EVALUATION OF CHARACTERS TO DISTINGUISH *FITCHIA APTERA* AND *F. SPINOSULA* (HETEROPTERA: REDUVIIDAE)

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ABSTRACT

Presence or absence of spines, and number of spines (4), on the posterior margin of the pronotum were found to be an unreliable character to distinguish *Fitchia aptera* and *F. spinosula*. The morphology of the male parameres and female terminalia, and the color of the abdominal spiracular peritreme, are diagnostic. Other characters were found that, as a group and in combination with presence of spines, are useful in distinguishing the two species but are not diagnostic. These include the lateral anteocular length, lengths and ratios of antennal segments, and width of the lateral abdominal stripe. Brachypterous and macropterous adults are found in both species; brachyptery is more common in *F. spinosula* than in *F. aptera*.

RESUMEN

La presencia o ausencia de espinas, el número de espinas (4), en el margen posterior del pronotum fue un caracter poco seguro para distinguir *Fetchia aptera* y *F. spinosula*. Se utilizaron como caracteres de diagnosis la morfología de los parametros del macho y la terminalia de la hembra y el color del peritreno espiracular abdominal. Otros caracteres en grupo y en combinacion con la presencia de espinas son utiles en la diferenciacion de dos especies, pero no se usan en la diagnosis. Estos incluyen la longitud del anteocular lateral, longitud y radio de los segmentos de las antenas y el grosor de la franja lateral abdominal. Adultos brachipteros y macropteros se encuentran en ambas especies; comunmente se encuentran mas especimenes brachipteros en la especie *F. spinosula* que en *F. aptera*.

Stål described the genus *Fitchia* in 1859 (p. 370-371) and included the single species, *F. aptera* (p. 371), apparently based on a single female specimen. He added a second species in 1872, *F. spinosula* (p. 79), also apparently based on a single female specimen. One of the primary characters given by Stål was the presence of spines in *spinosula* and, in fact, he divides the species into two groups, "Thorace inermi" (*aptera*) and "Thorace spinoso" (*spinosula*). Subsequent authors have used the presence or absence of these spines alone (e.g., Fracker 1912, Readio 1927, Slater & Baranowski 1978, Torre-Bueno 1923) or in combination with head shape (e.g., Blatchley 1926, Froeschner 1944) to distinguish these species.

Blatchley (1926) provided the most complete descriptions of the two species including the absence (*aptera*) or presence (*spinosula*) of spines on the posterior margin of the prothorax (two submedial and one on each humeral angle) and the shape of the posterior lobe of the head (gradually tapering from eyes in *aptera*, suddenly constricted behind middle in *spinosula*); both characters are mentioned only in his key. Other characters

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included coloration and markings, comparative lengths of antennal segments 3 and 4, presence or absence of obtuse ridges on the posterior lobe of the pronotum, and overall body length. During a recent survey of the Reduviidae of Illinois (unpublished), the senior author found that the presence or absence of spines, and the number of spines (4), to separate the two species was unreliable. This paper discusses problems with the use of the spine character, evaluates several additional characters, and identifies those characters we find diagnostic.

Materials and Methods

We examined specimens from several collections (see Acknowledgments). Characters evaluated included the presence or absence of spines, and number of spines, on the posterior margin of the pronotum, lateral anteocular length, lengths and ratios of antennal segments, wing form (macropterous or brachypterous), width of lateral abdominal stripe, color of spiracular peritreme, and the morphology of the male pygophore and female terminalia. Pygophores were extracted from dried specimens after the specimens were softened in warm water. Drawings of the pygophore and female terminalia were prepared using a camera lucida. The terminology for the figures of genitalia and terminalia follows Davis (1966) for males and Scudder (1959) for females.

SAS procedures (SAS Institute 1988) were used in all statistical analyses. Comparisons of spine pattern and wing morph were made using Chi-square contingency tables. Differences between species in lateral anteocular length, antennal segment lengths, ratios of antennal segment lengths, width of abdominal stripe, and, in females, the ratio of length to width of the genital plates, were tested using Student's *t* test. Stripe width was measured as a ratio of its width on the third visible abdominal segment (generally its widest point) with the lateral length of the same segment. Level of significance was 0.05 for all tests.

Results

Examination of 221 specimens from several states showed that the presence or absence of pronotal spines, and the number of spines (4), were unreliable as diagnostic characters. For example, specimens were found that matched the general description of *F. spinosula* but lacked the pronotal spines. Spines varied in size from simple swellings to well developed and in number from one to four. Most frequently, they were represented by groups of two or four, i.e., they were present only submedially on the posterior margin (2 spines), or submedially and on each lateral (humeral) angle. Thus, it was necessary to search for characters that were less variable. We selected individuals that matched the general description of *spinosula* (elongate body; Stål 1872, Blatchley 1926) and had four well developed spines and individuals that matched the general description of *aptera* (less elongate body) and lacked spines, and examined the male external genitalia and female terminalia of both groups. We found distinct dimorphism within sex between species (Fig. 1A-D). The parameres of *aptera* are slender and digitate, do not extend beyond the posterior rim of the pygophore, and are not visible in posteroventral view when the pygophore rests against the tergum. Those of *spinosula* are distinctly clavate, extend beyond the posterior rim of the pygophore, and are visible in posteroventral view. In females, the ninth tergum of *aptera* is depressed medially and tumescent laterally as a prominent ridge. That of *spinosula* is flat to slightly convex medially.

Once the two species could be reliably separated, it was possible to reexamine the spine characters (presence or absence, and number) and additional ones to determine their value as diagnostic characters.

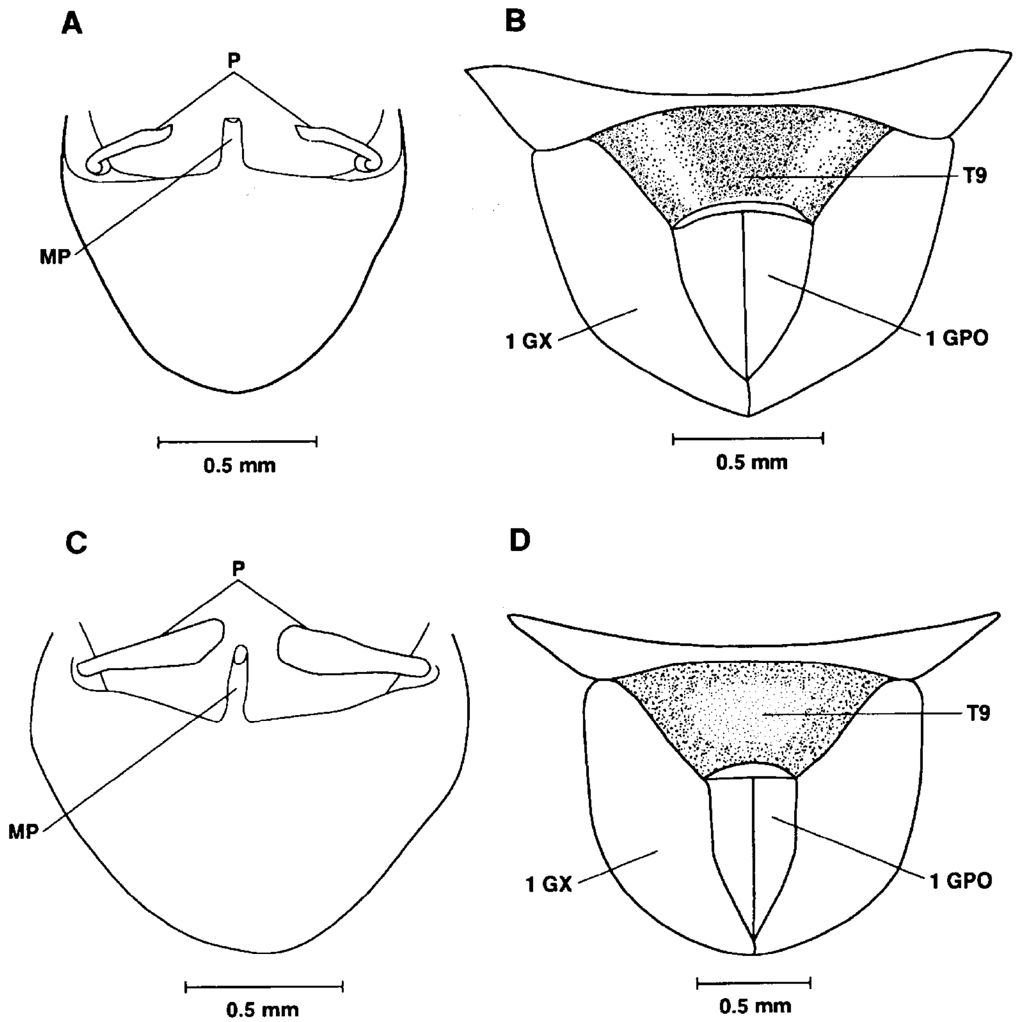

Fig. 1. Male and female genitalia of *Fitchia aptera* and *F. spinosula*. A. male, pygophore and claspers, posterior view, *F. aptera*. B. female terminalia, ventroposterior view, *F. aptera*. C. male, pygophore and claspers, posterior view, *F. spinosula*. D. female terminalia, ventroposterior view, *F. spinosula*. Abbreviations: 1 GPO, first gonapophysis; 1 GX, first gonocoxa; MP, medial process; P, parameres; T9, tergum 9.

We found that spines were present or absent in both species, and that there were several spine patterns (Table 1). Spines were usually present submedially and on each lateral (humeral) angle (denoted in tables as 1-1-1-1) or only submedially (0-1-1-0), or infrequently in other patterns (e.g., 1-0-0-1, 1-0-0-0); the infrequent patterns accounted for 7.4% of spined individuals and 3.2% of all individuals (7 of 95 and 220, respectively).

The two species differed significantly in the proportion of individuals with and without spines but the most dramatic difference was in the percent of these with four spines, i.e., 4.7% in *aptera*, 36.0% in *spinosula* (Table 1). This may explain why earlier authors relied so heavily on the presence or absence of four spines. Also, if only the two most frequent spine patterns are examined, i.e., 1-1-1-1 and 0-1-1-0, *aptera* specimens usually had two spines rather than four whereas *spinosula* specimens usually had four (Table 1). There was no significant difference in the proportion of males and females with spines

TABLE 1. COMPARISON OF PROTHORACIC SPINE PATTERNS WITHIN AND BETWEEN *FITCHIA APTERA* AND *F. SPINOSULA*.

Species	Spine Pattern[1]	Wing Morph[2]	Sex	N	df	χ^2	Prob.
aptera	1-1-1-1	M + B	♂ + ♀	5			
	0-0-0-0			68			
	other			33			
spinosula	1-1-1-1			41			
	0-0-0-0			57			
	other			16	2	34.795	<0.001
aptera	1-1-1-1	M + B	♂ + ♀	5			
	0-1-1-0			33			
spinosula	1-1-1-1			41			
	0-1-1-0			9	1	41.015	<0.001
aptera	present[3]	M + B	♂	13			
			♀	25			
	absent		♂	33			
			♀	35	1	2.035	0.154
spinosula	present[3]	M + B	♂	36			
			♀	21			
	absent		♂	15			
			♀	42	1	15.647	<0.001
aptera	present[3]	M	♂ + ♀	7			
	absent			41			
	present[3]	B		31			
	absent			27	1	17.250	<0.001
spinosula	present[3]	M	♂ + ♀	20			
	absent			3			
	present[3]	B		37			
	absent			54	1	15.741	<0.001

[1]1-1-1-1 = spines present submedially and on humeral angles; 0-1-1-0 = spines present submedially; other = spines present in various patterns excluding 1-1-1-1 (e.g., 0-1-1-0, 1-0-0-0-, 0-0-1-0); 0-0-0-0 = spines absent.
[2]M = macropterous, B = brachypterous.
[3]present includes 1-1-1-1, 0-1-1-0, and other spine patterns.

in *aptera* but a higher proportion of males had spines than females in *spinosula* (Table 1). Within each species, there was a significant difference in wing morph in proportion of individuals with spines but the proportion differed within each species (Table 1). In *aptera*, only 14.6% of macropterous individuals and 53.5% of brachypterous individuals had spines whereas in *spinosula*, 87.0% of macropterous individuals and 40.7% of brachypterous individuals had them.

Within each species, there was no significant difference in the frequency of macropterous and brachypterous morphs by sex (Table 2). However, between species, there was a significant difference. A higher percentage of adults were macropterous in *aptera* (45.3%) than in *spinosula* (20.2%) (Table 2). This was also true within each sex (Table 2).

All other characters and ratios examined differed significantly in mean values between the two species but all ranges overlapped (Table 3). Thus, they cannot be used as diagnostic characters.

Our conclusion, then, is that although there are significant differences in the characters between species listed in Tables 1-3, these differences are not diagnostic because of the overlap of their ranges or proportions. Thus, they must be used only as confirming characters. To this can be added general body shape which falls into two broad categories mentioned or implied in Stål's 1872 descriptions (more elongate in *spinosula*).

TABLE 2. COMPARISON OF DISTRIBUTION OF MACROPTEROUS AND BRACHYPTEROUS FORMS WITHIN AND BETWEEN *FITCHIA APTERA* AND *F. SPINOSULA*.

Species	Wing Morph	Males	Females	Males + Females	df	χ^2	Prob.
aptera	macropterous	23	25	—			
	brachypterous	23	35	—	1	0.730	0.393
spinosula	macropterous	13	10	—			
	brachypterous	38	53	—	1	1.619	0.203
aptera	macropterous	—	—	48			
	brachypterous	—	—	58			
spinosula	macropterous	—	—	23			
	brachypterous	—	—	91	1	15.842	<0.001
aptera	macropterous	23	—	—			
	brachypterous	23	—	—			
spinosula	macropterous	13	—	—			
	brachypterous	38	—	—	1	6.225	0.013
aptera	macropterous	—	25	—			
	brachypterous	—	35	—			
spinosula	macropterous	—	10	—			
	brachypterous	—	53	—	1	10.043	0.002

In addition to the structure of the male parameres and the female terminalia, we found the color of the abdominal spiracular peritremes to be diagnostic. Spiracular peritremes in *aptera*, though very narrow, varied from brown to black in both sexes; those in *spinosula* varied from concolorous with the surrounding yellowish sternite, to occasionally pale brown.

The geographical distribution of the two species is shown in Figure 2. Even using only those records from the present study, it is apparent that the species are sympatric or nearly so.

KEY TO SPECIES

1. Spines usually absent on posterior margin of pronotum but if present, then usually only two submedially; abdominal spiracular peritremes varying from brown to black; males with parameres slender, digitate, not visible in posteroventral view (Fig. 1A); females with ninth tergum depressed medially, tumescent laterally as promient ridge (Fig. 1B) .... *aptera*

1′. Spines present or absent on posterior margin of pronotum but if present, then usually two submedially and one on each humeral angle; abdominal spiracular peritremes usually concolorous with surrounding yellowish sternum, occasionally pale brown; males with parameres distinctly clavate, visible in posteroventral view (Fig. 1C); females with ninth tergum flat to slightly convex medially, not tumescent laterally (Fig. 1D) .... *spinosula*

REDESCRIPTIONS

Fitchia aptera Stål 1859, p. 371.

Body elongate, slender, wider behind middle. Color yellow, head and margins of anterior lobe of pronotum with dark brown tinge; abdomen with terga medially and sterna medially and laterally with brown to dark brown stripe, sternal stripes usually

TABLE 3. COMPARISONS OF ANTEOCULAR DISTANCE, ANTENNAL SEGMENTS, GONAPOPHYSIS, AND WIDTH OF ABDOMINAL STRIPE BETWEEN *FITCHIA APTERA* AND *F. SPINOSULA*.

Species	Structure or Ratio	N	Length or Ratio[4]	Range	df	t Value	Prob.
aptera	anteocular distance	106	0.73 ± 0.01	0.60–0.90			
spinosula		114	0.92 ± 0.01	0.60–1.10	191.7[5]	20.11	<0.001
aptera	1st antennal segment	87	3.45 ± 0.03	2.90–4.20			
spinosula		93	4.68 ± 0.06	3.70–6.00	137.8[5]	18.97	<0.001
aptera	2nd antennal segment	78	1.42 ± 0.02	1.20–2.00			
spinosula		83	1.75 ± 0.02	1.40–2.30	159[6]	11.97	<0.001
aptera	3rd antennal segment	68	2.21 ± 0.04	1.60–3.20			
spinosula		74	3.42 ± 0.06	2.60–4.70	114.5[5]	17.96	<0.001
aptera	4th antennal segment	56	1.82 ± 0.03	1.30–2.40			
spinosula		61	2.16 ± 0.04	1.50–2.80	115[6]	7.16	<0.001
aptera	antennal ratio 4th/3rd[1]	56	0.87 ± 0.01	0.54–1.06			
spinosula		61	0.64 ± 0.01	0.48–0.76	88.2[5]	–17.38	<0.001
aptera	antennal ratio 4th/2nd	56	1.30 ± 0.02	0.88–1.62			
spinosula		61	1.23 ± 0.02	0.87–1.50	115[6]	–2.59	<0.011
aptera	antennal ratio 4th/1st	56	0.53 ± 0.01	0.39–0.61			
spinosula		61	0.46 ± 0.01	0.33–0.55	115[6]	–7.83	<0.001
aptera	antennal ratio 3rd/2nd	68	1.50 ± 0.01	1.18–2.00			
spinosula		74	1.94 ± 0.02	1.53–2.43	134.0[5]	14.50	<0.001
aptera	antennal ratio 3rd/1st	68	0.61 ± 0.01	0.53–0.80			
spinosula		74	0.73 ± 0.01	0.58–0.84	140[6]	11.81	<0.001
aptera	antennal ratio 2nd/1st	78	0.41 ± 0.00	0.34–0.49			
spinosula		83	0.38 ± 0.00	0.33–0.43	141.6[5]	–7.81	<0.001
aptera	gonapophysis ratio[2]	60	1.53 ± 0.02	1.31–1.79			
spinosula		63	1.98 ± 0.02	1.60–2.29	121[6]	18.29	<0.001
aptera	stripe ratio[3]	97	0.59 ± 0.01	0.38–0.82			
spinosula		107	0.35 ± 0.01	0.18–0.70	202[6]	–15.98	<0.001

[1]Used by Blatchley (1926).
[2]Length of gonapophyses over width.
[3]Width of stripe on 3rd abdominal sternite/lateral length of same sternite.
[4]x ± SE; expressed in mm other than for ratios.
[5]Unequal variance.
[6]Equal variance.

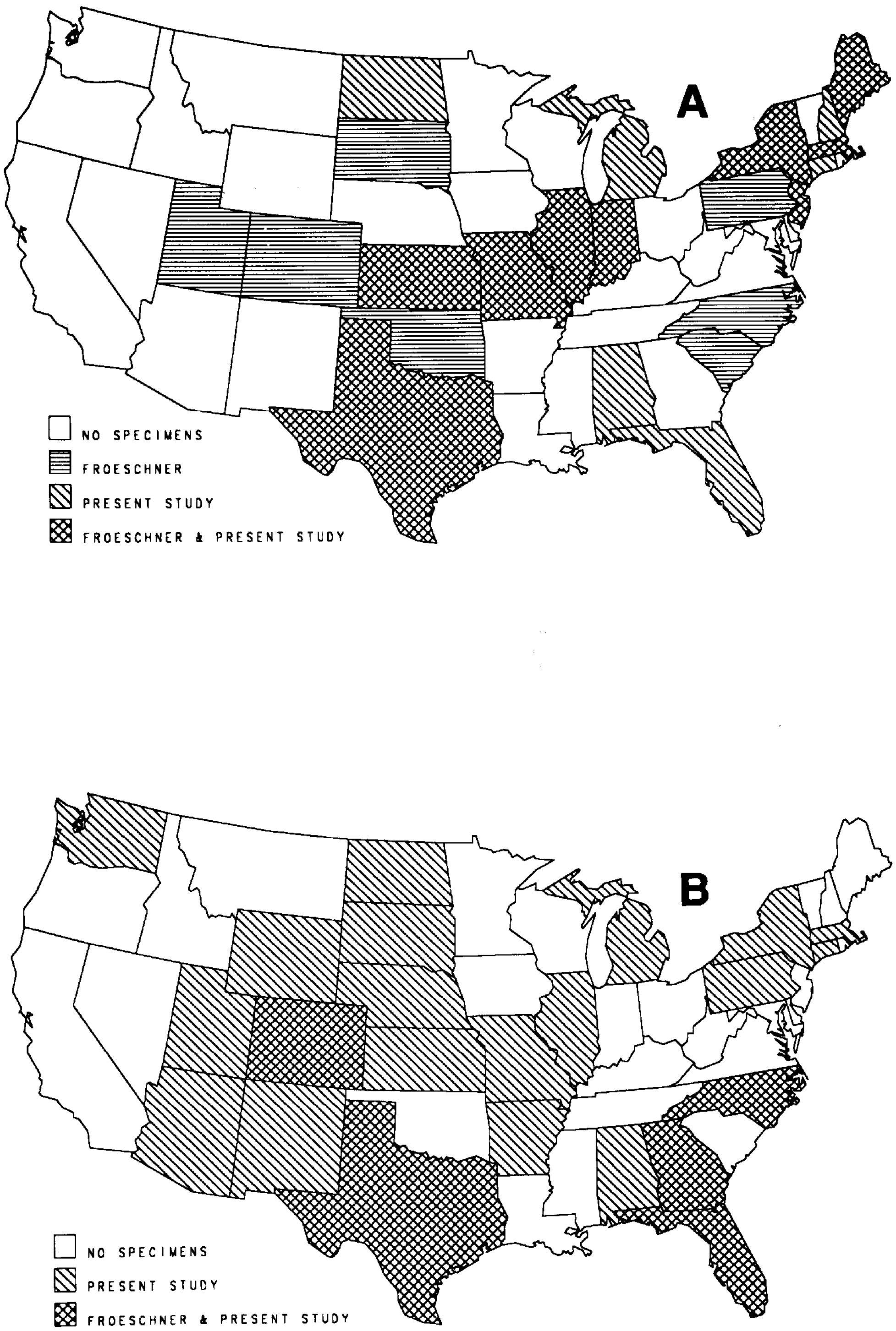

Fig. 2. Geographical distribution in U.S. of *Fitchia* as given by Froeschner (1988) and of specimens examined in present study. A. *F. aptera*. B. *F. spinosula*.

wider than in *F. spinosula* (i.e., width of lateral stripe on third abdominal sternite averaging 0.59× length of lateral margin of same sternite [range = 0.38-0.82, N = 97]); spiracular peritreme, though narrow, varying from brown to black.

Head with anteocular distance generally shorter than in *F. spinosula* ($\bar{x}$ = 0.73 mm, N = 106). Antennae with ratio of segment lengths one to four about 2.43:1.00:1.56:1.28; segment four about 0.87× length of three (range = 0.54-1.06, N = 56).

Spines usually absent on posterior margin of pronotum but if present, then usually only two submedially. Macropterous and brachypterous individuals present but macropterous form more common in males than females (♂ = 50.0%, N = 46; ♀ = 41.7%, N = 60).

Males with parameres slender, digitate (Fig. 1A), not visible in posteroventral view. Females with ninth tergum depressed medially, tumescent laterally as prominent ridge (Fig. 1B).

Length: 9.0-14.0 mm.

Distribution: AL, CO, CT, D.C., FL, IL, IN, KS, MA, ME, MI, MO, NC, ND, NH, NJ, NY, OK, PA, SC, SD, TX, UT (Fig. 2A) (ALBERTA, QUEBEC).

Fitchia spinosula Stål 1872, p. 79.

Similar in appearance to *F. aptera* but averaging longer and relatively narrower. Color similar to *F. aptera*, abdominal sternal stripes usually narrower (i.e., width of lateral stripe on third abdominal sternite averaging 0.35× length of lateral margin of same sternite [range, 0.18-0.70, N = 107]); spiracular peritreme usually concolorous with surrounding yellowish sternum, occasionally pale brown.

Head with anteocular distance generally longer than in *F. aptera* ($\bar{x}$ = 0.92 mm, N = 114). Antennae with ratio of segment lengths one to four about 2.67:1.00:1.95:1.23; segment four about 0.64× length of three (range = 0.48-0.76, N = 61).

Spines present or absent on posterior margin of pronotum but if present, then usually two submedially and one on each humeral angle. Macropterous and brachypterous individuals present but brachypterous more common in both sexes (♂ = 74.5%, N = 51; ♀ = 84.1%, N = 63).

Males with parameres distinctly clavate (Fig. 1C), visible in posteroventral view. Females with ninth tergum flat to slightly convex medially (Fig. 1D).

Length: 11.5-16.0 mm.

Distribution: AL, AR, AZ, CO, CT, Dakota, FL, GA, IL, KS, MA, MI, MO, NC, NE, NM, NY, PA, TX, UT, WA, WY (Fig. 2B) (Mexico).

Acknowledgments

We thank the following individuals for the loan of specimens from their respective institutions: J. K. Bouseman, Illinois Natural History Survey, Champaign; R. W. Brooks, Snow Museum, University of Kansas, Lawrence; R. L. Fischer, Michigan State University, East Lansing; R. C. Froeschner, National Museum of Natural History, Washington, D. C.; M. F. O'Brien, University of Michigan, Ann Arbor; N. D. Penny, California Academy of Science, San Francisco; A. V. Provonsha, Department of Entomology, Purdue University, West Lafyette, IN; R. T. Schuh, American Museum of Natural History, NY; and R. W. Sites, Department of Entomology, Texas Tech University, Lubbock.

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EFFECTS OF SHAPE AND SIZE OF COLORED TRAPS ON ATTRACTIVENESS TO IRRADIATED, LABORATORY-STRAIN MEXICAN FRUIT FLIES (DIPTERA: TEPHRITIDAE)

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ABSTRACT

Twenty-four trap types representing all combinations of 4 colors, 3 shapes and 2 sizes were evaluated for visual attractiveness to irradiated, laboratory-reared Mexican fruit flies, *Anastrepha ludens* (Loew), released into a grapefruit orchard when 1-3 days old. Spheres and vertically oriented rectangular panels were not significantly different in attractiveness summed over spring, summer and autumn seasons. Horizontally oriented rectangles were much less attractive than spheres and vertical rectangles. Larger rectangles (13 by 18 cm) and spheres (13 cm diam.) were more attractive than smaller rectangles (10 by 13 cm) and spheres (8 cm diam.). Yellow, green and red were equally attractive summed over trap shapes, sizes and seasons. Red was less attractive