The Prairie Crayfish (*Procamburus gracilis*), as Builders of Prairie Soil.

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P. gracilis Background Info

- Little is known about primary burrowing crayfish
- Found in nearly all remnant patches of prairie in Illinois
- Also found in forest ecotones and heavily disturbed areas such as roadside ditches
P. gracilis Life History

- Classified as a primary burrower
- Females carry young on their abdomen, and deposit them in surface waters in early spring.
- Males are cyclically dimorphic.
- There is generally one individual per burrow.
- Lifespan is 3 – 4 years
Collections of P. gracilis

- Other researchers have found breeding form I males in Illinois from February to May
- Females with young attached were found in March, April, and October.
Collections of *P. gracilis* at the Woodworth Prairie

- Crayfish were collected at the surface from April 18 to May 22

<table>
<thead>
<tr>
<th></th>
<th># collected</th>
<th>Average Weight (grams)</th>
<th>Average Carapace Length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>21</td>
<td>8.95 +/- 4.2</td>
<td>3.1 +/- 0.49</td>
</tr>
<tr>
<td>Females</td>
<td>8</td>
<td>9.4 +/- 1.3</td>
<td>3.3 +/- 0.24</td>
</tr>
</tbody>
</table>
Burrow Morphology

- From the entrance at the surface a vertical shaft extends down past the water table where it enlarges and terminates in a chamber 1.5 to 2 meters deep.

Tarr, 1884
Burrow Entrances at the Surface

- A single burrow may have more than one entrance.
- Burrow entrances are marked by a mound, a mound with a hole, or just a hole.
- We found 19% of open burrow entrances to be connected with one another.
Mound Characteristics

- Average mound height = 6.6 cm +/- 1.7
- Average mound width = 18.1 cm +/- 5.2
- Average diameter of holes = 2.7 cm
- Mounds contained soils from A, B, and C horizons, with clay mounds being most frequent.
- Soil analysis of mounds show that mounds are constructed of silty clay or clay.
Changes occurring at burrow entrances

Three types of changes occur:

• Holes are opened
• Holes are plugged
• Soil is excavated

• The excavated soil at the surface is eroded by weather conditions.
### 2004 Crayfish Activity

<table>
<thead>
<tr>
<th></th>
<th>13B 100 m²</th>
<th>16E 100 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two 100 square meter sites were inventoried</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Sites</td>
<td>97</td>
<td>40</td>
</tr>
<tr>
<td>New sites</td>
<td>58</td>
<td>8</td>
</tr>
<tr>
<td>Active Sites</td>
<td>78</td>
<td>27</td>
</tr>
<tr>
<td>Mound Building Sites</td>
<td>61</td>
<td>23</td>
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<tr>
<td>Inactive Sites</td>
<td>19</td>
<td>13</td>
</tr>
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</table>
### 2005 Crayfish Activity

<table>
<thead>
<tr>
<th>Category</th>
<th>13B</th>
<th>16E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same two plots - different years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Sites</td>
<td>131</td>
<td>48</td>
</tr>
<tr>
<td>New sites</td>
<td>41</td>
<td>10</td>
</tr>
<tr>
<td>Active Sites</td>
<td>114</td>
<td>40</td>
</tr>
<tr>
<td>Mound Building Sites</td>
<td>60</td>
<td>23</td>
</tr>
<tr>
<td>Inactive Sites</td>
<td>17</td>
<td>8</td>
</tr>
</tbody>
</table>
Temporal Patterns of Soil Movement

- 33 sites excavated out of 41 active sites.
Temporal Patterns of Soil Movement

- 32 sites excavated out of 89 active sites
Temporal Patterns of Soil Movement

- 15 sites excavated out of 40 active sites

**16E 2004 Excavation Frequency**

- % sites excavated
Temporal Patterns of Soil Movement

- 15 sites excavated out of 38 active sites
Spatial Patterns of Excavation

- Random survey of 47 1m² plots on July 12
- Crayfish prefer to build mounds in the wet undisturbed areas of prairie.
- On a fine scale I suspected that crayfish activity is of a slightly clumped distribution, due to the lifespan of a burrow and the possibility of multiple entrances to one burrow.
Amount of Soil Excavated by the Crayfish

- From random survey of 47 1m$^2$ plots
- 27 mounds were found on the total 47 m$^2$, giving 0.6 mounds m$^{-2}$
- The average mound weight was 339 grams
- This is equal to about 200 g m$^{-2}$
- This figure is an underestimate of soil moved per year, because it does not take erosion into account.
Rate of Mound Erosion

- Used measurement data from newly formed mounds to calculate erosion rate
- Subtracted mound volume at October 1st from mound volume at date of last recorded excavation, and divided by number of days in interval.
- The average rate of erosion is approximately 1 gram day$^{-1}$
The average start date of excavation is May 27.
This is 46 days of erosion until July 12.
Equaling about 220 g m\(^{-2}\) yr\(^{-1}\) of soil brought to the surface by crayfish.
Or 2200 kg ha\(^{-1}\) yr\(^{-1}\).
Amount of Soil Moved by Other Prairie Animals

- Rodents excavate from 44,927 kg ha\(^{-1}\) to 89,854 kg ha\(^{-1}\) yr\(^{-1}\)
- A single ant species may excavate around 1000 kg ha\(^{-1}\) yr\(^{-1}\)
- Earthworms also move a significant amount of material.
- Estimated that these three groups of animals turn over the top 0.6m of the prairie every 100 years.
Uniqueness of Crayfish Excavations

• Both ants and earthworms incorporate plant material into their excavations, giving excavations a low C:N ratio.
• Crayfish excavations come from deeper in the soil profile than excavations of other excavators.
• Crayfish mounds would be expected to have a different chemical composition than the surrounding topsoil.
Nutrient Leaching in Soils

- Water percolates through the soil carrying with it nutrients.
- This water gets trapped in clay particles.
- Crayfish move this clay to the surface.
Mounds as Ecological Disturbances

- Estimated that approximately 2% of the surface per year is disturbed by crayfish mounds.
- Brewer showed significant mortality of seedlings of *Drosera capillaris* caused by crayfish mounds.
- Study showing that mounds near coast have high salinity and disrupt plant communities.
CONCLUSIONS

- Crayfish move significant amounts of material to the surface
  - 200 g m$^{-2}$ yr$^{-1}$ is equivalent to 0.2 mm yr$^{-1}$ or 20 cm in 1000 years
  - Unlike the burrowing of rodents, ants and worms which churns the topsoil, crayfish bring material to the surface from deep soil layers.
- Crayfish are most active in mound building in mid June.