San Diego), and E. A. Seaman and C. S. Richards found two larvae near Bonsall, San Diego County (Seaman, 1945). Brookman and Reeves (1953: 234–235) were the first to report this species outside of San Diego County, having reared an adult of each sex from two pupae collected in northwestern Baja California, Mexico, some 45 miles south of San Diego. These authors also mentioned a series of rubbed females apparently of this species collected at lights by C. B. and R. N. Philip at Fairbanks Springs, Ash Meadows, Nye County, Nevada, on August 21, 1949. In the summer and fall of 1953, C. S. Richards took a small series of *anhydor* females in light traps and one larva and one pupa at St. David, Cochise County, Arizona (Richards, 1954 *in lit.*).

Closely related to *U. anhydor* is the more widely distributed and apparently more common *U. syntheta* Dyar & Shannon, 1924, originally described from a single female reared from a larva collected at Mission, Hidalgo County, Texas, in the lower Rio Grande Valley. Dampf (1943) reported *syntheta* adults quite common in the States of Jalisco and San Luis Potosi as well as in the Federal District of Mexico. Subsequently, this form has been found widely distributed in Texas (McGregor and Eads, 1943; Randolph and O'Neill, 1944; Rueger and Druce, 1950; Eads, Menzies and Ogden, 1951), western Oklahoma (Griffith, 1952) and eastern New Mexico (Ferguson and McNeel, 1954), but is apparently very localized and difficult to find in the immature stages.

Recently it has been pointed out that *anhydor* and *syntheta* are so close morphologically that when material from intermediate areas, such as the population from Fairbanks Springs, is examined the two forms may prove to be subspecies or even extremes of a single variable species (Brookman and Reeves 1953: 235; Galindo, Blanton and Peyton 1954: 118–119).

Since August, 1952 we have periodically visited Saratoga Springs, San Bernardino County, California, in the southern end of Death Valley near the sharp bend in the lower part of the Amargosa River drainage system. As what appeared to be *U. anhydor* had been collected at Fairbanks Springs, some 60 miles to the north in the same drainage system, we suspected that this species might be breeding at Saratoga Springs. On our fourth visit, on June 16–19, 1954, we finally succeeded in collecting adults of *U. anhydor* and in locating its immature stages. Additional visits on July 27–28, Sept. 11–12, and Oct. 16–17, 1954 resulted in the collection of abundant material of all stages and some ecological information.

We have studied all the stages of the Saratoga Springs population in considerable detail and have compared it with the limited available material of *anhydor* from San Diego County, Baja California and Arizona, and *syntheta* from several localities in Texas. It is rather surprising to find that the Saratoga Springs population is distinct from both *anhydor* and *syntheta* and that it is in no way intermediate between the two. However, this population exhibits in the immature stages such plasticity and strong morphological response to variations in environmental conditions that we feel that comparable material from several localities must be studied before any decision is made as to the taxonomic status of the various populations of the complex west of the Continental Divide. As none of the members of the complex have been described in detail, we are presenting at this time such descriptions of the Saratoga Springs population with emphasis on the immature stages. We are also including ecological notes and comparative data on other populations.

The descriptive terminology used is that of Belkin (1953a) except for corrections in the nomenclature of the larval and pupal chaetotaxy (Belkin 1953b). It is quite evident from inspection of the chaetotaxy of successive larval instars that additional corrections are needed, particularly in the thoracic chaetotaxy. We believe that such corrections should be postponed until early instars of all mosquito genera are studied.

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The data on the branching of hairs are indicated in parentheses following the hair number in this order: usual number of branches (representing 75% or more); mean; range. The measurements are all approximate and are based on no more than five specimens.

The figures of the first three larval instars are based on the study of a few specimens and are not intended to represent the modal chaetotaxy. On the other hand, the figures of the fourth larval instar and the pupa represent the modal chaetotaxy based on the study of all the specimens indicated in the tables. All the larval figures were drawn from somewhat flattened specimens mounted in a modified Berlese medium and therefore show considerable distortion. The figures of the female head and thorax are generalized and are intended to show only the differences in the pattern of bluish scales.

The following material was examined for this study: CALIFORNIA.—*Saratoga Springs*, San Bernardino Co., June 16–19 (UCLA 110, 114), July 27–28 (UCLA 127, 128), Sept. 10–11 UCLA 143, 144), Oct. 16–17, 1954 (UCLA 146, 147), 1046 adults (575♂, 471♀), 425 pupae, over 2000 fourth instar larvae, over 1000 each of third, second and first instar larvae, 18 egg rafts, 99 individual rearings (50♂, 49♀; 73 larval, 26 pupal) (Belkin and McDonald) [UCLA, USNM, CAS, CDC, CU, UCB, UCD, etc.]; *San Diego*, May 6-20, 1916, 5♂, 3♀, 3 pupae, 3 fourth instar larvae, 4 third instar larvae (H. G. Dyar) [USNM, UCLA]; *Bonsall*, San Diego Co., Sept. 15, 1944, 1 fourth instar larva (E. A. Seaman and C. S. Richards) [USNM]. MEXICO.—*Baja California*, highway 1, 46 km. south of Tijuana, June 13, 1948, 1♂, 1♀, 1 pupa (B. Brookman and W. C. Reeves) [CAS]. NEVADA.—*Fairbanks Springs*, Ash Meadows, Nye Co., Aug. 21, 1949, 6♀ (C. B. and R. N. Philip) [Philip, UCLA]. ARIZONA.—*St. David*, Cochise Co., July 20, Oct. 12, 23, 1953, 2♀, 1 fourth instar larva (C. S. Richards) [Richards, UCLA]. TEXAS.—*Dallas*, July 30, 1940, 1♂ (E. W. Laake and W. G. Bruce) [USNM]; *Fort Worth*, Meacham Field, July 10–11, 1944, 1♂ (J. E. Porter) [USNM]; *Kerrville*, June 19, July 3, 1953, 1♂, 1♀ (L. J. Boltimer) [USNM]; *San Marcos*, Hays Co., Aug. 8, 1943, 1♀ [USNM]; *Hays Co.*, July 1943, 1♀ [CDC]; *Luling*, Palmetto State Park, May 22, 24 and June 17, 1947, April 6 and Oct. 12, 1953, Oct. 16, 1954, 12♂, 3♀, 27 fourth instar larvae, 19 whole pupae (O. P. Breland) [CAS, CDC, UCLA]; *San Antonio*, Camp Normoyle and Ft. Sam Houston, July 6–Oct. 20, 1942, 4♂, 30♀, 1 pupa, 30 fourth instar larvae, 2 third instar larvae, 1 second instar larva, 2 first instar larvae (E. S. Ross) [CAS, CDC, UCLA, USNM]; *Bexar Co.*, June 7 and Oct 23, 1943, 3♀ [CDC]; *Del Rio*, Val Verde Co., May 23, 1928, 1♀ (W. H. W. Komp) [USNM]; *Cameron Co.*, 1♀, no date [USNM].

We are greatly indebted to the following individuals and institutions for the loan of material: Dr. Alan Stone and the United States National Museum [USNM]; Dr. E. S. Ross, California Academy of Sciences [CAS]; Dr. O. P. Breland, University of Texas; Dr. C. B. Philip, Rocky Mountain Laboratory; Dr. W. C. Reeves, Univ. of California, Berkeley [UCB]; Dr. B. Brookman and C. S. Richards, Water Projects Unit, U.S. P.H.S.; Dr. H. D. Pratt, Communicable Disease Center, U.S.P.H.S. [CDC].

DESCRIPTIONS

1. *Female*

Saratoga Springs population (Fig. 1a)

Wing: 2.5 mm. Abdomen: 1.65 mm. Proboscis, 1.60 mm. Front femur: 1.50 mm. In general as in description of *anhydor* (Howard, Dyar & Knab 1917, 4: 1041–1042), with the additions and exceptions noted. Specimens examined: 471.

Head: Frontal tuft not developed; orbital light line expanding laterally and bent toward *apn*, scales light bluish; numerous elongate dark erect vertical scales, stem slender, apex expanded but not distinctly forked; orbital bristles 1: 1: 1: 3 (4). Clypeus dark brown. Palpus about 0.08 of proboscis; dark brown scales apically; some of the slender hairs about equal to shaft length; segmentation not apparent. Proboscis strongly swollen apically; dark-scaled dorsally, lighter ventrally, especially on swollen part; numerous short hairs basally, longer and darker dorsoapically; labella dark, densely hairy. Antenna about 1.45 of proboscis; torus yellowish brown, with short hairs and a few short dark scales mesally; base of first flagellar segment yellowish brown, remainder of flagellum very dark brown, almost black; first flagellar segment mesally with about 8 dark scales somewhat longer than those on torus; apical flagellar segments subequal; usually 6 dark bristles in a flagellar whorl.

Thorax: Scutal integument brown to dark brown, often darker near anterior light-scaled area; rather sparse vestiture of recumbent narrow elongate curved dark bronzy scales, distinctly longer and lighter in color caudad, particularly in prescutellar space; an elongate patch of several rows of broad, apically rounded appressed iridescent light blue scales (becoming white or violet in some aspects) laterally on each side from some distance in front of scutal angle to level of humeral bristles; often a few almost black narrow scales laterad of this patch; area mesad of patch often with darker integument and usually with sparse vestiture of narrow dark scales; another patch of light scales on each side just above paratergite from in front of wing root to about level of spiracle, scales of same coloration as those in anterior patch, short and broad cephalad, progressively longer caudad, forming a

conspicuous outstanding tuft in front of wing root; area cephalad and immediately dorsad of supraalar patch usually without or with only a few narrow bronzy scales; the two light-scaled patches not in line; 10 or more pairs of short acrostichals; dorsocentrals and prescutellars well developed; 2 or 3 pairs of humerals; other bristles well developed, all dark. Scutellum brown; median lobe well developed, usually with 5 strong marginal bristles; lateral lobe with 4 strong marginal bristles; additional smaller bristles often present on all lobes; vestiture of recumbent narrow elongate curved light bronzy scales. Pleural integument brown, darker on *apn* and central portions of *stp* and *me;* scaling and chaetotaxy as figured; *ppn* with a few narrow recumbent dark bronzy almost black scales near upper margin, usually one sometimes 2 dark bristles; *apn* with patch of appressed rounded bluish scales, bristles 2: 1; one dark *pa* bristle; upper part of *stp* with a broad patch of similar scales, narrower and longer caudad, usually 5 dark bristles; lower posterior part of *stp* with a smaller patch of similar scales, usually one dark bristle and several light hairs; usually 1–3 strong dark *pp* and several light hairs; one strong dark *lme;* about 8 light *ume*. Halter light brown at base and stem, dark-scaled on knob.

Wing: Distance between crossveins 0.9–1.2 length of *m-cu*. Vein R_2 about 0.79 of R_{2+3}; vein M_{1+2} about 0.70 of M beyond *m-cu*. Anterior margin of R to slightly beyond arculus with dingy white or yellowish scales; remaining dorsal scales dark; fringe dark apically, lighter proximally. Microtrichia unusually conspicuous.

Legs: Coxae and trochanters light brown; fore coxa with a few broad bluish or whitish scales at base on anterior face followed by more numerous broad dark scales, mid and hind coxae with a few translucent broad scales; femora dark-scaled above, dingy white below to apex; knee spots on all femora, consisting of a few dingy white scales to rarely numerous pure white scales, more conspicuous on hind femur; tibia dark above, lighter below; hind tibia usually with a few dingy or pure white scales near apex; other tibiae rarely with such light spot; tarsi dark. Leg I: femur 1; tibia 1.03; tarsus 0.68, 0.29, 0.19, 0.11, 0.13. Leg II: femur 1.08, swollen basally; tibia 1.26; tarsus 0.80, 0.28, 0.14, 0.12. Leg III: femur 1.00; tibia 1.19; tarsus 1.11, 0.48, 0.32, 0.20, 0.12. All claws small, simple, subequal.

Abdomen: Tergite 1 with dark scales only; tergites 2–7 dark-scaled except for yellowish-brown to dingy white lateral basal patches; sternites with yellowish brown or dingy white scales.

Variation: The most conspicuous variation is in the amount and intensity of the light scaling on the head, thorax, abdomen and legs. All of the 471 females examined showed a well-defined prescutal light patch consisting of several rows of bluish scales. Frequently the length of this patch approaches that of the single line found in Texas *syntheta* but it may be reduced to the condition encountered in the most conspicuously marked individual of *anhydor* from Arizona. The supraalar patch of light scales usually consists of broad scales anteriorly but rarely a few of these are elongate. This patch may also rarely extend almost to the scutal angle, again approaching the condition found in Texas *syntheta*. The abdominal lateral light spots are well marked and almost pure white in a few individuals, as are the knee spots. Considerable variability is shown also in the density as well as coloration of the narrow dark scutal scales. Usually these are darker and much less numerous than in other *anhydor* populations. Reared individuals generally have a much lighter integu-

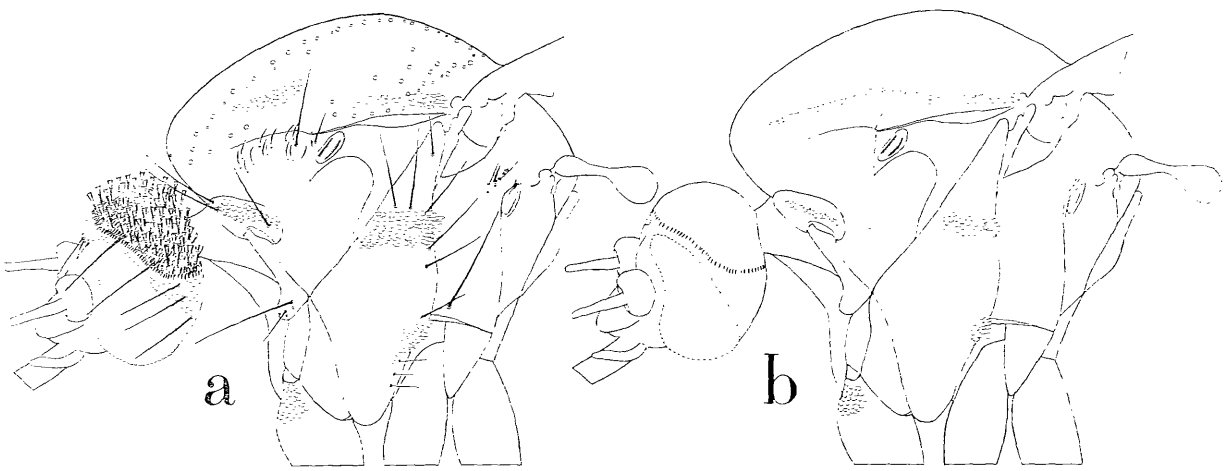


FIG. 1. Left lateral aspect of head and thorax of adult female of *Uranotaenia anhydor*. a, *U. a. anhydor* Dyar, Saratoga Springs population; b, *U. a. syntheta* Dyar & Shannon, Fort Sam Houston, Tex., showing differences in pattern of bluish scales only.

ment than field-collected specimens. One individually reared specimen (143–111) shows a remarkable departure from the rest in the development of broad appressed whitish scales symmetrically arranged in the space between the acrostichal and dorsocentral rows of bristles from the prescutellar space to almost the level of the scutal angle.

Fairbanks Springs population

The six females from Fairbanks Springs are badly rubbed and therefore lack most of the diagnostic features. However, all the visible characters indicate that this population will probably prove to belong to the same taxon as the Saratoga Springs population.

San Diego population

The description of the adults of typical *anhydor* is based on this population (Howard, Dyar & Knab, 1917, 4: 1041–1042). The three specimens we have seen agree well with this description as far as it goes. In general they also fit the more detailed description of the Saratoga Springs population except for the following: Somewhat larger in size, wing length 2.6–2.8 mm. Generally lighter in coloration; this is probably partially due to the age of the specimens as well as to the fact that they were reared. Scutum not darkened in area of light-scaled patch; dark scales lighter in coloration, longer and more numerous. Prescutal light-scaled patch poorly developed, inconspicuous, streaklike, consisting of about two rows of bluish scales surrounded by elongate light coppery scales; in one specimen reduced to two or three light scales. Supra-alar light-scaled patch well developed, anterior scales longer; area around patch with numerous elongate light coppery scales. Knee spots small, dingy white; undersurface of legs lighter in coloration. Abdominal tergal light spots dingy white. The upright vertical scales of the head are usually distinctly forked.

Baja California population

The single known specimen resembles the San Diego material. It has a wing length of 3.1 mm. The prescutal light-scaled patch is represented by a single small bluish scale on each side; the integument in this area is somewhat darkened and is densely covered with narrow elongate bronzy and coppery scales. The supra-alar patch is also reduced; there are only a few elongate bluish scales among many slender outstanding as well as recumbent coppery scales. The pleural light-scaled patches have smaller and more elongate scales. The tergal abdominal spots and the knee spots are reduced.

Arizona population

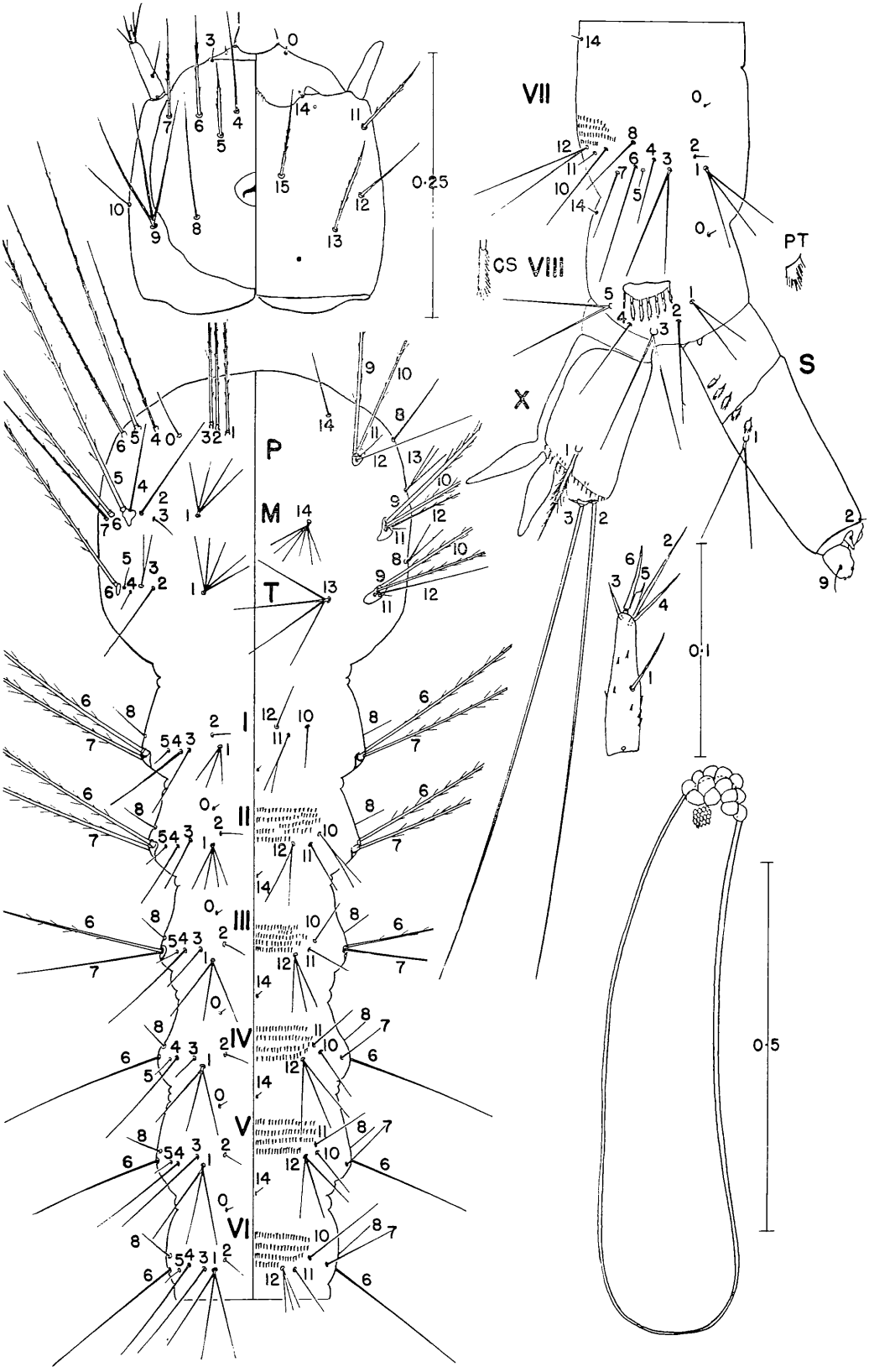
Two specimens collected in light traps on July 20 and Oct. 12, 1953 were examined. The wing lengths are 2.9 and 3.1 mm. respectively. The July specimen has a short well-marked prescutal patch of several rows of light blue scales. It also resembles Saratoga Springs specimens in its well-developed supraalar patch but differs in having numerous elongate coppery scales in this area. However, in overall features it is closer to an extremely well-marked San Diego specimen. The October specimen has the prescutal patch reduced to two light scales on the right side and a streak of about 8 short inconspicuous light scales in a single row on the left side; on both sides the light scales are surrounded by a dense vestiture of bronzy scales. The supraalar patches contain only a few elongate bluish scales posteriorly and more numerous bronzy and coppery elongate scales anteriorly. Superficially the coloration of this individual is very close to that of the Baja California specimen.

Texas populations (Fig. 1b)

Forty-one females from six different counties in Texas were examined. Despite some variation, all of them can be distinguished from the *anhydor* populations to the west on the basis of the extent of the light scaling of the mesoscutum as originally indicated by Dyar and Shannon (1924: 187,189). The following additions and corrections to their description and comparisons with the Saratoga Springs population appear desirable: Wing length 2.2–2.9 mm. Scutal integument and dark vestiture as in Saratoga Springs populations; bristles darker; prescutal blue scales in a single row forming a long streak usually from transverse suture of scutal angle to anterior dorsocentral bristles; space mesad of streak, particularly near middle, with few or no bronzy scales, space laterad of streak with very dark bronzy narrow scales; supraalar blue scales in a streak in line with prescutal streak, extending to the transverse suture and often forming a continuous line, scales broad anteriorly, elongated near wing root, surrounding area with few or no bronzy scales; light-scaled patch on *apn* and upper *stp* narrower. Wing with whitish scales at base of anterior margin of R to slightly beyond arculus, a few whitish scales on posterior margin near apex of this light streak. Fore coxa with a patch of bluish scales; knee spots large, conspicuous, pure white; similar white spots at apices of tibiae, smaller on mid leg; femora and fore and mid tibiae light-scaled below; tarsal segments lighter below. Abdominal tergal spots pure white; sternites cream-colored.

EXPLANATION OF PLATE I

FIG. 2. Egg and first instar larva of *Uranotaenia a. anhydor* Dyar, Saratoga Springs population. Lateral aspect of egg, showing detail of exochorion near upper end only; dorsal (left) and ventral (right) aspect of head, thorax and proximal abdominal segments, left lateral aspect of terminal abdominal segments, and dorsal aspect of left antenna of first instar larva.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2. *Male*

Saratoga Springs population

Wing: 2.0–2.5 mm. Abdomen: 1.9–2.0 mm. Proboscis: 1.45–1.7 mm. Front femur 1.4–1.6 mm. Generally very similar to female. Proboscis moderately swollen. Flagellar whorls about 0.45 of flagellum, about 30 bristles in whorl; penultimate segment about 4.0 of preceding, apical about 0.90 of penultimate. Leg I: femur 1; tibia 1.06; tarsus 0.57, 0.29, 0.18, 0.09, 0.10; claws enlarged, unequal, larger strongly curved. Leg II: femur 1.10; tibia 1.24; tarsus 0.71, 0.31, 0.19, 0.09, 0.10; claws enlarged, very unequal, larger very strongly curved. Leg III: femur 1.00; tibia 1.20; tarsus 1.00, 0.51, 0.39, 0.23, 0.14; claws small, equal. Light scaling of thorax about as extensive as in female; abdominal light spots not distinct. *Male genitalia* apparently indistinguishable from those of other populations, very similar to published figures for *anhydor* (Brookman and Reeves 1953:227; Galindo, Blanton and Peyton 1954:123) and *syntheta* (Dampf 1943:162–165, plate 8); shape of ninth tergite lobes variable; proctiger with a distinct large lateral spiculate sclerotization on each side (also present but not described in other populations). Specimens examined: 575, 10 genitalia mounts.

San Diego population

All five specimens from San Diego are in general similar to the females except that all of them have the prescutal light-scaled patch much better developed. This patch consists of several rows of blueish scales much as in the less well-marked members of both sexes of the Saratoga Springs population. The supraalar patch of bluish scales is also better developed than in the females. No obvious differences were noted in the single genitalia mount.

Baja California population

The single known male is extremely similar to the female except that it has a distinct prescutal light-scaled streak, consisting of about two rows of bluish scales. This patch is smaller and less distinct than in any of the San Diego specimens. No obvious differences were noted in the mounted genitalia.

Texas populations

The 19 males from five different localities appear to be identical with the females in coloration except that the abdominal light spots are greatly reduced or even apparently completely absent. No obvious differences from the Saratoga Springs population were noted in 8 genitalia mounts.

3. *Egg*

The egg stage is known only for the Saratoga Springs population. The eggs are laid in boat-shaped rafts as in the case of most other species of *Uranotaenia*. The rafts are tapered to a point at one end and broadened and rounded at the other end as seen from above and generally are about three times as long as the median width, measuring about 2–2.5 mm. in length and about 0.6–0.8 mm. in median width at the top and up to 3 mm. by 1 mm. at the bottom. Several shorter broader rafts were also collected. The rafts are rather strongly concave at the bottom in side view. The lower surface of the raft, as seen in alcohol-preserved material, is covered with a continuous amorphous translucent pellicle which forms an opaque white disc at the lower end of each egg. The number of eggs in a raft varies considerably but is generally between 80 and 100. The mature individual egg (fig. 2) is uniformly dark brown, almost black. It is about 0.75–0.80 mm. in length and approximately 0.15–0.16 mm. in median width. One surface is slightly concave while the opposite surface is more strongly convex near the upper end but shows a flattening near the lower third. The lower end is enlarged and broadly rounded except for a somewhat flattened extreme apex. The egg is gradually tapered to the upper end which is more acutely rounded. The exochorion appears to be thicker on the concave side. Its ornamentation consists of extremely minute hexagonal reticulations over the entire surface except for the extreme upper end. The latter bears a group of two dozen or more roughly hemispherical translucent projections which appear to arise from hexagonal bases. This type of ornamentation is apparently not found in mosquitoes of other genera. Specimens examined: 18 rafts, 50 individual eggs.

4. *First Instar Larva*

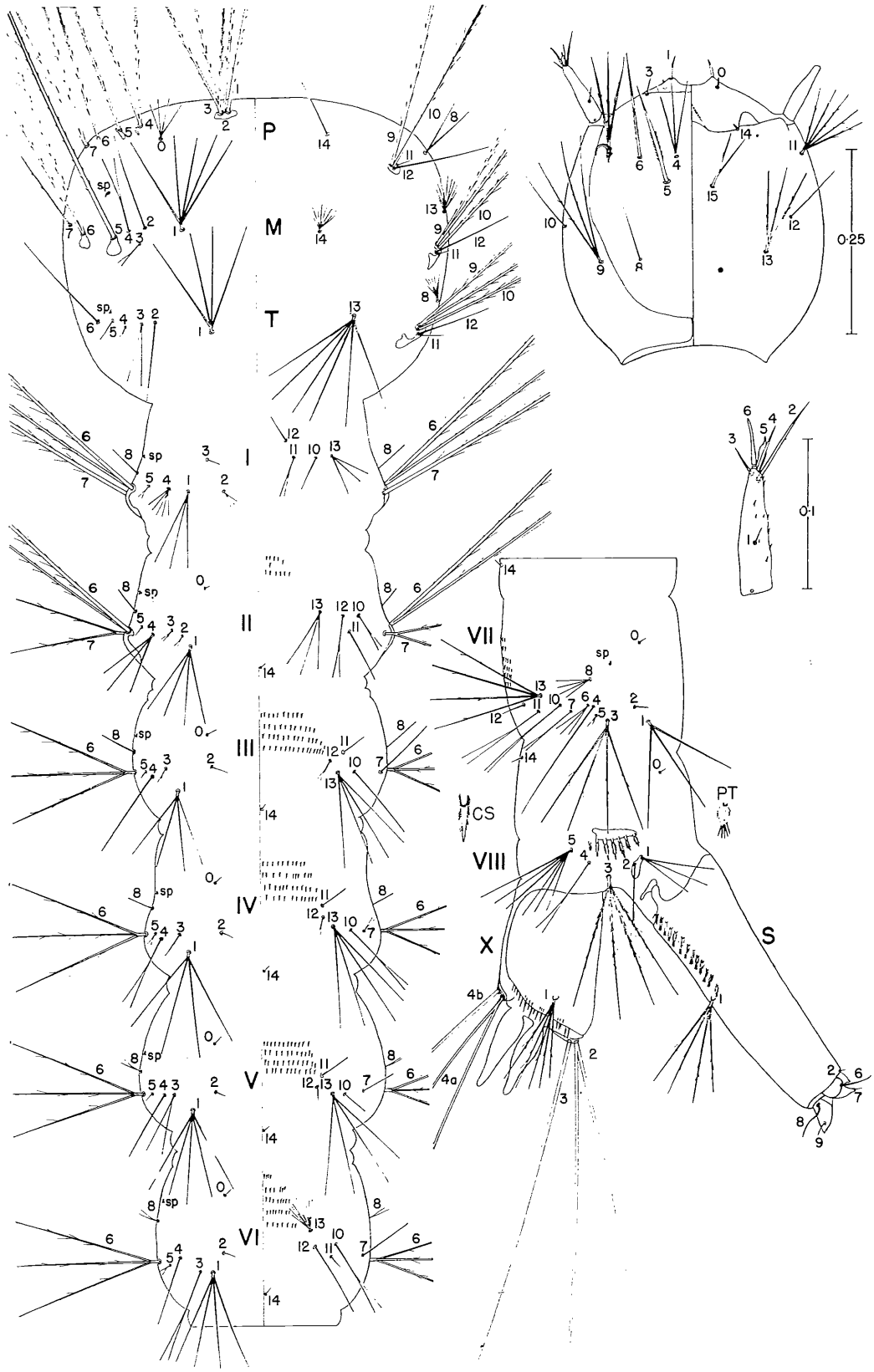
Saratoga Springs population (Fig. 2)

Head: 0.25 mm. Siphon: 0.23 mm. (sclerotized part about 0.17 mm.). Anal saddle: 0.14 mm. Specimens studied: 22.

Head: Width about 0.9 of length, greatest beyond middle; no distinct ocular bulge; pigmentation uniformly dark brown except for lighter ocular areas, a narrow black caudal ring incomplete dorsally, and black heavily sclerotized egg tooth; integumentary imbricate sculpturing well developed, uniform. No distinct collar; "ocular plate" with moderate dorsal caudal projection occupying area without black caudal ring; this projection probably represents the collar. Labrum well developed, about one-third width at 1-C; median emargination often deeper than

EXPLANATION OF PLATE II

FIG. 3. Second instar larva of *Uranotaenia a. anhydor* Dyar, Saratoga Springs population. Dorsal (left) and ventral (right) aspect of head, thorax and proximal abdominal segments, left lateral aspect of terminal abdominal segments, and dorsal aspect of left antenna.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shown on figure. Mental plate small, prominent, heavily sclerotized and black anteriorly; one strong median tooth and about 3-5 indistinct teeth on each side. Hairs of head capsule darker than integument, usually all single except 9-C which is usually 3b; 8, 10, 12–C occasionally 2f; heavier hairs barbed or minutely fringed. Antenna about 0.24 of head, distinctly narrowed at about middle; lighter in pigmentation than head capsule; spicules small, dark, sparse; a minute clear circular area at base dorsally, probably representing a sense organ. Antennal hairs lightly pigmented, apex of 5-A transparent; relative position, length and degree of development as figured; all single; 1-A at about middle of antenna, slightly more than 0.5 of shaft length.

Thorax: Integument smooth, nude, unpigmented. Larger hairs strongly pigmented, fringed or barbed; smaller hairs moderately or lightly pigmented; large hairs usually all single, with poorly pigmented basal tubercles, alveolar rim produced necklike around shafts; hairs 9–12 on common tubercles, 4, 5–M on common tubercles, all others usually separate, 6, 7-M sometimes with common tubercle; relative position, length, and degree of development of hairs as figured; hairs 1, 13, 14-M, 1, 3, 8, 13-T branched, double to multiple; 0-P often branched or forked; all other hairs usually single; 7-P, 8-M, 7-T absent, probably these hairs are homologous. Meso- and metathoracic spiracle rudiments not developed.

Abdomen: Integument smooth and nude throughout except for about 4 or 5 ventral median rows of spicules on II-VII; hairs 6, 7–I, II, 6–III with sclerotized basal tubercle plate; larger hairs with long necklike extension of alveolus around shaft; relative position, length and degree of development of hairs as figured; all hairs generally single and simple except as noted; 1-I-VIII usually 3b; 3-VII usually 2b; 6-I-III, 7-I, II single, fringed or barbed; 11-I, 10-II often 2f; 12-II-VII usually 2, 3b; 3, 5-VIII usually 2b; 1-S usually 2b; 1-X heavy, strongly barbed; 2, 3-X long, smooth; hairs 9, 13-I-VII, 8-S, 4-X absent, all others present as in fourth instar. Segment VIII: comb plate small, indistinct, restricted to base of scales; one or more scales free; scales usually 7 or 8, elongate, not tapered or pointed apically, with distinct fringe apically and laterally, at least on one side. Siphon: as figured, index about 3.5; basal 0.25 or more not sclerotized; distal, sclerotized part dark brown, with distinct imbrications; pecten restricted to basal half; teeth usually 5 or 6, three or more of which are on unsclerotized part; individual tooth broad, fringed laterally and apically; acus of two separate small unconnected plates on each side; hair 1 usually 2b, inserted slightly proximad of 0.5 of siphon; hair 2 single, minute; hair 13 minute or undeveloped, never twisted at base. Anal segment: saddle incomplete, brown, slightly darker dorsad; median width about 0.55 length; imbrications distinct; apical margin with short spines merging proximad into spicules arising from imbrications; gills subequal, about 0.55 saddle length, distinctly narrowed toward apex which is rounded; hairs 2 and 3 subequal, about 3.5 of saddle length. Spiracular rudiments on I-VII not developed. Dorsal sensilla on III-V not developed.

Other populations

Two specimens from San Antonio, Texas are indistinguishable from the Saratoga Springs population. No other material was available for study.

5. *Second Instar Larva*

Saratoga Springs population (Fig. 3)

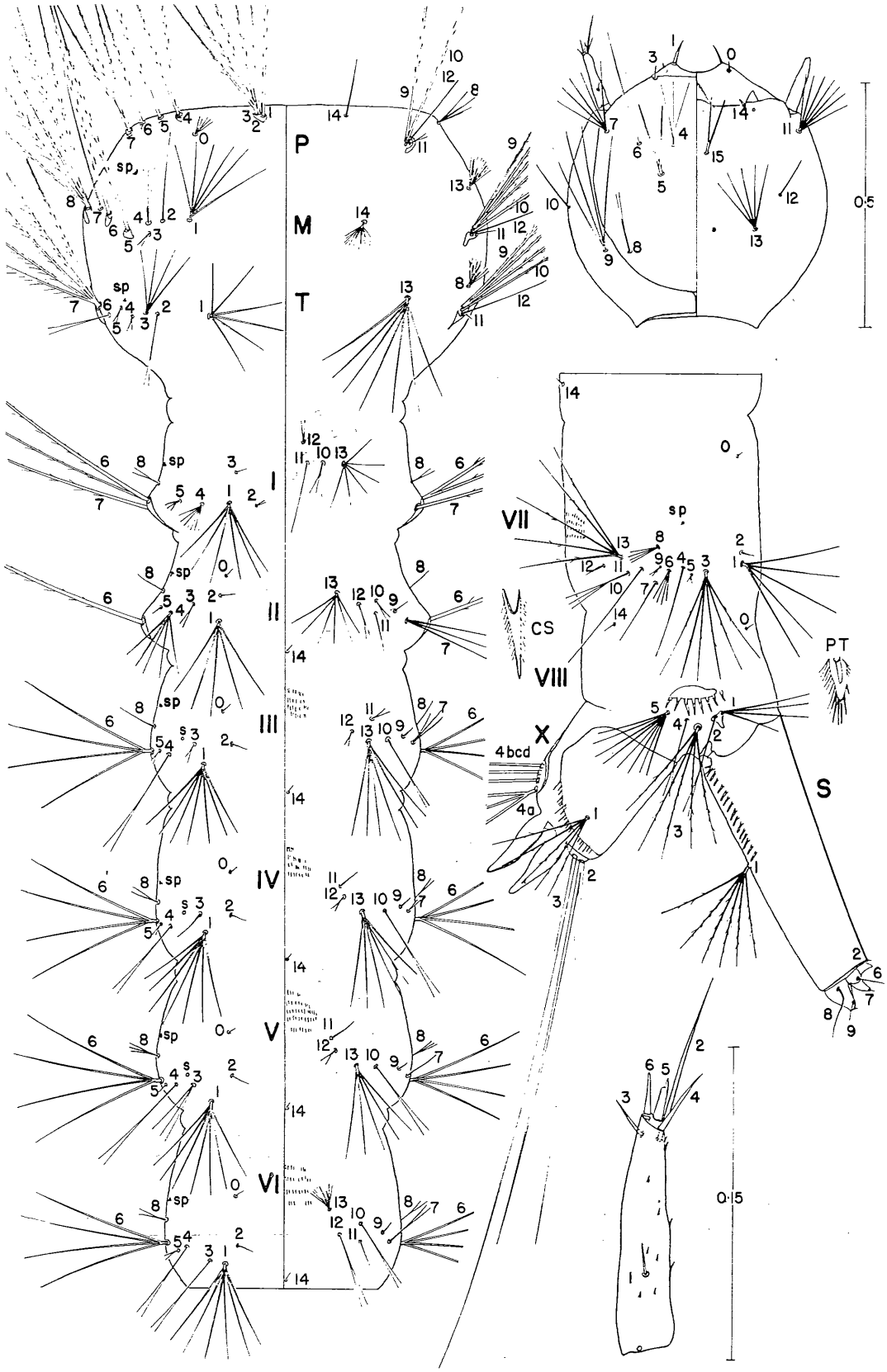
Head: 0.39 mm. Siphon: 0.37 mm. (sclerotized part about 0.34 mm.). Anal saddle: 0.19 mm. Specimens studied: 16.

Head: Width about 0.94 of length, greatest beyond middle; no distinct ocular bulge; pigmentation uniformly dark brown to almost black except for lighter ocular areas and very narrow dense black occipital ring; integumentary imbricate sculpturing well developed, uniform, weaker in ocular areas. Collar completely absent. Labrum well developed, slightly less than 0.4 of width at 1-C; median emargination usually greater than shown on figure. Mental plate small, prominent, heavily sclerotized and black anteriorly; one strong median tooth and at least 5 distinct teeth on each side. Hairs of head capsule darker than integument; relative position, length and degree of development as figured; hairs 5, 6 single, basal part heavy and finely barbed or fringed, distal part acutely tapered; 7, 9, 11, 13, 15 frequently finely fringed or minutely barbed; 7, 9 usually 3, 4b; 11 usually 4–7b; 13 usually 3–5b; 14 small, peglike; 15 usually 1, 2b; 8, 10, 12 single or 2b, f. Antenna about 0.23 of head; distinctly narrowed beyond 0.6; pigmentation as on head capsule; spicules small, sparse, darker than integument; all hairs single, dark, except apex of 5-A; 1-A at about 0.3–0.4, usually distinctly shorter than shaft width; basal sense organ prominent.

Thorax: Integument as in the first instar; larger hairs darkly pigmented, with strong basal tubercles and with long delicate fringes or barbs; hairs 1, 2, 3-P and 9–12-P, M, T with common tubercles; relative position, length and degree of development of hairs as figured; hairs 1-M, T and 13-T stellate tufts; 1, 2, 5, 6, 9, 10-P, 5, 7, 10, 12-M, and 10-T always single; 13, 14-M and

EXPLANATION OF PLATE III

FIG. 4. Third instar larva of *Uranotaenia a. anhydor* Dyar, Saratoga Springs population. Dorsal (left) and ventral (right) aspect of head, thorax and proximal abdominal segments, left lateral aspect of terminal abdominal segments, and dorsal aspect of left antenna.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8-T irregularly dendritic; 3-P usually 2, 3b; 7-P usually 2b; 8-P usually 2, 3b; 2-M single or 2f; 3, 4-M usually 2f; 2-T single or 2f; 3-T usually 2, 3b; 4-T usually 2b; 6-T single or 2f; other hairs usually single; hairs 8-M, 7-T absent. Meso- and metathoracic spiracle rudiments developed as small sclerotized spots.

Abdomen: Integument as in the first instar, ventral spicules reduced in number on II; segments I and II with sclerotizations near hairs 6 and 7; relative position, length and degree of development of hairs as figured; hairs 1-I-VIII stellate, usually 3, 4b; 6-I, II usually 2b; 7-I single; 7-II moderate, 2b; 6-III-VI moderate, stellate, usually 3b; 13-I, II usually 3b; 13-III-V, VII usually 4b; 13-VI irregularly dendritic. Hair 9 absent on I-VII. Segment VIII: comb plate small, restricted to bases of scales; comb scales usually 7 or 8, one or more not attached to plate; individual scale tapered apically, fringed laterally but with smooth apex; a common sclerotization at base of hairs 1 and 2; hair 3 fringed or barbed. Siphon: as figured; not sclerotized at extreme base; index 3.6–4.0 sclerotized portion light brown, darker at base; pecten extending to level of hair 1 or slightly beyond; teeth elongate, usually 12 to 14, distinctly and strongly fringed apically, indistinctly minutely fringed laterally; one small tooth often on unsclerotized part; hair 1-S at about 0.45, sparsely fringed or barbed, usually 4b; hair 8-S present, single, well developed, hooklike; other hairs as in first instar; acus of two connected sclerotizations, distal attached to sclerotized part of siphon. Segment X: saddle incomplete, dark brown, darker dorsocaudad, imbrications well developed; width 0.55–0.62 length; caudal margin with mixed small spines and spicules of varying sizes merging into spicules arising from imbrications more basally; gills as in the first instar, about 0.55 saddle length; hair 1 usually 3–5b, distinctly fringed; hair 2 about 3.5 saddle length, smooth, usually 2b; hair 3 single, smooth, about 4.2 saddle length; ventral brush represented by 4a (usually 2b) and 4b (single), both smooth; barred area of ventral brush poorly developed, not attached to saddle. Spiracular rudiments developed on I-VII. Dorsal sensilla on III-V not developed.

Other populations

A single larva from San Antonio, Texas appears to be very similar to the Saratoga Springs material except for a lighter pigmentation of sclerotized parts and hairs.

6. *Third Instar Larva*

Saratoga Springs population (Fig. 4)

Head: 0.56 mm. Siphon: 0.52 mm. Anal saddle: 0.25 mm. Specimens studied: 20.

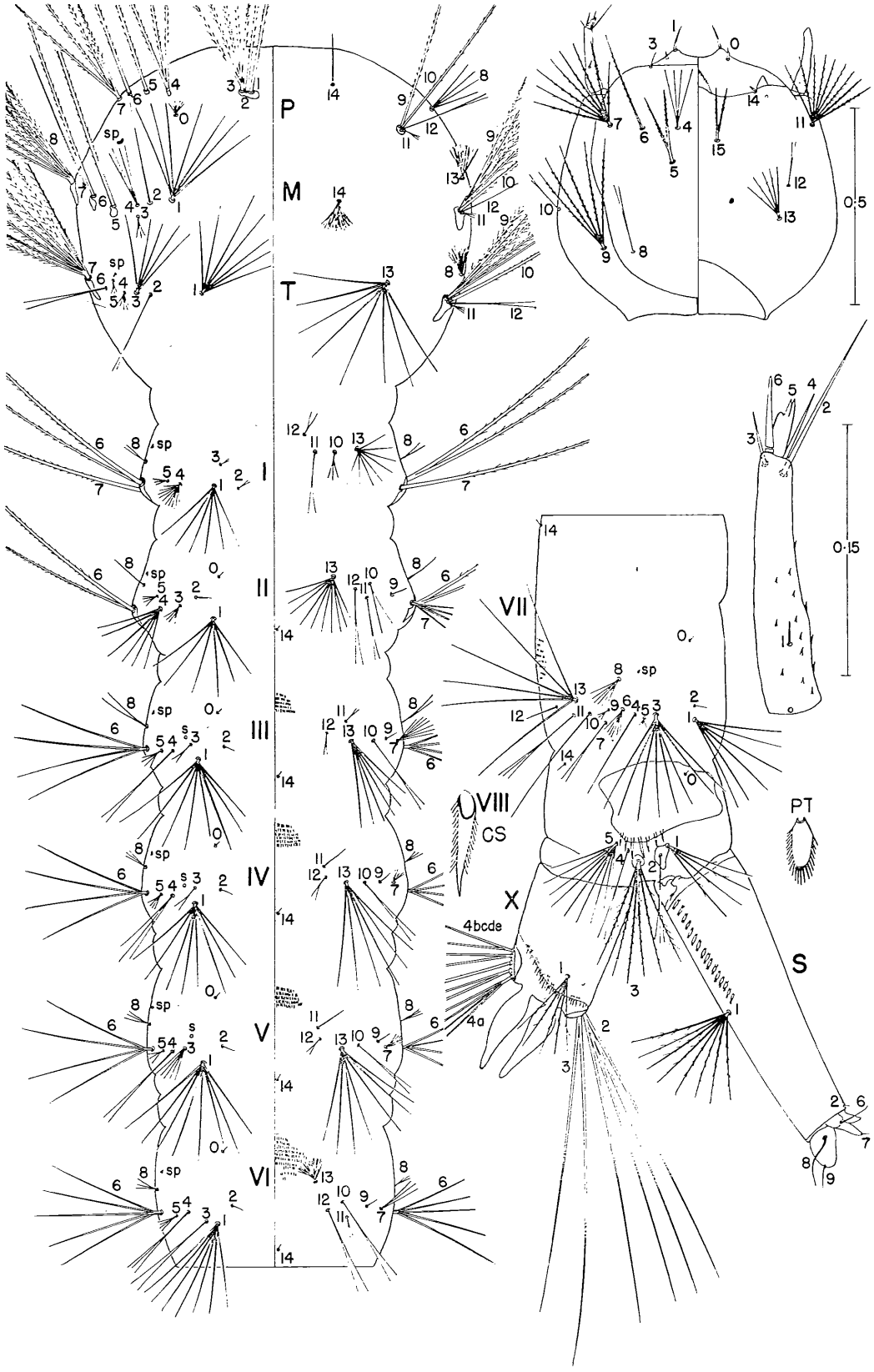
Head: Width about 0.96 of length, greatest beyond middle (figure incorrect in this respect); pigmentation extremely dark, almost black, except for lighter ocular areas; integumentary imbricate sculpturing well developed, uniform, weaker in ocular areas. Collar completely absent. Labrum well developed, about 0.31 width at 1-C; median emargination often deeper than shown in figure. Mental plate small, prominent; heavily sclerotized and black anteriorly; one strong median tooth and about 7 or 8 distinct teeth on each side. Heavier hairs of head capsule even more strongly pigmented than integument, usually strongly but minutely barbed; relative position, length and degree of development as figured. Antenna about 0.23 of head, gradually narrowed to apex; pigmentation as on head capsule; spicules small, sparse; basal sensillum distinct. Antennal hairs lighter than shaft; apex of 5-A transparent; relative position, length and degree of development as figured; all single; 1-A near basal third.

Thorax: Integument smooth, nude, unpigmented. Larger hairs strongly pigmented and fringed or barbed, provided with more or less well-developed basal tubercles; smaller hairs moderately pigmented, without tubercles; relative position, length and degree of development as figured; branching apparently as variable as in fourth instar; all hairs present, 7-T and 8-M appearing for the first time. Rudimentary spiracles distinct.

Abdomen: Integument smooth, nude, unpigmented except for about 4 or 5 ventral median rows of spicules on III-VII; segments II,III with strong lateral sclerotized plate at base of hairs 6 and 7. Hairs 6-I, II and 7-I distinctly fringed or barbed; other hairs nude or very minutely barbed; relative position, length and degree of development as figured; branching apparently as variable as in fourth instar; all hairs present, hair 9 appearing for the first time on I-VII. Segment VIII: comb plate small, well pigmented, with imbricate sculpturing, restricted to base of scales; one scale often free; scales usually 7 or 8, elongate, sharply pointed at apex, with distinct lateral fringes but smooth apically; a distinct small, sclerotized plate at base of hairs 1, 2-VIII. Siphon: as figured; index 3.5-4.2; extreme base not completely sclerotized; sclerotized part light brown, dark at base; imbricate sculpturing uniform, moderately distinct; pecten extending to about level of hair 1-S; teeth 12 to 18, elongate, distinctly fringed apically and laterally, all attached to sclerotized part; acus usually with long connection to sclerotized siphon; hair 1-S at about 0.45, usually 6b, delicately fringed;

EXPLANATION OF PLATE IV

FIG. 5. Fourth instar larva of *Uranotaenia a. anhydor* Dyar, Saratoga Springs populations. Dorsal (left) and ventral (right) aspect of head, thorax and proximal abdominal segments, left lateral aspect of terminal abdominal segments, and dorsal aspect of left antenna.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valve hairs as in second instar. Segment X: saddle incomplete, light brown, darker dorsoapically; median width about 0.7 length; imbrications moderately distinct; apical margin with small spines and spicules of varying lengths preceded by spicules arising from imbrications; gills subequal, narrowed and rounded apically, about 0.66 saddle length; hair 1-X usually 5b; 2-X about 3.5 saddle length, 2b, smooth; 3-X about 4.2 saddle length, single, smooth; ventral brush represented by 4a (usually 3b) and 4b, c, d (all usually single, occasionally 2b), all hairs smooth; barred area well developed, prolonged basally as a bar, not connected with saddle. Spiracular rudiments present on I-VII. Dorsal sensillum present on III-V, between and cephalad of hairs 3 and 4.

Other populations

Four specimens from San Diego, California cannot be distinguished from the Saratoga Springs population except for the somewhat lighter pigmentation of the head.

Two specimens from San Antonio, Texas appear to differ only in much lighter pigmentation of sclerotized parts and hairs.

7. *Fourth Instar Larva*

Saratoga Springs population (Fig. 5)

Head: 0.68–0.72 mm. Siphon: 0.72–0.80 mm. Anal saddle: about 0.32 mm. Specimens studied: 85.

Head: About as wide as long; ocular bulge moderately developed (not shown in figure because of flattening); pigmentation uniformly very dark brown, almost black, except for light ocular areas; imbricate integumentary sculpturing well developed, uniform, lighter in ocular areas; collar not developed. Labrum well developed, about 0.3 of width at 1-C. Mental plate small, prominent; heavily sclerotized and black anteriorly; with one prominent median tooth and 6 to 9 distinct teeth on each side. Heavier hairs extremely dark, practically black, with short barbs; weaker hairs dark brown, without visible barbs; relative position, length and degree of development as figured; hair 0(1; small, transparent, leaflike and pointed), 1(1; lightly pigmented, slender, moderately curved), 2(not developed), 3(1; thin, difficult to see), 4(4, 3, 5b; 4.74; 3–7), 5(3, 2b; 2.56), 6(1; 1.05; 1–2), 7(8, 7, 9b; 7.9; 6–11), 8(2f, 1; 1.64; 1–3), 9(5, 6b; 5.48; 5–7), 10(2f; 1.77; 1–2), 11(9, 8, 10b; 9.10; 7–11), 12(2f; 2.21; 2–3), 13(5, 4b; 4.95; 2–7), 14(1; small, peglike), 15(2b). Antenna about 0.24 of head; distinctly narrowed at about middle; pigmentation even darker than on head capsule, uniform except for slightly lighter apex and completely black base; spicules small, sparse, very dark. Antennal hairs slightly lighter than integument except for transparent apex of 5-A; all hairs simple; relative position, length and degree of development as figured; hair 1-A usually minute, extremely difficult to see, usually about 0.50 of shaft width, position variable but usually within basal third; basal sensillum distinct.

Thorax: Integument smooth, nude, unpigmented; larger hairs strongly pigmented but lighter than on head capsule. with basal tubercle plates and short fringes or barbs; smaller hairs moderately pigmented, without tubercles or conspicuous fringes or barbs; relative position, length and degree of development as figured; hair 1-P about as long as head capsule, 3-P about 0.8 of hair 1-P; hairs 1-M, T and 3, 13-T with uneven branches. Rudimentary spiracles distinct. Prothorax; hair 0(8, 7, 9, 6b; 7.88; 6–11), 1(1), 2(1), 3(5, 6, 4b; 5.16), 4(3, 4b; 3.33), 5(1), 6(1), 7(4b; 4.08; 3–5), 8(4, 5, 3b; 3.92; 2–6), 9(1), 10(1), 11(3, 4b; 3.44; 2–5), 12(2f; 2.05; 1–3), 14(1). Mesothorax: hair 1(7, 8b; 7.16; 5–9), 2(1), 3(3, 4b; 3.54; 3–5), 4(4, 3b; 3.67; 2–5), 5(1), 6(1), 7(1), 8(6, 7, 5b; 6.03), 9(5, 6b; 5.21; 4–7), 10(1; 1.03; 1–2), 11(3, 4b; 3.15; 2–4), 12(1), 13 (about 20–25d), 14 (about 25–30d). Metathorax: hair 1(7, 8b; 7.41; 6–9), 2(2, 3b; 2.45; 1–4), 3(5b; 4.92; 4–6), 4(5b; 4.72; 3–7), 5(3, 2b; 2.56; 1–4), 6(2f; 1.94; 1–3), 7(8, 9b; 8.60; 7–11), 8(11–20b), 9(4b; 3.92; 3–5), 10(1; 1.08; 1–2), 11(4, 3b; 2.71; 3–5), 12(2, 1–3b; 2.0), 13(8, 9b; 8.0; 6–10).

Abdomen: Integument smooth, nude and unpigmented except for 5 or more ventral median rows of small spicules on III–VII; segments I and II each with strong lateral sclerotized plate at base of hairs 6 and 7. Hairs 6–I, II and 7-I with numerous barbs or short fringes; other hairs nude or very minutely barbed except as noted; stellate hairs with uneven branches; relative position, length and degree of development as figured. Segment I: hair 1(6, 7b; 6.35; 5–7), 2(3, 2b; 2.40; 1–5), 3(2b; 1.92; 1–3), 4(9, 10, 8–12b; 9.60; 6–12), 5(4, 3b; 4.0; 3–6), 6(2b; lower branch weaker and shorter), 7(1; 1.05; 1–2), 8(2, 3b; 2.30; 1–3), 9 (not developed), 10(3, 2b; 2.67; 1–5), 11(2f; 1.90; 1–2), 12(2, 3b; 2.35; 2–4), 13(6, 9, 8, 7b; 7.64; 5–13), 14 (not developed). Segment II: hair 0(1), 1(6, 7b; 5.90; 5–8), 2(1), 3(5, 7, 4b; 5.58; 3–10), 4(6, 5b; 5.81; 4–7), 5(4, 3b; 3.81; 3–5), 6(2b; lower branch weaker and shorter), 7(4, 3b; 3.46; 2–4), 8(1, 2f; 1.32; 1–2), 9(1), 10(2b; 2.36; 1–4), 11(2f; 1.95; 1–3), 12(2f), 13(10, 8–11b; 9.56; 7–12), 14 (not developed). Segment III: hair 0(1), 1(8, 7b; 7.59; 6–9), 2(1), 3(2, 3b; 2.35; 1–4), 4(2, 3f; 2.38; 2–4), 5(4, 5b; 4.38; 3–6), 6(4, 5b; 4.43; 4–6), 7(7, 8, 6, 5b; 6.64; 3–9), 8(2f; 1.97; 1–3), 9(1), 10(2f; 1.79; 1–2), 11(2, 1–3f; 2.0), 12(2f; 2.18; 2–3), 13(6, 7b; 6.48; 5–8), 14(1; 1.05; 1–2). Segment IV: hair 0(1), 1(8, 7b; 7.40; 6–8), 2(1), 3(2f, 1; 1.85; 1–3), 4(3, 2b; 2.65), 5(4, 3b; 3.68; 2–5), 6(4b; 3.51; 3–5), 7(7, 5–6, 8b; 5.68; 3–8), 8(3b; 2.88; 2–4), 9(1), 10(2b; 1.92; 1–2), 11(1), 12(2f; 2.03; 1–3), 13(6, 5b; 5.65), 14(1). Segment V: hair 0(1), 1(8, 7b; 7.51; 6–9), 2(1), 3(5–7b; 5.56; 3–9),

4(2f; 1.95; 1–3), 5(3, 4b; 3.63; 2–6), 6(4, 5b; 4.26; 3–5), 7(6, 5, 7b; 5.84; 3–9), 8(3b; 2.92; 2–4), 9(1), 10(2b; 1.82; 1–3), 11(1; 1.10; 1–2), 12(2f; 1.97; 1–2), 13(7b; 6.78; 5–8), 14(1). Segment VI: hair 0(1), 1(7–8, 6b; 7.23; 4–9), 2(1; 1.03; 1–2), 3(2, 3b; 2.37; 2–4), 4(3, 2f; 2.75; 2–4), 5(4, 3–5b; 3.92; 2–5), 6(6, 4, 5b; 4.77; 3–7), 7(2, 3b; 2.62; 2–4), 8(3, 2b; 2.56; 2–3), 9(1; 1.05; 1–2), 10(2f; 1.75; 1–2), 11(2f; 1.91; 1–2), 12(2b; 1.74; 1–2), 13(10–24d), 14(1; 1.03; 1–2). Segment VII: hair 0(1), 1(6, 5–7b; 5.95; 4–8), 2(1), 3(8, 7, 9b; 7.57; 6–9), 4(1; 1.23; 1–2), 5(4, 5b; 4.62; 3–6), 6(6, 7b; 6.70; 6–9), 7(2–3b; 2.59; 2–4), 8(6, 7b; 6.54; 5–8), 9(3, 4b; 3.28; 2–4), 10(1, 2f; 1.41), 11(3f; 3.28; 2–4), 12(1), 13(6, 5b; 5.65; 4–7), 14(1; 1.03; 1–2). Segment VIII: comb plate large, including hair 0–VIII, lightly pigmented, darker along margins, with distinct imbricate sculpturing, irregularly truncate ventrally; all scales attached; scales (8, 7; 7.75; 6–10), black, sharply pointed at apex, with distinct lateral fringes but smooth apically; hairs 1, 2–VIII with a small common basal plate; hair 3–VIII with conspicuous fringes and a minute basal plate; hair 0(1), 1(4, 5b; 4.50; 4–6), 2(3, 2f; 2.62; 1–4), 3(6, 5b; 5.97; 5–8), 4(2, 3f; 2.26), 5(9, 10b; 9.02; 7–10), 14(1; 1.05; 1–3). Siphon: usually differently shaped from figure, with dorsal surface concave, ventral convex; index 3.8–5.0; completely sclerotized; pigmentation a very light yellowish brown, somewhat darker apically, a narrow black ring at base; imbricate sculpturing uniform, rather indistinct; pecten extending to about level of hair 1-S; teeth (16–17, 18; 16.65; 13–20), elongate but with expanded lateral margins, fringed apically and laterally; acus with short connection to siphon; hair 1-S at about 0.45, delicately fringed; hair 1(8, 9, 10b; 8.44; 6–11), 2(1; minute, at extreme apex of siphon), valve hairs as figured, not studied in detail, apparently all single, 13 (1; minute, peglike; never with twisted base). Segment X: saddle completely ringing segment; light brown, somewhat darker than siphon, darkened proximally; median width about 0.76 length; imbrications uniform, more distinct than on siphon; apical margin with small spines and spicules of varying lengths preceded by spicules arising from imbrications; caudal margin strongly emarginate in region of ventral brush; gills subequal; narrowed and rounded apically, about 0.7 saddle length; hair 1(5b; 4.95; 4–8; delicately fringed), 2(4, 3b; 3.65; 3–5; about 2.8 saddle length, smooth), 3(2b; about 3.4 saddle length, smooth), ventral brush represented by 4abcde, all smooth, 4a(4, 5b; 4.57; 3–6; about 1.6 saddle length), 4b(2b; about 1.7 saddle length), 4c(1; 1.05; 1–2; about 3.0 saddle length), 4d(2b; 1.97; 1–3; about 3.0 saddle length), 4e(2b; 2.07; 2–3; about 1.5 saddle length); barred area well developed, with strong lateral sclerotized plates and a median caudal bar uniting it to saddle. Spiracular rudiments present on I–VII. Dorsal sensillum present on III–V, usually between and cephalad of hairs 3 and 4.

Variation. We have noted considerable variation in the shape and size of all the sclerotized parts but the pigmentation appears to be quite uniform. Specimens reared from eggs in the laboratory tend to have a somewhat lighter head capsule; however, the pigmentation even then is stronger than we have seen in any specimen from other populations. The chaetotaxy is quite variable as indicated in the above description which is based on the study of the complete chaetotaxy of 10 skins from individually reared field-collected fourth instar larvae and 10 whole fourth instar larvae collected in a different breeding site. Although there appear to be significant differences in the two samples in the mode and mean of the number of branches in several hairs, we have combined these data for the characterization of the Saratoga Springs population and for comparison with other populations. Several hairs which have been suggested as diagnostic for *anhydor* or *syntheta*, or which showed promise of separating the Saratoga Springs population from others, were examined in 65 additional skins from individually reared field-collected fourth instar larvae from both breeding sites. The data on these hairs were combined with those from the first two samples and are presented in Table I in the hope that they may prove of value when comparable samples of other populations can be studied.

San Diego population

The three mounted larval skins examined are so badly twisted that it is difficult to identify all the hairs. However, we believe that we have interpreted the majority of the hairs correctly. The chaetotaxy shown in the figures of Galindo, Blanton and Peyton (1954: 123) is quite different, but it was probably obtained from the same material. None of the specimens we examined had hair 4–P two-branched, hair 5–VIII three-branched. In addition we have never seen a comb plate as pictured by these authors.

Pigmentation of the head capsule and antenna lighter, of the siphon and saddle darker. Siphon index about 5.0. Head capsule: hair 0(1), 1(1), 3(1), 4 (missing), 5(2b, 1), 6(1), 7(8b), 8(2f), 9(5b; 5–7), 10(2f), 11(10b), 12(3, 4b), 13 (missing), 14(1), 15(2b). Antenna: all hairs single. Prothorax: hair 0(7b; 7–11), 1 (1), 2(1), 3(5b), 4(3, 4b), 5(1), 6(1), 7(4b; 4–5), 8(4b; 3–7), 9(1), 10(1), 11(4, 3b; 3–5), 12(2f), 14(1; 1–2). Mesothorax: hair 1(7b; 6–7), 2(1), 3(3, 4b),4(4, 3b), 5(1), 6(1), 7(1), 8(6, 7b), 9(6, 7b; 5–7), 10(1), 11 (missing), 12(1), 13 (over 25d), 14 (over 30d). Metathorax: hair 1(6, 7b), 2(1), 3(4, 5, 6b), 4(4b; 3–4), 5(3b; 2–3), 6(2f, 1–2), 7(10, 11b; 8–11), 8(15, 16b), 9(4b), 10(1), 11 (not seen), 12(2f; 1–3), 13(8b). Abdomen I: hair 1(7b), 2(2b), 3(2b), 4(11, 12b), 5(3, 4b), 6(2b), 7(1),

8(1), 10(3b), 11(1, 2f), 12(2b), 13(11b). Abdomen II: hair 0(1), 1(6b), 2(1), 3(3b), 4(6b), 5(4b), 6(2b), 7(4b), 8(1), 9(1), 10(2b), 11(2f), 12(2f), 13 (missing). Abdomen III: 0(1), 1(7b), 2(1), 3(2b), 4(2f), 5(4, 6b), 6(5b), 7(8, 12b), 8(2f), 9(1), 10(2f), 11(2f), 12(2f), 13(6b), 14(1). Abdomen IV: 0(1), 1(7, 9b), 2(1), 3(2f), 4(3b), 5(4, 5b), 6(4b), 7(6b), 8(2b), 9(1), 10(2b), 11, 12 (not seen), 13(5b), 14(1). Abdomen V: 0(1), 1(7, 8b), 2(1), 3(7, 8b), 4(2f), 5(4b), 6(4b), 7(7, 8b), 8(2, 3b), 9(1), 10(2b), 11(2f), 12(2f), 13(6b), 14(1). Abdomen VI: 0(1), 1(7, 8b), 2(1), 3(2, 3b), 4(3b), 5(5b), 6(5, 6b), other hairs not seen. Abdomen VII: 0(1), 1(5, 6, 7b), 2(1), 3(6, 8b), 4(1, 2f), 5(3, 4, 5b), 6(7, 6b), 7(2, 3f), 8(6, 7, 8b), 9(2, 3b), 10(1), 11(3, 2b), 12(1), 13(5b), 14(1). Abdomen VIII: scales (9, 10, 8), hair 0(1), 1(4, 5b), 2(2, 3f), 3(6, 5b), 4(2f), 5(10b; 6–10), 14(1). Siphon: pecten teeth (17; 16–20); hair 1(10, 9b); 2(1); valve hairs all single. Segment X: hair 1(5b), 2(3b), 3(2b), others missing or not seen.

Bonsall population

A single mounted larval skin was examined. It appears to be quite similar to the San Diego specimens. Unfortunately it is also badly twisted and the siphon is so flattened that its index cannot be determined.

Pigmentation of the head capsule is intermediate between the San Diego and Saratoga Springs populations. The siphon and anal saddle appear to be darker than in the Saratoga Springs specimens. Head capsule: hair 0(1), 1(1), 3(1), 4 (missing), 5(2b), 6 (missing), 7(7b), 8 (missing), 9(6b), 10 (missing), 11(11b), 12(3b), 13 (missing), 14(1), 15(2). Antenna: pigmentation as in Saratoga Springs population; all hairs single. Prothorax: hair 0(8, 9b), 1(1), 2(1), 3(5b), 4(3b), 5(1), 6(1), 7(4b), 8(3b), 9(1), 10(1), 11 (not seen), 12 (not seen), 14 (missing). Mesothorax: hair 1(6b), 2(1), 3(4b), 4(3b), 5(1), 6(1), 7(1), 8(7b), 9(5, 6b), 10(1), 11(5b), 12 (missing), 13 (about 20d), 14 (about 25d). Metathorax: hair 1(6, 7b), 2(1), 3(4b), 4(4b), 5(2b), 6(2f), 7(8, 10b), 8(14, 16b), 9(3, 4b), 10(1), 11 (not seen), 12 (missing), 13(7b). Abdomen I: hair 1(7b), 2(1), 3(2b), 4(7b), 5(4b), 6(2b), 7(1), other hairs not identified. Abdomen II–VII: skin twisted, hairs not identified. Abdomen VIII: scales 8, 9; hair 0(1, 2b), 1(4b), 2(3f), 3 (not seen), 4(2f), 5(7b), 14(1). Siphon: pecten teeth 16, 17; hair 1(9b), 2(1), valve hairs all single. Abdomen X: hair 1(4, 5b), 2(1, 2b), 3(2b), 4a(5b), 4b(2b) 4c(1), 4d(2), 4e (not seen).

Arizona population

A single whole larva from St. David is very similar to the Saratoga Springs material but distinctly larger. The head capsule is almost as dark and the comb plate and anal saddle are darker. The ocular bulge is very prominent.

Head: 0.75 mm. Siphon: 0.82 mm.; index slightly less than 5.0. Anal saddle: 0.37 mm. Head capsule: hair 0 (not seen), 1(1), 3 (not seen), 4(4b), 5(2, 3b), 6(1), 7(7, 8b), 8(2f), 9(6b), 10(2f), 11(7, 10b), 12(2b), 13(4, 5b), 14 (not seen), 15(2b). Antenna about as dark as head capsule; all antennal hairs single. Prothorax: hair 0(7, 8b), 1 (missing), 2(1), 3(5b), 4(2, 3b), 5(1), 6(1), 7(4b), 8(3, 4b), 9(1), 10(1), 11(3, 4b), 12(2f), 14(1). Mesothorax: hair 1(6, 7b), 2(1), 3(3b), 4(3b), 5(1), 6(1), 7(1), 8(6, 7b), 9(4b), 10(1), 11 (not seen), 12(1), 13 (about 20d), 14 (about 25d). Metathorax: hair 1(7b), 2(2b), 3(4, 6b), 4(6, 7b), 5(2, 3b), 6(2f), 7(9b), 8(15, 18b), 9(3, 4b), 10(1), 11 (not seen), 12(2, 3f), 13(7, 8b). Abdomen I: hair 1(6, 7b), 2(2b), 3(1), 4(8, 12b), 5(4, 5b), 6(2b), 7(1), 8(2f), 10(2f), 11 (not seen), 12 (not seen), 13(7b). Abdomen II: hair 0(1), 1(6b), 2(1), 3(4, 5b), 4(6b), 5(3, 4b), 6(2b), 7(2, 3b), 8(1), 9(1), 10(3b), 11(2f), 12(2f), 13(9, 13b). Abdomen III: hair 0(1), 1(7, 8b), 2(1), 3(2, 3f), 4(2f), 5(5b), 6(4b), 7(7b), 8(2b), 9(1), 10(2f), 11(2f), 12(2f), 13(5b), 14 (not seen). Abdomen IV: hair 0(1), 1(6, 7b), 2(1), 3(1), 4(3b), 5(4b), 6(4b), 7(5b), 8(3b), 9(1), 10(2b), 11(1), 12(2f), 13(6b), 14 (not seen). Abdomen V: hair 0(1), 1(7b), 2(1), 3(6b), 4(2f), 5(2, 4b), 6(3b), 7 (not seen), 8(2b), 9(1), 10(1, 2f), 11(1), 12(2f), 13(5b), 14(1). Abdomen VI: hair 0(1), 1(7b), 2(1), 3(2, 3f), 4(3f), 5(4b), 6(5, 6b), 7(3b), 8(2b), 9(1), 10(2b), 11(2b), 12(2f), 13(18, 20d), 14(1). Abdomen VII: hair 0(1), 1(6b), 2(1), 3(8, 9b), 4(1), 5(4b), 6(8, 9b), 7(1, 2f), 8(7b), 9(4b), 10(1), 11(2, 3f), 12(1), 13(5b), 14(1). Abdomen VIII: comb scales 7, 8; hair 0(1), 1(4, 5b), 2(2f), 3(6, 8b), 4(2f), 5(8, 9b), 14 (not seen). Siphon: pecten teeth 14, 15; hair 1(9, 10b), 2(1); valve hairs all single. Abdomen IX: hair 1(5b), 2, 3 (missing), 4a(5b), 4b(2b), 4c(1), 4d(2b), 4e(2b); gills subequal, about 0.84 saddle length.

Texas populations

Fifty-seven whole larvae and larval skins from Luling and San Antonio were examined. The chaetotaxy of 10 specimens was determined in its entirety and 13 additional specimens were examined for certain hairs for comparison with the Saratoga Springs population (Table I).

In general *syntheta* larvae are closer morphologically to the Saratoga Springs population than to any of the other *anhydor* populations examined. They differ principally in the lighter coloration (darker than San Diego) of the head capsule, darker coloration of the siphon, comb plate and anal saddle, in their slightly larger size, and in the branching of some hairs.

Head: 0.70–0.75 mm. Siphon: 0.90 mm., index 4.6–5.2. Anal saddle: 0.35 mm. Head capsule: hair 0(1), 1(1), 3(1), 4(4, 3–5b; 4.0), 5(2b; 2.0; 1–3), 6(1), 7(7, 6b; 7.0; 6–9), 8(2f; 2.06; 2–3), 9(6, 5b; 5.61; 4–8), 10(2f, 1; 1.71; 1–4), 11(7, 10–8b; 7.94; 5–10), 12(2b; 2.11; 2–3),

TABLE I

BRANCHING OF SELECTED LARVAL HAIRS

	Saratoga Springs Population (170 hairs)					*Texas Populations* (44 hairs)				
HAIR	MODE*	RANGE	MEAN	SD	SE	MODE*	RANGE	MEAN	SD	SE
5-C	2, 3	1–4	2.48	0.36	0.03	2, 3	1–3	2.09	0.49	0.09
6-C	1	1–2	1.11	.32	.02	1	1	1	0	0
7-C	8, 7, 9	6–11	7.92	.93	.07	7, 8, 6	6–9	7.26	1.06	.16
11-C	9, 8, 10	6–11	8.86	1.02	.08	7, 9, 8, 10	5–10	7.91	1.34	.23
3-P	5, 4	3–6	4.86	.63	.05	5, 6, 4	3–7	4.91	.95	.17
4-P	3, 4	2–4	3.22	.24	.02	3	2–4	3.07	.69	.13
7-P	4	3–5	4.03	.40	.03	4	3–5	4.00	.46	.07
1-T	7, 8	5–10	7.52	.66	.06	7, 8	6–9	7.45	.75	.13
7-T	8, 9, 10	7–12	8.76	1.03	.08	8, 9, 7	7–11	8.33	.91	.15
2-I	2, 3	1–5	2.36	.62	.05	5, 3–4	3–7	4.35	.98	.17
4-I	8–12	6–13	10.09	1.51	.12	9–13	8–14	11.38	1.63	.28
3-II	5, 6, 7	3–10	5.70	1.13	.09	5, 6	4–9	5.83	1.32	.22
13-II	10, 8–12	7–15	10.00	1.54	.12	10, 11, 9	7–13	10.00	1.22	.21
13-III	6, 7	5–8	6.33	.44	.04	6, 5, 7	4–8	5.94	1.11	.19
5-VIII	9, 10, 8	6–11	8.99	.88	.07	7, 8	5–10	7.72	1.20	.20
1-S	8, 9, 7	6–12	8.42	1.04	.08	8, 9, 7–10	7–11	8.54	1.08	.18
Scales	8, 7, 9	6–10	7.79	.95	.07	8, 7	6–9	7.75	.76	.11

*Usual number of branches, in order of frequency, representing 75% or more of total.

13(4, 5b; 4.56: 3–7), 14(1), 15(2). Antenna: pigmentation darker than head capsule; all hairs single. Prothorax: hair 0(7–10b; 8.44; 6–12), 1(1), 2(1), 3(6, 5b; 5.43; 4–7), 4(3, 4, 2b; 3.08), 5(1), 6(1), 7(4b; 3.75; 3–4), 8(3, 4b; 3.39), 9(1), 10(1), 11(4, 3b; 3.54; 2–4), 12(2f, 1; 1.88; 1–3), 14(1; 1.05; 1–2). Mesothorax: hair 1(7, 8b; 7.19; 6–8), 2(1), 3(3, 4b; 3.74; 3–6), 4(3, 4b; 3.56), 5(1), 6(1), 7(1), 8(5, 6b; 5.79; 5–9), 9(6, 5, 4b; 5.19; 4–7), 10(1), 11(4b; 3.83; 3–4), 12(1), 13 (about 25d), 14 (about 35d). Metathorax: hair 1(8, 7b; 7.53; 6–9), 2(2b; 2.20; 2–4), 3(5, 4b; 4.64; 3–6), 4(4, 5b; 4.42; 3–6), 5(2, 3b; 2.16; 1–3), 6(2f, 1; 1.71), 7(8, 9–7b; 8.31; 7–11), 8(15–13b; 14.33; 11–19), 9(4b; 3.93; 3–5), 10(1), 11(4, 2–3b; 3.40), 12(2f; 2.07; 1–2), 13(7,9b; 8.0; 7–10). Abdomen I: hair 1(7, 6b; 6.40; 4–7), 2(3–4, 5b; 3.94); 3(2b; 1.84; 1–3), 4(11, 12, 9–14b; 11.25; 8–14), 5(4, 5, 3b; 4.00), 6(2b), 7(1), 8(2b; 2.10; 2–3), 10(3, 4, 2b; 3.00), 11(2b; 1.83; 1–2); 12(2, 3b; 2.41), 13(7, 6, 8b; 7.05; 6–9). Abdomen II: hair 0(1), 1(6.7b; 6.20; 5–7), 2(1), 3(5, 6b; 5.61; 4–9), 4(6, 7b; 6:20; 5–7), 5(4b; 3.77; 3–4), 6(2b), 7(4, 3b; 3.81; 3–5), 8(1), 9(1), 10(3, 2b; 2.94; 2–5), 11(2f), 12(2f), 13(10, 11b; 10.73; 9–13). Abdomen III: hair 0(1), 1(8, 6–7b; 7.08; 5–9), 2(1; 1.05; 1–2), 3(3, 2b; 2.67), 4(2f; 1.94; 1–2), 5(4, 5b; 4.22; 3–5), 6(4b; 4.06; 3–5), 7(7, 5, 8b; 6.77; 5–9), 8(2b; 1.70; 1–2), 9(1), 10(2f; 1.71; 1–2), 11(3, 2f; 2.46; 1–3), 12(2, 3f; 2.17; 1–3), 13(6, 5b; 6.10; 5–8), 14(1). Abdomen IV: hair 0(1), 1(7b; 6.93; 6–8), 2(1), 3(2, 3b, 1; 2.06), 4(3, 2b; 2.56; 1–3), 5(3, 4b; 3.53; 3–5), 6(4b), 7(6, 3, 7b; 5.0; 3–7), 8(3, 2b; 2.53), 9(1), 10(2b), 11(1), 12(2f; 2.19; 2–3), 13(5, 6b; 6.08; 5–7), 14(1). Abdomen V: hair 0(1), 1(7, 8b; 7.14; 6–8), 2(1), 3(6, 5, 7b; 5.88; 4–8), 4(2f), 5(3b; 3.20; 3–4), 6(4b; 3.92; 3–4), 7(7, 6, 8b; 6.38; 3–9), 8(2b; 2.12; 2–3), 9(1), 10(2f; 1.75; 1–2), 11(1; 1.07; 1–2), 12(2f; 2.14; 3–4), 13(6, 7b; 6.08; 5–7), 14(1). Abdomen VI: hair 0 (1), 1(6, 7–8b; 7.12; 6–9), 2(1), 3(2f; 2.0; 1–3), 4(3, 2f; 2.85; 2–4), 5(3b; 3.29; 3–4), 6(5, 4b; 5.12; 4–7), 7(3, 4b; 3.44; 3–5), 8(2b; 2.08; 2–3), 9(1), 10(2b; 1.75; 1–2), 11(2b, 1; 1.57), 12(2f; 1.75; 1–2), 13(12–28d), 14(1). Abdomen VII: hair 0(1), 1(6, 7, 5b; 6.19; 5–8), 2(1), 3(7, 8b; 7.36; 6–9), 4(1, 2f; 1.42), 5(3, 4b; 3.81; 3–6), 6(7, 6b; 6.53; 5–8), 7(3, 2b; 2.69), 8(6, 7b; 6.57; 5–8), 9(3b; 2.69; 2–3), 10(1; 1.07; 1–2), 11(3f; 3.24; 3–4), 12(1), 13(4, 5b; 4.81; 4–7), 14(1; 1.19; 1–2). Abdomen VIII: comb scales (8, 9; 8.05; 6–9); hair 0(1; 1.05; 1–2), 1(4b; 4.53; 4–7), 2(2f; 2.06; 1–3), 3(5b; 5.28; 5–6), 4(2f; 1.88; 1–2), 5(7, 8b; 8.0; 7–10), 14(1, 2b; 1.42). Siphon: pecten teeth (17, 14–20; 17.05; 14–21); hair 1(10, 7, 8b; 8.81; 7–11), 2(1), all valve hairs single except 6(1; 1.10; 1–3). Abdomen X: hair 1(5, 4–7–8b; 5.74), 2(3b; 3.06; 3–4), 3(2b), 4a(4, 5–6b; 4.6), 4b(2b), 4c(1), 4d(2b), 4e(2b; 2.15; 1–4); gills subequal or ventral slightly longer, variable in shape and length, 0.65–0.80 saddle length.

8. *Pupa*

Saratoga Springs population (Fig. 6a-h)

Abdomen: 2.4 mm. Trumpet: 0.42–0.56 mm. Paddle: 0.65 mm. Specimens studied: 81.

Cephalothorax: Lightly pigmented, darker on meso- and metanotum and base of appendage cases. Trumpet moderately pigmented except for very dark tracheoid; length and shape variable (fig. 6d-h), usually distinctly and abruptly flared at apex; length usually about 10.0 median width or more, rarely as little as 6.0; inner wall dis-

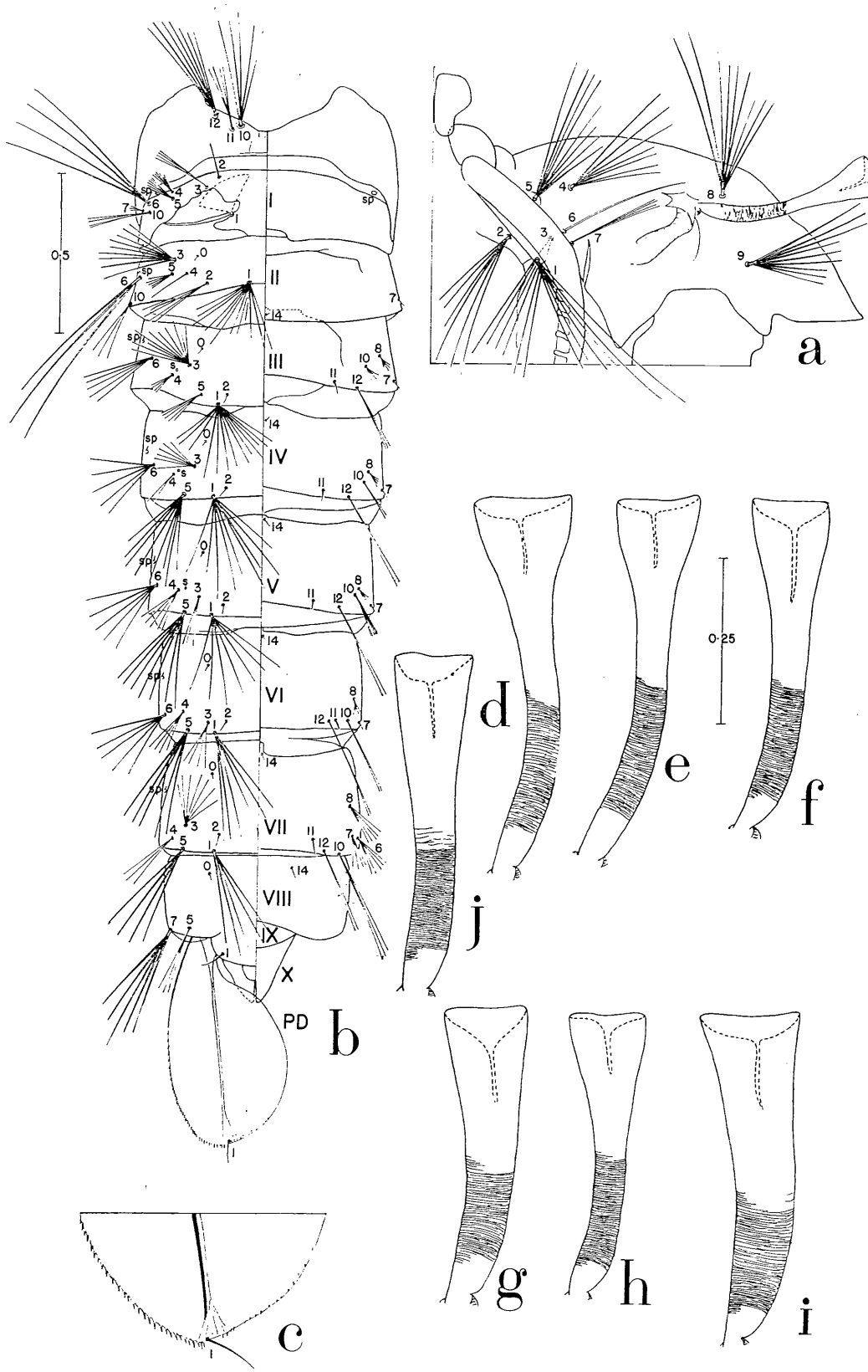
tinctly separated in pinna; tracheoid extending to slightly less than 0.5 on lateral surface, well developed on mesal surface, absent from base; reticulate usually indistinct; pinna usually very shallow, about 0.05–0.10; slit in meatus very narrow, usually extending about 0.2–0.3 trumpet length. Hairs strongly pigmented; relative position, length, and degree of development as figured; branches of larger hairs uneven in length and thickness, usually without conspicuous fringes except hairs 10 and 12. Hair 1(6, 5b; 6.11; 5–8), 2(6, 5b; 5.85; 4–7), 3(6, 7b; 6.30; 5–8), 4(7, 8, 6b; 7.05), 5(9, 8b; 8.05; 6–10), 6(1), 7(4, 3bf; 3.65), 8(10, 9, 11b; 9.55; 7–11), 9(10, 9b; 9.40; 8–11), 10(5, 4, 6b; 4.95; 3–7), 11(4–6b; 4.95; 3–7), 12(7, 8b; 7.20; 6–8).

Abdomen: Lightly to moderately pigmented, darker cephalad and on intersegmental areas; tergal and sternal spiculate areas as in other species of *Uranotaenia*. Rudimentary spiracles on II–VII small, located laterally on tergites; that of I large, located dorsally in intersegmental area caudad of metanotum. Dorsal sensilla present on III–V. Larger hairs strongly pigmented, smaller, lighter; all hairs usually smooth, without fringes or barbs, except as noted; larger hairs often with branches of uneven length and thickness; relative position, length and degree of development as figured. Segment I: hair 1 (compound palmate with 10–20 primary branches and total of 57–90 terminal branches), 2(1), 3(2–3, 4b; 3.0; 2–5), 4(6, 7, 8b; 6.90; 6–9), 5(6b; 6.11; 5–8), 6(3, 4b; 3.37; 2–5), 7(3, 2b; 2.60; 2–4), 10(4, 3b; 3.74; 3–5). Segment II: 0(1), 1(12, 11b; 11.60; 10–13; branches often of uneven length and thickness), 2(4, 3b; 3.70; 3–5), 3(9, 8, 10b; 8.85; 7–10),4(1), 5(5, 4b; 4.90; 4–7), 6(3b; 3.16; 2–4; usually the longest and strongest hair), 7(1), 10(3, 4b; 3.26; 2–4). Segment III: hair 0(1), 1(13, 14, 12b; 13.0; 10–15), 2(1), 3(10, 9, 11b; 9.70; 7–12), 4(4, 5b; 4.30; 3–6), 5(5, 4b; 4.75; 3–6), 6(5, 4b; 4.79; 3–6), 7(1), 8(5, 6b; 5.21; 4–6), 10(5-6b; 5.50; 4–7), 11(1), 12(2, 3bf; 2.42), 14(1). Segment IV: hair 0(1), 1(9, 10b; 9.21), 2(1), 3(6, 7b; 6.39; 5–8), 4(2, 3, 4b; 2.85), 5(8, 9b; 8.30; 6–11), 6(5, 6b; 5.40; 4–7), 7(1), 8(4, 5b; 4.47), 10(2bf; 2.20; 1–4), 11(1), 12(2, 3b; 2.26; 1–3), 14(1). Segment V: hair 0(1), 1(7, 8b; 6.90; 5–8), 2(1), 3(3, 4b; 3.61; 3–6), 4(5, 4b; 4.75; 3–6), 5(7, 6b; 6.55; 5–8), 6(5, 6b; 5.15; 4–6), 7(1), 8(4b; 4.11; 3–5), 10(5, 4b; 4.60; 2–6), 11(1), 12 (2b; 1.89; 1–2), 14(1). Segment VI: hair 0(1), 1(6, 7b; 6.33; 6–8), 2(1), 3(4, 3b; 3.40; 2–5), 4(4, 5b; 4.75; 3–5), 5(5, 4b; 4.90; 4–6), 6(5, 6b; 5.30; 4–6), 7(1), 8(4b; 3.75; 2–5), 10(2b, 1; 1.74), 11(1), 12(2f; 1.75; 1–3), 14(1). Segment VII: hair 0(1), 1(6, 5b; 5.85; 5–7), 2(1), 3(7–8, 6b; 7.05; 5–9), 4(3b; 2.89; 1–4), 5(4, 5b; 4.40; 3–6), 6(4–5b; 4.50), 7(4, 3b; 3.80; 2–5), 8(5, 4b; 4.77), 10(3, 2b; 2.65), 11(1; 1.30; 1–2), 12(2b), 14(1). Segment VIII: 0(1), 5(3b; 3.11; 2–5), 7(6, 5b; 5.74; 5–7), 14(1); caudal margin of sternite distinctly emarginate in male, straight in female. Segment IX: hair 1(1, about 0.75 of segment length). Paddle as figured; very lightly pigmented, darker at extreme apex and at base; midrib strongly sclerotized, evanescent apically; external buttress distinct proximad; basal pigment bar indistinct; external margin with distinct short, heavy serrations in apical half; internal margin with minute submarginal spicules; hair 1 (1; slender). Male genital lobe extending to about 0.30 of paddle; pair of small ventral patches of weak spicules. Female genital lobe about the same length as segment X, extending to about 0.25 paddle; with large ventrocaudal patch of distinct spicules. Segment X: in the male indistinct, extending to 0.20 of paddle; in the female also indistinct, without visible cercal plates, extending to 0.25 of paddle.

Variation: When we first collected this population, we immediately noted the unusual shape of the pupal trumpet (fig. 6d), entirely unlike that figured for *anhydor* (Galindo, Blanton and Peyton, 1954: 123). As the shape of the trumpet is one of the most reliable diagnostic characters for the separation of mosquito pupae we were amazed to find that in the Saratoga Springs population it changed drastically when the pupae were reared from second instar larvae or earlier stages in the laboratory (fig. 6g, h). Upon study of our entire material, we find that there is some variation in the shape as well as the length under natural conditions (fig. 6d, e, f). Our rearing data indicate that the length and flaring of the trumpet is very markedly affected by the length of time that the preceding larval instars are maintained under artificial conditions. Differences can be noted even when the pupae are reared from young fourth instar larvae. The Saratoga Springs population shows considerable variability in the pupal chaetotaxy as is evident in the above description, which is based on a study of 10 skins from a single collection. We have examined 71 additional skins from two breeding sites for selected hairs. Statistically significant differences were noted for some of these hairs between the two breeding sites as well as between field-collected pupae and those obtained from early instar larvae reared in the laboratory. The latter generally had fewer branches in at least some hairs. We have combined all our data for these selected hairs in Table II to provide a basis for comparison with other populations.

EXPLANATION OF PLATE V

FIG. 6. Pupa of *Uranotaenia anhydor* Dyar. *a-h*, *U. a. anhydor* Dyar, Saratoga Springs population; *i*, *U. a. anhydor* Dyar, San Diego population; *j*, *U. a. syntheta* Dyar & Shannon, Luling, Texas. *a*, Ventral aspect of left anterior portion of cephalothorax; *b*, dorsal (left) and ventral (right) aspect of metanotum and abdomen of male pupa; *c*, detail of terminal portion of paddle; *d-j*, ventrolateral aspect of left trumpet.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San Diego population (Fig. 6i)

Two pupal skins and one whole pupa from San Diego were examined. The same collection contains four third instar larval skins. It is quite possible that this material was reared under artificial conditions for a considerable period of time and therefore the characters may not be typical. Furthermore as noted below under bionomics the type of breeding site is quite different from the Saratoga Springs material. Nevertheless the difference in chaetotaxy is so marked that there is no difficulty in distinguishing the two populations in the pupal stage. The San Diego pupae appear to be distinctly larger and more heavily pigmented, have fewer branches in most hairs and a differently shaped trumpet.

Abdomen: 2.85 mm. Trumpet: 0.50 mm. Paddle: 0.67–0.72 mm.

Cephalothorax: Pigmentation stronger. Trumpet darker except for tracheoid which is much lighter; length and shape rather uniform in the three specimens (fig. 6i); gradually widened from about middle to apex; length about 5.2 median width; tracheoid about the same or less developed; pinna and slit in meatus similar. Hairs shorter and weaker, lightly pigmented; relative position similar. Hair 1(5b; 4.60; 3–5), 2(5b; 4.60; 3–5), 3(4, 5b; 4.40), 4(4b; 4.33; 4–5), 5(6b; 6.25; 6–7), 6(1), 7(4bf), 8(7–8b; 8.0; 7–10), 9(7b; 6.60; 5–8), 10(5b; 4.80; 4–5), 11(6b; 5.75; 4–7), 12(5, 6b; 5.20; 4–6).

Abdomen: Pigmentation darker throughout; integumentary ornamentation, rudimentary spiracles, and dorsal sensilla similar. Hairs shorter and weaker throughout, lightly pigmented; relative position similar. Segment I: hair 1(compound palmate, with about 65 terminal branches), 2(1), 3(2b), 4(6b; 6.33; 6–7), 5(6b), 6(3b; 2.75; 2–3), 7(3b; 2.67; 2–3), 10(3b; 2.67; 2–3). Segment II: hair 0(1), 1(9–10b; 9.20; 8–10), 2(3b), 3(7b; 7.25; 7–8), 4(1), 5(4–5b; 4.20), 6(3b; 2.67; 2–3), 7(1), 10(3b; 3.67; 3–5). Segment III: hair 0(1), 1(10b; 10.0; 9–11), 2(1), 3(9b; 8.50; 7–9), 4(3b; 3.25; 3–4), 5(5b; 4.80; 4–5), 6(3b; 3.33; 3–4), 7(1), 8(4–5b; 4.50), 10(4b), 11(1), 12(2bf), 14(1). Segment IV: hair 0(1), 1(6–7b; 6.80; 6–8), 2(1), 3(6–7b; 6.50), 4(2b; 2.20; 2–3), 5(6–7b; 6.20; 5–7), 6(4, 3b; 3.60), 7(1), 8(3b), 10(1), 11(1), 12(2b), 14(1). Segment V: hair 0(1), 1(5b; 5.20; 5–6), 2(1), 3(3b; 3.20; 3–4), 4(3b; 3.75; 3–5), 5(5b; 4.75; 4–5), 6(3b; 3.75; 3–5), 7(1), 8(3b; 3.33; 3–4), 10(4b; 4.33; 4–5), 11(1), 12(2b), 14(1). Segment VI: hair 0(1), 1(4b; 4.0; 3–5), 2(1), 3(3b), 4(4b; 3.67; 3–4), 5(4b; 4.20; 4–5), 6(4b; 3.75; 3–4), 7(1), 8(3b; 3.0; 2–4), 10(2b), 11(1), 12(1), 14(1). Segment VII: hair 0(1), 1(5b; 4.75; 4–5), 2(1), 3(5–6b; 5.50), 4(3–4b; 3.50), 5(4b; 3.25; 2–4), 6(4b; 4.50; 4–6), 7(3–4b; 3.50), 8(3-4b; 3.50), 10(2f), 11(1), 12(2f), 14(1). Segment VIII: hair 0(1), 5(3b; 3.0; 2–4), 7(3, 5b; 3.80; 3–5), 14(1). Segment IX: hair 1(1, length cannot be determined). Paddle similar; internal margin with stronger spicules; hair 1(1; lighter and weaker). Sexual differences apparently similar, structures in this area not clear.

Baja California population

Apparently only the male pupa was preserved by Brookman and Reeves. It is quite similar to the San Diego specimens and can be distinguished from the Saratoga Springs population on the basis of the same characters. The comparison in the description below is with the San Diego population.

Abdomen: 2.62 mm. Trumpet: 0.50 mm. Paddle: 0.72 mm.

Cephalothorax: Pigmentation similar. Trumpet almost identical. Hairs somewhat darker. Hair 1(3b), 2(5, 6b), 3(3, 4b), 4(6, 7b), 5(6b), 6(1), 7(4b), 8(9, 11b), 9(7, 8b), 10(6b), 11(6, 7b), 12(5b).

Abdomen: Pigmentation, ornamentation, rudimentary spiracles, and dorsal sensilla similar. Hairs somewhat darker and slightly better developed. Segment I: hair 1(50, 58d), 2(1), 3(2, 4b), 4(5b), 5(6, 7b), 6(2, 3b), 7(2, 3b), 10(3b). Segment II: hair 0(1), 1(8, 11b), 2(3, 4b), 3(9, 10b), 4(1), 5(4b), 6(3b), 7(1), 10(3, 4b). Segment III: hair 0(1), 1(13b), 2(1), 3(7, 11b), 4(3, 4b), 5(4b), 6(3, 4b), 7(1), 8(4b), 10(4, 5b), 11(1), 12(3b), 14(1). Segment IV: hair 0(1, 2b), 1(7, 9b), 2(1), 3(7b), 4(2, 3b), 5(6, 7b), 6(4, 5b), 7(1), 8(2b), 10(2, 3f), 11(1), 12(2, 3b), 14(1). Segment V: hair 0(1), 1(6b), 2(1), 3(3, 4b), 4(2, 5b), 5(5b), 6(5b), 7(1), 8(2, 3b), 10(4b), 11(1), 12(2b), 14(1). Segment VI: hair 0(1), 1(5b), 2(1), 3(3, 4b), 4(3, 4b), 5(4, 5b), 6(5b), 7(1), 8(2b), 10(1, 2f), 11(1), 12(1), 14(1). Segment VII: hair 0(1), 1(5b), 2(1), 3(5, 6b), 4(3, 4b), 5(3, 4b), 6(4, 5b), 7(2, 3b), 8(4b), 10(1, 2b), 11(1), 12(2b), 14(1). Segment VIII: hair 0(1), 5(3, 4b), 7(3, 4b), 14(1); caudal margin emarginate. Segment IX: hair 1(1, much weaker than in Saratoga Springs population, about 0.5 of segment length). Paddle similar; external margin with stronger spicules, some as well developed as teeth on external margin; basal pigment bar well developed; hair 1(1; similar). Male genital lobe extending to about 0.32 of paddle; ventral spicules small, arising from distinct imbrications. Segment X: indistinct, extending to about 0.22 of paddle; hair 1 present on both sides, with long stout basal portion widened apically and bearing about 6 slender branches (undoubtedly represents an anomaly, for this hair is normally developed only in *Toxorhynchites*).

Texas populations (Fig. 6j)

Nineteen whole pupae, collected in Palmetto State Park on Oct. 16, 1954, were examined but unfortunately many hairs are missing in the material and our sample for most hairs is less than

ten. However, there is no difficulty in separating this population in the pupal stage from the Saratoga Springs or other western populations. Except for the trumpet the similarity is much greater with the San Diego and Baja California specimens. The size and pigmentation are reminiscent of these populations. Many hairs have fewer branches than we have seen elsewhere in the complex while others are intermediate and a few show even more branches than the Saratoga Springs population. The trumpet is long and slender as in the typical Saratoga Springs specimens but it lacks the strong flaring of the apex. The comparison below is with the Saratoga Springs population.

Abdomen: 2.75 mm. Trumpet: 0.50 mm. Paddle: 0.65 mm.

TABLE II

BRANCHING OF SELECTED PUPAL HAIRS
SARATOGA SPRINGS POPULATION
(162 hairs)

HAIR	MODE*	RANGE	MEAN	SD	SE
3-C	6, 7, 5	5–8	6.08	0.76	0.06
4-C	7, 8, 6	4–10	7.01	1.15	.09
5-C	7, 8, 6, 9	5–10	7.42	1.08	.09
8-C	9, 10, 8	7–12	9.29	.91	.07
9-C	9, 8, 10	5–13	8.79	1.06	.08
12-C	7, 8, 6	5–10	7.28	1.09	.09
3-I	4, 3	1–6	3.46	.62	.05
10-I	4, 3	3–5	3.86	.45	.04
1-II	10–14	4–18	11.73	1.84	.15
3-II	9, 8, 10	6–12	8.74	.88	.07
1-III	10-14	5–16	12.08	1.92	.15
3-III	10, 9, 11	7–13	9.66	1.17	.09
6-III	5, 4	3–6	4.89	.60	.05
1-IV	8, 9, 7	5–11	8.29	1.15	.09
4-IV	8, 7, 9	5–11	7.69	.97	.08
6-IV	5, 6, 4	3–7	5.00	.58	.05
1-V	7, 6	4–8	6.50	.82	.07
4-V	7, 5, 6	4–9	6.16	1.01	.08
5-V	5, 4	3–7	4.79	.95	.08
6-V	5, 6	4–7	5.09	.59	.05
1-VI	6, 5, 7	4–8	6.03	.82	.07
6-VI	5, 4	3–6	4.91	.64	.05
1-VII	5, 6	3–7	5.33	.84	.07
3-VII	6, 7, 8	5–9	6.55	1.02	.08
7-VIII	5, 6, 7	3–7	5.45	.43	.03

*Usual number of branches, in order of frequency, representing 75% or more of total.

Cephalothorax: Pigmentation stronger. Trumpet darker except for tracheoid which is somewhat lighter; length and shape rather uniform in all 19 specimens, as figured (fig. 6j); gradually but only slightly widened to apex from slightly beyond middle; length about 8–8.2 median width; tracheoid, pinna and slit about the same. Hairs shorter, weaker, lightly pigmented; relative position similar. Hair 1(3, 2–4b; 3.00), 2(3, 4b; 3.73; 3–5), 3(4, 5b; 4.44), 4(5–7b; 6.00), 5(6, 5–7b; 6.25), 6(1; 1.06; 1–2), 7(4bf; 3.89; 3–4), 8(4–8b; 6.00), 9(5b), 10(4b; 4.83; 4–7), 11(4b; 4.46; 4–6), 12(4, 5–6b; 4.56; 3–6).

Abdomen: Pigmentation somewhat stronger; integumentary ornamentation, rudimentary spiracles and dorsal sensilla similar. Hairs shorter and weaker throughout, lightly pigmented; relative position similar. Segment I: hair 1 (compound palmate, with 50–60 terminal branches), 2(1), 3(3b; 3.19; 3–4), 4(6, 5b; 5.56; 4–7), 5(6, 5b; 5.77; 4–7), 6(4, 6b; 4.80; 4–6), 7(3, 2b; 2.79; 2–4), 10(3–4b; 3.50). Segment II: hair 0(1; 1.15; 1–2), 1(7–12b; 9.50), 2(3, 4b; 3.25; 2–4), 3(5–8b; 6.50), 4(1), 5(5, 3–4b; 4.62; 3–6), 6(3–4b; 3.50), 7(1), 10(3, 2, 4b; 2.89). Segment III: hair 0(1, 2b; 1.37; 1–3), 1(8–5–7–12b; 8.00), 2(1), 3(8, 9b; 8.12; 5–10), 4(4, 3b; 3.67; 2–5), 5(4, 3b; 3.25), 6(5, 4b; 4.43; 3–5), 7(1), 8(5, 4b; 4.93; 3–7), 10(4–5b; 4.80; 4–6), 11(1), 12(2bf; 2.07; 1–3), 14(1). Segment IV: hair 0(1, 2b; 1.33), 1(5–6–8b; 6.33), 2(1), 3(6, 5b; 5.83; 4–8), 4(2b; 2.12; 2–3), 5(5–8b; 6.50), 6(3, 5b; 4.43; 3–7), 7(1), 8(3, 4b; 3.27), 10(2bf; 2.06; 2–3), 11(1), 12(2b; 2.10; 1–3), 14(1). Segment V: hair 0(1, 2b; 1.30), 1(6, 5–7b; 6.00), 2(1), 3(3b), 4(5–6b; 4.60), 5(5, 4b; 5.50), 6(5, 4, 6b; 5.00), 7(1), 8(3, 2b; 2.71; 2–4), 10(4, 3b; 3.64; 2–5), 11(1), 12(2b, 1; 1.20), 14(1). Segment VI: hair 0(1; 1.11; 1–2), 1(4b; 4.25; 4–5), 2(1), 3(2, 3b; 2.33), 4(2, 3b; 2.62; 2–4), 5(4, 3b; 3.67), 6(4–5b; 4.50), 7(1), 8(3, 5b; 2.87; 2–4), 10(2b), 11(1), 12(1), 14(1). Segment VII: hair 0(1; 1.12; 1–2), 1(4–5b; 4.50), 2(1), 3(3–5–6b; 4.67), 4(3b; 2.75; 2–3), 5(4–5b; 4.50), 6(4, 3–5b; 4.00), 7(3, 4b; 2.92; 1–4), 8(5, 4b; 4.78; 4–6), 10(2b), 11(1), 12(2b, 1: 1.57), 14(1). Segment VIII: hair 0(1), 5(3b; 2.80; 2–3), 7(4, 5b; 4.33), 14(1; 1.21; 1–2). Segment IX: hair 1(1; about 0.5–0.6 of segment length; one hair duplicated in one specimen). Paddle similar; external and internal margins with serrations stronger and more distinct; hair 1(1; lighter and weaker). Sexual differences similar.

BIONOMICS

1. *Saratoga Springs Population*

Saratoga Springs (Fig. 7)

Saratoga Springs lies in N. W. ¼ sec. 2, T.18 N., R. 5 E., San Bernardino County, California, at an elevation of approximately 215 feet above sea level, a few feet above the level and about half a mile north of the main flood channel of the Amargosa River. This area is included in the southeast portion of Death Valley National Monument. Saratoga Springs comprises some 50 acres of seepages, springs, open permanent lakes and adjacent land nestled in a cove on the west side and at the southern extremity of the western spur of the Ibex Mountains (fig. 7a). A low, rocky hill at the end of a western extension of the spur bounds the area to the south. The entire area gives the impression of being on a ledge elevated slightly over the surrounding country to the west. At the southwest corner it is from one to three feet above the sparse salt meadow of the lower Amargosa. Beginning about 100 feet

north of the main spring a distinct sandy ridge (probably an artificial dike) forms the western boundary. The ridge expands into sand dunes which curve irregularly to form the northern boundary leading to another westerly extension of the mountain spur. The dunes reach a height of about 15 feet at their westernmost extension. As a result of these features, Saratoga Springs is hidden from view from almost every aspect. It is generally stated that there are four principal springs (Thompson, 1929: 587). The two springs which are usually visited are at the extreme southwest corner of the area only some 30 feet apart (fig. 7g). The more easterly is enclosed in a spring house and is used for drinking. Its outflow empties into the main spring pool to the west. This pool is about 32 feet in diameter and from 4 to over 5 feet in depth. The outflow from this spring, through a shallow channel to the north, is joined about 250 feet northward by a channel from the small open spring, which is located some 250 feet east of the main spring. The combined channel, hidden by vegetation, widens and empties some 500 feet north of the main spring into a large open pond, about 145 feet long and 35 feet wide, and up to 3 feet deep. This pool is hidden from view from the west by a very dense growth of *Scirpus olneyi*, reaching a height of 8 feet or more. Leading northeastward from this pond is an irregular shallow channel which eventually empties into the southeast lake. From the small spring an east branch of the outflow channel supplies the east lake. Finally the fourth spring, some 800 feet northeast of the main spring, drains directly into the east lake. The lakes comprise some 10 to 15 acres of open water. Their appearance suggests that they were dredged out. At low water three distinct interconnected lakes are seen separated by shallow bars; to the east is the largest lake, to the west there is a small northwest lake and a larger southwest lake. At high water all the lakes merge into one and extend into large beds of *Scirpus* to the south, apparently reaching the large pond. It has been generally assumed that the lakes are fed chiefly by the main spring and adjacent springs at the southwest corner. It appears to us, however, that the output of these springs is only a few gallons a minute and that the main supply comes from seepages in the lakes themselves and the immediately surrounding areas to the south. At every one of our visits to Saratoga Springs in 1954, except in October, there was no flow in the channel from the main spring nor from the other springs, yet the lakes, although considerably lower in September, were far from dry and were supporting millions of fish. It appears to us that the large pond is essentially a spring, possibly with a much higher output than the so-called main spring, and that it supplies the western lakes. In the stand of *Scirpus* at the south end of the eastern lake there is some deep water and it would seem that there are seepage springs in this area also. The water level in the area fluctuates probably at least two feet during the season. In October, 1954 it had risen about a foot above the level in September and had not yet reached the level in June.

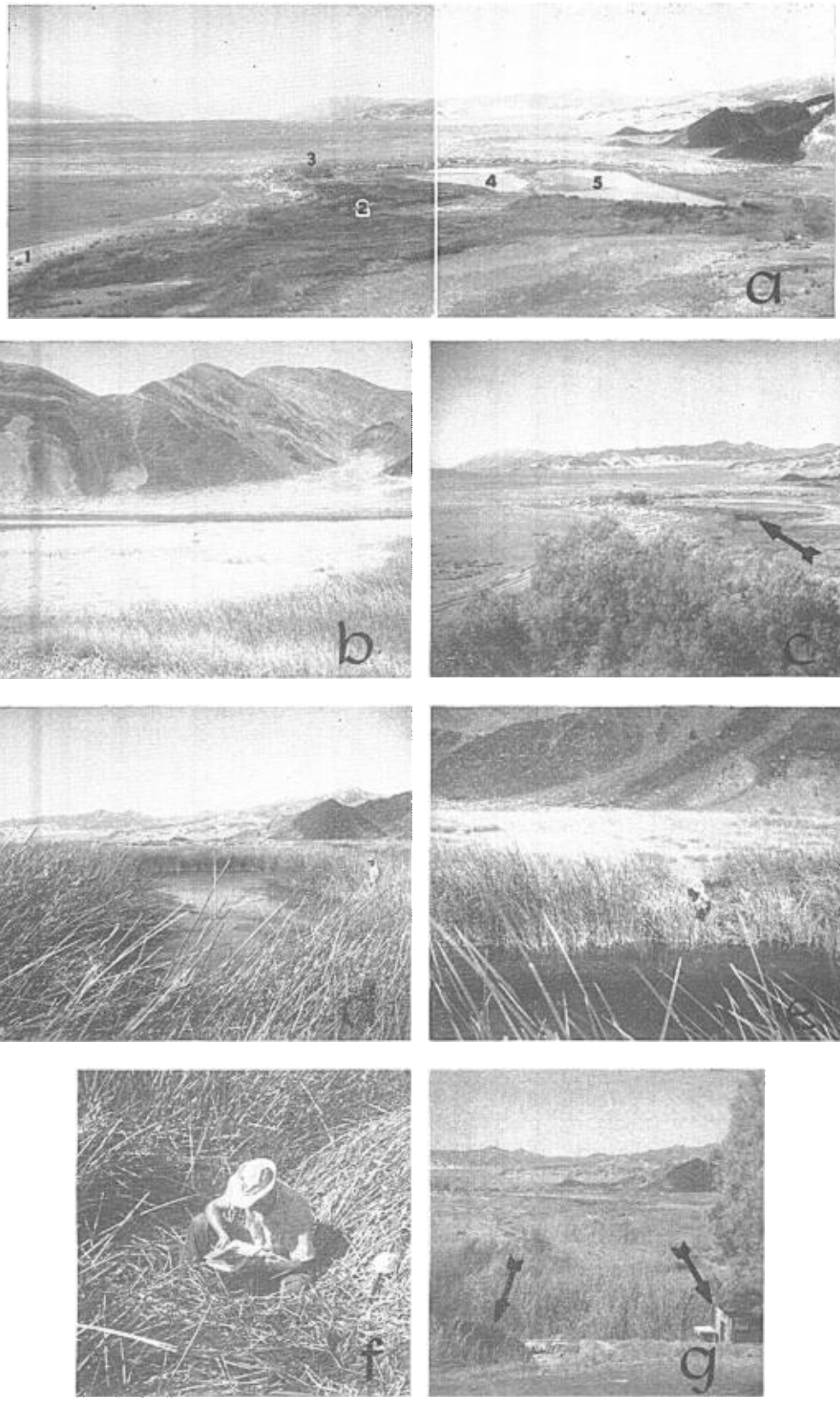
The air temperature at Saratoga Springs has been between 115° and 122° F. in the shade for the greater part of the day on our trips in June, July and September. In October it was still between 100° and 105° during the middle of the day. At night the temperature seldom dropped below 80° F. except in October, when it stayed at about 70° F. However, during the summer of 1954 there were two periods of considerably lower temperatures. In the general area the winter night temperatures probably fall below freezing, at least during December and January. The humidity was not measured but it is undoubtedly extremely low, except near water and in stands of vegetation in the water. The annual rainfall is probably no more than at Furnace Creek where it has averaged less than 1.50 inches in over 30 years.

The water from the main spring as well as from the lakes has been analyzed several times. The main spring water contains 3,041–3,098 p.p.m. total solids; 994 p.p.m. Na+K, 1,039 p.p.m. SO_4, 657 p.p.m. Cl, and has a pH of 8.2. The lake water contains 5,394 p.p.m. total solids with approximately the same proportions of salts and has a pH of 8.6. The temperature of the main spring is very uniform, usually between 82° and 83° F., with extremes of 80° and 85° F. recorded (Mendenhall, 1909: 47). The water temperature in the stands of *Scirpus* surrounding the large pond varies greatly as indicated below and in the shallow lakes there is probably even more fluctuation.

The aquatic and semiaquatic vegetation of Saratoga Springs has not been studied in detail but the following conspicuous forms have been identified for us by Dr. Mildred E. Mathias and Dr. Henry J. Thompson: *Chara* sp., *Ruppia maritima* L., *Distichlis spicata* (L.) Greene, *Phragmites communis* Trin., *Scirpus paludosus* Nelson, *S.*

EXPLANATION OF PLATE VI

FIG. 7. Saratoga Springs, California (photos by W. A. McDonald). *a*, Panoramic view looking northwest into Death Valley; 1, southwest corner in vicinity of main spring; 2, large pond; 3, northwest camping ground; 4, southwest lake; 5, east lake. *b*, Stand of *Scirpus olneyi* south of southwest lake, looking northeast; breeding site of *U. anhydor* in June, 1954. *c*, View north from hill south of main spring; large pond at arrow. *d*, General view of large pond; stands of *Scirpus olneyi* bordering the open water. *e*, View across large pond to breeding site of *U. anhydor* in July, Sept. and Oct. 1954. *f*, Close-up of breeding site of *U. anhydor* on east bank of large pond; collector on opened, trampled mat of *Scirpus olneyi* over about one foot of water and muck. *g*, Southwest corner of area with main spring pool at arrow on the left, spring house at arrow on the right.


1
2
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a
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g

Deep in a low stand of *Scirpus* (fig. 7b) in small isolated or interconnected pockets of water we finally discovered many egg rafts and young larvae and a smaller number of fourth instar larvae and a few pupae. These water pockets were between clumps of *Scirpus* and were covered over with previous years' growth of rushes so dense that the water was in almost total darkness. Furthermore the immature stages were chiefly in the heart of the clumps and not in the open water.

In July this site had dried out but we located a more prolific breeding place in the much taller and denser stand of *Scirpus* on the east bank of the large pond (fig. 7c, d). The accumulation of previous years' growth of *Scirpus* is so dense here that one can walk on this mat without realizing the presence of water from a few inches to two feet or more below it. It is under this mat that the *Uranotaenia* immature stages are found. To collect them the mat is trampled down to the water surface and partially opened up (fig. 7e, f). The water and muck below the mats is from a few inches to two feet or more in depth. Here again the immature stages are in almost total darkness and are protected from even the smallest fish which cannot penetrate into the dense mats.

Undoubtedly the *Urantaenia* will be found breeding in *Scirpus* mats elsewhere at Saratoga Springs but the large pond provides probably the best and least disturbed permanent habitat since the water level fluctuates relatively little here. At higher water the stands of *Phragmites* and other dense vegetation may also serve as breeding sites.

The water temperature is much lower in the *Scirpus* mats than in the open and fluctuates much less than in the open pond and lakes. In the large pond it was 80° F. at 4:00 p.m. on July 28, 70° F. at 1:30 p.m. on Sept. 11, and between 58° and 60° F. at 8:00 a.m. on Oct. 17, 1954. In both breeding sites the water is brown and has a strong sulfurous odor. It is clear when undisturbed but when dipped a fine flocculent muck is distributed through it only to settle in a short time.

The larvae, particularly the fourth instar, are very easily disturbed and will remain hidden in the muck for a long time. They have the usual *Uranotaenia* attitude at the surface and are rather conspicuous with their black heads strongly contrasting with the white bodies. Their movements are sudden and very quick. The small pupae are extremely active and are more difficult to find.

The intensity of the breeding increased greatly during the season. In June we were able to find less than 100 fourth instar larvae in about 10 man-hours of dipping in an area of more than 100 square feet. In September on the other hand we collected well over 2000 fourth instar larvae in an area less than 10 square feet in about 5 man-hours. In October the breeding did not appear to be as dense in any one area, but it was probably much more widespread as the result of a rise in water level. On every inspection egg rafts, all larval instars, and pupae were found. In all probability the breeding is greatly reduced and may stop completely during December and January, but there was little indication of a falling off in October.

The larvae are very sensitive to high temperatures and are easily injured in transporting in the field as well as in a car. Survival is increased by individual isolations in vials cooled by evaporation. The fourth instar larvae are particularly delicate, especially when ready to pupate. Pupae on the other hand are very hardy.

No information was obtained on the length of the life cycle in nature, but in the laboratory it took about two weeks to obtain mature fourth instar larvae from eggs and two days for pupation.

The most interesting mosquito found breeding in association with *Uranotaenia* at Saratoga Springs is *Corethrella laneana* Vargas, 1946, a species formerly known by a single male from Monterey, Nueva Leon, Mexico (Belkin and McDonald, 1955). In addition a few specimens of *Culex erythrothorax* Dyar, 1907 and *C. tarsalis* Coquillett, 1896 were found in the *Scirpus* stands.

2. *Other Populations*

Little is known about the adults of other populations of the complex except that both males and females may be attracted to artificial lights. C. B. and R. N. Philip (C. B. Philip, 1954 *in lit.*) collected a small series of females "on a sheet hung behind a gas light in the evening" at Fairbanks Springs, Nevada on August 21, 1949. On a trip later in the season C. B. Philip tried to get males but did not find even females. C. S. Richards (1954, *in lit.*) collected about eight females in light traps from July to October at St. David, Arizona. All the records from New Mexico (Ferguson and McNeel, 1954), Oklahoma (Griffith, 1952), and the majority of records from Texas (McGregor and Eads, 1943; Randolph and O'Neill, 1944; Porter, 1946; Rueger and Druce, 1950; Eads, Menzies and Ogden, 1951) are based on light trap catches made usually between May and October. Dampf (1943: 147–160) presented a great deal of data on light trap collections in the Federal District of Mexico and came to the conclusion that *syntheta* is apparently a winter species, most abundant in November and with scanty spring and summer generations. Freeborn (1926: 350) reports seeing a single female taken at Camp Kearney "in a large packing box placed near a fresh water creek for the purpose of affording a collection point in the otherwise barren terrain." Adults of other populations have not been collected in nature or are without data.

Brief notes on breeding sites are available for the Bonsall, San Diego, Baja California, Arizona and three Texas populations. In most of these cases the immature stages have been collected in open situations in contrast to the Saratoga Springs breeding sites. Dyar (1907: 128) collected a single larva in a temporary swamp full of reeds and later (Howard, Dyar and Knab, 1917, 4: 1042) rediscovered the larvae in the fringe of cat-tails and *Lemna* in a pond near the mouth of the San Diego River in early May. The larvae collected by Seaman and Richards at Bonsall (Seaman, 1945) on Sept. 15, 1944 were found in "grass-tule marsh" in the San Luis Rey River bed. Brookman and Reeves (1953: 226) collected two pupae on June 13, 1948 in Baja California "at the edge of a tule patch as well as in the mat of algae and *Lemna*" in a small pond formed by a sand bar at the ocean outlet of a small stream. C. S. Richards (1954, *in lit.*) found one pupa (skin lost) and later, on Oct. 22, 1953, one larva in a "small, grassy, roadside ditch, receiving water as seepage and overflow from an artesian well reservoir" at St. David, Arizona. Porter (1946: 535) collected on July 12, 1944 at Meecham Field, Texas a single larva "from still areas along the margins of a shallow, grass-clogged, flowing ditch. . . . Most of the ditch is exposed to bright sunshine throughout the day and no part is heavily shaded. The water is cool and clear, the source, a spring, being approximately 25 yards from where the larva was taken." E. S. Ross (1954, *in lit.*) collected all stages except eggs from July 6 to Oct. 30, 1942 at Fort Sam Houston, Texas "on the semi-shaded side of Salado Creek where it flows through the post. Larvae were found only in ruts, puddles and hoofprints in spring seepages on a slope near the creek, but never in it." The largest collections of immature stages of *syntheta* have been made by O. P. Breland from Aprll through October in Palmetto State Park, some eight miles south of Luling, Texas. He found all the larval instars exclusively in small depressions along a stream that contained masses of water hyacinths (Breland 1948: 108–109). None of the other numerous mosquito breeding sites in this area were utilized by *syntheta*.

SYNOPSIS OF THE ANHYDOR COMPLEX

The chief characteristics of the various components of the *anhydor complex* as here understood may be summarized as follows:

1. *Male and female:* wing 2.2–2.9 mm.; prescutal streak of bluish scales always well developed, narrow, consisting usually of one row of scales, usually with few or no dark scales bordering it mesally, extending from transverse suture at scutal angle to anterior dorsocentrals; supraalar streak of bluish scales in line with prescutal streak, extending to transverse suture, scales broad anteriorly, elongated toward wing root, surrounding area with few or no narrow bronzy scales; narrow scales of mesonotum dark bronzy, short and sparse; *stp* with a narrow upper streak of bluish scales; knee spots and tibial spots conspicuous, pure white; abdominal tergal spots usually well developed, pure white. *Pupa:* trumpet narrow and elongate, gradually and slightly flared to apex, index about 8.0; hairs poorly pigmented and often with fewer branches than in other populations; hair, 1, 2-C (usually 3, 4b), 9–C (usually 5b), 6-I (usually 4–6b), 3-II (usually 5–8b), 1-III (usually 5–8b), 7–VIII (usually 4–5b). *Fourth instar larva:* head capsule pigmentation intermediate; pigmentation of siphon, comb plate and anal saddle strongest; hairs usually intermediate in number of branches; hair 2–I (usually 3–5b), 5–VIII (usually 7, 8b). *Larval habitat:* open or semi-shaded situations, small depressions with vegetation along streams and near spring seepages, also margins of small streams.

East of Continental Divide—U. *anhydor syntheta.*

2. *Male and female:* wing 2.0–2.6 mm.; prescutal streak of bluish scales always well-developed, broad, consisting of several rows of scales, usually with few or no dark scales bordering it mesally, extending from a considerable distance cephalad of scutal angle to level of humeral bristles; supraalar streak of bluish scales not in line with prescutal streak, not reaching the transverse suture, scales broad anteriorly, elongated toward wing root, surrounding area with few or no narrow bronzy scales; narrow scales of mesonotum dark bronzy, short and sparse; *stp* with a broad upper patch of bluish scales; knee spots moderately well developed, dingy white; tibial spots poorly developed; abdominal tergal spots inconspicuous, dingy white. *Pupa:* trumpet narrow and elongate, usually abruptly and strongly flared at apex, index usually 10.0 or more; hairs well pigmented and usually with more branches than in other populations; hair 1, 2–C (usually 6, 5b), 9–C (usually 10, 9b), 6–I (usually 3, 4b), 3–II (8–10b), 1–III (10–14b), 7–VIII (usually 5–7b). *Fourth instar larva:* head capsule pigmentation extremely dark; pigmentation of siphon, comb plate and anal saddle weakest in complex; hairs usually with more branches than in other populations; hair 2–I (usually 1–3b), 5–VIII (usually 8–10b). *Larval habitat:* in almost total darkness in beds of *Scirpus olneyi* surrounding springs or seepages.

Amargosa drainage, Death Valley System; Saratoga Springs and probably Fairbanks Springs—*U. a. anhydor*, Saratoga Springs population.

3. *Female:* wing 2.6–2.8 mm.; prescutal streak of bluish scales variable, rarely approaching preceding, usually greatly reduced, sometimes completely absent, many narrow light coppery scales bordering mesally or replacing the streak; supraalar streak of bluish scales as in preceding but scales narrower, often greatly reduced in extent, and sometimes partially replaced by coppery

scales, surrounding area with many narrow coppery scales; narrow scales of mesonotum coppery, long and very dense, particularly caudad; *stp* as in preceding; knee, tibial and tergal abdominal light spots less developed and darker than in the preceding. *Male:* similar to female except that prescutal streak is always distinct and consists of at least two rows of scales and the supra-alar streak is better developed. *Pupa:* trumpet broader than in other populations, gradually and slightly flared to apex, index less than 6.0; hairs poorly pigmented and often with branches intermediate in number; hair 1, 2–C (usually 5b), 9–C (usually 7b), 6–I (usually 3b), 3–II (usually 7b), 1–III (usually 10b), 7–VIII (usually 3–5b). *Fourth instar larva:* head capsule pigmentation lighter than in other populations; pigmentation of siphon, comb plate and anal saddle intermediate; hairs usually with smallest number of branches; hair 2–I (usually 2b), 5–VIII (usually 7–10b). *Larval habitat:* open situations, permanent or intermittent pools, in fringe of cat-tails, tules, in mats of algae and *Lemna* and grassy seepage ditches.

West of Continental Divide; San Diego Co., Calif.; Baja California, Mexico; and Cochise Co., Ariz.—*U. a. anhydor.*

DISCUSSION

The populations of *U. anhydor* and *U. syntheta* we have examined are so close morphologically in all known stages that we believe this complex consists of a single polytypic species, *U. anhydor*, which is so distinct from all other American *Uranotaenia* that it deserves the rank of a separate series given to it by Galindo, Blanton and Peyton (1954: 112), although some of the characters mentioned by these authors do not hold. The *anhydor* series (or subsection in the nomenclature of Belkin, 1953a: 316) may be characterized as follows: *Adults:* head with narrow orbital line of bluish scales expanded laterally toward *apn*, erect vertical scales very numerous; mesonotum with supra-alar and prescutal lines of bluish scales, sometimes both reduced; *apn* with bluish scales; *ppn* with a few narrow dark scales dorsally; *stp* with longitudinal streak of bluish scales in upper part and a vertical streak of bluish scales in lower posterior part; *ume* with a patch of about eight light bristles; fore coxa with a small patch of bluish or whitish scales; light femoral knee spots well marked or reduced; tibiae, particularly hind and fore, with apical light scales; tarsi entirely dark; vein R_2 about 0.75–0.80 of R_{2+3}; base of vein R with light scales on anterior margin; "microtrichia" unusually large for genus; abdomen with conspicuous or reduced basal lateral light spots. *Male genitalia:* unique type in American species; tergal arms of lateral plates straight rods fused mesally to form a long narrow dorsal bridge; paraproct with distinct lateral sclerotizations. *Larva:* valve hair 13 not developed into a long hair with twisted base; head hairs 5 and 6 not spikelike, usually 2, 3b. *Pupa:* impossible to characterize because most American species are undescribed; pinna and slit in meatus of trumpet unusually short.

The known geographic range of *U. anhydor*, as here understood, includes a vast arid area from the Gulf of Mexico to the Pacific Ocean, from eastern Texas and central Oklahoma, New Mexico, Arizona, southwestern Nevada and southeastern California in the north to Mexico City in the south. Future collecting may extend the range in the north to southwestern Kansas and southern Colorado and Utah, and possibly to the south in Mexico.

The populations in the United States east of the Continental Divide are distinguished from those to the west largely on the basis of ornamentation of the adults. They constitute, in our opinion, the subspecies *U. anhydor syntheta*, which appears to be remarkably uniform throughout its range. We have not seen material from eastern or central Mexico but it appears that the populations in that area are to be referred to *syntheta* as has been done by Dampf (1943).

West of the Continental Divide the situation is much more complex and unfortunately, except for the population at Saratoga Springs, the material is very scanty. For this reason we prefer for the present to include all these populations under the nominate subspecies. However, we believe that the Saratoga Springs population together with the other populations in the Amargosa drainage will prove to be subspecifically distinct from the other western populations. In the material now at hand, the San Diego, Baja California and Arizona populations appear to be very similar morphologically and can be distinguished from the Saratoga Springs population in the female, pupa and fourth instar larva, whenever these stages are known. The plasticity of the Saratoga Springs population, its marked morphological response to unusual environmental conditions, such as rearing in the laboratory, its entirely different type of habitat, and the fact that we have found a number of instances of local ecological races well marked by morphological differences in other mosquitoes in California, suggest caution in interpreting this population as a distinct subspecies at this time. The variability of the other western populations, even with the scant material at hand, indicates a great plasticity in this complex and a strong direct response to environmental conditions in the expression of morphological characters.

Whatever its taxonomic status may prove to be, the Saratoga Springs population is of great interest for it very likely represents a relict population isolated in the Death Valley System from late Pleistocene times. From our observations on the behavior of the adults it appears unlikely that they are capable of long flights and

survival under extreme arid conditions. It is possible that some dispersal may take place in the winter months, particularly if this population reaches at that time a peak of abundance such as Dampf (1943) reports for *syntheta* in Mexico. However, at the present time there are apparently no suitable breeding sites for *Uranotaenia* for at least 50 miles outside of the Amargosa drainage. Within the Amargosa drainage itself this population has probably been isolated for a considerable length of time. There appear to be no *Uranotaenia* or no suitable breeding sites for this species at any of the springs within a radius of 12 miles, while other species, particularly *Culex tarsalis* and *Anopheles franciscanus*, occur commonly in such situations. Probably the nearest suitable permanent breeding sites for *Uranotaenia* at present are to be found near Tecopa, about 16 miles over mountain ranges and about 22 miles by way of the Amargosa River bed. Unfortunately we have made no collections at Tecopa.

The Saratoga Springs populations cannot be said to be intermediate between *syntheta* and the typical *anhydor*. While the light thoracic ornamentation is better developed than in other western populations, it represents merely an intensification of the condition found in typical *anhydor* and not a transition to *syntheta*. The larval characters show the extreme development within the complex in the dark pigmentation of the head capsule and in the number of branches of some hairs, while in other hairs the number of branches is intermediate or even the lowest for the complex. Probably the most obvious characteristic of this population is in the shape of the pupal trumpet. We have shown that this is somewhat variable and is apparently modified under laboratory conditions. Unfortunately, it is not known how constant this character is in other populations.

The great variability in most characters that we find in the Saratoga Springs population may be due to the plasticity that such a population must have maintained in the past and must still preserve to survive in an environment subject to extreme fluctuation. We find a similar great variability in *Chrysops latifrons* Brennan, another relict form endemic to the Amargosa drainage. It appears to us that the season of 1954 was particularly favorable to the breeding of *Uranotaenia* and that such densities are not often reached by this population. Some of the problems of population structure and population genetics could very advantageously be studied in nature with relict forms isolated in biological islands such as we find at Saratoga Springs.

It is obvious that taxonomic studies on the population level are much needed in mosquitoes. In the past even subspecies have been used very seldom in this family. It is evident however that local populations or races characterized by distinct morphological features are of common occurrence. Failure to recognize this situation has led some workers on the one hand to question the reliability of so-called species characters and on the other to report polytopic subspecies. Physiological differences between such races undoubtedly exist and would account for the differences in such behavior as food preference and susceptibility to insecticides. Isolated populations of species that are aquatic or semi-aquatic in one or more stages are particularly conspicuous and well characterized in the arid portions of the southwestern United States. It seems probable that many of these populations are intermixed from time to time during occasional periods of high rainfall. However, a few of these, such as the Saratoga Springs population of *U. anhydor*, undoubtedly remain isolated and evolve into distinct forms. We believe that good characters for the separation of related populations of mosquitoes will be found in the larval and pupal chaetotaxy. It will be noted in Table I that statistically significant differences exist in the case of several hairs for the Saratoga Springs and the Texas populations. The C.D. (coefficient of difference) for hair 2–I in the two populations is 1.24, indicating a separation of about 89% which is near the conventional level of subspecific difference. However, from a practical standpoint of identification this character is not satisfactory. None of the other hairs approach 2-I in the magnitude of the C.D. One solution would be to use a combination of hairs to obtain a multiple character index such as is used by ichthyologists for more clearcut separation of the various populations. Unfortunately our samples of the populations outside of Saratoga Springs are inadequate for this purpose and we confine ourselves to a presentation of the data from the latter population only. We must stress that blind reliance should not be placed on hair branching as a taxonomic character for, as with all other characters, the expression of the chaetotaxy is greatly influenced by the environment. Our hesitancy in recognizing the Saratoga Springs population as a subspecies is due to a large extent to ignorance of the possible direct environmental modifications in the material at hand.

Little attention has been paid in the past to the larval instars of culicine mosquitoes, particularly in North America. A knowledge of these would be of considerable value in taxonomic, phylogenetic and chaetotaxic studies. We have taken advantage of the abundant material of the Saratoga Springs population of *anhydor* to study these in some detail, particularly in regard to the chaetotaxy. The striking diagnostic characters of the four instars may be summarized as follows: *First instar:* egg tooth present; anal saddle incomplete; ventral brush completely absent; siphon unsclerotized in basal fourth or more; collar absent but "ocular plate" with distinct caudolateral projection dorsally; hairs 7–P,

8–M, 7–T, 9, 13–I–VII, 8–S, 4–X absent, all others present, spiracular rudiments and dorsal sensilla apparently not developed; comb plate restricted to base of scales; comb scales fringed laterally and apically; acus composed of two small separate plates on each side not joined to sclerotized part of siphon; pecten teeth broad, fringed apically and laterally, several present on unsclerotized part of siphon. *Second instar:* egg tooth absent; anal saddle incomplete; ventral brush composed of 2 pairs of hairs; siphon unsclerotized at most in basal tenth; collar completely absent and no caudolateral projection from ocular plate; hairs 8-M, 7-T, 9–I–VII absent, all others present; comb plate as in first instar; comb scales fringed laterally only; acus plates of each side united and joined to sclerotized part of siphon; pecten teeth narrower, with more distinct apical fringe, usually all on sclerotized part of siphon; spiracular rudiments present; dorsal sensilla absent. *Third instar:* as in second except for the following: ventral brush composed of 4 pairs of hairs; all hairs present; dorsal sensilla present. *Fourth instar:* as in the third instar except for the following: anal saddle completely ringing segment; ventral brush composed of 5 pairs of hairs; comb plate large, not restricted to base of scales, including hair 0.

It was of interest to find two morphological anomalies in our material. One of the 471 females from Saratoga Springs showed two lines of broad appressed whitish scales on the posterior part of the mesonotum in the general area where other species of *Uranotaenia* have a single median streak of bluish scales. In the single pupa from Baja California hair 1 of abdominal segment X was developed on both sides; this hair is normally present only in the genus *Toxorhynchites* (= *Megarhinus*). Such anomalies are of value not only to the comparative anatomist and taxonomist but may prove to be useful to the geneticist for they may represent mutations.

SUMMARY

An isolated population of the rare mosquito *Uranotaenia anhydor* Dyar, 1907 was discovered at Saratoga Springs at the south end of Death Valley in June, 1954, and was sampled in July, September and October. Large numbers of males and females were collected at Coleman lanterns and all immature stages were found in almost total darkness in mats of *Scirpus olneyi* growing on the margins of one of the lakes and a spring-fed pool. All the stages are described in detail and the complete chaetotaxy of all larval instars and the pupa is figured. Comparison with other populations of *anhydor* from San Diego Co., Calif., Baja California, Mexico, and St. David, Ariz. and several populations of *U. syntheta* Dyar & Shannon, 1924 from Texas reveals that all these populations are so close morphologically that they should be considered to form one species, *U. anhydor*, which is so distinct from other American *Uranotaenia* that it should be segregated as a separate series. The populations in the United States east of the Continental Divide, and in all probability those in eastern and central Mexico, constitute the subspecies *syntheta*, easily recognizable only in the adult stage by the thoracic ornamentation. The Saratoga Springs population cannot be considered to be in any way intermediate between the typical *anhydor* from San Diego Co. and *syntheta* but rather an extreme development of the former. It is suggested that the Saratoga Springs population, which is quite distinct morphologically and ecologically from the other western populations, has been isolated in the Amargosa drainage of the Death Valley System since late Pleistocene times, much like the relict populations of Cyprinodont fishes in that system, and that it may represent a third subspecies in the *anhydor* complex. However, because of the variability and remarkable morphological plasticity of the immature stages of this population, as well as the scarcity of material of other western populations, the Saratoga Springs population is not separated nomenclaturally from the typical *anhydor* for the present. The morphological characteristics of all known stages of United States populations of the complex are given as well as a review of their bionomics. It is suggested that related populations of mosquitoes may be separated by a multiple character index utilizing hair branching in the larva and pupa. Saratoga Springs is described in some detail in connection with observations on bionomics of *U. anhydor*, since this area appears ideally suited for studies on the ecology and genetics of natural populations. Two morphological anomalies, one in an adult female and the other in a pupa, were noted and it is suggested that they may represent mutations.

REFERENCES CITED

Belkin, J. N. 1953a. Mosquitoes of the genus *Uranotaenia* in the Solomon Islands (Diptera: Culicidae). Pacific Sci. 7: 312–91.

1953b. Corrected interpretations of some elements of the abdominal chaetotaxy of the mosquito larva and pupa (Diptera, Culicidae). Proc. Ent. Soc. Washington, 55: 318–24.

Belkin, J. N., and **W. A. McDonald.** 1955. A population of *Corethrella laneana* from Death Valley, with descriptions of all stages and discussion of the Corethrellini (Diptera, Culicidae). *In press.*

Breland, O. P. 1948. Notes on the mosquito, *Uranotaenia syntheta* Dyar & Shannon (Diptera: Culicidae). Mosquito News 8: 108–9.

1950. Additional studies on the larvae of *Uranotaenia syntheta* Dyar and Shannon (Diptera: Culicidae). Mosquito News 10: 25–8.

1954. Notes on the larvae of *Uranotaenia syntheta* (Diptera: Culicidae). Jour. Kansas Ent. Soc. 27: 156–8.

Brookman, B., and **W. C. Reeves.** 1953. New records of mosquitoes from Lower California, Mexico, with notes and descriptions (Diptera: Culicidae). Ann. Ent. Soc. Amer. 46: 225–36.

Dampf, A. 1943. Distribution y ciclo anual de *Uranotaenia syntheta* Dyar & Shannon en Mexico y de-description del hipopigio masculino (Insecta, Diptera). Rev. Soc. Mex. Hist. Nat. 4: 147–69.

Dyar, H. G. 1907. Report on the mosquitoes of the coast region of California, with descriptions of new species. Proc. U. S. Nat. Mus. 32: 121–9.

Dyar, H. G., and **R. C. Shannon.** 1924. The American species of *Uranotaenia* (Diptera, Culicidae). Insecutor Inscit. Menstr. 12: 187–92.

Eads, R. B., G. C. Menzies, and **L. J. Ogden.** 1951. Distribution records of West Texas mosquitoes. Mosquito News 11: 41–7.

Ferguson, F. F., and **T. E. McNeel.** 1954. The mosquitoes of New Mexico. Mosquito News 14: 30–31.

Freeborn, S. B. 1926. The mosquitoes of California. Univ. Calif. Publ. Ent. 3: 333–460.

Galindo, P., F. S. Blanton and **E. L. Peyton.** 1954. A revision of the *Uranotaenia* of Panama with notes on other American species of the genus (Diptera, Culicidae). Ann. Ent. Soc. Amer. 47: 107–77.

Griffith, M. E. 1952. Additional species of mosquitoes in Oklahoma. Mosquito News 12: 10–14.

Howard, L. O., H. G. Dyar and **F. Knab.** 1917. The mosquitoes of North and Central America and the West Indies. Carnegie Inst. Washington (Publ. 159), v. 4, p. 525–1064.

Hubbs, C. L., and **R. R. Miller.** 1948. The zoological evidence: correlation between fish distribution and hydrographic history in the desert basins of western United States *In* The Great Basin, with emphasis on glacial and postglacial times. B. Univ. Utah (Biol. Ser.) 10(7): 18–144.

McGregor, T., and **R. B. Eads.** 1943. Mosquitoes of Texas. J. Econ. Ent. 36: 938–40.

Mendenhall, W. C. 1909. Some desert watering places in southeastern California and southwestern Nevada. U. S. Geol. Surv., Water-Supply Pap. 224. 98 p.

Miller, R. R. 1948. The cyprinodont fishes of the Death Valley System of eastern California and southwestern Nevada. Misc. Publ. Mus. Zool. Univ. Michigan, 68. 155 p.

Porter, J. E. 1946. The larva of *Uranotaenia syntheta* (Diptera: Culicidae). Amer. Midl. Nat. 35: 535–7.

Randolph, N. M., and **K. O'Neill.** 1944. The mosquitoes of Texas. Texas State Health Dept. 100 p.

Rueger, N. E., and **S. Druce.** 1950. New mosquito distribution record for Texas. Mosquito News 10: 60–63.

Seaman, E. A. 1945. Ecological observations and recent records on mosquitoes of San Diego and Imperial Counties, California. Mosquito News 5: 89–95.

Thompson, D. G. 1929. The Mohave Desert region. U. S. Geol. Surv., Water-Supply Pap. 578. 759 p.