

MOSQUITO STUDIES (Diptera, Culicidae)

XV. A NEW SPECIES OF TREEHOLE BREEDING ANOPHELES
FROM THE SOUTHWESTERN UNITED STATES¹

By

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During the past 3 years a large number of specimens of the *Anopheles* commonly found breeding in treeholes in southern Arizona has been acquired by the project "Mosquitoes of Middle America." Examination of this material has shown it to be a species near, but distinct in all stages from, *Anopheles barberi*. This species, *judithae*, is described and illustrated in the present paper. To facilitate its separation from *barberi*, that species is redescribed and illustrated.

Terminology and format of the present paper are those of Belkin (1962, 1968). Abbreviations used for the references follow the "American Standard for Periodical Title Abbreviations" (Amer. Stand. Ass., 1964). The descriptions of the male genitalia and immature stages of *barberi* and *judithae* are restricted to features not shown in the drawings, such as color pattern and variations, and to characters which serve to separate the 2 species from each other. Since the adults are not illustrated, descriptions of them are somewhat more extensive and contain characters which should serve to separate the species from each other, from other treehole breeding *Anopheles*, and from the remaining New World *Anopheles*. The drawings of the preimaginal forms of each species show the modal condition for the position, length and branching of the hairs. Since a mature fourth instar larva of *barberi* in condition suitable for drawing was not available during this study, the outline of the larval drawing for that species was copied from *judithae*. The pecten teeth counts for each species include not only the large teeth along the posterior margin of the pecten plate, but also the smaller apical teeth. The spiculation of the larvae is described as it appears at 200 magnifications. The sidepiece indices are the ratio of the length of the sidepiece as measured from base to apex on the ventral surface and the width at the point halfway from the base to the apex. In tabulating the bristles on the anterior surface of the forecoxa, all well-developed setae, including those associated with the

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coxa-trachean joint, have been counted. From the vast literature on *Anopheles barberi*, only a few significant papers dealing with the morphology, ecology and distribution of the species have been cited.

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Anopheles (Anopheles) judithae Zavortink, n.sp.

Figs. 1, 2

TYPES: Holotype ♂ with associated larval and pupal skins (UCLA 302-40), Cochise Stronghold Recreation Area, Dragoon Mountains, Cochise County, Arizona, elevation about 5500 ft, larva from a rot hole in a living evergreen oak tree, 22 Mar 1966, T.J. Zavortink [USNM]. Allotype ♀ with associated larval and pupal skins (UCLA 302-42), same data as holotype. Paratypes: 6 lp♂ (302-25,41,43,45,46,48), 5 lp♀ (302-44,47,49,51,52), 3 p♂ (302-100,101,103), 1 p♀ (302-102), 1 ♀, 1 P, 6 L, same data as holotype; 1 lp♀ (306-20), same data as holotype except collected on 23 Mar 1966 (UCLA 306); 1 lp♂ (328-22), same data as holotype except collected on 4 Sept 1966 (UCLA 328); 7 lp♂ (342-13,15,30,33,38,43,44), 11 lp♀ (342-10,31,32,34-37,39-42), 10 p♂ (342-100-106,109,110,113), 5 p♀ (342-107,108,111,112,114), 17 ♂, 25 ♀, 48 P, 27 L, same data as holotype except collected on 6 Sept 1966 (UCLA 342).

Anopheles barberi of Vargas (1940:319-322; 1943:64,65,66,67, in part); Jenkins and Carpenter (1946:35-36, in part); Carpenter and LaCasse (1955:32-34, in part); Richards, Nielsen and Rees (1956:14); Vargas and Martinez (1956:111-113,140, in part); Rigby, Blakeslee and Forehand (1963:50); Burger (1965:396); Nielsen, Arnell and Linam (1967:76); Carpenter (1968:72, in part); Nielsen, Linam, Arnell and Zavortink (1968:363).

FEMALE. Wing: 3.31 mm. Proboscis: 1.92 mm. Forefemur: 2.18 mm. Abdomen: about 2.1 mm. **Head:** Integument light to dark brown; orbital bristles dark brown, interocular bristles amber; dorsum of head with erect scales only, these entirely pale white or a few lateral ones dark; interocular scales numerous, white, usually none appreciably elongate; labium and palpus entirely dark scaled, the proximal scales appressed; torus and first flagellar segment with a few small dark scales. **Thorax:** Mesonotum conspicuously shortened and arched; mesonotum with integument very light to dark brown, largely shining, without a broad hoary median longitudinal stripe; pleural integument lighter or becoming lighter ventrally; mesonotal bristles numerous, strongly developed, long and conspicuous, dark in color except for some amber anterior acrostichals; mesonotal scaling restricted to a small tuft of 5-20 whitish scales in center of anterior promontory and a few erect light or dark scales in prescutellar area; *apn*, *sp*, *pra*, *ppl*, *stp* and upper *mep* bristles or hairs present, those on *ppl* 2-5 in number, those on *stp* in a more or less continuous vertical row; pleuron without scales. **Legs:** Integument of coxae same color as or lighter than adjacent portions of pleuron; anterior portion of forecoxa with 6-18 strongly developed bristles; coxae without scales; femora, tibiae and tarsi entirely dark scaled. **Wing:** Veins and fringe entirely dark scaled, scales on veins uniformly distributed and not grouped into dark spots. **Haltere:** Integument of stem light, knob dark scaled. **Abdomen:** Integument of tergites light to dark brown, usually somewhat dappled, sternites lighter; completely devoid of scales.

MALE. As for female except for usual sexual differences.

MALE GENITALIA (fig.1). *Sidepiece*: More or less cylindrical or short conical, mesal edge nearly straight, length about 1.9-2.6 width; parabasal spines only slightly more strongly developed than internal spine; lateral parabasal spine not flattened preapically, apex gradually attenuate and strongly recurved; internal spine more strongly developed than large setae of sidepiece, apex usually recurved; distance from parabasal spines to internal spine usually 1.5-2.0 distance from latter to apex of sidepiece. *Clasper*: Setae present in basal 0.33. *Proctiger*: Generally extending to about level of internal spine.

PUPA (fig.1). Abdomen: 2.80 mm. Trumpet: 0.37 mm. Paddle: 0.83 mm. *Cephalothorax*: Lightly pigmented with middorsal area, region caudad of trumpet and upper portion of wing case darker. *Trumpet*: Light amber in color. *Abdomen*: Lightly pigmented with anterior and/or lateral portions of segments II-VIII darker; hair 9-II-VIII lightly pigmented, concolorous with integument; 9-III usually about 2.0 diameter and length of 9-II and 0.5 diameter and length of 9-IV; 5-III-VI fine, usually 2,3b; 5-VII usually fine and 2,3b, sometimes thickened and single, but then longer than 9-VII. *Paddle*: Lightly pigmented except for darker midrib.

FOURTH INSTAR LARVA (fig.2). Head: 0.67 mm. Anal Saddle: 0.30 mm. *Head*: Largely tan to brown in color with subantennal area and collar darker and area of imaginal eye lighter; mental plate brown, with 3 or 4 teeth on each side of median tooth; inner clypeals (2-C) closely approximated, separated by a distance less than that between inner and outer clypeals (3-C); outer clypeals usually double (single, double); hair 6-C an elongate seta subequal in length to 4-C, usually located nearly in line with 5,7-C; 14-C multiple, 3-6b (2-8). *Antenna*: Uniformly tan to brown in color or becoming lighter apically; hair 4-A usually 2,3f. *Thorax*: Integument without spicules; plumose hairs strongly developed, with lateral branches long and strongly pigmented; hair 2-P with only a few (2-6) long lateral branches; 9-P,M,T simple; 3,4-T usually single (single, double). *Abdomen*: Integument without spicules; plumose hairs strongly developed, with lateral branches long and strongly pigmented; hair 1-II-VII similarly developed, palmate; 13-II-V,VII usually single (1-3b); 7-VII usually 3b (1-3). *Segment VIII*: Hair 5 usually single (single, double). *Spiracular Lobe*: Pecten plate with 17-19 (15-20) teeth. *Anal Segment*: Spicules on posterior portion of saddle inconspicuous and arranged into short imbricate rows; ventral brush with 15 or 16 (14-17) hairs, the most caudal of which is normally longer than 2.0 length of saddle.

SYSTEMATICS. Vargas (1940:319-322) was the first to note the occurrence of a treehole *Anopheles* in North America west of the continental divide. His record was based on 3 males collected at Imuris, Sonora, Mexico, a site less than 40 air miles south of the Arizona border. This material was identified as *barberi*; although I have not seen the specimens upon which the report was based, I am certain they are conspecific with *judithae*. Richards, Nielsen and Rees (1956:14) first recorded *judithae*, as *barberi*, from Arizona. Their report was based on data supplied by W.A. McDonald, who had studied only 2 young instar larvae which he had collected near Patagonia. Since *judithae* is most conspicuously differentiated from *barberi* in the fourth instar larva, the failure of earlier workers to detect its specific distinctness was probably due in large part to the fact that they did not have this stage available for study.

While *judithae* and *barberi* form a pair of closely related vicarious species, they are easily differentiated in all stages. Adults of *judithae* have numerous white interocular scales, the erect scales of the head largely pale white, the anterior acrostichal bristles amber and accompanied by pale scales, and relatively few bristles on *ppl* and the anterior surface of the forecoxa. Those of *barberi* have the interocular scales reduced

or absent, the pale erect scales of the head largely dingy yellow, the anterior acrostichal bristles dark and usually not accompanied by scales, and relatively numerous bristles on *ppl* and the anterior surface of the forecoxa. The male genitalia of the 2 species differ most conspicuously in development of the parabasal spines. In *judithae* these spines are only slightly stouter than the internal spine and the lateral parabasal spine is not flattened preapically. In *barberi* the parabasal spines are 2-3 times as stout as the internal spine and the lateral one is flattened preapically. The sidepieces also differ in shape; the ramifications of this difference, such as the straightness of the mesal margin, the position of the internal spine relative to the parabasal spines and the apex of the sidepiece, and the level to which the proctiger projects, are indicated in the descriptions. Pupae of the 2 species are most readily separated on the basis of hairs 9-III-VIII and 5-VI,VII. In *judithae* 9-II-VIII is concolorous with the integument and 9-III is more or less intermediate in length and stoutness between 9-II and 9-IV, whereas in *barberi* 9-II alone is concolorous with the integument, 9-III-VIII being darkly pigmented, and 9-III is more similar to 9-IV than 9-II in length and stoutness. Hair 5-VI and usually also 5-VII of *judithae* is fine and divided into branches, while 5-VI,VII of *barberi* is thickened, single and shorter than hair 9 of the corresponding segment. A few specimens from nearly every collection of *judithae* have hair 5-VII thickened and single, but when it is developed in this manner it is longer than 9-VII. The fourth instar larvae of *judithae* and *barberi* differ in a striking number of characters, only the most conspicuous of which are enumerated here. Larvae of *judithae* have the inner clypeals separated by a distance less than that between the inner and outer clypeals, integument of the thorax and abdomen without spicules, strongly developed plumose hairs, hairs 13-II-V,VII and 5-VIII usually single, and spicules of the anal saddle inconspicuous and arranged in imbricate rows. Larvae of *barberi*, on the other hand, have the inner clypeals separated by a distance more than twice that between the inner and outer clypeals, integument of parts of the thorax and abdomen spiculate, weakly developed plumose hairs, hairs 13-II-V,VII and 5-VIII usually triple, and spicules of the anal saddle conspicuous and largely arranged singly.

Anopheles barberi and *judithae* are apparently quite removed from the other tree-hole *Anopheles* placed in the Coelodiagnosis group. Adults of these 2 species differ from *barianensis*, *fausti*, *plumbeus* and *xelajuensis* in the following: (1) interocular scales not forming a conspicuous white elongate tuft, (2) erect scales of head not sharply divided into brilliant white ones mesally and very dark ones laterally, (3) mesonotum conspicuously shortened and arched, giving a *Culex*-like aspect, (4) mesonotum without a conspicuous broad hoary median longitudinal stripe and (5) acrostichal scaling of mesonotum much reduced. They differ from all of the above-mentioned species except *plumbeus* by lacking light scales in the wing fringe and/or at the apices of the hindfemur and hindtibia. It should be pointed out, however, that two species of treehole breeding *Anopheles* from the western coast of India, *culiciformis* and *sintoni*, which are not placed in the Coelodiagnosis group, agree with *barberi* and *judithae* in all of the features mentioned above.

The larvae of the 2 other New World treehole breeding *Anopheles* differ from *barberi* and *judithae* in a number of characters. Both *fausti* and *xelajuensis* have hair 3-C laterad of 4-C; *fausti* has hair 9-III-VI elongate and plumose and hairs 5,7-VII weakly developed; *xelajuensis* has conspicuous stellate body hairs and does not have palmate hairs.

Larval hair 0-P has not been located on *barberi*, *fausti*, *judithae* or *plumbeus* and is apparently absent. The taxonomic significance, if any, of the presence or absence of this hair is unknown at the present time.

BIONOMICS. The bionomics of *judithae* are summarized in Nielsen, Arnell and Linam (1967:76) and Nielsen, Linam, Arnell and Zavortink (1968:363).

Larvae of this species, like *barberi*, are more frequently found in permanent than temporary treeholes. In southern Arizona the species is common in the high elevation xeric evergreen forest (*Arbutus*, *Cupressus*, *Juniperus*, *Pinus* and *Quercus*), the moderate elevation riparian woodland (*Fraxinus*, *Platanus*, *Populus*, *Salix* and *Sambucus*) and the low elevation gallery forest (*Populus* and/or *Salix*).

DISTRIBUTION. *An. judithae* has been found in Arizona, southwestern New Mexico (Nielsen, Linam, Arnell and Zavortink 1968:363) and Sonora (Vargas 1940:319-322). During this study only the Arizonan specimens cited below have been examined. All this material is in the UCLA collection. Material examined: 810 specimens; 154 ♂, 149 ♀, 279 pupae, 228 larvae; 147 individual rearings (92 larval, 47 pupal, 8 incomplete).

UNITED STATES. Arizona: Baboquivari Mountains, Kitt Peak National Observatory, 12 Sept 1968, T.J. Zavortink (UCLA 448), 1 lp♂ (448-27), 6 lp♀ (448-20-25), 1 p♀ (448-15), 1 lp (448-28). Dragoon Mountains, Cochise Stronghold Recreation Area, type series, see above. Nogales (13 mi NW), Calabasas Picnic Ground, 21 Mar 1966, T.J. Zavortink (UCLA 297), 2 lp♀ (297-20,21). Nogales (9 mi NE), 21 Mar 1966, T.J. Zavortink (UCLA 298), 3 lp♂ (298-40,42,49), 4 lp♀ (298-43, 45,50,51), 3 p♂ (298-101-103), 4 lp (298-41,46-48), 3 ♀, 4 P, 22 L; same data (UCLA 299), 5 lp♂ (299-21,26,28-30), 6 lp♀ (299-20,23-25,27,31), 1 lp (299-22), 2 L. Patagonia (2-4 mi WSW), Sonoita Creek, 24 Aug 1954, W.A. McDonald (UCLA 137), 2 L; 6 Sept 1963, J. Burger (UCLA 413A), 2 L; 18 Aug 1964, J. Burger (UCLA 253), 17 ♂, 11 ♀; 13 Sept 1964, J. Burger (UCLA 270), 3 L; 20 Sept 1964, J. Burger (UCLA 260), 17 ♂, 7 ♀; 25 July 1965, J. Burger (UCLA 281), 4 L; 27 July 1965, J. Burger (UCLA 282), 5 L; 21 Mar 1966, T.J. Zavortink (UCLA 300), 2 lp♂ (300-30,38), 6 lp♀ (300-32-36,39), 2 p♂ (300-100,102), 2 p♀ (300-101,103), 3 ♂, 3 ♀, 6 P, 12 L; 5 Sept 1966, T.J. Zavortink (UCLA 333), 1 ♂, 1 P, 2 L; same data (UCLA 334), 1 lp♂ (334-15), 4 lp♀ (334-12-14,16), 2 p♂ (334-102,103), 3 p♀ (334-100,101,104), 1 ♀, 3 P, 2 L; 14 Sept 1968, T.J. Zavortink (UCLA 458), 1 p♀ (458-100). Portal (15 mi WNW), 6 Sept 1966, T.J. Zavortink (UCLA 343), 9 lp♂ (343-14,15,17,31-34,36,37), 8 lp♀ (343-12,16,19,30,38-41), 10 p♂ (343-100-104,107,109,110,113,114), 4 p♀ (343-105,108,111,112), 2 lp (343-13,35), 30 ♂, 25 ♀, 69 P, 39 L. Prescott (7 mi NE), 1 Sept 1966, T.J. Zavortink (UCLA 315), 2 lp♂ (315-16,18). Santa Rita Mountains, 20 Oct 1940, R.A. Flock, 1 ♂.

Anopheles (Anopheles) barberi Coquillett

Figs.3,4

1903.*Anopheles barberi* Coquillett, 1903:310. TYPE: Holotype ♀, Plummer's Island, Maryland, 17 Aug 1903, H.S. Barber (USNM, 6959).

Anopheles barberi of Dyar (1904:243-244; 1928:454); Vargas (1942:329-331; 1943:64,65,66,67, in part); Matheson (1944:114-115); Jenkins and Carpenter (1946:35-36, in part); Darsie (1949: 524-525); Penn (1949:65-66); Carpenter and LaCasse (1955:32-34, in part); Vargas and Martinez (1956:111-113,140, in part); Carpenter (1968:72, in part).

Coelodiazesis barberi of Howard, Dyar and Knab (1917:1036-1038).

FEMALE. Wing: 3.49 mm. Proboscis: 1.73 mm. Forefemur: 2.10 mm. Abdomen: about 2.2 mm. Very similar to *judithae* but differing in the following features. **Head:** Interocular bristles dark or amber; erect scales on dorsum of head dingy yellowish mesally, dark or dingy yellowish laterally; interocular scales absent or very few. **Thorax:** Anterior acrostichal bristles dark in color; center of anterior promontory usually without scales, sometimes with 1-4 narrow dark scales; *ppl* bristles 7-11. **Legs:** Anterior forecoxal bristles 20-28.

MALE. As for female except for usual sexual differences.

MALE GENITALIA (fig.3). *Sidepiece*: More or less elliptical, mesal edge usually distinctly convex, length about 1.7-2.1 width; parabasal spines much more strongly developed than internal spine; lateral parabasal spine flattened preapically, apex sharply attenuate and recurved or sinuous; internal spine not more strongly developed than large setae of sidepiece, apex usually sinuous; distance from parabasal spines to internal spine about 0.8-1.0 distance from latter to apex of sidepiece. *Clasper*: Usually without setae in basal 0.33. *Proctiger*: Usually extending to near level of apex of sidepiece.

PUPA (fig.3). Abdomen: 3.04 mm. Trumpet: 0.37 mm. Paddle: 0.88 mm. *Cephalothorax*: Moderately pigmented, with dark areas a little more extensive than in *judithae*. *Trumpet*: Deep amber in color. *Abdomen*: Moderately pigmented, with dark areas somewhat more extensive than in *judithae*; hair 9-II moderately pigmented, concolorous with integument, 9-III-VIII darkly pigmented, strongly contrasting with integument; 9-III usually approaching 9-IV in both diameter and length; 5-III-V fine, usually single; 5-VI,VII thickened and single, shorter than hair 9 of corresponding segment. *Paddle*: Moderately pigmented except for darker midrib.

FOURTH INSTAR LARVA (fig.4). Head: 0.65 mm. Anal Saddle: 0.27 mm. *Head*: Largely brown in color with pattern of pigmentation as in *judithae*; mental plate dark brown, usually with 5 or 6 (4-6) teeth on each side of median tooth; inner clypeals (2-C) widely spaced, separated by a distance greater than 2.0 that between inner and outer clypeals (3-C); outer clypeals usually single (single, double); hair 6-C a short pointed peg only about 0.1 length of 4-C, located far caudad of 5-C; 14-C single (single, double). *Antenna*: Uniformly brown to dark brown in color or with apex lighter; hair 4-A single. *Thorax*: Integument, especially on underside of prothorax, spiculose; plumose hairs weakly developed, with lateral branches short and often lightly pigmented; hair 2-P with numerous (more than 8) short lateral branches; 9-P,M,T spiculate; 3,4-T usually 2,3b (1-4). *Abdomen*: Integument on underside of segments I-VIII spiculose; plumose hairs weakly developed, with lateral branches short and often lightly pigmented; hair 1-II usually not palmate, 1-4b, conspicuously less well developed than 1-III-VII when palmate; 1-III-VII palmate, similarly developed or 1-VII smaller; 13-II-V,VII normally 3b (3-5); 7-VII usually single (single, double). *Segment VIII*: Hair 5 usually 3b (2,3). *Spiracular Lobe*: Pecten plate with 12-15 (11-17) teeth. *Anal Segment*: Spicules on posterior portion of saddle more conspicuous than in *judithae* and, for the most part, not arranged into rows; ventral brush with 17 or 18 hairs, the most caudal of which is normally only 1.0-1.5 length of saddle.

SYSTEMATICS. The diagnostic features of this species are indicated above in the description and are discussed in the systematics section for *judithae*. The small series of larvae of this species which has been studied is remarkably uniform except for the development of hair 1-II. This hair varies from a weakly developed simple seta to a well-developed palmate hair. Material from Ohio exhibits this entire range of variation within one collection. While hair 1-VII is palmate in all specimens examined during this study, it may not always be developed in that manner (Howard, Dyar and Knab 1917:1036-1038; Dyar 1928:454).

BIONOMICS. The bionomics of this species are summarized in Jenkins and Carpenter (1946:35-36) and Carpenter and LaCasse (1955:32-34).

The immature stages are more frequently found in permanent treeholes in association with species of *Orthopodomyia* and *Toxorhynchites* than in temporary treeholes along with species of *Aedes*. Two collections made in Ohio in December of

1967 suggest that the 2 species of *Orthopodomyia* inhabiting the eastern United States, *alba* and *signifera*, may select different types of permanent treeholes for oviposition and that *barberi* selects the same type as *signifera*. The collections referred to were from horsechestnut trees (*Aesculus hippocastanum*) growing within 40 meters of each other; the relatively shallow, brown-colored water of a hole with a broad opening contained small numbers of *alba*, *barberi* and *signifera* larvae, while the deep, yellow-colored water of a hole with a narrow opening contained several hundred *alba* larvae and a single *signifera* larva.

DISTRIBUTION. *Anopheles barberi* has been found throughout the eastern United States, from South Dakota and New York in the north to Texas and Florida in the south (Carpenter and LaCasse 1955:32-34; Carpenter 1968:72). During this study only the material cited below, all of which is in the UCLA collection, has been seen. Material examined: 75 specimens; 17 ♂, 15 ♀, 23 pupae, 20 larvae; 20 individual rearings (15 larval, 3 pupal, 2 incomplete).

UNITED STATES. *Alabama*: Guntersville Lake, 28 May-27 Aug 1942, 3 ♀. Sheffield, 18 Aug 1942, J.N. Belkin, 1 ♀. Wilson Dam, 10 June-19 July 1942, J.N. Belkin, 1 lp♀ (167), 1 p♂ (171), 1 p♀ (168), 2 ♂. *Arkansas*: Little Rock, Little Fourche Bayou, 28-29 Mar 1943, J.N. Belkin, 2 lp (440,448), 3 P. *Maryland*: Baltimore, Patapsco State Park, 17 Oct 1965, W.A. McDonald (UCLA 286), 1 L. Cabin John, July 1965, W.A. McDonald (UCLA 286A), 1 L. *New York*: Ithaca, 18-26 July 1932, R. Matheson, 2 ♂, 3 ♀. *Ohio*: Canton, 22 Dec 1967, T.J. Zavortink (UCLA 437), 10 lp♂ (437-30-36,39,41,43), 4 lp♀ (437-37,38,40,42), 1 p♂ (437-44), 1 L. *Tennessee*: Kentucky Lake, 26 Aug 1942, 1 ♂. *Texas*: Abilene, 30 Aug 1953, R.X. Schick, 2 ♀.

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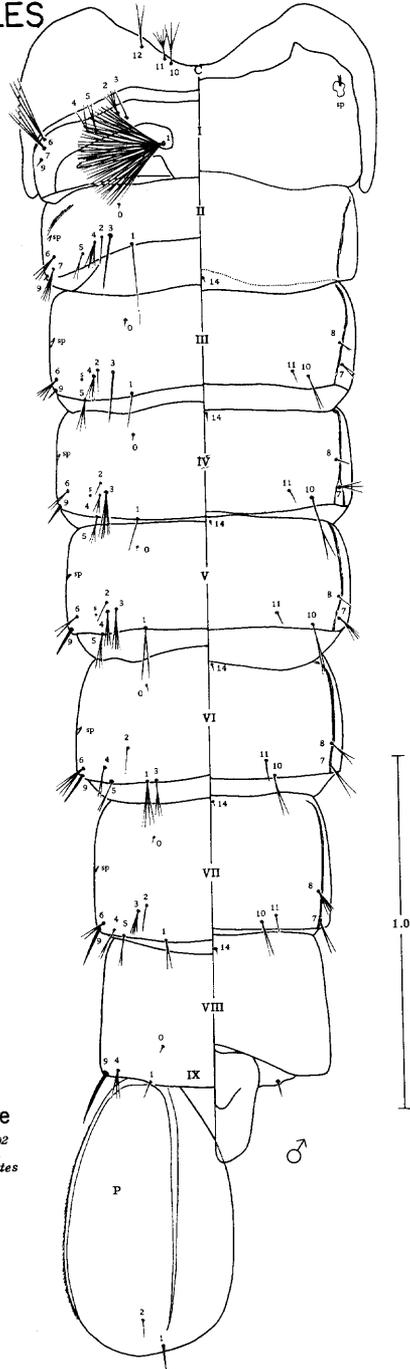
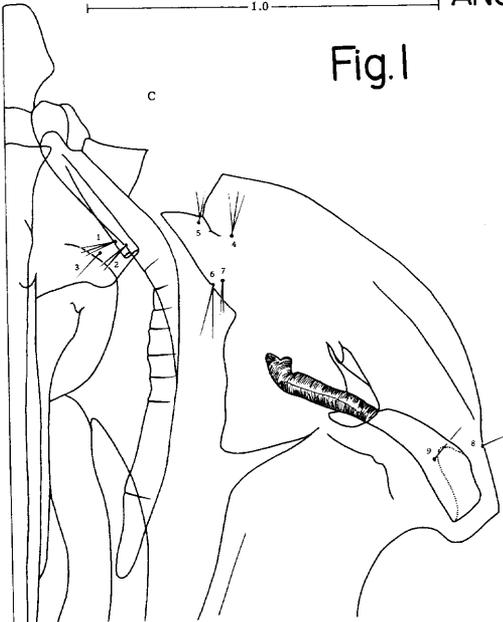
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FIGURES

1. *Anopheles (An.) judithae*; male genitalia and pupa
2. *Anopheles (An.) judithae*; larva
3. *Anopheles (An.) barberi*; male genitalia and pupa
4. *Anopheles (An.) barberi*; larva

ANOPHELES

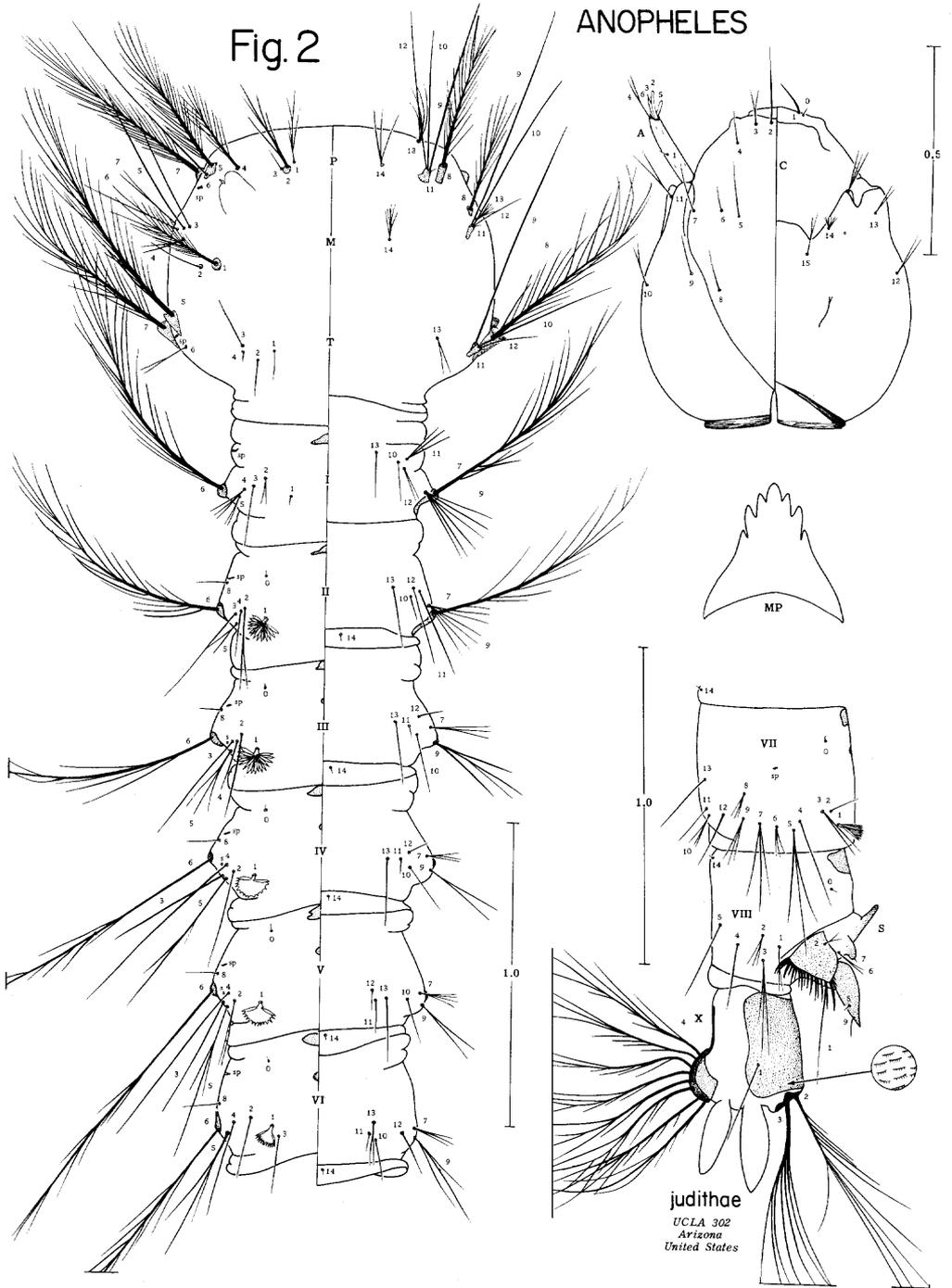
Fig. 1



judithae
UCLA 302
Arizona
United States

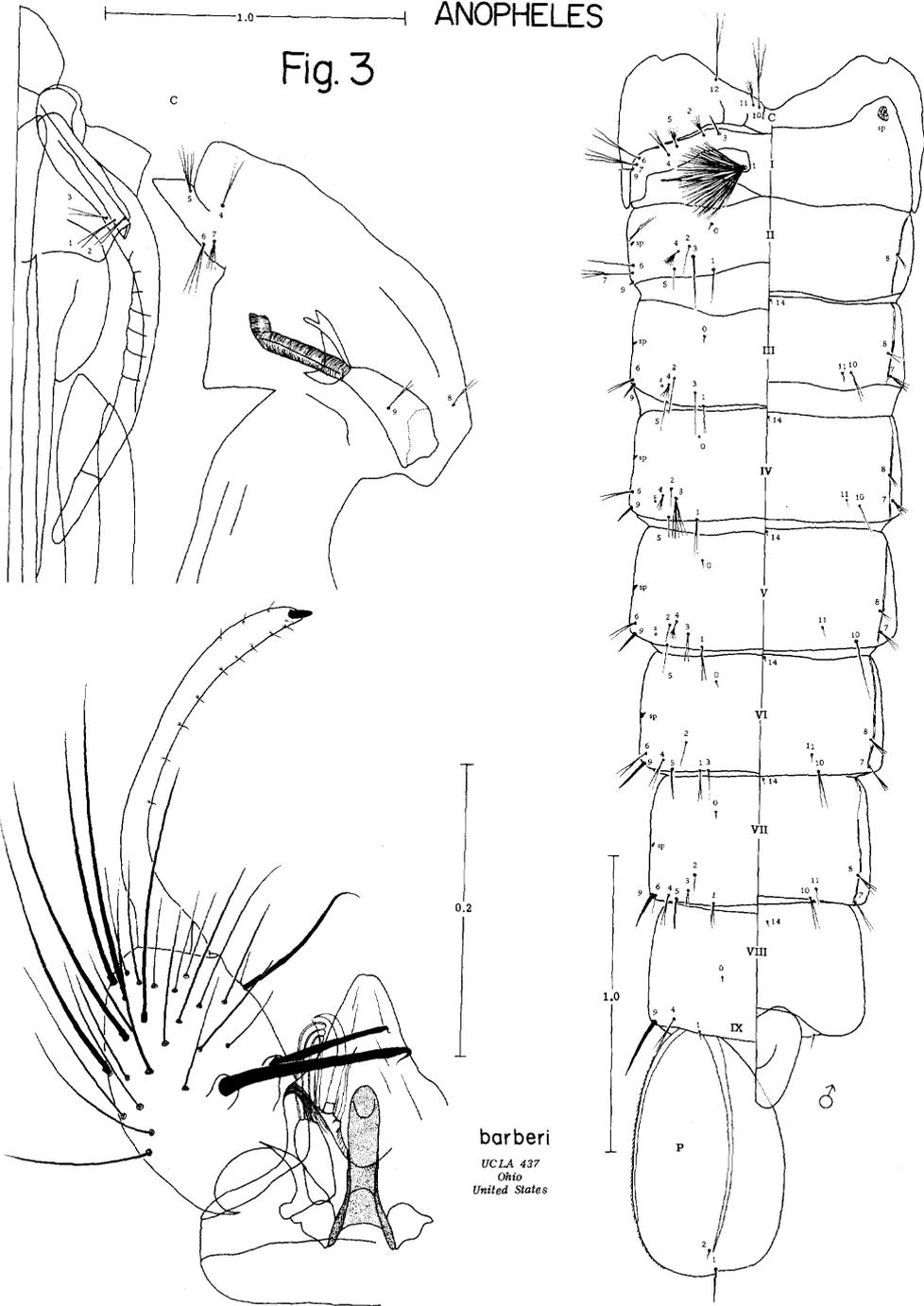
Fig. 2

ANOPHELES



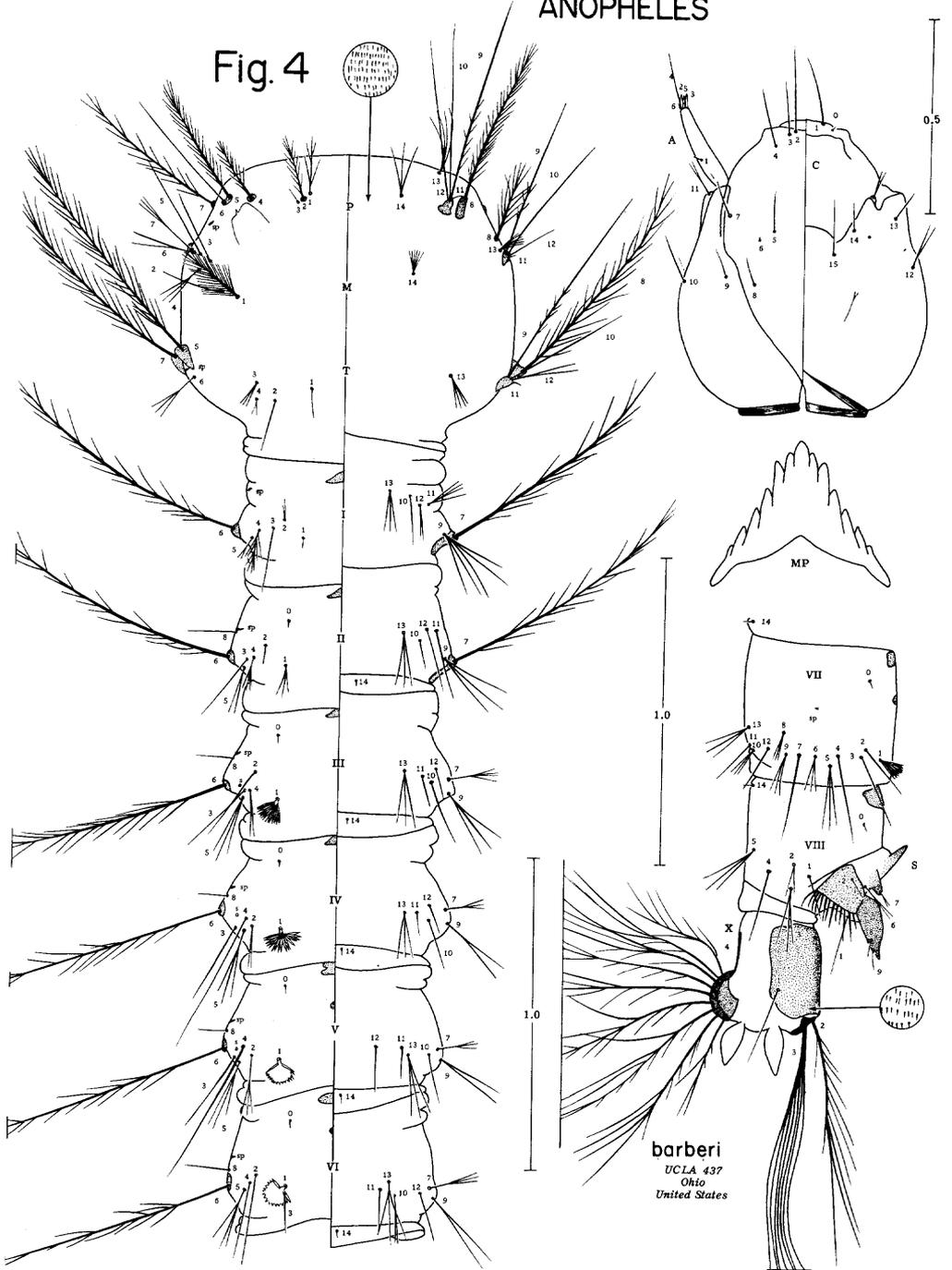
ANOPHELES

Fig. 3



ANOPHELES

Fig. 4



barberi
UCLA 437
Ohio
United States