HEMLOCK ADELGID, SMALL MAMMAL, AMPHIBIAN, AND TERRESTRIAL INVERTEBRATE STUDY, 1993-1994
IDENTIFICATION OF SPIDERS (ARACHNIDA: ARANEAE)
FINAL REPORT

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This **Final Report** summarizes the identification work that has been completed for this study. Three **Progress Reports** were previously submitted for this study as follows: 1st Progress Report, 10 November 1995; 2nd Progress Report, 20 June 1996; and 3rd Progress Report, 24 September 1996.

In August of 1993 and 1994, pitfall traps were deployed by National Park Service personnel at two sites on the Delaware Water Gap National Recreation Area. The collection sites were: Adams Creek, Pike County, Pennsylvania; and Van Campens Brook, Sussex County, New Jersey. The purpose of

these trap deployments was to inventory small mammals, amphibians, and terrestrial invertebrates at each site. Such inventories are needed to help ascertain the natural enemies, chiefly predators, that are associated with the hemlock adelgid. This **Final Report** concerns the spider identification component of this study. It does not address statistical comparisons of mean pitfall-trap catches among transects within sites, between sites, or between years. However, it does include some nonparametric comparisons (Sokal and Rohlf 1981) of spider frequencies and abundances by life stage, sex, and foraging guild. All comparisons were done at $P = 0.05$.

Spider identifications.____Only sexually mature spiders were identified to species; juveniles, including penultimate stages, were identified at least to family, and most to genus. Species determinations follow the identification keys and descriptions of Kaston (1981); other consulted sources included: Opell and Beatty (1976) for the Hahniidae; Chamberlin and Ivie (1940) for species of *Cicurina*; Bennett (1987) for species of *Wadotes*; Muma (1946) for species of *Coras*; Millidge (1983) for species of *Walckenaeria*; Millidge (1987) for species of *Eperigone*; and, Dondale and Redner (1978) for the Philodromidae and the Thomisidae.

The spider family and generic groupings follow those of Platnick (1993), which include numerous re-assignments of

genera and species. For example, the genera *Cicurina*, *Coras*, and *Wadotes* formerly were assigned to the Family Agelenidae; however, *Cicurina* is now considered to belong to the Family Dictynidae, and both *Coras* and *Wadotes* are now assigned to the Family Amaurobiidae. Likewise, species of the clubionid genera *Agroeca* and *Castianeria* have been assigned to separate families; i.e., *Agroeca* now belongs in the Family Liocranidae; *Castianeira* has been assigned to the Family Corinnidae.

Spider taxa.___At Adams Creek, spiders of 10 families, 13 genera, and at least 15 species were pitfall-trapped during August 1993 (Table 1); likewise, at Van Campens Brook, spiders of 7 families, 10 genera, and at least 14 species were captured by pitfall traps during August 1993 (Table 2). Similarily, the 1994 pitfall-trap samples yielded spiders of 12 families, 16 genera, and at least 17 species at Adams Creek (Table 3); and spiders of 9 families, 11 genera, and at least 13 species at Van Campens Brook. For both study years, fewer taxa (families, genera, species) were captured at Van Campens Brook than at Adams Creek.

Over all sampling dates and localities, the pitfall traps yielded spiders of 14 families, 24 genera, and at least 32 species. Of the 32 species, 27 were represented by adult spiders; whereas, 5 were represented by juveniles of identified genera (i.e., *Araniella* sp., *Gladicosa* sp., *Drassyllus*

sp., and *Gnaphosa* sp.), and one undetermined genus (i.e., LINYPHIIDAE, Erigoninae) (Tables 1-4). Juveniles of other identified genera (e.g., *Wadotes* spp.) probably belong to species represented by adults (e.g., *Wadotes calcaratus* (Keys.) and *W. hybridus* (Em.). Unfortunately, species descriptions and identification keys are not available for most juvenile spiders.

Two sexually mature spiders could not be determined to species; i.e., a *Rabidosa* male captured 18-27 August 1993, at Adams Creek in pitfall E-4; and a *Pirata* female captured 18-27 August 1993, at Van Campens Brook in pitfall M-7. Most likely, both of these lycosid spiders represent new, undescribed species. Both specimens have been sent to Dr. Allen R. Brady, Department of Biology, Hope College, Holland, MI for further evaluation (copy of transmittal letter attached).

Spider taxa varied considerably between study sites and sampling years. Species of only four families, i.e., Agelenidae, Hahniidae, Amaurobiidae, and Lycosidae, were captured each year and at both study sites (Tables 1-4). Species of Linyphiidae, Dictynidae, Liocranidae, and Philodromidae were caught both study years at Adams Creek, but only one year (1994) at Van Campens Brook. Gnaphosid spiders were captured at both sites in 1993; however, this family (Gnaphosidae) was represented by different species at

each site (i.e., *Gnaphosa* sp. and *Herpyllus ecclesiasticus* Hentz at Adams Creek; *Drassyllus* sp. at Van Campens Brook (Tables 1 and 2)). Females of the clubionid spider, *Clubionoides excepta* (L. Koch), were taken both study years, but only at Adams Creek (Tables 1 and 3). Species of crab spiders (Thomisidae) were taken at both sites, but family representation differed between years (i.e., in 1993, *Xysticus fraternus* Banks was captured at Van Campens Brook (Table 2); in 1994, *Misumenops oblongus* (Keyserling) was captured at Adams Creek (Table 3). Finally, species of two families (i.e., Araneidae and Salticidae) were captured in pitfall traps at only one site and in only one year (Tables 2 and 3).

Species composition varied among spider families each year and for each study site (Tables 1-4). However, species per spider family ranged from only 1 to 4, with the Amaurobiidae consistently the richest. Only 5 species were consistently captured each year at both sites: *Agelenopsis utahana* (Chamberlin & Ivie), *Neoantistea magna* (Keyserling), *Wadotes calcaratus* (Keyserling), *W. hybridus* (Emerton), and *Pirata montanus* Emerton.

The ranking order of abundance for the 3 most common species was:

Adams Creek, 1993

1st *Wadotes hybridus* (Emerton)

2nd *Neoantistea magna* (Keyserling)

3rd *Agelenopsis utahana* (Chamberlin & Ivie)

Adams Creek, 1994

1st *Wadotes hybridus* (Emerton)

2nd *Agelenopsis utahana* (Chamberlin & Ivie)

3rd *Neoantistea magna* (Keyserling)

Van Campens Brook, 1993

1st *Agelenopsis utahana* (Chamberlin & Ivie)

2nd *Wadotes hybridus* (Emerton)

3rd *Pirata montanus* Emerton

Van Campens Brook, 1994

1st *Neoantistea magna* (Keyserling)

2nd *Agelenopsis utahana* (Chamberlin & Ivie)

3rd *Wadotes calcaratus* (Keyserling)

Except for Van Campens Brook in 1993, species of *Wadotes*, *Agelenopsis*, and *Neoantistea* were consistently included in the rankings.

Spider numbers, life stages, sex ratios.___Over both study sites, the pitfall traps yielded a total of 804 spiders; 421 were captured in 1993; 383 were captured in 1994. Most of the captured spiders were adults (85.4%); juveniles (14.6%) comprised the remainder. Each year at both sites, the traps caught significantly more adult spiders than juvenile spiders: at Adams Creek in 1993, $G = 265.15$, $P < 0.001$; in

1994, G = 127.43, P < 0.001; both years combined, G = 387.62, P = 0.001; at Van Campens Brook in 1993, G = 27.13, P < 0.001; in 1994, G = 45.31, P < 0.001; both years combined, G = 72.37. Not surprisingly, when catches were combined for sites and years, significantly more adults (n = 687) were trapped than juveniles (n = 117); G = 447.48, P < 0.001.

For both study years, males were the most prevalent life stage trapped at each site; abundance of males usually was followed by females and juveniles in that order. At Adams Creek in 1993, males comprised 80.9% of total site catches (n = 345); whereas, females comprised only 9.9% and juveniles 9.3%. At Adams Creek in 1994, corresponding values were: males (71.0%), females (13.7%), and juveniles (15.4%), where n = 241. At Van Campens Brook in 1993, males comprised 46.0% of total site catches (n = 76), females 32.9%, and juveniles 21.1%. Corresponding values for this site in 1994 were: males (46.5%), females (31.0%), and juveniles (22.5%), where n = 142.

Sex ratios of captured male spiders to captured female spiders generally were biased in favor of males. At Adams Creek, ratio = 8.2, G = 218.79, P < 0.001 in 1993; ratio = 5.2, G = 102.23, P < 0.001 in 1994; and ratio = 6.7, G = 317.99, P < 0.001 for both years combined. At Van Campens Brook, ratio = 1.4, G = 1.67, P > 0.10 (n.s.) in 1993; ratio

= 1.5, G = 4.43, $P < 0.05$ in 1994; and ratio = 1.5, G = 6.06, $P < 0.05$ for both years combined. For combined sites and years, the values were: ratio = 4.05, G = 268.73, $P < 0.001$.

Spider foraging strategy.___Two basic foraging guilds were recognized: web-spinning spiders that forage with a catching web, and hunting spiders that forage without a web (Nyffeler et al. 1994). Consistently, more web-spinner species and individuals were captured in the pitfall traps than hunter species and individuals (Tables 1-4). Mean species per site ranged from 1.60, SD = 1.34 (Adams Creek, 1993) to 2.67, SD = 1.53 (Van Campens Brook, 1993). In 1994, the corresponding means were: 1.67, SD = 1.21 for Adams Creek; 1.80, SD = 1.30 for Van Campens Brook. For individuals, G-tests indicated that web-spinners were numerically dominant ($P < 0.001$) for all guild comparisons within sites and between study years. At Adams Creek: G = 320.02 in 1993, G = 134.38 in 1994, and G = 442.93 for both years combined. At Van Campens Brook: G = 27.13 in 1993, G = 32.35 in 1994, and G = 91.44 for both years combined.

CONCLUSIONS

The results of this study indicate that the two sampled hemlock ravines have a diverse assemblage of spiders. The absolute number of spider taxa (families, genera, species) that comprise the araneofauna of these communities and habitats no doubt far exceeds those observed during this

study; i.e., 14 families, 24 genera, and 32 species. For example, Coyle (1981) observed spiders of at least 134 species and 23 families in a southern Appalachian forest that included eastern hemlock, *Tsuga canadensis* (L.) Carr. Employment of other sampling methods (e.g., Tullgren funnels, Berlese traps, sweeping), sampling over longer time periods (i.e., > 10 days/year), and sampling other strata should yield additional individuals and other taxa.

Apparently, there are at least two undescribed species of spiders found in the hemlock ravines studied; i.e., species of *Rabidosa* and *Pirata*, both wolf spiders. Additional samples are needed to verify species status.

The preponderance of male spiders in these collections is not unusual because pitfall traps are selectively biased toward capture of wandering cursorial spiders (Uetz and Unzicker 1976). In general, male spiders are more mobile and may move considerable distances in search of mates; hence, the sexes are seldom equally represented in pitfall-trap catches (Hallander 1967; Muma 1975; Jennings et al. 1988; Collins et al. 1996).

The disproportionate abundances of web-spinners over hunters were unexpected because pitfall traps generally capture few web-spinner species of spiders (Uetz 1975). Web-spinners are relatively sedentary compared to the more active,

cursorial hunters (Gertsch 1979). Consequently, pitfall traps usually capture more species and individuals of the hunter guild than of the web-spinner guild; e.g., see studies by Uetz (1975); Hilburn and Jennings (1988); Jennings et al. (1988); and, Collins et al. (1996).

Additional studies are needed to fully determine and evaluate the araenofauna associated with hemlock ravines on the Delaware Water Gap National Recreation Area.

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TABLE 1. LIST OF IDENTIFIED ARANEAE

ADAMS CREEK, PIKE COUNTY, PENNSYLVANIA

PITFALL TRAP COLLECTION, 1993

Spider Taxa	Sampling Site		
	"S"	"M"	"E"
	Number of individuals		
	(m= male; f= female; j= juvenile)		
WEB SPINNERS			
LINYPHIIDAE			
Subfamily Erigoninae			
Undet. genus, sp.	1 j		
AGELENIDAE			
Agelenopsis utahana (Chamb. & Ivie)	11 m	10 m	32 m 5 f
HAHNIIDAE			
Neoantistea magna (Keys.)	22 m	39 m 1 f	30 m
DICTYNIDAE			
Cicurina arcuata Keys.			1 f
Cicurina sp.		1 j	
AMAUROBIIDAE			
Callobius sp.		1 j	2 j
Coras medicinalis (Hentz)		1 f	
Coras sp.	1 j		

Wadotes calcaratus (Keys.)	1 f	3 f	1 m
			1 f
Wadotes hybridus (Em.)	25 m	45 m	62 m
		3 f	4 f
Wadotes spp.	3 j	8 j	10 j
HUNTERS			
LYCOSIDAE			
Pirata montanus Emerton	7 f	3 f	3 f
Rabidosa sp. 1			1 m
LIOCRANIDAE			
Agroeca sp.		1 j	
CLUBIONIDAE			
Clubionoides excepta (L. Koch)			1 f
GNAPHOSIDAE			
Gnaphosa sp.			1 j
Herpyllus ecclesiasticus Hentz		1 m	
PHILODROMIDAE			
Philodromus sp.	1 j	1 j	1 j
Subtotals m =	58	95	126
f =	8	11	15
j =	6	12	14
Totals =	72	118	155

TABLE 2. LIST OF IDENTIFIED ARANEAE

VAN CAMPENS BROOK, SUSSEX COUNTY, NEW JERSEY

PITFALL TRAP COLLECTION, 1993

Spider Taxa	Sampling Site		
	"S"	"M"	"E"
	Number of individuals		
	(m= male; f= female; j= juvenile)		
WEB SPINNERS			
AGELENIDAE			
Agelenopsis pennsylvanica (C. Koch)			2 m
Agelenopsis potteri (Blkw.)			1 f
Agelenopsis utahana (Chamb. & Ivie)	1 m	8 m	5 m
Agelenopsis sp.	1 j	1 j	
HAHNIIDAE			
Neoantistea magna (Keys.)	1 m	5 m	3 m
AMAUROBIIDAE			
Callobius bennetti (Blkw.)		1 f	
Callobius sp.			2 j
Coras sp.	1 j		
Wadotes calcaratus (Keys.)	1 f	5 f	1 f
Wadotes hybridus (Em.)	2 m	2 m	6 m
		1 f	1 f
Wadotes spp.	3 j	5 j	1 j

HUNTERS

LYCOSIDAE			
Gladicosa sp.		1 j	
Pirata montanus Emerton	4 f	4 f	2 f
Pirata sp. 2		1 f	
GNAPHOSIDAE			
Drassyllus sp.		1 j	
THOMISIDAE			
Xysticus fraternus Banks			2 f
SALTICIDAE			
Hentzia mitrata (Hentz)	1 f		
Subtotals m =	4	15	16
f =	6	12	7
j =	5	8	3
Totals =	15	35	26

Callobius sp.			2 j
Coras sp.	1 j		1 j
Wadotes calcaratus (Keys.)	3 f		
Wadotes hybridus (Emerton)	35 m	43 m	49 m
	1 f	2 f	
Wadotes spp.	7 j	6 j	9 j

HUNTERS

LYCOSIDAE			
Pirata montanus Emerton	9 f	4 f	2 f
Schizocosa ocreata (Hentz)			1 f
LIOCRANIDAE			
Agroeca ornata Banks			1 f
Agroeca sp.			7 j
CLUBIONIDAE			
Clubionoides excepta (L. Koch)		1 f	
CORINNIDAE			
Castianeira cingulata (C. L. Koch)	2 m		5 m
			1 f
PHILODROMIDAE			
Philodromus exilis Banks	1 f		
THOMISIDAE			
Misumenops oblongus (Keys.)			1 f

Subtotals	m =	42	52	77
	f =	15	10	8
	j =	9	7	21
Totals	=	66	69	106

TABLE 4. LIST OF IDENTIFIED ARANEAE

VAN CAMPENS BROOK, SUSSEX COUNTY, NEW JERSEY

PITFALL TRAP COLLECTION, 1994

Spider Taxa	Sampling Site		
	"S"	"M"	"E"
	Number of individuals		
	(m= male; f= female; j= juvenile)		
WEB SPINNERS			
LINYPHIIDAE (Erigoninae)			
Halorates oxypaederotipus (Crosby)		1 f	
Undet. genus, sp.		1 j	
AGELENIDAE			
Agelenopsis utahana (Chamb. & Ivie)	2 m	6 m	10 m
		1 f	1 f
HAHNIIDAE			
Neoantistea magna (Keys.)	11 m	17 m	9 m
	1 f	1 f	
DICTYNIDAE			
Cicurina pallida Keys.	2 f	1 f	
Cicurina sp.		1 j	1 j
AMAUROBIIDAE			
Callobius sp.	1 j		
Coras parallelis Muma	1 f		

Coras sp.		1 j	
Wadotes calcaratus (Keys.)	6 f	8 f	2 f
Wadotes hybridus (Emerton)	1 m	4 m	2 m
		1 f	
Wadotes spp.	4 j	9 j	11 j

HUNTERS

LYCOSIDAE			
Pirata montanus Emerton	3 f	10 f	4 f
LIOCRANIDAE			
Agroeca sp.		1 j	1 j
CORINNIDAE			
Castianeira cingulata (C. L. Koch)		1 m	3 m
PHILODROMIDAE			
Philodromus vulgaris (Hentz)			1 f
Philodromus sp.	1 j		
Subtotals m =	14	28	24
f =	13	23	8
j =	6	13	13
Totals =	33	64	45