

*Gigantodax bierigi* & *G. willei* (Diptera:  
Simuliidae), two new black fly species from Costa Rica

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**Abstract:** The female, male, pupa and larva of *Gigantodax bierigi*, new species, and *Gigantodax willei*, new species, are described. Each of these species is most readily differentiated from other species of *Gigantodax*, by the general shape and number of the branches of the respiratory organ of the pupa. Both species were collected from upland streams in Costa Rica. Some biological notes are included.

The genus *Gigantodax* has been reported from Argentina (Patagonia), Bolivia, Perú, Colombia, Venezuela, Guatemala and México (Wygodzinsky 1949), and there are many problems in its taxonomy. The only list of species available is from Vulcano (1967), to which must be added, the species described by Wygodzinsky (1973), Ramírez-Pérez (1980), Moncada *et al.* (1981) and Takaoka *et al.* (1988) for Ecuador.

Wygodzinsky and Coscarón (1973) are in process of describing several new species which will help to better define the genus. *Gigantodax bierigi* Vargas and Ramírez-Pérez, new species.

Female (dry, pinned specimens). General body color blackish brown. Length: body, 3.0 mm; wing, 3.5 mm.

**Head:** Blackish, with whitish pollinosity. Frons (Fig. 1-A) narrow, nearly parallel sided, only slightly widening dorsally, about three times longer than width, about 1/6 width of head; slightly paler than occiput, rather densely covered with moderately long, decumbent, yellow pile. Postocular setae brownish. Clypeus

concolorous with frons slightly lighter at center, rather densely covered with moderately short, ventromedially directed, yellow pile. Occiput whitish pollinose, densely covered with long, pale yellow pile. Antenna with nine flagellomeres, pale brown, scape, and pedicel concolorous with flagellum, each segment paler at base, first flagellomere longer than pedicel, remaining flagellomeres subequal in length fine pubescence whitish, pedicel and scape with long black setae. Mandible (Fig. 1-B) with about 17-23 serrations. Blade of maxilla (Fig. 1-H) with about 9-14 retrorse teeth. Palpus (Fig. 1-K) dark brown, all palpomeres similar, with long brown setae. Palpomer five slightly longer than three, proportion of palpomeres 1:0.8:3.3:3:4. Sensory vesicle as in (Fig. 1-D), about 1/2 as long as its segment, proximally situated, its neck long, arising anterodorsally and extending vertically. with an enlarged mouth. Median proximal space of cibarium shallow, without denticles; dorso-lateral arms short, weakly sclerotized; inner surface of each arm smooth, without minute setulae.

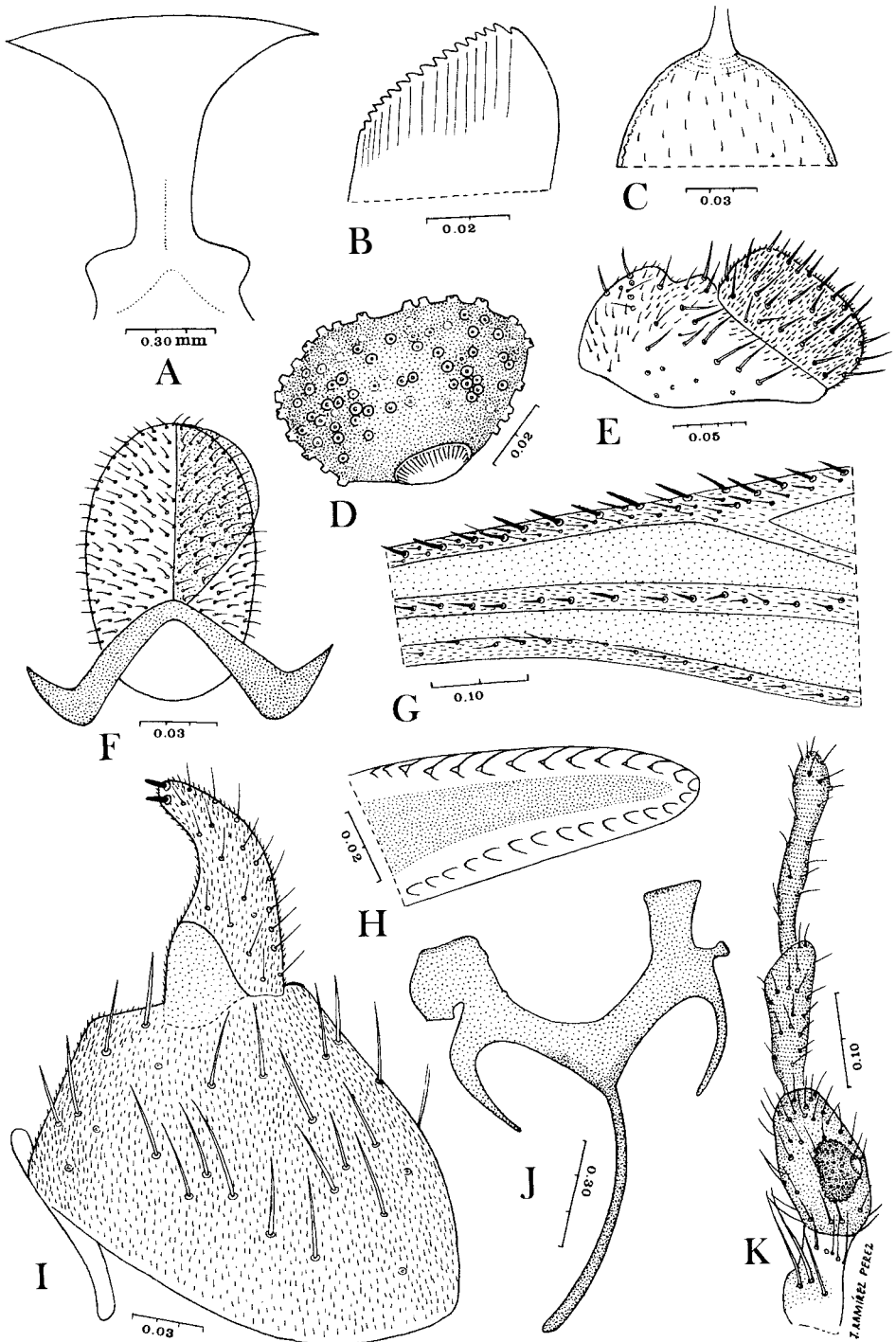


Fig. 1. *Gigantodax bierigi* n. sp. A. Frons of female, B. Apical region of mandible, C. spermatheca, D. sensory vesicle of maxillary palpus, E. cercus and anal lobe, F. ventral plate in ventral view, G. wing showing portion of C, R<sub>1</sub> and R<sub>5</sub>, H. apical region of blade of maxilla, I. gonostylus, J. genital fork, K. maxillary palpus.

**Thorax:** Blackish brown; anteprenotal lobe concolorous with scutum, with moderately dense, long yellow pile. Postpronotum black, smooth. Scutum black, with a sparse nacreous pollinosity and covered by an abundant long yellowish pilosity. Scutellum paler than scutum; densely covered with long, golden setae on hind margin. Postnotum black with a few short yellow setae and abundant nacreous pollinosity.

Anterior half of pleuron black, concolorous with the posterior half. Presternal lobe dark brown with yellowish pile. Anepisternal membrane darker than rest of pleuron, with whitish pollinosity. Mesepimeral tuft light brown. Wing (Fig. 1-G) membrane hyaline, with a light brownish tinge; veins yellowish brown. Base of C and stem vein with long black pile, rest of setae on veins black. Sc setose ventrally, R setose dorsally, R<sub>4+5</sub> setose ventrally; cell bm absent; C. with spiniform setae; fringe of calypter and alar lobe long and yellow. Stem of halter brownish, knob whitish, with hairs at base. Legs rather uniformly light brown, except for dark apex of femur and basal and distal areas of tibiae; coxae I and II with only dark setae, hindcoxae with paler setae, rest of setae on legs light brown. Hind basitarsus about eight times as long as broad. Calcipala large, broadly rounded. Pedisulcus absent. Claw slightly curving from base, with a prominent, subtriangular basal tooth that is wider than claw and less than half as long as claw.

**Abdomen:** Brownish. Basal scale (tergite one) dark brown, with a fringe of long, pale yellow pile; tergites broad, brownish, with darker brown margins, sparsely covered with short, pale yellow setae; pleural membrane brownish, bare, with faint whitish pollinosity. Terminalia as in Fig. 1 (C, E, J). Anal lobe subquadrate, with a notch posteroventrally; moderately covered with stout light brown setae. Cercus subrectangular, with abundant light brown setae. Hypogynial valves very small, not reaching base of cerci. Stem of genital fork (sternite nine) long, slender and moderately sclerotised, about half long as arms; arms short, weakly sclerotised except for a short, heavily sclerotised rod-like extension (lateral process) on each side emanating from stem of genital fork. Spermatheca ovoid, without reticulate pattern, but with sparse minute internal

spicules; with a corrugated area at junction with the spermathecal duct.

**Male:** (dry, pinned specimen). General body color blackish-brown. Length; body, 2.5 mm; wing, 3.7-3.8 mm.

**Head:** Frons and clypeus black, nacreous pollinose, with erect yellowish pile. Occiput with short, yellow setae. Antenna dark brown; scape and pedicel yellowish, remaining flagellomeres becoming darker distally; first flagellomere slightly broadened distally, slightly longer than pedicel, fine pubescence mixed with black setae; pedicel with long setae laterally and distally; scape with long, black setae at distal angle. Palpus brown, proximal two and distal two palpomeres paler than third, and with black pile interspersed with a few more yellowish setae; palpomere five about 1/4 longer than palpomere three and about 1/3 longer than palpomere four. Sensory vesicle round, 1/4 as long as its segment; neck short.

**Thorax:** Anteprenotum and postpronotum concolorous with scutum; anteprenotum with yellow setae; postpronotum bare. Scutum dark brown, densely covered with short, decumbent, pale yellow pile, and nacreous pollinose. Scutellum black, with long, yellow setae on hind margin. Postnotum concolorous with scutellum and having nacreous reflections. Pleuron uniformly dark, nacreous pollinose. Anepisternal membrane black, bare. Mesepimeral tuft yellowish. Wing membrane hyaline but with a distinct brownish tinge; veins yellowish brown; base of C and stem vein with dark pile, rest of setae on veins dark; Sc setose ventrally; base of R and R<sub>1</sub> setose dorsally; R<sub>4+5</sub> setose ventrally; C and distal half of R<sub>1</sub> with spiniform setae that are shorter than regular setae; cell bm absent; fringe of calypter and alar lobe pale yellow. Halter brownish, knob bare. Legs rather uniformly light brown, with color pattern as in female, with light brownish pile; hind basitarsus not swollen, about 6.6 times as long as broad; calcipala large, distinct, rounded apically; pedisulcus absent.

**Abdomen:** Blackish, basal scale light brown, with abundant long brown setae along hind margin. Tergites narrow, sparsely covered with

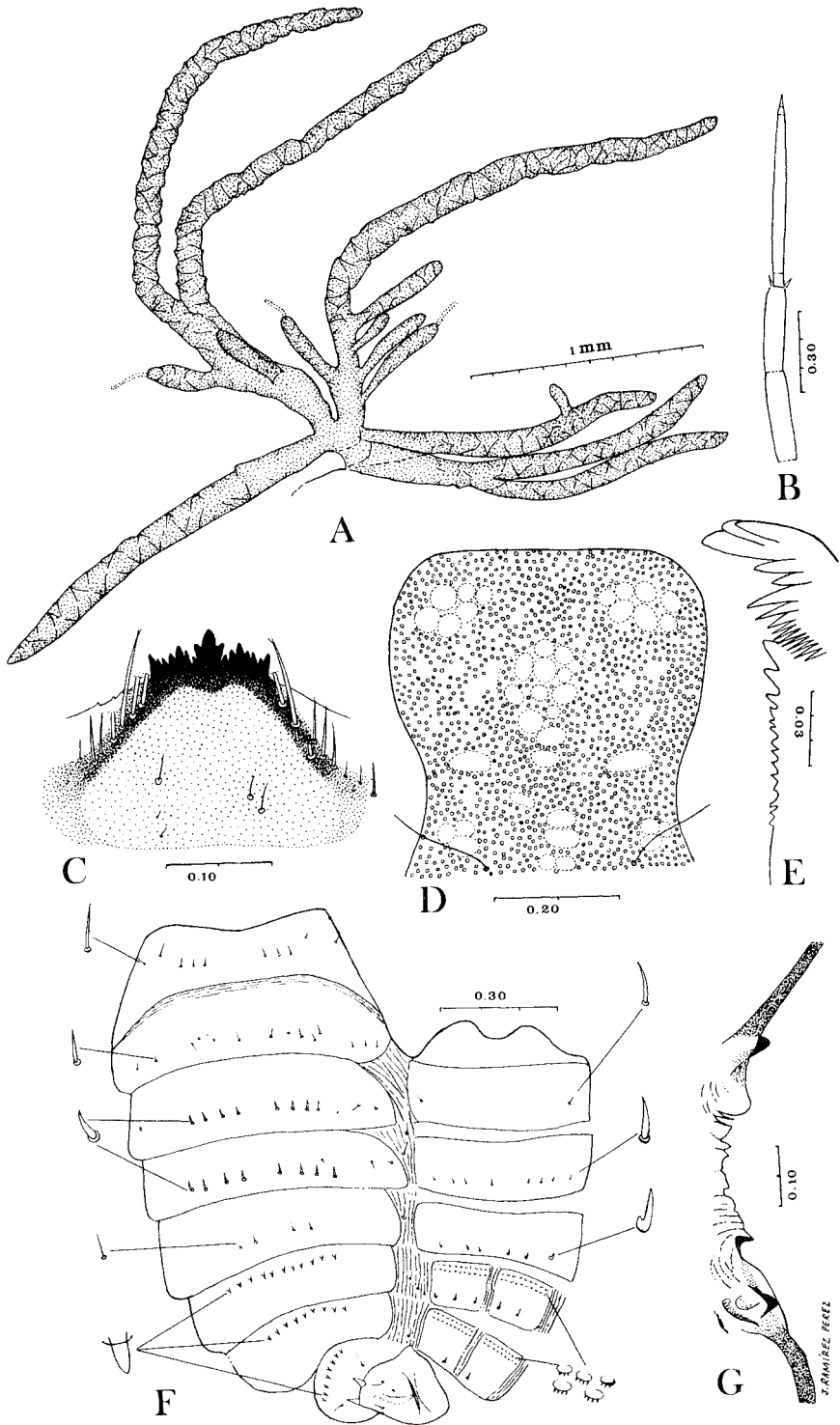


Fig. 2. *Gigantodax bierigi* n. sp. A, respiratory organ of pupa. B, larval antenna. C, larval hypostoma. D, pupal frons. E, apical region of larval mandible. F, abdomen of pupa. G, larval hypostomal cleft.

long, yellowish setae. Sternites brownish. Terminalia as in Fig. 1 (I, F) Gonocoxite trapezoidal, covered with short black setae and long pile. Gonostylus subtriangular, elongated, notched at basal angle, setose, apical margin bearing two, large terminal spines. Body of ventral plate of aedeagus ovate, elongated, moderately sclerotized, densely covered with light setae; distal margin rounded, keel-like lobe or ventral flap well-developed, half-heart shaped overreaching lateral margin of plate, covered with short setae; basal arms sclerotized, an inverted V-shape, slightly shorter than length of body of ventral plate; median sclerite of aedeagus short, stem larger than arms; aedeagal membrane rather densely covered with numerous rows and groups of 4-5 minute setulae. Plate of endoparameral organ membranous, poorly sclerotized, with one big fusiform and a group of about seven small spines, arm moderately long, sclerotized and twisting.

**Larva** (Mature, with fully developed respiratory histoblasts) Length about 7.0 mm. General body color brownish; intersegmental line narrow, lighter than rest of abdomen. Head capsule dark; head spots darker than surrounding area, anteromedian and posteriomedian spots slender, elongate, well separated; first and second anterolateral spots roundish, about equal in size and distinctly separated; posterolateral spots darkened. Eye spots small. Postociput with a broad gap dorsally, cervical sclerites slender, well defined and fused at their bases with the lateral areas of the head. Antenna (Fig. 2-B) pale brownish, shorter than stalk of labral fan; proportions of segments (basal to apical) 1: 0.9: 1.7: 0.1. Labral fan with 25-29 (mean 27) primary rays. Hypostoma as in Fig. 2-C; with 17 teeth arranged in three main groups of 7+ 1+ 7 plus a small tooth on each side at base of median tooth; median tooth long, subequal to longest lateral tooth of each side; each lateral group of teeth varying in structure to median group, consisting of (from inner to outer): small, median, large, median, median, small and large teeth, outer lateral margins of hypostoma with about 15 denticles irregularly distributed; six or seven long lateral setae and two large hypostomal setae, longest seta overreaching tip of longest hypostomal tooth. Hypostomal cleft (Fig. 2-G) poorly defined, a shallow, rather V-shaped

excavation extending about 2/8 distance to base of hypostoma. Hypostomal bridge distinctly longer (35:24) than hypostoma. Mandible (Fig. 2-E) with an apical tooth, 2 external, 1-3 preapical and 7-13 inner teeth; inner subapical ridge with about 7-15 fine serrations. Maxillary palpus about 2.8 times as long as width at base. Lateral plate of proleg extending half length of apical segment; irregularly subtriangular, two times longer than width; lightly sclerotized and with about 36 setulae projecting distally toward bases of hooks; circlet of apical hooks arranged in about 44-47 rows with 11-12 hooks each. Basal area of anal sclerite with short well-sclerotised, basal wings with 4+4 anal scales of 2, 3 or 4 prongs situated near auxiliary strut-like structures and about 20 additional anal scales in a circlet near anterior wings which have a serrated anterior border; rectal gills three, digitiform. Posterior circlet of hooks, consisting of about 25 hooks in about 108-120 rows.

**Pupa.** Length about 4.0 mm. Respiratory organ (Fig. 2-A) about 2.7 mm. long, consisting of five main basal filamentous corrugated trunks, branching as follows: one long, single posteroventral branch, two long dorsomedial and two short anteroventral branches, latter two groups variably bearing shorter accessory branches. Head (Fig. 2-D) and thoracic integument with round and ovoid granulosities that are darker than rest of integument. Antenna of male reaching 3/4 distance hind margin of head; antenna of female reaching hind margin of head; a single, slender seta present near inner corner of each antenna; each side of thorax with about one anterodorsal, two mediodorsal, one posterodorsal, two medioventral, and one posteroventral long, single, trichomes; anterodorsal trichomes stoutest. Dorsal abdominal chaetotaxy as follows (Fig. 2-F): Segment I with 5+5 fine setae; II with 8+8 spines; III with 4+4 hooks and 4+4 spines; IV with 4+4 hooks and 4+4 spines; V with 4+4 fine setae; VI with a row of scales and 3+3 fine setae; VII with a row of scales and 2+2 fine setae, VIII with a row of scales and 2+2 spines; IX bare. Ventrally: Segment III with 1+1 setae; IV with 5+5 spines; V with 3+3 hooks, 1+1 spines and in addition 3+3 spines on striated area, VI with 3+3 hooks plus 1+1 hooks, 2+2 spines and 1+1 setae on

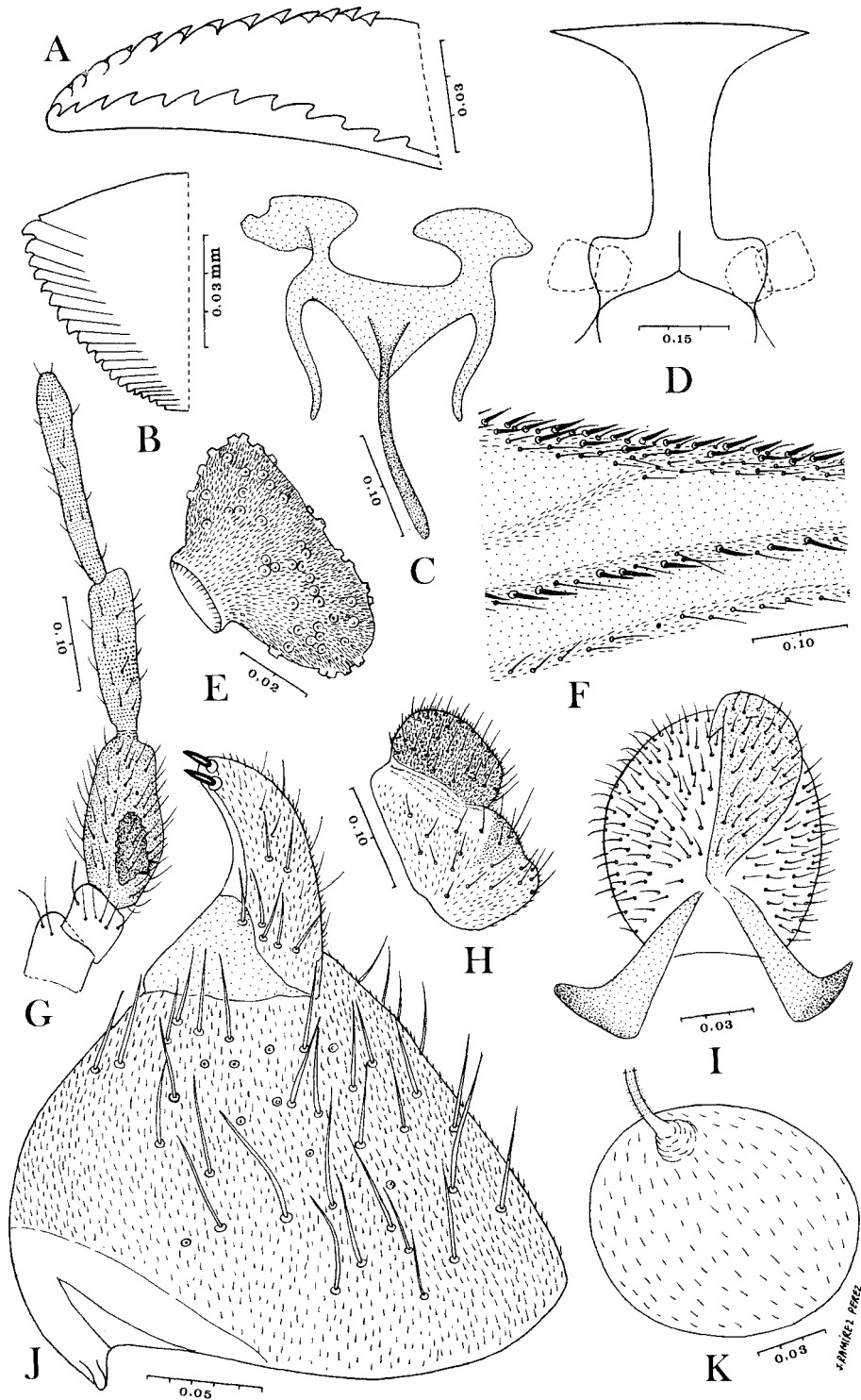


Fig. 3. *Gigantodax willei* n. sp. A, apical region of blade of maxilla. B, apical region of mandible. C, genital fork. D, frons of female. E, sensory vesicle of maxillary palpus. F, wing showing portion of C, R<sub>1</sub> and R<sub>2</sub>. G, maxillary palpus. H, cercus and anal lobe. I, ventral plate in ventral view. J, gonostylus. K, spermatheca.

striated area; VII with 1+1 hooks, 1+1 spines, 1+1 hooks and 2+2 spines on striated area; VIII bare; and IX with 6+6 stout spines; two pairs of ventral plates present on segments VI and VII, and patches of minute scales present on sternites III to VIII. Cocoon subtriangular, composed of loosely woven threads and without a thickened anterior margin; about 3.0 mm long.

#### Types:

**Holotype**, female, reared. From temporary stream No 73, at Rio Reventado, Prusia, Cartago, located 0.5 km NW of the "Sanatorio Durán" on the road to Irazú Volcano, November 30, 1984. J. F. Herrera, collector (USNM).

**Paratypes**, same data as holotype.

**USNM** (Mounted and alcohol specimens):

3 females, 5 males, 3 mature and 40 immature larvae, 7 pupae and 60 empty pupal pelts. U.C.R. (School of Microbiology, entomological collection. Mounted and alcohol specimens): 13 females, 4 males, 1 mature larva and 600 immature larvae. 245 pupae.

This species is dedicated to the late Alexander Bierig, first professor of Medical Entomology at the School of Microbiology University of Costa Rica.

*Gigantodax willei* Vargas and Ramírez-Pérez, new species.

**Female** (dry pinned specimens). General body color dark brown. Length: body 3.0 mm; wing 3.5 mm.

**Head:** Brownish; frons (Fig. 3-A) narrow, nearly parallel sided, only slightly widening dorsally, about seven times longer than width, and 1/9 width of head; paler than occiput, with yellowish pollinosity, and rather densely covered with moderately long, decumbent brownish pile. Clypeus slightly lighter than frons; rather densely covered with moderately short, ventromedially directed brownish pile. Occiput blackish, densely covered with short, yellow pile. Postocular setae yellowish, posteriorly directed. Antenna with nine flagellomeres; scape, flagellum and pedicel light brown, except two apical flagellomeres blackish; first flagellomeres longer than pedicel, remaining flagellomeres subequal in length;

pedicel and scape with long, black setae and fine black pubescence; flagellomeres with a few light setae and fine black pubescence. Mandible (Fig. 3-E) with about 19-22 serrations. Blade of maxilla (Fig. 3-I) with about 10-12 retrorse teeth. Palpus (Fig. 3-C) dark brown, all palpomeres similar, with long brown pile and fine, light setae; palpomere five subequal in length to three; proportions of segments: 1: 0.7 : 2.7 : 2.0 : 2.1 Sensory vesicle as in Fig. 3-G, about 1/2 as long as its segment, proximally situated, its neck short, with an enlarged mouth. Median proximal space of cibarium small, shallow, without denticles, dorsolateral arms short, weakly sclerotized, inner surface of each arm smooth, without minute setulae.

**Thorax:** Dark brown; anteprenotal lobe, concolorous with scutum, with moderately dense long, yellow pile. Postpronotum, bare. Scutum, with a few black spots, whitish pollinose and with abundant yellowish pile. Scutellum paler than scutum, densely covered with long, pale yellow setae on hind margin. Postscutellum dark brown, bare. Anterior half of pleuron dark brown, concolorous with posterior half; presternal lobe dark brown, bare; anepisternal membrane concolorous with rest of abdomen, but with a whitish pollinosity. Mesepimeral tuft of long, yellow hairs irregularly distributed at base, and bare distally. Wing (Fig. 3-D) membrane hyaline, with a light brownish tinge; veins yellowish brown; base of C and stem vein with short pile and long brown setae, rest of setae on veins brownish. Sc setose ventrally; R<sub>1</sub> setose dorsally and with spinules on distal fourth; R<sub>2+3</sub> setose ventrally and dorsally; cell bm absent; C with spines from basal 1/4 to end of vein; fringe of calypter and alar lobe with long, light brown setae. Halter light brown, with hairs at base. Legs rather uniformly light brown; coxae with a few light brown setae; hind basitarsus about six times as long as broad. Calcipala large, broadly rounded. Pedisulcus absent. Claw slightly curved from base, with a prominent subtriangular basal tooth that is wider than claw and about 1/4 as long.

**Abdomen:** Blackish; basal scale (tergite one) dark brown, with a fringe of long, yellow pile; tergites wide, with brown setae distributed over surface. Pleural membrane dark brown.

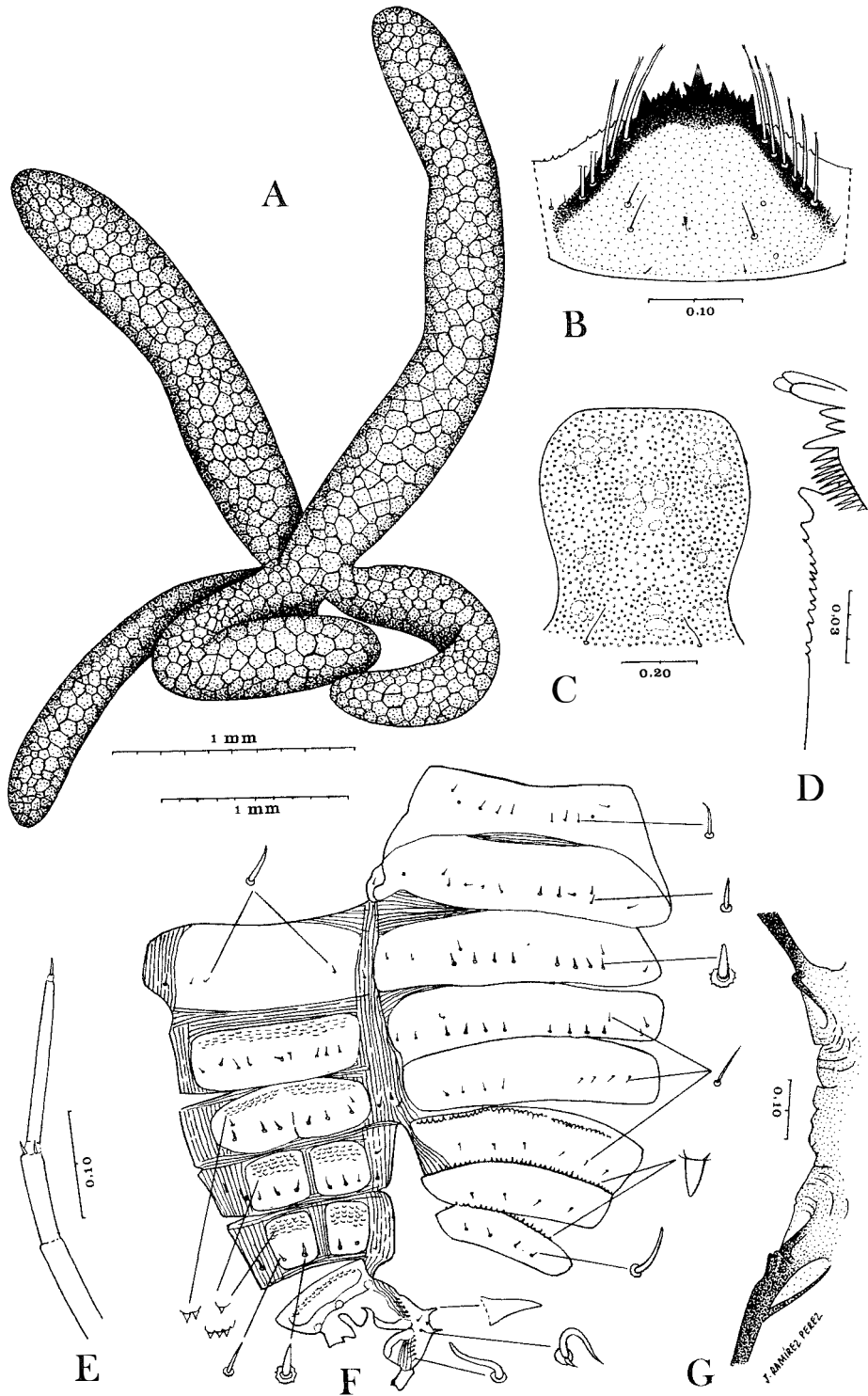


Fig. 4. *Gigantodax willei* n. sp. A, respiratory organ of pupa. B, larval hypostoma. C, pupal frons. D, apical region of larval mandible. E, larval antenna. F, abdomen of pupa. G, larval postgenal cleft.



with yellowish pile. Sternites darker than segmental membrane. Terminalia as in Fig. 3 (B, F, H). Anal lobe subtriangular with a posteroventral notch; setae light and dark brown. Cercus subrectangular, with abundant light brown setae. Hypogynial valves not reaching posterior border of cerci. Stem of genital fork (sternite nine) slender, more sclerotized and subequal in length to arms; arms short, hooked-shaped, weakly sclerotized, with a rodlike extension on each side emanating from stem of genital fork. Spermatheca rounded, slightly striated, with few internal spicules, and with a corrugated area at junction with spermathecal duct.

**Male** (dry, pinned specimens). General body color, dark brown. Length: body 3.0 mm; wing, 3.5 mm.

**Head.** Frons and clypeus black, with short yellowish pile. Occiput same color as scutum, with brown setae. Antenna light brown; pedicel wider than first flagellomere but  $1/3$  as long; scape, pedicel and first flagellomere with light brown setae and fine black pile; all flagellomeres with a pair of hooked setae ventrally. Palpus light brown, second palpomere slightly darker than rest; all with mixture of fine black, and light brown setae; palpomere five subequal to third and slightly larger than fourth. Sensory vesicle about  $1/2$  as long as its segment, with a wide mouth.

**Thorax:** Anteprepronotum and postpronotum dark brown, bare, concolorous with scutum. Scutum dark brown, covered with abundant short, yellowish pile, with narrow white lines and whitish pollinosity. Scutellum lighter than scutum, with long brown setae. Postscutellum concolorous with scutum, bare. Pleuron dark brown; anepisternal membrane with a whitish pollinosity, bare. Mesepimeral tuft with long, yellowish hairs. Wing membrane hyaline with a slight brownish tinge; veins yellowish brown; base of C with long, light brown setae and abundant short setae; rest of setae on veins light brown. Sc with setae ventrally; base of R and  $R_1$  setose dorsally along entire length and with spines distally;  $R_{2+3}$  with long setae dorsally and ventrally; C with spines reaching apex; cell bm absent; fringe of calypter and alar lobe light brown. Halter with brown pigment and small light

brown hairs at base. Legs rather uniformly light brown, same color pattern as females; hind basitarsus not swollen, about 6.5 times as long as broad; calcipala large, distinct, rounded apically, pedisulcus absent.

**Abdomen:** Dark brown. Fringe of basal scale (first tergite) yellow. Tergites narrow, dark becoming slightly paler posteriorly, with scattered yellow setae. Pleural membrane light brown in anterior segments and darker in posterior segments. Sternites dark, with yellow setae. Terminalia as in Fig. 3 (J, K). Gonocoxite trapezoidal with abundant long, dark setae. Gonostylus subtriangular, elongated about  $1/2$  as long as gonocoxite, notched at basal angle, with two apical spines. Body of ventral plate of aedeagus ovate, with abundant light hairs, distal margin with a rounded keel-like lobe. Stem of median sclerite of aedeagus longer than arms; aedeagal membrane with abundant pale setulae. Plate of endoparameral organ twisted, well sclerotized, with one big fusiform spine, and a group of about six small spines.

**Larva** (Mature, with fully developed respiratory histoblasts). Length about 7.0 – 8.0 mm. General body color brownish; intersegmental lines narrow, lighter than rest of abdomen. Head capsule light brown; head spots darker than surrounding area. anteromedian spot slender and posteromedian spots rounded, both sets of spots contiguous; three anterolateral spots distinctly separated, first smallest, second median sized third largest and elongated. Eye spots of median size, black. Postocciput with narrow sclerotized band; cervical sclerites subtriangular, slender, fused at their bases with lateral unsclerotized area of head. Antenna (Fig. 4-E) pale brownish, shorter than stalk of labral fan; proportions of segment (basal to apical) 1: 0.9:2: 0.2. Labral fan with 17–20 primary rays. Hypostoma as in Fig. 4–B; with 17 teeth arranged in three main groups of  $7 + 1 + 7$ , plus a small tooth on each side of base of median tooth; median tooth subequal to longest lateral teeth of each side; each lateral group consisting of (from inner to outer) a small, median, large, median, median, small and large tooth. Outer lateral margins of hypostoma with 5–9 denticles irregularly distributed; with five or six long, lateral setae

and two small, medial hypostomal setae and two small hairs, longest seta overreaching tip of longest hypostomal tooth. Hypostomal cleft (Fig. 4-G) poorly defined, a shallow excavation extending about 1/8 distance to base of hypostoma. Hypostomal bridge distinctly longer (35: 20) than hypostoma. Mandible (Fig. 4-D) with an apical tooth, 3 external, 3 preapical and 7-8 inner teeth; inner subapical ridge with about 11-13 fine serrations. Maxillary palpus about 2 times as long as width at base. Lateral plate of proleg extending half length of apical segment, irregularly subtriangular, 2 times as long as wide; moderately sclerotized, with a circlet of numerous setulae projecting distally toward bases of hooks; circlet of apical hooks arranged in about 55 rows, each with 11 hooks. Basal area of anal sclerite with short, sclerotized basal wings each with a patch of numerous scales that have 2-4 prongs near auxiliary strutlike structures, and an additional circlet of anal scales, near anterior wings, each with 1-4 prongs; rectal gills three, single, digitiform. Posterior circlet of hooks consisting of about 91 rows with 19 hooks each; Anterodorsal arms less than three times as long as posteroventral arms.

*Pupa.* Length about 4.0 mm. Respiratory organ (Fig. 4-A) about 2.5 mm; long filaments digitiform, consisting of five, simple, sacciform branches, with a corrugated surface, dark brown in color; a clear granularity is visible over each branch. Head (Fig. 4-C) and thoracic integument with round and ovoid brownish granulosities. Antenna of male reaching less than 3/4 distance to hind margin of head; antenna of female reaching hind margin of head; a single slender seta is present near inner corner of each antenna. Each side of thorax with about 2 anterodorsal, 1 medio-dorsal, 0 posterodorsal, 2 anteroventral, 1 medionventral and 1-2 long, single, posteroventral trichomes. Dorsal abdominal chaetotaxy (Fig. 4-F): Segment I with 4 + 4 setae; II with 7 + 7 spines; III with 4 + 4 hooks, 3-4 + 3-4 spines; IV with 4 + 4 hooks, 3-4 + 3-4 spines; V with 5 + 5 setae; VI with 3 + 3 setae and a row of scales; VII with 2 + 2 setae and a row of scales, and 1 + 1 setae on striated membrane; VIII with 2 + 2 spines and a row of scales; IX with 1 + 1 hooks, and 1 + 1 sclerotized processes. Ventrally: Segment III

with 0-1 fine setae and 1 + 1 larger setae; IV with 5 + 5 spines and 1 + 1 spines on striated membrane; V with 3 + 3 hooks, 1 + 1 hooks; 3 + 3 setae on striated membrane; VI 2 + 2 hooks and 1 + 1 spines on striated membrane; VII with 1 + 1 hooks, 1 + 1 spines, 1 + 1 hooks and 3 + 3 spines on striated membrane; VIII bare; IX with 5 + 5 hooks on striated membrane. Two pairs of ventral plates present on segments VI and VII, and with patches of minute scales on segments III to VIII. Cocoon subtriangular with loose threads and without a thickened anterior band.

#### Types:

*Holotype:* female. From temporary stream No. 73, Río Reventado, Prusia, Cartago, located 0.5 km of "Sanatorio Durán" on the road to Irazú Volcano, April 15, 1983. C. R. Méndez, collector (USNM).

*Paratypes,* same data as holotype.

USNM (mounted and alcohol specimens).

3 females, 5 males, 8 mature and 15 immature larvae and 16 pupae. U. C. R., School of Microbiology, entomological collection. (mounted and alcohol specimens).

5 females, 5 males, 248 immature larvae and 407 pupae.

This species is dedicated to Dr. Alvaro Wille, distinguished professor of Entomology at the University of Costa Rica.

#### GEOGRAPHICAL DISTRIBUTION

From the 100 streams in which blackflies were collected in Costa Rica during the period 1968-1970 (Vargas and Travis 1973), only 3 contained *Gigantodax*: No. 34 (Poasito, Alajuela), No. 42 (San Juan de Chicué, Oreamuno, Cartago) and No. 73 (Río Reventado, Prusia, Cartago). During the period 1983 to 1986 stream No. 45a (La Georgina, Pérez Zeledón, San José) proved positive for *Gigantodax*. The population densities, grossly estimated from numbers of larval and pupal stages, collected during a period of one hour each month by two people, show a general pattern of low densities and the need to collect throughout the year, because of the scattered detection of larvae and/or pupae (Fig. 5).

TABLE 1

*Annual appearance of Gigantodax spp. per stream, in Costa Rica*

YEAR	MONTH											
	JAN	FEBR	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
	Stream No. 34:											
1968			X						X			
1969	X	X	X	X	X	X		X				X
1970	XX	XX	X	XX	X	X				X		
1983	X	X	X	X	X		X	X				
1986			X	X	XX	X	XX	XX	X	X	X	X
	Stream No. 42:											
1968								X	XX		XX	X
1969	X		X	XX	X	X		X	X		X	
1970		XX	X	XX	X			X				
	Stream No. 73:											
1969				XXX	X	X		X	X		X	
1970		X	X	X	X							
1982									X	XXX	X	X
1983								X			XX	X
1984			XX		X	X		XXX	XXX		XXX	
	Stream No. 45:											
1983			X	X	X	X		XX	XX	XX		
1986	XX				X	X		XX	XX	XX	X	

X = minimum amount of larvae and/or pupae  
 XX = moderate amount of larvae and/or pupae  
 XXX = large amount of larvae and/or pupae

## ECOLOGY

The characteristics of the streams in which *Gigantodax* have been collected are as follows. Stream No. 34 (Poasito, Alajuela), altitude 1940 m, This is a moderate sized stream, 23.5 km from Carrizal on the road to Poas Volcano. The stream is about 30 cm deep and 3 m wide, with a bed of mostly stones and large boulders. The stream is fully shaded by large trees. The waterflow is fast with extreme turbulence as the water passes over and between the large boulders. The water is mostly clear with no evidence of pollution. Temperature ranges from 12 to 17 C. The stream arises from the nearby slopes and passes through pasture lands. Stream No. 42 (San Juan de Chicué, Oreamuno, Cartago) altitude 2790 m is a small stream 22.5 km from the Church "Los Angeles" in Cartago, on the road to the Irazú Volcano. The stream is 5 cm deep and about 0.25 m wide, with a bed of stones, boulders and volcanic ash. The waterflow is from moderate to fast with riffles where the water flows over the large boulders. The water is mostly clear with a small amount of turbidity caused by the fine volcanic ash; there is no apparent pollution. In some places, there is

a yellowish fibrous deposit on the stones that is typical of water containing sulphur. The stream is partially to densely shaded by trees, large shrubs and large herbaceous plants. Temperature ranges from 9 to 19 C. The stream arises on the slopes leading to the volcano and passes through some pasture land. Stream No. 45a (La Georgina, San José), altitude 3150 m, is a small, non permanent stream, located between Km 96 and Km 97 at one side of Interamerican high way to San Isidro de El General, near the locality known as "La Georgina". The number 45a assigned to this stream is not included in the original stream chart of Vargas and Travis (1973). The stream runs down a steep slope, and its bed consists of rocks, boulders and mud. The water flow is from slow to moderate, is clear and apparently unpolluted, with pH values from 7.1 to 7.8 and temperature ranges from 10 to 14 C. Stream No. 73 (Río Reventado, Prusia, Oreamuno, Cartago), altitude 2340 m, is a moderate size stream located 0.5 Km NW from the "Sanatorio Durán". The stream is 0.2 to 0.5 m deep and with a very widely spread bed of 8 m, but with little water volume. The bed consists mainly of mud, silt and rocks, covered by a ferruginous substance. There is no trailing

vegetation. It is partially shaded by trees and shrubs. The water is yellowish, very turbid and polluted by volcanic substance and ashes and flows over large rocks. Temperature ranges from 15 to 19 C. This stream arises on the slopes of Irazú Volcano and flows through cultivated areas and pasture lands.

## DISCUSSION

Edwards (1931) split *Gigantodax* in two groups according to the size and shape of the second hind tarsal segment, size of the adults, and shape of the cocoon. Wygodzinsky (1962) emphasized that the taxonomy of the genus *Gigantodax* has its basis not in the morphology of the adult, but in the structures of the larval and pupal stages which have the best specific characters. We can artificially divide the pupal forms into the following five subgroups, according to the general shape and branching of the respiratory organ (Dalmat 1955, D'Andretta & D'Andretta 1947, Coscarón & Wygodzinsky 1962, Edwards 1931, Ramírez-Pérez 1980, Vargas & Díaz-Nájera 1951, Wigodzinsky 1951, 1958). Subgroup I (branches of a filiform type): *G. antarcticum*, *G. bonorinorum*, *G. chilense*, *G. fulvescens*, *G. femineum*, *G. igniculum*, *G. kuscheli*, *G. ortizi*, *G. viannamartinsi*. Subgroup II (branches of a digitiform type): *G. aquamarensis*, *G. bettyae*, *G. conviti*, *G. wittmeri*, *G. wrighti*. Subgroup III (branches of a tubuliform type): *G. cervicorne*, *G. horcotiani*, *G. wygodzinskyi* and *G. lazoii*. Subgroup IV (branches of a mixed digitiform-tubuliform type): *G. corniculatum*. Subgroup V (branches arising from a globular or subglobular base): *G. abalosi*, *G. bolivianum*, *G. impossibile*. Unfortunately the pupae of eight species remain undescribed: *G. araucanum*, *G. brophy*, *G. marginale*, *G. nigrescens*, *G. pennipunctum*, *G. rufescens*, *G. rufinotum* and *G. shannoni*. According to the available descriptions, *G. bonorinorum*, *G. chilense*, *G. fulvescens*, *G. kuscheli*, *G. ortizi* and *G. viannamartinsi* show 18 distal branches with a varied branching mode. *Gigantodax antarcticum* and *G. femineum* show two groups of branches (8–10) oppositely directed, and *G. igniculum* with 90 to 120 distal filaments. It is obvious that some of the species described by Edwards (1931) need to be revised. Of the two Costarican species of *Gigantodax* described here, *G. willei* belong to the subgroup with

the respiratory organ of the pupa having branches of a digitiform type, and the other, *G. bierigi* to the subgroup with filiform type of branches.

Among the five known species with a respiratory organ of a digitiform type, the only one with single, undivided branches is *G. wittmeri*, which according to Wygodzinsky (1951), has only four branches instead of the five present in *G. willei*. *Gigantodax bierigi* on the other hand, belongs to the subgroup of nine known species with a filiform type respiratory organ.

Eight of these species have 17 or 18 terminal filaments and one has 90-120 terminal filaments. In contrast, our species shows five main basal trunks and seven terminal filaments, all corrugated, and most of them with caducous filaments.

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## RESUMEN

Se describen la hembra, macho, pupa y la larva de *Gigantodax bierigi* y *Gigantodax willei* n. spp. (Diptera: Simuliidae). Tales especies se diferencian de los otros miembros del

género *Gigantodax*, tomando como base, entre otros, la forma general y número de las ramas del órgano respiratorio de la pupa.

Ambas especies fueron colectadas de quebradas sitas entre los 1940 y 3150 m sobre el nivel del mar. Se incluyen algunas observaciones sobre la biología de las dos especies.

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