The Impact of a Large Surface Rock on Temperature and Decay Rate

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ABSTRACT

Purpose:
Goal: Do cadavers on rocks have faster rates of decay? How do rocks affect insect succession and ground level temperature? Is this effect more dramatic on small or large carcasses?

Background:
Assuming an organism is not consumed by scavengers, it goes through five stages in the process of decay– fresh, bloat, active decay, advanced decay, and putrid dry remains– which are distinguished through physical observation. Larger masses tend to decay at slower rates, and hotter temperatures tend to expedite the decay process.

Methods:
Four rabbit carcasses were placed out to decay. One small carcass and one large carcass were placed out in the sun on soil or on exposed rock. The mass, carcass dimensions, and ground level temperatures were monitored. This experiment was repeated three times over the summer. Insects were captured by hand for the first experiment and by pitfall trap for the last two experiments.
In the fall and winter, temperature probes were placed at varying heights and lengths from a rocky surface and a non-rocky surface. Temperature was recorded every half hour from September to January.

Results:
The effect of the rock on decay rate varied, so this experiment would need to be repeated. Ground level temperatures tended to be higher at the rock sites, and insect colonization was more abundant at the rock sites. The height the temperature probe was placed at affected temperature more compared to the length. The difference in temperature between rock and soil site was minimized when ground level temperatures reached 20ºC, as well as when it rained.

Future Directions/significance:
1. How does rainfall affect the cadaver mass?
2. Would a thicker rock cause a greater effect on temperatures?
3. Cadavers next to rocks may decay more quickly in summer months
4. Sites exposed to wind or rain saw no difference

BACKGROUND

Cadavers have five stages of decay: fresh, bloat, active decay, advanced decay, and putrid dry remains. Many studies utilize the physical manifestation of these stages in order to measure the rate of decay. One study in Argentina showed the effect of temperature on decay with fauna pig reaching fresh active decay in two days in the summer compared to 25 days in the winter (Hornstein et al., 2012). Several studies have shown that larger masses tend to decay at a slower rate (Spicka et al., 2011; Sutherland et al., 2013). There are few studies examining the effect of local temperature variations and body size on decay. Therefore this study examined the relationship between body size and mass and monitored the rate of decay on both rock and soil surfaces and monitored ground level temperatures.

DETERMINING PHASE OF DECAY

The phases of decay can be distinguished by insect succession and several physical characteristics. The fresh phase begins at death and involves autolysis of cells due to hypoxia; flies arrive and lay eggs in the natural orifices. The bloating phase can be identified by the swelling of the carcass, which is due to anaerobic decomposition and production of gases by bacteria in the gut microbiome. Eventually, the body cavity ruptures, and active decay begins. Invertebrates such as maggots proliferate and consume soft tissue, leaving behind mostly skin, cartilage, bones, and hair. These comprise most of the tissue present during advanced decay, in which invertebrate activity lowers, and parasites of the necrophagous insects take over the decomposition process. Once the remaining tissue consists almost completely of bones, the cadaver is said to be in the putrid dry remains stage (Horenstein et al., 2012).

DESIGN & METHODS

Summer

1. Thaw two small (0.45-1.00 kg) and two large (2.75-3.60 kg) frozen rabbits for 72 hours.
2. Place one small carcass and one large carcass in direct sunlight on a weighing frame on a grassy surface and on a rocky surface.
3. Ensure each carcass is placed on its left side with the anterior portion facing cardinal north and that each site is at least 10 meters from any other site.
4. Experiments 2 and 3: Set up pitfall traps using ethylene glycol.
5. Secure data loggers to wire cages to hang near surface.
6. Place wire cages around the carcasses and secure with bungee cord to t-poles. Secure one data logger on a t-pole.
7. Take samples (pictures, mass, dimensions, insects) every 12 hours until active decay is reached, once per day until advanced decay is reached, and every other day until putrid dry remains is reached or the experiment reaches a length of three weeks.
8. Remove rabbits and place in separate area at least 10 meters away from other sites.
9. Allow sites to rest for one week.
10. Relocate sites by one meter and switch rock and ground sites.

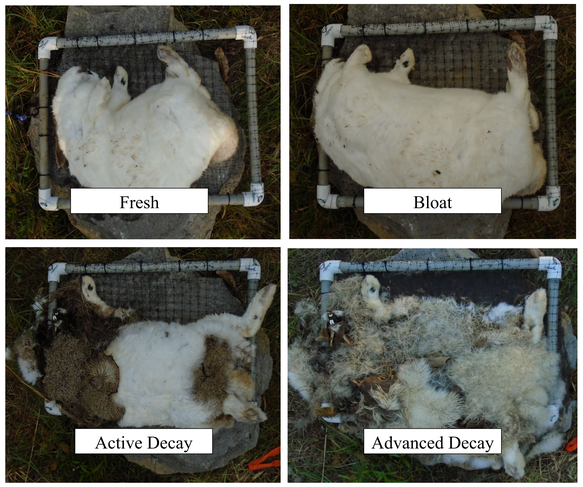

Figure 1. Stages of decay captured in experiment 1.

Fall/Winter

1. A large surface rock was placed in both an open environment and an environment shaded by tall forbes.
2. A pole and several stakes were placed next to the rock to create a rock site and at a mowed area to create a soil site.
3. For each experiment, temperature probes were secured to the poles and stakes and set to collect data every 30 minutes.
4. Data from the probes was collected and analyzed weekly.

- **Experiment 1**: Place probes on stakes at a length of 0.5 and 0.75 meters away from the rock site and soil site.
- All probes should be at a height of 0.15 meters.
- Conducted at grass site and open site from September 18th to 28th.
- Conducted from October 29th until January 24th at the grass site only.
- **Expermient 2:** Secure probes at a height of 0.15 meters and 1.5 meters on a pole above the rock site and soil site.
- Conducted at grass and open sites from September 28th to October 19th.
- Conducted from October 29th until January 24th at the grass site only.

RESULTS

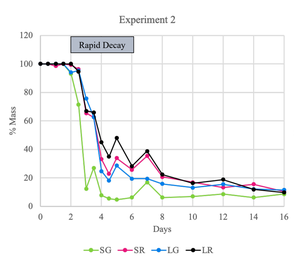

Figure 2. Percent of original cadaver mass remaining over time. Small carcass placed on the ground (SG). Small carcass placed on a rock (SR). Large carcass placed on the ground (LG). Large carcass placed on a rock (LR).

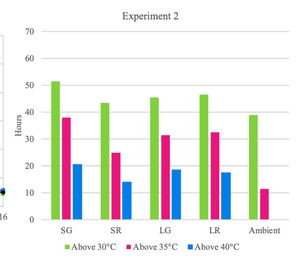

Figure 3. Hours spent above given temperatures in the first week of experiments.

- In experiments 2 and 3, small rabbits decayed more quickly when placed on the ground compared to those placed on rock.
- In experiments 1 and 3, large rabbits decayed more quickly when placed on rock compared to those placed on the ground.
- Rock sites experienced ground level temperatures over 30ºC more often than soil sites. An exception lies in experiment 2, when the small rabbit decaying on the ground had the highest amount of time over 30ºC. Likewise for experiment 2 the temperatures were the same for the rock and ground for the large rabbits.
- Beetle collection during experiment 1 was performed by hand, so substantially less beetles were collected. No conclusions could be made from this data.
- During experiments 2 and 3, flies and beetles were present in larger numbers at rock sites compared to ground sites.
- Beetle and fly presence was more abundant and lasted longer at the large rabbits compared to the small rabbits.

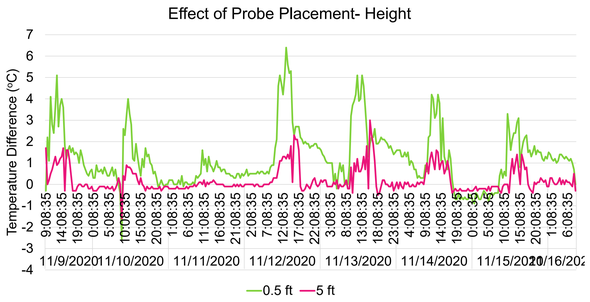

Figure 4. Difference in temperature between rock and soil site in grass environment. Calculated by subtracting the temperature at the soil site from the temperature at the rock site and then plotted over time.

- Length of placement of probe has little affect on temperature (average <2ºC difference during fall experiments (not shown)).
- Temperature of rock and soil sites are the same when ground level temperature is under 20ºC (not shown).
- When rain cools the ground, the ground level temperatures remain low both at the soil and rock sites, so no difference is seen all day (for example it rained in the morning of Nov 11, 2020 little difference is seen that day).
- At a height of 0.15 meter, the temperature difference between rock and soil sites averages 3-4ºC during the fall and winter months and 7ºC during the summer during the day time hours (Fall shown above).
- The temperature difference between rock and soil sites can reach up to 12ºC at a height of 0.15 meters during the summer (not shown).

RESULTS (CONT.)

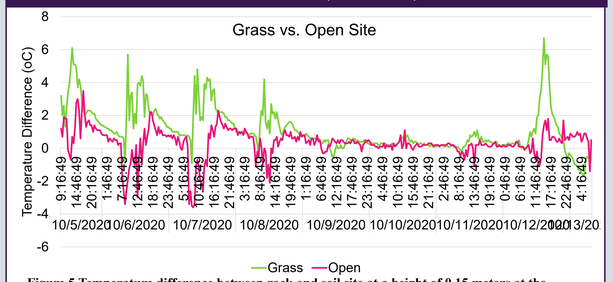

Figure 5.Temperature difference between rock and soil site at a height of 0.15 meters at the grass and open environment.

- The temperature difference between rock and soil sites is greater in an environment in which the sites are shaded by grass and shrubs than in an open environment. Open environments expose the sites to wind and lowers the temperature difference observed.

CONCLUSIONS

1. Larger carcasses placed on rocks tend to decay more quickly than those placed on the ground.
2. Smaller carcasses tend to decay more quickly when placed on the ground rather than on rocks.
3. Ground level temperature is higher at sites with carcasses decaying on rock when compared to those decaying on the ground.
4. Insect activity increases when a cadaver is placed onto a rock.
5. Height of a probe during placement affects temperature readings.
6. Rainfall, ambient temperature below 20ºC, and exposure to wind eliminates the temperature difference created by rocks.
7. The difference caused by rocks of just 55 kg is sufficient to increase the daytime temperature by 4-7ºC.

IMPLICATIONS

1. The surface on which a victim is placed upon death affects the insect succession, ground temperatures, and decay rate.
   - Even one large rock of 55 kg, 30 cm x 45 cm x 10 cm mostly covered by a carcass cause a substantial change in the temperature at the site.
2. Certain insects may be present later that what is typical in the decay process if the victim was placed on a rocky surface.
3. During summer, cases in which the crime scene is a rocky terrain may require different considerations when determining PMI.
   - Even a single large rock near the cadaver may result in ground level temperature changes, acting as a heat sink.

FURTHER RESEARCH

1. Do thicker rocks result in greater changes to the rate of decay, insect succession, and ground temperatures?
2. How does rainfall affect the cadaver mass?

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