Hong Kong Student Science Project Competition 2022

(Word Limit: 1,000 words, Pages: 2 pages only)

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Project Title: Analysis on case building behaviour of caddisfly larvae and the effects of microplastic pollution on their case functions

Project Type: Investigation Design Proposal

To our best knowledge and after thorough literature research, as at 29 /6 /2022 , there are similar works. The reference links are as below:

- PVC and PET microplastics in caddisfly (Lepidostoma basale) cases reduce case stability
- Microplastics in Water, Sediments and Macroinvertebrates in a Small River of Nw Spain
- Wrapped up in plastic
- Microplastics of different characteristics are incorporated into the larval cases of the freshwater caddisfly *Lepidostoma basale*
- Do all portable cases constructed by caddisfly larvae function in defence?

The enhancements of our project has made for existing related researches is summarised as below:

1. Focus on common species of caddisfly larvae
2. Find out whether the caddisfly larvae could distinguish colour and that the camouflage effect of the case is produced intentionally
3. Test whether the presence of microplastic affect the respiratory functions of the case
4. Find out whether there's a general preference for particular type of microplastic for caddisfly larvae's case construction

I. Background

Recently, microplastic pollution has become an increasingly serious issue, and is widely studied in marine systems. However, in Hong Kong, studies related to freshwater are uncommon and hence we aim at finding out the microplastic pollution level in freshwater systems, using caddisflies as bioindicators. As caddisflies build their cases from substratum, they may use microplastics if there is microplastic pollution. Through our project, how microplastics affect their functions can also be investigated.

Caddisfly larvae are usually found under rocks in clean water, making use of their silk to gather sand grains and fragments of materials from its surroundings to form a case. Their cases serve multivariate purposes, including camouflage, enhancing respiration, as well as facilitating protection from predation. In our project, our first objective is to confirm the functions of caddisfly. We will delve into the viability of the case in terms of camouflage and respiration. Our second objective is to find out the effect of microplastic on functions of cases

Previously, it has been proposed that the cases served camouflage, respiratory and defensive functions … To investigate the effect of microplastic pollution on the functions of the cases of caddisflies larvae, we will study their case's stability, camouflage and respiratory functions.

Concerning the effect of microplastic on respiration, microplastic poses harm tonj caddisfly larvae. Initially, larvae can generate water flow inside the case so that water can pass through their gills to obtain oxygen. However, when there is microplastic, the leachates will also reach the gills. It may potentially lower the amount of oxygen for the respiration of larva, as does the respiration rate.

Research gaps:

1. Studies show that the case of caddisflies serve camouflage functions, but whether the caddisfly larvae are able to actively distinguish between colours is unknown, as a camouflage effect is automatically produced in its natural habitat since its surroundings and sediments have the same colour. Besides, studies show that cases facilitate respiration, but the effect of microplastic pollution on its respiratory functions is unknown.
2. Studies show that caddisfly larvae will use microplastic to build case, but there's no studies to study whether there's a preference of particular type of microplastic for case construction of caddisfly larvae

II. Objective(s)

1. To analysis the functions of case-building behaviour of caddisfly larvae
2. To examine the level of plastic pollution in Hong Kong's rivers and find out if the caddisfly larvae those rivers have taken up microplastic for case construction
3. To examine the impact of microplastic on case functions (respiration and mechanical defence)
4. To investigate (if any) the preference for microplastics for case construction of caddisfly larvae

III. Hypothesis

1. Caddisfly larvae are able to distinguish the colour of particles and that the camouflage effect of the case is produced intentionally.
2. The case of caddisfly larvae facilitate respiration
3. The presence of microplastic in the case of caddisfly larvae affect its respiratory function
4. The presence of microplastic in the case of caddisfly larvae lowers its stability
5. There is preference for a particular type of microplastic for case construction for caddisfly larvae.

IV. Methodology

Materials used

- Light and dark coloured particles, normal sand particles, microplastics, cardboard, oxygen sensor, case cracker, microscope, forcep, needle

For hypothesis (1):
Caddisfly larvae are forced to build their case with dark coloured particles under a white background. After their case is constructed, light coloured particles will be provided to see if they will reconstruct the case using the light coloured particles. The experiment will then be repeated with a dark background and light coloured particles being provided in the beginning. The rebuilding of a case which is similar to the background colour shows that caddisfly larvae are able to distinguish colour.

For hypothesis (2):
Compare the rate of oxygen intake of a de-cased and cased caddisfly larvae and see if there is a considerable difference between the two. Higher rate oxygen intake indicates higher rate of respiration.

For hypothesis (3):
Compare the rate of oxygen intake of caddisfly larvae with cases made of sand particles only and cases made of both microplastic and sand particles.

For hypothesis (4):
Make use of a case cracker and compare the force needed to crack cases made of sand particles and cases made of both sand particles and microplastics

For hypothesis (5):
De-cased caddisfly larvae are provided with sand particles and different types of microplastics. After they have constructed their cases, the case is observed under a microscope and see whether there is a general trend in terms of microplastic selection for case construction.

V. Expected Results and Impact of research

Expected results
If the caddisflies intend to choose sediment with colour similar to the background to build their cases, then the case of the caddisfly serves as a camouflage. And such an effect is expected to be reduced under microplastic pollution as most of the microplastic stand out from sediments.

If the case of caddisfly larvae serves as a facilitator of respiration, such effect may be reduced, increased or remain unchanged with cases built with microplastic.

If microplastic pollution does exert a negative effect on the stability of their cases, the weight needed to crack the cases with microplastics would be lower than that of a normal case.

Limitations
For the set-up testing whether the case acts as a facilitator of respiration, our set-up is unable to provide a current similar to that in a stream, so the results would be unable to reflect the situation in a stream entirely.

The oxygen sensor provided at school is not very sensitive. Since the change in oxygen concentration is very small, there would be a high percentage error.

Significance of the research
It helps us understand the severity of microplastic pollution and how it affects caddisfly larvae. Through the experiment, it can also be found whether caddisfly larvae can act as a bioindicator for microplastic pollution.

VI. Conclusion

To conclude, through our experimental design, we would be able to fill the aforementioned research gaps. This experiment confirms the purpose of caddisfly larvae's case building behaviour, including camouflage, respiratory, and protective functions, and also how microplastic pollution affects such behaviour. Hence, allowing us to use caddisfly larvae as a bioindicator of microplastic pollution.