THE BRAZILIAN MALARIA VECTOR *ANOPHELES (KERTESZIA) CRUZII*: LIFE STAGES AND BIOLOGY (DIPTERA: CULICIDAE)[1]

RICHARD C. WILKERSON AND E.L. PEYTON[2]

Department of Entomology, Walter Reed Army Institute of Research, Washington, DC 20307-5100

ABSTRACT. The Brazilian malaria vector *Anopheles (Kerteszia) cruzii* is described, with a review of its biology and relation to disease. Complete descriptions of the larva and pupa are provided for the first time.

INTRODUCTION

Anopheles (Kerteszia) cruzii Dyar and Knab is a primary vector of malaria parasites in littoral southern and southeastern Brazil. Even though all life stages have been studied by various researchers, the immatures have not been fully described, although incomplete descriptions and illustrations were given by Peryassú (1908) and Netto (1940). During field research in Iguape, São Paulo State, Brazil in 1989, the authors obtained progeny rearings from 11 females of this species. These progeny provide the basis for complete descriptions of the pupa and fourth instar larva of *An. cruzii*. Also included here are redescriptions of the male and female and a review of selected literature on biology, disease transmission and systematics.

MATERIALS AND METHODS

Morphological terminology, abbreviations and numbering of larval and pupal setae follow Harbach and Knight (1980, 1982). Wilkerson and Peyton (1990) is followed for wing spot nomenclature. The wing spot names defined by Wilkerson and Peyton (1990) differ greatly from Zavortink's (1973) treatment of *Kerteszia*. To assist the reader, these wing spots are labeled on the adult habitus drawing (Fig. 1). Range and modal number of setal branches for pupae and larvae are presented in Tables 1 and 2.

Measurements were made using Nikon SMZ-10 and Optiphot (differential interference contrast "NT") microscopes, with a camera lucida and a Summagraphics SummaSketch Model MM1201 using "INPAD" software written by Joseph L. Russo (Office of Information Management, Smithsonian Institution).

TAXONOMIC TREATMENT

***Anopheles (Kerteszia) cruzii* Dyar and Knab**

Dyar and Knab 1908:53; Zavortink 1973:23 (synonymy, references, key, illustrations).

Female (Fig. 1). Integument brown to dark brown with silvery gray pollinose markings. *Head:* Interocular space with frontal tuft of long, pale yellow setae and semierect, white, rounded spatulate scales, anterior scales about twice as long as others and projecting forward; vertex immediately posterior to frontal tuft with erect, white to very pale brown, rounded and truncate spatulate scales and a few long dark setae; remainder of vertex and occiput with erect, dark brown spatulate scales; postgena with tuft of small, white, spatulate scales and short, pale yellow setae at junction of eyes; ocular setae black. Clypeus bare. Pedicel of antenna yellowish brown, without scales; flagellomere 1 with a few small, mesal, brown scales. Scales of maxillary palpus slender and spatulate, dark brown except for a few white scales usually at apices of palpomeres 3-5, sometimes

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[2]Reprint requests: Walter Reed Biosystematics Unit, Museum Support Center, Smithsonian Institution, Washington, DC 20560.

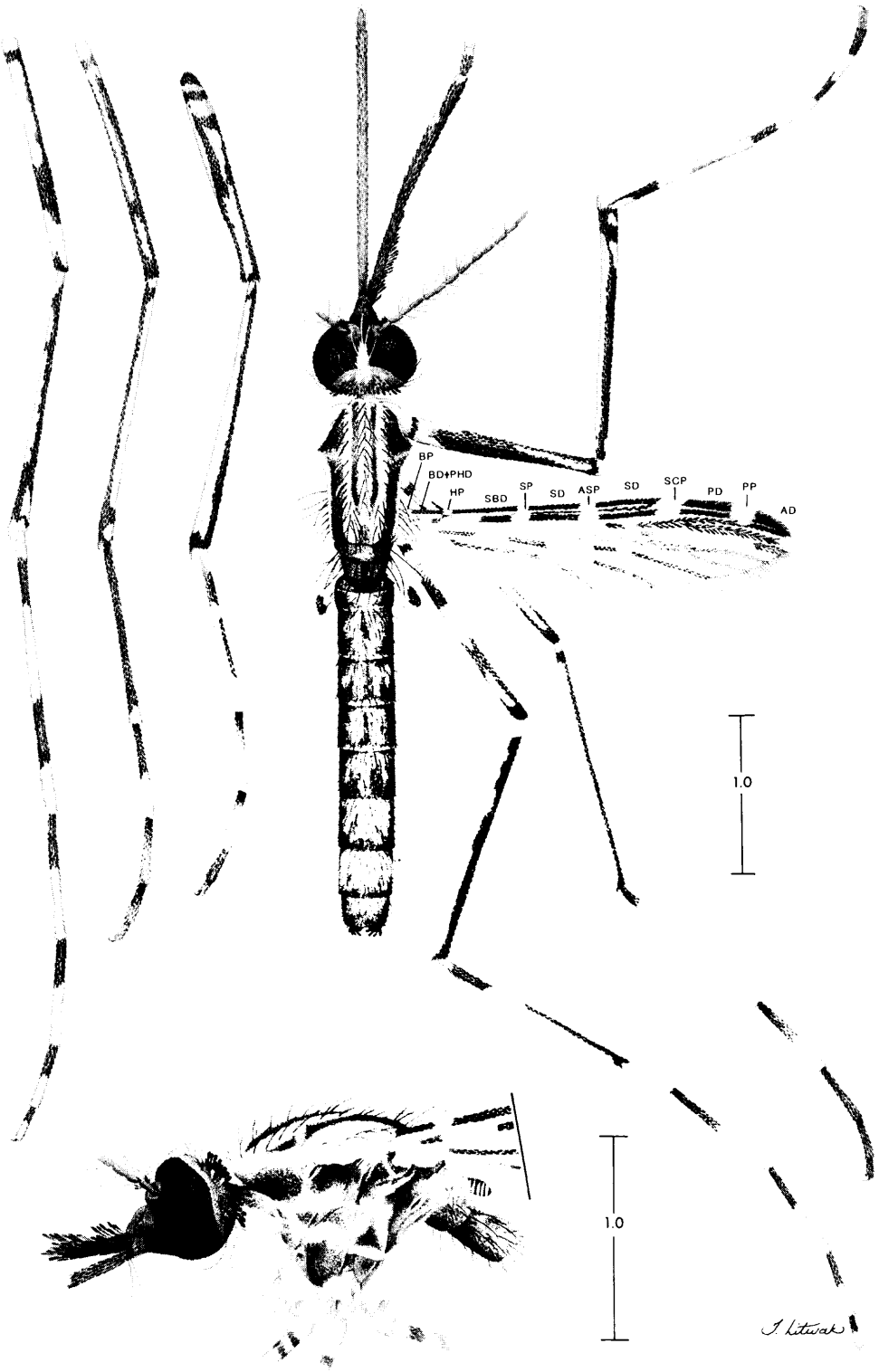

Fig. 1. *Anopheles (Kerteszia) cruzii*: Adult female. Abbreviations for wing spots as follow: BP = basal pale; BD = basal dark; PHD = prehumeral dark; HP = humeral pale; SBD = subbasal dark; SP = sector pale; SD = sector dark; ASP = accessory sector pale; SCP = subcostal pale; PD = preapical dark; PP = preapical pale; AD = apical dark.

absent; palpus with short dark brown setae intermixed; scales and setae of palpomere 2 and to a lesser extent those on base of palpomere 3, erect, contrasting with decumbent scales and setae on remainder of palpus; length of maxillary palpus (n = 10 for this and following measurements) 1.52-2.03 mm (mean 1.72); length palpomere 2/palpus length = 0.26-0.33 (mean 0.30), length palpomere 3/palpus length = 0.36-0.45 (mean 0.41), length palpomere 4/palpus length = 0.14-0.19 (mean 0.17), length palpomere 5/palpus length = 0.10-0.16 (mean 0.13). Proboscis with pale brown setae and decumbent dark brown spatulate scales, base with a few longer erect scales and setae; proboscis length 1.70-2.10 mm (mean 1.91), proboscis 1.02-1.23 (mean 1.11) length of maxillary palpus, 1.23-1.43 (mean 1.34) length of forefemur. *Thorax*: Integument dark brown, silvery pollinose, pattern of paler pollinosity on side of thorax and scutum as figured. Pale pollinosity on scutum defines 4 prominent longitudinal dark stripes, these not setose except for yellowish setae on scutal fossa; setae of scutum yellowish with somewhat longer dark brown acrostichal, dorsocentral and supraalar setae; pale median stripe with a very narrow, less well-defined dark stripe in its center; median anterior promontory with patch of white fusiform scales; lateral scutal fossa with well-defined line of short white spatulate scales; lower antealar area with a well-defined line of long white spatulate scales; supraalar area with a few long white spatulate scales. Scutellum with long dark brown setae. Mesopostnotum bare. Antepronotum with long dark brown setae and dark brown spatulate scales anteriorly and long pale yellow setae and a few white fusiform scales posteriorly. Pleural vestiture of white spatulate scales and yellowish brown setae as follows: upper proepisternum with 1 or 2 setae; prespiracular area bare; prealar area with a few setae and scales; prespiracular area with 2-4 setae and 0-4 scales; upper mesokatepisternum with discrete patch of scales and 1 or 2 setae; lower mesokatepisternum usually with patch of small scales on border with mesepimeron; upper mesepimeron with patch of scales and a few long scale-like setae; middle of mesepimeron with discrete patch of broad scales. *Legs*: Segments as figured, dark scales brown, pale scales pale yellowish white. Distribution of scales on coxae and trochanters as figured, all scales white except for a few dark brown scales on upper area of forecoxa. Foreleg: tarsomere 2 with apical 0.54-0.78 pale (mean 0.65) (n = 11, from 11 individuals, for this and following ratios); tarsomere 3 with apical 0.54-0.78 pale (mean 0.65). Midleg: tarsomere 2 with apical 0.13-0.58 pale (mean 0.43). Hindleg: tarsomere 1 with apical 0.11-0.26 pale (mean 0.19); tarsomere 2 with apical 0.44-0.59 pale (mean 0.52); tarsomere 3 with apical 0.47-0.67 pale (mean 0.57); tarsomere 4 with apical 0.39-0.58 pale (mean 0.47); tarsomere 5 with apical 0.25-0.59 pale (mean 0.45), one specimen entirely dark. *Wing* as figured: Length (n = 22 wings from 22 individuals) 2.54-3.01 mm (mean 2.81), width 0.56-0.69 mm (mean 0.62). Pale wing scales yellowish white on costa, somewhat paler on other veins; dark scales dark brown on costa, R, R_1 and base of CuA, and pale brown on other veins. Ratios of costal wing spots to wing length: basal pale 0.002-0.040 (mean 0.016); basal dark plus prehumeral dark (prehumeral pale not present) 0.07-0.12 (mean 0.09); humeral pale 0.01-0.04 (mean 0.03); subbasal dark (presector pale not present) 0.13-0.18 (mean 0.16); sector pale 0.03-0.07 (mean 0.04), absent in one specimen; sector dark (including accessory sector pale) 0.29-0.36 (mean 0.32); accessory sector pale 0.01-0.06 (mean 0.03), absent in one specimen; subcostal pale 0.03- 0.08 (mean 0.05); preapical dark 0.11-0.18 (mean 0.15); preapical pale 0.04-0.09 (mean 0.06); apical dark 0.04-0.09 (mean 0.07). Plume scales present on dorsal wing surface on veins R_s, R_{2+3}, R_2, R_3, M and M_{1+2}; plume scales present on ventral surface of wing on veins R_1 (basal 0.5), R_{4+5}, M_1, M_2, M_{3+4}, apex of CuA and apex of 1A. *Halter*: Scabellum, pedicel and basal 0.5 of capitellum with pale yellowish white integument, remainder of capitellum with dark brown integument, basal 0.5 of capitellum with a few pale yellowish-white scales, apical 0.5 with brown scales. *Abdomen* as figured: Integument brown to dark brown, covered with numerous dark brown setae, but without scales except for brown scales on cercus.

Male. Similar to female except for sexual differences. Maxillary palpus with sparse dark

brown scales, semierect on palpomere 2, decumbent on palpomere 3; mesal surfaces of all palpomeres largely without scales, palpomeres 4 and 5 with long dark brown setae; palpomere 3 usually with small dorsoapical patch of white scales, palpomere 4 with patch of white scales on dorsoapical 0.25, palpomere 5 with white scales on dorsoapical 0.75. *Genitalia* (Fig. 2): Parabasal seta on a long tubercle, apex truncate with a small cup-like depression; internal seta flattened and broadened apically, with a pointed tip. Ventral lobe of claspette with many long spicules except laterally; lateral expansion broad, its tergolateral margin rounded or sinuous. Aedeagus with stout, basally directed, lateral projections; projections approximately 0.33 length aedeagus.

Pupa (Fig. 2). Position and development of setae as figured; range and modal number of branches in Table 1. With a characteristic red color. *Cephalothorax*: Trumpet angusticorn, without meatal cleft; pinna variable, usually short but in some specimens quite long. Seta 13-CT, or its alveolus, present. *Abdomen*: Seta 2-5-IV close-set, usually more or less in line with each other. Seta 3-VI laterad of 1-VI (corresponds to position of 3-VI in larva). Seta 11-II, or its alveolus, usually present. Seta 1-VII on posterior margin of segment. Seta 14-III absent. Seta 9-II,III short, peg-like; 9-IV-VIII long, with strong lateral aciculae on V-VIII. Ratios of seta 9-II-VI,VIII to 9-VII as follow: II, 0.03-0.08 (mean 0.05); III, 0.07-0.16 (mean 0.11); IV, 0.38-0.72 (mean 0.51); V, 0.64-1.05 (mean 0.79); VI, 0.89-1.07 (mean 0.99); VIII, 0.81-1.01 (mean 0.88). *Paddle*: Index 1.65-2.01 (mean 1.83). Toothed margin index (Colless 1956) 0.97-1.03 (mean 1.00). Marginal serrations present, very short basally, about as long as 1-P distally. Dark pigmented area present near base. Seta 1-P 0.03-0.06 length of paddle (mean 0.04).

Fourth instar larva (Figs. 3,4). Position and development of setae as figured; range and modal number of branches in Table 2. With characteristic dorsal pattern of red pigment (Fig. 4), sometimes present on all segments of thorax and abdomen but most consistently on abdominal segments III and VI-VIII. *Head*: Antennal length 0.17-0.21 mm (mean 0.18); width 0.031-0.037 mm (mean 0.034); antenna curved slightly outward. Seta 1-A usually single (1 of 10 double), length 1.57-2.14 width of antenna (mean 1.88); distance of 1-A from base of antenna 0.15-0.29 length of antenna (mean 0.22); seta 4-A single or double. Seta 2-C 0.90-1.31 length of antenna (mean 1.08), sometimes with sparse aciculae; seta 3-C stout, 0.52-0.68 length of 2-C (mean 0.58), sometimes with stout aciculae; seta 4-C stout with stout aciculae, about as long as 2-C; setae 5,7-C aciculate; seta 11-C stout, with 4-9 branches. *Thorax*: Setae 9,10-P,M,T aciculate or sparsely aciculate; setae 2,3-M aciculate, 2-M with long basal aciculae. *Abdomen*: Seta 1-I-VII palmate, relatively small and weakly developed on I, leaflets moderately broad, lanceolate. Seta 3-VI laterad of 1-VI. Seta 4-VI sometimes aciculate. Seta 5-II-VI well developed, multi-branched. Seta 6-III-VI aciculate, of nearly equal development. Setae 3-II, 2,3,7-III, 2-IV, 2-V, sometimes 4-VI and 5-VII aciculate. Pecten teeth subequal in length, with fine basal spinules; spinules usually only on dorsal margin, but often found on both sides of ventral teeth. Saddle more darkly pigmented on basal and basoventral margins; posteroventral margin with long spicules, most posterior with 2-7 apical branches. Seta 2-X well developed, with relatively long branches, about as long as 3-X; most caudal seta of 4-X well developed, multibranched.

Systematics. *Anopheles cruzii* was first described as *An. lutzii* by Theobald (1901). The name however, was preoccupied by *An. (Nyssorhynchus) lutzii* Cruz (1901). *Anopheles cruzii* was proposed as a new name by Dyar and Knab (1908). See Zavortink (1973) for a complete synonymy and other references.

Females of *An. cruzii* can be distinguished from those of all other species of *An. (Kerteszia)*, except *An. homunculus* Komp, by the following characters: abdomen without scales; mesepimeron with upper and middle patches of scales; vein R_{4+5} with basal and long median pale scale spots; hindtarsomeres 2-5 with apical 0.4-0.7 pale; longer acrostichal, dorsocentral and scutellar setae dark; acrostichal and dorsocentral areas and scutellum without scales; basal 0.5 of vein M dark-scaled. *Anopheles homunculus* can be distinguished from *An. cruzii* by the following

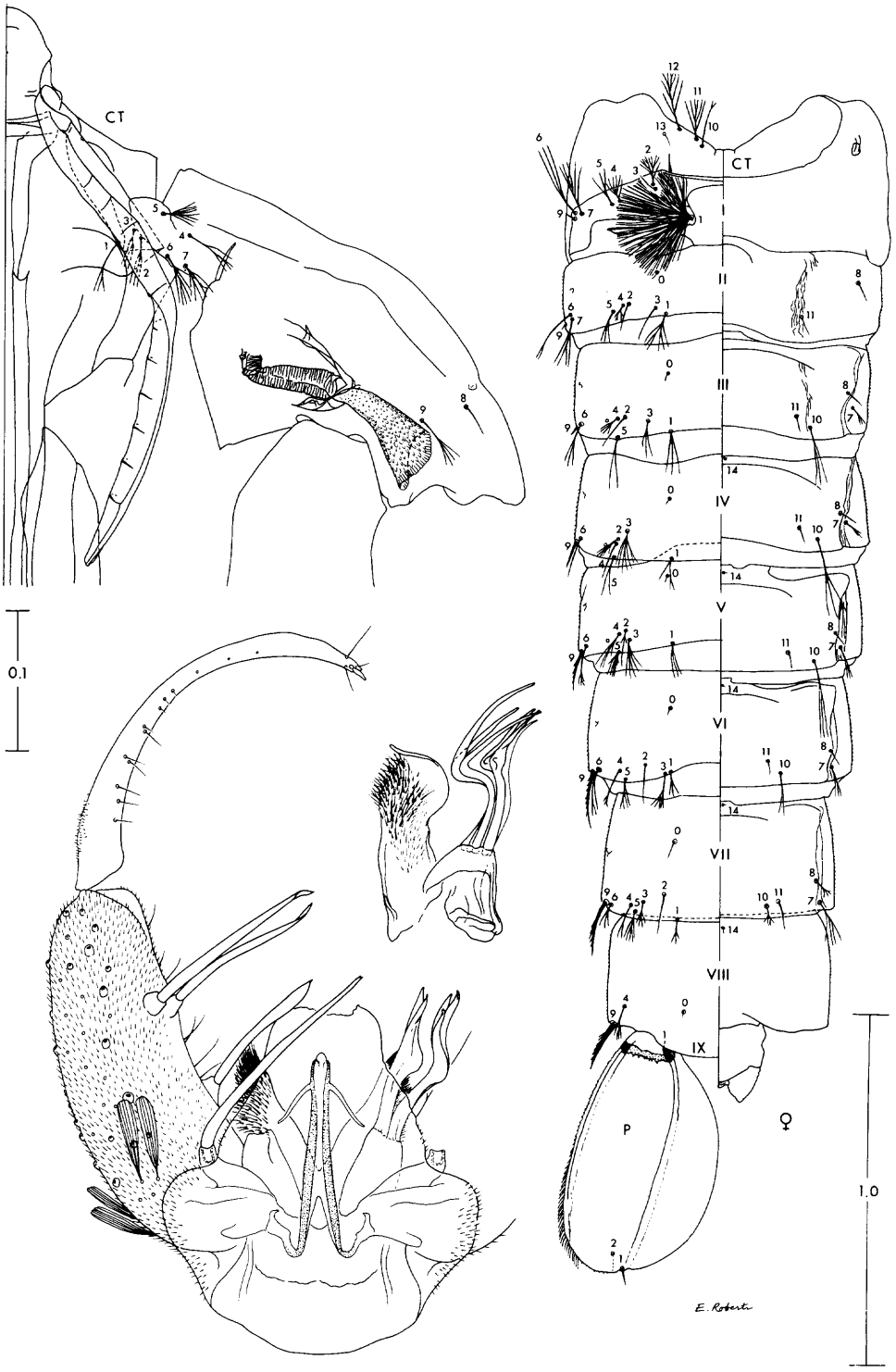

Fig. 2. *Anopheles (Kerteszia) cruzii*: Pupa and male genitalia.

Table 1. Pupal setal branching for *Anopheles (Kerteszia) cruzii*: range (mode). Ten setae counted.

Seta no.	Abdominal segments CT	I	II	III	IV
0	-	-	1	1	1
1	2-4 (3)	12-22*	3-7 (4)	3-6 (3)	2,3 (3)
2	2-4 (3)	4-11 (8)	1,2 (1)	1,2 (1)	2-5 (4)
3	2,3 (2)	1	1-3 (1)	1-3 (3)	5-9 (7)
4	2-7 (5)	6-11 (10)	4-10 (8)	3-7 (5)	1,2 (1)
5	6-10 (8)	1-4 (3)	2-4 (3)	2-4 (2)	1-4 (3)
6	4-9 (5)	2-5 (3)	1-4 (2)	1-3 (2)	1-3 (2)
7	4-9 (5)	5-8 (7)	3-6 (6)	1-4 (1)	1-4 (3)
8	1,2 (2)	-	1	1-3 (1)	1-3 (1)
9	4-7 (5)	1	1	1	1
10	2,3 (2)	-	-	2-5 (4)	2-4 (3)
11	4-7 (5)	-	1	1	1
12	6-12 (9)	-	-	-	-
13	1,2 (2)	-	-	-	-
14	-	-	-	-	1

Seta no.	Abdominal segments V	VI	VII	VIII	IX	Paddle P
0	1	1	1	1	-	-
1	1-3 (3)	2-5 (2)	1-9 (3)	-	1	1,2 (1)
2	1-6 (1)	1-4 (3)	1-5 (1)	-	-	1,2 (2)
3	4-7 (6)	3-7 (7)	4-8 (6)	-	-	-
4	3-7 (5)	3-6 (4)	2-6 (5)	4-8 (6)	-	-
5	3-7 (6)	2-6 (6)	3-7 (6)	-	-	-
6	1-4 (3)	2-4 (4)	1-5 (2)	-	-	-
7	1-4 (4)	3-5 (4)	3-5 (3)	-	-	-
8	1-3 (1)	1-3 (1)	1-8 (2)	-	-	-
9	1	1	1	1	-	-
10	2-4 (3)	1-5 (2)	2-7 (5)	-	-	-
11	1	1	1-3 (1)	-	-	-
12	-	-	-	-	-	-
13	-	-	-	-	-	-
14	1	1	1	1	-	-

* Primary branches.

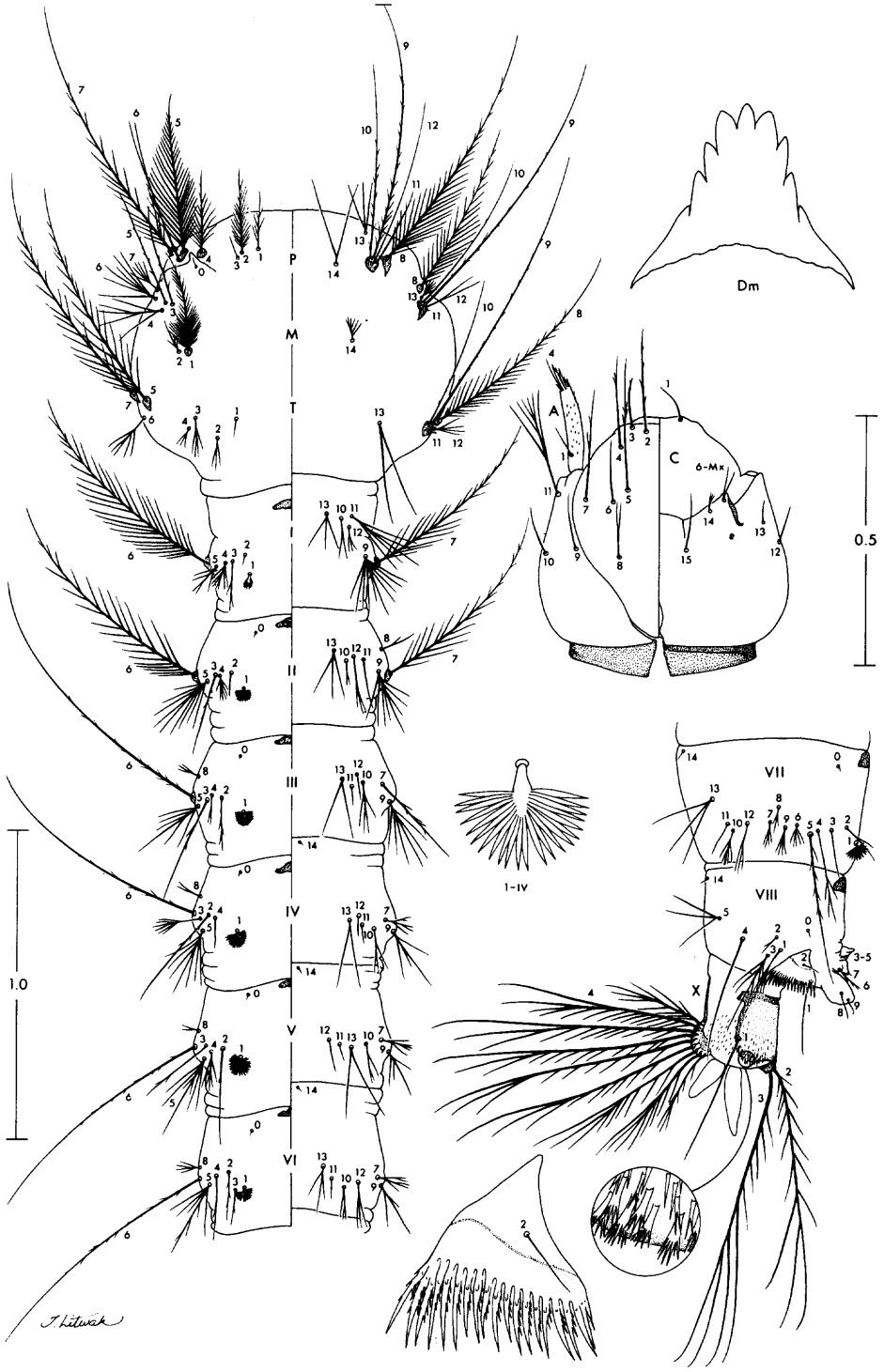

Fig. 3. *Anopheles (Kerteszia) cruzii*: Fourth-instar larva.

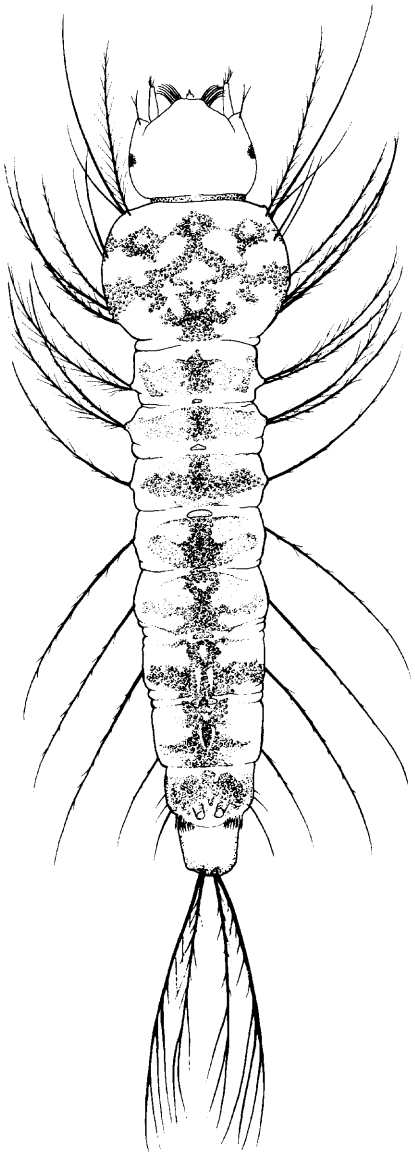

Fig. 4. *Anopheles (Kerteszia) cruzii*: Fourth-instar larva showing pattern of red pigmentation.

characters. *An. homunculus*: maxillary palpus with moderately to slightly erect scales on palpomere 3 and slightly erect to decumbent scales on palpomere 4; maxillary palpus with patch of white scales at apices of palpomeres 3, 4 and 5, apices of palpomeres 4 and 5, or only palpomere 4, if present on more than one palpomere it is largest on 4. *An. cruzii*: maxillary palpus with scales decumbent on palpomeres 3 and 4, sometimes slightly erect basally on 3; maxillary palpus with patch of white scales at apices of palpomeres 3-5, the patch on 3 equal to or larger than the patch on 4. We find these characters difficult to interpret for some specimens, but have found no others which will serve better.

Fourth instar larvae of *An. cruzii* are very similar to *An. homunculus* and *An. bellator* Dyar and Knab. All three species have seta 6-VI long and aciculate, seta 1-II-VII palmate and pecten teeth with spinules mostly only on one side. They can be distinguished, however, by the following combination of characters. *Anopheles cruzii*: pecten teeth subequal in length; leaflets of palmate setae lanceolate, not extended into long points and with smooth, unserrated sides; seta 3-C much more stout than 2-C; seta 5-II-V distinctly multibranched. *Anopheles homunculus*: pecten teeth alternating long and short; leaflets of palmate setae extended into long slender points with slightly serrated margins; seta 3-C much more stout than 2-C; seta 5-II-V with few basal branches. *Anopheles bellator*: at least median pecten teeth alternating long and short; leaflets of palmate setae extended into long slender points with smooth margins; seta 3-C nearly as stout as 2-C; seta 5-II-V distinctly multibranched.

The pupae of *An. cruzii*, *An. bellator* and *An. homunculus* are also similar. All three have seta 9-V long, paddle with short marginal serrations and setae 1,2-P present. They can be distinguished as follows. *Anopheles cruzii:* seta 12-CT well-developed, 6-12 branched; 9-IV relatively long, about 0.50-0.66 length of 9-V; 7-II 3-6 branched; paddle not highly pigmented. *Anopheles homunculus:* seta 12-CT usually 3-4 branched; 9-IV relatively short, about 0.25-0.50 length 9-V; 7-II 1-3 branched but usually single; paddle not highly pigmented. *Anopheles bellator:* seta 12-CT 3-4 branched; 9-IV relatively short, 0.25-0.33 length 9-V; 7-II 3-5 branched; paddle highly pigmented, as dark or darker than segment VIII, with few widely spaced marginal serrations in comparison to *An. cruzii* and *homunculus*.

The male genitalia of *An. cruzii* and *An. homunculus* are similar, but *An. homunculus* can be distinguished by its anteriorly projecting,

Table 2. Larval setal branching for fourth instar *Anopheles (Ker.) cruzii*: range (mode). Ten setae counted.

Seta no.	Head C	Thorax P	Thorax M	Thorax T	Abdominal segments I	Abdominal segments II	Abdominal segments III
0	-	1	-	-	-	1	1
1	1	3-6 (6)	32-50	1	11-14 (13)	19-29	18-29
2	1	18-24 (20)	1	1-3 (2)	1	1	1
3	1	1,2 (1)	1	3-5 (4)	1	1,2 (1)	1
4	1-3 (1)	17-25	3-6 (6)	2-4 (3)	3-10 (10)	4-7 (6)	1,2 (2)
5	1	27-45	1	25-37	3-9 (3)	6-13 (10)	5-9 (5)
6	1	2-4 (3)	3-6 (6)	4-7 (5)	25-35	23-35	1
7	1	20-43	3-7 (5)	25-40	22-37	21-38	1
8	1-3 (1)	26-47	27-34	24-43	-	1-4 (3)	1-3 (2)
9	1,2 (1)	1	1	1	6-11 (8)	6-11 (10)	5-12 (10)
10	1	1	1	1	1-4 (3)	1,2 (1)	3-6 (3)
11	4-9 (8)	1	1	1	3-7 (4)	1-5 (1)	1
12	1,2 (1)	1-4 (1)	2,3 (2)	2-4 (3)	2-5 (4)	1-3 (3)	1
13	1	3,4 (3)	5,6 (5)	1-3 (2)	2-5 (3)	3	2,3 (2)
14	1-3 (3)	2,3 (2)	5-9 (8)	-	-	-	-
15	1	-	-	-	-	-	-

Seta no.	Abdominal segments IV	V	VI	VII	VIII	X
0	1	1	1	1	1	-
1	25-34	18-32	21-30	12-16	2-7 (5)	1
2	1	1	1-4 (3)	1-3 (2)	1,2 (1)	14-18 (17)
3	5-11 (6)	1-6 (3)	1-3 (3)	1-4 (1)	4-7 (5)	8-14 (12)*
4	1,2 (1)	4-7 (5)	1-4 (1)	1	1,2 (1)	9,10 (9)**
5	3-9 (8)	5-8 (8)	4-10 (8)	1	3	-
6	1	1	1	3-6 (5)	-	-
7	3-7 (4)	3-6 (6)	3-7 (5)	4,5 (5)	1-S	1
8	1-3 (2)	2-4 (3)	2-4 (4)	2-5 (4)	2-S	1
9	3-5 (4)	3-5 (4)	2-5 (4)	2-4 (4)	6-S	3,4 (3)
10	2-4 (3)	2-6 (4)	3,4 (4)	4-8 (6)	7-S	1,2 (1)
11	1	1,2 (1)	1	1	8-S	1-3 (1)
12	1	1	3-6 (3)	3-6 (4)	9-S	1
13	2,3 (2)	2,3 (3)	3-5 (3)	2,3 (3)	-	-
14	1	1	1	1	1	-
15	-	-	-	-	-	-

* Primary stems only.
** Pairs.

pointed, lateral extension of the ventral lobe and much shorter and weaker lateral subapical aedeagal projections.

Through the examination of late prepupal stage larvae, we have determined that pupal seta 3-VI is positioned laterad of seta 1-VI in approximately the same positional relationship as that encountered in the larva. This is the reverse of the usual positional relationship of 3-VI to 1-VI encountered in the pupa of most other anophelines, although it is not unique. Belkin (1962) pointed out that pupal seta 3-VI was "laterad or at level of 1-VI, never distinctly mesad" in the South Pacific anopheline genus *Bironella*. Harrison and Scanlon (1975) showed larval and pupal seta 3-VI distinctly laterad of 1-VI in all members of the Umbrosus Group of the subgenus *Anopheles* in Thailand. Although of little practical application in the identification of species, the character has considerable phylogenetic significance.

Bionomics. Larvae of *An. cruzii*, as well as the larvae of most other members of the subgenus *Kerteszia*, are usually found in bromeliads. One exception is *An. bambusicolus* Komp, which utilizes bamboo. The presumably accidental occurrences of *An. cruzii* in rain water pools, a ditch and a river eddy were reported by Rachou and Ferreira (1947). The larvae develop very slowly; the specimens reared for this study required approximately 35 days from egg to adult in the laboratory. Egg clutches recovered from 11 females, engorged with human blood, were placed into 500 ml plastic rearing cups filled with water and a few dried leaves. Each clutch consisted of about 20-40 eggs and hatching occurred within 24 hours. A dry mixture of baby fish food, "TetraMin E and L," sprinkled on the surface of the water, was used to supplement any natural food organisms produced by the infusion of dead leaves. There appeared to be little or no growth of the larvae for the first 8-10 days but little mortality occurred. Once growth became apparent, it remained constant and relatively synchronous for all broods. Time constraints in the field did not allow the rearing of all of the progeny to the adult stage. The first faint indication of the characteristic reddish pigmentation described for the larva, illustrated in Fig. 4 (see also color illustration in Peryassú, 1908, Fig. 20), appears in live late third instars and becomes quite pronounced and easily seen in late fourth instars. The pupal stage lasted about 3 days and also exhibited a reddish color. In the field, Aragão (1968) reported that up to four months was needed for development.

Anopheles cruzii is usually the dominant anopheline species in its range (Guimarães and Arlé 1984; Guimarães et al. 1985; Forattini et al. 1968, 1986a, 1986b; Gomes et al. 1987). The best example of its relative abundance was documented by Rachou (1946a), who found that during a one year study in Santa Catarina nearly all the mosquitoes collected in houses (14,265, 93.3%) were this species. Females can be found throughout the year and are aggressive biters throughout the day and night, especially in primitive forest areas. They exhibit peak biting activity, however, during the evening crepuscular period, and another smaller one during the dawn crepuscular period (Guimarães and Arlé 1984; Guimarães et al. 1985; Forattini et al. 1968, 1986a, 1986b; Guimarães and Victorio 1986). Our observations on the behavior of this species closely parallel these published reports. Adult collections were made during daylight and early evening hours from a platform about 15 meters above the ground on the lower slope of a densely forested mountain, with at least some of the surrounding canopy on the downward side level with or slightly below the platform; and also from ground level below the platform. An adult biting collection was also made on January 27, 1989 just inside a park located at the edge of the city of Iguape, which borders a forested hillside. A pronounced peak of aggressive biting activity by this species began at sunset and lasted for about one and one-half hours. An occasional biting female was also encountered inside various patches of forest during daylight hours.

This species most commonly feeds in the canopy but readily bites at ground level and, less commonly, in the open away from the forest (Guimarães et al. 1985; Forattini et al. 1968, 1986b; Gomes et al. 1987). Deane et al. (1984) investigated the possibility that the canopy feeders might be a different species from those biting at ground level. Using a capture, mark and release experiment, they found the same

individuals biting at both levels. They noted that this does not rule out the possibility that two species could be present, both of which feed at ground level and in the canopy.

In another capture, mark, and release experiment, *An. cruzii* was found to disperse a distance of 1,000 m at a right angle to the predominant wind direction (Ferreira et al. 1969a). Correa et al. (1961) reported that *An. cruzii* crossed about 700 m of ocean from island larval habitats to a town. Adults of *An. cruzii* are long-lived; in the laboratory wild-caught specimens lived up to 31 days (Luz et al. 1977), and in the wild up to 56 days with an estimated average of 35 days (Ferreira et al. 1969b). Various aspects of *An. cruzii* biology were reported in a series of papers by researchers at the Federal University of Parana, Brazil. Luz et al. (1979) found that females collected in and near houses, or in the forest all had similar physiological ages: 80% nulliparous, 19% uniparous and 1% biparous. Borba et al. (1978) measured blood ingestion and found the average blood meal weighed 1.266 mg. Consolim et al. (1979a) discovered that when *An. cruzii* entered and fed in houses treated with DDT, they left without contacting the treated surfaces long enough to receive a fatal exposure. In contrast, in untreated houses *An. cruzii* rested for extended periods after feeding. They speculated that the mosquitoes were irritated by the DDT, and that this was part of the reason for residual cases of malaria in the area. Consolim et al. (1979b) found *cruzii* to be fully susceptible to DDT at the same site in spite of DDT usage over many years.

Disease transmission. In southeastern littoral Brazil, *An. cruzii* is a primary vector of human malaria (Rachou 1946a, 1946b, 1958) and monkey malaria (Deane et al. 1970, 1971). In addition, Lopes and Sacchetta (1974) isolated Boraceia virus, a member of the Anopheles B group, from *An. cruzii*. Neutralizing antibodies to the virus were found in 24% of the humans in Casa Grande, São Paulo State, as well as in many domestic and wild animals. Three other viruses, whose relation to human disease is not known, have been isolated from *An. cruzii* in São Paulo State. These are Guaratuba virus of the Guama group, Icoaraci virus from the Phlebotomus group and Tacaiuma virus from the Anopheles A group (Karabatsos 1985).

Distribution. Literature records for *An. cruzii* (Zavortink 1973) indicate a range for this species from Costa Rica to Argentina. Most of these records cannot be confirmed and we believe the true distribution is probably restricted to the coast and coastal mountains of southeastern Brazil to include the following states: ?Pernambuco, Sergipe, Bahia, Espírito Santo, Rio de Janeiro, Guanabara, São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul (Aragão 1964; Zavortink 1973, see his Fig. 2).

Material examined. 349 specimens (NMNH); 40 larval exuviae (Le), 55 pupal exuviae (Pe), 123 whole larvae (L), 16 males (♂), 2 male genitalia (G), 113 females (♀) as follow. **BRAZIL.** *São Paulo State*: Iguape, 11 progeny broods from adult females collected from human bait 27-I-1989 by Peyton and Wilkerson: BR 8(2), 2LePe♀, 3LePe♂; BR 8(3), 4LePe♀, 1LePe♂, 1Pe♂, 23L; BR 8(4), 2LePe♀, 1LePe♂, 1Pe♂; BR 8(5), 5LePe♀, 12L; BR 8(6), 1Pe♀, 11L; BR 8(7), 1LePe♀, 3Pe♀, 21L; BR 8(8), 2LePe♀, 2Pe♀, 10L; BR 8(9), 1LePe♀, 1LePe♂, 4L; BR 8(10), 2LePe♀, 3LePe♂, 2G, 2Pe♀, 18L; BR 8(11), 3LePe♀, 1Pe♀, 1Pe♂, 6L; BR 8(12), 2LePe♀, 3Pe♀, 4L; BR 8, 7LePe, 29♀, 13L; Município de Salesópolis, Est. Biol. Boracéia, 1-3-IV-1977, C.M. and O.S. Flint, 15♀; C. do Jordão, 20-III-1937, PCAA coll., 1♂; Serra do Mar, 21-VI-1965, J.P. Duret, 3♀. *Rio de Janeiro State*: "Rio de Janeiro," USNM 139, Mark F. Boyd, 1L. *Santa Catarina*: Florianópolis, VI-1953, J.P. Duret, 6♀; J.P. Duret, 1♂; Brusque, 26-VI-1953, VI-1953, J.P. Duret, 4♀, 2♂; Caldas de imperatriz, VI-1953, 26-VI-1953, J.P. Duret, 6♀. *Paraná*: Boguazu, 26-I-1965, J.P. Duret, 3♀; Costeloes (?Casteloes), 22-II-1964, J.P. Duret, 1♀; Guaratuba, 24-III-1964, 25-III-1964, 31-III-1964, 24-I-1965, 26-I-1965, J.P. Duret, 10♀.

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