An investigation into the abundance of fresh water black fly larvae, Simuliidae, between pools and riffles in Woodford meanders on the 19th September 2003.

Abstract:-

My investigation was to see where the black fly larvae, Simuliidae, preferred to inhabit, slower moving pools or fast moving riffles. I accomplished my results on the 19/09/03 at Woodford meanders using a "stone shake" sampling method. The results were conducted on the same day and within 3 hours from the first to the last. Readings of temperature, width, depth and impellor travel time were taken at each sample point. I plotted a graph of, pools or riffles against number of black fly larvae, Simuliidae. To analyse my results I used a Mann Whitney U significance test which showed with a 5% significance that the black fly larvae, Simuliidae, preferred the faster moving riffles or the slow moving pools.

Introduction:-

I accomplished my investigation at Woodford meanders (Grid reference - Sr06370638) on the 19th of September 2003. I chose to investigate the abundance of the black fly larvae, Simuliidae, whether they are in higher concentration in the slow moving pools or the fast moving riffles. I chose a freshwater dwelling species because there was a stream, Woodford meanders near to the base camp, Nettlecombe court, where we were staying, therefore it was more accessible, there was no time limit and in case of emergencies, help was only at the base camp. I chose the black fly larvae, Simuliidae, because in preliminary experiments at Woodford meanders, there was a moderate amount of the species, so comparisons could be made on the preferred dwelling for the black fly larvae, Simuliidae; Plus I was personally curious why there were large amounts of the species under trees or bushes so I decided to investigate further.

Background information:-

The black fly larvae, Simuliidae, is a detritivore;

Detritivore, an animal that feeds on animal and plant waste or remains, sequentially reducing the particle sizes so that the true decomposers, bacteria and fungi, can break them down to their constituent chemical parts for recycling in the ecosystem. Without the action of detritivores to increase the surface area of this particulate matter, the rate of decomposition is reduced, or stops altogether. The gradual reduction in particle size is often called comminution. Excerpted from The Oxford Interactive Encyclopedia.

The black fly larvae, Simuliidae, spins a small silken mat over a surface of the stone and then using it's posterior hook circlet, it positions itself on the silken mat so that the body is projected down stream parallel to the current. The head of the black fly larvae, Simuliidae, carries two brush-like structure which sweeps the current picking up detritus food passively and unselectively from the water.

The black fly larvae, Simuliidae, has gills positioned on either side of its body and are unable to pump are provide oxygen for itself; where as in comparison, a fresh water shrimp devotes 8 legs to usher water to its gills by stroking them very quickly.

Nitrate, from animal fertilisers, are easily leached from the soil, particularly in wet weather, and may end up in watercourses, resulting in eutrophication. This leads to a high biochemical oxygen demand and eventually the lack of oxygen kills animal life. The black fly larvae, Simuliidae, has a high tolerance to mild organic pollution or enrichment; But generally the black fly larvae, Simuliidae, is absent from grossly polluted waterways.

In species such as black fly larvae, Simuliidae, they have several generations each year (multivoltine), larvae of the generation attain a greater size than those of subsequent generations. The adult Black fly, Simuliidae, lays many eggs at one time. This ensures that an offspring will survive predation, and that the adult Black flies, Simuliidaes, genetic imprint will be passed on to future generations.

Natural selection occurs in the species black fly larvae, Simuliidae, as to select for an advantage in that particular environment. Directional selection occurs, this is when a new environmental factor appears. Through time, our British waterways become more polluted, and particular black fly larvaes, Simuliidaes, with a tolerance to a high polluted water are advantageous so survive to pass on their advantageous allele.

Water is a very good medium for organisms to inhabit, it has many qualities which make it perfect for life to thrive. Water on a large scale acts as a protective barrier for the aquatic life and cells that would usually dry up on land. Also water has a high ability to supply marine life with the nutrients and oxygen through diffusion and remove waste products also. As a large mass, the temperature of water will fluctuate mildly so organisms living deep within oceans and lakes will have no need for temperature control, unlike land organisms. Plus, water filters out harmful ultra-violet rays from the sun, protecting the water life from damage.

Pools are deep, quiet areas created by erosion, and riffles, shallow, fast flowing areas of water, form from the deposition of material during high water levels. The presence of pools and riffles benefit insects, fish, and other creatures because riffles oxygenate the water as it tumbles over the shallow bed, which provides oxygen rich water to the pools where most of the stream life resides.

Pools and riffles are related to meanders in that they form from the erosion and depositing of material. The pools are the deep quiet areas and riffles are the shallow fast flowing areas. They tend to form at regular intervals spaced between five and seven times the width of the channel. They are better developed in streams where the slope is not very steep.

In riffles, the increased surface area caused by the shallow flow, splashing, and bubbles improves air-water mixing. The more surface area and mixing, the more oxygen that can get into the water.

In riffles the water is fast, but shallow so larger stones are deposited increasing the surface area exposed to the air.

In pools the water is slower so the bottom of the stream is covered in silt. It is slower due to back flow from the bedsides and is deeper because of the erosion from the back flow.

In the centre of a riffle, are where the fastest flowing water may be found. In the pools the flow is much slower but the water in the middle still moves faster than the rest of the pool. If an organism requires fast flowing water, the middle of the stream is where they would accumulate.

Preliminary experiment:-

I conducted my preliminary experiments at Embercombe on Exmoor and also at Woodford meanders.

At Embercombe, I did a investigation of “Abundance of Freshwater Invertebrates in pools or riffles” Here I became familiar with equipment and procedures. The equipment given by Nettlecombe court was adequate for the job needed: flat-bottomed net, 5 litre tub, impellor & stand, brightly coloured tray, spoon, pipette, stopwatch, metre rule, tape measure & a temperature probe.

Thus I will use the identical equipment for my investigation in to whether there is a higher abundance of black fly larvae, Simuliidae, in pools or riffles.

I learnt how to use the equipment efficiently giving more accurate results; all readings must be taken in the middle and bottom of the stream (i.e. temperature, depth & impellor travel time) as to standardise the results so that a pattern can be seen. The impellor and stand must point parallel to the current, this is to time the correct velocity of the stream, otherwise the current will appear slower; also in front of the impellor it must be clear of obstructions such as rocks, algae or weed as they clog up the impellor giving a false reading.

If a physical (abiotic) factor is introduced to a sample site or down stream of a sample site, a note of the factor should be taken as to account for and explain any anomalous results later. Such factors that we encountered were animal crossings, where excreting can occur raising the nitrogen content leading to increased water plant growth which leads to more herbivores which in turn leads to more carnivores; also when a confluence occurs more factors are introduced as anything could have occurred up the second stream such as pollution or increased amount of fish, killing the invertebrates, giving me a false reading. Overhanging trees or bushes increase the number of detritivores, so these factors must be noted as well.

It is at Embercombe where I found a high abundance of the black fly larvae, Simuliidae, and for this reason and their eccentric nature, I decided that I wanted to analyse them further and to study them for my investigation.

On my first visit to Woodford meanders I carried out a trial run in which I tested different procedure to find the optimum choice.

I tried different types of sampling, my options were foot sampling, where I would shuffle my foot in the stream bed for 20 seconds or rock sampling where I would pick 3 stones and shake in the mouth of the net for 10 seconds for each stone. I found a higher concentration of black fly larvae, Simuliidae, and less debris in the rock sampling, this would make it easier to make conclusions thus I chose the rock sampling method. On doing this method I noticed an inaccuracy that could occur; the surface area of each rock differs to which the black fly larvae, Simuliidae, could attach itself, would not be constant. To regulate the size of the stones, I would pick palm sized stones.

When doing the preliminary experiment with the other students, it was not long before the stretch of stream before my site had been disturbed and contaminated with the remnants of their investigations which altered the accuracy of my results. To overcome this I shall do my experiment either upstream of my peers or go to a stretch or the stream that has not been used by others.

Hypothesis:-

I believe that I will find a higher abundance of black fly larvae, Simuliidae, in the fast riffles than in slower pools.

Null Hypothesis:-

There will be no difference in abundance of black fly larvae, Simuliidae, between slow pools and faster riffles.

Prediction:-

I believe that the black fly larvae, Simuliidae, will be in a higher abundance in the riffles. I think this because the black fly larvae, Simuliidae, needs a constant supply of oxygen to its gills, as it has no means to supply itself. In riffles, the increased surface area caused by the shallow flow, splashing, and bubbles improves air-water mixing and with the riffles high velocity the black fly larvae, Simuliidae, would get a high supply of oxygen enriched water. The pools though supplied with oxygenated water from the riffles, are too still and because the black fly larvae, Simuliidae, cannot supply its own oxygen it need a current to brush oxygen past its gills.

The black fly larvae, Simuliidae, carries a brush-like structure on its head which sweeps the current picking up detritus food passively and unselectively from the water, so the black fly larvae, Simuliidae, would need a stable current to supply its head fans with detritus food; thus it would prefer a faster current, such as a riffle, as it would be more likely to carry food for the black fly larvae, Simuliidae. The pools run too slowly and have a large amount of silt suspended in its still waters so when the black fly larvae, Simuliidae, filters its food unselectively it would not find as much food, but a high concentration of silt.

The black fly larvae, Simuliidae, spins a small silken mat over a surface of the stone and then using it's posterior hook circlet, it positions itself on the silken mat so that the body is projected down stream parallel to the current. In a riffle, large stones are deposited leaving a large surface area for black fly larvae, Simuliidae, to spin its silken mat and position itself down stream, because of the large area for the black fly larvae, Simuliidae, to attach itself I think it will prefer riffles. In pools the slow current means a large deposition of silt, the silt can settle in the still water and coat the bottom of the pool, with a layer of silt on the bottom of the pool the black fly larvae, Simuliidae, cannot attach itself to a stone.

In a graph of velocity against number of black fly larvae, Simuliidae, I believe it will portray the graph below:-

I believe this because all the pools results will have a slow velocity, thus being portrayed being low down the velocity scale; also pools will have a low value for number of black fly larvae, Simuliidae, so will be low on the 'number of black fly larvae, Simuliidae' scale. The riffles have a higher velocity so will be described on the graph, high up on the velocity scale; also riffles will have a higher number of black fly larvae, Simuliidae, so will be higher on the 'number of black fly larvae, Simuliidae' scale.

On the bar graph of number of black fly larvae, Simuliidae, against site number, I believe I it will show a larger number of black fly larvae, Simuliidae, in riffles than pools thus the bars for riffles will be higher than the bars for pools.

Safety:-

Working on a different location compared to the usual environment of a laboratory brought forth many safety procedures that have to be followed:-

* At all times there must be two or more people at one site - This makes sure that if an accident occurs, help can be administered by the partner immediately.
* A first aid kit and mobile phone should be kept by at least 1 member of the group - If an accident occurs, then first aid is at hand, if the accident is untreatable then the mobile phone can call for assistance or emergency services.

* Awareness of traffic - The country road to which the stream path opens to is relatively busy, an awareness of traffic must be upheld so that a major incident does not occur.
* Awareness of steep and slippery banks - The banks to the stream are naturally steep and slippery, to fall or slip down a bank could cause injury. Either use lower, dryer banks to enter the stream or wear good footwear with good grip so that trouble can be avoided.
* Do not ingest stream water - The stream is home to wild rats, they carry Weils disease and infect the waterways. If eating at the site, either wash hands with clean water or do not touch food. (Dispose of food wrappers and rubbish when you leave as to preserve the site)

Equipment:-
1. 1 Impellor and stand - This is to measure the speed of the current at the centre and bottom of the stream, this is where the measurements should be taken each time as to regulate the results, in doing so, the results will be consistent and more accurate. The impellor time travel is altered with an equation to find the speed.
2. 5 litre bucket - This is to rinse the net of organisms and hold the organisms once counted. The organisms should be transferred to this bucket to stop recounting occurring. Doing so will improve the reliability and accuracy of my results.
3. 1 Brightly coloured tray - This is where the organisms are transferred from the net. The organisms can be clearly identified against the bright background, this will lower the chance of miss identification thus improving the accuracy of the results
4. Wellies or waders - These will be used so that you can access the centre of the stream. This is where the measurements should be taken each time as to regulate the results, doing so the results will be consistent and more accurate.
5. 1 Temperature probe (grading of 0.1°C)- This is to measure the temperature of the stream, it should be a probe rather than a thermometer so that the temperature can be read at the bottom and middle of the stream, this is where the measurements should be taken each time as to regulate the results, in doing so, the results will be consistent and more accurate. It should be graded at 0.1°C, this will improve the accuracy of the results.
6. 1 metre rule (grading of millimetres) - This is to measure the depth of the stream. The depth should be measured in the centre and bottom of the stream, this is where the measurements should be taken each time as to regulate the results, in doing so, the results will be consistent and more accurate. It should be graded to millimetres as to improve the accuracy of the measurement.
7. 1 tape measure 5 metre (grading in millimetres) - This is used to measure the width of the stream. The width should be measured perpendicular to the flow of the current, this is where the measurements should be taken each time as to regulate the results, in doing so, the results will be consistent and more accurate. It should be graded to millimetres as to improve the accuracy of the measurement.
8. 1 flat bottomed net - This is used to trap the organisms. The net should be placed flat on the bottom and centre of the stream, this is where the measurements should be taken each time as to regulate the results, in doing so, the results will be consistent and more accurate.
9. 1 stopwatch - Used to measure the time taken for the impellor to reach the end of the screw thread and for the temperature probe to level out. The stopwatch should measure to 0.01 of a second. This will improve the accuracy of the velocity readings.
10. Pipette - This will be used to remove the organisms from the tray to the bucket.

11. Plastic spoon - This will be used to transfer the organisms from the tray to the bucket.

Precision and accuracy:-

To improve the accuracy of the measurement taken, they should all be taken at the same point in the stream. The measurements for using:

* the metre rule for depth,
* the temperature probe for temperature,
* the impellor and stand for the velocity,

should all be taken in the middle and bottom of the stream as to regulate the results, in doing so, the results will be more reliable and more accurate.

Repeats:-

To gain a true representation of the stream, many repeats should be achieved; for this reason I have chosen to repeat the experiment 20 times for both pools and riffles. I feel that this will give an accurate representation, in the time given to me, of the concentration of black fly larvae, Simuliidae, in the river. 20 repeats is the maximum number of results I can have for a Mann-Whitney U test; having the maximum values possible will give me a precise value to compare to the critical value.

Range:-

I will be measuring the following factors at each site of the stream:-

* The temperature of the stream, to view if the abundance of black fly larvae, Simuliidae, alters with the temperature of the water.
* The width and depth of the stream, to differ from pools and riffles
* The velocity of the stream, to see whether the black fly larvae, Simuliidae, are in a higher abundance in the fast riffles or the slower pools.

Variables:-

Independent variablesDependent variablesControlled variables* Whether it is a pool or a riffle.* Abundance of black fly larvae, Simuliidae.

* Velocity.
* Width.
* Depth.
* Temperature.* Standardise procedure.
* Same climate and day.
* Same chemistry of water.
* Sample the same stream.
* Same environment.
* Same geology.

In choosing a pool or riffle, the independent variable, will alter the abundance of black fly larvae, Simuliidae, the width and depth of the stream, the temperature and the velocity, the dependent variables. I will be measuring the dependent variables.

In controlling some variables, I will gain more accurate results as not taking account for these factors can alter my results dramatically,

In standardising my procedure, it will keep my result from showing a bias outcome, my results will then be standardised and portray a true representation of the experiment.

Doing the experiment on the same day and constant climate, stops large biotic factors, such as the weather and temperature, affecting my results. Rainfall would affect the stream depth so all readings as time proceeds would be off.

To keep the chemistry, geology and environment of the water constant, I shall note down any factors which may affect the activity of black fly larvae, Simuliidae, such as confluences, overhanging trees or cattle crossings.

In sampling the same stream, the chemistry and geology of the water will remain similar, where as changing streams and merging results will produce data with a large amount of errors.

Recording and analysing data:-

I will be recording numerous amount of data so I must construct a results table that can hold all the information. To count the number of black fly larvae, Simuliidae, I shall be using a tally chart, this will make counting simple and eradicate time wasting of recounting. For the 4 data values of width, depth, temperature and impellor time travel, I shall use separate boxes for each site and write the value in the corresponding box.

I will display my data in appropriately chosen graphs this will demonstrate my data with much ease.

To analyse the statistical significance of my data I will be performing two kinds of statistical tests: Mann-Whitney U test and the Spearman rank test.

The Mann-Whitney U test, tests for the significance of the difference between two sets of data. In putting my data into this test it will tell me to what significance I can reject the null hypothesis, that there is no difference in abundance of black fly larvae, Simuliidae, between pools and riffles. I will test to the 5% significance, this will show whether my results are true to 95%.

Spearman Rank Correlation is a technique used to test the direction and strength of the relationship between two variables. In other words, its a device to show whether any one set of numbers has an effect on another set of numbers. It uses the statistic Rs which falls between -1 and +1.

Method:-

1. Put on wellies or waders.
2. Find a riffle on the stream (characterised in background information).
3. Get partner to hold 1 end of the tape measure at 1 side of the stream.
4. Enter downstream of the site area, as to not disturb the sample site and place the other end of the tape measure on the opposite side of the stream keeping the tape perpendicular to the current.
5. Record width result.
6. Divide the width result by 2, this is half way across the stream and place the metre rule at this distance flat on the bottom of the stream bed.
7. Record depth result.
8. Place temperature probe at the same point as the metre rule; at the bottom and centre of the stream.
9. Time 30 seconds on the stopwatch for the temperature reading to settle.
10. Record temperature reading.
11. Attach impellor to its stand and twist impellor until it is at the end of its screw threads.
12. At the site, make sure that it is flat on the bottom, free of weeds and algae and has no protruding rocks as to obstruct the flow of water of the impellor.
13. Hold the impellor and stand above the site you will place it.
14. Place the impellor and stand on the bottom of the stream pointing in the direction of the current and start the stopwatch.
15. Stop the stopwatch when the impellor has reached the end of the screw threads and has stopped turning.
16. Record impellor time travel result.
17. Fill brightly coloured tray and bucket 2/3 full of river water and remove organisms with spoon and pipette back into the stream carefully.
18. Place net flat on the bottom of the stream bed perpendicular to the current.

19. Grab 1 palm sized stone from in front of the net.
20. Place stone in net opening at shake in water for 10 seconds then remove stone and place away from the net opening.
21. Repeat steps 18 - 20 until you have shaken 3 stones for 10 seconds each.
22. Remove net from water and invert into the brightly coloured tray.
23. Use bucket of water to rinse net of organisms.
24. Refill bucket to 2/3 of water.
25. Remove black fly larvae, Simuliidae from the brightly coloured tray using the spoon and pipette and place in bucket. Take a tally of black fly larvae, Simuliidae removed from tray.
26. Once all black fly larvae, Simuliidae are removes from the brightly coloured tray, pour the tray of unwanted organisms and bucket of black fly larvae, Simuliidae into the stream, close to the surface so not to harm the organisms.
27. Repeat steps 3 - 26 for a pool (characterised in background information).
28. Repeat steps 3 - 26 until you have 20 results for riffles and 20 results for pools.

Results:-

Results for Riffles
Site NumberNumber of black fly larvae, Simuliidae, in RifflesWidth (m)Depth (m)Temperature (°C)Velocity (m/s)1193.10.0813.80.4962243.50.0913.80.326303.90.0813.90.147403.50.0913.90.147521.30.2014.10.177641.80.0713.90.200792.80.0813.80.326862.20.0914.00.233961.60.0714.00.2331032.30.0813.80.1921151.70.0714.10.2151220.90.0814.00.16413102.20.1214.20.4381442.50.0814.30.3401562.40.0714.60.3131662.70.0914.40.4381742.40.0715.00.35618181.90.1015.00.3261992.40.1115.00.5322011.80.1315.20.356
Results for Pools
Site NumberNumber of
black fly larvae, Simuliidae, in pools.Width (m)Depth (m)Temperature (°C)Velocity (m/s)
to 4
SF112.00.1813.90.136202.30.2114.00.078303.10.1913.90.060401.80.2214.00.067511.20.2114.10.070601.50.1813.80.062722.10.2013.90.061813.20.2814.00.072902.00.1914.00.0841011.90.2114.00.0801101.80.1513.90.0641202.00.1914.00.0651311.50.2214.30.0641402.10.1714.30.0741502.00.2614.70.0951602.10.1815.10.1291712.20.1315.00.1541801.70.1315.00.1301902.10.1315.00.1272004.20.1015.00.101

Velocity was calculated by putting the impellor travel time results into the following equation:-

Conclusion:-

The scatter diagram of number of black fly larvae, Simuliidae, against temperature shows no correlation or trend, therefore the temperature of the steam does not affect the abundance of black fly larvae, Simuliidae.

The scatter diagram of velocity against depth in pools and riffles shows that pools are slow as they are low down the velocity this is scale and deep as they are high on the depth scale. It also shows that that riffles are fast as they are high on velocity scale and shallow as they are low on the depth scale. From this we can say that the depth of the stream affects the velocity of the stream.

From the bar chart of number of black fly larvae, Simuliidae, against site number, it clearly shows that the black fly larvae, Simuliidae, is in a higher number in the riffles. Which means that Therefore I can reject the null hypothesis, as it supports the hypothesis.

From the scatter graph of number of black fly larvae, Simuliidae, against velocity, the numbers of black fly larvae, Simuliidae, in riffles are mainly on the right hand side of the graph, showing that riffles are at a higher velocity; also the riffle values are mostly at the top of the graph showing that there is a high number of black fly larvae, Simuliidae, in riffles. The graph shows that the numbers of black fly larvae, Simuliidae, in pools are mainly on the left hand side of the graph, showing that pools are at a lower velocity; also the pool values are mostly at the bottom of the graph showing that there is a low number of black fly larvae, Simuliidae, in pools.

The data in this graph portrays a positive correlation, thus the number of black fly larvae, Simuliidae, is proportional to the velocity, as predicted in my hypothesis.

The Mann-Whitney U test:-

This test is used to test the significance of the difference between two data sets. It does this by measuring the amount of overlap between two sets of data. The two sets of data I am using is the number of black fly larvae, Simuliidae, in pools and the number of black fly larvae, Simuliidae, in riffles.

The outcome of the Mann-Whitney test was a U value of 15 (calculations in appendix) using the table of critical values at the 5% level, I can see that 15 is much lower than the proposed critical value 127 therefore:

The Mann-Whitney U test showed:-

The value of U is less than the critical value, therefore I can reject the null hypothesis, at the 5% significance level, therefore there is a significant difference in the abundance of black fly larvae, Simuliidae, between pools and riffles.

The Spearman rank correlation coefficient:-

Spearman Rank Correlation is a technique used to test the direction and strength of the relationship between two variables. In other words, its a device to show whether any one set of numbers has an effect on another set of numbers. It uses the statistic Rs which falls between -1 and +1.

The closer Rs is to +1 or -1, the stronger the likely correlation. A perfect positive correlation is +1 and a perfect negative correlation is -1.

The Rs value of 0.59 suggests a fairly strong positive relationship.

Also I must test the significance of the relationship. The Rs value of 0.59 must be looked up on the Spearman Rank significance graph. The value 0.59 gives a significance level of slightly less than 1%. That means that the probability of the relationship of the abundance of black fly larvae, Simuliidae, in areas where the velocity is high, being a chance, is 1 in a 100. Therefore I am 99% certain that my hypothesis is correct.

Discussion:-

The scatter diagram of number of black fly larvae, Simuliidae, against temperature shows no correlation or trend to make a clear conclusion other than the temperature of this steam does not affect the abundance of black fly larvae, Simuliidae. I believe that temperature does affect the abundance of black fly larvae, Simuliidae, but my experiment did not cover the range of temperatures the stream experiences over seasonal changes. The black fly larvae, Simuliidae, egg stage takes place all year round but the temperature affects the time to which the egg hatches. I believe that when the temperature is low, such as the winter, it slows the chemical reactions needed for the egg to grow, mature and hatch, prolonging the time to hatching. When the temperature rises, in the spring, the eggs chemical reactions return to normal, and the egg hatches. I believe that the black fly larvae, Simuliidae, does this so that it does not h.

So when the temperature is low the egg stage is prolonged reducing the number of black fly larvae, Simuliidae, thus affecting the abundance of black fly larvae, Simuliidae, when the temperature fluctuates.

In the scatter graph of number of black fly larvae, Simuliidae, against velocity, the numbers of black fly larvae, Simuliidae, in riffles are mainly on the right hand side at the top of the graph, showing that the black fly larvae, Simuliidae, in riffles are at a higher velocity and at a greater abundance, the graph also shows that the numbers of black fly larvae, Simuliidae, in pools are mainly on the left hand side and at the bottom of the graph, showing that pools are at a lower velocity and a lower abundance; I believe the varying velocity is due to the depth of the stream, pools are much deeper than riffles so I feel this is the reason for the distinct difference in velocity. The abundance of black fly larvae, Simuliidae,

The data in this graph portrays a positive correlation, thus the number of black fly larvae, Simuliidae, is proportional to the velocity, as predicted in my hypothesis.

The graph of velocity against depth shows that riffles, which are mainly shallow, because they are on the left of the graph, have a higher velocity and that pools which are deep, because they are on the right side of the graph have a lower velocity. Therefore I believe that the depth of the stream affects the velocity of the stream. I believe this is due to the area of the river bed; when the depth increases, the size of the sides of the river bed increase also so the area the water comes in to contact with increases. With the more the area the water has to comes into contact with the more friction the water has to go against, thus decreasing the velocity.

The bar chart of number of black fly larvae, Simuliidae, against site number, shows that there is a higher number of black fly larvae, Simuliidae, in riffles than in pools. This follows the original prediction made. I believe this is due to the physical features of the black fly larvae, Simuliidae.

The black fly larvae, Simuliidae, has the two gill spots on either side of its body and cannot provide oxygen rich water to its gill spots so solely relies on the current bringing the oxygenated water to it; also the black fly larvae, Simuliidae, has two brush-like structures which sweep the current picking up detritus food passively and unselectively from the water. The riffles have an increased surface area caused by the shallow flow, splashing, and bubbles improves air-water mixing. The more surface area and mixing, the more oxygen that can get into the water; therefore the riffles have a higher oxygen content. Riffles are faster (demonstrated in graphs 1 and 2) so the amount of oxygen and detritus food brought to the black fly larvae, Simuliidae, is increased; therefore for this reason and the increased amount of oxygen caused by the hallow flow and splashing of the riffles, I believe that the black fly larvae, Simuliidae, favours the riffles.

The Mann-Whitney U test showed that I could reject the nulls hypothesis at the 5% significance.

Evaluation:-

I feel my data is reliable as I accomplished my investigation and have a full set of results to support my hypothesis; however my statistical tests did not prove to support my results to a acceptable significance level suggesting inaccuracies.

In graph 1 there are 4 anomalous results; at sites 3 and 4 there are no readings of black fly larvae, Simuliidae, in pool or riffles, however on the day I noted down a high concentration of leeches, flatworm and fish, all these are predators to the black fly larvae, Simuliidae, this would explain the anomalous results. At sites 1 and 2 the readings for black fly larvae, Simuliidae, is higher than all other readings, in my notes of this site there were overhanging trees; the black fly larvae, Simuliidae, is a detritivore feeding on dead plants, such as fallen leaves, the leaves from the overhanging tree would fall into the stream and feed many black fly larvae, Simuliidae, thus explaining the anomalous results.

In graph 2 there is 1 anomalous result, at a velocity of 0.177 m/s in a riffle the depth is 0.2 metres which is deep for a riffle, this could be a systematic error of myself reading off the measurement wrong, or a random error of this particular riffle being a lot deeper than all the rest.

The accuracy of measurements taken could be taken to a higher degree of accuracy such that the temperature being measure to 0.01 degrees. This would improve the accuracy of my results. The limit of time affected the number of readings I could take, thus affecting the accuracy of my results. To improve the accuracy I would take more readings.

The metre rule measuring the depth could have not been directly on the bottom of the stream bed but sitting on stone, giving a false reading. To eliminate this error the bottom of the bed should be examined and the metre rule placed carefully away from stones.

The width measurement was measured perpendicular to the current, but there was no way to be sure that it was perpendicular to the current as it was done by eye so could have given a false measurement. To remove this error a piece of thick string could be held in the current and then the tape measure be held at 90 degrees to the string.

The Impellor travel time was measured parallel to the current, but there was no way to be sure that it was parallel to the current as it was done by eye so could have given a false measurement. To remove this error a piece of thick string could be held in the current and then the impellor can be held parallel to the string. The impellor travel time was taken using a stopwatch so the decision to start or stop the stopwatch was down to me so human error was introduced. To eliminate this a digital impellor could be used cutting out human error.

The equipment used was dated and of poor condition, the net was worn and had small holes, but were small enough to let black fly larvae, Simuliidae, escape. This affects the true number of black fly larvae, Simuliidae, counted.

The stone shake was much more efficient in collecting the black fly larvae, Simuliidae, as not so much debris went into the net as in foot sampling, so miss identification was lessened.

The limit of time affected the number of readings I could take, thus affecting the accuracy of my results. If I could repeat this experiment with unlimited time I would investigate the abundance of black fly larvae, Simuliidae, at different temperatures.