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Hemiptera (Heteroptera/Homoptera) as Prey of Robber Flies (Diptera: Asilidae) with Unpublished Records

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ABSTRACT

Of the approximately 58,000 plus prey records in the Asilidae Predator-Prey Database, 9.1% are Hemiptera (3.5% Heteroptera and 5.6% Homoptera). Forty six of the 133 recognized worldwide Hemiptera families are preyed upon with generally more prey records for female than male robber flies. Potential explanations for robber flies, in particular females, preying upon Hemiptera are discussed. Numbers of Hemiptera prey are examined based on their associated families, genera and species. Hemiptera prey are also discussed in relation to robber fly subfamilies and genera. New records of Hemiptera prey are presented and compared with prey records in the Database.

Keywords: Hemiptera, Heteroptera, Homoptera, prey, robber flies, Diptera, Asilidae

INTRODUCTION

The Hemiptera, the largest order of hemimetabolous insects consisting of approximately 70,000 to 80,000 plus described species (Meyer, 2008), occur worldwide. Traditionally the Hemiptera are divided into two suborders, the Heteroptera and Homoptera, although some taxonomists believe that the Coleorrhyncha, Stenorrhyncha and Auchenorryncha also are suborders. In this paper and in the Asilidae Predator-Prey Database (Lavigne, 2003), the Hemiptera are divided into only two suborders: Heteroptera (formerly Hemiptera) and Homoptera.

The web-based Asilidae Predator-Prey Database created by Lavigne (2003) currently contains approximately 58,000 plus prey records. However, these records do not necessarily provide exact numbers, since in many cases authors have stated that “several”, “multiple”, or “many” of a species were taken as prey. For the purposes of the present paper, where several, multiple or many prey are indicated in the Database, this is conservatively interpreted as two prey. On this basis, 2,003 and 3,275 of the records in the Database are Heteroptera and Homoptera, respectively, consisting of the following as shown in Table 1:

Heteroptera – 22 families, 170 genera, 203 species

Homoptera – 24 families, 228 genera, 276 species.

Thus in the Database, Hemiptera represent approximately 9.1% of total prey taken by Asilidae. In addition, the families of Hemiptera in the Database represent 46 of the 133 recognized worldwide subfamilies (Meyer, 2008). Within the Heteroptera, the largest number of genera preyed upon are from the families Miridae (44), Pentatomidae (43), Coreidae (28) and Lygaeidae (16). For the Homoptera the largest number of genera are from the families Cicadellidae (93), Aphididae (50), Cicadidae (19), Membracidae (17), Cercopidae (12) and Psyllidae (14). All other families have less than 10 genera each represented, with 14 families with a single genus. Londt (2006) in his analysis of 2,000 prey records found that Hemiptera prey composition consisted of Cicadidae, Cicadellidae, Lygaeidae, Pentatomidae and Cercopidae.

The purpose of this paper is to record additional Heteroptera and Homoptera prey records and to discuss the role that Hemiptera play as prey of robber flies.

It should be noted that Dikow (2009a and b) recently recognized 14 robber fly subfamilies. In this paper we have retained the 11 subfamily classification of Geller-Grimm (2003) so that the data can be more easily compared with other detailed robber fly prey evaluations in Dennis & Lavigne (2007), Dennis et al. (2009), and Londt (1993, 1999, 2006).

MATERIALS AND METHODS

Robber flies and their prey were collected in various habitats in the states of Colorado, Wyoming and New Mexico, USA. The robber flies were netted while feeding and the prey were separated from the robber flies, or the prey were collected following feeding. The robber fly and/or prey were subsequently pinned and placed in the University of Wyoming Insect Collection. Observations are also included where both the robber fly and prey were readily recognized in the field. Robber flies were identified by the authors, while prey were subsequently identified by taxonomists in various institutions.

RESULTS

Listed below are new records of Heteroptera/Homoptera taken by robber flies. These records add 143 prey to the Asilidae Predator-Prey Database and represent the inclusion of 10 additional genera and 44 additional species as follows:

Heteroptera – 6 additional genera and 18 additional species.

Homoptera – 4 additional genera and 26 additional species.

The inclusion of some additional genera and species resulted from the lack of specific identification in published papers.

The sex, if known, of the predator is presented in parentheses in the records below:

***Backomyia limpidipennis* (Wilcox)**

Heteroptera: Lygaeidae

Geocoris uliginosus (Say), Wyoming: Laramie County (Co), Pine Bluffs; 1-XI-65; R.J. Lavigne, collector (coll.) (as Lygaeidae in Lavigne, 1971)

Nysius ericae (Schilling), Wyoming: Weston Co., Newcastle [field recognition]

Homoptera: Aphididae

Capitophorus elaeagni (Del. Guer.) (alates), Wyoming: Platte Co., Glendo, 5.8 miles South (S); 20-X-70; R.J. Lavigne, coll. (2 males) (as Aphididae in Lavigne, 1971)

Homoptera: Cicadellidae

Empoasca decora DeLong & Davidson, Wyoming: Platte Co., Glendo, 9.3 km S; 19-X-70, 20-X-70; R.J. Lavigne, coll. (males) (as Cicadellidae in Lavigne, 1971)

Empoasca nigra, var. typhlocyboides Gillette & Baker, Wyoming: Platte Co.,

Glendo, 9.3 km S; 20-X-70 (2 females and 2 males); R.J. Lavigne, coll. (as Cicadellidae in Lavigne, 1971)

Macrosteles fascifrons (Stal), Wyoming: Platte Co., Glendo, 9.3 km S; 20-X-70; R.J. Lavigne, coll. (male) (as Cicadellidae in Lavigne, 1971)

Texananus latipex DeLong, Wyoming: Platte Co., Glendo, 9.3 km S; 20-X-70; R.J. Lavigne, coll. (female) (as Cicadellidae in Lavigne, 1971)

Homoptera: Psyllidae

Aphalara sp., Wyoming: Platte Co., Glendo, 9.3 km S; 20-X-70; R.J. Lavigne, coll. (male) (as Psyllidae in Lavigne, 1971)

***Backomyia seminoensis* Lavigne**

Homoptera: Aphididae

Dactynotus sp., Wyoming: Carbon Co.: Seminoe Mountains (Mts.); 6-X-65 (alate); R.J. Lavigne, coll. (as Aphididae in Lavigne, 1971)

Pleotrichopterus sp., Wyoming: Carbon Co.: Seminoe Mts.; 6-X-65 (alates) (2 records); R.J. Lavigne (coll.) (as Aphididae in Lavigne, 1971)

***Comantella fallei* (Back)**

Heteroptera: Miridae

Lygus elisus Van Duzee, Wyoming: Platte Co., Guernsey, 11.3 km W; 19-X-61; R.J. Lavigne, coll. (female)

Homoptera: Cicadellidae

Aceratagallia sp., Colorado: Weld Co., Nunn, 8 km North (N), International Biological Program (IBP) site; 21-X-73, 9-X-74; S. Dennis, coll.

Athysanella obesa Ball and Beamer, Wyoming: Seminoe Mts near Glenrock; 4 May–25 June [field recognition]

Balclutha neglecta DeLong & Davidson, Colorado: Weld Co., Nunn, 8 km N, IBP site; 9-X-74 (2 records); S. Dennis, coll.

Texananus latipex DeLong, Colorado: Weld Co., Nunn, 8 km N, IBP site; 25-X-73; S. Dennis, coll. (female)

Xerophloea peltata (Uhler), Colorado: Weld Co., Nunn, 8 km N, IBP site; 11-XI-71; R.J. Lavigne, coll.

Homoptera: Cixiidae

Cixius sp., Colorado: Weld Co., Nunn, 8 km N, IBP site; 9-X-74 (2 records), 17-X-74; S. Dennis, coll.

Homoptera: Psyllidae

Aphalara curta Caldwell, Colorado: Weld Co. [field recognition]

***Cyrtopogon banksi* Wilcox & Martin**

Homoptera: Aphididae

unidentified alate aphid, Wyoming: Teton Co., Teton N.F., Grassy Lake; 7-VIII-66; R.J. Lavigne, coll. (female)

Rhopalosiphum padi (Linnaeus), Wyoming: Teton Co. [field recognition]

***Cyrtopogon montanus wilcoxi* James**

Homoptera: Cicadellidae

Balclutha neglecta (DeLong), Wyoming, Carbon Co., Elk Mountain; 27-VII-72; S. Dennis, coll. (male)

***Cyrtopogon pulcher* Back**

Homoptera: Cicadellidae

Aceratagallia sp., Wyoming: Carbon Co., Elk Mt.; 19-VII-72; R.J. Lavigne, coll (female)

Dicropaltum mesae (Tucker) (as *Asilus mesae* in Dennis & Lavigne, 1975)

Heteroptera: Lygaeidae

Nysius ericae (Schilling) (as Lygaeidae, unidentified in Dennis & Lavigne, 1975), Wyoming: Fremont Co., Shoshoni, 16 km. S; 11-VI-72; R.J. Lavigne, coll. (female)

Heteroptera: Miridae

Lepidopsallus sp., Wyoming: Fremont Co., Shoshoni, 16 km. S; 6-VI-72; (male) 16-I-72 (female); R.J. Lavigne , coll.

Homoptera: Cicadellidae

Aceratagallia sp., Wyoming: Fremont Co., Shoshoni, 16 km. S; 8-VI-72 (3 records), 20-VI-72, 21-VI-72, 25-VI-72 (2 records); R. Lavigne, coll. (1 male & 6 females)

***Efferia benedicti* (Bromley)**

Heteroptera: Rhopalidae

Harmostes reflexulus (Say), Wyoming: Fremont Co., Shoshoni, 10 mi. S; 6-VI-72; R.J. Lavigne , coll. (female)

***Efferia bicaudata* (Hine)**

Homoptera: Cicadellidae

Mocuellus collinus (Boh.), Wyoming, Converse Co., Douglas; 25-VIII-69; R.J. Lavigne, coll. (male)

***Efferia frewingi* Wilcox**

Heteroptera: Nabidae

Nabis americoferus Carayon, Wyoming: Fremont Co., Shoshoni, 16 km. S; 14-IX-71; R.J. Lavigne, coll. (male) *Efferia helenae* (Bromley)

Heteroptera: Lygaeidae

Nysius ericae (Schilling), Wyoming: Platte Co., Wheatland, 16 km NW; 10-IX-64; F.R. Holland, coll. (male)

Homoptera: Cicadellidae

Aceratagallia sp., Colorado: Weld Co., Nunn, 8 km N, IBP site; 19-VIII-81; E. Schreiber, coll. (male)

Balclutha neglecta (DeLong), Colorado: Weld Co., Nunn, 8 km N, IBP site 28-VIII-81 (female), 1-IX-81 (female); E. Schreiber, coll.

Cuerna costalis (Fabricius), Wyoming: Platte Co., Wheatland, 16 km Northwest (NW); 21-VIII-72; R.J. Lavigne, coll. (female)

Gypona melanota Spangberg, Wyoming: Platte Co., Wheatland, 16 km NW; 21-VIII-72; R.J. Lavigne, coll. (female)

unidentified, Colorado: Weld Co., Nunn, 8 km N, IBP site; 19 to 31-VIII-81; E. Schreiber, coll. (male, 3 females)

Homoptera: Membracidae

Spissistilus festinus (Say), Colorado: Weld Co., Nunn, 8 km N, IBP site; 21-VIII-81; E. Schreiber, coll. (male)

***Efferia pallidula* (Hine)**

Heteroptera: Lygaeidae

Nysius californicus Stal, Wyoming: Platte Co., Glendo, 11.3 km S; 30-VII-57; R.E. Pfadt, coll. (female)

Heteroptera: Miridae

Litiomeris debilis (Uhler), Wyoming: Platte Co., Guernsey, 11.3 km W; 13-VII-61; R.J. Lavigne, coll. (female)

Homoptera: Membracidae

Tortistilus collinus (Van Duzee), Wyoming: Platte Co., Guernsey, 11.3 km W; 15-VII-60; R.J. Lavigne, coll. (male)

***Efferia staminea* (Williston)**

Heteroptera: Cicadellidae

Cuerna striata (Walker), Wyoming: Platte Co. [field recognition]

***Efferia varipes* (Williston)**

Heteroptera: Lygaeidae

Nysius raphanus Howard, Wyoming: Platte Co., Wheatland, 11 km N; 29-VII-74; R.J. Lavigne, coll. (female)

Homoptera: Cicadellidae

Aceratagallia uhleri (Van Duzee), Wyoming: Platte Co., Wheatland, 11 km N; 29-VII-74; S. Dennis, coll. (female) (as unidentified record in Dennis & Lavigne, 1976a)

Psammotettix lividellus (Zetterstedt), Wyoming: Platte Co., Wheatland, 11 km N; 30-VII-74; S. Dennis, coll. (female) (as unidentified record in Dennis & Lavigne, 1976a)

***Eucyrtopogon comantis* Curran**

Heteroptera; Alydidae

Alydus eurinus (Say), Wyoming: Albany Co., Laramie, Pole Mt.; 26-X-71; R.J. Lavigne, coll.

Heteroptera: Lygaeidae

Nysius angustatus Uhler (as *Nysius* sp. in Dennis & Lavigne, 1975), Wyoming: Albany Co., Laramie, Pole Mt.; 22-IX-72; R.J. Lavigne, coll. (female)

Nysius ericae (Schilling) (as *Nysius* sp. in Dennis & Lavigne, 1975), Wyoming: Albany Co., Laramie, Pole Mt.; 30-IX-72; R.J. Lavigne, coll. (2 females)

Nysius raphanus Howard, Wyoming: Albany Co., Laramie, Pole Mt.; 28-X-73; D.S. Dennis, coll. (as Nysius sp. in Dennis & Lavigne, 1975)

Heteroptera: Miridae

Lepidopsallus sp., Wyoming: Albany Co., Laramie, Pole Mt.; 29-IX-72; D.S. Dennis, coll. (female)

Lygus hesperus Knight, Wyoming: Albany Co., Laramie, Pole Mt.; 27-IX-7 (female); 1-X-72 (female); D.S. Dennis, coll.

Heteroptera: Nabidae

Nabis americoferus Carayon, Wyoming: Albany Co., Laramie, Pole Mt.; 30-IX-72; R.J. Lavigne, coll. (male)

Heteroptera: Saldidae

Saldula major (Provancer), Wyoming: Albany Co., Laramie, Pole Mt.; 1-X-72; R.J. Lavigne, coll. (male)

Homoptera: Aphididae

Prociphilus sp., Wyoming: Albany Co., Pole Mt., Medicine Bow Nat'l. Forest; 28-X-73; D.S. Dennis, coll. (female) (different record than in Dennis & Lavigne, 1975)

Homoptera: Cicadellidae

Aceratagallia uhleri (Van Duzee), Wyoming: Albany Co., Pole Mt., Medicine Bow Nat'l. Forest; 28-X-73; D.S. Dennis, coll. (female)

***Heteropogon wilcoxi* James**

Heteroptera: Lygaeidae

Emblethis vicarius Horvath, Wyoming: Platte Co., Hartville, 11.3 km N; 13-VII-68 (male & female), 14-VII-68 (male), 15-VII-68 (female); R.J. Lavigne, coll.

Ligyrocoris sylva ?estris (L.), Wyoming: Platte Co., Hartville, 11.3 km N; 14-VII-68; R.J. Lavigne, coll. (male)

Nysius angustatus Uhler, Wyoming: Platte Co., Hartville, 11.3 km N; 1-VII-68 (female), 14-VII-68 (2 males, 5 females), 15-VII-68 (2 females); R.J. Lavigne, coll.

Nysius ericae (Schilling), Wyoming: Platte Co., Hartville, 7 mi N; 12-VII-68 (2 females), 13-VII-68 (male), 14-VII-68 (female), 17-VII-68 (female); R.J. Lavigne, coll.

Xyonysius californicus (Stal), Wyoming: Platte Co., Hartville, 11.3 km N; 13-V-68; R.J. Lavigne, coll. (female)

Heteroptera: Cydnidae

Microporus obliquus Uhler, Wyoming: Platte Co., Glendo, Hartville [field recognition]

Heteroptera: Nabidae

Nabis alternatus Parshley, Wyoming: Fremont Co., Riverton; Platte Co., Glendo, Guernsey, Hartville [field recognition]

Heteroptera: Pentatomidae

Neottiglossa sulcifrons Stal, Wyoming: Platte Co., Glendo, Guernsey, Hartville, Wheatland [field recognition]

Heteroptera: Rhopalidae

Harmostes reflexulus (Say), Wyoming: Platte Co., Glendo, Hartville [field recognition]

Homoptera: Cicadellidae [field recognition]

Aceratagallia fuscoscripta Oman, Wyoming: Platte Co.

Euscelidius schenkii (Kirschbaum), Wyoming: Platte Co., Guernsey, Hartville

Frigartus frigidus Ball, Wyoming: Platte Co.

Paraphlepsius lascivius (Ball), Wyoming: Platte Co.

Homoptera: Delphacidae

Delphacodes campestris (Van Duzee), Wyoming: Platte Co. [field recognition]

Homoptera: Membracidae

Campylechia latipes (Say), Wyoming: Platte Co., Glendo, Guernsey, Hartville [field recognition]

***Holopogon seniculus* Loew** [field recognition]

Homoptera: Cicadellidae

Aceratagallia uhleri (Van Duzee), Wyoming: Platte Co.

Balclutha neglecta (Delong & Davidson), Wyoming: Platte Co.

Dikraneura carneola (Stal), Wyoming: Platte Co.

Empoasca neaspersa Oman and Wheeler, Wyoming: Platte Co.

Empoasca nigra Gillette & Baker, Wyoming: Platte Co.

Endria inimica (Say), Wyoming: Platte Co.

Hebecephalus occidentalis Beamer and Tuthill, Wyoming: Platte Co.

Hebecephalus rostratus Beamer and Tuthill, Wyoming: Platte Co.

Macrosteles fascifrons (Stal), Wyoming: Platte Co.

Dikraneura carneola (Stal), Wyoming: Platte Co.

Homoptera: Delphacidae

Delphacodes campestris (Van Duzee), Wyoming: Platte Co. [field recognition]

Homoptera: Dictyopharidae

Scolops angustatus (Uhler), Wyoming: Platte Co., Glendo, Hartville, Wheatland [field recognition]

***Laphria sadales* Walker**

Homoptera: Cicadellidae

Draeculacephala crassicornis Van Duzee, Wyoming: Park Co., Pahaska Tepee; 12-VIII-64; R.J. Lavigne, coll.

***Laphystia rufofasciata* Curran**

Homoptera: Cicadellidae

Aceratagallia poudris Oman, Wyoming: Carbon Co. [field recognition]

***Lasiopogon polensis* Lavigne**

Homoptera: Cicadellidae

Stragania atra (Baker). RFH; Albany County-Pole Mountain; 25 to 26 VI-65; R.J. Lavigne , coll.

***Leptogaster parvoclava* Martin**

Heteroptera: Miridae [as Miridae (3 records) in Dennis & Lavigne, 1976b]

Europiella ?nicholi Knight, Wyoming: Albany Co., Laramie, Sherman Hills; 5-VII-74; R.J. Lavigne, coll. (female)

Europiella sp. (new), Wyoming: Albany Co., Laramie, Sherman Hills; 27-VI-74; R.J. Lavigne, coll. (female)

Europiella stigmosa (Uhler), Wyoming: Albany Co., Laramie, Sherman Hills; 5-VII 74; R.J. Lavigne, coll. (female)

***Ospriocerus abdominalis* (Say)**

Homoptera: Cicadellidae

Cuerna sp., Wyoming: Laramie Co., Pine Bluffs; 8-VIII-67; R.J. Lavigne, coll. (male)

***Ospriocerus latipennis* (Loew)**

Heteroptera: Lygaeidae

Nysius ericae (Schilling) (as *Nysius* sp. in Dennis & Lavigne, 1975), Wyoming: Platte Co., Register Cliff; 13-VII-72; R.J. Lavigne, coll. (female)

Xyonysius californicus (Stal), Wyoming: Platte Co., Guernsey, Oregon Trail Park; 07-VII-72 (male, female); 13-VII-72 (female); D.S. Dennis, coll.

Heteroptera: Miridae

Adelphocoris ?*rapidus* (Say), Wyoming: Platte Co., Guernsey, Oregon Trail Park; 29-VI-72; D.S. Dennis, coll. (female)

Lepidopsallus sp., Wyoming: Platte Co., Guernsey, Oregon Trail Park; 12-VII-72; D.S. Dennis, coll. (male)

Lygus hesperus Knight, Wyoming: Platte Co., Guernsey, Oregon Trail Park; 30-VI-72 (female); 14-VII-72 (male); D.S. Dennis, coll.

Heteroptera: Nabidae (as *Nabis* sp. in Dennis & Lavigne, 1975)

Nabis americoferus Carayon, Wyoming: Platte Co., Guernsey, Oregon Trail Park; 29-VI-72 (male); 30-VI-72 (male); 6-VII-72 (male); D.S. Dennis, coll.

***Proctacanthella cacopiloga* Hine**

Heteroptera: Lygaeidae

Geocoris bullatus (Say), Wyoming: Platte Co., Register Cliff; 18-VII-72; R. J. Lavigne, coll. (male)

Nysius ericae (Schilling) (as *Nysius* sp. in Dennis & Lavigne, 1975), Wyoming: Platte Co., Register Cliff; 18-VII-72; R.J. Lavigne, coll. (female)

Homoptera: Cicadellidae

Exitianus exitiosus (Uhler), Wyoming: Platte Co., Guernsey, Register Cliff; 30-VII-71 (male, female); R.J. Lavigne, coll.; 23-VII-72 (female); D.S. Dennis, coll.

Homoptera: Issidae

Aphelonema rugosa Ball, Wyoming: Platte Co., Guernsey, Register Cliff; 9-VII-73; D.S. Dennis, coll. (female) (as *Aphelonema* sp. in Dennis & Lavigne, 1975)

***Proctacanthella leucopogon* (Williston)**

Heteroptera: Lygaeidae

Nysius angustatus Uhler, Wyoming: Platte Co., Glendo, 11.3 km S; 23-VII-57; R.E. Pfadt, coll. (female)

***Promachus dimidiatus* (Curran)**

Heteroptera: Pentatomidae

Homaemus bijugus Uhler, Wyoming: Natrona Co., Glenrock, Dave Johnston Power Plant; 17-VII-74; R.J. Lavigne, coll. (male)

***Promachus giganteus* Hine**

Homoptera: Cicadidae

Diceroprocta eugraphica Davis, New Mexico: Hachita, 16 km W; 20-VI-88; T.J. McNary, coll. (female)

***Scleropogon neglectus* (Bromley)**

Heteroptera: Alydidae

Alydus conspersus (Montandon), Wyoming: Teton Co., Grand Teton Nat'l Park, Teton Point; 8-VIII-71 (female); 13-VIII-71 (male); R.J. Lavigne, coll.

Alydus eurinus (Say), Wyoming: Carbon Co., Elk Mt.; 28-VII-72; R.J. Lavigne, coll. (male)

Heteroptera: Pentatomidae

?*Thanta* sp., Wyoming: Fremont Co., Riverton, 3.8 km NW; 18-VIII-81; R. Lavigne, coll. (female)

***Stichopogon trifasciatus* (Say)**

Homoptera: Cicadellidae

Cuerna sp. (nymph), Wyoming: Platte Co., Wheatland, 16 km N; 24-VI-66; R.J. Lavigne, coll. (female)

DISCUSSION

In an examination of the literature in which prey of robber flies are recorded, robber flies have been reported to prey more often upon certain orders of insects, although they generally appear not to prey upon Hemiptera as frequently as on members of other orders. In the older literature, when Hemiptera and Homoptera were considered separate orders by taxonomists, they were reported as making up a relatively low number of robber fly prey. Hobby (1931a) observed that for several species of robber flies in Great Britain, most prey captured were in the orders “Diptera, Hymenoptera, Coleoptera, Lepidoptera and other orders”. Poulton (1906) and Brues (1946) stated that prey consist almost exclusively of Hymenoptera, Diptera, Coleoptera and Lepidoptera. Cole and Lovett (1921) and Melin (1923) made similar observations. In more recent literature, Lavigne et al. (1994) specifically recorded percentages of prey for *Proctacanthus* spp., with the largest number of prey from the orders Hymenoptera (38.5%), Orthoptera (26.4%), Diptera (14.2%) and Coleoptera (7.5%), and only 4.6% Heteroptera. Hayat (1997), provided 68 prey records for 16 species of robber flies in Turkey. For these species the prey consisted of Hymenoptera (57.4%; mostly *Apis mellifera* Linnaeus), Diptera (19.1%), Coleoptera (10.3%), Hemiptera (7.3%), Homoptera (4.4%) and Lepidoptera (1.5%). Londt (2006) concluded that asilids preyed upon, in order of importance, Hymenoptera (26.4%), Diptera (22%), Coleoptera (14.7%), Orthoptera (14%), Hemiptera (9.6%) and Lepidoptera (8.2%).

In papers since 1969 in which there are a large number of robber fly prey reported including Hemiptera, the figures are more revealing as shown in Table 2. Of the 59 Hemiptera species, the total percentage preyed upon ranged from 0 to 73.5%, with an average of 24.1%. When separating these species into sub-orders, the number of Heteroptera prey taken by individual robber fly species was as high as 34% but as an average of total prey it was only 5.0%. However, Homoptera served as prey of individual robber fly species 59.5% of the time, but only averaged 17.4% of the total prey taken.

Londt (1993) evaluated robber fly prey from records in the Natal Museum computer database. Lygaeidae and Cicadellidae were the two families whose members served as prey more than 25 times. Of 1,608 prey recorded, 107 (approximately 6.7%) belonged to Hemiptera. The robber fly subfamilies and genera reported as preying upon Hemiptera (with the indicated number of prey in parentheses) were: Apocleinae – *Neolophonotus* (32), *Philodicus* (18), *Promachus* (10), *Alcimus* (9), *Dasophrys* (9); Dasypogoninae – *Pegesimallus* (6); Laphriinae – *Laxenecera* (2), *Stiphrolamyra* (1);

Stenopogoninae – *Microstylum* (18), *Daspletis* (2). Similar results were reported in Londt's (2006) subsequent analysis.

A comparison of new prey records with those in the Asilidae Predator – Prey Database show that members of the same families and genera of Heteroptera and Homoptera are preyed upon by asilids. The largest number of genera and species of unpublished Heteroptera prey records are in the families Coreidae, Lygaeidae, Miridae and Pentatomidae; for Homoptera, they belong to the families Aphididae, Cercopidae, Cicadellidae, Membracidae and Psyllidae. As previously indicated and also illustrated in Table 1, the same is true in the Database.

The tendency for some robber fly species to selectively choose Hemiptera may be due to prey cuticular hardness and flight characteristics, and possibly weak robber fly mouthparts (Melin, 1923; Martin, 1968; Dennis & Lavigne, 1975, 1976b; Hespenheide & Rubke, 1977; Scarbrough, 1978; Scarbrough & Sraver, 1979). Scarbrough (1978), and Scarbrough & Sraver (1979) commented that *Cerotainia albipilosa* Curran and *Atomosia puella* Curran, respectively, inserted their hypopharynx in areas where the prey's cuticle was thin or soft. For *A. puella* this was intersegmental membranes, compound eyes of Hymenoptera and below the wings on the dorsal surface of the abdomen of cicadellids and Coleoptera. Patton & Cragg (1913), and Lavigne & Holland (1969) commented that robber flies usually inserted their hypopharynx in some region of the prey's neck.

For the new prey records presented in this paper, there were about twice as many prey collected by female robber flies as opposed to those by males. Many investigators have reported that female robber flies were captured with prey more often than males (Dennis & Lavigne, 1975; Dennis, 1979; Hobby, 1931a and b, 1935; Lavigne, 1970; Lavigne and Pogue, 2009; Lehr, 1958a and b; Londt, 1999, 2006; Poulton, 1906; Richards, 1927; Scarbrough, 1978). This has been attributed to, (1) the nutritional requirements of the females for development of eggs, (2) males spending less time foraging and feeding than they do searching for and mating with females, (3) females foraging throughout the day, (4) more females than males existing in some populations of robber flies, and (5) females possibly having shorter feeding and inter-feeding times and thus catching more prey than males. Scarbrough (1979) observed for *Diogmites missouriensis* Bromley that females selected a wider range of prey than males and suggested that females have a greater metabolic requirement for egg production and cannot afford to specialize on specific prey taxa or prey whose bodies contribute limited energy. Lavigne (1971) observed that more *Backomyia seminoensis* Lavigne males were captured with prey than females and attributed this to the fact that 50% more males were recorded in the population. For the species in Table 2 where both sexes were recorded with prey, 14 species had females with more Hemiptera prey as opposed to 4 species of males.

The data in Table 2 suggests that smaller species of robber flies tend to feed more on Homoptera such as Aphididae and Cicadellidae than do larger asilids.

Table 3 presents data from the Predator-Prey Database showing that all 11 of the subfamilies of robber flies recognized by Geller-Grimm (2003) have been reported to prey upon Hemiptera. Londt (2006) reported similar results.

In Table 4, the prey numbers have been consolidated to show total numbers of prey records for each robber fly subfamily. As can be seen from this list, the largest number of Hemiptera prey were taken by members of the subfamilies Apocleinae, Asilinae, Dasypogoninae, Laphriinae and Stenopogoninae. According to Geller-Grimm (2003), these are also the subfamilies with the largest number of valid genera, and so one could expect that more prey records would be recorded for these subfamilies.

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Table 1.Hemiptera (Heteroptera and Homoptera) in the Asilidae Predator - Prey Database (Lavigne, 2003).

Superfamily/Family	Unidentified	Number of Genera	Number of Species
Heteroptera	169	-	-
Acanthosomatidae	0	1	1
Alydidae	4	5	6
Anthocoridae	4	3	2
Aradidae	1	0	0
Cimicidae	0	1	0
Ceptosomatidae	0	1	1
Coreidae	18	28	27
Corizidae	1	0	0
Cydnidae	5	4	3
Gerridae	1	1	1
Lygaeidae	40	16	20
Miridae	33	44	50
Nabidae	1	2	2
Pentatomidae	52	43	63
Plataspidae	0	1	1
Reduviidae	13	6	6
Rhopalidae	1	6	7
Saldidae	0	2	3
Scutelleridae	0	3	4
Tingidae	0	2	4
Triatomidae	1	0	0
Veliidae	1	1	1
Total	345	170	203
Homoptera	175	-	-
Acanaloniidae	1	0	0
Achilidae	1	0	0
Aleyrodidae	9	1	0
Aphididae	52	50	72
Aphrophoridae	1	1	1
Capsidae	0	1	0
Cercopidae	19	12	18
Cicadellidae	97	93	118
Cicadidae	55	19	16
Cicadoidea	15	0	0
Cixidae	1	5	4
Coccoidea	2	0	0
Delphacidae	4	6	4
Deltocepalidae	0	1	1
Derbidae	2	1	1
Dictyophoridae	2	2	2
Drabescidae	0	1	1
Fulgoridae	4	1	1
Issidae	0	4	5
Kinnaridae	1	0	0
Macropsidae	0	1	0
Margarodidae	1	2	2
Mernopilidae	1	0	0
Membracidae	10	17	16
Phylloxeridae	1	1	0
Psyllidae	11	9	14
Psylloidea	2	0	0
Total	467	228	276

Table 2. Hemiptera (Heteroptera and Homoptera) recorded in recent literature as prey of robber flies.

Reference/Species	Sex	Heteroptera (%)	Homoptera (%)	Total Prey
Bullington & Lavigne, 1992				
Cyrtopogon montanus wilcoxi James	Male	2.4	32.5	83
	Female	4.5	36.2	199
Dennis, 1979				
Holcocephala fusca Bromley	Male	0	6.5	31
	Female	1.1	1.1	89
Dennis & Lavigne, 1975				
Dicropaltum mesae (Tucker) (as *Asilus mesae)*	n/a	10.1	57.4	129
Comantella fallei (Back)	n/a	34.0	19.8	162
Eucyrtopogon comantis Curran	n/a	7.3	34.5	165
Holopogon albipilosus Curran	n/a	3.4	48.9	178
Megaphorus guildiana (Williston) (as *Mallophorina guildiana*)	n/a	1.2	13.3	173
Ospriocerus latipennis (Loew)	n/a	18.7	1.9	209
Proctacanthella cacopiloga (Hine)	n/a	14.4	42.6	209
Proctacanthus micans Schiner	n/a	1.3	0	158
Scleropogon neglectus (Bromley)	n/a	14.5	1.1	179
Stenopogon inquinatus Loew	n/a	0	2.3	172
Dennis & Lavigne, 1976a				
Efferia varipes (Williston)	n/a	2.4	5.6	125
Dennis & Lavigne, 1976b				
Leptogaster parvoclava Martin	n/a	2.7	58.5	144
Dennis & Lavigne, 1979				
Machimus callidus (Williston)	Male	1.6	14.8	61
	Female	3.4	15.7	89
Dennis, Lavigne & Bullington, 1986				
Efferia cressoni (Hine)	Male	7.1	7.1	28
	Female	2.6	12.2	115
Fisher & Hespenheide, 1982				
Glaphyropyga dryas Fisher	n/a	1.8	13.3	113
Hespenheide, 1978				
Nannocyrtopogon neoculatus Wilcox & Martin	n/a	3.5	59.1	115
Hespenheide & Rubke, 1977				
Holopogon wilcoxi Martin	n/a	14.0	59.5	121
LaPierre, 2000				
Holcocephala oculata (Fabricius)	n/a	2.1	1.9	379
Lavigne, 1970				
Cyrtopogon auratus Cole	Male	3.4	6.6	30
	Female	2.0	7.7	52
Cyrtopogon glarealis Melander	Male	0	10.0	10
	Female	0	2.4	42
Lavigne, 1979				
Efferia argyrogaster (Macquart)	Male	19.0	4.7	20
	Female	17.2	3.5	29

Table 2 continued.

Lavigne, 1982a				
Cerdistus vittipes (Macquart) (as Neoitamus vittipes)	Male	10.0	10.0	10
	Female	0	5.0	21
Lavigne, 1982b				
Neoscleropogon elongatus (Macquart)	Male	1.1	0	9
	Female	14.3	0	14
Lavigne, 1984				
Neocerdistus acutangulatus (Macquart)	Male	0	5.6	54
	Female	3.2	6.3	95
Lavigne & Bullington, 1984				
Laphria fernaldi (Back)	Male	1.6	0	62
	Female	0	0	4
Lavigne & Bullington, 1999				
Heteropogon paurosomus Pritchard	n/a	11.3	16.5	194
Lavigne, Bullington & Stephens, 1993				
Holopogon seniculus Loew	Male	3.1	48.1	54
	Female	0	49.5	93
Lavigne & Dennis, 1975				
Efferia frewingi Wilcox	Male	3.0	1.0	30
	Female	1.0	9.0	102
Lavigne & Dennis, 1979				
Proctacanthus nearno Martin	Male	0	33.3	3
	Female	0	0	2
Lavigne & Dennis, 1985				
Efferia cressoni (Hine)	Male	8.3	41.7	12
	Female	7.0	34.9	43
Efferia subcuprea (Schaffer)	Male	0	1.0	2
	Female	5.9	35.3	17
Efferia triton (Osten Sacken)	Male	0	16.7	42
	Female	11.6	4.7	43
Lavigne & Holland, 1969				
Cyrtopogon willistoni Curran	n/a	0	0	17
Diogmites angustipennis Loew	n/a	3.1	1.1	97
Efferia helenae (Bromley)	n/a	2.7	17.3	185
Efferia pallidula (Hine)	n/a	2.5	17.2	81
Efferia staminea (Williston)	n/a	6.0	10.4	67
Heteropogon wilcoxi James	n/a	8.3	4.9	61
Lasiopogon cinereus Cole	n/a	0	0	75
Lasiopogon polensis Lavigne	n/a	0	34.0	102
Promachus dimidiatus Curran	n/a	1.9	0	108
Scleropogon picticornis Loew (as *Stenopogon picticornis*)	n/a	0	0	13
Stichopogon trifasciatus (Say)	n/a	0	16.0	20
Lavigne & Pogue, 2009				
Omninablautus nigronotum (Wilcox)	Male	7.1	7.1	14
	Female	0	14.0	50
Lavigne, Pogue & Johnson 1983				
Laphystia rufofasciata Curran	Male	4.0	8.0	25
	Female	11.4	19.0	105

Table 2 continued.

Lavigne, Rogers & Lavigne, 1976				
Efferia benedicti (Bromley)	Male	2.0	13.0	119
	Female	3.0	20.0	131
O'Neil, 1995				
Cyrtopogon willistoni Curran	n/a	10.8	20.8	120
Rogers & Lavigne 1972				
Ablautus rufotibialis Back	n/a	17	8	12
Dicropaltum mesae (Tucker) (as *Asilus mesae)*	n/a	0	0	6
Comantella fallei (Back)	n/a	14	17	29
Efferia helenae (Bromley)	n/a	2	9	81
Efferia staminea (Williston)	n/a	4	11	27
Lasiopogon quadrivittatus Jones	n/a	0	12	17
Ospriocerus abdominalis Say	n/a	0	0	5
Proctacanthella leucopogon (Williston)	n/a	4	38	47
Proctacanthus micans Schiner	n/a	0	0	56
Scleropogon picticornis Loew	n/a	0	5	22
Scarbrough, 1978				
Cerotainia albipilosa Curran	n/a	3.8	28.4	739
Scarbrough, 1979				
Diogmites missouriensis Bromley	n/a	11.1	0	253
Scarbrough, 1981				
Eudioctria tibialis (Banks)	n/a	0.2	35.9	462
Scarbrough, 1982				
Holcocephala abdominalis (Say)	n/a	1.7	5.5	656
Holcocephala calva (Loew)	n/a	1.9	14.7	592
Scarbrough & Sipes, 1973				
Leptogaster flavipes Loew	n/a	0	50.0	20
Scarbrough & Sraver, 1979				
Atomosia puella (Wiedemann)	n/a	5.7	21.7	1,567

Footnote: n/a indicates that the sex of the robber fly was not identified.

Table 3. Subfamilies and genera of robber flies in the Asilidae Predator - Prey Database (Lavigne, 2003) preying upon Hemiptera (Heteroptera and Homoptera).

	Number of Prey Records				
	Heteroptera	**Homoptera**		**Heteroptera**	**Homoptera**
Subfamily Apocleinae			**Subfamily Asilinae continued**		
Alcimus	3	11	*Ktyr*	0	4
Blepharotes	0	2	*Machimus*	163	131
Dasophyrs	2	7	*Mauropteron*	0	1
Efferia Group	158	231	*Neoaratus*	1	3
Eicherax	1	0	*Neocerdistus*	3	10
Eichoichemus	0	1	*Neoitamus*	28	15
Glaphyropyga	2	12	*Neomochtherus*	0	1
Lecania	0	1	*Philonicus*	3	1
Lophopeltis	0	1	*Polysarca*	1	0
Mallophora	6	5	*Porasilus*	1	56
Megaphorus	11	38	*Pseudoeremisca*	0	1
Neolophonotus	25	31	*Reburrus*	0	1
Philodicus	9	22	*Satanas*	2	0
Proctacanthella	52	175	*Threnia*	0	1
Proctacanthus	38	14	*Tolmerus*	10	28
Promachus	89	169	*Trichomachimus*	1	2
Triorla	0	1	*Turkiella*	11	16
Total	396	721	*Zosteria*	0	1
Subfamily Asilinae			**Total**	598	785
Aneomochtherus	7	3	**Subfamily Dasypogoninae**		
Antipalus	0	1	*Allopogon*	1	0
Antiphrisson	2	1	*Comantella*	61	43
Asilella	1	2	*Dakinomyia*	0	2
Asilus	0	1	*Dasypogon*	80	0
Asiola	0	1	*Diogmites*	35	6
Cerdistus	8	8	*Molobratia*	97	0
Clephydroneura	1	0	*Neocyrtopogon*	1	0
Colepia	6	0	*Nicocles*	0	1
Dicropaltum	13	72	*Pegesimallus*	6	1
Didysmachus	0	3	*Saropogon*	4	0
Dolopus	0	2	*Senobasis*	0	1
Dysmachus	268	365	*Stizochymus*	0	1
Echthistus	55	23	*Thereutria*	2	0
Engelepogon	0	4	**Total**	287	55
Eremisca	2	19	**Subfamily Dioctrinae**		
Eutolmus	9	7	*Dioctria*	6	1
Filiolus	1	0	*Eudioctria*	5	181
Heligmoneura	0	1	**Total**	11	182
Hoplopheromerus	1	0			

Table 3 continued.

Subfamily Laphriinae		
Andrenosoma	3	1
Atomosia	9	359
Cerotainia	28	218
Choerades	26	27
Hybozelodes	0	2
Lampria	1	0
Laphria	13	14
Laphyctis	0	1
Laxenecera	1	4
Nannolaphria	0	3
Oidardis	0	1
Pagidolaphria	1	0
Proagonistes	0	3
Smeryngolaphria	0	1
Stiphrolamyra	0	1
Total	172	635
Subfamily Leptogastrinae		
Euscelidia	0	2
Leptogaster	20	103
Leptopteromyia	0	1
Psilonyx	2	3
Unidentified	0	1
Total	22	110
Subfamily Laphystiinae		
Laphystia	13	22
Psilocurus	0	3
Trichardis	0	1
Total	13	26
Subfamily Ommatiinae		
Cophinopoda	1	0
Ommatius	4	17
Total	5	17
Subfamily Stenopogoninae		
Ablautus	2	2
Acnephalum	4	0
Afroholopogon	2	0

Subfamily Stenopogoninae continued		
Amphisbetetus	1	0
Ancylorrhynchus	1	0
Backomyia	4	27
Bathypogon	11	1
Ceraturgus	1	1
Cyrtopogon	24	74
Daspletis	0	2
Eucyrtopogon	11	59
Gonioscelis	2	0
Heteropogon	25	16
Holopogon	40	169
Jothopogon	0	2
Microstylum	6	22
Myelaphus	0	1
Nannocyrtopogon	4	69
Neoscleropogon	3	0
Ospriocerus	41	1
Pedomyia	1	0
Rhabdogaster	0	1
Scleropogon	26	3
Scylaticus	6	0
Stenopogon	252	116
Total	467	566
Subfamily Stichopogoninae		
Clinopogon	2	0
Eremodromus	0	1
Lasiopogon	1	28
Stichopogon	8	15
Total	11	44
Subfamily Trigonomiminae		
Damalis	9	11
Holcocephala	12	113
Total	21	124
Subfamily Unidentified	0	10

Table 4. Hemiptera (Heteroptera and Homoptera) prey by subfamily as recorded in the Asilidae Predator - Prey Database (Lavigne, 2003).

	Number of Prey	
Subfamily	**Heteroptera**	**Homoptera**
Apocleinae	396	721
Asilinae	598	785
Dasypogoninae	287	55
Dioctriinae	11	182
Laphriinae	172	635
Laphystiinae	13	26
Leptogastrinae	22	110
Ommatiinae	5	17
Stenopogoninae	467	566
Stichopogoninae	11	44
Trigonomiminae	21	124

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