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Lichen Use by Larval *Leucochrysa pavid* (Neuroptera:Chrysopidae)

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Lichen use by larval

Leucochrysa pavid (Neuroptera:Chrysopidae)

(TITLE)

BY

Penni Jo Wilson

THESIS

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Abstract

*Leucochrysa pavid*a is a species of green lacewing (Neuroptera:Chrysopidae) that uses lichen fragments to build a larval debris "packet." The "packet" is eventually used to form a cocoon used during pupation. Only minute lichen fragments are harvested for formation of the packets which makes identification of the actual lichens utilized difficult using morphological characteristics. For this reason, thin-layer chromatography was employed. The thin-layer chromatographic process identifies acetone-soluble lichen chemicals that are formed in lichen thalli. By comparing the chemistry of lichen communities at Tower Rock Recreation Area in Hardin County, Illinois, with the chemicals identified during thin-layer chromatography of larval packets, *L. pavid*a larvae were found to use material harvested from the unstratified crustose lichens *Lecanora stobilina* and *Lepraria* sp. #1 and the stratified lichen *Myelochroa aurulenta*. *Leucochrysa pavid*a larva seem to harvest mostly cortical material from stratified lichens with very little occurrence of medullar material.

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INTRODUCTION

Many insects use debris from their habitats to form structures that aid them in survival. These structures may function adaptively in different ways: first, as anti-predator devices that allow them to be cryptic or inaccessible through shielding or foul tasting to a would be predator (Matthews and Matthews, 1978); second, as a predator adaptation, making the predator cryptic to prey, as in *Chrysopa slossonae* Banks (Neuroptera: Chrysopidae), an aphid-eating larva (Eisner *et al.*, 1978); third, as the basis for the formation of pupal cocoons. These adaptations, or combinations of them, are viable explanations for the construction of structures with material found in an insect's environment.

Many larvae in the family Chrysopidae (Neuroptera) form debris "packets" (Smith, 1922). Of particular interest is the green lacewing *Leucochrysa pavidata* Hagen. During larval stages this green lacewing constructs a packet by using lichen pieces from the surface of trees it inhabits (Skorepa and Sharp, 1971). The packet is attached to specialized dorsal setae with a silk-like substance (Smith, 1922). As a result of their composition, the packets may render the lacewing cryptic amongst the lichens inhabiting the tree bark. Eventually, this packet becomes part of the cocoon built for pupation (Smith, 1922; Slocum and Lawrey, 1976).

Smith (1922) is an excellent reference to the biology of the family Chrysopidae, but little has been published on the life history of *Leucochrysa pavidata*. Much of the information gathered to date is in the form of unpublished research and personal experiences of Dr. E. MacLeod, a neuropterist at the University of Illinois, Urbana-Champaign. Lacewings exhibit holometabolous development; the stages of development are egg, larva, pupa and adult. The durations of these stages under natural conditions have not been determined for *L. pavidata*. During its three larval instars *L. pavidata* collects lichen material, builds a packet, and eventually creates a cocoon. A laboratory rearing technique for members of the Chrysopidae

was developed and outlined by Sheldon and MacLeod (1971). Muma (1959) figured the heads of both the adult and larval stages of *Leucochrysa pavid*a and noted that their head-markings distinguish them from other species.

Since only minute lichen fragments are gathered for inclusion in packets or cocoons it is difficult to identify lichen components using macromorphological characters. However, some lichen components can be identified utilizing thin-layer chromatography (TLC) to determine the presence of species-specific, acetone-soluble, metabolic compounds (Culberson, 1972). By correlating lichen community structure on trees with species-specific compounds extracted from *L. pavid*a packets it should be possible to determine (1) whether *L. pavid*a "browse" selectively or randomly for lichen packet materials and (2) if only a single species or several species of lichens are used to form packets.

This study involves of the observation of *L. pavid*a larvae, collection of larval packets and pupal cocoons, analysis of lichen species and community structure on trees where larvae are collected, and identification of lichen species composition in the packets and cocoons using morphology and thin-layer chromatography. These data are used to address the following questions: What species of lichens are used by *L. pavid*a larva to form packets and are the lichens gathered randomly or selectively?

MATERIALS AND METHODS

Study site

The study site for this project was Tower Rock Recreation Area, (T 12 S, R 8 E, Sections 19 and 20) Hardin Co., Illinois. The recreation area lies on the north side of the Ohio River, approximately 5 miles east of Elizabethtown and 4 miles west of Cave-in-Rock. This area is managed by the U. S. Forest Service as a picnicking, camping, and hiking area. Despite some degree of human disturbance, corticolous lichen communities are well-developed and evidently help support an extensive population of *Leucochrysa pavida*. Field work was concentrated in the campground at the west end of the park.

Field techniques

Trees in the Tower Rock campground were surveyed from ground level to 2 m in height to ascertain which trees support *L. pavida* larvae. Trees with *L. pavida* larvae or cocoons were identified to species, tagged, and the diameter at breast height was recorded. Once trees were tagged, all lichens occurring in the sample plots on the tree surveyed for *L. pavida* were identified and the lichen community structure noted. Representative lichen thalli were collected, identified, and deposited in the herbarium at the Morton Arboretum in Lisle, Illinois (duplicate set in the Stover Herbarium at Eastern Illinois University) for use as voucher specimens as well as for thin layer chromatographic analysis. The position of individual larvae or cocoons on trees (height from base and compass point) were recorded. Larvae and cocoons were then collected and stored in dry vials for laboratory study.

Laboratory techniques

The TLC protocol of Culberson (1972, 1974) and Culberson and Kristinsson (1970) was utilized in this study. Acetone-soluble lichen compounds were extracted from lacewing packets and cocoons using acetone. Following extraction, silica gel plates were spotted with

the acetone and extract. Three solvent systems were then used for development of plates: Solvent A, benzene-dioxane-acetic acid (180:45:5 ml); Solvent B, *n*-hexane-ethyl ether-formic acid (120:90:20 ml); Solvent C, toluene-acetic acid (200:30 ml). Since each extract was developed in each of the three solvent systems, three plates were spotted with the same extracts in corresponding positions. *Parmotrema perforatum* (Jacq.) Mass., which contains atranorin and norstictic acid, was used for a control extract. Since atranorin and norstictic acid have known R_f values, these compounds serve as standard reference points to identify lichen metabolites extracted from cocoons, larval packets, and lichen thalli. The atranorin and norstictic acid spots were used to divide the plates into eight R_f classes, which allowed for the determination of unknown lichen products. Comparisons of thin layer chromatographic data, lichen species inventories, and morphological characteristics identifiable in lichen packets were utilized to determine if *L. pavidus* larvae select specific lichen material for use in packets.

RESULTS

Field results

Between 25 June 1994 and 4 May 1995, 31 trees inhabited by lacewing larva were tagged. Tagged trees included *Ulmus rubra* Muhl. (12), *Celtis laevigata* Willd. (8), *Celtis occidentalis* L. (3), *Acer saccharum* Marsh. (2), *Acer saccharinum* L. (2), *Carya illinoensis* (Wang.) K. Koch (2), *Cornus florida* L. (1), and *Populus deltoides* Marsh. (1). The majority of trees in the Tower Rock campground are *Ulmus rubra* and the two species of *Celtis*. Two tree species that grow in the campground did not show any sign of inhabitation by larval lacewings: a specimen of *Juniperus virginiana* L. and one of *Platanus occidentalis* L. Although these trees were not surveyed for specific lichens, it was noted that they did not support the growth of many lichens. Surveys performed on trees supporting lacewing larva revealed well-developed epiphytic corticolous lichen communities. Table 1 lists all epiphytic corticolous lichen species recorded during the survey of the campground at Tower Rock as well as the number of trees on which the lichens were found.

Laboratory results

A list of extracellular lichen products present in the lichens of Tower Rock was established (Table 2) using Brown, *et al.* (1976), Culberson (1969, 1970), Culberson, *et al.* (1977), Hale (1979) and Wilhelm (1995) as references. Table 2 lists lichen products present in lichen thalli at Tower Rock, including abbreviations, number of occurrences in 121 packets, and the location of the products in the lichen thallus. Lichen products labeled "cortex" are found within the cortical tissues of stratified lichens and those labeled "medulla" are in the medulla of stratified lichens. Chemical compounds that are not deposited in stratified tissues (some crustose lichens are unstratified and present only leprous or granular

thalli) or whose location is undetermined are noted with a "?". Thin-layer chromatography was conducted on a combination of 121 individual larval packets and cocoons. Zeorin (ZN) was present in 98.3% of the specimens; atranorin (AT) in 87.6%; and usnic acid (UA) in 78.5%. Other chemicals were found at much smaller percentages: unknown triterpenoids (UT) in 6.6%; calycin (CL) in 4.1%; norstictic acid (NA) in 2.5%; and connorstictic acid (CN) and protocetraric acid, individually, in less than 1%. All of these chemicals are known to occur in the lichens from Tower Rock (Table 3). Species of lichens collected that produce known chemicals are listed along with their metabolic products in Table 3. While many lichens produce unique acetone-soluble chemicals that can be detected through TLC some do not produce these chemicals or their chemical constituents have yet to be isolated or defined. Lichens that produce lichen substances undetectable in TLC are designated with an "*" in Table 1. This summary is of particular importance because lichen species without distinct chemical profiles cannot be defined using TLC.

Table 1: Species of lichens at the west end of Tower Rock Recreational Area, including the total number of trees on which they occur (out of 31). Nomenclature approximates Egan (1987, 1989, 1990, 1991).

Species of Lichens	Trees
* <i>Anisomeridium biforme</i> (Borrer in Hook and Sow) R. C. Harris	1
* <i>Buellia punctata</i> (Hoffm.) Mass.	1
<i>Buellia stilligiana</i> Steiner	1
<i>Caloplaca cerina</i> (Ehrh. ex Hedwig) Th. Fr.	1
<i>Candelaria concolor</i> (Dickson) B. Stein	24
<i>Candellariella reflexa</i> (Nyl.) Lettau	2
<i>Candellariella xanthostigma</i> (Ach.) Lettau	2
<i>Canoparmelia crozalsiana</i> (B. de Lesd. ex Harm.) Elix & Hale	15
<i>Cladonia</i> sp.	1
<i>Flavoparmelia caperata</i> (L.) Hale	13
* <i>Graphis scripta</i> (L.) Ach.	1
<i>Heterodermia albicans</i> (Pers.) Swinscow & Krog	5
<i>Heterodermia granulifera</i> (Ach.) Culb.	1
* <i>Hyperphyscia syncolla</i> (Tuck. ex Nyl.) Kalb	4
<i>Hypotrachyna livida</i> (Taylor) Hale	1
<i>Lecanora hybocarpa</i> (Tuck.) Brodo	1
<i>Lecanora strobilina</i> (Sprengel) Kieffer	16
<i>Lepraria</i> sp. #1, sensu Wilhelm (1995)	8
<i>Loxospora pustulata</i> (Brodo & Culb.) R. C. Harris in Egan	1
<i>Myelochroa aurulenta</i> (Tuck.) Elix & Hale	18
<i>Myelochroa galbina</i> (Ach.) Elix & Hale	6
* <i>Opegrapha vulgata</i> auct.	4
<i>Parmotrema hypotropum</i> (Nyl.) Hale	21
* <i>Phaeophyscia cernohorskyi</i> (Navd.) Essl.	5
* <i>Phaeophyscia ciliata</i> (Hoffm.) Moberg	6
* <i>Phaeophyscia hirtella</i> Essl.	4
* <i>Phaeophyscia orbicularis</i> (Necker) Moberg	1
* <i>Phaeophyscia pusilloides</i> (Zahlbr.) Essl.	4
<i>Phaeophyscia rubropulchra</i> (Degel.) Moberg	16
<i>Physcia americana</i> G. K. Merr. in A. Evans & Meyrow	17
<i>Physcia millegrana</i> Degel.	31
* <i>Physconia detera</i> (Nyl.) Poelt	1
<i>Physconia kurokawae</i> Kashiw.	1
* <i>Porina pulla</i> (Ach.) Müll. Arg.	1
<i>Punctelia missouriensis</i> G. Wilh. & Ladd	1
<i>Punctelia rudecta</i> (Ach.) Krog	29
<i>Pyxine soorediata</i> (Ach.) Mont.	2
<i>Pyxine subcinerea</i> Striton	11
<i>Ramalina unifolia</i> J. W. Thomson	1
<i>Rimelia reticulata</i> (Taylor in Mack.) Hale & Fletcher	3
* <i>Rinodina ascociscana</i> Tuck.	1
* <i>Rinodina cf. pachysperma</i> Magnusson	1
* <i>Rinodina subminuta</i> Magnusson	1
* <i>Scoliosporum chlorococcum</i> (Graewe ex Stenh.) Vezda	1
<i>Usnea mutabilis</i> Stirton	1
<i>Xanthoria</i> sp. #1, sensu Wilhelm (1995)	10

*Do not produce lichen substances detectable with TLC.

Table 2: Summary of chemicals present in lichen thalli at Tower Rock Recreational Area, including abbreviations, number of occurrences in 121 packets, and location in the lichen thallus.

Lichen substance	Abbr.	Occur.	Location
4-O-methylphysodic acid	MP		Medulla ^{1,2}
Anthroquinones (various)	AN		Cortex
Atranorin	AT	105	Cortex ¹
Calycin	CL	5	Cortex ¹
Caperatic Acid	CA		Medulla ¹
Connorstictic Acid	CN	1	Medulla ^{1,2}
Constictic Acid	CO		Medulla ¹
Galbinic Acid	GA		Medulla ^{1,2}
Gyrophoric Acid	GY		Medulla ^{1,2}
Lecanoric Acid	LA		Medulla ¹
Lichexanthone	LI		Cortex ¹
Lividic Acid	LV		Medulla ^{1,2}
Norstictic Acid	NA	3	Medulla ^{1,2}
Parietin	PA		Cortex ¹
Protocetraric Acid	PR	1	Medulla ¹
Pulvinic Acid	PU		Cortex
Pulvinic Dilactone	PD		Cortex
Salazinic Acid	SA		Medulla ^{1,2}
Skyrin	SK		Medulla ³
Stictic Acid	ST		Medulla ^{1,2}
Thamnolic Acid	TH		?
Unknown Triterpenoids	UT	8	?
Usnic Acid	UA	95	Cortex ¹
Zeorin	ZN	119	?

? - location undetermined or in unstratified crustose lichens

¹Brown, et al, 1976.

²Culberson, 1969.

³Hale, 1979.

Table 3: Lichen species with known chemical constituents found in association with *Leucochrysa pavidia* larvae.

Species:	Position:	Cortex	Medulla	?
<i>Buellia stilligiana</i>				AT,NA
<i>Caloplaca cerina</i>				AN
<i>Candelaria concolor</i>		CL,PD		
<i>Candellariella reflexa</i>				CL,PD,PU
<i>Candellariella xanthostigma</i>				CL,PD,PU
<i>Canoparmelia crozalsiana</i>		AT	ST	
<i>Flavoparmelia caperata</i>		UA	CA,PR	
<i>Heterodermia albicans</i>		AT	SA	
<i>Heterodermia granulifera</i>		AT	SA	ZN
<i>Hypotrachyna livida</i>		AT	LV,MP	
<i>Lecanora hybocarpa</i>				AT
<i>Lecanora strobilina</i>				UA,ZN
<i>Lepraria</i> sp. #1				AT,ZN
<i>Loxospora pustulata</i>				TH
<i>Myelochroa aurulenta</i>		AT		ZN,UT
<i>Myelochroa galbina</i>		AT	GA	ZN
<i>Parmotrema hypotropum</i>		AT	NA	
<i>Phaeophyscia rubropulchra</i>			SK	
<i>Physcia americana</i>		AT		UT
<i>Physcia millegrana</i>		AT		
<i>Physconia kurokawae</i>			GY	
<i>Punctelia missouriensis</i>		AT	LA	
<i>Punctelia rudecta</i>		AT	LA	
<i>Pyxine soorediata</i>		AT		
<i>Pyxine subcinerea</i>		AT,LI		
<i>Ramalina unifolia</i>		UA		
<i>Rimelia reticulata</i>		AT	SA	
<i>Usnea mutabilis</i>		UA		
<i>Xanthoria</i> sp. #1		AT	AN	

? - Unstratified lichen thallus or location undetermined

Observations on *Leucochrysa pavid*a life history

Observations on *L. pavid*a larvae are based on collections made in the study area on 24 February 1995 and observations in the laboratory during the weeks that followed. A 4-mm, slightly oval-shaped lichen packet was teased away from one larva's dorsal setae. The consistency of the packet was fairly uniform in structure. When the lichen packet was removed the larva seemed to become active and began to search for material to use for covering. As the packet was returned to the larva in small pieces, the larva began to rebuild the packet by placing the pieces on the dorsal setae. Although the larva tried to pull smaller pieces from those placed in the chamber the complete pieces were used when unsuccessful at this attempt. For this reason, the consistency of the new packet was not as uniform as that of the original packet. When the larva with the restructured packet was placed in a chamber with a small piece of bark that bore small, non-sorediate thallus of *Phycia millegrana*, the larva was observed to collect material for its lichen packet. Using its long pointed jaws as pincers, the larva scraped the cortical surface of the lichen. With only a dissecting microscope it was impossible to see exactly what the larva was harvesting from the lichen surface. After scraping the surface for a short time the larva rolled the material from the lichen surface into a ball using its jaws and placed the ball on the dorsal setae. Upon examination of the lichen surface no scars that exposed medullar material were apparent on the surface of the lichen.

Ten third-instar larvae collected on 24 February 1995 were placed in shell vials lined with filter paper and capped with a cotton plug. These were fed 10-15 etherized adult *Drosophila* sp. approximately every other day. On 15 March 1995 the first larva began to spin its cocoon. By 23 March 1995 all of the larva had begun the pupation process. Pupation lasted approximately two weeks with the first adult emerging on 29 March 1995 and the last adult

emerging on 9 April 1995. Identification of adults were confirmed by E. MacLeod and voucher specimens deposited at the Illinois Natural History Survey, Champaign, Illinois.

DISCUSSION

Data derived from TLC shows that zeorin (ZN) is the most commonly found chemical in lichen packets (Table 2). Over 98% of all the *L. pavidus* packets assayed with TLC contained zeorin. This chemical occurs in only a few lichens at the study site: *Heterodermia granulifera*, *Lecanora strobilina*, *Lepraria* sp. #1, *Myelochroa aurulenta*, and *Myelochroa galbina* (Table 3). Of these only *Lecanora strobilina* (usnic acid and zeorin), *Lepraria* sp. #1 (atranorin and zeorin), and *Myelochroa aurulenta* (atranorin and zeorin) have chemical compositions consistent with those regularly encountered in lichen packets. *Lecanora strobilina* and *Lepraria* sp. #1 also have a common characteristic. The thalli are not stratified into a distinctive cortex and medulla. Rather, they can be described as leprose or consisting of unconsolidated soredioid granules. If larva were harvesting cells from the surface of these lichens, it is likely that they would have access to all the chemical products. This is supported by the TLC data (Table 3). Zeorin never occurs alone in the lichen packets but always in association with either atranorin or usnic acid; 86% of the time zeorin occurs with atranorin; 77% of the time it occurs with usnic acid; 65% of the time zeorin occurs with both atranorin and usnic acid. In the lichens at Tower Rock, usnic acid and atranorin never occur in the same thalli (Table 3). During morphological studies of the packets, an entire apothecium from *Lecanora strobilina* was discovered in a larval packet. Consequently, it is logical to assume that *Lepraria* sp. #1, *Lecanora strobilina*, and *Myelochroa aurulenta* are being selectively harvested by *L. pavidus* larvae.

Another source of cortical chemicals such as usnic acid and atranorin is the more highly developed thalli of stratified lichens. Using a fine, sharp tool, cortical cells can be removed

from stratified lichens without disturbing the underlying medulla. Likewise, larvae with small pincer-like jaws could harvest only cortical material from stratified lichens. Therefore, only the cortical chemicals of stratified lichens would be detected by TLC. The cortical chemicals, atranorin and usnic acid, account for the majority of cortical compounds found at the study site (Table 3). Atranorin is the most common substance, occurring in nearly half of the total lichen species surveyed. Calycin, another cortical compound, is not commonly found in the chemical profiles of lichen packets. This is interesting, since *Candelaria concolor*, a very common member of the lichen flora at the study site (Table 1), contains calycin in the cortex (Table 3). It would appear that larvae of *L. pavidus* are not selecting *C. concolor* at a very high rate or more calycin would have been detected.

Another facet of the selection process is the size of the pieces of lichen thalli in the packets. No packets were observed to contain distinct portions of lichen thalli. Since the TLC of lichen packets shows little the presence of medullar compounds, the chemical tests do not support the use of whole lichen thalli as components of packets. If pieces of the thallus were harvested at random from stratified lichens, one would expect that all chemicals commonly found in both the cortex and medulla of lichens would be detected. Chemicals from the medulla such as stictic acid (*Canoparmelia crozalsiana*), caperatic acid (*Flavoparmelia caperata*), norstictic acid (*Parmotrema hypotropum*), the red pigment skyrin (*Phaeophyscia rubropulchra*), and lecanoric acid (*Punctelia missouriensis*) should be present or more prevalent in the extracts if the larvae are randomly selecting whole pieces of the thallus. Norstictic acid was detected in only 3 extracts; in one extract, the larva was collected on a tree that had no lichens which produce norstictic acid. The other two extracts were from trees that supported the growth of *Parmotrema hypotropum*, a lichen that produces soredia. Soredia are vegetative lichen propagules that are composed of medullary material which is

exposed above the cortex of the lichen. Larvae could easily detach soredia from the surface of the lichen during browsing. Most other medullary chemicals were rarely detected using TLC.

The process of TLC does not allow a researcher to define the quantity of a certain chemical found in a sample; it can only define the presence or absence of a chemical compound. Therefore, it is impossible to tell which chemicals by volume make up the majority of a packet or which lichens make up the majority of a packet by volume.

Some of lichens found at the study site lack acetone-soluble chemicals altogether or have no detectable chemicals in the cortex or in the medulla. This makes it impossible to determine the presence of these lichens in packets using TLC. With no chemical clues, researchers must rely on morphological characteristics of the lichens and observation of the lichen harvesting behavior of larvae. One larva observed in the lab readily harvested *P. millegrana* but is too small a sample to make any definitive statement on lichen usage.

All 31 trees, regardless of diameter at breast height, that supported lacewing larvae possessed a diverse assemblage of lichens and at least moderate coverage. *Juniperus virginianus* and *Platanus occidentalis*, which had only a few lichens, showed no signs of lacewing larvae. With only a small selection of lichens for packet construction and a camouflage technique with diminished effectiveness, inhabitation of sparsely lichenized trees would be non-beneficial. However, one cocoon was found attached to the vertical surface of a galvanized fence pole that was less than a meter from the closest tree. The cocoon was formed in the same way as others found at the site. Since no lichens were observed growing on the pole, obviously those lichens were collected elsewhere. This observation supports the likelihood that *L. pavidus* use more than one tree in the same vicinity for harvesting lichens.

Due to the nature of larval *L. pavid*a movements, this study focused on lichen species composition at the study site as a whole, rather than on the individual trees on which larvae were collected. Trees were surveyed only to a height of 2 meters. Since the larvae vagile and do not stop crawling up or down a tree because it has reached the 2 meter survey line, lichens being utilized by the larvae may be overlooked if they do not occur in the area surveyed.

It is evident that some selective processes are being utilized by the larvae of *L. pavid*a. However, data on percent coverage by lichen species were not taken during lichen surveys. Without this type of data it is difficult to quantify selection. These processes may only begin with larvae choosing the most easily gained material for a debris-packet. Controlled observations and experimentation on the uses of lichens could be initiated to gather more data on the behavior of *L. pavid*a.

LITERATURE CITED

- Brown, D. H., D. L. Hawksworth, R. H. Bailey. 1976. Lichenology: Progress and Problems. Academic Press. London, England. pp. 551.
- Culberson, C. F. 1969. Chemical and Botanical Guide to Lichen Products. University of North Carolina Press. Chapel Hill, North Carolina. pp. 628.
- Culberson, C. F. 1970. Supplement to "Chemical and Botanical Guide to Lichen Products." Bryologist **73**:177-377.
- Culberson, C. F. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. J. Chromatogr. **72**:113-125.
- Culberson, C. F. 1974. Conditions for the use of Merck silica gel 60 F₂₅₄ plates in the standardized thin-layer chromatographic technique for lichen products. J. Chromatogr. **97**:107-108.
- Culberson, C. F., W. L. Culberson, and A. Johnson. 1977. Second Supplement to "Chemical and Botanical Guide to Lichen Products." The American Bryological and Lichenological Society. Missouri Botanical Garden. St. Louis, Missouri. pp. 400.
- Culberson, C. F. and H. Kristinsson. 1970. A standardized method for the identification of lichen products. J. Chromatogr. **46**:85-93.
- Egan, R. S. 1987. A fifth checklist of the lichen-forming lichenicolous and allied fungi of the continental United States and Canada. Bryologist **90**:77-173.
- Egan, R. S. 1989. Changes to the "Fifth checklist of the lichen-forming lichenicolous and allied fungi of the continental United States and Canada." Edition I. Bryologist **92**:68-72.
- Egan, R. S. 1990. Changes to the "Fifth checklist of the lichen-forming lichenicolous and allied fungi of the continental United States and Canada." Edition II. Bryologist **93**:211-219.
- Egan, R. S. 1991. Changes to the "Fifth checklist of the lichen-forming lichenicolous and allied fungi of the continental United States and Canada." Edition II. Bryologist **94**:396-400.
- Eisner, T., K. Hicks, M. Eisner, and D. S. Robson. 1978. "Wolf-in-sheep's clothing" strategy of a predaceous insect larva. Science **199**:790-794.
- Hale, M. E. 1979. How to know the lichens. 2nd ed. Wm. C. Brown Co. Publ. Dubuque, Iowa. pp. 246.

- Matthews, R. W. and J. R. Matthews. 1978. Insect Behavior. John Wiley & Sons, Inc. New York. pp. 507.
- Muma, M. H. 1959. Chrysopidae associated with citrus in Florida. Fla. Ent. **42**:21-29.
- Sheldon, J. K. and E. G. MacLeod. 1971. Studies on the Biology of the Chrysopidae II. The feeding behavior of the adult of *Chrysopa carnea* (Neuroptera). Psyche **78**:107-121.
- Skorepa, A. C. and A. J. Sharp. 1971. Lichens in "packets" of lacewing larva (Chrysopidae). Bryologist **74**:363-364.
- Slocum, R. D. and J. D. Lawrey. 1976. Viability of the epizoic lichen flora carried and dispersed by green lacewing (*Nodita pavidula*) larvae. Can. J. Bot. **54**:1827-1831.
- Smith, R. C. 1922. The biology of the Chrysopidae. Cornell Univ. Agr. Exp. Sta., Memoir **58**:1291-1372.
- Wilhelm, G. 1995. Lichens of the Chicago Region. Morton Arboretum. Lisle, Illinois. Draft Transcript. pp. 95.

VITA

Penni Jo Wilson was born on the seventh day of September 1968 at 1:26 a.m. to Mr. and Mrs. Donald E. Whitten. She spent two years of life in Canton, Illinois where her father taught at Spoon River College. After moving to Mechanicsburg, Illinois in 1971, she attended Tri-City School K-12. Upon graduation in 1986, she entered Lincoln Land Community College in Springfield as a music major. After taking a marine biology course in Jamaica, Penni realized how important biological sciences were to her and the world around her. She graduated with an A.S. in biological science in 1989 and moved to the promised land of southern Illinois where she attended SIU at Carbondale. In 1991, after two years of work she attained her B.A. in biological science from SIU-C. Life's true perspective came in two years of "real" employment between May 1991 and August 1993 when Penni realized that life without a M.S. would be incomplete. She began working toward her M.S. in August of 1993 and met her husband Thomas P. Wilson, a fellow EIU graduate. She received her M.S. and Mrs. in August 1995.