

# Investigating Variation and Classification (AQA AS)



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# Investigating Variation and Classification

## *Teachers' Notes*

This unit comprises several exercises which aim to introduce students to the principals of biodiversity, variation and classification, including methods of estimating habitat biodiversity and variation within a population. Grasshoppers and crickets are very numerous in the grounds of the Eagles Nest from early June onwards. Butterflies can also be used for this exercise during high summer, although they are more difficult to capture and handle. However, they can be used to estimate species richness and evenness by walking transects around the Centre, as species are easy to identify from a distance. Pit fall trapping, sweep netting, the use of beating trays and pooters can all be introduced during a practical session in the field. A number of small mammal traps are also available and can be set each night through the week.

## *Key Syllabus Areas*

### **3.2.1 Living organisms vary and this variation is influenced by genetic and environmental factors.**

Investigating variation, causes of variation

3.2.8 Classification is a means of organising the variety of life based on relationships between organisms and is built around the concept of species.

Principals of taxonomy.

3.2.11 Biodiversity may be measured within a habitat

Species diversity, index of diversity

## *Reference List*

Adds, J., Larkcom, E., Miller, R. (1997) The Organism and the Environment. Nelson.

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Sunderland, W. J. (Ed.) (1996). Ecological Census Techniques. Cambridge.

## Exercise One: Variation in Wart-biter Crickets.

### **Introduction**

The wart-biter cricket is exceedingly rare in the UK, which is thought to be the north-western limit of its range and as such, the crickets have very precise habitat requirements. Adults are most frequently found in short to mid-length grass sward with high species richness. There need to be open patches where the adult females can oviposit (lay their eggs), and medium height clumps of vegetation for the adult males to sing from. This study investigates the population density and variability (sex ratio, brown / green colour polymorphism, size differences) and habitat requirements of the wart-biter cricket around the Centre.

### **Aims**

- ✓ To determine the sex ratio of wart-biter crickets at two contrasting sites;
- ✓ To determine the ratio of brown and green colour types in these populations;
- ✓ To determine whether there is a difference in body size between the two populations or whether there is a link between body size and sex of cricket;
- ✓ To determine the habitat preferences for this species.

### **Objectives**

To establish the variation in cricket size, and establish whether there is a link with sex; to investigate distribution of colour polymorphisms and habitat preference of wart-biter crickets on the south slopes of Mont Lozere.

### **Equipment**

Conical flasks  
50m tape measure  
Vernier callipers  
Recording sheet

### **Method.**

Select two sites. Two similar fields at different altitudes, or with different aspects works well. At each site in turn, mark out an area 10mx10m using the tape measure. Catch an example of a water-biter cricket and show the students how to measure the animals so that they don't get damaged (and the students minimize their chances of being bitten – which is not painful!).

- Note the sex of the cricket (females have a long ovipositor);
- Note the colour of the cricket – basically brown or green;
- Measure and record the length of the cricket, from the front of the head to the base of the tail;

Finally, students should assess the habitat quality for wart-biter crickets at each site, to determine possible reasons for autoecological differences which they may discover between the two populations. Biotic and abiotic factors are recorded:

- Quantify the vegetation structure of the area. Carry out 10 vegetation quadrats, measuring number of individuals of each species in each quadrat (to calculate Simpson's Diversity index);
- Calculate the total species richness for the vegetation in each quadrat;
- Measure the maximum sward height in each quadrat;
- Count the number of broom plants in the total 10x10m area. These act as singing posts for adult male wart-biter crickets;
- Count the number of significant bare patches in the total 10x10m area. These include mole hills and areas of poached grassland (caused by cattle);
- Measure the ground surface and soil temperatures.

### ***Data Presentation and Analysis***

#### 1) Sex ratio and ratio of green / brown colour polymorphism

Use a chi-square test to ascertain whether there is a significant difference between the numbers of males and females within and between each site, and between the different colour polymorphisms at each site and between sites;

#### 2) Size of crickets:

Use a student's t-test to determine whether there is a size difference between males and females within each site, and between the populations of animals at the two locations;

#### 3) Habitat preference:

Which plant species are most common at the two sites? Calculate the modal value for the abundance scale for each species and calculate the mean species richness for the ten quadrats. How many open areas and singing posts were there at each site?

Calculate an index of habitat quality (IHQ) for each site surveyed:

$IHQ = \text{Mean species richness} \times \text{number of open areas} \times \text{number of singing posts}$

### ***Discussion Points Specific to this Investigation:***

- Why may there be differences in the observed sex ratio, green/brown colour polymorphism, body length and population size between the two fields?
- What is the difference between continuous and discontinuous variation as illustrated by this study?
- Discuss the possible effects of habitat quality. How does the site affect growth rate / egg hatching time – could the site be affected by altitude or aspect? Is one site likely to be warmer than the other? How could this influence colour polymorphism. Is the darker form commoner at one site – why might this be?

Eagles Nest

Autecology of the Wart-biter Cricket, *Decticus verrucivorus*.

Habitat quality assessment:

Site description (aspect, relief, altitude, gradient):											
Plant species	Number of plants of each species present in quadrat:										
	1	2	3	4	5	6	7	8	9	10	Mean
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
Species richness											Mean =
Vegetation height											Mean =
Ground temp. (°C)											Mean =
Soil temp. (°C)											Mean =
No. of singing posts:	No. of bare patches:										

Eagles Nest

Autecology of the Wart-biter Cricket, *Decticus verrucivorus*.

Site.....

Site.....

Cricket	Sex (m/f)	Colour (g/b)	Body length (mm)	Cricket	Sex (m/f)	Colour (g/b)	Body length (mm)
1				1			
2				2			
3				3			
4				4			
5				5			
6				6			
7				7			
8				8			
9				9			
10				10			
11				11			
12				12			
13				13			
14				14			
15				15			
16				16			
17				17			
18				18			
19				19			
20				20			
21				21			
22				22			
23				23			
24				24			
25				25			
26				26			
27				27			
28				28			
29				29			
30				30			
31				31			
32				32			
33				33			
34				34			

## Exercise Two: Methods for Measuring Species Richness, Evenness and Calculating Simpson's Diversity Index.

### *Introduction*

Different techniques for measuring biodiversity and estimating species richness and species evenness will be introduced, one investigating the many butterfly species observed around the Eagles Nest, by walking a transect through suitable habitat; a second investigating woodland beetles using pit fall trapping; and a third using sweeping and pooting techniques for collecting samples of invertebrates living on foliage.

Work involving invertebrates and small mammals is seasonal and weather dependent. Butterflies are at the height of their activity during late June, July, August and September - and do not like rain, cold or strong wind. Beetles will come out if it is raining so they are also a useful subject animal. The use of a sweep net or beating tray combined with a pooter becomes difficult during rain, as everything gradually becomes saturated and invertebrates stick to everything and become damaged. Small mammals hate the rain and will tend to go to ground, often for several nights, until hunger drives them out again. We will do our best to predict the weather for you, but Meteo France is not infallible! Generally speaking though, conditions are generally excellent for all this work in the summer months.

### *Aims*

To utilise a variety of techniques to study different aspects of population biology.

### *Objectives*

To walk a transect around the Eagles Nest and estimate population density of different butterfly species;

To use pitfall trapping to estimating the population density of woodland beetles;

To use beating trays and pooters to compare invertebrate populations on different tree species;

### *Investigation 1: Butterfly diversity, species richness and evenness.*

#### *Equipment*

Butterfly and sweep nets, numbered bamboo canes and butterfly keys;

#### *Method*

Mark out the circuit (the forestry track at the back of the Eagles Nest) using numbered canes. This enables you to subdivide the circuit and send groups of students to each section spreading the work load, and to split the transect into broad habitat types - enclosed conifer woodland, open mixed woodland, heath and a mixture of the three.

Have a briefing session during which you catch examples of the species on which you wish to concentrate. Make sure that the students can identify key species. Species common around the Centre include Silver Washed, Pearl Bordered and Dark Green Fritillary, Meadow Brown, Arran Heath, Scarce Copper, Marbled and Black-Veined White, Essex Skipper, Small Tortoiseshell and Common Blue. Either give each group a different species or concentrate on one species between the whole group.

Groups (pairs or threes) go to an allocated section of the transect. The groups walk the transect slowly, noting every time they see butterflies within five meters of the track, on both sides (ie. a 10m wide transect). This can become quite sophisticated with students also noting what the butterfly is doing - feeding (and on what plant)? Flying? Interacting with another butterfly? giving further insights into the autecology of the species. When the group has walked their section, the groups return to base, pacing the length of their transect.

### **Data Processing and Analysis**

Species richness and species evenness are probably the most frequently used measures of the total biodiversity of a region. Species richness is the number of species present in the area surveyed. Species evenness is an indication of how evenly represented the species in a community are numerically.

One could imagine a habitat which has the greatest diversity in terms of species richness. However, another habitat could be described as being *richer* insofar as most species present are more evenly represented by numbers of individuals; thus the species evenness (E) value is larger. A process is often seen in tropical ecosystems, where disturbance of the ecosystem causes uncommon species to become even less common, and common species to become even more common. There may even be an increase in the number of species in some disturbed ecosystems but this may occur with a concomitant reduction in the abundance of individuals or local extinction of the rarer species.

1) Calculate species richness (number of species/area surveyed) ie. number of butterflies of each species spotted / Length of transect (m) x width of transect (m)

2) Calculate the Simpson's index of Diversity for each habitat studied:

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

What is the significance of your answer? Remember that a higher value for Simpsons indicates a high level of biodiversity. Remember that the Simpsons index of Diversity also gives you an indication of evenness of species representation in a community. A higher value also indicates relative equality of numbers of all representatives;

- 3) Discuss the limitations of data collection based on random sampling;
- 4) Discuss the problems involved in collecting data in the field.

### **Discussion Points**

What does the Simpson's Diversity index tell you about the biodiversity of butterflies around the eagles Nest? What does the value tell you about species richness and evenness? Is there any pattern to distribution of butterfly species – have you noticed any food plant preferences? Do butterfly species tend to prefer one habitat type to another? Is there any notable behaviour for certain species?

*Eagles Nest.  
Butterfly Autecology Recording Sheet.*

Names.....

Section number:

Please note each species of butterfly seen on your section. Note its' behaviour and finally total the number of each species seen on your section.

Butterfly species	Flying	Feeding	Interacting (same species)	Interacting (other species)	Total number
Scarce copper					
Essex skipper					
Meadow brown					
Grayling					
Arran heath					
Marbled white					
Other whites					
Fritillary species					

## Investigation 2: Beetle diversity, species richness and evenness.

### Equipment

Plastic cups, squares of plywood, tape measure, trowels and beetle keys.

### Method

Pitfall trapping is a sampling method suitable for use with active, surface-living invertebrates in low vegetation or bare ground. A pitfall trap is a straight-sided container sunk level with the surface of the ground into which invertebrates inadvertently fall.

Mark out an area 10m x 10m in the conifer wood at the back of the Eagles Nest. Depending on the group size, set in position plastic cups at regular intervals at least 2m apart - up to 36 cups. Dig small holes using the trowels and set the plastic cups into the holes, leaving no gaps around the outsides. Place four small stones in a square around the cup and rest a piece of plywood on top - this will prevent rain getting into the cup and drowning the beetles. Repeat this exercise at a contrasting site - in a meadow or a deciduous woodland. Leave the cups set out for 1 night and check in the morning. Empty the beetles (and others) from the cups the following morning.

### Data Processing and Analysis

- 1) Calculate species richness (number of species/area surveyed) ie. number of beetles of each species spotted / 100
- 2) Calculate the Simpson's index of Diversity for each habitat studied:

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

What is the significance of your answer? Remember that a higher value for Simpson's indicates a high level of biodiversity. Remember that the Simpson's index of Diversity also gives you an indication of evenness of species representation in a community. A higher value also indicates relative equality of numbers of all representatives;

- 3) Discuss the limitations of data collection based on random sampling;
- 4) Discuss the problems involved in collecting data in the field.

Use a chi-squared test to determine if there is a significant difference between the numbers of beetles at the two sites.

	Observed	Expected
Site 1		
Site 2		



1) Calculate a chi-square test to determine whether there is a significant difference between the invertebrate community found on each vegetation type.

2) Calculate the Simpson's index of Diversity for each tree type or habitat studied:

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

What is the significance of your answer? Remember that a higher value for Simpson's indicates a high level of biodiversity. Remember that the Simpsons index of Diversity also gives you an indication of evenness of species representation in a community. A higher value also indicates relative equality of numbers of all representatives;

3) Discuss the limitations of data collection based on random sampling;

4) Discuss the problems involved in collecting data in the field.

### *Discussion points*

- What observable similarities do some of the organisms identified have?
- Why is taxonomy important?
- Why is there confusion about how many species have already been identified in the world?
- Why can it sometimes be difficult to classify organisms as distinct species?