NOTES ON THE STREPSIPTERA AND THEIR HYMENOPTEROUS HOSTS.¹

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In the course of a study of the effects of stylopization on aculeate Hymenoptera, a number of new and interesting host records and various notes on parasitism by Strepsiptera have been accumulated. Although their varied nature render it somewhat disjointed, it seems wise to bring these miscellaneous facts together in the present paper.

The following is an annotated list of the eighty-one species of Hymenoptera of which I have examined stylopized specimens. Two genera, *Zethus* and *Montezumia*, and several species apparently constitute new host records.

Sphecidæ.

Ammophila

abbreviata (Fabr.), det. Banks. Virginia: Falls Church (N. Banks).

alberti Hald., det. Banks. Arizona: Palmerlee, Tucson (F. H. Snow).

conifera Arnold, det. Arnold. Belgian Congo: Kabare (Jos. Bequaert).

pictipennis Walsh and Riley, det. Fernald. Virginia: Falls Church and Great Falls (N. Banks).

vulgaris Cress., det. Robertson. Illinois: Carlinville (Chas. Robertson); Florida: Inverness (Chas. Robertson).

*Chlorion**(Isodontia)*

auripes Fern., det. Banks. Texas: Dallas (J. Boll).

harrisi Fern., det. Fox in Coll. M. C. Z. Connecticut: Stamford (A. P. Morse).

(Proterosphex)

ichneumoneum (Linn.), det. Salt. Illinois: Carlinville (Chas. Robertson); Texas: Fedor.

pennsylvanicum (Linn.), det. Fernald. North Carolina: Southern Pines (H. Manee).

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Vespidæ.

Zethinæ.

Zethus

pubescens Smith, det. Bequaert. Zululand: Mfongosi (W. E. Jones).

spinipes var. *variegatus* Sauss., det. Bequaert. Texas: Dallas (J. Boll).

Eumeninæ.

Eumenes

campaniformis var. *marshalli* Bequaert, det. Bequaert, Paratype. "Dr. Melle, Arcturus. 1916, Salisbury."

fraternus Say, det. Bequaert. Massachusetts: Forest Hills (George Salt).

maxillosus var. *circinnalis* Fabr., det. Bequaert. Moluccas: Amboine (Rouyer).

maxillosus var. *reginus* Sauss., det. Bequaert. "Diego, Suarez."

Montezumia

sp. near *brunnea* Sm., det. Bequaert. Argentina: Chaco de Santiago (Del Estero, Rio Salado).

infernalis (Spin.), det. Bequaert. Paraguay: Villarrica.

Odynerus

annulatus Say, det. Bequaert. Texas: Austin, New Braunfels; Dakota: Custer Co. (S. W. Garman).

anormis Say, det. Robertson. Illinois: Carlinville (Chas. Robertson).

arvensis Sauss., det. Robertson. Illinois: Carlinville (Chas. Robertson).

bellulus Cress., det. Bequaert. Texas: Lee Co. (Birkman).

blandus Sauss., det. Bequaert. California: Stanford Univ.

bradleyi Robt., det. Robertson. No locality label.

foraminatus Sauss., det. Bequaert. Massachusetts: Woods Hole; Illinois: Carlinville (Chas. Robertson), Chicago; Pennsylvania: Philadelphia; Texas: Dallas (J. Boll), Fedor; Ohio: West Jefferson (Jos. Bequaert); Virginia: Vienna, Dyke, and Falls Church (N. Banks).

fundatus Cress., det. Bequaert. Texas: Austin; Illinois: Carlinville (Chas. Robertson).

histrion Lepel., det. Robertson. Florida: Inverness (Chas. Robertson).

histrionalis Robt., det. Robertson. No locality label.

manifestus Cress., det. Bequaert. Texas: (Fedor).

perennis Sauss., det. Bequaert. Virginia: Great Falls, Falls Church and Dyke (N. Banks).

pratensis Sauss., det. Bequaert. Texas: El Paso.

toas Cress., det. Bequaert. Texas: Valentine, El Paso; New Mexico: Steins.

Pachodynerus

cubensis (Sauss.), det. Bequaert. Cuba: Soledad (Jos. Bequaert).

erynnis (Lepel.), det. Bequaert. Florida: Lakeland (Wm. T. Davis), Miami (Jos. Bequaert), Inverness (Chas. Robertson).

guadulpensis (Sauss.), det. Bequaert. Grenada: Santeurs (Allen and Brues).

nasidens (Latr.), det. Bequaert. Rep. Honduras: Pto. Castilla (Jos. Bequaert).

Ancistrocerus

albophaleratus (Sauss.), det. Bequaert. Connecticut: Canaan (Jos. Bequaert); New Hampshire: Mount Washington (Halfway House) (C. W. Johnson); Maine; Alberta: Bilby (George Salt).

birenimaculatus (Sauss.), det. Bequaert. New York: Flushing (Jos. Bequaert); New Jersey: Newfoundland.

catskillensis (Sauss.), det. Bequaert. Massachusetts: Forest Hills (L. H. Taylor), Auburndale (C. W. Johnson); New York: Keene Valley (H. Notman); Connecticut: Colebrook (W. M. Wheeler).

fulvipes (Sauss.), det. Bequaert. Texas: Lee Co. (Birkman), New Braunfels.

parietum (Linn.), det. Bequaert. New York: Ithaca.

tigris (Sauss.), det. Bequaert. New Jersey: (Ramsey), Fort Lee (Jos. Bequaert); Virginia: Falls Church and Glen-carlyn (N. Banks); Pennsylvania: Melsh; Connecticut: Colebrook ((W. M. Wheeler).

waldenii (Vier.), det. Bequaert. Massachusetts: Forest Hills (O. E. Plath).

Belonogaster

filiventris (Sauss.), det. Bequaert. Belgian Congo: La Panda (Katanga) (Dr. Mich. Bequaert).

junceus (Fabr.), det. Bequaert. Victoria Nyanza: Masinga Archipelago (Dr. J. Carl).

Ropalidia

cincta (Lepel.), det. Bequaert. Belgian Congo: Gani (Lisalto, Monveda) (Jos. Bequaert).

nobilis (Gerst.), det. Bequaert. Congo: Lisala.

Polistes

canadensis var. *annularis* (Linn.), det. Bequaert. West Virginia: Mongolia Co. (L. H. Taylor).

crinitus (Felton), det. Bequaert. Rep. Dominica: Sanchez (A. M. N. H.).

crinitus var. *americanus* (Fabr.), det. Bequaert. Porto Rico: Aibonito, Cayey, Coamo Springs, Jayuya, Manati, and Mayaguez.

gallicus (Linn.), det. Bequaert. No locality label.

pallipes Lepel., det. Bequaert. Connecticut: Colebrook, Robertsville, and Chapenville (W. M. Wheeler).

variatus Cress., det. Robertson. Illinois: Carlinville (Chas. Robertson).

Apidæ

Chloralictus

sp. Washington: Pullman (A. D.)

sp. (N. B. Several species are probably here grouped together). Connecticut: Colebrook (W. M. Wheeler); Massachusetts: Forest Hills (George Salt).

sparsus Robt., det. Robertson. Illinois: Carlinville (Chas. Robertson).

versatus Robt., det. Robertson. Illinois: Carlinville (Chas. Robertson).

zephyrus Sm., det. Robertson. Illinois: Carlinville (Chas. Robertson).

Andrena

- andrenoides* Cress., det. Robertson. Illinois: Carlinville (Chas. Robertson).
- asteris* Robt., det. Robertson. Illinois: Carlinville (Chas. Robertson).
- bradleyi* Vier., det. Salt. Massachusetts: Forest Hills (George Salt).
- canadensis* D. T., det. Viereck. Connecticut: Colebrook (W. M. Wheeler).
- carolina* Vier., det. Viereck. Massachusetts: Billerica (P. J. Darlington Jr.).
- cressoni* Robt., det. Viereck. Connecticut: Colebrook (W. M. Wheeler).
- erigeniæ* Robt., det. Robertson. Illinois: Carlinville (Chas. Robertson).
- forbesi* Robt., det. Viereck. Connecticut: Colebrook (W. M. Wheeler).
- fragilis* Sm., det. Viereck. New York: Oliveria (Catskills) (Jos. Bequaert).
- hippotes* Robt., det. Robertson. Illinois: Carlinville (Chas. Robertson).
- hirticincta* Prov., det. Salt. Connecticut: Colebrook, Robertsville, and Doolittle Pond (Litchfield Co.) (W. M. Wheeler); Vermont: Chittenden (Rutland).
- illinoiensis* Robt., det. Robertson. Illinois: Carlinville (Chas. Robertson).
- imitatrix* var. *claytoniæ* Robt., det. Robertson. Illinois: Carlinville (Chas. Robertson).
- mandibularis* Robt., det. Robertson. Illinois: Carlinville (Chas. Robertson).
- miranda* Sm., det. Viereck. Connecticut: Colebrook (W. M. Wheeler); Wisconsin.
- nasoni* Robt., det. Viereck. Massachusetts: Forest Hills (L. H. Taylor, George Salt).
- nuda* Robt., det. Robertson. Illinois: Carlinville (Chas. Robertson).
- salictaria* Robt., det. Robertson. Illinois: Carlinville (Chas. Robertson).

solidaginis Robt., det. Viereck. Nebraska: Malcolm (C. R. Oertel); New Jersey: Alpine and Fort Lee (Jos. Bequaert).

vicina Sm., det. Viereck. Massachusetts: Petersham (C. T. Brues).

Panurginus

innuptus Ckll., det. Stevens. North Dakota: Minot (O. A. Stevens).

Pseudopanurgus

aethiops Cress., Colorado: Wray.

rudbeckia Robt., det. Robertson. Illinois: Carlinville (Chas. Robertson).

solidaginis Robt., det. Robertson. Illinois: Carlinville (Chas. Robertson).

Various writers have given data on the extent of parasitism by Strepsiptera, and in his monograph and its supplements, Pierce (1909, 1911, 1918) has brought together these records and added others. Most of the published notes, however, deal with *Polistes* and *Andrena*, whereas the following have to do largely with other genera.

In 1922, Dr. W. M. Wheeler collected a total of 373 specimens of *Andrena hirticincta* Prov. Forty-four of these or 11.9% were stylopized, 6 of 23 males or 26.1%, and 38 of 350 females or 10.9%. His collecting records for the same year of species of *Chloralictus*, mostly *albipennis*, show 98 stylopized of a total of 470 specimens collected, an infestation of 20.9%; 88 of 378 males or 23.3% were stylopized, and 10 of 92 females or 10.9%.

No collecting records are available for the Vespidae other than *Polistes* but some indication of the extent to which they suffer from strepsipterous attack may be obtained from the frequency of the occurrence of stylopized individuals in collections. Of 4525 specimens of miscellaneous Eumeninae examined by the writer, 74, or 1.64%, were stylopized. Collections of particular genera contained stylopized specimens as follows:

Masarinae	of	96	specimens,	0	stylopized,	or	0	%.
<i>Zethus</i>	of	53	"	2	"	"	3.8	%.
<i>Eumenes</i>	of	214	"	3	"	"	1.4	%.

<i>Nortonia</i>	of 5	"	0	"	"	0 %.
<i>Pachymenes</i>	of 42	"	0	"	"	0 %.
<i>Monobia</i>	of 52	"	0	"	"	0 %.
<i>Alastor</i>	of 33	"	0	"	"	0 %.
<i>Pterocheilus</i>	of 43	"	0	"	"	0 %.
<i>Stenogaster</i>	of 5	"	0	"	"	0 %.
<i>Belonogaster</i>	of 104	"	2	"	"	1.9 %.
<i>Ropalidia</i>	of 160	"	2	"	"	1.3 %.

In addition, 217 specimens of *Synagris* were examined rather summarily but none was observed to be stylized.

To give detail of the sex, number, and position of the parasites in the various species of hosts would require more space than is at our disposal, but the general conditions are indicated by the following analyses of the parasitism in four of the better-known genera.

Odynerus (sens. lat.).

51 specimens (29 ♂, 22 ♀)	carrying 1 parasite	(15 ♂, 35 ♀, 1?)
13 " (6 ♂, 7 ♀)	" 2 parasites	(5 ♂, 21 ♀).
3 " (3 ♀)	3 "	(3 ♂, 6 ♀).
2 " (2 ♂)	" 4 "	(3 ♂, 5 ♀).
1 " (1 ♂)	" 6 "	(2 ♂, 4 ♀).
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70 " (38 ♂, 32 ♀)	" 100 "	(28 ♂, 71 ♀, 1?)
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Average infestation:—1.43 parasites per host.

99 parasites (28 ♂, 71 ♀) situated as follows:—42 on the right, 56 on the left, 1 median;

	2nd.	3rd.	4th.	5th. abdominal segments.
♂ parasites		1	21	6
♀ parasites	6	45	19	1

In this genus of hosts the female parasites prefer a position anterior to that of the male.

Polistes.

29 specimens	(3 ♂, 26 ♀)	carrying	1	parasite	(21 ♂, 8 ♀).
11	"	(1 ♂, 10 ♀)	"	2 ♂	parasites (22 ♂).
2	"	(1 ♂, 1 ♀)	"	2 ♀	" (4 ♀).
6	"	(6 ♀)	"	1 ♂, 1 ♀	" (6 ♂, 6 ♀).
6	"	(6 ♀)	"	3 ♂	" (18 ♂).
2	"	(2 ♀)	"	2 ♂, 1 ♀	" (4 ♂, 2 ♀).
2	"	(2 ♀)	"	1 ♂, 2 ♀	" (2 ♂, 4 ♀).
1	"	(1 ♀)	"	4 ♂	" (4 ♂).
2	"	(2 ♀)	"	5 ♂	" (10 ♂).
1	"	(1 ♀)	"	7 ♂	" (7 ♂).
3	"	(3 ♀)	"	larval	"
65	"	(5 ♂, 60 ♀)	"	118. larval	" (94 ♂, 24 ♀).

Average infestation of wasps carrying adult parasites:—1.9 parasites per wasp.

118 parasites (94 ♂, 24 ♀) situated as follows:—54 on the right, 63 on the left, 1 median; 105 dorsal, 3 lateral, 10 ventral;

under the	2nd.	3rd.	4th.	5th.	abdominal segments.
♂ parasites	1	44	41	8	
♀ parasites		1	2	21	

The normal position for the male is here obviously under the 3rd. and 4th. segments. In the eight cases in which a male was found under the 5th. segment, only once was it the only parasite; twice it was one of two, twice one of three, once one of four, and twice one of five parasites, and may be considered to have been crowded from its normal position. On the other hand, the female usually occurs under the 5th. segment; where it was under the 3rd. it was one of three parasites, where it was under the fourth it was one of two or one of three parasites. This condition, in which the males normally lie anterior to the females in the body of the host, is exactly the opposite of that in *Odynerus* where the females lie anteriorly, the males behind.

Chloralictus

313 specimens	(276 ♂, 37 ♀)	carrying	1	parasite.
161	"	(142 ♂, 19 ♀)	"	2 parasites.
45	"	(44 ♂, 1 ♀)	"	3 "
1	"	(1 ♂)	"	4 "
520	"	(463 ♂, 57 ♀)	774	"

Average infestation:—1.5 parasites per host.

774 parasites, all females, situated as follows—386 on the right, 358 on the left, 30 median; 763 dorsal, 4 lateral, 7 ventral; 40 under the 3rd., 712 under the 4th., and 22 under the 5th. abdominal segments. In seven of the eleven cases in which the parasite was lateral or ventral, it was one of three parasites; in three cases, one of two; and in only one case was it the only parasite. The normal position of the parasite in *Chloralictus*, therefore, is dorsal, under the 4th. abdominal segment.

It will be noticed that here, as also in the case of the stylopized *Halicti* studied by Perkins (1892, 1918), all of the parasites found were females; no males or male exuvia were seen in *Halictus*. This fact at once raises the question of parthenogenesis among the females of *Halictoxenos* already suggested by Perkins. Mrs. Schrader (1924), to be sure, has shown that the females of *Acroschismus* must be fertilized to produce their young; but in that genus males are of common occurrence and, indeed, in the present study were found in much larger numbers than the females. Pierce (1918) claims to be the only one who has ever captured an *Halictus* with a male parasite. In view of the very rare occurrence of males of *Halictoxenos*, then, or their almost complete absence, parthenogenesis is strongly suggested in this group notwithstanding Mrs. Schrader's contrary observations on *Acroschismus*.

Andrena.

147specimens	(41 ♂, 106 ♀)	carrying 1	parasite	(40 ♂ 107 ♀).
18	"	(4 ♂, 14 ♀)	" 2 ♀	parasites (36 ♀).
3	"	(3 ♀)	" 2 ♂	" (6 ♂ 3 ♀).
3	"	(3 ♀)	" 1 ♂, 1 ♀	" (3 ♂, 3 ♀).
1	"	(1 ♀)	" 3 ♀	" (3 ♀).
2	"	(2 ♀)	" 1 larval parasite	
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174	"	(45 ♂, 129 ♀)	" 200 parasites	(49 ♂, 149 ♀, 2 larval).

Average infestation:—1.1 parasites per host.

200 parasites (49 ♂, 149 ♀, 2 larval) situated as follows:—97 on the right, 93 on the left, 1 median, 3 unextruded, 6 unrecorded; 187 under the 4th., 9 under the 3rd., 1 under the 5th. abdominal segments, 3 unextruded. The normal position for the parasites of *Andrena* is obviously under the 4th. abdominal segment.

Finally, attention must be drawn to a matter of nomenclature. It appears to have been overlooked that von Heyden (1868, p. 398) used the name *Xenos smithii* for two male parasites of *Sphex ichneumoneus* L. from North America. Pierce (1909, p. 185) notes the specimens but apparently does not recognize the description. There can be no doubt of the validity of the name, however, for not only is the insect partly described, but also the name of the host, the essential part of many a more recent description of a strepsipterous parasite, is given. *Homilops bishoppi* Pierce (1909, p. 146), parasitic on *Sphex ichneumoneus* L. at Waco, Texas, is known only in the female sex, while *Xenos smithii* was described by von Heyden from two males only. It is therefore possible to consider the former the female of the latter, especially as it is a common practice to couple male and female strepsiptera simply by their infestation of a single species of host.

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