Short Review for Flower colour preference of *Aporia bieti* (Lepidoptera:

Pieridae) in Xiama Forest Farm, Gansu, China

---Flower colour preference of insects and Cubic model

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Abstract:

We investigated the foraging preferences of the butterfly *Aporia bieti* and the relationship between plant and pollinator morphology from a co-evolutionary perspective[1]. The results indicated that the butterfly show distinct preferences for the flower color, whereas no preference for the flower size; in addition, the analysis showed that these butterflies exhibited a preference for yellow flowers both when just visual and when visual and olfactory cues were available. We also discovered that the length of the nectaries of the most frequently visited flowers corresponded to the one of the bimodal peaks in mouthpart length of the butterfly thus providing evidence supporting a co-evolutionary relationship. This time we also cast a cubic model to help us evident more insects flower color preference in the future.

Introduction for *Aporia bieti* in ecology

Our research casts some new insights on the butterfly adaptation of light related ecology(in the field) aspects, which provides some evidence for previous butterfly physiology research.

This study conducted the observations and analyses of the butterfly *Aporia bieti* with its pollinating flowers in the Xiama Reserve Station, Qilianshan National Nature Reserve, aiming to explore the adaptive relationship between *A. bieti* mouthpart with the body length as well as the size, number, and corolla tube length of the flowers[1].

And This article makes a significant contribution to the literature because it provides evidence for the co-evolution of pollinators and the plants that they pollinate.

There was an experiment in 1987[2] Which is Pier & brassicae L. (Pieridae) spontaneous select color, in the experiment. The butterfly was placed under PVC(different color) membrane in disk and carried out experiments on the eggs produced by the experimental group. The results of the study is that baby from *Pieridae* color sensitivity is sensitive to gold yellow. So laboratory experiments have shown that learning effect don't have any relationship with age or genetics. We just need *Pieridae* experiment in outdoor.

In Scherer C study[2], We can see butterflies and flower colour spectrum have close relationship. Butterflies have color preferences, *Pieridae* color sensitivity is sensitive to gold yellow. Such as *Polygonum viviparum*, *Stellera chamaejasme*, and *Parnassia oreophila*, were dominant in shady meadows while yellow flowering plants, such as *Oxytropis ochrocephala*, *Taraxacum mongolicum*, and *Potentilla fruticosa*, were dominant in sunny meadows. Butterfly foraging temperature is similar to the temperature observed in the sunny meadows, and yellow flowers are more widely distributed in these meadows; thus, *A. bieti* chose yellow flowers as a foraging source. Finally, *A. bieti* habitat may also provide feedback on butterfly flower-visiting behaviour. Plants with yellow flowers with nectar accounted for a large proportion of all nectariferous plants in Xima Forest, and yellow-flower plants share certain characteristics, namely a dense nectar source (multiple and wide distributions, dense inflorescences). For *A. bieti*, this could mean that they were able to obtain more resources with less energy expended and thus improve their competitiveness, enabling them to become the dominant species[1].

Cubic model in ecology:

Though the related studies are relatively common for other insect groups, such as the bees, however, the studies for butterflies are still in a state of scarcity. This is our first time to use this method to prove this very interesting question. Which the experimental setup of artificial flowers that share a common odor of honey water applied to the 'corolla' and built 5×5 square matrix. But its not enough random to prove my question. We built a model to illustrate problem with a random sequence of numbers. How can we more effectively prove the preference of insects for color and design? And the platter of 25 flowers that we showed earlier in before article. Our change is that use completely random model- -Cubic model to prove a series of flower colour preference (ecology) problems.

So Cubic model question is how many cases about find five colors in 5×5 square vertically, horizontally or diagonally random.

We know that in a 5×5 square grid. When the top left first cell is sat down, there is only one color and the slant is not repeated if there are only two possibilities (as shown in the table above). So each color in the rule that exists 5×5 table is only A and B. And A and B are independent events. In the case of A and B, we can determine the color of the entire table by just determining the color of the first row. The first row has

$5! = 120$ conditions. So A,B total situations are $120 \times 2 = 240$ cases.

And there are another research for olfactory, said olfactory signal played attractive role, which is stimulate feeding [3]. In order to eliminate the impact of olfactory, we used foam flowers with honey and illustrate yellow is preferred by *Aporia bieti* in the field. And evident evolutionary mechanisms driving this Flower colour preferences of *Aporia bieti* preference. The combination of olfactory and visual, we can built a perfect model for study the relationship between insects and flower.

Discussion for *Aporia bieti*:

One does not know if the attraction to yellow flowers is an evolved, 'innate' preference or a learned preference. And baby is sensitive to gold yellow. What we discuss above is try to explain this interesting question in outside. And what we have done is explain this question and methodological advance.

The previous research can conclude co-evolution by the methods that we employ and can coevolution be suggested from the data as it stands.

When the colour and size of the disk common influence of *Aporia bieti* flower choice. From observing the videos of *A. bieti* visiting foam flowers, it seemed that the butterfly preferred small flowers to big ones. However, there was no statistical difference in flower size preference. This could be explained by the situation in which a butterfly population grew so large that food resources were lacking, leading the population to adapt by evolving shorter and longer mouthparts.[4-6]

Butterflies with short mouthparts then fed on short nectary flowers such as *O. ochrocephala* and the short flowers of *C. crispus*, while butterflies with long mouthparts fed on flowers with long nectaries, such as the long flowers of *C. crispus*. Through preliminary comparison, we got the length of pollen tubes indirectly decide, Fed on this plant, butterfly mouthparts length, Thus, there is a linear relationship between flower nectary length and the length of the butterfly's mouthparts. This result is similar to those from predator (butterfly)-prey (nectar plant) relationships in which there is mutual survival pressure, mutual choice, and promotion. Organs such as mouthparts are plastic and may be different in different environments. Vertebrates, such as endotherms and ectotherms, also exhibit this characteristic[7-10]. Just like higher attitude's ectotherms like *Phrynocephalus vlangalii*'s heart, lung is obviously different from lower. And there are also differences in organs between genders and their prey animal and habitat areas. The general conclusion that can be drawn from this study is that *A. bieti* foraging is not only based on visual and olfactory cues, but it also depends on the butterfly's morphology and parameters of their environment. And in this review, we built cubic model assist all of us in future ecology investigations. It can expand to more flower colours, which depends on the number of colours of local flowers. and research relationship between another insects and flowers.

Figure

Figure 1. *Aporia bieti* (Lepidoptera: Pieridae) is florisugent in Xiama Forest Farm, Gansu, China(Photo by HJM)

Figure2. left is our previous research model, right is our cubic model. The pattern of the simulated disc is change. In order to make the simulated flower disk of different colors totally random on the display.

Figure 3.left is A square matrix, right is B square matrix.

Figure 4. There are 10 cases about cubic model suitiation. These cases are example for all cubic models.

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