CUBE Kishore Bharati Assistantship Report August 2024 (Second half)

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Throughout August 2024, I attended ChatShaala for 12 days out of 16 days. During this time, I moderated discussions alongside Theertha M.D., Enas Shirin, Kiran Yadav.
Here are some of the key highlights from this period:

A) Developing Context to Curriculum by addressing Simple questions

1. Understanding Pupal Color Change in Common Mormon - The discussion centered on an experiment investigating the color change of pupae in the Common Mormon butterfly when placed on various surfaces. The experiment aimed to determine whether pupal color adaptation occurs based on the substrate. By placing newly formed pupae on rough and colored surfaces, Cubists sought to observe color changes and test hypotheses regarding camouflaging. The objective was to understand if the environment influences pupal color and how this might affect survival in natural habitats.

   We also discussed a paper by veteran Cubist Harshad Mayekar, which explores how many species, including butterflies, use adaptive phenotypic plasticity to cope with heterogeneous environments. The paper highlighted that pupal color in butterflies is sensitive to the pupation substrate, with green and brown pupae evolving as adaptive responses to minimize predation risk. This work proves the idea that environmental factors play a significant role in the color adaptation of pupae.

   In addition, we went through a reference on how humidity affects the plasticity of pupal color. The researchers found that caterpillars use leaves to anchor themselves while forming a pupa. In different seasons, such as summer (dry) and monsoon (wet), the predominant color of the foliage changes from brown to green. To avoid detection by predators, the pupae must match their color to that of the leaves. To test this, the study separated larvae into two groups, both feeding on maize leaves and exposed to uniform light and temperature. One group was subjected to 60% humidity (dry season) and the other to 85% humidity (wet season), thereby representing different seasonal conditions.

2. Understanding the Genetic Basis of Mimicry in Common Mormon - The discussion focused on recent research into the *doublesex* gene and its influence on mimicry and sexual differentiation in the Common Mormon butterfly. We reviewed a study led by Krushnamegh Kunte from the National Centre for Biological Sciences, Bangalore, in collaboration with teams from the Universities of Chicago, Boston, and Cornell. This research discovered that the *doublesex* gene, previously known for its role in sexual differentiation and genitalia formation, also plays a significant role in wing patterning and mimicry. Contrary to the earlier hypothesis of a supergene controlling mimicry, the study highlights that the *doublesex* gene is crucial for both visual traits and evolutionary adaptation. This work reveals how genetic factors impact the butterfly's survival and reproduction through the regulation of mimicry and other traits.

3. Understanding Adaptive Plasticity in Monsoon Fast Plants - The discussion focused on Monsoon Fast Plants, inspired by the Wisconsin Fast Plants model, known for their rapid life cycles and suitability for research and education. We examined the growth patterns of these plants during the monsoon season, comparing plant families like Cleomaceae, Capparaceae, and Brassicaceae, and explored how the South-West and North-East monsoons affect plant life. We highlighted model plants such as Arabidopsis and *Cardamine*, noting their roles in studying plant responses to monsoon patterns and their growth adaptations.

   We also referenced Dr. Paul Williams' significant contributions, including his development of the Fast Plants model through his research on cabbage diseases. His notable achievements include a Guggenheim Fellowship, being named a Fellow and president of the American Phytopathological Society, and receiving the Eriksson Gold Medal from the Royal Swedish Academy of Science.

4. Understanding *Hydra-Chlorella* Symbiosis and Reproduction - The discussion focused on the symbiotic relationship between *Hydra* and *Chlorella*. We reviewed how *Hydra's* growth and color depend on its association with *Chlorella*. The experiment concluded that *Hydra* requires both sufficient feeding and light for optimal growth. When kept in the dark without adequate feeding, *Chlorella* detaches, leaving *Hydra* pale and colorless. Growth is best when *Hydra* receives both proper feed and light. *Hydra* can grow reasonably well when fed but kept in darkness, but growth is severely hindered when

only light is provided without feeding.

We discussed a reference that highlights the impact of light and feeding on *Hydra's* health. The pale color observed in the *Chlorohydra* culture sent to Kiran in Uttarakhand from Mumbai was likely due to the lack of sunlight during transport in a closed box. Additionally, the discussion covered the package of *Chlorohydra*, *Moina*, and *Artemia* sent to Kiran.

Furthermore, we reviewed *Hydra's* reproductive strategies. *Hydras* typically reproduce asexually by budding, where a new *Hydra* forms as a bud on the side of the original and eventually detaches. Some species also reproduce sexually by releasing sperm into the water to fertilize eggs on another *Hydra*.

5. Understanding Host Plant Identification in Butterflies - The discussion began with an exploration of how swallowtail butterflies, specifically from the Papilionidae family, identify their host plants for egg laying. Female butterflies utilize a specialized mechanism involving their foreleg chemosensilla to detect plant chemicals. By drumming their forelegs on the leaf surface, they can "taste" the chemical components of the vegetation, which informs their choice of host plant. This process ensures that eggs are laid only on suitable plants that can support the developing larvae.

   We discussed a reference detailing that *Papilio polytes* females use chemosensilla, or elongated bristles, to detect chemical signals from potential host plants. This involves scratching the leaf to gather information through chemo tactile sensory receptors. In contrast, males use their antennae to detect salt and mineral rich bodies of water. We proposed a mechanism for plant identification which involves a chemical component (Y) in the plant that is detected by receptors on the foreleg, which then sends a signal through sensory neurons to the brain. The brain processes this information, sends a signal to the oviduct, causing it to contract and release eggs onto the chosen plant. This process highlights the sensory and behavioral adaptations butterflies use to ensure the survival of their offspring.

6. Understanding Genetic Mechanisms in Leaf Development and Wing Morphology - The discussion focused on the genetic mechanisms behind leaf development in plants and

wing morphology in fruit flies. We explored how KNOX genes influence the transition from simple to compound leaves in *Cardamine*, with their expression contributing to this diversity. Additionally, we examined the role of homeobox genes like Ultrabithorax in fruit flies, where mutations can lead to extra wings instead of halteres. This highlighted the significance of developmental genetics in understanding how gene expression and mutations impact growth and form across different species.

7. Understanding Curd Formation and Bacterial Classification - The discussion began with an exploration of curd formation, highlighting the role of bacteria in the process. Gram staining is a method used to identify the bacteria involved in curd production. Gram-positive bacteria, which appear purple and rod-shaped, are typically responsible for the initial fermentation stages. They retain the crystal violet dye due to their thick peptidoglycan cell walls. Conversely, gram-negative bacteria, which appear red and spherical, are less involved in this process and their thinner cell walls do not retain the crystal violet dye when alcohol is applied.

   We also reviewed the use of the *lac* operon system in *E. coli*, emphasizing the *lacZ* gene's role as a reporter in genetic experiments. This system's relevance extends to understanding bacterial gene expression and fermentation.

   Furthermore, we discussed lactic acid bacteria, crucial for curd formation. These gram-positive, non-spore forming bacteria produce lactic acid from carbohydrates, contributing to the curd's texture and flavor. Their classification as cocci or rods helps identify their role in dairy fermentation and curd production.

B) Citizen Science Projects

1. Understanding Mosquito Identification - The discussion focused on understanding the identification of mosquitoes as a major citizen science project aimed at spreading awareness about Aedes and Non-Aedes mosquitoes.

2. Understanding Mango Mapping through Observations - The discussion focused on the seasonal flowering and fruiting patterns of mango trees in North Kerala, based on data collected from a survey conducted by Cubists on August 24, 2024. This survey involved

20 mango trees in Peruvemba, where 25% of the trees were found to be flowering, while 75% were not showing any signs of flowering or fruiting. Notably, none of the trees were in the fruiting stage at the time of the survey.

The objective was to determine if there are distinct phenological patterns followed by these trees as they respond to climatic changes throughout the year. By analyzing the timing of flowering and the lack of fruiting, we aim to understand how environmental factors such as temperature, rainfall, and seasonal shifts affect mango tree behavior.

3. Understanding Nail Regeneration - The discussion revolved around understanding regeneration and growth and how by simply using mehndi/ ink we can track the nail growth and understand the role of hormones in nail growth.

C) Development through Discussion

1. To invite more Cubists in the ChatShaala whiteboard during the discussion along with a small summary was shared.

2. Screenshot of the whiteboard along with the summary and the leading question was shared alongside Theertha M. D; Enas Shirin to follow up the discussion.

3. Daily CUBE ChatShaala maps of participants were shared in all the CUBE groups, for acknowledging them.

D) Homelab updates

As of now I don't have any Model system in my Homelab, but I am planning to get some *Chlorohydra* and *Moina* from Sophia Resource Centre with the help of Sakshi, a collaborator from Bhandup, Mumbai.

Further plans - Culturing and Maintaining *Chlorohydra* and *Moina* in Homelab

E) Future Plans for Enhancing CUBE Program Operations

1. Resolving issues on Documentation of Context to Curriculum Chat on STEM Games.

2. Joining through the microphone mode - Participants find it difficult to join through microphone mode.

   Possible solution - We can have a screen recording of how to change the setting of the browsers so that Cubists find it easy to join through microphone mode.

3. Activation of CUBE groups - With the help of reliable Cubists, simple discussion can be carried out in small CUBE groups so that new Cubists find it easier to join the discussion.

4. Making celebration of Goof ups more streamline.