

**ACANTHAGRION SPECULUM SPEC. NOV., A NEW DAMSELFLY
FROM COSTA RICA (ZYGOPTERA: COENAGRIONIDAE)**

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A. speculum sp. n. (holotype male and allotype female: Finca La Selva, 2.4 km S of Puerto Viejo, Heredia Province, Costa Rica) is described and compared with the sibling species *A. kennedii* Wllmsn. Males of these species are distinguished by characters of the penis. The new species is known only from several localities in eastern Costa Rica.

INTRODUCTION

In 1979, my wife and I collected five specimens of *Acanthagrion* in Costa Rica which represented an undescribed species. Dr Dennis R. Paulson had also collected a large series of this species from various localities in eastern Costa Rica, and he kindly loaned them to me for study. This species, according to LEONARD (1977), is most similar to *A. kennedii* Williamson.

DESCRIPTION

ACANTHAGRION SPECULUM SP. N.

Figures 1-6, 9-10

Material — **Holotype:** Male in tandem with allotype female: Costa Rica, Heredia Province, Finca La Selva, 2.4 km S of Puerto Viejo, 60 m elev., 2 July 1967, collected by Dennis and Mary Lynn Paulson, collection No. 67-146. — **Allotype:** Female in tandem with holotype male: same data as holotype. Both specimens in Florida State Collection of Arthropods, University of Florida. — **Paratypes:** 61 ♂, 13 ♀; all Costa Rica: Alajuela Prov.: Los Chiles, 60 m (D.R. Paulson), 30 July 1966, 2 ♂, 1 ♀; 31 Aug. 1966, 2 ♂; 12 Oct. 1966, 1 ♂; 13 Oct. 1966, 2 ♂; 14 Oct. 1966, 1 ♂; 24 Nov. 1966, 2 ♂; — ponds 1.6 km N of La Marina, 305 m, (D. R. & M. Lynn Paulson) 5 July 1966, 1 ♂; 10 Oct.

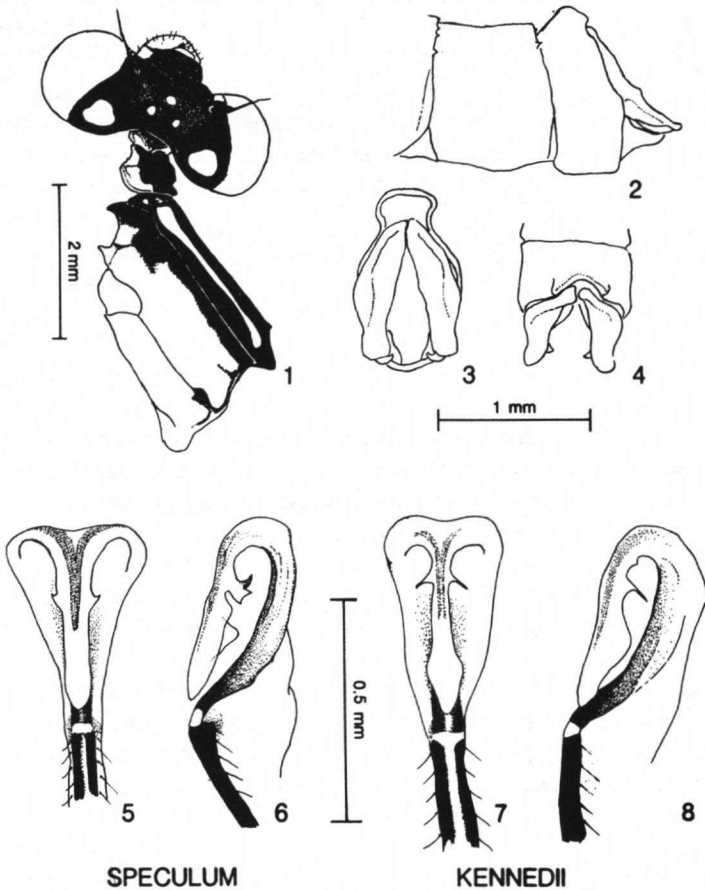
1966, 1 ♂; — Cartago Prov.: Instituto Interamericano de Ciencias Agrícolas, SE of Turrialba, 609 m, 17 Oct. 1947, (A. Svihla), 1 ♂, 1 ♀; 3 Aug. 1963, (F. Thompson), 1 ♂; 12 July 1966 (D.R. & M. Lynn Paulson), 2 ♂; 2 Aug. 1966, 3 ♂, 1 ♀ (1 pair in tandem); 4 Oct. 1966, 7 ♂, 3 ♀ (2 pairs in tandem); — Río Reventazón, SE of Turrialba, by Hwy 10, 10 Aug. 1979, (R.W. & J.A. Garrison), 5 ♂; — Guanacaste Prov.: Laguna Arenal, S side, 488 m, 16 July 1966 (D.R. Paulson), 2 ♀; — Heredia Prov.: Finca La Selva, 2.4 km S of Puerto Viejo, 60 m (D.R. & M. Lynn Paulson), 17 Sept. 1966, 1 ♂; 18 Sept. 1966, 3 ♂, 1 ♀ (1 pair in tandem); 20 Sept. 1966, 2 ♂; 21 Sept. 1966, 1 ♂; 23 Sept. 1966, 6 ♂, 1 ♀ (1 pair in tandem); 30 June 1967, 2 ♂; 1 July 1967, 3 ♂, 1 ♀; 2 July 1967, 4 ♂; 12 Aug. 1967, 3 ♂; 13 Aug. 1967, 2 ♂, 1 ♀ (1 pair in tandem); 14 Aug. 1967, 2 ♂; — Limon Prov.: La Lola, 45.5 km W of Limon, (F. Thompson), 23 July 1963, 1 ♀; 6 km WSW of Pandora, 5 July 1964, 1 ♂. — Paratype pairs are in the collections of D.R. Paulson, R.W. Garrison, T.W. Donnelly, the U.S. National Museum, and the University of Michigan. Paratype males are in the collections of D.R. Paulson, R.W. Garrison, C. Cook, and S.W. Dunkle.

Male: Head. — Labrum, base of mandibles, anteclypeus and genae blue; lateral margin and basomesal portion of labium black; postclypeus and top of head black. Large blue postocular spots (Fig. 1) a little larger than ocellar triangle, blue from genae extending mesally above postclypeus and meeting narrow black middorsal line from frons. Antennae black, rear of head largely pale buff, occiput and area around occipital foramen black.

Thorax. — Anterior lobe and extreme sides of prothorax blue (Fig. 1), remainder black, sometimes with small blue midlateral spots on median lobe. Distal half of mesostigmal plates blue, mesal portion black. Synthorax with large middorsal black stripe about 4 times as wide as narrow blue antehumeral stripe, upper end of black middorsal stripe extending laterally below antealar sinus and connecting with large humeral stripe, lower end also connecting with lower end of humeral stripe along posterior margin of mesostigmal plates. Black humeral stripe covering anterior half of mesepimeron and anterior half to all of mesinfraepisternum. Upper end of humeral stripe with thin black line extending posteriorly just under wing bases and sending small elongate line along upper fifth to half of incipient midlateral suture and a larger, wider elongated spot on upper three quarters of second lateral suture; some specimens with this second lateral spot forming a narrow lateral thoracic stripe almost touching metinfraepisternum. Remainder of sides of synthorax blue, metinfraepisternum, metasternum, and coxae pale buff. Inner surfaces of tibiae and femora black, outer sides of tibiae dark brown; spines and armature black.

Abdomen. — Dorsum and posterior margin of segment 1 and 2 black, sides blue; some specimens with anterior margin of segment 2 also black; segments 3-7 mostly black on dorsum and sides, blue on sides of terga extending dorsally along anterior margin of 3 and 4 and almost meeting middorsally; these markings separated from pale sides on 5 and 6 forming small blue midlateral spots along anterior margins; segments 8-9 blue; segment 10 black; caudal appendages black and as shown in Figures 2-4.

Wings hyaline to slightly infumated, venation and pterostigmata black; wings



Figs 1-6. (Figs 1-6): *Acanthagrion speculum* sp. n., paratype male: Costa Rica, Cartago Prov., Rio Reventazón, SE of Turrialba, by Hwy 10, 10 August 1979: (1) Thorax and head, lateral view; — (2) Superior appendages, lateral view; — (3) Same, posterior view; — (4) Same, dorsal view; — (5) Penis, ventral view; — (6) Same, lateral view. — (Figs 7-8): *A. kennedii* Williamson: Trinidad, St. George Co., forest and small stream along trail called Indian Walk Ride, off Main Road, 6.2 km N of Cumuto, 7 April 1980: (7) Penis, ventral view; — (8) Same, lateral view.

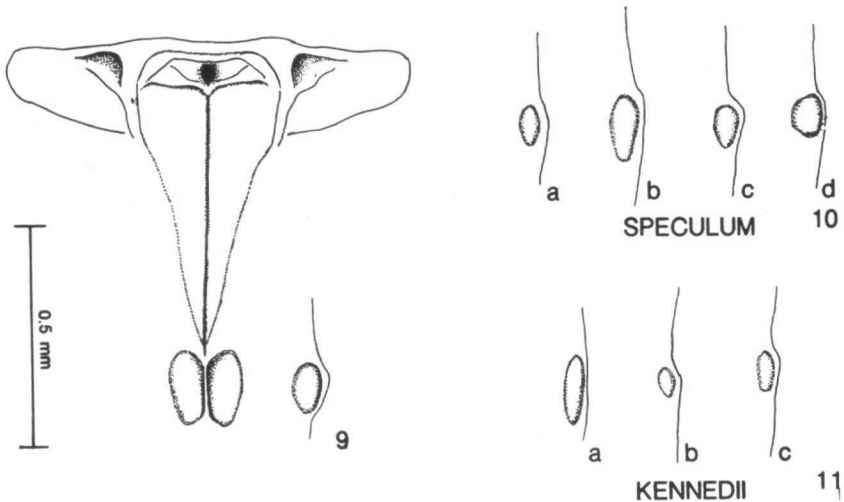
petioled beyond Ac juncture by distance equal to length of Ac; arculus slightly distal to second antenodal in all wings; postnodals of holotype: $\frac{11}{9} \cdot \frac{11}{9}$; R_3 in holotype arising just before fifth antenodal in fore wings, just before fourth antenodal in hind wings; IR_2 in holotype arising at eighth antenodal in fore wings and hind wings.

Holotype: Abdomen 28 mm; hind wing 17.5 mm.

Female: Head. — Pale head colors blue-green and similar in design to male but more extensive as follows: small midlateral spot often present on postclypeus, pale area extending from genae to median ocellus, sometimes with small pale spots between median and lateral ocelli. Black from frons extending anteriorly surrounding bases of antennae and forming small lateral arms distally toward compound eyes and mesally; black markings anterior to median ocellus narrowing then enlarging forming a large diamond, its anterior end connecting to thin line to base of postclypeus; sides of diamond sometimes connecting with black mesally-directed arms below antennae forming pale midlateral spots.

Thorax. — Prothorax as in male but pale blue-green areas more extensive, pale midlateral spots usually present on middle lobe. Synthorax as in male, but blue replaced by blue-green; mesepisternal fossae and mesostigmal plates as shown in Figure 9. Legs with black largely confined to distal parts of femora, becoming paler mesally.

Abdomen. — Segments 1-3 as in male but blue-green areas more extensive; 4-7 similar to 1-3 but anteriorly with blue invaginating dorsally forming incomplete pale transverse rings; posterior annuli behind transverse carinae of 7-8 pale;



Figs 9-11. (Figs 9-10): *Acanthagrion speculum* sp. n., paratypes: (9) Mesepisternal fossae of paratype: Guanacaste Prov., Laguna Arenal, 16 July 1966; — (10) Mesepisternal fossae, lateral views of allotype and paratype females: (a) Cartago Prov., Instituto Interamericano de Ciencias Agrícolas, SE of Turrialba, 17 October 1947, — (b) Same data, 4 October 1966. — (c) Allotype, Heredia Prov., Finca La Selva, 2.4 km. S. of Puerto Viejo, 2 July 1967, — (d) Same data as for Fig. 9. — (Fig. 11): *A. kennedii* Williamson, mesepisternal fossae, lateral views of females: (a) Trinidad, St Andrew Co., swamp just N of Sangre Grande, on Eastern Main Road, 13 January 1981. — (b) Same data as for (a). — (c) Trinidad, St Andrew Co., Plantation Rd., by Tumpana Rd, 1.6 km W of Cumuto, 11 January 1981.

dorsum of 8 black; 9 blue except for irregular black spots occupying anterior fourth of segment, or extending posterolaterally to transverse carinae; 10 blue; appendages black.

Wings similar to male; postnodals of allotype $\frac{12}{10} \cdot \frac{10}{10}$; R_3 in allotype arising at fifth postnodal in fore wings, at fourth postnodal on left hind wing, just before fifth postnodal on right hind wing; IR_2 in allotype arising at ninth postnodal in fore wings, at eighth postnodal in hind wings.

Allotype; Abdomen 27 mm; hind wing 19 mm.

Venational features (64 ♂, 14 ♀). — Number of postnodals: males, fore wing, 10-12, ave. 11.2; hind wing, 8-11, ave. 9.4. Females, fore wing 11-12, ave. 11.2; hind wing, 9-10, ave. 9.3 — Origin of R_3 : Males, fore wing, arising at fourth postnodal 5%, at fifth 91%, just before sixth 2%, at sixth 2%; hind wing, arising at fourth postnodal 86%, just beyond fourth 2%, just before fifth 8%, at fifth 4%. Females, fore wing, arising at fifth postnodal 100%; hind wing, arising at fourth postnodal 100%. — Origin IR_2 : Males, fore wing, arising at seventh postnodal 4%, at eighth 69%, just before ninth 2%, at ninth 25%; hind wing, arising at seventh postnodal 22%, at eighth 70%, at ninth 6%, at tenth 2%. Females, fore wing, arising at seventh 7%, at eighth 22%, at ninth 71%; hind wing, arising at seventh postnodal 14%, at eighth 79%, at ninth 7%.

Measurements (64 ♂, 14 ♀):

	Abdomen (mm)			Hind wing (mm)			Ratio: Hind wing/Abdomen		
	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.
♂	29	27.1	23	18	17.3	15.5	0.76	0.64	0.60
♀	28	25.4	24	19	17.9	16.5	0.75	0.71	0.64

Etymology. "*Speculum*": Latin for "mirror". The name refers to this species' overall similarity (as a mirror image) to *A. kennedii* and *A. quadratum* Selys.

DISCUSSION

Acanthagrion speculum belongs to LEONARD's (1977) *ascendens* group and will key out to *A. kennedii*. The only positive way to separate *A. speculum* from *A. kennedii* is by the shape of the penis. In *A. kennedii*, the ental surface of the penis bears a pair of fenestrate spurs which are straight (Figs 7-8) or curved (cf. LEONARD, 1977, figs 31, 32). In *A. speculum*, this same structure is modified into a pair of small chitinized (darkened) curved spurs (Figs 5-6). Anterior to these spurs are fenestrate truncate lobes. The distal part of the penis is similar for both species, although *A. speculum* possesses more of a keel than does *A. kennedii*. Like *A. kennedii*, *A. speculum* differs from *A. quadratum* and *A. trilobatum* Leonard by the narrow, nearly parallel sides of the distal part of the penis when viewed dorsally.

Differentiation of females of *A. speculum* from *A. kennedii*, *A. quadratum*, and *A. trilobatum* is difficult. LEONARD (1977) diagnosed females of the latter three species using the shape of the mesepisternal fossae and laminal sinus. Females of *A. trilobatum* have the "mesepisternal fossae separated from the posterior end of the interlaminal sinus by more than their own length", while these structures are closer together in *A. kennedii* and in *A. quadratum*. In *A. quadratum*, the posterolateral margins of the interlaminal sinus are convex, and the sinus is "much narrower than each mesostigmal lamina", while for *A. kennedii*, the margins are concave, and the sinus is "approximately [the] same width as each lamina" (LEONARD, 1977: 24).

I examined one female *A. trilobatum* (Panama), eight female *A. quadratum* (Mexico to Guatemala), and eight female *A. kennedii* (Trinidad), as well as the 14 female *A. speculum* from Costa Rica. An analysis of the characters used by Leonard does not show them to be reliable to differentiate these species. The posterolateral margin of the interlaminal sinus of *A. quadratum*, *A. kennedii*, and *A. speculum* can be straight, concave, or convex. The shape of the mesepisternal fossae also varies from specimen to specimen (Figs 10, 11). When viewed laterally (Fig. 10), these structures are slightly more prominent in *A. speculum* than in *A. kennedii*. However, there is a fair degree of overlap between these species.

I statistically analyzed the means of the following two ratios for all three species (*A. trilobatum* was not included, as I had only one specimen): (1) the distance from the posterior end of the mesepisternal fossae to the posterior margin of the sinus, divided by the distance from the antealar crest to the posterior margin of the sinus (hereafter called Fossa/Crest) and (2) width of the sinus along its posterior margin divided by the width of the posterior margin of the mesostigmal plate (hereafter called Sinus/Plate). The sinus was not always clearly seen in some specimens, rendering possible some inaccuracy in Sinus/Plate measurements. Both sets of data were first analyzed for homoscedasticity (equality of variances) using Bartlett's test (SOKAL & ROHLF, 1981), as a necessary prerequisite for parametric tests of analysis of means. The Fossa/Crest data, the variances of which showed homoscedasticity, were then subjected to a one-way analysis of variance (Anova); and an analysis of individual means was conducted using the GT-2 test (unplanned comparison) (SOKAL & ROHLF, 1981: 248). Variances for the Sinus/Plate data were heteroscedastic, so analysis of means for unequal sample sizes was conducted using the Games and Howell test (SOKAL & ROHLF, 1981: 409).

The single specimen of *A. trilobatum* had a Fossa/Crest ratio of 0.46: that is, the fossae are located almost at the middle of the thoracic dorsum. These measurements were much smaller for the other three species (*A. quadratum*: $\bar{Y} = 0.33$, range: 0.29-0.38; *A. kennedii*: $\bar{Y} = 0.29$, range: 0.26-0.33; *A. speculum*: $\bar{Y} = 0.30$, range: 0.27-0.42). This character is probably reliable in separating *A.*

Table I
One way analysis of variance for Fossa/Crest data. Results show significance at 0.05 level

Source of variation	df	MS	Fs
Among species	2	0.0045	3.957*
Within species	27	0.0012	

trilobatum from the other three species.

Results of the Anova for Fossa/Crest (Tab. I) show only a slight significance at the 0.05 level. An analysis of the means by the GT-2 method (Tab. II) shows only *A. quadratum* to be significantly different from *A. kennedii*. The difference between means (0.04) is equal to the critical Mean Significant Difference (MSD) of 0.04, also indicating that means of this character are only barely significantly different.

Table II
GT-2 multiple comparison test among pairs of means based on unequal sample sizes (unplanned comparison) of Fossa/Crest ratios. Values below diagonal are differences between means; values above diagonal are critical mean significant difference (MSD) values. A pair of means is significantly different at 0.05 level if the difference in means equals or is greater than the corresponding MSD

	N	\bar{Y}	<i>A. kennedii</i>	<i>A. speculum</i>	<i>A. quadratum</i>
<i>A. kennedii</i>	8	0.29	0	0.04	0.04
<i>A. speculum</i>	14	0.30	0.01	0	0.04
<i>A. quadratum</i>	8	0.33	0.04*	0.03	0

The Sinus/Plate data (Tab. III) show only *A. speculum* to be significantly different from *A. quadratum*. The sinus in *A. speculum* tends to be equal to or slightly broader than each mesostigmal plate ($\bar{Y} = 1.03$), but the plate is almost always wider than the sinus in *A. quadratum* ($\bar{Y} = 0.89$). Only one *A. quadratum* had a measurement of 1.00.

Even though significant differences were detected using these characters, overlap exists and one cannot rely solely on any one character to differentiate these three species. In summary, the Fossa/Crest measurement is probably a good distinguishing characteristic for *A. trilobatum*. The Sinus/Plate and Fossa/Crest characters will help in separating *A. speculum* from *A. quadratum*, but female *A. kennedii* will be difficult to separate from *A. speculum* and *A. quadratum*.

Acanthagrion speculum is thus far known only from eastern Costa Rica from near sea level (30 m) to 600 m. It is allopatric with *A. quadratum* (southern Texas to Nicaragua: Metagalpa Prov., 4.8 mi. SSE Dario, 23 Aug. 1964, in coll. D.R. Paulson) and *A. kennedii* (Panama, Trinidad, Venezuela, Brazil). *Acanthagrion*

Table III

Games and Howell test for equality of means for Sinus/Plate ratios. Values below diagonal are differences between means. Values above diagonal are critical mean significant difference (MSD) values. A pair of means is significantly different at the 0.05 level if the difference in means equals or is greater than the corresponding MSD

	N	\bar{Y}	<i>A. quadratum</i>	<i>A. kennedii</i>	<i>A. speculum</i>
<i>A. quadratum</i>	8	0.89	0	0.12	≈0
<i>A. kennedii</i>	8	0.92	0.03	0	0.13
<i>A. speculum</i>	14	1.03	0.14*	0.11	0

trilobatum replaces *A. speculum* in western Costa Rica, and it also occurs on the Meseta Central up to 1400 m; but both species have been taken in Cartago Province (Instituto Interamericano de Ciencias Agrícolas, D.R. Paulson, pers. comm.). Some specimens of *A. speculum*, as noted in the description, have more extensive black markings on the thorax than others, but this condition does not coincide with elevation or geography. I collected *A. speculum* at a temporary pond SE of Turrialba near the Rio Reventazon in August, 1979. Its habits were the same as I have observed for *A. quadratum*: both species are found in lentic situations where the adults rest on emergent vegetation. Other Odonata collected at the site were *Anisagrion allopterum* Selys, *Enallagma novaehispaniae* Calvert, *Telebasis salva* (Hagen), *Erythrodiplax fusca* (Rambur), and *Erythrodiplax funerea* (Hagen). Collection dates for *A. speculum* fall within the rainy season, from 30 June to 24 November.

Those specimens mentioned by CALVERT (1907) from Costa Rica (San Jose and Surubres) probably belong to *A. trilobatum*.

ACKNOWLEDGMENTS

Dr DENNIS R. PAULSON, Seattle, Washington, kindly supplied the majority of specimens of *A. speculum* for me to describe. Dr Paulson and Mr CARL COOK (Center, Kentucky) reviewed the manuscript and provided constructive criticisms. I especially appreciate Dr Paulson's help in sharing with me his extensive knowledge of the Odonata of Costa Rica. My wife, Jo, edited and typed the paper. To all of these people, I express my sincere thanks.

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