

Ecology of the Burgess Shale

Aim

We are going to investigate the ecology of an ancient community of marine animals by using information from the famous Burgess Shale fossil site in Canada. If you wish, you can use Microsoft Excel to analyse the data and answer the questions.

Introduction

The Burgess Shale is a 515 million year old fossil site located high up in the Rocky Mountains of British Columbia, Canada. Many thousands of primitive animal fossils have been found there making it one of the best places to hunt for fossils in the world. When an animal is fossilized, usually only the hard parts survive such as the shell or bones. What makes the Burgess Shale so special is that it also preserves the soft parts such as muscle tissue. Because all members of this fossil community are preserved we can learn about its food chain.

All ecosystems are made up of a web of relationships with primary producers being eaten by primary consumers, which in turn are preyed upon by secondary consumers. Energy is lost at each level in the food chain. To understand the pattern of energy flow in an ecosystem is important to know the number of animals at each level of the food web. We are going to find out this information for the Burgess Shale ecosystem by doing a simple calculation.

Food Chain of the Burgess Shale

On the handout you are given a table showing the 25 most common animal species found in the Burgess Shale. For each you are told: (1) whether that species had any hard parts, or whether it was entirely soft-bodied, (2) the number of specimens of that species that have been found, (3) the average length of the species, and (4) the way in which it fed.

In the table, the following abbreviations are used for mode of feeding:

S, Suspension Feeder, meaning that the animal captured particles of organic material floating through the water a bit like shellfish feed today (a primary consumer)

D, Deposit Feeder, meaning that the animal ate any dead or decaying organic material that was lying on or within the muddy seabed, a bit like a worm feeds today (a primary consumer)

P, Predatory Feeder, meaning that the animal killed and ate other animals a bit like shark or octopus feed today (a secondary consumer)

The primary producers in the ecosystem are green algae but are not listed in the table

Calculation

To learn more about the food chain of the Burgess Shale ecosystem, use the information in the table to draw two bar charts that show the percentage of animals in each of the three feeding categories.

In the first bar chart calculate the percentages based on the number of individual specimens in each feeding category. Note there are a total of 35,497 individual represented in the table.

In the second bar chart re-calculate the percentages taking into account the different size of organisms. You can do this by multiplying the number of individuals of each species by the average length of that species. Then add together the results for each species in each feeding group.

E.g. Feeding group 1 = (no. of Species A x length) + (no. of Species B x length) + etc

The table is also available as an Excel spreadsheet. Why not try using the simple maths functions to do the calculations and plot your charts using the Chart function?

Questions

1. On your first bar chart, how many secondary consumers (predators) are there relative to primary consumers (deposit and suspension feeders)? Can you think of a reason for this pattern?
2. Compare your two bar charts. How does the relative proportion of secondary consumers (predator) differ when size is taken into account? What does this tell you about the predators?
3. If the Burgess Shale was a normal fossil site where only hard parts are preserved, how would this change your understanding of the ecosystem?
4. Do you think that the Burgess Shale fossil site is representative of what marine life was like 515 million years ago?

Image: Arthropleura (top left) captures a trilobite



Table: Information about the Burgess Shale fossils

| Name of animal | Any hard parts? | Number of individuals | Length (mm) | Feeding category |
|-----------------------|------------------------|------------------------------|--------------------|-------------------------|
| Aysheaia | No | 20 | 60 | P |
| Branchiocaris | No | 4 | 80 | P |
| Burgessia | No | 2140 | 30 | D |
| Canadaspis | No | 4676 | 55 | D |
| Helmetia | No | 12 | 200 | S |
| Marrella | No | 14956 | 12 | D |
| Naraoia | Yes | 128 | 30 | P |
| Odaraia | No | 24 | 150 | P |
| Olenoides | Yes | 84 | 70 | P |
| Polychaete | No | 9200 | 2 | S |
| Sidneyia | No | 176 | 120 | P |
| Waptia | No | 1020 | 75 | D |
| Yohoia | No | 384 | 15 | P |
| Burgessochaeta | No | 376 | 30 | P |
| Canadia | No | 188 | 30 | P |
| Ottoia | No | 1480 | 80 | P |
| Selkirkia | No | 188 | 35 | P |
| Eiffelia | No | 16 | 20 | S |
| Priania | No | 128 | 25 | S |
| Dictyonina | No | 12 | 8 | S |
| Pikaia | No | 60 | 40 | S |
| Dinomischus | No | 3 | 20 | S |
| Hallucigenia | No | 40 | 20 | P |
| Opabinia | No | 28 | 50 | P |
| Wiwaxia | No | 136 | 30 | P |

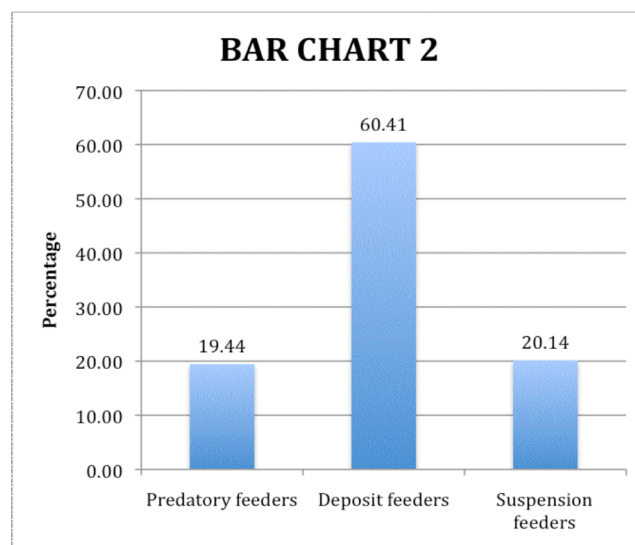
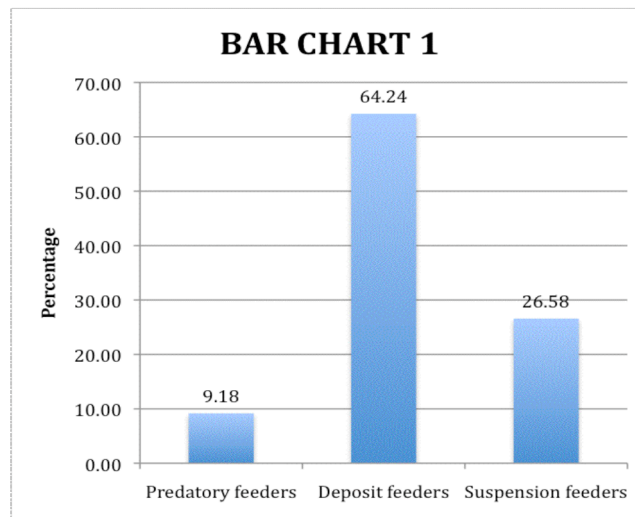
Worked answer

0. Table for Bar Chart 1

| 0. | 0.Number of Individuals | 0.Percentage |
|---------------------|-------------------------|--------------|
| 0.Predatory feeder | 0.3,256 | 0.9.18 |
| 0.Deposit feeder | 0.22,792 | 0.64.24 |
| 0.Suspension feeder | 0.9,431 | 0.26.58 |
| 0.Total | 0.35,479 | 0.100.00 |

Table for Bar Chart 2

| 0. | 0.Individuals x Length | 0.Percentage |
|---------------------|------------------------|--------------|
| 0.Predatory feeder | 0.185,820 | 0.19.44 |
| 0.Deposit feeder | 0.577,352 | 0.60.41 |
| 0.Suspension feeder | 0.192,476 | 20.14 |
| 0.Total | 0.955,648 | 0.100.00 |



Answers

1. On your first bar chart, how many secondary consumers (predators) are there relative to primary consumers (deposit and suspension feeders)? Can you think of a reason for this pattern?

Secondary consumers (predators) make up 9.18% while primary consumers make up 88.82% (deposit feeders 64.24%, suspension feeders 26.58%). Energy is lost at each level in the food chain, so the ecosystem can support far fewer predators than primary producers.

2. Compare your two bar charts. How does the relative proportion of secondary consumers (predator) differ when size is taken into account? What does this tell you about the predators?

Predators are twice as important when body size is taken into account, making up 19.44% of the total. This is because predators, although small in numbers, are generally much larger.

3. If the Burgess Shale was a normal fossil site where only hard parts are preserved, how would this change your understanding of the ecosystem?

Yes, our understanding would be completely different! Only two species in the table have hard parts, these being *Naraoia* and *Olenoides* so this is all we'd know about.

4. Do you think that the Burgess Shale fossil site is representative of what marine life was like 515 million years ago?

Yes, because it preserves soft-bodied organisms as well as those with hard parts, it preserves a complete cross-section of life in that part of the ocean at that time. Normal fossil sites by contrast are highly biased as they only preserve the animals that have hard parts.