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A Revision and Phylogenetic Analysis of the Genus Eutyphlus LeConte (Coleoptera: Staphylinidae: Pselaphinae) with a Comparison of Sampling Methodologies

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A REVISION AND PHYLOGENETIC ANALYSIS OF THE GENUS *EUTYPHLUS* LECONTE (COLEOPTERA: STAPHYLINIDAE: PSELAPHINAE) WITH A COMPARISON OF SAMPLING METHODOLOGIES

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ABSTRACT

My thesis research includes three components: (1) a methodology project, (2) a systematic project comprising a taxonomic revision, and (3) a morphology-based, cladistic analysis.

1. The methodological study compared the Winkler (Moczarski) eclector and the Berlese-Tullgren funnel (referred to hereafter as "Winkler" and "Berlese" funnels, respectively) as methods for extracting forest litter-dwelling Coleoptera from sifted substrate, with a focus on relevance for taxonomic studies. A general review of the history and methodologies of leaf litter arthropod extraction was provided, in conjunction with repeated, timed trials to compare the relative effectiveness of the two methods using litter samples from various geographic regions. Extraction rates for Winkler and Berlese funnels were evaluated based on temporal and taxonomic criteria by comparing accumulations of Coleoptera specimens and species at timed intervals. In addition, the Curculionidae and Staphylinidae, as well as "rare" species were targeted and evaluated, individually. Results did not indicate clear differences in extraction efficiency, either temporally or taxonomically, between Winklers and Berleses. However, extraction patterns for both Winklers and Berleses suggested that intervals at the beginning of trials (3-18 hours) and later in the trials (60-144 hours) yielded information most relevant for taxonomic studies. An extraction protocol for litter-dwelling Coleoptera is suggested based on these results. A checklist of all species collected was provided.

2. A taxonomic revision of the North American trichonychine genus *Eutyphlus* LeConte reviewed the current status of described species. These were redescribed along with documentation and drawings of external variations, male genitalia, biometrics, and range maps for each species. One undescribed species was described from museum specimens based on morphological and phylogenetic criteria.
3. Monophyly of the genus *Eutyphlus* was tested and the phylogenetic placement of this genus within the subtribe Panaphantina Jeannel was evaluated based on morphological cladistic analysis of trichonychine genera, including numerous relevant outgroup taxa. *Eutyphlus* was recovered as a monophyletic genus within the tribe Trichonychini Reitter, while many other higher-level taxa were not grouped together and merit redefinition or further examination.

CHAPTER 1. INTRODUCTION

The Staphylinidae is the largest family of beetles, containing about 60,000 named species and perhaps an even greater number of undescribed species. The Pselaphinae is the second most diverse subfamily within the family, including approximately 9000 named species and 1200 genera worldwide (Thayer 2005). The subfamily Pselaphinae was originally described as the family Pselaphidae (Latreille 1802) based on the type specimen *Pselaphus heisei* Herbst 1792. The taxon was downgraded to the status of subfamily in 1995 (Newton and Thayer 1995). Subsequent treatments of staphylinid taxonomy have consistently placed pselaphines as a monophyletic taxon within the omaliine group of staphylinid subfamilies (Newton et al. 2001, Thayer 2005).

Pselaphines are consistently and strikingly morphologically distinct from members of other staphylinid subfamilies and all other beetles. Adults are generally small (from less than 1 mm to a maximum of 8 mm), and possess a robust body of limited flexibility in contrast to the typically more elongate, flexible bodies that are characteristic of the majority of other staphylinids. This general appearance is due to the heavily sclerotized external body wall and the proliferation of foveae, sclerotized, concentrically ringed invaginations of the exoskeleton that extend into the body cavity.

The unique and remarkably consistent structure of pselaphine foveae provides the most important set of morphological characters defining the group's monophyly. These and other less obvious characters were discussed by Newton and Thayer (1995). The conservation of the locations of foveae in body-wall sclerites extends to genus-group taxa, making them taxonomically and phylogenetically informative at the level of genus and higher. However, only a small number of such groupings have been treated phylogenetically (Chandler 1988, Kurbatov and Sabella 2008), highlighting the importance for future phylogenetic studies at the taxonomic level of subtribe and tribe.

Pselaphines are interesting from the perspectives of phylogenetic and morphological diversity, and are important elements of faunal diversity. Globally, pselaphines are widespread, abundant members of the forest litter fauna, where they are known to be micro-predators of organisms such as mites, worms, and springtails (Park 1947a, Engelmann 1956, DeMarzo and Vit 1982, Schomann et al. 2008). Outside of forested habitats, pselaphines are restricted to a small assortment of other habitats, including grasslands and deserts, where they are typically associated with riparian areas or live as inquilines of social insects. Pselaphines exhibiting myrmecophilous lifestyles often exhibit extreme morphological and behavioral modifications that have generated much interest (Lapeva-Gjonova 2013, Parker and Maruyama 2013). Ecological studies on pselaphines have highlighted the sensitivity of these beetles to ecological changes and disturbances, especially those affecting the forest floral composition and age structure (Chandler 1987, Chandler 2001). As ecosystem studies take into consideration the essential role of the forest-floor community in nutrient turnover and overall system productivity and structure, pselaphines will be ideal candidates for indicators of biodiversity and forest health (Sackchoowong et al. 2008).

Consistent with global diversity patterns exhibited by many taxa, species richness of pselaphines is highest in the tropics with single site diversity in tropical forests exceeding 200 species in some areas. However, diversity of the subfamily is high in many temperate regions (Jeannel 1962, Chandler 2001). Patterns of global diversity differ significantly among the six supertribes of pselaphines. The supertribes Batrisitae and Clavigeritae exhibit highest diversity in the tropics, whereas the Goniaceritae and Pselaphitae are well represented in both tropical and temperate regions. In temperate regions, the Faronitae and the two largest tribes of the Euplectitae exhibit the highest diversity (Newton and Chandler 1987). This distribution pattern facilitates taxonomic and phylogenetic studies of several particularly speciose subtribes represented in North America.

In addition, the low dispersal ability and microhabitat specificity of many species results in many pselaphines exhibiting very limited geographic ranges. Due to their global distribution and low vagility, pselaphines are a model group for addressing deep-time biogeographic questions and assessing more recent processes of community restructuring and refugia formation influenced by mountain building, volcanism, and glaciation in a variety of regions. This high endemism and diversity in temperate areas exhibited by the Pselaphinae combined with the implications for biogeographic studies highlights the importance of study of North American fauna, in particular (Barr 1974, Carlton and Cox 1990).

Along these lines, my thesis work aimed to improve the study of North American litter dwelling Pselaphinae and to add to the collective taxonomic and phylogenetic knowledge of this subfamily. My thesis includes two components: 1) a methodology project that compared methods of extraction of litter-dwelling Coleoptera and 2) a taxonomic project that revises the exclusively North American genus, *Eutyphlus* LeConte. The latter includes a phylogenetic analysis to establish the monophyly of the genus within the subtribe Panaphantina Jeannel.

CHAPTER 2. "BERLESE VS. WINKLER": COMPARISON OF TWO FOREST LITTER COLEOPTERA COLLECTION PROTOCOLS

2.1 Introduction

2.1.1 Forest litter: habitat challenges and sampling methods

Soil and litter-dwelling arthropods collectively form one of the most diverse assemblages of life on earth, both taxonomically and empirically (Ghilarov 1977, Anderson 1978, Stanton 1979). This biodiversity-rich community of micro-arthropods plays an essential ecological role in nutrient turnover of the entire forest and may serve as a critical bio-indicator of whole ecosystem health (Chandler 1987, Giller 1995, Chandler 2001, Sackchoowong et al. 2008). However, the soil and litter community remains one of the most understudied terrestrial faunas (Arnett 1990, Whitford 1992, Giller 1995, Andre et al. 2002). The main obstacles to progress in such biodiversity studies are twofold: taxonomic bottlenecks and lack of sampling standardization (Brussaard et al. 1997, Andre et al. 2002). Comparison of existing methods of extraction in a taxonomically and temporally informative way is an essential step towards overcoming these impediments to the study of leaf litter arthropod fauna.

Over time, a diverse array of sampling methods has been utilized to target the collection of certain elements of the litter fauna. The introduction of modern collection methods have yielded higher estimates of soil and litter arthropods from samples and have increased the accessibility of this fauna to researchers (Ghilarov 1977). But, despite these advancements in collection techniques and yield, only a small fraction of this biota has been catalogued. A large number of organisms collected in such studies are not brought to full taxonomic resolution due to their small size and the expertise required for such identifications, a phenomenon known as "Overlooked Syndrome" (Gaston 1991, Andre et al. 1994, Wilkinson 1998, Ferro and Carlton 2010). In addition, comparative studies of these collection methods, themselves, remain scarce. Basic evaluations of many popular collection methods have not been performed in a manner that compares collection efficiency and biases of time and taxon selectivity. Therefore, standardization of procedures for collecting certain taxa is generally nonexistent (Andre et al. 2002).

Methods for forest-litter arthropod collection may be broadly divided into two main categories based on the process of separating organisms from substrate: direct and indirect collection methods (Andre et al. 2002). Direct collection methods involve the physical separation of organisms from the substrate, such as hand collecting or soil washing. Such methods involve removal of specimens *in situ* either by researchers or via the application of an additional agent to enhance separation. Indirect collection methods rely upon the active movement of the organisms, themselves, to separate them from the surrounding substrate in the sample. This often occurs due to the response of the organisms to a gradient established by external stimuli applied to the sample. Both direct and indirect methods of collection have been utilized in a variety of studies focused on different taxa of forest litter arthropods. Surveys of researchers and literature searches indicate that the most popular collection methods of litter and soil-dwelling arthropods are two indirect methods: the Winkler Extractor (Winkler) and the Berlese-Tullgren Funnel (Berlese) (Edwards and Fletcher 1971, Petersen and Luxton 1982). Despite a general similarity in basic collection process, Berleses and Winklers differ in form, function, and portability, with each possessing a particular set of advantages and drawbacks that may influence researcher choice and study results.

2.1.2 Historical Review: Berleses and Winklers

Introduced by Antonio Berlese, a mite specialist, the original Berlese extractor featured an apparatus composed of a funnel, into which soil or litter samples were placed, and a heated water jacket surrounding the sample (Berlese 1910). This design was reliant upon the application of heat via the surrounding flow of warm water to establish a temperature gradient throughout the sample that would drive arthropods into a collection vial. This original apparatus was later modified by Albert Tullgren (Tullgren 1918). Tullgren's newer version replaced the more complicated heated water system with an incandescent bulb suspended above the sample. The introduction of a heated light source increased the efficiency of this extraction method, resulting in a better retention and distribution of heat, and an increased rate of desiccation (Edwards 1991). The light source had the additional effect of both establishing a heat gradient within the source and driving organisms away from the light itself (Barberena-Arias 2012). Modern Berlese funnels often feature some modification of Tullgren's design and are commonly referred to as "Berlese-Tullgren" funnels (referred to hereafter as "Berlese funnels"). As such, these devices exploit the general tendency of soil and litter arthropods to actively avoid increased temperatures, desiccation, and high light levels. Over time, a temperature and moisture gradient is established within the sample, driving organisms downwards and into a collection container filled with ethanol or some form of killing solution (Haarlov 1947, Block 1966, Coleman et al. 2004).

The popularity of the Berlese funnel as a method of extraction of soil and litter arthropods is well-documented (MacFadyen 1961, Ghilarov 1977, Walter et al. 1987, Bremner 1990). However, several drawbacks of this method are also well-known and have led researchers to opt for other extraction devices under certain conditions. Berlese funnels are reliant upon an external light source for extraction, rendering this method dependent upon the availability of electricity. This limitation makes Berlese funnels impractical for use in many field situations and has led some authors to, instead, adopt other electricity-free methods (Besuchet et al. 1987, McHugh and Wheeler 1987, Barberena-Arias et al. 2012). In addition, the design of these devices is both heavy and bulky. Again, such a limitation may make Berlese funnels less ideal for use in field situations than other, more portable methods (McHugh and Wheeler 1987, Sabu and Shiju 2010). Impracticality and lack of portability aside, the possibility of over-heating or of exposing specimens to desiccation too rapidly for them to escape from the sample has raised concerns over the possibility of incomplete sampling (Walter et al. 1987, Andre et al. 2002). Despite these limitations and concerns, Berlese funnels remain one of the most popular methods of indirect sampling, along with Winkler funnels.

Around the same time as the development of Berlese funnel methods, the Winkler funnel was first introduced by Emil Moczarski, a specialist of Pselaphinae, during 1907. This device obtained its name and was made available to other soil and litter arthropod specialists when Karl Holdhaus began manufacturing eclectors, devices for extraction of arthropods from substrate, with the Winkler and Wagner Company (Holdhaus 1910). Since then, the Winkler funnel's original, portable design has changed little. This extraction method is both lightweight and free from reliance on electricity. The basic setup comprises a series of thin mesh bags hanging vertically within a funnel casing. As organisms move throughout the sample, the permeable walls of the bags provide a large surface area from which they evacuate the surrounding substrate and fall into a container of killing solution. Extraction is achieved via the random movement of the arthropods, themselves, and is enhanced by the exposure of a large surface area of the sample to air via the mesh casing, which increases substrate desiccation. Unlike the Berlese, this method of extraction does not include the application of an external stimulus to establish a gradient within the sample. However, the creation and maintenance of a moisture gradient is dependent upon local, external environmental conditions such as temperature and humidity (Krell et al. 2005, Hopp et al. 2011). Because of the dependence upon the movement of the organisms and sample drying, mixing of the sample or some form of disturbance is sometimes directly applied to the substrate, itself, in order to promote organisms' movement and ensure exposure to the surface of the mesh bags (Besuchet et al. 1987).

Although free from reliance on electricity and much more portable in design than the Berlese, as a method of extraction, the Winkler funnel has its own drawbacks and concerns. In this case, the moisture gradient within the sample is created via open air-drying and is dependent directly upon the surrounding environment. Concerns over incomplete or taxon-biased extraction resulting from sensitivity to external weather conditions and the pre-existing moisture content of samples have been cited as possible limiting factors of this method (Krell et al. 2005, Sakchoowong 2007, Hopp et al. 2011, Delsinne and Arias-Penna 2012). Studies have demonstrated that the creation and maintenance of the moisture gradient is dependent upon the surrounding temperature and humidity (Krell et al. 2005, Hopp et al. 2011). Thus, although more portable and adaptable to field situations, extraction completeness may be significantly hampered in high-moisture litter and high-humidity environments. Additionally, the expediency of extraction may be compromised by external conditions. In some cases much longer extraction times are required for Winklers than other devices, imposing a temporal limitation on this extraction method (Besuchet et al. 1987, McHugh and Wheeler 1987, Krell et al. 2004, Krell et al. 2005). To combat these constraints, some authors stress the necessity of manually disturbing the sample to ensure arthropod movement in high-moisture litter and environmental conditions and to enhance both completeness and speed of extraction (Besuchet et al. 1987, Guenard and Lucky 2011). This process is time-consuming and requires repeated handling of samples, which may result in some specimen loss. Although the simplified design of the Winkler may make it more appropriate for use in field situations, this also makes it vulnerable to a number of external conditions and drawbacks that must be taken into consideration.

2.1.3 Current Challenges

In addition to limitations imposed by external factors, these two extraction methods may also be subject to taxonomic biases. For example, entomologists focusing on collecting ants favor Winklers (Bestelmeyer et al. 2000, Delabie et al 2000, Delsinne and Arias-Penna 2012). A combination of pitfall trapping and use of

Winklers has been established by the A. L. L. (Ants of the Leaf Litter) protocol as the standard method of collection for leaf-litter dwelling Formicidae (Agosti and Alonso 2000). Since its inception, the A. L. L. has been repeatedly tested by a number of studies, many of which support the use of Winkers as an extraction method that accurately captures important metrics of litter ant biodiversity (Lopes and Vasconcelos 2008, Ivanov and Keiper 2009, Delsinne and Arias-Pena 2012). Other litter ant studies utilizing this protocol reiterate concerns over the influences of external environmental conditions on Winklers' extraction abilities, demonstrating that extraction via this device is susceptible to variables such as drying, and therefore may not be appropriate under certain ecological conditions (Delsinne et al. 2008). In any case, the A. L. L. is cited in many recent studies where it is either employed as stated or serves as a template that is subsequently modified to suit researcher preferences or habitat variations (Leponce et al. 2004, Delsinne 2008, Lopes and Vasconcelos 2008, Delsinne and Arias-Penna 2012, Demetrio and Silvestre 2013). Thus, the establishment of the A. L. L. and its subsequent role in current studies and literature serves as an example in which the availability of a standard protocol for the extraction of a certain taxa of litter-dwelling insects appears to be a relevant and useful tool to aid in research.

The establishment of a protocol for the extraction of temperate litter dwelling arthropods, however, is not common for most taxa. To date, no such widespread, standardized protocol has been provided for the collection of one of the most taxonomically diverse taxa of litter-dwelling arthropods, the Coleoptera (Kouadio et al. 2009, Hopp et al. 2011). Some authors have adopted the A. L. L. for studies dealing with Coleoptera with some success (Kouadio et al. 2009). However, the majority of studies vary widely in their use of extraction method and duration of extraction time, with some suggesting as short as 24 hours and others extending the duration to as long as 7 weeks (Grebennikov 2008, Sabu et al. 2011). Thus, either Berleses or Winklers, or a combination of the two, are employed by Coleopterists for varying lengths of extraction time, with little or no established method to serve as either standard protocol or a baseline for comparison.

Despite the prevalence in current studies and the long history of the use of both Winklers and Berleses as methods of litter arthropod extraction, few published studies have compared them at temporally or taxonomically significant scales. Several past studies have examined differences in total yields of arthropod groups after pre-determined sampling times (Longino et al. 2002, Krell et al. 2005, Sabu and Shiju 2010, Sabu et al. 2011). These studies produced mixed results, either finding Winklers to be slightly inferior to Berleses when considering complete extraction (Longino et al. 2002, Sabu et al. 2011), or about equal (Sabu & Shiju 2010). These studies were universally focused on determining the completeness of extraction of both methods for different orders of litter-dwelling insects. While such information is useful for determining appropriateness of different extraction methods for studies aimed at obtaining total numbers of most common taxa for use in ecology and comparative biodiversity studies, this information is not sufficient for taxonomically focused studies. Such community-level studies simply fail to address differences in extraction at lower taxonomic levels or to take into consideration less abundant taxa or those that are important for investigating issues such as species boundaries and the presence of rare species, all of which are central to answering taxonomic questions. In addition, these studies do not address differences in recovery rates that occur throughout the extraction period that may be important in field situations where the total time for running samples is usually limited. Such information is essential for practical use in the field and laboratory.

A few past studies have sought to compare the recovery rates of arthropod taxa throughout the total extraction time, examining numbers of extracted taxa at certain intervals. One such study suggested that extraction by Berleses is more efficient for obtaining higher numbers of specimens across taxa, although this study yielded low numbers of adult Coleoptera overall (Barberena-Arias et al. 2012). This study did not include any collection intervals of less than 24 hours and extractors were only run for a total of five intervals during a 168-hour period. Shorter time intervals of less than 24 hours or intervals that exceed 168 hours may prove significant for extraction in the field. This study also failed to identify Coleoptera below the ordinal level, a shortcoming that is inexplicably common in many comparative diversity studies. Currently, only one study has compared Berlese and Winkler recovery rates of Coleoptera identified below the ordinal level and at more frequent time intervals (Sakchoowong et al 2007). However, this study terminated after one week (161 hours) and longer extraction times may be needed for certain organisms (Sabu et al. 2011). Again, this study focused on a taxonomic level above the genus or species level, which leaves out important, taxonomically relevant information.

Building off of this body of previous research, our study aims to address the two main obstacles to progress in studies of litter-dwelling arthropods: lack of sampling standardization and taxonomic inadequacy (Andre et al. 1997, Brussard et al. 1997). We will focus on the numbers of both total specimens and individual species of litter-dwelling Coleoptera extracted by both Winklers and Berleses throughout this experiment across a series of pre-determined collection intervals. Attention will specifically be given to determining the minimum time required to ensure extraction of rare species of Coleoptera within samples, which hold special significance for taxonomic studies. Thus, this study will add to the current understanding of appropriate extraction methods and protocol for the litter-dwelling Coleoptera with a focus on obtaining information that is relevant to taxonomic studies and practical for lab and field settings.

2.2 Materials and Methods

Organic forest litter samples consisting of leaf litter, rotten wood, and indeterminate organic surface debris were obtained from sites in six states, North Carolina, Alabama, Arkansas, Louisiana, New Mexico, and Arizona. Samples were gathered by hand and sifting into cloth bags (pillow cases) using 1 cm mesh wire 30 (square) cm sifters. Samples were collected from unstandardized areas of closed canopy forest where the litter layer was sufficiently deep to provide a moist, stable habitat conducive to diverse communities of forest litter invertebrates. Samples varied between 12-15 kg per site and sample trial. Samples were protected from extreme temperatures and kept moist while being transported back to the lab for processing.

A total of six trials (one trial per site) were conducted during the course of the experiment. For each trial, we homogenized the sifted litter sample from a single site by hand and then divided the total volume equally among four Berlese funnels and four Winkler funnels (Table 1). Berlese funnels were custom-made vinyl funnels modified from the design of Norton and Kethley 1988 (Figs. 1 and 2) and Winkler funnels were purchased from "Marizete do Brasil Materiais Entomologicos" (Ilheus, Brazil) (Figs. 3 and 4). Details of each trial are as follows: 1) “Arkansas Sample,” Polk County, Arkansas (N 34.22050°, W 94.01636°) (Fig. 5, ◆), 16 October 2012, 13.5 kg litter from upland hillside, mixed deciduous forest, Paleozoic sandstone/shale rock substrate, 1.70 kg/ funnel. 2) “Louisiana Sample,” West Feliciana Parish, Louisiana (N 30.47680°, W 91.15240°) (Fig. 5, ✖), 6 November 2012, 14.8 kg litter from mixed mesophytic forest habitat, late Cenozoic loess soil substrate, 1.85 kg /funnel. 3) “Alabama Sample,” Winston County, Alabama (N 34.2975°, W 87.2697°) (Fig. 5, ★), 25-27 June 2013, 12.0 kg litter from upland deciduous forest, Paleozoic limestone rock substrate, 1.5 kg/funnel. 4) “Arizona Sample,” Cochise County, Arizona (N 31.73594°, W 109.24554°) (Fig. 5, ○), 5 August 2013, 12.0 kg litter from Sky Island conifer woodland, Cenozoic granitic igneous rock substrate, 1.5 kg/funnel. 5) “North Carolina Sample,” Swain County, North Carolina (W 83.47607°, N 35.56514°) (Fig. 5, ✚), 8 July 2014, 11.5 kg litter from mixed deciduous conifer forest, Paleozoic metamorphic rock substrate, 1.45 kg/funnel. 6) “New Mexico Sample,” Hidalgo County, New Mexico (31.43016°N, 108.96521°W) (Fig. 5, ✖), 5 August 2014, 15.0 kg litter from Sky Island open oak woodland, Cenozoic granitic igneous rock substrate, 1.90 kg/funnel.

Fig. 1. Berlese funnel.

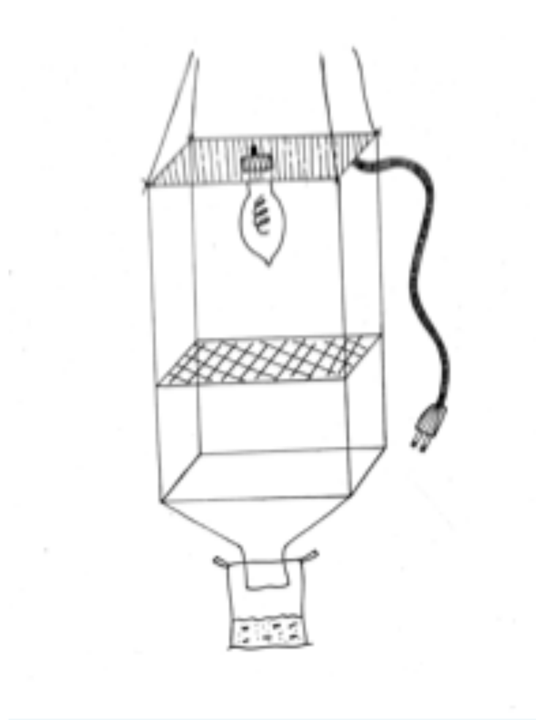

Fig. 2. Diagram of Berlese funnel.

Fig. 3. Winkler funnel.

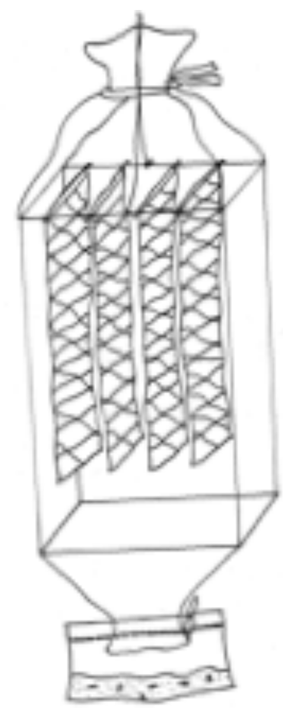

Fig. 4. Diagram of Winkler funnel.

Table 1. Collection sites, dates, and sample sizes

Collection Site	Date	Total Litter Mass	Litter Mass per Funnel
Alabama, Winston County	June 25-27, 2013	12.0 kg	1.5 kg
Arizona, Cochise County	August 5, 2013	12.0 kg	1.5 kg
Arkansas, Polk County	October 16, 2012	13.5 kg	1.7 kg
Louisiana, West Feliciana Parish	November 6, 2012	14.8 kg	1.85 kg
North Carolina, Swain County	July 8, 2014	11.5 kg	1.45 kg
New Mexico, Hidalgo County	August 5, 2014	15.0 kg	1.90 kg

Fig. 5. Southern United States showing locations of litter sample field sites. Polk County, Arkansas= ◆; West Feliciana Parish, Louisiana=■; Winston County, Alabama=★; Cochise County, Arizona=O; Swain County, North Carolina=✚; Hidalgo County, New Mexico=✖.

Each funnel received 1.50-1.90 kg of litter, depending on original volume of sample. Duration of extraction time for each trail was based on time to extinction (i.e., no additional specimens recovered from either Winklers or Berleses within a 48 hour period). To establish standardized rates of extraction, the first trial was run for 585 hours, with 19 collection intervals at 3, 6, 9, 12, 15, 21, 27, 33, 39, 45, 57, 69, 81, 93, 105, 177, 249, 417, and 585 hours. Due to low numbers of specimens recovered during the last few collection intervals and in order to increase the numbers of specimens obtained per interval, the frequency of collection intervals and duration of total extraction time was reduced for all subsequent trials. The subsequent five trials were run for a total of 215 hours, with thirteen collection intervals at 3, 6, 9, 12, 18, 24, 30, 36, 48, 60, 72, 144, and 216 hours. Specimens were collected into either 500 ml Whirlpaks® or 900 ml Ziplock® bags containing 95% ethanol placed beneath the funnels. Bags were pre-labeled and replaced at each service interval.

Adult Coleoptera specimens obtained for each time interval per funnel were sorted and identified to species or genus/morphospecies. Individuals were either pinned or point-mounted and appropriate label data were pinned below each specimen. In cases where dissection was necessary for species-level identification, individuals were prepared and dissected according to the methods of Hanley and Ashe (2003). These individuals were stored in glycerin in genitalia vials pinned above label data. All voucher specimens are housed at the Louisiana State Arthropod Museum (LSAM), Louisiana State University, Baton Rouge, LA, USA.

Taxa from each interval and extractor type were entered into Microsoft Excel® to create a spreadsheet of all specimens of all taxa collected for each funnel type at each collection interval. These data were used to generate a total of eleven different graphs for each trial. Two of these graphs depict total specimens and species collected per time interval for both extractor types. Graphs were also generated for the numbers of new species collected in each time interval, defined as those that had not been recovered during previous intervals for each trial and funnel type. In addition to total specimens and new species collected per interval, these data were compiled to generate two "temporal addition curves" for each trial, depicting the cumulative addition of species and specimens collected across intervals for both funnel types. Specimens within the Curculionidae and Staphylinidae were targeted for more detailed analysis to determine if species level patterns existed in the recovery profiles. These two taxa are commonly found in the forest litter and often collected via these extraction methods, so determining optimal funnel type and length of extraction for these families is especially pertinent. Four graphs were generated of temporal addition curves, depicting the specimens and new species of both families collected across time intervals. In addition, special attention was given to those species determined to be "rare" species in each sample. We defined this on trial-by-trial basis, with those species represented by fewer than five specimens at the end of the collection period qualifying as "rare". For taxonomic purposes, obtaining rare individuals is often extremely important for presence/absence studies and for the collection of type specimen series on which new species descriptions are based, so information focused on the extraction method appropriate for these species is extremely useful for such studies. Temporal addition curves of species and specimens of "rare" species in each sample were used to generate graphs of this information for both funnel types.

Comparisons of funnel types across sites were performed via Students' t-test ($\alpha=0.05$) to evaluate differences in extraction products between Winklers and

Berleses for each category of data (total Coleoptera specimens, total Coleoptera species, Staphylinidae species, Staphylinidae specimens, Curculionidae species, Curculionidae specimens, rare specimens, and rare species) of all 6 trials.

A checklist of all species collected during the course of the experiment is included at the end of the discussion section (Table 2).

2.3 Results

2.3.1 Cumulative specimens

2.3.1.1 Specimens per time interval

A total of 4720 specimens of adult Coleoptera were collected from both Berlese and Winkler funnels after the completion of all six trials. The total number of specimens collected during each individual trial varied widely. The largest number of specimens was obtained from the Louisiana sample, with 2250 total specimens collected, 1043 by Berlese funnels and 1207 by Winkler funnels. The Alabama sample yielded 696 specimens, 452 from Berleses funnels and 244 from Winkler funnels. The Arkansas sample yielded 694 specimens, 386 from Berlese funnels and 308 from Winkler funnels. The New Mexico sample yielded 326 specimens, 184 from Berlese funnels and 142 from Winkler funnels. The North Carolina sample yielded 587 specimens, 367 from Winkler funnels and 220 from Berlese funnels. The lowest number of specimens was collected in the Arizona trial, with a total of 167 specimens, 80 by Berlese funnels and 87 by Winkler funnels. The t-test yielded a value of P=0.99; there was no significant difference in the total number of specimens extracted by Berlese funnels or Winkler funnels across all trials.

Across all six trials, the largest numbers of specimens were consistently obtained from both funnel types during intervals within two distinct periods (Figs. 6-11). An initial high point occurred at the end of the first interval, from 0-3 hours. This initial peak then decreased during the second interval, from 3-6 hours, with the number of specimens collected per interval fluctuating during intermediate intervals following this point. The second, smaller peak in the number of specimens collected per interval occurred in all trials towards the end of the collection period, between 60 and 144 hours. This relatively large number of specimens per interval decreased dramatically during the intervals after 144 hours in all funnels and trials except for the Winkler funnels Arkansas trial, which exhibited a peak during the very last collection interval from 144-216 hours (Fig. 7).

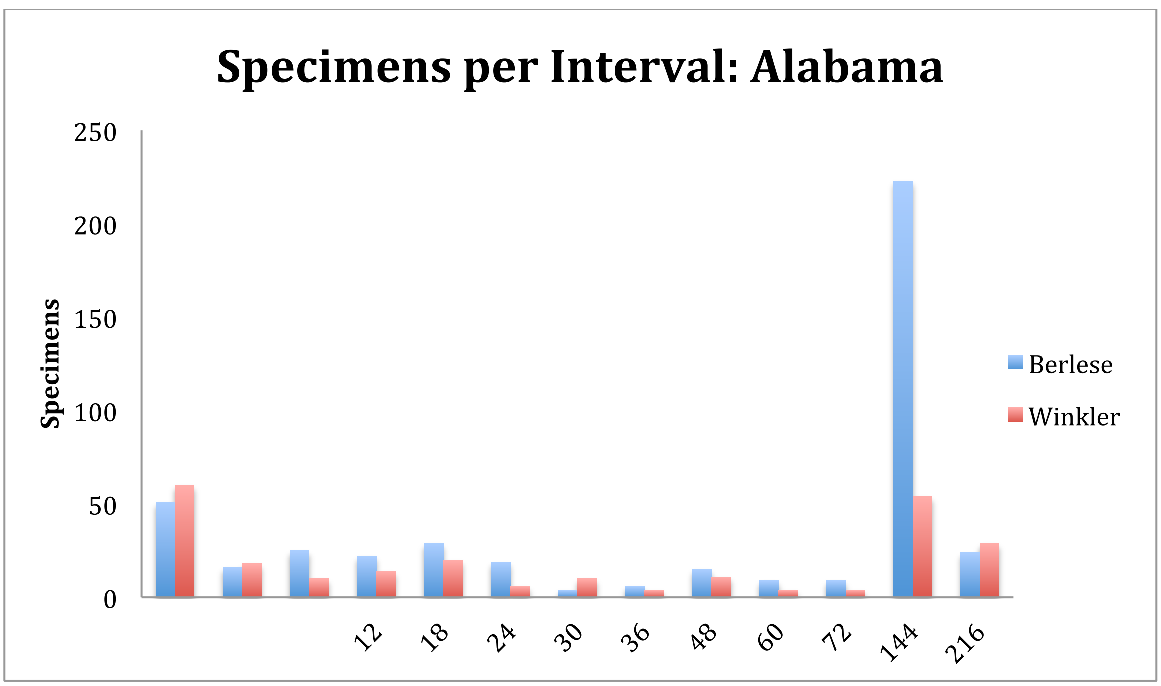

Fig. 6. Number of Coleoptera specimens obtained from the Alabama litter sample per time interval by Winkler and Berlese funnels.

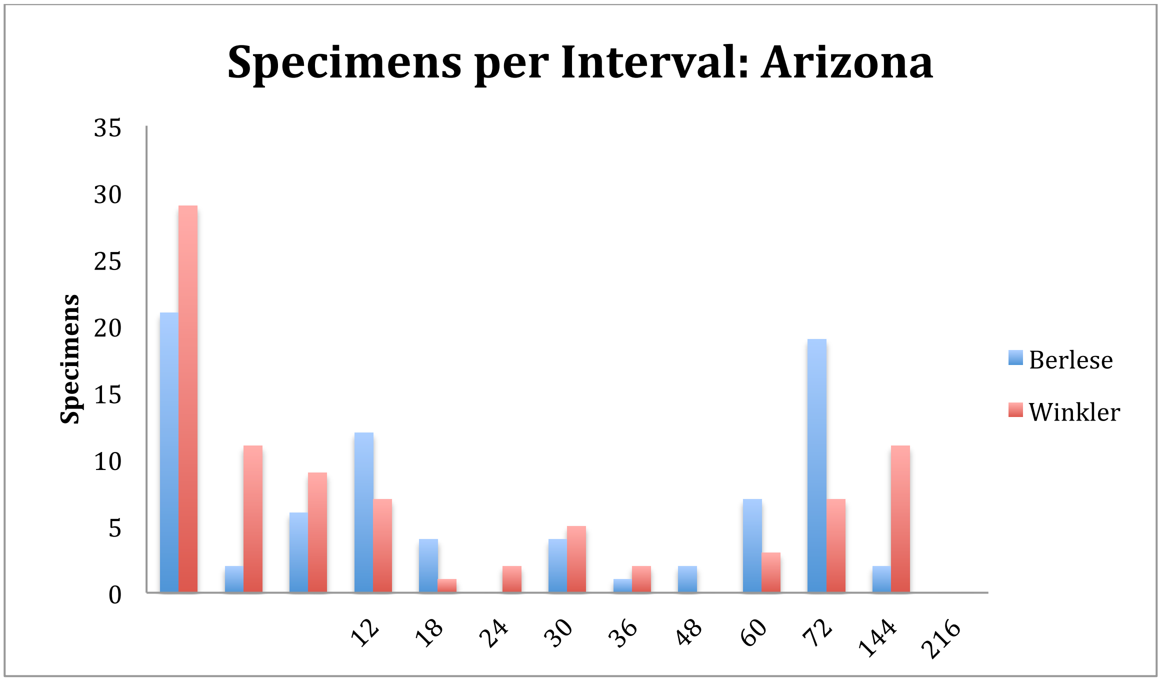

Fig. 7. Number of Coleoptera specimens obtained from the Arizona litter sample per time interval by Winkler and Berlese funnels.

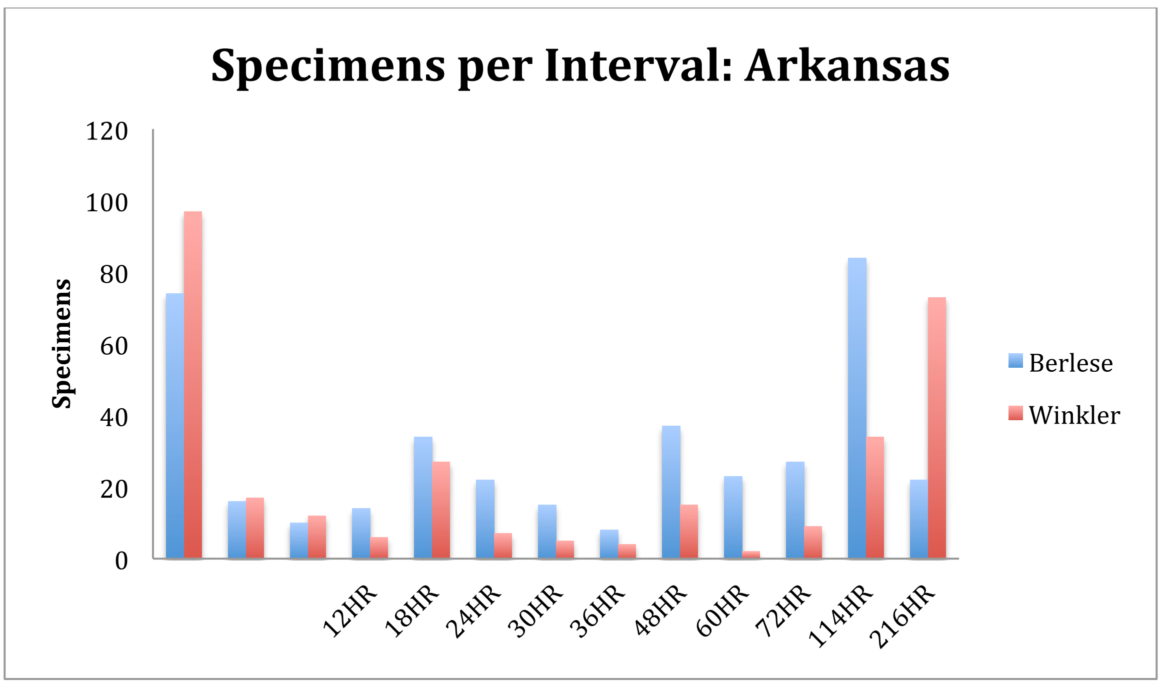

Fig. 8. Number of Coleoptera specimens obtained from the Arkansas litter sample per time interval by Winkler and Berlese funnels.

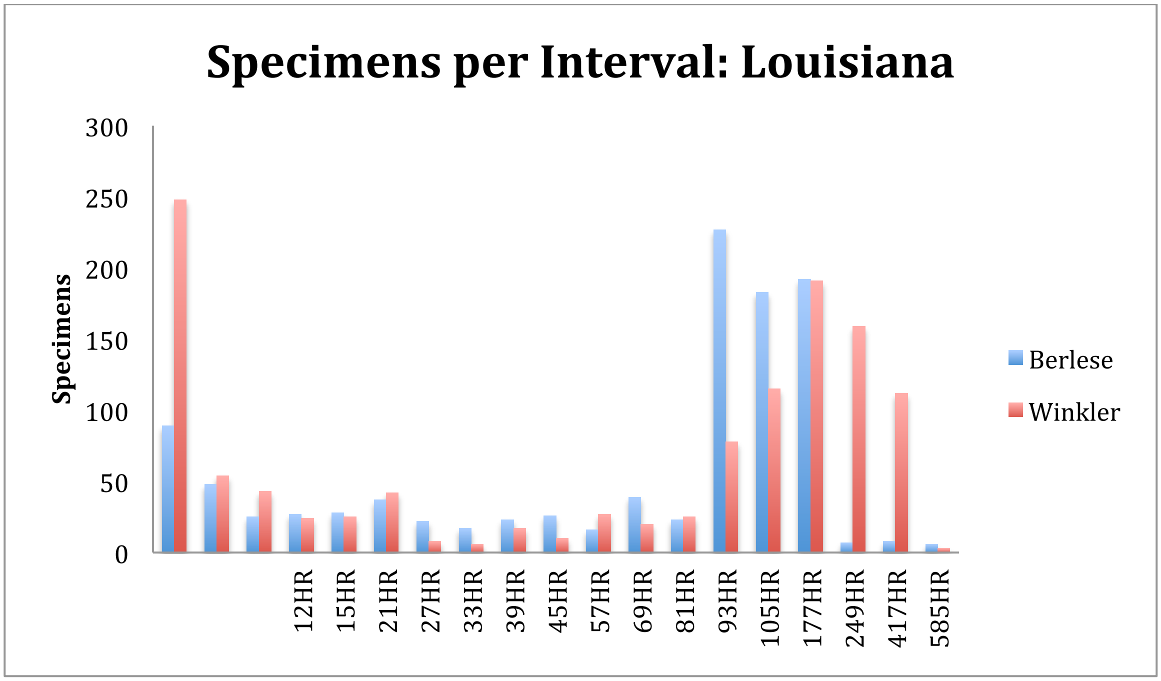

Fig. 9. Number of Coleoptera specimens obtained from the Louisiana litter sample per time interval by Winkler and Berlese funnels.

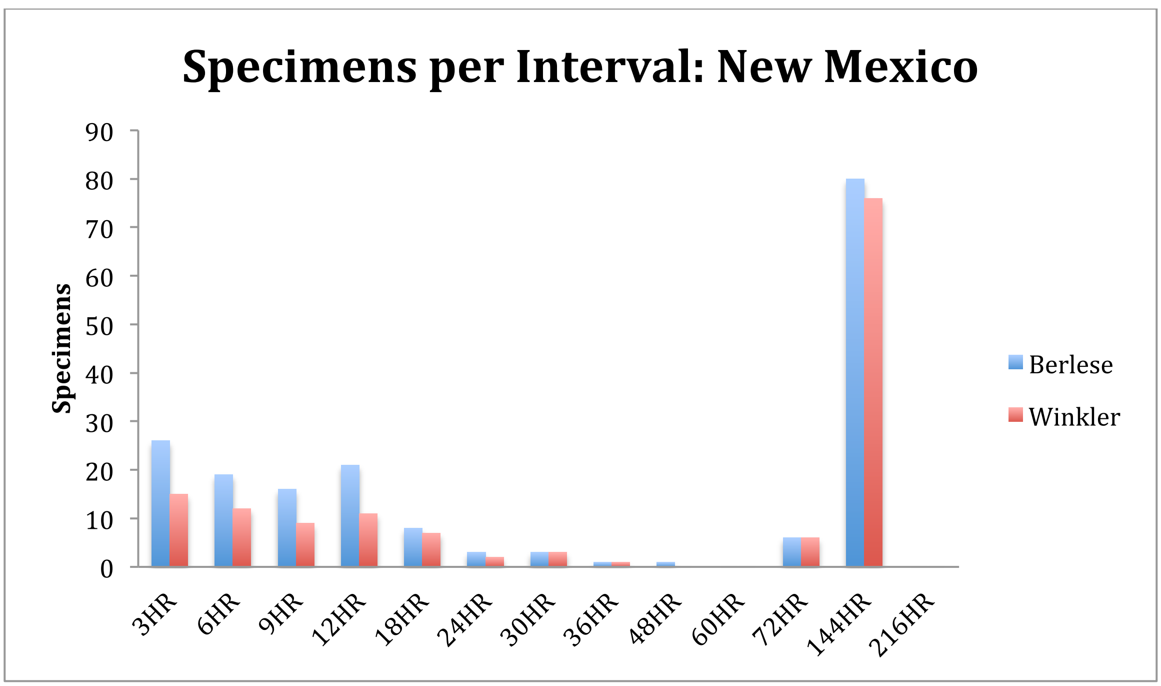

Fig. 10. Number of Coleoptera specimens obtained from the New Mexico litter sample per time interval by Winkler and Berlese funnels.

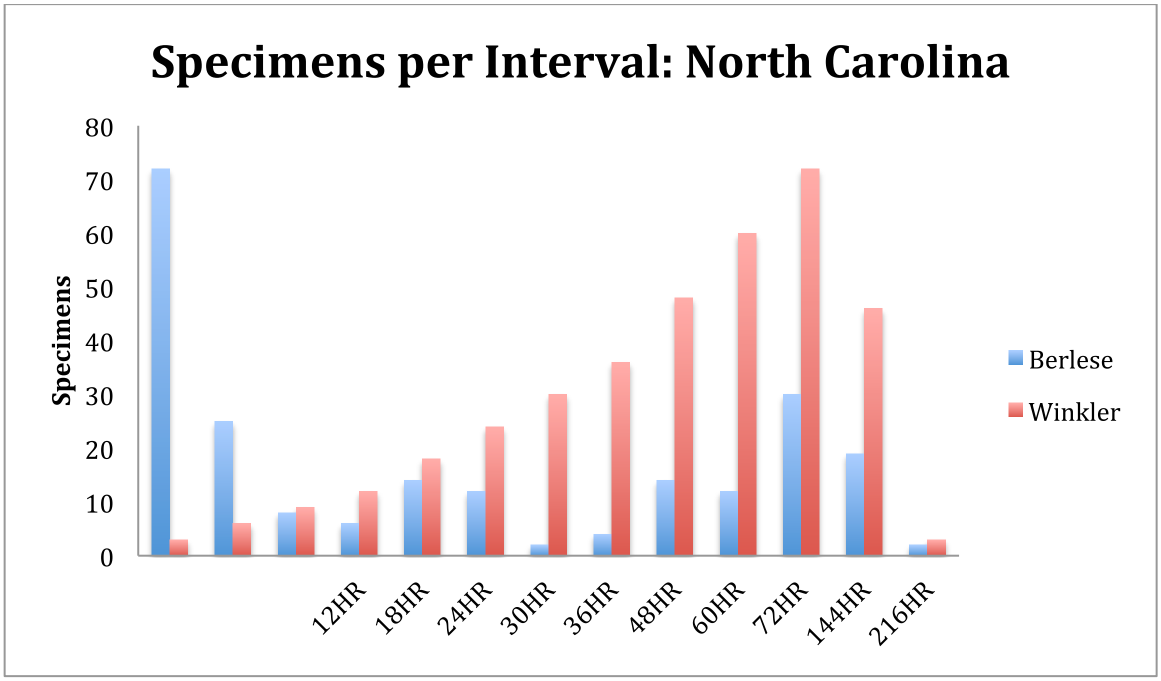

Fig. 11. Number of Coleoptera specimens obtained from the North Carolina litter sample per time interval by Winkler and Berlese funnels.

These two high points in the number of specimens collected per interval were apparent for all samples and were exhibited by both extractor types. However, the relative intensity of the initial and terminal periods of high specimen extraction varied among trials. In four out of the six trials (Figs. 6, 8, 9, 10), the second peak for the Berlese was higher than in the initial intervals, with the largest number of specimens per interval collected at an interval between 60-144 hours. For the remaining trials, the interval with the greatest number of specimens collected either occurred at the beginning of the trial period during the first time interval from 0-3 hours, or this initial high number was equal to the later peak, as in the case of the Alabama Winkler funnels (Fig. 6). Intervals between these initial and terminal intervals varied in numbers of specimens collected. However, the overall pattern of two, distinctly higher periods of specimen recovery, one towards the beginning and one towards the end of each trial, was apparent for both Berlese and Winkler funnels in all trials.

2.3.1.2 Temporal addition of specimens

For all six trials, the pattern exhibited by the temporal addition of specimens across time intervals was characterized by two periods of relatively higher addition of specimens. The specimen temporal addition for both Berleses and Winklers in all samples was highest in two distinct periods, during both the beginning of the individual trials from intervals between 3-18 hours and towards the end of the trials between 60-144 hours (Figs. 12-17). The Louisiana sample exhibited a continued increase in the numbers of specimens collected from Winklers to 249 hours. The Arkansas Winkler continued extracting high numbers of specimens to the 144-216

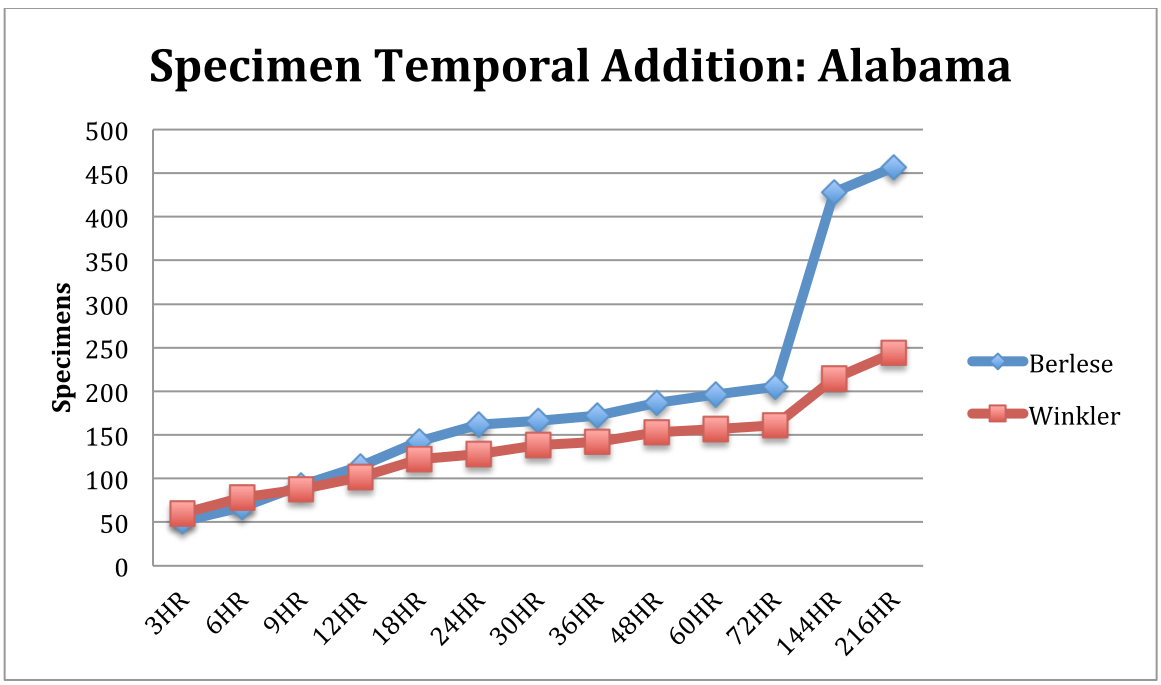

Fig. 12**.** Number of Coleoptera specimens obtained from the Alabama litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

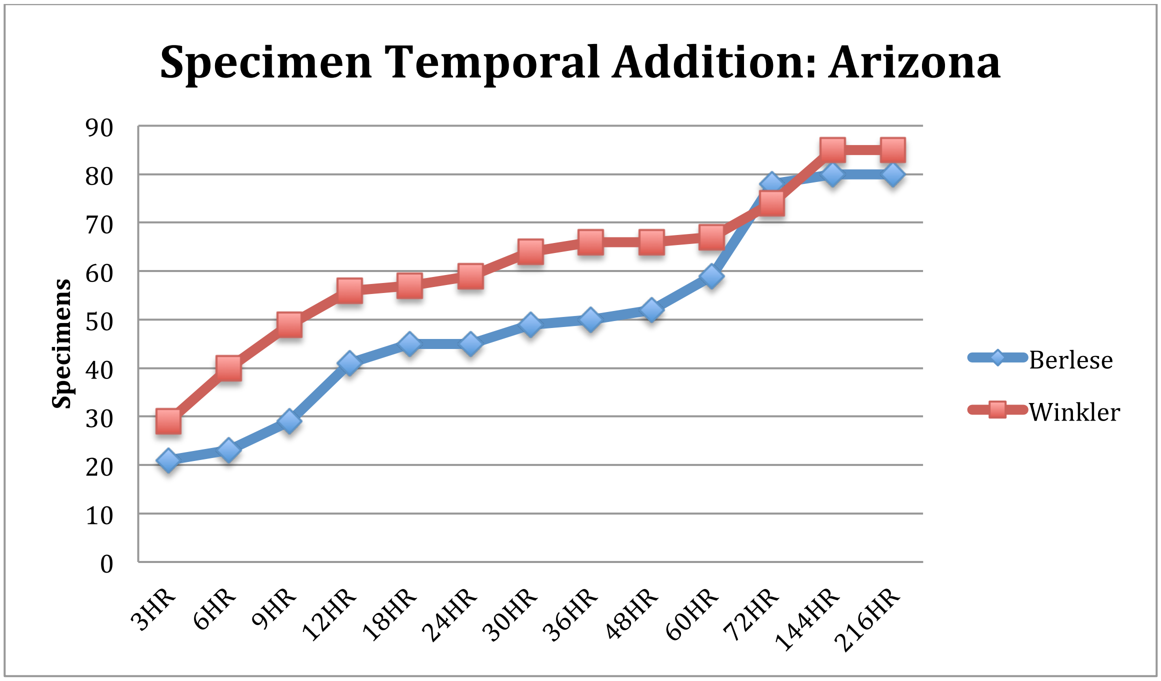

Fig. 13. Number of Coleoptera specimens obtained from the Arizona litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

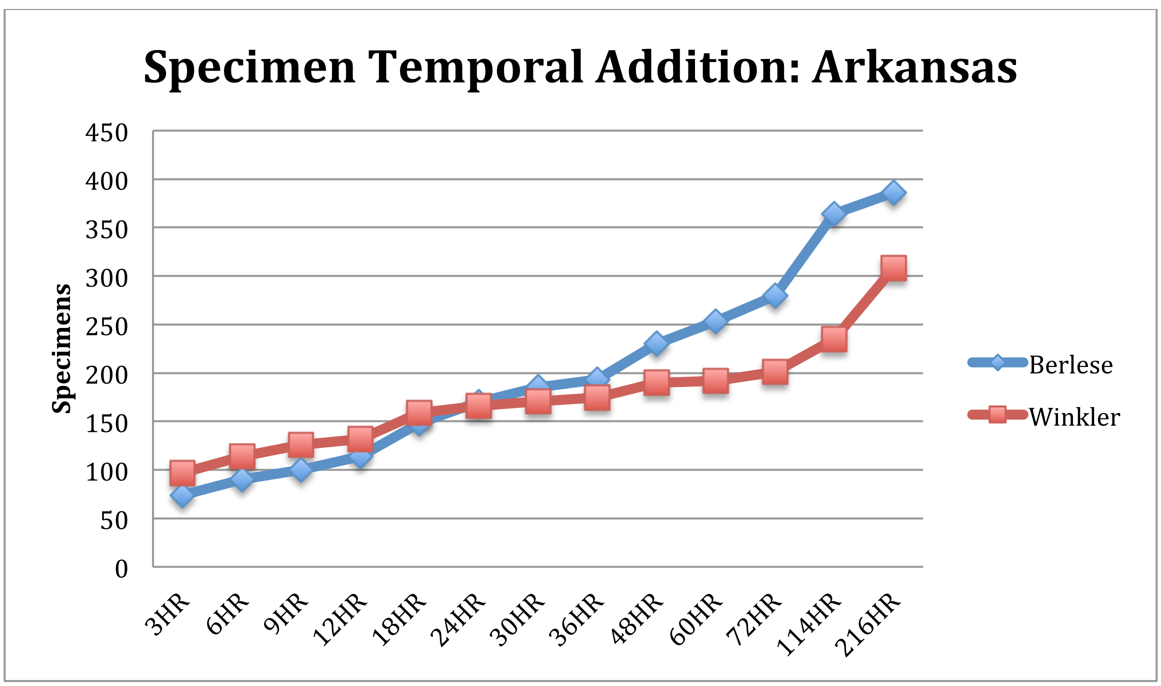

Fig. 14. Number of Coleoptera specimens obtained from the Arkansas litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

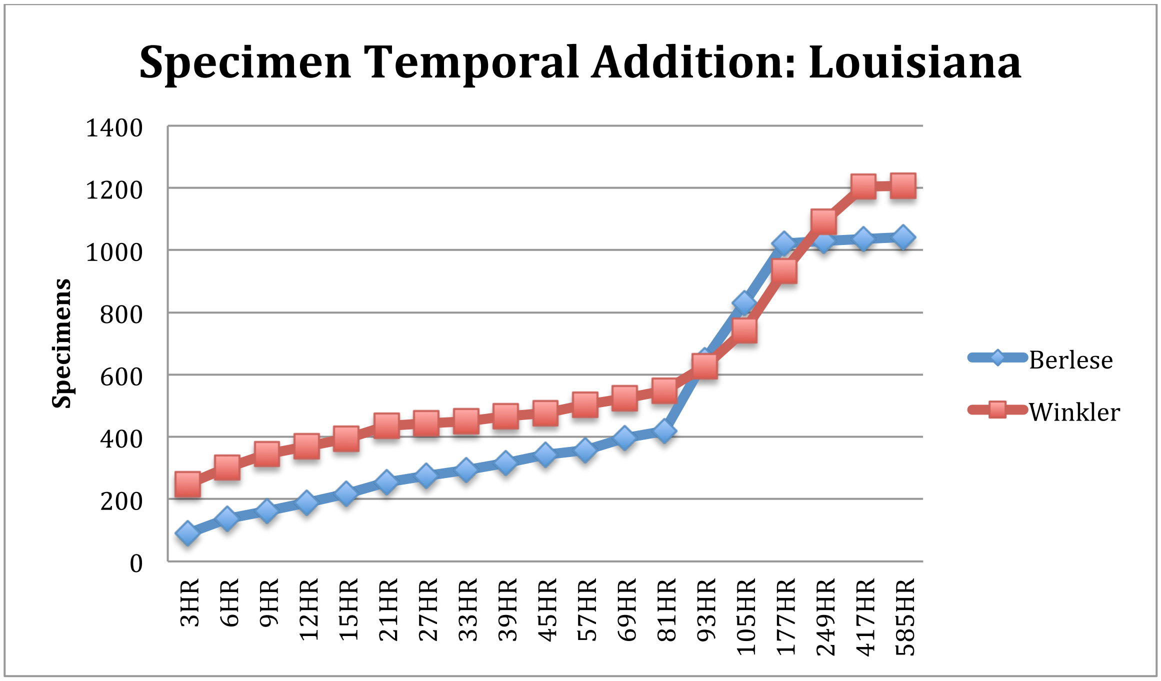

Fig. 15. Number of Coleoptera specimens obtained from the Louisiana litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

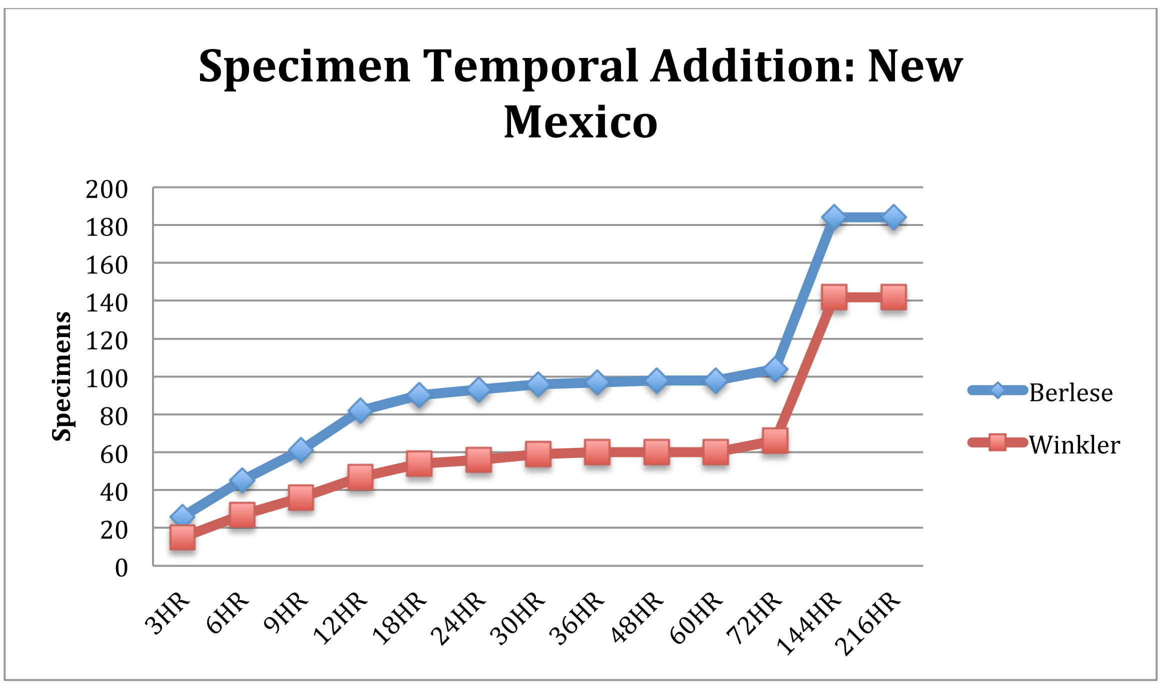

Fig. 16. Number of Coleoptera specimens obtained from the New Mexico litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

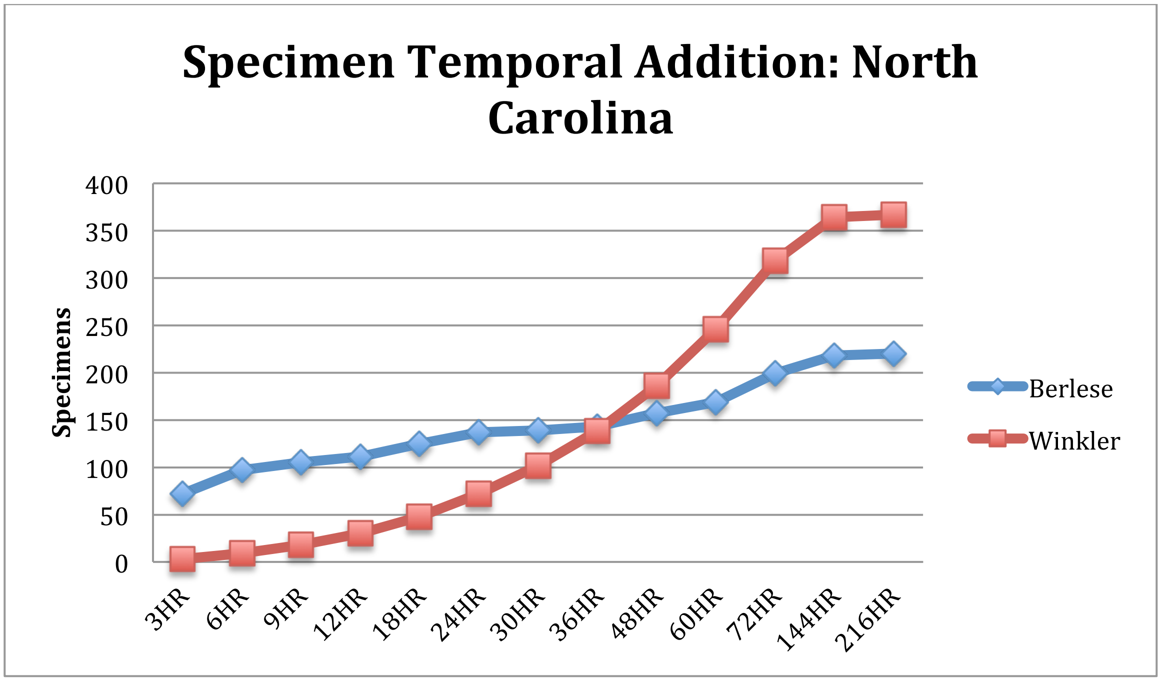

Fig. 17. Number of Coleoptera specimens obtained from the North Carolina litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

hour interval. For both Berleses and Winklers in all four trials, with the exception of the Arizona Winkler funnels, the greatest increase in specimen addition between intervals occurred in an interval during the last peak (Figs. 12, 14-17).

2.3.2 Cumulative species

2.3.2.1 Species per time interval

A total of 310 individual species were collected by both Berleses and Winklers in all trials. As with the numbers of specimens, the total number of species from the six individual samples varied greatly. The largest number of species was obtained during the Louisiana trial, with 137 species, 99 from Berleses and 107 from Winklers. The Arkansas sample yielded 75 species, 58 from Berlese funnels and 45 from Winkler funnels. The Alabama sample yielded 84 species, 62 from Berlese funnels and 55 from Winkler funnels. The North Carolina sample yielded 51 species, 39 from Berlese funnels and 36 from Winkler funnels. The Arizona sample yielded 31 species, 22 from both Berlese and Winkler funnels. The lowest number of species was obtained from the New Mexico sample with 29 species obtained in total, and 23 and 22 species from Berlese funnels and Winkler funnels, respectively. The t-test yielded a value of P=0.88; there was no significant difference in the total number of species extracted by Berlese funnels or Winkler funnels across all trials.

Numbers of species of Coleoptera per interval (Figs. 18-23) exhibited a pattern similar to that of specimens per interval. The largest number of species per interval was collected in each trial during two distinct periods, one at the beginning of the trial and another during a second spike towards the end of the trial. Winklers and Berleses in all trials exhibited this collection pattern, with the exception of the Arizona Winkler funnels, in which the number of species collected in the last several intervals did not exceed a third peak that occurred at the 9-12 hour interval (Figs. 18, 20-23). Winklers and Berleses in all trials yielded a relatively high number of species during the 0-3 hour interval, with this number dropping during the intervals from 3-9 hours. After this initial high point, numbers of species fluctuated until a second peak between 72-144 hours. After this second peak, the number of species extracted declined during the terminal interval(s) in all except the Arkansas Winkler funnels, which exhibited an increase in species collected during the 144-216 hour interval (Fig. 19).

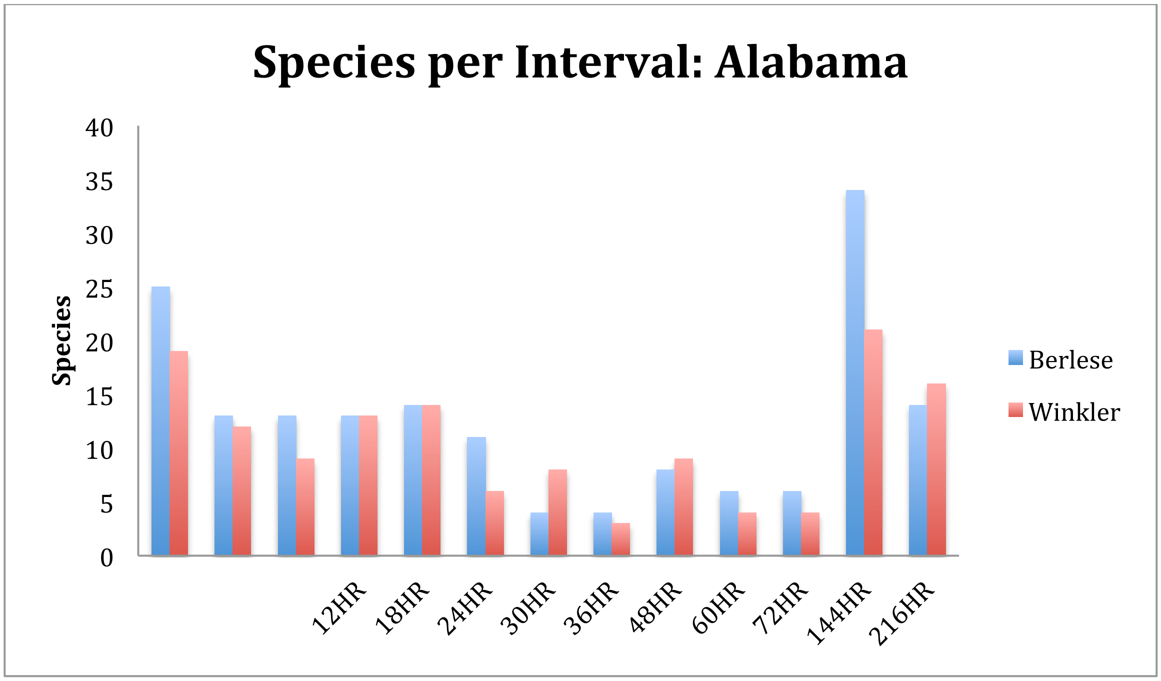

Fig. 18. Number of Coleoptera species obtained from the Alabama litter sample per time interval by Winkler and Berlese funnels.

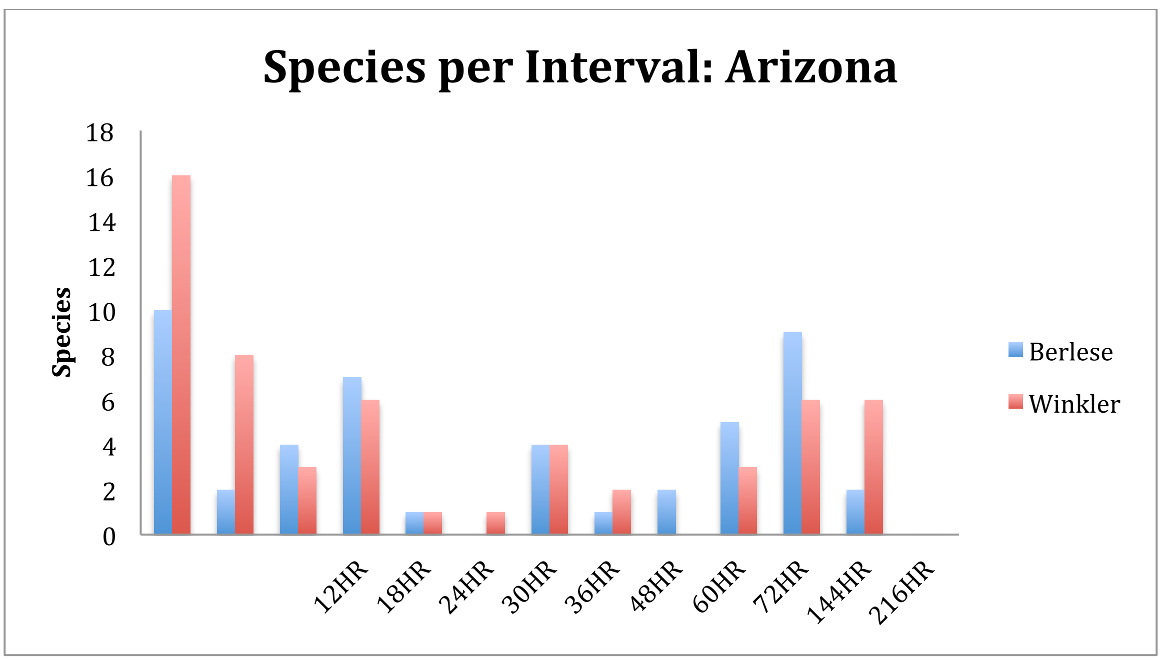

Fig. 19. Number of Coleoptera species obtained from the Arizona litter sample per time interval by Winkler and Berlese funnels.

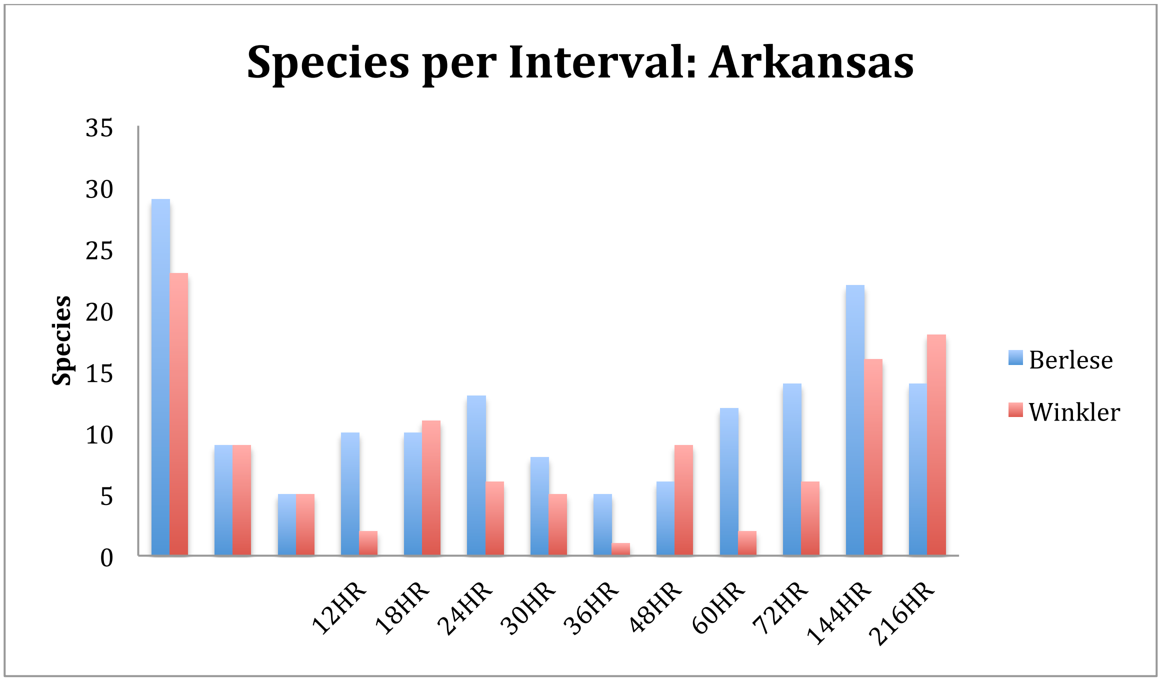

Fig. 20. Number of Coleoptera species obtained from the Arkansas litter sample per time interval by Winkler and Berlese funnels.

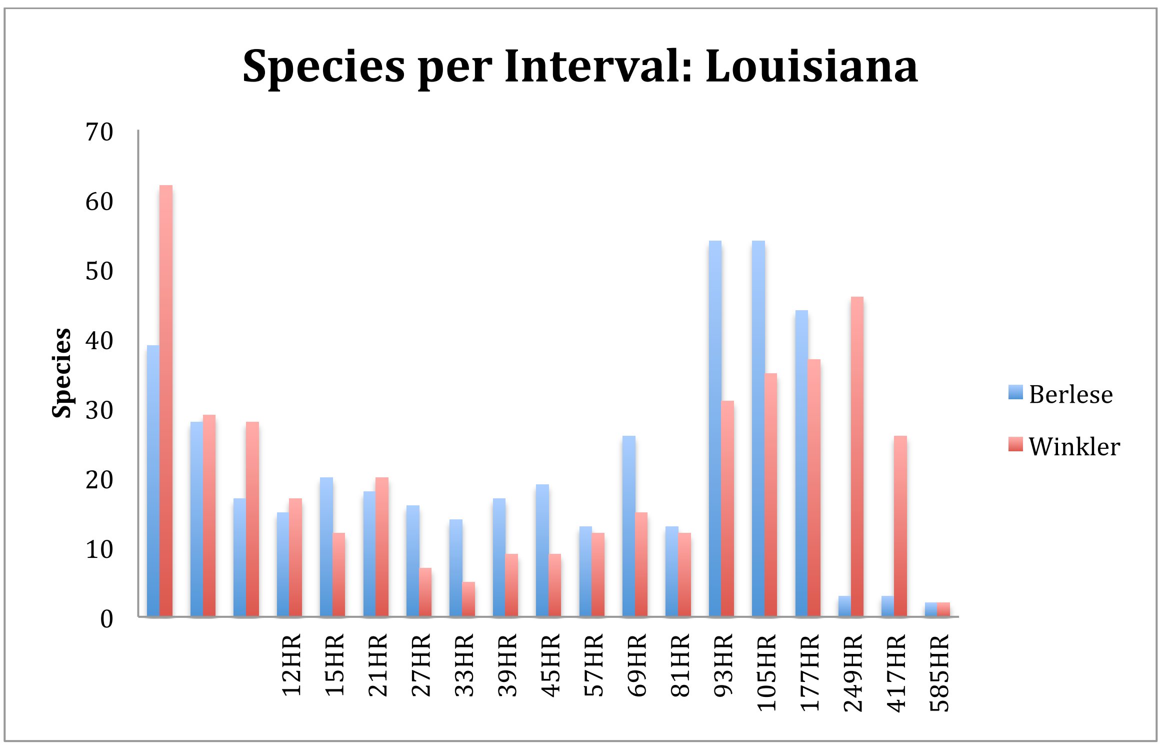

Fig. 21. Number of Coleoptera species obtained from the Louisiana litter sample per time interval by Winkler and Berlese funnels.

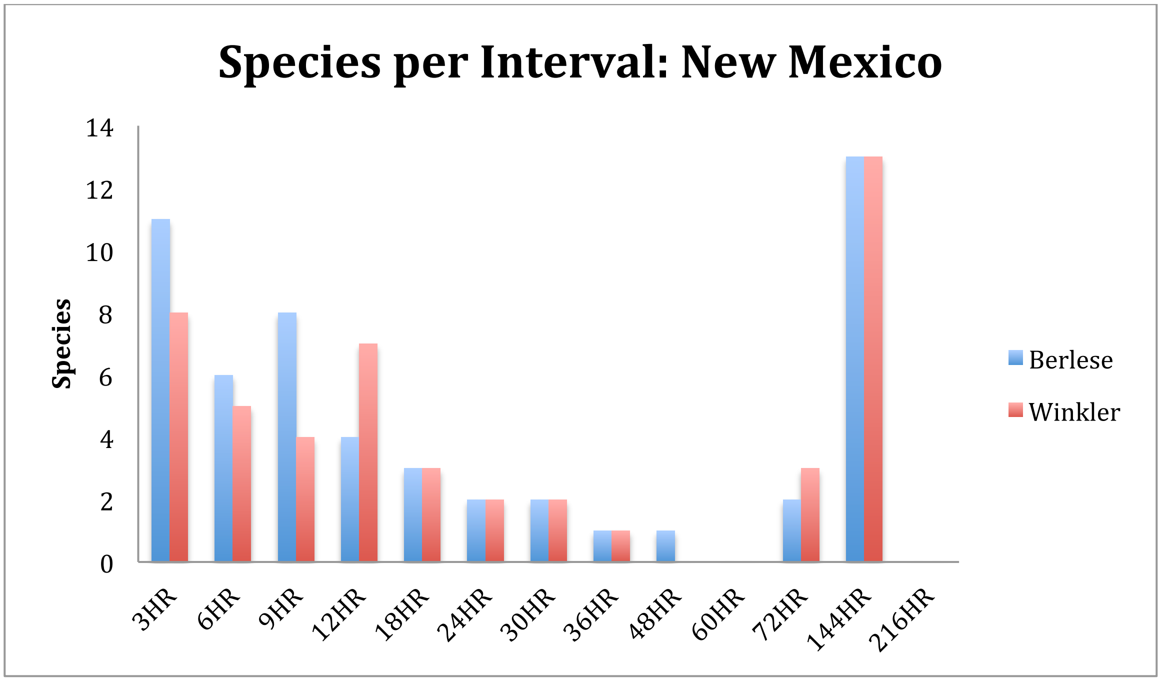

Fig. 22. Number of Coleoptera species obtained from the New Mexico litter sample per time interval by Winkler and Berlese funnels.

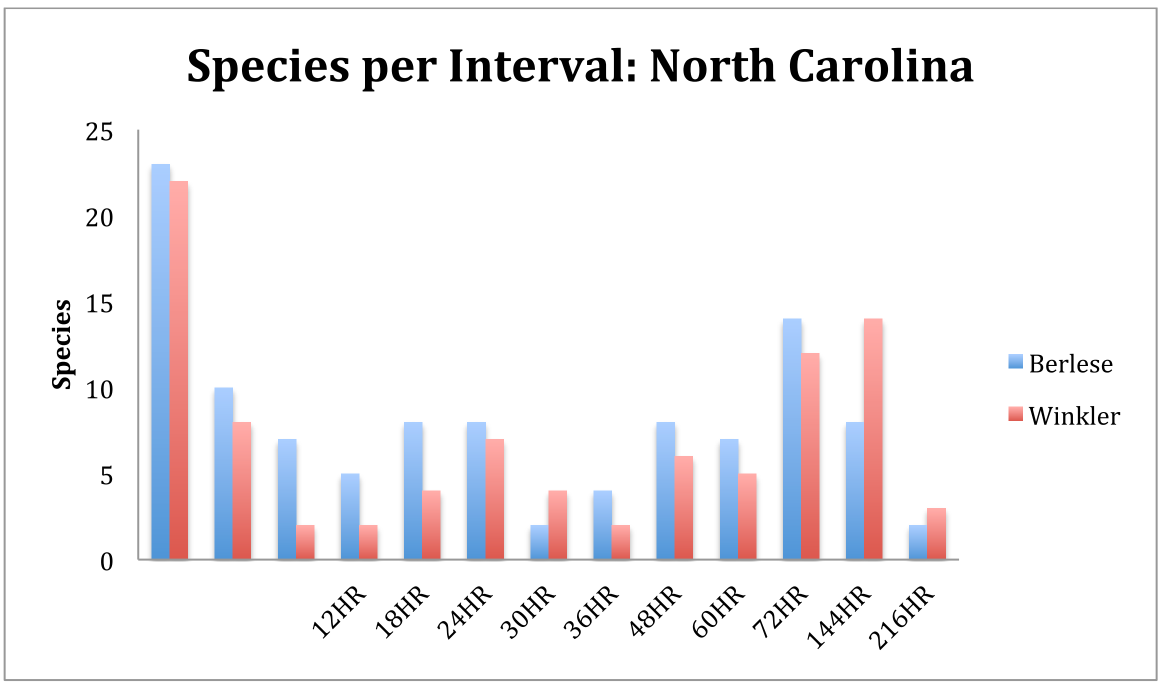

Fig. 23. Number of Coleoptera species obtained from the North Carolina litter sample per time interval by Winkler and Berlese funnels.

Both funnel types in the Arkansas, Arizona, and North Carolina trials, as well as the Winkler in the Louisiana trial, collected more species in the initial intervals than during the second peak during later intervals (Figs. 19-21, 23). However, both Berlese and Winkler funnels in the Alabama and New Mexico trials and the Louisiana Berlese funnels obtained more species during the later peak than during the initial intervals (Figs. 18, 21, 22). Thus, no pattern of difference in species collected per interval was evident between Winklers and Berleses. Both funnels collected total numbers of species per interval in a pattern that was similar throughout all trials.

2.3.2.2 Temporal addition of species

For all trials, with the exception of the Arizona sample, the temporal addition of species was also the greatest during two distinct periods, one at the beginning and one at the end of the trials, while intermediate intervals experienced relatively lower species addition per interval (Figs. 24-29). These two periods of relatively higher temporal addition of species occurred between 3-18 hours and then 72-144 hours. For the Arizona sample, the highest addition of species also occurred at the beginning and towards the end of the trials, with a third, equivalent intermediate peak in species addition occurring in the 30-36 hour interval (Graph 26). In this trial, the addition of species across intervals occurred at a more constant rate throughout the entire trial period. However, for both Berlese and Winkler funnels in all other trials the period of highest species addition between intervals occurred during an interval within the last peak between 60-144 hours (Figs. 24, 25, 27-29).

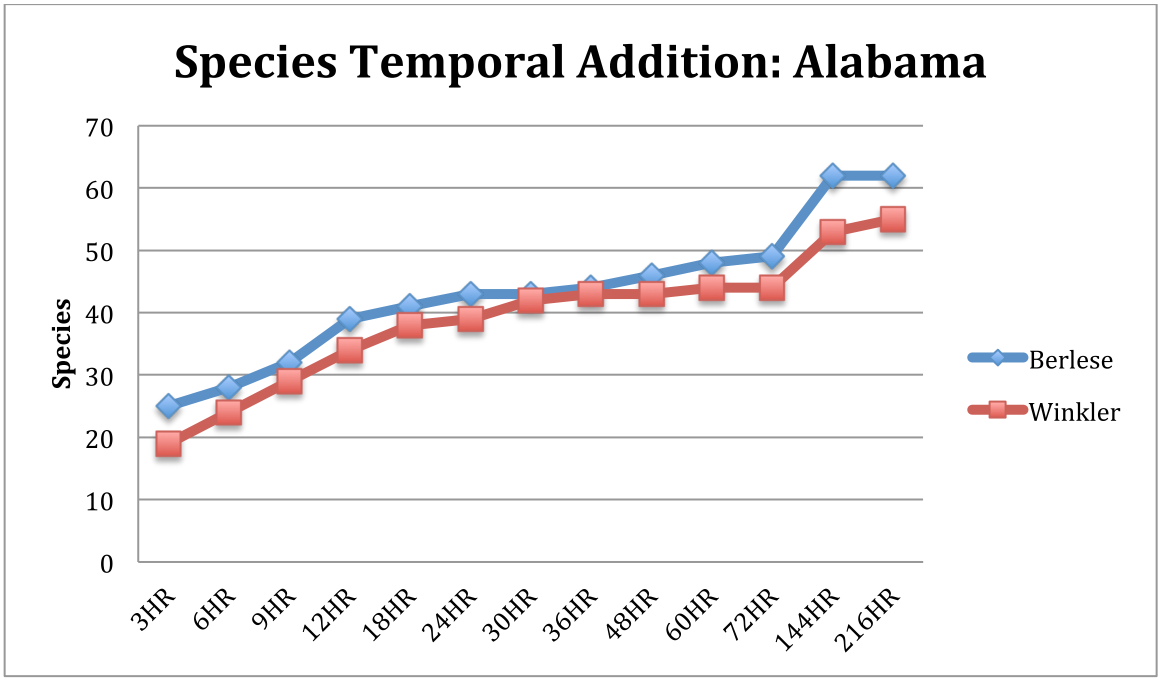

Fig. 24. Number of Coleoptera species obtained from the Alabama litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

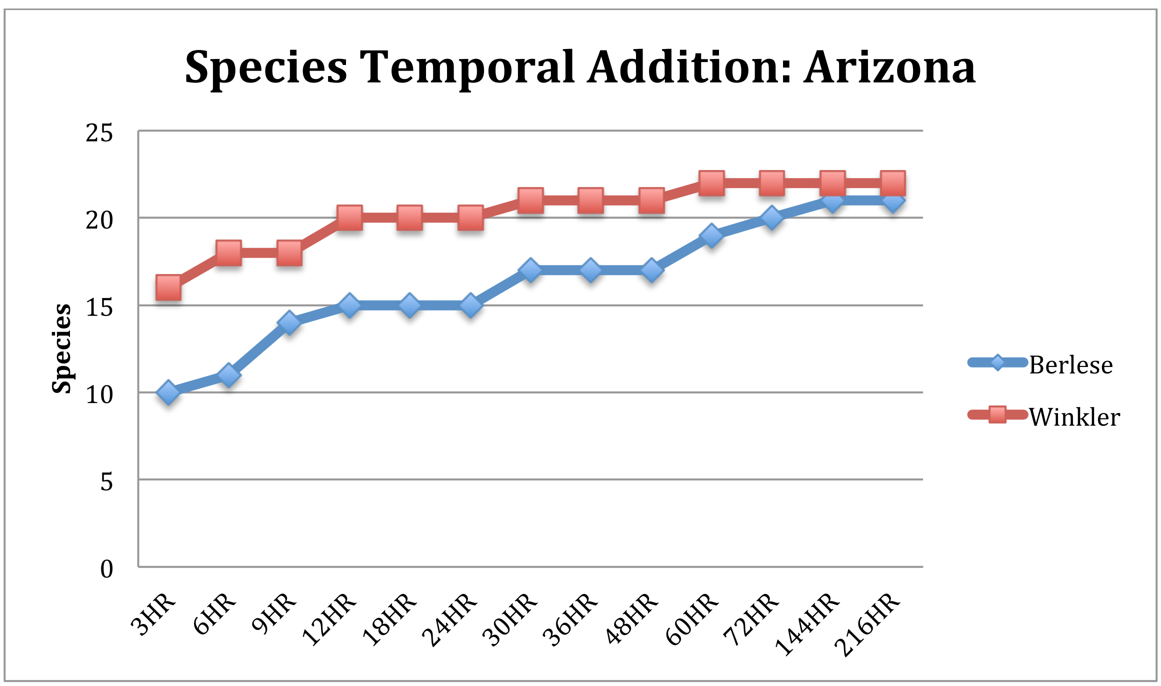

Fig. 25. Number of Coleoptera species obtained from the Arizona litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

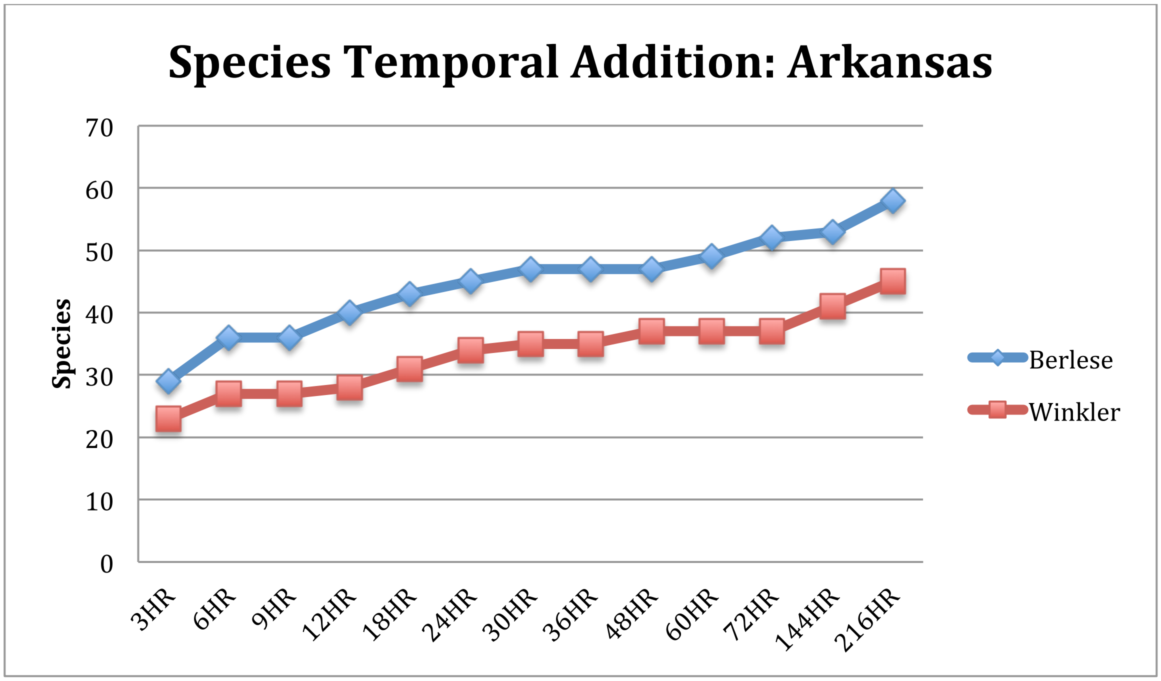

Fig. 26**.** Number of Coleoptera species obtained from the Arkansas litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

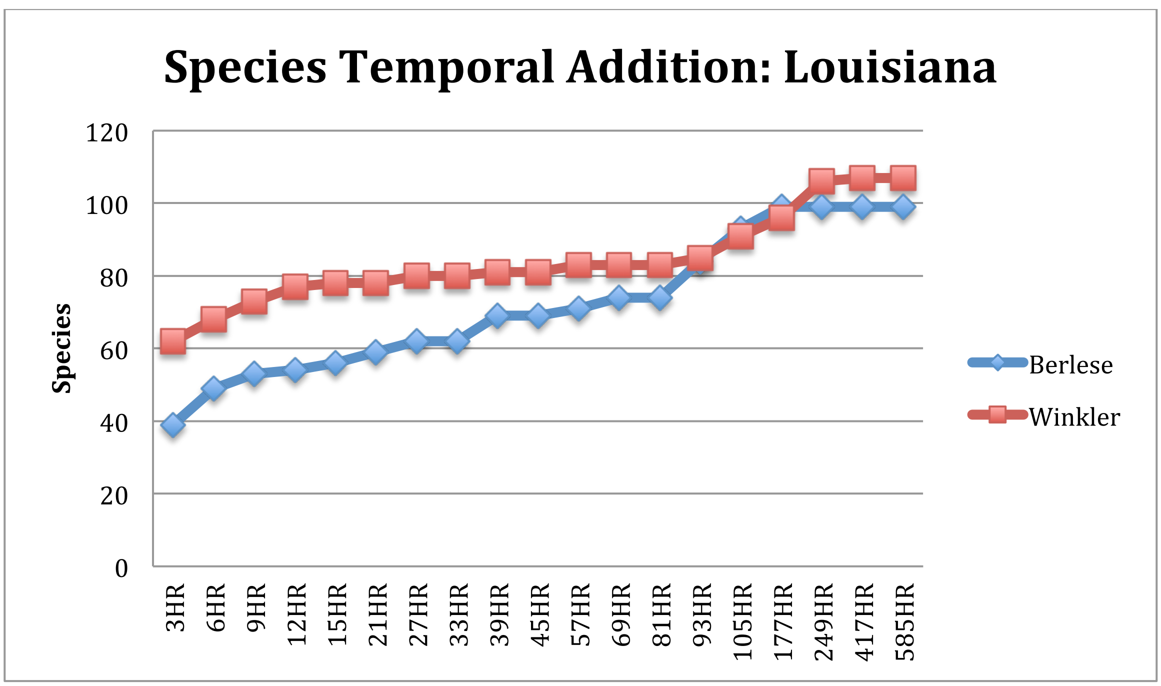

Fig. 27. Number of Coleoptera species obtained from the Louisiana litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

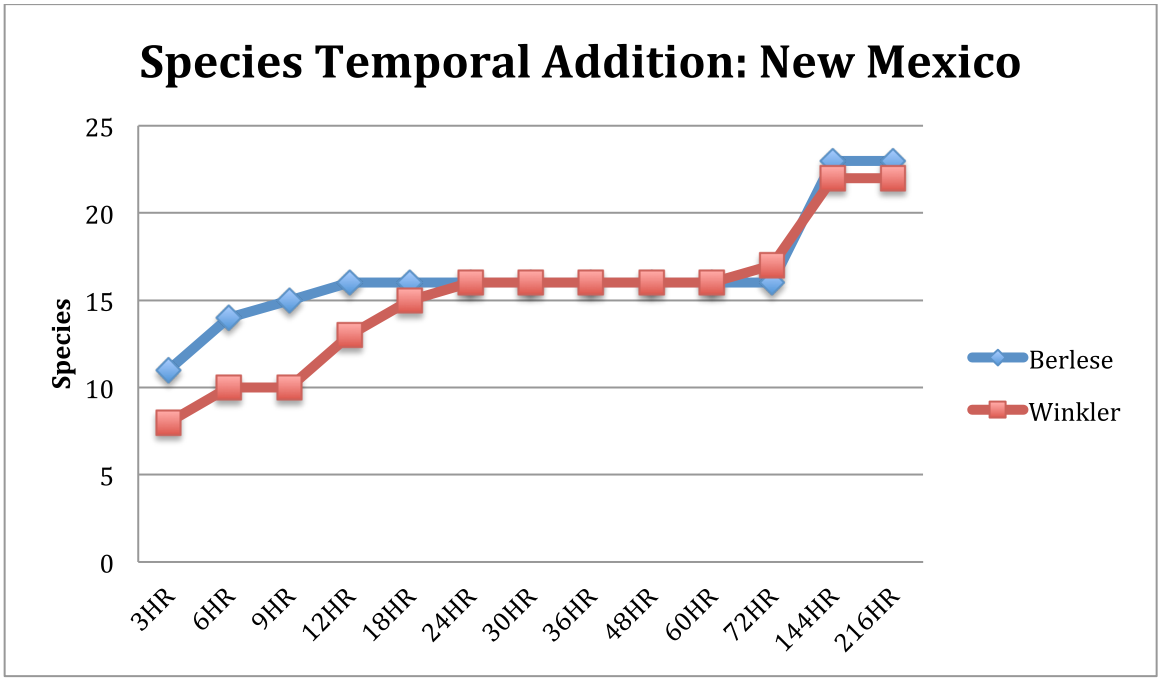

Fig. 28. Number of Coleoptera species obtained from the New Mexico litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

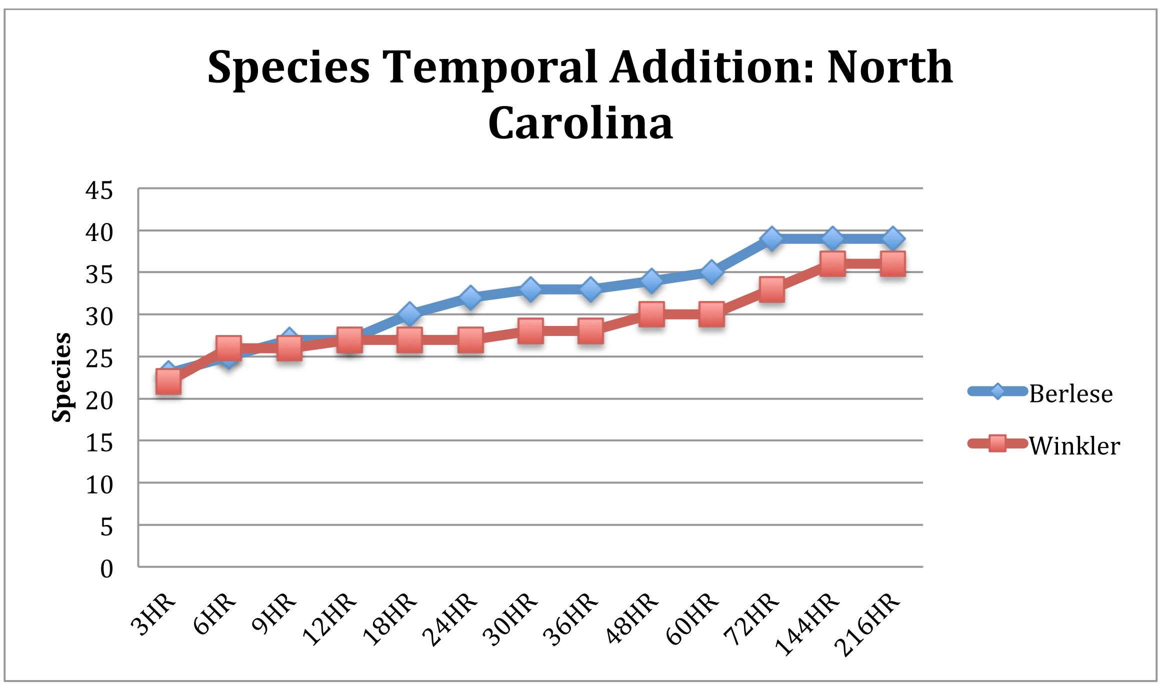

Fig. 29. Number of Coleoptera species obtained from the North Carolina litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

Although relatively higher temporal species addition occurred during both the initial intervals and second peaks compared to the rest of the intervals, the second period during the later intervals was the most productive considering the number of species collected per interval in the majority of trials.

2.3.2.3 New species per time interval

For both the Winkler funnels and Berlese funnels of all trials, the greatest number of new species per interval was obtained during the first interval of 0-3 hours (Figs. 30-35). This initial high number decreased rapidly during the second interval of 3-6 hours. After this peak, the number of new species per interval fluctuated throughout the following intermediate intervals. In five of the six trials, a second peak of relatively higher numbers of new species collected per interval occurred later in the trial between the intervals from 72-216 hours. During this period, at least one interval exhibited a higher number of new species per interval than those collected in intermediate intervals following the initial 0-3 hour interval (Figs. 30, 32-35). This second peak was not exhibited by the Arizona trial. In this trial, the high number of new species in initial intervals was followed by a fluctuating number of new species per interval throughout the rest of the trial (Fig. 31). Nevertheless, the overall pattern of an initial high number and later peak in numbers of new species collected per interval between the 0-3 hour interval and the 72-216 hour intervals were similar to that of total species and specimens per interval, and no difference in the overall pattern of extraction was evident between Winkler and Berlese funnels.

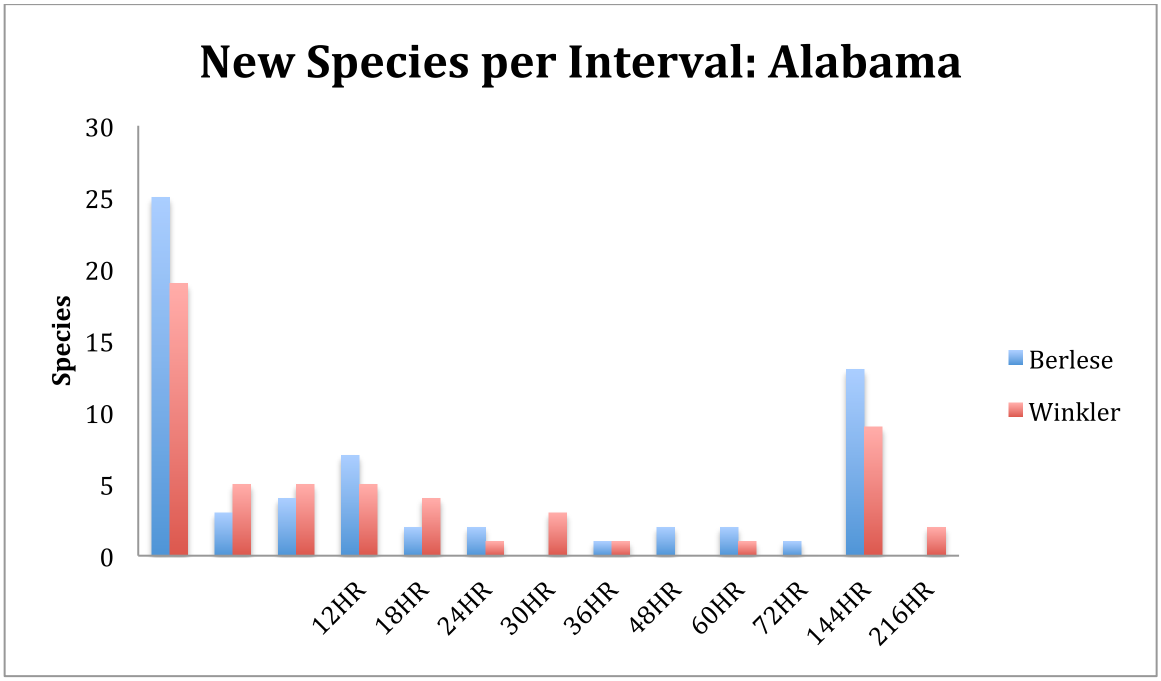

Fig. 30. Number of new species obtained from the Alabama sample at each time interval by Winkler and Berlese funnels.

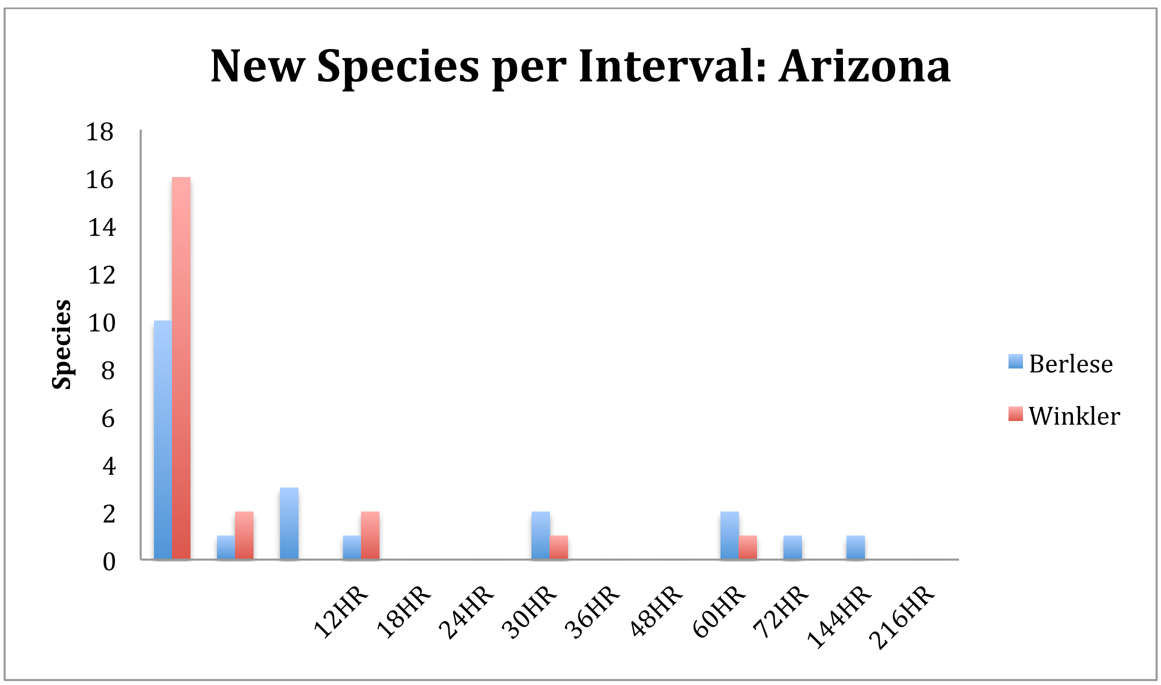

Fig. 31. Number of new species obtained from the Arizona sample at each time interval by Winkler and Berlese funnels.

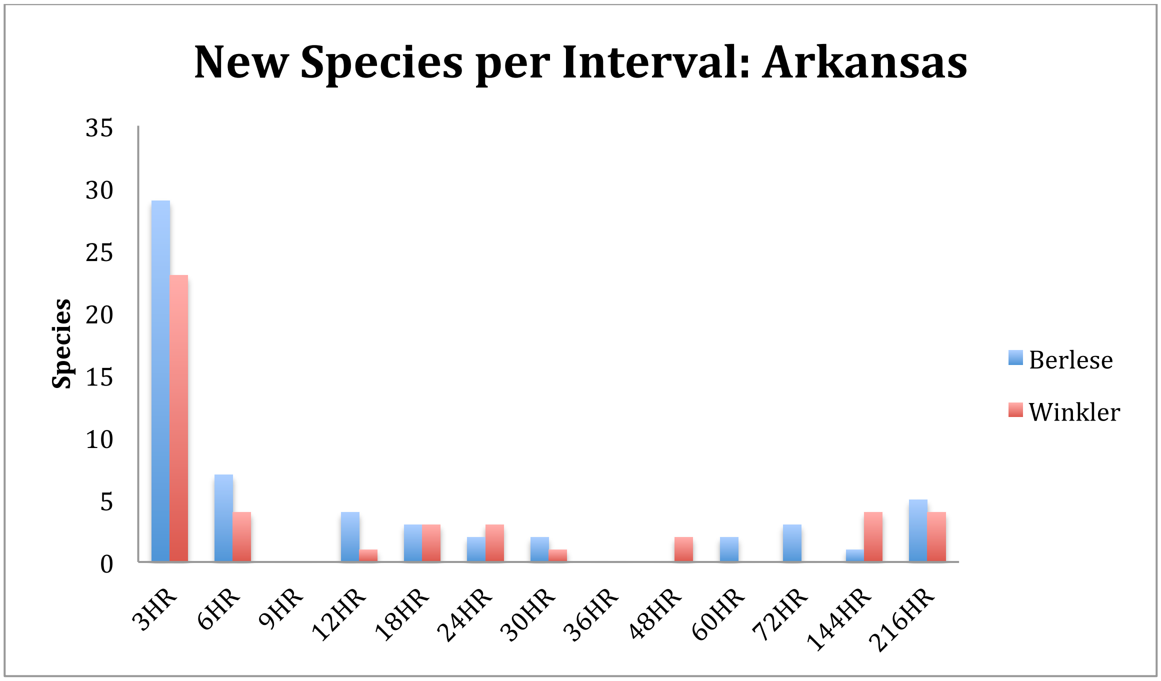

Fig. 32. Number of new species obtained from the Arkansas sample at each time interval by Winkler and Berlese funnels.

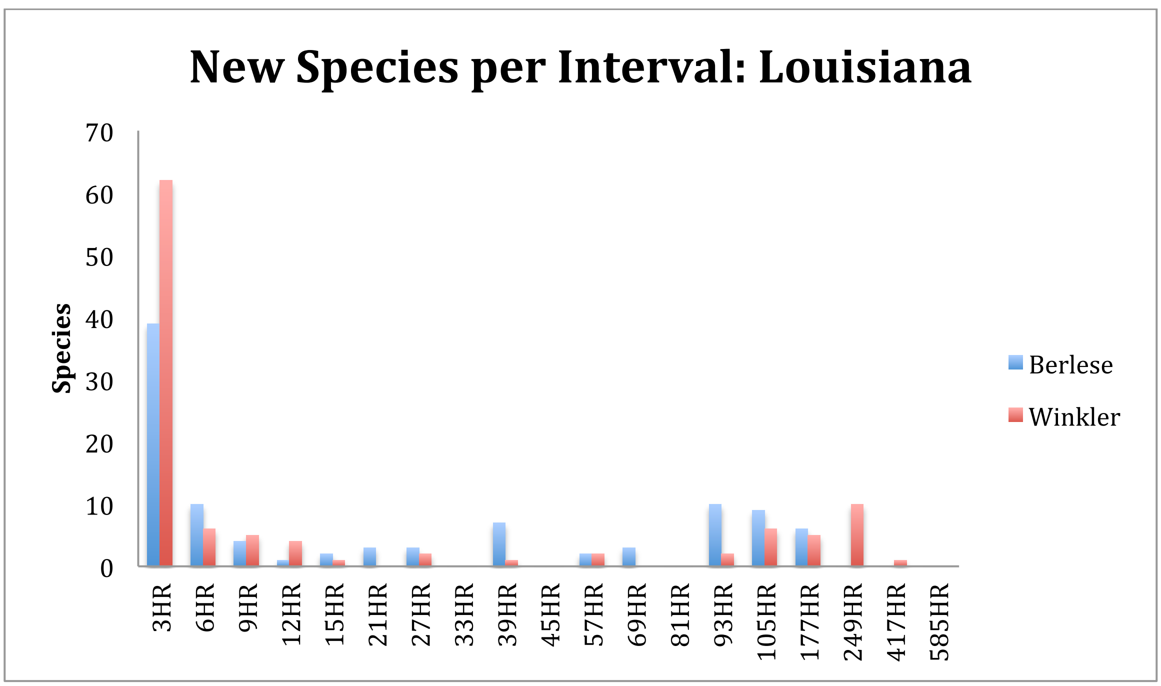

Fig. 33. Number of new species obtained from the Louisiana sample at each time interval by Winkler and Berlese funnels.

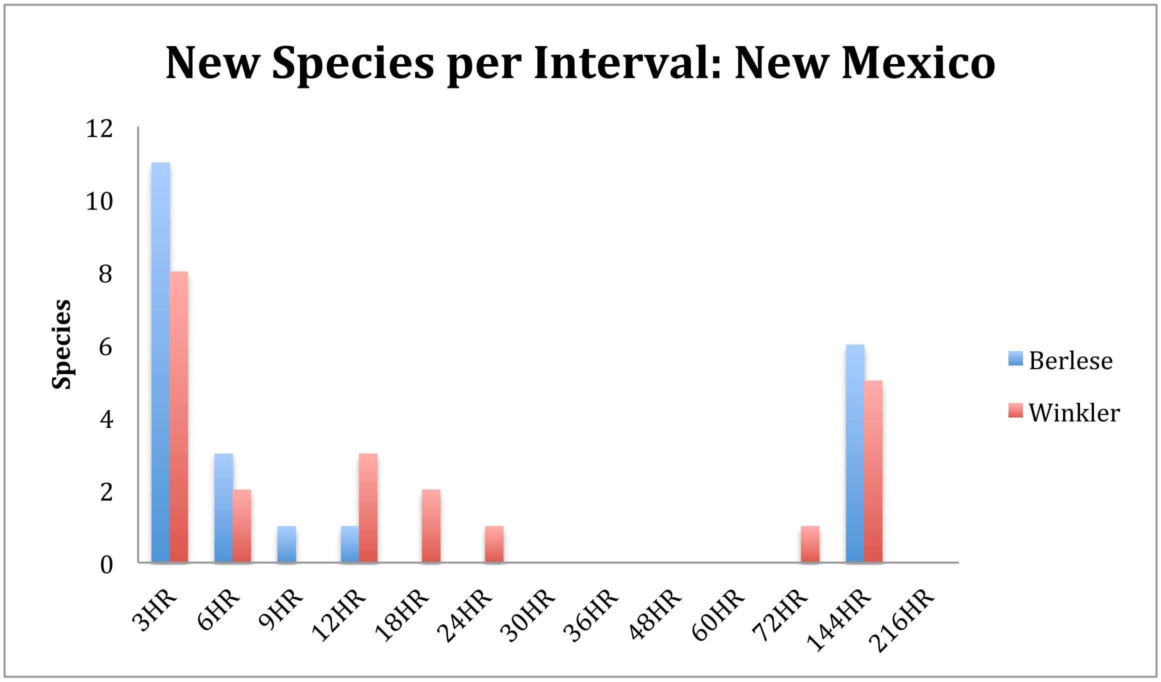

Fig. 34. Number of new species obtained from the New Mexico sample at each time interval by Winkler and Berlese funnels.

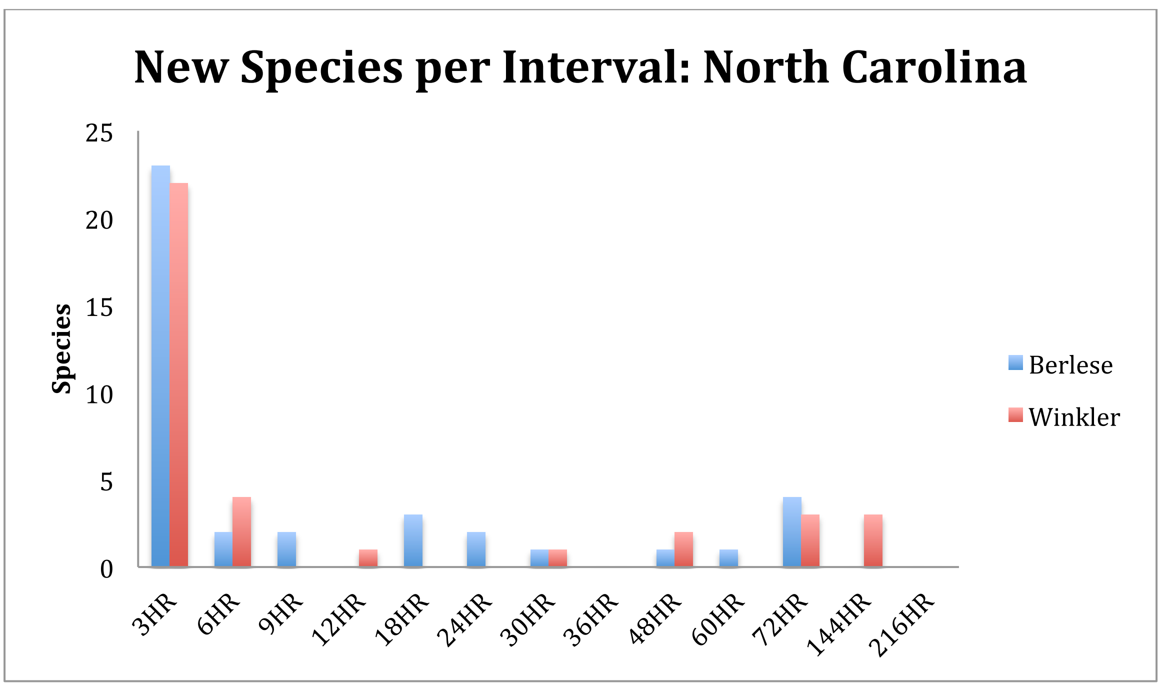

Fig. 35. Number of new species obtained from the North Carolina sample at each time interval by Winkler and Berlese funnels.

2.3.4 Curculionidae

2.3.4.1 Temporal addition of specimens

The total number of Curculionidae specimens collected varied between trials, as did the number of Curculionidae specimens obtained by Winkler funnels and Berlese funnels within individual trials. The Arkansas sample yielded the highest number, with 112 specimens, 64 from Berleses and 48 from Winklers. The New Mexico sample yielded 83 total specimens, 49 from Berlese and 34 from Winkler funnels. The Alabama sample yielded 61 specimens, 35 from Berlese and 29 from Winkler funnels. The Louisiana sample yielded 50 specimens, 26 from Berlese and 29 from Winkler funnels. The North Carolina sample produced 47 specimens, and 26 from Berleses and 21 from Winkler funnels. The Arizona sample yielded the lowest number of specimens, with 19 total, seven from Berlese funnels and 12 from the Winkler funnels. In four of the trials, more Curculionidae specimens were collected by Berlese funnels than by Winkler funnels, while in the other two trials Winkler funnels obtained more specimens. Total numbers of Curculionidae specimens and numbers collected by each funnel type varied between trials, but these differences did not indicate a consistent difference between Winkler and Berlese funnels. The t-test yielded a value of $P = 0.13$; there was no significant difference in the total number of specimens of Curculionidae extracted by Berlese funnels or Winkler funnels across all trials.

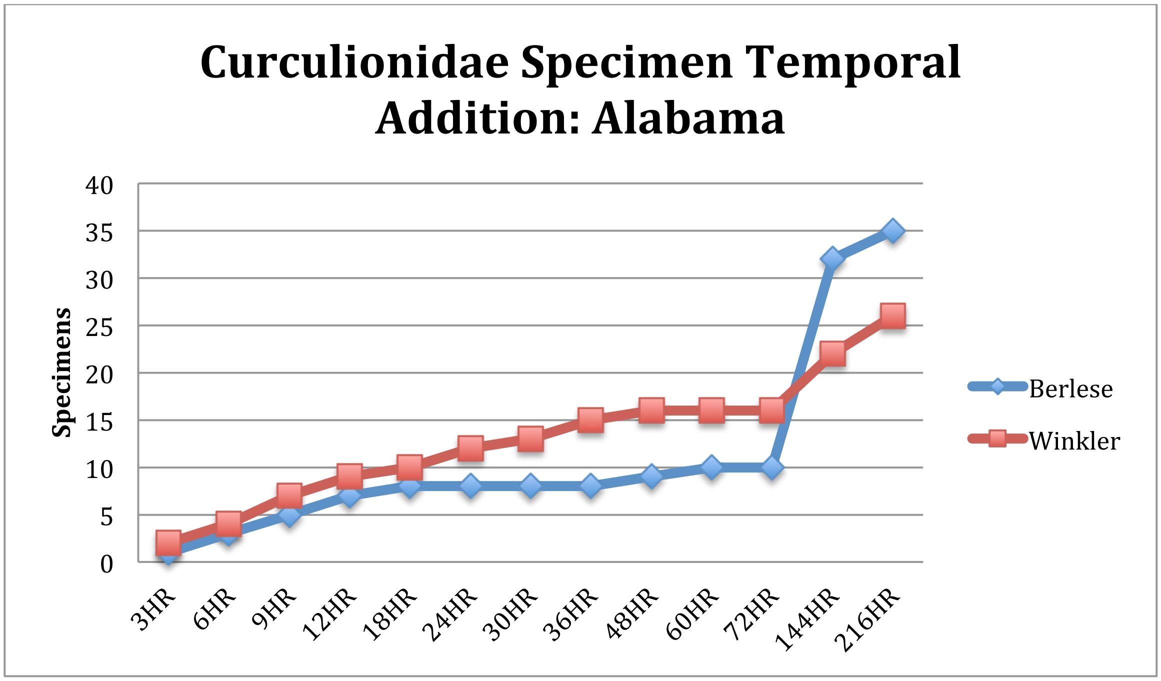

Fig. 36. Number of Curculionidae specimens obtained from the Alabama litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

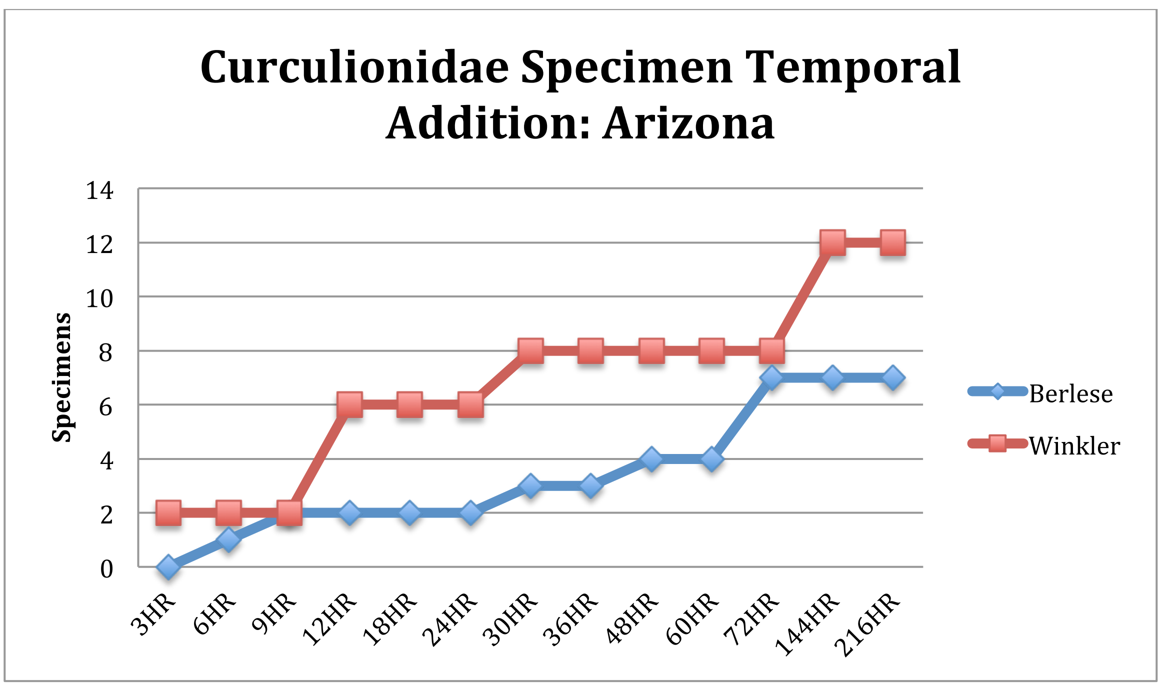

Fig. 37. Number of Curculionidae specimens obtained from the Arizona litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

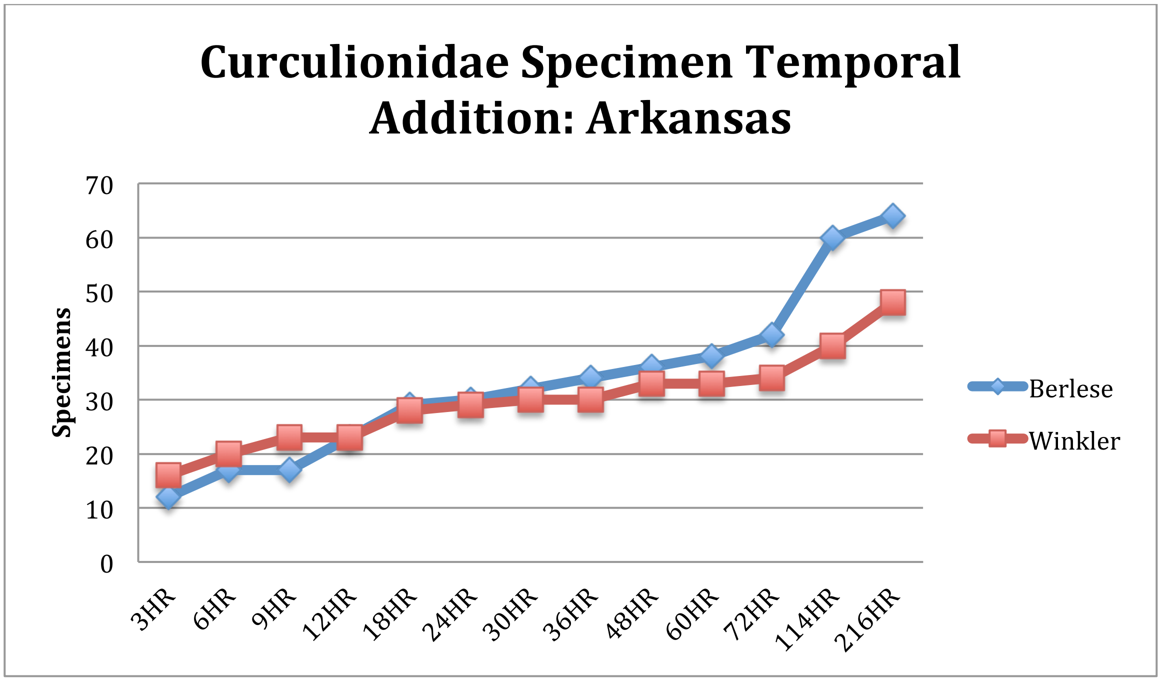

Fig. 38. Number of Curculionidae specimens obtained from the Arkansas litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

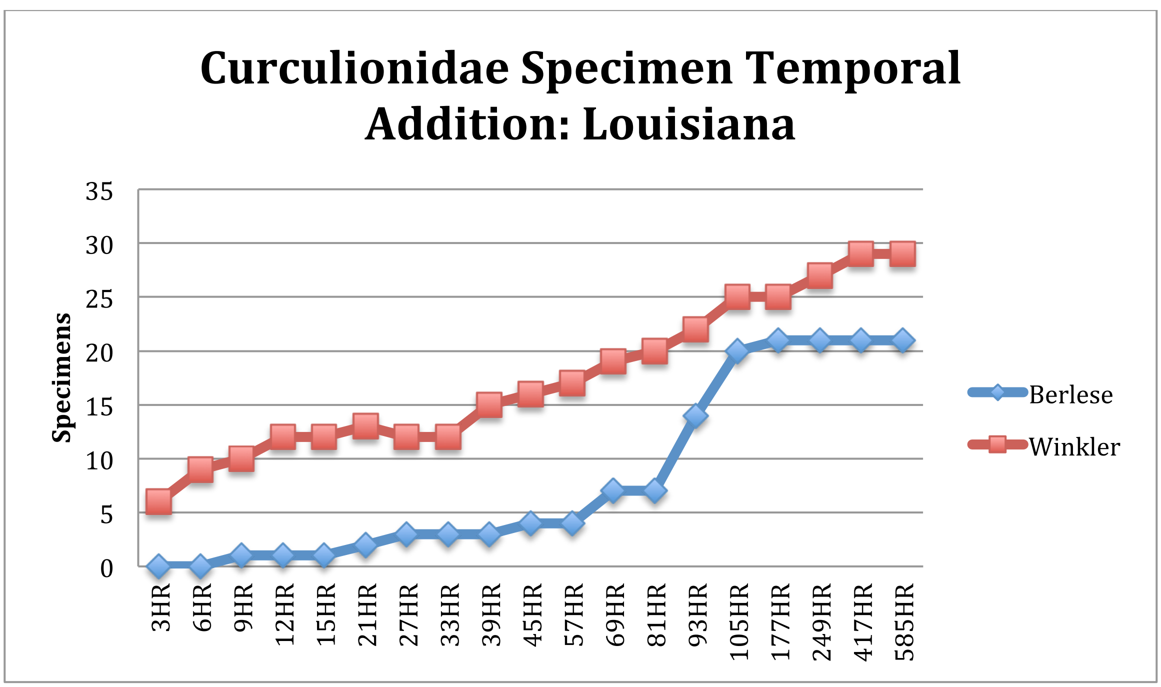

Fig. 39. Number of Curculionidae specimens obtained from the Louisiana litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

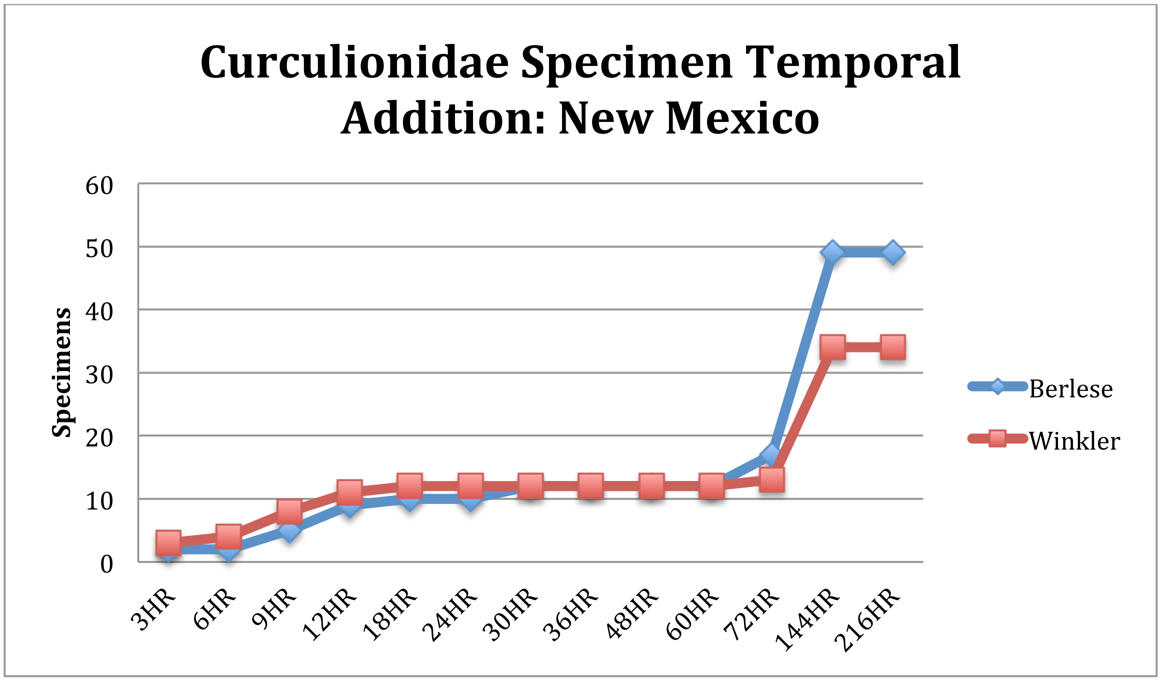

Fig. 40. Number of Curculionidae specimens obtained from the New Mexico litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

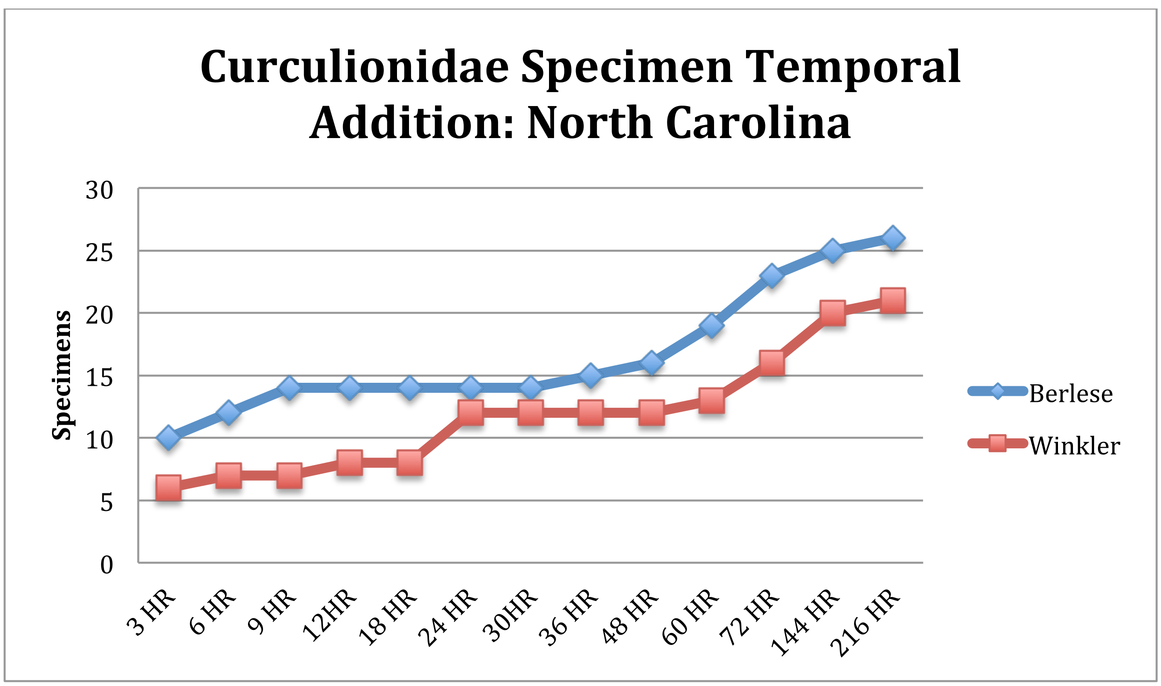

Fig. 41. Number of Curculionidae specimens obtained from the North Carolina litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

Temporal addition graphs of the specimens of Curculionidae, alone, are somewhat different from those considering total Coleoptera specimens. With the exception of the Winkler funnels in the Arizona and Louisiana samples, the intervals between 60-144 hours yielded the highest number of specimens added per interval for both funnel types (Graphs 36, 38, 40, 41). The Winkler funnels for the Arizona sample yielded a relatively high number of specimens accumulated during these later intervals, but this was equivalent with the number collected during an initial high period of addition between the 9-12 hour interval (Graph 37). For most samples, this later peak was higher relative to the rest of the sampling period, with specimen addition between intermediate intervals equal to or greater than the temporal specimen addition of the initial intervals between 3-12 hours (Graph 37, 38, 39, 41). Therefore, with the exception of the Louisiana Winkler funnel samples, the time period with the cumulatively highest species addition per interval fell between the 60-144 hour time intervals, with the initial high period of addition between the 3-18 hour intervals, in only some cases, yielding a specimen addition slightly higher than that of intermediate intervals. This varied somewhat from the pattern of overall specimen addition per interval with both an initial and terminal period of high addition per interval, but a continued accumulation of specimens in later intervals was demonstrated.

2.3.4.2 Temporal addition of species

Numbers of species of Curculionidae collected from each sample varied from three to 14 species. The Arkansas sample yielded the highest number of species of Curculionidae, 14 total, nine from Berlese funnels and eight from Winkler funnels.

The Alabama sample yielded 12 species, seven from both Berlese and Winkler funnels. The Louisiana sample yielded 11 species, six from Berlese funnels and 9 from Winkler funnels. The Arizona sample yielded five species, two from Berlese funnels and three from Winkler funnels. The North Carolina sample yielded four species from Berlese funnels and three from Winkler funnels. The New Mexico sample yielded the lowest number of specimens, three total from both Berlese and Winkler funnels. The t-test yielded a value of $P = 0.61$ there was no significant difference in the total number of species of Curculionidae extracted by Berlese funnels or Winkler funnels across all trials.

Species addition curves of Curculionidae for both Winkler and Berlese funnels in three trials were characterized by a plateau indicating a specimen addition of zero per time interval during a range of intermediate intervals (Figs. 42, 44-47). In the Alabama sample, this plateau extended from 9-72 hours in the Winkler and 12-36 hours in the Berlese (Fig. 42). In the Arkansas sample, the plateau stretched from18-72 hours in the Winkler funnels and 12-60 hours in the Berlese funnels (Fig. 44). In the Louisiana sample, the plateau extended from 27-81 in the Winkler funnels and 12-177 in the Berlese funnels (Fig. 45). Thus, for these three trials the highest species addition rates of Curculionidae occurred on either side of this middle plateau.

For the Arizona trial, a plateau extended from 3-9 hours and then appeared again from 12-216 hours for the Winkler funnel samples. For the Berlese funnels, a single plateau extended from 9-216 hours. Thus, for this sample, the 3-12 hour interval was the most productive for new species collection per interval (Fig. 43).

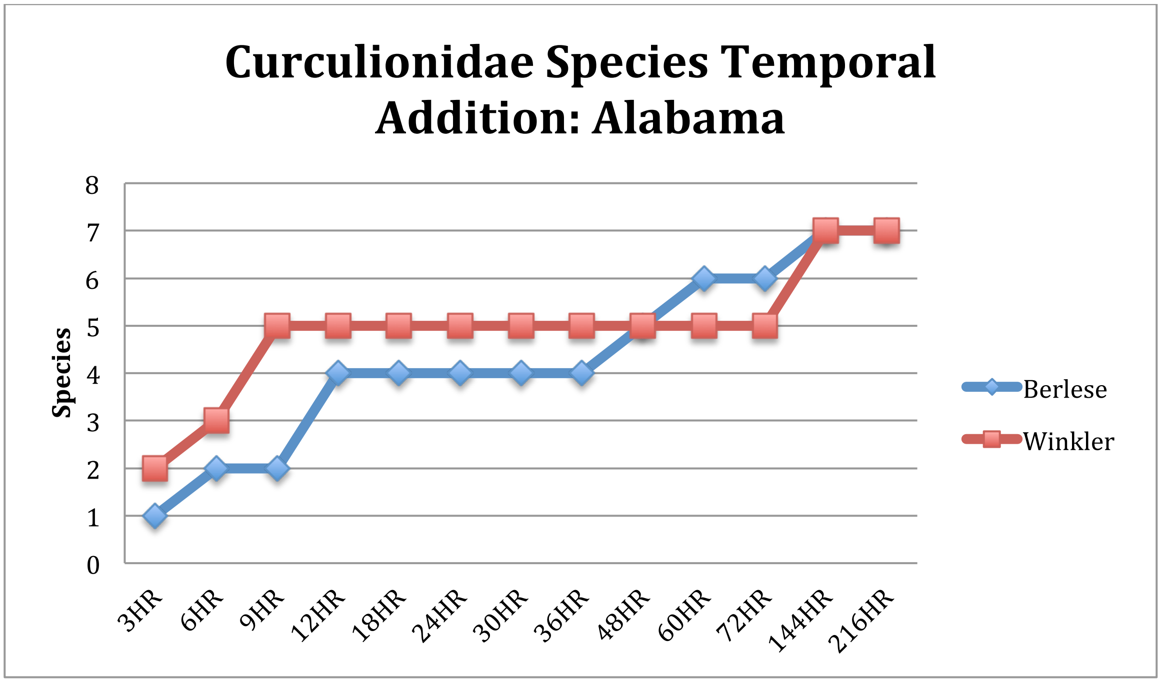

Fig. 42. Number of Curculionidae species obtained from the Alabama litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

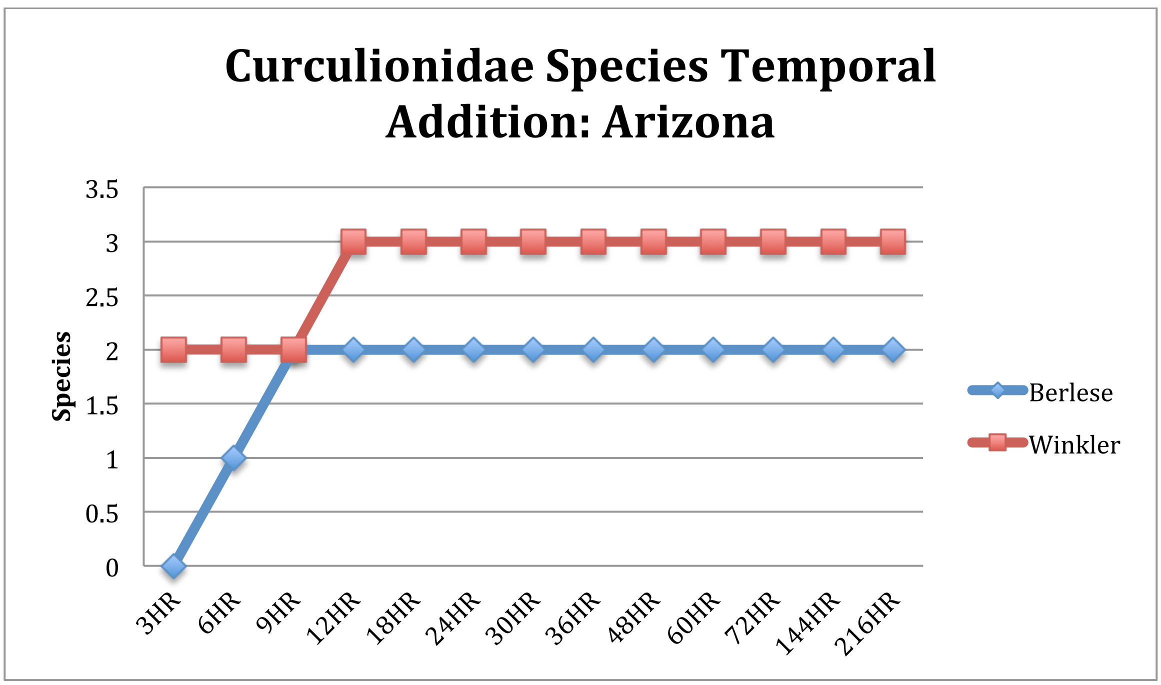

Fig. 43. Number of Curculionidae species obtained from the Arizona litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

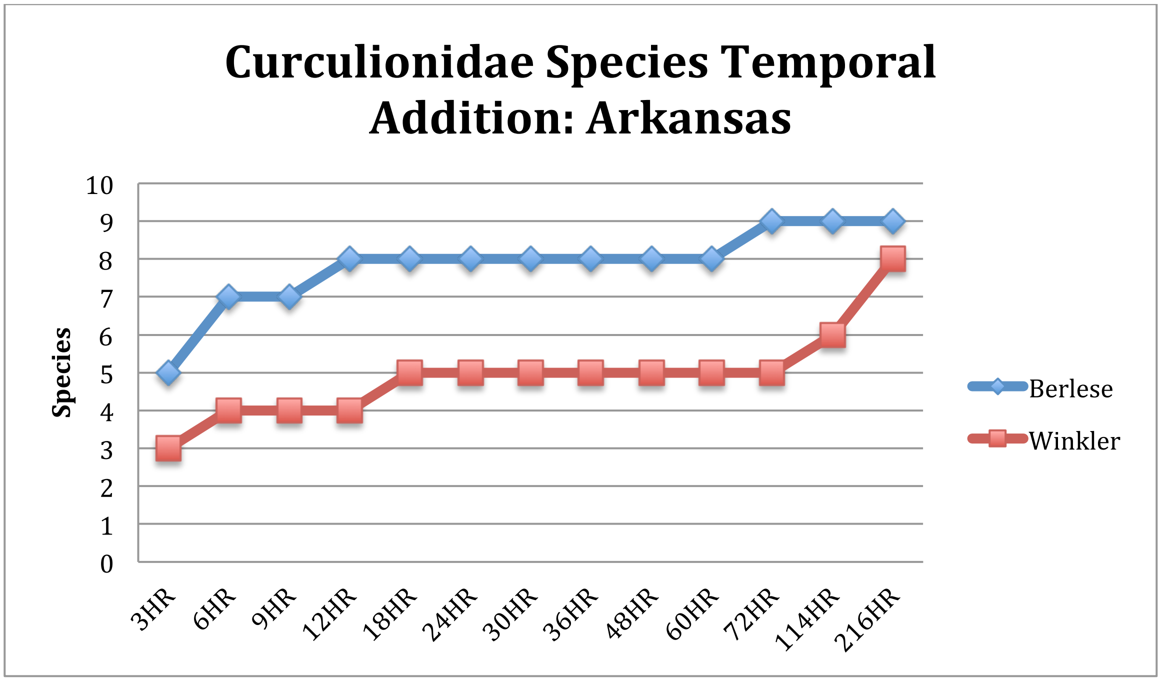

Fig. 44. Number of Curculionidae species obtained from the Arkansas litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

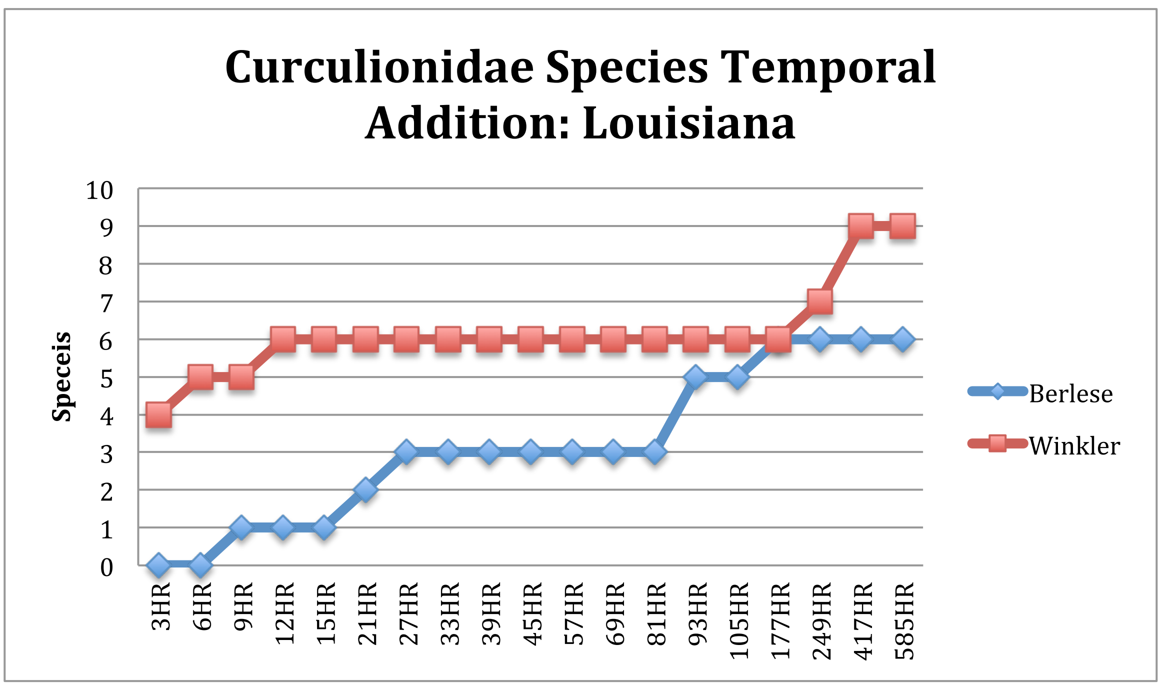

Fig. 45. Number of Curculionidae species obtained from the Louisiana litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

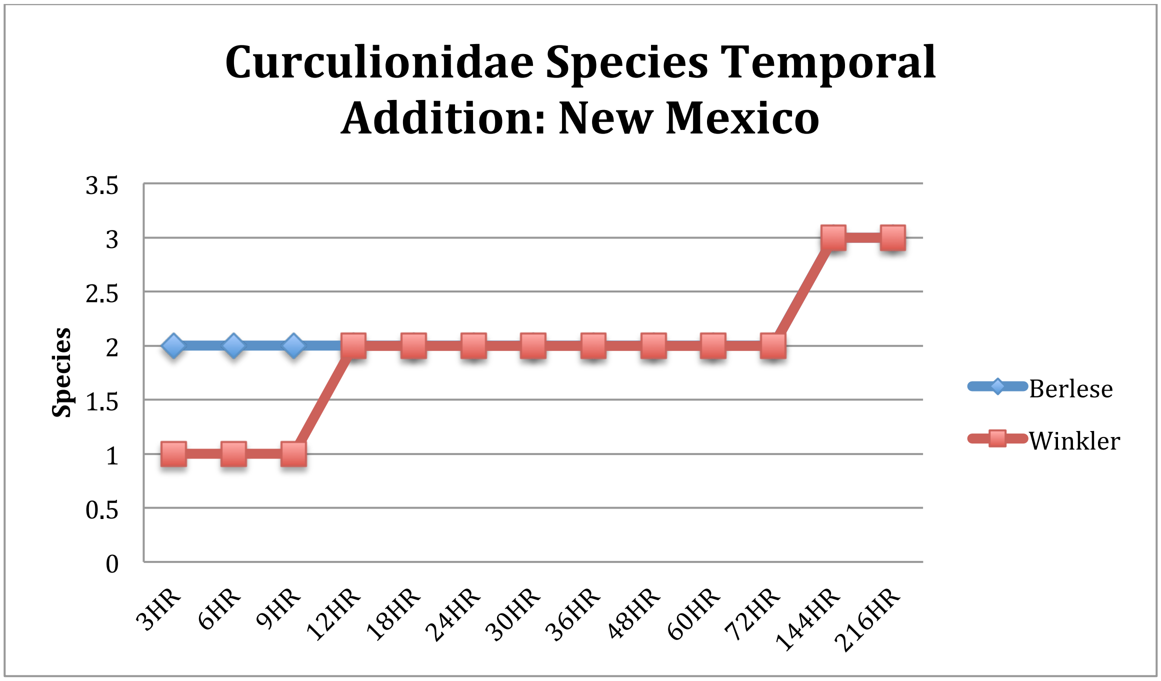

Fig. 46. Number of Curculionidae species obtained from the New Mexico litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

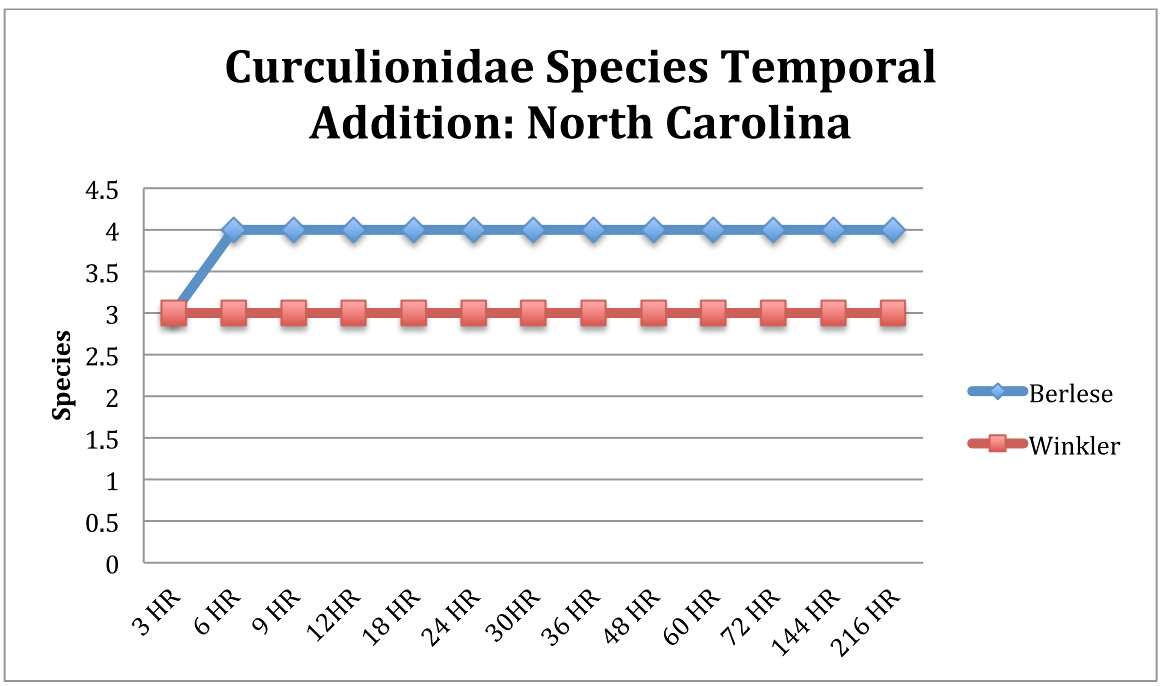

Fig. 47. Number of Curculionidae species obtained from the North Carolina litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

The Winkler funnels of the New Mexico sample exhibited a similar pattern of higher species addition on either side of an intermediate plateau, while the Berlese funnels maintained a constant plateau from 0-72 hours with a single peak during the 72-144 hours (Fig. 46). The temporal species addition for the Winkler funnels reached a peak of three species at the 3 hour interval and then plateaued for the rest of the trial, while the Berlese funnels plateaued after the initial increase during the 3-6 hour interval. Thus, for all funnel types and samples, the greatest number of new species of Curculionidae was collected per interval during some combination of early and later collection intervals, yielding a pattern similar to that of total species temporal addition.

2.3.5 Staphylinidae

2.3.5.1 Temporal addition of specimens

The six trials varied in the total number of specimens of Staphylinidae obtained by the end of the trial period, as well as in the number of specimens of Staphylinidae obtained by Berlese funnels and Winkler funnels. The highest number of Staphylinidae specimens was obtained from the Louisiana sample, with 1197 specimens in total, 574 from Berlese funnels and 623 from Winkler funnels. The Alabama sample yielded 310 specimens, 197 from Winkler funnels and 113 from Berleses funnels. The Arkansas sample yielded 246 specimens, 139 specimens from Berlese funnels and 107 from Winkler funnels. The North Carolina sample yielded 123 specimens, 48 from Winkler funnels and 78 from Berlese funnels. The Arizona sample yielded 107 specimens, 52 from Winkler funnels and 55 from Berlese funnels. The New Mexico sample yielded the lowest total specimens of

Staphylinidae, with 81 total specimens obtained, 39 by Winkler and 42 by Berlese funnels. In all samples except for the Louisiana sample, the Berlese funnels obtained higher numbers of Staphylinidae specimens, in total, than did the Winkler funnels. However, the t-test yielded a value of $P= 0.93$; there was no significant difference in the total number of specimens of Staphylinidae extracted by Berlese funnels or Winkler funnels across all trials.

The temporal addition graphs of specimens of Staphylinidae were similar to those of the Curculionidae specimens. Across all funnel types and in all trials, the specimen addition per interval for the Staphylinidae was relatively high towards the end of the trial (Graphs 48-53). A noticeable increase in the temporal addition of specimens occurred in all trials during intervals between 60-417 hours, although this increase was not as pronounced in the Winkler funnels of the North Carolina

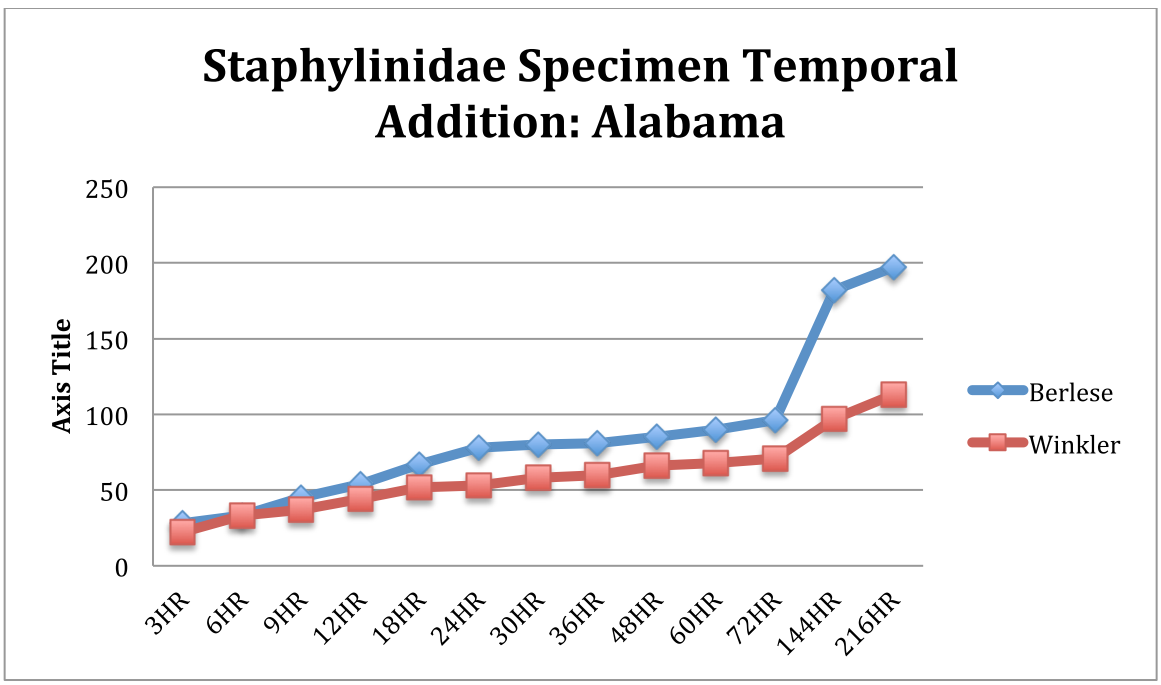

Fig. 48. Number of Staphylinidae specimens obtained from the Alabama litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

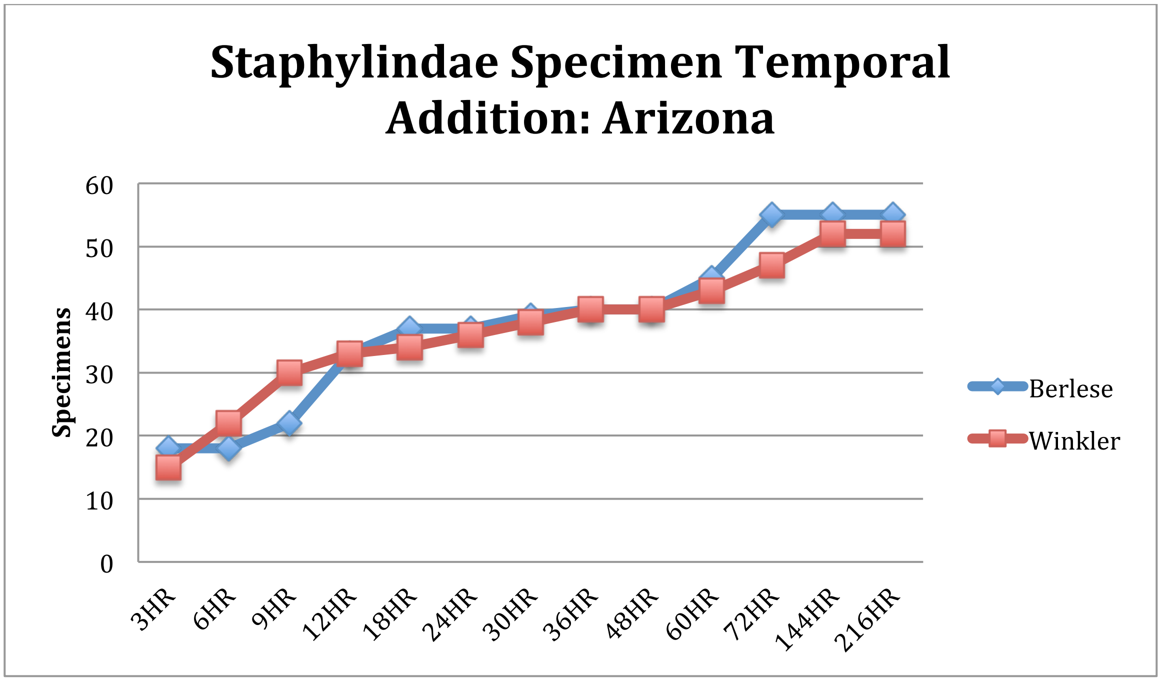

Fig. 49. Number of Staphylinidae specimens obtained from the Arizona litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

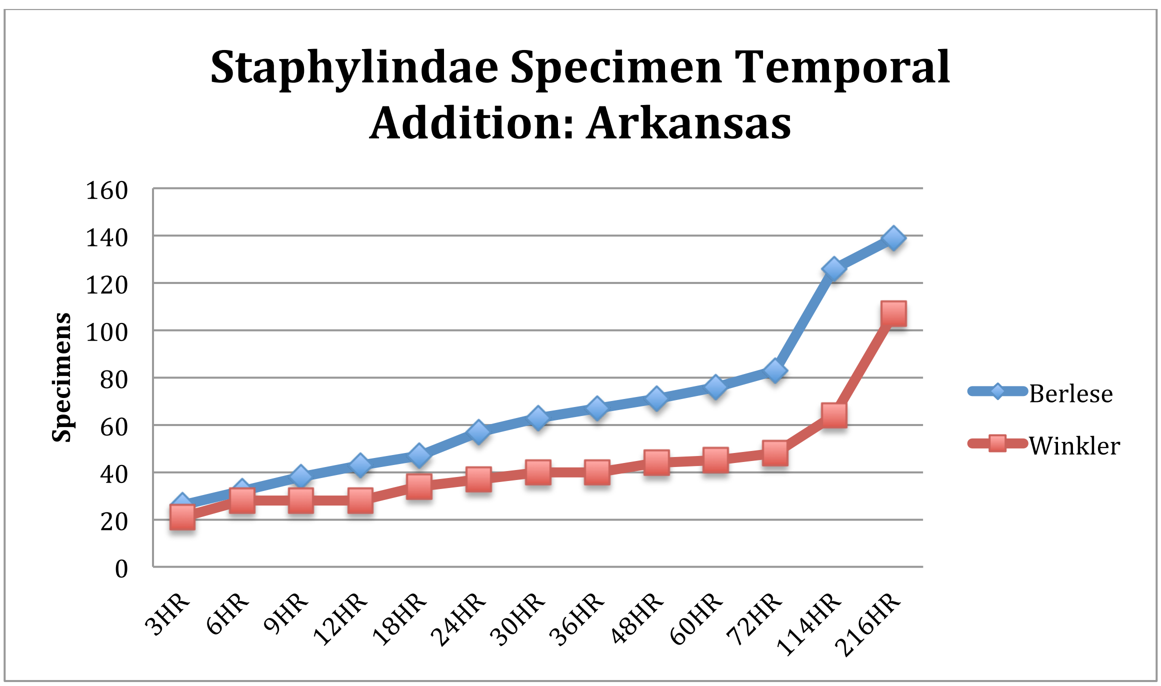

Fig. 50. Number of Staphylinidae specimens obtained from the Arkansas litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

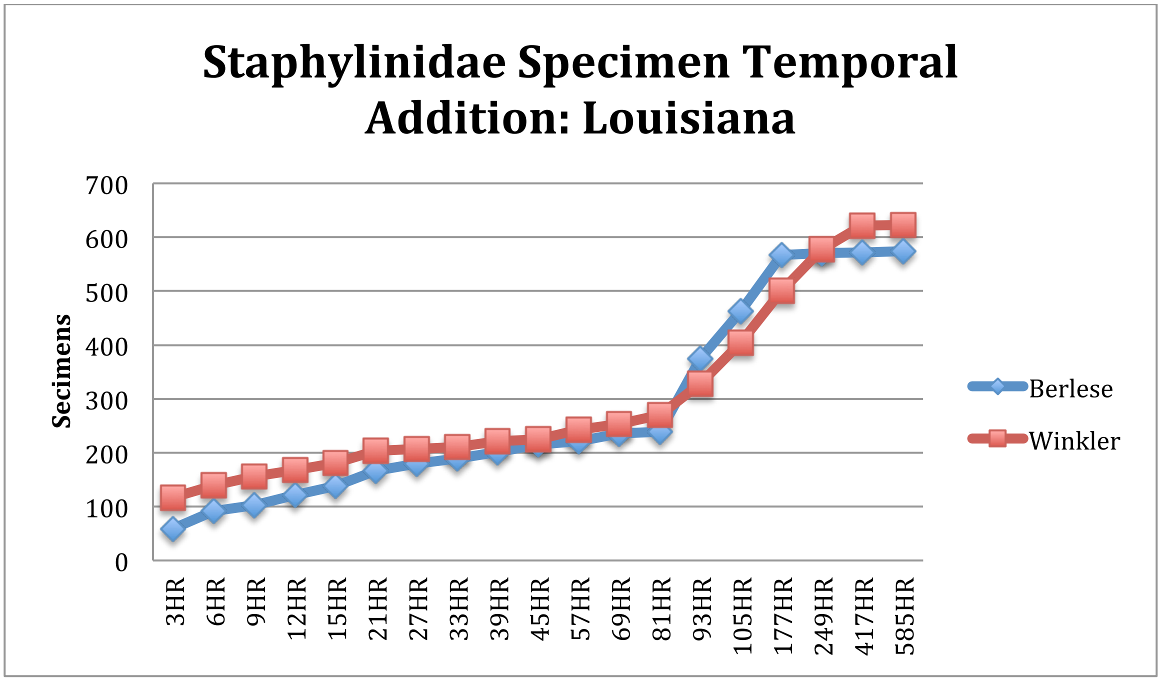

Fig. 51. Number of Staphylinidae specimens obtained from the Louisiana litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

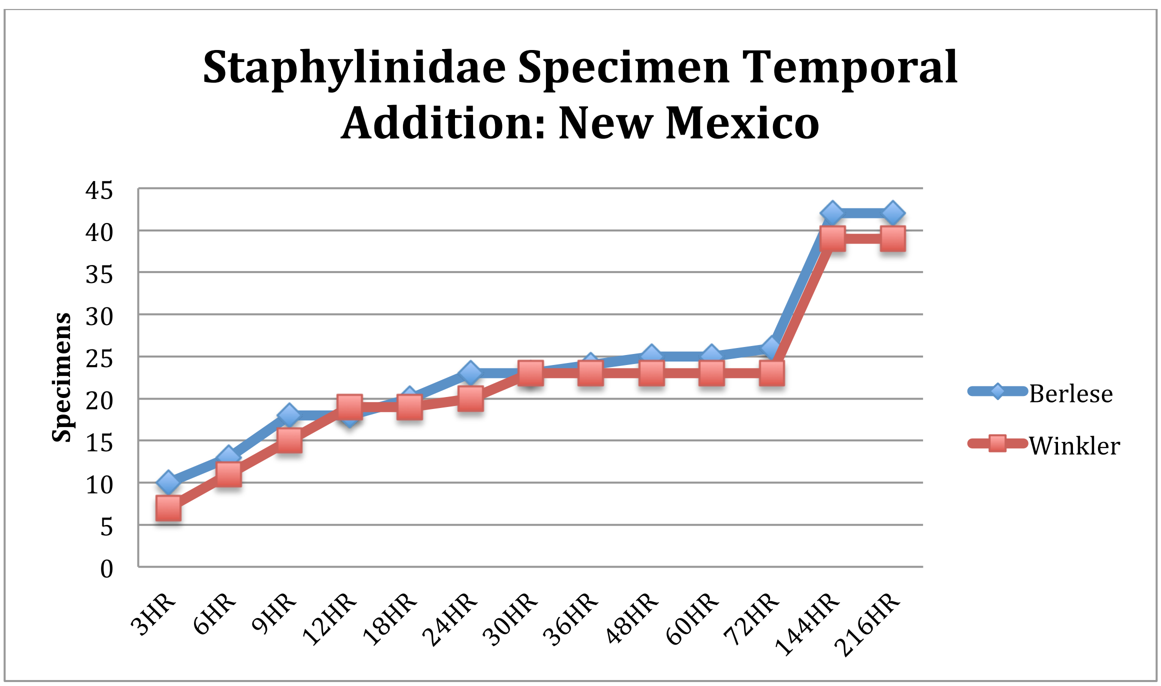

Fig. 52. Number of Staphylinidae specimens obtained from the New Mexico litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

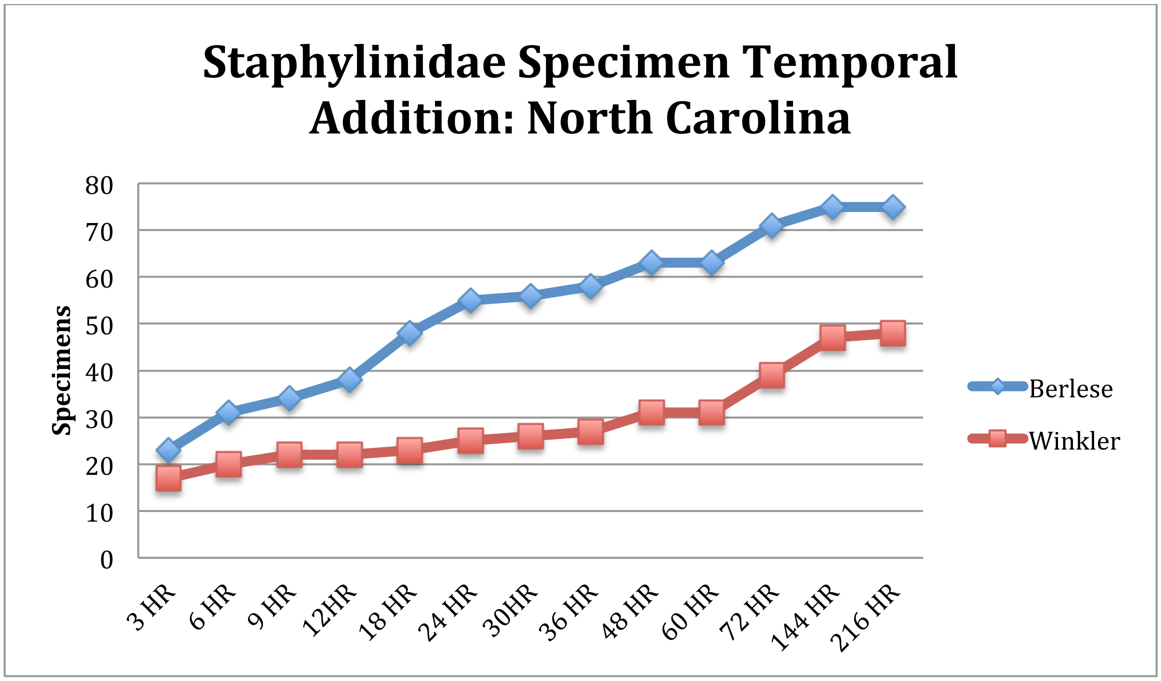

Fig. 53. Number of Staphylinidae specimens obtained from the Alabama litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

sample (Fig. 53). For all funnels and all trials except for the Arizona and New Mexico trials, an initial high specimen addition per interval did not occur in during the first several intervals (Figs. 49, 52). This differs from the graphs of the total temporal specimen addition curves and several of the Curculionidae specimen temporal addition curves, in which a high addition of specimens was evident during initial intervals.

The Arizona and New Mexico trials both exhibited an initial high rate followed by somewhat lower temporal addition for intermediate intervals before an increase in later intervals. In the New Mexico sample, however, the species temporal addition of later intervals was much higher than that of initial intervals. With the exception of the high initial period in the Arizona sample, across all trials the time period between 60-417 hours contained the interval that yielded more species than previous ones. Thus, in five of the six trials, later intervals yielded the most productive interval for collection of Staphylinidae specimens by both Winkler and Berlese funnels.

2.3.5.2 Temporal addition of species

The total numbers of Staphylinidae species obtained varied widely between trials, from 11 to 60. However, there was a much smaller difference in the numbers of species obtained between funnel types within trials. The Louisiana sample yielded the greatest number of species of Staphylinidae collected during the trial, with 60 total species obtained, 47 from Winkler funnels and 48 from Berlese funnels. The Alabama sample yielded 50 species, 24 from Winkler funnels and 26 from Berlese funnels. The Arkansas sample yielded 30 species, 23 from Winkler funnels and 24 from Berlese funnels. The North Carolina samples yielded 21 species, 13 from Winkler funnels and 20 from Berlese funnels, this being the trial with the greatest difference between total number of species extracted by the two funnel types. The Arizona trial yielded 13 species, nine from Winkler funnels and ten from Berlese funnels. The New Mexico trial yielded the lowest number of species, nine from Winkler funnels and ten from Berlese funnels. Overall, more species of Staphylinidae were collected by Berlese funnels across all trials. However, in five of the six trials, there was a difference of only one or two species. The t-test yielded a value of P= 0.80; there was no significant difference in the total number of species of Staphylinidae extracted by Berlese funnels or Winkler funnels across all trials.

All six samples exhibited a high point in the temporal addition of Staphylinidae species per interval during the initial intervals between 3-18 hours

(Figs. 54-59). Intermediate intervals following this initial peak exhibited relatively low number of species added per interval in five of the trials (Figs. 54, 55, 57-59).

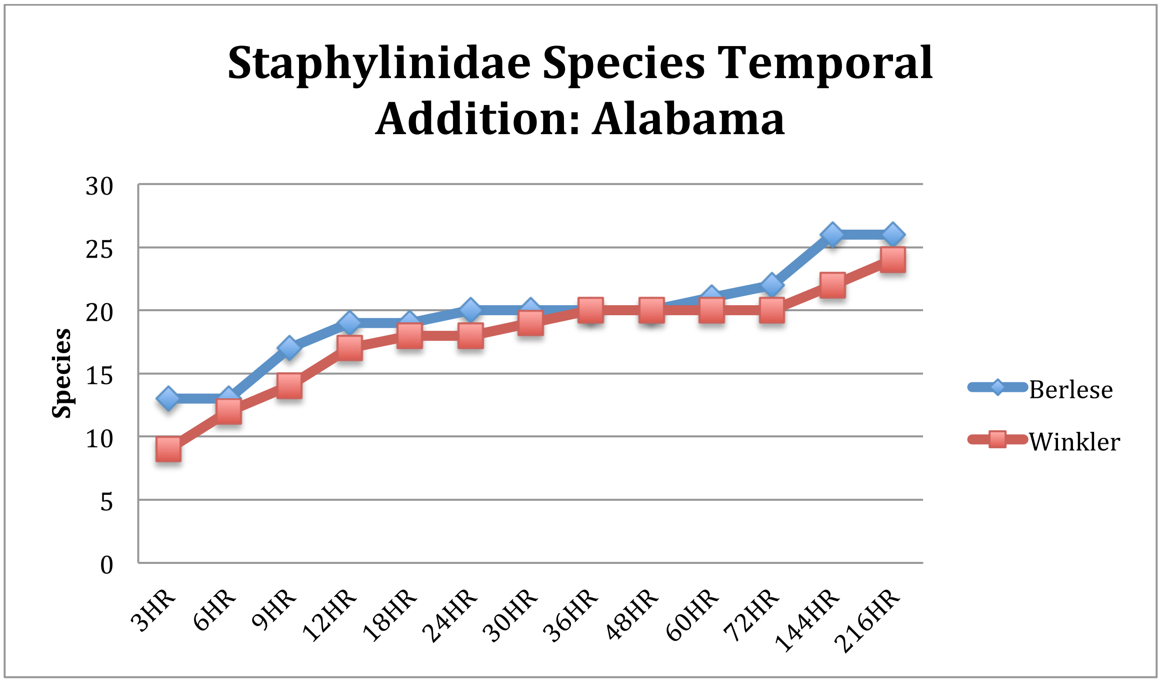

Fig. 54. Number of Staphylinidae species obtained from the Alabama litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

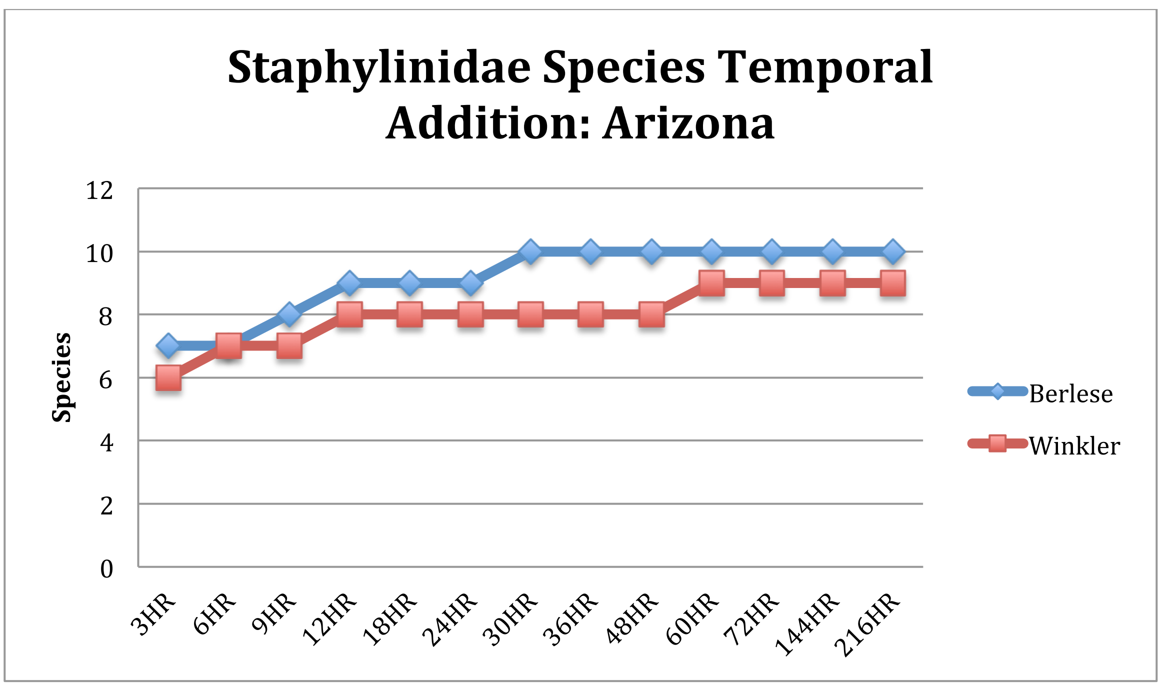

Fig. 55. Number of Staphylinidae species obtained from the Arizona litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

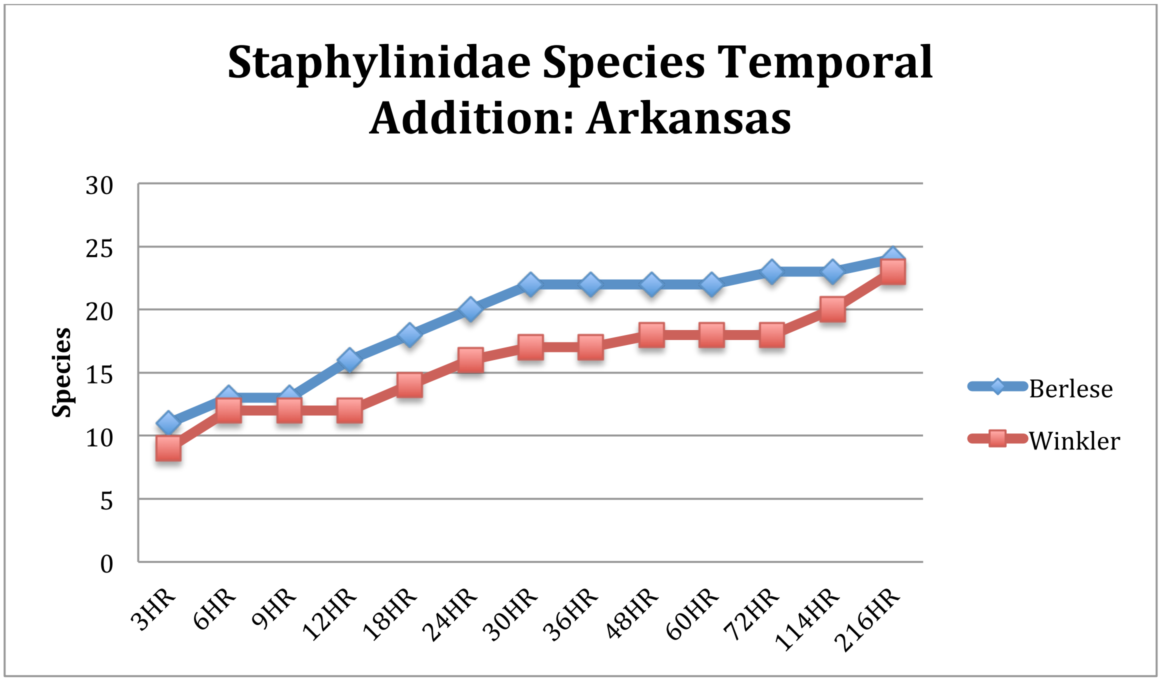

Fig. 56. Number of Staphylinidae species obtained from the Arkansas litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

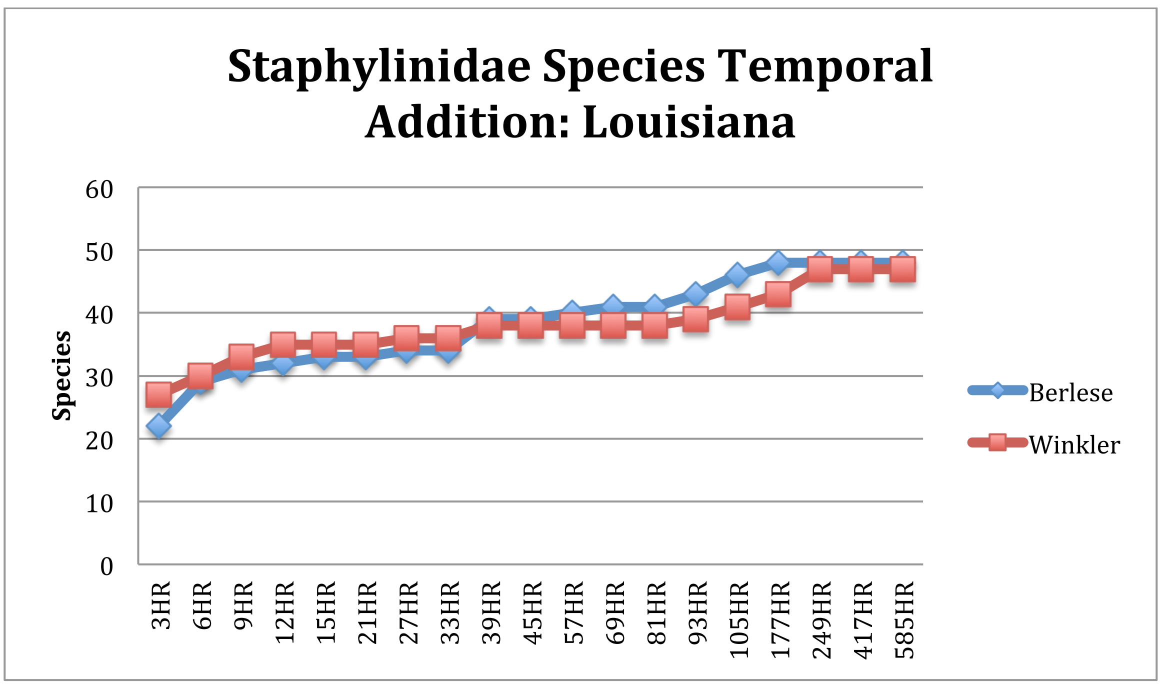

Fig. 57. Number of Staphylinidae species obtained from the Louisiana litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

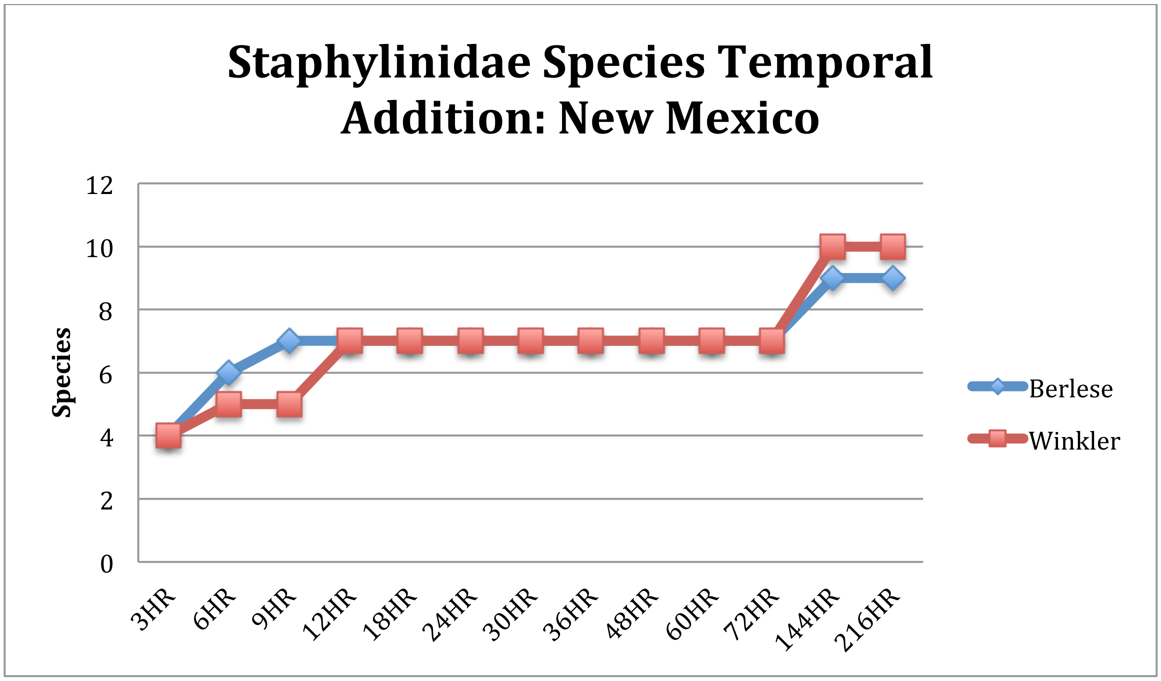

Fig. 58. Number of Staphylinidae species obtained from the New Mexico litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

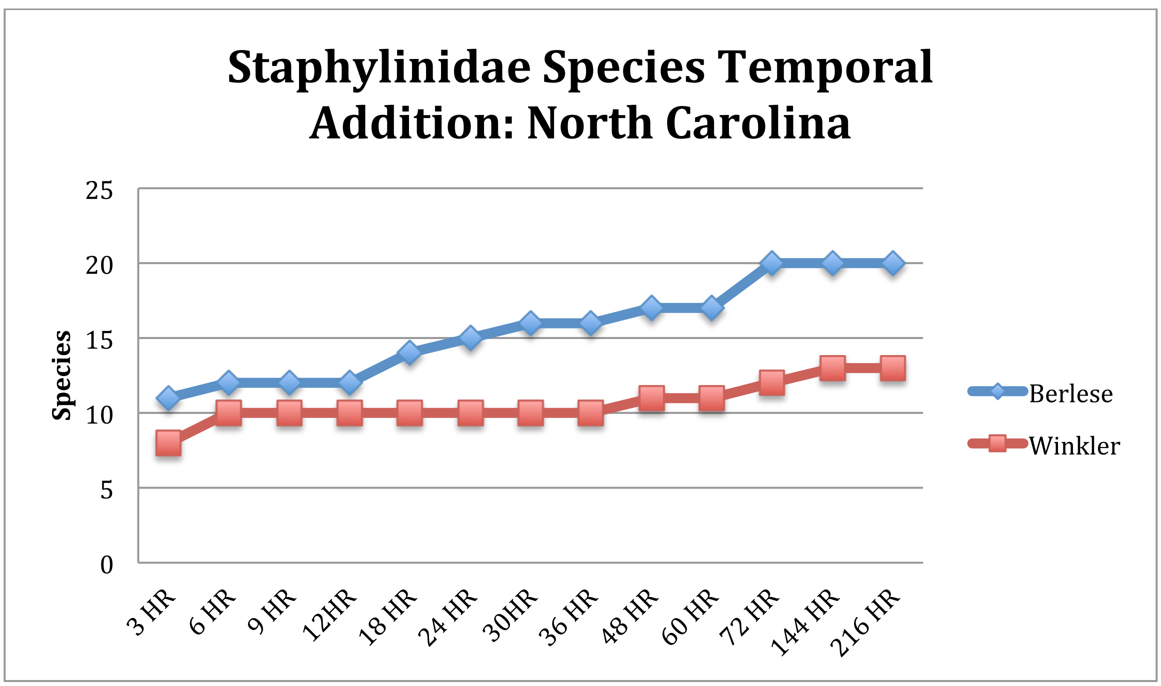

Fig. 59. Number of Staphylinidae species obtained from the North Carolina litter sample, cumulatively, at each time interval by Winkler and Berlese funnels.

However, in the Arkansas sample the middle intervals between 12 and 48 hours exhibited the greatest temporal addition values for both funnel types before decreasing and then peaking again in later intervals (Fig. 56).

Although not as high as the peak exhibited by the graphs of Staphylinidae specimen additions per interval, the later intervals of most trials yielded a relatively high species addition compared to the rest of the intervals within the sample. From 72-249 hours all samples, with the exception of the Arizona sample, exhibited a relatively high species addition per interval following a period of low or zero species accumulation per interval (Figs. 54, 56-59). In the Arizona sample, the Staphylinidae species addition plateaued at zero species added per interval after the 12 hour interval for the duration of the trial, with the exception of the gain of a single species at the 24-30 hour interval for the Berlese funnels and the 48-60 hour interval for the Winkler funnels (Fig. 55). Thus, for both Winkler and Berlese funnels the pattern of species addition of the Staphylinidae appeared to adhere to the general temporal pattern of higher initial and terminal periods with intermediate intervals exhibiting lower species addition rates.

2.3.6 Rare Species

2.3.6.1 Specimens per time interval

Total numbers of specimens of rare species obtained during the different trials ranged from 48 to 240 specimens. Total numbers of specimens obtained by Berlese and Winkler funnels within trials varied as well. Four of the six trials yielded higher numbers of specimens of rare species from Winkler funnels, while two trials yielded higher numbers of from Berlese funnels. The Louisiana trial yielded the greatest number of total specimens of rare species, with 240 extracted, 112 by Winkler funnels and 128 by Berlese funnels. The Arkansas sample yielded 161 rare specimens, 68 from Winkler funnels and 93 from Berlese funnels. The Alabama sample yielded 129 specimens, 57 from Winkler funnels and 72 from Berlese funnels. The North Carolina sample yielded 117 specimens, 60 from Winkler funnels and 57 from Berlese funnels. The Arizona sample yielded 54 specimens, 30 from Winkler funnels and 47 from Berlese funnels. The New Mexico sample yielded the lowest number of specimens of rare species, 48 total, 25 from Winkler funnels and 23 from Berlese funnels. Thus, numbers of specimens of rare species varied among trials and funnel types, and no apparent difference existed in total specimens between Winkler and Berlese funnels. The t-test yielded a value of $P = 0.92$; there was no significant difference in the total number of specimens of rare species extracted by Berlese funnels or Winkler funnels across all trials.

Similar to the pattern exhibited by graphs of the numbers of total specimens collected per interval, the highest number of representatives of rare species was collected by both Winklers and Berleses during both the initial intervals and again during the later intervals in the trial. A relatively high number of specimens of rare species were collected in the 0-3 hour interval when compared to intermediate intervals in all trials, with the exception of the Berlese funnels of the Alabama and Louisiana trials and the Winkler funnels of the New Mexico trial (Figs. 60, 63, 64). Numbers of specimens per interval rapidly declined during the 3-6 hour interval and then fluctuated during intermediate intervals. A second high peak in numbers specimens of rare species per interval occurred between the 60-417 hour intervals.

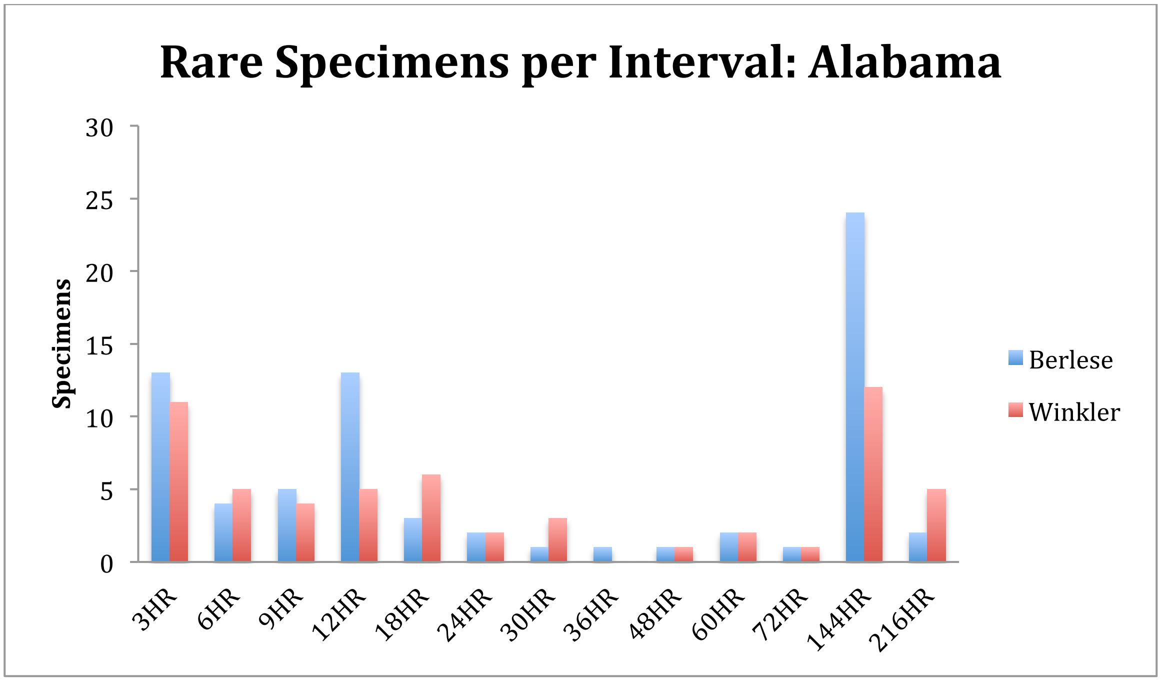

Fig. 60. Number of specimens of rare species obtained from the Alabama litter sample at each time interval by Winkler and Berlese funnels.

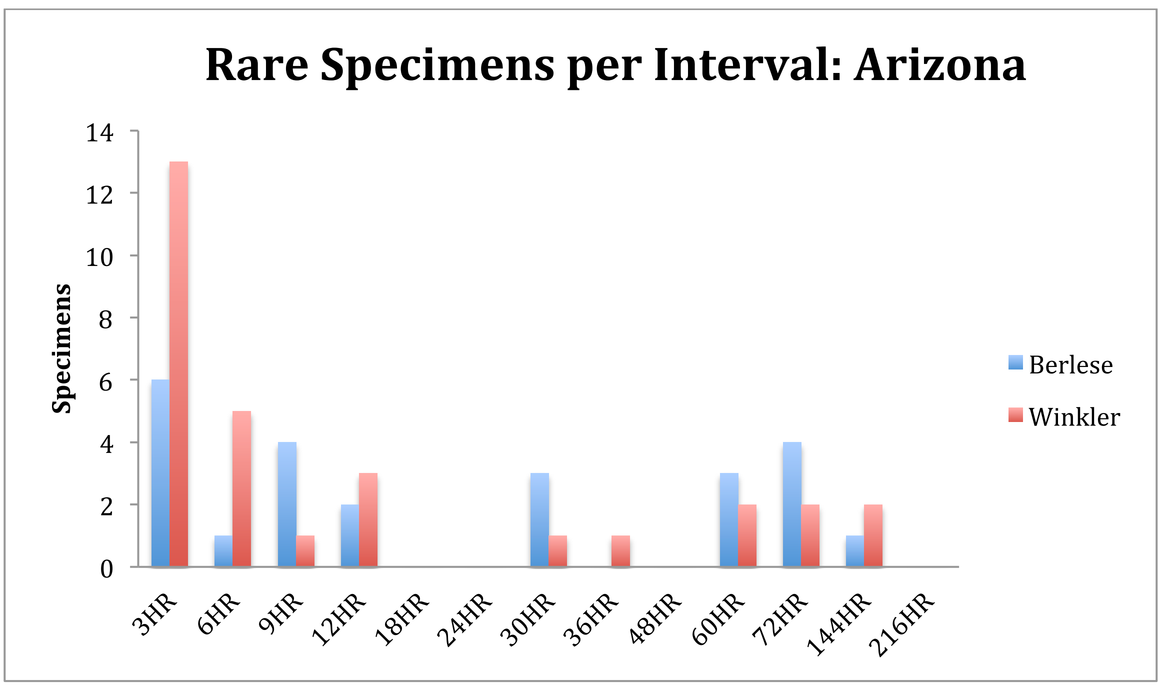

Fig. 61. Number of specimens of rare species obtained from the Arizona litter sample at each time interval by Winkler and Berlese funnels.

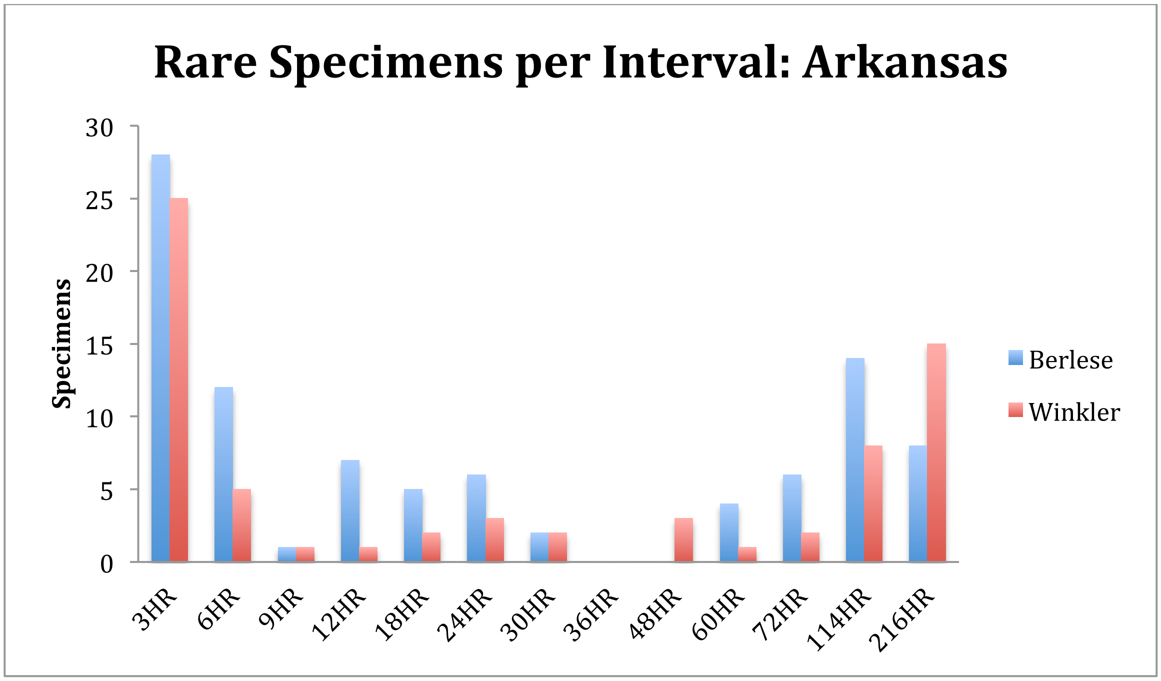

Fig. 62. Number of specimens of rare species obtained from the Arkansas litter sample at each time interval by Winkler and Berlese funnels.

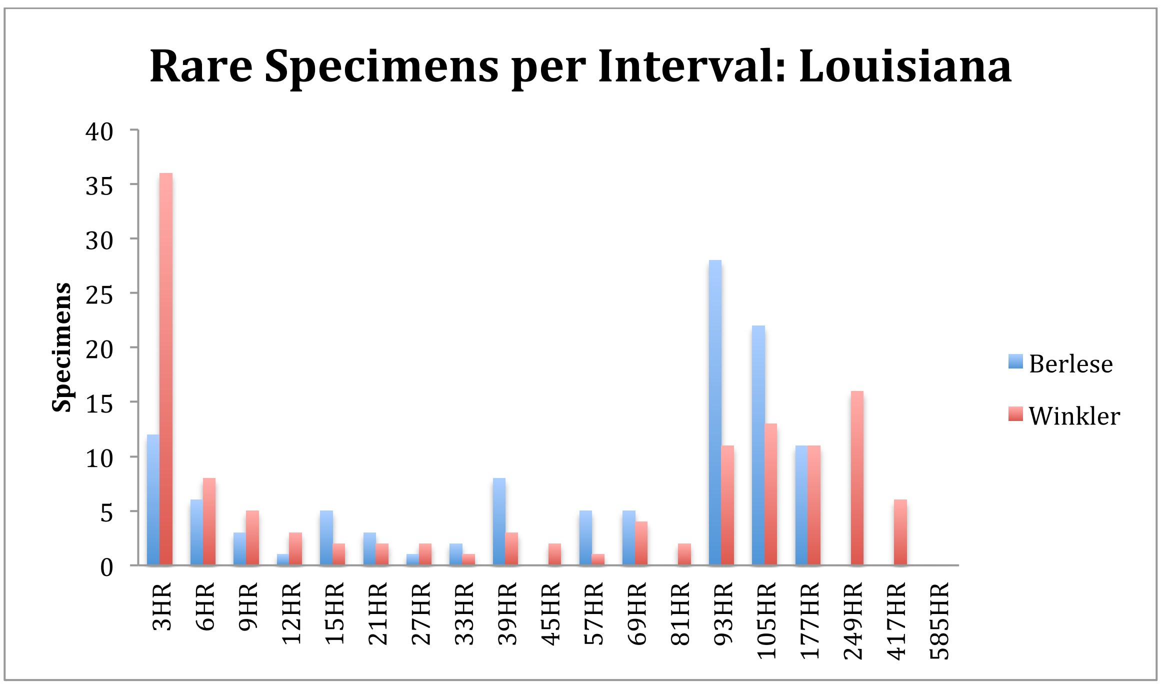

Fig. 63. Number of specimens of rare species obtained from the Louisiana litter sample at each time interval by Winkler and Berlese funnels.

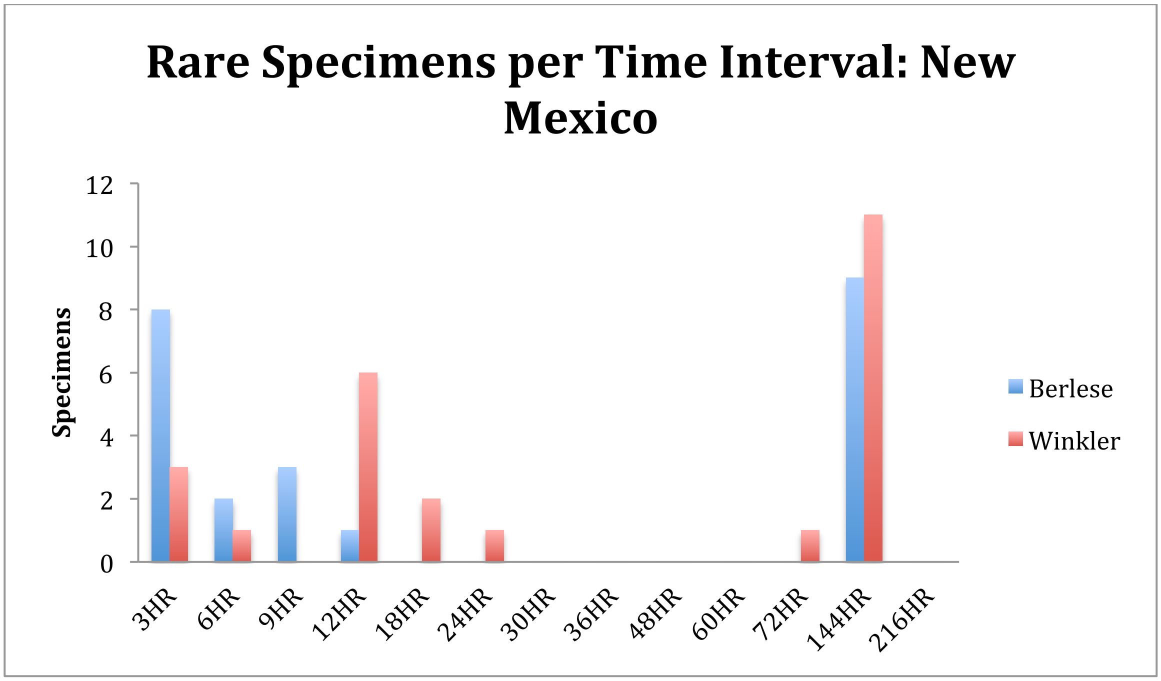

Fig. 64. Number of specimens of rare species obtained from the New Mexico litter sample at each time interval by Winkler and Berlese funnels.

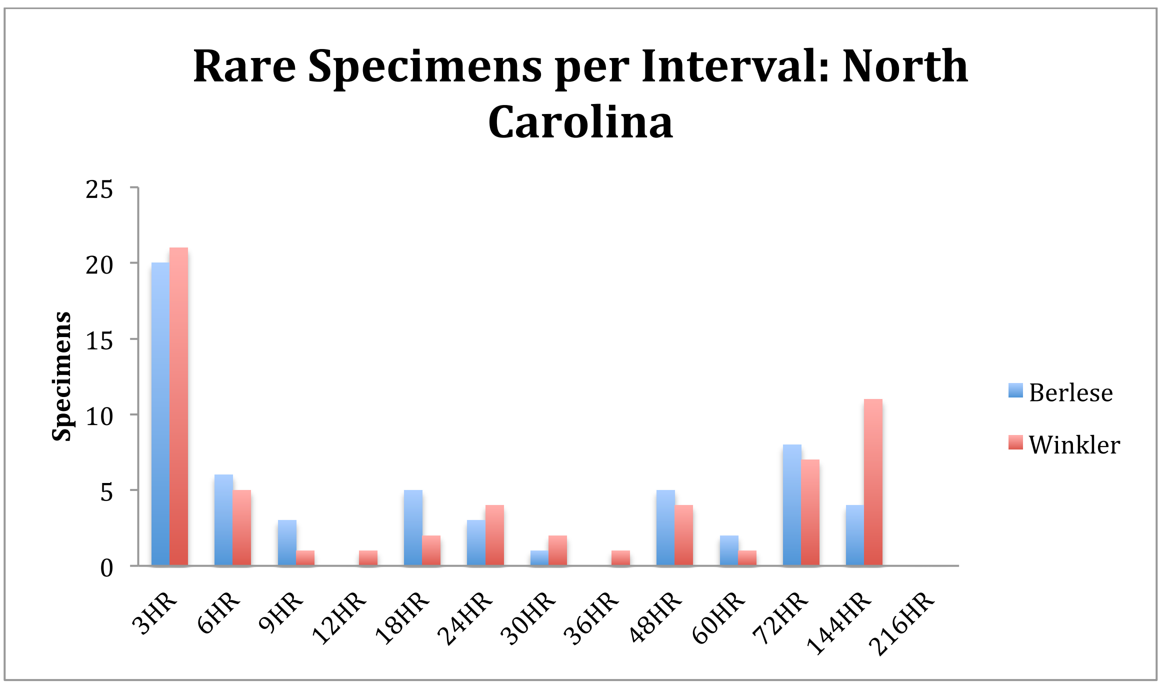

Fig. 65. Number of specimens of rare species obtained from the North Carolina litter sample at each time interval by Winkler and Berlese funnels.

in all trials relative to numbers obtained during intermediate intervals. For both the Berlese and Winkler funnels in the Alabama and New Mexico trials and the Berlese funnels of the Louisiana trial, the peak in these later intervals exceeded the initial high period (Figs. 61, 63, 64). In the rest of the trials, the most productive interval occurred early in the trial during the initial intervals between 0-12 hours (Figs. 60, 62, 65). Thus, both Winkler and Berlese funnels extracted specimens of rare species over the duration of the trials in a manner similar to that of total specimens and that of specimens of Curculionidae and Staphylinidae, adhering closely to the pattern of an initial high number of specimens which then declined in the initial intervals followed by a terminal peak in numbers of specimens.

2.3.6.2 New species per time interval

Total numbers of rare species obtained from different samples varied among the six trials and between Winkler and Berlese funnels within individual trials. The highest total number of rare species was obtained from the Louisiana sample, with 76 extracted, 68 from Winkler funnels and 55 from Berlese funnels. The Alabama sample yielded 57 rare species, 43 from Berlese funnels and 41 from Winkler funnels. The Arkansas trial yielded 47 rare species, 32 from Winkler funnels and 45 from Berlese funnels. The North Carolina sample yielded 35 rare species, 29 from Winkler funnels and 31 from Berlese funnels. The Arizona and New Mexico trials yielded the lowest total numbers of rare species, with 19, each. In these two samples, equal numbers of rare specimens were extracted from Winkler and Berlese funnels, with 16 extracted by both funnels from the Arizona sample and 15 extracted by both funnels from the New Mexico sample. The t-test yielded a value of

P= 0.63; there was no significant difference in the total number of rare species extracted by Berlese funnels or Winkler funnels across all trials.

The numbers of new rare species obtained per time interval exhibited the same pattern that has been demonstrated by other taxa, in both Winkler and Berlese funnels across all trials (Figs. 66-71). An initial high number of species during the intervals of 3-18 hours occurred in both funnel types across all samples. Fluctuation occurred throughout the middle intervals. In all samples, the terminal intervals between 60-216 hours constituted a second period of high numbers of new rare species collected per interval. In the Arizona sample, this peak was not as extreme, but new representatives of rare species were still obtained during this later time period (Fig. 68). In both funnels of the Alabama trial and the Winkler of the New Mexico trial, this second, later period yielded more species per time interval than

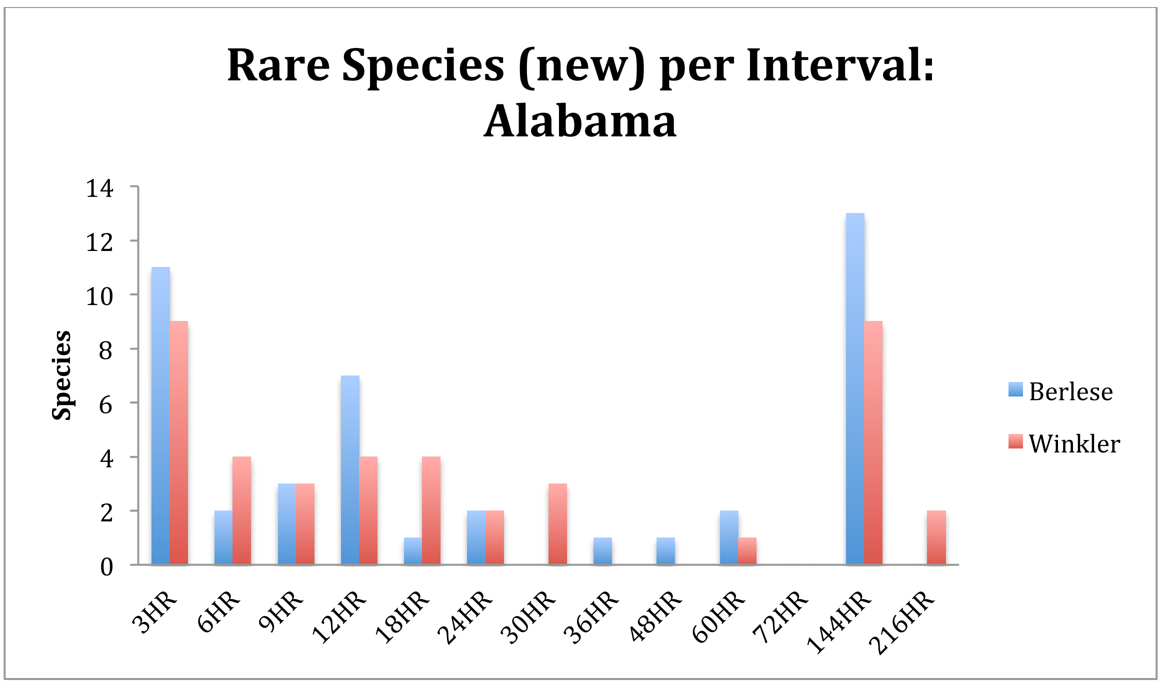

Fig. 66. Number of new rare species obtained from the Alabama litter sample at each time interval by Winkler and Berlese funnels.

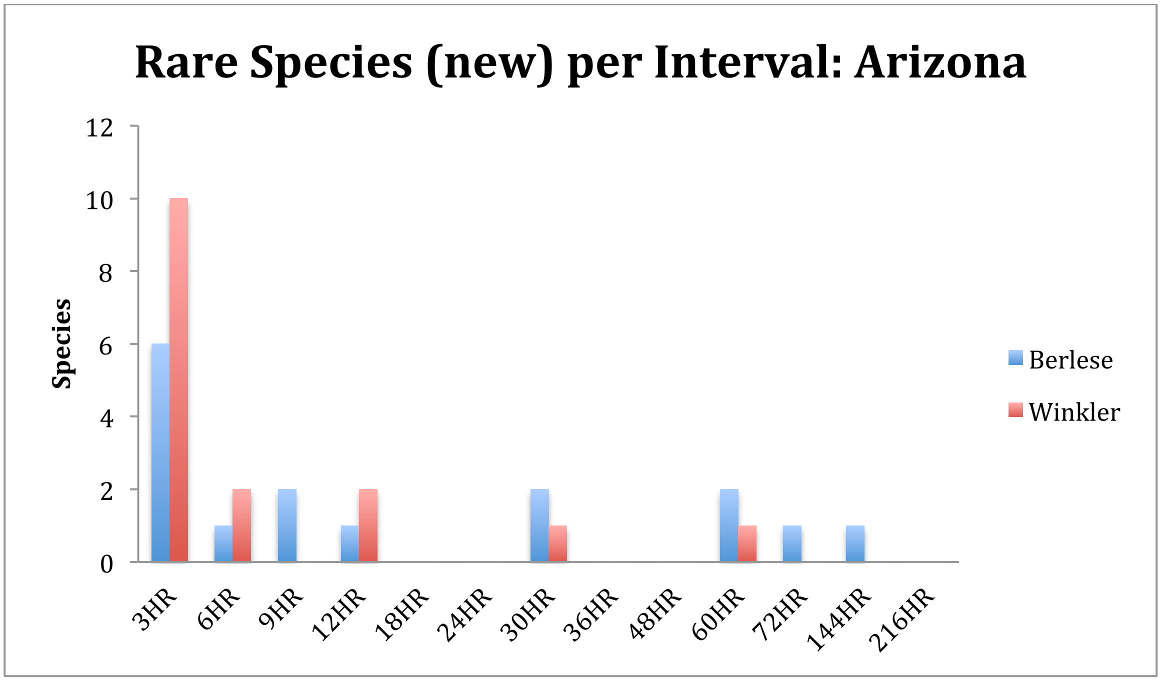

Fig. 67. Number of new rare species obtained from the Arizona litter sample at each time interval by Winkler and Berlese funnels.

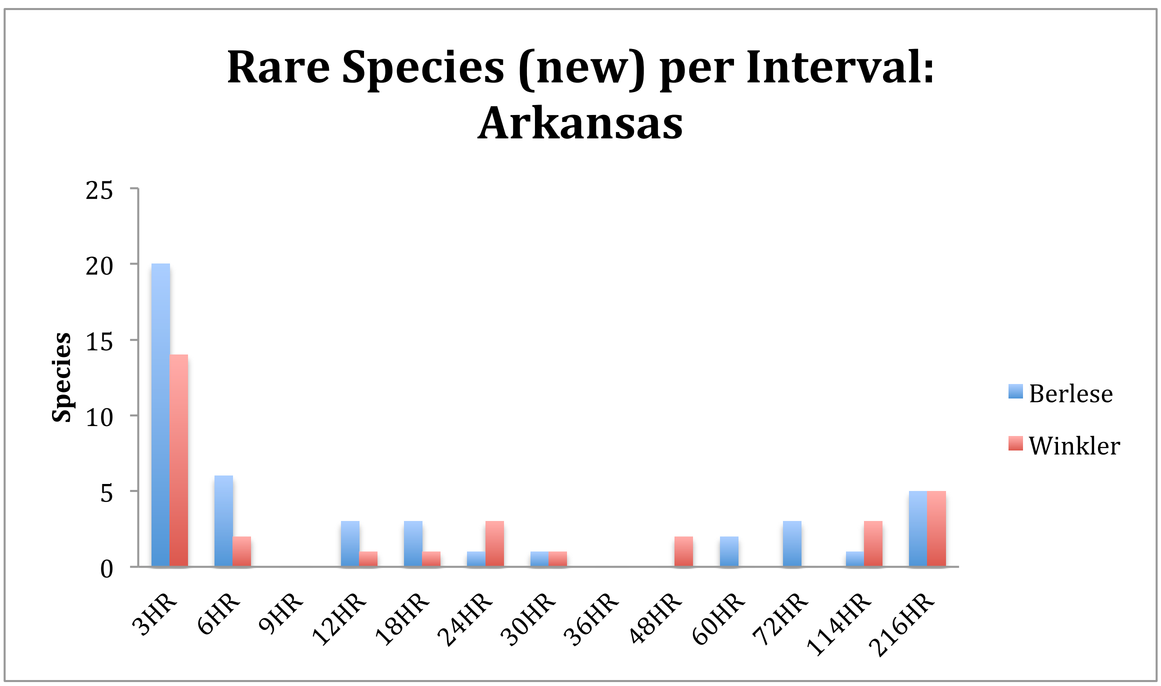

Fig. 68. Number of new rare species obtained from the Arkansas litter sample at each time interval by Winkler and Berlese funnels.

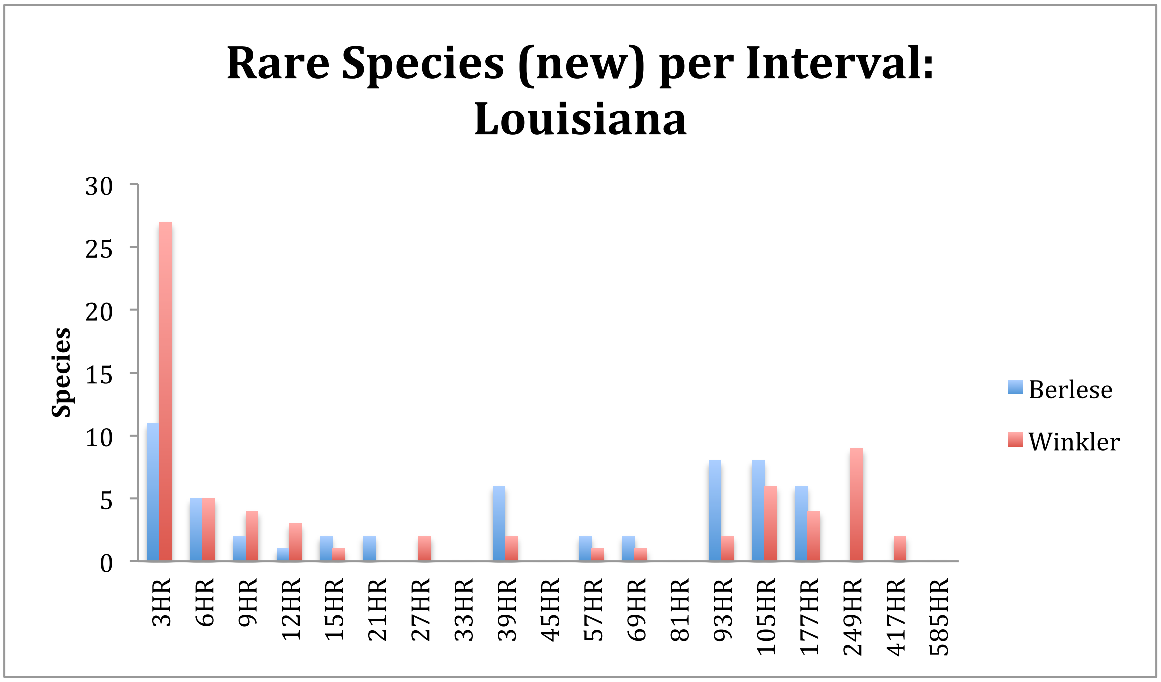

Fig. 69. Number of new rare species obtained from the Louisiana litter sample at each time interval by Winkler and Berlese funnels.

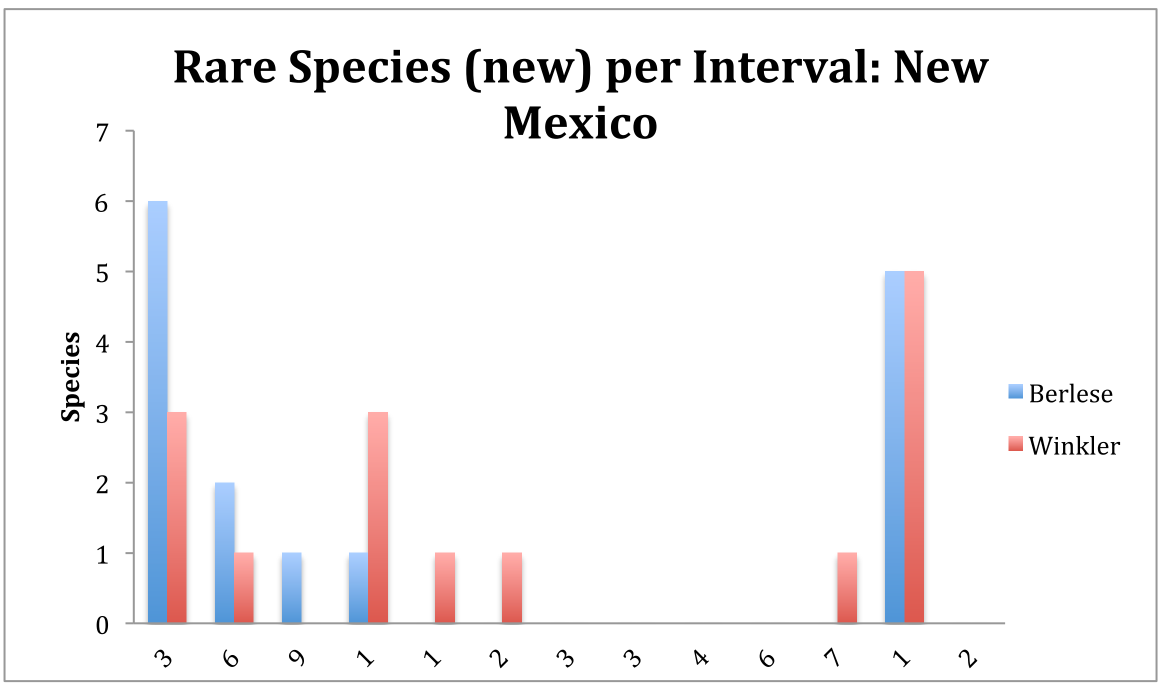

Fig. 70. Number of new rare species obtained from the New Mexico litter sample at each time interval by Winkler and Berlese funnels.

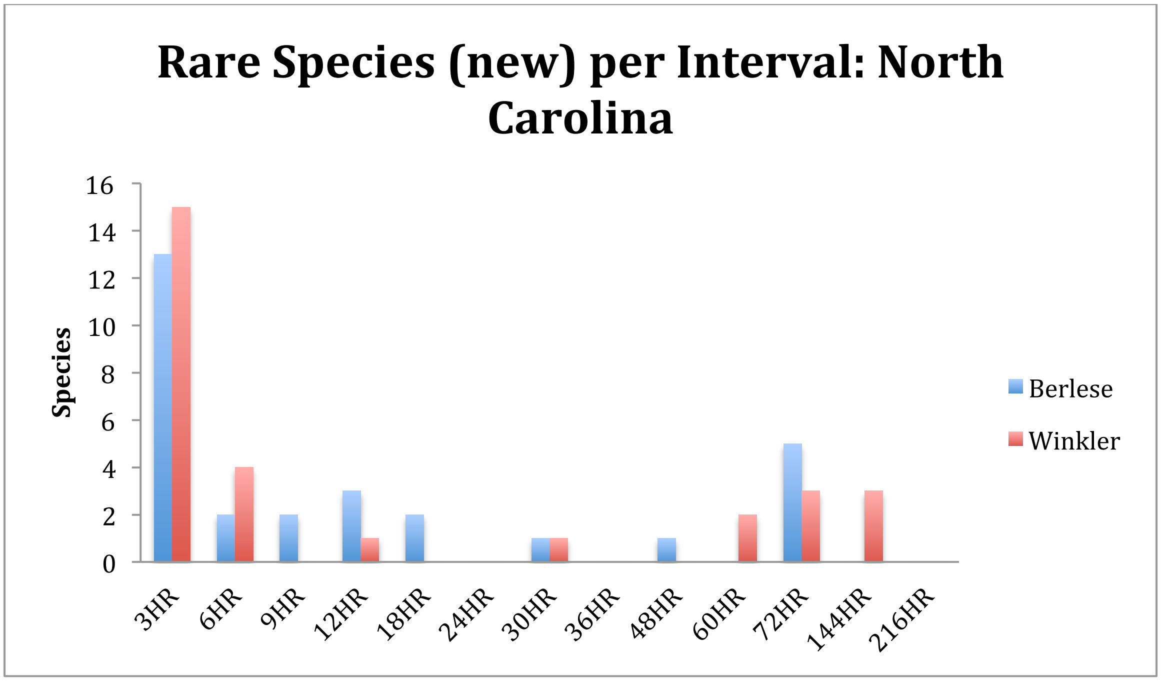

Fig. 71. Number of new rare species obtained from the North Carolina litter sample at each time interval by Winkler and Berlese funnels.

did the first peak during early intervals (Figs. 66, 70). Thus, new specimens were obtained in higher numbers early in the extraction period and a number emerged later in the trial period after a middle period which yielded lower levels of new species. Again, this pattern closely followed that exhibited by other taxa and there was no noticeable difference in this pattern of extraction between funnel types.

2.4 Discussion

The initial objective of this study was to compare two common methods used for sampling litter dwelling Coleoptera, Berleses and Winklers, in a manner that would highlight any taxonomic and temporal differences in the extraction products of these two apparatus. As a secondary goal, we sought to establish optimal extraction times required for each funnel type. Since no other studies have compared the extraction abilities of Winklers and Berleses at a species level or at such a fine temporal scale, our study was designed to provide information relevant to future studies with both a time limitation and a taxonomic focus. After considering the results of our study, any differences in the relative efficiencies of Berleses and Winklers appeared inconsistent throughout the trials. No consistent differences in numbers of specimens or species collected throughout the duration of the extraction time were observed. Standardization of collection of litter arthropods remains one of the major obstacles to ecological studies of this fauna (Andre et al. 2002). Our study suggests that extractor type (Winkler or Berlese funnel) is a less important choice than decisions about the duration of extraction and collection of extraction products at certain intervals.

With respect to all taxonomic groups evaluated in our study (total specimens, total species, species and specimens of Curculionidae, species and specimens of Staphylinidae, and rare species), the major differences in total extraction over the course of the study was not driven by funnel type, but instead by the total length of extraction times and the time intervals at which collections were recovered. A major question when considering the duration of extraction is that of sample extinction and the associated appropriate time for the termination of extraction. Since determining the total number of specimens in a field collected sample is not practical, we determined extinction to be the point at which no more individuals exited the sample after a 48 hour period. The six trials in this experiment reached extinction sometime during the 144-216 hour interval, suggesting that this time, between 6-9 days, is a suitable termination point for such experiments, regardless of funnel type, if time is not a limiting factor. The Louisiana sample was run for a much longer (585 hours) duration than others. The extinction point for the Winkler funnels of this sample occurred between the 177 and 249 hour interval and this was used to predict a tentative termination point for other trials, which was consistent throughout subsequent trials.

This termination point was also consistent for taxa that were considered in more detail. For species of Curculionidae and Staphylinidae, and rare species, extinction also occurred some time during the 144-216 hour interval. Thus, extraction times required for obtaining both the majority of individual specimens and the majority of species are similar. Therefore, our study suggests that 216 hours of extraction is a sufficient termination point for taxonomically focused studies concerned with numbers of particular species, as well as those that are more ecologically focused and concerned with total numbers of individuals or numbers of common species.

Two high points were observed during which relatively larger numbers of taxa were collected per interval. Again, the differences in extraction patterns during intervals were inconsistent with regards to funnel type. Berleses and Winklers extracted species and specimens similarly within trials. However, the initial peak during the initial 0-3 hour interval and a second, later peak from 60-144 hours were exhibited during the majority of trials, indicating that time of extraction, not funnel type, is the major driving factor behind members of taxa and individuals collected per interval throughout extraction duration. As with the extinction point for species and specimens, the overall pattern of an earlier and a later peak was exhibited consistently by the taxa and species considered in detail, individually. Whereas the initial and secondary peaks varied in intensity from sample to sample and with respect to different taxa and groups, the presence of a second peak indicated that samples should be run for longer periods of time than the traditional 24-48 hours in order to capture this second peak in both total numbers of specimens as well as species.

Numbers of species and specimens obtained during each trial varied widely according to sample. We chose to use samples from a variety of localities and habitat types in order to examine underlying patterns and differences in extraction between funnel type. Some studies have cited differences in extraction due to sample source, with tropical forest litter taking longer due to higher humidity conditions (Delsinne and Arias-Penna 2012). Our samples were all collected in different habitats within the temperate United States, yet extractions were run under identical laboratory conditions.

Our study indicates that the impact of funnel type was not an important consideration with regard to extraction numbers, from either a temporal or taxonomic perspective. Therefore, when considering a standardization protocol for the extraction of forest litter-dwelling Coleoptera, a similar protocol could be adopted for either use by Berlese funnels or Winkler funnels. Additionally, total numbers of specimens, species, and the different taxa considered (Curculionidae, Staphylinidae, and rare species) exhibited similar patterns of extraction over time, so any protocol developed would most likely be applicable to a range of studies focused on a variety of aspects of litter-dwelling Coleoptera. Variables, such as size of sample, surrounding extraction environment, and initial sampling habitat may affect extraction times. Based on results from these samples originating from a broad array of habitats, we suggest the following protocol for extraction of litter-dwelling Coleoptera. The protocol below is based on an assumption of four large samples requiring processing.

Berlese funnels and/or Winkler funnels should be run for a combination of earlier and later intervals to take advantage of both peaks. The first sample should be run for an initial 24 hour period. This will take advantage of the initial peak between 0-3 hours and the subsequent declining but still productive 24 hour recovery period. After this initial 24 hours, the sample should be removed and additional samples rotated through the 24 hour intervals. Each sample should be conserved in a cloth container after this initial run without rewetting. After an initial run of the four samples (96 hours) in this example, the first sample should be placed back on the funnels for an additional 24 hours to take advantage of the later and final recovery peak during the 96-120 hour interval. Allowances for larger or smaller numbers of samples can be accommodated. Further studies may further refine the exact intervals necessary to maximize extraction completeness and efficiency, but this protocol is a first step towards standardization of litter collection for the exploration of this diverse yet understudied fauna.

Table 2. List of taxa represented in six Berlese/Winker funnel extraction trials. Higher-level taxa are indicated where relevant. Samples are indicated by symbols as follows: ★= Alabama; ○= Arizona; ◆= Arkansas; ■= Louisiana; ✖= New Mexico; ✚= North Carolina.

FAMILY	**SUBFAMILY**	**GENUS/SPECIES**	Sample
Aderidae		*Aderidae sp.*	■
Anthicidae		*Anthicidae sp.*	■◆
Archaeocrypticidae		*Enneboeus caseyi* Kaszab, 1981	◆
Biphyllidae		*Diplocoelus rudis* (LeConte) 1863	◆★
Carabidae	Brachininae	*Brachinus sp.* Weber 1801	■◆
Carabidae	Carabinae	*Scaphinotus sp.* Dejean 1826	✚
Carabidae	Harpalinae	*Anisodactylus sp.* Dejean 1829	✚
Carabidae	Harpalinae	*Cymindis (Pinacodera) limbata* (Dejean) 1831	★
Carabidae	Harpalinae	*Cymindis sp. 2* Latreille 1806	○
Carabidae	Harpalinae	*Gastrellarius sp.* Casey 1918	✚
Carabidae	Harpalinae	*Lebia ornata* Say, 1823	★
Carabidae	Harpalinae	*Lebia sp. 1* Latreille 1802	○
Carabidae	Harpalinae	*Lebia sp. 2*	✖
Carabidae	Harpalinae	*Olisthopus sp.* Dejean 1828	✖
Carabidae	Harpalinae	*Pterostichus sp. 1* Bonelli 1810	■★
Carabidae	Harpalinae	*Pterostichus sp. 2*	✖
Carabidae	Pterostichitae	*Cyclotrachelus sp.*Chaudoir 1838	■★
Carabidae	Rhysodinae	*Clinidium sp.* Bell 1970	◆
Carabidae	Trechinae	*Anillinus sp.* Casey 1918	■★✚
Carabidae	Trechinae	*Elaphropus sp.* Motschulsky 1839	✚
Carabidae	Trechinae	*Micratopus aenescens* (LeConte) 1848	■
Carabidae	Trechinae	*Mioptachys flavicauda* (Say) 1823	◆
Carabidae	Trechinae	*Polyderis laeva* (Say) 1823	■★
Cerylonidae	Ceryloninae	*Mychocerus striatus* (Gupta and Crowsen) 1973	✚
Cerylonidae	Ceryloninae	*Philothermus glabriculus* LeConte, 1863	■◆✚
Chrysomelidae	Bruchinae	*Bruchus bruchialis* Fahraeus 1839	○
Chrysomelidae	Cryptocephalinae	*Pachybrachis pectoralis* (Melsheimer) 1847	★
Chrysomelidae	Galerucinae	*Longitarsus sp.* Latreille 1829	■
Chrysomelidae	Galerucinae	*Psylliodes convexior* LeConte 1857	○
Chrysomelidae	Galerucinae	*Psylliodes sp. 2* Latreille 1829	✖
Chrysomelidae		*Chrysomelidae sp. 2*	■◆
Chrysomelidae		*Chrysomelidae sp. 3*	✚

(Table 2 continued) List of taxa represented in six Berlese/Winker funnel extraction trials. Higher-level taxa are indicated where relevant. Samples are indicated by symbols as follows: ★= Alabama; ○= Arizona; ◆= Arkansas; ■= Louisiana; ✖= New Mexico; ✚= North Carolina.

Ciidae	Ciinae	*Ceracis sp.* Mellie 1848	★
Ciidae	Ciinae	*Cis sp.* Latreille 1796	◆
Ciidae	Ciinae	*Malacocis brevicollis* (Casey) 1898	◆
Ciidae		*Ciidae sp. 4*	◆
Ciidae		*Ciidae sp. 5*	◆
Ciidae		*Ciidae sp. 6*	◆
Ciidae		*Ciidae sp. 7*	◆
Ciidae		*Ciidae sp. 8*	■◆
Clambidae		*Clambus sp.* Fischer von Waldheim 1822	○
Corylophidae	Rypobiinae	*Gleosoma sp.* Wollaston 1854	■★
Corylophidae		*Corylophidae sp. 2*	✚
Cryptophagidae	Atomariinae	*Curelius japonicas* (Reitter) 1877	◆
Curculionidae	Baridinae	*Buchananius sulcatus* LeConte 1876	◆
Curculionidae	Cossoninae	*Acamptus sp.* LeConte 1876	★
Curculionidae	Cryptorhyncinae	*Acalles porosus* Blatchley 1916	■◆
Curculionidae	Cryptorhynchinae	*Acalles carinatus* LeConte 1876	■◆
Curculionidae	Cryptorhynchinae	*Acalles clavatus* (Say) 1831	◆
Curculionidae	Cryptorhynchinae	*Acalles crassulus* LeConte 1876	★
Curculionidae	Cryptorhynchinae	*Acalles sp. 1* Schonherr 1825	★
Curculionidae	Cryptorhynchinae	*Acalles sp. 2*	★
Curculionidae	Cryptorhynchinae	*Canistes schusteri* Casey 1892	★
Curculionidae	Cryptorhynchinae	*Eurhoptus pyriformis& sordidus* LeConte 1876	■★✚
Curculionidae	Cryptorhynchinae	Cryptorhynchinae sp. 9	✖
Curculionidae	Curculioninae	*Anthonomus suturalis* LeConte 1824	◆
Curculionidae	Curculioninae	*Oopterinus perforatus* (Horn) 1873	★
Curculionidae	Dryopthorinae	*Dryopthorus americanus* Bedel 1885	■◆
Curculionidae	Entiminiae	*Cercopeus isquitus* Sleeper 1955	★
Curculionidae	Entiminae	*Cyrtepistomus castaneus* (Roelofs) 1873	★
Curculionidae	Entiminae	*Epicaerus sulcatus* Casey 1888	○
Curculionidae	Entiminae	*Lepidophorus setiger* Hamilton 1895	✚
Curculionidae	Molytinae	*Conotrachelus adspersus* LeConte 1876	○
Curculionidae	Molytinae	*Conotrachelus aratus* (Germar) 1824	■
Curculionidae	Molytinae	*Conotrachelus carinifer* Casey 1892	✖
Curculionidae	Molytinae	*Conotrachelus elegans* (Say) 1831	■

(Table 2 continued) List of taxa represented in six Berlese/Winker funnel extraction trials. Higher-level taxa are indicated where relevant. Samples are indicated by symbols as follows: ★= Alabama; ○= Arizona; ◆= Arkansas; ■= Louisiana; ✖= New Mexico; ✚= North Carolina.

Curculionidae	Molytinae	*Conotrachelus naso* LeConte 1876	★
Curculionidae	Molytinae	*Conotrachelus posticatus* Boheman 1837	■★✚ ✖
Curculionidae	Molytinae	*Conotrachelus sp. 6* Dejean 1835	■
Curculionidae	Molytinae	*Lymantes puteolatum* (Dury) 1901	○
Curculionidae	Molytinae	*Odontopus calceatus* (Say) 1831	★✚
Curculionidae	Molytinae	*Rhyssomatus sp.* Schonherr 1837	○
Curculionidae	Scolytinae	*Scolytinae sp. 1*	■◆
Curculionidae	Scolytinae	*Scolytinae sp. 2*	◆
Curculionidae		*Microhyas setiger* LeConte 1876	■◆
Curculionidae		*Curculionidae sp. 31*	■
Curculionidae		*Curculionidae sp. 32*	■
Curculionidae		*Curculionidae sp. 33*	■
Dytiscidae	Hydroporinae	*Uvarus sp.* Guignot 1939	★
Elateridae	Elaterinae	*Melanotus sp.* Eschscholtz 1829	✚
Elateridae		*Elateridae sp. 2*	★
Endomychidae	Anamorphinae	*Bystus ulkei* Crotch 1873	◆
Endomychidae	Anamorphinae	*Clemmus minor* Crotch 1873	◆
Endomychidae	Endomychinae	*Danae testacea* Zeigler 1875	◆
Endomychidae	Lycoperdininae	*Mycetina perpulchra* (Newman) 1838	◆✚
Endomychidae	Merophysiinae	*Holoparamecus sp.* Curtis 1833	◆
Erotylidae	Xenoscelinae	*Toramus hirtellus* Schwarz 1878	◆
Eucinetidae		*Eucinetus morio* LeConte 1853	★
Histeridae	Abraeinae	*Aeletes simplex* (LeConte) 1844	◆
Histeridae	Dendrophilinae	*Anapleus sp.* Horn 1873	✖
Histeridae	Dendrophilinae	*Bacanius punctiformis* (LeConte) 1853	■◆
Histeridae	Dendrophilinae	*Dendrophilus xavieri* Marseul 1873	■
Histeridae	Dendrophilinae	*Paromalus seminulum* Erichson 1834	◆
Histeridae	Histerinae	*Eblisia Carolina* (Paykull) 1811	■◆
Histeridae	Histerinae	*Hister sp.* Linnaeus 1758	✚
Histeridae	Histerinae	*Margarinotus sp.* Marseul 1853	✚
Histeridae	Histerinae	*Platysoma leconti* Marseul 1850	◆
Histeridae	Onthophilinae	*Onthophilus intermixtus* Helava 1978	✖
Histeridae	Tribalinae	*Caerosternus americanus* LeConte 1844	◆
Histeridae	Tribalinae	*Epierus pulicarius* Erichson 1834	◆

(Table 2 continued) List of taxa represented in six Berlese/Winker funnel extraction trials. Higher-level taxa are indicated where relevant. Samples are indicated by symbols as follows: ★= Alabama; ○= Arizona; ◆= Arkansas; ■= Louisiana; ✖= New Mexico; ✚= North Carolina.

Histeridae	Tribalinae	*Epierus regularis* (Palisot de Beauvois) 1818	◆
Histeridae		*Histeridae sp. 12*	○
Histeridae		*Histeridae sp. 13*	○
Hybosoridae	Ceratocanthinae	*Ceratocanthus sp.* White 1842	■◆
Hydrophilidae	Sphaeridiinae	*Dactylosternum sp.* Wollaston 1854	✚
Hydrophilidae	Sphaeridiinae	*Oosternum sp.* Sharp 1882	★
Hydrophilidae		*Hydrophilidae sp.*	◆
Latridiidae	Latridiinae	*Dienerella pilifera* (Reitter) 1875	○
Latridiidae	Latridiinae	*Dienerella sp. 2* Reitter 1911	✖
Latridiidae	Latridiinae	*Metophthalmus septemstriatus* Hatch 1962	○
Latridiidae	Latridiinae	*Metophthalmus sp. 2* Wollaston 1854	■
Leiodidae	Catopocerinae	*Catopocerus sp.* Motschulsky 1869	✚
Leiodidae	Cholevinae	*Adelopsis appalachiana* Peck 1978	★
Leiodidae	Cholevinae	*Ptomaphagus sp.* Illiger 1798	■◆✚
Leiodidae	Leiodinae	*Agathidium sp. 1* Panzer 1797	■★✚
Leiodidae	Leiodinae	*Agathidium sp. 2*	■★
Leiodidae	Leiodinae	*Agathidium sp. 3*	◆
Leiodidae	Leiodinae	*Agathidium sp. 4*	◆
Leiodidae	Leiodinae	*Agathidium sp. 5*	◆
Leiodidae	Leiodinae	*Agathidium sp. 6*	◆
Leiodidae	Leiodinae	*Anisotoma sp. 1* Panzer 1979	★
Leiodidae	Leiodinae	*Anisotoma sp. 2*	★
Leiodidae	Leiodinae	*Colenis impunctata* LeConte 1853	★✚
Leiodidae	Leiodinae	*Colenis sp. 2* Erichson 1845	✚
Leiodidae	Leiodinae	Leiodinae sp. 11	◆
Leiodidae	Platyspillinae	*Leptinus americanus* LeConte 1866	◆★
Lycidae	Erotinae	*Eropterus trilineatus* Melsheimer 1846	★
Melandryidae	Melandryinae	*Orchesia sp.* Latreille 1807	◆
Monotomidae		*Bactridium sp.* LeConte 1861	◆
Mordellidae		*Falsomordellistena hebraica* (LeConte) 1862	★
Mycetophagidae		*Litargus sp.* Erichson 1846	◆
Mycetophagidae		*Thrimolus minutus* Casey 1900	○
Nitidulidae	Carpophilinae	*Carpophilus sp.* Stephens 1830	✚
Nitidulidae	Cillaeinae	*Colopterus sp.* Erichson 1842	◆

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Nitidulidae	Nitidulinae	*Lobiopa falli* Parsons 1939	⭘✖
Nitidulidae	Nitidulinae	*Stelidota octomaculata* (Say) 1825	■★✚
Nitidulidae	Nitidulinae	*Pallodes austrinus* Leschen 1988	★
Nitidulidae	Nitidulinae	*Pallodes pallidus* (Beauvois) 1805	◆★
Ptiliidae	Acrotrichinae	*Acrotrichis sp.* Motschulsky 1850	⭘✚
Ptiliidae	Acrotrichinae	*Acrotrichis sp. 2*	✖
Ptiliidae	Acrotrichinae	*Acrotrichis sp. 3*	✖
Ptiliidae	Ptiliinae	*Micridium sp. 1* Motschulsky 1869	★
Ptiliidae	Ptiliinae	*Micridium sp. 2*	■◆✚
Ptiliidae	Ptiliinae	*Micridium sp. 3*	✖
Ptiliidae	Ptiliinae	*Nossidium sp. 1* Erichson 1845	◆
Ptiliidae	Ptiliinae	*Nossidium sp. 2*	■
Ptiliidae	Ptiliinae	*Ptenidium sp.* Erichson 1845	⭘
Ptiliidae	Ptiliinae	*Pteryx sp. 1* Matthews 1858	★
Ptiliidae	Ptiliinae	*Pteryx sp. 2*	✖
Ptiliidae		*Ptiliidae sp. 7*	◆
Ptiliidae		*Ptiliidae sp. 8*	◆
Ptilodactyllidae		*Ptilodactyla sp.* Horn 1880	★
Ptinidae	Anobiinae	*Ptinidae sp. 1*	★
Ptinidae	Anobiinae	*Ptinidae sp. 2*	✚
Ptinidae	Ptininae	*Protheca hispida* LeConte 1865	★
Scarabaeidae	Aphodiinae	*Aphotaenius carolinus* Van Dyke 1928	■◆
Scarabaeidae	Aphodiinae	*Ataenius sp. 1* Harold 1867	◆
Scarabaeidae	Aphodiinae	*Ataenius sp. 2*	◆
Scarabaeidae	Aphodiinae	*Auperia sp.* Chevrolat 1864	◆
Scarabaeidae	Aphodiinae	*Stenotothorax sp.* Schmidt 1913	★
Scarabaeidae	Aphodiinae	Aphodiinae sp. 4	✖
Scarabaeidae	Melonthinae	*Serica sp.* MacLeay 1819	✚
Scarabaeidae	Scarabaeinae	*Ateuchus histeroides* Weber 1801	◆
Scarabaeidae	Scarabaeinae	*Canthon viridis* (Palisot de Beauvois) 1805	◆★
Scarabaeidae	Scarabaeinae	*Onthophagus pennsylvanicus* Harold 1871	★
Scarabaeidae	Scarabaeinae	*Onthophagus oklahomensis* Brown 1927	◆
Scarabaeidae	Scarabaeinae	*Onthophagus sp. 3* Latreille 1802	✖
Scarabaeidae		Scarabaeidae sp. 9	★

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Silvanidae	Silvaninae	*Ahasverus advenus* Waltl 1834	★
Smicripidae		*Smicrips (nr.) texana* (Casey) 1916	✖
Sphindidae	Sphindinae	*Sphindus (nr.) americanus* LeConte 1866	✖
Sphindidae	Sphindinae	*Sphindus trinifer* Casey 1898	★
Staphylinidae	Aleocharinae	*Hamotus sp.* Aube 1844	✚
Staphylinidae	Aleocharinae	*Holobus sp. 1* Solier 1849	◆✚
Staphylinidae	Aleocharinae	*Holobus sp. 2*	◆
Staphylinidae	Aleocharinae	*Leptusa brevicollis* Casey 1893	◆
Staphylinidae	Aleocharinae	*Leptusa canonica* Casey 1906	◆
Staphylinidae	Aleocharinae	*Leptusa cribratula* (Casey) 1906	◆
Staphylinidae	Aleocharinae	*Leptusa elegans* Blatchley 1910	■
Staphylinidae	Aleocharinae	*Leptusa sp.* Kraatz 1856	✚
Staphylinidae	Aleocharinae	*Myllaena sp.* Erichson 1837	✚
Staphylinidae	Aleocharinae	*Myrmecocephalus cingulatus* (LeConte) 1866	◆
Staphylinidae	Aleocharinae	*Hamalotini sp.*	◆
Staphylinidae	Aleocharinae	*Eumicrota sp.* Casey 1906	◆
Staphylinidae	Aleocharinae	*Phanerota sp.* Casey 1906	◆
Staphylinidae	Aleocharinae	*Drusilla sp.* Leach 1819	■
Staphylinidae	Aleocharinae	*Pella sp.* Stephens 1835	◆
Staphylinidae	Aleocharinae	*Lomechusini sp. 2*	◆
Staphylinidae	Aleocharinae	Aleocharinae sp. 17	✖
Staphylinidae	Dasycerinae	*Dasycerus carolinensis* Horn 1882	★
Staphylinidae	Dasycerinae	*Dasycerus sp. 2* Brong 1799	✚
Staphylinidae	Euaesthetinae	*Edaphus sp.* Motschulsky 1857	◆
Staphylinidae	Euaesthetinae	*Euaesthetus sp. 1* Gravenhorst 1806	◆★
Staphylinidae	Euaesthetinae	*Euaesthetus sp. 2*	■✖
Staphylinidae	Euaesthetinae	*Stictocranius sp.* LeConte 1866	■★
Staphylinidae	Megalopsidiinae	*Megalopinus sp.* Eichelbaum 1915	◆
Staphylinidae	Omaliinae	*Eusphlarum sp.* Kraatz 1858	■◆
Staphylinidae	Osoriinae	*Osorius sp.* Latreille 1829	◆
Staphylinidae	Osoriinae	*Thoracophorus costalis* (Erichson) 1840	■★
Staphylinidae	Paederinae	*Achenomorphus corticinus* (Gravenhorst) 1802	◆★
Staphylinidae	Paederinae	*Astenus sp.* Dejean 1833	■◆
Staphylinidae	Paederinae	*Echiaster brevicornis* (Casey) 1886	◆★

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Staphylinidae	Paederinae	*Echiaster sp. 2* Erichson 1840	○
Staphylinidae	Paederinae	*Echiaster sp. 3*	○
Staphylinidae	Paederinae	*Homaeotarsus sp.* Hochhuth 1851	✖
Staphylinidae	Paederinae	*Lithocharis sp.* Dejean 1833	✚
Staphylinidae	Paederinae	*Orus sp. 1* Casey 1884	○
Staphylinidae	Paederinae	*Orus sp. 2*	○
Staphylinidae	Paederinae	*Palaminus sp.* Erichson 1839	■★
Staphylinidae	Paederinae	*Pinophilus sp.* Gravenhorst 1802	◆
Staphylinidae	Paederinae	*Rugilus sp. 1* Leach 1819	■★
Staphylinidae	Paederinae	*Ruglius sp. 2*	✖
Staphylinidae	Paederinae	*Stilicopsis paradoxa* Sachse 1852	■★
Staphylinidae	Paederinae	*Thinocharis sp.* Kraatz 1859	◆★
Staphylinidae	Pselaphinae	*Actium sp.* Casey 1886	✚
Staphylinidae	Pselaphinae	*Allotrimium excavatum* Chandler 1985	○✖
Staphylinidae	Pselaphinae	*Arianops sp.* Brendle 1893	◆
Staphylinidae	Pselaphinae	*Batrisodes sp. 1* Reitter 1881	★
Staphylinidae	Pselaphinae	*Batrisodes sp. 2*	★
Staphylinidae	Pselaphinae	*Batrisodes sp.* 3	■◆
Staphylinidae	Pselaphinae	*Brachygluta elegans* (Brendel) 1890	○
Staphylinidae	Pselaphinae	*Conoplectus suzae* Carlton 1983	■
Staphylinidae	Pselaphinae	*Conoplectus caniliculatus* (LeConte) 1850	■◆
Staphylinidae	Pselaphinae	*Conoplectus sp. 3* Brendel 1890	■◆
Staphylinidae	Pselaphinae	*Custotychus sp.* Park and Wagner 1961	■◆
Staphylinidae	Pselaphinae	*Custotychus sp.*	◆★
Staphylinidae	Pselaphinae	*Dalmosanus steevesi* (Schuster and Grigarick) 1968	★
Staphylinidae	Pselaphinae	*Dalmosella tenuis* Casey 1897	◆✚
Staphylinidae	Pselaphinae	*Decarthron sp.* Brendel 1865	★
Staphylinidae	Pselaphinae	*Euplectus sp.* Leach 1817	◆
Staphylinidae	Pselaphinae	*Eutyphlus sp.* LeConte 1880	
Staphylinidae	Pselaphinae	*Leptoplectus pertenuis* (Casey) 1884	■◆
Staphylinidae	Pselaphinae	*Melba parvula* (LeConte) 1849	■◆
Staphylinidae	Pselaphinae	*Melba sulcatula* Casey 1897	■◆
Staphylinidae	Pselaphinae	*Melba thoracica* (Brendel) 1889	■◆
Staphylinidae	Pselaphinae	*Melba sp. 4* Casey 1897	■◆
Staphylinidae	Pselaphinae	*Mipseltyrus nicolayi* Park 1953	✚

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Staphylinidae	Pselaphinae	*Nearctitychus sternalis* (Raffray) 1904	★
Staphylinidae	Pselaphinae	*Prespelea copelandi* Park 1956	✚
Staphylinidae	Pselaphinae	*Prespelea quirsfeldi* Park 1953	✚
Staphylinidae	Pselaphinae	*Pseudactium mendicum* (Park) 1962	■
Staphylinidae	Pselaphinae	*Pycnoplectus sp. 1* Casey 1897	★
Staphylinidae	Pselaphinae	*Pycnoplectus sp. 2*	■◆
Staphylinidae	Pselaphinae	*Rhexius insculptus* LeConte 1849	★
Staphylinidae	Pselaphinae	*Rhexius sp. 2* LeConte 1849	■◆
Staphylinidae	Pselaphinae	*Simplona dybasi* Chandler 1985	○
Staphylinidae	Pselaphinae	*Sonoma sokolovi* Ferro and Carlton 2010	★
Staphylinidae	Pselaphinae	*Sonoma sp.* Casey 1886	✚
Staphylinidae	Pselaphinae	*Thesiastes sp.* Casey 1894	◆
Staphylinidae	Pselaphinae	*Tmesiphorus carinatus* (Say) 1824	◆
Staphylinidae	Pselaphinae	*Tmesiphorus costalis* LeConte 1850	◆★
Staphylinidae	Pselaphinae	*Trimiomelba dubia* (LeConte) 1849	★
Staphylinidae	Pselaphinae	*Trimiomelba sp.2* Casey 1897	■
Staphylinidae	Pseudopsinae	*Pseudopsis subulata* Herman 1975	✚
Staphylinidae	Scaphidiinae	*Baeocera sp. 1* Erichson 1845	★
Staphylinidae	Scaphidiinae	*Baeocera sp. 2*	★
Staphylinidae	Scaphidiinae	*Baeocera sp. 3*	■◆
Staphylinidae	Scaphidiinae	*Cyparium ater* (Casey) 1900	★✖
Staphylinidae	Scaphidiinae	*Cyparium concolor* (Fabricius) 1801	◆
Staphylinidae	Scaphidiinae	*Toxidium sp.* LeConte 1860	◆
Staphylinidae	Scydmaeninae	*Chelonoidum sp.* Strand 1935	✖
Staphylinidae	Scydmaeninae	*Euconnus (Napochus)* Thomson 1862	✚
Staphylinidae	Scydmaeninae	*Euconnus (Noctophus)* Casey 1897	✖
Staphylinidae	Scydmaeninae	*Euconnus (Scopophus)* Casey 1897	✚
Staphylinidae	Scydmaeninae	*Euconnus s. sr. 1* Thomson 1859	★✚
Staphylinidae	Scydmaeninae	*Euconnus s. sr. 2*	✚
Staphylinidae	Scydmaeninae	*Euconnus sp. 1* Thomson 1859	■◆
Staphylinidae	Scydmaeninae	*Euconnus sp. 2*	■
Staphylinidae	Scydmaenidae	*Euconnus sp. 3*	○
Staphylinidae	Scydmaeninae	*Leptoscydmus sp.* Casey 1897	■
Staphylinidae	Scydmaeninae	*Scydmaenus sp.* Latreille 1802	◆
Staphylinidae	Scydmaeninae	*Stenichnus sp.* Thomson 1859	◆
Staphylinidae	Staphylininae	*Diochus schaumi* Kraatz 1860	◆

(Table 2 continued) List of taxa represented in six Berlese/Winker funnel extraction trials. Higher-level taxa are indicated where relevant. Samples are indicated by symbols as follows: ★= Alabama; ○= Arizona; ◆= Arkansas; ■= Louisiana; ✖= New Mexico; ✚= North Carolina.

Staphylinidae	Staphylininae	*Diochus sp. 2* Erichson 1839	◆
Staphylinidae	Staphylininae	*Platydractus cinnamopterus* (Gravenhorst) 1802	✖
Staphylinidae	Staphylininae	*Philonthus caeruleipennis* (Mannerheim) 1830	✚
Staphylinidae	Staphylininae	*Philonthus sp. 2* Stephens 1829	■★
Staphylinidae	Staphylininae	*Philonthus sp. 3*	✖
Staphylinidae	Staphylininae	*Philonthus sp. 4*	✖
Staphylinidae	Staphylininae	*Quedius sp. 1* Stephens 1829	◆
Staphylinidae	Staphylininae	*Quedius sp. 2*	◆
Staphylinidae	Staphylininae	*Quedius sp. 3*	✚
Staphylinidae	Staphylininae	*Xantholininus sp.* Dejean 1821	◆
Staphylinidae	Tachyporinae	*Derops divalis* (Sanderson) 1847	■
Staphylinidae	Tachyporinae	*Bryoporus rufescens* (LeConte) 1863	★
Staphylinidae	Tachyporinae	*Bryoporus sp.* Kraatz 1857	■◆
Staphylinidae	Tachyporinae	*Ischnosoma flavicolle* (LeConte) 1863	◆
Staphylinidae	Tachyporinae	*Lordithon facilis* (Casey) 1884	★
Staphylinidae	Tachyporinae	*Mycetoporus sp.* Mannerheim 1831	★
Staphylinidae	Tachyporinae	*Sepedophilus cinctulus* (Erichson) 1839	★
Staphylinidae	Tachyporinae	*Sepedophilus testaceus* (Fabricius) 1792	★
Staphylinidae	Tachyporinae	*Sepedophilus sp.* Cistel 1856	◆
Staphylinidae	Tachyporinae	*Coproporus laevis* (LeConte) 1863	★
Staphylinidae	Tachyporinae	*Coproporus rutilus* (Erichson) 1893	○
Staphylinidae	Tachyporinae	*Coproporus sp. 1* Kraatz 1857	■◆
Staphylinidae	Tachyporinae	*Coproporus sp. 2*	◆
Staphylinidae	Tachyporinae	*Tachyporus sp.* Gravenhorst 1802	✚
Tenebrionidae		*Bolitotherus cornutus (*Panzer) 1794	◆
Tenebrionidae		*Dioedus punctatus* LeConte 1866	■
Tenebrionidae		*Paratenetus exutus* Bosquet and Bourchard 2014	★
Tenebrionidae		*Paratenetus punctatus* Spinola 1844	◆✚
Tenebrionidae		*Platydema sp.* LaPorte and Brulle 1831	◆
Tenebrionidae		*Uloma sp.* LaPorte 1840	◆
Tenebrionidae		*Tenebrionidae sp. 5*	◆
Throscidae		*Aulonothroscus punctatus* (Bonvouloir) 1859	◆★

(Table 2 continued) List of taxa represented in six Berlese/Winker funnel extraction trials. Higher-level taxa are indicated where relevant. Samples are indicated by symbols as follows: ★= Alabama; ○= Arizona; ◆= Arkansas; ■= Louisiana; ✖= New Mexico; ✚= North Carolina.

Throscidae		*Aulonothroscus sp.* Horn 1890	■
Zopheridae		*Zopheridae sp. 1*	◆
Zopheridae		*Zopheridae sp. 2*	◆
Zopheridae		*Eucicones marginalis* (Melsheimer) 1846	◆

CHAPTER 3. REVISION OF *EUTYPHLUS* LECONTE (STAPHYLINIDAE: PSELAPHINAE) WITH A DESCRIPTION OF A NEW SPECIES

3.1. Introduction

The genus *Eutyphlus* LeConte (1880) is restricted to the continental United States, where it exhibits a predominantly Eastern range, extending from Georgia north through New York, with additional records in Illinois and Ohio. This genus has been shifted among several higher-level taxa under the speciose supertribe Euplectitae. Within this taxon, tribes and subtribes have been traditionally defined based on a series of somewhat variable morphological characters and patterns of distribution that yield poorly supported groups of limited phylogenetic importance (Chandler 2001). *Eutyphlus* was originally placed originally in the subtribe Euplectina Raffray, 1894 of the Euplectini LeConte, 1861. Casey later examined the genus and subsequently erected the subtribe Euplecti Casey 1885, transferring *Eutyphlus* to this taxon (Bowman 1934). In 1951, Park proposed a classification system for the Euplectitae, and under the resulting classification scheme transferred *Eutyphlus* from the Tribe Euplectini to the Trichonychini and into the newly formed subtribe Bibloporina Park, 1951. The genus was later transferred back to the Euplectini and placed within the subtribe Panaphantina Jeannel, 1950. Most recently, the re-organization and synonymization of several tribes and subsequent subtribes resulted in the final placement of *Eutyphlus* within the subtribe Panaphantina Jeannel,1950, *sensu novu* under the tribe Trichonychini Reitter, 1882, *sensu novo* (Chandler 2001). Five species are currently described in the genus: *Eutyphlus dybasi* Park, 1956, *Eutyphlus prominens* (Casey, 1894), *Eutyphlus schmitti*

Raffray, 1904, *Eutyphlus similis* LeConte, 1880 (type species), and *Eutyphlus thoracicus* Park, 1956.

Eutyphlus was last revised by Orlando Park (1956). Since then, this genus had not been revisited. An examination of available literature revealed that drawings and descriptions of relevant morphological characters and genitalia, as well as published descriptions of both males and females, were nonexistent for several of the described species. In addition, species' range information and documentation of significant variation in male secondary sexual characters for all described species were absent from current literature. We provide here an updated revision of the genus with more complete redescriptions of described species and the addition of a new species in the *E. dybasi* complex, *E.* n. sp. Carlton and Owens, bringing the current number of species in the genus to six. Dissections and examination of phylogenetically informative morphological characters were used to clarify species' boundaries. Variations among secondary sexual characters in males of *E. prominens* were documented for the first time. Detailed drawings of taxonomically relevant characters for all species and high-quality photographs of representatives of the genus were included to aid in species identification. This was consistent with our efforts to advance the understanding and taxonomic resolution of an understudied genus of pselaphines within the relatively well-known eastern U.S. fauna.

3.2 Materials and methods

1086 dry, point-mounted specimens were examined, in total. From these, 167 dissections resulting in temporary and permanent slide mounts were prepared. Type specimens of *E. dybasi* and *E. prominens* were examined. Redescriptions were based on a designated reference specimen of each sex. Material used in this study was obtained from the following institutions and curators:

DSC. University of New Hampshire Insect Collection, Donald S. Chandler (Curator), Durham, NH, USA.

GMNH. Georgia Museum of Natural History, Richard E. Hoebeke (Curator), Athens, GA, USA.

LSAM. Louisiana State Arthropod Museum, Victoria Bayless (Curator), Baton Rouge, LA, USA.

NCSUIM. North Carolina State University Insect Museum, Robert Blinn (Curator), Raleigh, NC, USA.

FSCA. Florida State Collection of Arthropods, Donald C. Thomas (Curator), Gainesville, FL, USA.

Verbatim label data were provided for all specimens examined and were organized alphabetically by locality. A slash ("/') was used to indicate label breaks and an asterisk ("*") to separate specimens. The lending institution and the number and sex of specimens were also indicated (i.e. "(DENH) (2M)"). Label data and lending institution of reference specimens were listed first, and indicated as such (i.e. "(description of female based on this specimen)"). Specimens were point-mounted unless otherwise indicated.

External morphological characters of all dry specimens were examined using an Olympus SZH10 dissecting microscope. Additionally, a minimum one male from each collection event series was selected for dissection. For dissection, point-mounted individuals were removed from insect pins and cleared in 10% KOH solution for approximately 24-48 hours. Specimens were washed in several changes of 95% ethanol and separated from points by using an insect pin to tease away residual adhesive. Dissection protocols were similar to those of Hanley and Ashe (2003). While still in ethanol, the abdomen was disarticulated from the rest of the body using insect pins and then split into dorsal and ventral halves to remove the aedeagus. For slide-mounted individuals, either Euparal® or glycerin mounting medium was used to create permanent and temporary slide-mounts, respectively. An appropriate amount of mounting medium was placed on a glass slide and then the forebody and abdominal ventrites were arranged ventral side up while the aedeagus and abdominal tergites were mounted dorsal side up. A glass slide cover was then applied. Label data was affixed to slide mounts for storage. Some individuals were subsequently removed from temporary slide mounts and placed into microvials filled with glycerin and pinned above label data. A minimum of two females of each species were prepared and stored in a similar manner, with attention given to the recovery of female genital sclerites.

Measurements of body parts were obtained from slide-mounts of reference specimens. All measurements were given in millimeters and were taken in the dorsal view. The length of the head was measured from the anterior margin of the clypeus to the back of the tempora, and the width was measured at the widest point of the head, intersecting the middle of the eyes. The length of the pronotum was measured from the anterior margin to the posterior margin, and the width was measured from the widest point (about 1/3 the length from the anterior margin). The length of the elytra was taken for the right elytron, measured from the middle of the articulation with the pronotum to the middle of the posterior margin, while the width was measured across the posterior portion of both elytra together. The total body length was measured from the anterior margin of the clypeus to the end of the fourth visible abdominal tergite. The following standard acronyms were used: HL (head length), HW (head width), PL (pronotum length), PW (pronotum width), EL (elytra length), EW (elytral width), A1-A6 (length of abdominal tergites 1-6, respectively), An1-An11 (length of antennomeres 1-11, respectively), MP1-4 (length of maxillary palpomeres 1–4, respectively), GL (aedeagus length), GW (aedeagus width), and ML (maximum length). Descriptions of external morphology followed Chandler (2001) except meso-meta, and abdominal sternites were referred to as ventrites (Beutel and Leschen 2005).

Morphological characters were compared across individuals of each species and with respect to the species descriptions and type specimens. Line drawings were prepared using an Olympus BX50 compound microscope fitted with a drawing tube. Plates were prepared and edited using Adobe Photoshop®. Habitus photographs were taken using a Syncroscopy® Automontage imaging system and images were also edited using Adobe Photoshop®.

Species' distributions were mapped at the level of county. Separate collection events within a county (sometimes more than 40/county) were consolidated for ease of interpretation.

3.3 Genus diagnosis

Eutyphlus LeConte, 1880: Possessing characters of the tribe Trichonychini (*sensu* Reitter 1882). Type species: *Eutyphlus similis* LeConte 1880 (Figs. 72-76). Integument. Body and appendages uniformly light brown, evenly covered by sparse, short, suberect pubescence. Capitate genal setae present. Head: Tempora rounded. Vertexal foveae present, large, setose, located posterior to shallow, U-shaped vertexal sulcus. Antennal acetabula remote, articles 1-10 unmodified, antennomere 11 with lateral, shelf-like excavation bearing dense cluster of setae. Labrum wider than long, slightly expanded distally, apical margin gently concave, bearing two simple sensory pegs, lateral angles partially rounded. Mandibles sickle-shaped with 6 teeth on incisor edge. Labial palpi small, 2-segmented. Maxillary palpi unmodified, palpomere 1 minute and obliquely joined to palpomere 2, palpomere 2 pedunculate, narrower in basal one-third, then slightly expanded and rounded distally, palpomere 3 subtraingular, palpomere 4 widest, unmodified, bearing apical palpal cone. Paired gular fovea present. Thorax: Prothorax moderately convex. Basal sulcus present, margin delimited by basolateral foveae. Mediobasal foveae absent. Prosternum bearing robust prosternal median carina, procoxal foveae present on either side of carina. Lateral mesoventral and mesocoxal foveae both present. Mesocoxae contiguous. Metacoxae conjunct, not separated by short intercoxal process of ventrite 1. Lateral metaventral foveae present, paired, metaventrite

Fig. 72*. Eutyphlus similis* (m) dorsal.

Fig. 73. *Eutyphlus similis* (m) ventral**.**

Fig. 74*. Eutyphlus similis* (m) lateral**.**

otherwise afoveate. Elytra narrower basally, then gradually wider posteriorly, bearing sutural striae with fovea. Lateroapical cleft present. Abdomen: First visible abdominal tergite bearing laterobasal foveae with weak, oval depression, margined anteriorly. Second tergite bearing similar, weaker depression and foveae. Other tergites unmodified. Second ventrite with longitudinal basal carina extending between basolateral foveae, continuous. Third ventrite bearing small basolateral foveae. Other ventrites variously modified in some species as male secondary sexual characters. Genitalia: Asymmetrical, somewhat laterally compressed. Dorsal diaphragm and internal sac visible. Parameres fixed. Median lobe sclerotized with varying combinations of spines and spicules. Females: Generally more heavy-bodied

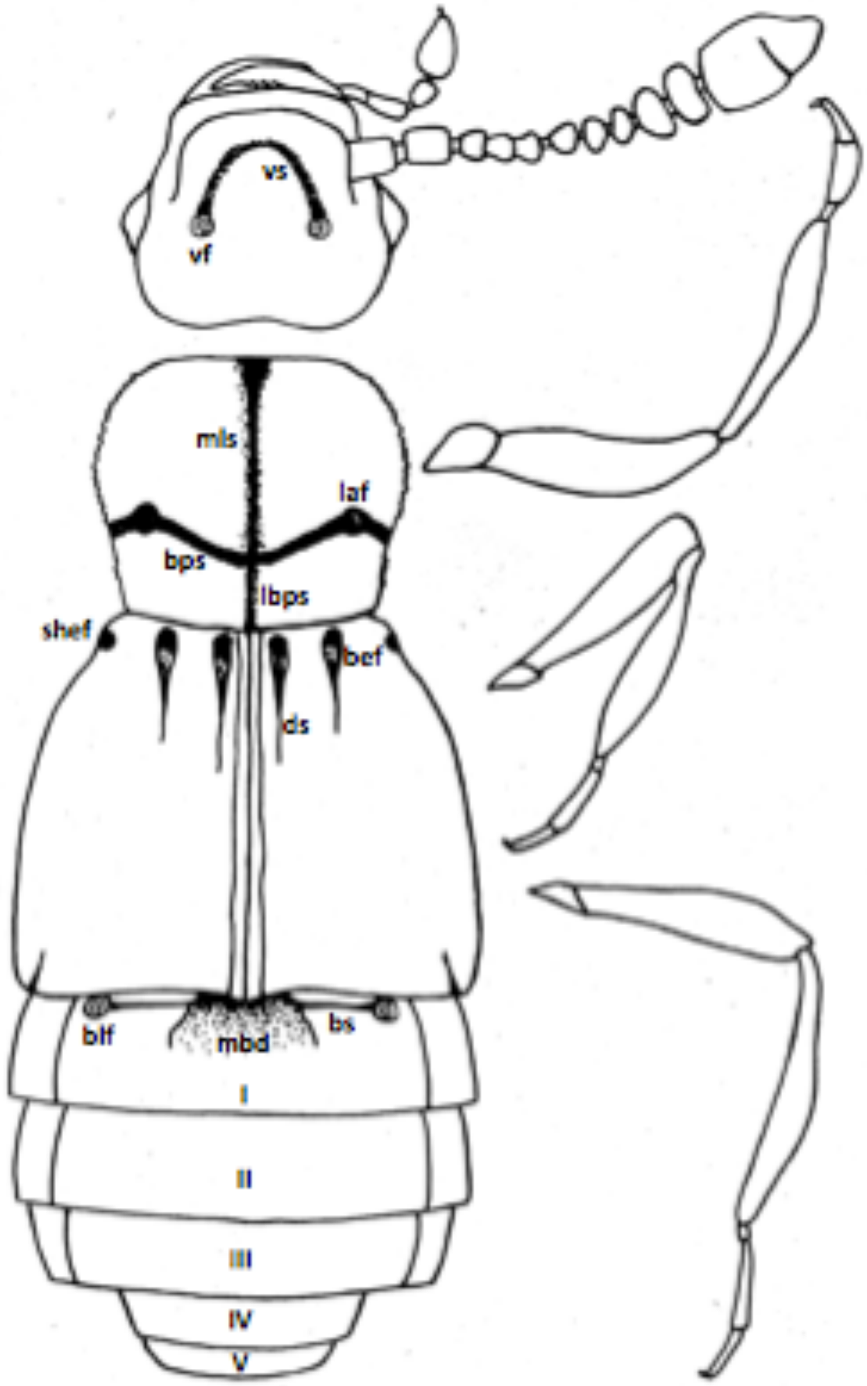


Fig. 75. *Eutyphlus similis*, male, dorsal features. *HEAD*: vs, vertexal sulcus; vf, vertexal fovea. *PROTHORAX*: mls, median longitudinal sulcus; laf, lateral antebasal foveae; bps, basal prosternal sulcus; lbps, longitudinal basal pronotal sulcus. *ELYTRA*: shef, subhumeral elytral foveae; bef, basal elytral fovea; ds, discal stria. *ABDOMEN*: blf, basolateral foveae; bs, basal sulcus; mbd, median basal depression; I-V, visible tergite number.

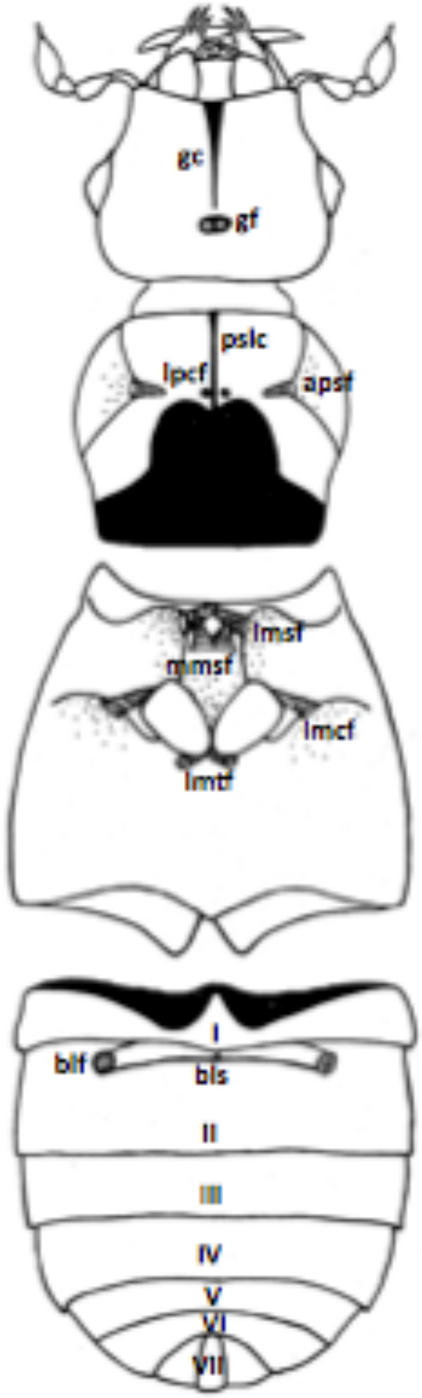


Fig. 76. *Eutyphlus similis*, male, ventral features. *HEAD*: gc, gular carina; gf, gular fovea. *PROSTERNUM*: pslc, prosternal longitudinal carina; apsf, anterprosternal foveae; lpcf, lateral procoxal foveae. *MESO- and METAVENTRITES*: lmsf, lateral mesosternal fovea; mmsf, median mesosternal foveae; lmcf, lateral mesocoxal fovea; lmtf, lateral metasternal foveae *ABDOMEN:* blf, basolateral fovea; bls, basolateral sulcus; I-VII, visible abdominal ventrites.

and dorso-ventrally flattened. Ocular canthus more expanded. Eyes usually very reduced to absent (with the exception of *E. dybasi*). Larvae: Unknown

Comments. Examination revealed that *Eutyphlus* possesses a generalized euplectine shape and body form. While a combination of characters, sometimes variable, have been relied upon to include the genus within the subtribe Panaphantina, the presence of a prosternal carina has been used to quickly and readily separate this genus from most of the rest of the Euplectitae in the Eastern U.S. A prosternal carina is also present in *Thesium* Casey, but this genus is shorter and broader in form and possesses a completely different combination of ventral thoracic foveae.

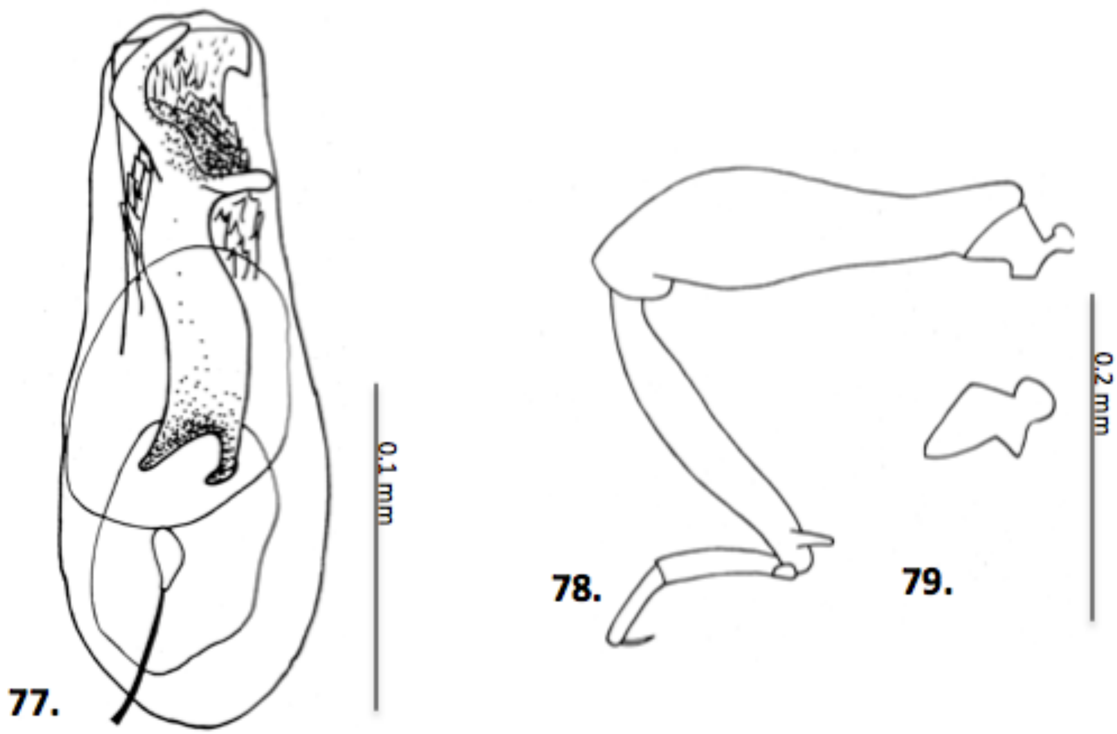
Since *Eutyphlus* was last revised by Park (1956), no taxonomic changes have occurred within the genus. Park designated the species *E. thoracicus* as a separate subgenus, *Planityphlus* Park, 1956, based on the absence of a median, longitudinal sulcus on the pronotum, a character present in all other described *Eutyphlus* species. Although Park determined this character to be significant enough to warrant subgeneric status to this species, it should be noted that the two species in the *E. dybasi* complex, *E. dybasi* and *E.* n. sp., were found to possess an even greater number of morphological differences from the rest of the species in the genus, including the well-developed eyes in the females, the absence of anteroprosternal foveae, the presence of a sulcate mesosternum, quadrifoveate elytra, and significant differences in the size and morphology of the male and female genitalia and terminal abdominal segments. In addition, only two species, *E. prominens* and *E. schmitti* were found to exhibit male secondary sexual characters in the form of significant excavations of the abdominal ventrites, distinguishing these two species from all others in the genus. The designation of subgeneric status to *E. thoracicus*, therefore, did not appear to indicate a significant degree of difference relative to the morphological variation among other species and species groups in *Eutyphlus*, and this taxonomic ranking is not considered valid.

3.4 Species redescriptions and description of a single new species of *Eutyphlus*

3.4.1 *Eutyphlus dybasi* Park

Diagnosis. *Eutyphlus dybasi* differs from all known *Eutyphlus* species, except for *E.* n.sp., in lacking the anteroprosternal foveae, the presence of secondary sexual modifications on the legs of males (Fig. 78, 79), the quadrifoveate elytra and concave metaventrite of both sexes, along with the larger, broadly ovate 7th ventrite of males and the large, concave, triangular 7th ventrite of the females. The aedeagus is larger than that of other species in the genus, with the exception of *E.* n. sp., and differs greatly in structure, bearing an enlarged dorsal lobe, a left paramere bearing distal ctenidia, a median lobe with an extensive fimbriated process, and a flattened, ventral right paramere (Fig. 77). The female genitalia comprises a broadly triangular membranous structure with an internally sclerotized y-shaped process. *Eutyphlus dybasi* was most similar to *E.* n.sp. and can be separated by differences in the morphology of the aedeagus. In. *Eutyphlus dybasi*, a brush of ctenidial spines occurs on the left, dorsally-located paramere and the distal expansion of the right, ventrally located paramere curves towards the right, while the left paramere is spiral-shaped and the right paramere curves towards the left in *E.* n. sp..

Redescription. Male. Measurements: HL 0.20 mm, HW 0.29 mm; PL 0.34 mm, PW 0.32 mm; EL 0.55 mm, EW 0.55 mm; A1-6, respectively, 0.02, 0.15, 0.15, 0.11, 0.11, 0.3 mm; An1–11, respectively, 0.09, 0.05, 0.03, 0.02, 0.02, 0.02, 0.03, 0.03, 0.04, 0.04, 0.10 mm. MP1–4, respectively, 0.01, 0.05, 0.01, 0.05 mm. GL 0.22 mm, GW 0.14 mm. ML 1.62 mm. Integument: Typical for genus. Head: Slightly narrower than pronotum. Tempora evenly rounded. Eyes present and well-developed with 35 facets, slightly emarginate posteriorly, ocular canthus weakly developed, projecting weakly laterally and sloping gently to gular area. Ventral surface of head flat, slightly rounded in gular area, gular sulcus well-developed anteriorly and projecting to margin of posteriorly located, paired, gular foveae. Thorax: Prothorax with basolateral margin slightly crenulate, median longitudinal sulcus present, area behind basal sulcus with thin longitudinal sulcus extending from basal bead to basal sulcus. Prosternum lacking anteroprosternal foveae. Mesotrochanter bearing tubercle, mesotibia with blunt apical spine. Metaventrite slightly concave baso-medially. Metatrochanter with tubercle. Elytra bearing three basal foveae, as well as subhumeral foveae. Wings well-developed. Abdomen: Tergites un-modified. Seventh ventrite broadly oval. Other ventrites unmodified. Genitalia: Aedeagus asymmetrical. Broad, membranous lobe dorsal. This process closely associated with internal, sclerotized, left paramere that is expanded distally, bearing brush of ctenidial spines. Median lobe with distally fimbriated process. Right paramere more ventral, flattened, distally expanded towards right, with apical patch of scattered flattened setae.



Figs. 77—79. Fig. 77. aedeagus, *Eutyphlus dybasi*. Fig. 78. male mesotrochanter with flange and mesotibia with subapical spine, *Eutyphlus dybasi*. Fig. 79. male metatrochanter with spine, *Eutyphlus dybasi*.

Female. Measurements: HL 0.25 mm, HW 0.30 mm; PL 0.38 mm, PW 0.32 mm; EL 0.50 mm, EW 0.60 mm; A1-6, respectively, 0.03, 0.17, 0.15, 0.15, 0.13, 0.05 mm. An1–11, respectively, 0.09, 0.05, 0.03, 0.02, 0.02, 0.02, 0.03, 0.03, 0.04, 0.04, 0.10 mm. MP1–4, respectively, 0.01, 0.05, 0.01, 0.05 mm. GL 0.15 mm, GW 0.21. ML 1.7 mm. Integument, head, thorax, abdomen: Similar to male except eyes smaller with 12 facets, legs unmodified, seventh abdominal ventrite slightly concave, broadly triangular. Genitalia: Female genitalia membranous, narrowed towards distal end. Internally sclerotized portion forked at base and fused at one-thirds length.

Variation. Males of *E. dybasi* are the largest in the genus and appear more heavy-bodied than others. Observed body size was relatively consistent, the eyes are more convex and larger than those of other species, and the shape and number of facets vary among individuals. Considerable variation occurs among males with respect to the presence of secondary sexual characters on the legs, ranging from no modifications to a possessing either a combination of modifications or the full spectrum of modifications present within the species (Figs. 91, 92). These characters are highly plastic within populations, sometimes varying among individuals from the same collection event and apparently not linked with differences in locality or habitat. No differences in genitalia correlated with these variations was observed.

Within the genus, the eyes of *E. dybasi* females were larger and more convex. However, some females possessed eyes with a reduced number of facets. The genitalia of females vary in the degree of sclerotization of the internal y-shaped process, which ranged from well-defined to almost translucent, possibly an artifact of clearing and preparation.

Bionomics. Biological information on *E. dybasi* in the literature is limited to locality data in the original description (Park 1956) and a study of the leaf litter Coleoptera of the Great Smoky Mountains National Park (Ferro et al. 2012). The following information was obtained from the data on the collection labels of the 99 specimens included in this study. Seasonality. *Eutyphlus dybasi* has been collected from late spring through winter (earliest date 21 March; latest 18 December). Elevation. The majority of individuals were collected from 620m-1800m. However, several individuals were collected from an elevation of 2750m. Habitat/ Microhabitat. Substrates at collection sites were mixed forest and hardwood litter, specific woody plant cover mentioned included oak, *Rhododendron*, tulip tree, and alder. Collecting methods. Most specimens were collected by sifting litter and then extracting specimens using a Berlese funnel. However, *E. dybasi* was the only species of *Eutyphlus* collected by both malaise traps and pitfall traps. This either suggests that the adults of this species are more prone to fly or these may be chance sampling events.

Distribution. *Eutyphlus dybasi* is known from Georgia (Union County), North Carolina (Macon and Swain Counties), and Tennessee (Blount, Cocke, and Sevier Counties) (Fig. 80).


Fig. 80. Distribution of *E. dybasi*. Dots indicate county records.

Material Examined**:** (n=99). *USA Tenn. Cocke Co. GSMNP Cosly Creek trail/ Lot #76-105 Oct. 15, 1976 Berlesate R.Chenowith &R.T.Allen/ LSAM0036060 (LSAM)(slide mounted M)(description of male based on this specimen). *USA: TN: Cocke Co. GSMNP Snake Den Ridge Trail btw 299077 3957780 & 299657 3957885 CWright June 2005 (LSAM)(slide mounted F)(description of female based on this specimen). *#5/ SMOKIES, TENN DYBAS 1953/ male symbol/ Field Mus. Nat. Hist Orlando Park Pselaphidae Colln/ (orange paper) HOLOTYPE/ (orange paper) *Eutyphlus dybasi* Park (FMNH)(1M; HOLOTYPE). *Brasstown Bald, GA. Union Co. 8-IX-63 El.2750'/ Forest floor debris nr. Rotten wood/ H.R.Steeves, Jr. J.D.Patrick, Jr. Collectors/ H.R.Steeves, Jr. Collection (FMNH)(7F; 6M, 1dissected). *USA: NC. Macon Co. 10 mi SW Franklin, Back country info center, v-22-1991, berlese oak &

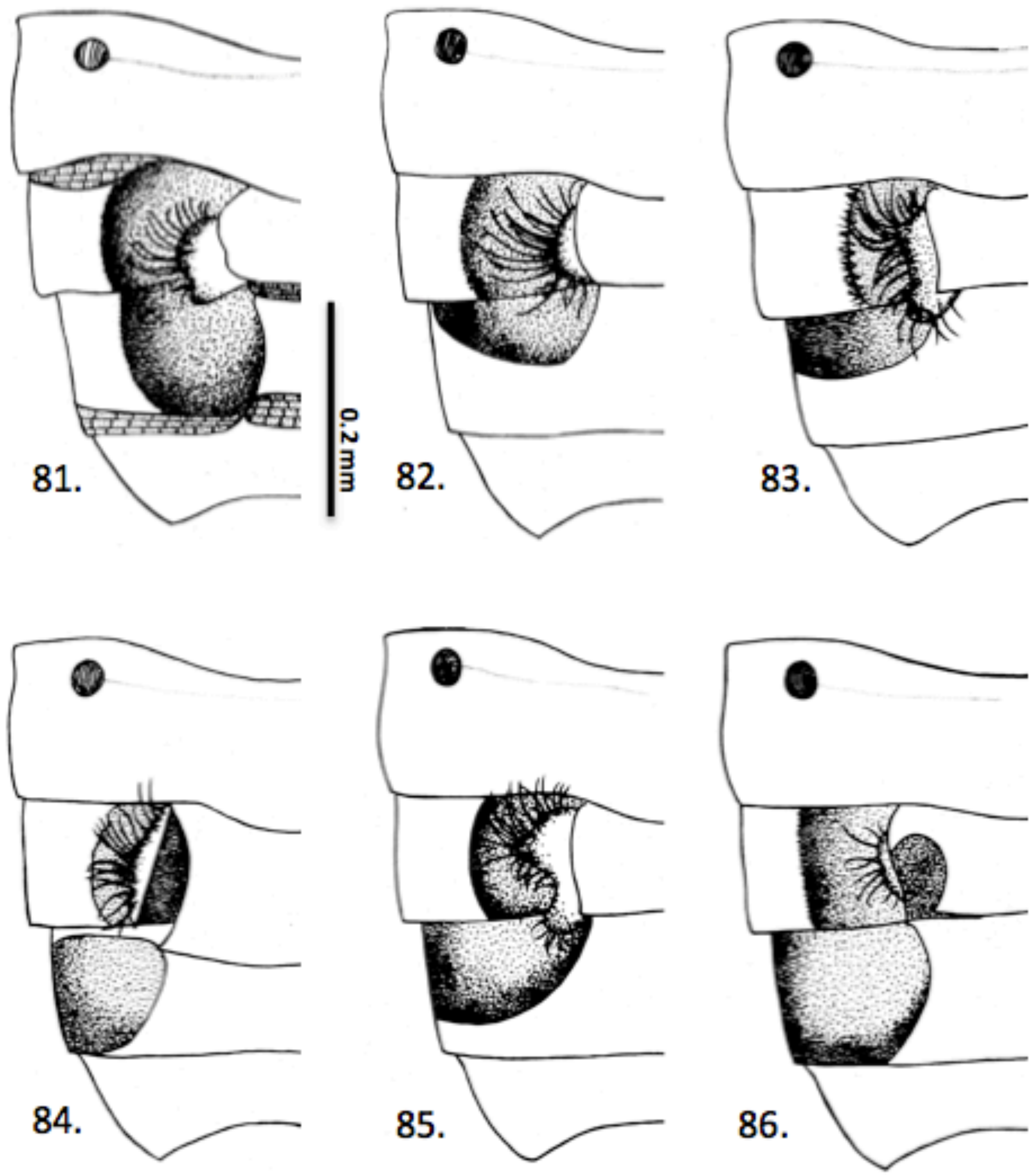
Rhododendron, S.O'Keefe (DENH)(3F; 4M,1dissected). *N CAROLINA: Swain Co. GSMNP, App. Tr., Buckeye Gap. 35°43.6'N 83°36.1'W 1480m. Forest litter. 6 June 2005. A.K.Tishechkin/ LSAM 0094904 (LSAM)(1F). *U.S.A., NC, Swain Co. GSMNP, Beech Gap Trail 83°12'42"W, 35°37'39"N elv. 1000m, 20 Oct. 2001, berlese Carlton, Cline/ LSAM 0017029 (LSAM)(1F). *same locality/ LSAM 0017032 (LSAM)(1F). *same locality/ LSAM 0017037 (LSAM)(1F). *same locality/ LSAM 0017300 (1M, dissected). *same locality/ LSAM 0017031 (LSAM)(1M, dissected).*N CAROLINA: Swain Co. GSMNP, Jenkins Ridge Tr. ~1mi from Appalachian Tr. 35°33.75'N 83°43.2'W 1540m. Forest litter. 30 Jul; 2004. A.K. Tishechkin/ LSAM 0094943 (LSAM)(1F,dissected). *same locality/ LSAM 0094946 (1F,dissected). *NORTH CAROLINA: Swain Co., GSMNP, Lakeshore Tr. 0.5mi above Forney Creek 15 April 2004. Tulip tree, oak. A.J.Mayor collr./ LSAM 0092557 (LSAM)(1M,dissected). *N CAROLINA: Swain Co. GSMNP, nr. Pecks Corner Shelter.35°39.1'N 83°18.5'W 1620m. Forest litter. 13 Jun 2005. A.K.Tishechkin/ LSAM 0094907 (LSAM)(1M,dissected). *N CAROLINA: Swain Co GSMNP, Twentymile Tr. Proctor Field Gap. 35°29.1'N 83°50.3'W. 740m. Forest litter. 9 May 2004. W.Merritt/ LSAM 0094930 (LSAM)(1M,dissected). *N CAROLINA: Swain Co, GSMNP, upper Balsam Mt. Tr. ~2km from App. Tr. @ 35°41.59'N 83°14.59'W 1800m Forest litter. 13 Jun 2005. A.K.Tishechkin/ LSAM 0094983 (LSAM)(1M,dissected). *USA: NC: Swain Co. GSMNP Upper Deep Creek Trail UTM 280352E 3942040 N moist upland berlese 22July2002 CEC/ LSAM 0077204 (LSAM)(1M,dissected). *USA: NC/TN boundary; GSMNP AT btw. Silers; Bald&Miry Ridge Tr.; 265375, 3938911 1570m; 6 Jun 2005 A.Tishechkin/ LSAM 092177 (LSAM)(1F). *TENNESSEE: Blount Co., GSMNP, App. Tr. at Beechnut Gap. 35°34.16'N83°41.51'W 1510m. Forest litter sifting 13 April 2006. A.K.Tishechkin/ LSAM 0107296 (LSAM)(1F). *same locality/ LSAM 0107297 (LSAM)(1M,dissected). *U.S.A., TN, Blount Co., GSMNP, Gregory Ridge Trail 83°50'6"W,35°32'25"N/ elv.900m, forest litter berlese 22 March 2002 CECarlton, VLMoseley/ LSAM 0014819 (LSAM)(1F,dissected). *same locality/ LSAM 0014820 (LSAM)(1F,dissected). *TENNESSEE: Blount Co. GSMNP, Indian Grave Gap Tr.@35°37.6'N83°47.4'W 1080m. Forest litter 3 June 2005. R. Ward/ LSAM 0091935 (LSAM)(1F,dissected). *TENNESSEE: Blount Co., GSMNP, upper Gregory Ridge Tr. At 35°31.61'N 83°51.18'W. 1315m. For. Litter 12 April 2006. A.K.Tishechkin/ LSAM 0109099 (LSAM)(1F). *same locality/ LSAM 0109098 (LSAM)(1F). *same locality/ LSAM 0109097 (LSAM)(1M,dissected). *TENNESSEE: Blount Co., GSMNP, upper Long Hungry Ridge Tr. At 35°30.89N 83°51.00'W. 1390m. For. Litter 12 April 2006. A.K. Tishechkin/ LSAM 0109096 (LSAM)(1F). *same locality/ LSAM 0109093 (LSAM)(1M,dissected). *same locality/ LSAM 0109094 (LSAM)(1M). *TN: Blount Co., GSMNP, White Oak Sink, 35°38'07"N 83°44'49"W, 620m, mixed forest, litter hand sifting Sokolov I.M. 16.06.2006/ LSAM 0109069 (LSAM)(1F). *same locality/ LSAM 0109070 (LSAM)(1F). *same locality/ LSAM 0109071 (LSAM)(1F). *same locality/ LSAM 0092320 (LSAM)(1M,dissected). *TENNESSEE: Cocke Co., GSMNP, Albright Grove Loop Tr. 980m. Forest litter sifting. 13 April; 2006. C.E.Carlton/ LSAM 0109092 (LSAM)(1M,dissected). *U.S.A.,TN, Cocke Co. GSMNP, Albright Grove Trail 83°16'45"W, 35°44'10"N/elv. 1000m, decid. Berlese, 19 October 2001. C. Carlton, A. Cline, A. Tishechkin/ LSAM 0016989 (LSAM)(1F). *same locality/ LSAM 0016995 (LSAM)(1F). *same locality/

LSAM 0016997 (LSAM)(1F,dissected). *same locality/ LSAM 0017000 (LSAM)(1F). *same locality/ LSAM 0017002 (LSAM)(1F). *same locality/LSAM 0017004 (LSAM)(1F). *same locality/ LSAM 0017008 (LSAM)(1F). *same locality/ LSAM 0016997 (LSAM)(1F,dissected). *same locality/ LSAM 0016991 (LSAM)(1M,dissected). *same locality/ LSAM 0016993 (LSAM)(1M,dissected). *same locality/ LSAM 0016994 (LSAM)(1M,dissected). *same locality/ LSAM 0016996 (LSAM)(1M,dissected). *same locality/ LSAM 0016998 (LSAM)(1M,dissected). *same locality/ LSAM 0017001 (LSAM)(1M). *same locality/ LSAM 0017003 (LSAM)(1M). *same locality/LSAM 0017005 (LSAM)(1M). *same locality/ LSAM 0017006 (LSAM)(1M). *same locality/ LSAM 0017007 (LSAM)(1M). *same locality/ LSAM 0016992 (LSAM)(1M). *same locality/ LSAM 0017018 (LSAM)(1M). *same locality/ LSAM 0017009 (LSAM)(1M). USA Tenn. Cocke Co. GSMNP Cosly Creek Trail/ Lot#76-105 Oct. 15, 1976 Berlesate R. Chenowith&R.T.Allen/ LSAM 0036079 (LSAM)(1F). *same locality/ LSAM 0036060 (LSAM)(1M,dissected). *same locality/ LSAM 0036064 (LSAM)(1M). *same locality/ LSAM 0036066 (LSAM)(1M,dissected). *same locality/ LSAM 0036076 (LSAM)(1M). *same locality/ LSAM 0036073 (LSAM)(1M). *same locality/ LSAM 0036076 (LSAM)(1M). *same locality/ LSAM 0036084 (LSAM)(1M). *USA: TN: Cocke Co. GSMNP Snake Den Ridge Trail/ btw 299077 3957780&299657 3957885 Cwright June 2005/ LSAM 0092175 (LSAM)(1F). *same locality/ LSAM 0092176 (LSAM)(1F,dissected). *U.S.A., TN, Sevier Co. Appalachian Trail at Beech Gap on Clingman's Dome Rd 83°26'50"W, 35°36'36"N/ elv.1750m, forest litter berlese 28June 2001, C.Carlton, A.Tishechkin, V.Moseley/ LSAM 0002627 (LSAM)(1F). *same locality/ LSAM 0002628 (LSAM)(1F). *same locality/ LSAM 0002624 (LSAM)(1M). *same locality/ LSAM 0002625 (LSAM)(1M). *same locality/ LSAM 0002626 (LSAM)(1M,dissected). *TN: Sevier Co. GSMNP ATBI Plot. Goshen Prong Pitfall 106 83 32 34 35 36 38 Parker, Stocks, Peterson 28 Nov-11 Dec 2000 (DENH)(1F). *TENNESSEE: Sevier Co.; GSMNP, Goshen Prong; ATBI Plot. Malaise trap; MT-2120022218. 5-18Dec; 2001. C.R.Parker/ LSAM 0096244 (LSAM)(1M,dissected). *same locality/ LSAM 0096245 (LSAM)(1M). *TENNESSEE: Sevier Co. GSMNP, Indian Head Tr. 35.60944°N 83.44659°W Sift litter. 5290' 20 July 2003. S.O'Keefe/ LSAM 0091654 (LSAM)(1F). *USA Tenn.-N.Car. Sevier Co, GSMNP, Newfound Gap to Clingman's Dome/ Lot#76-107 Oct. 11, 1976 Berlesate; R.Chenewith&R.T.Allen/ LSAM 0036083 (LSAM)(1F). *U.S.A., TN, Sevier Co., GSMNP Ramsey Cascade Trail (middle) 83°18'24"W, 35°42'34"N/elv. 1300m, forest litter berlese 21 March 2002 CECarlton, VLMoseley/ LSAM 0014852 (LSAM)(1F). *TENNESSEE: Sevier Co., GSMNP, Road Prong Tr. at 35°36'36"N 83°27'3"W 1580m. Leaf/ moss mat' litter. 20 July 2003; A. Tishechkin/ LSAM 0091843 (LSAM)(1F). *same locality/ LSAM 0096242 (LSAM)(1M,dissected). USA: TN: Sevier Co. 10 mi S Gatlinburg 3800, v-24-1977 Anewton, Mthayer/ berlese alder & rhododendron litter by stream (DENH)(1F; 2M,1dissected). *TENNESSEE: Sevier Co., GSMNP, Twin Creek ATBI Plot. Malaise Trap MT-0120011205. 5 Nov-5 Dec 2001. I.C.Stocks/ LSAM 092643 (LSAM)(1F). *same locality/ LSAM 0096255 (LSAM)(1M,dissected). *same locality/ LSAM 0096256 (LSAM)(1M,dissected).

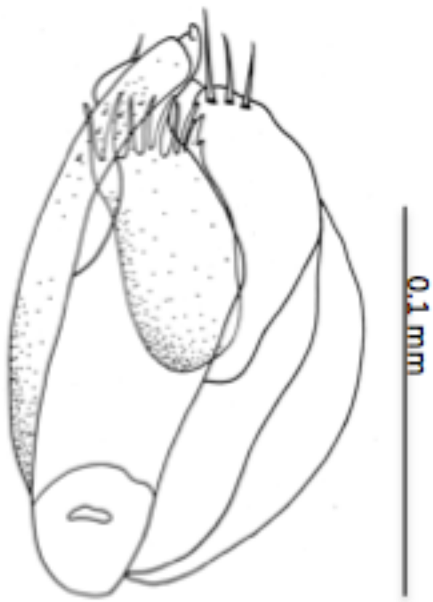
3.4.2 *Eutyphlus prominens* Casey

Diagnosis. *Eutyphlus prominens* may be distinguished from all known *Eutyphlus* species by the combination of a lateral excavation and vertical lamina of the third male ventrite and an excavated fourth male ventrite (Figs. 81—86). The aedeagus bears a large, membranous projection associated broadly with the fimbriated median lobe and the three distal setae on the single ventrally located paramere (Fig. 87).

Redescription. Male. Measurements: HL 0.20 mm, HW 0.25 mm; PL 0.30 mm, PW 0.29 mm; EL 0.40 mm, EW 0.42 mm; A1–6, respectively, 0.02, 0.14, 0.11, 0.10, 0.10, 0.02 mm. An1–11, respectively, 0.08, 0.06, 0.03, 0.03, 0.02, 0.02, 0.02, 0.03, 0.04, 0.04, 0.11 mm. MP1–4, respectively, 0.01, 0.05, 0.01, 0.05 mm. GL 0.06 mm, GW 0.04 mm. ML 1.53 mm. Integument: Typical for genus. Head: Slightly narrower than pronotum. Eyes present and well-developed, bearing 25 facets, convex, longer than wide, ocular canthus weakly developed, projecting laterally and sloping gently to gular area. Ventral surface of head slightly rounded in gular area, gular sulcus developed anteriorly and projecting to margin of posteriorly located, paired, gular foveae. Thorax: Pronotum with margin slightly crenulate, median longitudinal sulcus present, area behind basal sulcus bearing small, median longitudinal carina that extends into and bisects sulcus. Prosternum bearing anteroprosternal foveae. Paired, median mesoventral foveae present. Metaventrite convex. Elytra bearing two, closely approximate basal foveae, as well as subhumeral foveae. Wings well-developed. Abdomen: First visible abdominal tergite with oval depression wide (at least ¾ segment length). Other tergites unmodified. Second ventrite with longitudinal carina interrupted, medially. Third ventrite modified with shelf-like excavation laterally, setose lamina produced vertically in median of



Figs. 81—86. *Eutyphlus prominens,* variations of male secondary sexual characters on abdominal ventrites. Fig. 81. Type I. Fig. 82. Type II. Fig. 83. Type III. Fig. 84. Type IV. Fig. 85. Type V. Fig. 86. Type VI.



87.

Figs. 87. aedeagus, *Eutyphlus prominens.*

excavation, sclerotized shelf produced over excavation bearing fringe of setae projecting laterally. Fourth ventrite excavated in lateral one-third, excavation unmodified. Seventh ventrite small and strap-like. Other ventrites unmodified. Genitalia: Aedeagus complex and asymmetrical. Left paramere more dorsal, comprising an oblique, sclerotized bar. Associated process immediately beneath, sclerotized, bearing two erect setae. Median lobe modified into internal, fimbriated process associated with extensive, membranous projection. Right paramere more ventral, bearing three distal setae.

Female. Measurements: HL 0.15 mm, HW 0.25 mm; PL 0.28 mm, PW 0.28 mm; EL 0.40 mm, EW 0.41 mm; A1–6, respectively, 0.03, 0.15, 0.11, 0.10, 0.10, 0.02 mm. An1–11, respectively, 0.08, 0.05, 0.03, 0.02, 0.02, 0.02, 0.02, 0.03, 0.03, 0.04, 0.11 mm. MP1–4, respectively, 0.01, 0.05, 0.01, 0.05 mm. ML 1.32 mm. Integument, Head, Thorax, Abdomen: Similar to male except eyes greatly reduced to two facets, ocular canthus well-developed. Tempora rounded and broad. Pronotum more quadrate. Third and fourth ventrites unmodified. Seventh ventrite small and transverse. Genitalia: Female genitalia membranous, completely lacking sclerotization. Produced into voluminous median structure and billowy right sac.

Variation. Males of *E. prominens* varied slightly in the size and shape of the eyes, and the elytra varied from being bi- to tri-foveate. However, the main variations occurred in the secondary sexual characters. Externally, males of *E. prominens* were easily be identified by the modifications of the third and fourth ventrites, but variation was observed in this secondary sexual character among individuals within the species. Specifically, the sclerotized shelf of the third ventrite that overhangs the lateral excavation on this segment ranged in shape from a small, crescent-shaped projection to an expanded shelf that extended, posteriorly, over part of the excavation of the fourth ventrite. In addition, the vertical lamina of the excavation on the third was produced to varying degrees, as was the degree of excavation of the fourth ventrite. After examining 27 males, including at least one male from each of the 22 localities, six distinct “types” of ventrite modifications in *E. prominens* (Figs. 83—88) were identified with a range of more subtle variations within each form. In addition, variations in these characters sometimes occurred within individuals, with noticeable differences existing between the left and right sides of the ventrites. These differences were still within the range of what can be considered a single type. Type II (Fig. 84) appeared most frequently, with 16 of the 27 males possessing characters that fell into this category. When multiple individuals were observed from a single locality, most exhibited the same form.

However, two specimens collected from the same locality in Caldwell County, North Carolina, were found to exhibit different forms.

The aedeagus of *E. prominens* was of a relatively consistent form, but slight variations were observed. The number of setae on the ventral paramere was variable. Most possessed three, some individuals had a fourth that was shorter and narrower in form offset slightly from the three main setae. The degree of extension of the inflated membranous projection varied greatly among individuals. This process appeared to be associated with the median lobe of the aedeagus and varied in position from one individual to the next. The differing degree of inflation may be related to the positioning of the median lobe during mating.

Female *E. prominens* were all similar, with variation in eye facet number and the shape of the ocular canthus. This feature covaried with arrangement and number of eye facets, with the ocular canthus more rounded in females with a greater number of eye facets and more angular in those with fewer facets.

Bionomics. No published information exists dealing with the biology of *E. prominens*. Seasonality. Specimens were collected from early spring to early winter (earliest date 6 February; latest 11 November). The two month winter gap likely reflects lack of collecting events. Elevation. Most specimens were collected from elevations between 430m-1520m. Habitat/Microhabitat. Most specimens were associated with heavily decayed and rotting wood, either in litter near the wood or in the rotting wood, itself. Collecting methods. Most specimens were collected using sifting and Berlese funnel extraction, with a small number taken using flight intercept traps.

Distribution. *Eutyphlus prominens* is known from Georgia (Rabun County), North Carolina (Buncombe, Caldwell, Haywood, Macon, and Yancy Counties), South Carolina (Oconee County), Tennessee (Blount, Cocke, Sevier, Unicoi Counties), Virginia (Smythe County), and West Virginia (Pocahontas County) (Fig. 88).

Fig. 88. Distribution of *E. prominens*. Dots indicate county records.

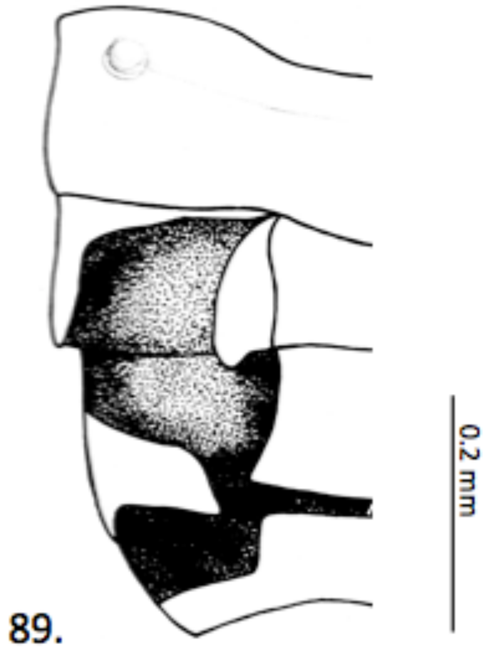
Material Examined: (n=68). *TENNESSEE: Great Smoky Mtns. NP, Newfound Gap. F.I.T.#2, 26 June-1 July 2001. 35°36.7'N 83°25.30'W. C.Carlton, V.Moseley, A.Tishechkin/ LSAM 0002519 (LSAM)(slide mounted M)(description of male based on this specimen). *TENNESSEE: Sevier Co. GSMNP, Trillium gap Tr. @ 35°39.9'N 83°26.2'W 1400m. Forest litter. 29 July 2004. A. Tishechkin/ LSAM 0094865 (LSAM)(slide mounted F)(description of female based on this specimen). *Rabun Bald, GA. Rabun Co. El. 3630 30.v.64/ Forest floor debris nr. Dead wood/ H. R. Steeves Jr. Collector/ H.R. Steeves Jr. Collection (FMNH)(1F; 2M,1dissected). *Clingmans Peak Buncombe Co., N.C. 3.VII.60 Rhododendron duff/ H.R. Steeves Jr. Collector/ H.R. Steeves Jr. Collection/ CNHM 1963 H.R. Steeves, Jr. Pselaphidae Colln. Acc. Z-13, 288/ Field Mus. Nat. Hist. Orlando Park Pselaphidae Colln. (FMNH)(15F; 5M,1dissected). *USA: NC. Caldwell Co. 1miS Julian Price Mem Park v-20-1991 sift oak litter S.O'Keefe (DENH)(4F,1dissected; 2M,1dissected); (FSAC)(3F). *N CAROLINA: Caldwell Co, Pisgah Natl. For., nr. Mortimer Cmg. 35°59.54'N 81°45.64'W 430m. Litter sifting. 30 April 2006. A.K.Tishechkin/ LSAM 108944 (LSAM)(1M,dissected). *N.C./ Field Mus. Nat. Hist. Orlando Park Pselaphidae Colln./ Compared with type specimen O. Park XI.II.41 (FMNH)(1F,dissected). *NC: Haywood Co. GSMNP. Purchase Knob, 35°35'05" N 83°03'45"W, mixed forest, 1520m, litter hand sifting Sokolov, LM. 22.06.2006/ LSAM 0109066 (LSAM)(1M,dissected). *USA:NC: Macon Co. 3 mi NW highlands v-29-1983 DSChandler, sift; Rhododendron duff (DENH)(1M,dissected). *USA: NC, Yancy Co. B.R. Pkw. 37.4 mi. SW intersection

US 221 elv. 4600', log litter 2.vi.1991 C.E.Carlton (LSAM)(1M, dissected). *USA: SC: Oconee Co 7 mi S NC state line on Hwy. 107/ v-29-1983 DSChandler, sift forest litter (DENH)(1F; 1M,dissected). *TENNESSEE: Blount Co.; GSMNP, lower Gregory Ridge Tr. @ 35°33.5'N; 83°50.5'W. 630m. For. Litter; 28 July 2004. A.K. Tishechkin/ LSAM 0095710 (LSAM)(1M,dissected). *USA: TN: Blount Co. GSMNP White Oak Sink: F.I.T/ 251399 3946695 920m 11 Jun 2005 A.Tishechkin/ LSAM 0092300 (LSAM)(1M,dissected). *U.S.A., TN, Cocke Co. GSMNP, Albright Grove Trail 83°16'45"W, 35°44'10"N elv. 1000m, old growth Berlese 29 June 2001, C.Carlton, A. Tishechkin, V. Moseley/ LSAM0002432 (LSAM)(1M,dissected). *USA:TN:Cocke Co., 6 mi SE Cosby v-31-1983 DSChandler, sift forest litter (DENH)(1F,dissected; 4M,2dissected). *TENNESSEE: Great Smoky Mtns. NP, Newfound Gap. F.I.T.#2, 26 June-1 July 2001. 35°36.7'N 83°25.30'W. C.Carlton, V.Moseley, A.Tishechkin/ LSAM 0002519 (LSAM)(1M,dissected). *USA:TN:Sevier Co. GSMNP: AT 2km fr. Derrick Knob Shelter 258686, 3939145, 1440m Berlese 7 Jun 2005 A. Tishechkin/ LSAM 0092187 (LSAM)(1M,dissected). *TENNESSEE: Sevier Co. GSMNP, nr. Derrick Knob Shelter. 35°33.87'N 83°38.53'W. 1465m. beating 6 Jun 2005. S.Kazantsev/ LSAM 0092199 (LSAM)(1M,dissected). *same locality/ LSAM0094973 (LSAM)(1M). *same locality/ LSAM 0092187 (LSAM)(1M). *TENNESSEE: Sevier Co. GSMNP, Porters Creek Tr. Sift litter near rotten logs Beetle Blitz - 2003 18 July 2003. S. O'Keefe/ LSAM 0091738 (LSAM)(1M,dissected). *TN: Sevier Co., GSMNP Porter's Creek Trail 9617 El. 738m 18-19 June 1996 Coyle, Brooks, Aiken, Davis/ LSAM 0017645 (LSAM)(1M,dissected). *TENNESSEE: Sevier Co. GSMNP, Trillium gap Tr. @ 35°39.9'N 83°26.2'W 1400m. Forest litter. 29 July 2004. A. Tishechkin/ LSAM 0094865 (LSAM)(1F). *same locality/ LSAM 0094883 (LSAM)(1F). *same locality/ LSAM 0094872 (LSAM)(1F). *same locality/ LSAM 0094864 (LSAM)(1M). *same locality/ LSAM 0094866 (LSAM)(1M). *same locality/ LSAM 0094878 (LSAM)(1M). *USA: TN: Sevier Co. upper miry ridge tr: litter/ 264327 3941078 1520m 6 Jun 2005 A.Tishechkin/ LSAM 0092258 (LSAM)(1M,dissected). *Unicoi Co. Tenn. 3500' VII 5, 53/ Field Mus. Nat. Hist, Orlando Park Pselaphidae Colln. (FMNH)(3F; 1M). *Unicoi Co, Tenn Una(illegible) Mtn. July 5, 1953/ Field Mus. Nat. Hist. Orlando Park Pselaphidae Colln (FMNH)(1F). *USA, VA. Smythe Co. 7.5 mi SE Marion, Racoon; Branch cmpgrnd, v-10-91 sift pine & oak litter S.O'Keefe collector (DENH)(1M,dissected). *USA: WV. Pocahontas Co. 6 mi SE Marlinton forest trail 407 off Hwy 92, v-16-1991 sift oak S. O'Keefe (DENH)(1F).

3.4.3 *Eutyphlus schmitti* Raffray

Diagnosis. *Eutyphlus schmitti* differs from all known *Eutyphlus* species in the structure of the male ventrites. The apical margin of the second is excavated, the third ventrite is excavated laterally with vertical lamina and median plates that overlap the fourth ventrite, and the fourth and fifth ventrites are excavated laterally

(Fig. 89). The aedeagus bears a process on either side of the parameres, and the median lobe is modified into a fimbriated, sclerotized process (Fig. 90).



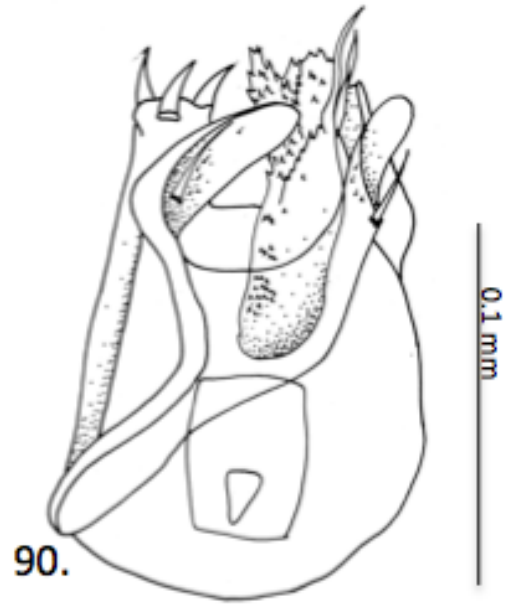


Fig. 89. male secondary sexual characters on ventrites, *Eutyphlus schmitti*. Fig. 90. aedeagus, *Eutyphlus schmitti.*

Redescription. Male. Measurements: HL 0.21 mm, HW 0.25 mm; PL 0.27 mm, PW 0.26 mm; EL 0.43 mm, EW 0.51 mm; A1–6, respectively, 0.04, 0.11, 0.11, 0.11, 0.09, 0.03 mm. An1–11, respectively, 0.07, 0.05, 0.04, 0.03, 0.02, 0.02, 0.02, 0.04, 0.04, 0.05, 0.14 mm. MP1–4, respectively, 0.01, 0.05, 0.01, 0.05 mm. GL 0.08 mm, GW 0.05 mm. ML 1.44 mm. Integument: Typical for genus. Capitate genal setae sparse. Head: About as wide as pronotum. Eyes small, with 12 facets, weakly convex, longer than wide, ocular canthus weakly developed, projecting laterally and sloping gently to gular area. Ventral surface of head slightly rounded in gular area, gular sulcus developed weakly anteriorly and projecting to margin of posteriorly located, paired, gular foveae. Thorax: Pronotum with lateral margin crenulate, median longitudinal sulcus present, area behind basal sulcus bearing small, median longitudinal carina that extends into and bisects sulcus. Prosternum bearing anteroprosternal foveae. Paired, median mesoventral fovea present. Mesotrochanters bearing single, median spine. Metaventrite concave baso-medially. Elytra bearing two, closely approximate basal foveae, as well as subhumeral foveae. Wings present, well-developed. Abdomen: Tergites unmodified. Second ventrite with apical margin excavated laterally to receive vertical lamina of third ventrite. Third ventrite excavate laterally, bearing lamina with numerous setae, median portion of sclerites with sclerotized plates extending over excavation and slightly over margin of the fourth ventrite, bearing fringe of setae. Fourth ventrite excavated laterally, middle portion of sclerites contiguous with two lateral, sclerotized projections that overhang excavated portion of the fifth ventrite. Fifth ventrite laterally excavated to about $\frac{2}{3}$ length of the segment. Seventh ventrite small and elongate teardrop-shaped. Other ventrites unmodified. Genitalia: Aedeagus asymmetrical. Left paramere more dorsal, formed as an oblique, sclerotized bar with numerous small setae and single large seta about middle, distal end flattened and slightly twisted to expose ventral face. Process associated with paramere branched off ventrally and to the left, similar in form to paramere. Median lobe modified into internal, sclerotized process bearing two distinct arms, the left bearing numerous spicules and spines and the right more membranous, bearing longer projections. Process associated with right paramere sclerotized, slightly narrowed and curved towards distal end. Right paramere most ventral, flattened and bearing three enlarged, thickened distal setae.

Female. Measurements: HL 0.20 mm, HW 0.30 mm; PL 0.30 mm, PW 0.30 mm; EL 0.41 mm, EW 0.50 mm; A1–6, respectively, 0.03, 0.14, 0.14, 0.13, 0.12, 0.05 mm. An1–11, respectively, 0.07, 0.06, 0.02, 0.01, 0.01, 0.01, 0.02, 0.02, 0.04, 0.03, 0.10 mm. MP 1–4, respectively, 0.01, 0.04, 0.01, 0.04 mm. MP 1.73 mm. Integument, Head, Thorax, Abdomen: Similar to male except eyes greatly reduced, comprising two facets, ocular canthus well-developed. Tempora rounded and broad. Pronotal margin barely crenulate, basal sulcus on pronotum straight between basal foveae. Lacking abdominal secondary sexual characters. Seventh ventrite small and transverse. Genitalia: Female genitalia membranous, completely lacking sclerotization. Produced into slightly elongate median structure and billowy right sac.

Variations. Slight variations were observed in the overall shapes and size of the sclerotized plates, as well as in the depths and sizes of the excavated portions of the male ventrites. These variations were less extreme than those noted for *E. prominens*.

Among females, only the number of eye facets varied. No individuals observed completely lacked facets, but the number of facets varied from 1-6 among individuals. In addition, the length of the hind margin of the prothorax posterior to the basal sulcus was slightly different among individuals. The depth and angle of this sulcus was slightly variable, as well, with the sulcus being generally straight and strong but becoming slightly curved and shallower in some individuals, never attaining the same angle as in *E. prominens* or *E. similis*.

Bionomics. Seasonality. *E. schmitti* was collected from summer through late fall/early winter (earliest date 16 May; latest 11 November). Based on the data available, occurrence of adults in this species is somewhat more seasonal than in other species, though this may be an artifact of sampling. Elevation. Two elevations were included in the label data from the available material: 274m and 914m, somewhat lower than most other species in the genus, but again, based on limited data. Habitat/Microhabitat. Specimens were collected from forest hardwood leaf litter, *Rhododendron* litter, beech litter, oak litter, and birch litter. Specimens were also found in *Sphagnum* moss. This species was represented in the study of old growth forest habitat ("The Bowl") in New Hampshire (Chandler 1987). Collecting methods. Sifting and processing by Berlese was the only collection method mentioned for this species.

Distribution. The distribution of *E. schmitti* is known from New Hampshire (Carr, Coos, and Grafton Counties), New York (Cattaraugns County), Ohio (Highland County), Pennsylvania (Elk, Huntington, Jefferson,McKean, and Somer Counties), and West Virginia (Pocahontas County) (Fig. 91).

Fig. 91. Distribution of *E. schmitti.* Dots indicate county records.

Material Examine**d:** (n=31). *Ohio, Highland Co, Mohican St. For. V-31-1976/ LEWatrous Berlese forest litter (DENH)(slide mounted male)(description of male based on this specimen. *USA: PA:Hunt. Co. Rothrock St.For. Seeger Nat. Area 900', V-30-1985/ DSChandler, sift Rhododendron leaf litter (DENH)(slide mounted female)(description of female based on this specimen). *USA:NH:Carr. Co., The Bowl, 2,5 mi;NW Wonalancet VII-17-1985/ DSChandler sift birch/beech leaf litter (DENH)(1M,dissected). *Jefferson Notch, N. Hamp., Coos Co. 3000' IX-20-1974 ANewton/ Berlese forest litter (FMNH)(6F). *USA: NH. Grafton Co Waterville valley viii-30-1990; sift litter; S. O'Keefe (FSAC)(4F). *NY:Cattaraugns Co. Allegany St. Park VI-27-1971 berlesed deciduous litter W.B.Muchmore coll. (DENH)(1M,dissected). *Ohio, Highland Co. Mohican St. For. V-31-1976/ LEWatrous; berlese forest litter (DENH)(2M,dissected). *USA:PA:Elk Co., Allegheny Nat. For. 3 mi NW Beltown Millstone Creek, VI-7-1997, DSChandler hardwood leaf litt. (DENH)(2M,1dissected). *USA:PA:Hunt. Co. Rothrock St.For. Seeger Nat. Area 900', V-30-1985/ DSChandler, sift Rhododendron leaf litter (DENH)(3F,1 dissected; 2M,1 dissected). *USA: PA: Jeffer. Co., Cook State Forest, 0.4mi S Cooksburg; Mohawk Trail, V-6-1997, DSChandler hardwood leaf litt. (DENH)(1F; 1M, dissected). *USA: PA: Jeffer. Co., Cook State Forest, 0.4mi S Cooksburg Mohawk Trail, V-6; -1997, DSChandler hardwood leaf litt. (DENH)(3M,1dissected). *USA: PA: McKean Co, Allegheny N. For. Tionesta Scenic/ Area, V-29-1985 DSChandler, sift beech leaf litter (DSC)(3M,1dissected). *Penn., Somer Co., 1 mi S Kentner VI-10-1976/ LEWatrous berlese forest litter (DENH)(1F). *USA: WV. Pocahontas Co. 6 mi SE Marlinton forest trail 407 off Hwy 92, V-16-1991 sift oak, S. O'Keefe (DENH)(1M,dissected). *

3.4.4 *Eutyphlus similis* LeConte

Diagnosis. *Eutyphlus similis* differs from all known *Eutyphlus* species in the form of the 7th ventrite of males (small and strap-like) (Fig. 76), the absence of sexual modifications on the ventrites of males, and the absence of wings in both sexes. The aedeagus was broadly egg-shaped with a rounded internal membrane associated with the distinctly forked, spinose median lobe and the more ventral paramere bearing four distal setae (Fig. 92).

Redescription. Male. Measurements: HL 0.24 mm, HW 0.28 mm; PL 0.31 mm long, PW 0.30 mm; EL 0.41 mm, EW 0.50 mm; A1–6, respectively, 0.03, 0.15, 0.12, 0.10, 0.10, 0.03 mm. An1–11, respectively, 0.08, 0.05, 0.03, 0.03, 0.02, 0.02, 0.02, 0.03, 0.03, 0.04, 0.11 mm. MP1–4, respectively, 0.01, 0.05, 0.01, 0.05 mm. GL 0.08 mm long, GW 0.05 mm. ML 1.60 mm. Integument: Typical for genus. Capitate

92.

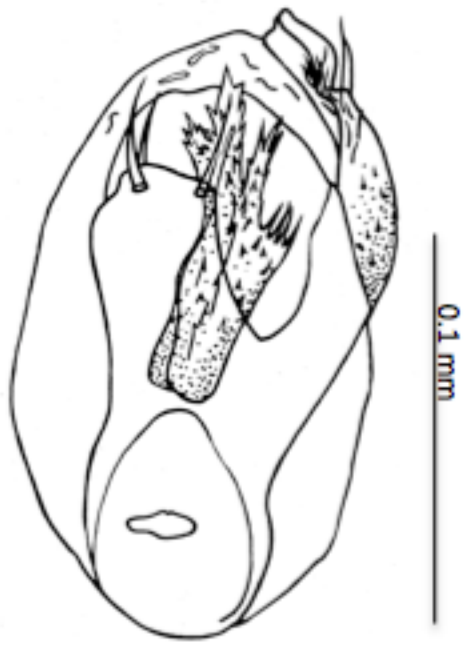


Fig. 92. aedeagus, *Eutyphlus similis*.

genal setae sparse. Head: About as wide as pronotum. Eyes small, with 12 facets, weakly convex, longer than wide, ocular canthus weakly developed, projecting laterally and sloping gently to gular area. Ventral surface of head slightly rounded in gular area, gular sulcus developed anteriorly and projecting to margin of posteriorly located, paired, gular foveae. Thorax: Pronotum with lateral margin barely crenulate, if at all. Median longitudinal sulcus present. Area behind basal sulcus bearing small, median longitudinal carina that extends into and bisects sulcus. Prosternum bearing anteroprosternal foveae. Paired, median mesoventral fovea present. Metaventrite strongly convex, more prominently so in apical ¼. Elytra bearing two basal fovea, subhumeral foveae present. Wings absent. Abdomen: Tergites unmodified. Fifth ventrite with lateral sides flattened, quadrate. Seventh ventrite small and strap-like. Other ventrites unmodified. Genitalia: Aedeagus asymmetrical. Left paramere dorsally attached, forming an oblique, sclerotized bar with distal end curved and slightly expanded, bearing two large, erect setae. Median lobe modified into internal, sclerotized process bearing two distinct arms with numerous spicules and spines, associated with inflated, membranous internal sac. Right paramere flattened, ventrally associated with phallobase and bearing four distal setae.

Female. Measurements: HL 0.20 mm, HW 0.30 mm; PL 0.33 mm, PW 0.32 mm; EL 0.41 mm, EW 0.50 mm; A1–6, respectively, 0.04, 0.15, 0.12, 0.11, 0.11, 0.03 mm. An1–11, respectively, 0.08, 0.06, 0.03, 0.02, 0.02, 0.02, 0.02, 0.03, 0.04, 0.04, 0.12 mm. MP1–4, respectively, 0.01, 0.05, 0.01, 0.05 mm. ML 1.74 mm. Integument, Head, Thorax, Abdomen: Similar to male except eyes greatly reduced, comprising a single facet, ocular canthus well-developed. Tempora rounded and broad. Pronotum more quadrate. Metasternum more flattened and evenly rounded. Fifth ventrite not flattened laterally as in males. Seventh ventrite small and transverse. Genitalia: Female genitalia membranous, completely lacking sclerotization. Produced into voluminous median membrane and billowy right sac.

Variations. The median and basal pronotal sulci vary from relatively shallow to well-defined. These sulci are always present, although they sometimes require careful scrutiny and high light conditions to observe. The aedeagus varies slightly between individuals. The number of setae on the ventral paramere varies from three to six, with four the most common number. When more are present they are shorter and/or narrower in form and set off slightly from the four main setae. The median membranous projection giving the aedeagus of *E. similis* its characteristic "egg-shape" varies in degree of inflation, which is probably an artifact of preparation.

Number of eye facets in females varies greatly from one to over twenty, and the ocular canthus covaries in development. In *E. similis* the sex ratio was often heavily skewed towards females.

Comments. Several collecting events included in the study produced over 40 females and fewer than ten males from the same site. A number of other sites only females were collected, making the accurate identification of females important. However, the process of distinguishing *E. similis* females from the females of *E. prominens* was extremely difficult and complicated efforts to determine accurate population counts from sites represented by females, only.

In his revision, Park (1956) suggested differences in head and pronotum width as a reliable way to discriminate between females of the two species. To test this and to investigate other possible characters useful for identification, body parts were measured for 111 *E. similis* females and 13 *E. prominens* females (Table 3). A single individual was taken from each locality represented in this study. *E. similis* females exhibited a slightly wider range of sizes, but the two different species, on average, were not noticeably different. The overlap in measurements of the two species suggests that they cannot be distinguished based on these characters. Association with male specimens remains the only method of identification of the females of these two species.

Table 3. Measurements of the head and pronotum lengths and widths of *E. similis* and *E. prominens* females (mm).

Head Length (mm)			
	Max.	**Min.**	**Avg.**
E. prominens	0.20	0.19	0.20
E. similis	0.22	0.15	0.20
Head Width (mm)			
	Max.	**Min.**	**Avg.**
E. prominens	0.30	0.30	0.30
E. similis	0.32	0.22	0.30
Pronotum Length (mm)			
	Max	**Min.**	**Avg.**
E. prominens	0.31	0.29	0.30
E. similis	0.38	0.29	0.34
Pronotum Width (mm)			
	Max	**Min.**	**Avg.**
E. prominens	0.31	0.29	0.30
E. similis	0.38	0.20	0.32

Bionomics. No published information on the biology of *E. similis* exists*.*

Seasonality. The majority of *E. similis* specimens were collected during the months of April, May, June, and July (earliest date 19 February; latest 6 December). Adults are most certainly present year round and at least one sample from snow and ice covered litter yielded specimens. Elevation. Specimens were collected from elevations between 460m and 2024m. Habitat/Microhabitat. Specimens were collected from a wide range of forest litter habitats, including in the rotted leaves, oak litter, beech litter, *Rhododendron,* old-growth and non-old growth hardwood litter, and conifer litter (pine, spruce, and fir). The occurrence in conifer litter differs from habitats (mainly hardwood litter) other species are known from, but this may simply be due to the much larger sample size (approximately 700). This was the only *Eutyphlus* species collected from tree hole debris, gilled fungi, or cave litter. In a study of the Coleoptera community of the woody debris of the Great Smoky

Mountains National Park, a single male specimen of *E. similis* was collected from a dead wood emergence chamber (Ferro et al. 2012). **Collecting methods**. Most individuals were collected by hand collecting or sifting the substrate and then processing the material in a Berlese funnel. Some individuals were collected via flight intercept traps.

Distribution. This species is known from Arkansas (Washington County), Georgia (Dade and White Counties), Kentucky (Edmonson County and Mammoth Cave), Maryland (Calvary County), North Carolina (Avery, Buncoabe, Caldwell, Haywood, Meclenburg, Swain, Transylvania, Watauga, Wilkes, and Yancy Counties), Ohio (Fairfield and Lawrence Counties), Pennsylvania (Somerset and St. Vincent Counties), South Carolina (Greenville and Pickens Counties), Tennessee (Blount, Carter, Cocke, and Sevier Counties), Virginia (Giles, Madison, Page, Smythe, and Washington Counties) and West Virginia (Fayette, Mercer, and Pocahontas Counties) (Fig. 93).

Fig. 93. Distribution of *E. similis.* Green dots indicate county records.

Material Examined: (n=737). *TENNESSEE:Sevier Co.; GSMNP, Indian Head Tr.; 35.60944°N 83.44659°W; Sift litter. 5290'; 20 July 2003. S.O'Keefe/ LSAM; 0080789 (LSAM)(slide mounted male)(description of male based on this specimen). *VIRGINIA: Page Co., Shennandoah Natl. Park, Little Stony Man at 38°36.24'N 78°21.99'W. 1024m. For. litter 3 May 2006. A.Tishechkin/ LSAM/ 0268331 (LSAM)(slide mounted female)(description of female based on this specimen). * USA, AR, Washington Co. Ozark Nat. Forest Weddington 36°06.312N 94°23.390W Litter between rocks 25 Jul. 2010. MJ Skvarla APGD 10-0726-004 (LSAM)(2F). *Cloudland Canyon S.Pk. Dade Co., GA. 17.VI.62 Foret floor debris/ H.R. Steeves Jr. collector/ H.R. Steeves Jr. Collection/ CNHM 1963 H.R.Steeves, Jr. Pselaphidae Colln. Acc. Z-13, 288 (FMNH)(2F; 1M,dissected). *USA: GEORGIA, Dade Co., Cloudland Canyon State Pk. 34°48.88'N 85°29.10'W 510m. 17 Sept. 2006. Forest litter sifting. I.M.Sokolov/ LSAM 0108985 (LSAM)(1F). *same locality/ LSAM 0108986 (LSAM)(1F). *same locality/ LSAM 0108987 (LSAM)(1F). *same locality/ LSAM 0108988 (LSAM)(1F). *same locality/ LSAM 0108989 (LSAM)(1F). *same locality/ LSAM 0092335 (LSAM)(1F). *GA:White Co. 8 August 1984 coll. R.J. Beshear "Eutyphlus"/ det. DSChandler (GMNH). *KY. Edmonson Co. Mammoth Cave Nat. Park Ugly Creek 8.5 mi NE Rhoda Berlese sample of rotted leaves 22-NOV-1992, E.A. Lisowski/ LSAM 0036133 (LSAM)(1F). *same locality/ LSAM 0036134 (LSAM)(1F). *same locality/ LSAM 0036135 (LSAM)(1F). *same locality/ LSAM 0036136 (LSAM)(1F). *Mammoth Cave KY. V-3-47 O.Park/ Field. Mus. Nat. Hist. Orlando Park Pselaphidae Colln. (FMNH)(2F). *USA: MD: Calv. Co. 4 mi S Prince Frederick, IV-16/V-7-1987, L Masner FIT, forest by crk (DSC)(2M,dissected). *N CAROLINA: Avery Co. Blue Ridge Pkwy., Grandfather Mt. at 36°5.70'N 81°49.62'W 1580M. Litter sifting 1 May; 2006. A.K.Tishechkin/ LSAM 00108908 (LSAM)(1F). *same locality/ LSAM 0108909 (LSAM)(1F). *same locality/ LSAM 0108910 (LSAM)(1F). *same locality/ LSAM 0108911 (LSAM)(1F). *same locality/ LSAM 0108912 (LSAM)(1F). *same locality/ LSAM 0108913 (LSAM)(1F). *same locality/ LSAM 0108914 (LSAM)(1F). *same locality/ LSAM 0108915 (LSAM)(1F). *same locality/ LSAM 0108916 (LSAM)(1F). *same locality/ LSAM 0108917 (LSAM)(1F). *same locality/ LSAM 0108918 (LSAM)(1F). *same locality/ LSAM 0108919 (LSAM)(1F). *same locality/ LSAM 0108920 (LSAM)(1F). *same locality/ LSAM 0108921 (LSAM)(1F). *same locality/ LSAM 0108922 (LSAM)(1F). *same locality/ LSAM 0108923 (LSAM)(1F). *same locality/ LSAM 0108924 (LSAM)(1F). *same locality/ LSAM 0107278 (LSAM)(1F). *same locality/ LSAM 0108926 (LSAM)(1F). *Clingman's Peak Buncoabe Co., N.C. 3-VII-60 spruce grove debris/ H.R. Steeves Jr. Collector/ H. R. Steeves Jr. Collection/ CNHM 1963 H.R.Steeves, Jr. Pselaphidae Colln. Acc. Z-13, 288/ Field Mus. Nat. Hist. Orlando Park Pselaphidae Colln. (FMNH)(1F). *NCBuncoabeCo.; MtPisgah5600 26Ap74PDebs soiluRocks (LSAM)(2F). *USANCCALDWELLCO Nr Cragg36°4'31" N81°46'52" W el 2930' 14Nov2009J&S J&SCornellExMoss&RhododendronlitterRoadsideDitch (LSAM)(1F). *Grandfather Mt. N.C. 14.X.50 T.Daggy/ Field Mus. Nat. Hist. Orlando Park Pselaphidae Colln. (FMNH)(1F). *USA:NC: Haywood GSMNP BRPW nr. Cove Field Ridge Overlook: litter/ 35°25.84'N 83°21.15'W' 1420m 21 Sep 2005 ATishechkin/ LSAM 0092316 (LSAM)(1F). *same locality/ LSAM 0092317 (LSAM)(1F). *same locality/ LSAM 0092322 (LSAM)(1F). *same locality/ LSAM 0092323 (LSAM)(1F). *same locality/

LSAM 0092327 (LSAM)(1F). *N CAROLINA: Haywood Co. GSMNP, Caldwell Fork Tr. At UTM 30897 E; 3940883N. Moist forest Berlese. 3 August 2002. C.Carlton & N.Lowe/ LSAM 0091763 (LSAM)(1F). *same locality/ LSAM 0091767 (LSAM)(1F). *same locality/ LSAM 0091768 (LSAM)(1F). *same locality/ LSAM 0091769 (LSAM)(1F). *same locality/ LSAM 0091770 (LSAM)(1F). *same locality/ LSAM 0091775 (LSAM)(1F). *same locality/ /LSAM 0091764 (LSAM)(1M,dissected). *U.S.A, NC Haywood Co. GSMNP, Balsam Mt. Trail 83°10'57"W, 35°38'12"N/20 Oct 2001, A. Tishechkin elv. 1500m, hdwd. Berlese/ LSAM 0017025 (LSAM)(1F). *same locality/ LSAM 0017026 (LSAM)(1F). *same locality/ LSAM 0017027 (LSAM)(1F). *U.S.A., NC, Haywood Co. GSMNP, Baxter Creek Tr. 83°06'36"W, 35°43'24"N/ elv.1350m.forest litter, Berlese 23 March 2002, C.Carlton V.Moseley/ LSAM 0014787 (LSAM)(1F). *same locality/ LSAM 0014785 (LSAM)(1M). *same locality/ LSAM 0014786 (LSAM)(1M,dissected). *USA:NC: Haywood lower Baxter Cr. Tr/308798 3957165 5 Jun 2005 CWright/ LSAM 0092285 (LSAM)(1F). *same locality/ LSAM 0092288 (LSAM)(1F). *same locality/ LSAM 0092290 (LSAM)(1F,dissected). *same locality/ LSAM 0092291 (LSAM)(1F). *same locality/ LSAM 0092293 (LSAM)(1F). *same locality/ LSAM 0092294 (LSAM)(1F). *same locality/ LSAM 0092295 (LSAM)(1F). *same locality/ LSAM 0092297 (LSAM)(1F). *same locality/ LSAM0092296 (LSAM)(1F). *USA: NC: Haywood Co. GSMNP Catalooche Divide Tr. Near Purchase/ 311819E 3940339N 17 Jul 2002 CCarlton/ LSAM 0092242 (LSAM)(1F). *same locality/ LSAM 0091900 (LSAM)(1F). *USA: NC: Haywood Co. GSMNP Cataloochee Rough Ridge Tr., lower/ 306360E 3940881N moist berlese 29 Jul 2002 CCarlton/ LSAM 92271 (LSAM)(1F). *same locality/ LSAM 92272 (LSAM)(1F). *U.S.A., NC, Haywood Co. GSMNP, Chestnut Branch Trail 83°07'24"W,35°45'34"N elv.740m, leaf litter Berlese 1 August 2001, A.Tishechkin/ LSAM 0002408 (LSAM)(1F) *same locality/ LSAM 0002409 (LSAM)(1F). *same locality/ LSAM 0002410 (LSAM)(1F). *same locality/ LSAM 0002412 (LSAM)(1F). *USA:NC: Haywood Co. GSMNP McKee Branch Tr./310220E 3940349N, most upland berlese 16 Jul 2002 CCarlton/ LSAM 0092248 (LSAM)(1F). *USA: NC: Haywood Co.; GSMNP Purchase; Knob, berlese/313124E; 3939640N 5089 ft; 20 July 2002; CCarlton/ LSAM 0092274 (LSAM)(1F). *MECKLENBURG Co., N.C. iv-22-57 T.Daggy (NCSUIM)(2F; 1M,dissected). *NORTH CAROLINA: Swain Co., GSMNP, admin. Road W of Fontana Dam, Lewellyn Branch UTM 0250085E 392971N 12 Apr 2004. A.J.Mayor/ LSAM 0092556 (LSAM)(1F). *N CAROLINA: Swain Co. GSMNP, Appalachian Tr. ~1.5mi E Newfound Gap 35°36.96'N 83°24.66'W 1730m. Forest litter 18 July 2002. C.Carlton/ LSAM 0091919 (LSAM)(1F). *same locality/ LSAM 0091920 (LSAM)(1F). *same locality/ LSAM 0091921 (LSAM)(1F). *same locality/ LSAM 0091923 (LSAM)(1F). *same locality/ LSAM 0091924 (LSAM)(1F). *same locality/ LSAM 0091925 (LSAM)(1F). *same locality/ LSAM 0091926 (LSAM)(1F). *same locality/ LSAM 0091927 (LSAM)(1F). *same locality/ LSAM 0091929 (LSAM)(1F). *same locality/ LSAM 0094860 (LSAM)(1F). *USA: NC: Swain Co GSMNP Appalachian Tr. 1.5 mi NE Newfound Gap/ 281639E 3944038N ridgetop berlese 18 July 2002 CCarlton/ LSAM 0092344 (LSAM)(1F). *same locality/ LSAM 0092345 (LSAM)(1F). *same locality/ LSAM 0092346 (LSAM)(1F). *same locality/ LSAM 0092342 (LSAM)(1M,dissected). *USA:NC: Swain Co. GSMNP Appalachian Tr. at Sweat Heifer Cr. Tr. Ridgetop berlese/ 282160E 3944324N 18 July 2002

CCarlton/ LSAM 0092254 (LSAM)(1F). *same locality/ LSAM 0092256 (LSAM)(1F). *same locality/ LSAM 0092255 (LSAM)(1M,dissected). *N CAROLINA: Swain Co. GSMNP, E branch of Balsam Mt. Tr. Nr. Balsam Mt. Rd; 35°37.5'N 83°12.7'W. 980m Forest litter. 26 July 2004 J.Ciegler & M.Fitzgerald/ LSAM 0094903 (LSAM)(1F). *N CAROLINA: Swain Co. GSMNP, W branch of Beach Gap Tr. @35°37.3'N; 83°12.8'W. 975m. Forest litter.9.vi.2005.A.Tishechkin/ LSAM 0094978 (LSAM)(1F). * U.S.A., NC Swain Co. GSMNP, Clingman's Dome 83°29'50"W, 35°33'34"N/elv.2024m, upper Berlese 30 June 2001, Ccarlton, A.Tishechkin, V.Moseley/ LSAM 0003163 (LSAM)(1F). *same locality/ LSAM 0003164 (LSAM)(1F). *same locality/ LSAM 0003165 (LSAM)(1F). *USA: NC: Swain Co. GSMNP Upper Deep Creek Trail UTM 280352E 3942040 N moist upland berlese 22July2002 CEC/ LSAM 0077201 (LSAM)(1F). *same locality/ LSAM 0077202 (LSAM)(1F). *same locality/ LSAM 0077205 (LSAM)(1F). *same locality/ LSAM 0077206 (LSAM)(1F). *same locality/ LSAM 0077207 (LSAM)(1F). *same locality/ LSAM 0077208 (LSAM)(1F). *same locality/ LSAM 0077203 (LSAM)(1F). *same locality/ LSAM 0077209 (LSAM)(1M,dissected). *same locality/ LSAM 0077210 (LSAM)(1M). *USA:NC:Swain Co. GSMNP, Deep Creek area, Loop Tr. at Indian Creek Trail, UTM 280689 E 3928371 N, moist forest berlese C.Carlton 26 July 2002/ LSAM 006005 (LSAM)(1F). *U.S.A., NC, Swain Co. GSMNP, Flat Creek Trail 83°10'21"W, 35°31'1"N/ elv.1500m, leaf litter Berlese 31 July 2001 A.Tishechkin/ LSAM 0002509 (LSAM)(1F). *same locality/ LSAM 0002509 (LSAM)(1F). *same locality/ LSAM 0002510 (LSAM)(1F). *same locality/ LSAM 0002511 (LSAM)(1F). *USA: NC: Swain Co. 5.8mi. S. Heintooga Overlook, Great Smoky Mt. N.P. 1.vi.1991 C.E.Carlton/ LSAM 0036119 (LSAM)(1F,dissected). *USA N.Car. Swain Co. Dirt Rd. from Heintooga Overlook to Cherokee/Lot#76-102 Oct. 14, 1976 Berlesate 5000'-4500' R.Chenowith&R.T.Allen/ LSAM 0036001 (LSAM)(1F). *same locality/ LSAM 0036004 (LSAM)(1F). *same locality/ LSAM 0036005 (LSAM)(1F). *same locality/ LSAM 0036006 (LSAM)(1F). *same locality/ LSAM 0036007 (LSAM)(1F). *same locality/ LSAM 0036008 (LSAM)(1F). *same locality/ LSAM 0036009 (LSAM)(1F). *same locality/ LSAM 0036010 (LSAM)(1F). *same locality/ LSAM 0036011 (LSAM)(1F). *same locality/ LSAM 0036012 (LSAM)(1F). *same locality/ LSAM 0036013 (LSAM)(1F). *same locality/ LSAM 0036014 (LSAM)(1F). *same locality/ LSAM 0036015 (LSAM)(1F). *same locality/ LSAM 0036016 (LSAM)(1F). *same locality/ LSAM 0036017 (LSAM)(1F). *same locality/ LSAM 0036018 (LSAM)(1F). *same locality/ LSAM 0036019 (LSAM)(1F). *same locality/ LSAM 0036021 (LSAM)(1F). *same locality/ LSAM 0036022 (LSAM)(1F). *same locality/ LSAM 0036023 (LSAM)(1F). *same locality/ LSAM 0036024 (LSAM)(1F). *same locality/ LSAM 0036025 (LSAM)(1F). *same locality/ LSAM 0036026 (LSAM)(1F). *same locality/ LSAM 0036027 (LSAM)(1F). *same locality/ LSAM 0036028 (LSAM)(1F). *same locality/ LSAM 0036029 (LSAM)(1F). *same locality/ LSAM 0036030 (LSAM)(1F). *same locality/ LSAM 0036031 (LSAM)(1F). *same locality/ LSAM 0036033 (LSAM)(1F). *same locality/ LSAM 0036034 (LSAM)(1F). *same locality/ LSAM 0036035 (LSAM)(1F). *same locality/ LSAM 0036036 (LSAM)(1F). *same locality/ LSAM 0036037 (LSAM)(1F). *same locality/ LSAM 0036038 (LSAM)(1F). *same locality/ LSAM 0036039 (LSAM)(1F). *same locality/ LSAM 0036040 (LSAM)(1F). *same locality/ LSAM 0036041 (LSAM)(1F). *same locality/ LSAM 0036042 (LSAM)(1F). *same locality/ LSAM 0036043 (LSAM)(1F). *same locality/ LSAM 0036044 (LSAM)(1F). *same locality/ LSAM 0036045 (LSAM)(1F). *same locality/ LSAM 0036046 (LSAM)(1F) *same locality/ LSAM 0036055 (LSAM) (1F). *same locality/ LSAM 0036057 (LSAM)(1F). *same locality/ LSAM 0036096 (LSAM)(1F). *same locality/ LSAM 0036097 (LSAM)(1F). *same locality/ LSAM 0036109 (LSAM)(1F). *same locality/ LSAM 0036002 (LSAM)(1M,dissected). *same locality/ LSAM 0036032 (LSAM)(1M). *same locality/ LSAM 0036063 (LSAM)(1M). *N CAROLINA: Swain Co.; GSMNP, Jenkins Ridge Tr. ~1mi from Appalachian Tr. 35°33.75'N83°43.2'W 1540m. Forest litter. 31 Jul; 2004. A.K.Ticheshkin/ LSAM 0094940 (LSAM)(1F). *same locality/ LSAM 0094941 (LSAM)(1F). *same locality/ LSAM 0094945 (LSAM)(1F). *same locality/ LSAM 0094951 (LSAM)(1F). *same locality/ LSAM 0094958 (LSAM)(1F). *N CAROLINA: Swain Co. GSMNP, upper Jenkins Ridge Tr. At Gunna Cr. 35°28.3'N; 83°42.65'W 1400m. Forest litter. 29 July 2004. A.Tishechkin/ LSAM 0109148 (LSAM)(1M,dissected). *N CAROLINA: Swain Co. GSMNP, Kephart Prong Tr. at 35°35'36"N 83°21'55"W 930m. Forest litter 20 July 2003. A.Tishechkin/ LSAM 0009181 (LSAM)(1F). *N CAROLINA: Swain Co. GSMNP, Lakeshore Tr. at 35°28'20"N 83°27'3"W 1580m. Forest litter 18 July 2003. A.Tishechkin/ LSAM 0091819 (LSAM)(1F). *same locality/ LSAM 0091820 (LSAM)(1F). *same locality/ LSAM 0091829 (LSAM)(1F). *same locality/ LSAM 0091830 (LSAM)(1F). *same locality/ LSAM 0091834 (LSAM)(1F). *same locality/ LSAM 0091836 (LSAM)(1F). *N CAROLINA: Swain Co. GSMNP, Lost Cove Tr. @ 35°29.45'N 83°48.10'W 685m. Forest litter. 8 May 2004. W.D.Merritt/ LSAM 0095667 (LSAM)(1F). *same locality/ LSAM 0095668 (LSAM)(1F). *same locality/ LSAM 0095669 (LSAM)(1F). *same locality/ LSAM 0095672 (LSAM)(1F). *same locality/ LSAM 0095673 (LSAM)(1F). *same locality/ LSAM 0095674 (LSAM)(1F). *same locality/ LSAM 0095675 (LSAM)(1F). *same locality/ LSAM 0095676 (LSAM)(1F). *same locality/ LSAM 0095677 (LSAM)(1F). *same locality/ LSAM 0095679 (LSAM)(1F). *same locality/ LSAM 0095680 (LSAM)(1F). *same locality/ LSAM 0095681 (LSAM)(1F). *same locality/ LSAM 0107272 (LSAM)(1F). *same locality/ LSAM 0095670 (LSAM)(1M). *same locality/ LSAM 0095671 (1M,dissected). *same locality/ 0095678 (LSAM)(1M). *N CAROLINA: Swain co. GSMNP, McGee Spring Cmpgr., 5 site. 35°38.31'N 83°14.36'W. 1535m. Forest litter. 2 Oct 2004. W. Merritt/ LSAM 0094861 (LSAM)(1F). *N CAROLINA: Swain Co. GSMNP, ~250m W Mingus Mill Parkgr. 650m. 1m2 litter 28 Apr 1996. Coyle collr./ LSAM 0096237 (LSAM)(1F). *same locality/ LSAM 0096238 (LSAM)(1F). *USA:NC,SwainCo. 2mi. Neintooga overlook.Beech-fir berlesate 1.vi.1990 C.E.Carlton/ LSAM 0036120 (LSAM)(1F). *same locality/ LSAM 0036121 (LSAM)(1F). *same locality/ LSAM 0036122 (LSAM)(1F). *same locality/ LSAM 0036123 (LSAM)(1F). *same locality/ LSAM 0036124 (LSAM)(1M,dissected). *N CAROLINA: Swain Co. GSMNP, Noland Divide Tr. at 35°33'57"N 83°28'36"W 1770m.Leaf/moss mat litter 19 July 2003. A.Tishechkin/ LSAM 0080740 (LSAM)(1F). *same locality/ LSAM 0080741 (LSAM)(1F). *same locality/ LSAM 0080742 (LSAM)(1F). *same locality/ LSAM 0080743 (LSAM)(1F). *same locality/ LSAM 0080745 (LSAM)(1F). *same locality/ LSAM 0080746 (LSAM)(1F). *same locality/ LSAM 0080747 (LSAM)(1F). *same locality/ LSAM 0080749 (LSAM)(1F). *same locality/ LSAM 0080752 (LSAM)(1F). *same locality/ LSAM 0080754

(LSAM)(1F). *same locality/ LSAM 0080755 (LSAM)(1F). *same locality/ LSAM 0080758 (LSAM)(1F). *same locality/ LSAM 0080760 (LSAM)(1F). *same locality/ LSAM 0080763 (LSAM)(1F). *same locality/ LSAM 0080765 (LSAM)(1F). *same locality/ LSAM 0080766 (LSAM)(1F). *same locality/ LSAM 0090769 (LSAM)(1F,dissected). *same locality/ LSAM 0080770 (LSAM)(1F). *same locality/ LSAM 0080756 (LSAM)(1M). *same locality/ LSAM 0080761 (LSAM)(1M). *same locality/ LSAM 0080764 (LSAM)(1M). *same locality/ LSAM 0080771 (LSAM)(1M,dissected). *USANCTRANSYLVANIACONr Brevard PisgahNFPinkBedsPicnic Area N35°21'11"W82°43. 557' El 3208' 5 Aug 09. J.F.& TADCornellAspirExGillFungi (LSAM)(3F). *USA:NC, Watauga Co. Rough Ridge Trailhead 8 mi. SW Blowing Rock elv.4200', 2.vi.1991/ LSAM 0036102 (LSAM)(1F). *same locality/ LSAM 0036111 (LSAM)(1F). *USA: NC: Wilkes Co. Stone Mt. State Park, nr. Hutchinson's Homestead 36°23.37'N 81°2.75'W. 485m. Litter sifting. 2 May 2006 A.K.Tishechkin/ LSAM 0108928 (LSAM)(1F). *same locality/ LSAM 0108930 (LSAM)(1F). *same locality/ LSAM 0108929 (LSAM)(1M,dissected). *USA: NC: Yancy Co. B.R. Pkw. 37.4 mi. SW intersection US 221 elv. 4000' log litter 2.vi.1991 C.E.Carlton/ LSAM 0036108 (LSAM)(1F). *same locality/ LSAM 0036106 (LSAM)(1M). *same locality/ LSAM 0036107 (LSAM)(1M,dissected). * Clear Creek 10mi S Lancaster, Fair.Co.,Ohio v010-1974/ DSChandler sifting rotten logs (DSC)(1M,dissected). * USA, OH, Fairfield Co. Barneby Center 11 May 1989 P. Kovarik/ LSAM 0036126 (LSAM)(1F). *same locality/ LSAM 0036127 (LSAM)(1F). *same locality/ LSAM 0036128 (LSAM)(1F). *OHIO: Lawrence Co. Vinton Furnace Experim. Forest, nr. Forest Serv. Stn. Pu. Carrion-baited pitfall 19 Aug 1995. P.W.Kovarik (LSAM)(1M). * USA, PA, Somerset Co. Mt. Davis, elv. 3200 ft. Hdwd forest berlesate 16 Aug. 1989, Carlton/ LSAM 0036129 (LSAM)(1F). *same locality/ LSAM 0036130 (LSAM)(1F). *same locality/ LSAM 003613 (LSAM)(1F). *same locality/ LSAM 0036132 (LSAM)(1F). * St. Vinc. Penn./ 12/ C.N.H.M. Colln. (F.Psota Colln. Ex H.F. Wickham Colln.)/ Field Mus. Nat. Hist. Orlando Park Pselaphidae Colln/ Eutyphlus similis 12 Lee (FMNH)(1F). *SCGreenvilleCo 5miCaesar's HeadStPk5Aug95 J&Scornell Ex ForestLitter& rotFungi; 995VIII-5-2 (LSAM)(4F). *USA SC PICKENS CO RockyBottomN35°3'32" W82°47'52"E12027'15Aug O9J&Scornellsifte&Berl-20kglitteronRockyBottom Creek (LSAM)(6F). *USA SC PICKENS CO SassafrasMtN35°3'49"N 82°46'42"W15Aug 2009J&SCornellExAlba treliusCristatusinConiFor (LSAM)(2F). *#8/ SMOKIES, TENN. DYBAS 1953/ Field Mus. Nat. Hist. Orlando Park Pselaphidae Colln. (FMNH)(13F). *USA:TN, Blount Co. Great Smoky Mt. N.P. S. of entrance. Elv. 3000' leaf/log litter 1.vi.1991 C.E.Carlton/ LSAM 0036101 (LSAM)(1F). *same locality/ LSAM 0036114 (LSAM)(1F). *same locality/ LSAM 0036115 (LSAM)(1F). *same locality/ LSAM 003116 (LSAM)(1F). *same locality/ LSAM 0036117 (LSAM)(1F). *same locality/ LSAM 0036118 (LSAM)(1F). *TENNESSEE: Blount Co. GSMNP, Ace Gap Tr. @ 35°38.7'N 83°48.3'W. 600m Forest litter. 2 Aug 2004 V.Bayless& S. Gil/ LSAM 0094936 (LSAM)(1F). *same locality/ LSAM 0094939 (LSAM)(1F). *TENNESSEE: Blount Co. GSMNP, App. Tr. At Beechnut Gap. 35°34.16'N 83°41.51'W 1510m. Forest litter sifting 13 April 2006. A.K.Tishechkin/ LSAM 0107300 (LSAM)(1F). *same locality/ LSAM 0107299 (LSAM)(1M,dissected). *same locality/ LSAM 0107301 (LSAM)(1M,dissected). *TENNESSEE: Blount Co. GSMNP, NE corner of Cades Cove at 35°36'33"N

83°47'12"W. 640m Forest litter. 18 July 2003. A.Tishechkin/ LSAM 0014973 (LSAM)(1F). *same locality/ LSAM 0014974 (LSAM)(1F). *TENNESSEE: Blount Co. GSMNP, Little Bottoms Tr. @35°37.125'N 83°55.397'W 520m. Forest; litter. 31 Jul 2004. J.Ciegler/ LSAM 0095652 (LSAM)(1F). *same locality/ LSAM 0095653 (LSAM)(1F). *same locality/ LSAM 0095654 (LSAM)(1F). *same locality/ LSAM 0095655 (LSAM)(1F). *same locality/ LSAM 0095656 (LSAM)(1F). *same locality/ LSAM 0095657 (LSAM)(1F). *same locality/ LSAM 0095658 (LSAM)(1F). *same locality/ LSAM 0095659 (LSAM)(1F). *same locality/ LSAM 0095660 (LSAM)(1F). *same locality/ LSAM 0095661 (LSAM)(1F). *same locality/ LSAM 0095662 (LSAM)(1F). *same locality/ LSAM 0095663 (LSAM)(1F). *same locality/ LSAM 0095664 (LSAM)(1F). *same locality/ LSAM 0095665 (LSAM)(1F). *TENNESSEE: Blount Co. GSMNP, lower Gregory Ridge Tr. @ 35°33.5'N 83°50.5'W. 630m. For. Litter 28 July 2004. A.K.Tishechkin/ LSAM 0095614 (LSAM)(1F). *same locality/ LSAM 0095615 (LSAM)(1F). *same locality/ LSAM 0095616 (LSAM)(1F). *same locality/ LSAM 0095617 (LSAM)(1F). *same locality/ LSAM 0095618 (LSAM)(1F). *same locality/ LSAM 0095619 (LSAM)(1F). *same locality/ LSAM 0095620 (LSAM)(1F). *same locality/ LSAM 0095621 (LSAM)(1F). *same locality/ LSAM 0095624 (LSAM)(1F). *same locality/ LSAM 0095625 (LSAM)(1F). *same locality/ LSAM 0095626 (LSAM)(1F). *same locality/ LSAM 0095627 (LSAM)(1F). *same locality/ LSAM 0095628 (LSAM)(1F). *same locality/ LSAM 0095629 (LSAM)(1F). *same locality/ LSAM 0095630 (LSAM)(1F). *same locality/ LSAM 0095631 (LSAM)(1F). *same locality/ LSAM 0095632 (LSAM)(1F). *same locality/ LSAM 0095633 (LSAM)(1F). *same locality/ LSAM 0095634 (LSAM)(1F). *same locality/ LSAM 0095594 (LSAM)(1F). *same locality/ LSAM 0095682 (LSAM)(1F). *same locality/ LSAM 0095683 (LSAM)(1F). *same locality/ LSAM 0095684 (LSAM)(1F). *same locality/ LSAM 0095685 (LSAM)(1F). *same locality/ LSAM 0095686 (LSAM)(1F). *same locality/ LSAM 0095687 (LSAM)(1F). *same locality/ LSAM 0095688 (LSAM)(1F). *same locality/ LSAM 0095689 (LSAM)(1F). *same locality/ LSAM 0096690 (LSAM)(1F). *same locality/ LSAM 0095691 (LSAM)(1F). *same locality/ LSAM 0095692 (LSAM)(1F). *same locality/ LSAM 0095693 (LSAM)(1F). *same locality/ LSAM 0095694 (LSAM)(1F). *same locality/ LSAM 0095695 (LSAM)(1F). *same locality/ LSAM 0095696 (LSAM)(1F). *same locality/ LSAM 0095697 (LSAM)(1F). *same locality/ LSAM 0095698 (LSAM)(1F). *same locality/ LSAM 0095699 (LSAM)(1F). *same locality/ LSAM 0095700 (LSAM)(1F). *same locality/ LSAM 0095701 (LSAM)(1F). *same locality/ LSAM 0095702 (LSAM)(1F). *same locality/ LSAM 0095703 (LSAM)(1F). *same locality/ LSAM 0095704 (LSAM)(1F). *same locality/ LSAM 0095705 (LSAM)(1F). *TENNESSEE: Blount Co. GSMNP, Upper Long Hungry Ridge Tr. At 35°30.89'N; 83°51.00'W 1390m. For. Litter 12 April 2006. A.K. Tishechkin/ LSAM 0109095 (LSAM)(1F,dissected). *TENNESSEE: Blount Co. GSMNP, Mt. Thunderhead nr. Summit @ 35°34.1'N 83°42.5'W. 1650m. Litter 30 July 2004. A.K. Tishechkin/ LSAM 0091946 (LSAM)(1F). *same locality/ LSAM 0091951 (LSAM)(1F). *same locality/ LSAM 009145 (LSAM)(1M,dissected). * TENNESSEE: Blount Co. GSMNP, West Prong Campgr. 35°37.7'N 83°42.3°W. 520m. Forest litter. 30 Jul 2004. J Ciegler/ LSAM 0095597 (LSAM)(1F). *same locality/ LSAM 0095598 (LSAM)(1F). *same locality/ LSAM 0095600 (LSAM)(1F). *same locality/ LSAM 0095601 (LSAM)(1F). *same locality/ LSAM 0095602 (LSAM)(1F). *same locality/ LSAM 0095603 (LSAM)(1F). *same locality/ LSAM 0095604 (LSAM)(1F). *same locality/ LSAM 0095605 (LSAM)(1F). *same locality/ LSAM 0095607 (LSAM)(1F). *same locality/ LSAM 0095608 (LSAM)(1F). *same locality/ LSAM 0095609 (LSAM)(1F). *same locality/ LSAM 0095610 (LSAM)(1F). *same locality/ LSAM 0095611 (LSAM)(1F). *same locality/ LSAM 0095612 (LSAM)(1F). *same locality/ LSAM 0095613 (LSAM)(1F). *same locality/ LSAM 0095622 (LSAM)(1F). *same locality/ LSAM 0095623 (LSAM)(1F). *same locality/ LSAM 0095635 (LSAM)(1F). *same locality/ LSAM 0095636 (LSAM)(1F). *same locality/ LSAM 0095637 (LSAM)(1F). *same locality/ LSAM 0095638 (LSAM)(1F). *same locality/ LSAM 0095630 (LSAM)(1F). *same locality/ LSAM 0095640 (LSAM)(1F). *same locality/ LSAM 0095641 (LSAM)(1F). *same locality/ LSAM 0095642 (LSAM)(1F). *same locality/ LSAM 0095643 (LSAM)(1F). *same locality/ LSAM 0095644 (LSAM)(1F). *same locality/ LSAM 0095645 (LSAM)(1F). *same locality/ LSAM 0095646 (LSAM)(1F). *same locality/ LSAM 0095647 (LSAM)(1F). *same locality/ LSAM 0095648 (LSAM)(1F). *same locality/ LSAM 0095649 (LSAM)(1F). *same locality/ LSAM 0095650 (LSAM)(1F). *Carter Co. Tenn. #228 Copeland 12.VII.53/ Field Mus. Nat. Hist. Orlando Park Pselaphidae Colln. (FMNH)(1F). *TENNESSEE: Cocke Co. GSMNP, Albright Grove @ 35°44.11'N 83°16.78'W 970m Forest litter. 1 Aug; 2004. J. Ciegler, A. Tishechkin/ LSAM 0094820 (LSAM)(1F,dissected). *same locality/ LSAM 0094821 (LSAM)(1F). *same locality/ LSAM 0094823 (LSAM)(1F). *same locality/ LSAM 0091894 (LSAM)(1F). *same locality/ LSAM 0091895 (LSAM)(1F). *same locality/ LSAM 0091896 (LSAM)(1F). *TENNESSEE: Cocke Co. GSMNP, Albright Grove Loop Tr. Ca. 950m. Berlese near rotten longs 19 Jul 2003. S.O'Keefe/ LSAM 0096229 (LSAM)(1F). *same locality/ LSAM 0096230 (LSAM)(1F). *same locality/ LSAM 0096231 (LSAM)(1F). *same locality/ LSAM 0096232 (LSAM)(1F). *same locality/ LSAM 0096233 (LSAM)(1F). *same locality/ LSAM 0096234 (LSAM)(1F). *same locality/ LSAM 0096235 (LSAM)(1F). *same locality/ LSAM 0096236 (LSAM)(1F). *same locality/ LSAM 0109143 (LSAM)(1F). *same locality/ 0109144 (LSAM)(1F). *U.S.A., TN, Cocke Co. GSMNP, Albright Grove Trail 83°16'45"W, 35°44'10"N/elv.1000m, old growth Berlese 29 June 2001, C.Carlton, A. Tishechkin, v. Moseley/ LSAM 0002434 (LSAM)(1F). *same locality/ LSAM 0016990 (LSAM)(1F). *same locality/ LSAM 0017010 (LSAM)(1F). *same locality/ LSAM 0017011 (LSAM)(1F). *same locality/ LSAM 0017012 (LSAM)(1F). *same locality/ LSAM 0017013 (LSAM)(1F). *same locality/ LSAM 0017014 (LSAM)(1F). *same locality/ LSAM 0017015 (LSAM)(1F). *same locality/ LSAM 0017016 (LSAM)(1F). *same locality/ LSAM 0017017 (LSAM)(1F). *same locality/ LSAM 0002433 (LSAM)(1M,dissected). *TN: Cocke Co GSMNP Albright Grove Trail loop/ 35°39'42"N 83°27'46"W 1500m Carlton Mayor 6 Dec 2003/ LSAM 0109035 (LSAM)(1F). *same locality/ LSAM 0109036 (LSAM)(1F). *same locality/ LSAM 0109037 (LSAM)(1F). *same locality/ LSAM 0109038 (LSAM)(1F). *same locality/ LSAM 0109039 (LSAM)(1F). *same locality/ LSAM 0109040 (LSAM)(1F). *same locality/ LSAM 0109041 (LSAM)(1F). *same locality/ LSAM 0109042 (LSAM)(1F). *same locality/ LSAM 0109043 (LSAM)(1F). *same locality/ LSAM 0109044 (LSAM)(1F). *same locality/ LSAM 0109045 (LSAM)(1F). *same locality/ LSAM 0109046 (LSAM)(1F). *same locality/ LSAM 0109047 (LSAM)(1F). *same locality/ LSAM 0109048 (LSAM)(1F). *same locality/ LSAM

0109049 (LSAM)(1F). *same locality/ LSAM 0275700 (LSAM)(1F). *USA Tenn. Cocke Co. GSMNP Cosby Creek Trail/ Lot #76-106 Oct. 15, 1976 Berlesate R.Chenowith&R.T.Allen/ LSAM 0036059 (LSAM)(1F). *same locality/ LSAM 0036061 (LSAM)(1F). *same locality/ LSAM 0036062 (LSAM)(1F). *same locality/ LSAM 0036063 (LSAM)(1F). *same locality/ LSAM 0036065 (LSAM)(1F). *same locality/ LSAM 0036067 (LSAM)(1F). *same locality/ LSAM 0036069 (LSAM)(1F). *same locality/ LSAM 0036070 (LSAM)(1F). *same locality/ LSAM 0036071 (LSAM)(1F). *same locality/ LSAM 0036072 (LSAM)(1F). *same locality/ LSAM 0036074 (LSAM)(1F). *same locality/ LSAM 0036075 (LSAM)(1F). *same locality/ LSAM 0036077 (LSAM)(1F). *same locality/ LSAM 0036078 (LSAM)(1F). *same locality/ LSAM 0036080 (LSAM)(1F). *same locality/ LSAM 0036082 (LSAM)(1F). *same locality/ LSAM 0036083 (LSAM)(1F). *same locality/ LSAM 0036085 (LSAM)(1F). *same locality/ LSAM 0036086 (LSAM)(1F). *same locality/ LSAM 0036068 (LSAM)(1M,dissected). *USA:TN:Cocke Co. GSMNP Cosby House 35°46.67N 83°12.83W 7Oct2005 M.Gimmel sifting litter/ LSAM 0095767 (LSAM)(1F). *same locality/ LSAM 0095768 (LSAM)(1F). *same locality/ LSAM 0095769 (LSAM)(1F). *same locality/ LSAM 0095770 (LSAM)(1F). *same locality/ LSAM 0095771 (LSAM)(1F). *U.S.A., TN, Cocke Co. GSMNP, Cosby Ranger Station 83°12'25"W, 35°46'12"N elv. 622m, leaf litter Berlese 31 July 2001, A. Tishechkin/ LSAM 0002512 (LSAM)(1F). *same locality/ LSAM 0002513 (LSAM)(1F). *USA: TN: Cocke Co. GSMNP Gabes Mnt. Tr @ Hen Wallow Fall, moist forest berlese/297649E 3959487N 19 Jul 2002 CCarlton, NLowe/ LSAM 0092251 (LSAM)(1F). *same locality/ LSAM 0092252 (LSAM)(1F). *U.S.A., TN, Cocke Co. GSMNP, Hen Wallow Falls 83°14'27"W, 35°46'22"N elv. 580m, leaf litter Berlese 31 July 2001, A. Tishechkin/ LSAM 0002532 (LSAM)(1F). *same locality/ LSAM 0002534 (LSAM)(1F). *same locality/ LSAM 0002542 (LSAM)(1F). *same locality/ LSAM 0002544 (LSAM)(1F). *same locality/ LSAM 0002545 (LSAM)(1F). *USA TN CockeCo GSMNP MaddronBaldTrail17-2916 31E3959236NA027 2320 8Aug06JCornell&Sranger BerlExSiftLitterOf30"DiamHem RockStumpJC006-VII-0-40 (LSAM)(3F). *TENNESSEE: Cocke Co. GSMNP, Maddron Bald Tr. @ lower end of the Albright Grove Loop. ~970m. Forest litter. 19 Feb 2004. A.Mayor/ LSAM 0094850 (LSAM)(1F). *same locality/ LSAM 0094851 (LSAM)(1F). *same locality/ LSAM 0094852 (LSAM)(1F). *same locality/ LSAM 0094853 (LSAM)(1F). *same locality/ LSAM 0094856 (LSAM)(1F). *same locality/ LSAM 0094855 (LSAM)(1F). *same locality/ LSAM 0094857 (LSAM)(1F). *same locality/ LSAM 0094859 (LSAM)(1F). *USA: TN: Cocke Co. GSMNP Snake Den Ridge Trail/ btw 299077 3957780 & 299657 3957885 Cwright June 2005/ LSAM 92172 (LSAM)(1F). *TENNESSEE: Sevier Co. GSMNP, App. Tr. ~1mi E Newfound Gap. 35°36.96'N; 83°24.88'W. 1650m. Forest; litter. 7 Oct 2005 D.Chouljenko& M.Gimmel/ LSAM 0091897 (LSAM)(1F,dissected). *TENNESSEE: Sevier Co. GSMNP, App. Tr. At Sweat Heifer Cr. Tr. 35°37.29'N 83°24.25'W. 1725m. Forest litter. 23 Aug 2006. V.Bayless/ LSAM 0109149 (LSAM)(1F). *same locality/ LSAM 0109150 (LSAM)(1F). *same locality/ LSAM 0109151 (LSAM)(1F). *same locality/ LSAM 0109152 (LSAM)(1F). *same locality/ LSAM 0109153 (LSAM)(1F). *same locality/ LSAM 0109155 (LSAM)(1F). *same locality/ LSAM 0109156 (LSAM)(1F). *same locality/ LSAM 0109157 (LSAM)(1F). *same locality/ LSAM 0109154 (LSAM)(1M,dissected). *TENNESSEE: Sevier Co.

GSMNP, App. Tr. Just W of Sweat Heifer Cr. Trhd. 1720m 35°37.3'N83°24.35'W. Forest litter. 14 April 2006. C.Carlton/ LSAM 0107280 (LSAM)(1F). *same locality/ LSAM 0107282 (LSAM)(1F). *same locality/ LSAM 0107283 (LSAM)(1F). *same locality/ LSAM 0107279 (LSAM)(1M,dissected). *U.S.A., TN Sevier Co. GSMNP, Chimneys Picnic Area Nature Trail, 83°29'45"W, 35°38'6"N, elv. 891m/soil litter berlese 30 June 2001, C.Carlton A.Tishechkin, V.Moseley/ LSAM 0002894 (LSAM)(1F). *same locality/ LSAM 0002845 (LSAM)(1F). *Sevier Co. Tenn. Smoky Mt. Pk. Summer 1953 T.P. Copeland/ Field Mus. Nat. Hist. Orlando Park Pselaphidae Colln. (FMNH)(1F). *Cove Forests S.&E. Gatlinburg, TENN. Sevier Co. V-16-23 1972 2500-3500'/ Eutyphlus similis LeConte det. DSChandler '95 (FMNH)(1F). *Rocky Creek Gap Smoky Mts. Nat. Pk. Tenn. IX:14:53, SA-HD/ Field Mus. Nat. Hist. Orlando Park Pselaphidae Colln. (FMNH)(3F). *Gt. Smoky Mts. Nat. Pk. Elkmont Sevier Co., Tenn. 8-VI-60 Allt. 2250' Leaf Duff/ H. Buter J. Wagner Collectors/ H. R. Steeves, Jr. Collection/ CNHM 1963 H.R. Steeves, Jr. Pselaphidae Colln. Acc. Z-13, 288/ Field Mus. Nat. Hist. Orlando Park Pselaphidae Colln. (FMNH)(2F)(2M,1dissected). *Greenbrier Cove Smoky Mts. Nat. Pk. Sevier Co., TENN./ Field Mus. Nat. Hist. Orlando Park Pselaphidae Colln. (FMNH)(8F). *USA: TN: Sevier Co. GSMNP Greenbrier Ridge Tr. 26014. 3941340. 1260m Berlese 7 Jun 2005 A. Tishechkin/ LSAM 0092195 (LSAM)(1F). *same locality/ LSAM 0092196 (LSAM)(1F). *TENNESSEE: Sevier Co. GSMNP, Indian Head Tr. 35.60944°N 83.44659°W sift litter. 5290' 20 July 2003. S.O'Keefe/ LSAM 080773 (LSAM)(1F). *same locality/ LSAM 080775 (LSAM)(1F). *same locality/ LSAM 080776 (LSAM)(1F). *same locality/ LSAM 080777 (LSAM)(1F). *same locality/ LSAM 080778 (LSAM)(1F). *same locality/ LSAM 080781 (LSAM)(1F). *same locality/ LSAM 080782 (LSAM)(1F). *same locality/ LSAM 080783 (LSAM)(1F). *same locality/ LSAM 080785 (LSAM)(1F). *same locality/ LSAM 080790 (LSAM)(1F). *same locality/ LSAM 0080792 (LSAM)(1F). *same locality/ LSAM 0080794 (LSAM)(1F). *same locality/ LSAM 0080795 (LSAM)(1F). *same locality/ LSAM 0080796 (LSAM)(1F). *same locality/ LSAM 0080797 (LSAM)(1F). *same locality/ LSAM 0080798 (LSAM)(1F). *same locality/ LSAM 0091649 (LSAM)(1F). *same locality/ LSAM 0091651 (LSAM)(1F). *same locality/ LSAM 0091655 (LSAM)(1F). *same locality/ LSAM 0080772 (LSAM)(1M,dissected). *same locality/ LSAM 080779 (LSAM)(1M). *same locality/ LSAM 080780 (LSAM)(1M). *same locality/ LSAM 0080786 (LSAM)(1M,dissected). *same locality/ LSAM 0080789 (LSAM)(1M,dissected). *same locality/ LSAM 0080791 (LSAM)(1M). *same locality/ LSAM 0080793 (LSAM)(1M,dissected). *same locality/ LSAM 0080799 (LSAM)(1M). *same locality/ LSAM 0091653 (LSAM)(1M,dissected). *U.S.A., TN, Sevier Co. GSMNP, Laurel Falls Trail 83°35'36"W, 35°40'19"N/ elv. 747m, leaf litter berlese 1 July 2001, C.Carlton, V. Moseley, A.Ticheshkin/ LSAM 003231 (LSAM)(1F,dissected). *same locality/ LSAM 0003232 (LSAM)(1F). *same locality/ LSAM 0003233 (LSAM)(1F). *TENNESSEE: Sevier Co., GSMNP Middle Prong Tr. at 35°36.9'N 83°39.4'W 30 July 2004. J.Ciegler/ LSAM 0107270 (LSAM)(1F). *same locality/ LSAM 0109145 (LSAM)(1F). *same locality/ LSAM 0109146 (LSAM)(1F). *TENNESSEE: Sevier Co. GSMNP, lower Middle Prong Tr. @ 35°36.9'N 83°39.4'W. 700m. Forest litter. 30 Jul 2004. J.Ciegler/ LSAM 0095588 (LSAM)(1F). *same locality/ LSAM 0095589 (LSAM)(1F). *same locality/ LSAM 0095590 (LSAM)(1F). *same locality/ LSAM

0095591 (LSAM)(1F). *same locality/ LSAM 0095592 (LSAM)(1F). *same locality/ LSAM 0095593 (LSAM)(1F). *same locality/ LSAM 0095595 (LSAM)(1F). *same locality/ LSAM 0095596 (LSAM)(1F). *TENNESSEE: Sevier Co. GSMNP, Mt LeConte nr. Cliff Top Cabins 35°39'20"N 83°26'40"W. 1980m. Leaf moss litter. 18.VII.2003 A.Mayor&P.Skelly/ LSAM 0091879 (LSAM)(1F). *same locality/ LSAM 0091881 (LSAM)(1F). *same locality/ LSAM 0091883 (LSAM)(1F). *same locality/ LSAM 0091880 (LSAM)(1M). *same locality/ LSAM 0091882 (LSAM)(1M,dissected). *Newfound Gap 16.IX.53 HSD/ Field Mus. Nat Hist. Orlando Park Pselaphidae Colln (FMNH)(2F)(1M,dissected). *USA Tenn.-N.Car.; Sevier Co.; GSMNP Newfound; Gap to Clingmans Dome/Lot #76-107; Oct. 11, 1976; Berlesate; R. Chenowith&R.T.Allen/ LSAM 0036088 (LSAM)(1F). *same locality/ LSAM 0036089 (LSAM)(1F). *same locality/ LSAM 0036091 (LSAM)(1F). *same locality/ LSAM 0036092 (LSAM)(1F). *same locality/ LSAM 0036093 (LSAM)(1F). *U.S.A., TN, Sevier Co. GSMNP, 0.5km NE Newfound Gap, elv. 1600m 83°24'46"W, 35°38'9"N/forest litter Berlese 26 June 2001 C.Carlton, V.Moseley, A. Tishechkin/ LSAM 0002293 (LSAM)(1F). * TENNESSEE: Sevier Co. GSMNP, W Old Settlers Trhd. 35°42.46'N 83°22.9'W Forest litter. 6 Oct 2005 D. Chouljenko, M. Gimmel & A.Hepperman/ LSAM 0091902 (LSAM)(1F). *same locality/ LSAM 0091918 (LSAM)(1F). *USA:, TN, Sevier Co. GSMNP, Porters Crk. Tr. 83°23'52"W,35°40'13"N/ elv.870m, 18Oct. 2001 old growth berlese A.Tishechkin, A.Cline/ LSAM 0017019 (LSAM)(1F). *same locality/ LSAM 001720 (LSAM)(1F). *same locality/ LSAM 0017033 (LSAM)(1F). *same locality/ LSAM 0017034 (LSAM)(1F). *same locality/ LSAM 0017035 (LSAM)(1F). *same locality/ LSAM 0017036 (LSAM)(1F). *TENNESSEE: Sevier Co;. GSMNP, Porters Creek Tr. @35°40.1'N83°23.6'W 850m. Forest litter. 31 July 2004. C.E.Carlton&N.Lowe/ LSAM 0094962 (LSAM)(1F). *same locality/ LSAM 0094968 (LSAM)(1F). *same locality/ LSAM 0094969 (LSAM)(1F). *TENNESSEE: Sevier Co. GSMNP, Porters Creek Tr. Sift litter near rotten logs Beetle Blitz-2003 18 July 2003. S.O'Keefe/ LSAM 0091698 (LSAM)(1F). *same locality/ LSAM 0091699 (LSAM)(1F). *same locality/ LSAM 0091700 (LSAM)(1F). *same locality/ LSAM 0091701 (LSAM)(1F). *same locality/ LSAM 0091702 (LSAM)(1F). *same locality/ LSAM 0091703 (LSAM)(1F). *same locality/ LSAM 0091704 (LSAM)(1F). *same locality/ LSAM 0091705 (LSAM)(1F). *same locality/ LSAM 0091706 (LSAM)(1F). *same locality/ LSAM 0091707 (LSAM)(1F). *same locality/ LSAM 0091708 (LSAM)(1F). *same locality/ LSAM 0091709 (LSAM)(1F). *same locality/ LSAM 0091710 (LSAM)(1F). *same locality/ LSAM 0091711 (LSAM)(1F). *same locality/ LSAM 0091712 (LSAM)(1F). *same locality/ LSAM 0091713 (LSAM)(1F). *same locality/ LSAM 0091714 (LSAM)(1F). *same locality/ LSAM 0091715 (LSAM)(1F). *same locality/ LSAM 0091716 (LSAM)(1F). *same locality/ LSAM 0091717 (LSAM)(1F). *same locality/ LSAM 0091718 (LSAM)(1F). *same locality/ LSAM 0091719 (LSAM)(1F). *same locality/ LSAM 0091720 (LSAM)(1F). *same locality/ LSAM 0091732 (LSAM)(1F). *same locality/ LSAM 0091733 (LSAM)(1F). *same locality/ LSAM 0091734 (LSAM)(1F). *same locality/ LSAM 0091676 (LSAM)(1F). *same locality/ LSAM 0091677 (LSAM)(1F). *same locality/ LSAM 0091678 (LSAM)(1F). *same locality/ LSAM 0091679 (LSAM)(1F). *same locality/ LSAM 0091680 (LSAM)(1F). *same locality/ LSAM 0091681 (LSAM)(1F). *same locality/ LSAM 0091682 (LSAM)(1F). *same locality/ LSAM 0091683 (LSAM)(1F). *same locality/

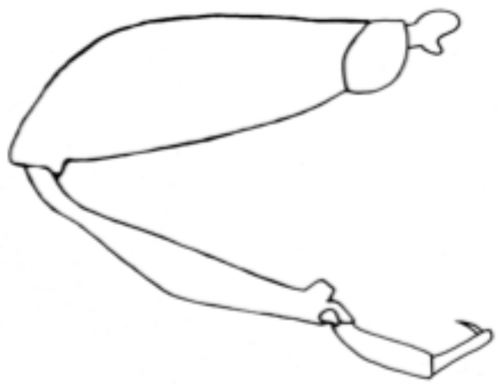
LSAM 0091684 (LSAM)(1F). *same locality/ LSAM 0091685 (LSAM)(1F). *same locality/ LSAM 0091686 (LSAM)(1F). *same locality/ LSAM 0091687 (LSAM)(1F). *same locality/ LSAM 0091688 (LSAM)(1F). *same locality/ LSAM 0091689 (LSAM)(1F). *same locality/ LSAM 0091690 (LSAM)(1F). *same locality/ LSAM 0091691 (LSAM)(1F). *same locality/ LSAM 0091692 (LSAM)(1F). *same locality/ LSAM 0091693 (LSAM)(1F). *same locality/ LSAM 0091694 (LSAM)(1F). *same locality/ LSAM 0091695 (LSAM)(1F). *same locality/ LSAM 0091696 (LSAM)(1F). *same locality/ LSAM 0091697 (LSAM)(1F). *USA: TN: Sevier Co. GSMNP Rainbow Falls snowy litter berlese/ 35°39'42"N/ 83°27'46"W 1500m Carlton Mayer 6 Dec 2003/ LSAM 0109034 (LSAM)(1F). *TENNESSEE: Sevier Co. GSMNP Ramsey Cascades Tr.@38°42.53'N 83°19.21'W 1165m. Forest litter. 10 May 2002. W.D.Merritt/ LSAM 0091940 (LSAM)(1F). *same locality/ LSAM 0091941 (LSAM)(1F). *same locality/ LSAM 0091942 (LSAM)(1F). *U.S.A, TN, Sevier Co., GSMNP Ramsey Cascade Trail(middle) 83°18'24"W, 35°42'34"N/elv.1300m. Forest litter berlese 21 March 2002 CECarlton, VLMoseley/ LSAM 0014845 (LSAM)(1F). *same locality/ LSAM 0014846 (LSAM)(1F). *U.S.A, TN, Sevier Co., GSMNP Ramsey Cascade Trail(upper) 83°18'7"W, 35°42'30"N/elv.1375m. Forest litter berlese 21 March 2002 CECarlton, VLMoseley/ LSAM 0014895 (LSAM)(1F). *same locality/ LSAM 0014896 (LSAM)(1F). *same locality/ LSAM 0014897 (LSAM)(1F). *TENNESSEE: Sevier Co. GSMNP, Road Prong Tr. at 35°36'36"N 83°27'3"W 1580m. Leaf/moss mat litter. 20 July 2003 A.Ticheshkin/ LSAM 0091841 (LSAM)(1F). *same locality/ LSAM 091842 (LSAM)(1F). *same locality/ LSAM 0091844 (LSAM)(1F). *same locality/ LSAM 0091850 (LSAM)(1F). *same locality/ LSAM 0091851 (LSAM)(1F). *same locality/ LSAM 0091852 (LSAM)(1F). *same locality/ LSAM 0091853 (LSAM)(1F). *same locality/ LSAM 0091855 (LSAM)(1F). *same locality/ LSAM 0091857 (LSAM)(1F). *same locality/ LSAM 0091859 (LSAM)(1F). *same locality/ LSAM 0091862 (LSAM)(1F). *same locality/ LSAM 0091863 (LSAM)(1F). *same locality/ LSAM 0091865 (LSAM)(1F). *same locality/ LSAM 0091866 (LSAM)(1F). *same locality/ LSAM 0091869 (LSAM)(1F). *same locality/ LSAM 0091870 (LSAM)(1F). *same locality/ LSAM 0091871 (LSAM)(1F). *same locality/ LSAM 0091874 (LSAM)(1F). *same locality/ LSAM 0091876 (LSAM)(1F). *same locality/ 0091847 (LSAM)(1M,dissected). *USA:TN:Sevier Co. GSMNP, Roaring Fork Area, Rainbow Falls Tr./ 1Aug2002 moist cave Berlese UTM275790E 3949640N C.Carlton/ LSAM 0056862 (LSAM)(1F). *same locality/ LSAM 0056863 (LSAM)(1F). *same locality/ LSAM 0056864 (LSAM)(1F). *same locality/ LSAM 0056865 (LSAM)(1F). *same locality/ LSAM 0056866 (LSAM)(1F). *same locality/ LSAM 0056867 (LSAM)(1F). *same locality/ LSAM 0056868 (LSAM)(1F). *same locality/ LSAM 0056869 (LSAM)(1F). *same locality/ LSAM 0056870 (LSAM)(1F). *same locality/ LSAM 0056871 (LSAM)(1F). *same locality/ LSAM 0056872 (LSAM)(1F). *same locality/ LSAM 0056874 (LSAM)(1F). *same locality/ LSAM 006907 (LSAM)(1F). *same locality/ LSAM 0056908 (LSAM)(1F). *same locality/ LSAM 0056912 (LSAM)(1F). *same locality/ LSAM 0056913 (LSAM)(1F). *same locality/ LSAM 0056914 (LSAM)(1F). *same locality/ LSAM 0056915 (LSAM)(1F). *same locality/ LSAM 0056916 (LSAM)(1F). *same locality/ LSAM 0056925 (LSAM)(1F). *same locality/ LSAM 0056926 (LSAM)(1F). *TENNESSEE: Sevier Co. GSMNP Trillium Gap Tr. @ 35°39.9'N 83°26.2'W 1400m. Forest litter. 29 July 2004. A.

Tishechkin/ LSAM 0091953 (LSAM)(1F). *same locality/ LSAM 0091962 (LSAM)(1F). *same locality/ LSAM 0091970 (LSAM)(1F). *same locality/ LSAM 0091971 (LSAM)(1F). *same locality/ LSAM 0091974 (LSAM)(1F). *same locality/ LSAM 0091975 (LSAM)(1F). *same locality/ LSAM 0091988 (LSAM)(1F). *same locality/ LSAM 0091989 (LSAM)(1F). *same locality/ LSAM 0091995 (LSAM)(1F). *same locality/ LSAM 0091996 (LSAM)(1F). *same locality/ LSAM 0091998 (LSAM)(1F). *same locality/ LSAM 0091999 (LSAM)(1F). *same locality/ LSAM 0094800 (LSAM)(1F). *same locality/ LSAM 0094801 (LSAM)(1F). *same locality/ LSAM 0094802 (LSAM)(1F). *same locality/ LSAM 0094803 (LSAM)(1F). *same locality/ LSAM 0094804 (LSAM)(1F). *same locality/ LSAM 0094805 (LSAM)(1F). *same locality/ LSAM 0094806 (LSAM)(1F). *same locality/ LSAM 0094807 (LSAM)(1F). *same locality/ LSAM 0094808 (LSAM)(1F). *same locality/ LSAM 0094809 (LSAM)(1F). *same locality/ LSAM 0094810 (LSAM)(1F). *same locality/ LSAM 0094811 (LSAM)(1F). *same locality/ LSAM 0094812 (LSAM)(1F). *same locality/ LSAM 0094813 (LSAM)(1F). *same locality/ LASM 0094814 (LSAM)(1F). *same locality/ LSAM 0094815 (LSAM)(1F). *same locality/ LSAM 0094816 (LSAM)(1F). *same locality/ LSAM 0094817 (LSAM)(1F). *same locality/ LSAM 0094818 (LSAM)(1F). *same locality/ LSAM 0094874 (LSAM)(1F). *same locality/ LSAM 0094888 (LSAM)(1F). *same locality/ LSAM 0094889 (LSAM)(1F). *same locality/ LSAM 0094876 (LSAM)(1F). *same locality/ LSAM 0094885 (LSAM)(1F). *same locality/ LSAM 0094892 (LSAM)(1F). *same locality/ LSAM 0107273 (LSAM)(1F). *same locality/ LSAM 0091963 (LSAM)(1M). *same locality/ LSAM 0091972 (LSAM)(1M, dissected). *same locality/ LSAM 0091975 (LSAM)(1M). *same locality/ LSAM 0091977 (LSAM)(1M). *same locality/ LSAM 0091980 (LSAM)(1M). *same locality/ LSAM 0091986 (LSAM)(1M). *same locality/ LSAM 0091997 (LSAM)(1M). * TENNESSEE: Sevier Co. GSMNP, jct. Trillium Gap & Brushy Mt. Trls. 35°40.4'N 83°26.0'W. 1430m. Forest litter. 29 July 2004 C.E.Carlton & J.Ciegler/ LSAM 0091954 (LSAM)(1F). *same locality/ LSAM 0091955 (LSAM)(1F). *same locality/ LSAM 0094825 (LSAM)(1F). *same locality/ LSAM 0094827 (LSAM)(1F). *same locality/ LSAM 0094828 (LSAM)(1F). *same locality/ LSAM 0094829 (LSAM)(1F). *same locality/ LSAM 0094830 (LSAM)(1F). *same locality/ LSAM 0094831 (LSAM)(1F). *same locality/ LSAM 0094832 (LSAM)(1F). *same locality/ LSAM 0094833 (LSAM)(1F). *same locality/ LSAM 0094834 (LSAM)(1F). *same locality/ LSAM 0094836 (LSAM)(1F). *same locality/ LSAM 0094837 (LSAM)(1F). *same locality/ LSAM 0094839 (LSAM)(1F). *same locality/ LSAM 0094840 (LSAM)(1F). *same locality/ LSAM 0094841 (LSAM)(1F). * VA., Giles Co. Jefferson Nat'l. Forest Mt. Lake Tech. Area 4.VII.67/ Rhododendron duff/ H.R.Steeves, Jr. H.R. Steeves III Collectors/ H.R.Steeves, Jr. Collection (FMNH)(1F; 1M). * VIRGINIA: Madison Co., Shenandoah NP, nr. Upper Hawksbill Parking. 38°32.73'N; 78°23.64'W. 1115m. Litter sifting. 3.v.2006. A. Tishechkin/ LSAM 026832 (LSAM)(1F). *same locality/ LSAM 026833 (LSAM)(1F). * Mountain Lake, VA./ VII-23-47 J.H.Davis/ Field Mus. Nat. Hist. Orlando Park Pselaphidae Colln. (FMNH)(1F). * VIRGINIA: Smyth Co., Lewis Fork Wildrns., Mt. Rogers Tr. at 36°39.63'N 81°33.11'W 1540m. Litter sifting. 30 April 2006. A.K.Tishechkin/ LSAM 0108927 (LSAM)(1F). *same locality/ LSAM 0108931 (LSAM)(1F). *same locality/ LSAM 0108932 (LSAM)(1F). *same locality/ LSAM 0108933 (LSAM)(1F). *same locality/ LSAM 0108934 (LSAM)(1F). *same locality/ LSAM 0108935 (LSAM)(1F). *same locality/ LSAM 0108936 (LSAM)(1F). *same locality/ LSAM 0108937 (LSAM)(1F). *same locality/ LSAM 0108938 (LSAM)(1F). *same locality/ LSAM 0108939 (LSAM)(1F). *same locality/ LSAM 0108940 (LSAM)(1F). *same locality/ LSAM 0108941 (LSAM)(1F). *same locality/ LSAM 0108943 (LSAM)(1F). *same locality/ LSAM 0 108942 (LSAM)(1M,dissected). *USA,VA. Smythe Co. 7.5; mi SE Marion, Raccoon; Branch cmpgrnd, v-29-91; sift pine & oak litter; S. O'Keefe collection (DSC)(1M,dissected). * USA: VA, Wash. Co. E of Damascus leaf litter 3.vi.1991 C.E.Carlton/ LSAM 0036109 (LSAM)(1F). *same locality/ LSAM 0036112 (LSAM)(1F). *same locality/ LSAM 0036113 (LSAM)(1F). *USA WV Fayette Co. 35mi N Beckley18-III-83 JFcornellExConiferlitter JFC983-III-18-4 (LSAM)(1M,dissected). * W. Virginia: Mercer Co. Camp Ck. St. Forest. IV:8:1971. Leg: S. Bird. FM(HD)#71-72/ Eutyphlus similis det. DSChandler (FMNH)(1F; 1M,dissected). * WVPocahontasCo Snedegar'sCave (illegible) 10-vi-1989 JPCornall (illegible) forest litter (NCSUIM)(1F; 6M,1dissected).

3.4.5 *Eutyphlus* n. sp. Owens & Carlton

Holotype. (male) USA: NC. Macon Co. 10 mi SW Franklin; Back Country info center; V-22-1991; Berlese oak & Rhododendron; S.O'Keefe (LSAM)(1M,dissected).

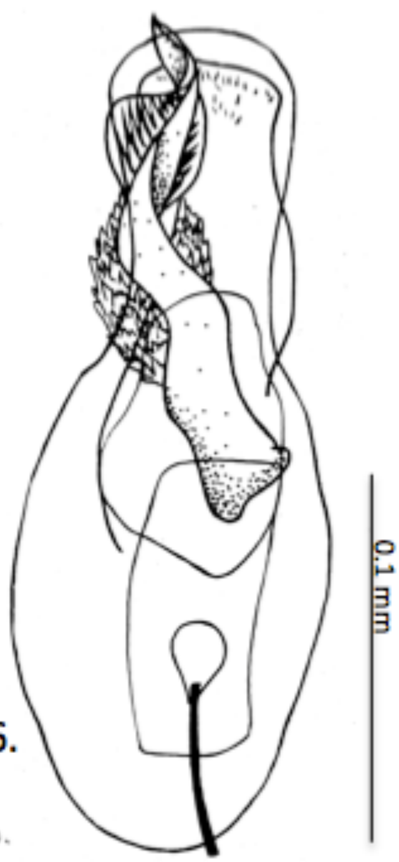
Diagnosis. *Eutyphlus* n. sp. is similar to *E. dybasi*, externally, based on the absence of anteroprosternal foveae, the presence of secondary sexual characters on the legs of males (Figs. 94, 95), the quadrifoveate elytra, concave metaventrite, and the larger, broadly ovate 7^{th} ventrite of males. In *E.* n. sp., the right paramere of the aedeagus is ventrally located and expanded distally towards the left (the right paramere of *E. dybasi* is expanded distally towards the right), and left paramere is dorsally located and twisted counter-clockwise and bearing a series of spines along both sides of the process (the left paramere of *E. dybasi* is expanded distally into a process bearing ctenidial spines along one face) (Fig. 96). Females of this species are unknown.



94.

95.

Fig. 94. male protibia with flange, *Eutyphlus* n. sp. Fig. 95. male mesotibia with subapical spine and mesotrochanter with flange, *Eutyphlus* n. sp.



96.

Fig. 96. aedeagus, *Eutyphlus* n. sp.

Description of Male. Holotype. Measurements: HL 0.20 mm, HW 0.29 mm; PL 0.35 mm, PW 0.33 mm; EL 0.56 mm, EW 0.56 mm; A1-6, respectively, 0.02, 0.16, 0.15, 0.12, 0.11, 0.3 mm; An1–11, respectively, 0.10, 0.05, 0.03, 0.02, 0.02, 0.02, 0.03, 0.03, 0.04, 0.04, 0.11 mm. MP1–4, respectively, 0.01, 0.05, 0.01, 0.05 mm. GL 0.23 mm, GW 0.14 mm. ML 1.63 mm. Integument: Typical for genus. Head: Head slightly narrower than pronotum. Eyes present and well-developed with 27 facets, slightly emarginate posteriorly, ocular canthus weakly developed, projecting weakly laterally and sloping gently to gular area. Ventral surface of head level, slightly rounded in gular area, gular sulcus well-developed anteriorly and projecting to margin of posteriorly located, paired, gular foveae. Thorax: Prothorax with basolateral margin slightly crenulate, median longitudinal sulcus present, area behind basal sulcus with thin longitudinal sulcus extending from basal bead to basal sulcus. Prosternum lacking anteroprosternal foveae. Protibia with apical spine. Mesotrochanter with tubercle, mesotibia with apical flange. Metaventrite slightly concave baso-medially. Elytra bearing three basal foveae, as well as subhumeral foveae. Wings well-developed. Abdomen: Tergites un-modified. Seventh ventrite broadly oval. Other ventrites unmodified. Genitalia: Aedeagus asymmetrical. Broad, membranous lobe dorsal. This process closely associated with left paramere that is twisted counter-clockwise distally, bearing a row of ctenidial spines on both sides. Median lobe with distal fimbriated process. Right paramere most ventral, flattened, distally expanded towards the left, with apical patch of very sparse, scattered, short, suberect setae.

Female. Unknown.

Variations. Unknown

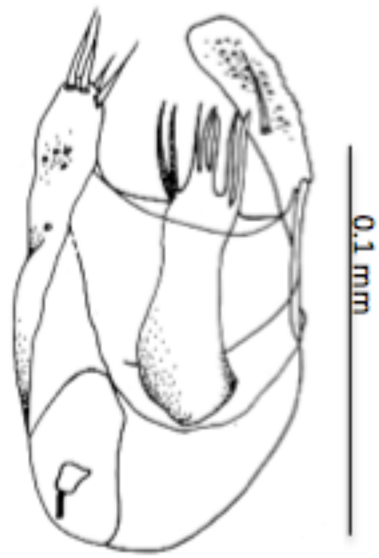
Bionomics. Seasonality. The type species was collected in May. Elevation. The elevation at the type locality is 646 m. Habitat/Microhabitat. The holotype was collected from oak and rhododendron litter. Collecting methods. The holotype was collected by sifting material and then processing it via a Berlese funnel.

Distribution. This species was known from a single specimen collected in Macon County, North Carolina (Fig. 97).

Fig. 97. Distribution of *E.* n. sp. Green dots indicate county records.

3.4.6 *Eutyphlus thoracicus* Park

Diagnosis. *Eutyphlus thoracicus* is distinguished from all known *Eutyphlus* species by the generally smaller body size and the absence of a longitudinal pronotal sulcus as well as by the left paramere of the aedeagus forming a sclerotized bar bearing small spicules and setae, and possessing a single, elongate, median, seta and the right paramere attached ventrally, flattened and bearing four distal setae (Fig. 98).



98.

Fig. 98. aedeagus, *Eutyphlus thoracicus.*

Redescription. Male. Measurements: HL 0.14 mm, HW 0.20 mm; PL 0.21 mm, PW 0.20 mm; EL 0.34 mm, EW 0.38 mm; A1–6, respectively, 0.03, 0.11, 0.10, 0.09, 0.09, 0.02 mm. An1–11, respectively, 0.05, 0.03, 0.01, 0.01, 0.01, 0.01, 0.02, 0.02, 0.02, 0.03, 0.09 mm. MP1–4, respectively, 0.01, 0.03, 0.01, 0.03 mm. GL 0.05 mm, GW 0.04 mm. ML 1.20 mm. Integument: Typical for genus. Capitate genal setae sparse. Head: About as wide as pronotum. Vertex bearing small, longitudinal depression extending dorsally from posterior margin of head to about the margin of the eye. Eyes present, well-developed, with 27 facets, convex, about as long as wide. Ocular canthus weakly developed, projecting laterally and sloping gently to gular area. Ventral surface of head slightly rounded in gular area, gular carina or sulcus absent or weakly developed anteriorly, posteriorly located paired, gular foveae present. Thorax: Pronotum with lateral margin smooth, median longitudinal sulcus absent, area behind basal sulcus smooth. Prosternum bearing anteroprosternal foveae. Paired median mesoventral fovea present. Metaventrite flat. Elytra bearing two basal foveae, as well as subhumeral foveae. Wings present and well-developed. Abdomen: Tergites unmodified. Fourth ventrite bearing small basolateral foveae. Seventh ventrite small and strap-like. Other ventrites unmodified. Genitalia: Aedeagus asymmetrical. Left paramere most dorsal, oblique, forming a sclerotized bar bearing small spicules and setae, and possessing a single, elongate, median, seta. Median lobe modified into internal, fimbriated process associated with internal, membranous sac. Right paramere attached ventrally, flattened and bearing four distal setae.

Female. Measurements: HL 0.16 mm, HW 0.16 mm; PL 0.23 mm, PW 0.21 mm; EL 0.30 mm, EW 0.29 mm; A1–6, respectively, 0.02, 0.11, 0.10, 0.10, 0.08, 0.04 mm. An1–11, respectively, 0.04, 0.02, 0.01, 0.01, 0.01, 0.01, 0.01, 0.01, 0.02, 0.03, 0.07 mm. MP1–4, respectively, 0.01, 0.03, 0.01, 0.03 mm. ML 1.20 mm. Integument, Head, Thorax, Abdomen: Similar to male except eyes completely absent, ocular canthus weakly developed. Tempora rounded and nearly parallel. Pronotum more quadrate. Seventh ventrite small and transverse. Genitalia: Female genitalia membranous, completely lacking sclerotization. Produced into somewhat elongate, median membranous structure and billowy right sac.

Variations. Although generally smaller than members of other species, size is sufficiently variable that it is not reliably diagnostic. Degree of pronotal convexity varied slightly. The aedeagus of *E. thoracicus* varied little among individuals, but three distal setae were present on the right, ventrally located paramere of a few specimens instead of the usual four.

Bionomics. Published information on the biology of *E. thoracicus* was absent. Seasonality. The specimens of *E. thoracicus* included in this study were all collected from late winter/early spring through the fall (earliest collection 21 February; latest 20 October). Elevation. Specimens were obtained from between 870m and 1920m elections. Habitat/Microhabitat. Specimens were collected from hardwood forest litter, *Rhododendron* litter, oak litter, spruce litter, fir litter, and old-growth forest mixed litter. Several individuals were also collected from moss mats. Collecting methods. The majority of individuals were collected via litter sifting and Berlese extraction. Several individuals were collected in flight intercept traps.

Distribution. The species is known from Georgia (Dade County), North Carolina (Haywood, Macon, Sway, and Yancy Counties), Tennessee (Blount, Cocke, and Sevier Counties), Virginia (Washington County), and West Virginia (Pocahontas County) (Fig. 99).

Fig. 99. Distribution of *E. thoracicus.* Green dots indicate county records.

Material Examined**. (**n=150). *TENNESSEE: Sevier Co. GSMNP, Trillium Gap Tr. @ 35°39.9'N 83°26.2'W 1400m. Forest litter. 29 July 2004. A.Tishechkin/ LSAM 0080787 (LSAM)(slide mounted male)(description of male based on this specimen). *TENNESSEE:Sevier Co.; GSMNP, Trillium Gap Tr. @; 35°39.9'N 83°26.2'W; 1400m.

Forest litter. 29 July; 2004. A.Tishechkin/ LSAM 0091650 (LSAM)(slide mounted female)(description of female based on this specimen). *Rocky Creek Gap Smoky Mts. Nat. Pk. Tenn. 1X:14:53, SA-HD/ Field Mus. Nat. Hist. Orlando Park Pselaphidae Colln./ (orange label) HOLOTYPE/ Eutyphlus thoracicus. Park, nsp. (FMNH)(1M; HOLOTYPE). *same locality/ (orange label) PARATYPE. (FMNH)(2F). *Chimney Cp. Gr Smoky Mts. N. P. Tenn.16:IX:53 Auerbach #5/ Field Mus. Nat. Hist Orlando Park Pselaphidae Colln./ (orange label) PARATYPE (FMNH)(1F). *Chimney Cp. Gr Smoky Mts. N. P. Tenn.16:IX:53 Auerbach #5/ Field Mus. Nat. Hist Orlando Park Pselaphidae Colln./ (orange label) PARATYPE (FMNH)(1F). *Cloudland Canyon S. Pk. Dade Co., GA. 14.VI.62 Forest floor debris/ H.R. Steeves, Jr. J.D.Patrick Jr. Collectors/ H.R.Steeves Jr. Collection (FMNH)(5F). * N CAROLINA: Haywood Co. GSMNP, Caldwell Fork Tr. At UTM 30897 E 3940883 N. Moist forest Berlese. 3 August 2002. C.Carlton & N. Lowe/ LSAM 0091744 (LSAM)(1F)* same locality/ LSAM 0091745 (LSAM)(1F). *same locality/LSAM 0091746 (LSAM)(1F). *same locality/LSAM 0091747 (LSAM)(1F). *same locality/ LSAM 0091748 (LSAM)(1F). *same locality/ LSAM 0091749 (LSAM)(1F). *same locality/ LSAM 0091750 (LSAM)(1F). *same locality/ LSAM 0091751 (LSAM)(1F). *same locality/ LSAM 0091752 (LSAM)(1F). *same locality/ LSAM 0091753 (LSAM)(1F). *same locality/ LSAM 9901754 (LSAM)(1F). *same locality/ LSAM 0091756 (LSAM)(1F). *same locality/ LSAM 0091757 (LSAM)(1F). *same locality/ LSAM 0091758 (LSAM)(1F). *same locality/ LSAM 0091759 (LSAM)(1F). *same locality/ LSAM 0091761 (LSAM)(1F). *same locality/ LSAM 0091762 (LSAM)(1F). *same locality/ LSAM 0091765 (LSAM)(1F). *same locality/ LSAM 0091760 (LSAM)(1M,dissected). *same locality/ LSAM 0091766 (LSAM)(1M,dissected). *USA: NC Haywood Co. GSMNP McKee Branch Tr. 35°35'6"N 83°05'W/ 1370m 16Jul-12Aug2002 FIT C.Carlton & S.Gil/ LSAM 002823 (LSAM)(1M,dissected). *N CAROLINA: Haywood Co. GSMNP, Mt. Sterling Gap. 35°42.0'N 83°5.9'W 1190m. Forest litter. 29 July 2004. R.T.Allen/ LSAM 0095711 (LSAM)(1F). *same locality/ LSAM 0095714 (LSAM)(1F). *same locality/ LSAM 005715 (LSAM)(1F). *same locality/ LSAM 0095716 (LSAM)(1F). *same locality/ LSAM 0095717 (LSAM)(1F). *same locality/ LSAM 0095718 (LSAM)(1F). *same locality/ LSAM 0095179 (LSAM)(1F). *same locality/ LSAM 0095720 (LSAM)(1F). *same locality/ LSAM 0095721 (LSAM)(1F). *same locality/ LSAM 0095722 (LSAM)(1F). *same locality/ LSAM 0095723 (LSAM)(1F). *same locality/ LSAM 0095724 (LSAM)(1F). *same locality/ LSAM 0095725 (LSAM)(1F). *same locality/ LSAM 0095726 (LSAM)(1F). *same locality/ LSAM 0107303 (LSAM)(1F). *same locality/ LSAM 0107304 (LSAM)(1F). *same locality/ LSAM 0107305 (LSAM)(1M,dissected). *USA: NC: Haywood Co. GSMNP Purchase Knob, berlese/ 313124E 3939640N 5089ft. 20 Jul 2002 CCarlton/ LSAM 092275 (1F). *same locality/ LSAM 0184049 (LSAM)(1F). *same locality/ LSAM 0112678 (LSAM)(1F). *same locality/ LSAM 0184048 (LSAM)(1M). *USA: NC: Macon Co. 3 mi NW Highlands v-29-1983, sift rhododendron litter, DSChandler (DENH)(7F). *USA: NC: Swain Co GSMNP Appalachian Tr. 1.5 mi NE Newfound Gap/ 281639E 3944038N ridgetop berlese 18 Jul 2002 CCarlton/ LSAM 0092340 (LSAM)(1F). *same locality/ LSAM 0092341 (LSAM)(1F). *same locality/ LSAM 0092343 (LSAM)(1F). *N CAROLINA: Swain Co. Appalachian Tr. ~1.5mi E Newfound Gap. 35°36.96'N 83°24.66'W 1730m. Forest litter; 18 July 2002. C.Carlton/ LSAM 091922

(LSAM)(1F). *U.S.A., NC, Swain Co.; GSMNP, Beech Gap Tr.; 83°12'32"W, 35°38'23"N/ elv. 1400m, 20, Oct. 2001; N. hardwood berlese; LSAM, C.Carlton/ LSAM 0017039 (LSAM)(1F). *same locality/ LSAM 0017038 (LSAM)(1F). *N CAROLINA: Swain Co. GSMNP, jct. of Beech Gap & Hyatt Ridge Trails 35°37.82'N 83°42.07'W 1495m. Forest litter. 2 Oct 2005. W.D.Merritt/ LSAM 0094959 (LSAM)(1F). *same locality/ LSAM 0094960 (LSAM)(1F). *same locality/ LSAM 0094961 (LSAM)(1F). *USA N.C. Swain Co. Dirt Ri. From Heintooga Overlook to Cherokee/ Lot #76-102 Oct. 14, 1976 Berlesate 5000'-4500' R.Chenowith & R.Tallen/ LSAM 0036050 (LSAM)(1F). *same locality/ LSAM 0036051 (LSAM)(1F). *same locality/ LSAM 0036052 (LSAM)(1F). *same locality/ LSAM 0036053 (LSAM)(1F). *same locality/ LSAM 0036054 (LSAM)(1F). *same locality/ LSAM 0036056 (LSAM)(1F). *same locality/ LSAM 0036058 (LSAM)(1F,dissected). *U.S.A., NC, Swain Co. GSMNP, Flat Creek Trail 83°10'21"W, 35°33'1"N/ elv. 1500m, leaf litter Berlese, 31 July 2001. A. Tishechkin/ LSAM 0002507 (LSAM)(1M,dissected). *N CAROLINA: Swain Co. GSMNP, Jenkins Ridge Tr. ~1mi from Appalachian Tr. 35°33.75'N 83°43.2'W 1540m. Forest litter. 30 Jul 2004. A.K.Tishechkin/ LSAM 0094947 (LSAM)(1F). *same locality/ LSAM 0094949 (LSAM)(1F). *same locality/ LSAM 0094957 (LSAM)(1F). *N CAROLINA: Swain Co. GSMNP, upper Jenkins Ridge Tr. At 35°33.75'N 83°43.2'W.1540m. Leaf litter 31 Jul 2004. A.K.Tishechkin/ LSAM 0107307 (LSAM)(1F). *N.CAR. Swain Co. Mt. Collins 5900' v.21.1977 A.Newton, M.Thayer (DENH)(2F). *N CAROLINA: Swain Co. GSMNP, Noland Divide Tr. at 35°33'57"N 83°28'36"W 1770m.Leaf/moss mat litter 19 July 2003. A.Tishechkin/ LSAM 0080751 (LSAM)(1F). *same locality/ LSAM 0080739 (LSAM)(1F). *USA:NC. Yancey Co. Black Mtn. info cntr v-21-1991 sift fir-oak S.O'Keefe collr (DENH) (3m,1dissected). *USA: NC, Yancy Co. B.R. Pkwy. 37.4 mi. SW intersection US 221 elv. 4600' log litter 2.vi.1991 C.E.Carlton/ LSAM 036103 (LSAM)(1F). *SC: Oconee Co. 6.7 mi NNW Walhalla 1.vii 1983 1760' hdwd forest litter J. Pakaluk #148 (DENH)(1M,dissected). *TENNESSEE: Blount Co. GSMNP, App. Tr. ~0.5mi E Thunderhead Mt. summit 35°34.05'N 83°43.05'W 1510m. Forest litter. 30 Jul 2004 A.K.Tishechkin/ LSAM 0094916 (LSAM)(1F). *same locality/ LSAM 0094917 (LSAM)(1F). *same locality/ LSAM 0094918 (LSAM)(1F). *same locality/ LSAM 0094919 (LSAM)(1F). *same locality/ LSAM 0094921 (LSAM)(1F). *TENNESSEE: Blount Co. GSMNP, App. Tr. ~0.5km W Mt. Thunderhead summit at 35°34.11'N 83°42.00'W 1585m. Forest litter sifting 13 April 2006. A.K.Tishechkin/ LSAM 0107287 (LSAM)(1F). *same locality/ LSAM 0107289 (LSAM)(1F). *same locality/ LSAM 0107290 (LSAM)(1F). *same locality/ LSAM 0107294 (LSAM)(1F). *USA: TN, Blount Co. 5.8mi. ECling. Dome 1.vi.1991 C.E.Carlton/ LSAM 0036098 (LSAM)(1F). *same locality/ LSAM 0036100 (LSAM)(1F). *TENNESSEE: Blount Co. GSMNP, Gregory Cave entrance. 35°33.74'N 83°51.624'W. Litter. 28 July 2004. V.Bayless, C.Carlton & A.Tishechkin/ LSAM 095706/ (LSAM)(1F). *TENNESSEE: Blount Co. GSMNP, lower Gregory Ridge Tr. @ 35°33.5'N 83°30.5'W. 630m. For. Litter 28 Jul 2004. A.K.Tishechkin/ LSAM 0095709 (LSAM)(1F). *same locality/ LSAM 0095708 (LSAM)(1F). *same locality/ LSAM 0095707 (LSAM)(1F). *TENNESSEE: Cocke Co. GSMNP, Albright Grove Loop Tr. Ca. 950m. Berlese near rotten longs 19 July 2003. S.O'Keefe/ LSAM 0096239 (LSAM)(1F). *same locality/ LSAM 0096240 (LSAM)(1F). *USA Tenn Cocke Co. GSMNP Cosly Creek Trail/ Lot#76-105 Oct. 15, 1976 Berlesate

R.Chenowith&R.T.Allen/ LSAM 0036047 (LSAM)(1F). *same locality/ LSAM 0036048 (LSAM)(1F). *same locality/ LSAM 0036049 (LSAM)(1F). *same locality/ LSAM 0036081 (LSAM)(1F). *TENNESSEE: Sevier Co. GSMNP, App. Tr. Just W of Sweat Heifer Cr. Trhd. 1720m 35°37.3'N 83°24.35'W. Forest litter. 14 April 2006. C.Carlton/ LSAM 0107281 (LSAM)(1F). *TENNESSEE: Sevier Co. GSMNP, Indian Head Tr. 35.60944°N 83.44659°W Sift litter. 5290' 20 July 2003. S.O'Keefe/ LSAM 0091650 (LSAM)(1F,dissected). *same locality/ LSAM 0091652 (LSAM)(1F). *same locality/ LSAM 0080787 (LSAM)(1M,dissected). *same locality/ LSAM 0080788 (LSAM)(1M). *USA-TN: Sevier Co. GSMNP. Mount LeConte, Alum Cave Tr. at 35°39.33'N 83°26.75'W, 1920m, spruce-fir litter berlese Sokolov I.M 6 Oct 2008 (LSAM)(3F; 3M,1dissected). *TENNESSEE: Sevier Co. GSMNP, Porters Creek Tr. Sift litter near rotten logs Beetle Blitz- 2003 18 July 2003. S.O'Keefe/ LSAM 0091721 (LSAM)(1F). *same locality/ LSAM 0091722 (LSAM)(1F). *same locality/ LSAM 0091727 (LSAM)(1F). *same locality/ LSAM 0091728 (LSAM)(1F). *same locality/ LSAM 0091729 (LSAM)(1F). *same locality/ LSAM 0091730 (LSAM)(1F). *same locality/ LSAM 0091735 (LSAM)(1F). *same locality/ LSAM 0091736 (LSAM)(1F). *same locality/ LSAM 0091737 (LSAM)(1F). *U.S.A., TN, Sevier Co. GSMNP, Porters Crk. Tr. 83°23'52"W, 35°40'13"N/ elv. 870 m, 18 Oct. 2001 old growth berlese A.Tishechkin, A. Cline/ LSAM 0017021 (LSAM)(1F). *same locality/ LSAM 0017024 (LSAM)(1F). *same locality/ LSAM 0091723 (LSAM)(1M,dissected). *same locality/ LSAM 0091725 (LSAM)(1M,dissected). *same locality/LSAM 0091726 (LSAM)(1M,dissected). *same locality/ LSAM 0091731 (LSAM)(1M,dissected). *TENNESSEE: Sevier Co. GSMNP, Road Prong Trail 35°36'36"N 83°27'3"W 1580m. Leaf/moss mat litter. 20 July 2003 A.Tishechkin/ LSAM 0091846 (LSAM)(1F). *same locality/ LSAM 0091861 (LSAM)(1F). *same locality/ LSAM 0091875 (LSAM)(1F). *same locality/ LSAM 0091873 (LSAM)(1M,dissected). *USA: TN: Sevier Co. GSMNP, Roaring Fork Area, Rainbow Falls Tr UTM 275540 E 3949710 N, Moist forest Berlese 1Aug2002 CEC/ LSAM 0056859 (LSAM)(1F). *same locality/ LSAM 0056860 (LSAM)(1F). *same locality/ LSAM 0056861 (LSAM)(1F). *same locality/ LSAM 0056873 (LSAM)(1F). *same locality/ LSAM 056909 (LSAM)(1F). *same locality/ LSAM 0056910 (LSAM)(1F,dissected). *TENNESSEE: Sevier Co. Trillium Gap Tr. @ 35°39.9'N 83°26.2'W 1400m. Forest litter. 29 July; 2004. A.Tishechkin/ LSAM 0091994 (LSAM)(1F,dissected). *USA Tenn.-N.Car. Sevier Co. GSMNP, Newfound Gap to Clingman's Dome/ Lot #76-107 Oct. 11, 1976 Berlesate R.Chenowith & R.T.Allen/ LSAM 0036094 (LSAM)(1F). *same locality/ LSAM 0036095 (LSAM)(1F). * USA: VA, Wash. Co. E. of Damascus leaf litter 3.vi.1991 C.E.Carlton/ LSAM 0036110 (LSAM)(1M,dissected). *USA: WV. Pocahontas Co. 6 mi SE Marltinon Co. forest trail #407, off Hwy 92, v-16-1991, sift oak litter, S.O'Keefe (DENH)(1F).

3.5 Key to species

Eyes well-developed, convex (Fig. 75); pineal plate rounded-oval to minute and strap-like (Fig. 76) (males) Key A

Eyes vestigial, of a few facets or completely absent; ventrite 7 not visible or slightly concave triangular (females) Key B

KEY A

1. Possessing secondary sexual characters in the form of excavations on abdominal ventrites. (2)

1.’ Lacking secondary sexual characters on abdomen, ventrites smooth and unmodified. (3)

2. Modifications on ventrites limited to excavations on 3rd visible ventrite with lamellae and shelf extending over excavation, 4th variously excavated contiguous with third (Figs. 83-88); aedeagus with single process associated with dorsal paramere (Fig. 78). *E. prominens,*

2.’ Modifications on ventrites more extensive, including excavations on the 5th (Fig. 89); aedeagus more complex, possessing additional process on either side associated with dorsal and ventral parameres (Fig. 79). *E. schmitti.*

3. Pronotum with median sulcus. (4)

3.’ Pronotum lacking median sulcus. *E. thoracicus*.

4. Each elytron with three basal foveae in addition to subhumeral and sutural foveae; males with combination of modifications on the

protibiae, mesotibiae and mesotrochanter, and metatrochanter (Figs. 90—92); mesoventrite concave; pineal plate large and rounded-oval. (5)

4.' Elytra with one or two basal foveae in addition to subhumeral and sutural foveae; males lacking any modifications on the legs; mesoventrite convex; pineal plate minute and strap-like. *E. similis.*

5. Aedeagus with left paramere located dorsally, distal end expanded with terminal brush of ctenidial spines, right paramere ventral and and expanded distally to the right (Fig. 77). *E. dybasi.*

5.' Aedeagus with left paramere located dorsally, distal end twisted, bearing row of ctenidial spines along both sides of process, right paramere ventral and expanded distally to the left (Fig. 81). *E.* n. sp.

KEY B

1. Eyes poorly developed to absent (typically < 12 facets); elytra with or two basal foveae in addition to subhumeral and sutural foveae; ventrite 7 not broadly triangular; genitalia consisting of median and right membranous sacs. (2)

1.' Eyes more robust and convex (typically > 12 facets); elytra with three basal foveae in addition to subhumeral and sutural foveae; ventrite 7 broadly triangular and slightly concave; female genitalia of different form, broadly triangular membranous with Y-shaped sclerotized internal process. *E. dybasi.*

2. Eyes comprising at least a few facets (occasional exceptions may

occur in which no facets are present), ocular canthus well-developed; pronotum with median longitudinal sulcus. (3)

2.' Eyes completely absent, ocular canthus poorly developed; pronotum lacking median longitudinal sulcus. *E. thoracicus.*

3. Basal pronotal sulcus slightly "u-shaped" between basal foveae, pronotum crenulate to slightly crenulate; more southeastern in distribution (mainly south of PA). (*E. similis* and *E. prominens*).

3.' Basal pronotal sulcus straight between basal foveae, pronotum smooth or barely crenulate; more Northeastern in distribution (mainly PA to NH). *E. schmitti.*

3.6 Checklist of Species (Mod. after Chandler 1997)

EUTYPHLUS LeConte, 1880
Eutyphlus LeConte 1880: 185 (as genus).
TYPE SPECIES: *Eutyphlus similis* LeConte, 1880.
Nicotheus Casey 1884b: 121 (as genus) [synonymized with *Eutyphlus* LeConte by Horn, 1885].
TYPE SPECIES: *Nicothaeus tibialis* Casey 1884b [synonymized with *Eutyphlus similis* LeConte by Horn, 1885].
Nicothaeus (error) Raffray 1890a: 102 (description in French).
REDESCRIPTION: Grigarick and Schuster, 1980.
DISTRIBUTION: Eastern United States (AL AR GA TN SC NC VA WV MD OH IL PA NH NJ NY).

Subgenus *EUTYPHLUS* LeConte
E. dybasi Park, 1956.
E. dybasi Park 1956: 58.
TYPE DEPOSITORY: FMNH.
TYPE LOCALITY: Smoky Mountains, TN.
SEX OF TYPE: M.
DISTRIBUTION: GA NC TN.
HABITAT: Leaf litter (hardwood litter, tulip tree, oak, alder, and *Rhododendron*).
E. prominens Casey, 1894.
E. prominens Casey 1894: 460.
TYPE DEPOSITORY: USNM.
TYPE LOCALITY: Lee County, VA.
SEX OF TYPE: F.

DISTRIBUTION: GA MD NC NY SC TN VA WV.

HABITAT: Leaf litter (old growth litter, pine, oak, *Rhododendron,* litter near rotting wood); rotted wood.

E. schmitti Raffray, 1904.

E. schmitti Raffray 1904a: 546, fig. 9 (description in French).

TYPE DEPOSITORY: MNHP.

SEX OF TYPE: M.

DISTRIBUTION: OH NC NH NJ NY PA VA WV.

HABITAT: Leaf litter (hardwood litter, deciduous litter, birch, beech, and *Rhododendron*); *Sphagnum* moss.

E. similis LeConte, 1880.

E. similis LeConte 1880: 186.

TYPE DEPOSITORY: MCZC.

TYPE LOCALITY: "Washington" (presumably D.C.).

SEX OF TYPE: F.

DISTRIBUTION: AL AR GA IL KY MD NC NY OH PA SC TN VA WV.

HABITAT: Leaf litter (hardwood litter, old growth litter, oak, beech, *Rhododendron,* conifer litter, pine, spruce, fir); litter accumulation in caes; rotten logs and stumps; tree-hole debris; gill fungi.

N. tibialis Casey 1884

N. tibialis Casey 1884b: 121 [synonymized by Horn, 1885]

TYPE DEPOSITORY: USNM

SEX OF TYPE: M.

HOST: Leaf litter (various hardwoods); rotten logs.

E. spiralis Carlton & Owens, 2014 (n. sp.).

TYPE DEPOSITORY: FMNH.

TYPE LOCALITY: Macon Co., NC.

SEX OF TYPE: M.

DISTRIBUTION: NC: Macon Co., 10 mi. SW Franklin.

HOST: Leaf litter (oak and *Rhododendron*).

Subgenus *PLANITYPHLUS* Park

Planityphlus Park, 1956

Planityphlus Park 1956: 62 (as subgenus)

TYPE SPECIES: *Eutyphlus thoracicus* Park (original description)

E. thoracicus Park, 1956.

E. thoracicus Park 1956: 60.

TYPE DEPOSITORY: FMNH.

TYPE LOCALITY: Smoky Mountains, TN.

SEX OF TYPE: M.

DISTRIBUTION: GA NC SC TN VA WV.

HOST: Leaf litter (hardwood litter, old growth litter, oak, spruce-fir, *Rhododendron*, litter near rotten logs); moss mats.

CHAPTER 4. PHYLOGENETIC ANALYSIS OF THE SUBTRIBE PANAPHANTINA JEANNEL TESTING THE MONOPHYLY OF THE GENUS *EUTYPHLUS* LECONTE

4.1 Introduction

A phylogenetic analysis conducted to supplement the revision resulted in the generation of a phylogenetic hypothesis of the relationships between the newly revised *Eutyphlus* and other genera of the Panaphantina. This was included in the interest of strengthening the hypothesis for the monophyly or non-monophyly of this genus within the subtribe and exploring the phylogenetic relationships of species within the genus, itself.

4.2 Materials and Methods

A phylogenetic analysis based on morphological characters was performed to test for the monophyly of *Eutyphlus* and determine genus group (tribe and subtribe) placement of the six species. One hundred and six morphological characters were included in this analysis (Table 4). Characters were based on preliminary data sets from utilized from a Carlton and Chandler (unpublished) with additional characters based on detailed study of ingroup taxa.

A representative of each species of *Eutyphlus* (male) was included in the character matrix. Representatives of 37 genera were included from 12 tribes (Appendix A). Taxon selection was guided by the classification presented by Chandler (2001). At least one representative (male) subtribes of the Trichonychini available for study were included in the analysis (sixteen genera). Additionally, representatives (male) from other tribes within the Euplectitae were included as follows: Euplectini (three genera), Trogastrini (two genera), Jubini (two genera), Mayetiini (one genus), Dimerini (one genus), Metopiasini (one genus), and Bythinoplectini (one genera). More distant outgroups were included from the tribes Brachyglutini, Tychini, Bythinini, Batrisini and Faronini.

Specimens were prepared as described for *Eutyphlus*. A character matrix was constructed in Mesquite (version 2.75) (Maddison & Maddison 2011). The data matrix was analyzed using Nona (Goloboff 1999) in WinClada (version 0.9.9) (Nixon 1999). Characters were un-weighted and unordered. Maximum parsimony and Bootstrap trees were generated.

Table 4. List of the characters and character states used in the data matrix.

1	Surface of integument: squamous, at least in patches=0; normally pubescent=1; completely nude, glabrous=2
2	"U" or "V" shaped vertexal sulcus: absent=0; present=1
3	Interantennal median sulcus: absent=0; present=1
4	Frontal foveae: absent=0; present, paired=1; present, single=2
5	Vertexal foveae: present=0; absent=1
6	Antennal acetabula: remote=0; approximate=1
7	Antennal rostrum: indistinct=0; distinct=1
8	Palpal cavities: absent=0; present=1
9	Palpal rest: absent=0; present=1
10	Specialized genal setae: absent=0; capitate or frayed=1; dense genal beard=2
11	Gular secondary sexual characters (male): absent=0; present=1
12	Gular foveae: present, paired and distant=0; present, paired, common round opening=1, absent=2
13	Number of antennomeres: 11=0; 10=1; 5-9=2; extremely reduced, 2-4=3
14	Form and number of segments in antennal club: Feebly clavate=0; club apparent, 2-4 segmented=1; club apparent, single segment=2; club absent=3
15	Mouthparts: exposed=0; partly enclosed and reduced=1
16	Gular carina/sulcus: absent=0; straight=1; forked=2, gular sulcus=3
17	Ocular canthus: present=0; absent=1
18	Apex of cardo: not prolonged or spinose=0; prolonged, typically spinose=1
19	Labrum shape: normal, quadrate=0; transverse, reduced=1; transverse, lobate=2
20	Labral sensory pegs: absent=0; present, simple=1; present, curved elongate=2
21	Maxillary palpomere number: 4=0; 3=1; 2=2; 1=3
22	Maxillary palpomere 2: absent=0; linear=1; extremely elongate=2; globose=3
23	Maxillary palpomere 2 lateral margin: absent=0; smooth or with minute setae only=1; spinose or densely setose=2; bispinose=3; studded with tubercles=4
24	Maxillary palpomere 3: absent=0; less than 1.5 times as long as wide=1; two times or more as long as wide=2
25	Maxillary palpomere 3 lateral margin: absent=0; smooth=1; lobed=2; spinose or densely setose=3; studded with tubercles=4
26	Maxillary palpomere 3, base: absent=0; quadrate or triangular=1; pedunculate=2

(Table 4 continued). List of the characters and character states used in the data matrix.

27	Maxillary palpomere 3 mesal margin: absent=0; rounded or straight=1; angulate=2; asymmetrically rounded=3
28	Maxillary palpomere 3 length: absent=0; less than one-half the length of palpomere 4=1; more than one half the length of four or equal to four=2; longer than four=3
29	Maxillary palpomere 4, length: lacking=0; short=1; normal=2; elongate=3
30	Maxillary palpomere 4, width: wider than 3=0; subequal to 3=1; narrower than three=2; lacking=3
31	Maxillary palpomere 4, lateral margin: palpomere lacking=0; smooth=1; lobed=2; prolonged or angulate=3; spinose or setose=4; studded with tubercles=5
32	Maxillary palpomere 4, lateral margin: palpomere lacking=0; convex or rounded=1; constricted in apical half=2
33	Maxillary palpomere 4, shape: elongate=0; transverse=1; palpomere lacking=3
34	Palpal cone: palpomere lacking=0; apical=1; lateral=2; internalized=3
35	Additional structure on fourth palpal segment: absent=0; present=1
36	Palpal cone socket: palpomere lacking=0; small=1; large=2; internalized=3
37	Median antebasal pronotal foveae: absent=0; present, typical, as large as lateral antebasal foveae=1; present, reduced, pit-like=2
38	Lateral antebasal pronotal foveae: absent=0; present=2
39	Inner basolateral foveae: 0=absent; 1=present
40	Outer basolateral foveae: absent=0; present=1
41	Anterolateral discal foveae: absent=0; present=1
42	Pronotal disc: simple=0; paramedian carina=1; paramedian spine series=2
43	Pronotum, median longitudinal sulcus: absent=0; present=1
44	Pronotum, median longitudinal carina from basal bead to disc: absent=0; present=1
45	Pronotum, median longitudinal sulcus from basal bead to sulcus: absent=0; present=1
46	Pronotum lateral margin : rounded=0; margined, incomplete=1; margined, complete=2
47	Pronotum, basolateral tooth: absent=0; present=1
48	Pronotum, antebasal tubercles: absent=0; present=1
49	Pronotum, apical lobe: absent=0; distinct lobe=1; pedunculate=2
50	Pronotum antebasal sulcus: absent=0; present=1
51	Prosternum: smooth=0; carinate=1
52	Prosternum shape: slightly convex=0; concave=1
53	Lateral procoxal foveae: absent=0; present=1
54	Anterior lateral prosternal foveae: absent=0; present=1
55	Median procoxal foveae: absent=0; present=1
56	Mesosternum median carina: absent=0; present=1
57	Median mesosternal foveae: absent=0; present, paired=1; present, forked=2; present, single=3
58	Lateral mesosternal foveae: absent=0; present, simple or forked=1; present, meeting internally=2
59	Prepectal foveae: absent=0; present=1
60	Promesocoxal foveae: absent=0; present=1
61	Lateral mesocoxal foveae: absent=0; present=1
62	Median metasternal foveae: absent=0; present=1
63	Lateral metasternal foveae: absent=0; present, separate=1; present, fused, single=2
64	Elytral subhumeral foveae: absent=0; present=1
65	Elytral sutural striae: absent=0; present=1
66	Elytral basal foveae: absent=0; 2-3=1; 1=2
67	Elytral subhumeral foveae: absent=0; present=1
68	Elytral discal foveae: absent=0; present=1

(Table 4 continued). List of the characters and character states used in the data matrix.

69	Elytral discal stria: absent=0; present, one-half length of elytra=1; present, extending to near apex=2
70	Lateroapical cleft: present=0; absent=1
71	Mesocoxae: contiguous=0; narrowly separate=1; widely separated=2
72	Metacoxae: conjunct=0; narrowly separate=1; distant=2
73	Mesotrochanter/femora articulations: oblique, posterior margin less than one times the length of contact=0; perpendicular, margin greater than two times the length of contact=1; intermediate, margin 1.0-1.5 times the length of contact=2
74	Metacoxa, trochanter articulation: prominent=0; flat=1
75	Tarsomere number: 3=0; 1 and 2 fused, 2 apparent=1
76	Tarsomere 2 lengths: short, shorter or subequal to 1=0; subequal to three=1
77	Male mesotibia: simple=0; single preapical=1; apical and preapical=2
78	Male metatrochanter: simple=0; spined=1
79	Male mesotrochanter: simple=0; modified with spine or tubercle=1
80	Male protrochanter: simple=0; spined=1
81	Paratergites, visible tergite 1: flexible=0; fused, 2 carinae=1; fused, single carina=2
82	Lateral foveae visible tergite 1: present=0; absent=1
83	Mediobasal foveae visible tergite 1: present=0; absent=1
84	Visible tergite 2 setose basal sulcus: present=0; absent=1
85	Tergite 1 setose basal sulcus: absent=0; present, laterally delimited by foveae=1; present, not laterally delimited by foveae=2
86	Basal apophyses of abdomen: separate, foveal cavities normally developed=0; conjunct/continuous, foveal cavities developed as large internal tubular cavities=1
87	Intercoxal process: acute=0; truncate=1; absent=2; triangular rounded=3; short rounded=4
88	Metacoxal lines and posterior margin of ventrite 1: not reaching posterior margin of ventrite 1=0; reaching apex of ventrite 1, ventrite 1 clearly visible laterally=1; ventrite 1 completely covered=2
89	Ventrite number: typical 6-7=0; 1-3 apparent=1
90	Ventrites 1-3 lateral carinae: absent=0; present=1
91	Ventrite 2, basolateral foveae: absent=0; present=1
92	Ventrite 2, mediobasal foveae: absent=0; present=1
93	Ventrite 2 basal sulcus: setose=0; laterally setose=1; nude=2; flat=3
94	Male sternite 3 excavation: absent=0; present=1
95	Male sternite 3 excavated laterally with lamina and projecting lobe: absent=0; present=1
96	Male sternite 4 with excavation: absent=0; present=1
97	Male sternite 5 with excavation: absent=0; present=1
98	Males with sternite secondary sexual characters: absent=0; present=1
99	Male ventrite 7 (pineal plate): ovoid, elongate=0; short, transverse=1; internalized=2; minute and strap-like=3; divided=4
100	Phallobase, basal bulb: distinct=0; reduced=1
101	Phallobase with ventrolateral accessory process: absent=0; present=1
102	Parameres: present=0; absent=1
103	Aedeagal diaphragm: present=0; absent=1
104	Aedeagus with ventrobasal projection: absent=0; present=1
105	Parameres: symmetrical=0; asymmetrical=1; absent=2
106	Median lobe: symmetrical=0; asymmetrical=1

Table 5. Character matrix of the taxa and morphological characters.

Taxa	Character Number
	00000000011111111112222222222333333333344444444445555
	12345678901234567890123456789012345678901234567890123
Arthmius bulbifer	10000000000101001001011111112011010101000000000000011
Hendecameros panamaea	10000100000121031001011111122011111111100010020011001
Barroeuplectoides sp.	11000001000101001001011111112011010111000010011000001
Euplectus confluens	11000000000101031001011111112011010121000010010011001
Leptoplectus pertenuis	11000000000101001001011111112111010121000010010001001
Pycnoplectus linearis	11000000000101001001011111112011010121000010010011001
Jubus sp.	11000000000101021121011111112011010111100000111011001
Sebaga sp.	11000000000101021121011111112011010101100000110011011
Mayetia domestica	11000000000101000001031111122111010100000001000000001
Metopias sp.	10000110000101031001011111112011011121000000010000001
Foveoscapha terracola	11000000000101031001011111112011010111000010110011011
Bibloplectus cherokee	11030000000101031001011111112011010111000000010001001
Eutyphlus dybasi	11000000101010310010111111120110101010000101100011 01
Eutyphlus n. sp.	11000000101010310010111111120110101010000101100011 01
Eutyphlus prominens	11000000101010310010111111120110101010000110100011 01
Eutyphlus schmitti	11000000101010310010111111120110101010000110100011 01
Eutyphlus similis	11000000101010310010111111120110101010000101100011 01
Eutyphlus thoracicus	11000000101010010010111111120110101010000000100011 01
Pseudactium carolinae	11000000101010010010111111120110101010000101100110 01
Rhinoscepsis bistriatus	11000110000000100100101111111201101011110010111011001
Thesiastes sp.	11000000000101001001011111112011010111000010010011001
Thesium sp.	11000000000101031001011111112011010111110010110011001
Trimioplectus australis	11000000101010110010111111120110101110000000100001011
Actiastes globiferum	11000000101010310010111111120110101110000000100111 11
Dalmosanus quercavum	11000000101010310010111111120110101110000000100001001
Dalmosella tenuis	11000000101010310010111111120110101010000000100210 01
Hanfordia sp.	11000000000101011001011111112011010100000000000001001
Melba clypeata	11000000101010310010111111120110101010000000100001000
Trimiomelba dubia	11000000101010310010111111120110101110000000000001000
Trimium brevicorne	11000000101010310010111111120110101010000000100001000
Quadrelba sp.	11000000000101011001011111112011010100000000000001001
Conoplectus acornus	11000000201010110010111111120110101010000101100010 11
Rhexius sp.	11000000201010310010111111120110101110002101110210 11
Sonoma baylessae	10131000000000000002001111111201101311122000000000001
Reichenbachia howardi	10030000000101031001011111112011010121000000000000011
Pselaptrichus perfidus	11000110101101001001024141113011010101000000000001001
Lucifotychus cognatus	11000110000101001002021212323111010121110000010000001

(Table 5 continued). Character matrix of the taxa and morphological characters.

Taxa	Character Number
	55555566666666667777777777888888888899999999991111111
	45678901234567890123456789012345678901234567890123456
Arthmius bulbifer	00111001011110000010001101000011010001110000030000011
Hendecameros panamaea	00101011011111001000110000000101001000100000010010021
Barroeuplectoides sp.	10011011011111010000001000000001001001000000040010021
Euplectus confluens	10021001001111010010001100000111000001011010140000011
Leptoplectus pertenuis	10031001011111010000001100000011000001110000040000011
Pycnoplectus linearis	00011001001111010010001100001001000000110011140000011
Jubus sp.	00032001001111001000001000001112001001110000000000011
Sebaga sp.	00032001001121001000001000001112001001110000000000011
Mayetia domestica	00000000000000000010111000001102010000000000040010021
Metopias sp.	00001001111111001000010111000010100000010000000100000
Foveoscapha terracola	00011001011111010000001000000011000001110000010000011
Bibloplectus cherokee	00001001011111000000001000000011000001020000000000011
Eutyphlus dybasi	00011001011111010000001111000111000001010000000000011
Eutyphlus n. sp.	00011001011111010000001110000111000001010000000000011
Eutyphlus prominens	10011001011111010000001000000111001001011110130000011
Eutyphlus schmitti	10011001011111010000001000000111001001011011130000011
Eutyphlus similis	10011001011111010000001000000111000001010000030000011
Eutyphlus thoracicus	10011001011111010000001000000111001001010000030000011
Pseudactium carolinae	00011001011111011010001110001112000001010000000000011
Rhinoscepsis bistriatus	00001001111121020010001100001112001001010000000000011
Thesiastes sp.	00011001011111011010001100000001000001010010100000011
Thesium sp.	10031011011111011200001100000111000001000000000000011
Trimioplectus australis	00022001001120011010001101100011000001001111000000011
Actiastes globiferum	00011001001111011010001100000111001001020000000000011
Dalmosanus quercavum	00031001011121000010001000000111010001020000100000011
Dalmosella tenuis	00001001001121001000001000000111000001020000000000011
Hanfordia sp.	00032000001120000010001111001112000001000000000000011
Melba clypeata	00002000001110000010001101000111000001011110100000011
Trimiomelba dubia	00032000011120000010001000000111000001000000000000010
Trimium brevicorne	00032011001120001000001000000111000001000000000000011
Quadrelba sp.	00032001011121000000001100000111000001010000000000011
Conoplectus acornus	00012001011111000000001100000011000001110000000000011
Rhexius sp.	00012001001111010000001100000011000001110000000000011
Sonoma baylessae	01001111111111111000000000000110000000000000000001011
Reichenbachia howardi	00032001011110020020001100000011010001110000030000000
Pselaptrichus perfidus	00031001011111000111001000000111030001110000000000000
Lucifotychus cognatus	00012001011110010111001010000011031001110000010000000

4.3 Results

Cladistic analysis of the data matrix resulted in 26 equally most parsimonious trees (length= 347, CI=0.37, RI=0.52).

In the preferred tree selected for illustration (Fig. 100) *Sonoma baylessae* was recovered as sister to all other included taxa. A clade comprising two panaphantine genera, *Rhinoscepsis* and *Trimioplect*us, was recovered as sister to the remaining taxa. Remaining taxa were supported by five synapomorphies (14=1, 17=1, 20=1, 68=0, 71=0) and one homoplasious character (50=1). *Hendecameros*, the single representative of the Bythinoplectini diverged based on a number of homoplasies and a single apomorphy (13=2). The clade containing the remaining taxa was supported by five synapomorphies (2=1, 12=1, 35=0, 60=0, 91=1).

Two homoplasies (39=0, 49=0) supported a clade comprised of all representatives of the Trimiina, plus members of the genus *Bibloplectus* (subtribe Panaphantina) and Mayetiini. *Bibloplectus* was sister to Trimiina, and *Mayetia* was nested within the trimiine taxa close to the genus *Hanfordia*. The second branch, linked by the homoplasies (45=1, 57=3), contained *Eutyphlus* and a number of trichonychine genera and genera from the remaining Euplectitae tribes and supertribes, with the exception of the basal Faronitae.

The two genera of the tribe Jubini were recovered as sister taxa based on a number of synapomorphies and homoplasies. *Thesium* was not recovered with other panaphantines. *Actiastes* was not recovered with the other trimiine genera but was included as sister with *Pseudactium*.

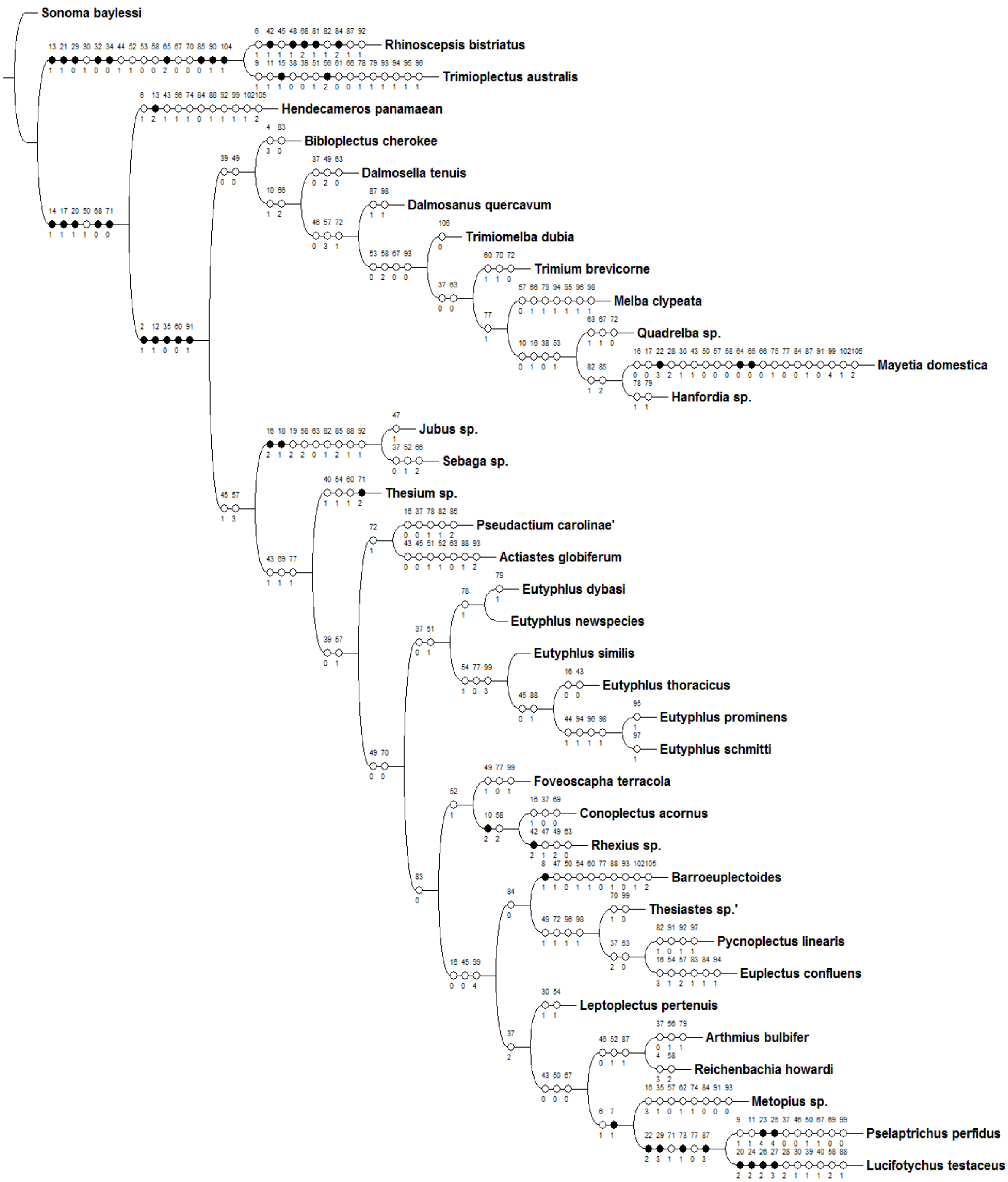


Fig. 100. Example tree of 26 most parsimonious trees (Length= 347, CI=0.37, RI=0.52) with character states mapped. Open circles indicate homoplasious characters; black circles indicate unambiguous characters. Characters are listed above circles; character states are below circles.

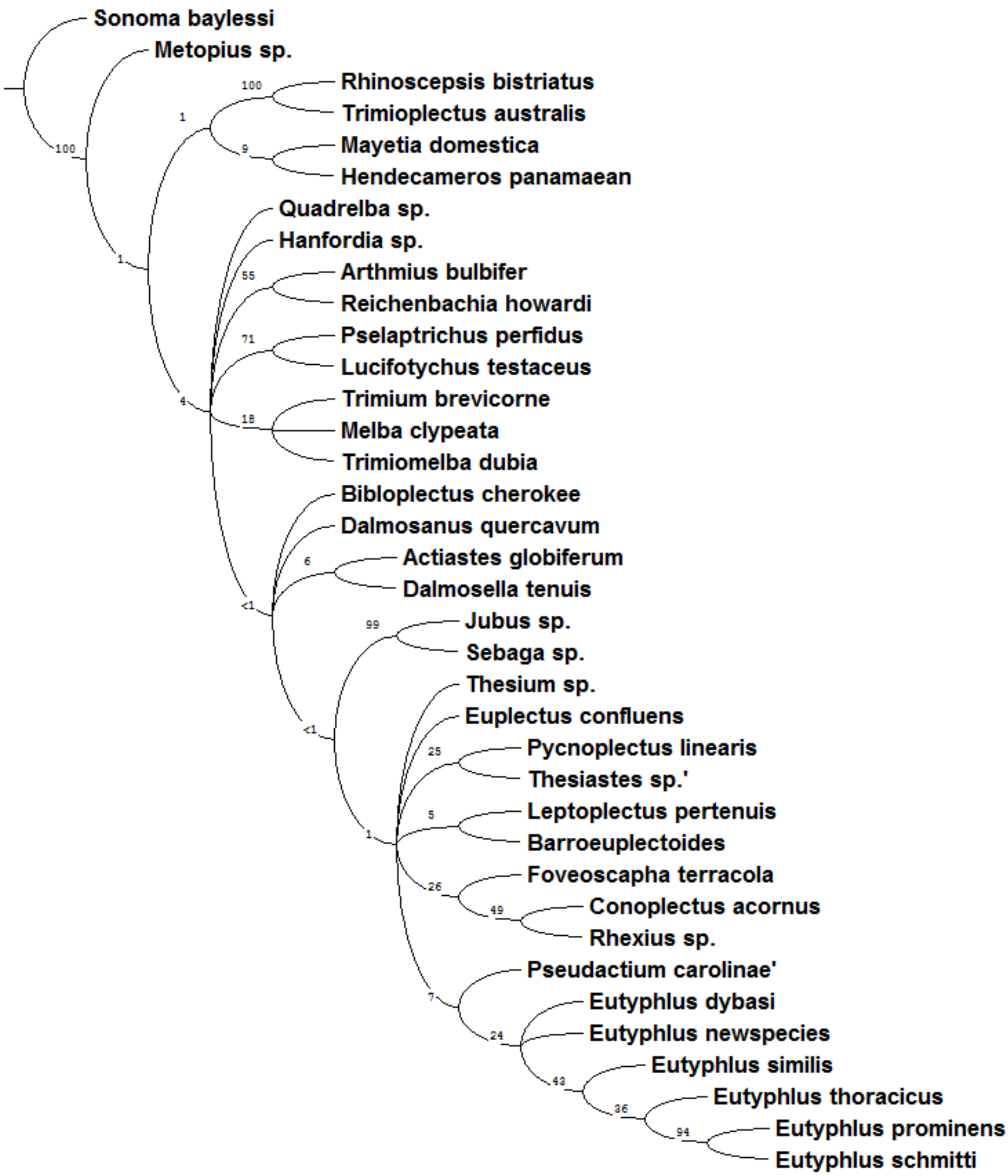


Fig. 101. Maximum likelihood tree provided by bootstrapping (L= 453, CI=0.34, RI=0.34). Support values are listed by corresponding branches.

Eutyphlus was recovered as monophyletic, grouped with other members of the Panaphantina excluding *Thesium* based on two homoplasies. Within the genus, *E. dybasi* and *E.* n. sp. formed a sister clade to the other 4 species based on a single character (78=1). The remaining species were grouped as *E. similis* sister to *E. thoracicus* and the *E. schmitti* sister to *E. prominens.*

Other clades included a mixture of trichonychine genera on trees that differed in topology among various equally parsimonious trees. Non-trichonychine genera generally segregated on the trees with batrisine and goniacerine genera as sister taxa and the two representatives of the Tychini recovered as sister taxa.

Bootstrap support was low for many of the internal branches of the tree (Fig, 101). Four branches on the tree had a branch support above 90%. The branch from *Sonoma* and linking the rest of the taxa in the tree, the branch supporting the *Rhinoscepsis*-*Trimioplectus* clade, the branch supporting the Jubini clade, and the branch linking *E. prominens* and *E. schmitti* had branch supports of 1.0, 1.0, 0.99, and 0.94, respectively. The next highest branch support was one of 0.71 for the goniacerine clade containing *Pselaptrichus* and *Lucifotychus*. The branch containing *Arthmius* and *Reichenbachia* had a support of 0.55. The rest of the branches in the tree had a support below 0.50.

4.4 Discussion

The main objective of the phylogenetic analysis was to test for the monophyly of *Eutyphlus.* Although branch support was low, monophyly of the genus was supported by several homoplasious character states. These results, in addition to the relatively straightforward diagnosis of the genus using easily observable external characters, argue for retaining genus status for this group of species.

Several tribes and subtribes were recovered as paraphyletic among different branches of the tree. Only the Bythinoplectini, Jubini, Trogastrini, Dimerini, and Metopiasini formed monophyletic branches, and only the Bythinoplectini and Jubini were not nested within other tribes.

The supertribe Euplectitae is a collection of tribes and subtribes that have been taxonomically defined on the basis of regional treatments, with previously untreated genera sometimes placed into these taxa arbitrarily (Newton and Chandler 1989). The subjective nature of these higher level classifications have resulted in downstream issues for the classification of large genus groups that share a number of distinct morphological features, yet cannot be separated in a consistent manner under the current system. In addition, a number of characters exhibited by the Euplectitae, such as foveae and sulci, have proven to be highly variable within tribes and supertribes, sometimes differing extensively between genera and even at the level of species. This results in large number of homoplasious characters and requires inclusion of a large number of outgroups within the Euplectitae and other supertribes to polarize characters for tree rooting. Homoplasy is a particularly vexing problem with the external characters available for use in morphological phylogenetic analysis and this may reflect conserved developmental genes that may be turned on and off in phylogenetically remote taxa. Thus, these characters are poor indicators of relationship at genus group nodes (tribe and subtribe), but may provide phylogenetically shallow nodes within genera), as required in the present study for testing monophyly of *Eutyphlus*.

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APPENDIX. CHECKLIST OF TAXA IN PHYLOGENETIC ANALYSIS

SUPERTRIBE BATRISITAE

TRIBE BATRISINI Reitter

Arthmius bulbifer Casey 1983:

USA: AR, Montgomery Co. approx. 5 mi. W. of Little Mo. Falls rec. Area MVLT 25.vii.1991 C.E. Carlton

SUPERTRIBE EUPLECTITAE

TRIBE BYTHINOPLECTINI Schaufuss

Hendecameros panamaea Comellini 1985:

PANAMA: Colon Pr., San Lorenzo Forest. 9°17'N 79°58'W. Flight intercept FIT-C1-5. 27-28.ix.2003 A. Tishechkin – IBISCA'03. LSAM 0267471

TRIBE DIMERINI Raffray

Barroeuplectoides sp. Park 1942:

BELIZE: Orange Walk Dist. Rio Bravo Conservation Area La Milpa Ruins 17.IV.1995 P.W.Kovarik rot. Log. Berlese det. C. Carlton 1995

TRIBE EUPLECTINI Streubel

Euplectus confluens LeConte 1849:

USA, AR, Newton Co. Buf. Nat. Riv. Kyles Landing Hdwd. Berlesate 10. Mar. 1988 C.Carlton

Leptoplectus pertenuis (Casey) 1884:

USA, Ark, Polk Co, Shady Lake Rec. Area, 1200ft. Hdwd-pine berlese. 13 Oct. 1974 A. Newton

Pycnoplectus linearis (LeConte) 1849:

FLORIDA: Alachua Co. 29°34½'N, 82°29'W 18-X-1994 Randall W. Lundgren Flight-barrier trap in hardwood hammock det. C. Carlton 1996

TRIBE JUBINI Raffray

Jubus sp. Schaufuss 1872:

ECUADOR, Azuay Pr. 45 km NE Cuenca, 195 elv. 2850 m, 1 Jan 1992 cloud forest Berlese C. Carlton, R. Leschen

Sebaga sp. Raffray 1891:

BELIZE: Orange Walk Dist. Rio Bravo Cons. Area Research Station 15-20 IV 1995, F.I.T. P.W. Kovarik

TRIBE MAYETIINI Winkler

Mayetia domestica Shuster, Marsh, and Park 1959:

USA: MO: Taney Co., Ozark Underground Lab 36.5789°N, 92.8641°W. 19.X.2007, soil under fungi, #998. L.F. Watrous

TRIBE METOPIASINI Raffray

Metopias sp. Gory 1832:

ECUADOR: Depto. Orellana, Res. Ethnica Waorani, 1 km S Onkone Gare Camp, Trans. Ent. 0°39'10"S 76°26'W. 220m. 5 February 1996 T.L. Erwin et al. collectors Insecticidal fogging of mostly bare green leaves, some with covering of lichenous or bryophytic plants in terra firme forest. Project MAXUS Lot 1427 Trans. 3 Sta. 7

TRIBE TRICHONYCHINI Reitter

Subtribe Trichonychina Reitter

Foveoscapha terracola Park & Wagner 1962:

USA: Washington, Pierce Co. Mt Rainier NP, 1000ft N Green Lake, 12.3 mi (19.8km) SE Wilkeson UTM: 10Z, 586840mE, 5203500mN elev:3360ft 27Oct1996 E.A. Lisowski Berlese of rotting wood and forest litter #105-01

Subtribe Panaphantina Jeannel

Bibloplectus cherokee Chandler 1990:

USA: LA: Bossier Par Bodcau WMA. UVLT 22 May 1996 C.Carlton/ V. Moseley LSAM0004940. Det. CE CARLTON 2002

Eutyphlus dybasi Park 1956:

USA: TN: Cocke Co. GSMNP Snake Den Ridge Trail btw 299077 3957780 & 299657 3957885 CWright June 2005 LSAM 0092176

Eutyphlus n. sp. Carlton & Owens:

USA: NC: Macon Co. 10 mi SW Franklin; Back country info center; V-22-1991; Berlese oak & Rhododendron; S.O'Keefe

Eutyphlus prominens Park 1956:

TENNESSEE: Sevier Co. GSMNP, Trillium Gap Tr. @ 35°39.9'N 83°26.2'W 1400m. Forest litter. 29 July 2004. A. Tishechkin LSAM 0094878

Eutyphlus schmitti Raffray 1904:

USA: PA: Jeffer. Co., Cook State Forest 0.4 mi S Cooksburg Mohawk Trail. VI-6-1997, DSChandler hardwood leaf litt.

Eutyphlus similis LeConte 1880:

USA: Tenn. Cocke Co. GSMNP Colby Creek Trail Lot #76-106 Oct 15, 1976 Berlesate R. Chenowith & R.T. Allen LSAM0036068

Eutyphlus thoracicus Park 1956:

N CAROLINA: Haywood Co. GSMNP, Caldwell Fork Tr. At UTM 30897 E 3940883 N. Moist forest Berlese. 3 August 2002. C.Carlton & N.Lowe LSAM 0091766

Pseudactium carolinae Casey 1908:

USA, TX, Sabine Co. 9 mi. E Hemphill Beech Bottom 11 May 1988 beech, magnolia sifter R. Anderson

Rhinoscepsis bistriatus LeConte 1878:

Crescent City, Fla. Coll Hubbard & Schwarz

Thesiastes sp. Casey 1894:

Falls Church 6:iv:1919 Va EA Chapin Collector

Thesium sp. Casey 1884:

USA Ark. Scot Co. 6.7 Mi. S. Inters Hwys. 270 & 71 on 71 Lot #77-103 July 25, 1977 Berlesate Hardwood-Pine Chenowith, Carlton, Heiss

Trimioplectus australis Chandler 1990:

USA, AR, Polk Co. Rich Mt., Eagleton Overlook Berlesate R.T. Allen, 17 Feb. 1988

Subtribe Trimiina Bowman

Actiastes globiferum (LeConte) 1849:

Nashville Tenn H Soltau Collection

Dalmosanus quercavum (Chandler) 1990:

USA Ark. St. Francis Co. 6.5 Mi. NW. Inters Hwys 79 & 38 on 38 Lot #77-23 March 10, 1977 Berlesate Oak R Chenowith LSAM0039912

Dalmosella tenuis Casey 1878:

USA, AR, Cross Co., Village Crk. St. Pk. Camp loop A Berlesate 7 Feb. 1989 C. E. Carlton

Hanfordia sp. Park 1960:

BELIZE: Orange Walk Dist. Rio Bravo Conservation Area La Milpa ruins, 18.IV.1995 Atta debris pile, P.W. Kovarik det. C. Carlton 1995

Melba clypeata (Reitter) 1883:

Virgin IS: St Croix Est. Rust-up-Twist North Shore Rd. 01Oct1987, M.A. Ivie under bark

Trimiomelba dubia (LeConte) 1849:

USA: TX Brewster Co. Big Bend N.P., Cattail Falls, elv. 1310m 6 Sept 1988 hdwd. Berlesate R. Anderson

Trimium brevicorne (Reichenbach) 1816

PQ# A20402 DC 9.XII.32 in moss, taking from Czechoslovzk USNM

Quadrelba sp. Park 1942:

VIRGIN IS: St. John Bordeaux Mt. Elv.1150 ft. 13-AUG 1980 M A Ivie Colr. Rotten Log

TRIBE TROGASTRINI Jeannel

Subtribe Trogastrina Jeannel

Conoplectus acornus Carlton 1983:

USA Ark. Fulton Co. 1.4 Mi. N. Inters. Hwys. 62& 289 on 289 Lot #77-186 Oct. 18, 1977 Berlesate Hardwoods R. Chenowith

Subtribe Rhexiina Park

Rhexius sp. LeConte 1849:

USA, Ark., Desha Co. 1.9mi. W. intersec. Hwy. 65+I59 on I59. Bottomland Hdwd. Mar. 8, 1977 Chenowith 77-19

SUPERTRIBE FARONITAE

Sonoma baylessae Ferro & Carlton 2010:

USA Tenn-N. Car. Sevier Co. GSMNP, Newfound Gap to Mt. Le Conte Lot #77-74 June 22, 1977 Berlesate 5000’-6300’ R. Chenowith & J. Keiss

SUPERTRIBE GONIACERITAE

TRIBE BRACHYGLUTINI Raffray

Reichenbachia howardi Park 1958:
Gueydan La Aug 7 1925 EKalmbach At lights

TRIBE BYTHININI Raffray

Pselaptrichus perfidus Schuster & Marsh 1956:
USA: Washington, King Co. Mt. Baker-Snoqualmie Nat. Forest. 0.8 mi SSW Mount Defiance summit 11.3 mi ESE North Bend UTM: 10Z, 607800mE, 5253180mN Elev: 3200ft, 1-ix-1996 E.A. Lisowski #523-01 berlese of moss and liverworts on wood

TRIBE TYCHINI Raffray

Lucifotychus cognatus (LeConte) 1874:
USA: WASHINGTON, Yakima Co. #567-1 ravine north of Wild rose Campground 3.8mi(6.1km) ENERimrock UTM: 10Z, 649460mE, 5170760mN Elev:2650ft, 780m 15-II-1998, EA Lisowski Berlese creek litter

VITA

Brittany E. Owens was born and raised in southeastern Louisiana. She attended Tulane University from August 2008 to May 2012 and received a bachelor's of science degree in Ecology and Evolutionary Biology. Upon completion of her B.S. degree, Brittany was admitted to the entomology department graduate program at LSU. Since then she has been working on her master's of science degree in Entomology under Dr. Christopher Carlton on projects involving the systematics and taxonomy of Pselaphines. She will receive her master's degree this December and plans to begin work on her doctorate upon graduation.