

## SCIENCE PRACTICUM ACTIVITIES THROUGH WATER AND AIR POLLUTION EXPERIMENTS ON ENVIRONMENTAL POLLUTION MATERIALS IN JUNIOR HIGH SCHOOLS

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**Abstract:** Learning that is carried out using the experimental practicum method gives students the ability to think critically, actively and collaboratively in solving a problem in science material, especially environmental pollution material. This study aims to provide an alternative way for educators to convey material related to environmental pollution, especially water and air pollution so that students are easier to understand and apply it in the environment. The method used is the development of practicum learning methods on the material of water pollution and air pollution which is carried out in class VII students at junior high school level. The results of the water pollution practicum research stated that the higher the dose of detergent, the lower the movement of the fish operculum and the slower the motility or movement of fish and eventually it died. The results of the air pollution practicum stated that the longer the crickets were exposed to the smoke of the mosquito coils, the lower the displacement of the places carried out by the crickets and the higher the activity of moving the antennas on the heads of the crickets.

Keywords: Practicum Method; Water Pollution; Air Pollution

### INTRODUCTION

The application of learning methods with experiment-based practicum methods is one way to increase students' scientific literacy in the process of understanding the material. Students tend to do the process of critical thinking and creative thinking in solving a problem. This makes the scientific learning process for students continue to increase and it is easy to find and understand existing concepts (Damarwulan, 2020). According to Doloksaribu & Suaka (2021) practicum activities have provided an increase in students' scientific literacy through direct practice on teaching material obtained in theory. In addition, students

will also have the ability to cooperate well with other students when implementing the learning process.

A distinctive feature of the practicum method is a method with a scientific or scientific approach. The stages in the scientific approach are observing, asking, gathering information, processing information, and communicating. The scientific approach focuses on students' scientific process abilities which are developed based on scientific research concepts. This is in accordance with the ability of the learning process which must contain a series of research activities carried out by students in an effort to build knowledge (Dewi & Rochintaniawati, 2016). The stage of gathering information in a scientific approach is an activity that seeks to answer the questions that have been asked. One of the student activities in order to gather information is to design and conduct experiments. Scientific learning invites students to observe various phenomena that are familiar with students' daily lives (Narut & Supardi, 2019).

The advantage of applying the learning process with the experimental-based practicum method is of course one of the most influential ways for the student learning process. Students will tend to find new things and will feel that the material is not so far from everyday life (contextual) so that students not only record, listen, but also feel the impact of the material (Afriani, 2018). Teachers will find it easier to observe student development not only from the cognitive aspect but also from the affective and psychomotor aspects (skills) (Khoiri et al., 2020). However, not all science material can be delivered using the experimental-based practicum method. Only certain materials can use this method, for example in environmental pollution material. Environmental pollution material becomes material that can be observed directly around. This can be seen from the natural disasters that occurred in every region, starting from floods, landslides, polluted air, dirty water, and others. These natural disasters are never separated from the human factor due to a lack of understanding of the values of wisdom towards the natural environment, which should be obtained through science education in schools (Mayasari, 2017).

Based on this it is very important for students to study and understand the factors and impacts of environmental pollution that occur around them (Jiang et al., 2023). However, the way to understand to students about the causes, impacts, and prevention of environmental pollution is certainly not so easy. There needs to be a method or way of learning in conveying explanations related to this matter to students that are effective. The method that is very possible to do in conveying learning concepts related to environmental pollution, especially water pollution and air pollution, is the experimental practicum method. Thus, students will easily understand the material concept of water pollution and air pollution by being directly involved in observing, analyzing, and evaluating the results of observations from the practicum carried out. This research has a goal as an alternative method in

the learning process to convey the material concept of water pollution and air pollution to students.

## METHOD

This research is the development of an experiment-based practicum learning method on environmental pollution material which was carried out in class 7th grade students at junior high school level. This method aims to understand and demonstrate an event that occurs in the practicum object with events that occur in the natural surroundings. In other words, students are required to think critically and think creatively about every event that exists so that later they can solve every problem that exists. According to Haniyah et al. (2014) the experimental method (experiment) is a way of presenting learning in which students conduct experiments by experiencing and proving for themselves something that is learned. In the process of teaching and learning with this experimental method students are given the opportunity to experience themselves or do it themselves, follow a process, observe an object, analyze, prove and draw their own conclusions about an object, a state or a process of something.

This practicum material is divided into two, namely water pollution practicum material and air pollution material. This practicum material is a sub-material of environmental pollution material. This practicum is carried out for 2-3 lesson hours or about 80-120 minutes with groups of students totaling 6 groups with 5-6 students each member. The six groups were then divided into two major groups, namely the practicum group on water pollution material and the air pollution material. In the beginning three groups carried out water pollution practicum and 3 groups of air pollution. Furthermore, the 3 groups exchanged practicums that had not been carried out, so that at the end of the lesson each group finished working on water pollution and air pollution practicums.

Table 1 Tools and materials for practicum on water pollution

Tool's name	Amount	Material name	Amount
1. Jar size 200 mL	3 pieces	1. Powder detergent	550 gr
2. Digital scales	1 piece	2. Small fish	6-9 tails
3. Stopwatch	1 piece	3. Plain/fresh water	1 Liter
4. Counters	2 pieces		
5. Stationery/LKPD	1		

Table 2 Tools and materials for practice on air pollution

Tool's name	Amount	Material name	Amount
1. A 5 liter jar	2 pieces	1. Mosquito coils	1 piece
2. Plastic cups	2 pieces	2. Crickets	2-4 tails
3. Matches	1 piece		

Tool's name	Amount	Material name	Amount
4. Clear plastic cover	1 piece		
5. Rapi rope	1 roll		
6. Stopwatch	1		
7. Stationery/LKPD	1		

### Procedure

This research is divided into two work steps, namely water pollution practicum work steps and air pollution practicum work steps.

### Water pollution

The dependent variable in the water pollution practicum focuses on the amount of operculum and fish movement in the water, while the independent variable is the amount of detergent powder used. The following is a flowchart of water pollution practicum.

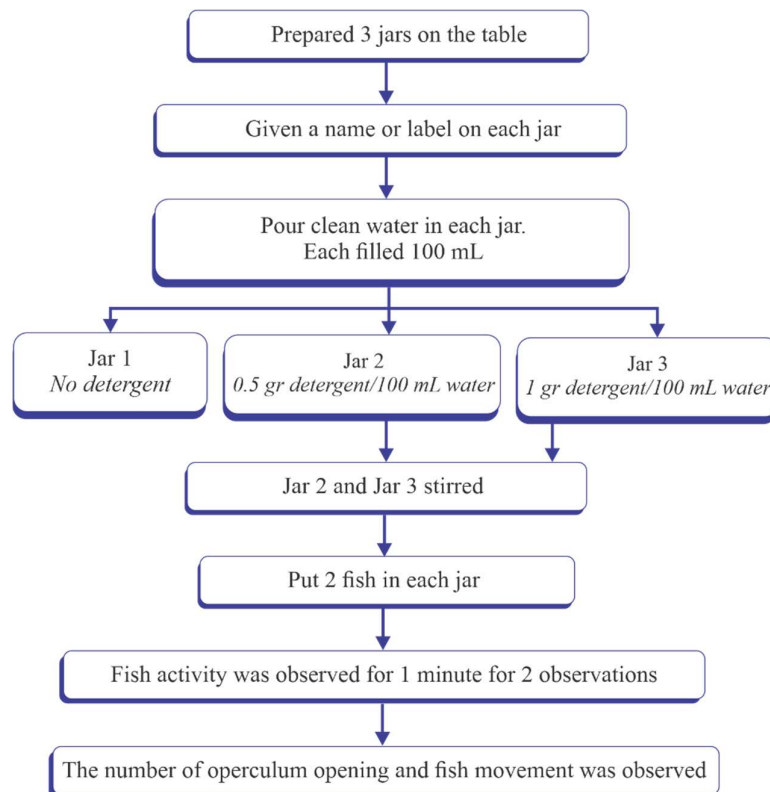


Figure 1 Flowchart of water pollution practicum work steps

There are 3 jars used. Jar 1 was used as a control, that is, without detergent, jar 2 was filled with water and detergent 0.5 gr/mL water, and jar 3 filled with water

and detergent 1 g/mL of water. Each jar is filled with 2 fish that are relatively the same size. There are 6 groups in the implementation of the experiment. The observed aspects were counting the opening and closing of the fish operculum and the movement of the fish. Counting the number of opening and closing of the operculum using a counter.

### Air pollution

The independent variable in the air pollution practicum is the use of smoke from mosquito coils, while the dependent variable is cricket activity. The following is a flowchart in the practice of air pollution.

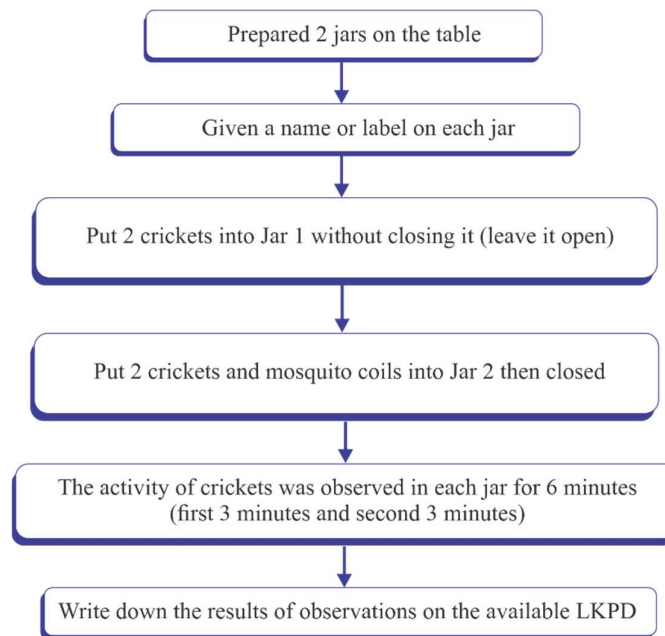


Figure 2 Flow chart of air pollution practicum work steps

The time used in this practicum is 6 minutes divided by two, namely the first 3 minutes and the second 3 minutes. The crickets put into each jar consist of 2 crickets. The way to observe cricket activity is by looking directly at the activity and movement of the crickets in the jar.

The results of the observation process are recapitulated on the student worksheets (LKPD) that have been given by the teacher. Student worksheets (LKPD) are teaching materials in the form of sheets containing material and instructions for students to carry out. Student activity sheets are student guides that are used to carry out investigative or problem-solving activities. Student activity sheets can be in the form of guides for cognitive development exercises as well as guidelines for the development of all aspects of learning in the form of experimental

or demonstration guides (Ansyah et al., 2021). LKPD has a function, namely as teaching material that minimizes the role of a teacher, but activates students more and as teaching material that makes it easier to understand the tasks or work steps to be carried out (Utami & Aznam, 2020). LKPD in this study consists of the main page (cover) contains practicum title, agency logo and group identity; the next page contains tools and materials, work steps (procedures), results of observations and group discussion sheets. Each group that has done the practicum is given time to discuss and answer questions in the LKPD according to the observations and ideas of each group.

## RESULTS AND DISCUSSION

### Water Pollution Practice

Based on the practical results of water pollution in fish given different doses of detergent in Jars 1, 2 and 3, the movement of the fish operculum has decreased in Jars 2 and Jar 3 except in Jar 1 (control) which has increased from the first minute to second minute. In Jar 1, the operculum movements of the fish increased by an average of 18 times from the first minute to the second minute, in Jar 2, the operculum movements of the fish decreased by an average of 10 times from the first minute to the second minute, while in Jar 3, the operculum movements fish decreased by an average of 26 times from the first minute to the second minute. Figure 3 shows the results of calculating operculum movements in fish.

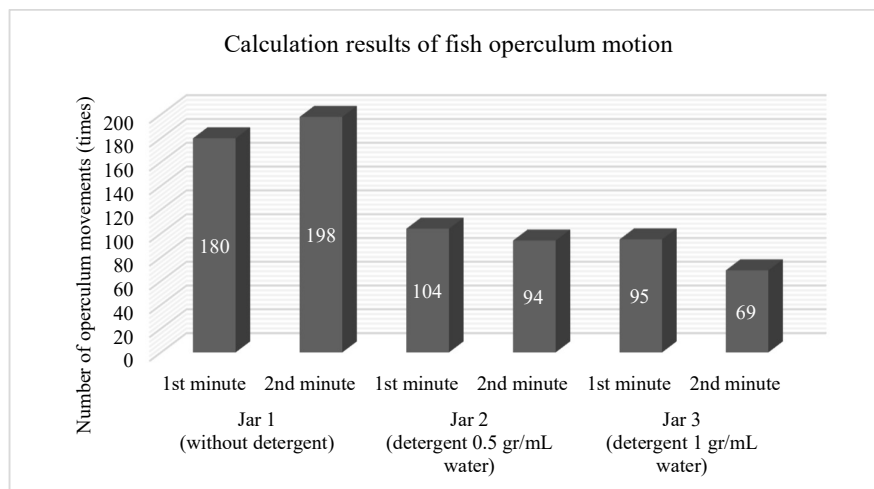


Figure 3 Graph of the average observed number of fish operculum movements in each jar

Based on the above data, the more amount of detergent added to the jar and the longer the time used, the amount of movement of the fish operculum will

decrease. The reduced number of fish operculum movements in the results of the practicum carried out was caused by water quality factors. This is in accordance with research conducted by Wahyuni et al. (2018) that fish have decreased along with the high concentration of detergent waste, it can even interfere with the survival of fish because fish are unable to adapt to conditions where the availability of dissolved oxygen in water is decreasing. Other research Amah et al. (2023) and Pagoray et al. (2021) explained regarding the results of his research related to liquid waste that if the source of the waste is very close to the population of living things, especially the fish population, the fish population will decrease and eventually leave the water area. The levels of BOD (*Biological Oxygen Demand*) and COD (*Chemical Oxygen Demand*) to measure the good and bad quality of water are very important for the life of aquatic biota. Water that has high levels of BOD and COD will make aquatic organisms unable to live. This is in accordance with the results of research conducted by Atima (2015) that if the BOD and COD values are high enough and exceed the quality standard, it can be assumed that there is an indication of organic matter contamination in the waters.

Water quality and food sources are very important factors for the survival and support of fish life, for example in the process of breathing and movement of fish (Tahir et al., 2021; Wiyoto et al., 2022). Water quality is very closely related to the life of various kinds of organisms that are near sources of pollutants, for example fish organisms in river waters. Water quality will decrease as a result of pollutants from households, industry and agriculture. According to Forgione et al. (2023) and Kahfi (2017) household waste can be sourced from bathrooms, residential kitchens, and restaurants. The waste can be in the form of residual detergent from washing clothes and the result of cleaning something for daily needs. Industrial waste, for example, the disposal of various kinds of chemicals and agricultural waste, for example, remnants of insecticides and fertilizers. Thus, fish organisms in the water will be greatly disturbed by the increasing detergent intensity. The fish will lack oxygen and their breathing process will be disrupted so that it is difficult for the fish to breathe and it is difficult for them to move, so the fish will die (Figure 4 and Figure 5).

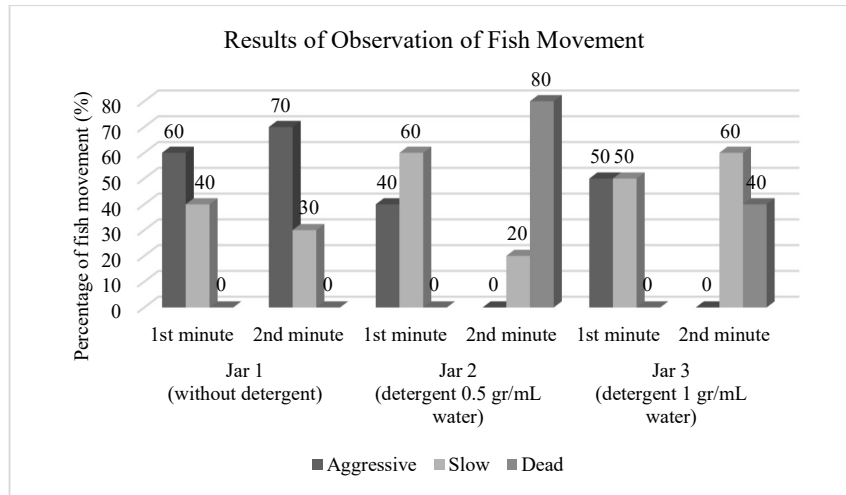


Figure 4 Graph of the average results of observations of fish movements in each jar



Figure 5 Weak and dead condition of fish

Based on the results of the data from Figure 4 show that aggressive and slow fish movements are found in Jars 2 and Jar 3 in the first minute, while in Jars 2 and Jar 3 in the second minute the movement of fish is getting slower and some of them die (not moving). The average percentage of the total number of fish that moved aggressively and slowly in the first minute in Jars 2 and Jars 3 was not too different. Jar 2 in the first minute the average number of aggressive fish was 40% while Jar 3 was 50%. Jar 2 in the second minute the average number of slow moving fish is 60% while Jar 3 is 50%. The high number of fish that moved aggressively and slowly in Jars 2 and 3 showed that the fish were still able to adapt in the first few minutes after the fish were placed in a jar filled with detergent. Based on Figure 4, it can be seen that in the first minute there were no dead fish in all the jars. In the second minute, no aggressive fish were observed in jars 2 and 3. In Jar 2 there was



an average fish mortality of 80% and in Jar 3 40%. This could possibly happen due to the level of fish's ability to adapt and the fish's body conditions were different so that more fish died in Jar 2 than Jar 3 (Figure 4 and Figure 5). If we observe Figure 4 above, it will be seen that there is a change in the movement of the fish from those that initially move aggressively to become slow and die or those that initially move slowly become dead. Thus, the decrease in aggressive and slow moving fish is due to the presence of detergent in the water in the jar and the time factor so that the fish appear to be moving weakly or slowly (Ambarwati et al., 2019; Nurhariati et al., 2021)

Fish that are not moving in Jars 2 and Jars 3 have increasingly slippery and slimy skin and the condition of the fish that looks unbalanced so that the fish will appear to be in a vertical condition and then fall to the bottom of the jar (Figure 5). This is probably due to the chemical content of the detergent soap which reacts with the mucus or liquid on the fish's skin (Supenti et al., 2022). According to research results Khasanah et al. (2023) treatment with a concentration of 25% and 50% liquid waste will cause balance disturbances in fish which are characterized by abnormal swimming behavior such as swimming upside down or sideways, lack of swimming activity, staying on the surface of the water with the head poking up, or staying at the bottom of the water. This happens because there are physiological conditions in fish that are disturbed by exposure to liquid waste. According to research Yuliyanti et al. (2019) that the content contained in liquid detergent is *Linear Alkylbenzene Sulfonate* (LAS). LAS is an anionic surfactant that produces foam in detergents. LAS can be degraded (decomposed) under aerobic conditions (sufficient oxygen), but cannot be decomposed under anaerobic conditions or in turbid rivers, causing water pollution. This is made clear by the findings Larasati et al. (2021) that anionic detergents containing *Linear Alkylbenzen Sulfonate* (LAS) such as *Sodium Dodecyl Sulfate* (SDS) caused the coastal waters of the Red Sea (Pantai Laut Merah) to experience a decrease in filtration ability and damaged the gill cells of *Tapes philippinarum* clams and reduced the ability of algae to carry out photosynthesis.

### **Air Pollution Practicum**

The dependent variable in the air pollution practicum is cricket activity while the independent variable used was the use of mosquito coils. The following is the percentage of the results of air pollution practicum carried out by students.

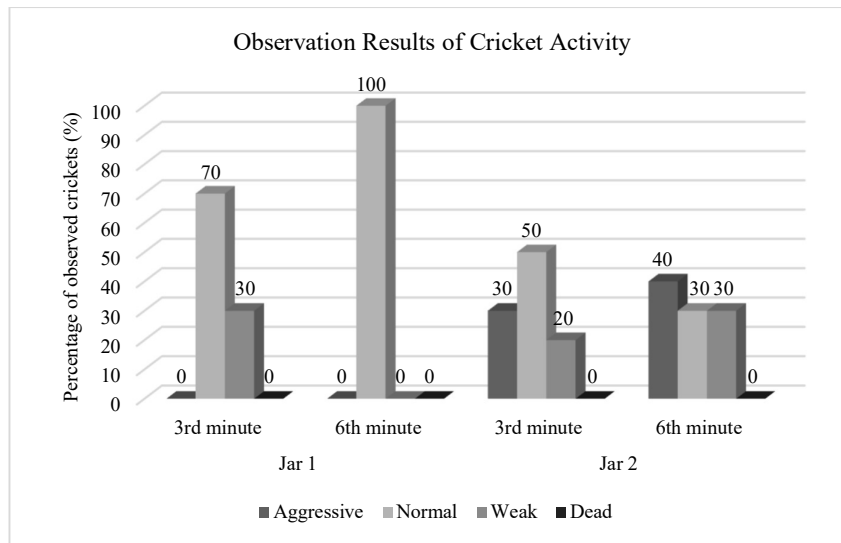


Figure 6 Observation results of cricket activity



Figure 7 Condition of crickets that keep moving their antennae

Based on the results of observing the activity of crickets in the picture above, in general, cricket activity looks normal (Figure 6). It is normal here that the crickets sometimes move actively, sometimes they are still without moving. Meanwhile, the weakness in the graph above is that the crickets have not moved at all for the allotted time. Aggressive crickets here are crickets that are not disturbed the same as normal crickets but the intensity of their activity exceeds that of normal crickets. These activities are like crickets that keep moving and changing places. Based on the graph above, Jar 1 generally has normal cricket activity only in the 3rd minute which looks weak. This is probably due to factors from the location of the crickets before being moved to a place or container for practicum. The percentage of cricket activity in Jar 2 changed with increasing time, namely crickets that were aggressive in minute 3 experienced an increase from 30% to 40% in

minute 6, as well as weak crickets experienced an increase from 20% to 30%. In contrast to normal crickets, normal crickets in Jar 2 decreased from 50% in minute 3 to 30% in minute 6. When compared to the two jars, it can be seen that there is a difference in aggressive cricket activity, in Jar 1 it is not visible. There were aggressive crickets, while in Jar 2 we began to see crickets moving aggressively. This can be seen from observing the results of cricket activity when treated with smoke from mosquito coils, the crickets often move their antennae (Figure 7).

Crickets will start to feel intolerant if the temperature is high enough, namely the maximum at 45°C. Crickets that live in the ground are usually in the range of 24°C-26°C so that crickets will carry out normal activities in that temperature range (Sharifah, 2021). The existence of insects in every place is influenced by several environmental factors. The response of insects to the characteristics of their environment greatly influences their presence in a habitat. The results of measuring insect parameters indicate that an increase in the potential for environmental disturbance in a habitat is correlated with a decrease in individual abundance (Taradipha et al., 2018). Based on the results of research conducted by crickets, which were affected by the smoke from the mosquito coils, they did not die until they were slow or silent by continuing to move their antennae. It is possible that the crickets are still tolerant to the smoke and temperature in the jar and is one way for the crickets to adapt if given this influence so that the crickets are still strong for 6 minutes in a jar covered with plastic.

According to research Melisa (2021) that the application of insecticides to insects causes the average rate of respiration or breathing tends to be lower compared to insects without being given insecticides. Giving insecticide concentrations will increase toxicity to insects. Insecticides inhibit the process of cellular respiration, which inhibits the function of the cytochrome C oxidase enzyme in the electron transport chain in mitochondria which results in oxidative phosphorylation and reduces ATP production. ATP inhibition causes the cell to lack energy so that the processes in the cell are hampered and the organism will be poisoned. Crickets have a high level of respiration rate or oxygen consumption compared to other insect animals (Suharsono, 2018). Other research Bakri et al. (2017) explained that the breathing process in crickets would weaken after 5 minutes. This was due to the binding capacity of KOH to CO<sub>2</sub>. The results of cricket respiration decreased because KOH had experienced saturation binding water vapor. Any form of KOH is a deliquescent compound that is very hygroscopic, that is, it can bind water vapor quickly. Perhaps, after more than 5 minutes KOH has bound water vapor so that the ability to bind CO<sub>2</sub> decreases. This is because the binding of CO<sub>2</sub> has decreased so that the partial pressure in the respirometer tube will remain high and finally the rate of oxygen absorption by the test animals is relatively slow. Thus, the results of air pollution in this practicum carried out are

crickets that can still move, but only in one particular place and the movement is mostly in moving the antenna.

## CONCLUSION

The higher the dose of detergent in the water, the activity of the fish will be increasingly disrupted, such as the movement of fish becomes slow and eventually dies. This is because fish are not able to adapt to their environment. This can be seen from the weakened movement of the operculum and the slower motility of the fish so that the breathing process is disrupted and the fish are unable to move. The activity of the crickets observed was that the higher the smoke caused by the mosquito coils or the unfavorable air conditions, the less movement of the crickets (more silent) but they always moved their antennae continuously.

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