Litter is Not "Litter"! Drop No "Litter" On Litter!

枯葉非垃圾！垃圾離枯葉！

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F.5C Yim Chak Hing
F.4D Leung Wai Ching
F.4D Hui Wan Ying
F.4D Cheung Weng Lam
1. Abstract

This project aims to investigate the invertebrates community in leaf litter, and find out how environmental conditions affect their density and variety. It is found that high water content in litter encourage the density and variety of the invertebrates, which have specialized features to adapt to the respective micro-habitats. However, location of cars’ road and hiking trail nearby and freshly fallen leaves discourage them.

2. Background

Once we were digging up the soil preparing for a tree-planting programme, a woodlouse came out. This raised our curiosity. Later, we wanted to find out more information about invertebrates found in leaf litter and carried out this project. Leaves and twigs usually fall around and deposit as litter. They are finally decomposed by microorganisms to recycle the materials and nutrients stored. How do invertebrates help break down the large pieces of litter to facilitate the decomposition by microorganisms?

3. Focus Areas and Hypothesis

We focus on the relationship between leaf-litter invertebrates and their living environment, and how their structural features help them adapt to it. Would there be any difference in the density and variety of them under different surrounding environmental conditions (light intensity, temperature, water content of litter, or human activities), and the nature of leaves (from natural or plantation trees, colour and degree of decomposition). We will finally design a dichotomous key to help layman identify some common invertebrates living inside litter.

We made a hypothesis that the litter with higher water content, with lower light intensity outside, with fewer human impacts, or from natural woodland encourages the invertebrates’ density and variety.

4. Methods

4.1 Study Sites
4.2 Process of Field Work
1. A quadrat (50 cm x 50 cm) was put on the ground randomly in the woodland.
2. Light meter and thermohygrometer were used to measure light intensity, temperature and relative humidity just above the litter.
3. All litters inside the quadrat were collected and put into labelled polythene rubbish bags for later experiments.
4. Steps 1 to 4 were repeated once more in each woodland.
   Note: 2 quadrats of litter were collected in natural and plantation woodland in Chuen Lung respectively; 2 quadrats in Tai Po Kau woodland, and 3 quadrats in woodland near Shan King in Tuen Mun.

4.3 Laboratory Work
A. Home-made Berlese-Tullgren Funnel for Collecting Leaf-litter Invertebrates
   1. The fresh litter collected from field was weighed.
   2. The bottom of a 4.5 L Watsons water bottle was cut away. It was inverted to act as a funnel. Dark paper was wrapped on the outside to avoid light from the surrounding.
   3. A mesh screen was put at the bottom of the funnel.
   4. Litter was put into the funnel.
   5. A flask with 70% alcohol was put under the funnel. There was no space for the leaf-litter invertebrates to escape.
   6. Lamp with tungsten filament light bulb (60 W) was set above the funnel. The set up was illuminated by the lamp for two days.
   7. The dry litter was weighed.
   8. Step 1 to 7 were repeated until all the litter collected from a quadrat has dried out.
   9. The flask with alcohol and invertebrates was collected.

   Principle of Berlese-Tullgren Funnel: The lamp created gradients of humidity, temperature and light intensity downwards to force the invertebrates down. Until the bottom layer dried out completely, they left the funnel and were collected and preserved in the flask of alcohol. (Owen, 1982)

B. Observation of the Invertebrates Collected
   1. The alcohol with invertebrates collected was poured into a petri dish and observed under the stereomicroscope.
   2. The Invertebrates were identified, counted, recorded and classified into different groups (taxa).
   3. Photos of typical invertebrates were taken under the microscope.
   4. Steps 1 to 3 were repeated until all invertebrates collected were processed.

4.4 Literature Review
Books and websites were first used to get the background information of leaf litter invertebrates, such as their significance, and methods of collecting them. After collecting the invertebrates, photos and keys were used to identify them.

5. Results

5.1 Physical environment of the sites

<table>
<thead>
<tr>
<th>Sites (Where Litter Was Collected)</th>
<th>Surrounding Environmenta</th>
<th>Light intensity (Lux)b</th>
<th>Temp. (°C)c</th>
<th>Relative Humidity (%)d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chuen Lung Natural 1o</td>
<td>Woodland, with natural treesa</td>
<td>1450°</td>
<td>20°</td>
<td>70%</td>
</tr>
<tr>
<td>Chuen Lung Natural 2o</td>
<td>Woodland, with natural treesa</td>
<td>1250°</td>
<td>18°</td>
<td>81%</td>
</tr>
<tr>
<td>Chuen Lung Plantation 1o</td>
<td>Woodland, with plantation treesa</td>
<td>3320°</td>
<td>20°</td>
<td>80%</td>
</tr>
<tr>
<td>Chuen Lung Plantation 2o</td>
<td>Woodland, with plantation treesa</td>
<td>9500°</td>
<td>22°</td>
<td>75%</td>
</tr>
<tr>
<td>Tai Po Kau 1o</td>
<td>Near hiking traila</td>
<td>2350°</td>
<td>22°</td>
<td>71%</td>
</tr>
<tr>
<td>Tai Po Kau 2o</td>
<td>Near water streama</td>
<td>2100°</td>
<td>19°</td>
<td>80%</td>
</tr>
<tr>
<td>Shan King 1o</td>
<td>Near hiking trail &amp; roada</td>
<td>5000°</td>
<td>18°</td>
<td>73%</td>
</tr>
<tr>
<td>Shan King 2o</td>
<td>Near water streama</td>
<td>1850°</td>
<td>18°</td>
<td>71%</td>
</tr>
<tr>
<td>Shan King 3o</td>
<td>Near hiking trail &amp; roada</td>
<td>2500°</td>
<td>18°</td>
<td>78%</td>
</tr>
</tbody>
</table>

The surrounding environment varies with presence of water, other natural factors and human impacts.

For the light intensity outside, the brightest was in Plantation Woodland of Chuen Lung and Shan King 1, while the dimmest was in Chuen Lung Natural woodland and Shan King 2.

The temperature and relative humidity of the sites were similar.

5.2 Nature of the Litter Collected

<table>
<thead>
<tr>
<th>Sites</th>
<th>Coloura</th>
<th>Compositiona</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chuen Lung Natural 1o</td>
<td>Browna</td>
<td>70% middle-sized leaves, 30% branchesa</td>
</tr>
<tr>
<td>Chuen Lung Natural 2o</td>
<td>Browna</td>
<td>70% small-sized leaves, 30% branchesa</td>
</tr>
<tr>
<td>Chuen Lung Plantation 1o</td>
<td>Dark Browna</td>
<td>Mostly leavesa</td>
</tr>
<tr>
<td>Chuen Lung Plantation 2o</td>
<td>Dark Browna</td>
<td>Mostly leaves, with some broken into very small piecesa</td>
</tr>
<tr>
<td>Tai Po Kau 1o</td>
<td>Even Darker Browna</td>
<td>Mostly leavesa</td>
</tr>
<tr>
<td>Tai Po Kau 2o</td>
<td>Even Darker Browna</td>
<td>Mostly broad and large leavesa</td>
</tr>
<tr>
<td>Shan King 1o</td>
<td>Yellowa</td>
<td>Mostly broad and large leavesa</td>
</tr>
<tr>
<td>Shan King 2o</td>
<td>Brown and Yellowa</td>
<td>Mostly broad and large leaves, with some having lots of holesa</td>
</tr>
<tr>
<td>Shan King 3o</td>
<td>Green and Brown Yellowa</td>
<td>Mostly broad and large leavesa</td>
</tr>
</tbody>
</table>

Colors of the leaves suggested the nature of the types of leaves and how long they have fallen and accumulated. The greener leaves in Shan King 3 suggested more freshly fallen ones.

Composition of litter also varies, most of which contains leaves in majority. Appearance of litter show the degree of decomposition. The leaves in small pieces and with many holes in Tai Po Kau 2 and Shan King 2 respectively show rather high degree of decomposition.

5.3 Decrease in Weight of Litter After Placing in the Funnel Under Lamp Illumination
The weight loss of litter after drying in the funnel can be used to estimate the water content of fresh litter. The greatest water loss was shown in Tai Po Kau 2 and Shan King 2, which suggested the litter in these 2 quadrats were quite damp. These 2 sites are both right next to the water stream.

The least loss was shown in Chuen Lung Natural and Plantation woodland. This also indicated that the litter was drier and actually these sites were found deep inside the woodlands.

5.4 Invertebrates Survey

<table>
<thead>
<tr>
<th>Region</th>
<th>Weight Before Drying (g)</th>
<th>Weight After Drying (g)</th>
<th>Drop in Weight (g)</th>
<th>Percentage of water loss in litter (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chuen Lung Natural 1</td>
<td>198.8</td>
<td>191.7</td>
<td>7.1</td>
<td>3.57</td>
</tr>
<tr>
<td>Chuen Lung Natural 2</td>
<td>97.9</td>
<td>80.2</td>
<td>10.5</td>
<td>10.73</td>
</tr>
<tr>
<td>Chuen Lung Plantation 1</td>
<td>95.6</td>
<td>93.5</td>
<td>2.1</td>
<td>2.20</td>
</tr>
<tr>
<td>Chuen Lung Plantation 2</td>
<td>157.5</td>
<td>154.4</td>
<td>3.1</td>
<td>1.97</td>
</tr>
<tr>
<td>Tai Po Kau 1</td>
<td>85.5</td>
<td>80.2</td>
<td>5.3</td>
<td>6.20</td>
</tr>
<tr>
<td>Tai Po Kau 2</td>
<td>119</td>
<td>71.7</td>
<td>47.3</td>
<td>39.75</td>
</tr>
<tr>
<td>Shan King 1</td>
<td>124.6</td>
<td>111.7</td>
<td>12.9</td>
<td>10.35</td>
</tr>
<tr>
<td>Shan King 2</td>
<td>114.2</td>
<td>97.7</td>
<td>16.5</td>
<td>14.45</td>
</tr>
<tr>
<td>Shan King 3</td>
<td>103.4</td>
<td>89.4</td>
<td>14</td>
<td>13.54</td>
</tr>
</tbody>
</table>

The weight loss of litter after drying in the funnel can be used to estimate the water content of fresh litter. The greatest water loss was shown in Tai Po Kau 2 and Shan King 2, which suggested the litter in these 2 quadrats were quite damp. These 2 sites are both right next to the water stream.

The least loss was shown in Chuen Lung Natural and Plantation woodland. This also indicated that the litter was drier and actually these sites were found deep inside the woodlands.
Graph 1 shows the population of different groups of animals in the litter invertebrate community. Graph 2 shows the presence of different groups in different quadrats. In terms of total number, the most commonly found invertebrates were flies, springtails and thrips; while in terms of presence in the quadrats, they were flies, mites and thrips.

Table 4 Distribution of different taxa and the density of the invertebrates in different quadrats

<table>
<thead>
<tr>
<th>Site</th>
<th>Number (percentage) of Individual in different taxa</th>
<th>Total no. of taxa found</th>
<th>Total no. of invertebrates found</th>
<th>Total no. of invertebrate per kg of wet litter (kg⁻¹)</th>
<th>Dominant Taxa (% of individual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tai Po Kau 2</td>
<td></td>
<td>8</td>
<td>20</td>
<td>168</td>
<td><em>Annelida</em> (segmented worm) (40%)</td>
</tr>
<tr>
<td>Tai Po Kau 1</td>
<td></td>
<td>2</td>
<td>4</td>
<td>46.8</td>
<td><em>Diptera</em> (flies) (75%)</td>
</tr>
<tr>
<td>Shan King 2</td>
<td></td>
<td>7</td>
<td>32</td>
<td>280.2</td>
<td><em>Collembola</em> (springtail) (56%)</td>
</tr>
<tr>
<td>Shan King 1</td>
<td></td>
<td>3</td>
<td>5</td>
<td>40.1</td>
<td><em>Diptera</em> (flies) (60%)</td>
</tr>
</tbody>
</table>
Note: Other quadrats’ invertebrates survey (Chuen Lung Natural and Plantation woodland) is recorded in the Appendix. No specific difference in density and variety of invertebrates was found as the numbers were small and the differences in results were not obvious.

Total number of taxa shows the variety. Since different litter samples have different weight, in order to make the results comparable, the density is shown by dividing the total number of invertebrates by weight of litter.

Shan King 2 and Tai Po Kau 2 got the greatest variety (7 and 8 kinds respectively) and density of invertebrates (280.2kg\(^{-1}\) and 168kg\(^{-1}\) respectively), when compared with other quadrats’ results in the same region. In contrast, Shan King 1 and 3 got the lowest variety (3 and 2 kinds respectively) and density of invertebrates (40.1kg\(^{-1}\) and 29.0kg\(^{-1}\) respectively).

Figure 2 Some photomicrographs of invertebrates of different taxa collected

6. Discussion

6.1 Tai Po Kau 2 and Shan King 2 Having the Greatest Variety and Density of Invertebrates

A. Significance of High Water Content Surrounding the Invertebrates’ Environment

From surrounding environment of water stream, water loss in weight of litter, the litter in these 2 areas has high water content.
The optimum humidity for the invertebrates is about 90%. They absorb and lose water through their water-permeable integuments. If loss of water is too serious, they might well die by becoming desiccated. (Friedrich, 1968; David and D.A. Crossley, 1996)

However, too much water in soil easily immobilizes them due to surface tension or endosmosis; it also lowers the oxygen supply in waterlogged soils. (Alison, 1980)

Litter has more air spaces between, so the impact of excess water is less likely to occur, but if the litter is really dry, the invertebrates go into the deeper soil with more water content. Therefore, relatively high water content in leaf litter is rather beneficial to them.

**B. How Higher Degree of Decomposition of Litter induces Greater Density and Variety of Invertebrates**

The litter in Tai Po Kau 2 and Shan King 2 were more decomposed as seen from holes on them and were made up of broken small pieces. They had a greater density and variety of invertebrates.

Leaves fallen are broken down by fenestration, perforation, deskeletonization, etc. step by step by different invertebrates like springtails, smaller dipterous larvae, woodlice, millipedes, etc respectively. (Friedrich, 1968) Litter with greater degree of decomposition should be palatable enough to invertebrates and so they keep feeding on the litter in the past. These are signs ensuring the invertebrates’ presence.

**C. Specific Invertebrates that Appeared in Regions near Water Streams**

(1) *Collembola* (springtails)

Springtails appeared in both regions. The water-saturated environment is so necessary for primitive wingless springtails. If the surrounding is too warm or dry, they will die quickly. (Irene, 1975; David and D.A. Crossley, 1996)

Springtails found on the litter surface are larger, richly pigmented, with dense scales or hairs, compound eyes, and long, well-developed springing organs. (Elizabeth and Kefyn, 2002)

Springtails’ ventral tube on the underside of the abdomen is important in maintaining a salt and water balance. Muscular action of furcula, the jumping organ folded under abdomen, throws itself well out of the way of predators. (George, 2000)

(2) *Millipedes*

Millipedes were found in Tai Po Kau 2.

They lack a waxy layer on their epicuticle and are subjected to rapid desiccation in environment with low relative humidity. They become abundant in calcium-rich, high rainfall areas in tropical and temperate zones. They avoid hot, dry conditions by hiding themselves under vegetation or debris. (David and D.A. Crossley, 1996)

They protect themselves against attacks by rolling into a ball to pretend to be dead. They have high significance in returning calcium into ecosystem by consuming litter and having calcareous exoskeleton. (David and D.A. Crossley, 1996)
6.2 Shan King 1 and 3 had the Least Variety and Density of Invertebrates

Both regions are right next to the cars’ road and the hiking trail.

A. Harmful Effect of Air Pollution on the Invertebrates

Cars passed by give out exhaust gases containing high concentration of harmful pollutants. Reports showed that sulphur compound induced changes in populations of soil arthropods, such as the reduced population of *Collembola, Diplura* due to sulphur dioxide. (M.G. Paoletti and M. Bressan, 1996)

Accumulated chemicals in vegetation and soil indirectly harm the invertebrates. Some statistics show that in U.S. earthworms collected near main roads contained toxic lead and other metals being fatal to young pigs. (Alison, 1980)

B. Harmful Effect of Land Pollution on the Invertebrates

Hiking trail nearby might cause land pollution by human activity. Reports demonstrated that soil invertebrates react to pollution near roadsides; heavy metals, in particular lead and zinc, seem to be the dominant cause of toxicity. Rubbish from human activities would contain heavy metals, from electronic wastes, or other chemicals like organochlorine compound, such as pesticides (DDT), PVC plastics. They are poisonous to the soil invertebrates such as earthworms. (M.G. Paoletti and M. Bressan, 1996)

C. How Shorter Time Length after Leaves Fall and Litter Accumulation is Related to Lower Invertebrate Density and Variety

Leaves found in Shan King 3 were greener than others. These litter might be freshly dropped from trees.

Fungi and bacteria soften litter and increase the food value as protein-rich microbial tissues accumulate. Detritivore feeding may be delayed until litter has been ‘conditioned’. Leaves that have fallen recently contain defensive chemicals to repel herbivores, and did not become palatable to detritivores. (David and Richard, 2004)

7. Assumptions, Errors and Limitations

7.1 Assumptions

There are a lot of variables affecting the density and variety of invertebrates inside litter. When investigating the effect of a certain factor, e.g. water content, other variables such as temperature, light intensity, nature of the leaves forming the litter were assumed to be fixed or controlled.

7.2 Errors

A. Measuring Physical Conditions

Measurements of temperature, humidity and light intensity might not be accurate as they were constantly changing. For example, the light intensity in Plantation 2 in Chuen Lung was an extreme datum with the
greatest error. The light intensity outside the litter might not reflect the light intensity inside the litter.

B. Estimating the Water Content in Litter

It was done by weighing the litter before and after drying in the funnel, but the litter might not be absolutely dried after illumination, as air spaces between leaves in the funnel, time length of drying, etc might affect the drying rate.

C. Identifying the Invertebrates’ Types

This was only done by observing the structural features under microscope with the help of dichotomous keys.

7.3 Limitations

A. Restricted Time and Resources Causing Small Sample Sizes

Only 9 samples of litter in 3 different places were analyzed, and the total numbers of invertebrates found were quite small, which means not statistically reliable.

B. Berlese-Tullgren Method Not Extracting Entire Density and Variety of Invertebrates

Some litter invertebrates might not respond to the temperature, humidity and light gradients created by lamp, so keep staying in the funnel and not captured. Large invertebrates may not get through the mesh screen. Also, using this funnel causes invertebrates preserved dead after entering the alcohol. This cannot allow observation of the behaviour of living invertebrates.

C. Time of Activity of Invertebrates

All litter were collected during daytime of field work, but some invertebrates in fact are active at night due to several factors like light intensity, temperature, humidity, etc. For example, *Isopod* (Woodlouse) has nocturnal habit to resist to desiccation. (David and D.A. Crossley, 1996). Some may hide deep in the soil at daytime and not collected.

8. Improvements

8.1 Other Extraction Methods

Other extraction methods can be tried, such as Macfadyen’s funnel, Baermann funnel, Nielson extractor, etc. (Alison, 1980) They might collect other invertebrates apart from those by Berlese-Tullgren funnel.

8.2 Adjusting the Power of Lamp used in Berlese-Tullgren Funnel

60W lamp might not be the optimum power. Higher power one can be tried, as faster drying rate, higher temperature and stronger light intensity might force more invertebrates to get out.

8.3 Improvement in the experimental design

There are lots of factors affecting the density and variety of invertebrates inside the litter in the field. When investigating the effect of a certain factor, other variables should be fixed or controlled. However, it is almost impossible to control the numerous factors in the field. We could carry out the investigation inside the laboratory where controlled variables could be fixed more easily.

The sampling size of the investigation could also be increased to enhance the reliability of the investigation.

9. Conclusion

There is a great variety of invertebrates living in the leaf litter. Their population and variety are affected by the surrounding physical environment and nature (colours and types) of leaves.
Higher water content of leaves is the dominant factor of increasing density and variety of invertebrates. This is related to the habit of invertebrates staying in a water-saturated environment due to water-permeable skin.

Greater decomposition of litter is a sign showing invertebrates’ presence in the past. After long period of feeding by invertebrates, the leaf litter has lots of holes or broken into many small pieces.

The invertebrates possess specialized features to adapt to these environmental conditions. These include springtails, millipedes, etc.

In contrast, human activities decrease their density and variety. Air and land pollution are great factors limiting so, from cars’ road and hiking trail. Exhaust gases harm them directly and indirectly, while rubbish containing chemicals like organochlorine poisons their lives.

Litter that have relatively freshly fallen leaves are believed to have lower density and variety of invertebrates, as they contain defensive chemicals that repel those invertebrates.

10. Further Studies and Questions

10.1 Relationship between Different Kinds of Leaf-litter Invertebrates

The study only investigated the overall density and variety of invertebrates in different areas, and individual adaptive features. However, how do different types of invertebrates interact with each other, for example, feeding relationship such as predation, competition, or mutualism?

10.2 How the Invertebrates Affect the Environment

The study only investigated how the environment affects the invertebrates. However, how do the invertebrates benefit the environment through their activities, such as energy flow and cycling of materials?

11. Suggestions for Protection of the Litter

Leaf litter is an important micro-habitat for many organisms, and is crucial to maintaining the woodland ecosystem dynamic, stable and self-supporting.

11.1 Park and Woodland Managers

1. Leave litter accumulate on soil and do not sweep them away. Litter is not “litter”!

2. Do not disturb the soil and litter by cultivation or use of pesticides, but wait for natural decomposition of the litter.

3. Educate visitors about the biodiversity in the microhabitat of leaf litter.

11.2 Visitors of parks and woodland and General Public

1. Drop no “litter” on litter! Keep the woodland and park clean.

2. Follow the instructions by managers. Stay on trail but not trample on litter or soil.

3. Minimize driving. Exhaust gases contain harmful pollutants to the invertebrates.

11.3 Students

1. Understand more. Read about and research on functions of litter in woodland and tell our friends and families.

2. Take actions. Organize exhibitions in school about our research on litter to increase the awareness of schoolmates. We had already carried out an exhibition in the Hong Kong Student Science Project Competition 2014 and will carry out a similar exhibition in our school as a post-exam activity.

Figure 11 Our group teaching the school’s janitor to deal with litter properly. We placed the litter used in the investigation on the soil in the school garden for natural decomposition.
12. References


Internet resources: Hope College Leaf Litter Arthropod Key
http://www.hope.edu/academic/biology/leafflitterarthropods/ last retrieved on 30th April, 2014


13. Appendix

13.1 Remaining Invertebrates Survey

Table 5 Distribution of different taxa and the density of the invertebrates in different quadrats

<table>
<thead>
<tr>
<th>Site</th>
<th>Percentage of Individual in different taxa</th>
<th>Total no. of taxa found</th>
<th>Total no. of invertebrates found</th>
<th>Total no. of invertebrate per kg of wet litter (kg⁻¹)</th>
<th>Dominant Taxa (% of individual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chuen Lung Natural 1</td>
<td>![Chart] Hymenoptera (ants) No.: 3 50%</td>
<td>4</td>
<td>10</td>
<td>50.3</td>
<td>Thysanoptera (thrips) (40%)</td>
</tr>
<tr>
<td></td>
<td>Acarina (mites) No.: 1 10%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diplura (flies) No.: 4 40%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chuen Lung Natural 2</td>
<td>![Chart] Acarina (mites) No.: 1 33%</td>
<td>2</td>
<td>3</td>
<td>40.9</td>
<td>Diptera (flies) (67%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chuen Lung Plantation 1</td>
<td>![Chart] Acarina (mites) No.: 1 13%</td>
<td>3</td>
<td>8</td>
<td>83.9</td>
<td>Diptera (flies) (75%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chuen Lung Plantation 2</td>
<td>![Chart] Acarina (mites) No.: 1 8%</td>
<td>5</td>
<td>12</td>
<td>76.2</td>
<td>Diplura (67%)</td>
</tr>
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<td></td>
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</tr>
</tbody>
</table>
### Main Field Work Equipment

<table>
<thead>
<tr>
<th>Item</th>
<th>Name</th>
<th>Quantity</th>
<th>Borrow</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quadrat, folding (50 cm x 50 cm)</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Transect, 50 m, coded in roller</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Light Meter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Digital thermometer</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Anemometer (wind meter)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Plastic bag</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Trowel (spade)</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Gloves</td>
<td>2 pair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Tray, white, sorting</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Vials with different sizes</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
13.3 Homemade Dichotomous Key to Help Layman Identify Some Common Invertebrates Living Inside Litter

**Dichotomous Key for Identifying 8 Common Leaf Litter Invertebrates**

**Unknown**
- 6 jointed legs
- More than 6 jointed legs

**With wings**
- No wings

**Diptera** (Flies)
- With spring-like tail
- Not 2 pairs of legs per segment

**Collembola** (Springtail)
- No spring-like tail
- 2 pairs of legs per segment

**Hymenoptera** (Ant, Wasp, Bee)

**Acarina** (Mites)
- With a pair of pincers
- Not 2 pairs of legs per segment

**Araneae** (Spiders)
- No pincers
- 2 distinct body parts

**Pseudoscorpionida** (False Scorpion)
- Not 2 pairs of legs per segment

**Isopoda** (Isopods, Woodlice)
- 2 pairs of legs per segment

**Diplopoda** (Millipedes)
- Unknown