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AN INVESTIGATION OF THE DIFFERENT SPECIES OF MAYFLY WITHIN THE POOL & RIFFLE

AIM:

I am going to investigate the different species of Mayfly within the pool and riffle. I am going to create tables to show results from my investigation. I am also going to draw graphs to show the distribution of Mayfly Nymphs within the pools & riffles.

NULL HYPOTHESIS:

There is no significant difference in numbers of Mayfly Nymphs found within the riffles and pools.

ALTERNATE HYPOTHESIS:

There is a significant difference in numbers of Mayfly Nymphs found in the riffles and pools.

STREAM:

Data was collected from Nant Iago (James Stream) which is situated in St Mary's Vale. It is surrounded by Beech woodland. The source of the stream is the Sugar Loaf Mountain. It also contains peaty soils that are slightly acidic.

Many erosive streams receive most of their energy from organic matter washed into the stream, largely as leaf litter. The litter is processed to carbon dioxide by a succession of microrganisms and animals, which deal with successively smaller particles of it in a continuous sequence, as it is moved downstream. This is common where the stream is bordered by gallery forest

A flowing freshwater stream is all business. It rushes forward. If it slows at all, it is just to create small whirlpools or eddies and then it’s back on down the mountain. It makes its bed on gravel or hard rock. Its water is cool, sometimes painfully cold, especially in the spring when the stream is brimming with newly-melted snow.

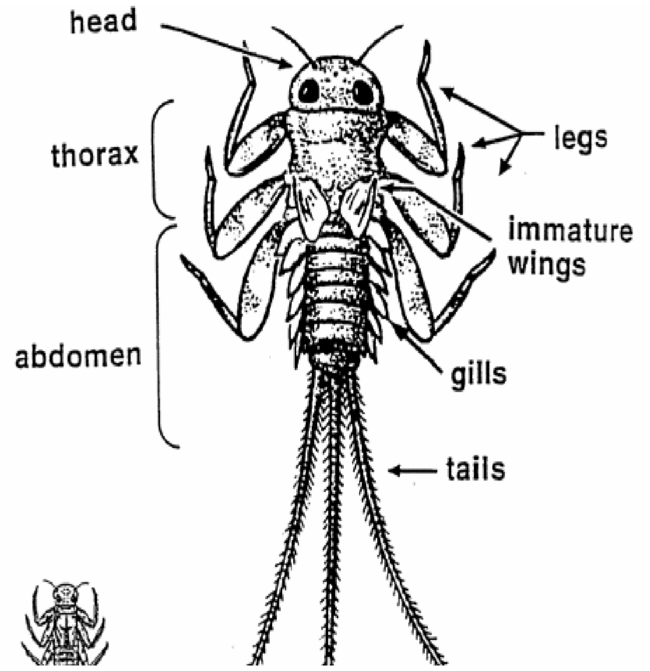
A stream is not like a river. A stream’s banks follow the straight and narrow. No playful meandering curves, no muddy bottom, no sunny, quiet shores. A river is a stream without the push.

Animals that live in a stream are adapted to life in the fast lane. Brook trout have strong, streamlined bodies and powerful tail fins that can push against the current. These fish need the cold, oxygen-rich water of a flowing stream in order to thrive.

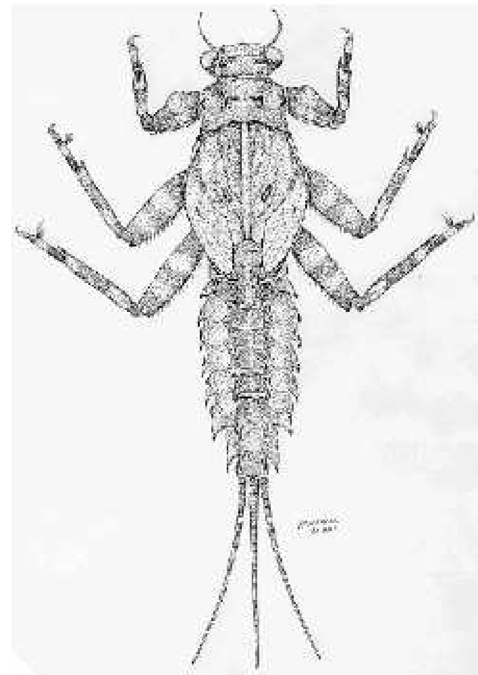
Shade is very important in keeping the stream cold. Atlantic salmon are famous for their ability to buck the current. They swim upstream in spring in order to lay their eggs on the gravel bottom where they were born. Where man-made dams block their route, they will dash themselves to death against the concrete walls trying to leap over them.
Other animals adapt to the swift current. Black fly larvae attach their rear ends to the underside of rocks by tiny hooks. If they lose their foothold (so to speak), they can lasso another rock with silken threads. Caddis fly larvae fashion durable homes from sand grains, leaf pieces, or grasses.
In rivers and streams, the water moves in one direction, though the flow rate may vary from very slow to extremely fast. In a given stretch of a river, there is continual exchange of water, so that events at some distance upstream can affect the river much lower down. Movement of water sometimes creates turbulence, so mixing occurs more readily than in static waters. Often this movement considerably increases the oxygenation of water.
The normal nutrient status depends closely on the bedrock, soil and vegetation of the surrounding catchment area. Water that is relatively poor in nutrients is described as oligotrophic, whereas intermediate nutrients are described as eutrophic. This classification of nutrients refers mainly to levels of inorganic nitrogen and phosphorus, although other mineral elements are also important to aquatic organisms. Higher nutrient levels are likely to support high productivity in terms of biomass within the water environment. Organic compounds found in water are derived mainly from decomposition of plants and detritus. They nay include proteins, carbohydrates and fats as well as more complex particles of organic matter, which are sometimes suspended rather than dissolved in the water.

SOURCE: *Freshwater Life, John Clegg*

MAYFLY NYMPHS



Flat Mayfly



Ephemerellida

Swimming Mayfly

Burrowing Mayfly

MAYFLY NYMPHS

Cylindrical body or flattened with pale-like or filamentous gills arranged laterally or dorso-laterally along abdomen with three tails.
They are only found in very clean water containing lots of oxygen. They absorb oxygen from the water through their gills which are plate-like structures attached to the sides of the abdominal region.
They walk on sediments and occasionally swim. They often hide under rocks.
They are herbivores, so they eat water plants and tiny algae. They are eaten by water spiders, newts, and damselfly and dragonfly nymphs.
They undergo incomplete metamorphosis. (Egg-nymph-adult). The nymphs may take from two months to two years before they swim to the water surface and shed their nymphal skin to emerge as a winged fly.
They are seen in the spring.
They are 3-30 mm long

SOURCE: *http://www.naturegrid.org.uk/biodiversity/invert/mayfly.html*

SWIMMING MAYFLY

They are small with more less cylindrical spindle shaped bodies and delicate legs. The cerci (tail) are provided with numerous hairs and are used in swimming.

FLAT MAYFLY

Parts of the body and limbs are flattened. The claws on its feet are particularly strong for clinging to stones in fast flowing water. (Found in swift flowing water mainly mountain streams & at edges of lakes)
The body is flat with a very broad head and femora. Gills consist of flat plate and tuft of filaments. Large or moderate size found clinging closely to stones.

BURROWING MAYFLY

Live in tunnels which they make in sandy mud near the edge of streams and small rivers. Only become visible when the mud is scooped up on to the bank & examined. They only swim in muddy waters if the light is not too intense. Too much light is detrimental.
Gills are held over the back in life. Mandibles project in front of the head.

EPHEMERELLIDAE

These genera are especially abundant in the trout streams of eastern North America. The genera may be distinguished in the naiad stage by details of the maxillae and by the presence of long intersegmental setae on the apical half of the caudal filaments (the "tails"). Adults emerge in the spring through early summer; nymphs collected in September and October are about halfway through their nymphal stages.

SOURCE: *Animal Life In Freshwater by Helen Mellanby, 1983 sixth edition, publisher: Methuen & Co Ltd.*
SOURCE: *A Guide to Freshwater Invertebrate Animals, Published in 1959 by Longman*

ABIOTIC FACTORS IN FRESHWATER THAT AFFECT MAYFLY NYMPHS

PH

Low pH can upset oxygen uptake through the gills (mayfly nymphs) and ion regulation. Values below 5.0 cause an alteration in the permeability of the gills, which allows H+ ions to move in and sodium ions (Na+) to leak out.

SUBSTRATE

The nature of the substrate is dependent to some extent both on water velocity and geology. Depositing substrates are the normal in slow flowing and still water, where fine particulate matter and detritus settle out. The silts and muds deposited are often low in dissolved oxygen due to the decomposition of organic matter by micro-organisms. Substrate size increases with increased water velocity, providing and increasingly complex series of microhabitats. Beyond a certain velocity the stream bed becomes unstable and at very high velocities only large boulders and sheets of rocks will be present, leading to a reduction in diversity of microhabitats. The size and shape of the rocks forming the bed of the stream will also depend on how easily weathered the underlying rocks are.

TEMPERATURE

Water is a poor conductor of heat. Because of its high specific heat, it takes longer time to warm up than air and is slower in cooling. So fluctuations in temperature are neither great nor violent in water is in air, which is important to creatures that are dependent on their surroundings for body temp.
An important indirect effect pf temperature on freshwater organisms is the varying quantities of oxygen that water can hold in solution as it becomes warmer/colder. Each species has an optimum temperature at which lives can only survive within a fixed temperature range. Temperature also indirectly influences distribution by affecting water availability and humidity.

STREAMS/RIVERS

The flow of water is always in one direction, produces many effects that determine the kinds of animals that can live in such habitats. Mayflies are only found in very clean water containing lots of oxygen. They absorb oxygen from the water through their gills which are plate like structures attached to the sides of the abdominal region.

EDAPHIC FACTORS

Soil forms when mineral particles interact with living organisms, air and water. The processes which define the structure and composition of the soil are:
Interactions with living organisms – production of leaf litter, decomposition of dead organic matter by bacteria and fungi, breakdown by earthworms and other soil invertebrates and nitrogen fixation. Interactions with the atmosphere - nitrogen fixation, oxidation and reduction.) Interactions with water - leaching and chelation

Human processes - ploughing and drainage

LIGHT

Light is an essential abiotic factor in the ecosystems because it constitutes the main supply of energy for organisms. It affects reproduction, hibernation and migration in animals
In streams and rivers the depth of water is not usually enough to limit light availability.
Incident light will affect the temperature and oxygen concentration of water bodies.
Light intensity decreases with depth in the water and is also reduced by material suspended in the water. The intensity of light at different depths within the water is a critical factor in determining the distribution of photosynthetic organisms.

BIOTIC FACTORS

Biotic Components are all the living beings in an environment; Individuals should have specific behavioural and physiological characteristics that permit their survival and reproduction in a defined environment. The condition of sharing an environment generates a competence among the species, competence that is given for food, space, etc.

AIR & WATER MOVEMENTS (WIND)

Both are important in dispersing seeds and spores so they determine the distribution of many species. Intensity of the movement may also influence shape and survival of organisms, especially plants where transpiration rates are affected.

Source: *http://www.biocab.org/Ecology_1.html#anchor_19*

SAFETY PRECAUTIONS

Always have a first aid kit
During and after sampling keep hands away from eyes, nose and mouth
Always wash hands with antiseptic soap
Stay away form steep and isolated parts of the stream

APPARATUS

Serber Net- 0.1m2

The Serber Net is used to collect the invertebrates in both riffles and pools.

Waterproof clothing and gloves

The waterproof clothes and the Wellington boots were there to protect our clothes from the stream water
Two white trays

The invertebrates are put into the trays before and after they have been identified.

PH pens with built-in thermometer

The pH pen is used to measure the pH and temperature in the riffles and pools

Ruler

The ruler is used to measure the depth

Braystoke Flow meter

Identification Keys

The identification keys are used to identify the invertebrates that are found in the tray.

PRELIMINARY METHOD

We went to St Mary's Vale stream to carry out investigations based on freshwater invertebrates.
I had to choose a site where we were going to collect data.
I had to fill the two trays with water from the stream because we were going to put the invertebrates in on of the trays.
I then used the Serber net to catch the invertebrates which we put in one of the trays. Then I had to use a spoon to pick out the invertebrates and put them in the other tray. Before I put the invertebrates in the other tray we had to use the identification key to identify the invertebrate.
Once I had picked out all the invertebrates, I then had to throw them back into the stream.
I used a tally chart to record the number of each different species found, which I then had to put onto my recording sheet.
I then had to use the Braystoke flow meter to measure the velocity, and I had to use the ruler to measure the depth of the pool and riffle.
I also had to use the ph pen to measure the ph and temperature.
We were only collecting data in one pool and one riffle.

Here are results from my preliminary

	RIFFLE	POOL
SPECIES		
Ephemerellidae	1	5
Cased Limnephilidae	1	3
Perlidae	1	0
Gammarus	20	32
Perlolidae	3	3

Taeniopteridae	5	2
Nemouridae	1	0
Rhyacophilidae	3	1
Swimming Mayfly	0	1
Flat Mayfly	0	2
Philopotamidae	5	0
TOTAL NUMBER OF SPECIES	*40*	*49*
Velocity	*0.632*	*0.031*
Temperature	*6.8*	*6.7*
Ph	*7.8*	*6.9*
Depth	*210*	*130*

From the data above I can see that there are more species in the pool than in the riffle. That is probably because the species are not specially adapted to live in the riffle.

There are more Gammarus in the pool than in the riffle, which might have something to do with the flow of water in both riffle and pool. The water is fast flowing in the riffle but in the pool, the water is slow flowing.

Also, I noticed that the velocity, depth, ph, and temperature are all higher in the riffle than in the pool. Again that would be down to the flow of water.

SIMPSONS SPECIES DIVERSITY:

The number of certain species and relative abundance.

I applied the "Simpsons Species Diversity Index" to my preliminary results.

Formula: $D = \frac{N(N-1)}{n(n-1)}$

N = total number of individuals
n = number of individuals of each species

RIFFLE

$$D = \frac{40(40-1)}{(1 \times 0) + (1 \times 0) + (1 \times 0) + (20 \times 19) + (3 \times 2) + (5 \times 4) + (1 \times 0) + (3 \times 2) + (5 \times 4)}$$

$$D = \frac{1560}{432}$$

D = 3.6
The species diversity for the riffle is 3.6

POOL

$$D = \frac{49(49-1)}{(2 \times 1) + (5 \times 4) + (1 \times 0) + (3 \times 2) + (2 \times 1) + (3 \times 2) + (1 \times 0) + (32 \times 31)}$$

$$D = \frac{2352}{1028}$$

D = 2.3
The species diversity for the pool is 2.3

I couldn't use the Simpson's Diversity in my real investigation because I was only looking at one species.

MANN-WHITNEY U TEST:

Test for any significant difference between the riffles and pools.

I used the Mann-Whitney Test to see if there was a significant difference between the numbers of mayflies found in the pools against amount in the rifles

NULL HYPOTHESIS:

There is no significant difference in number of Gammarus (shrimps) found in riffles and pools.

ALTERNATIVE HYPOTHESIS:

There is a significant difference in the number of Gammarus found in riffles and pools.

Before I could apply the test I had to rank all the data- smallest value to highest value. I also have to rank between both riffle and pool datasets.

We had to rank the data as a group using each others data for the Gammarus.

RIFFLES	2.4	3.6	5.1	3.8	5.3	4.7
POOLS	2.4	2.3	3.4	2.8	1.3	3.8

Rank

RIFFLES	3.5	7	11	8.5	12	10
POOLS	3.5	2	6	5	1	8.5

TOTAL (RIFFLE): 3.5 + 7 + 11 + 8.5 + 12 + 10 = 52

TOTAL (POOL) : 3.5 + 2 + 6 + 5 + 1 + 8.5 = 26

I then had to calculate the U values (U1 & U2)

$$U1 = nxny + \frac{ny(ny + 1)}{2} - Ry$$

$$U2 = nxny + \frac{nx(nx + 1)}{2} - Rx$$

nx = number of values in riffles
ny = number of values in pools
Ry = Total for the pools
Rx = Total for the riffles

$$U1 = 6 \times 6 + \frac{6(6 + 1)}{2} - 52$$

U1 = 5

$$U2 = 6 \times 6 + \frac{6(6 + 1)}{2} - 26$$

U2 = 31
Critical Value = 5 (No. of samples: 6)

"If the smallest U value is less than or equal to the critical value we reject the null hypothesis and accept the alternative hypothesis"

As the smallest U value (5) is equal to the critical value, I have to reject the null hypothesis and accept the alternative hypothesis,

"there is a significant difference in the number of Gammarus found in the riffles and pools"

I used the Mann-Whitney Test in my real investigation.

INVESTIGATION METHOD

I had to select the part of the stream where I would be collecting my data. I then had to collect all the equipment that I would need from the above list. Before I could collect the invertebrates, I had to fill the two trays with water from the stream.

I decided to collect data from the pools first so I had to get the Serber net and place it in a pool in the stream. I had to disturb the sediment for three minutes by rubbing the substrate in front of the net.

I then needed to put the net in of the trays of water to remove the invertebrates in the nets. I had to use a spoon to find and lift the mayflies in the midst of the invertebrates from the tray to identify them using the identification key, before I put them in the other tray.

Once I had identified the mayflies I had to make a tally chart on record sheet to keep a record of the number of each different species found in the pool.

Once I had finished picking out the mayflies in the tray I had to pour the water with the invertebrates back into the stream.

As I was doing a random sample, I had to randomly select six pools in the stream to collect my data. To make it a fair test I had to make sure I spent ten minutes picking out the invertebrates.

Before I could move onto the next pool I had to use the *pH pen* to measure the ph and the temperature of the pool. To measure the ph/temperature I had to place the ph pen in the middle of the pool for five minutes. Once I had obtained the ph/temperature, I had to record it in my record sheet.

I also had to use the *Braystoke Flow meter* to measure the velocity. To do this I had to point the flow meter in the direction of the flow of water. I had to leave it in the water for one minute before I could record the measurement. But I had to make sure that I converted the results into ms-1 because the flow meter only recorded the number of revolutions in the pool.

Then I had to get the *ruler* to measure the depth of the pool.
Once all the measurements for the pool had been recorded, I had to select another pool at random. Then I had to repeat the above process for this pool. I had to make sure that at the end of it I remembered to take the ph and velocity readings, also the depth of the pool.

I had to repeat the process for the remaining four pools selected at random. Making sure I recorded the ph, velocity and depth readings.

Then I had to move on to the riffles. I had to randomly select the riffle I would be collecting data from.

Once I had selected the riffle I would be working in I had to fill the two trays with water.

Then I had to get the Serber net and place it at the mouth of the riffle. Once I had done that, I had to disturb the sediment by rubbing the substrate for three minutes.

Once the three minutes was finished, I had to place the net in on of the trays and empty the invertebrates into it.

I then had to get the spoon and pick out the mayflies in the midst of the invertebrates. Once I had identified the mayflies I had to place them in the other tray.

As I identified the different species of mayflies, I had to make a tally chart on my recording sheet.

Once I had finished picking out the mayflies in the tray, I had to pour both trays of water and invertebrates back into the stream.

Then I had to get the ph pen and record the readings of the ph and temperature. To do this I had to place the ph pen in the midst of the riffle and hold it for five minutes before I recorded the reading.

I had to use the Braystoke flow meter to measure the velocity. To do it I had to make the flow meter face the mouth of the riffle. I had to measure the velocity for one minute. Then I had to record the reading on my recording sheet. But I also had to make sure that I converted the result into ms-1, because the flow meter only recorded the number revolutions in the riffle.

I also had to use the ruler to measure the depth of the riffle, and record it.

Before I could move on to the next riffle, I had to make sure that I had recorded all my data onto my record sheet.

Then I had to do the five remaining riffle, making sure that they were randomly selected, and repeating the above process.

COLLECTED DATA

Here is the data I collected from the pools and riffles for the number of mayflies found in each riffle and pool.

MAYFLY NYMPHS	RIFFLES					
	1	2	3	4	5	6
Flat Mayfly	5	1	19	5	0	0
Ephemerellidae	2	1	0	6	0	0
Burrowing Mayfly	0	0	0	0	0	0
Swimming Mayfly	2	1	9	7	1	3
Velocity	0.596	0.389	0.551	0.875	0.452	0.776
Depth (cm)	230	160	200	180	220	175
Temperature	6.9	8.2	6.9	7.4	7.2	7.5
pH	7.6	7.3	7.9	7.2	6.7	6.9

MAYFLY NYMPHS	POOLS					
	1	2	3	4	5	6
Flat Mayfly	4	12	10	1	3	0
Ephemerellidae	10	7	0	6	4	3
Burrowing Mayfly	0	0	0	0	0	0
Swimming Mayfly	2	3	3	6	2	8
Velocity	0.031	0.048	0.048	0.04	0.031	0.031
Depth (cm)	160	170	210	150	160	130
Temperature	6.4	7.3	7.8	7.6	7.1	7.6
Ph	7.1	7.9	7.3	7.1	7.0	7.1

From these results I can see that the velocity, temperature, depth and pH are all higher in the riffles than in the pools

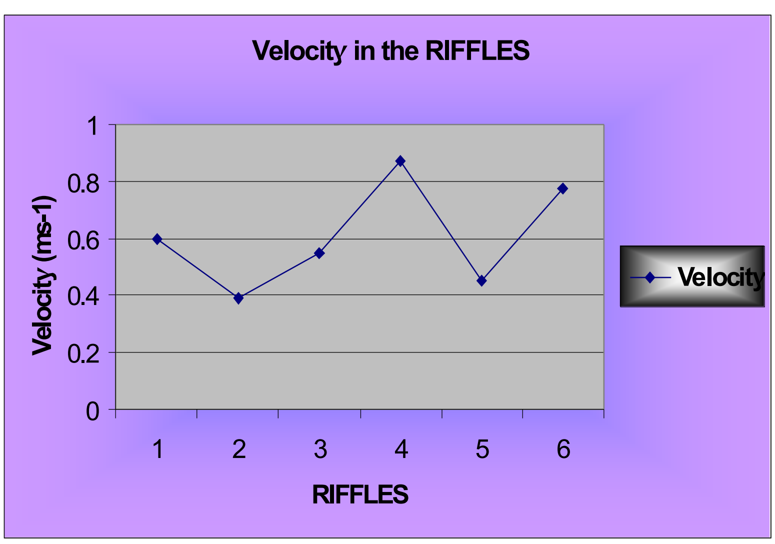
The data shows that there were more mayflies in the pools than in the riffles
I also noticed that there were no Ephemeridae in the pools or riffles.

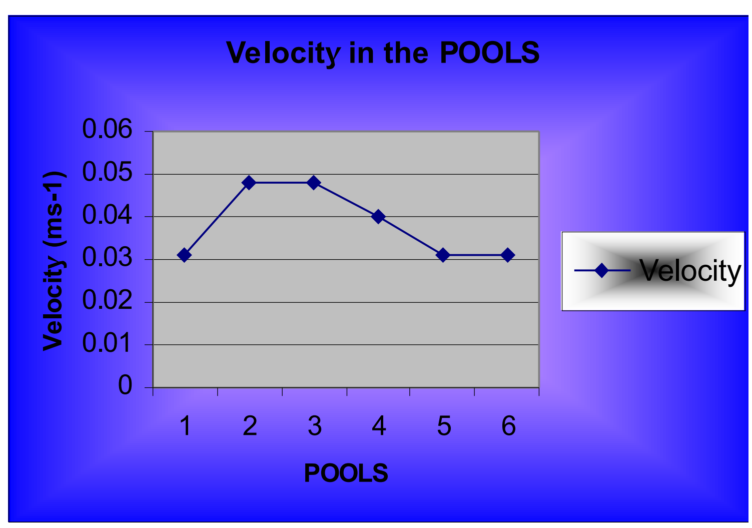
The amount of mayfly nymphs found in my real investigation were low compared to the amount of mayflies found in my preliminary

The factors affecting the number of species found could be the fact that the flow of water increased in both pools and riffles.

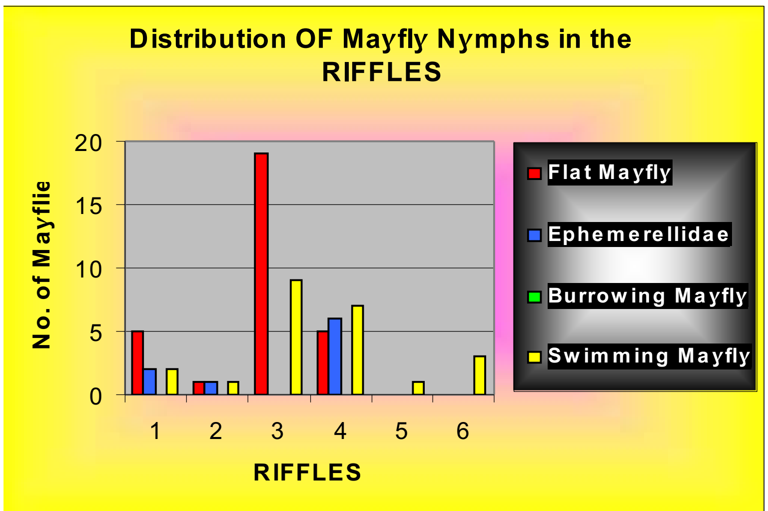
These are graphs to show:

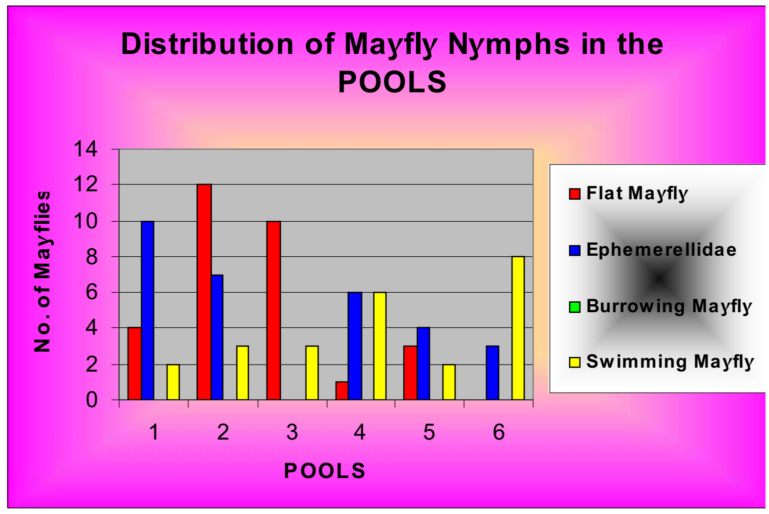
- The distribution of velocity in the POOLS & RIFFLES





- Distribution of Mayfly Nymphs in the RIFFLES & POOLS





This shows that there was not much of difference in the distribution of mayfly nymphs within the pools and riffles.
Also it shows that there were more mayfly nymphs found in the pools than in the riffles which agree with their characteristics as mayflies prefer still water than fast flowing water, even though they are adapted for both.

MANN-WHITNEY TEST

NULL HYPOTHESIS:

There is no significant difference in numbers of Mayfly Nymphs found in the riffles and pools.

ALTERNATE HYPOTHESIS:

There is a significant difference in numbers of Mayfly Nymphs found in the riffles and pools.

Critical Value = 5 (No. of samples: 6)

"If the smallest U value is less than or equal to the critical value we reject the null hypothesis and accept the alternative hypothesis"

I had to do a Mann Whitney test for each mayfly nymph because I was investigating the different species of mayfly.

Flat Mayfly						
RIFFLE	5	1	19	5	0	0
POOL	4	12	10	1	3	0

Before I could apply the test I had to rank all the data- smallest value to highest value. I also have to rank between both riffle and pool datasets.

RANK						
RIFFLES	8.5	4.5	12	8.5	2	2
POOLS	7	11	10	4.5	6	2

TOTAL (RIFFLE): 8.5 + 4.5 + 12 + 8.5 + 2 + 2 = 37.5
TOTAL (POOL) : 7 + 11 + 10 + 4.5 + 6 + 2 = 40.5

$$U1 = 6 \times 6 + \frac{6(6 + 1)}{2} - 37.5$$

U1 = 19.5

$$U2 = 6 \times 6 + \frac{6(6 + 1)}{2} - 40.5$$

U2 = 16.5

As the smallest U value, 37.5 is the critical value, I have to accept the null hypothesis, *"There is no significant difference in numbers of flat mayfly nymphs found in the riffles and pools*."

I then had to follow the steps to do the same for the Burrowing Mayfly

Burrowing Mayfly						
RIFFLE	2	1	0	6	0	0
POOL	10	7	0	6	4	3

Before I could apply the test I had to rank all the data- smallest value to highest value. I also have to rank between both riffle and pool datasets.

RANK						
RIFFLES	6	5	2.5	9.5	2.5	2.5
POOLS	12	11	2.5	9.5	8	7

TOTAL (RIFFLE): 6 + 5 + 2.5 + 9.5 + 2.5 + 2.5 = 28
TOTAL (POOL) : 12 + 11 + 2.5 + 9.5 + 8 + 7 = 50

$$U1 = 6 \times 6 + \frac{6(6 + 1)}{2} - 28$$

U1 = 29

$$U2 = 6 \times 6 + \frac{6(6 + 1)}{2} - 50$$

U2 = 7

As the smallest U value, 29, is more than the critical value I have accept the null hypothesis.
"There is no significant difference in the number of Burrowing Mayfly Nymphs found in the pools and riffles"

Swimming Mayfly						
RIFFLE	2	1	9	7	1	3
POOL	2	3	3	6	2	8

Before I could apply the test I had to rank all the data- smallest value to highest value. I also have to rank between both riffle and pool datasets.

RANK						
RIFFLES	4	1.5	12	10	1.5	7
POOLS	4	7	7	9	4	11

TOTAL (RIFFLE): 4 + 1.5 + 12 + 10 + 1.5 + 7 = 36
TOTAL (POOL) : 4 + 7 + 7 + 9 + 4 + 11 = 42

$$U1 = 6 \times 6 + \frac{6(6 + 1)}{2} - 36$$

U1 = 21

$$U2 = 6 \times 6 + \frac{6(6 + 1)}{2} - 42$$

U2 = 15

As the smallest U value, 15, is more than the critical value I have accept the null hypothesis.
"There is no significant difference in the number of Swimming Mayfly Nymphs found in the pools and riffles"

Ephemerellidae						
RIFFLE	0	0	0	0	0	0
POOL	0	0	0	0	0	0

I then had to rank between the riffles and pools datasets.

RANK						
RIFFLES	6.5	6.5	6.5	6.5	6.5	6.5
POOLS	6.5	6.5	6.5	6.5	6.5	6.5

TOTAL (RIFFLE): 6.5 + 6.5 + 6.5 + 6.5 + 6.5 + 6.5 = 39

TOTAL (POOL) : 6.5 + 6.5 + 6.5 + 6.5 + 6.5 + 6.5 = 39

$$U1 = 6 \times 6 + \frac{6(6 + 1)}{2} - 39$$

U1 = 18

$$U2 = 6 \times 6 + \frac{6(6 + 1)}{2} - 39$$

U2 = 18

As both U values are the same and more than the critical value I have accept the null hypothesis.
"There is no significant difference in the number of Ephemerellidae found in the pools and riffles"

I had to accept the null hypothesis for each mayfly nymph. That shows that there were no significant differences in the number of mayfly nymphs found in the riffles and pools.

ANALYSIS

I was comparing the different species of mayfly nymphs within the pools and riffles. I chose to do this because I wanted to see if there were different mayfly nymphs found within the pools and riffles.

My null hypothesis stated that here would be no significant difference between the numbers of mayflies found within the pools and riffles. I chose to agree with that because the abiotic factors showed that the mayflies only lived in pools/riffles with a pH of 5.0 and above; low pH can upset uptake through the gills and ion regulation. Values below 5.0 cause an alteration in the permeability of the gills. The preliminary results showed that the pH tended to be above 5.0 rather than below.

(SOURCE)

Also my null hypothesis worked for each different species found within the pools and riffle

so that showed that there was no significant difference in the number of mayflies within the pools and riffles.
I chose to compare the different species of mayfly nymph within the pools and riffles because I felt that I would be able to collect a wide range of mayfly nymphs, therefore my results would show the different species of mayfly nymphs collected from the pools and riffles.

The Mann-Whitney test also showed that there was no significant difference in the number of mayfly nymphs found within the pools and riffles.
So even though there were more mayflies within the pools. The test shows that the difference between them was not great.

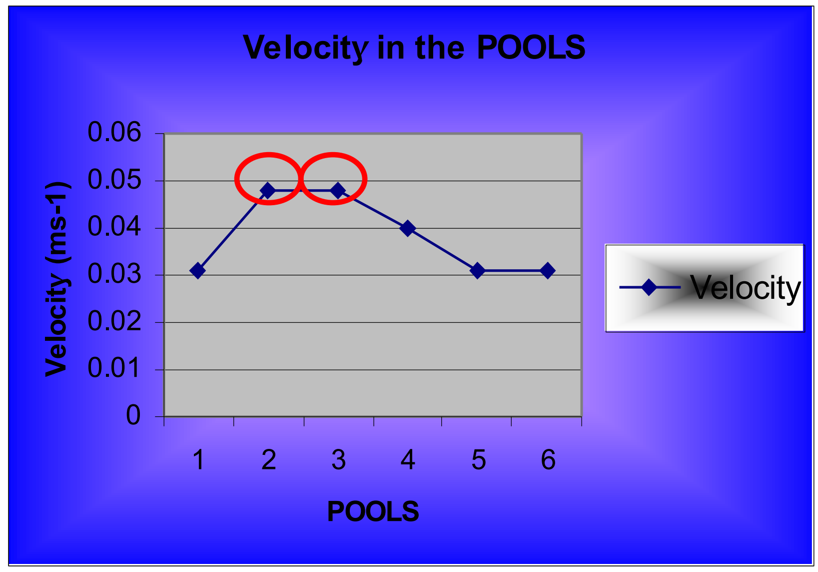
My results tables show that there were four different species of mayfly nymphs found within the pools and riffles. It also shows that out of the four only three were found in the some of the pools and riffles. The odd data I collected was the results for the Ephemerellidae. My data showed that there were no Ephemerellidae found within any of the pools and riffles I was looking at.
This shows that either this particular species did not meet the characteristics of the stream, or the flow of water could have pushed it upstream from where I was working.
The results also show that there wasn't much of a difference between the velocity flow levels of the riffles and pools. That was because the flow of water had increased from when I did my preliminary, where it shows that there were some Ephemerellidae found in the riffle and pool and it also showed that there was a difference in the velocity of the pool/riffle. So my results were not accurate as I only managed to find three out of four different mayfly nymphs.

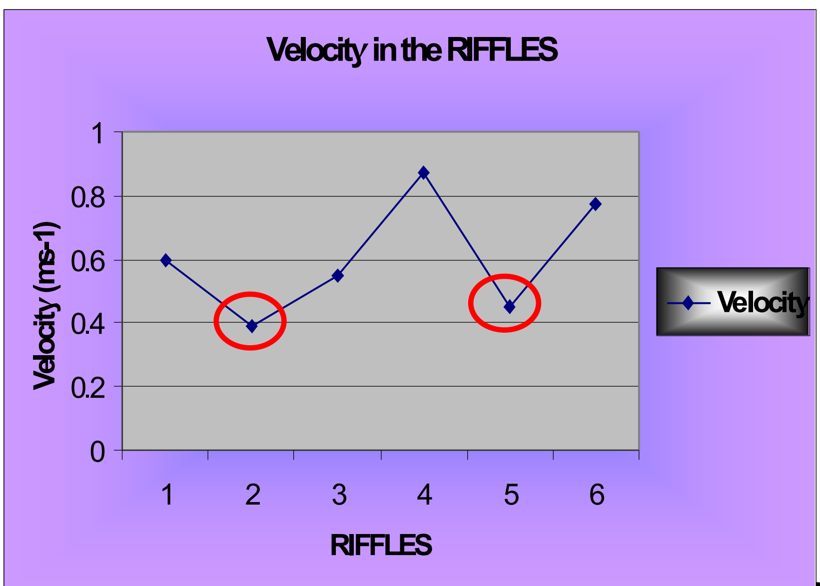
My graph shows that there were a few errors regarding the distribution of mayfly nymphs in the pools and riffles. The data shows that there were more flat mayfly nymphs found in one of the riffles even though they tend to live in the pool more than the riffle.
That shows that there were a few factors affecting the distribution of mayfly nymphs, the flow of water was a strong factor because I noticed that the speed had changed and increased the day after my preliminary was done. So it agrees with their characteristics as mayflies prefer slow flowing water than fast flowing water, even though they are adapted for both.

The movement of the wind and water had also increased, so that showed that they had a big impact on the distribution of mayfly nymphs within the pools and riffles; intensity of the movement may also influence the shape and survival of organisms.

(SOURCE: http://www.biocab.org/Ecology_1.html#anchor_19)
There were also errors in the graph for the velocity readings in the pools and riffles.
The graphs show that the velocity was greater in the riffles than in the pools. This is in accordance with the fact that in the water is fast flowing in the riffle so there would be turns of water. Whereas in the pool the water is slow flowing so I didn't expect it to produce any turns.
There were quite a few errors within the graphs which have been circled below. The factors that could have affected the velocity would be the wind and water movements, because I noticed that the flow of water had increased as I was carrying out my investigation.

Throughout this investigation I have learnt that there are lots of abiotic factors which can affect the distribution of microorganisms between two different sites. I have also learnt that it helps to have the right equipment so that the investigation can be carried out to its best ability.





EVALUATION

My results show that there were no significant differences in the number of species within the riffles and pools.
However there were many problems and limitations with my method and results collected, so they could have affected the results. There are also external factors which I could not control that could have affected my results.

The accuracy of the equipment is an important problem. This is very important to the experiment as the equipment's sensitivity is what makes the experiment valid and accurate. The meter ruler used to measure the depth is not scientifically equipped to give precise results.
The pH pen and thermometer were not totally sensitive so they could only give average

results which were not correct enough.
The Braystoke flow meter was a good piece of equipment because it counted the number of revolutions in the water. But that was not good enough because I then had to convert it into ms-1 (metres per second). So I couldn't completely trust the flow meter.
Also the net used did not help because I felt that there were too many holes in it which could have caused some of the invertebrates to escape, therefore my result would not be accurate enough as I might have lost some of the invertebrates. However, as the stream was filled with leaves, it could have helped some of the invertebrates to stay in the net by blocking a few holes in the net.

Accurate results can be achieved by increasing the amount of readings taken. If there's more than one sampling taken, I am likely to achieve accurate results. This could only be done if my time limitations were equal. So I decided to make sure I spent ten minutes counting the species per sample. But I feel that my time-constraints limited me greatly as I had to increase the speed at which I was working just to make sure that I completed my twelve samplings. If I had found more species it would have changed the succession of my Mann-Whitney. Also the identification key did not help because most of the mayfly nymphs looked the same and it was hard to keep the invertebrates still enough the notice their characteristics to help with identifying them.

I made a slight mistake during my experiment, as I decide to collect data from the riffles before I collected it from the pools. So it was difficult for me to discover which species of mayflies belonged in the riffles and pools. Also there were other people in the stream so it didn't help that they contributed to the dispersal of invertebrates between the pools and riffles. It also didn't help that the flow of water continued to increase therefore, my results were not accurate enough.

Earlier I mentioned that leaves, twigs and debris were collected in the net as well as invertebrates. That did not contribute to the distribution of invertebrates because I had to remove most of the leaves and as some of the species would have been clinging to them, I inadvertently removed some of them as well. Plus I realised that some of the invertebrates would have been left behind in the net as it wasn't easy removing them from the net into the trays.

Ethical involvements were also an issue in my investigation. It is part of the biotic factor as my presence in the stream could have affected the stream in some ways. It starts with the removal of rocks during my kick sampling methods. I had to move around some of the rocks so that the net could lay flat in the stream to stop the invertebrates from escaping. By moving the rocks around I was interfering with the species' microhabitat, and could cause the species to move to another part of the stream with some or less of their required abiotic factors, or dying because they were not specially equipped for certain parts of the stream.
This is why I made sure I replaced all of the rocks I removed so that the species' microhabitat was not completely ruined. It also meant that they would have a higher rate of survival.
There were a few factors that affected the distribution of mayflies, which I could not control.
The weather was a main concern because, as I was doing the sampling during the winter, the weather could have affected the flow of water because the wind was strong and it had

also rained heavily days before I had to carry out my investigation. So they could have affected the distribution of mayflies in the pools and riffles. had an impact on the flow of water as it had increased from when I did my preliminary sampling, which was the previous day.

If I was to do this investigation there are many improvements and adjustments I would make sure I achieved the most accurate results.
The collection of data would have to be spread over two days, that way I would have more time to collect the data without the hassle of rushing at the last minute just make sure I had the correct results.

Time constrictions would also increase by 5 minutes to be sure that I had identified all the invertebrates within the trays. The identification key would have to be changed so that I could identify the species as accurate as possible.
I would also make sure that I cleared some of the leaves from the stream just to make sure that none of the invertebrates were clinging to them.

The time of disturbance could be increased so that more invertebrates could find their way into the net. That way there would be more invertebrates to collect and identify taking into account the holes in the net.
The equipment would have to be updated and scientific so that the results gathered were as accurate as possible
Also I could have had more intervals between the gatherings of data to make sure that I was putting in the same amount of effort into each site.
I could also have extended my investigation by collecting data in two or more pools and riffles.

CONCLUSION

Overall my investigation shows that I had to accept the null hypothesis; there was no significant difference in the number of mayfly nymphs found within the riffles and pools.
It also shows that there no Ephemerellidae was found in both pools and riffles.
Also it shows that the velocity flow levels changed the results of the number of mayflies found. That shows that the high water levels which might be seasonal, affect the velocity.

There were also a few errors in the results for the distribution of mayfly nymphs within the riffles and pools.

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