BIODIVERSITY OF RIVERS

COMENIUS PROGRAM 2013 – 2015

http://www.comenius-rivers.eu/a-3.html

Studying a freshwater system – Biodiversity of rivers in Cyprus

Visit to Rivers in Cyprus from Saint Anthony's High School, Limassol Cyprus

Students: Agathokleous Andri, Aristeidou Ifigenia, Panayiotou Elena

Coordinator teacher: Nikolas Nikolaou

BIODIVERSITY OF RIVERS

COMENIUS PROGRAM 2013 – 2015

http://www.comenius-rivers.eu/a-3.html

Saint Anthony's High School, Limassol, Cyprus

Context

Studying the biodiversity of a freshwater system in Cyprus

Our project's main objective is to study rivers located in our country, Cyprus, and additionally raise public awareness through our experience, measurements, results and conclusions, which have to do with humans' need of rivers. Rivers have been used by us, humans, through the centuries. They helped us in transportation and agriculture development, provided us with necessary food for living, and even made us exploit electricity through hydro-power. For the purpose of our project, we have visited Kryos river three times Initially in order to measure its biotic characteristics, its nutrients concentration, its flow (discharge) , its temperature and the dissolved oxygen in it. In our second visit we wanted to explore its flora and in the last, third one, its benthic invertebrates used as bioindicators for the water quality. By extracting this piece of work, we managed to understand in depth the factors which affect riverine systems and draw conclusions on Kryos river, via the measurements taken. Meanwhile, we gained experience whilst getting to take measurements ourselves by instructions given from an expert biologist (Mrs Athina Papatheodoulou). Summing up, we conclude that rivers are delicate systems which purvey a better life quality, when they are kept clean. Any change of their condition can directly and indirectly affect us, too. A sally by the sea or near a river will not be the same again, if we keep on polluting these sensitive areas.

Summary

Our project is meant to study rivers located in our country, Cyprus, and additionally raise awareness of the public at large, through our experience, calculations and conclusions, which have to do with humans' need of rivers. For the purpose of our project, we have visited Kryos River three different times. Our first visit was in order to measure its biotic characteristics, its nutrients concentration, its discharge, its temperature and the dissolved oxygen in it. Separated in three groups, we took measurements with special equipment for water flow and turbidity, for nutrients, and last, measurements on the dissolved oxygen and on the acidity of water. All these were done from each group separately.

On September 30th, we visited again the river so as to identify the flora species related to the river. Eleven students, two professors and the biologist Mrs. Athina Papatheodoulou participated in the exploration, collecting plants or leafs, and then observing and identifying them. Through this exploration, the participants came in touch with the riverine system flora spectrum and could be able to tell if there's water or even river near their location, just by recognising plants and leafs, which apparently can't live without the supply of water.

Our last (3rd) visit happened to be on Tuesday, April 7th. Three students, our professor and the biologist Mrs. Athina Papatheodoulou took part in the excursion. The exploration involved the sampling, sorting and identification of benthic invertebrates, used as bioindicators for river water quality. These species are classified in four groups. The first group was the one with sensitive to pollution species, the second one concerned semi-sensitive, the third semi-tolerant and the fourth, tolerant to pollution.

Krios River contained more of the first and second class/group species. Summarising through measurements, Krios' water quality can be characterised as good, reaching excellent.

Recapitulating, through the opportunities given to us by the Commenius project we gained life-changing experiences. We were involved in hands-on educational processes, worked with members of the scientific community, worked closely together as group with our classmates and our teachers, we read, review, discuss, conducted research. It has been fascinating for 2 years from September 2013 till June 2015. Moreover, in terms of meeting our educational objectives, rivers and other fluvial systems are really delicate systems which purvey a better life quality, when clean, and any charge of their condition can directly and indirectly affect us, too. We have been using rivers for various of needs through the centuries, depending on their length, water level and flow, and we still do. Let us also take into consideration the fact that with the passage of time we do not care that much about our environment. The most simple thing it gives us is water. It feels so luxurious that we, the first world countries have, owning clean crystal water in our houses, yet we don't appreciate it. We do not really appreciate it, right? These things are taken much for granted. *The number of people with non-safe drinking water source decreases by one (1) every second [according to the World Health Organization (WHO)].* This happens not because they found a safe source to provide them water, but because they died from lethal diseases. If you still cannot imagine this example, think about a walk or a bath by a polluted beach. I bet it sounds like a nightmare to you

Prologue – Introduction

Our project is meant to study rivers located in our country, Cyprus, and additionally raise awareness of the public at large, through our experience, measurements and conclusions, which have to do with humans' need of rivers. For the purpose of our project, we have visited Kryos River three different times, initially in order to calculate its biotic characteristics, its nutrients, its water supply, its temperature and the dissolved oxygen in it. In our second visit we wanted to explore its flora and in the last, third one, its microorganisms and biomarkers. By extracting this piece of work, we managed to understand in depth the factors which affect fluvial systems and draw conclusions on Kryos river, via the measurements taken.

Significance of Rivers

Rivers have been used by us, humans, through the centuries. They helped us in transportation and agriculture development, provided us with necessary food for living, and even made us exploit electricity through hydro-power. Depending on their length, depth / water level and way of flow, they can be used in various ways. Take for example a deep river with serene flow; sure it can be used as a waterway. This is the way people in the past used most for not only for transfers, but also for connecting with areas located near the rivers. An impetuous river can be used for generating electrical energy; therefore hydro electrical factories are built next to them.

Their water is used for irrigating cultivated areas and water supply. Near the river locations are fruitful and are useful in agriculture, thanks to rivers' sediments. Brooks have their beginning in springs. Streams are connected with other brooks, which are created by rainfalls and ice melting. They can all meet at a river junction or confluence [the place where two rivers come together] and create the main flow of the river. The main flow is the biggest part, they are usually located in plains, and may lead to tributaries. Meandering rivers are the rivers flowing over gently sloping ground begin to curve back and forth across the landscape. An estuary is a body of water formed where freshwater from rivers and streams flows into the sea, mixing with the seawater. Estuaries and the lands surrounding them are places of transition from land to sea, and from freshwater to saltwater. Many times the water is separated in sections, usually creating a "delta". (Figure 1).

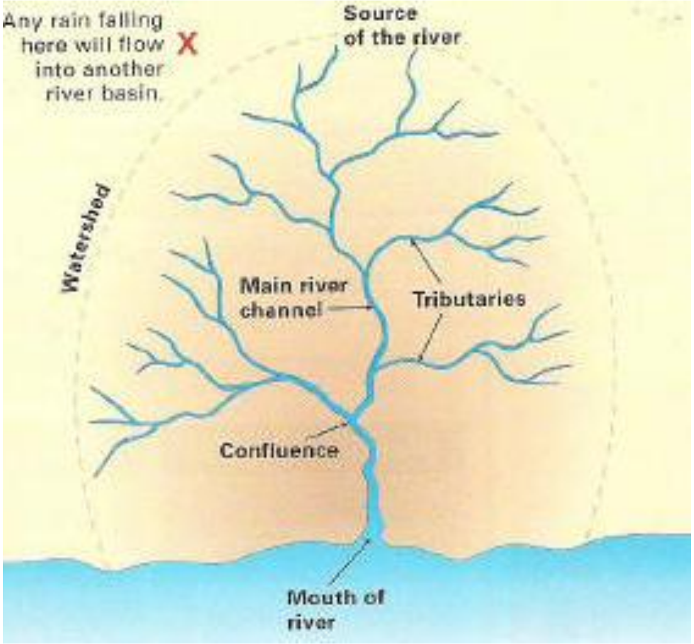


Figure 1: main Characteristic of a river (http://www.sln.org.uk/geography/schools/blythebridge/GCSERevisionRiversDB.htm)

Summing up, a river is a long pond containing running water which flows thanks to gravity. It is formed from raining water which creates streams, and later on brooks connect, creating larger watercourses which end up in sea. Only a part of the raining water ends up in rivers and another part ends up in the ground and rocks. The water quantity following any of these ways, depends on the conditions of the surroundings (take for example the density of the ground which affects water's speed entering it). All watercourses ending up in rivers (main and secondary ones) located in a basin runoff, consist the basin's hydrographical network.

The river catchment, or drainage basin, is all the land from the mountain to to the seashore, drained by a single river and its tributaries. Catchment areas vary greatly in size - a big river may have a catchment area of several thousand square kilometres, whereas a smaller tributary will have a catchment area of only a few hectares. Catchments are separated from each other by watersheds. The characteristics of any river (physical, chemical, biological) are determined by the nature of the catchment and the activities , both human and natural, that take place in it (Figure 2), (Skoulikiidis, 1997).

Figure 2: Catchment of a River, Stylianou et al., 2002)

Riverine Ecosystem

While water flows across the landscape it carries deposits which are later ending up in sea. Rivers are dynamic systems and react to the topography of a region, such as inclination changes. The formations of the river change depending on place and time, and so the habitat changes, too (Hadjinicolaou, 2001). The ecological quality of the structure of a river ecosystem is a combination of natural habitats and the habitats of the rivers alone. The river ecosystem is the result of interaction between abiotic and biotic factors. It is characterized by a continuous transport of various ingredients, such as organic matter and nutrients from the soils of the basin, including matter from the start to the end of the water's route. Organisms living in the river depend on the organic and inorganic matter.

Abiotic factors are the physicochemical conditions of water, the morphological characteristics of the river and the structure and composition of the soil.

Rivers' biotic characteristics are flora and fauna which live and grow near or in the fluvial system: decomposed organic matter, decomposers (bacteria and fungi), plant and animal organisms entrained in water (phytoplankton and zooplankton), macroscopic and microscopic plant and animal organisms living on the deposit of the riverbed or are attached on rocks or other plants, and aquatic macrophytes and fauna of floodplains surfaces, fish, amphibians and birds.

The freshwater ecosystems contain a big number of species. More than 12% of known animals on the planet are found in freshwater (rivers, lakes, wetlands, etc). Often aquatic organisms are divided into benthos, plankton and nekton. Benthos is the mass of organisms living at the bottom of the aquatic area and seek their food in the bottom sludge (figure 3). The benthic communities are divided according to the space they occupy at the bottom. Plankton is the set of the organisms moving, mainly due to underwater forces and waves. They are divided in phytoplankton (algae) and zooplankton. Nekton consists of swimming organisms. In rivers, benthos is more common than plankton. (Papatheodoulou, 2013).

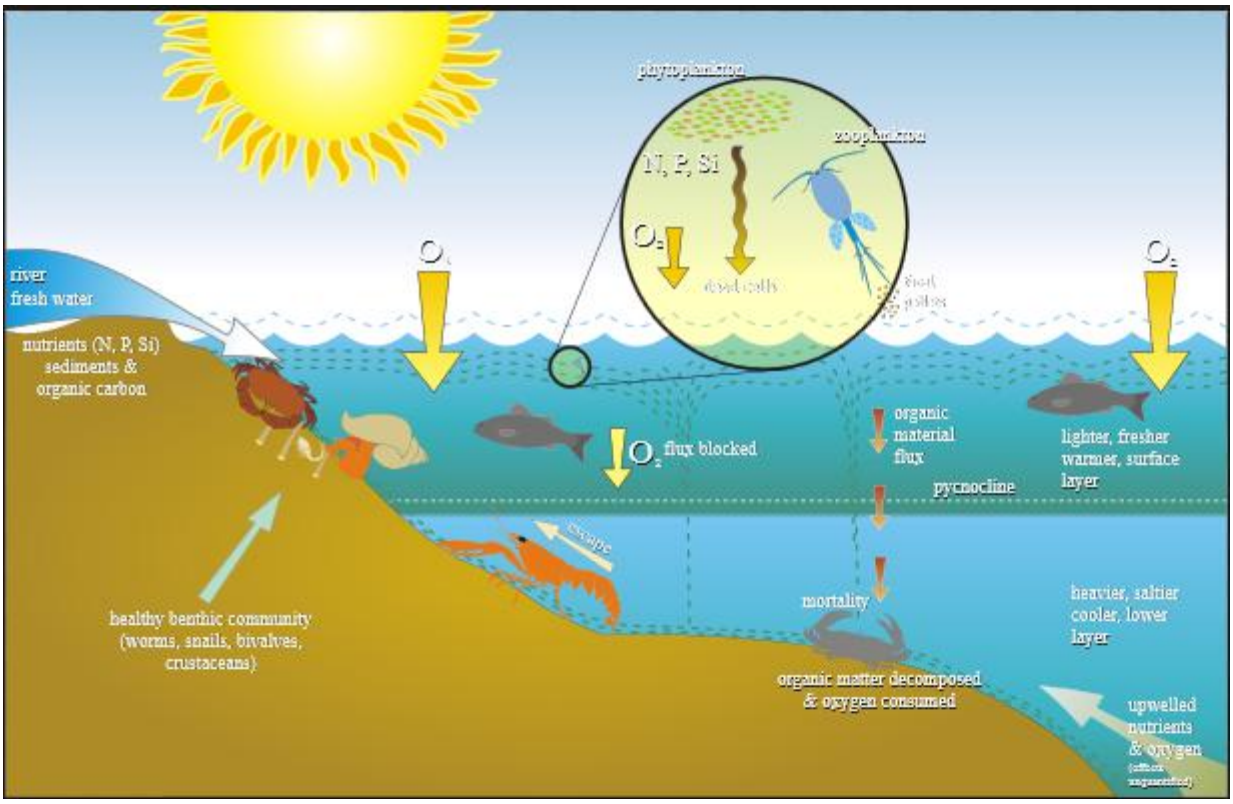


Figure 3: Benthic Zone

As mentioned previously, the rivers can be regarded as gradient systems which sources mainly function as heterotrophic after intense riverside vegetation in mountain streams affects photosynthesis offers allochthonous organic matter. Then, as the river becomes larger , the influence of the inserted upstream from organic material is reduced and the dominant indigenous production and transport downstream .Thus the system becomes autotrophic. A significant quantity of transferring fine organic matter is detected. At the river estuary, heterotrophic procedures are noticed again.

The adjustments of the morphology and behaviour of organisms living in rivers reflect these food relationships. Aquatic invertebrate animals can be divided into four food groups (Brickers & Jones 1995):

1. Shredders that are fed with dead plants and coarse organic matter (1>mm), such as leaves (figure 4).

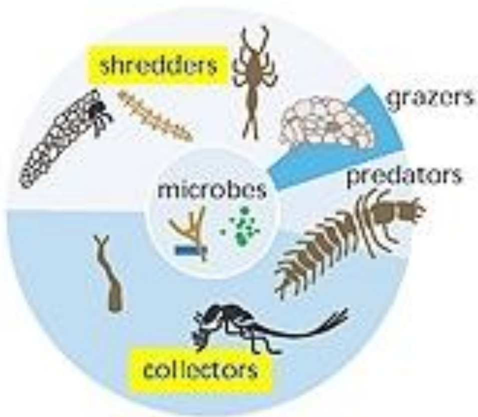


Figure 4. Leaves accumulate in leaf packs in streams. The animals adapted to feeding on leaves are called "shredders." Shredders and collectors form the major proportion of stream macroinvertebrates.

2. Collectors that are fed with fine matter which they leach from water. These organisms leach fine organic matter or they absorb it with its precipitate. For their diet particles' periphyton is also significant (Figures 5 and 6).

Figure 5. Collectors gather or filter plant fragments, feces, and plankton. Grazers, also known as scrapers, browse on algae. More sunlight reaches this mid-sized stream.

Figure 6. Filtering collectors such as mussels are found in greater abundance in larger streams and rivers.

3. Scrapers / grazers (microbes) that are fed with seaweed and other plant material attached on rocks or on other plants (Figure 7)
4. Predators (microbes) (Figure 7)

In mountain streams, coarse organic matter is more common, that shredders and collectors abound. Grazers are in common. As we are going downstream, collectors and scrapers increase, and shredders decrease. Later, at the broad river branches collectors prevail. In each area along a river, the bio – societies are in dynamic equilibrium. If in some area types are limited by the lack of food, there is a trend towards more efficient use of available food and thus minimize losses. New species can occupy the habitat, if they find food available. If a kind of species that prevails, disappears due to changes in environmental conditions, it will be replaced by another kind of species, which is adapted to survive in the conditions created last. Therefore, during the year changes on the prevalence of species are descried.

The sheltered river sides and reed beds of rivers provide areas to nest and hunt different kinds of water – birds, as squacco heron (*Ardeola ralloides*) and moorhen (*Gallinula chloropus*). Rivers's sides, areas with stagnant or very low water flow and wet meadows of flooding surfaces, are important habitats for aquatic plants. Areas with stagnant or very low water flow are also important for fish, birds, invertebrates, amphibians and reptiles. Rivers of Cyprus host species protected by international, European or national legislations. These include the eel *Anguilla anguilla*, characterized as critically endangered, the freshwater crab *Potamon potamios*, the green toad *Bufo Vvridis*, the Cyprus grass snake *Natrix natrix cypriaca*, the terrapin *Mauremys rivulata* and habitat types containing the plant communities with Chara Ssp.

The River Continuum Concept

Physical conditions vary greatly in small headwater streams compared to large rivers. In general width, depth, temperature, and discharge increase further downstream.

The River Continuum Concept (Figure 7) seeks to correlate this continuum of physical changes with biological changes throughout a river system and provides a conceptual model to compare with stream systems throughout the world.

The River Continuum Concept was developed by Robin Vannote at Stroud Water Research Center, and was the first unified hypothesis about how streams and their watersheds work. It dominated river studies for the next decade, and it established the Center as a pioneer in innovative research.

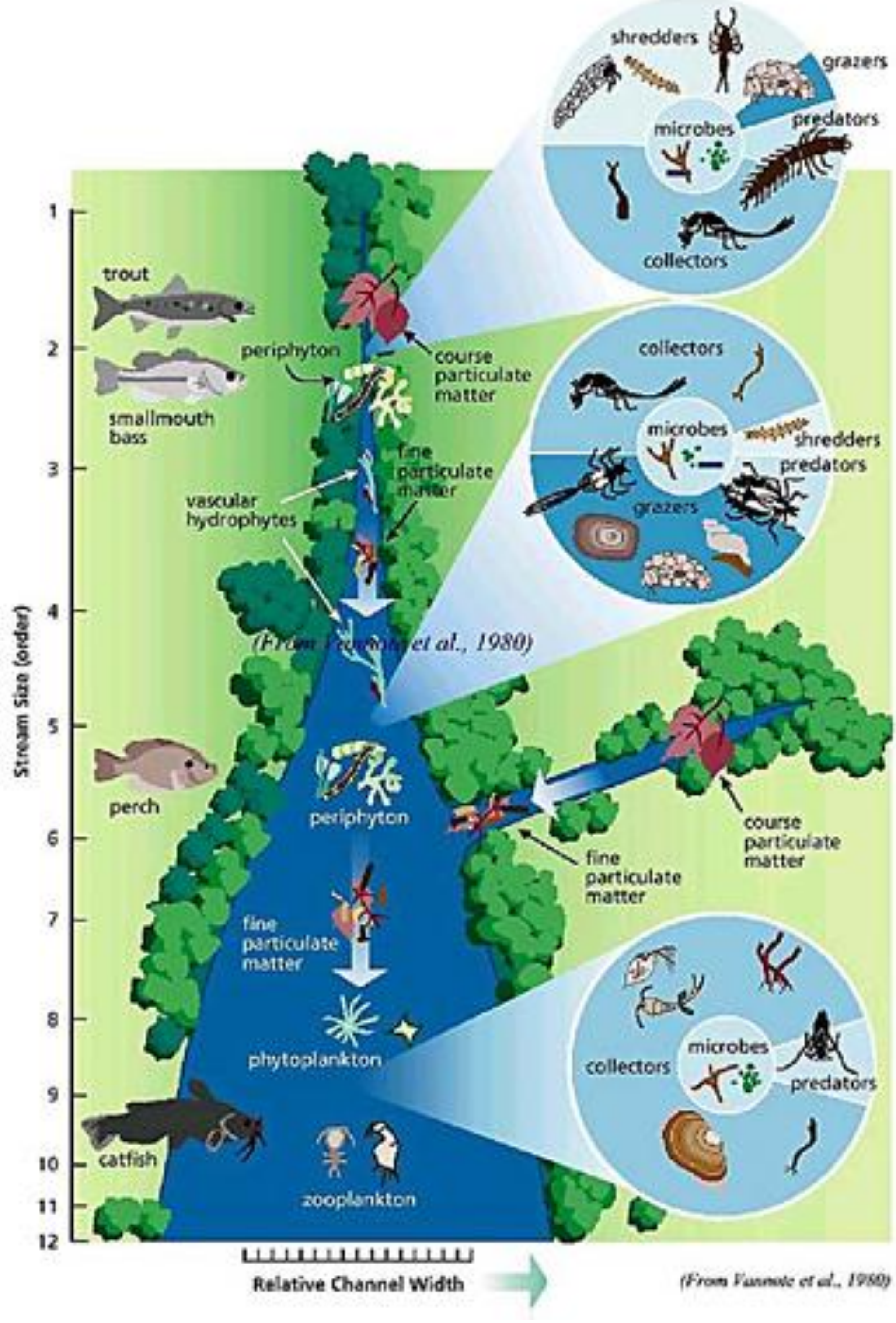


Figure 7. The River Continuum Concept. Source: *Stream Corridor Restoration: Principles, Processes, and Practices*, 10/98, by the Federal Interagency Stream Restoration Working Group (FISRWG).

Measuring Biotic and Abiotic Characteristics of Kryos River

As part of our research we visited Kryos River three times, every time for different measurements. First, we visited the river in order to calculate its biotic characteristics, its nutrients, its water supply, its temperature and the dissolved oxygen in it. In our second visit we wanted to explore its flora and in the last, third one, its microorganisms and biomarkers. Our measurements taken while visiting the river are described below. The measurements are taken, of course, from the students of St. Anthony's High School.

First Visit at Kryos River (Measuring Abiotic Factors)

Picture 1: Kryos River (the area that first measurements were taken, actually that all measurements are taken)

Kryos River (picture 1) is one of the three rivers ending up in Kourris Dam – the largest reservoir of Cyprus, supplying water to almost all parts of the island. . Water ending in this dam goes almost all around Cyprus and it is collected and saved near Troodos Mountain. Sampling took place near Lofou village, below the Flowmeter of Water Development Department. Water flow metre is a structure counting continuously water flow. We were separated in three groups. Every group was in charge for taking different measurements. The first group had to take measurements for water flow and turbidity. The second group, had to measure the nutrients of the river. Lastly, the third group, using special equipment (pH metre and oxygen metre), had to measure pH / acidity in water and the quantity of dissolved oxygen in it.

Measuring Water flow

Water flow is a determining factor in the ecological characteristics of rivers. The speed changes according to the ground inclination and river bed. It can also decelerate due to friction. While water flows in riverbed, has not the same flow speed at all the points across the riverbed. For measuring water flow in various of points across the riverbed, we used water flowmeter (picture 2) and tape metre for calculating riverbed's width and distance from the river bank. We also used depth gauge for measuring river's depth. Specifically, starting from river's shore, we took water flow measurements, every 0,5m,

Picture 2: Flowmeter

Picture 3: Measurements of water flow in different points in the river.

so as we could have measurements for every point across the river and at the end could calculate water supply (picture 3). Additionally, while counting water flow, we took measurements on the river's depth at the specific point, so as we could calculate the cross-sectional area (at that point); [measurements are shown on Table 1]. According to Table 1, we observe that on one side, water flow was much higher than on the other shore. Last but not least, at the current side, the river was a little bit deeper.

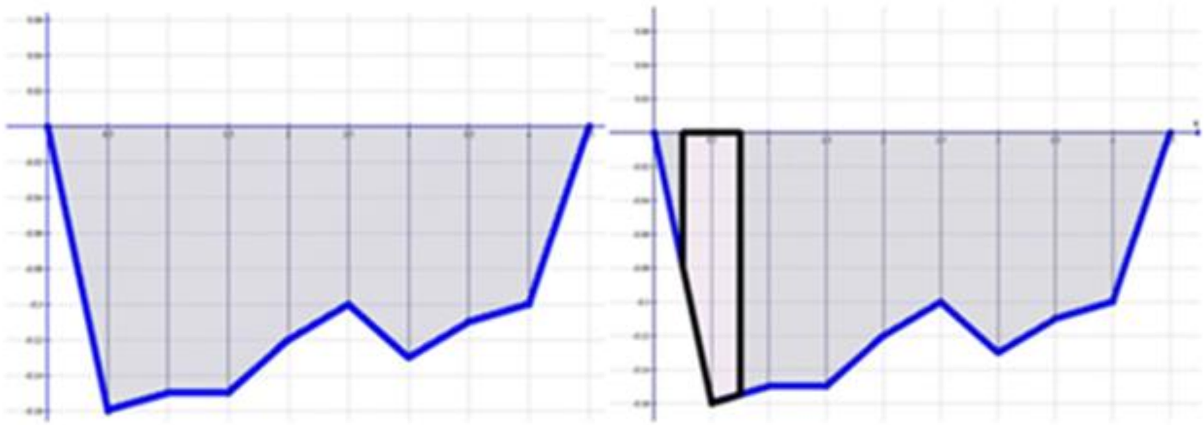
Table 1: Measurements on water speed and depth on several distances between the shores.

Distance from shore (m)	Depth (cm)	Water speed (m/s)
0.5	0.16	0.7
1	0.15	1.5
1.5	0.15	0.9
2	0.12	0.4
2.5	0.10	0.1
3	0.13	0.2
3.5	0.11	0.1
4	0.10	0.2

Computing river discharge

River discharge is the water volume passing through a specific river intersection per time (water volume/second). By multiplying the cross-sectional area of the river with the average speed of water at that point, we calculate water volume passing through that surface per time passage. The flow unit is m^3/s. Water flow varies through the passage of time. (At graph 1 you can see the process we went through for calculating water flow) To convert the water velocity (m/s) to m^3/s, we used: Q = SAiVi where:

Q= water supply (m^3/s), **A**= River sectional area and **V**= water speed (m/s)



Graph 1: calculating River's incision area. The area of every incision was calculated by using the programme 'graph 32'. The riverbed can be seen in the graph.(Papatheodoulou, 2013)

Water flow measurements were formed according to Table 2, calculating in this way every variable in water supply. The individual measurement of the water supply (0,289m^3/s) could not lead us to any summarise on the quantities of water ending in Kourris Dam, as many parameters should be taken into account, rainfall for example. The water flow station of Water Development Department is installed near the point where measurements were taken. Water supply calculation is a very important parameter, since it is an indication of the volume of water which ends into dams. Also, the calculation of water supply at various points along a river, can give us an indication of the use of water upstream, for example if the water supply diminishes between two points in the river, there can be stated an assumption on water abstraction directly from the river, only when we exclude the probability of natural water loss. Taken into account the limited rainfall on the two months before the visit, we can assume that water supply is reduced. For a more complete view and export results we should have rainfall and previous years' water supply data for comparison purposes.

Table 2: Calculating water flow at Kryos River (Monday, December 9th, 2013, 10:00 am.)

Average Distance	***River Sectional Area***	***Water speed (m/s)***	***Water Supply (m^3/s)***
0.25-0.75	0.069375	0.7	0.0485625
0.75-1.25	0.075625	1.5	0.1134375
1.25-1.75	0.073125	0.9	0.0658125
1.75-2.25	0.060625	0.4	0.02425
2.25-2.75	0.053125	0.1	0.0053125
2.75-3.25	0.061875	0.2	0.012375
3.25-3.75	0.055625	0.1	0.0055625
3.75-4.25	0.044375	0.2	0.008875
4.25-4.50	0.006250	0.7	0.004375
		Total Water Supply (m^3/s)	0.2885625

Measuring Water Turbidity

On that day, turbidity measurements were also taken. Turbidity measurement is important because if the water is not clear, the sunlight cannot reach to plants living underwater and let them photosynthesise. In the river, there are also animals breathing through gills, and if there is sediment, then it can be stuck on the animals' gills and then die. Turbidity unit is Ntu (nephelometric turbidity unit). For the measurement, we had a water sample from the river, shake it well enough to mix evenly the solid forms, existing in the sample. Turbidity measurements are taken by turbidity meter (Picture 4). Water turbidity was 19,27 Ntu. The individual value of turbidity cannot lead us to summaries on Kryos' river water quality. Turbidity changes through the seasons. After heavy rainfall, turbidity levels are high. We have to take into consideration the fact that if there was another group of people in the river while collecting samples, could lead to high levels of turbidity.

Picture 4: Turbidity meter

Εικόνα 5: Οξυγονόμετρο

Picture 5: Oxygen meter

Measuring pH, Temperature (^oC) and Dissolved Oxygen Quantity (DO) in Water

Oxygen meter (picture 5) counts the dissolved oxygen quantity and temperature in water. Dissolved oxygen has direct impacts on temperature. As the temperature rises, dissolved oxygen lessens in water.   For example, in summer water is expected to have less dissolved oxygen, due to high temperatures. For measuring these quantities, we need to immerse the oxygen metre in the water and command to start measuring. **Dissolved Oxygen (DO)** in rivers is required from all aerobic organisms. This is why it is vital. The oxygen comes from 3 notable processes happening: from water ventilation while flowing, from photosynthesis happening from the underwater plants and from oxygen existing in the atmosphere which mixes with the river water through the aeration process. Oxygen concentration depends on many factors according to the processes noted before. Low dissolved oxygen rates indicate highly charged waters with organic substances. Dissolved oxygen unit is mg/l (mass of oxygen in mg (10^{-3} g) existing in every Litre of water). *In Kryos River exist **11.3mg of dissolved oxygen** in every **litre of water.***

Water temperature is a parameter that is important in aquatic environments, since it determines the presence or not of some specific groups of microorganisms. The temperature has a significant influence on waters' density, on the solubility of the ingredients in water, on pH and on conductivity, the rate of chemical reactions and biological activity, that happen in the water. The temperature definitely depends on where we are, in what period of time and at what altitude. Temperature unit used: ^{o}C. The temperature at Kryos River on December 19th, 2013, at 10:00am, was 1**2 – 13 ^{o}C.**
PH metre (Picture 6), calculates water's acidity, water's pH. To take our measurements, the ph metre is immersed in water and given command for measurement. PH has no unit. PH values between 0- 14, with 7 being neutral, values above 7 being basic and acidic below 7, as approaching to both ends of the measuring scale. pH is affected by temperature, rocks (and salts presented on rocks), photosynthesis, free CO_2, organic acids and salts of strong acids. The pH is particularly important as living organisms (organisms existing in rivers) have their own value range and show very little tolerance to changes. The **pH** in Kryos River was 9.38.

Picture 6: Ph meter

Picture 7: Nutrients meter

Measuring Nutrients in Water

The nutrients are minerals necessary for life, since their main components are used by organisms, not only as construction materials, but also for energy production. The main feature of nutrients in the water is seasonal and local variation. The biological productivity in water depends on the dissolved nutrients in it. We had to take measurement for nitrates, phosphates and ammonia, containing in river (measurements were taken with nutrients meter, picture 7). Generally, as the nitrates and ammonia are nitrogen compounds (nitrogen containing), we do not expect big amounts in clean rivers which are not influenced by the presence of people. High concentrations show infection / contamination in water. The ammonia comes mainly from fertilizers and from the decay of organic substances such as waste water or household waste. Similarly the above apply for phosphates. To measure the amount of nutrients in mg / l we used the colorimeter. As explained above, if we find a high concentration of ammonia, then we see a recent water contamination index. *The measurement we got for ammonia was 0,38 mg / L. The measurement for phosphate 0.08 mg / L. And finally, the measurement* *we took for nitrates was 0,1 mg / L.* Measurements of nutrients are a good indicator of the quality of river water at the time of sampling. For exporting complete conclusions as regards the pressures on the river, such measurements must be taken repeatedly during the year and at many points of the river, to have measurements at all seasons of the year and possible activities happening to or in the river (water abstraction, discharge of sewage, etc).

Second Visit at Kryos River (Characterising Flora)

On Tuesday, September 30th, we made our second visit at Kryos River for sampling aquatic organisms. At this visit joined eleven students, two teachers, and the expert mrs Athina Papatheodoulou, who is a biologist. We discussed about Cyprus' rivers and their characteristics. Then, we were interested in collecting plants or leafs found in or near the river. We analysed them and learned what kind of trees and plants are found near rivers. After this procedure we were able to tell by looking at plants or leaves, if there is water near us.

Picture 8: *Platanus orientalis* (oriental plane tree) leaves

Picture 9: Nerium Oleander (oleander)leaves

Picture 10: Tamarix sp. (tamarisk) **Picture 11: leaves of Arundo donax (giant reed)**

We observed the following plants from Cyprus' flora: a) Platanus orientalis (picture 8), b) Nerium oleander (picture 9), c) Tamarix sp. (picture 10), d) *Arundo donax* (picture 11), (e) *Smilax aspera* (picture 12), (f) Pistacia terebinthus (picture 13), (g) Thistles (Picture 14) and (h) Dittrichia viscosa (picture 15). The plants of Figures 12-15 are not obligatory related to riverine environment, they can be found in a variety of habitats. (In Pictures 8-16, are shown the plants discovered and the group joining the visit (Picture 16). Through this visit, we all came in touch and familiarise ourselves with a part of Cyprus flora, some of them related to the riverine environment..

Picture 12: *Smilax aspera* (Rough bindweed)

Picture 13: Pistacia terebinthus (Terebinth)

Picture 14: thistle

Picture 15: Dittrichia viscosa (sticky fleabane)

Picture 16: Group of second visit (measurements) at Kryos River (September 2014)

Third Visit at Kryos River (Bioindicators of water quality)

Bioindicators are used to define water quality. They are animals living in riverbeds, under mud, move a little and are not moved thanks to water flow, like planktons do. Therefore, they tend to accept and react not only to the local conditions prevailing where they belong to, but also to the pollutants existing in the river due to exogenous factors. This fact makes them differ composition of the biocoenosis gives us information on changes happening to the ecosystem, But since we know the composition in uninterrupted and non influenced by any condition pollutants.

This happens because biocoenosis contain many species that are or are not sensitive to pollutants and especially at the reduction of the dissolved oxygen pollutants cause. To be sure however that the disappearance of certain species from these due to pollution and other physicochemical parameters , you should know some features of the life cycle and preferences (Lazaridou - Dimitriadis , 1998).

On Tuesday, April 7th 2015, at 10:00 a.m, three students, a teacher and an expert, visited Kryos River at Lofou area, in order to understand the importance of aquatic organisms in relation to the pollution of the river. We noted down the weather conditions (sunny with 15 ° C) and began with a brief discussion of our knowledge on the use of bioindicators to indicate the state of the environment around us. Bioindicators are animals and plants whose behaviour interpretation indicates the state of habitat observed (Annex 1). For the collection of biomarkers we had at our disposal special net for small aquatic organisms (picture 17), boots, container for sampling (picture 18),

 **Picture 17: At Kryos river with the sampling net that we used for finding bio indicators**	 **Picture 18: At Kryos river as we are working with bio indicators**

separated trays for aquatic organisms, worksheets and plastic spoons. We got into the river carrying the special sampling net, taking samples from different points of the river moving against water flow. The samples were taken by disturbing the river bed, so as the organisms living in the sediment would be removed and carried in the net. In cases where we found roots, we combed with our fingers in the net, or where we had large stones, we gently rubbed them to release the organims attached on them (picture 19). Through this methodology we made sure that we searched the majority of places (habitats) these invertebrates bioindicators live. After we collected the organisms, we emptied the net's content into the sorting container, and waited for some minutes, for the sample to settled and the organisms come over the "shock" and let them come out of their hiding places and swim. We collected the organisms using plastic spoons and forceps, dividing them in groups according to the identification card we were given and our worksheets. We could not sort all the organisms in the sorting container because of time constrains. On our worksheet were given four organism groups starting from the pollution sensitive organisms and ending up in pollution tolerant (In Annex 1 the four groups are analysed. In Annex 2, our scanned worksheets are shown).

Picture 19: At Kryos river as we were trying to find microorganism

From the 1st group (containing sensitive to pollution organisms), we collected 83 organisms, from the 2nd group (with semi-sensitive to pollution organisms) 65, from the 3rd one (semi-resistant to pollution organisms) 6, and, last, from the 4th group (resistant to pollution organisms) only one (1). The sum of the organisms equals to 155 organisms. We multiplied the sum of the first group by four (4), of the second one by three (3), of the third one by two (2) and of the fourth by one (1). The sum of the four multiplications equals to 540 (Annex 2) and was the sum of the coefficient.

Grade index = Sum coefficient (540) / Sum of organizations (155) = 3.48.

The rate 3.48, signified the good situation of the river, as it was really close to the maximum rate (3,5). River's case could be excellent.

Summing up, depending on the quantity of the different species, and species themselves, collected and identified, after group discussion with an expert based on the data give to us, we found river's situation "good to excellent".

Overall Conclusions

The results presented in this report, do not portray the water quality and/or status of the Kryos River. They are just an indication, through our work done. In order to reach conclusive results for the water quality of the river under study, we should have conducted a more lengthy and inclusive study, involving more sampling sites and denser sampling frequency.

Recapitulating, rivers and other freshwater systems are really delicate systems which purvey a better life quality, when clean, and any charge of their condition can directly and indirectly affect us, too. We have been using rivers for various of needs through the centuries, depending on their length, water level and flow, and we still do. Let us also take into consideration the fact that with the passage of time we do not care that much about our environment. The simplest thing it gives us is water. It feels so luxurious that we, the first world countries have, owning clean crystal water in our houses, yet we don't appreciate it. We do not really appreciate it, right? These things are taken much for granted. *The number of people with non-safe drinking water source decreases by one (1) every second [according to the World Health Organization (WHO)].* This happens not because they found a safe source to provide them water, but because they died from lethal diseases. If you still cannot imagine this example, think about a walk or a bath by a polluted beach. I bet it sounds like a nightmare to you.

Through the opportunities given to us by the Commenius project we gained life-changing experiences. We were involved in hands-on educational processes, worked with members of the scientific community, worked closely together as group with our classmates and our teachers, we read, review, discuss, conducted research. It has been fascinating 2 years.

Bibliography

- Papatheodoulou A. (2013), Εκπαιδευτικός οδηγός για τα ποτάμια της Κύπρου: Μαθαίνοντας για τα ποτάμια στα ποτάμια, Ίδρυμα προστασίας του περιβάλλοντος - Terra Cypria, Limassol.
- Stylianoy P., Tsaliki E., Fragkou E. (2002), «Υδατικά (Ποτάμια) Συστήματα». Environmental Education, Pedagogical Department, University of Athens, University of Athens.
- Skoulikidis N., (1997) «Η περιβαλλοντική κατάσταση των Ελληνικών ποταμών», Βιώσιμη Ανάπτυξη για την Περιβαλλοντική Εκπαίδευση, Νομός Αιτωλοακαρνανίας, ΥΠΕΧΩΔΕ, Μεσολόγγι. You can find the article on webpage: http://www.rivernet.gr
- Chatjinikolaou, N. (2001): Παρακολούθηση της οικολογικής ποιότητας των νερών και της δομής των ενδιαιτημάτων του ποταμού Αξιού, MSc Theses, Biology Department. University of Thessaloniki.
- Brickers, O.P. & Jones, B. F. (1995): Main factors effecting thw composition of natural waters in B. Salbu, E. Steinnes (eds) ‘Trace elements in natural waters’ Boca Raton: CRC Press.
- Lazaridou – Demetriadou, M. (1998): Έλεγχος της οικολογικής ποιότητας των επιφανειακών υδάτων της κ. και Δ. Μακεδονίας με τη χρήση βιολογικών δεικτών. Τελική έκθεση πεπραγμένων 1995 και 1997. Γενική Γραμματεία Έρευνας και Τεχνολογίας, Thessaloniki.

For our whole research of our work we visited a lot of websites such as:

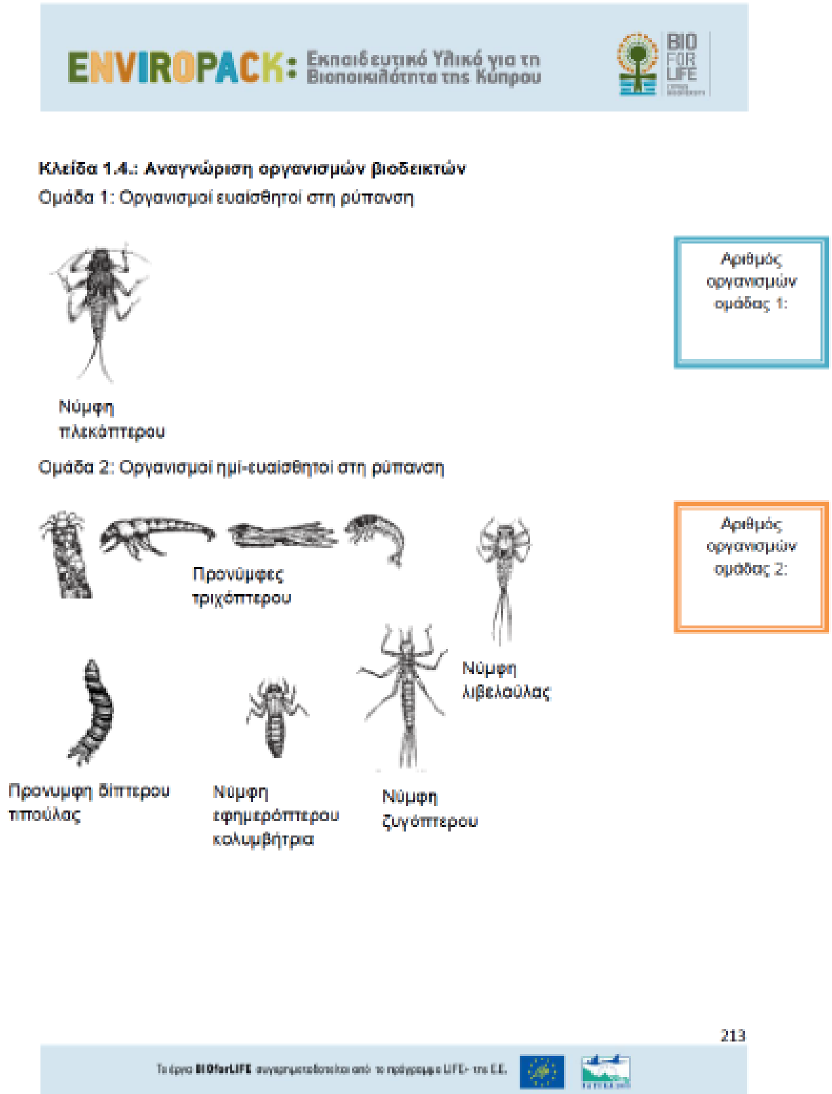
http://gym-k-achaias.ach.sch.gr/bolog.htm
http://www.bio.auth.gr/river/river/theory/unit4/chapter5.htm#5.10.2
http://el.wikipedia.org/wiki/ποιότητα_του_νερού
http://lsg.ucy.ac.cy/research/wetlands/WEBQuests/Athalassa/katharo_nero/biologikoi_deiktes.htm
http://kpe-kastor.kas.sch.gr/biodiversity_site/b/aquatic_ecos.htm
http://old.biol.uoa.gr/zoolmuseum/freshwgr.htm

Annex 1: Bioindicators and measurements.

In here the groups are analysed in their organisms, with information on some of them (www.wikipedia.org).

Group 1: Organisms sensitive to pollution

Stonefly nymph



The **Plecoptera** are an order of insects, commonly known as **stoneflies**. Some 3,500 species are described worldwide, with new species still being discovered. Stoneflies are found worldwide, except Antarctica. Stoneflies are believed to be one of the most primitive groups of Neoptera, with close relatives identified from the Carboniferous and Lower Permian geological periods, while true stoneflies are known from fossils only a bit younger. The modern diversity, however, apparently is of Mesozoic origin.

Plecoptera are found in both the Southern and Northern Hemispheres, and the populations are quite distinct, although the evolutionary evidence suggests species may have crossed the equator on a number of occasions before once again becoming geographically isolated.

All species of Plecoptera are intolerant of water pollution, and their presence in a stream or still water is usually an indicator of good or excellent water quality.

Group 2: Organisms semi-sensitive to pollution

Dragonfly Nymph

A **dragonfly** is an insect belonging to the order Odonata, suborder **Anisoptera** (from Greek ανισος *anisos* "uneven" + πτερος *pteros*, "wings", because the hindwing is broader than the forewing). Adult dragonflies are characterized by large multifaceted eyes, two pairs of strong transparent wings, sometimes with coloured patches, and an elongated body. Dragonflies can be mistaken for the related group, damselflies (Zygoptera), which are similar in structure though usually lighter in build; however, the wings of most dragonflies are held flat and away from the body, while damselflies hold the wings folded at rest, along or above the abdomen. Dragonflies are agile fliers while damselflies have a weaker, fluttery flight. Many dragonflies have brilliant iridescent or metallic colours produced by structural coloration, making them conspicuous in flight.
Fossils of very large dragonfly ancestors in the Protodonata are found from 325 million years ago in Upper Carboniferous rocks; these had wingspans of up to 750 mm. There are about 3000 species of Anisoptera in the world today. Most are tropical, with fewer species in temperate regions.

Dragonflies are predators, both in their aquatic larval stage, when they are known as nymphs or naiads, and as adults. Several years of their life are spent as a nymph living in freshwater; the adults may be on the wing for just a few days or weeks. They are fast agile fliers, sometimes migrating across oceans, and are often but not always found near water. They have a uniquely complex mode of reproduction involving indirect insemination, delayed fertilisation and sperm competition. During mating, the male grasps the female at the back of the head or on the prothorax, and the female curls her abdomen under her body to pick up sperm from the male's secondary genitalia at the front of his abdomen, forming the "heart" or "wheel" posture.

Damselfly Nymph

Damselflies are insects of suborder **Zygoptera** in the order Odonata. They are similar to dragonflies, which constitute the other odonatan suborder, Anisoptera, but are smaller, have slimmer bodies, and most species fold the wings along the body when at rest. An ancient group, damselflies have existed since at least the Lower Permian, and are found on every continent except Antarctica.

All damselflies are predatory; both nymphs and adults eat other insects. The nymphs are aquatic, with different species living in a variety of freshwater habitats including acid bogs, ponds, lakes and rivers. The nymphs moult repeatedly, at the last moult climbing out of the water to undergo metamorphosis. The skin splits down the back, they emerge and inflate their wings and abdomen to gain their adult form. Their presence on a body of water indicates that it is relatively unpolluted, but their dependence on freshwater makes them vulnerable to damage to wetland habitats.

Some species of damselfly have elaborate courtship behaviours. Many species are sexually dimorphic, the males often being more brightly coloured than the females. Like dragonflies, they reproduce using indirect insemination and delayed fertilisation. A mating pair form a shape known as a "heart" or "wheel", the male clasping the female at the back of the head, the female curling her abdomen down to pick up sperm from secondary genitalia at the base of the male's abdomen. The pair often remain together with the male still clasping the female while laying eggs within the tissue of plants in or near water using a robust ovipositor.

Fishing flies that mimic damselfly nymphs are sometimes used in wet-fly fishing. Damselflies sometimes provide the subject for personal jewellery such as brooches.

Mayfly Nymph

It has got three tails, abdominal gills and its legs end up on a nail. Life length: short (1 day to 1 week)

Mayflies or **shadflies** are insects belonging to the order **Ephemeroptera** (from the Greek *εφήμερος*, *ephemeros* = "short-lived" (literally "lasting a day" "daily" or "day-long"), and *πτερόν*, *pteron* = "wing", referring to the brief lifespan of adults). They have been placed into an ancient group of insects termed the Palaeoptera, which also contains dragonflies and damselflies. They are aquatic insects whose immature stage (called "naiad" or, colloquially, "nymph") usually lasts one year in fresh water. The adults are short-lived, from a few minutes to a few days, depending on the species. The *Dolania americana* has the shortest lifespan among *Ephemeroptera*; the adult females of the species only live for less than five minutes. About 2,500 species are known worldwide, including about 630 species in North America. The naiads live primarily in streams under rocks, decaying vegetation, or in the sediment. Few species live in lakes, but they are among the most prolific. For example, the emergence of one species of *Hexagenia* was recorded on Doppler weather radar along the shores of Lake Erie.

Most species feed on algae or diatoms, but a few species are predatory. The naiad stage may last from several months to several years, with a number of moults along the way. Most mayfly naiads are distinctive in having seven pairs of gills on the dorsum of the abdomen. In addition, most possess three long cerci or tails at the end of their bodies. Some species, notably in the genus *Epeorus*, have only two tails. In the last aquatic stage, dark wingpads are visible. Developmentally, these insects are considered hemimetabolous. A more casual and familiar term is "incomplete metamorphosis". Mayflies are unique among insects in that they moult one more time after acquiring functional wings (this is also known as the alate stage); this last-but-one winged instar usually lives a very short time, often a matter of hours, and is known as a subimago or to fly fishermen as a dun. Mayflies in this stage are a favourite food of many fish, and many fishing flies are modelled to resemble them.

Group 3: Organisms semi-resistant to pollution

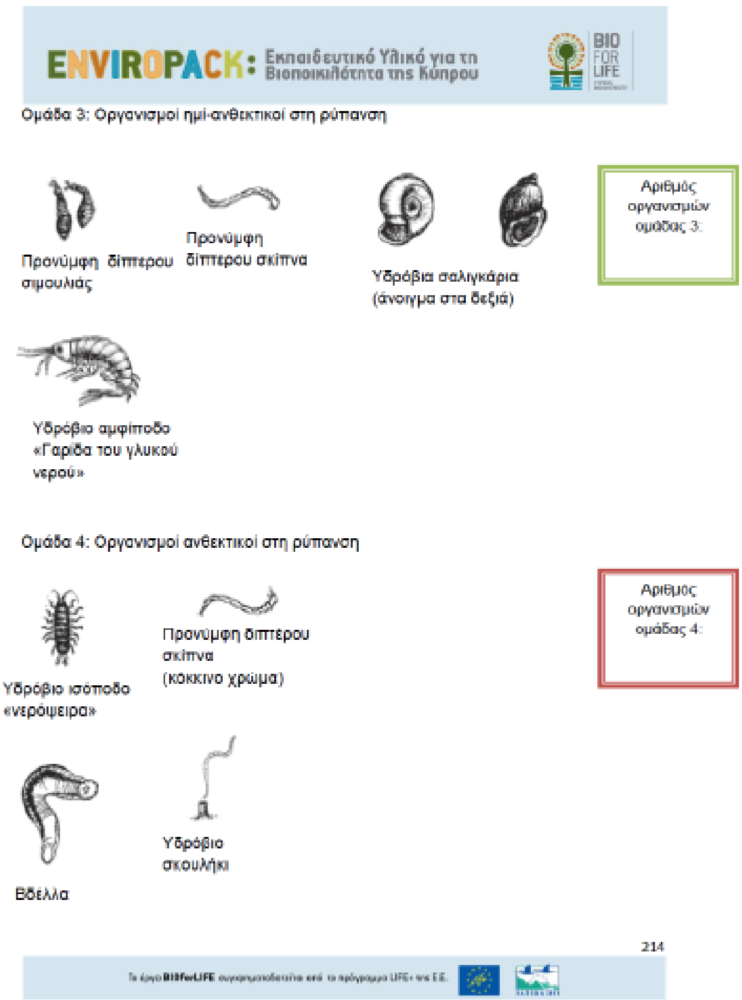
Fly Larvae – Simuliidae

With the hooks of the anchor disc that have in the back of their body, they attach themselves to the substrate layer in silk they produce. With a structure like a comb infiltrate fine organic material from the water

Non Biting Midge Larvae – Chironomidae

The red colour occurs due to haemoglobin. [see: Non Biting Midge Larvae Red - chironomidae)] Thanks to haemoglobin they can utilize low oxygen concentrations. They are an important source for other insects, birds and fish.

- Aquatic snails
- Aquatic amphipods



Group 4: Organisms resistant to pollution

Leech

It can be adhered to the host via its myzitires. Most kind of leeches have a diet consisting of little invertebrates, crushing their prey with its mouth molecules and absorb their fluids. Parasitic leech species feed on vertebrates' blood (fish, frogs, turtles, birds), passing through their preys' skin with their tongue. To prevent the thickening of their prey's blood, they secrete an anticoagulant agent in their blood.

Aquatic Worm

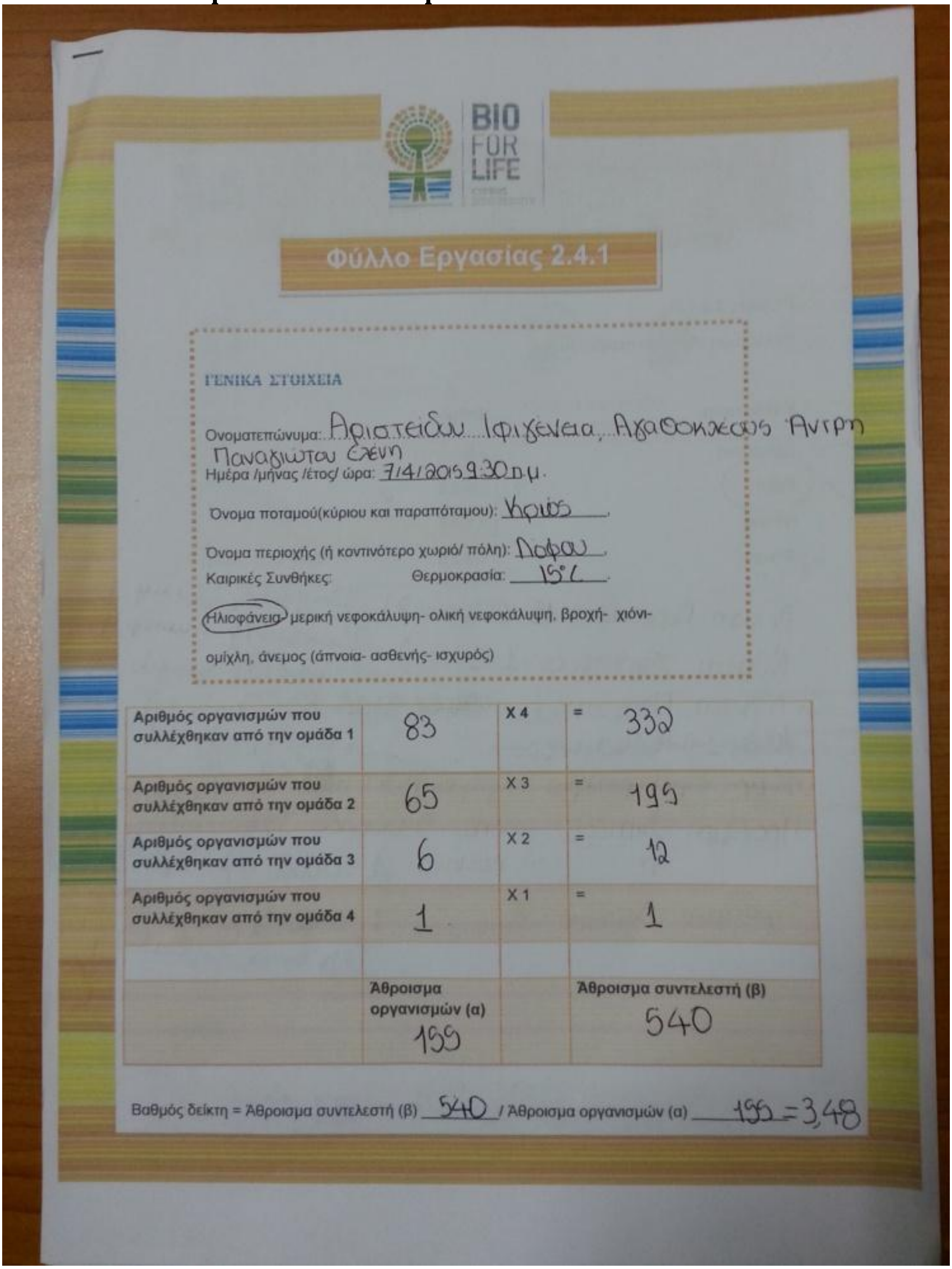
They live in conditions of very low dissolved oxygen. They have protein haemoglobin which has almost the same substances with oxygen. In this way they can exploit the low rates of dissolved oxygen in water.

Non Biting Midge Larvae Red – Chironomidae

As mentioned before, they carry haemoglobin, which accounts for their red colour.

Chironomidae (informally known as **chironomids** or **nonbiting midges**) are a family of nematoceran flies with a global distribution. They are closely related to the Ceratopogonidae, Simuliidae, and Thaumaleidae. Many species superficially resemble mosquitoes, but they lack the wing scales and elongated mouthparts of the Culicidae.

Annex 2: Papers that we complete in our measurements



BIO FOR LIFE

Φύλλο Εργασίας 2.4.1

ΓΕΝΙΚΑ ΣΤΟΙΧΕΙΑ

Ονοματεπώνυμο: Αριστείδου Ιφιγένεια, Αγαθοκλέους Άντρη Παναγιώτου Ελένη

Ημέρα /μήνας /έτος/ ώρα: 7/4/2015 9:30 π.μ.

Όνομα ποταμού(κύριου και παραπόταμου): Κρίος

Όνομα περιοχής (ή κοντινότερο χωριό/ πόλη): Λόφου

Καιρικές Συνθήκες: Θερμοκρασία: 15°C

Ηλιοφάνεια- μερική νεφοκάλυψη- ολική νεφοκάλυψη, βροχή- χιόνι-

ομίχλη, άνεμος (άπνοια- ασθενής- ισχυρός)

Αριθμός οργανισμών που συλλέχθηκαν από την ομάδα 1	83	X 4	= 332
Αριθμός οργανισμών που συλλέχθηκαν από την ομάδα 2	65	X 3	= 195
Αριθμός οργανισμών που συλλέχθηκαν από την ομάδα 3	6	X 2	= 12
Αριθμός οργανισμών που συλλέχθηκαν από την ομάδα 4	1	X 1	= 1
	Άθροισμα οργανισμών (α) 155		Άθροισμα συντελεστή (β) 540

Βαθμός δείκτη = Άθροισμα συντελεστή (β) 540 / Άθροισμα οργανισμών (α) 155 = 3,48

Πίνακας 2.4.1

Κατάσταση υδάτινου περιβάλλοντος

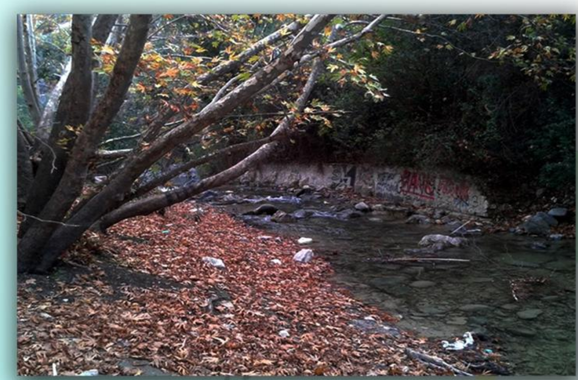
Κατάσταση	**Βαθμός**
Εξαιρετική	3,6+
Καλή	2,6-3,5 ✓
Μέτρια	2,1-2,5
Φτωχή	1,0-2,0

Νύμφη Λιβελούλας: 15 (Ομάδα 2) Dragonfly numph
Νύμφη Ζυγόπτερου: 1 (") Damsefly numph
Νύμφη Πλεκοπτέρου: ~~[illegible]~~ 83 (Ομάδα 1) Stonefly numph
~~[illegible]~~
Νυμφη εφημεροπτερου κολυμβητρια: 49 (Ομάδα 2) Mayfly numph
Προνύμφη Διπτερου άσπρο: 5 (Ομάδα 3) Non bitting midge larva - Chironomidae
" " κόκκινο: 1 (Ομάδα 4) Non-bitting midge larva (red) Chironomidae
Προνύμφη Διπτερου Σιμουλίας: 1 (Ομάδα 3) fly larva - Simulidae.

Το έργο BIOforLIFE συγχρηματοδοτείται από το πρόγραμμα LIFE+ της Ε.Ε.

Studying a fluvial system – Biodiversity in Cyprus

Student Group: Agathokleous Andri, Aristidou Ifigenia, Panayiotou Elena
Coordinator Teacher: Nikolaou Nikolas
Saint Anthony`s High School 2013-2015

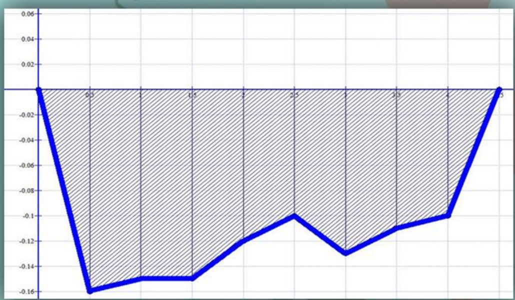


Krios River

Picture from our first visit to the Krios River back in 2013

Our project is meant to study rivers located in our country, Cyprus, and additionally raise awareness of the public, at large, through our experience, calculations and conclusions, which have to do with humans' need of rivers. Rivers have been used by us, humans, through the centuries.

For the purpose of our project, we have visited Kryos river three times at intervals, initially in order to calculate its biotic characteristics, its nutrients, its water supply, its temperature and the dissolved oxygen in it. In our second visit we wanted to compute its flora and in the last, third one, its microorganisms and biomarkers.



Water flow of Krios River

Multiplying the cross-sectional area of the river at a point, with the average speed of the water at this point, we calculate the volume of water that passes per unit time from this intersection surface of the river. The flow unit is m3 / s. The water supply does not remain constant throughout the year. To convert the water velocity (m / s) to provide m3 / s we use the relationship: $Q = \Sigma A_i V_i$. The individual flow measurements (0,289 m3 / s) can not lead us to a conclusion on the amount of water transported to the dam of Kouris. We must also take in consideration many parameters, such as rainfall.

Our first visit was in order to calculate its biotic characteristics, its nutrients, its water supply, its temperature and the dissolved oxygen in it. Separated in three groups, we took measurements with special equipment for water flow and turbidity, for nutrients, and last, measurements on the dissolved oxygen and on the acidity of water.

On September 30th, we visited again the river so as to compute its flora. Eleven students, two teachers and the biologist Mrs. Athena Papatheodoulou participated in the exploration, collecting plants or leafs, and then analysing them, later characterising them. Through this exploration, the participants came in touch with the whole Cyprus' flora spectrum and could be able to tell if there's water or even river near their location, just by recognising plants and leafs, which apparently can't live without the supply of water.

Flora of Krios River

Microorganisms and biomarkers of Krios River

Our last (3rd) visit happened to be on Tuesday, April 7th. Three students, our teacher and the biologist Mrs. Athena Papatheodoulou took part in the exploration. The exploration had to do with detecting biomarkers and microorganisms living in or near the river. These species are classified in four groups. The first group was the one with sensitive to pollutants species, the second one concerned semi-sensitive, the third semi-tolerant and the fourth, tolerant to pollutants. Krios river contained more first and second class/group species. Summarising through calculations, Krios' water quality is good, reaching excellent.

Rivers and other fluvial systems are really delicate systems which purvey a better wuality of life when clean, and any change of their condition can directly and indirectly affect us, too. We have been using rivers for various of needs through the centuries, depending on their length, water level and flow and still do. Let us also take into consideration the fact that with the passage of time we do not care that much about our environment.

We dont really appreciate it, right?