

# **The effect of colours and different materials on physico-chemical properties of water and on the appearance of mosquitos**

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## 1. Abstract

Water is necessary for all life on Earth. Today lots of junkyards contain many materials which collect water. Stagnant water is also a common site in gardens where people often leave water in watering cans which they later use to water fruits or vegetables. Stagnant water can become a home for many organisms which cause a variety of diseases. Some of these materials are plastic, glass and rubber. Each of these materials has its specific characteristics. The main characteristic of glass is its transparency to the visible part of the spectrum, while it is mostly impervious to the rest of the spectrum. Plastic materials take a long time to decompose and harm the environment. Because of its characteristics rubber heats up fast, thereby heating up the water stored in it. Alongside the materials themselves, the colours of the materials can also effect the properties of water. Certain colours absorb certain wave lengths and reflect others. Colours which have a small wave length, like purple, have more energy. Black materials absorb all wave lengths and therefor absorb more energy and heats up more.

The largest number of species on Earth are bugs. Mosquitos belong to the family Culicidae and order Diptera. They are cosmopolitan species because they can be found all around the world and they are a common sight in Croatia during the warmer months. They feed on blood of other animals, especially on blood of mammals. They are vectors for a number of diseases like yellow fever, dengue fever, malaria, etc. *Culex pipiens* L., the common mosquito, is the most common mosquito in Croatia. Mosquito development is a mean of encouragement for disposing and recycling waste. If countries were more aware of the dangers of mosquito development, they would probably focus more of their attention on properly dealing with waste. This is especially important for developing countries where mosquito carried diseases are more frequent. A recent example of this problem is the Zika virus. The spread of this harmful virus could be prevented with proper mosquito number regulation

Our research question is: What are the effects of colours and different materials on physico-chemical properties of water and on the appearance of mosquitos? The objective of this paper is to keep track of physico-chemical properties of water, kept in different materials of different colours during spring weeks, and to notice how these physico-chemical properties of water influence the appearance of mosquitos. The hypothesis says that more mosquitos will be found in black materials, because of greater energy absorption. More energy increases the number of organic and inorganic compounds, thus providing better conditions for the development of mosquitos and microorganisms. The assumption is that more mosquitos will develop in the containers with more dissolved oxygen and nitrates, and less dissolved ammonium.

Containers, made out of different materials and of different colours, were paced around the school station, which is located at 45.8188 °N, 16.0077 °E. Three materials (glass, plastic, rubber) and five colours (black, white, green, yellow, red) were used. The containers made out of glass and plastic are the same size, while the rubber container are a bit shorter but of a greater diameter. All of the containers contained the same volume of water (700 mL) and the same water surface was exposed to the sun in all of the containers. The measurements took place from 1.3.2016. to 25.4.2016. „Mosquito Larvae Sampling Field Guide“ was used for sampling in natural habitats and in the containers. Physico-chemical properties of water that were measured: oxygen, nitrite, nitrate and ammonium concentrations, water temperature and pH. These properties were measured using GLOBE protocols. “Globe protocol identification” and a school loupe were used for determination of the genera of mosquitos.

Using the collected data we got the following results:

The number of found larvae (in black glass) of the genus *Culex* on 18.4. was 27. 36 larvae were found the week after. Mosquito larvae in black plastic were found on 25.4. All of the larvae were found in glass containers of dark colours (all containers except white and yellow) and in black plastic. The pH values were closest to neutral in black glass, while the pH values in other containers were quite high. Only two larvae were found in the sample in black plastic and green glass, and only one was found in the blue glass container. No larvae had developed in the rest of the containers. All concentrations of the inorganic compounds we measured were low. Algae and dead flies were found in all samples and their quantity became greater and greater during this research. The largest amount of algae was found in black and green rubber, and in green plastic while the smallest amount was found in yellow glass and plastic, and blue rubber. Using a microscope we determined the presence of algae, cyanobacteria, euglenas, amoebas and roundworms in all samples.

Using our results we concluded the following:

The only larvae, that were found, were found in black glass and plastic containers. We noticed that female mosquitos prefer darker containers for laying her eggs. A high pH value is an inhibiting factor for the development of mosquitos. The low concentrations of inorganic compounds don't have an inhibiting effect on the development of mosquitos and were suitable for the development of microorganisms, which larvae feed on.

Throwing inorganic waste into nature can induce the development of mosquitos and different organisms that can harm human health. The results indicate that the greatest number of organisms, such as mosquitos and algae, will develop in black materials. This tells us that we should pay greater attention to the recycling and disposing of black and dark materials (such as rubber and other materials coloured in dark colours).

In this research only the common mosquito, that doesn't spread diseases, was found (genus *Culex*). This doesn't mean that a disease spreading mosquito couldn't have developed in the later, warmer months. This research could be improved by continuing monitoring the development of mosquitos and physico-chemical properties of water in the samples until autumn, and also by doing a microbiological analysis.

## 2. Introduction

Water is necessary for all life on Earth. Today lots of junkyards contain many materials which collect water. Stagnant water is also a common site in gardens where people often leave water in watering cans which they later use to water fruits or vegetables. Stagnant water can become a home for many organisms which cause a variety of diseases. Some of these materials are plastic, glass and rubber. Each of these materials has its specific characteristics. The main characteristic of glass is its transparency to the visible part of the spectrum, while it is mostly impervious to the rest of the spectrum. Plastic materials take a long time to decompose and harm the environment. Because of its characteristics rubber heats up fast, thereby heating up the water stored in it. Alongside the materials themselves, the colours of the materials can also effect the properties of water. Certain colours absorb certain wave lengths and reflect others. Colours which have a small wave length, like purple, have more energy. Black materials absorb all wave lengths and therefor absorb more energy and heats up more.

The largest number of species on Earth are bugs. Mosquitos belong to the family Culicidae and order Diptera. They are cosmopolitan species because they can be found all around the world and they are a common sight in Croatia during the warmer months. They feed on blood of other animals, especially on blood of mammals. They are vectors for a number of diseases like yellow fever, dengue fever, malaria, etc. *Culex pipiens* L., the common mosquito, is the most common mosquito in Croatia. This species, while aggressive, does not carry diseases.<sup>1</sup> Invasive species of mosquitos are getting more and more often, and are supressing the mosquitos of our region. One of these mosquitos is the tiger mosquito, *Aedes albopictus* S., that originates from southeast Asia. This mosquito, which was first sighted in Croatia in 2004., can now be found in eight counties.<sup>2</sup> This species has adapted to temperate climate by spending cold winters in the form of eggs. Besides being aggressive, this species carries malaria, four types of dengue, arbovirus.<sup>3</sup> Female mosquitos are the ones that suck blood and spread diseases. Mosquitos have four stages of development: eggs, larvae, pupae and adult mosquitos. The first three stages take place in water, while the adult mosquito moves through air.<sup>3</sup> Many species of mosquitos have adapted to winter by hibernating. The development of mosquitos completely depends on the availability of water and on its temperature. The water temperature should be over 2°C, because lower temperature kills the eggs.<sup>4</sup> Standing waters, like water residues in old car tires, different containers, watering buckets and flower vases, are suitable places for mosquito development. Mosquito larvae are located on the surface of water, and some have breathing tubes or gills. They are predators, even prone to cannibalism, or they feed on detritus.<sup>1</sup>

Mosquito development is also a mean of encouragement for disposing and recycling waste. If countries were more aware of the dangers of mosquito development, they would probably focus more of their attention on properly dealing with waste. This is especially important for developing countries where mosquito carried diseases are more frequent. A recent example of this problem is the Zika virus. The spread of this harmful virus could be prevented with proper mosquito number regulation.

Our research question is: What are the effects of colours and different materials on physico-chemical properties of water and on the appearance of mosquitos? The objective of this paper is to keep track of physico-chemical properties of water, kept in different materials of different colours during spring weeks, and to notice how these physico-chemical properties of water influence the appearance of mosquitos. The hypothesis says that more mosquitos will be found in black materials, because of greater energy absorption. More energy increases the number of organic and inorganic compounds, thus providing better conditions for the development of mosquitos and microorganisms. The assumption is that more mosquitos will develop in the containers with more dissolved oxygen and nitrates, and less dissolved ammonium.

### 3. Research methods

Containers, made out of different materials and of different colours, were paced around the school station, which is located at 45.8188 °N, 16.0077 °E. Three materials (glass, plastic, rubber) and five colours (black, white, green, yellow, red) were used. The containers made out of glass and plastic are the same size, while the rubber container are a bit shorter but of a greater diameter. All of the containers contained the same volume of water (700 mL) and the same water surface was exposed to the sun in all of the containers. The measurements took place from 1.3.2016. to 25.4.2016. „Mosquito Larvae Sampling Field Guide“ was used for sampling in natural habitats and in the containers.

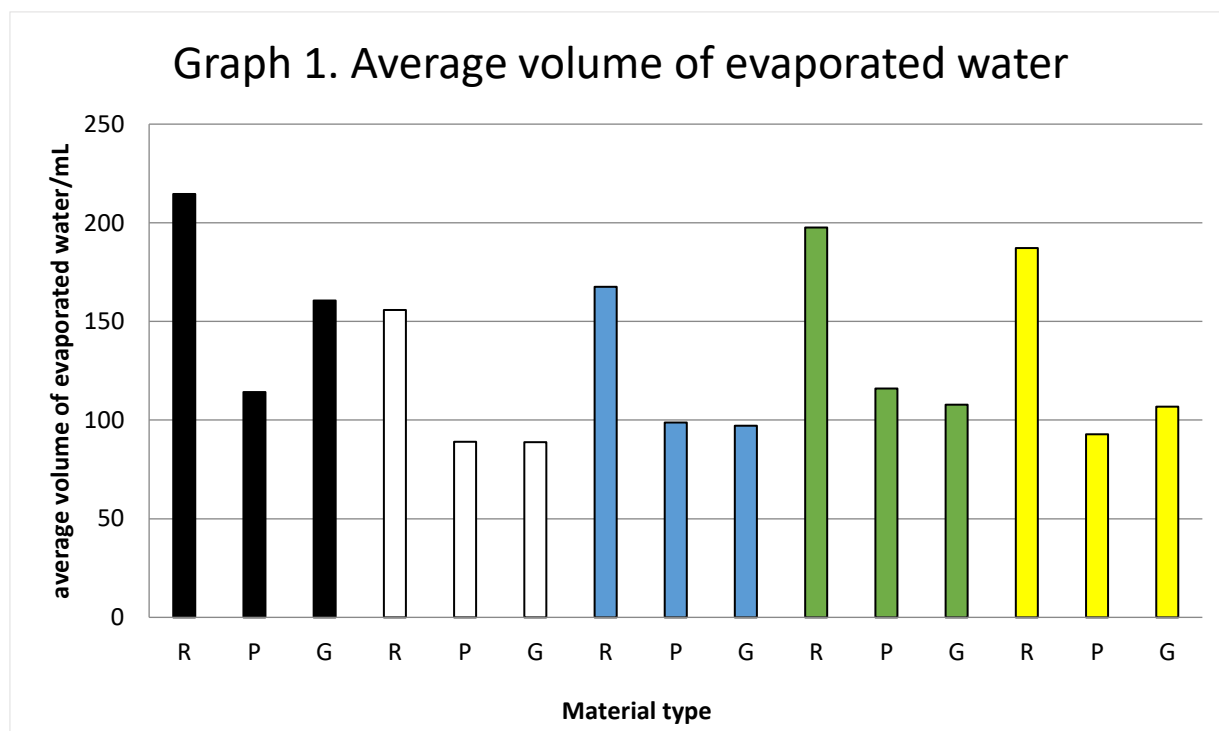
Physico-chemical properties of water that were measured: oxygen, nitrite, nitrate and ammonium concentrations, water temperature and pH. These properties were measured using GLOBE protocols. “Globe protocol identification” and a school loupe were used for determination of the genera of mosquitos.

Container labels: the graph colour represents the container colour, the letter underneath represents the material (R – rubber, P – plastic, G – glass)

### 4. Results

#### a. Evaporation

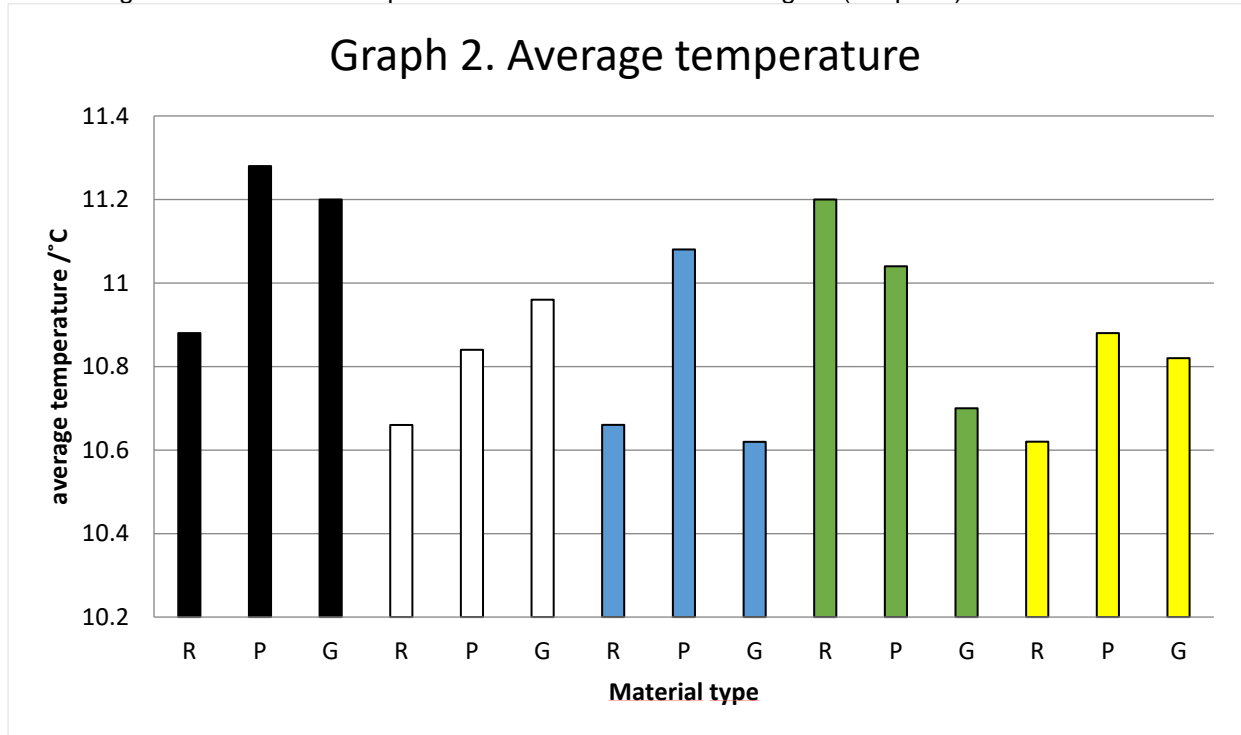
The most water, during all 5 weeks, evaporated from rubber materials. Overall, the greatest volume changes happened in black materials (Graph 1.).



*Graph 1. Average values of the volume of evaporated water*

### b. Temperature

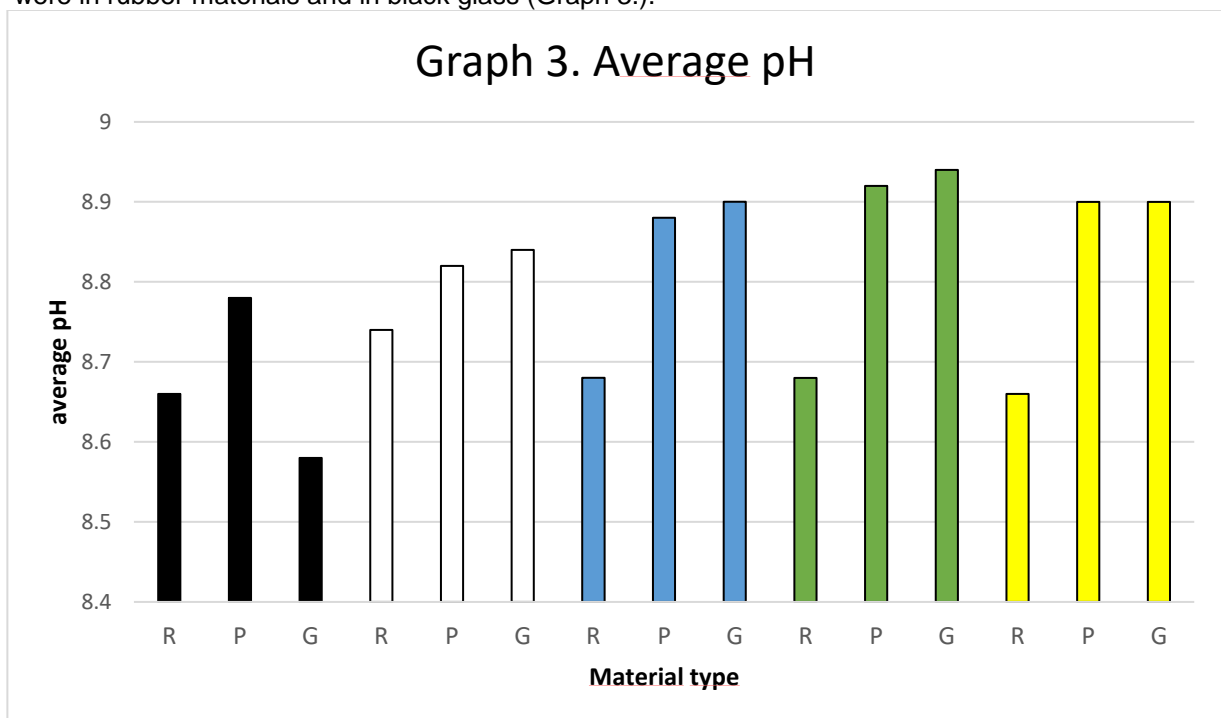
The values of water temperature don't have any great deviations within each material and colour. Overall, the average values of water temperature in black materials are higher (Graph 2.).



*Graph 2. Average values of water temperature*

### c. pH

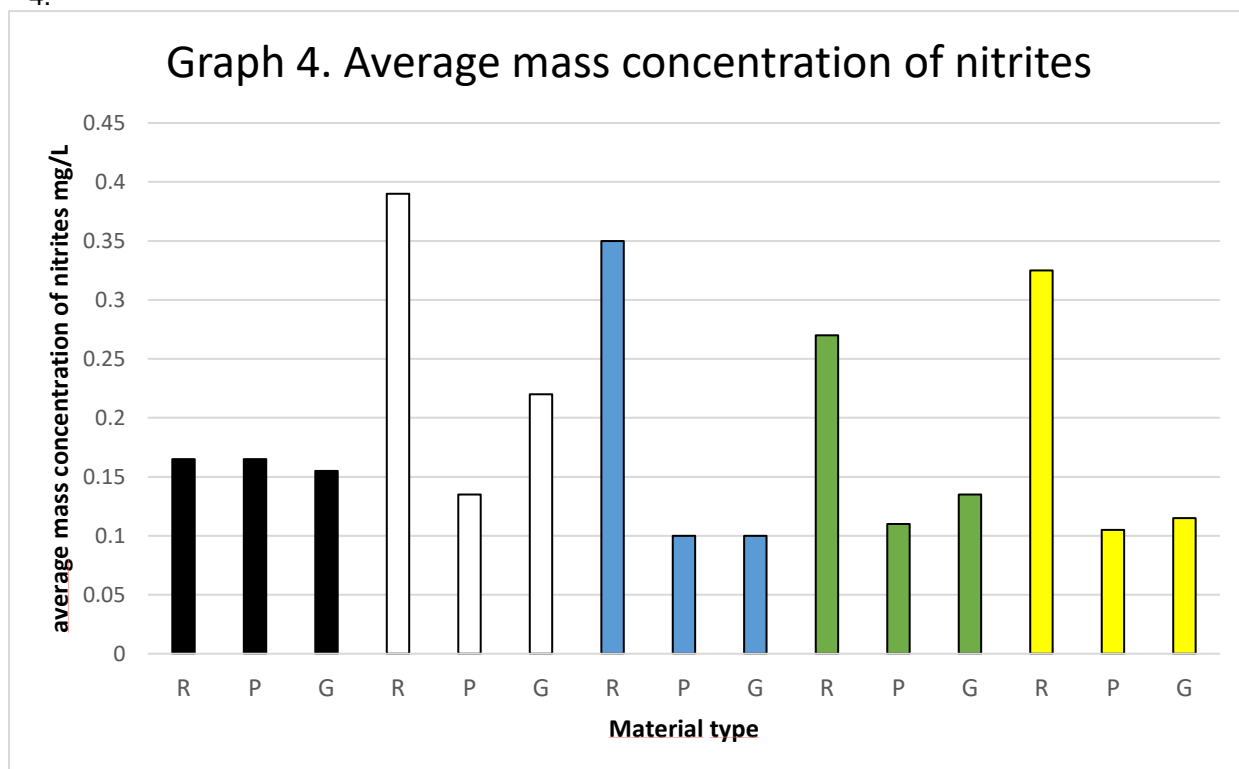
pH values of all of the samples are in the alkaline range. The average pH is lowest in the samples that were in rubber materials and in black glass (Graph 3.).



*Graph 3. Average pH values*

#### d. Nitrites

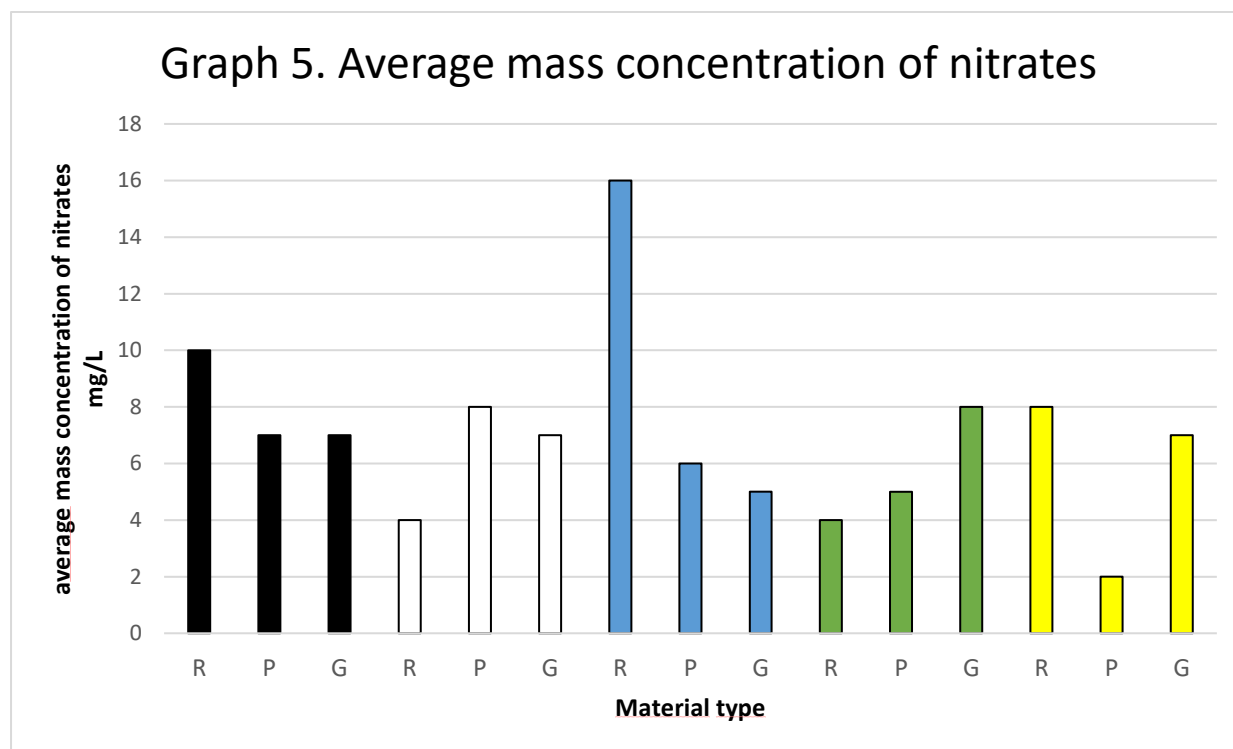
Mass concentration of nitrites is greatest in the samples that were in rubber materials as shown in Graph 4.



*Graph 4. Average values of mass concentration of nitrites*

#### e. Nitrates

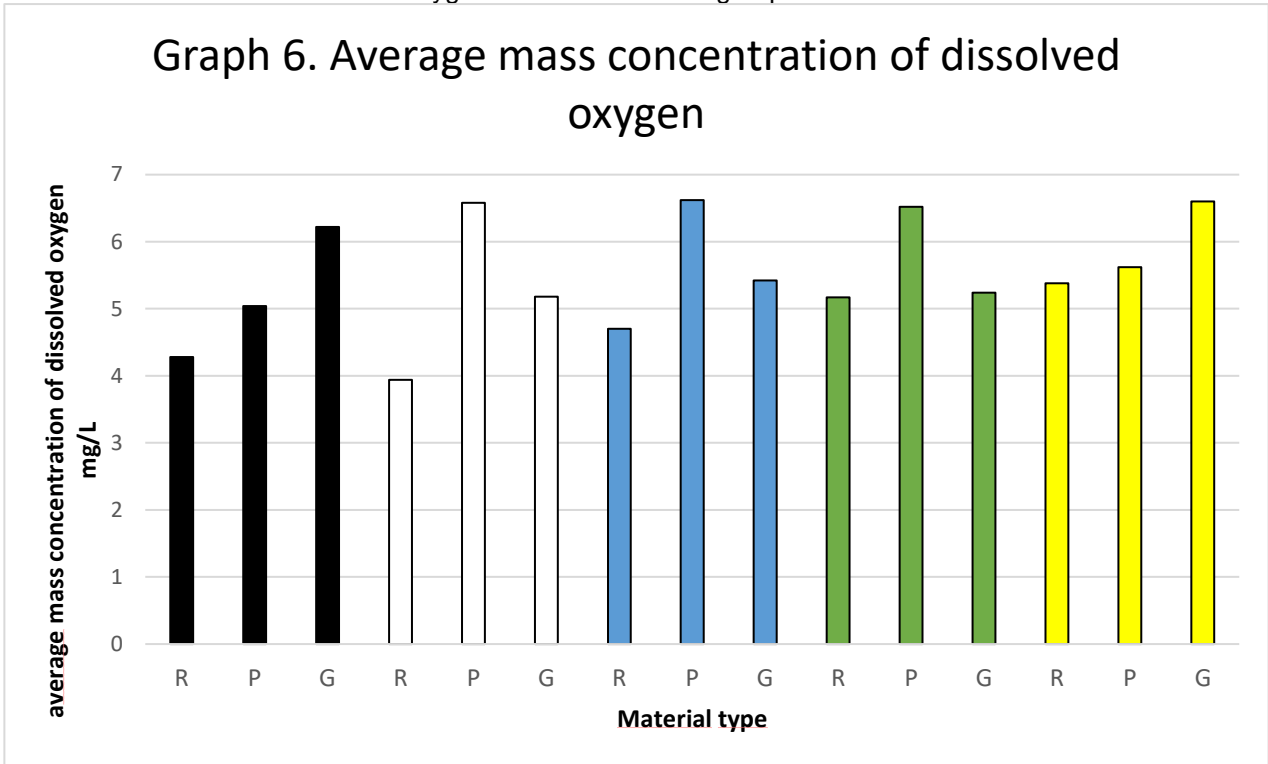
The values of mass concentration of nitrates are mainly greatest for samples in rubber materials, except white rubber (Graph 5.).



*Graph 5. Average values of mass concentration of nitrates*

### f. Dissolved oxygen

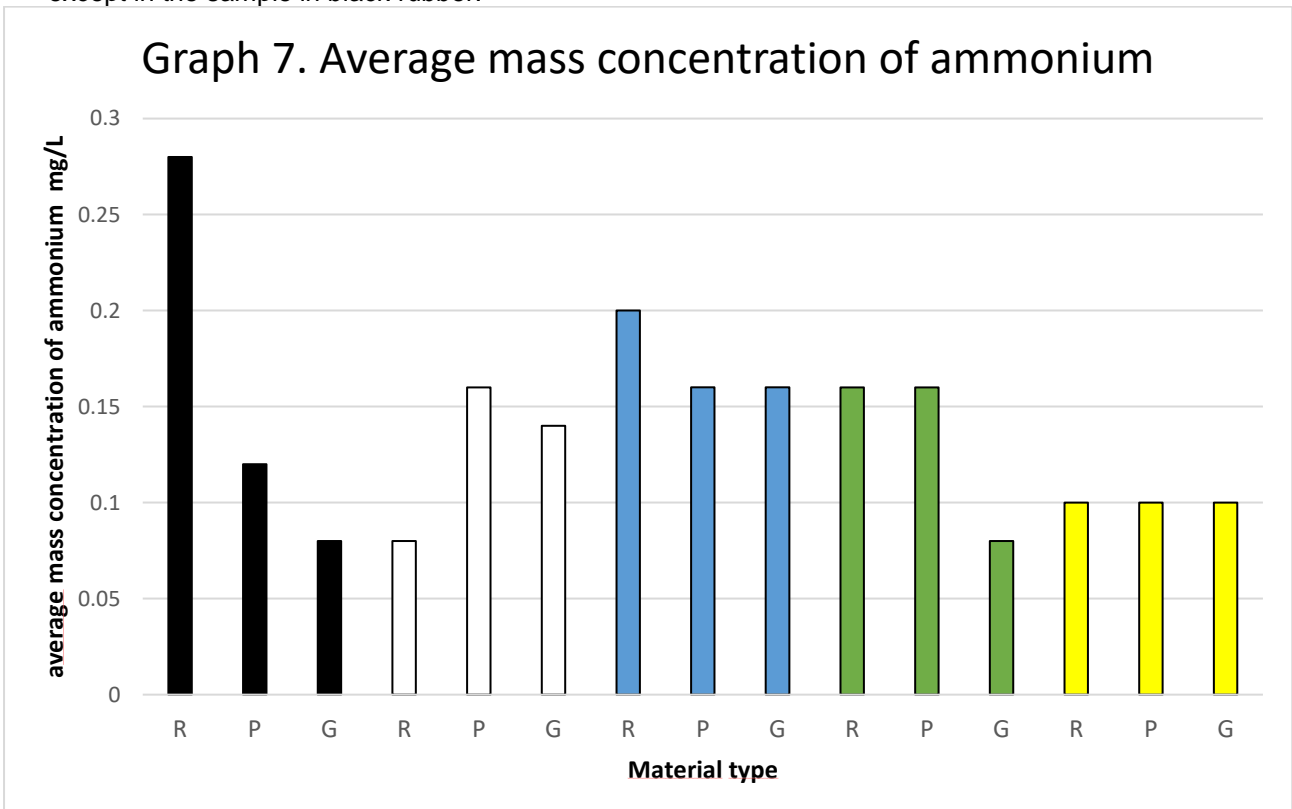
The concentration of dissolved oxygen varies within each group of materials and colours.



*Graph 6. Average values of mass concentration of dissolved oxygen*

### g. Ammonium ion

In the beginning the concentration of ammonium ions was high in all samples. Later the values decrease except in the sample in black rubber.



*Graph 7. Average values of mass concentration of ammonium ions*

### h. Mosquitos

The larvae that were found belong to the genus *Culex*. Larvae were found only in four containers named in Table 1.

Table 1. The number of found larvae of the genus *Culex*

Material	The number of found larvae	
	18.4.	25.4.
Black glass	27	36
Black plastic	0	2
Blue glass	1	0
Green glass	2	0

#### Qualitative results:

Algae and dead flies were found in all samples and their quantity became greater and greater during this research. The largest amount of algae was found in black and green rubber, and in green plastic while the smallest amount was found in yellow glass and plastic, and blue rubber. Using a microscope we determined the presence of algae, cyanobacteria, euglenas, amoebas and roundworms in all samples.

### 5. Analysis

The number of found larvae (in black glass) of the genus *Culex* on 18.4. was 27. 36 larvae were found the week after. Mosquito larvae in black plastic were found on 25.4. All of the larvae were found in glass containers of dark colours (all containers except white and yellow) and in black plastic. The pH values were closest to neutral in black glass, while the pH values in other containers were quite high.

It is evident that the lower the temperature is in a container, the oxygen concentration is higher. Toxic compounds are less likely to form if the oxygen concentration is higher.<sup>5</sup> At low pH values and low temperatures ammonia reacts with water, thus creating ammonium ions. When the pH values are high more ammonia can be found in water.<sup>6</sup> Ammonia (NH<sub>3</sub>) is more poisonous than ammonium ions. Concentrations of ammonium ions over 3 mg/L have an inhibiting effect on mosquito larvae.<sup>7</sup> The water temperature in black glass was 10.9°C in the week when mosquito larvae were found. Larvae of the *Culex* genus hatch from eggs and develop at 15 °C<sup>3</sup>. However, it has been recorded that larvae can develop on a temperature lower than 10°C<sup>8</sup>. It is thought that the high pH values had a negative effect on the larvae, while the concentrations of the measured compounds were too low to have a negative effect. To have an untoward effect on mosquito larvae the concentration of oxygen would have to fall under 3 mg/L and the concentration of nitrates would have to be over 90 mg/L.<sup>9</sup>

The excessive development of algae in black and green rubber, and their breakup, could have led to excretion of toxic compounds that could have had an inhibiting effect on the larvae. It is likely that rubber materials also let out toxic compounds.

Only two larvae were found in the sample in black plastic and green glass, and only one was found in the blue glass container. No larvae had developed in the rest of the containers. This experiment was done in the colder months and the results would be different if the experiment was done in late spring or summer. More genera and more larvae would have probably been found. The results also depend on the probability of where the female mosquito will lay her eggs. Bacteria, which produce compounds that attract female mosquitos, also effect this probability.<sup>10</sup>

### 6. Conclusion

The only larvae, that were found, were found in black glass and plastic containers. We noticed that female mosquitos prefer darker containers for laying her eggs. A high pH value is an inhibiting factor for the development of mosquitos. The low concentrations of inorganic compounds don't have an inhibiting effect on the development of mosquitos and were suitable for the development of microorganisms, which larvae feed on.

Throwing inorganic waste into nature can induce the development of mosquitos and different organisms that can harm human health. The results indicate that the greatest number of organisms, such as mosquitos and algae, will develop in black materials. This tells us that we should pay greater attention to the recycling and disposing of black and dark materials (such as rubber and other materials coloured in dark colours).



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## 7. Sources

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