



Description of male, pupa and larva of *Psorophora (Grabhamia) paulli* and redescription of the female (Diptera: Culicidae)

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Abstract

The female of *Psorophora (Grabhamia) paulli* Paterson & Shannon is redescribed, and the pupa, fourth-instar larva and male genitalia are described and illustrated for the first time. Information about the distribution, bionomics and taxonomy is also included. Adults of *Ps. paulli* can be separated from the other species of the genus and subgenus by its small size. The larva of *Ps. paulli* is similar to that of *Ps. varinervis* Edwards and *Ps. discolor* (Coquillett) but can be separated based on the development of setae 1-X and 5-VIII, the length of the anal papillae and the comb on a sclerotized area.

Key words: *Psorophora paulli*, immature stages, male genitalia, morphology, description

Introduction

Psorophora (Grabhamia) paulli was described by Paterson & Shannon (1927) from seven females collected in Tres Pozos, Salta, Argentina. Shannon & Del Ponte (1927) included a key to species in a systematic review of the mosquitoes of Argentina based on specimens from the Instituto Bacteriológico and Museo Nacional de Historia Natural de Buenos Aires. Lane (1953) redescribed the female, adding minor variations to the original description. Guedes *et al.* (1965) illustrated the female genitalia. None of these authors included descriptions of the larva, pupa and adult male. The purpose of this paper is to provide a complete description of all life stages to aid the unequivocal recognition of the species.

Material and methods

During sampling in Chaco Province, Argentina, larvae belonging to the genus *Psorophora* were collected from ground pools. Several larvae were individually reared to obtain adults. Some larvae could not be identified to species using the keys of Darsie (1985), but the respective adults were identified as *Ps. paulli*. Adults were pin-mounted and the immature stages and male genitalia were mounted in Canada balsam on microscope slides.

The morphological terminology follows Harbach & Knight (1980, 1982). Life stages are indicated as follows: M (male), MG (male genitalia), F (female), Pe (pupal exuviae) and Le (larval exuviae), and an asterisk following these indicates that a drawing is available. Measurements are given in millimeters (mm) and micrometers (µm), as a range followed by the mean in parentheses. Counts and ratios are formatted similarly. Voucher specimens are deposited in the Departamento de Entomología, Instituto de Medicina Regional (Universidad Nacional del Nordeste) and Centro de Investigaciones Entomológicas de Córdoba (Universidad Nacional de Córdoba), Argentina.

Psorophora (Grabhamia) paulli Paterson & Shannon

Psorophora paulli Paterson & Shannon, 1927: 4,9 (F). Type locality: Tres Pozos, Salta, Argentina (I.N.M). Lane 1953: 768 (F). Guedes *et al.* 1965: 18 (F*). Casal in Belkin *et al.* 1968: 13 (lectotype designation).

FEMALE: Small mosquito. General colour dark brown. *Head:* Occiput covered with narrow silver decumbent scales; forked scales broad and pale. Antenna same length as proboscis. Pedicel with silver scales on mesal side. Proboscis slightly longer than forefemur, mainly dark with small white scales scattered on whole length except, at apex. Maxillarypalpus 0.16 length of proboscis, with black scales. *Thorax:* Scutal integument dark brown, covered with thin dark brown scales and narrow silver scales laterally, extending mesad on scutum. Acrostichal and dorsocentral setae light brown. Pleura with broad white scales forming groups on mesokatepisternum, mesanepimeron and paratergite. Pleural setae light brown: 9–12(10) proepisternal, 10–16(14) prealar, 6–10 and 2–4 upper and lower mesanepimeral respectively, 4–6(6) and 3–6(5) upper and lower mesokatepisternal and 1 or 2 and 4 or 5 pre- and postspiracular respectively. Scutellum with silver scales confined to lobes, large setae on mid (13) and lateral lobes 8 total. *Wing:* Whitish and dark scales on most veins. White scale-spots before bifurcation of R_{2+3} , on R_{4+5} , apically on R_{2+3} , R_2 and R_3 , at base of M_{1+2} , R_{3+4} and CuA, and middle of CuA and 1A. *Halter:* Integument white, capitellum covered with white scales. *Legs:* Integument dark brown, coxae with white scales. Femora black-scaled anteriorly, posteriorly white-scaled, and pre-apically with white-scaled band. Femur-tibial joints white-scaled. Tibiae dark scaled. Joints of tarsomeres with small rings of white scales. Ungues of all legs simple. *Abdomen:* Integument dark brown. Terga with black scales and triangular spots that join to form an apical band of white scales. Tergum VII with scattered white scales. Sterna with white scales, black scales on lateral margins of some sterna.

MALE: Like female except for following sexual differences. *Genitalia* (Fig. 1c): Tergum IX sclerotized, lobes separated by central concavity, each lobe with 6 conspicuous setae. Gonocoxite cylindrical, 2.5 times longer than basal width, minutely spiculate, long, strong setae on dorsal surface, shorter and thinner setae ventrally. Apex of gonocoxite expanded. Gonostylus narrow, widened in middle, round basally, enlarged reticulate surface at middle, slender at apex, 0.60 of gonocoxite length, with 2 setae on inner side. Gonostylar claw gently curved and pointed. *Claspette:* Not divided, narrow, apex with 7 flattened setae with blunt tips and small distal spicules. *Proctiger:* Narrow, toothed. Cercus with 4 setae. *Aedeagus:* Cylindrical, moderately broad at base with large basal opening.

PUPA (Fig. 1a, b): Insertions and character of setae as figured; range and modal number of branches in Table 1. *Cephalothorax:* Integument light brown. Trumpet cylindrical, lightly tanned; length 0.40–0.45 mm (mean 0.42 mm), width 0.10–0.16 mm (mean 0.13 mm), index 3.33–4.00; pinna ~0.37 length of trumpet; tracheoid area ~0.60 length of trumpet. *Abdomen:* Lightly tanned, similar to cephalothorax, with darker median longitudinal strip. Setae 1-IV-VII usually double. *Genital lobe:* Tanned in both sexes, length 0.22–0.23 mm (mean 0.23 mm) in female, 0.30 mm in male. *Paddle:* Ovoid, hyaline, buttress darker, length 0.65–0.70 mm (mean 0.68 mm), width 0.43–0.52 mm (mean 0.47 mm), paddle index 0.66–0.74, midrib evident, except apically, length 0.50–0.55 mm (mean 0.53 mm). Seta 1-Pa usually single, seta 2-Pa 0.50 length of 1-Pa.

LARVA (fourth-instar) (Fig. 2): Placement and character of setae as figured; range and modal number of branches in Table 2. *Head:* Wider than long, width 1.12–1.22 mm (mean 1.18 mm), length 0.68–0.75 mm (mean 0.70 mm). Integument lightly tanned. Dorsomentum triangular, with 9–10 (9) dark teeth on each side of median tooth. Setae 1,3-C single; seta 2-C absent; seta 3-C, 0.10 length of 1-C; seta 4-C very small, with 3–6(4) branches, inserted posterior to setae 5,6-C; setae 5,6-C single, aciculate; seta 7-C with 3,4(3) branches; setae 8,9-C similar in length, 8-C with 1,2(2) branches, seta 9-C with 2,3(2) branches; seta 11-C with 2–4(3) branches; seta 15-C with 8,9(9) branches; setae 10,13,14-C single, seta 12-C with 3,4(4) branches. *Antenna:* Length 0.74–0.85 mm (mean 0.79 mm), slightly S-shaped, spiculose, darkly tanned. Seta 1-A with 6–8(6) aciculate branches, inserted before mid-length of antenna; setae 2,3-A broad, inserted on apical third of antenna. *Thorax:* Integument hyaline, smooth. Tubercles of setae 9–12-M,T with small rounded apical denticles. Seta 0-P with 2–4(3) branches; setae 1–4-P single; seta 5-P single or double; setae 1,6,7-P aciculate, 6,7-P each on sclerotized tubercle, seta 6-P single, seta 7-P double; seta 8-P triple; setae 9–12-P single, inserted on common tubercle; seta 14-P single. Setae 1–3-M single, small; seta 4-M single or double, small; seta 5-M single, strong; seta 6-M with 4,5(4) branches; seta 7-M single; seta 8-M with 5 branches; seta 9-M with 3–5(5) branches; setae 10,12-M single; seta 11-M double; seta 13-M with 6,7(7) branches; seta 14-M with 4,5(5) branches. Setae 1,2,4,5,6-T single; seta 3-T double; seta 7-T with 5–7(7) aciculate branches; seta 8-T with 7–9(7) branches; seta 9,11,12-T single; seta 10-T with 3,4(3) branches; setae 11,12-T similar to 11,12-M; seta 13-T single. *Abdomen:* Integument hyaline, smooth. Tubercles of setae 6,7-I,II evenly colored light brown. Seta 0-II–V single;

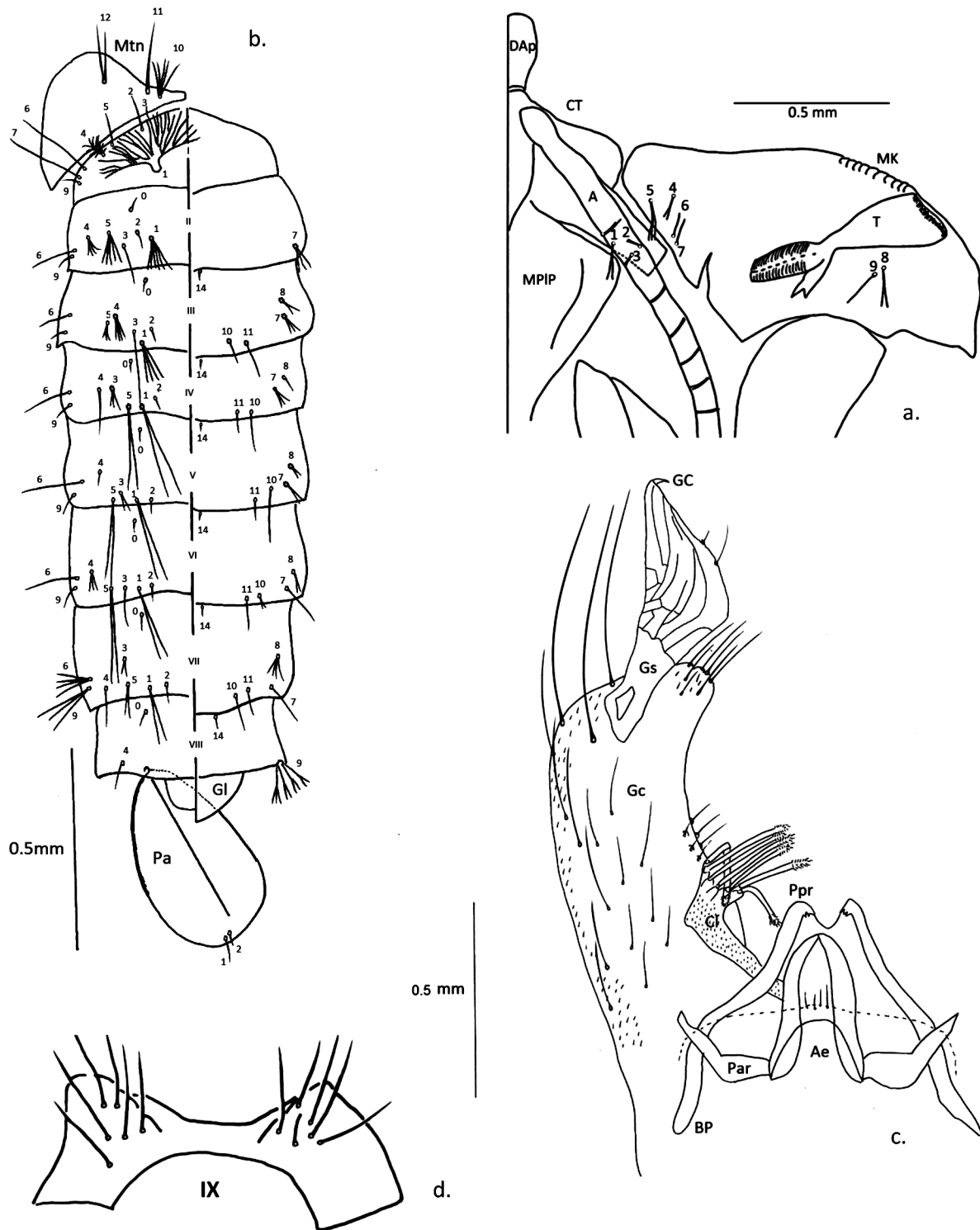


FIGURE 1. Pupa and male genitalia of *Psorophora paulli*. a: Cephalothorax; b: metanotum and abdomen; c: gonocoxopodite and phallosome; d: tergum IX. A = antenna; Ae = aedeagus; BP = basal piece; CT = cephalothorax; Cl = claspette; Dap = dorsal apotome; Gc = gonocoxite; GC = gonostylar claw; Gl = genital lobe; Gs = gonostylus; MK = median keel; MPIp = maxillary palpus; Mtn = metanotum; Pa = paddle; Par = paramere; Ppr = paraproct; T = trumpet; I–VIII = abdominal segments.

seta 1-I with 3–5(5) branches, seta 1-II–V, VII, VIII single, seta 1-III–V longer than corresponding segment, seta 1-VI triple; seta 6-I with 5,6(6) branches, seta 6-II with 2,3(3) branches, seta 6-III with 2,3(2) branches, seta 6-IV, V double; seta 7-I with 3,4(4) branches, seta 7-II–IV–V triple, seta 7-III with 2,3(3) branches, seta 7-VI single. Segment VII with short setae, only seta 1-VII stout, long. *Segment VIII*: Comb with 6,7(6) spine-like scales of same size in a row on

sclerotized plate; apical spine 4 times longer than lateral spicules. Seta 5-VIII twice length of segment X, broad. *Segment X*: Saddle complete, brown, with minute spicules on posterolateral margins. Setae 1,3-X single, 1-X <0.5 length of segment X; 2-X triple; seta 4-X with 3 precratal setae and 4 setae on grid.. Anal papillae 4.3 times longer than segment X, each with conspicuous tracheae. *Siphon*: Brown, length 0.65–0.70 mm (mean 0.66 mm), width at base 0.25–0.28 mm (mean 0.26 mm), index 2.50. Pecten on basal 0.30, with 4–6(5) spines, length of spines 125–150 μm , sometimes with 1,2 basal denticles. Seta 1-S with 6–9(6) aciculate branches; seta 2-S curved, strong, length 125 μm , similar to apical diameter of siphon.

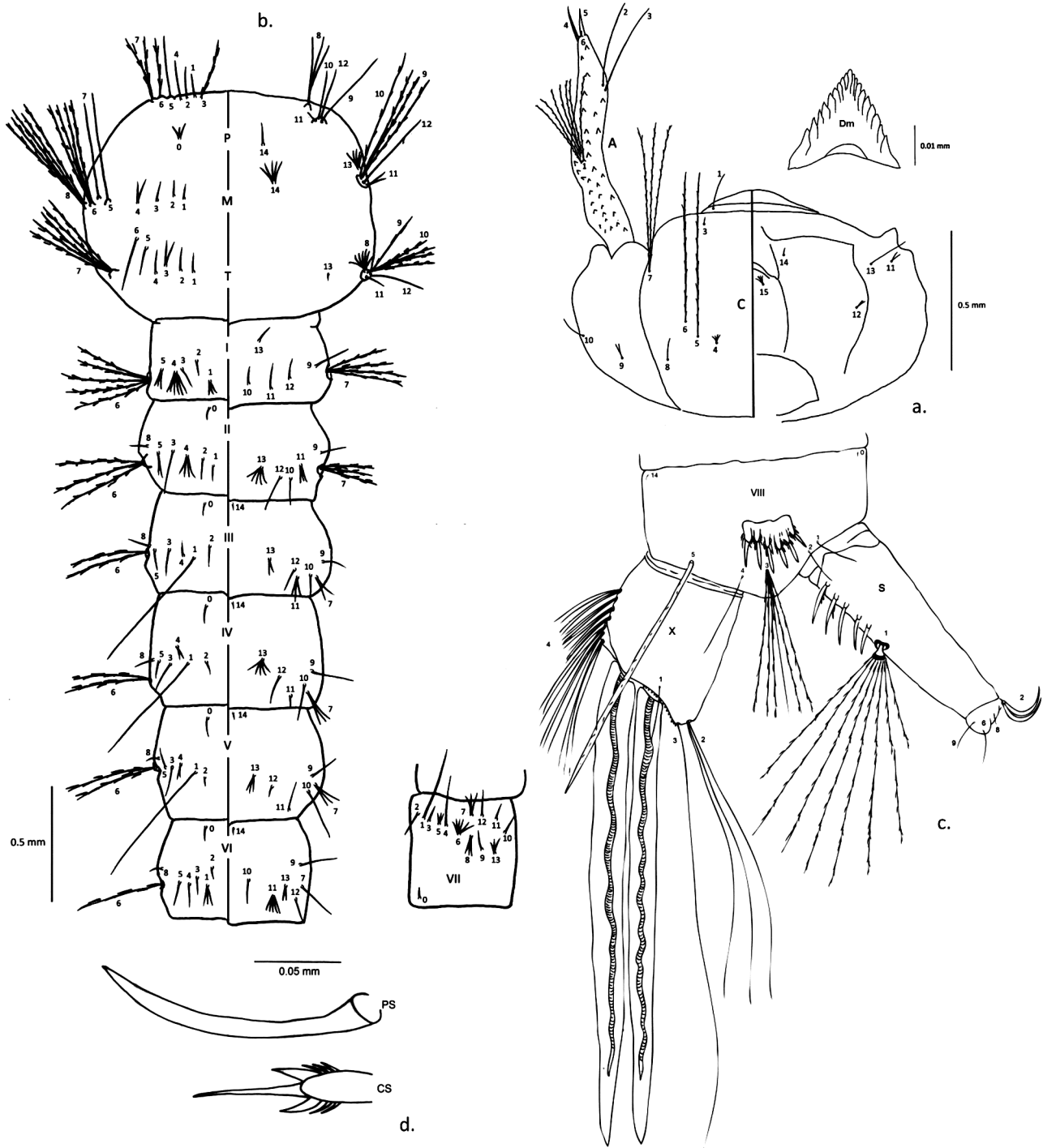


FIGURE 2. Larva of *Psorophora paulli*. a: Head; b: thorax and abdominal segments I–VI; c: abdominal segments VII,X and siphon. A = antenna; C = cranium; CS = comb scale; Dm= dorsomentum; M=mesothorax; P=prothorax; PS = pecten spines; S = siphon; T=metathorax; I–VIII,X = abdominal segments.

TABLE 1. Range (mode) of branches for setae of the pupa of *Psorophora (Grabhamia) paulli* (n=6). CT: cephalothorax; Pa: paddle.

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

†Seta 1-I has 6–10 main branches and more than 60 secondary branches. *: uncountable.

Material examined. Argentina, Chaco: Monte Alto (27° 26' S, 58° 55' W), 3F, 1M, 1MG, 4Le, 4Pe collected 21-III-2002 and 2F, 2Pe, 2Le collected 23-X-2003, Stein & Willener coll.

Distribution. This species is known from Argentina and Bolivia (Knight & Stone 1977). In Argentina, it is known from the following provinces: Chaco, Corrientes, Formosa, Jujuy, Salta, Santa Fe and Santiago del Estero (Mitchell & Darsie 1985; Campos & Maciá 1998; Ludueña Almeida *et al.* 2004).

Bionomics. Immature stages were collected from shallow, temporary, ground pools with clear or turbid water, with or without emergent grasses and full exposure to sun light. They were found in association with larvae of *Ochlerotatus albifasciatus* (Macquart), *Ps. ciliata* Fabricius, *Ps. cingulata* (Fabricius), *Ps. cyanescens* (Coquillett), *Ps. pallescens* Edwards and *Ps. varinervis* Edwards.

Taxonomy. The antennal shape and positions of setae 2 and 3-A of *Ps. paulli* are similar to those of *Ps. varinervis* and *Ps. discolor* (Coquillett). *Psorophora paulli* can be distinguished from these two species by the following characters: seta 1-X single less 0.5 length of segment X, anal papillae 4.3 times as long as segment X, seta 5-VIII strong and long, comb with 6 spines on sclerotized plate, seta 1-C long and straight and seta 2-S sometimes hook-like. In *Ps. discolor* seta 1-X is single, longer than segment X, anal papillae approximately three times as long as segment X, comb similar to that of *Ps. paulli*, seta 1-C long and very curved, similar to an inverted U, and seta 2-S curved. In *Ps. varinervis*, seta 1-X is double, anal papillae approximately twice as long as segment X, seta 5-VIII multi-branched and comb with 6 separated spines (Carpenter & La Casse 1955; Rossi *et al.* 2008). The pupa of *Ps. paulli* is similar to the pupa of *Ps. varinervis* but can be distinguished by having setae 6,7-I nearly the same length whereas seta 7-I is shorter than seta 6-I in *Ps. varinervis*. The pupa of *Ps. discolor* may be distinguished from the pupae of *Ps. paulli* and *Ps. varinervis* by the extremely long paddle seta, which is generally more than 0.25 the length of the paddle (Barr & Barr 1969) (in *Ps. paulli* and *Ps. varinervis* it is less than 0.17 the length of the paddle). Seta 12-CT is long and double and seta 5-I is generally long and single in *Ps. paulli*; seta 12-CT is short and single, and seta 5-I is short and multiple in *Ps. varinervis* (Rossi *et al.* 2008). The male genitalia of *Ps. paulli* are similar to the genitalia of other species of subgenus *Grabhamia*, but the claspette differs in having seven flattened setae with blunt tips and small distal spicules, the three internal setae have distal spicules and the three external setae have minute striation in *Ps. varinervis*. The gonostylus is narrow, quadrangular basally and has an enlarged median reticulated area in *Ps. discolor* whereas in *Ps. paulli* it is round basally and in *Ps. varinervis* it is slightly expanded at mid-length. Each ninth tergal lobe has six setae in *Ps. paulli* and 12–14 in *Ps. varinervis* (Rossi *et al.* 2008). The adults of *Ps. paulli*

TABLE 2. Range (mode) of branches of setae for the fourth-instar larva of *Psorophora (Grabhamia) paulli* (n=6). P = prothorax; M = mesothorax; S=siphon; T = metathorax.

Seta no.	Head		Thorax			Abdominal segments									
	P	M	T	I	II	III	IV	V	VI	VII	VIII	X			
0	-	-	-	-	1	1	1	1	1	1	1	1	1		
1	1	1	1	3-5	1	1	1	1	3	1	1	1	1		
2	-	1	1	1	1	1,2(1)	1	1	1	1	1	1	3		
3	1	1	2	1	1	1,2(1)	1	1	1	1	1	6	1		
4	3-6(3)	1,2(2)	1	6-8(6)	4	1,2(1)	2	2	1	1,2	1	3+4*	1		
5	1	1,2(2)	1	2-4	2	1	1	1	1	1-3	1	1	1		
6	1	4,5(4)	1	5,6(6)	3	2,3(2)	2	2	1	7,8	1	1	1		
7	3,4(3)	2	5-7(5)	3,4(4)	3	2,3	3	3	1	1	1	1	1		
8	1,2(1)	3	7-9	-	1	1	1	1	1,2(2)	1-3	1	1	1		
9	2,3(2)	1	3	1,2	1	1	1	1	1	3-6	1	1	1		
10	1	1	4	1	1	1	1	1	1	1	1	1	1		
11	2-4(3)	2	1	1	3	3	1	1	5,6	1	1	1	1		
12	3,4(4)	1	1	1	1	1	1	1	1	1	1	1	1		
13	1	-	7	1	5-7	2	5	3	2	3	1	1	1		
14	1	4,5	-	-	-	1	1	1	1	-	1	1	1		
15	8,9(8)	-	-	-	-	-	-	-	-	-	-	-	-		

*Number of precratal + cratal setae.

1-S	6-8(6)
2-S	1
6-S	1
8-S	1
9-S	1

are small, which allows this species to be separated from other species of *Psorophora*. The general coloration is dark, similar to *Ps. confinnis* (Lynch Arribalzaga), but *Ps. paulli* can be separated from *Ps. confinnis* by the presence of white-scaled spots on the wings and the absent of basal pale-scaled bands on hindtarsomere 1 (Darsie 1985). *Psorophora varinervis* and *Ps. discolor* are generally pale with dark-scaled spots on the wings. The wings of *Ps. varinervis* have a single dark spot on the base of vein R_{4+5} whereas the distribution of pale and dark scales in *Ps. discolor* is similar to that of *Ps. paulli*. The species can be separated by the preponderance of pale scales on veins 1A and CuA in *Ps. discolor* (pale scales are located in a median strip or at the base of the wing in *Ps. paulli*). Pale scales occur on the middle of veins M_{1+2} and R_{3+4} in *Ps. discolor* whereas in *Ps. paulli* they extend to the apex of vein M_{1+2} and are absent from vein R_{3+4} .

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