Spring 2022
Department of Biology & Chemistry,
College of Science

Seasonal Abundance and Sex Ratio of Earwigflies (*Merope tuber*) in Eastern Kentucky

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ABSTRACT

The earwigfly is a rarely seen insect in the family of scorpionflies. There are three species total, one in Brazil, one in Australia, and the third (*Merope tuber*), widespread throughout the eastern United states. In a 1984 study, Chris Maier collected 69 earwigflies between 1977 and 1982 from New England. Most of these were collected in July using sticky traps. He collected 43 females and 26 males (sex ratio 2.4:1). In a 2014 study, Skvarla, Hartshorn, and Dowling collected 77 earwigflies from Arkansas, mostly in August using malaise traps, pan traps, Lindgren funnels, and pitfall traps. They collected 58 females and 24 males (sex ratio 1.65:1). Over the course of two field seasons in 2011 and 2012, we collected over 500 earwigflies from pan traps, which is the largest collection in the world that we know of. We collected 339 females and 165 males, which is roughly a 2.05:1 sex ratio. It seems that earwigflies in Eastern Kentucky are most abundant in late August and early September. Our results are similar to those of Maier and Skvarla, Hartshorn, and Dowling with their smaller data sets. We plan to use statistical analysis to better evaluate seasonal variance of earwigflies.

INTRODUCTION

The earwigfly, scientifically known as *Merope tuber*, is a small invertebrate that is related to the scorpionfly. They are a relatively large insect, measuring 20 to 25 mm. Not much is known about the lifespan of these insects, but the male and female morphology is distinguished well. The male earwigfly has large pincher-like accessory structures as seen in Figure 2 called claspers, but the female earwigfly lacks this feature as seen in Figure 1. There are only three species of the earwigfly, one in Australia, another in Brazil, and the third widespread across the eastern United States.

Figure 1: Female Earwigfly

Figure 2: Male Earwigfly

They are a very rare insect with only around 350 collected worldwide, as seen in Table 1. Over the course of two collection seasons, 2011 and 2012, we have collected around 500 earwigflies, which is the biggest collection to our knowledge. As seen in Figure 4, we collected a large number of earwigflies, approximately 75, in one week at one site. We collected these insects from three locations, each in Eastern Kentucky within a mile of Cave Run Lake. Samples were collected using pan traps of various colors, which were water-based traps that insects crawled or flew into. We looked at the effectiveness of yellow versus brown pan traps by comparing the collected sample data from each. We compared the seasonal distribution and sex ratios of our data to that of other papers. After completing a comprehensive literature review on *Merope tuber*, some of the information found is as follows.

Figure 3: Accessory sex organs of the earwigfly

Figure 4: One week's collection of earwigflies

We compared our data to that of two major collections documented in scientific papers, by Skvarla et al. (2014) and Johnson (1995). Skvarla et al. (2014) collected 82 specimens and Johnson (1995) collected 163 specimens. Skvarla found a sex ratio of 2.41:1 female to male. Johnson found a sex ratio of 1.67:1 female to male. For most large collections, there seems to be a trend with an average of 2:1 female to male ratio. Seasonally, Skvarla et al. (2014) collected earwigflies from June until late October, with a peak occurrence in July, followed by much smaller but consistent numbers of specimens. Skvarla used mostly different colored pan traps, but also used some malaise traps. Johnson collected weekly or bi-weekly from early July through late September. Due to inaccuracies in collection times, there was not a peak date recorded.

MATERIALS and METHODS

Samples were taken over the course of two collection seasons, during 2011 and 2012, around Cave Run Lake in Eastern Kentucky. Earwigflies were collected in two different colored pan traps as seen in Figures 4 and 5 over several locations, documented in Figure 6. The pan trap consists of a 9 in by 12 in colored pan filled with saltwater and dish soap that breaks surface tension when insects walk in. Specimens were collected weekly and stored in 70% ethanol until studied. We used the data between these brown and yellow pan traps to discuss potential preferences of the earwigfly based on color. Collected specimens were identified by Dr. O'Keefe, and studied by Nick Finch. A statistical analysis was done using Excel and *Statistical Ecology* (Ludwig 1988). Basic sample graphs were produced comparing the seasonal variance and sex ratio of these insects, as seen in Figures 7, 8, and 9.

Figures 4 and 5: Pan traps used to collect the earwigflies.

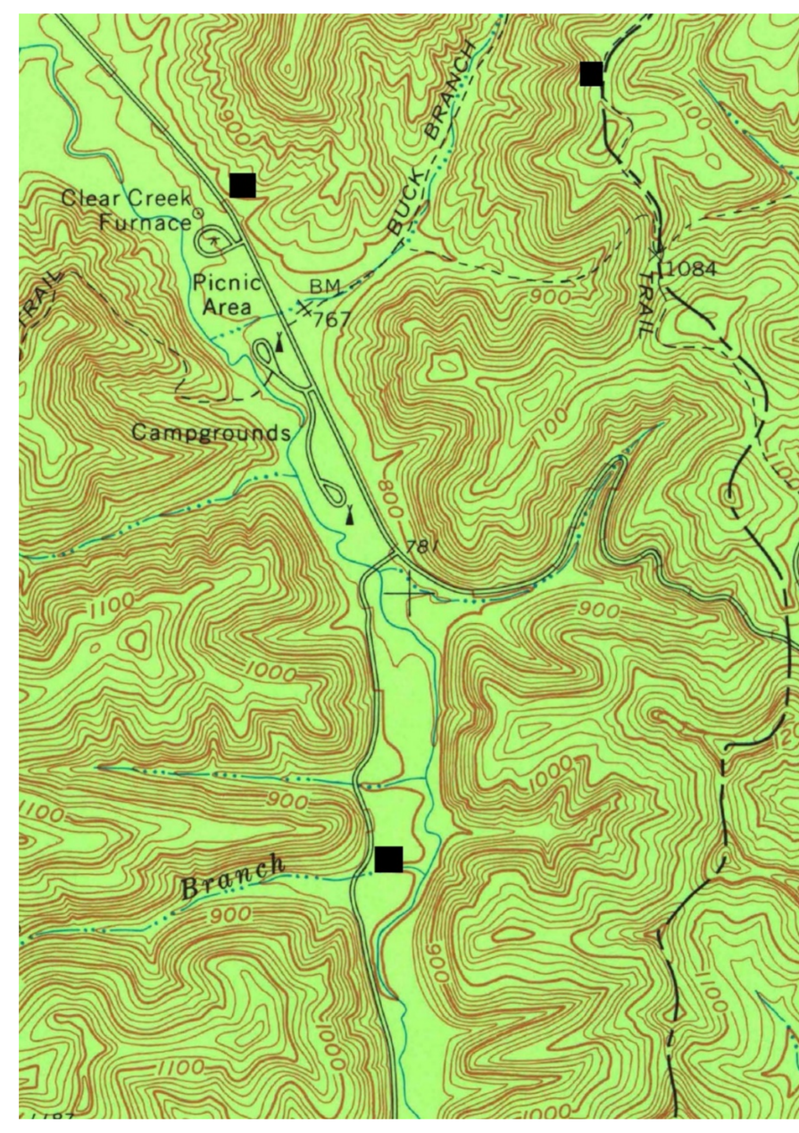

Figure 6: Locations of the three collection sites around Cave Run Lake

RESULTS

Our data regarding sex ratio and seasonal variance was comparable to that of the reference papers. There was a distinct sex ratio of around 2:1 for female to male, which coordinated with that of the reference papers. There was also a seasonal variation that was comparable to that of the papers, with similar peaks and overall collection seasons. We found a difference between trap color effectiveness. While the pan traps produced the greatest number of earwigflies, the brown pan trap seemed to be slightly more favorable throughout the collection seasons.

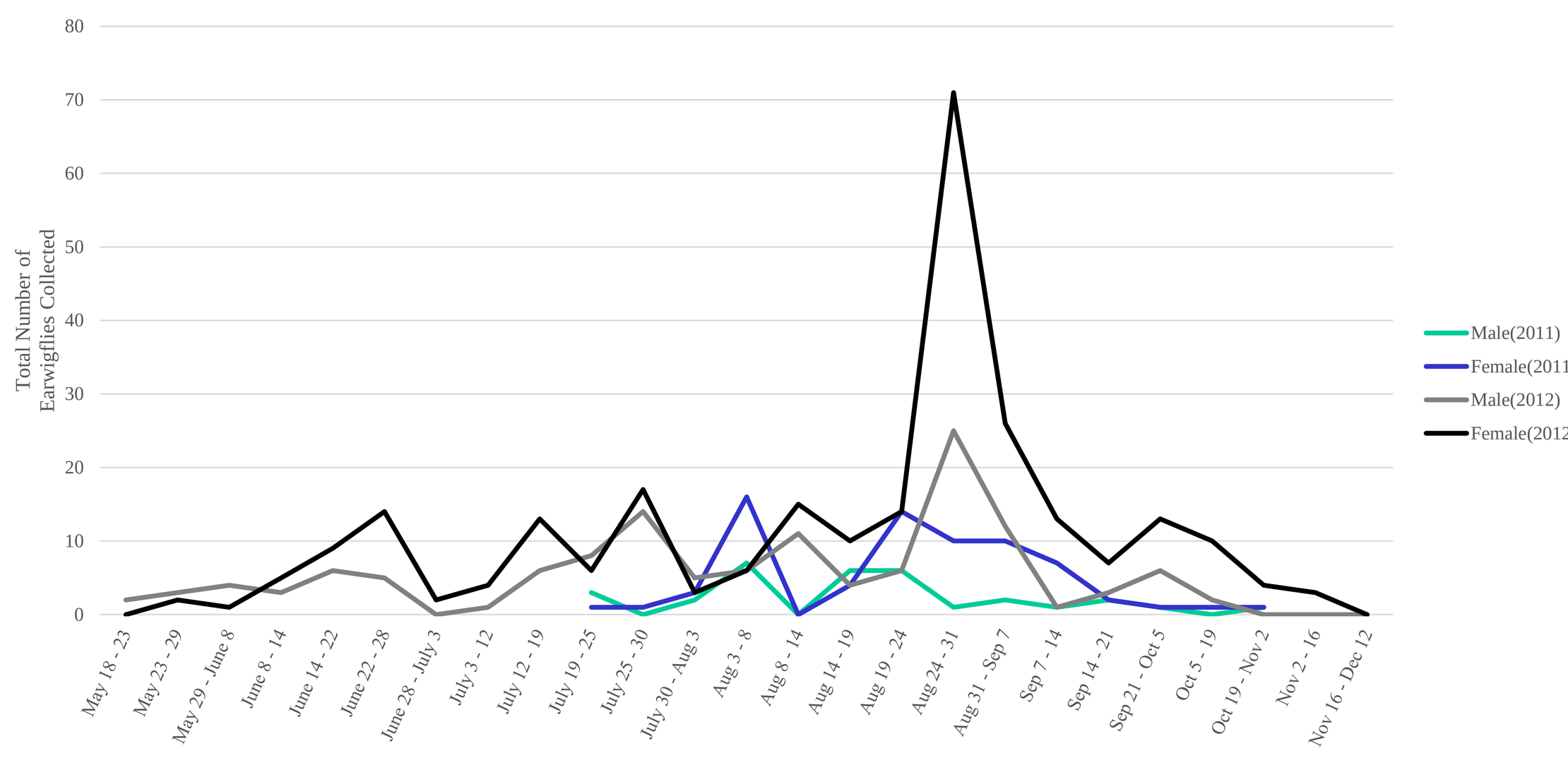

Figure 7: Collection of earwigfly over time by collection season and sex.

As seen in Figure 7, there was a distinct ratio of more females than males over both collection seasons. Our data found a 2.05:1 sex ratio of female to male, with 339 females and 165 males collected. This corresponds with other papers as we hypothesized, with approximately two females for every male collected. We also looked at seasonal variation. For the 2012 data there was a distinct spike of earwigflies around late August and early September. In 2011 there was a small spike around early to mid August. This did not correlate to either paper, so this is something we will research later on. It may have to do with the location of collections.

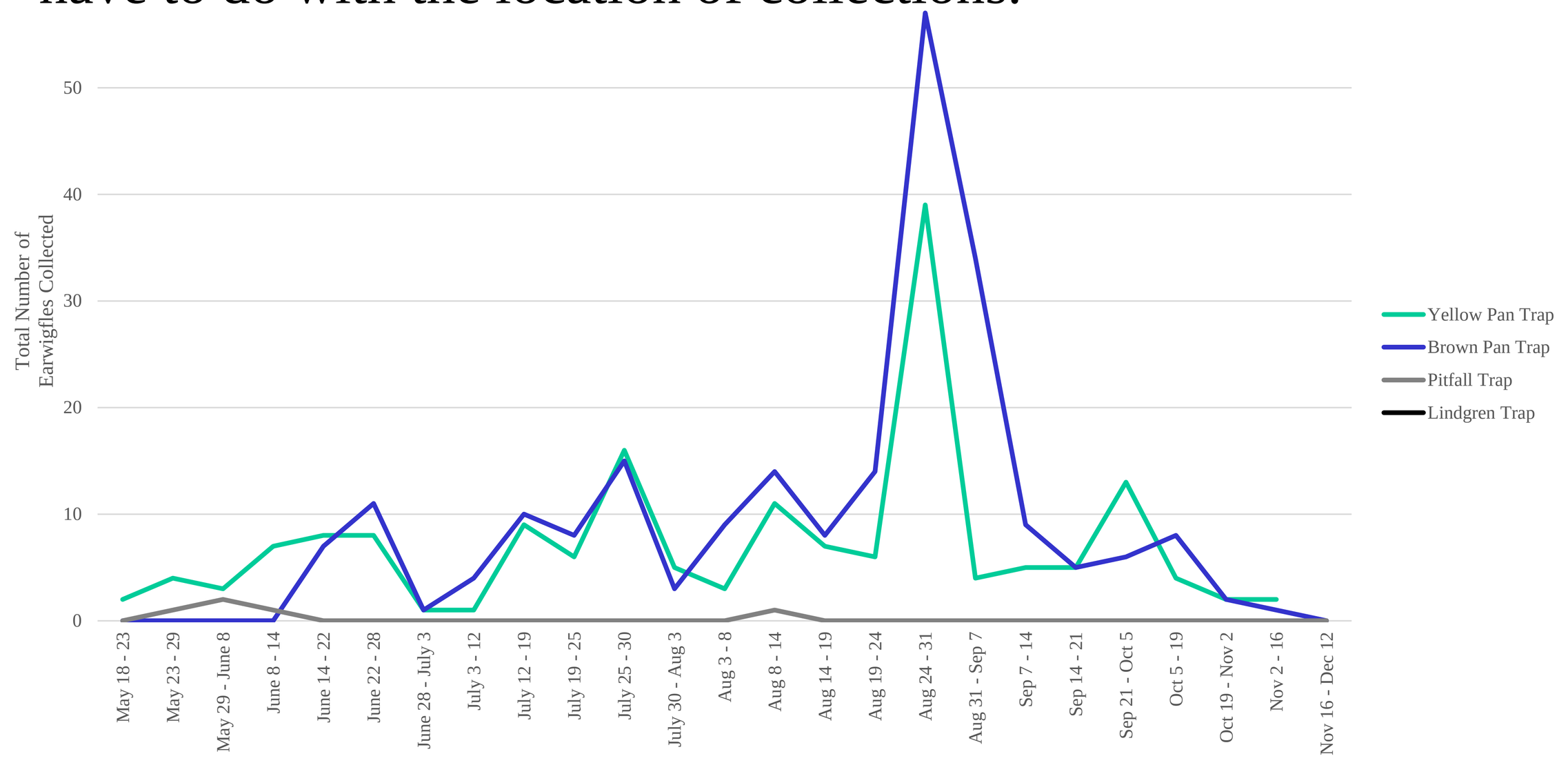

Figure 8: Collection of earwigfly over time by trap type.

For the trap type, there was an overall greater number of earwigflies collected in the brown pan trap as opposed to the yellow pan trap, but this was mostly excluded to one small season, around the peak collection period. The Lindgren trap and pitfall traps were negligible compared to the pan trap data.

DISCUSSION

We compare our data to that of Skvarla (2014) and Johnson (1995) as they have the largest collections thus far. We compare data such as sex ratio, seasonal distribution, data peaks, and trap types. Since we collected such a large data set, we can look at our data from 2011 and 2012 separately as well as a combined data set.

Table 1: Comparisons for multiple data sets by different papers regarding amount of earwigflies collected and by sex.

Paper Author	Total Number	Number of Females	Number of Males	Sex Ratio F:M
Skvarla et. al. 2014	82	58	24	2.41:1
Johnson 1995	163	102	61	1.67:1
Barrows et. al. 2019	38	38	0	38:0
Caron 1967	1	1	0	1:0
Coffman 1982	20	10	10	1:1
Byers 1993	4	2	2	1:1
Bowles 2013	5	1	4	1:4
Robinson et. al. 1997	7	5	2	2.5:1
Dunford et. al.* 2007	302	202	100	2:1
Dunford et. al. 2016	40	24	16	1.5:1

*This Dunford publication is a set of 122 collections found in the Florida State Collection of Arthropods found over a 30 year period.

ACKNOWLEDGEMENTS

We would like to acknowledge the Department of Biology and Chemistry for providing materials and space to work.

We would like to thank the Department of Forestry for allowing us to collect specimens from the Daniel-Boone National Forest.

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