Comparative Analysis of Decomposition in Water
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Abstract

Forensics is the application of science in litigation. Aquatic systems provide challenges in forensic investigations, with limited information about differences in decomposition due to water quality.. The purpose of this study was to examine decomposition in various types of water and monitor insect activity. We compared the number of species and abundance to each of the treatments.After identifying a total of 91 insects, we found that quality is not a factor to consider in regards to the time for decomposition to complete in the aquatic setting nor is it a factor for abundance.

Introduction

Forensics sciences are a critical part in investigations. Investigations first incorporated aspects of science in the 13th century when in China flies were used to identify the murder weapon(3). Since that time, forensics has expanded and is now used in nearly every aspect of an investigation. Aquatic settings in crime scene investigation have often added new challenges. These challenges include factors like streamflow which has been shown to effect which species can access carrion (2) and water temperature which effects larval development. Unfortunately, some factors are vital to understand the effects of the aquatic environment but have yet to be studied. The time of colonization (ToC) refers to the time between when the first insect eggs were laid and when the carrion was discovered. ToC is the most accurate representation we can get for the postmortem interval (PMI) which is the time between when an organism died and when it was discovered (1). ToC and PMI are critical because they help investigators establish a timeline of events. Information around water quality is even more lacking. This factor is of great importance to understand as water such as agriculture runoff (12) may contain chemical or biological pollutants that may impact oviposition and ToC.

ToC is used due to insect rearing and carrion succession. Decomposition and succession can vary on numerous factors like geographical location (7,11) and the environment. In an aquatic environment some species will not oviposit. This lack of oviposition may be due to water quality. Understanding water quality is important when one considers that all factors may have an impact on ToC and the use of ToC in criminal trials.

To analyze the effect of water quality in abundance on carrion, examine if there was a difference in insect abundance on carrion in aquatic environments. We used deceased fetal pigs as my model of vertebrate decomposition and employed photography to keep track of decomposition. The pigs were submerged using water from three sources of differing water quality. Samples were either reared into adults or stored in ethanol for identification to the species level using morphological features.

Methods

This project was conducted at Purdue University Entomology Field Observation Building (EFOB) starting September 19, 2021 and ending on October 28, 2021. Nine fetal pig (*Sus scrofa domesticus*) carcasses were used as a model of vertebrate decomposition. Each pig carcass was assigned to one of three treatments: distilled, pond, or runoff. We 18L plastic bins were filled with water and a pig carcass was placed inside. which held both the pig and water. These were placed outside to allow for insect access. To prevent scavengers from disturbing the fetal pigs, cages made of chicken wire and camping stakes were used to cover the plastic tubs that contained both deceased pig and water.

Observations were made every 24 hours for 1 week, and then every other day for the duration of the study. Observation periods included photographs of each carcass, as well as samples of insects. Eggs and larvae were collected, and placed into containers and reared to adult flies. Adult and larval beetles were preserved in 70% ethanol for identification. Insects were identified to family, or species if possible. Insects were identified to family or to species using dichotomous keys (4,6,9,10). We also checked water level to ensure the water level remained constant by adding or removing water as needed.

Results

In terms of abundance, the runoff treatment showed the lowest with a total of 16 insects. In contrast to the runoff treatment, the pond treatment had the highest abundance with a total of 54 insects. The distilled water fell between these two extremes with 21 insects, but one of its replicates attracted no insects (fig. 2).

We found that the distilled treatment had the highest number of days until the first insect eggs or larva to appear on the remains on average with 3.5, while both the pond treatment and the runoff treatment had 3.3 days on average. Remains of the distilled treatment would submerge the fastest on average, after 24 days. With this we also found the average decomposition period was 20.5 days for this treatment. The pond treatment took the longest by comparison with 40.7 days until submersion and an average decomposition period of 37.3 days. The runoff treatment falls between these two, with 31 days until remains would submerge on average. This gives us an average decomposition period of 27.7 days for the runoff treatment (fig. 1).

Discussion

We don't see differences in abundance overall, but there is a significant difference between runoff and pond treatments. This means that investigators should expect to see a difference in abundance if agricultural runoff is present. Insects are a reliable source of information regarding decomposition due to them appearing shortly after remains become available. This also extends to our data on the decomposition period. We see no differences. This means that the overall duration of the decomposition continues as it would be expected to once the remains become available to the insects. This does extend to aquatic decomposition although a slight delay is expected for the remains to begin bloating thus allowing it to float, however water quality as shown by our work does not affect this delay.

More research in aquatic decomposition is still needed (1). More replicates are required to obtain significant results. Additionally, replicates in more locations would also further our current understanding of aquatic decomposition as we see in other areas of forensic entomology (7,11). Other improvements that should be undertaken by future research would be using quantitative measures of water quality rather than the qualitative ones like the ones done with this work. Some more work on initial oviposition would be beneficial as these delays could play a key role in establishing a timeline in investigations or calculating TOC. Additionally our work did have some sources of error, namely a large number of larvae dying during rearing. This could be due to the presence of *Lucilia coeruleiviridis* which doesn't rear well in a lab setting, and humidity could be another factor that affected the lab rearing.

We do see an effect in colonization in terms of abundance that should be explored further in future research. Other areas such as microbiomes that should also be researched to further our understanding of aquatic decomposition. We can generally expect to see the same forensically relevant families regardless of water quality but abundance may vary depending on this factor.

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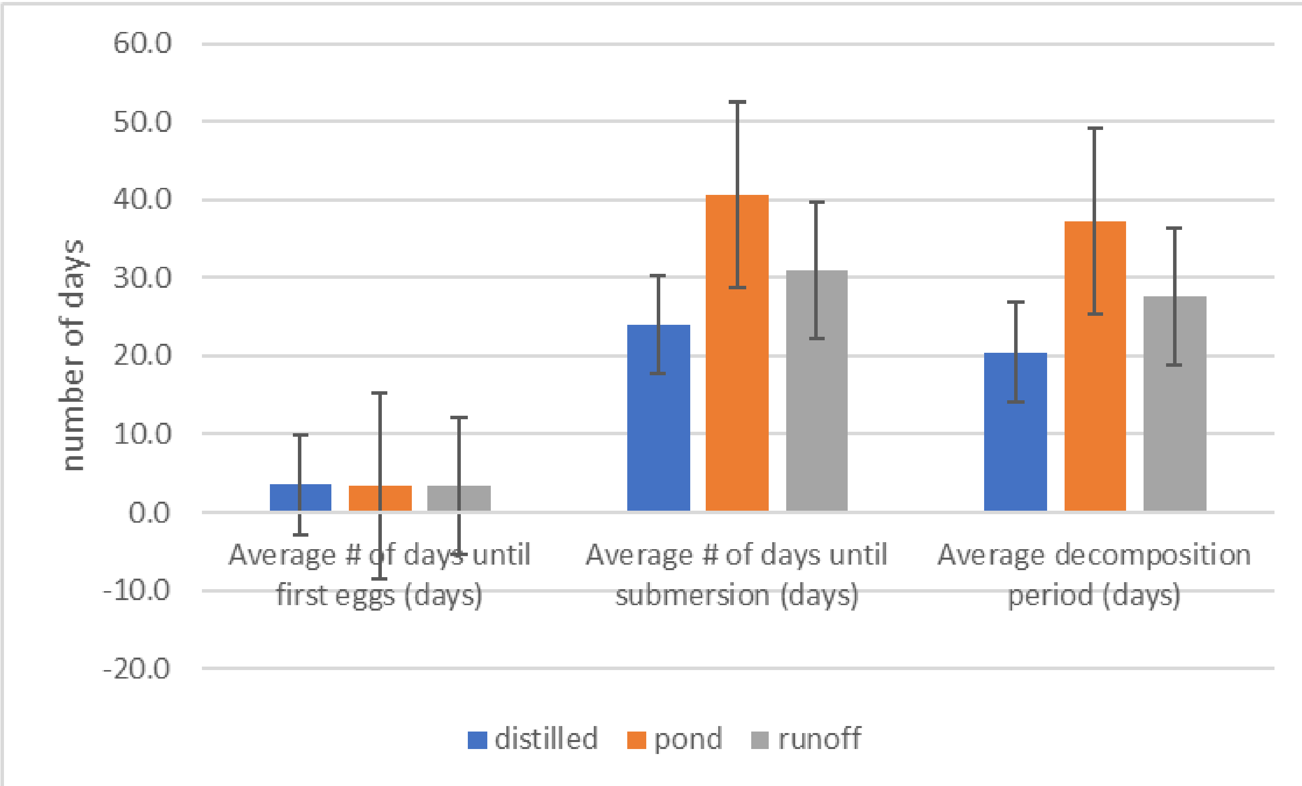

Figure 1. Mean number of days until first oviposition event for each water treatment.

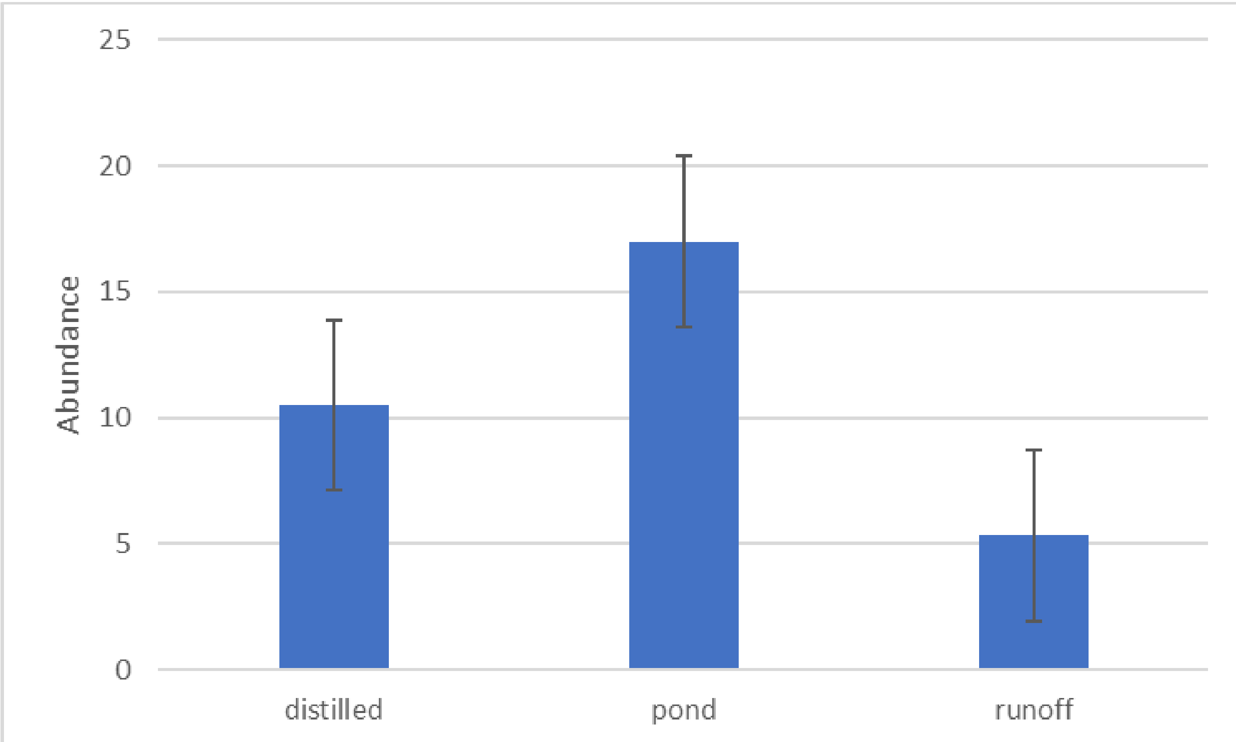

Figure 2. Mean insect abundance for each water treatment.

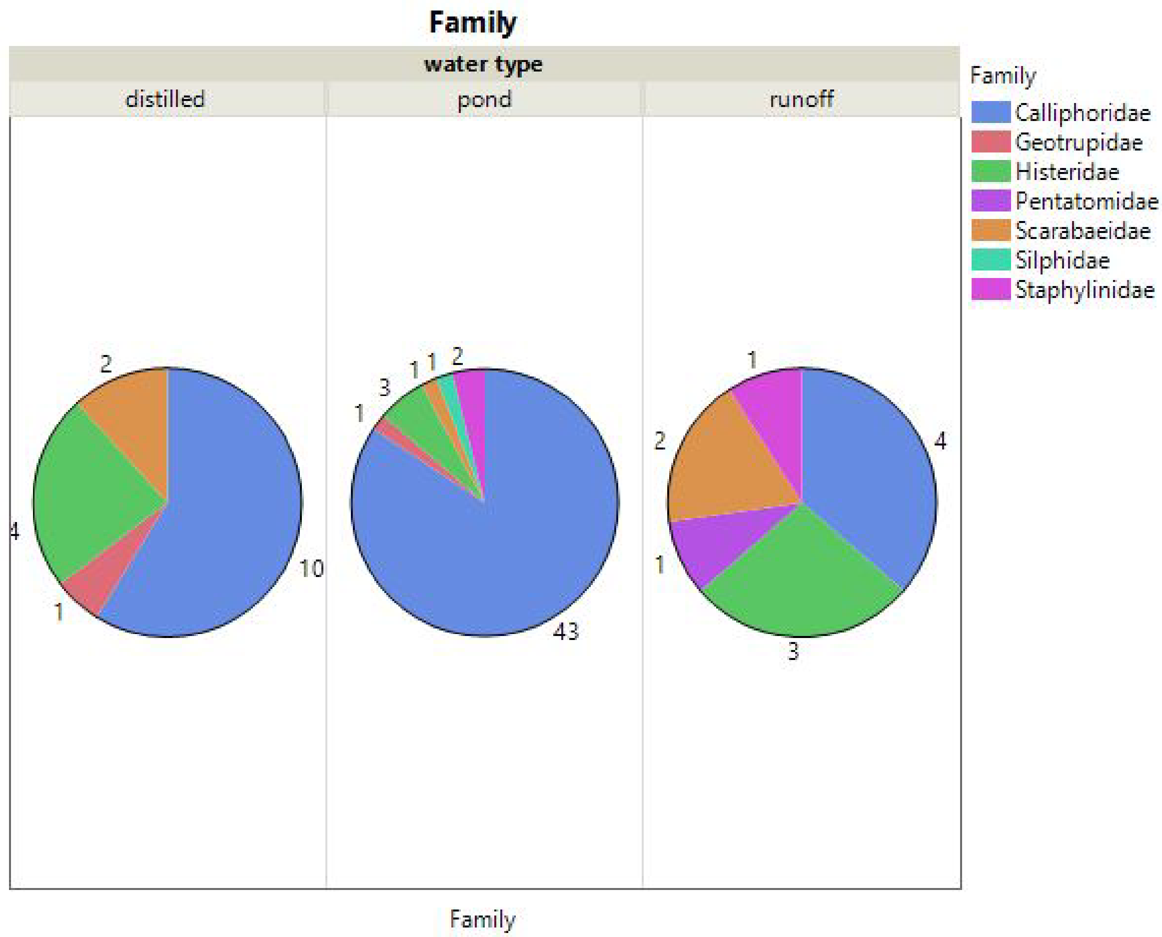

Figure 3. Abundance of each family for each water treatment.