ZooKeys 83: 1–42 (2011)
doi: 10.3897/zookeys.83.1176
www.zookeys.org

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Planthoppers of Delaware (Hemiptera, Fulgoroidea), excluding Delphacidae, with species incidence from adjacent States

Charles R. Bartlett[1], Erin R. Adams[1], Anthony T. Gonzon, Jr.[2]

1 *Department of Entomology and Wildlife Ecology, 250 Townsend Hall, University of Delaware, Newark, Delaware, 19717-1303. U.S.A.* **2** *DE Natural Heritage and Endangered Species Program, DE Division of Fish and Wildlife, DNREC 4876 Hay Point Landing Road, Smyrna, Delaware, 19977. U.S.A.*

Corresponding author: *Charles R. Bartlett* (Bartlett@udel.edu)

Academic editor: *Michael Wilson* | Received 8 November 2010 | Accepted 29 January 2011 | Published 25 February 2011

Citation: Bartlett CR, Adams ER, Gonzon AT Jr. (2011) Planthoppers of Delaware (Hemiptera, Fulgoroidea), excluding Delphacidae, with species incidence from adjacent States. ZooKeys 83: 1–42. doi: 10.3897/zookeys.83.1176

Abstract

The number of species of planthoppers (excluding Delphacidae) known from Delaware is updated from 7 (in 4 families) to 62 species (in 9 families). Specimen abundance is tallied by county and seasonally by two week intervals. The Chao1 abundance estimator suggests that the true fauna may be 74 species, although species incidence tallied from adjacent states (MD, NJ, PA and DC) suggests that a total fauna of approximately 100 species may be possible. An artificial key is presented to genus and select species with photos of most included taxa.

Keywords

Auchenorrhyncha, Fulgoromorpha, Acanaloniidae, Achilidae, Caliscelidae, Cixiidae, Derbidae, Dictyopharidae, Flatidae, Issidae, species inventory, generic key

Introduction

The distribution of planthoppers (Hemiptera: Auchenorrhyncha: Fulgoroidea) in the eastern United States was most recently summarized by Wilson and McPherson (1980a). Excluding the Delphacidae, Wilson and McPherson (1980a) reported only 4 planthopper species from Delaware, specifically *Acanalonia conica* (Say, 1830, Acanaloniidae), *Catonia cinctifrons* (Fitch, 1956, Achilidae), *Melanoliarus ecologus* (Caldwell,

1947; as *Oliarus,* Cixiidae), and *Metcalfa pruinosa* (Say, 1830, Flatidae). Additional species were later reported by Kramer in his revisions of the Cixiidae, specifically *Cixius nervosus* (Linnaeus, 1758) by Kramer (1981), *Bothriocera cognita* Caldwell, 1943, and *Bothriocera drakei* Metcalf, 1923, by Kramer (1983), bringing the reported fauna to 7 species in 4 families.

Our objectives were to provide an abundance-based list of planthopper species found in Delaware (excluding Delphacidae) established primarily on specimen records from the University of Delaware Insect Reference Collection (UDCC) in Newark, DE; provide a measure of completeness of this inventory using the Chao1 abundance-based diversity estimator (Chao 1984) and by comparison with incidence records from adjacent states (MD, NJ, PA and DC); and begin to assess their biology by providing preliminary information regarding the seasonality of the planthoppers of Delaware. We provide an artificial key to genus and select species to allow users to recognize planthopper species in the Mid-Atlantic States more easily.

Methods

Planthopper specimens from Delaware, Maryland, New Jersey, and Pennsylvania in the UDCC were identified to species. Identification of some taxa requires dissection of male genitalia, in which case the abdomen was removed (sometimes after relaxing the specimen overnight in high humidity) and cleared for 24 hours in 15% potassium hydroxide (KOH), rinsed in water and transferred to glycerol for observation and manipulation (see, e.g., Wilson and McPherson 1980b, Bartlett and Deitz 2000). Species identification was made according to the following sources: Metcalf (1923, Derbidae except *Cedusa*, Dictyopharidae except *Scolops* and *Phylloscelis*, Flatidae), McAtee (1923, Derbidae: *Otiocerus*), Breakey (1928, Dictyopharidae: *Scolops*), Doering (1938, Issidae; 1939, Caliscelidae: *Bruchomorpha*; 1941, Caliscelidae: *Aphelonema*), Beirne (1950, Achilidae: *Cixidia* [as *Epiptera*]), O'Brien (1971, Achilidae: Plectoderini), Kramer (1977, Cixiidae: *Oecleus*; 1979, Cixiidae: *Haplaxius* [as *Myndus*]; 1981, Cixiidae: *Cixius;* 1983, Cixiidae: *Bothriocera*, *Pintalia*), Mead and Kramer (1982, Cixiidae: *Melanoliarus* [as *Oliarus*]), Flynn and Kramer (1983, Derbidae: *Cedusa*), Freund and Wilson (1995, Acanaloniidae), McPherson and Wilson (1995, Dictyopharidae: *Phylloscelis*). The specific identities of some taxa were confirmed by comparison with authoritatively determined specimens at the US Smithsonian Institution National Museum of Natural History (USNM), although in a few cases we examined types, or photographs of types (specifically the derbids *Otiocerus signoretii* Fitch, *Anotia burnetii* Fitch, and *Anotia robertsonii* Fitch from the USNM; and *Otiocerus stollii* Kirby and the purported type of *Anotia bonnetii* Kirby [but see discussion] from the Hope Entomological Collections Oxford University Museum of Natural History, OUMNH). Additional Kirby types were sought (from the British Museum, Manchester Museum, and Oxford), but are apparently missing. Females of some genera (e.g., Derbidae: *Cedusa* and many Cixiidae) cannot be identified to spe-

cies with confidence. These specimens were tallied at the generic level and included in the specimen counts, but not included in species counts or calculation of the Chao1 statistic (see below). The artificial key to genus and select species was constructed for all taxa not requiring dissection for identification. The key was developed by modification of keys within the above listed taxonomic references. Author and year for all species is provided in table 2.

Family-level nomenclature follows Emeljanov (1999) in recognizing Acanaloniidae and Caliscelidae as independent from Issidae. Keys to families of Fulgoroidea can be found in Wilson (2005). Generic nomenclature has been updated for Cixiidae following Emeljanov (2001) and Holzinger and colleagues (2002) and for Issidae by Gnezdilov (2004).

Incidence records were listed for Maryland, New Jersey, Pennsylvania, and the District of Columbia based on literature (see below) and specimen records. Specimen records were compiled both from the UDCC and USNM collections. Specimens from Delaware were totaled by county and collection date increment. For collection date tallies, each month was divided into two increments, "early" (the 1–15th of each month), and "late" (the 16th-end of month) dates. Specimens with incomplete date information were omitted from these counts (resulting in the number of specimens tallied for seasonal data for some species to be less than the number of specimens observed). Because some species were at times found in abundance, seasonality records were tallied in two ways; complete specimen counts, and observation records where each series (all specimens recorded from a particular location and date) was tallied as a single observation.

To help assess completeness of the inventory, literature records were compiled from published sources (viz. Wilson and McPherson 1980a, Kramer 1981, 1983; Mead and Kramer 1982, Flynn and Kramer 1983, and McPherson and Wilson 1995) into a species incidence table. Specimen incidence records were compiled with literature records, but independently annotated.

Photographs were taken using a Nikon SMZ-1500 Digital Imaging Workstation with Nikon DS-U1 digital Camera and NIS Elements Imaging software (version 3.0). Line drawings were made by Kimberley Shropshire (see acknowledgements) by tracing photographs and rendering detail freehand with reference to specimens.

Total planthopper species richness for Delaware was also evaluated using Chao's (1984) abundance based estimator of species richness calculated as $S_{chao} = S_{obs} + F_1^2/2F_2$, where S_{obs} = # observed species, F_1 = # of species observed by exactly one specimen, F_2 = # of species observed by exactly two specimens.

Results

Among 1,734 specimens from Delaware we observed 62 planthopper species in 27 genera and 9 families (Table 1), including 55 new state records. Not surprisingly, specimen records were strongly biased (72% of observed specimens) toward New Castle

County where the main campus of University of Delaware is located. Some females in the genera *Bothriocera*, *Cixius*, *Haplaxius*, *Melanoliarus* (all Cixiidae) and *Cedusa* (Derbidae), representing 88 specimens, could not be definitively identified to species and these female specimens were subsequently excluded from the species tally and the calculation of the Chao1 statistic; however, one of the female *Bothriocera* specimens appears to represent an additional species. Specimens of *Omolicna* evidently represented 2 species, but we were unable to identify them or parse the species with confidence. For this reason, we have reported the specimens identified to the generic level and included them in the species count and calculations.

The most abundant species were *Melanoliarus placitus* (18% of observed specimens), *Aphelonema simplex* (10%), *Acanalonia conica* (9%), *Flatormenis chloris* (7%), and *Scolops sulcipes* (5%), collectively representing 49% of the specimens observed (Figure 1). However, for *Aphelonema simplex* there were only 5 collecting events, one of which comprised 70, and a second 69 specimens (out of 165 total observed specimens). In contrast, *Metcalfa pruinosa* (5%) and *Acanalonia bivittata* (3%) were both observed in many collecting events, but these frequently encountered species are readily recognized in the field and either avoided by collectors or not accessioned by the collection manager, and therefore are probably relatively underrepresented.

The Chao1 biodiversity estimator was calculated as 74.08 species, indicating that 12 additional planthopper species are predicted to occur. The incidence list for Delaware and adjacent states (Table 2) includes 112 taxa, of which 50 species were recorded from surrounding states with no Delaware records. In addition, 22 species from MD, 5 from NJ, 8 from PA, and 21 from DC are new state records.

The seasonality data suggests that the optimal time of year to find planthoppers in Delaware is between late June and early August (Table 1). It appears that most species have one generation per year, although the available data is sparse for some taxa. *Bruchomorpha oculata, Aphelonema simplex,* and *Cixius nervosus* may have two generations a year. It is evident from specimens collected in logs in March that *Apache degeerii* overwinters as adults (early record March 1: 9 specimens from 3 collection events), although the overwintering status of other taxa is not clear from this data. Records of cixiids from late April may indicate overwintering as immatures, as has been reported for cixiids in Germany (Nickel and Remane 2002).

Specimens reported incidentally by Zuefle (2006) and Zuefle and colleagues (2008) (Table 3) provide host data for 3 Delaware planthopper species. Zuefle (2006) sampled insect use of 45 woody plants that were: 1) native, 2) non-native with native US congeners, and 3) 'alien' plant species with no US congeners, using pesticide knock-down or vacuum sampling. Vouchers were reported in Zuefle (2006) as '*Oliarus sablensis*' were mostly *Melanoliarus ecologus* (32 of 35 dissected males were *M. ecologus* and the remaining 3 *M. sablensis*), so we here reported her cixiids as *Melanoliarus* spp. The hosts for the 3 *M. sablensis* specimens were *Rhododendron mucronatum, Cotoneaster lucidus,* and *Betula pendula*. Her results confirm a polyphagous host use for *Flatormenis chloris* and suggest that adult *Melanoliarus,* or at least *M. ecologus*, are polyphagous on woody plants.

Table 1. County and seasonality records for Delaware planthoppers. Number of observed specimens given for county records, with distribution of records over the year provided, including earliest and latest observation. For seasonality records, records were divided into early (day 1–15 of the month) and late (remainder of month) observations, and for each observation a specimen count is followed parenthetically by number of independent collecting events (see methods). Sum of seasonality records may be less that sum of specimen records as ambiguous date records were omitted from seasonality tally. Column totals below seasonal entry is a count of the number of species observed during that time interval.

	County records						**March**		**April**		**May**		**June**		**July**		**August**		**September**		**October**	
	New Castle	Kent	Sussex	Sum	Early date	Late date	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late
Acanaloniidae																						
Acanalonia bivittata	29	5	11	45	16-May	5-Oct						1(1)			5(1)	8(4)	6(5)	11(6)	9(7)	4(3)	1(1)	
Acanalonia conica	138	10	2	150	2-Jul	7-Oct									16(7)	25(17)	14(10)	24(15)	49(18)	22(8)	22(7)	2(2)
Achilidae																						
Catonia carolina	9		15	24	29-Jul	7-Oct										1(1)	4(1)	6(3)	10(1)	1(1)	1(1)	
Catonia cinctifrons	1			1	26-Jul											1(1)						
Catonia nava	10			10	3-Aug	27-Sep											1(1)			8(1)		
Catonia picta			1	1	7-Oct																1(1)	
Catonia pumila			3	3	4-Aug	8-Sep											1(1)			2(1)		
Cixidia fusca			4	4	28-Jul	7-Oct										1(1)					3(1)	
Cixidia opaca		1		1	28-Aug													1(1)				
Cixidia variegata			1	1	7-Oct																1(1)	
Caliscelidae																						
Aphelonema simplex	15	141	9	165	30-May	3-Oct						8(1)				9(1)	4(1)	69(1)		70(1)	1(1)	
Bruchomorpha sp. n.			7	7	29-Jun	21-Aug								2(1)	3(2)			2(1)				
Bruchomorpha oculata	53		1	54	22-Jun	9-Oct								4(1)	6(4)			3(2)	15(3)	12(5)	12(6)	

	County records						March		April		May		June		July		August		September		October	
	New Castle	Kent	Sussex	Sum	Early date	Late date	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late
Bruchomorpha pallidipes			2	2	29-Jun									2(1)								
Cixiidae																						
Bothriocera cognita	9	3	34	46	22-Jun	4-Aug				1(1)				4(2)	20(5)	17(8)	2(1)					
Bothriocera drakei	2			2	29-Jun	3-Jul								1(1)	1(1)							
Bothriocera maculata			3	3	29-Jun									1(1)								
Bothriocera spp. Female	1			1	15-Jul										1(1)							
Cixius angustatus	1			1	9-May						1(1)											
Cixius nervosus	45			45	8-May	29-Jul					10(4)	1(1)		5(3)	28(6)	1(1)						
Cixius spp. Female	2			2	24-Apr	2-Jun				1(1)			1(1)									
Haplaxius ovatus	1	3		4	7-Jun	29-Jul							3(1)			1(1)						
Haplaxius pictifrons	57		3	60	18-Jun	29-Jul								27(3)	30(3)	3(3)						
Haplaxius radicus	3		1	4	11-Jun	29-Jun							3(2)	1(1)								
Haplaxius spp. Female	1			1	22-Jul											1(1)						
Melanoliarus chuliotus			1	1	12-Jul										1(1)							
Melanoliarus ecologus	90			90	16-Jun	14-Jul								66(4)	24(1)							
Melanoliarus montanus		1		1	19-Jun									1(1)								
Melanoliarus placitus	265	2	47	314	22-Apr	30-Aug				2(1)		10(3)	21(2)	38(10)	198(18)	35(12)	1(1)	3(3)				

	County records						March		April		May		June		July		August		September		October	
	New Castle	Kent	Sussex	Sum	Early date	Late date	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late
Melanoliarus quinquelineatus	10		1	11	24-Jun	16-Jul								1(1)	9(5)	1(1)						
Melanoliarus sablensis	1			1	27-Jun									1(1)								
Melanoliarus near *sablensis*	6			6	16-Jun	27-Jun								6(3)								
Melanoliarus spp. Female	59		4	63	23-May	26-Jul						1(1)		47(6)	12(8)	3(3)						
Melanoliarus spp. Fem. dark wing	4	1		5	29-Jun	26-Jul								2(2)		3(3)						
Oecleus productus			2	2	11-Aug												2(1)					
Pintalia vibex	27		20	47	23-May							4(2)	3(2)	19(8)	16(5)	5(2)						
Derbidae																						
Anotia kirkaldyi	5			5	22-Jul	9-Sep										1(1)	1(1)	1(1)	2(1)			
Anotia robertsonii	5	3	1	9	19-Jun	19-Oct								1(1)		3(3)				2(2)		3(1)
Anotia westwoodi	7			7	18-Jun	1-Sep								3(2)		3(2)			1(1)			
Apache degeerii	19		10	29	1-Mar	21-Oct	9(3)								7(3)	3(3)	2(2)		1(1)	3(2)	3(1)	1(1)
Cedusa carolinensis	1			1	13-Aug												1(1)					
Cedusa near *cedusa*	10		1	11	26-Jul	13-Aug										6(1)	5(3)					
Cedusa kedusa	21		2	23	7-Jul	30-Aug									1(1)	19(1)	1(1)	2(1)				
Cedusa redusa	6		8	14	9-Jun	8-Sep							5(1)		5(1)		2(1)		1(1)			
Cedusa mallochi	1			1	23-Jun									1(1)								

	County records						March		April		May		June		July		August		September		October	
	New Castle	Kent	Sussex	Sum	Early date	Late date	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late
Cedusa vulgaris	1			1	3-Aug												1(1)					
Cedusa spp. Female	16			16	9-Jun	26-Jul							1(1)		3(1)	12(1)						
Neocenchrea heidemanni	3			3	2-Sep	6-Sep													3(2)			
Omolicna spp.	11	2	23	36	14-Jun	7-Oct							1(1)		2(1)	1(1)	1(1)	17(6)	4(3)		7(1)	
Otiocerus coquebertii	1		1	2	(22-26)-June	12-Jul								1(1)	1(1)							
Otiocerus francilloni			1	1	15-Jul										1(1)							
Otiocerus reaumurii	2			2	26-Jul	9-Aug										1(1)	1(1)					
Otiocerus wolfii	7		5	12	(19-20)-July	7-Sep										2(2)	4(3)		6(2)			
Patara vanduzei	2		2	4	3-Jul	4-Aug									1(1)	2(1)	1(1)					
Sikaiana harti		1		1	1-Jul										1(1)							
Dictyopharidae																						
Rhynchomitra lingula			14	14	21-Aug	1-Sep												10(2)	4(1)			
Rhynchomitra microrhina	16	1	1	18	27-Jul	13-Sep										3(2)	4(3)	11(7)				
Scolops angustatus	8			8	18-Jul	20-Jul										2(2)						
Scolops perdix			7	7	19-Aug	21-Aug												7(2)				
Scolops pungens			1	1	17-Jul											1(1)						
Scolops sulcipes	92	2		94	11-Jul	1-Oct									1(1)	50(14)	4(4)	12(4)	3(1)	11(4)	10(1)	

	County records						March		April		May		June		July		August		September		October	
	New Castle	Kent	Sussex	Sum	Early date	Late date	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late
Flatidae																						
Flatormenis chloris	85	18	9	112	2-Jul	21-Oct									2(1)	14(12)	16(11)	23(18)	19(12)	15(12)	8(5)	11(3)
Metcalfa pruinosa	58	12	13	83	22-Jun	11-Oct								2(2)	6(6)	15(11)	20(14)	12(7)	14(10)	5(5)	4(3)	
Ormenoides venusta	18	2	1	21	22-Jul	1-Oct										2(2)	2(2)	8(3)	5(3)		2(1)	
Fulgoridae																						
Cyrpoptus belfragei	4			4	4-Jun	18-Jul							2(2)	1(1)		1(1)						
Issidae																						
Thionia bullata	1	1		2	2-Aug	17-Oct											1(1)					1(1)
Thionia simplex	14			14	4-Jul	16-Sep									2(2)	1(1)	1(1)	2(2)	7(5)	1(1)		
Totals	1253	209	272	1734			1	0	0	3	2	6	9	24	28	36	27	19	17	13	14	5

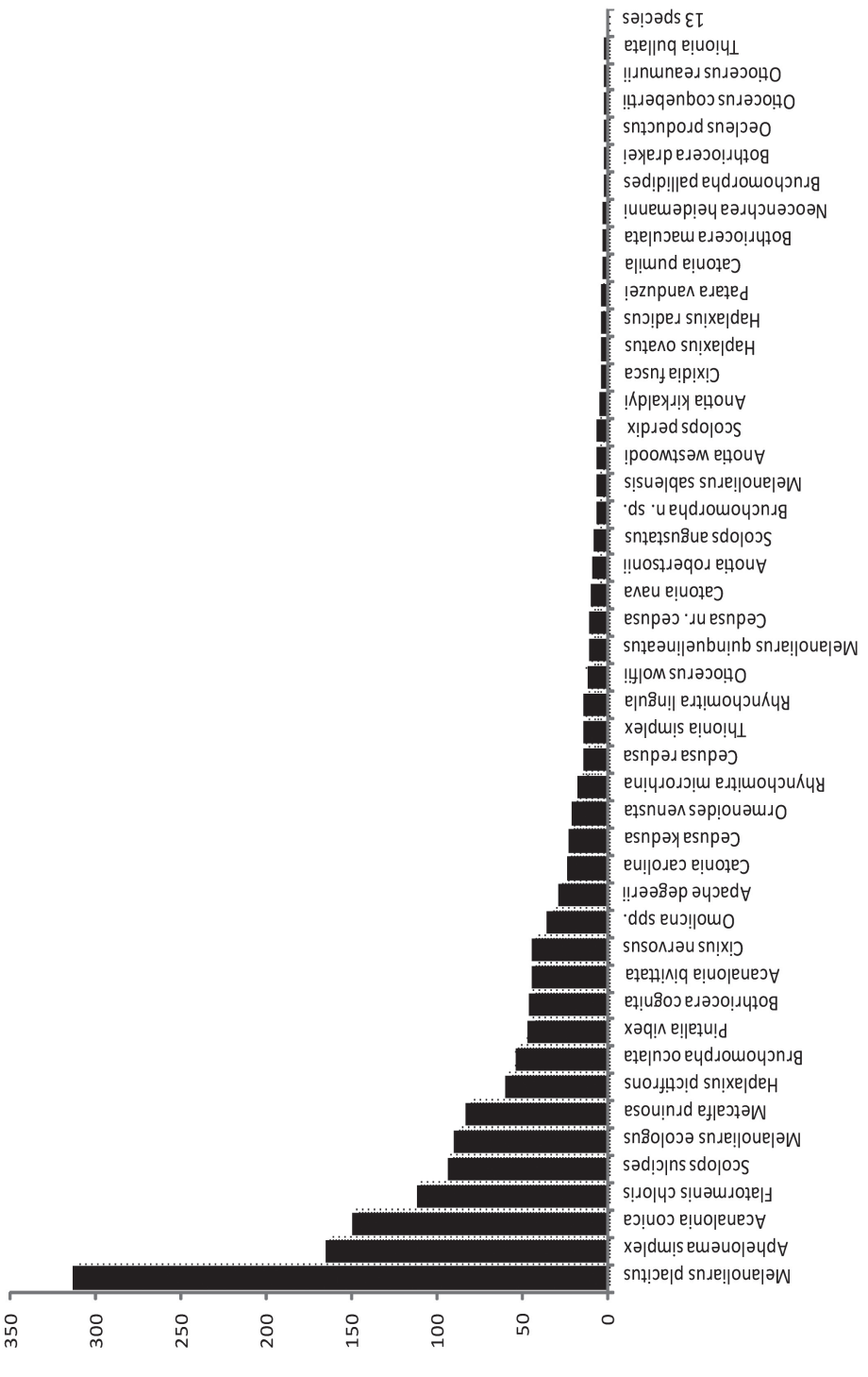


Figure 1. Rank abundance frequency distribution of planthopper species of Delaware. Number of specimens of each species found in Table 1.

Table 2. Planthopper incidence list for Delaware, Maryland New Jersey, Pennsylvania, and the District of Columbia. Specimen records are indicated by "S", literature records by "L", tentative or subsequent questioned records are annotated by "?", and records reported as erroneous by "E". Records from Wilson and McPherson (1980) except as noted.

Species	DE	MD	NJ	PA	DC	References and comments
Acanaloniidae						
Acanalonia bivittata (Say, 1825)	S	S,L	S,L	S,L	S,L	
Acanalonia conica (Say, 1830)	S,L	S,L	S,L	S,L	S	
Acanalonia servillei Spinola, 1839		S		S,L		*Acanalonia latifrons* (Walker, 1851) synonymized with *A. servillei* by Fennah 1971: 334-6.
Achilidae						
Catonia carolina (Metcalf, 1923)	S	S,L	S		S	
Catonia cinctifrons (Fitch, 1856)	S,L	S,L	S,L	S,L	S	
Catonia lunata Metcalf, 1923		S,L	S,L		S	
Catonia nava (Say, 1830)	S	S,L			S	
Catonia picta Van Duzee, 1908	S		S,L			
Catonia pumila Van Duzee, 1908	S	S,L	S,L	S,L	S	
Cixidia fusca (Walker, 1852)	S	S	S,L		S	
Cixidia opaca (Say, 1830)	S	L	L	S,L		
Cixidia pallida (Say, 1830)			L	L	S,L	
Cixidia septentrionalis (Provancher, 1889)			L	L	L	
Cixidia variegata (Van Duzee, 1908)	S	S	S,L		S	
Synecdoche dimidiata (Van Duzee, 1910)		S,L	S,L	S,L		
Synecdoche grisea (Van Duzee, 1908)		S,L		L		
Synecdoche impunctata (Fitch, 1851)		S	L	L	S	
Caliscelidae						
Aphelonema decorata (Van Duzee, 1908)			L			
Aphelonema histrionica (Stål, 1864)		S				
Aphelonema rugosa (Ball, 1932)		L?				
Aphelonema simplex Uhler, 1876	S	S,L	S,L			
Bruchomorpha dorsata Fitch, 1856			S,L	L		
Bruchomorpha jocosa Stål, 1862			L		L	
Bruchomorpha oculata Newman, 1838	S	S,L	S,L	S,L	S	
Bruchomorpha pallidipes Stål, 1862	S	S	S		S,L	
Bruchomorpha sp. n.	S	S	S			
Bruchomorpha tristis Stål, 1862			L		L	
Fitchiella robertsonii (Fitch, 1856)		L		L		
Cixiidae						
Bothriocera bicornis (Fabricius, 1803)		*E*	*E*			Noted as error by Kramer 1983
Bothriocera cognita Caldwell, 1943	S,L		S,L	L		Kramer 1983
Bothriocera drakei Metcalf, 1923	S					
Bothriocera maculata Caldwell, 1943	S					

Species	DE	MD	NJ	PA	DC	References and comments
Bothriocera signoreti Stål, 1864		*E*				Noted as error by Kramer 1983
Cixius angustatus Caldwell, 1938	S	S				
Cixius apicalis Metcalf, 1923				L		Kramer 1981
Cixius coloepeum Fitch, 1856		S	L	L		
Cixius misellus Van Duzee, 1906			L	L		Kramer 1981(PA record)
Cixius nervosus (Linnaeus, 1758)	S,L	S,L	S,L	S,L		Kramer 1981
Cixius nike Kramer, 1981				S,L		Kramer 1981
Cixius pini Fitch, 1851		S,L		S,L	S	Kramer 1981
Cixius stigmatus (Say, 1825)			L	L		
Haplaxius enotatus (Van Duzee, 1909)		S,L				
Haplaxius ovatus (Ball, 1933)	S	S,L	S,L			
Haplaxius pictifrons (Stål, 1862)	S	S,L	L	S,L	S	
Haplaxius pusillus (Van Duzee, 1909)			S,L			
Haplaxius radicus (Osborn, 1903)	S	S,L			S	
Haplaxius wheeleri (Wilson, 1996)			S,L	S		
Melanoliarus chuliotus (Ball, 1934)	S				L	
Melanoliarus ecologus Caldwell, 1947	S	S,L	S,L	S,L	S,L	Mead and Kramer 1982(MD/NJ/PA)
Melanoliarus humilis (Say, 1830)	S	S,L	L	S,L	L	Mead and Kramer 1982(NJ/PA)
Melanoliarus montanus (Metcalf, 1923)	S	S,L	S	S,L		Mead and Kramer 1982
Melanoliarus placidus Van Duzee, 1912	S	S,L	S,L	S	L	Mead and Kramer 1982
Melanoliarus quinquelineatus (Say, 1830)	S	S,L	S,L	S,L		Mead and Kramer 1982
Melanoliarus sablensis (Caldwell, 1951)	S	S,L	S,L	S,L	L	Mead and Kramer 1982(MD/NJ/PA)
Melanoliarus near sablensus	S	S		S		
Melanoliarus spp. females	S	S		S		
Pentastiridius cinnamomeus (Provancher, 1889)	S		L	L		Kramer 1981
Oecleus borealis Van Duzee, 1912		S,L	S,L	S,L	S	
Oecleus productus Metcalf, 1923	S	S,L				
Pintalia delicata (Fowler, 1904)		S,L				
Pintalia vibex Kramer, 1981	S	S,L				Kramer 1981
Derbidae						
Anotia bonnetii Kirby, 1821			L			
Anotia burnetii Fitch, 1856				L		
Anotia fitchi (Van Duzee, 1893)				L		
Anotia kirkaldyi Ball, 1902	S			S,L		
Anotia robertsonii Fitch, 1856	S		L	L		
Anotia westwoodi Fitch, 1856	S	S	L	S,L	S	
Apache degeerii (Kirby, 1821)	S	S,L	S,L	S,L		
Cedusa carolinensis Flynn & Kramer, 1983	S	S,L			S	Flynn and Kramer 1983
Cedusa cedusa McAtee, 1924		S,L			S	Flynn and Kramer 1983
Cedusa chuluota Ball, 1928			S,L			Flynn and Kramer 1983

Species	DE	MD	NJ	PA	DC	References and comments
Cedusa edentula (Van Duzee, 1912)		S	L		S	Flynn and Kramer 1983
Cedusa gedusa McAtee, 1924		S,L	S,L	S,L		Flynn and Kramer 1983
Cedusa hedusa McAtee, 1924		S,L				Flynn and Kramer 1983
Cedusa incisa (Metcalf, 1923)		S		S,L		Flynn and Kramer 1983
Cedusa kedusa McAtee, 1924	S	S,L	S,L		S	Flynn and Kramer 1983
Cedusa maculata (Van Duzee, 1912)		S,L		S,L		Flynn and Kramer 1983
Cedusa mallochi McAtee, 1924	S	L				Flynn and Kramer 1983
Cedusa obscura(Ball, 1902)		S,L	S,L		S	Flynn and Kramer 1983
Cedusa redusa McAtee, 1924	S	S,L				Flynn and Kramer 1983
Cedusa shawi Flynn & Kramer, 1983		S,L				Flynn and Kramer 1983
Cedusa vulgaris (Fitch, 1851)	S	S,L				Flynn and Kramer 1983
Cedusa spp. Females	S	S		S		
Neocenchrea heidemanni (Ball, 1902)	S	L	L		L	
Omolicna uhleri (Ball, 1902)		L	L		L	
Otiocerus amyotii Fitch, 1856			L	L	L	
Otiocerus coquebertii Kirby, 1821	S	L	L	S,L		
Otiocerus francilloni Kirby, 1821	S		L			
Otiocerus reaumurii Kirby, 1821	S					
Otiocerus signoretii Fitch, 1856		S	L	L		
Otiocerus stollii Kirby, 1821		S	L	L		
Otiocerus wolfii Kirby, 1821	S	S,L	L	S,L		
Patara vanduzei Ball, 1902	S	S		L		
Shellenius ballii (McAtee, 1923)		S,L				
Shellenius schellenbergii (Kirby, 1821)			L			
Sikaiana harti (Metcalf, 1923)	S	S				
Dictyopharidae						
Mitrops dioxys (Walker, 1858)		L	L			
Phylloscelis atra Germar, 1839		L	L	S,L	L	
Phylloscelis pallescens Germar, 1839		L	L	L		
Phylloscelis rubra Ball, 1930			S,L			
Rhynchomitra lingula (Van Duzee, 1908)	S	S	S,L			
Rhynchomitra microrhina (Walker, 1851)	S	S	L	S		
Scolops angustatus Uhler, 1929	S	S,L	S,L		L	
Scolops grossus Uhler, 1876			L?			Record probably in error.
Scolops perdix Uhler, 1900	S	L	S,L	S	L	
Scolops pungens (Germar, 1830)	S	L	S,L	L	L	
Scolops sulcipes (Say, 1825)	S	S,L	S,L	S,L	L	
Flatidae						
Flatormenis chloris (Melichar, 1902)	S	S,L	S,L	S,L	L	*Anormenis septentrionalis* auct. (nec. Spinola, 1839) synonymized with *A. chloris* by O'Brien 1985: 657-660, and transferred to *Flatormenis* by Medler 2003: 593.

Species	DE	MD	NJ	PA	DC	References and comments
Cyarda melichari Van Duzee, 1907					L	Species needs confirmation.
Metcalfa pruinosa (Say, 1830)	S,L	S,L	S,L	S,L	L	
Ormenoides venusta (Melichar, 1902)	S	S	S	S	S	
Fulgoridae						
Cyrpoptus belfragei Stål, 1869	S	L				
Poblicia fuliginosa (Olivier, 1791)		S				
Issidae						
Exortus punctiferus (Walker, 1851)			L			Originally reported by Smith (1890) as *Issus aciculatus* Uhler, 1876, possibly in error.
Thionia bullata (Say, 1830)	S	S	S,L	S,L	S,L	
Thionia elliptica (Germar, 1830)		S	L		L	
Thionia simplex (Germar, 1830)	S	S,L	S,L	S	L	
New records*	55	22	5	8	21	
Total species*	62	88	74	60	46	

*Unidentified females and errors excluded, *Melanoliarus* near *sablensus* included with *M. sablensus*, 2 species of *Omolicna* counted for Delaware.

Table 3. Planthoppers reported by Zuefle (2006) collected in Delaware by host sampled 2004–2005. Host species were segregated into 3 categories; **1** Native woody plants **2** Non-native plants congeneric with US species; and **3** "Alien" woody plants - those with no US congeners. The *Melanoliarus* species were reported as '*Oliarus sablensis*', but voucher specimens in the UDCC were found to be mostly *Melanoliarus ecologus* with a few *M. sablensis*.

		Planthopper species		
Plant Family	Plant species	*Melanoliarus* spp.	*Flatormenis chloris*	*Thionia simplex*
Native				
Aceraceae	*Acer rubrum*	0	0	0
Betulaceae	*Betula nigra*	0	2	0
Betulaceae	*Carpinus caroliniana*	2	0	0
Cornaceae	*Cornus florida*	0	0	0
Fagaceae	*Fagus grandifolia*	0	0	0
Hamamelidaceae	*Hamamelis virginiana*	0	0	0
Juglandaceae	*Juglans nigra*	4	0	0
Moraceae	*Morus rubra*	6	0	0
Rosaceae	*Prunus serotina*	0	2	0
Ericaceae	*Rhododendron periclymenoides*	7	0	0
Rosaceae	*Rosa carolina*	2	0	0

Plant Family	Plant species	Planthopper species		
		Melanoliarus spp.	*Flatormenis chloris*	*Thionia simplex*
Salicaceae	*Salix nigra*	1	1	1
Tiliaceae	*Tilia americana*	1	0	0
Ulmaceae	*Ulmus americana*	0	0	0
Caprifoliaceae	*Viburnum dentatum*	8	0	0
	Subtotal	31	5	1
Non-native congeneric plants				
Aceraceae	*Acer platanoides*	0	2	0
Betulaceae	*Betula pendula*	3	0	0
Betulaceae	*Carpinus betulus*	0	0	0
Cornaceae	*Cornus kousa*	2	0	0
Fagaceae	*Fagus sylvatica*	3	0	0
Hamamelidaceae	*Hamamelis mollis*	2	0	0
Juglandaceae	*Juglans regia*	2	0	0
Moraceae	*Morus alba*	0	0	0
Rosaceae	*Prunus serrulata*	1	1	0
Ericaceae	*Rhododendron mucronatum*	42	0	0
Rosaceae	*Rosa multiflora*	7	1	0
Salicaceae	*Salix babylonica*	0	0	0
Tiliaceae	*Tilia cordata*	2	0	0
Ulmaceae	*Ulmus parvifolia*	2	5	0
Caprifoliaceae	*Viburnum dilatatum*	14	2	0
	Subtotal	80	11	0
Alien plants				
Lardizabalaceae	*Akebia quinata*	9	0	0
Fabaceae	*Albizia julibrissin*	5	1	0
Rosaceae	*Cotoneaster lucidus*	16	2	0
Fabaceae	*Cytisus scoparius*	9	1	0
Oleaceae	*Forsythia suspensa*	10	0	0
Ginkgoaceae	*Ginkgo biloba*	1	0	0
Araliaceae	*Hedera helix*	6	0	0
Sapindaceae	*Koelreuteria paniculata*	1	0	0
Lythraceae	*Lagerstroemia indica*	5	0	0
Oleaceae	*Ligustrum vulgare*	6	1	0
Scrophulariaceae	*Paulownia tomentosa*	1	0	0
Rutaceae	*Phellodendron amurens*	0	0	0
Rutaceae	*Poncirus trifoliata*	1	0	0
Rosaceae	*Pyrus pashia*	4	0	0
Oleaceae	*Syringa vulgaris*	1	0	1
	Subtotal	75	5	1
	Total	**186**	**21**	**2**

Systematics

Artificial key to genus and select planthopper species from Delaware and vicinity.

1 Hind tibiae with large movable spur at apex (Fig. 2A)..... **Delphacidae**
– Hind tibiae without movable spur at apex (e.g., Figs 2B–D)..... **2**
2 Second tarsomere of hind legs with row of apical spines (Fig. 2E)..... **3**
– Second tarsomere of hind legs with one apical spine on each side (Fig. 2F) or spines absent..... **7**
3 Larger species, greater than 10 mm, with patterned forewings (Figs 3H, I); hindwings with numerous cross veins near apex and in anal area; uncommon in study area ..... **Fulgoridae, 71**
– Mostly smaller species, forewings variable; hindwings without cross veins near apex or in anal area..... **4**
4 Forewings overlapping posteriorly (Figs 4G–L, 5F–L, 6F–H), trailing margins angled; body flattened ..... **Achilidae, 13**
– Forewings not overlapping posteriorly; body variable..... **5**
5 Beak with apical segment subequal in length and width (except *Cedusa*); forewings often with tubercles on claval veins (Figs 8G, 9B); antennae may bear projections (Figs 10E, F) or subtended by a shelf-like structure (Figs 10A–D); median carina of frons often absent; parameres of male much longer than pygofer ..... **Derbidae (most), 41**
– Beak with apical segment longer than wide; forewings without tubercles on claval veins (or with tubercles on all veins); antennae never bearing projections or subtended by a shelf-like structure; median carina of frons present; parameres of male shorter than length of pygofer..... **6**
6 Frons with two or three median carinae and/or head with elongate anterior projection (Figs 13–14); median ocellus absent; wing vein tubercles usually absent ..... **Dictyopharidae, 60**
– Frons with one median carina; head not elongate; median ocellus usually present above frontoclypeal suture (Figs 6D–E, 7B, H); usually with tubercles on veins of wings ..... **Cixiidae, 35**
7 Forewings with tubercles on claval veins (e.g., Figs 8G, 9B), if tubercles present in claval area (Figs 3D–G) then forewings waxy with row of many small peripheral cells; beak with apical segment subequal in length and width; frons often compressed with median carina absent (Figs 10B, D, G); parameres much longer than pygofer..... **Derbidae (few), 41**
– Forewings without tubercles on claval veins (or with tubercles on all veins); beak with apical segment longer than wide; frons not compressed, median carina generally present (e.g., Figs 12, 15A–D); parameres shorter than length of pygofer **8**
8 Forewings waxy, bearing tubercles between veins on clavus (Figs 3D–G) and with numerous costal crossveins..... **Flatidae, 68**

Figure 2. Hind legs of planthoppers. **A** Delphacidae, tibia with calcar **B** Acanaloniidae, tibia without spines **C** Caliscelidae, tibia with 1 spine **D** Issidae, tibia with 2 spines **E** Dictyopharidae, second tarsal segment with row of teeth **F** Acanaloniidae, second tarsal segment with pair of spines.

– Forewings not waxy, without tubercles on clavus; without numerous costal crossveins (e.g., Figs 3A–C, 15E–H) **9**

9 Hind tibiae without lateral spines (Fig. 2B); forewings with reticulate venation, usually extending to apex of abdomen (even in brachypters); usually green (occasionally pink) (Figs 3A–C) ..... **Acanaloniidae, 11**

– Hind tibiae with lateral spines (Figs 2C–D); forewing venation not reticulate (Figs 15E–H), brachypters may have forewings short (Fig. 11), exposing several segments in dorsal view; color not green, usually brown, black, or straw (pinkish in males of 1 species) **10**

10 Usually brachypterous with forewings shorter than abdomen (Fig. 11); frons with sublateral carinae bordering a large disc-like or elongate areolet, sublateral carinae of frons meeting ventrally (or nearly so) (Fig. 12); hind tibiae with single lateral spine (Fig. 2C) ..... **Caliscelidae, 26**

– Forewings covering abdomen (both brachypters and macropters) (Figs 15E–H); frons with median carina, with or without sublateral carinae; if present, not meeting ventrally (Figs 15A–D); hind tibiae with two lateral spines (Fig. 2D) ..... **Issidae, 72**

Acanaloniidae

11 Body green (rarely pink) with conspicuous brownish to reddish marking along lateral portions of thoracic nota (Fig. 3B), continuing onto wings ..... ***Acanalonia bivittata***

– Body uniformly green (rarely pink) (Figs 3A, C); may have middorsal vitta on thorax **12**

12 Head distinctly produced conically (Fig. 3A); without prominent median carina across vertex and thorax; abundant in Mid-Atlantic states ..... ***Acanalonia conica***

– Head not produced conically (Fig. 3C); with prominent median carina across vertex and thorax; southeastern species occasional in Mid-Atlantic States ..... ***Acanalonia servillei***

Achilidae

13 Head, including eyes, less than 2/3 as wide as pronotum (Figs 5F–J) (Myconini) ..... ***Cixidia*, 14**

– Head including eyes at least 2/3 as wide as pronotum (Figs 4G–L, 6F–H) (Plectoderini) **18**

14 Clypeus and upper half of frons dark brown or black, strongly contrasting with pale lower half of frons (Fig. 5B) ..... ***Cixidia opaca***

– Frons more uniformly colored, upper half not strongly contrasting (Figs 5A, C–E) **15**

15 Vertex short, projecting in front of eye for distance less than length of eye (Fig. 5J); frons distinctly and uniformly speckled (Fig. 5E) ... ***Cixidia variegata***

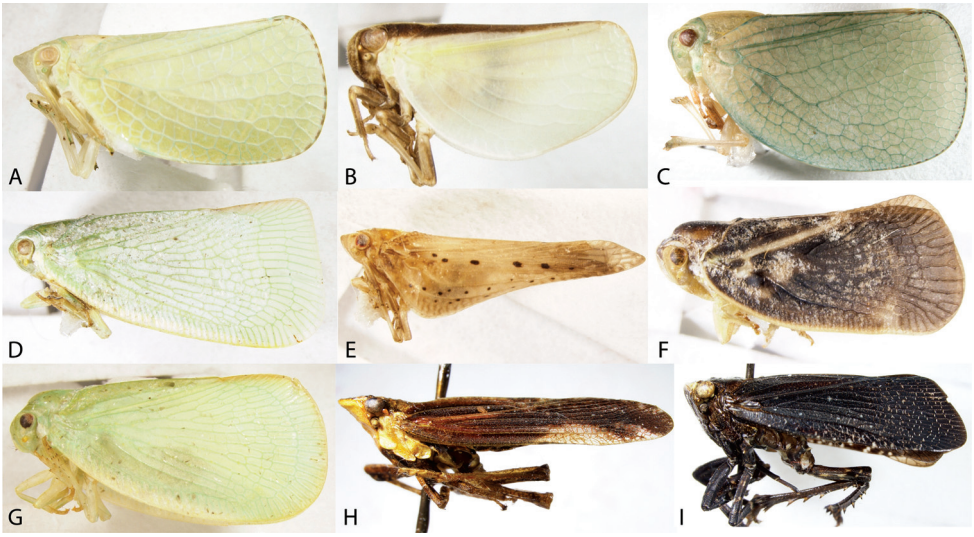


Figure 3. Lateral habitus of Acanaloniidae, Flatidae, and Fulgoridae. **A** *Acanalonia conica* **B** *A. bivittata* **C** *A. servillei* **D** *Flatormenis chloris* **E** *Cyarda* sp. **F** *Metcalfa pruinosa* **G** *Ormenoides venusta* **H** *Cyrpoptus belfragei* **I** *Poblicia fuliginosa.*

– Vertex elongate, projecting in front of eye for distance equal to or greater to length of eye; frons more uniformly colored (Figs 5A, C).....**16**

16 Frons and clypeus uniformly colored (Fig. 5D)..... ***Cixidia septentrionalis***

– Clypeus distinctly darker than frons (Figs 5A, C).....**17**

17 Vertex projected in front of eye for distance greater than eye length, vertex 1.3–1.5× as long as basal width (Fig. 5F); frons and clypeus about as dark as pronotum; forewings nearly uniform brown .....***Cixidia fusca***

– Vertex projected in front of eye for distance about equal to eye length, vertex length about equal (1–0.95x) to basal width (Fig. 5H); frons and clypeus paler than pronotum; forewing variegated with grayish white .... ***Cixidia pallida***

18 Subcostal cell of forewing longer than 1/3 length of forewing, narrow throughout (Fig. 16B); medioventral lobe of male pygofer entire (Fig. 16G)..... ..... ***Synecdoche*, 19**

– Subcostal cell of forewing about 1/3 length of forewing, wider before its apex (Fig. 16A); medioventral lobe of male pygofer apically bifurcate (Fig. 16F)... .....***Catonia*, 21**

19 Frons entirely pale (Fig. 6B)..... ***Synecdoche grisea***

– Frons with dark transverse bands or all dark (Figs 6A, C).....**20**

20 Frons with dark bands (Fig. 6C) .....***Synecdoche impunctata***

– Frons uniformly dark, contrasting with pale clypeus (Fig. 6A) .... ***Synecdoche dimidiata***

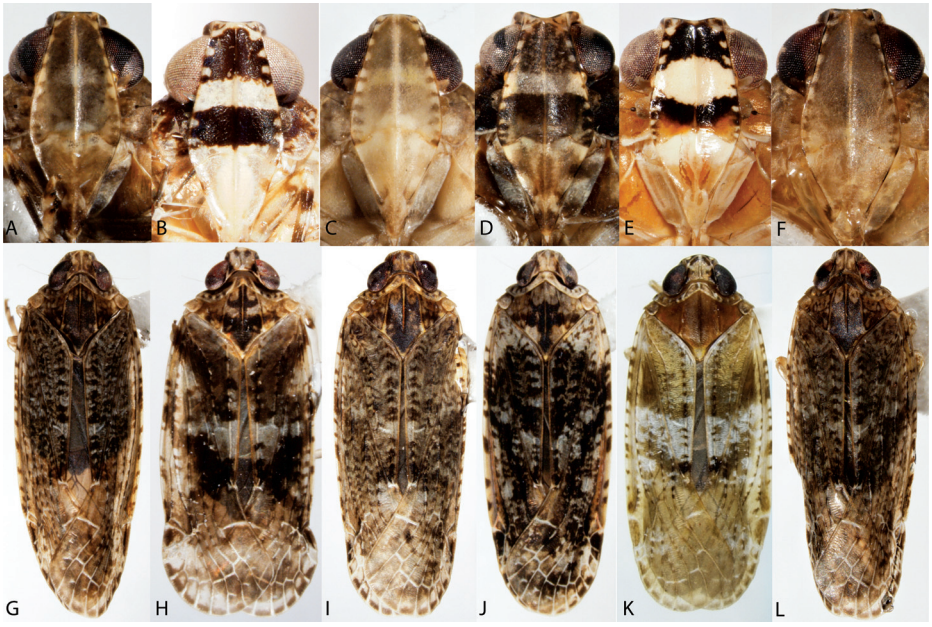


Figure 4. Habitus of *Catonia* (Achilidae) (**A–F** frons, **G–K** dorsal view). **A, G** *Catonia carolina* **B, H** *C. cinctifrons* **C, I** *C. lunata* **D, J** *C. nava* **E, K** *C. picta* **F, L** *C. pumila*.

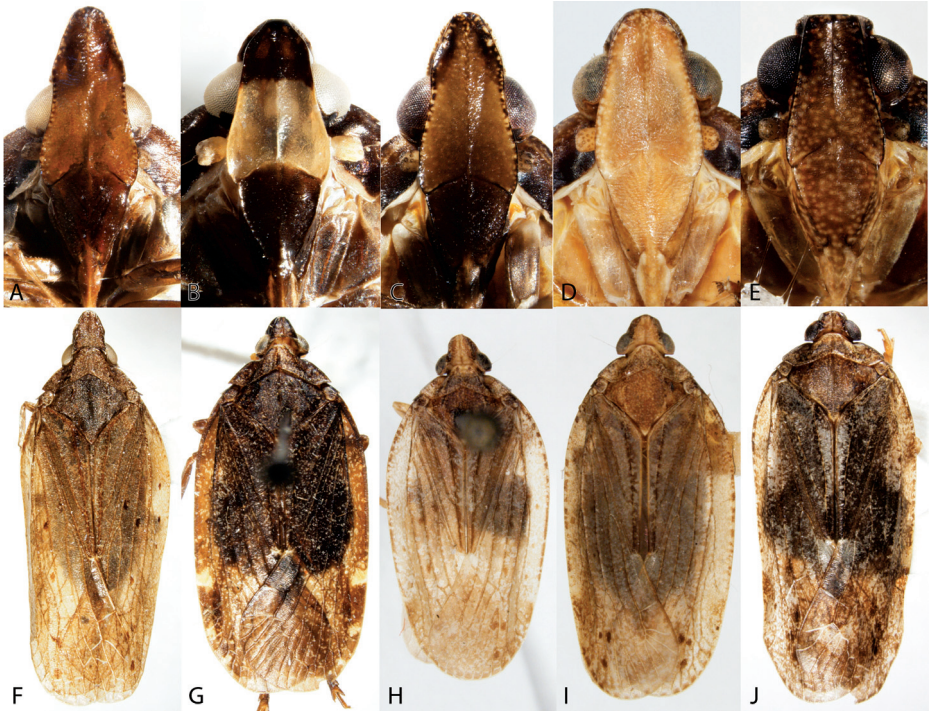


Figure 5. Habitus of *Cixidia* (Achilidae) (**A–E** frons, **F–J** dorsal view). **A, F** *Cixidia fusca* **B, G** *C. opaca* **C, H** *C. pallida* **D, I** *C. septentrionalis* **E, J** *C. variegata.*

21 Upper dark band of frons mottled, distinctly paler than lower band (Fig. 4D); larger species usually more than 5.8 mm ..... ***Catonia nava***

– Frons, if banded (Figs 4A–C, E), with upper dark band not mottled and not paler than lower, or frons not dark banded (Fig. 4F); size less than 6.2 mm **22**

22 Frons with two very dark transverse bands (Figs 4B, E) **23**

– Frons pale with pale bands, or uniformly pale (Figs 4A, C, F) **24**

23 Lower dark band distinctly paler near frontoclypeal suture giving frons a tri-colored appearance (Fig. 4E); body often with orangish cast ... ***Catonia picta***

– Lower dark band uniformly dark (Fig. 4B); body brown or grayish..... ..... ***Catonia cinctifrons***

24 Pale transverse marking at frontoclypeal suture not reaching lateral margin of frons (Figs 4A, C) **25**

– Frons uniformly colored or pale transverse marking at frontoclypeal suture extending to lateral margin of frons (Fig. 4F) ..... ***Catonia pumila***

25 Pale transverse marking at level of ocelli complete, reaching lateral margin of frons (Fig. 4C) ..... ***Catonia lunata***

– Pale transverse marking at level of ocelli incomplete, not reaching lateral margin of frons (Fig. 4A) ..... ***Catonia carolina***

Caliscelidae

26 Head produced into weevil-like snout (Figs 11E–H); usually black..... **30**

– Head not produced (Fig. 11A–D); paler ..... ***Aphelonema*, 27**

27 Vertex very broad, width at least 5–6× median length (Figs 12A, D); frons greatly exposed above, fastigium rounded when viewed laterally; mostly straw to pink colored (Figs 11A, D), may have darker wings and abdomen..... **28**

– Vertex longer, width 2–3× median length, frons not as exposed from above (Figs 12B–C); fastigium angled when viewed laterally; mostly black and pale colored (Figs 11B–C) **29**

28 Head and thorax orange-tan, rest of dorsum blackish brown (Fig. 11A, especially in males); central frontal tablet of frons pointed below (Fig. 12A); found mostly in the southeast, reported from NJ ..... ***Aphelonema decorata***

– Uniformly pale ochreous (females) to pink (most males) in color (Fig. 11D); central frontal tablet of frons almost circular (Fig 12D) .... ***Aphelonema simplex***

29 When viewed from the side, fastigium of head produced forward, frons slanted; vertex somewhat triangular (Fig. 11B) ..... ***Aphelonema histrionica***

– When viewed from the side, fastigium not produced, frons not slanted; vertex broadly rounded anteriorly (Fig. 11C) ..... ***Aphelonema rugosa***

30 Middle and front tibiae expanded ..... ***Fitchiella robertsonii***

– Middle and front tibiae not expanded..... ***Bruchomorpha*, 31**

31 Dorsal light stripe broad and conspicuous, extending from near apex of face to apex of forewings or beyond ..... ***Bruchomorpha sp. n.***

– Dorsal light stripe not broad and conspicuous, generally of lesser extent ... **32**

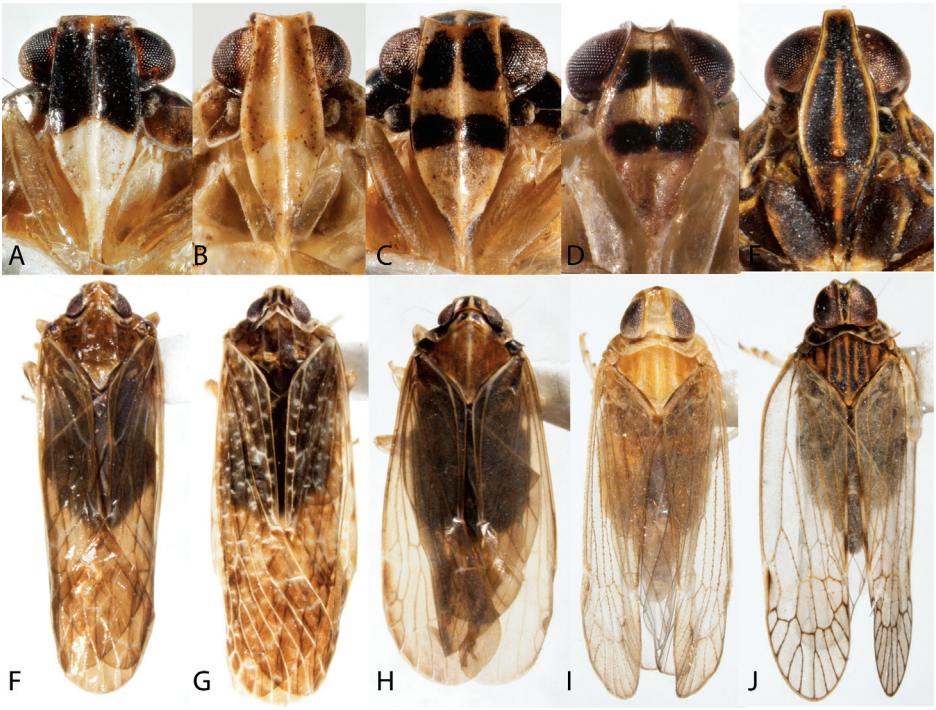


Figure 6. Habitus of *Synecdoche* (Achilidae), *Haplaxius* and *Oecleus* (Cixiidae) (**A–F** frons, **F–J** dorsal view). **A, F** *Synecdoche dimidiata* **B, G** *S. grisea* **C, H** *S. impunctata* **D, I** *Haplaxius pictifrons* **E, I** *Oecleus borealis.*

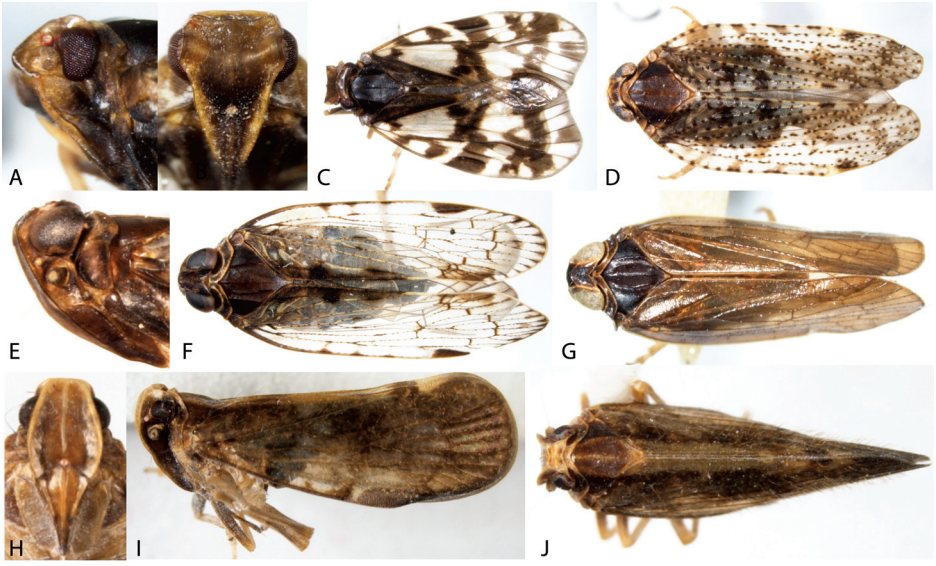


Figure 7. Habitus of Cixiidae. **A** *Bothriocera cognita*, head, lateral view **B** same, frons **C** same, dorsal view **D** *Cixius pini*, dorsal view **E** *Melanoliarus placidus*, head, lateral view **F** same, dorsal view **G** *Pentastiridius cinnamomeus*, dorsal view **H** *Pintalia vibex*, frons **I** same, lateral view **J** same, dorsal view.

32 Nasal process distinctly pronounced, head concave ventrally in lateral view (Fig. 11F); in dorsal view extending anteriorly beyond eye for a distance equal or greater than length of eye.....***Bruchomorpha oculata***

– Nasal process less pronounced, head weakly convex ventrally; in dorsal view extending anteriorly beyond eye for a distance less than length of eye (Figs 11E, G–H).....**33**

33 Reddish-brown in color with a dark spot on clypeus..***Bruchomorpha jocosa***

– Uniformly black, usually with light stripe on vertex (sometimes reaching thorax).....**34**

34 Legs pale (Fig 11G); small species, less than 2.6 mm.....
.....***Bruchomorpha pallidipes***

– Legs dark (Fig 11H); large species, more than 2.6 mm.....***Bruchomorpha tristis***

Cixiidae

35 Antennae arising from elongated cup-like cavities anterior to eyes (Fig. 7A)..
.....***Bothriocera***

– Antennae not within cup-like cavities, arising below eyes (Fig. 7E, 7I).....**36**

36 Hind tibiae without spines (similar to Fig. 2B).....**37**

– Hind tibiae with one or more spines along axis before apex (similar to Figs 2C–D).....**38**

37 Mesonotum with 5 carinae; crown strongly narrowed (Fig. 6J).....***Oecleus***

– Mesonotum with 3 carinae; crown slightly narrowed (Fig. 6I) .....***Haplaxius***

38 Mesonotum with 5 longitudinal carinae (although intermediate pair sometimes obsolete); posterior margin of crown angularly incised (Figs 7F–G)...
.....**39**

– Mesonotum with 3 carinae; posterior margin of crown quadrately or roundly incised (Figs 7D, J).....**40**

39 Apex of basitarsus of hind leg with 12 teeth.....***Pentastiridius***

– Apex of basitarsus of hind leg with no more than 10 teeth.....***Melanoliarus***

40 Forewings roof-like in position with distal portions clearly separated (Fig. 7D); spines on hind tibiae conspicuous.....***Cixius***

– Forewings vertical in position with distal portions oppressed (Figs 7I–J); spines on hind tibiae inconspicuous.....***Pintalia***

Derbidae

41 Clavus open (Figs 16C–D; combined anal veins reaching posterior cubitus and usually curved to follow wing margin); most taxa with head projecting well beyond eyes in lateral view (e.g., Figs 10E–F); frons very narrow (Fig. 10G); forewings twice as long as body or more, delicate appearing (Otiocerinae: Otiocerini and Sikaianini).....**42**

– Clavus closed (Fig. 16E; combined anal veins reaching wing margin within claval area); most taxa with head projecting only slightly beyond eyes

Figure 8. Lateral habitus of Derbidae I. **A** *Anotia bonnetii* **B** *A. kirkaldyi* **C** *A. robertsonii* **D** *A. westwoodi* **E** *Apache degeerii* **F** *Neocenchrea heidemanni* **G** *Patara vanduzei* **H** *Sikaiana harti* **I** *Anotia fitchi* **J** *Anotia westwoodi*, head lateral view; **K** *Sayiana sayi*, head lateral view.

(Figs 10A, C); frons usually not as narrow (Figs 10B, D) (except *Patara*, see Fig. 8G); forewings not as long, most taxa less delicate (Otiocerinae: Patarini; Cedusinae; and Derbinae: Cenchreini) **57**

42 Antennae with 2 or 3 conspicuous appendages (Figs 10E–F) **43**

– Antennae lacking appendages (Figs 8J, 10G) **51**

43 General color uniformly rose or reddish (Fig. 8E); head in lateral view with vertex distinctly concave in apical third and apex pointed (Fig. 10F); dorsal margin of wings in repose sharply angled upward in apical third; forewings with dusky spots in cells..... ***Apache degeerii***

– General color white or yellow (e.g., Figs 9D–J), although red markings may be present; head in lateral view with vertex rounded (Fig. 9I, J, 16H, I), or nearly flat (Fig. 10E); dorsal margin of wings straight or curved slightly upward **44**

44 In lateral view, demarcation between vertex and frons obtusely angular (Fig. 10E) ..... ***Otiocerus*, 46**

– In lateral view, demarcation between vertex and frons smoothly rounded (Figs 9I, J; 16H–I) ..... ***Shellenius*, 45**

45 Head in lateral view 1.5× as long as broad (Figs 9J, 16I); forewing brownish apically in trailing portion of wing; red markings reduced or absent .... ***Shellenius schellenbergii***

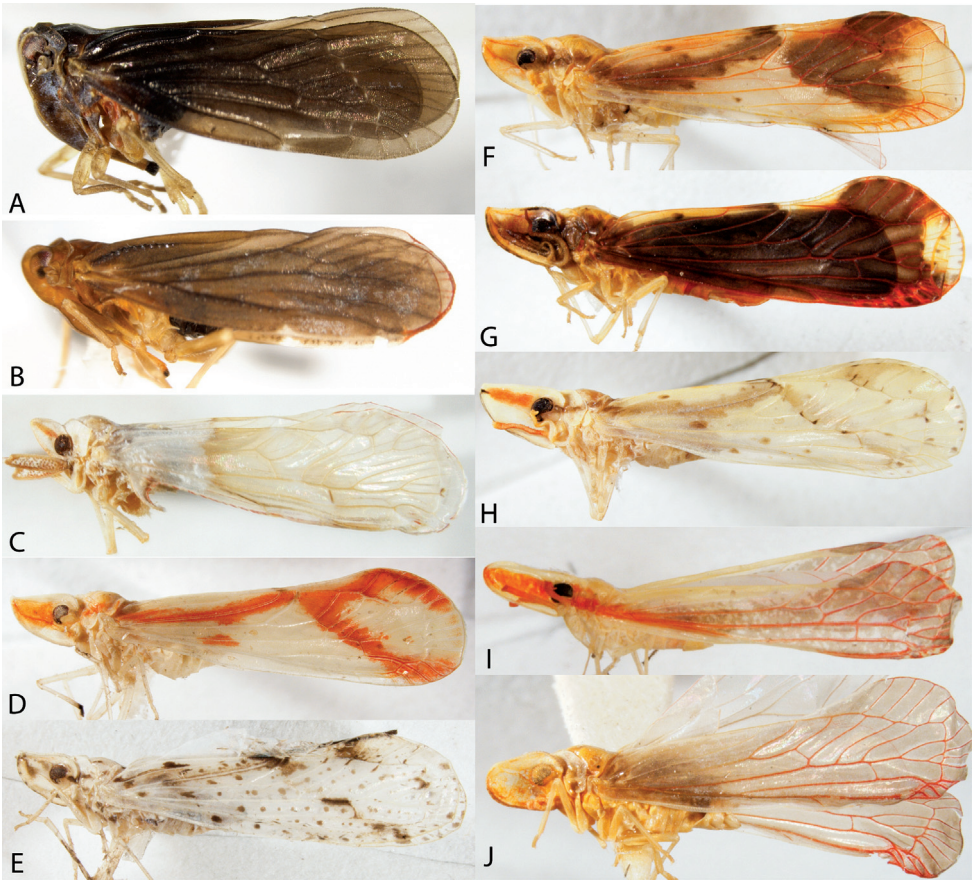


Figure 9. Lateral habitus of Derbidae II. **A** *Cedusa* sp. **B** *Omolicna* sp. **C** *Sayiana sayi* **D** *Otiocerus coquebertii* **E** *O. francilloni* **F** *O. reaumurii* **G** *O. stollii* **H** *O. wolfii* **I** *Shellenius balli* **J** *S. schellenbergii*.

– Head in lateral view 2.0× as long as broad (Figs 9I, 16H); forewings with very pale brown markings widely distributed; with red markings on head and wing ..... ***Shellenius balli***

46 Wings with conspicuous round dusky spots in cells (Figs 9E, F, H) **47**

– Wings without conspicuous round dusky spots in cells (Figs 9D, G) **50**

47 Apical margin of forewings with a row of spots in the cells (Figs 9E, H) ... **48**

– Spots not in row within apical cells (Fig. 9F) **49**

48 Apex of head with a black line laterally followed by a broader red line (Fig. 9H); forewings with spots throughout ..... ***Otiocerus wolfii***

– Apex of head without a black line laterally (Fig. 9E); forewings with spots mostly in proximal half..... ***Otiocerus francilloni***

49 Forewings with a large black spot on the sutural margin (in the clavus) and four smaller ones in a square, including 1 in costal cell.... ***Otiocerus signoretii***

– Forewings with spots arranged differently from above (Fig. 9F) .... ***Otiocerus reaumurii***

50 Color of the wings dark, without distinct band (Fig. 9G) ... ***Otiocerus stollii***
– Color of the wings pale with distinct reddish forked band (Fig. 9D)..... ..... ***Otiocerus coquebertii***
51 In lateral view, head projecting in front of eyes for a distance of less than half width of eyes; forewings with scattered spots..... ***Sikaiana harti***
– In lateral view, head projecting in front of eyes for a distance subequal to width of eyes (Fig. 8J); color mostly following veins .....***Anotia*, 52**
52 Costa narrow; forewings with veins not crowded together to give appearance of a stigma (Figs 8A–D); some or most veins of forewings with smoky borders.....**53**
– Costa broader; Sc and R vein tips crowded together to give appearance of a stigma (Fig. 8I); forewings more extensively marked with fuscous .....***Anotia fitchi***
53 First 3 segments of abdomen with middorsal black stripe ....***Anotia burnetii***
– Abdomen without middorsal black stripe **54**
54 Forewings mostly pale with a few fuscous marked crossveins (Fig. 8C); apex of forewing without dark round spots..... ***Anotia robertsonii***
– Forewings more extensively marked; most veins with smoky borders (Figs 8B, D); apex of forewing often with dark round spots.....**55**
55 Head with a single marking, below antennae; apical border of forewings with four dark round spots in the cells (Fig. 8A) ..... ***Anotia bonnetii***
– Head with dark or red markings above and below antennae; apical border of forewings usually without round spots in the cells.....**56**
56 At least some veins dark in color (Fig. 8B) .....***Anotia kirkaldyi***
– All veins pale (Fig. 8D) .....***Anotia westwoodi***
57 Antennae terete, subtended by flattened subantennal process from gena or anterior portion of lateral margin of pronotum (Figs 10A–D), often strongly modified into a reversed "c" (in lateral view) directly behind antennae, or strongly keeled; face not strongly compressed, frons evident; clavus at least half as long as whole forewing (Derbinae: Cenchreini, and Cedusinae).....**58**
– Second segment of antennae flattened (more evident in males than females), antennae not subtended by process; lateral margin of pronotum not strongly modified; face strongly compressed, frons keel-like (similar to Fig. 10G); clavus less than half as long as whole forewing (Fig. 9C) (Otiocerinae: Patarini)..... .....***Patara vanduzei***
58 Subantennal process large, extending from gena, completely subtending antennae as a shelf (Fig. 10A); reduced (or absent) sensory pits on head and wings; color uniform, near black or deep grey (Fig. 9A), infrequently near white with yellowish brown patches (Cedusinae) ..... ***Cedusa***
– Subantennal process extending from pronotum, smaller (Fig. 10C); lateral carinae of vertex and second claval vein with sensory pits; color usually orange to pale (Figs 8F, 9B) (Derbinae: Cenchreini).....**59**
59 Media with more than two branches, connected to cubitus by crossvein; size less than 6 mm, usually distinctly orangish (Fig. 9B)..... ***Omolicna***

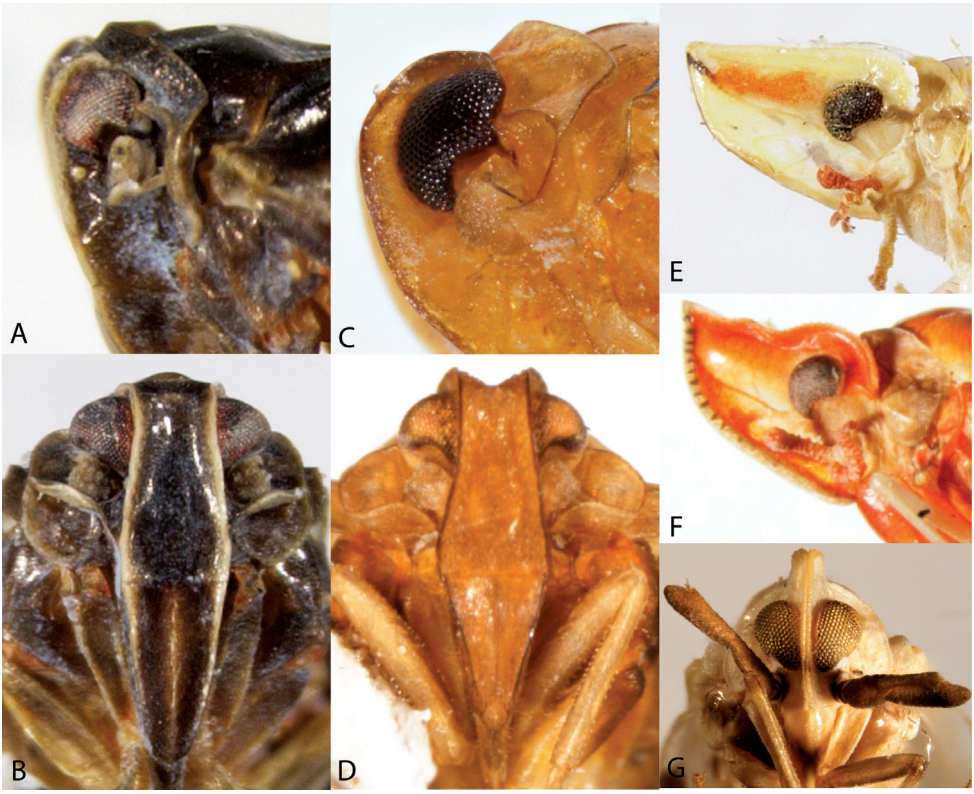


Figure 10. Heads of Derbidae. **A** *Cedusa* sp. lateral view **B** *Cedusa* sp., frontal view **C** *Omolicna* sp., lateral view **D** *Omolicna* sp., frontal view **E** *Otiocerus wolfi*, lateral view **F** *Apache degeerii*, lateral view **G** *Anotia robertsonii*, frontal view.

– Media and cubitus each with two branches, not connected by crossveins; size over 7 mm; color orangish white (Fig. 8F) ..... ***Neocenchrea heidemanni***

Dictyopharidae

60 Head projected in front of eyes (Figs 13, 14G, H); front femora not foliaceous.....**63**

– Head not projected in front of eyes (Figs 14A–F); front femora foliaceous.... .....***Phylloscelis*, 61**

61 Eight or fewer longitudinal veins on the forewing; color either uniformly black to dark brown in dorsal view or yellowish body with reddish-brown forewings with prominent yellow wing veins (Figs 14C, F); carinae of frons indistinct .....***Phylloscelis atra***

– With more than 8 longitudinal veins; color not as above; carinae of frons distinct (Figs 14A–B, D–E) **62**

62 Veins concolorous with forewings; body black to light reddish brown (Fig. 14D)..... ***Phylloscelis rubra***

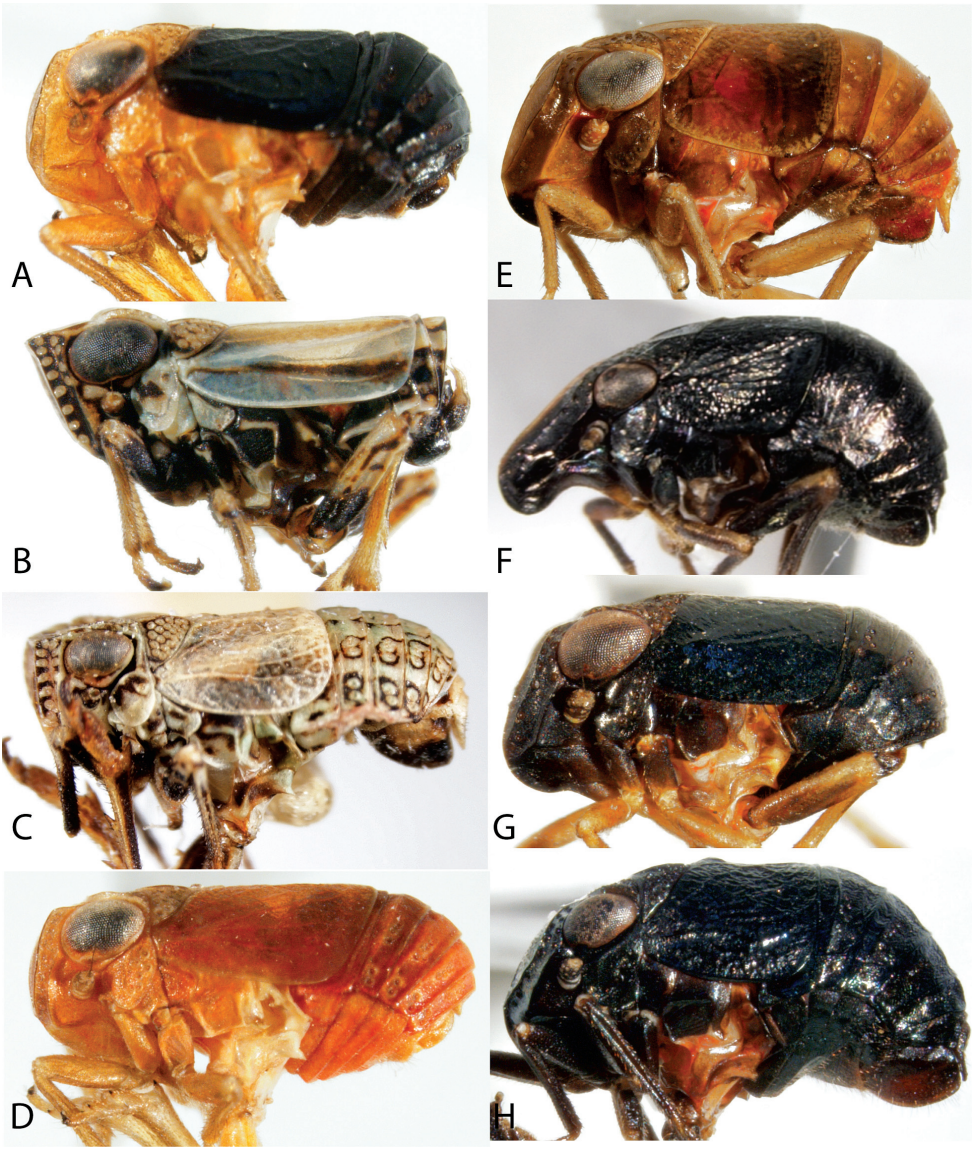


Figure 11. Lateral view of Caliscelidae. **A** *Aphelonema decorata* **B** *A. histrionica* **C** *A. rugosa* **D** *A. simplex* **E** *Bruchomorpha jocosa* **F** *B. oculata* **G** *B. pallidipes* **H** *B. tristis*.

– Veins of forewings dark mottled with pale; body light grey-brown (Fig. 14E)... ..... ***Phylloscelis pallescens***

63 Forewings clear, macropterous; head projection anterior to eyes subequal in width to vertex; body green (Figs 14G–H)..... ***Rhynchomitra*, 64**

– Forewings patterned, usually brachypterous; head projection anterior to eyes narrower than vertex; body brownish (Fig. 13)..... ***Scolops*, 65**

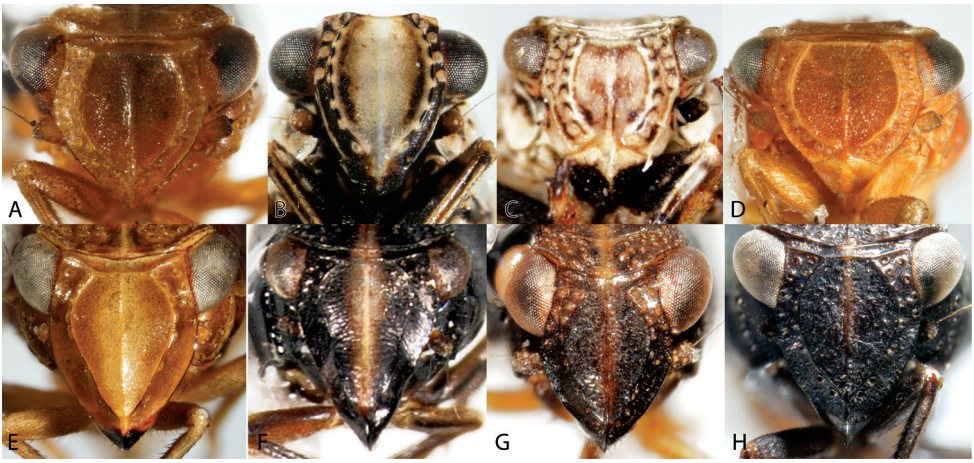


Figure 12. Frontal view of Caliscelidae. **A** *Aphelonema decorata* **B** *A. histrionica* **C** *A. rugosa* **D** *A. simplex* **E** *Bruchomorpha jocosa* **F** *B. oculata* **G** *B. pallidipes* **H** *B. tristis*.

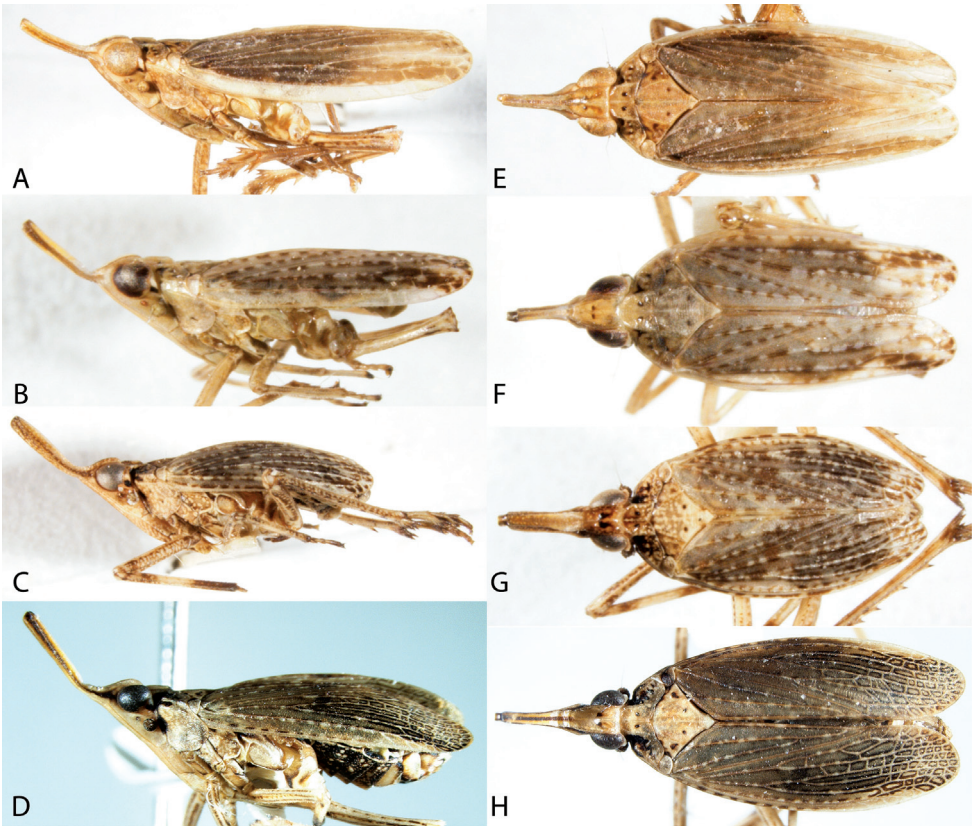


Figure 13. Habitus of *Scolops* (Dictyopharidae). **A, E** *Scolops angustatus* **B, F** *S. perdix* **C, G** *S. pungens* **D, H** *S. sulcipes*.

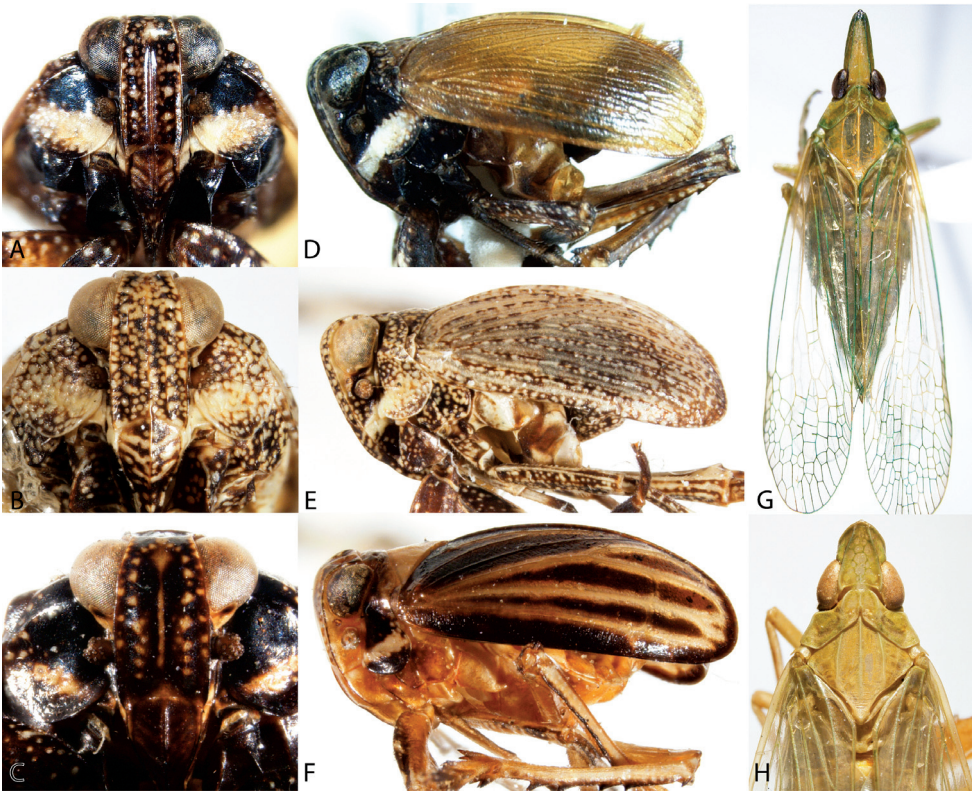


Figure 14. *Phylloscelis* and *Rhynchomitra* (Dictyopharidae) (**A–C, G** Dorsal view habitus, **D–F** frontal view, **H** Dorsal view, head and thorax). **A, D** *Phylloscelis rubra* **B, E** *P. pallescens* **C, F** *P. atra* **G** *Rhynchomitra microrhina* **H** *R. lingula*.

64 Head projection long (Fig. 14G), in dorsal view narrowing anterior to eyes, projected in front of eyes greater than width of vertex; upcurved in lateral view ..... ***Rhynchomitra microrhina***

– Head projection short (Fig. 14H), in dorsal view rather quadrate, projected in front of eyes for distance about width of vertex; not distinctly upcurved in lateral view..... ***Rhynchomitra lingula***

65 Costal cell of forewing with costal vein and membrane white (Fig. 13A) .... ***Scolops angustatus***

– Costal cell of forewing with costal vein variegated (Figs 13B–D) **66**

66 Forewings reticulate over apical half (especially brachypters), veins margined with dark (Figs 13D, H) ..... ***Scolops sulcipes***

– Forewings not reticulate over apical half (Figs B–C, F–G)..... **67**

67 Pronotum and usually vertex with dark markings (Fig. 13G); body with grayish cast ..... ***Scolops perdix***

– Pronotum and vertex without dark markings (Fig. 13F); body with brownish cast ..... ***Scolops pungens***

Figure 15. Issidae (**A–D** frontal view **E–H** Lateral view). **A, E** *Exortus punctiferus* **B, F** *Thionia bullata* **C, G** *T. elliptica* **D, H** *T. simplex*.

Flatidae

68 Wings much longer than wide, distinctly narrowing caudally to caudal apex (Fig. 3E); brown ..... ***Cyarda***

– Wings slightly longer than wide, truncate to broadly rounded caudally (Figs 3D, F–G); green or grey **69**

69 Body grey to blackish (Fig. 3F); forewings with single row of marginal cells along apical and trailing margin (set off by a submarginal vein) ..... ***Metcalfa pruinosa***

– Body green (Figs 3D, G); forewings with one or two rows of marginal cells **70**

70 Frons broader than long; forewings with two rows of marginal cells along apical and trailing margin (set off by two submarginal veins) (Fig. 3D); wings usually rather truncate apically ..... ***Flatormenis chloris***

– Frons longer than broad; forewings with one row of marginal cells (Fig. 3G); wings usually rounded apically (forewings often with orangish cast along apices) ..... ***Ormenoides venusta***

Fulgoridae

71 Forewings and much of body nearly black (Fig. 3I); caudal abdominal tergites red; head in lateral view with frons at acute angle from vertex; flange of head behind eye small ..... ***Poblicia fuliginosa***

– Forewings and body mottled (Fig. 3H), predominately reddish brown; abdomen not red; head in lateral view with frons at sharp angle from vertex; flange of head behind eye distinct ..... ***Cyrpoptus belfragei***

Issidae

72 Hind wings absent or rudimentary; smaller insects, less than 4.5 mm (Figs 15A, E); southeastern species, reported from NJ, possibly in error ..... ***Exortus punctiferus***

– Hind wings present, entire, with strongly marked notches at the joints of the folds, anal area large; larger insects varying from 5.5 to 8.0 mm (Figs 15B–D, F–H) ..... ***Thionia*, 73**

73 Uniformly colored, lacking proximal bulla (Fig. 15H); carinae of face weak (Fig. 15D) ..... ***Thionia simplex***

– Body patterned, wings with proximal bulla (Figs 15F–G); carinae of face conspicuous (Figs 15B–C) **74**

74 Vertex broader than long; distinctly concave in frontal view with lateral margins elevated (Fig. 15B) ..... ***Thionia elliptica***

– Vertex longer than broad, slightly concave in frontal view, lateral margins not strongly elevated (Fig. 15C) ..... ***Thionia bullata***

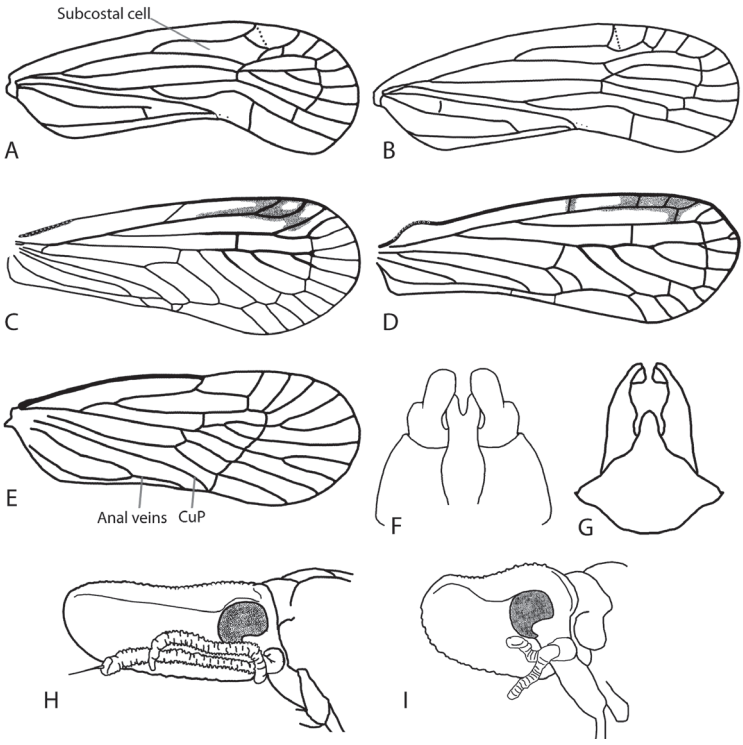


Figure 16. Line drawings of Achilidae and Derbidae (**A–E** Forewing, head left, costal margin top **F–G** Male genitalia, ventral view **H–I** *Shellenius* spp., head, left lateral view). **A** *Catonia pumila*; **B** *Synecdoche rubella* (Van Duzee, 1910); **C** *Anotia fitchi*; **D** *A. robertsonii*; **E** *Cedusa* sp.; **F** *Catonia picta*; **G** *Synecdoche dimidiata*; **H** *Shellenius balli*; **I** *Shellenius schellenbergii* (**A–B** Redrawn from O'Brien, 1971; **E** redrawn from Metcalf, 1923).

Discussion

Biodiversity

This survey brings the known diversity of Delaware planthoppers (excluding Delphacidae) from 7 to 62, plus provides new state records for MD (22), NJ (5), PA (8) and DC (21) providing species counts for those states as 88, 74, 60 and 46 respectively (Table 2). The Chao1 estimator suggests an additional 12 species may be found in the state. State-level incidence records of 112 species (Table 2) provides some basis for speculation of which species might be missing from the current inventory, and might be interpreted to suggest that the true diversity of planthoppers in Delaware may be closer to 100 species. A better understanding of the habits and finer-scale distribution pat-

terns would be desirable in order to construct a candidate list of species not yet detected in the Delaware fauna. However, some species detected were not previously known from the region (viz. *Aphelonema histrionica*, *Bothriocera drakei*, *B. maculata*, *Cixius angustatus*, *Sikaiana harti*, *Poblicia fuliginosa,* and *Otiocerus reaumurii*), suggesting that the compiled species list may yet be substantially incomplete for the combined states.

In addition to the planthopper fauna reported here, a preliminary inventory of the delphacids of Delaware suggests at least 54 species in the state, although additional taxa are likely to be found before the completion of that inventory.

Taxonomy

Cixiidae: A number of specimens presented taxonomic difficulties. In the Cixiidae, specimens that appeared close to *Melanoliarus sablensis* differed from that depicted by Mead and Kramer (1982: 474) by having an additional ventral process on the aedeagus and a differing arrangement (size and orientation) of the other ventral processes. Similar specimens were observed in the Great Smoky Mountains National Park (Gonzon et al. 2007). In addition to the odd specimens, a specimen much more similar to that depicted by Mead and Kramer (1982) was found. While the possibility that these specimens represent an undescribed species should be investigated, we feel it is likely that they simply represent a variant of the more conventional form, and we have treated them as the same species with respect to biodiversity estimation calculations. Also, a group of females of *Melanoliarus* with uniformly dark wings were separated from others because they appear to represent a species not found among the males; they were excluded from the species counts.

Emeljanov (2001) moved several Nearctic Pentastirini from *Melanoliarus* to *Pentastiridius* and *Reptalus. Pentastiridius* can be separated from the other two genera by having 12 teeth at the apex of the basitarsus, versus 10 or fewer in *Melanoliarus* and *Reptalus*; however, the features of *Melanoliarus* have not been investigated relative to *Reptalus* and diagnostic features separating these genera have not been defined. It is probable that *Melanoliarus* as currently defined is not monophyletic.

Achilidae: Species of *Cixidia* were identified primarily using features described by Beirne (1950), whose key emphasized color, particularly that of the face. He admitted that there was "some variation" (Beirne 1950: 186) within taxa, and key color features were often relativistic, making species difficult to distinguish without access to authoritatively identified specimens , particularly in the context of this study *C. fusca*, *C. pallida*, *C. variegata*, and *C. septentrionalis*. Unfortunately, Beirne (1950) did not describe sufficient structural features to assist in doubtful cases. A revision of *Cixidia* would be desirable to address ambiguities, and to describe potential new species from the southwestern US.

Dictyopharidae: The only member of *Phylloscelis* collected by the authors (or the senior author's students) was *Phylloscelis rubra* in New Jersey on cranberry (*Vaccinium macrocarpon* Aiton). This genus is a good example of a taxon that is likely to be in

Delaware, but has not yet been found. While there are only 4 species in the genus, and 3 in the study area (Figure 14), the species are best confirmed by genitalic features as presented in McPherson and Wilson (1995).

Derbidae: A number of taxonomic issues were found among the Derbidae, including problems separating species in the genera *Omolicna*, *Cedusa* and two genera of Otiocerinae (*Anotia* and *Otiocerus*). Specimens of *Omolicna* (Derbidae) could not be definitively identified to species despite there being only 4 described North American species, and only 3 of these eastern - *O. fulva* (Van Duzee, 1909), *O. mcateei* (Dozier, 1928), and *O. uhleri* (Ball, 1902). While literature records suggest that *O. uhleri* (Ball, 1902) should be the only northern species, it was evident from the genitalia of Delaware specimens that at least 2 species are present. Because the original descriptions are incomplete, and at times conflicting with subsequent authors, we were unable to determine which of the specimens were *O. uhleri*, and whether the remainder were *O. mcateei*, *O. fulva* or undescribed.

The derbid genus *Cedusa* is diverse and its members require examination of male genitalia for identification, and even then considerable study is required. Two species within this genus were found to differ from the descriptions provided by Flynn and Kramer (1983). *Cedusa kedusa* bears a large bifid process on both the left and right sides of the aedeagus. For the horizontal ramus of the bifid process on the left side, Flynn and Kramer (1983: 235) state that the apex may be "…occasionally trifurcate and dentate anteapically with the number of teeth varying from none to four…". Most of the observed specimens in this study had 4–6 teeth, but otherwise agreed with the description of this species. For *Cedusa cedusa*, a feature in the key (couplet 72) states that this species has the "paramere with inner ventral margin truncately incised in basal portion" (Flynn and Kramer 1983: 135); but for most of our specimens, this feature was rounded or acute. Variations (in this feature and/or details of the processes of the aedeagus) contrast to Flynn and Kramer's (1983: 228) comment that "all specimens [of *C. cedusa*] seen are similar to the illustration", and have led us to consider our specimens as 'near *cedusa*' until further evaluation of the variation in this species can be made.

Species in the Otiocerinae tended to be problematic, particularly since most taxa are rare in collections. It is also a problem that otiocerines have been described primarily based on superficial color features whose diagnostic value has not been verified by reference to genitalic features. While attempting to verify our species concepts, we solicited photographs or examined type specimens of select otiocerines. We found that many of the Fitch types (deposited at the USNM) are in poor shape and greatly faded. It is likely that some of the Kirby collection had been lost (see Horn and Kahle, 1935), and 6 of 8 otiocerine Kirby types could not be located at this time (specifically *Otiocerus schellenbergii, O. reaumurii, O. degeerii, O. abbotii, O. coquebertii* and *Anotia bonnetii* [but see below]). It is clear that both *Anotia* and *Otiocerus* are in need of revision. The revision should reference genitalic features to verify species identities, provide a critical reexamination of geographic records, and (as needed) designate neotypes for the apparently missing Kirby types, although Kirby (1821) generally provided adequate descriptions. Also, based on Kirby's (1821) description, it is possible that the

balli of McAtee (1923) is the same as Kirby's *schellenbergii.* While McAtee (1923) and Metcalf (1923) may have misapprehended these species, we have retained their view of these taxa until definitive evidence (esp. Kirby's *schellenbergii* type) can be found.

Ten species of *Anotia* are reported from the United States (including species formerly in *Amalopota* Van Duzee, 1889, subsumed under *Anotia* by Fennah, 1951: 152). Of the 10 species, *A. caliginosa* Ball, 1937, and *A. lineata* Ball, 1937, are southwestern species (recorded from Arizona) and *A. mcateei* (Dozier, 1928), reported from Illinois and Mississippi, does not occur in the study area. Of the remainder, 5 (*A. burnetii, A. bonnetii, A. kirkaldyi, A. robertsoni*, and *A. westwoodi*) are similar in appearance in having white wings whose veins are variably bordered with dark. It is not clear how much intraspecific variation would be expected in features of wing color or pattern, and such patterns were difficult to interpret in the greatly faded Fitch type specimens (we examined types of *Anotia robertsonii* and *A. burnetii*). *Anotia kirkaldyi* and *A. westwoodi* share with *A. bonnetii* the presence of dark spots in the apical cells of the forewing, although they may be more prominent in the latter species. *Anotia kirkaldyi* and *A. westwoodi* can be separated with difficulty based on the presence of darkened wing veins in the former species, but these taxa are otherwise very similar and may not be distinct. *Anotia robertsonii* is similar to *A. burnetii* in possessing less extensive wing markings than *A. kirkaldyi*, *A. westwoodi,* and *A. bonnetii;* and in possessing dark markings on the dorsum of the abdomen, although in *A. burnetii* the markings are confined to the middorsum of segments 1–3 and in *A. robertsonii* the entire dorsum of subsequent terga (5–7 or 8).

The type specimen of *Anotia bonnetii* (the type species of the genus) was also sought, along with types of other otiocerines described by Kirby (1821). Kirby (1821) specified that he had a single *A. bonnetii* specimen, which he described and illustrated. The specimen photographed as the type of *A. bonnetii* (at OUMNH) is pinned and spread, missing the abdomen, both wings on the left side, and the head anterior to the eyes; but it was clear that the specimen was not the one used to describe *A. bonnetii*. We feel the type has been mislabelled, and this specimen is actually the type of *Otiocerus francilloni*. The specimen could readily have been mislabeled when the Oxford Museum type collection was evacuated to the cellar underneath the Ashmolean Museum during World War II. Kirby (1821: 17), reports black spots and bands ("elytris nigro punctatis et fasciatis") for *O. francilloni*, with the black band interrupted, which is consistent with this specimen.

Nine species of *Otiocerus* are reported from the north of Mexico; two species, *O. abbotii* Kirby, 1821, and *O. kirbyii* Fitch, 1851; are not reported from the study area (but see below). We examined the types of *O. signoretii* and *O. stollii* to help confirm features attributed to these species. The type specimen of *O. signoretii,* at the USNM, is in rather poor condition, faded, and partially enmeshed in mycelium, but shows the pattern of spots described by Fitch (1856: 394) that was used in subsequent keys to the genus ("…four dots… placed at the angles of an imaginary square…"). Fitch (1856) also reports "…a broad dusky cloud-like stripe from the base to the middle of the inner margin, and extending thence obliquely across to the outer margin at its tip, and send-

ing a very broad branch to the tip of the inner margin…". In the type specimen, these marking are very faint. The type specimen of *Otiocerus stollii* Kirby (at OUMNH) consists of only of one front and one hind wing (evidently of the right side), but the forewing was consistent with our understanding of that species.

McAtee (1923: 47) noted within his key that *O. reaumurii, O. wolfii,* and *O. signoretii* "may be one species". While we are confident that *O. wolfii* is distinct from the other taxa, *O. reaumurii* and *O. signoretii* are very similar. Because the type specimen of *O. signoretii* is greatly faded, we attempted to diagnose this species from *O. reaumurii* by the distribution of dark spots on the wing, in particular the presence of a spot in the costal cell of *O. signoretii*. From the available material, these species appear to differ externally mainly in the spot organization. McAtee (1923: 46–47) noted that between the two species, the vitta of *O. reaumurii* was broader and 'percurrent', and the vitta of *O. signoretii* was 'forked at apex of clavus', but we have been unable to verify these features. These species are both similar to *O. stollii* except for more extensive dark markings of *O. stollii.* Interestingly, all observed specimens of *O. reaumurii* and *O. signoretii* were female, and all observed *O. stollii* were male, possibly suggesting that all these species are part of a single sexually dimorphic species. However, we did not observe a sufficient number of specimens to exclude the possibility that this sex ratio was obtained by chance alone. Also, Fitch reported the type of *O. signoretii* to be a male, but the condition of the type specimen makes this difficult to confirm.

A single specimen of *Otiocerus* from Maryland was not clearly associated with any of the described species. The specimen is uniformly pale, head without markings, forewings without spots and with a very faint band. A similar specimen was found among undetermined Derbidae at the USNM. It is possible that this specimen is *Otiocerus kirbyii*, but we were unable to confirm this identification.

Flatidae: The genus *Cyarda* is under revision by S. Wilson (S. Wilson, pers. comm.). Species in this genus are largely Caribbean. Four *Cyarda* have been reported from the United States: *Cyarda acuminipennis* (Spinola, 1839), *C. melichari* Van Duzee, 1907, *C. sordida* Fennah, 1965 (= *C.* sp. nr. *acutissima* Metcalf & Bruner, 1948; see Fennah, 1965: 115) and *C. walkeri* Metcalf, 1923. However, Fennah (1965: 112) noted that for *C. walkeri* it "…must be assumed that this species occurs only in Jamaica". Metcalf (1923) reported *C. acuminipennis* from the eastern US, and later from Florida by Metcalf and Bruner (1948), but occurrence of this species in the US has not been subsequently substantiated (e.g., by Fennah 1965). Of the remaining species, *C. sordida* is reported only from Florida (Fennah 1965) and *C. melichari* is widely reported in the eastern United States (including the District of Columbia), but its genitalic features have not been compared to the other US species, so it cannot be assumed that *Cyarda* found outside of Florida (including the D.C. record) are *C. melichari* as has apparently been previously assumed. The image used here (Figure 3E) is from an undetermined specimen from Ft. Lauderdale, FL.

Caliscelidae: Specimens reported as *Bruchomorpha* sp. n. were collected at Phillips Landing, Sussex Co., DE (on 3 dates) as well as single specimens from Medford, NJ and Baltimore, MD. Superficially, these specimens are similar to *Bruchomorpha dor-*

sata, which has been reported in the Mid-Atlantic region by Dozier (1928), Doering (1939), and Wilson and McPherson (1980a); however, the snout is longer than that described by Doering (1939) for *B. dorsata*, and females are larger than the reported size range for this species. The specimens are also superficially similar to *Bruchomorpha beameri* Doering, 1939; a Midwestern species, but the dimensions of the snout and coloration of the legs do not match. Unlike both *B. beameri* and *B. dorsata*, the aedeagus bears no dorsally directed process, and the ventral process is strongly retrosely curved. We conclude this taxon to be an undescribed species, which will be described after further review of *Bruchomorpha* species,

Seasonality

Seasonality data were compiled from available Delaware specimens as a way to begin to understand the life history of local planthopper taxa. From the available seasonality information, it appears that all non-delphacid planthoppers have a single generation a year in Delaware, with the possible exceptions of *Bruchomorpha oculata, Aphelonema simplex,* and *Cixius nervosus.* This would be in general agreement with Nickel and Remane (2002) who report that all non-delphacid planthoppers in Germany have a single generation a year. From these data it is evident that *Apache degeerii* overwinters as an adult, and based on April records that at least *Bothriocera cognita* and *Melanoliarus placitus* may overwinter as nymphs. Of the remaining species little can be determined concerning overwintering stage. Nickel (2003) reports that 18.6% of Fulgoromorpha (including Delphacidae) in Germany overwinter as eggs, 61.4% as nymphs, and12.4% as adults, with the remainder unclear. Published literature reports that *Flatormenis chloris*, *Metcalfa pruinosa*, *Ormenoides venusta*, *Acanalonia bivittata, A. conica*, *Thionia elliptica* and *Phylloscelis pallescens* overwinter as eggs (Wilson and McPherson 1981a, b; Wilson and Wheeler 1987, McPherson and Wilson 1996). Nickel and Remane (2002) report for the German fauna that all cixiids and achilids overwinter as nymphs.

A large number of *Melanoliarus placitus* were collected in early July of 2002 by the senior author and several students. The series was collected at mercury vapor lights (many specimens landed on trees near the lights instead of at the lights). Interestingly, this time period fell between the last quarter (July 2, 2002) and the New Moon (July 10 2002), which is similar to observations made by Bartlett and colleagues (2008) concerning Membracidae, where large numbers were collected at lights at times near a new moon.

Conclusion

While the planthoppers of the eastern United States may be characterized as relatively well known from a taxonomic perspective, their faunistics and ecology remain

poorly understood. Although Delaware is near the two largest insect collections in the US (the USNM and the American Museum of Natural History, both of which employ hemipterists), it is a testament to our inchoate understanding of US planthopper faunistics that this study has increased our known Delaware fauna by over 700%. The diversity of planthopper species in Delaware is expected to be relatively modest relative to other states because it is small and physiographically rather uniform, and because planthopper diversity tends to generally increase inversely with latitude (and within North America, is greatest overall in the southwest). Here we also report totals of 88 species for Maryland, 74 for New Jersey, 60 for Pennsylvania, and 46 for the District of Columbia based on a compilation of literature records and available specimens. The only other state with a modern, relatively complete, survey of its planthopper fauna is Illinois (Wilson and McPherson 1980b), which reported 150 species, of which 66 were delphacids. In comparison, the total North American planthopper fauna appears to be 12 families, 165 genera and 935 species, of which 61 genera and 338 species are delphacids, and approximately 2/3 of all US planthopper species are western (unpublished data from species checklist compiled by S. W. Wilson, L. B. O'Brien, and C. R. Bartlett). Clearly our understanding of the faunistics of US planthoppers is limited, and our appreciation of planthopper ecology remains in its infancy. Further regional investigations would be helpful in gaining a more complete understanding of the US planthopper fauna.

Acknowledgements

We are indebted to Kimberley Shropshire (University of Delaware) for the line art and most of the photography used in this work. We are grateful to Lois O'Brien for advice, support, specimens, and many helpful comments on early versions of this text; Stuart McKamey (USNM) for the loan of specimens, photographs of types, and assistance at the USNM collection; Zoë Simmons (Hope Entomological Collections, Oxford University Museum of Natural History) for locating and photographing some of the Kirby derbid types; Dmitri Logunov (Manchester Museum, University of Manchester, UK) and Mick Webb (British Natural History Museum, London) for seeking Kirby types in their collection. We are particularly grateful for past and present students whose diligent collecting has provided much of the basis for this work, especially Lawrence Barringer, Leo Donovall, Christopher Heckscher, Ashley Kennedy, Nate Nazdrowicz, Rob Snyder, and Katie Weglarz. We also thank an anonymous reviewer for helpful comments. This project was supported by the USDA Agriculture and Food Research Initiative Competitive Grants Program Grant No. 2009-55605-05006 from the National Institute of Food and Agriculture and Hatch Project W-2185 Biological Control in Pest Management Systems of Plants. Additional support was provided by the University of Delaware Department of Entomology and Wildlife Ecology.

References

Bartlett CR, Deitz LL (2000) *Revision of the New World delphacid planthopper genus Pissonotus (Hemiptera: Fulgoroidea).* Thomas Say Publications in Entomology: Monographs, Lanham, Maryland, 234pp.

Bartlett CR, Deitz LL, Rothschild MJ, Wallace MS (2008) Treehopper diversity (Hemiptera: Membracidae) of Little Orleans, Allegany Co., Maryland. Proceedings of the Washington Entomological Society 110: 130–143.

Beirne BP (1950) The Canadian species of *Epiptera* (Homoptera: Achilidae). Canadian Entomologist 82: 186–190.

Breakey EP (1928) The genus *Scolops* (Homoptera, Fulgoridae). University of Kansas Science Bulletin 18(6): 417–455.

Chao A (1984) Non-parametric estimation of the number of classes in a population. Scandinavian Journal of Statistics 11: 265–270.

Doering KC (1938) A contribution to the taxonomy of the subfamily Issinae in America north of Mexico (Fulgoroidea: Homoptera). Part II. University of Kansas Science Bulletin 25(20): 447–575.

Doering KC (1939) A contribution to the taxonomy of the subfamily Issinae in America north of Mexico (Fulgoroidea: Homoptera). Part III. University of Kansas Science Bulletin 26(2): 83–167.

Doering KC (1941) A contribution to the taxonomy of the subfamily Issinae in America north of Mexico (Fulgoroidea: Homoptera). Part IV. University of Kansas Science Bulletin 27(10): 185–233.

Dozier HL (1928, dated 1926) The Fulgoridae or planthoppers of Mississippi, including those of possible occurrence. Technical Bulletin of the Mississippi Agricultural Experiment Station 14: 1–152.

Emeljanov AF (1999) Notes on delimitation of families of the Issidae group with description of a new species of Caliscelidae belonging to a new genus and tribe (Homoptera, Fulgoroidea). Zoosystematica Rossica 8: 61–72.

Emeljanov AF (2001) The generic position of some Nearctic Pentastirini (Homoptera: Fulgoroidea: Cixiidae). Zoosystematica Rossica 9: 122.

Fennah RG (1952) On the generic classification of Derbidae (Homoptera: Fulgoroidea) with descriptions of new Neotropical species. Transactions of the Royal Entomological Society of London 103(4): 109–170.

Fennah RG (1965) New Species of Fulgoroidea (Homoptera) from the West Indies. Transactions of the Royal Entomological Society, London 117(4): 95–126.

Fitch A (1856) Third report on noxious and other insects of the State of New York. Transactions of the New York State Agricultural Society 16: 315–490.

Flynn JE, Kramer JP (1983) Taxonomic study of the planthopper genus *Cedusa* in the Americas (Homoptera: Fulgoroidea: Derbidae). Entomography 2: 121–260.

Freund RL, Wilson SW (1995) The planthopper genus *Acanalonia* in the United States (Homoptera: Issidae): male and female genitalic morphology. Insecta Mundi 9(3–4): 195–215.

Gnezdilov VM (2004) Two new genera of the family Issidae (Homoptera: Cicadina: Fulgoroidea) from North America. Russian Entomological Journal 13 (1–2): 1–2.

Gonzon AT, Bartlett CR, Bowman JL (2007) (Dated 2006) Planthopper (Hemiptera: Fulgoroidea) diversity in the Great Smoky Mountains National Park. Transactions of the American Entomological Society 132: 243–260.

Holzinger WE, Kammerlander I, Emeljanov AF (2002) The family Cixiidae Spinola 1839 (Hemiptera: Fulgoromorpha) - a review. In: Holzinger W (Ed) *Zikaden: Leafhoppers, Planthoppers, and Cicadas (Insecta: Hemiptera: Auchenorrhyncha).* Denisia 4: 113–138.

Horn W, Kahle I (1935) Uber entomologische Samlungen (Ein Beitrag zur Geschichte der Entomo-Museologie). Entomologische Beihefte aus Berlin-Dahlem, Teil 2: 1–160.

Kirby W (1821) The characters of *Otiocerus* and *Anotia*, two new genera of Hemipterous insects belonging to the family of Cicadiadae [sic]: with a description of several species. Transactions of the Linnaean Society of London Zoology 13: 12–23.

Kramer JP (1977) Taxonomic study of the planthopper genus *Oecleus* in the United States (Homoptera: Fulgoroidea: Cixiidae). Transactions of the American Entomological Society 103: 379–449.

Kramer JP (1979) Taxonomic study of the planthopper genus *Myndus* in the Americas (Homoptera: Fulgoroidea: Cixiidae). Transactions of the American Entomological Society 105: 301–389.

Kramer JP (1983) Taxonomic study of the planthopper family Cixiidae in the United States (Homoptera: Fulgoroidea). Transactions of the American Entomological Society 109: 1–57.

McAtee WL (1923) A new species of *Otiocerus* (Homoptera; Fulgoridae). Proceedings of the Biological Society of Washington 36: 45–48.

McPherson KR, Wilson SW (1995) The planthopper genus *Phylloscelis* in the United States (Homoptera: Dictyopharidae). Insecta Mundi 9: 177–188.

McPherson KR, Wilson SW (1996) Life history and descriptions of immatures of the dictyopharid planthopper *Phylloscelis pallescens* (Homoptera: Fulgoroidea). Journal of the New York Entomological Society 103: 170–179.

Mead FW, Kramer JP (1982) Taxonomic study of the planthopper genus *Oliarus* in the United States (Homoptera: Fulgoroidea: Cixiidae). Transactions of the American Entomological Society 107: 381–569.

Medler JT (2003) Types of Flatidae. XXIV. Type designations and taxonomic notes on species in the Natural History Museum of Geneva (Homoptera, Auchenorrhyncha, Fulgoroidea). Revue Suisse de Zoologie 110: 591–597.

Metcalf ZP (1923) A key to the Fulgoridae of Eastern North America with descriptions of new species. Journal of the Elisha Mitchell Scientific Society 38: 139–230, plate(s): 38–70.

Metcalf ZP, Bruner SC (1948) Cuban Flatidae with new species from adjacent regions. Annals of the Entomological Society of America 41: 63–118.

Nickel H (2003) The leafhoppers and planthoppers of Germany (Hemiptera, Auchenorrhyncha): patterns and strategies in a highly diverse group of phytophagous insects. Pensoft Publishers, Sofia-Moscow, 460 pp.

Nickel H, Remane R (2002) Check list of the planthoppers and leafhoppers of Germany, with notes on food plants, diet width, life cycles, geographic range and conservation status(Hemiptera, Fulgoromorpha and Cicadomorpha). Artenliste der Zikaden Deutschlands 5: 27–64 [English reprint of Beiträge zur Zikadenkunde 5: 27–64],

O'Brien LB (1971) Systematics of the tribe Plectoderini (Insecta, Fulgoroidea, Achilidae) in America North of Mexico. University of California Publications in Entomology 64: 1–79.

O'Brien LB (1985) New synonymies and combinations in New World Fulgoroidea (Achilidae, Delphacidae, Flatidae, Fulgoridae: Homoptera). Annals of the Entomological Society of America 78: 657–662.

Smith JB (1890) Sub-order Homoptera. In: Catalogue of insects found in New Jersey. Geological Survey of New Jersey. Final Report of the State Geologist, volume 2. John L. Murphy, Trenton, New Jersey, 436–447.

Wilson SW (2005) Keys to the Families of Fulgoromorpha with Emphasis on Planthoppers of Potential Economic Importance in the Southeastern United States (Hemiptera: Auchenorrhyncha). Florida Entomologist 88: 464–481.

Wilson SW, Wheeler AG Jr (1987) Life history of *Thionia elliptica* (Homoptera: Fulgoroidea) with description of a new *Thionia* species from Texas. Journal of the New York Entomological Society 95: 440–451.

Wilson SW, McPherson JE (1980a) The Distribution of the Fulgoroidea of the Eastern United States (Homoptera). Transactions of the Illinois State Academy of Science 73(4): 7–20.

Wilson SW, McPherson JE (1980b) Keys to the planthoppers, or Fulgoroidea of Illinois (Homoptera). Transactions of the Illinois State Academy of Science 73(2): 1–61.

Wilson SW, McPherson JE (1981a) Life histories of *Acanalonia bivittata* and *A. conica* with descriptions of immature stages. Annals of the Entomological Society of America 74: 289–298.

Wilson SW, McPherson JE (1981b) Life histories of *Anormenis septentrionalis*, *Metcalfa pruniosa*, and *Ormenoides venusta* with descriptions of immature stages. Annals of the Entomological Society of America 74: 299–311.

Zuefle ME (2006) The impact of non-native woody plants on the native herbivorous insect community of northern Delaware. M.S. Thesis, University of Delaware, Department of Entomology and Applied Ecology, 66 pp.

Zuefle ME, Brown WP, Tallamy DW (2008) Effects of non-native plants on the native insect community of Delaware. Biological Invasions 10: 1159–1169.

ZooKeys 83: 43–56 (2011)
doi: 10.3897/zookeys.83.783
www.zookeys.org

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Taxonomy and biology of two seed-parasitic gracillariid moths (Lepidoptera, Gracillariidae), with description of a new species

Bingbing Hu†, Shuxia Wang‡, Jing Zhang§, Houhun Li|

College of Life Sciences, Nankai University, Tianjin 300071, China

† *urn:lsid:zoobank.org:author:13D685ED-B399-4F38-BF72-A3BC8AD96958*
‡ *urn:lsid:zoobank.org:author:DA6622BB-0BEA-421F-A9DA-BB4916F75481*
§ *urn:lsid:zoobank.org:author:764BABDE-B63F-4F4D-8657-D0AC356EF8CA*
| *urn:lsid:zoobank.org:author:F6AAB0C0-F312-4035-A08B-3DFE03D02F62*

Corresponding author: *Houhun Li* (lihouhun@nankai.edu.cn)

Academic editor: *E. van Nieukerken* | Received 7 December 2010 | Accepted 7 February 2011 | Published 25 February 2011

urn:lsid:zoobank.org:pub:AEEA8DD8-9210-4DF7-92A4-D1A6BFE28733

Citation: Hu B, Wang S, Zhang J, Li H (2011) Taxonomy and biology of two seed-parasitic gracillariid moths (Lepidoptera, Gracillariidae), with description of a new species. ZooKeys 83: 43–56. doi: 10.3897/zookeys.83.783

Abstract

A new species and new record of gracillariid moths from China are reported: *Conopomorpha flueggella* Li, **sp. n.** and *Epicephala relictella* Kuznetzov, 1979. Specimens were collected on flowers or leaves of *Flueggea suffruticosa* (Pall.) Baill. (Euphorbiaceae) at night, and reared from fruits in captivity. Larvae of both species feed on the seeds of *F. suffruticosa*, but they can be differentiated externally by the position of the red pattern on the thorax and abdomen. Morphology of the eggs, larvae, pupae and the life history of the two species are described and compared. Images of the life history and figures of the genital structures are provided.

Keywords

Lepidoptera, Gracillariidae, *Conopomorpha*, *Epicephala*, *Flueggea suffruticosa*, new species, biology

Introduction

Most species of Gracillariidae are leaf-miners, although some are stem-, fruit- or peel-miners or feed on flower buds (Fletcher 1920, Huang et al. 1997; Vargas and Landry 2005, Grafton-Cardwell et al. 2008, Kawahara et al. 2009). An obligate pollination mutualism

exists between *Epicephala* moths and Euphorbiaceae (or Phyllanthaceae) trees. The seed-parasitic habit of *Epicephala*, as in the pollination mutualisms of fig wasps, yucca moths and senita moths, is unique in Gracillariidae (Riley 1892, Fleming and Holland 1998, Bai and Li 2008, Weiblen 2002, Kato et al. 2003, Pellmyr 2003, Kawakita and Kato 2004a and b, Kawakita 2010). Currently, the biology and hostplants of most *Epicephala* species remain unknown according to our recent study. Previous studies in the Euphorbiaceae–*Epicephala* mutualism have revealed a high degree of specificity between pollinating moths and plants, although the relationships between hostplants and insects are not always an exact one-to-one relationship (Kawakita and Kato 2006). We found a high degree of diversity in the biology of adults and larvae, which enables us to understand more about the obligate pollination mutualism between the *Epicephala* moths and the Euphorbiaceae trees.

In this paper, we describe the morphology and biology of adults and larvae of *Conopomorpha flueggella* Li, sp. n. and *Epicephala relictella* Kuznetzov, 1979. Both species are seed–parasites of *Flueggea suffruticosa* in the Baxian Mountain State Nature Reserves in Tianjin, China. The hostplant of *E. relictella* is here recorded for the first time, and the biology of the two gracillariid species is described and compared. Images of the adults and genitalia are provided.

Material and methods

Field studies were conducted from 2007 to 2009 in the Baxian Mountain State Nature Reserves (40°7'24"–40°13'53"N, 117°30'35"–117°36'24"E) in Tianjin, China (Fig. 1), at an altitude ranging from 500 to 800 m. The area covers 5360 hm^2, with 1583 hm^2 as the core region. It is characteristic of warm temperate deciduous broad-leaved forest, and belongs to the warm and humid continental monsoon climate. The annual average rainfall amounts to 968.5 mm, and the annual average temperature is 8–10 °C (Li et al. 2009).

Flueggea suffruticosa (Pall.) Baill. (Fig. 3) occurs in scrubby slopes, forest margins and at road sides (Fig. 2) at an altitude of 500 to 2500 m. It is distributed in China (except in Gansu, Qinghai, Xinjiang and Tibet), Japan, Korea, Mongolia and Russia (Li 1994). *Flueggea suffruticosa* (Pall.) Baill. forms typically 1–3 m tall shrubs, is dioecious, and the inflorescences are axillary and cymose. The male flowers have 3–18 clusters, 5 sepals, free filaments, and 5 stamens. The female flowers have 3 styles, erect to spreading horizontally, free or connate at base, and bifid; the ovary is 3-celled, each cell having 2 ovules. The fruit is an oblate capsule, reddish brown when ripe (Fig. 4). The flowering period lasts from May to August, and the fruiting period from June to November in Baxian Mountain.

The biology of *Conopomorpha flueggella* Li, sp. n. and *Epicephala relictella* Kuznetzov was observed and studied during August–October 2007 and May–October of 2008 and 2009. Life history observations were made during flowering and fruiting seasons. The developing and mature fruits were collected from different individuals and dissected to examine the feeding habit with a light microscope. In addition, the developing fruits were collected in a cylindrical box (10 cm × 10 cm^2) to rear mature larvae and braconid wasps, and the behaviors of the mature larvae were observed.

Figures 1–4. Habitats and host plants of two gracillariid species in Baxian Mountain State Nature Reserves. **1** general habitat **2** habitat of *Flueggea suffruticosa*, arrow pointing to host plant **3** female individual of *F. suffruticosa* **4** fruits of *F. suffruticosa*.

Specimens examined in this study were collected on flowers or leaves of *Flueggea suffruticosa* at night, and reared from fruits in captivity, and a few specimens were collected by using light traps. Genitalia dissection and mounting follow Li and Zheng (1996). Photographs of *F. suffruticosa* and moths were taken primarily in the field using Canon G10 and Canon S3 IS digital cameras. Photographs of adult specimens were taken with a Nikon D300 digital camera. Dissections of genitalia were conducted under an Olympus SZ11 stereo zoom microscope. Figures of genitalia were prepared using an Olympus C-7070 digital camera attached to an Olympus BX51 microscope.

The type specimens are deposited in the Insect Collection, College of Life Sciences, Nankai University, Tianjin, China.

Taxonomic history

Meyrick (1885) established the genus *Conopomorpha* based on the type species *C. cyanospila* Meyrick, 1885. The wing pattern suggests it may be closely related to *Epicephala* Meyrick, 1880, but the complete separation of the sacculus and costa as well as the simple ovipositor distinguishes *Conopomorpha* from *Epicephala*.

Conopomorpha currently consists of 13 species worldwide: eight species in the Australian Region, three in the Oriental and Afrotropical regions respectively, and one in the Palearctic Region (De Prins and De Prins 2005, 2011). Prior to this study, three species, *C. litchiella* Bradley, 1986, *C. sinensis* Bradley, 1986 and *C. cramerella* (Snellen, 1904), were recorded in China. They are important fruit pests on litchi, longan and cacao in Fujian, Guangdong, Hainan, Hong Kong, Taiwan (Hwang et al. 1989, Huang et al. 1997, Robinson et al. 2001, Shapiro et al. 2008).

Meyrick (1880) described *Epicephala* based on the type species *E. colymbetella* Meyrick, 1880. Species of this genus are extremely similar and difficult to distinguish. They usually have a fine or indistinct, curved, transverse silvery-metallic line before the apical area and a small round black dot in the apical area. The general structure is close to the genus *Caloptilia* Hübner, 1825, differing from it in the venation and in the peculiar resting posture: the *Epicephala* adult rests with its head appressed horizontally, the hind-part raises considerably and is seemingly supported by the hind legs, the fore and mid legs extended laterally and appressed to the horizontal surface (Meyrick 1880); the hind tibiae are bristly above, which also distinguishes the genus from *Caloptilia*. The wing pattern of *Epicephala* shows some resemblance to the genus *Stomphastis* Meyrick, 1912, but from this *Epicephala* can be separated by the wing venation and the very peculiar shape of the apo- and antapophyses in the female genitalia (Vári 1961).

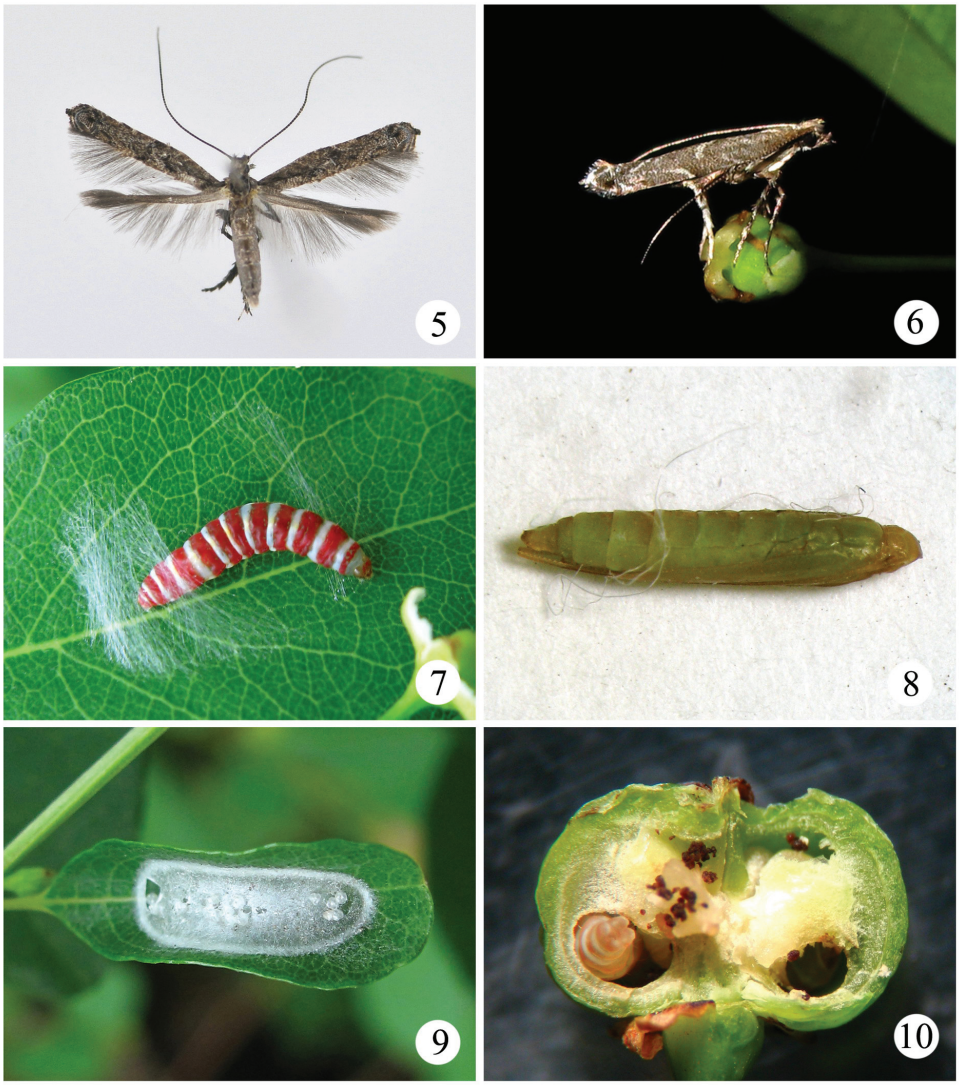
Epicephala includes 40 described species: 18 in the Oriental Region, 15 in the Australian Region, six in the Afrotropical Region, and one in the Palearctic Region (Russian Far East). Two species were recorded to occur in China prior to this study: *E. venenata* Meyrick, 1935 and *E. albifrons* (Stainton, 1859) (De Prins and De Prins 2005, Kendrick 2005). *Epicephala venenata* occurs only in Taiwan, and the hostplant is unknown. *Epicephala albifrons* is widely distributed in Hong Kong, India, Indonesia, Sri Lanka, Thailand and Vietnam. The larvae of *E. albifrons* are known to feed on *Phyllanthus niruri* Linn. (Euphorbiaceae).

In 2007, we discovered *Conopomorpha flueggella* Li, sp. n. and *Epicephala relictella* Kuznetzov, 1979 in the Baxian Mountain State Nature Reserves in Tianjin, China, whose larvae feed on *Flueggea suffruticosa* (Pall.) Baill. (Euphorbiaceae). *Epicephala relictella* is the only species of the genus distributed in the Palearctic Region, and is newly recorded for China. Its hostplant and biology were unknown previously.

Results

***Conopomorpha flueggella* Li, sp. n.**
urn:lsid:zoobank.org:act:66017EDE-6984-4D06-B309-9414D0BE3C19
Figs 5–10, 11, 13

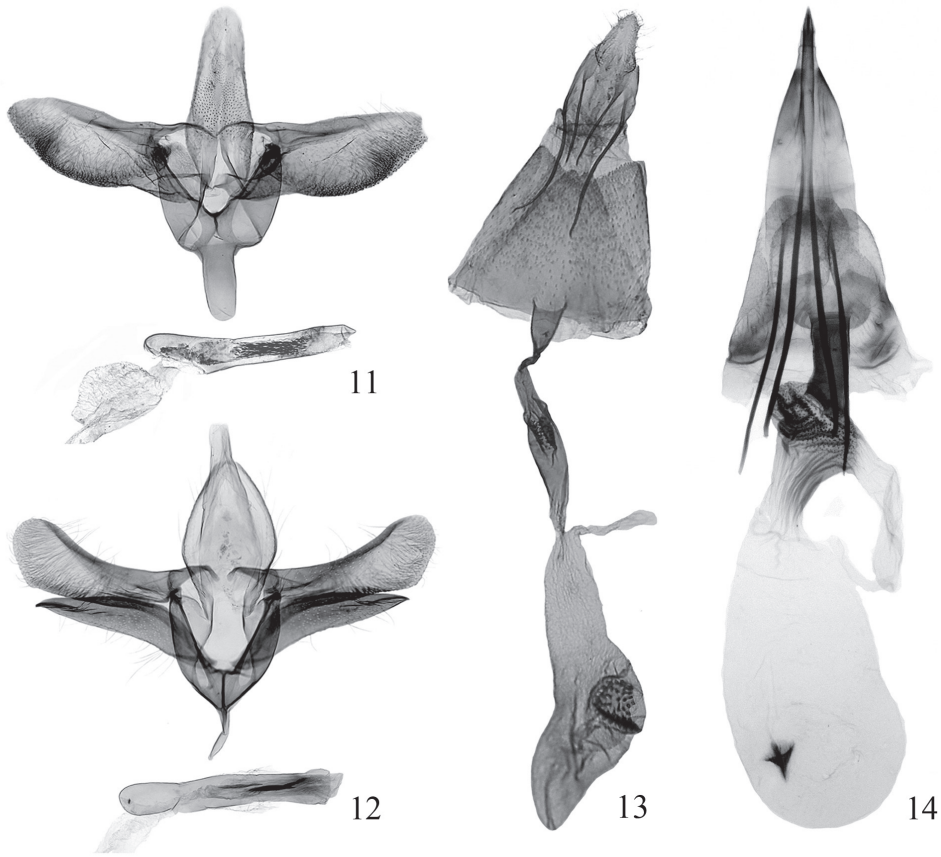
Type material. Holotype ♂ – **China,** [1] **Tianjin:** Baxian Mountain [40°11'03"N, 117°32'55"E], | Ji County, 600 m, 23.VII.2009, | Bingbing Hu reared [from fruit of *Flueggea suffruticosa* (Pall.) Baill.]. [2] *Conopomorpha* | *flueggella* | Li, sp. nov. Holotype



Figures 5–10. Life history of *Conopomorpha flueggella*. **5** adult, holotype, male **6** female moth resting on a female flower at night **7** mature larva weaving pupal cocoon on a host leaf **8** pupa **9** pupal cocoon on a host leaf **10** infested fruit.

♂. Paratypes – 82 ♂♂, 172 ♀♀, same data as for holotype except date and altitude: 19–24.VIII.2007, 10.V.–26.VII.2008, 16.V.–30.VIII.2009, 290–600 m; 1 ♂, Limutai (40°11'17"N, 117°33'23"E), Ji County, 360 m, 24.VI.2009, coll. Bingbing Hu.

Diagnosis. This species is similar to *Conopomorpha litchiella*, but distinguishable by the uniformly greyish brown to dark brown forewing with three pairs of stripes (more conspicuous when moths alive); the valva without protuberance on ventral margin distally and the saccus long linguiform in the male genitalia; the corpus bursae



Figures 11–14. Genitalia of two gracillariid species. **11** *Conopomorpha flueggella*, male, paratype, slide No. BHY07239 **12** *Epicephala relictella*, male, slide No. BHY07296 **13** *C. flueggella*, female, paratype, slide No. HBB09034 **14** *E. relictella*, female, slide No. BHY08143.

shorter than twice the length of the ductus bursae in the female genitalia; and the larva red-coloured. In *C. litchiella*, the forewing is whitish yellow in distal portion; the valva has one large and one small protuberance on ventral margin distally, and the saccus is very short and small; the corpus bursae is twice as long as the ductus bursae; and the larva is yellowish green.

Description. Adult (Figs 5–6). Wing expanse 8.0–15.5 mm. Head grey to greyish brown, frons greyish white. Compound eye dark brown. Labial palpus white, second segment with outer surface and distal tuft of ventral surface fuscous, third segment porrect or obliquely upward. Maxillary palpus greyish brown to dark brown. Antenna with scape greyish brown, flagellum brown to dark brown ringed with greyish white basally. Thorax and tegula dark brown. Forewing narrow, costal and dorsal margins nearly parallel; ground color greyish brown to dark brown; costal and dorsal margins

with three oblique greyish white stripes respectively, first costal stripe from near middle extending obliquely to end of cell; dorsal margin with black speck at basal 1/3; bluish grey fascia with metallic reflection extending from near costal 5/6 to dorsum and along termen, respectively, between them set a large black spot; cilia pale greyish brown except fuscous apically. Hindwing and cilia greyish brown. Fore and mid legs brown; hind leg greyish white, distal half of tibia dark fuscous on outer surface. Abdomen grey, with first two segments shining white; ventral surface with five pairs of dark brown stripes along lateral sides.

Male genitalia (Fig. 11). Tegumen narrowed gradually to rounded caudal margin, with lateral side straight. Tuba analis indistinct. Valva broad, slightly longer than tegumen; costa nearly straight, basal half slightly sinuate, apex rounded; ventral margin of valva roundly protruded medially, densely with fine hairs; sacculus narrow and short, about 1/4 length of valva. Vinculum broad and short, nearly quadrate. Saccus long linguiform, about half length of tegumen, rounded at apex. Phallus tubular, nearly straight, as long as valva, medially with dense small spines inside.

Female genitalia (Fig. 13). Papillae anales short and small, sparsely with setae. Apophysis anterioris thicker than and 1.6 × as long as apophysis posterioris. Antrum long funnel-shaped. Ductus bursae longer than apophysis anterioris, membranous except posterior 1/3 sclerotized and narrowed, medially expanded slightly and with longitudinal carinae. Corpus bursae membranous, prolonged pyriform, about 1.5 × as long as ductus bursae, with one side concave; signum large, rounded, situated at middle, covered with spines.

Egg. Flat, elliptic, 0.3 mm in length and 0.2 mm in width. Transparent membrane in surface, irregular meshy stripe on egg shell. Milky white, semitransparent; straw yellow when close to hatch.

Larva (Fig. 7). Young instar larva flat, yellowish white, semitransparent, segments distinct, with sparse setae, anterior end wider than posterior. Head capsule semicircular, brown; mandible strong, protruded like pincers. Mature larva 5.5–7.0 mm; head deep brown, anterior 1/2–2/3 of each segment on thorax and abdomen red, posterior 1/3–1/2 white. Body with sparse setae. Three pairs abdominal legs on segment 3, 4 and 5 respectively; anal leg protruded backward.

Pupa (Fig. 8). 4.0–6.0 mm, fusiform. Greenish yellow in early pupal stage, changing gradually to yellowish brown, blackish brown before eclosion. A corniform cocoon breaker on forehead. Forelegs to third abdominal segment, midlegs to fourth abdominal segment, hindlegs to seventh or eighth abdominal segment, wings to fifth abdominal segment, antenna to or slightly exceeding end of abdomen.

Cocoon (Fig. 9). 7.0–9.0 mm, white, flat elliptic, with some white grains attached on surface.

Host plant. Euphorbiaceae: *Flueggea suffruticosa* (Pall.) Baill.

Life history. *Conopomorpha flueggella* has two generations annually in Tianjin, China (Table 1). The larvae feed on the seeds of *Flueggea suffruticosa* (Fig. 10). Mature larvae quit the fruits before they are ripe and pupate on leaves or leaf litter. The pupal stage lasts from 9 to 12 days. Adults of the second generation hibernate.

Table 1. Annual life history of *Conopomorpha flueggella* in Tianjin, China.

Months	1–4			5			6			7			8			9			10–12		
Generations	F	M	L	F	M	L	F	M	L	F	M	L	F	M	L	F	M	L	F	M	L
Second generation	(+)	(+)	(+)	+	+	+	+														
First generation				●	●	●	●														
					–	–	–	–	–												
							□	□	□		□										
									+	+	+	+	+								
Second generation (hibernating)									●	●	●	●	●								
										–	–	–	–	–							
												□	□	□	□	□					
															(+)	(+)	(+)	(+)	(+)	(+)	(+)

● egg, — larva, □ pupa, + adult, (+) adult hibernating.

F: First ten days, M: Middle ten days, L: Last ten days.

Adults occur from May to the first ten days of June, and from the last ten days of June to the first ten days of August. Adults can emerge during the whole day, but the peak occurs in the morning. The mating occurs usually in the morning. At night, the moths are actively drinking nectar and ovipositing. Adults come sometimes at light. A parasitic Ichneumonid species was reared from pupae collected on leaves of *F. suffruticosa* in the field.

Distribution. China (Tianjin).

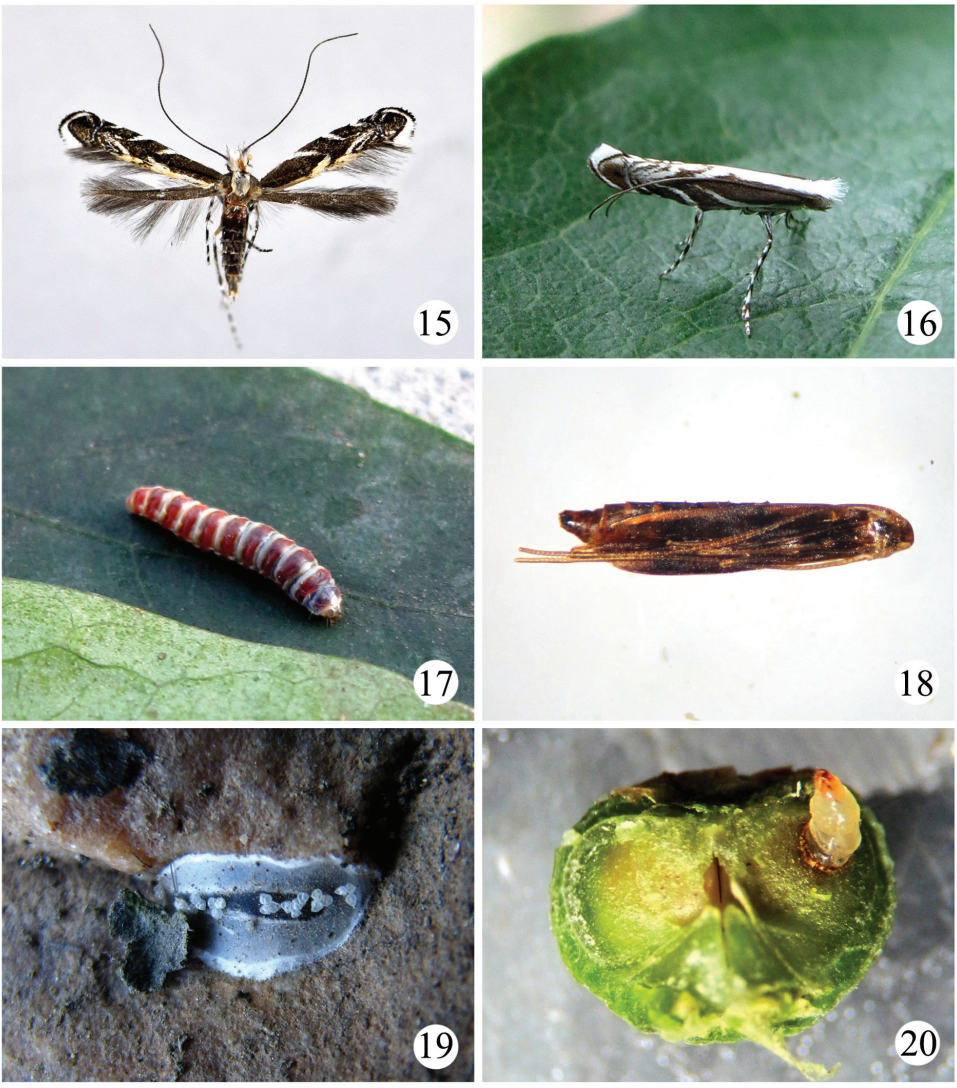
Etymology. The species name is derived from the larval host plant, *Flueggea*.

Epicephala relictella Kuznetzov, 1979

Figs 12, 14, 15–20

Epicephala relictella Kuznetzov, 1979: 854; Kuznetzov, 1981: 179; De Prins and De Prins, 2005: 181; Kawahara et al. 2010: 132.

Material examined. Russia: Holotype ♂, – Southern Maritime Territory, Gornotayezhnaya Station, 12.VII.1978, coll. V. I. Kuznetzov [in Russian]. Paratypes – 2 ♂♂, 1 ♀, same data as for holotype but dated 3.VII.1978. **China, Tianjin:** 20 ♂♂, 9 ♀♀, Mt. Jiulong, Ji County, 130–200 m, 9–28. VI.2004; Limutai, Ji County, 300 m, 11.VI.2004, coll. Houhun Li et al., 6 ♂♂, 1 ♀, 24.VI.2009, coll. Bingbing Hu; 1 ♂, 2 ♀♀, Baxian Mountain, Ji County, 550 m, 15.VII.2007, coll. Mingfeng Cao & Bingbing Hu; 74 ♂♂, 60 ♀♀, 290–480 m, 8.V.–1.VII.2008, 19.V.–30.VIII.2009, coll. Bingbing Hu; **Hebei Province:** 1 ♂, Shangsi, Xiaowutai, Wei County, 1200 m, 25.VII.2000, coll. Yanli Du & Zhendong Li; **Heilongjiang Province:** 1 ♀, Haerbin, 150 m, 22.VII.1997, coll. Houhun Li; **Gansu Province:** 1 ♂, 2 ♀♀, Bifenggou, Wenxian, 860 m, 10–12.VII.2005, coll. Haili Yu.



Figures 15–20. Life history of *Epicephala relictella*. **15** adult **16** moth resting on a leaf of host **17** mature larva resting on host leaf **18** pupa **19** pupal cocoon on stone nearby host **20** infested fruit.

Redescription. Adult (Figs 15–16). Wing expanse 9.0–13.0 mm. Head white, tufted. Labial palpus white except outer surface grey. Antenna with scape pale grey dorsally, white ventrally; flagellum dark brown dorsally, copper-colored ventrally. Thorax white. Tegula and forewing greyish brown; white stripes at costal 2/5, 3/5, 4/5 and near apex as well as at dorsal 2/5 and 3/5 respectively, concentrated obliquely outward to 2/3 length and outside of cell, outmost one shortest, between first three stripes sometimes with short white strigulae; thin bluish white fascia with metallic reflection extending from costal 5/6 to dorsum; large black spot near apex; dorsal margin

white tinged with ocherous yellow, longitudinally forming a broad band; termen dark brown; cilia white except fuscous distally from costal 5/6 along termen to before tornus, greyish brown along dorsal margin. Hindwing and cilia greyish brown. Fore and mid legs brown, hind leg greyish white, tibiae and tarsi with white rings. Abdomen greying brown on dorsal surface except first two segments grey; ventral surface grey, with five pairs of oblique dark brown stripes along lateral sides.

Male genitalia (Fig. 12). Tegumen broadly elliptic, caudal margin rounded. Tuba analis broad, distinct. Valva narrow, slightly longer than tegumen, expanded subapically, rounded at apex; costa sclerotized, gently concave; ventral margin nearly straight except basal 1/4 oblique, with dense fine hairs. Sacculus sclerotized, separated from valva, elongate lanceolate, about 4/5 length of valva; dosal margin gently arched, ventral margin slightly concave medially; distal portion longitudinally with sclerotized carina, apex spiculate. Vinculum broad, rounded anteriorly. Saccus slender, tapering, about 1/3 length of tegumen. Phallus tubular, straight, as long as valva, apex truncate; cornuti composed of dense small spines, compacted into one to three bundles.

Female genitalia (Fig. 14). Ovipositor sclerotized to a strong spine, extensible. Apophysis very strong, apophysis posterioris slightly longer than apophysis anterioris. Lamella antevaginalis nearly trapezoid, caudal margin concave medially. Antrum strongly sclerotized, about half length of apophysis anterioris, oblique anteriorly. Ductus bursae thick and short, weakly sclerotized, slightly longer than antrum, expanded with irregular sclerotized carinae posteriorly, narrowed gradually towards corpus bursae, with sclerotized longitudinal pleats. Corpus bursae membranous, elongate elliptic, about same length as apophysis posterioris; signum small, coniform or stelliform, placed anteriorly.

Egg. Oval, diameter about 0.15–0.20 mm. Surface smooth, shiny. Egg first yellowish white, nearly transparent, then becoming straw yellow before hatching.

Larva (Fig. 17). Young instar larva very similar to that of *Conopomorpha flueggella*. Mature larva 5.0–6.5 mm; head capsule brownish yellow, median 2/3 of each segment on thorax and abdomen dark red, anterior and posterior ends white; thoracic segments slightly blue, abdominal segments with blue spots. Body with sparse white setae. Three pairs abdominal legs on segment 3, 4 and 5 respectively; anal leg protruded backward.

Pupa (Fig. 18). 4.0–5.5 mm, fusiform. Greenish yellow in early pupal stage, changing gradually to dark brown. A corniform coccon breaker on forehead. Forelegs to third abdominal segment, midlegs to fourth abdominal segment, hindlegs to eighth abdominal segment, wings to fifth abdominal segment, antenna obviously exceeding end of abdomen.

Cocoon (Fig. 19). 6.0–8.0 mm; white, flat elliptic, with some white grains attached on surface.

Host plant. Euphorbiaceae: *Flueggea suffruticosa* (Pall.) Baill., recorded for the first time herein.

Life history. *Epicephala relictella* has one generation annually in Tianjin, China (Table 2). The larvae feed on the seeds of *Flueggea suffruticosa* (Fig. 20). The larval stage is completed within one fruit. When completing larval development, the mature larvae quit the fruits and pupate on the leaves, and overwinter under leaf litter or stones.

Table 2. Annual life history of *Epicephala relictella* in Tianjin, China.

Months	1–5			6			7			8			9			10–12		
Generation	F	M	L	F	M	L	F	M	L	F	M	L	F	M	L	F	M	L
First generation	(□)	(□)	(□)	(□)	(□)	(□)	(□)											
				+	+	+	+	+										
				●	●		●	●	●									
						–	–	–	–	–	–	–	–	–				
									(□)	(□)	(□)	(□)	(□)	(□)	(□)	(□)	(□)	(□)

● egg, – larva, □ pupa, (□) pupa through the winter, + adult

F: First ten days, M: Middle ten days, L: Last ten days.

Adults appear from June to July. They can emerge during the whole day, but the peak occurs in the morning. The moths are most active at night, drinking nectar and ovipositing. During the daytime they rest on leaves or branches. Adult longevity is 3–10 days, but adults generally live for 5–7 days. Adults hardly come to light.

Distribution. China (Tianjin, Hebei, Heilongjiang, Gansu), Korea, Russia.

Discussion

Calybites securinella (Ermolaev, 1986) was the only species in Gracillariidae known to be associated with *Flueggea suffruticosa*. It occurs in Russia (Primorye) and Korea (Ermolaev 1986, Kawahara et al. 2010). Associations of the gracillariid moths with fruits or seeds of different euphorb genera, including *Flueggea*, are known for *Epicephala* (Kawakita and Kato 2009). *Conopomorpha flueggella* is another seed-feeder, similar to several species of the genus that feed on fruits or seeds of other plant families (Bradley 1986).

Similar to *Conopomorpha flueggella*, *Epicephala relictella* also feeds on the seeds of *Flueggea suffruticosa*. They are very similar in morphology and biology, and hard to distinguish. Table 3 compares the life histories of the two species.

Table 3. Life history comparisons of *Conopomorpha flueggella* and *Epicephala relictella*

	Characteristics	*Conopomorpha flueggella*	*Epicephala relictella*
Similarities	Feeding habits	Seed parasite	
	Pupation site	Boring an exit hole to escape from the fruit to pupate on the leaves or litter	
	Mating site	On the leaves of host	
	Do adults feed ?	Yes	
Differences	Flight period	In early May, slightly earlier than flowering season	In early June, keeping pace with early fruiting season
	Overwintering	Adult	Pupa
	Generation	Two generations annually	One generation annually
	Phototaxy	Feeble	Hardly any

Most gracillariid species are leaf-miners, and the seed-parasitic habit is infrequent. *Epicephala* is noteworthy for its obligate pollination habit, which involves a mutualistic relationship with trees of Euphorbiaceae (Kawakita 2010). However, *Epicephala relictella* is not pollinating its host.

Acknowledgments

We are grateful to Mr. Xiubai Ren and Mr. Tiejian Zhao (Baxian Mountain State Nature Reserves, Tianjin) for their assistance given in the fieldwork, to Dr. Roger C. Kendrick (Fauna Conservation Department, Kadoorie Farm & Botanic Garden, Hong Kong) for providing useful literature. Special thanks are given to Dr. Svetlana Baryshnikova (Zoological Institute, Russian Academy of Sciences, St. Petersburg) for her kind assistance given to the corresponding author in checking the types of *Epicephala relictella* Kuznetzov, and to Dr. Erik J. van Nieukerken (Netherlands Centre for Biodiversity Naturalis, Leiden) and Jurate De Prins (Royal Museum for Central Africa, Belgium) for reviewing the manuscript and giving valuable suggestions in improving the quality of the paper. This research was supported by the National Natural Science Foundation of China (No. 30930014).

References

Bai HY, Li HH (2008) Brief review of obligate pollination mutualism between *Epicephala* moths and Euphorbiaceae trees. Chinese Bulletin of Entomology 45(1): 166–169.

Bradley JD (1986) Identity of the South-East Asian cocoa moth, *Conopomorpha cramerella* (Snellen) (Lepidoptera: Gracillariidae), with descriptions of three allied new species. Bulletin of Entomological Research 76: 41–51.

De Prins J, De Prins W (2011) Global Taxonomic database of Gracillariidae (Lepidoptera). World Wide Web electronic publication, available at http://www.gracillariidae.net/ [accessed 31 January 2011]

De Prins W, De Prins J (2005) Gracilariidae (Lepidoptera). World Catalogue of Insects 6: 1–502.

Ermolaev VP (1986) New and little known species of leafblotch miners (Lepidoptera, Gracillariidae) from the south of the Primorye Territory. Entomologicheskoe Obozrenie 65: 741–752. [In Russian]

Fletcher TB (1920) Life histories of Indian insects. Microlepidoptera 6. Gracillariidae. Memoirs of the Department of Agriculture in India. Entomological Series 6: 137–167.

Fleming TH, Holland JN (1998) The evolution of obligate pollination mutualisms: senita cactus and senita moth. Oecologia 114: 368–375.

Grafton-Cardwell EE, Godfrey KE, Headrick DH, Mauk PA, Peña JE (2008) Citrus Leafminer and Citrus Peelminer. ANR Publications, 1–12.

Huang CQ, Wu HQ, Lin YW, Xie YD, Huang J, Huang BK (1997) A review of shoot and fruit borers and two species of Gracilariid mothes attacking litchi and longan. Wuyi Science Journal 13: 125–129.

Hwang JS, Hsieh FK (1989) The bionomics of the cocoa pod borer, *Conopomorpha cramerella* (Snellen), in Taiwan. Plant Protection Bulletin Taipei 31(4): 387–395.

Kato M, Takimura A, Kawakita A (2003) An obligate pollination mutualism and reciprocal diversification in the tree genus *Glochidion* (Euphorbiaceae). Proceedings of the National Academy of Sciences 100(9): 5264–5267.

Kawahara AY, Nishida K, Davis DR (2009) Systematics, host plants, and life histories of three new *Phyllocnistis* species from the central highlands of Costa Rica (Lepidoptera, Gracillariidae, Phyllocnistinae). ZooKeys 27: 7–30.

Kawahara AY, Sohn JC, De Prins J, Cho S (2010) Five species of Gracillariidae (Lepidoptera) new to Korea. Entomological Research 40: 131–135.

Kawakita A (2010) Evolution of obligate pollination mutualism in the tribe Phyllantheae (Phyllanthaceae). Plant Species Biology 25: 3–19.

Kawakita A, Kato M (2004a) Evolution of obligate pollination mutualism in New Caledonian *Phyllanthus* (Euphorbiaceae). American Journal of Botany 91(3): 410–415.

Kawakita A, Kato M (2004b) Obligate pollination mutualism in *Breynia* (Phyllanthaceae): further documentation of pollination mutualism involving *Epicephala* moth (Gracillariidae). American Journal of Botany 91(9): 1319–1325.

Kawakita A, Kato M (2006) Assessment of the diversity and species specificity of the mutualistic association between *Epicephala* moths and *Glochidion* trees. Molecular Ecology 15: 3567–3581.

Kawakita A, Kato M (2009) Repeated independent evolution of obligate pollination mutualism in the Phyllantheae–*Epicephala* association. Proceedings of the Royal Society B 276: 417–426.

Kendrick RC (2005) Kadoorie farm & botanic garden 2005 fauna checklist. Hong Kong, China: Kadoorie Farm and Botanic Garden, 8–31.

Kuznetzov VI (1979) A review of the genera of Gracillariidae (Lepidoptera) of the Palaearctic fauna. Entomologicheskoe Obozrenie 58: 835–856.

Kuznetzov VI (1981) Gracillariidae. In: Medvedev GS (Ed) Keys to the insects of the European part of the USSR 4(2): 149–311.

Li BT (1994) Flora of China. Science Press, Beijing 44(1): 68–70.

Li HH, Zheng ZM (1996) Methods and techniques of specimens of microlepidoptera. Journal of Shannxi Normal University (Natural Science Edition) 24(3): 63–70.

Li HH, Hu BB, Liang ZP, Zao TJ, Ren XB (2009) Butterflies of Mt. Baxian, Illustrated Handbook of Insects Mt. Baxian State Nature Reserves, Tianjin, Science Press, Beijing, vi + 216 pp.

Meyrick E (1907) Descriptions of Australasian Micro-lepidoptera. XIX. Plutellidae. Proceedings of the Linnean Society of New South Wales 32: 53.

Meyrick E (1880) Descriptions of Australian Micro-lepidoptera. IV. Tineina. Proceedings of the Linnean Society of New South Wales 5: 168.

Meyrick E (1885) Descriptions of New Zealand Microlepidoptera. Gelechiadae. VIII. Tineina (part). New Zealand Journal of Science 2: 592.

Pellmyr O (2003) Yuccas, yucca moths, and coevolution: a review. Annals of the Missouri Botanical Garden 90: 35–55.

Riley CV (1892) The yucca moth and yucca pollination. Annals of the Missouri Botanical Garden 32: 99–159.

Robinson GS, Ackery PR, Kitching IJ, Beccaloni GW, Hernández LM (2001) Hostplants of the moth and butterfly caterpillars of the Oriental Region. The Natural History Museum, London and Southdene Sdn Bhd, Kuala Lumper, 744 pp.

Shapiro LH, Scheffer SJ, Maisin N, Lambert S, Purung HB, Sulistyowati E, Vega FE, Gende P, Laup S, Rosmana A, Djam S, Hebbar PK (2008) *Conopomorpha cramerella* (Lepidoptera: Gracillariidae) in the Malay Archipelago: Genetic signature of a bottlenecked population? Annals of the Entomological Society of America 101(5): 930–938.

Stainton HT (1859) Descriptions of twenty-five species of Indian Micro-Lepidoptera. Transactions of the Entomological Society of London, N. S. (series 2) 5(3): 111–126.

Vargas HA, Landry B (2005) A new genus and species of Gracillariidae (Lepidoptera) feeding on flowers of *Acacia macracantha* Willd. (Mimosaceae) in Chile. Acta Entomologica Chilena 29: 47–57.

Vári L (1961) South African Lepidoptera. Vol. I. Lithocolletidae. Transvaal Museum Memoir 12: 42–48.

Weiblen GD (2002) How to be a fig wasp. Annual Review of Entomology 47: 299–330.

ZooKeys 83: 57–62 (2011)
doi: 10.3897/zookeys.83.1177
www.zookeys.org

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

A new species of the leafhopper genus *Diomma* Motschulsky (Hemiptera, Cidadellidae, Typhlocybinae) from China

Yuehua Song[1,2,†], Zizhong Li[1,‡], Kangning Xiong[2,§]

1 *Institute of Entomology, Guizhou University, Guiyang, Guizhou 550025, China* **2** *Institute of South China Karst, Guizhou Normal University, Guiyang, Guizhou 550001, China*

† *urn:lsid:zoobank.org:author:62E9B76A-24FF-4C61-9E33-E88393B5012A*
‡ *urn:lsid:zoobank.org:author:9BA8A6EF-F7C3-41F8-AD7D-485FB93859F2*
§ *urn:lsid:zoobank.org:author:F3B9A06B-B8FC-4A29-9B7E-0DEEE2E3CF66*

Corresponding author: *Kangning Xiong* (xiongkn@163.com)

Academic editor: *Michael Wilson* | Received 14 September 2010 | Accepted 2 February 2011 | Published 25 February 2011

urn:lsid:zoobank.org:pub:EE8101F2-BEC1-44E4-896D-7556B9C61022

Citation: Song Y, Li Z, Xiong K (2011) A new species of the leafhopper genus *Diomma* Motschulsky (Hemiptera, Cidadellidae, Typhlocybinae) from China. ZooKeys 83: 57–62. doi: 10.3897/zookeys.83.1177

Abstract

In the present paper, a new species is added to the genus *Diomma* Motschulsky (Hemiptera: Cicadellidae: Typhlocybinae) from Southwest China, *D. pincersa* **sp. n.** At the same time, a key can distinguish all Chinese species of the genus is provided.

Keywords

Hemiptera, Auchenorrhyncha, new species, morphology, taxonomy, China

Introduction

The leafhopper genus *Diomma* was established by Motschulsky in 1863 (Dworakowska 1981; Chiang and Knight 1990). *Diomma* belongs to the tribe Erythroneurini (Typhlocybinae) with *Diomma ochracea* Motschulsky, 1863 as its type species. The genus consists of three subgenera: *Diomma* Motschulsky; *Bunyipia* Dworakowska and *Dilobonota* Dworakowska. So far, all species occurring in China belong to the subge-

nus *Diomma*, which distributed only in Oriental region. A new species from Guizhou Province, China is described and illustrated. A key to Chinese species of *Diomma* is given. All specimens examined are deposited to the collection of the Insititute of Entomology, Guizhou University, Guiyang, China (GUGC).

Taxonomy

Diomma Motschulsky

Diomma Motschulsky 1863: 102

Type species: *Diomma ochracea* Motschulsky, 1863.

Description. Body yellow or brownish yellow, more or less flattened. Head almost equally broad as pronotum. Crown anterior margin produced medially. Pronotum with width greater than length. Vertex and pronotum usually ornamented with dark spots or stripes. Scutellum small, triangular; transverse impression distinct. Forewing apical veins free or 3rd apical cell stalked; 4th apical cell smallest. Hind venation reduced, submarginal vein poorly developed.

Abdominal apodemes long and narrow.

Pygofer large and broad, with numeous long setae at caudal margin and baso-ventral angle respectively. Subgenital plate extending beyond pygofer, with several microsetae on dorsal margin and with few of long macrosetae on outer surface. Pygofer dorsal appendage with distinct basal suture, but not movably articulated or immovably fused to margin, without basal suture. Central part of style very thick; preapical lobe prominant, sensory pits situated at preapical portion. Aedeagal shaft curved ventrally, usually with a obvious big process between preatrium and base of shaft. Gonopore terminal or subapical. Connective V- or Y-shaped; two lateral arms very long; central lobe absent or vestigial.

Distribution. Afrotropical region, Australian region, Oriental region.

Key to Chinese species (♂) of the genus *Diomma*

1 Aedeagus preatrium with a large preatrial process.....**2**
– Aedeagus preatrium without preatrial process (Fig. 18).....
..... ***D. pulchra*** **(Matsumura, 1916)**
2 Gonopore apical **3**
– Gonopore subapical.....**5**
3 Aedeagal shaft with paired processes medially, which edges serrated (Fig. 19) ...
..... ***D. taiwana*** **(Shiraki, 1912)**
– Aedeagal shaft without paired processes medially.....**4**
4 Apex of aedeagal shaft with a short, rigid process (Fig. 17).....
.....***D. knighti*** **Dworakowska, 1981**

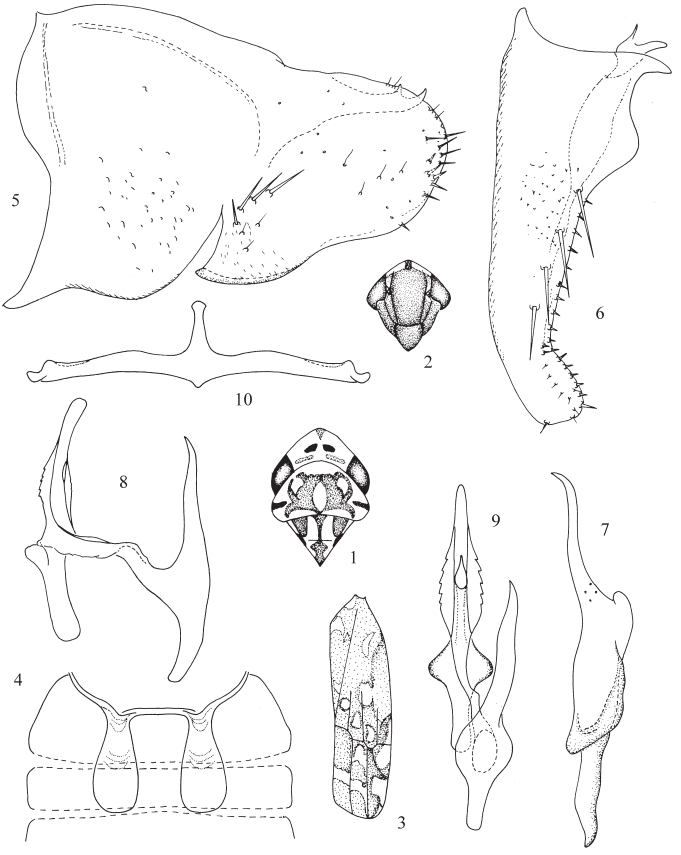
– Apex of aedeagal shaft without short, rigid process (Fig. 16) .... ***D. katoi* Dworakowska, 1981**

5 Aedeagal shaft with wide and compressed processes in median, which lateral margin serrated (Figs 8, 9) ..... ***D. pincersa* sp. n.**

– Aedeagal shaft without process in median (Fig. 14).. ***D. ilsae* (Jacobi, 1941)**

***Diomma* (*Diomma*) *pincersa* Song, Li & Xiong, sp. n.**
urn:lsid:zoobank.org:act:32756A97-957D-4B3E-8D11-398522C61F34
Figures 1–10

Description. Head (Fig. 1) width about equal in length to greast width of pronotum. Vertex (Fig. 1) yellow, with a large median apical spot, orange red and with four irregular spots: one pair near posterior margin of crown light brown; other pair smaller, blackish



Figures 1–10. *Diomma* (*D.*) *pincersa* Song, Li & Xiong, sp. n. **1** Head and thorax, dorsal view **2** Face **3** Fore wing **4** Abdominal apodemes **5** Pygofer lobe, lateral view **6** Subgenital plate **7** Style **8** Aedeagus, lateral view **9** Aedeagus, ventral view **10** Connective.

brwon. Eyes (Figs 1, 2) greyish black. Face (Fig. 2) brownish black, with a orange red spot at its upper part. Anteclypeus quite large and broad, little expanded, nearly pentagonal. Pronotum (Fig. 1) with large irregular nut-brown stripes. Scutellum (Fig. 1) small, triangular; basal triangles blackish brown, a longitudinal dark stripe extended from base to apex. Forewing wax field orange yellow, with several irregular markings as in Fig. 3.

Abdominal apodemes (Fig. 4) extended to posterior margin of 4th sternite.

Pygofer lobe (Fig. 5) broad, with few of long macrosetae on lateral surface. Pygofer dorsal appendage immovably fused to margin, its terminal part bifurcate. Subgenital plate (Fig. 6) long, much protruding beyond pygofer lobe, with four basal macrosetae and numerous short rigid setae along upper margin. Style (Fig. 7) broad in middle, long and slender at apical portion, with four sensory pits not far from preapical lobe. Preapical lobe small, but prominent. Aedeagal shaft (Figs 8, 9) curved ventrally, with serrated lateral margin in median; shaft elongated. Preatrium with a large process, its length about as long as that of dorsal apodeme. Gonopore subapical, ventrad. Connective (Fig. 10) Y-shaped, two lateral arms very long, which more than two times of connective stem length; central lobe small, quite vestigial.

Measurement. Body length males 2.8 mm.

Type material. *Holotype*, male, China: Guizhou Province, Qianxi County, 15~17 October 2007, coll. QIONG-ZHANG SONG. *Paratype*: one male, same date as holotype.

Remarks. The new species can be distinguished from other species of the genus by its unique aedeagus's structure (Figs 8, 9).

Etymology. The specific name is derived from the Latin word "pincersa" (claw, clamp), which refers to the pygofer dorsal appendage with terminal part branched or bifurcate (Fig. 5).

***Diomma* (*Diomma*) *ilsae* (Jacobi, 1941), rec. n.**
Figures 11–15

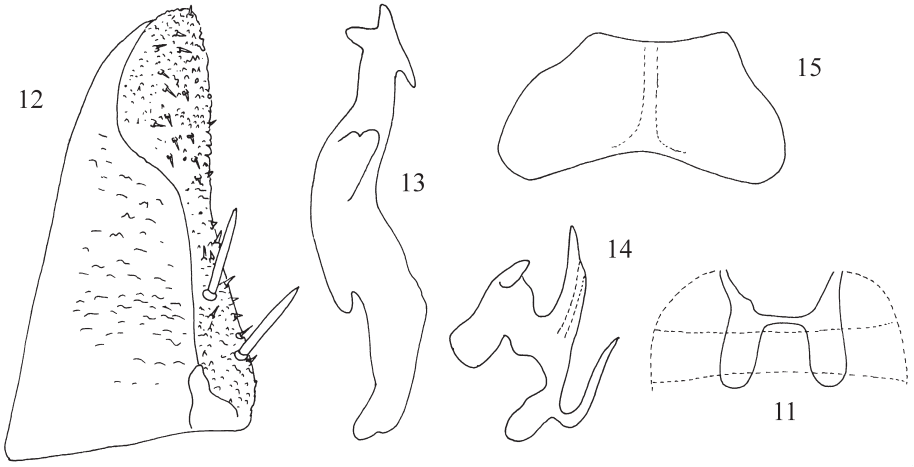
Typhlocyba ilsae Jacobi 1941
Zyginoides ilsae Dworakowska 1972: 860
Diomma ilsae Dworakowska 1981: 364

Type material. six males, six females, China: Yunnan Province, Mengla County, 18 July 2008, coll. Yuehua Song; one female, China: Yunnan Province, Menghai County, 24 July 2008, coll. Yuehua Song.

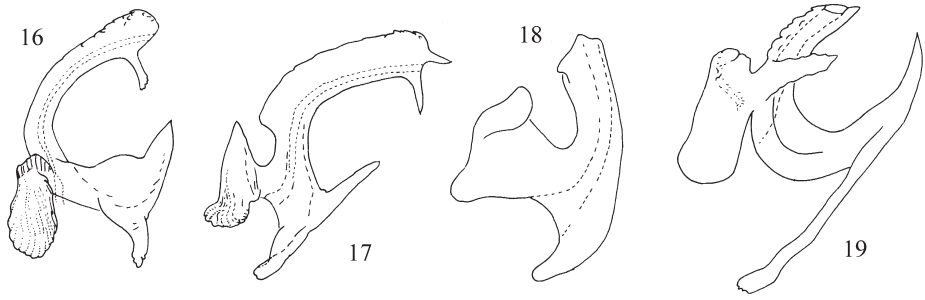
Distribution. Sunda; China (Yunnan).

Species checklist of *Diomma* from China

Diomma (*D.*) *ilsae* (Jacobi 1941), rec. n.
Typhlocyba ilsae Jacobi 1941



Figures 11–15. *Diomma* (*D.*) *ilsae* Jacobi, 1941, rec. n. (after Dworakowska, 1972) **11** Abdominal apodemes **12** Subgenital plate **13** Style **14** Aedeagus, lateral view **15** Connective.



Figures 16–19. Aedeagus, lateral view of *Diomma* species. **16** *Diomma* (*D.*) *katoi* Dworakowska, 1981 **17** *Diomma* (*D.*) *knighti* Dworakowska, 1981 **18** *Diomma* (*D.*) *pulchra* (Matsumura, 1916) **19** *Diomma* (*D.*) *taiwana* (Shiraki, 1912) (all figures after Dworakowska, 1972; 1981).

Zyginoides ilsae Dworakowska 1972
Diomma ilsae Dworakowska 1981
Distribution: China (Yunnan: Mengla, Menghai); Sunda
Diomma (*D.*) *katoi* Dworakowska 1981
Distribution: China (Taiwan: Taipei; Guizhou: Rongjiang)
Diomma (*D.*) *knighti* Dworakowska 1981
Distribution: China (Taiwan: Chiayi; Guizhou: Bijie)
Diomma (*D.*) *pincersa* Song, Li & Xiong, sp. n.
Distribution: China (Guizhou: Qianxi)
Diomma (*D.*) *pulchra* (Matsumura 1916)
Motschulskia pulchra Matsumura 1916

Platytettix pulchrus Matsumura 1932
Zyginoides (*Platytetticis*) *pulchra* Dworakowska 1972
Diomma pulchra Dworakowska 1981
Distribution: China (Taiwan: Taichung; Guizhou: Guiyang, Yanhe); Japan
Diomma (*D.*) *taiwana* (Shiraki 1912)
Eupteryx taiwanus Shiraki 1912
Zygina bokotonis Matsumura 1932
Pakeasta notata Ahmed 1971
Diomma taiwana Dworakowska 1981
Distribution: China (Taiwan: Taipei, Chiayi; Guizhou: Luodian, Xingyi; Yunnan: Pu'er; Hainan: Haikou); Japan; India

Acknowledgements

The project supported by the Key Technologies R&D Program of Guizhou Province (SY[2010]3068) and Guizhou Provincial Natural Science Foundation of China (No. [2010]2063).

References

Chiang CC, Knight WJ (1990) Studies on Taiwanese Typhlocybinae (Homoptera: Cicadellidae) (IV) Tribe Erythroneurini. Bulletin of the National Museum of Natural Science No. 2: 199–204.

Dworakowska I (1972) *Zyginoides* Mats. and some other Typhlocybinae (Auchenorrhyncha, Cicadellidae). Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Biologiques 20(12): 857–866.

Dworakowska I (1981) On the genus *Diomma* Motschulsky (Auchenorrhyncha, Cicadellidae, Typhlocybinae). Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Biologiques 28(6): 363–370.

Jacobi A (1941) Die Zikadenfauna der Kleinen Sundainseln. Nach der Expeditionsausbeute von B. Rensch. Zoologische Jahrbücher, Abteilung für Systematik Ökologie 74: 277–322.

Matsumura S (1916) Keiseisha Shoten. Applied Entomology 1, Tokyo, 1–731.

Motschulsky V (1863) Essai d'un catalogue des insectes de l'ile Ceylon. Bulletin of Society and Nature of Moscow 63: 1–153.

Shiraki T (1912) Investigations upon insects injurious to cotton. Formosa Agricultural Experimental Station Special Report 5: 1–282.

ZooKeys 83: 63–72 (2011)
doi: 10.3897/zookeys.83.1178
www.zookeys.org

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Three new species of the leafhopper genus *Tautoneura* Anufriev (Hemiptera, Cicadellidae, Typhlocybinae) from China

Yuehua Song[1,2,†], Zizhong Li[2,‡], Kangning Xiong[1,§]

1 *Institute of South China Karst, Guizhou Normal University, Guiyang, Guizhou 550001, China* **2** *Institute of Entomology, Guizhou University, Guiyang, Guizhou 550025, China*

† *urn:lsid:zoobank.org:author:62E9B76A-24FF-4C61-9E33-E88393B5012A*
‡ *urn:lsid:zoobank.org:author:9BA8A6EF-F7C3-41F8-AD7D-485FB93859F2*
§ *urn:lsid:zoobank.org:author:F3B9A06B-B8FC-4A29-9B7E-0DEEE2E3CF66*

Corresponding author: *Kangning Xiong* (xiongkn@163.com)

Academic editor: *Michael Wilson* | Received 14 December 2010 | Accepted 1 February 2011 | Published 25 February 2011

urn:lsid:zoobank.org:pub:BD4409B1-B32E-4219-AAFA-49CA92B2D35E

Citation: Song Y, Li Z, Xiong K (2011) Three new species of the leafhopper genus *Tautoneura* Anufriev (Hemiptera, Cicadellidae, Typhlocybinae) from China. ZooKeys 83: 63–72. doi: 10.3897/zookeys.83.1178

Abstract

In the present paper, three new species are added to the genus *Tautoneura* Anufriev from China, *T. baiyunshana* **sp. n.**, *T. caoi* **sp. n.** and *T. yunnanensis* **sp. n.** A key to species recorded from China is provided.

Keywords

Homoptera, *Tautoneura*, new species, morphology, taxonomy, China

Introduction

The leafhopper genus *Tautoneura* Anufriev (1969) belongs to the tribe Erythroneurini (Typhlocybinae) with *Tautoneura tricolor* Anufriev, 1969 as its type species. The genus consists of fifty-one species distributed in the Oriental and Palaearctic Regions. So far, twelve species in *Tautoneura* have been reported from China. A key to Chinese species

and a species checklist of *Tautoneura* from China are provided. In this paper, three new species are described and illustrated from Henan, Yunnan and Gangsu Provinces of China. All specimens examined are deposited to the Institute of South China Karst, Guizhou Normal University (ISCK) and Insititute of Entomology, Guizhou University (IEGU), Guiyang, China.

Materials and methods

The specimens were obtained by sweep net method and were studied under Olympus SZX7 and CX41 microscopes. Morphological techniques and terminology follow Dietrich and Dmitriev (2006). Measurements of the new species are given in millimeters; body length is measured from the apex of head to apex of forewing in repose.

Taxonomy

Tautoneura Anufriev, 1969

Tautoneura Anufriev, 1969: 186–188
Erythroneura (*Balia*) Dworakowska, 1970 (Dworakowska, 1977: 290)
Erythroneura (*Havelia*) Ahmed, 1971 (Dworakowska, 1977: 290; Dworakowska 1980: 182)

Type species: *Tautoneura tricolor* Anufriev, 1969

Description. Body small, about 2.0–3.0 mm, usually yellow or light yellow. Head bluntly produced medially, slightly narrower than pronotum or equal to greatest width of pronotum. Median length of vertex equal to or longer than length between eyes. Some species with more rounded anterior margin of vertex. Pronotum broad, often with irregular patches or spots; scutellum nearly triangular. Forewings usually with red markings or spots.

Pygofer lobe broad, usually with several macrosetae at basal lower angle and some short stout setae in distal part of lobe on inner surface, peg-like. Dorsal appendage of pygofer long, tapering apically, movably articulated with pygofer lobe. Some species have ventral appendage. Aedeagus usually with large dorsal apodeme and one or two pairs of processes of variable length at apex of shaft. Style slender, with slim "neck" subapically, and prominent preapical lobe. Connective nearly M- or Y-shaped, central lobe well developed, as long as or little shorter than lateral arms. Shape of anal tube appendage diverse, but that of most species hook-like at apex.

Distribution. Palaearctic and Oriental Regions.

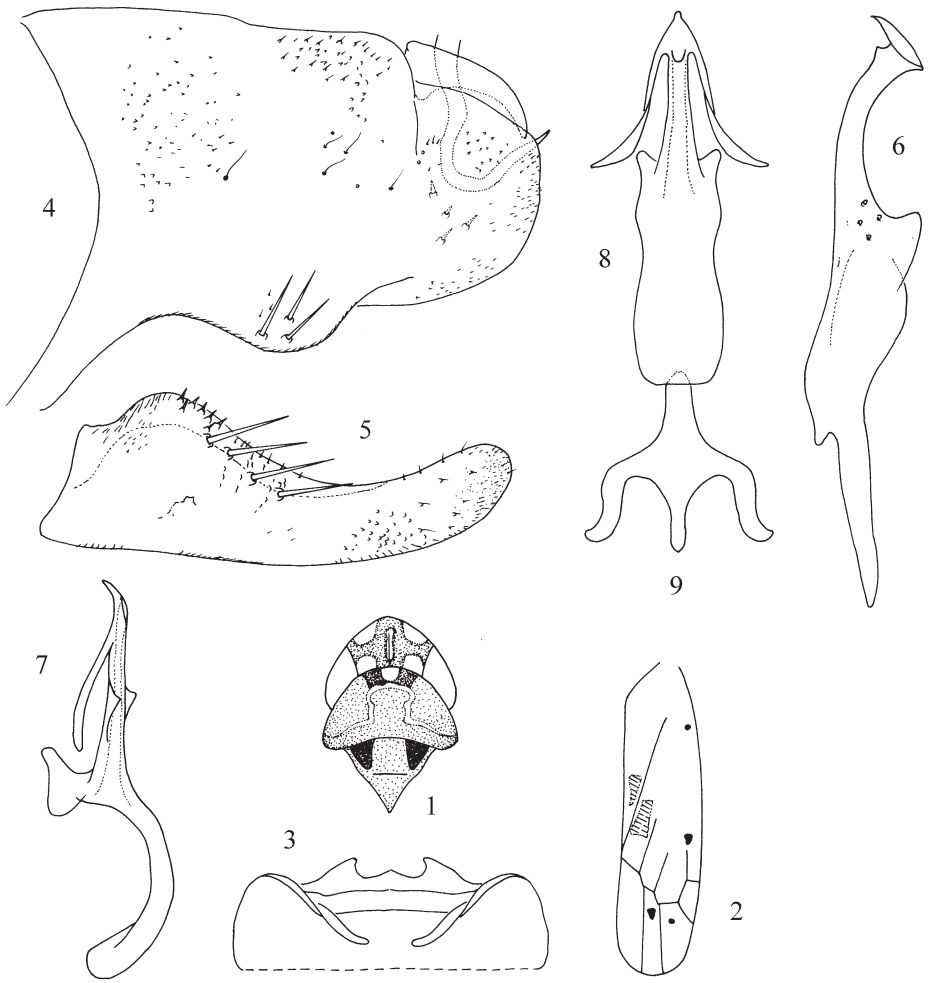
Key to males of *Tautoneura* from China

1 Vertex with two longitudinal red stripes that converge at anterior margin midpoint of vertex ..... ***T. mori***
– Vertex without convergent longitudinal stripes **2**
2 Aedeagal shaft without processes **3**
– Aedeagal shaft with one or more processes **4**
3 Aedeagus preatrium with one pair of processes ..... ***T. arachisi***
– Aedeagus preatrium without processes (Figs 16, 17) .... ***T. yunnanensis* sp.n.**
4 Aedeagal shaft with two pairs of processes **5**
– Aedeagal shaft with only one or one pair of processes 7
5 Aedeagal shaft process small, short, with one or more teeth **6**
– Aedeagal shaft process long, slim, finger-like ..... ***T. formosa***
6 Abdominal apodemes very slim, not extended beyond posterior margin of 3rd sternite (Fig. 3) ..... ***T. baiyunshana* sp. n.**
– Abdominal apodemes expanded distinctly, extended to 5th sternite ..... ***T. longiprocessa***
7 Aedeagal shaft with single, irregular process ..... ***T. sinica***
– Aedeagal shaft with pair of processes **8**
8 Processes arising from apex or sub-apex of aedeagal shaft **9**
– Processes arising from base or sub-base of aedeagal shaft **13**
9 Processes arising from apex of aedeagal shaft **10**
– Processes arising from sub-apex of aedeagal shaft ..... ***T. prima***
10 Apex of style long and slim, slightly curved ..... ***T. fusca***
– Apex of style truncate or short and broad **11**
11 Pronotum with nearly rectangular red spot medially ..... ***T. choui***
– Pronotum without red medial spot **12**
12 Forewing with three round red spots ..... ***T. tripunctula***
– Forewing with many orange-yellow markings, some areas with red spots or stripes ..... ***T. multimaculata***
13 Aedeagus dorsal appendage bifurcate at apex (Fig. 22) ..... ***T. caoi* sp. n.**
– Aedeagus dorsal appendage not bifurcate at apex ..... ***T. albida***

(Note: the key does not include *T. takaonella* Mats. 1932, as only females of the species are known.)

***Tautoneura baiyunshana* Song, Li & Xiong, sp. n.**
urn:lsid:zoobank.org:act:87B96B3F-18A7-4F49-A9B4-B3D42863ECC4
Figures 1–9

Description. Body brownish yellow or brown testaceous. Head (Fig. 1) narrower than pronotum. Crown (Fig. 1) anteriorly produced medially, coronal suture distinct. Ver-



Figures 1–9. *Tautoneura baiyunshana* Song, Li & Xiong, sp. n. **1** Head and thorax, dorsal view **2** Forewing **3** Abdominal apodemes **4** Pygofer lobe, lateral view **5** Subgenital plate **6** Style **7** Aedeagus, lateral view **8** Aedeagus, ventral view **9** Connective.

tex (Fig. 1) median length little shorter than width between two eyes. Vertex and pronotum (Fig. 1) with milky yellow stripes. Eyes (Fig. 1) brownish yellow. Scutellum (Fig. 1) brownish yellow, basal triangles darker. Forewing (Fig. 2) brownish yellow, semitransparent, with four irregular dark spots and with two broad orange red patches near claval suture.

Abdominal apodemes (Fig. 3) small, not exceeding hind margin of 3rd sternite.

Pygofer (Fig. 4) broad, with three macrosetae at baso-lateral angle and a few sparse long fine setae. Pygofer microtrichia conspicuous, well developed. Pygofer dorsal appendage simple, not extended beyond pygofer apex, curved ventrally. Anal tube appendage (Fig. 4) hook-like apically. Subgenital plate (Fig. 5) lateral margin distinctly

widened subbasally, with four macrosetae near median and with several short rigid setae along upper margin of sub-basal part. Style (Fig. 6) apex expanded, preapical lobe prominent. Connective (Fig. 9) nearly Y-shaped, central lobe and lateral arms slender; stem well developed, compressed. Aedeagal shaft (Fig. 7) almost straight, with pair of long processes arising near apex, another pair of short processes at middle area of shaft, triangular, lamellate in lateral view. Gonopore (Figs 7, 8) subapical and on ventral margin. Dorsal apodeme (Fig. 7) short; preatrium (Figs 7, 8) long and slim, about as long as or little longer than shaft.

Measurement. Body length males 2.5~2.6 mm, females 2.6~2.8 mm.

Host Plant. Unknown.

Type material. *Holotype*, male, China: Henan Province, Mt. Baiyunshan, 1300~1400 m, 17 August 2008, coll. Can Li. *Paratypes*: two males, ten females, same data as holotype.

Remarks. The new species is similar to *Tautoneura longiprocessa* Song & Li (2008), but can be distinguished from the latter by the paired long processes arising from subapex of shaft (Figs 7, 8); gonopore (Figs 7, 8) subapical; preatrium (Fig. 7) slim, longer than aedeagal shaft.

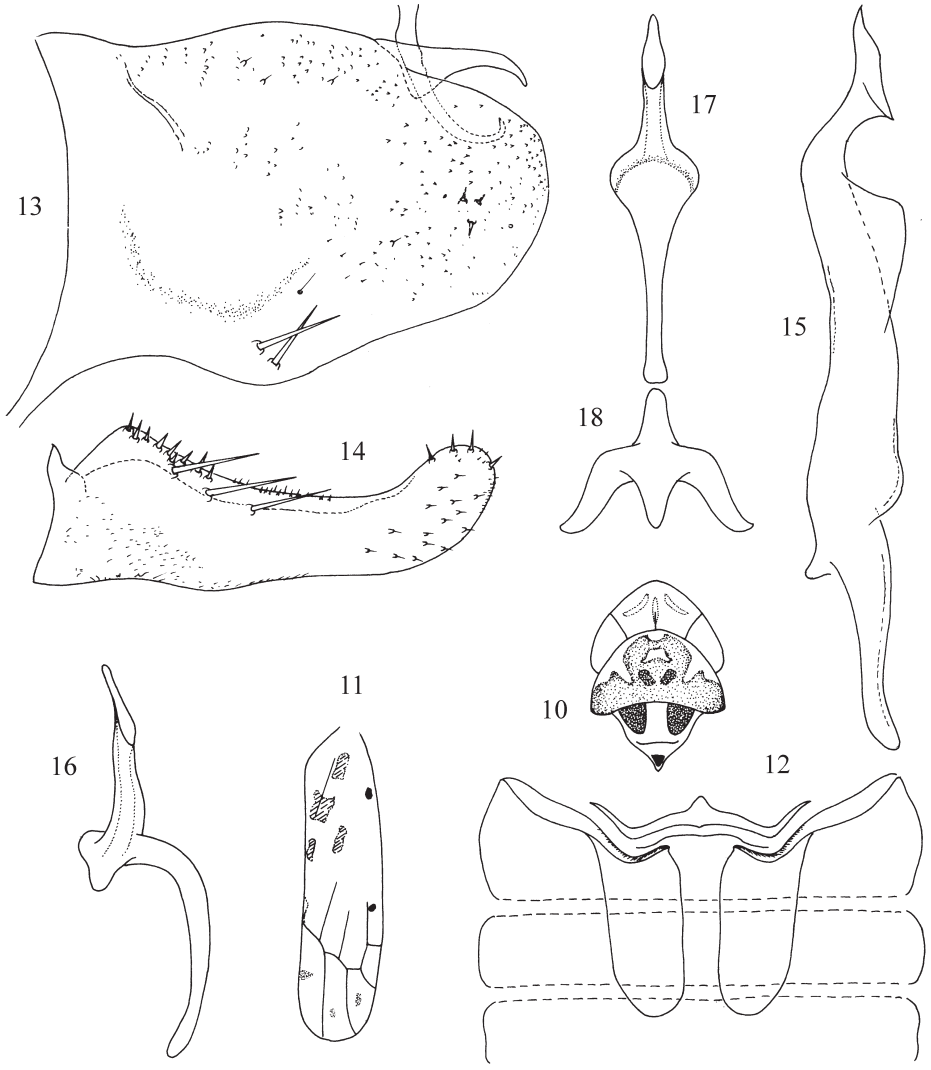
Etymology. The new species is named after its type locality: "Baiyunshan", Henan Province.

***Tautoneura yunnanensis* Song, Li & Xiong, sp. n.**
urn:lsid:zoobank.org:act:A8E8704B-EE04-457B-BA5E-1E00413FCDC7
Figures 10–18

Description. Body brownish yellow. Crown (Fig. 10) fore margin strongly produced and angulate medially. Coronal suture (Fig. 10) long, milky, nearly extended to 4/5 middle length of vertex. Two slim curving milky stripes situated at sides of coronal suture symmetrically. Eyes (Fig. 10) grey testaceous. Pronotum (Fig. 10) with two small orange red spots medially and broad area around them brownish. Scutellum (Fig. 10) light brown, with orange yellow spot at apex; basal triangles orange yellow. Forewing (Fig. 11) with four orange markings around claval suture and several brownish or blackish brown spots.

Abdominal apodemes (Fig. 12) large, broad, reaching 5th sternite.

Pygofer lobe (Fig. 13) broad, with two macrosetae at basal lower angle and numerous fine setae or microsetae distributed on lateral surface. Pygofer microtrichia distinct. Pygofer dorsal appendage expanded at base and tapering towards apex, bent ventrally. Anal tube appendage (Fig. 13) slim, hook-like apically. Subgenital plate (Fig. 14) with three basal macrosetae, expanded subbasally and with several peg-like short setae. Style (Fig. 15) quite long, apex expanded obviously; preapical lobe large, prominent. Connective (Fig. 18) Y-shaped, lateral arms strong, central lobe and stem well developed. Aedeagal shaft (Figs 16, 17) almost straight and short in lateral view, its base conspicuously expanded in ventral view; without any process. Gonopore (Figs 16, 17) broad,



Figures 10–18. *Tautoneura yunnanensis* Song, Li & Xiong, sp. n. **10** Head and thorax, dorsal view **11** Forewing **12** Abdominal apodemes **13** Pygofer lobe, lateral view **14** Subgenital plate **15** Style **16** Aedeagus, lateral view **17** Aedeagus, ventral view **18** Connective.

apically. Aedeagus dorsal apodeme (Fig. 16) short and small; preatrium (Figs 16, 17) much longer than aedeagal shaft.

Measurement. Body length males 2.2~2.3 mm.

Host plant. Unknown.

Type material. *Holotype*, male, China: Yunnan Province, Lijiang, 16 July 2010, coll. CAN LI. *Paratypes*: one male, same data as holotype; one male, China: Yunnan Province, Mengla County, 18 July 2008, coll. YUEHUA SONG.

Remarks. The new species is similar to *Tautoneura misrai* Dworakowska (1977), but can be distinguished from the latter by the large and broad, apical gonopore; the aedeagus dorsal apodeme short, not expanded distinctly and the ventral appendage absent; the forewing with four orange patches near claval suture.

Etymology. The new species is named after its type locality: "Yunnan", China.

***Tautoneura caoi* Song, Li & Xiong, sp. n.**
urn:lsid:zoobank.org:act:1CAE0426-23ED-4C0B-AC2A-7013DBAC940F
Figures 19–27

Description. Body yellowish. Structural characters as in *T. baiyunshana* sp. n. and *T. yunnanensis* sp. n. Vertex and pronotum (Fig. 19) with irregular orange red markings. Eyes grey. Scutellum (Fig. 19) basal triangles orange yellow and apex with dark spot. Forewing (Fig. 20) brownish yellow, semitransparent, with numerous orange yellow markings, some parts with red spots or streak, apex (apical cells) dark brown.

Abdominal apodemes (Fig. 21) broad, extended beyond posterior margin of 3rd sternite.

Pygofer lobe (Fig. 22) broad, with numerous macrosetae, long fine setae and rigid short setae. Pygofer microtrichia inconspicuous. Dorsal appendage bifurcate far from base, extended beyond pygofer apex. Subgenital plate (Fig. 23) with four basal macrosetae and distinct marginal subbasal rigid setae formed continuous row. Style (Fig. 24) slender, apex expended slightly; preapical lobe prominent. Connective (Fig. 27) Y-shaped, two arms strong, central lobe well developed. Aedeagal shaft (Figs 25, 26) short, with pair of lateral processes at sub-base, part between aedeagal shaft and preatrium expanded. Gonopore nearly median, on ventral margin. Dorsal apodeme little longer than that of other two new species. Preatrium long, much longer than aedeagal shaft.

Measurement. Body length males 2.5~2.6 mm, females 2.7~2.8 mm.

Host plant. *Ulmus pumila* L. (Elm)

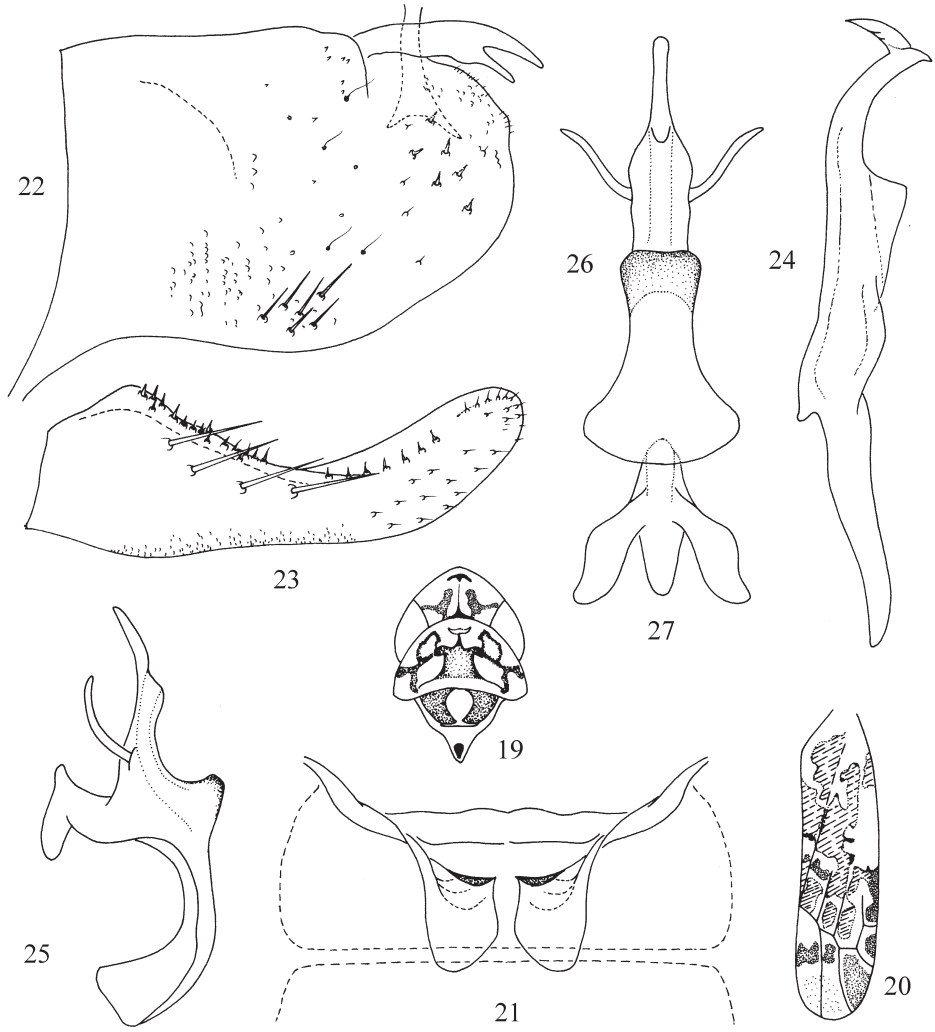
Type material. *Holotype*, male, China: Gansu Province, Zhenyuan County, 19 May 2010, coll. WEI CAO. *Paratypes*: seven males, ten females, same data as holotype.

Remarks. The new species is distinguishable from *T. ahmedi* Dworakowska (1977) by the aedeagus preatrium strongly expended at terminal part; the dorsal appengage bifurcate apically and the gonopore near median area of aedeagal shaft.

Etymology. This sepcies is named after its collector.

Species checklist of *Tautoneura*

T. (*Havelia*) *ahmedi* Dworakowska 1977. India
T. (*Havelia*) *alba* (Ahmed, 1971) India
T. (*T.*) *albida* (Dworakowska 1970). China (Guangdong)



Figures 19–27. *Tautoneura caoi* Song, Li & Xiong, sp. n. **19** Head and thorax, dorsal view **20** Forewing **21** Abdominal apodemes **22** Pygofer lobe, lateral view **23** Subgenital plate **24** Style **25** Aedeagus, lateral view **26** Aedeagus, ventral view **27** Connective.

T. (*T.*) *arachisi* (Matsumura, 1916). China (Taiwan)
T. (*Havelia*) *bellula* Dworakowska 1994. Sikkim
T. (*T.*) *bena* Dworakowska 1981 India
T. (*Havelia*) *baiyunshana* Song, Li & Xiong, sp. n. China (Henan)
T. (*Havelia*) *caoi* Song, Li & Xiong, sp. n. China (Gansu)
T. (*Havelia*) *choui* Ma 1983. China (Shaanxi)
T. (*T.*) *deska* (Dworakowska 1970). Samoa
T. (*T.*) *dubiosa* Dworakowska 1981. Nepal
T. (*T.*) *dubiosissima* Dworakowska 1981. Nepal

T. (*T.*) *dukara* Dworakowska 1981. India
T. (*T.*) *eda* Dworakowska 1981. India
T. (*T.*) *erythropunctata* (Ramakrishnan & Menon, 1973) India
T. (*T.*) *ficaria* Dworakowska, 1984. India; Singapore
T. (*T.*) *formosa* (Dworakowska 1970). China (Jiangsu)
T. (*T.*) *fusca* (Dworakowska 1970). China (Guangdong)
T. (*T.*) *incisa* Dworakowska 1980. India
T. (*T.*) *indefinita* (Dworakowska 1970). Samoa
T. (*T.*) *japonica* Dworakowska, 1972. Japan
T. (*T.*) *kira* Dworakowska 1981. India
T. (*T.*) *klara* Dworakowska 1981. India
T. (*T.*) *leucothoe* (Kirkaldy, 1907). Fiji; Samoa
T. (*T.*) *longiprocessa* Song and Li 2008. China (Guizhou)
T. (*Havelia*) *maculosa* Sohi, Mann & Shenhmar, 1987. India
T. (*Havelia*) *manica* Thapa, 1989. Nepal
T. (*T.*) *marthae* (Linnavuori, 1960). Fiji
T. (*T.*) *mayarami* Mathew & Ramakrishnan, 1996. India
T. (*T.*) *misrai* Dworakowska 1977. India
T. (*T.*) *mori* (Matsumura, 1910). China (Shangdong, Anhui, Jiangsu, Zhejiang, Sichuan, Guizhou)
T. (*T.*) *mukla* Dworakowska 1981. India
T. (*Havelia*) *multimaculata* Song and Li, 2009. China (Guizhou).
T. (*T.*) *mureda* Dworakowska 1981. Nepal
T. (*T.*) *napa* Dworakowska 1981. India
T. (*T.*) *ochreleuca* Thapa, 1984. Nepal
T. (*Havelia*) *panthera* Dworakowska 1994. Sikkim
T. (*T.*) *panti* Dworakowska,1977. India
T. (*Havelia*) *pewna* Sohi & Mann, 1992. Nepal
T. (*T.*) *prima* Dworakowska 1979. China (Guizhou)
T. (*T.*) *redama* Dworakowska 1981. Nepal
T. (*T.*) *sanguinalis* (Distant, 1918). India
T. (*T.*) *secunda* Dworakowska 1979. Vietnam
T. (*T.*) *sinica* (Dworakowska 1970). China (Guangdong, Jiangsu)
T. (*T.*) *smocza* Dworakowska 1980. India
T. (*T.*) *takaonella* (Matsumura 1932). China (Taiwan)
T. (*Havelia*) *tricolor* Anufriev 1969. Russia
T. (*T.*) *tripunctula* (Melichar, 1903). China (Guizhou, Yunnan)
T. (*Havelia*) *unicolor* Dworakowska 1979. Vietnam
T. (*Havelia*) *yunnanensis* Song, Li & Xiong, sp. n. China (Yunnan)
T. (*T.*) *zembata* Dworakowska 1979. Japan
T. (*T.*) *zizypha* Thapa, 1984. Nepal
T. (*T.*) *zobra* Dworakowska 1979. Vietnam
T. (*Havelia*) *zygina* Dworakowska 1994. Sikkim

Acknowledgements

We would like to express our sincere thanks to Mr. Wei Cao, Bureau of Agriculture and Pasture of Zhenyuan County, Gansu, China, for providing material for the study and Dr. Can Li, Department of Biology and Engineering of Environment, Guiyang University, China for help in the current research. The present study is part of a wider survey of Typhlocybine leafhoppers from China. The project was supported by the Guizhou Provincial Natural Science Foundation of China (No. [2010]2063) and Key Technologies R&D Program of Guizhou Province (SY[2010]3068).

References

Anufriev GA (1969) New and little known leaf-hoppers of the subfamily Typhlocybinae from the Soviet Maritime Territory (Homoptera, Auchenorrhyncha). Acta Faunistica Entomologica Musei Nationalis Pragae 13: 186–188.

Dietrich CH, Dmitriev DA (2006) Review of the New World genera of the leafhopper tribe Erythroneurini (Hemiptera: Cicadellidae: Typhlocycbinae). Illinois Natural History Survey Bulletin 37(5): 119–190.

Dworakowska I (1970) A new subgenus of *Erythroneura* Fitch (Auchenorrhyncha, Cicadellidae, Typhlocybinae). Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Biologiques 18(6): 347–354.

Dworakowska I (1977) On some north Indian Typhlocybinae (Homoptera, Auchenorrhyncha: Cicadellidae). Reichenbachia 16(29): 290–293.

Dworakowska I (1979) On some Erythroneurini from Vietnam (Typhlocybinae, Cicadellidae). Annotationes Zoologicae et Botanicae 131: 27–28.

Dworakowska I (1980) On some Typhlocybinae from India (Homoptera, Auchenorrhyncha, Cicadellidae). Entomologische Abhandlungen und Berichte aus dem Staatlichen Museum fur Tierkunde in Dresden 43: 151–201.

Dworakowska I (1981) *Proskura* gen. n. and some Erythroneurini from Souther India (Homoptera, Auchenorrhyncha, Cicadellidae, Typhlocybinae). Reichenbachia 19(37): 231, 241.

Dworakowska I (1994) Typhlocybinae (Auchenorrhyncha, Cicadellidae) known to occur in Sri Lanka. Annotationes Zoologicae et Botanicae 216: 30–33.

Ma (1983) A new species of the genus *Tautoneura* and a new record from China. Entomotaxonomia 5(2): 149–150.

Matsumura S (1932) A revision of the Palaearctic and Oriental Typhlocybid-genera with descriptions of new species and new genera. Insecta Matsumurana 6(3): 118.

Song YH, Li ZZ (2008) Notes on Chinese species of the genus *Tautoneura* Anufriev (Hemiptera: Cicadellidae: Typhlocybinae), with descriptions of two new species. Zootaxa 1769: 60–68.