TEMPERATURE EFFECTS ON CRICKET’S LEARNING ABILITY

Sophomore,Science and Mathematics,Kanazawa Izumigaoka High School, Ishikawa, Japan
Group 6 Mitsuru Ochi, Ryuitiro Kaji, Momoko hayakawa, Yuta Miwa, Yuya Yagasaki

Research Summary
We conducted a study to determine the optimal learning temperature for crickets for efficient cricket harvesting. We conducted classical conditioning (a learning experiment in which sensory stimuli are combined with reward/punishment) using odor sources, water, and salt water in four different temperature environments (20°C, 24°C, 28°C, and 32°C) and found significant differences in crickets' learning ability under different temperature environments. The temperature environment of 24-28°C was found to be better suited for learning than the higher temperature of 32°C, which is associated with optimal growth and lower mortality for crickets.

1 Research background

These days, about 828 million people are suffering from starvation due to the rapid increase of population around the world. One of the solutions to this problem is using insect food.
crickets are famous insect food. However, crickets are currently harvested inefficiently. Therefore, we hypothesized that we could harvest crickets by gathering them together. Previous research shows that crickets have high learning ability, so we thought that we could use their learning ability to harvest them efficiently. Specifically, if we can make crickets remember a small and gather them at the point of origin of the smell. If we can make crickets learn a smell in the best environment for learning, we can strengthen their memory and gather them at one point easier. This would allow us to harvest them efficiently.Therefore we decided to research the relationship between cricket’s learning ability and their learning environment

2 Previous research and hypotheses

On the other hand, honeybees have higher learning ability in 35-36 ℃ than in 32-33℃. Therefore, we thought that could also be the case with cricket’s learning ability: there could be some correlation between their learning ability and environmental temperature at the time of learning.

3 Purpose of the experiment

Therefore, we decided to research this correlation, and find the best environmental temperature for cricket’s learning.

4 Experiment 1

The experiment was based on the experiment by Yukihisa Matsumoto, "Odor Learning and Memory in Crickets"

《Experimental apparatus》

30 European yellow crickets (female) (crickets were purchased at DREAM REPTILES in Kanazawa), incubator, plastic experimental apparatus (self-made), peppermint essence, vanilla essence, petri dish, filter paper, salt water, insect breeding case, egg carton, food container, commercial cricket food, stopwatch, non-fat cotton, video recording equipment

《Experimental space》

Izumigaoka High School Biology Laboratory

《Experimental procedure》

① To ensure that conditions were right, only female European yellow crickets were divided into two groups of 15 crickets each.
② The water supply to the crickets was stopped for two days.
③We prepared a petri dish which gives crickets water as a reward so that the crickets would like the smell of peppermint. We prepared the other petri dish which gives
crickets salt water as a punishment so that the crickets would hate the smell of vanilla.
④one group was tested under 24℃ and the other group was tested under 32℃.
⑤We conducted a preference test to check cricket`s learning progress.

【About preference test】

① In the preference test of smells, we prepared two smells (peppermint and vanilla) in the cage, then we let the crickets move freely.

②During the test, we investigated how long crickets smell peppermint or vanilla. We calculated the palatability index.

③The time that the crickets spent faciy the gaze on the petri dish was defined as the search time.

④We left crickets and Petri dishes that we had prepared into two incubators for two days. We set one incubator at 24℃ and the other at 32℃.

⑤ We conducted our preference test to confirm the crickets learning ability.

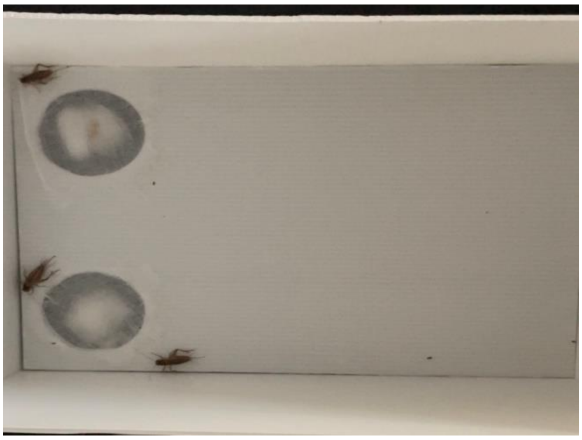

Fig.1 Preference test

《Expected Results》

Based on previous research showing that there is a difference in learning ability depending on the temperature environment during learning in honey bees6), we predicted that crickets would similarly have a difference in learning ability depending on the temperature during learning

《Results of Experiment 1》

The results of the experiment showed that the average preference index immediately after the end of the study was 0.718 for 24°C and 0.460 for 32°C, with 24°C being higher. A significant difference was also observed in the t-test). However, from the day after the end of the study, individual differences in the preference index were so large that they could not be compared (Figures 3 and 4)

※The t-test is a type of hypothesis test, which is used to determine the probability that there is no difference between two types of data based on the mean and variance of the data. If the value of the probability obtained by this test is small enough, it can be judged that there is a difference between the two types of data.

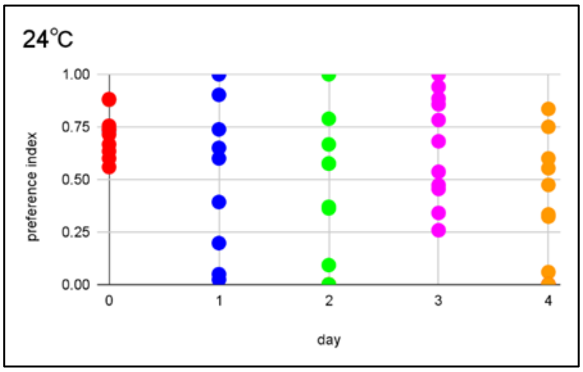

Fig.2 The preference index at 24℃

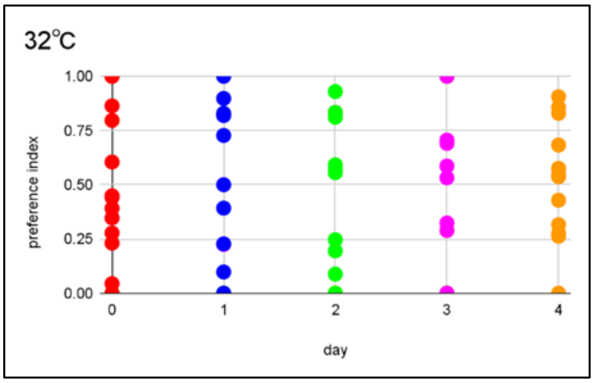

Fig.3 The preference index at 32℃

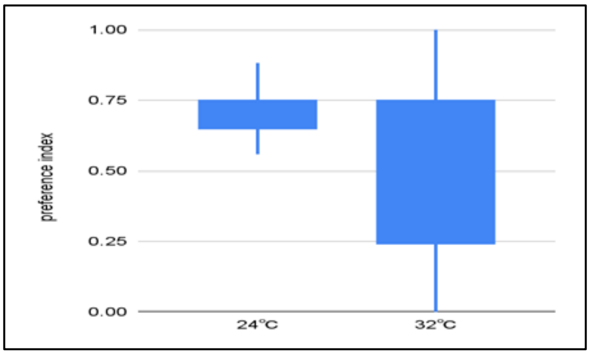

Fig.4 The preference indexes at 24℃ and 32℃
(24℃:n=11, 32℃:n=14)

《Discussion of Experiments 1 》

Since the preference index was higher at 24°C than at 32°C, it can be said that the 24°C temperature environment is more conducive to learning than the 32°C environment. The reason why the variation in the preference index was greater one day after the end of learning is thought to be due to the short period of time the animals were allowed to learn and the learning memory was lost in one day. In a previous study, crickets' learning memory was lost after one day of short-term learning, and the present experiment confirmed the same.

5 Experiment2

To examine more specifically the differences in learning ability due to temperature, we decided to increase the number of temperatures to be experimented with at around 24°C.

The experimental method remained unchanged from Experiment 1, with only the temperature during learning being changed to 20°C and 28°C. The temperatures were set at 20°C and 28°C, varying by 4°C from 24°C, the temperature at which the preference index was high in Experiment 1. In the present study, only the preference index immediately after the end of training, which showed little variation in Experiment 1, was determined.

《Results of the experiment2》

As a result of the experiment, the average preference index immediately after learning was 0.615 at 20℃ and 0.803 at 28 ℃ , and throughout Experiments 1 and 2, the preference index was highest at 28℃

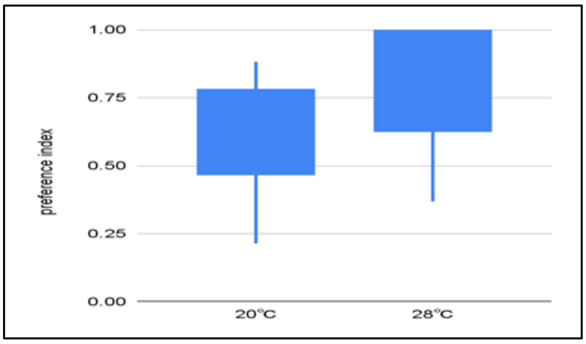

Fig.5 The preference indexes at 20℃ and 28℃ (20℃:n=8, 28℃:n=7)

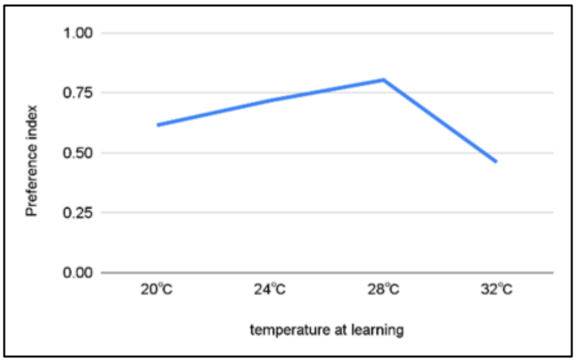

Fig.6 The preference indexes

《Discussion of Experiments 1 and 2》

In the results of Experiments 1 and 2, t-tests confirmed significant differences between 24°C and 32°C and between 28°C and 32°C. From this, we considered that a temperature environment of 24-28°C was more suitable for learning than the higher temperature of 32°C.

We found that the highest learning ability was obtained when crickets were allowed to learn at 24-28°C. Since 28°C is the optimal temperature for crickets in terms of growth rate, development time, and final body size from previous studies7) , we believe that crickets' learning ability and growth efficiency are similarly correlated in the temperature environment. Since previous studies have shown that crickets have lower mortality at 26°C, it can be said that crickets' learning ability tends to be higher in less stressful environments where they can grow more easily.

6 Conclusion

It was found that the learning ability of crickets changes depending on the temperature environment during learning.

The temperature environment of 24-28°C was found to be suitable for learning, and for crickets at around 32°C, the ability to learn decreased under the high temperature environment.

7 Future prospects

In the future, we would like to increase the number of learning sessions to create long-term memories and investigate the state of forgetting by measuring the amount of forgetting and the amount of memory.

In addition, since previous studies have shown that memory substances (such octopamine) exist in the cricket brain and are involved in reward learning, we would like to further investigate the effects of temperature on learning by conducting an experiment involving memory substances and temperature. We also need to consider concrete practical ways to apply the results of this experiment.

8 References

Makoto Mizunami, “A closer look at the insect brain, with its incredible learning and memory capabilities.“ 2009

Makoto Mizunami, “Cricket behavior becomes habitual.” 2019

Yukihisa Matsumoto, “Odor Learning and Memory in Crickets.” 2008

Joshua S. Graff Zivin, Solomon M.Hsiang, Matthew J. Neidell,”Temperature and Human Capital in the Short- and Long-Run”,NBER,1 Feb 2023.

Julia C. Jones Æ Paul Helliwell Æ Madeleine Beekman Ryszard Maleszka Æ Benjamin P. Oldroyd,The effects of rearing temperature on developmental stability and learning and memory in the honey bee, Apis mellifera, 1 Feb 2023.

Craig W. Clifford, J. P. Woodring Methods for rearing the house cricket, Acheta domesticus (L.), along with baseline values for feeding rates, growth rates, development times, and blood composition ,1 Mar 2023.

Shelley A. Adamo and Maggie M. E. Lovett.”Some like it hot: the effects of climate change on reproduction, immune function and disease resistance in the cricket Gryllus texensis, 1 Feb 2023.