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Using Oribatid Mites as a Measure of Biodiversity

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ABSTRACT

Oribatid, or beetle, mites constitute an extremely diverse and numerous group of leaf-litter inhabiting arthropods. A good leaf-litter sample may include some 50 to 100 different species of mites that may number a few thousand individual specimens. Adult beetle mites range in size from a staggering 1.5 mm to 0.25 mm. This great diversity of species and abundance of specimens within most samples makes beetle mites a potentially useful group in which to assess biodiversity; however, the quite small body size and potentially thousands of individuals, makes a challenge to sort and identify all of the specimens that may occur in a single sample. The objective of this project was to develop a foundation in the collection, processing, and preparation of beetle mites in order to establish a basis from which biodiversity comparisons could be implemented. Beetle mites from Kentucky, California, Arizona, Alabama, Florida, South Carolina, and Costa Rica were used to build an initial synoptic series of oribatid mite diversity.

INTRODUCTION

Biodiversity refers to the variety of species within a group of organisms found in a specific habitat or ecosystem. Biodiversity is important to humans because it can be an indicator of possible environmental decay and sustainability of an area. Groups that are suitable for biodiversity often contain organisms that are easily affected by the environment, easily identified, and are well known. Mammals, birds, and plants are often used to measure and monitor biodiversity. Although, these organisms are usually studied, in a small area these organisms are few in species and have few number of individuals. Oribatid mites, referred to as beetle mites, armored mites or moss mites, can be indicators of environmental health because they have long life spans, low fecundity, slow development, low dispersion ability, with a large number of species and an extreme number of individuals in a small area (Gulvik. 2007). Oribatids can show humans the direct impact that they have on the environment.

Oribatid mites constitute 172 families that include some 9,000 species (Norton and Behan-Pelleticer. 2009). Oribatids dwell within the soil-litter system. Oribatid mites are detritivores, feeding on dead organic material, and fungivores, feeding on fungi, but can also be opportunistic predators. They are described as being "hyper-diverse" due to the range in body size (15 to 2000 µm) (Fig. 1). The vast number of species and morphological differences could be related to competition or area occupied within the soil.

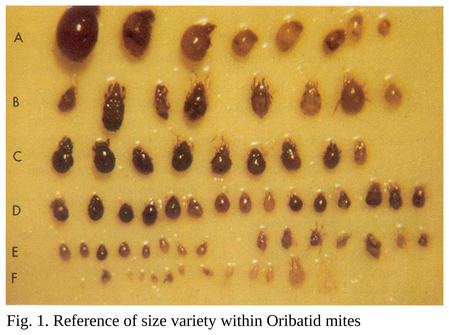

Fig. 1. Reference of size variety within Oribatid mites

Due to the small size of these mites, the leaf litter is dominated with Oribatids. These mites show trophic flexibility (Walter. 1999). This means they can live in many different microhabitats within the forest ecosystem, and they are found in a variety of ecosystems. The beetle mites of the same family are widespread across the country. For some areas, it is possible that 100-150 species exist in a density of 100,000 mites m-2 (Moldenka and Fitcher. 1988). The dominance of these mites in a forest means a sample can have many of these specimens for a study. The great diversity and abundance of Oribatids can assist researchers in measuring the biodiversity within an area.

Oribatids' small size made them very difficult to identify. When viewing under a dissecting microscope, not all features or relativity of dimension was completely seen. Mites within a family can have different characteristics as well. An overall appearance may not fit a specimen into a family but underlying morphology may fit them into the family. In order to observe the characters of these small organisms, they need to be mounted on microscope slides. The mites were mounted on temporary slides containing glycerin because often the mites need to be rotated to view specific features. The process of identification came with a steep learning curve because of the techniques for handling such small organisms, the ability to view key characteristics, and the learning of a large word-bank of unfamiliar morphological terms.

We were able to use mites from collections that included samples from Kentucky, California, Arizona, Alabama, Florida, South Carolina, and Costa Rica. Although we had samples from all these locations, different species from the same family were represented in many of these samples. Some mites were specific to only one location. Some species were in abundance while there was only one or two of another species within the entirety of the collection. The study conducted was designed to specifically craft skills when working with mites.

MATERIALS and METHODS

Collection of Mites:

In a wooded area we obtained a large amount of leaf litter, usually near downed logs or tree buttresses. We placed this leaf litter into the sifter (Fig. 2). The material is then sifted by briskly shaking the sifter from side to side as well as up and down. Large items, such as leaves or rocks, remained on the screen while fine organic matter and organisms fell into the collection bag. This occurred as I moved one handle clockwise and the one handle counterclockwise. We continued to collect soil and place it onto sifter until the desired amount of sample was collected.

Fig. 2. Jessica with sifter

Sorting of samples

Once our sample was brought back to the lab, it was placed into a Berlese funnel (Fig. 3). This funnel has a light bulb in the lid. Soil organisms do not like heat or light, therefore they are driven down through the litter then through the screen into the collection dish. The collection dish contains ethanol to capture and preserve all organisms that fall out. These organisms will be identified later.

Fig. 3. Berlese funnel

Slide mounting of mites:

A small selection of mites were mounted on temporary glycerin slides. This means glycerin is dropped into the center of the slide, the mites were placed in the glycerin with forceps, and a cover slip placed on top of the immersion (Fig. 4). We used these as many of the features needed to identify mites are difficult to assess. The glycerin allowed us to move the mites to position them in order to look at features laterally, dorsally, or ventrally. These slides are messy and temperamental. If a slide was left unbalanced, the specimen and cover slip would slide down. This left a mess but moved the mite under the cover slip with warrant. The slides were very fragile and if moved too harshly, the specimen could break apart in the glycerin.

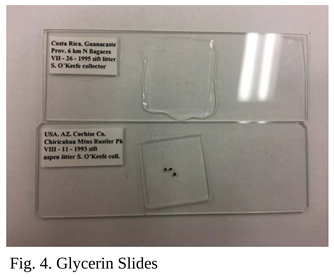

Fig. 4. Glycerin Slides

Identification of mites

Once the slide was viewed under a microscope, mites were identified using the few references in existence (Fig. 5). A large portion of the learning curve that came with this research was understanding morphological terms. I used figures from most of the referenced texts, as in Figs. 6, 7, 8, and 9, to learn this terminology. I could compare these to the slides and learn the vocabulary associated with the morphology. These keys helped identify specimens to family, and possibly to genus.

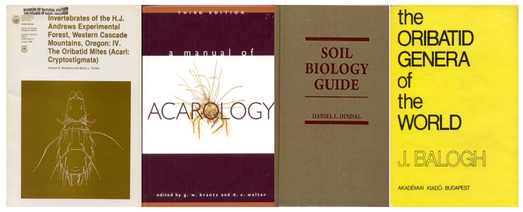

Fig 5. References used to identify mites

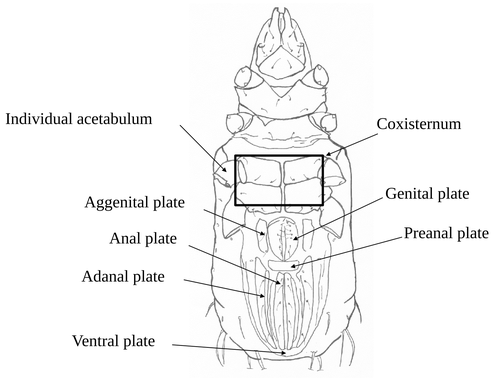

Fig. 6. Ventral view of mite illustrating key morphological terms.

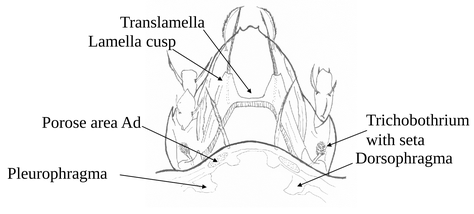

Fig. 7. Anterior dorsal view illustrating key morophological terms

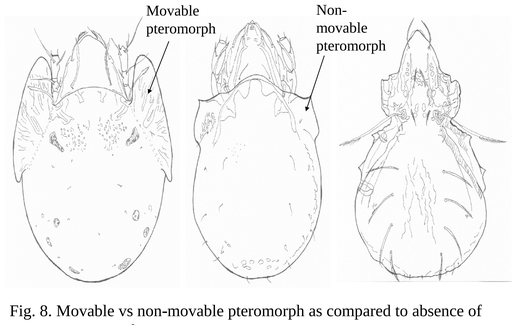

Fig. 8. Movable vs non-movable pteromorph as compared to absence of pteromorph

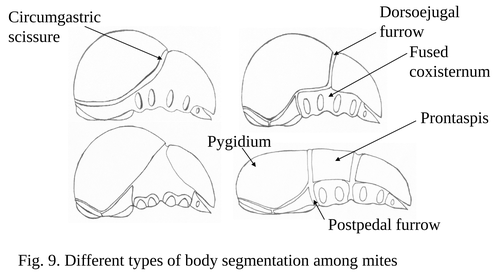

Fig. 9. Different types of body segmentation among mites

DISCUSSION

We identified 16 different families compromising of 69 different specimens. This was just a small number of the collection as many mites are still unprocessed. The small size and vast amount of mites make it difficult to identify all mites in the laboratory. The yield of some sites makes the processing portion quite strenuous. One site can contain hundreds of specimens while another could yield fewer than ten. The sites containing hundreds of specimens often takes many hours to sort through. This research project was designed to learn techniques to handle and identify this very large and diverse group of very small and abundant leaf-litter dwelling organisms.

Part of this study focused on the ways on how Oribatids represent biodiversity. As shown in Fig. 10, Oribatid mites take on many different forms. The differences in morphology can be minute or extremely large . Within a family, two species may have completely different appearances. The similarity may be that they have pteromorphs or segmented body shapes. This sometimes made identification difficult.

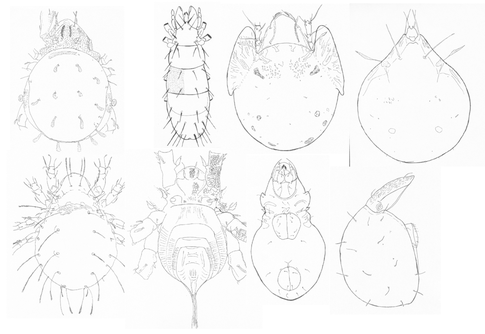

Fig. 10. Diversity of Oribatid body morphology

This research was helpful in my learning, understanding of techniques and interpretation of the specialized terms associated with Oribatid mites. The identification of these mites can be later used to help assess the health and sustainability of the areas sampled. Oribatids can give insight into a variety of different ecosystems and microhabitats.

ACKNOWLEDGEMENTS

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REFERENCES

Marshall, V.G., R. M. Reeves, and R.A. Norton. 1987. *Catalog of the Oribatida (Acari) of Continental United States and Canada. Memoirs of the Entomological Society of Canada No, 139*. Ottawa, Canada. vi + 418 pp. This source is the only catalog of all of the species of oribatid mites known to occur within the United State and Canada, along with all literature of the known species. The catalog treats 1177 species organized in 329 genera of 108 families. Other species have been described since then, but this catalog has not been updated.

Balogh, J. 1972. *The Oribatid Genera of the World*. Akademia Kiado, Budapest, Hungary. 188 pp plus 71 plates. This source is the only reference in which oribatid mites of North America can be identified to genus. The genera recognized here fairly closely match those listed in Marshall et al. 1987. Oribatids are identified to superfamily first, then to the worldwide genera within each superfamily. Balogh did not use the family category within his text.

Moldenke, A.R., and B.L. Fichter. 1988. *Invertebrates of the H.J. Andrews Experimental Forest, Western Cascade Mountains, Oregon: IV. The Oribatid Mites (Acari: Cryptostigmata. Gen. Tech. Rep. PNW-GTR-217*. Portland, Oregon. vi + 118 pp. This source is a final report of a long-term biodiversity study in western Oregon that covers the oribatid mites. The mites collected were identified and illustrated with scanning electron micrographs. Many of the families, and many of the genera collected in Oregon are also found in California, Kentucky, Alabama, and South Carolina.

Norton, R. 1990. *Acarina: Oribatida*, pp. 779 – 804. In *Dindal, D.L. (ed.) Soil Biology Guide*. John Wiley & Sons, New York, NY. This source provides a key to the 50 or so most commonly encountered families of oribatid mites known to occur in North America. The key works for many of the mites encountered in our samples, but does not include several relatively uncommon species that we captured.

Norton, R.A. and U..M. Behan-Pelleticer. 2009. *Suborder Oribatoda*, pp. 430-564.. In Kranz, G., and D.E. Walter (eds.). *A Manual of Acarology, 3rd ed*. Texas Tech University Press. 816 pp. This source provides an identification key to the 180 or so families of oribatid mites from around the world. This represents the most current arrangement of families.

Gulvik, M. 2007. Mites (Acari) as indicators of soil biodiversity and land use monitoring : a review. *Polish Journal of Ecology*, 55: 415-440.

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