ANOPHELES (ANOPHELES) CALDERONI N.SP., A MALARIA VECTOR OF THE ARRIBALZAGIA SERIES FROM PERU (DIPTERA: CULICIDAE)[1]

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ABSTRACT. *Anopheles (Anopheles) calderoni*, a new species in the Arribalzagia Series, is described. Descriptions and illustrations are given for the adult, larval and pupal stages. This species is purported to be an important vector of malarial parasites in western Peru.

INTRODUCTION

The species that has been called *Anopheles (Anopheles) punctimacula* Dyar and Knab on the Pacific side of the Andes in Colombia, Ecuador and Peru is recognized by many as a vector of malarial parasites (Levi Castillo 1949, Russell et al. 1963, Calderon et al. 1974, G. Calderon and E. Rogers personal communication 1990). However, a recent study and redescription of *An. punctimacula* by Wilkerson (1990) revealed that the species treated by the above authors is not *punctimacula*, but a morphologically similar, undescribed species. This species, from the departments of Piura, Lima and Ica in Peru, is described here as *An. (Ano.) calderoni* n. sp.

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. Range and modal number of setal branches for larvae and pupae are presented in Tables 1 and 2. Setal branching counts that differ from 2 closely related species, *An. punctimacula* and *An. malefactor* Dyar and Knab, are given in the text and in Tables 3 and 4. Insufficient immature material of another similar species, *An. guarao* Anduze and Capdevielle, was available to include in this comparison; however, known salient differences from all life stages among all 4 species are given in Table 5. Descriptive statistics for costal wing spot lengths are given in Table 6. 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). Illustrations were produced from the holotype unless otherwise noted.

TAXONOMIC TREATMENT

Anopheles (Anopheles) calderoni, new species (Figs. 1-4)

Diagnosis. *Anopheles calderoni* can be distinguished from the other members of the Arribalzagia Series by a combination of characters from 3 life stages. *Adult*: Scutum with 3 distinct dark spots; upper mesepimeron with small patch of pale scales; femora and tarsi speckled, hindtarsomere 5 pale or with small dark spot; wing with sector dark and preapical dark spots darkened and therefore more distinct than other dark costal spots, costal dark spots dark brown, costal pale spots white, remaining pale wing scales pale yellowish with intermixed white patches; abdominal terga II-VII with dark posterolateral scale tufts, sternum I bare, other sterna with numerous dark brown and white scales; aedeagus with 3 pairs of leaflets, first pair with thin, nearly transparent margin; ninth tergal lobes short, slender and widely separated,

[1]The views of the author do not purport to reflect the views of the Department of the Army or the Department of Defense.

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Table 1. Pupal setal branching for *Anopheles calderoni* paratypes: range, mode ( ). Twenty setae counted except 1-II (59).

Seta no.	Abdominal segments CT	I	II	III	IV
0	-	-	1	1,2 (1)	1
1	1-3 (2)	6-16 (12)	3-12 (7)	4-12 (7)	3-6 (5)
2	1-3 (2)	1-7 (4)	3-7 (5)	3-6 (5)	2-4 (3)
3	1-3 (2)	1-3 (2)	1	1,2 (1)	2-5 (4)
4	1-4 (3)	3-6 (4)	1-6 (4)	1-4 (3)	1-4 (3)
5	1-3 (2)	1-3 (2)	2-5 (3)	3-9 (6)	2-4 (3)
6	1,2 (2)	1-3 (2)	1,2 (1)	1,2 (1)	1
7	1-3 (2)	1	2,3 (2)	2-4 (3)	2-5 (3)
8	1-4 (2)	-	-	1-3 (2)	1,2 (1)
9	1,2 (2)	1	1	1	1
10	2-4 (2)	-	1,2 (1)	1-4 (2)	1,2 (1)
11	2-4 (3)	-	-	1,2 (1)	1,2 (1)
12	1-3 (2)	-	-	-	-
13	-	-	-	-	-
14	-	-	-	1	1,2 (1)

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

apices somewhat striated. *Pupa*: Trumpet without tragus, lobes of secondary cleft about 0.5 length of pinna; paddle ovoid, marginal spicules about 0.5 length 1-P. *Fourth instar larva*: Seta 2-C simple or with a few short median aciculae, 3-C short, with relatively few branches (range 1-11, mean 4.2); pecten teeth alternating large and small; 1-X not inserted on saddle.

Female (Fig. 1). Integument brown to dark brown, grayish brown pollinose. *Head*: Interocular space with frontal tuft of 12-19 long, pale yellow setae and row of small, pale yellow,

Table 2. Larval setal branching for fourth instar *Anopheles calderoni* paratypes: range, mode ( ). Twenty setae counted except 3-C (58), 9-I (54), 8-II (52), 6-IV (50) and 6-V (47).

Seta no.	Head	Thorax			Abdominal segments		
	C	P	M	T	I	II	III
0	-	1	-	-	-	1	1
1	1	5-10 (8)	10-27 (23)	1-5 (3)	6-14 (10)	10-17 (10)	14-24 (18)
2	1	8-15 (12)	2-6 (3)	1	1-6 (4)	5-7 (5)	3-6 (6)
3	1-11 (3)	1,2 (1)	1,2 (1)	9-17 (12)	1-6 (1)	1	1
4	1-4 (2)	11-18 (14)	1-3 (1)	3-8 (4)	4-10 (7)	5-9 (6)	2-5 (4)
5	13-20 (18)	20-38 (32)	1	20-30 (30)	3-7 (5)	4-12 (8)	5-9 (7)
6	12-19 (15)	1,2 (1)	1-5 (3)	2-4 (2)	16-27 (25)	22-28 (25)	19-28 (27)
7	13-19 (16)	23-34 (27)	3-5 (3)	14-28 (26)	14-23 (20)	18-28 (22)	3-5 (3)
8	7-10 (9)	22-34 (25)	8-17 (15)	20-30 (28)	-	2-5 (3)	1-4 (2)
9	4-10 (7)	1	1	1	1-7 (5)	6-11 (8)	5-8 (7)
10	2-6 (3)	1	1	1,2 (1)	1,2 (1)	2-4 (3)	1-3 (1)
11	21-39 (26)	1-4 (2)	1	1,2 (1)	2,3 (3)	1	1-4 (2)
12	3-5 (4)	1	1	1-3 (2)	1-3 (2)	1	1-4 (3)
13	3-6 (6)	5-13 (12)	5-8 (7)	2-5 (3)	7-13 (8)	8-13 (12)	6-13 (9)
14	1-4 (3)	3-5 (4)	9-17 (11)	-	-	-	-
15	2-5 (3)	-	-	-	-	-	-

Seta no.	Abdominal segments					
	IV	V	VI	VII	VIII	X
0	1	1	1	1	1	-
1	13-23 (19)	14-22 (19)	17-22 (19)	9-21 (17)	1	1
2	2-4 (2)	2,3 (2)	4-8 (4)	4-11 (8)	4-10 (7)	17-27 (24)
3	1-4 (3)	1-3 (1)	1	2-4 (3)	5-9 (7)	4-7 (6)*
4	3-5 (4)	4-7 (5)	1	1	1	9-10 (10)**
5	3-7 (5)	4-9 (5)	7-10 (9)	7-13 (12)	4-8 (5)	-
6	1-3 (1)	1-3 (2)	4-9 (5)	2-6 (4)	-	-
7	2-4 (3)	2-4 (3)	2-4 (3)	2-11 (8)	1-S	4-7 (5)
8	1-3 (1)	1-4 (2)	2-5 (3)	4-7 (5)	2-S	4-7 (6)
9	6-12 (8)	7-11 (9)	7-11 (9)	3-7 (6)	6-S	1-3 (1)
10	1,2 (1)	1	2-5 (3)	4-9 (6)	7-S	1
11	1-4 (2)	3,4 (4)	2,3 (2)	1-3 (2)	8-S	2-4 (3)
12	3-5 (4)	2-5 (3)	1	1	9-S	2-5 (3)
13	3-8 (6)	4-6 (5)	5-12 (11)	2-5 (4)	-	-
14	1	1	1	1,2 (1)	-	-
15	-	-	-	-	-	-

*Primary stems only.
**Pairs.

Table 3. Comparison of selected pupal setal counts for *An. malefactor, An. calderoni* and *An. punctimacula.*

	malefactor			*calderoni*			*punctimacula*		
Seta	*n*	range	mean	*n*	range	mean	*n*	range	mean
8-CT	26	2-4	2.9	20	1-4	2.5	49	1-2	1.2
12-CT	10	1-2	1.2	20	1-3	1.8	31	1-3	1.1
2-I	29	1-6	3.7	20	1-7	4.6	51	1-4	2.5
4-I	10	2-7	4.3	20	3-6	4.6	31	1-6	3.1
1-II	9	10-20	12.7	59	3-12	7.1	31	6-24	12.7
2-II	10	5-10	7.1	20	3-7	4.8	32	3-7	5.7
10-II		(absent)			1-2	1.3	37	1-3	2.0
					(present in 4 of 20)				
1-III	10	3-16	10.8	20	4-12	7.1	32	6-13	9.3
5-III	9	5-15	10.1	20	3-9	6.5	32	5-10	7.2
7-III	29	1-4	2.2	20	2-4	3.0	51	1-3	1.8
11-III	30	1-3	1.8	20	1-2	1.2	49	1-2	1.4
7-IV	10	1-4	2.0	20	2-5	3.0	32	1-3	1.6
1-V	10	1-5	2.7	20	3-6	3.9	31	1-5	2.5
8-V	10	1-3	1.6	20	1-2	1.1	32	1-3	1.5
3-VI	10	2-5	3.0	20	2-4	2.8	31	1-3	1.8
8-VI	10	1-3	2.0	20	1-2	1.1	32	1-3	1.8
3-VII	30	1-5	3.0	20	1-4	2.9	49	1-4	1.9

appressed scales bordering eyes; vertex, occiput and postgena with numerous erect, brown, truncate spatulate scales; longer, slender, pale yellow spatulate scales intermixed near and at vertex; patch of broader and darker scales on side of head concolorous with similar scales on anterior promontory and upper antepronotum; each side of head with 8-10 long, brown, ocular setae; postgena with long, dark brown setae and small patch of broad, pale yellow spatulate scales ventrally at junction of eyes. Clypeus bare. Pedicel of antenna with 8-17 small, dorsolateral, narrow to broad, pale yellow spatulate scales; flagellomere 1 with 6-13 narrow to broad, mesal, pale yellow spatulate scales. Scales of maxillary palpus slender and spatulate, dark brown and pale yellow with intermixed dark brown setae; scales and setae of palpomere 2, and to lesser extent 3, more erect than on other palpomeres; pale yellow scales present at joints of palpomeres 2-3, 3-4, 4-5, apex of 5, in basal dorsomesal patch on palpomere 2 and sparsely intermixed on palpomeres 3-5; length of maxillary palpus 1.72-2.28 mm (mean 1.89) (n = 21 for this and following measurements); ratio of length of palpomeres 2-5 to total length of palpus, 2 = 0.24-0.32, 3 = 0.30-0.43, 4 = 0.16-0.26, 5 = 0.1-0.15; ratio of palpomere 4 to 5 1.37-2.38 (mean 1.75); palpus 0.88-1.28 (mean 1.13) forefemur length. Proboscis with brown setae and decumbent dark brown spatulate scales, base with some longer erect scales and setae; proboscis length 1.96-2.44 mm (mean 2.14), proboscis 1.05-1.25 (mean 1.14) palpus length. *Thorax*: Integument brown to dark brown, silvery pollinose, pattern of paler pollinosity on side of thorax as figured. Scutum with 3 prominent black spots, 2 at ends of and slightly posterior to prescutal sutures, and another in prescutellar area continuing onto scutellum. Scutal setae numerous and predominantly pale yellow, except 5-12 posterior dorsocentral and 5-10 supraalar setae, these setae usually dark brown and longer than scutal setae; scutum mottled with small dark spots roughly corresponding, but not restricted to, setal insertions in acrostichal and

Table 4. Comparison of selected larval setal counts for *An. malefactor, An. calderoni* and *An. punctimacula*.

	malefactor			*calderoni*			*punctimacula*		
Seta	*n*	range	mean	*n*	range	mean	*n*	range	mean
3-C	12	7-16	11.5	58	1-11	4.2	20	3-8	4.4
8-C	12	5-9	6.6	20	7-10	8.4	19	3-8	4.5
9-C	12	2-6	4.3	20	4-10	6.9	19	2-6	4.3
10-C	12	1-4	2.2	20	2-6	3.5	19	2-3	2.5
1-P	11	3-6	4.6	20	5-10	7.2	13	4-7	6.1
11-P	12	1-2	1.1	20	1-4	1.8	14	1	
14-M	12	8-15	10.2	20	9-17	11.8	12	7-9	7.9
2-I	11	2-4	3.1	20	1-6	4.4	14	3-4	3.6
9-I	12	3-9	5.4	54	1-7	4.9	13	3-4	3.3
8-II	11	2-5	3.6	52	2-5	3.0	11	1-2	1.8
9-III	12	7-14	9.2	20	5-8	6.5	14	4-9	5.8
6-IV	12	1		50	1-3	1.6	12	1	
4-V	12	4-6	4.6	20	4-7	5.5	14	3-5	3.9
6-V	12	1		47	1-3	1.8	9	1	
13-V	12	3-6	4.6	20	4-6	4.9	13	2-5	3.2
6-VI	10	3-7	5.1	20	4-9	5.4	13	2-4	3.2
3-VII	10	3-5	4.4	20	2-4	3.3	13	4-6	4.7
5-VII	12	6-10	8.2	20	7-13	10.6	12	5-9	6.8
7-VII	12	3-10	6.3	20	2-11	7.3	10	3-5	4.2
5-VIII	11	5-6	5.4	20	4-8	5.7	11	3-5	4.1

dorsocentral areas; median anterior promontory with a prominent patch of long, pale yellow falcate scales; scutal fossa usually with scattered, pale yellow spatulate scales, anterior scutal fossa with patch of broad, mostly dark brown scales; supraalar area with mixture of spatulate, elongate, fusiform and falcate scales. Scutellum with 20-30 (9 to 20 specimens used for this and following counts) shorter, pale yellow, and 12-19 long, dark and evenly spaced setae. Antepronotum with 13-20 yellowish to dark brown setae and 5-13 upper, usually all dark, and 3-7 lower, usually all pale, spatulate scales. Pleural vestiture as follows: all scales pale yellow and spatulate, upper proepisternum with 3-5 setae, 0-1 scales; prespiracular area with 3-5 setae; prealar area with 5-10 setae, 1-3 scales; upper mesokatepisternum with 3-9 setae, 2-12 scales; lower mesokatepisternum with 2-5 setae, 3-13 scales; upper mesepimeron with 2-7 setae, 2-7 scales. *Leg*: Segments as figured, dark scales dark brown, pale scales nearly white to very pale yellow, scales and setae at apices of fore- and hindtibiae yellow. Distribution of scales on coxae and trochanters as figured. Extent and number of pale spots on legs variable. Bases of femora and tibiae pale. Mid- and hindfemora with ventral pale stripes, stripe on midfemur often discrete and with even borders; apex of hindtibia sometimes less extensively pale than shown; foretarsomere 1 with pale ventral stripe, articulations of foretarsomeres sometimes with more extensive pale scales than shown; midtarsomere 2 sometimes with intermixed pale scales, apical pale scales at articulations of midtarsomeres 1-2, 2-3, 3-4 often more extensive than shown, midtarsomere 5 pale or with a small dark spot; articulations of hindtarsomeres 1-2, 2-3 and 3-4 with pale scales predominantly at apices of tarsomeres, less on base of following tarsomere, hindtarsomere 5 usually pale but sometimes with a small dark spot. Leg lengths and

Table 5. Comparison of salient characters among species of the Arribalzagia Series that have the first pair of aedeagal leaflets with a broad transparent margin.

Character	*An. calderoni*	*An. punctimacula*	*An. malefactor*	*An. guarao*
Upper mesanepimeral scales	present	absent	present	present
Pale wing scales on posterior veins	pale yellow with scattered white	usually all yellow	mostly white but with some very pale yellow	white
Postsubcostal pale spot on veins C and R_1	separated by dark scales	contiguous	contiguous	contiguous
Scales on R_1 at postsubcostal pale spot	usually all dark	predominantly pale	predominantly pale	predominantly pale
Hindtarsomere 5	usually pale, sometimes with dark spot	usually with a dark band	pale	pale
Larval seta 3-C branches	1-11, mean = 4.2	3-8, mean = 4.4	7-16, mean = 11.5	?
Larval seta 1-X insertion	not on saddle	not on saddle	on saddle	not on saddle (n = 2)
Secondary cleft of trumpet/ pinna	0.36-0.55, mean 0.47	0.31-0.44, mean 0.37	0.47-0.56, mean 0.51	?
Distribution	Pacific lowlands of Peru, ?Ecuador, ?southern Colombia	Mexico, Central America, N. Colombia N. Venezuela	Panama and adjacent N. Colombia	N. Venezuela, Trinidad

ratios (n = 16): foreleg 5.53-7.78 mm (mean 6.62), 1.82-2.1 wing length; midleg 6.75-8.84 mm (mean 7.8), 2.2-2.5 wing length; hindleg 8.28-11.28 mm (mean 9.64), 2.73-3.08 wing length. *Wing* (Table 6): Length (measured from humeral crossvein) 2.92-3.97 mm (mean 3.43) (n = 27). Dark scales brown with darker scales on presector dark, sector dark and preapical dark spots; pale wing scales mostly pale yellow but costal pale spots with white scales, and with scattered white scale patches, commonly found on vein 1A, base of CuA and near base of M_{3+4} and sometimes other areas. Basal pale spot sometimes present, made up of 1 to a few scales. Prehumeral pale spot apparently absent, although 2 specimens with single pale scale at that

Table 6. *Anopheles calderoni*: Descriptive statistics for ratios of costal wing spots lengths to length of wing from 27 wings (17 individuals) (wing length measured from the humeral crossvein).

Wing Spot	Range	Mean	SD
Humeral Pale	0.01-0.03	0.02	0.01
Humeral Dark	0.03-0.12	0.09	0.02
Presector Pale	0.01-0.03	0.02	0.01
Presector Dark	0.05-0.14	0.09	0.02
Sector Pale	0.06-0.14	0.10	0.02
Accessory Sector Dark	0.04-0.10	0.06	0.02
Sector Dark	0.11-0.18	0.15	0.02
Subcostal Area	0.24-0.31	0.28	0.02
Presubcostal Dark	0.02-0.06	0.04	0.01
Presubcostal Pale (proximal)	0.01-0.06	0.02	0.01
Presubcostal Pale (distal)	0.01-0.03	0.02	0.01
Postsubcostal Dark	0.07-0.12	0.10	0.01
Postsubcostal Pale (proximal)	0.01-0.04	0.02	0.01
Postsubcostal Pale (distal)	0.02-0.06	0.04	0.01
Subcostal Dark	0.01-0.04	0.02	0.001
Preapical Dark	0.10-0.18	0.13	0.016
Preapical Pale	0.09-0.12	0.11	0.01
Accessory Preapical Dark	0.04-0.07	0.05	0.01
Apical Dark	0.01-0.03	0.02	0.01

location. Subcosta basad of humeral crossvein with patch of dark scales ventrally, sometimes with 1 to a few white scales. Humeral crossvein dark-scaled dorsally and ventrally. Accessory sector dark spot sometimes missing from costa; 2 pre- and 2 postsubcostal pale spots and 1 pre- and 1 postsubcostal dark spot usually present, 1 specimen without presubcostal dark spot; apical dark spot often absent, if present, represented by a few scales at end of R_1 and sometimes dark scales on fringe (figured holotype lacks apical dark spot); if apical dark spot absent, then tip of wing pale from R_1 to R_{4+5}. Spots on posterior veins variable: R_{4+5} sometimes nearly all pale-scaled, M_2 sometimes with 2 pale spots, mcu at CuA often dark-scaled, CuA basad of mcu often paler than shown, 1A with 4-7 pale spots. Pale fringe spots sometimes indistinct, usually present at ends of cells M_1, M_2, M_{3+4} and at end of vein CuA. *Halter*: Scabellum and pedicel with pale brown integument, capitellum with dark brown integument; pedicel and capitellum white-scaled dorsally except for dark-scaled apical margin, concave center of capitellum without scales, capitellum dark-scaled ventrally. *Abdomen*: Integument dark brown with some grayish brown pollinosity. Terga with numerous long yellowish setae; terga II-VII with erect, posterolateral, dark scales and anterolateral, broad, white spatulate scale patches (seen in uncollapsed specimens), occasionally other scattered pale scales present laterally; tergum VIII with posterior and posterolateral, narrow, pale yellow and white spatulate scales and also with patches of posterolateral, dark spatulate scales. Cercus with basal pale yellow and apical dark brown scales. Sterna with scattered yellow to brown setae, not as abundant as on terga. Sternum I without scales; sterna II-VII with scattered, broad, white spatulate scales and posteromesal patches of broad, dark, spatulate scales, more numerous and prominent on sternum VII; sternum VIII with scattered, narrow, pale yellow and white spatulate scales. Lateral edges of segments II-VII each with 2 even rows of about 6-8 setae (seen in uncollapsed specimen).

Male (Figs. 2, 3). As in female except for sexual differences. Maxillary palpus 2.16-2.56 mm (mean 2.36) (n = 11 for this and following measurements), 0.84-0.92 length of proboscis; apex of palpomere 3 and all of 4 and 5 enlarged, palpomere four 1.74-3.40 (mean 2.67) broader than base of palpomere 3. Maxillary palpus dark brown and yellow-scaled; basal 0.33 of palpomere 2 with erect scales, base with dorsomesal patch of yellow scales; articulation between palpomeres 2-3 pale yellow-scaled; apex of palpomere 3 with dorsal patch of pale yellow scales; palpomere 4 variable, mostly yellow-scaled, usually with discrete area of dark scales at apex; palpomere 5 variable, mostly pale-scaled; palpomeres 4 and 5 mostly bare mesally, 4 with very long yellow setae dorso- and ven-

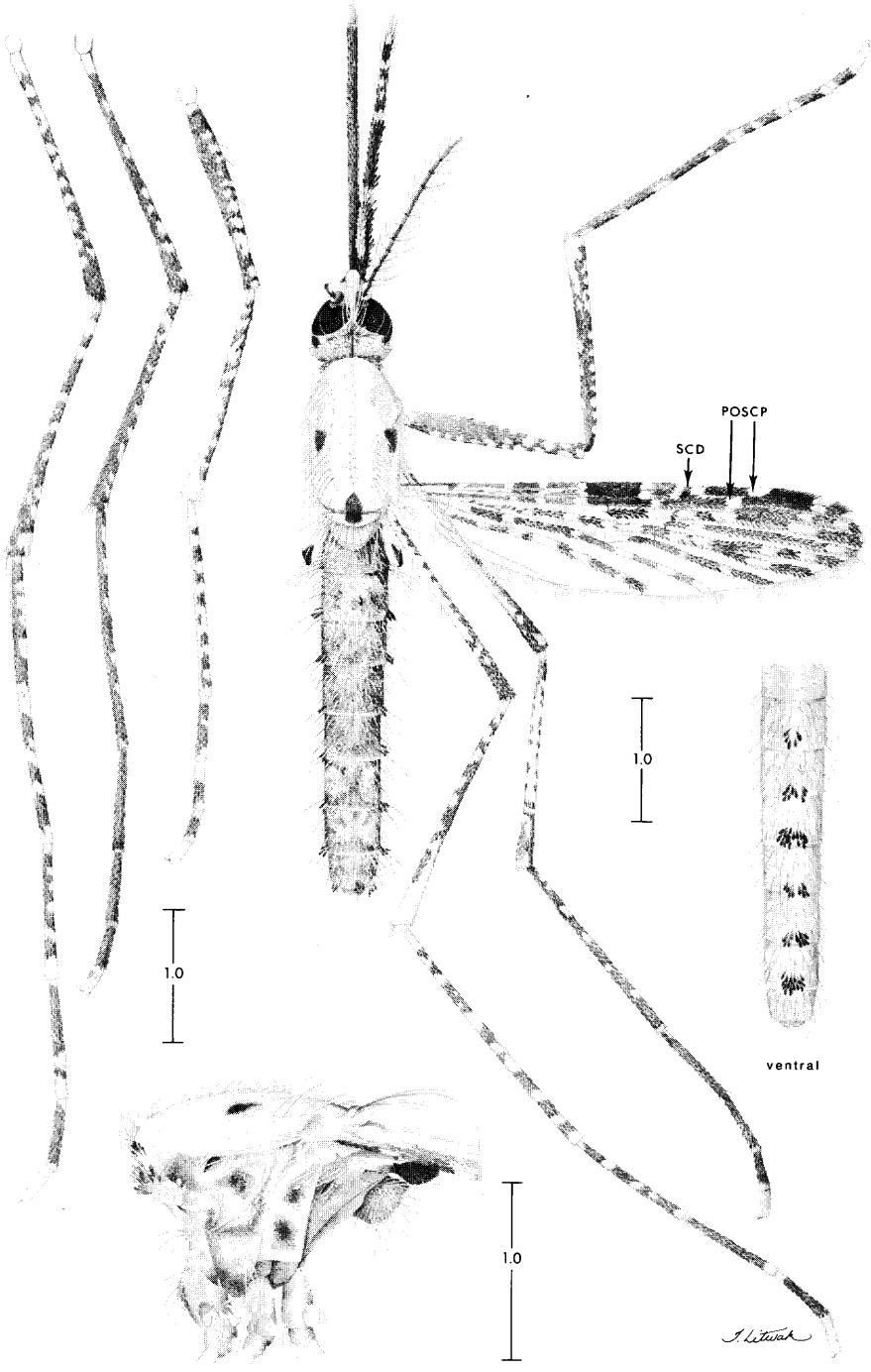

Fig. 1. *Anopheles (Ano.) calderoni*. Female. POSCP is distal postsubcostal pale spot on R_1 and C (see systematics section), and SCD is subcostal dark spot.

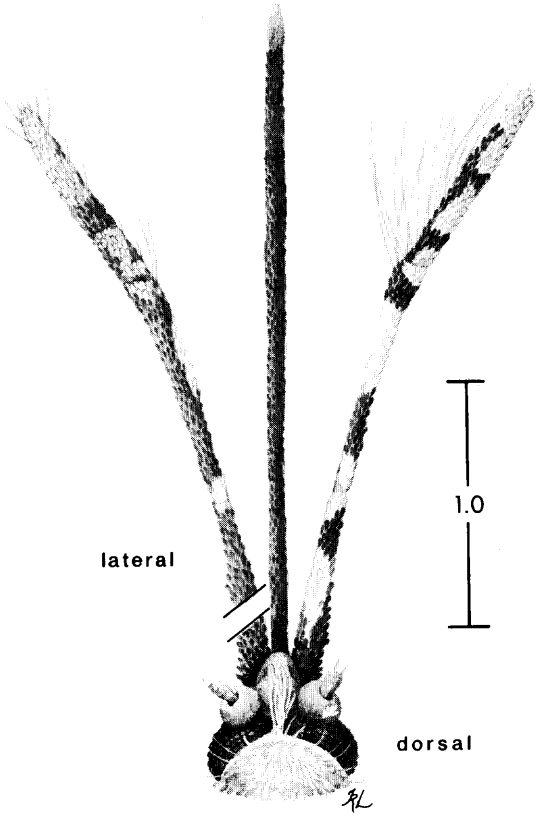

Fig. 2. *Anopheles (Ano.) calderoni*. Male head.

tromesally. Proboscis 2.43-2.91 mm (mean 2.67), 1.08-1.19 length of palpus. Proboscis with ventrobasal patch of erect, dark brown scales, remainder with small, decumbent, dark scales, labella yellowish brown. Foreungues with a strong, sharp, median projection and 2 blunt basal projections, posterior projection about twice as long as anterior. *Genitalia*: Ninth tergal lobes slender, apices somewhat striated, 3.5-5.0 longer than wide, widely separated, distance between lobes 17-21 width of lobe. Dorsal lobe of claspette with 3-4 setae, fused basally, rounded in lateral view, but not club-shaped; ventral lobe with 2 long setae, sometimes nearly equal in length; lateral and mesal surfaces of claspette with numerous small spicules. Gonostylus with 16-23 minute setae on dorsal surface, gonostylar claw short and blunt. Aedeagus with 3 pairs of leaflets, large mesal pair with thin transparent margin. Proctiger membranous, covered with many minute spicules; paraproct represented by distinct but weakly sclerotized, broad ventrolateral lines.

Pupa (Fig. 3). Positions and development of setae as figured; range and modal number of branches in Table 1. *Cephalothorax*: Trumpet laticorn, without tragus. Secondary cleft 0.36-0.54 (mean 0.47) (n = 24 for this and following measurements) length of pinna; lobes formed by secondary cleft broad. *Abdomen*: Terga and sterna II-VIII with large areas of small spicules, usually borne mesally and anteriorly (not shown in Fig. 3); posterior margins of terga II-VII and lateral margins of terga II-VIII with numerous spicules, lateral spicules on last segments more prominent, appearing serrated. Seta 10-II sometimes present. Seta 9-II-VII peglike to long and pointed; seta 9-VIII with numerous long aciculae. Segment VII 1.03-1.23 (mean 1.14) length of segment VI; segment VIII 1.24-1.49 (mean 1.38) length of segment VI. Length/width (at posterior margins) of segment VI 0.32-0.38 (mean 0.35), VII 0.41-0.46 (mean 0.43), VIII 0.50-0.57 (mean 0.55). Seta 8-V-VII laterad of 7-V-VII. *Paddle*: Paddle ovoid, 1.30-1.49 (mean 1.39) longer than wide; refractile index 0.60-0.70 (mean 0.65); length of marginal spicules 0.03-0.06 mm (mean 0.04).

Fourth instar larva (Fig. 4). Positions and development of setae as figured; range and modal number of branches in Table 2. *Head*: Length 0.67-0.76 mm (mean 0.70) (n = 21 for this and following measurements); width 0.69-0.78 mm (mean 0.74). Antennal length 0.25-0.28 mm (mean 0.27), enlarged toward base, 4.52-5.73 (mean 5.04) longer than wide; with prominent spicules, longer and more numerous dorsally in vicinity of seta 1-A; seta 1-A 6-13 branched, inserted 0.34-0.42 (mean 0.37) distance from base; seta 2-A fimbriate. Seta 2-C single, sometimes with small aciculae toward middle, 0.99-2.09 (mean 1.52) length 3-C, seta 2-C close to mate of opposite side, distance between bases 0.91-2.75 (mean 1.64) width base of single seta; 3-C single to 11-branched (mean 4.2). *Thorax*: Seta 1-P 5-10-branched; 11-P usually double (range 1-4), much shorter than 9,10,12-P; 12-M about 0.33 length of 9,10-M, 11-M very short, single; 11,12-T very short; 3-T

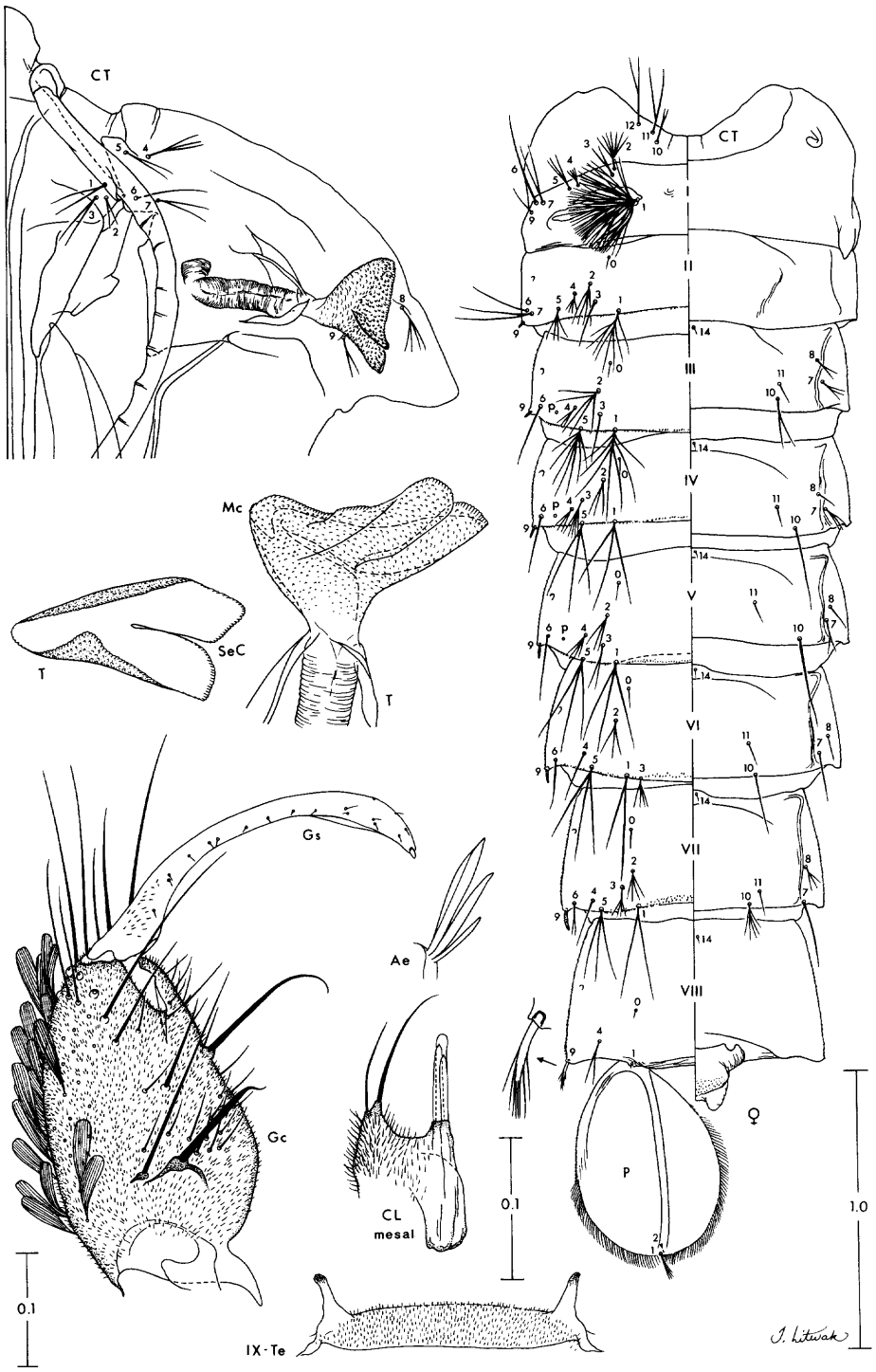

Fig. 3. *Anopheles (Ano.) calderoni*. Pupa and male genitalia.

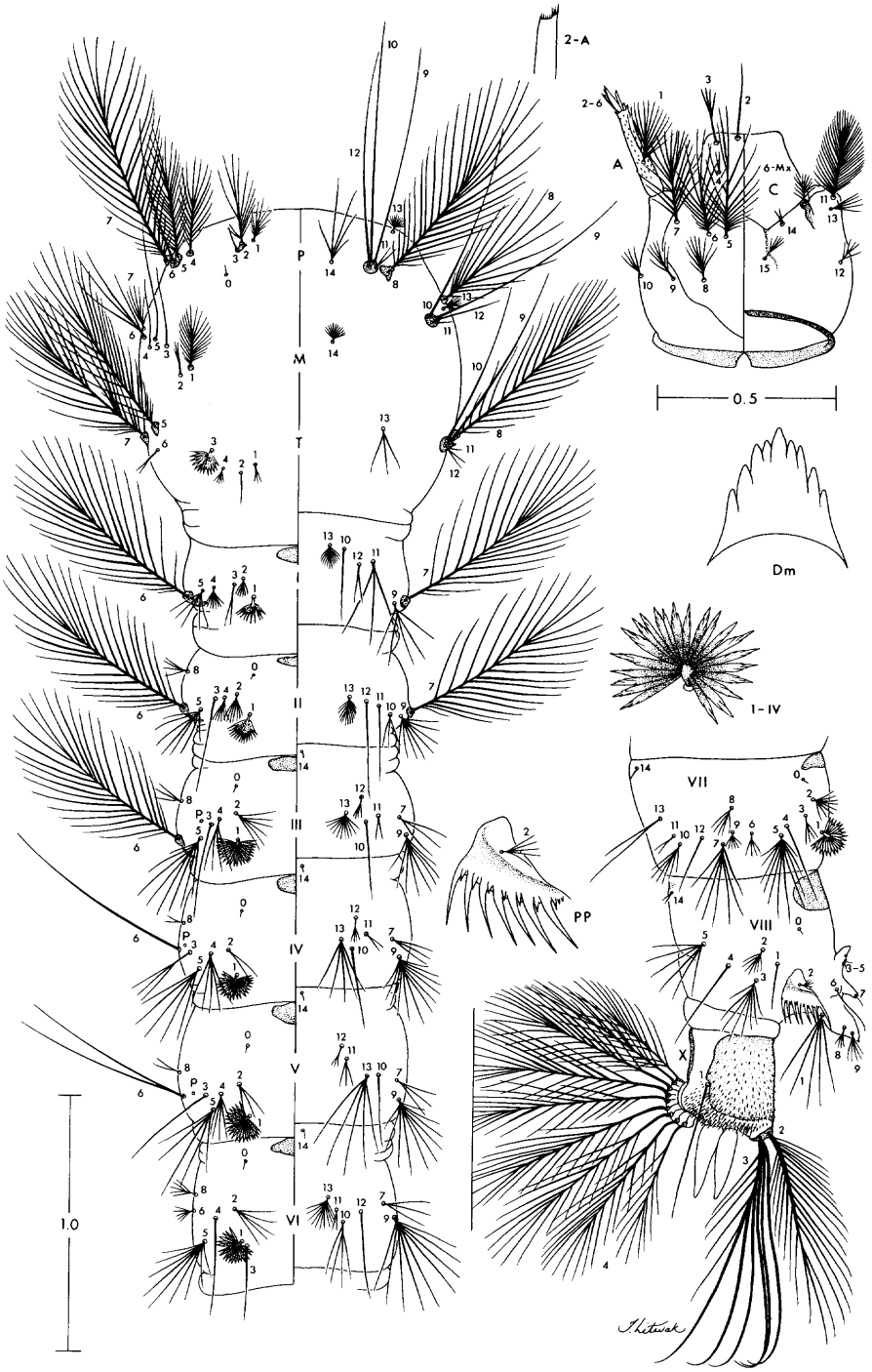

Fig. 4. *Anopheles (Ano.) calderoni*. Larva.

weakly developed, palmate. *Abdomen*: Setae 1-I-VII palmate, 1-I, and to lesser extent 1-II, weakly developed; leaflets usually broad, with jagged margins, apex weakly pigmented; 9-I single to 7-branched; 8-II 2-5-branched; 6-IV,V single to triple. Pecten spines usually alternating long and short, with 7-8 long and 6-9 short, 1-4 dorsal spines sometimes all short; long spines 2.83-4.75 (mean 3.87) length of short spines. Seta 1-X not inserted on saddle. Integument of posterior margin of segment X with many long spicules.

Type data. Holotype, female, PE 400(2)-37 (see below) National Museum of Natural History, Smithsonian Institution, Washington, DC.

The paratypes consist of 2 progeny broods (43 adults with associated larval and pupal exuviae) and a female parent of one of the broods [400(2)]. The progeny broods were reared from eggs obtained from 2 females captured at a cattle yard in Peru, Department of Piura, Salitral (near Sullana), 4° 50' S 80° 42' W, 23-IV-87, by Calderon and Gutierez. In addition to the holotype, the progeny of female PE 400(2) are as follows: Females -10, -11, -13, -15, -18, -19, -20 (wing on slide no. 89/287), -21, -22, -23, -24, -25, -28, -29, -31, -33, -34, -35, -38, -40, -43, -45; males -12, -14 (allotype, genitalia on slide no. 90/39), -16, -17, -26 (genitalia on slide no. 90/39), -27 (genitalia on slide 87/59), -30, -32 (genitalia on slide no. 90/40), -36 (genitalia on slide no. 90/41), -39, -41, -42 (genitalia on slide no. 87/58), -44. Progeny of non-extant female PE 400(1) include: females -13, -14; males -10 (genitalia on slide no. 88/412), -11, -12 (genitalia on slide no. 88/411), -15, -16. Two paratypes, PE 400(1)-10 and -13, will be deposited in The Natural History Museum, London.

Other material examined. A series from south of Lima in Peru: 9 males (2 with genitalia on slides), 12 females, 15 larval exuviae and 15 pupal exuviae (all individually reared specimens are from a single female) from the Department of Ica, Santa Luisita, located between Independencia and Pisco, 13° 45' S 76° 00' W, collection number 021(1), 22-IV-1988, Calderon and Valle coll.; and 6 females from the Department of Lima, Baños de Boza, near Huaral, 11° 30' S 77° 00' W, Calderon and Inga coll.

Bionomics. *Anopheles calderoni* has been encountered only at elevations below 250 m. The larvae are found in small streams, small irrigation canals and swamps, mostly in dense emergent vegetation, but especially associated with *Typha* sp. (cattail) (G. Calderon personal communication 1990). In the laboratory, eggs were maintained on moist paper towels for 5 days and then placed in rearing pans. When the eggs did not hatch, they were placed in hay infusion water and hatching occurred within 5-10 minutes. Larvae reared at approximately 21°C developed very slowly and died before reaching the pupal stage. Almost all larvae reared at approximately 26°C survived to become adults. Development at 26°C was fairly rapid, with all individuals reaching the adult stage by day 9 after eclosion from the egg.

Systematics. *Anopheles calderoni* is a member of the Arribalzagia Series. Reid and Knight (1961) characterized this series to be New World *Anopheles (Anopheles)* species with the following features: pupa with laticorn trumpet, costa with 2 pale spots near the junction of the subcosta, abdomen usually with short lateral scale-tufts, abdominal sterna commonly with scattered white scales anteriorly, legs usually speckled, maxillary palpus of female usually shaggy and forefemur somewhat swollen toward base, coxae with scales. Wilkerson and Peyton (1990) demonstrated that species in the Arribalzagia Series have unique wing spots: the sector pale and preapical pale spots both have accessory dark spots, and the subcosta ends in a dark spot, the subcostal dark. As noted in the description, seta 8-V-VII is positioned laterad of 7-V-VII. This placement of setae is not known in other *Anopheles (Anopheles)* species (Bruce Harrison, personal communication, 1990). However, species of the Arribalzagia Series for which there is available material share this character with *An. calderoni*. These are: *apicimacula* Dyar and Knab, *malefactor*, *mattogrossensis* Lutz and Neiva, *mediopunctatus* (Theobold), *neomaculipalpus* Curry, *peryassui* Dyar and Knab, *punctimacula*, *shannoni* Davis and *vestitipennis* Dyar and Knab.

Anopheles calderoni, *An. punctimacula*, *An. malefactor* and *An. guarao* are all members of

the Arribalzagia Series which have a broad transparent margin on the first pair of aedeagal leaflets. This shared character implies a close phylogenetic relationship, and they are therefore contrasted with *calderoni* in Table 5. *Anopheles calderoni* differs from these species by a combination of the following characters. *Adult*: Upper mesanepimeral scales present; pale wing scales on either side of costal dark spots white and pale scales on remainder of wing predominantly pale yellow with scattered white scale-patches; scales on vein R_1 at subcostal dark area usually dark (this portion of R_1 is dark-scaled and found between the pale spots which correspond to the proximal presubcostal pale spot and the distal postsubcostal pale spot); the distal postsubcostal pale spot (POSCP) on costa not contiguous with corresponding pale scales on R_1 (see Fig. 1); and hindtarsomere 5 usually pale, but sometimes with small dark spot. *Larva*: Seta 3-C single to 11-branched (mean 4.2) and seta 1-X not inserted on saddle. *Pupa*. Secondary cleft long, usually about 0.5 length of pinna, and paddle marginal spicules relatively short, about 0.5 length of seta 1-P. The known distribution of *An. calderoni* does not overlap with the other 3 species.

Anopheles guarao is distinct from the others in having the pale wing scales all white and mostly broad. Insufficient material was available to compare the immature stages. *Anopheles punctimacula* has the pale wing scales usually all yellow on the posterior veins, does not have upper mesepimeral scales, the postsubcostal pale spot on the costa and its corresponding spot on R_1 are usually contiguous, and the scales on R_1 at the subcostal area are all pale or predominantly so. Larval setae 3-C and 1-X are similar to *calderoni*. *Anopheles malefactor* has the pale wing scales mostly white except for a scattering of very pale yellow scales, the postsubcostal pale spot on the costa and R_1 is as in *punctimacula*, larval seta 3-C is 7-16 branched (mean 11.5), and seta 1-X occurs on the saddle.

Setal branching counts that may be useful to separate *calderoni* from *punctimacula* and *malefactor* are presented in Tables 3 and 4. *Pupa* (Table 3): *An. calderoni* differs from *An. malefactor* at setae 2-II, 5-III and 11-III, from *An. punctimacula* at setae 8-CT, 2-I, 4-I, 3-VI and 3-VII, and from both species at setae 12-CT, 1-II, 10-II, 1-III, 7-III, 7-IV, 1-V, 8-V and 8-VI. *Larva* (Table 4): *An. calderoni* differs from *An. malefactor* at setae 3-C, 1-P, 2-I and 9-III, from *An. punctimacula* at setae 14-M, 9-I, 8-II, 4-V, 13-V, 6-VI, 5-VII, 7-VI and 5-VIII, and from both species at setae 8-C, 9-C, 10-C, 11-P, 6-IV, 6-V and 3-VII.

Etymology. I am pleased to name this species for Guillermo Calderon Felero: friend, collaborator and highly respected colleague, formerly of the Ministry of Health in Lima, Peru.

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