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Ujjwal Paul*

Abstract

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Keywords: Mimicry, Model, Mimic, Predator, Evolution, Speciation, Fauna

Introduction: Mimicry occurs when one species (the 'mimic') evolves to resemble a second species (the 'model') because of the selective benefits associated with confusing a third species (the 'receiver'). For example, natural selection can favour phenotypic convergence between completely unrelated species when an edible species receives the benefit of reduced predation by resembling an inedible species that predators avoid.

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The Phenomena of Mimicry & its Evolutionary impact on Speciation among Fauna

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Abstract

Researches into mimicry have a rich history that traces back to the beginnings of modern evolutionary biology. Mimicry and warning colour are highly paradoxical adaptations. Colour patterns in both Mullerian and Batesian mimicry are often determined by relatively few pattern-regulating factors with major effects. Species have evolved conspicuous warning signals, such as bright colours and striking patterns, to deter predators. Some edible and harmless species take advantage of this preventive effect by mimicking their appearance. Mimicry is a great example of how natural selection produces remarkable adaptation. Despite renewed interest in the role of mimicry in natural selection as a catalyst for the origin of species. Environmental pollution agents affect the phenomena of mimicry very much which also the *affect the process of speciation. Though mimicry represents an excellent example of a trait in which ecological selection driven by predation can lead to divergence, with reproductive isolation and speciation as a side effect.*

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1. To study the various types of phenomena of mimicry among the fauna.
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3. To study the proximate mechanisms of underpin mimicry.
4. To study the role of mimicry on speciation and diversification.
5. To study environmental pollution effect on mimicry.

Basic types of mimicry

1. Protective Mimicry

Defensive or protective mimicry takes place when organisms are able to avoid harmful encounters by deceiving enemies into treating them as something else.

a. Concealing Mimicry

Mimicker conceal or harmonize with the environment to get protect from the predator. (Fig.1)

Fig.1: *kallimaparalekta sp.* did mimics as a leaf

b. ***Warning Mimicry***

In this type of mimicry the mimicker warns as a dangerous individual in front of their predator. (Fig.2)

Fig.2: *Macroxiphus sp.* did mimics as an ant

2. Aggressive mimicry

In some situations it is of advantage to a predator to resemble its prey, or a parasite to its host. Aggressive mimicry, for which the phrase "a wolf in sheep's clothing" is a suitable description, does not involve warning mechanisms. The mimic adopts certain of the recognition marks of its model in order to secure advantage over the model itself or over a third species that interacts with the model. The model may be mimicked during only a single stage of the life cycle, as in the case of parasitic cuckoos, the eggs of which resemble those of their hosts or the model may be a prey of the mimic's victim, as in the case of anglerfishes, which possess rod like spines tipped with a fleshy "bait" to lure other fishes within reach Vane-Wright RI (1980).

According to Theory

Batesian mimicry

In Batesian mimicry, described by Henry Bates in 1861, the model is distasteful or venomous and the mimic is not. Predators learn to associate the appearance of the model with un-palatability. Ultimately, the palatable mimic is protected because it resembles the unpalatable model. In 1862 published an explanation for unexpected similarities in appearance between certain Brazilian forest butterflies of two distinct families. Members of one family, the Heliconiidae, are unpalatable to birds and are conspicuously coloured; members of the other family, the Pieridae, are edible to predators. Bates concluded that the conspicuous colouration of the inedible species must serve as a warning for predators that had learned of their inedibility through experience. The deceptively similar colour patterns of the edible species would provide protection from the same predators. This form of mimicry, in which a defenceless organism bears a close resemblance to a noxious and conspicuous one, is called Batesian, in honour of its discoverer. It is named after Henry Walter Bates, an English naturalist whose work on butterflies in the Amazon rainforest (described in *The Naturalist on the River Amazons*) was pioneering in this field of study. Mimics are less likely to be found out (for example by predators) when in low proportion to their model. This phenomenon is called negative frequency dependent selection, and it applies in most forms of mimicry.

Mullerian mimicry

Mullerian mimicry, named for the German naturalist Fritz Muller (1878), describes a situation where two or more species have similar warning or aposematic signals and both share genuine anti-predation attributes (e.g. being unpalatable). At first, Bates could not explain why this should be so if both were harmful why did one need to mimic another? Muller put forward the first explanation for this phenomenon: if a common predator confuses two species, individuals in both those species are more likely to survive. This type of mimicry is unique in several respects. Firstly, both the mimic and the model benefit from the interaction, which could thus be classified as mutualism in this respect. The signal receiver is also advantaged by this system, despite being deceived about species identity, as it avoids potentially harmful encounters. The usually clear distinction between mimic and model is also blurred. Where one species is scarce and another abundant, the rare species can be said to be the mimic. When both are present in similar numbers, however, it is more realistic to speak of each as a *co-mimic* than of distinct 'mimic' and 'model' species, as their warning signals tend to converge. Also, the two species may exist on a continuum from harmless to highly noxious, so Batesian mimicry grades smoothly into Mullerian convergence.

Fig.3

The *Heliconius sp.* butterflies (Fig.3) from the tropics of the Western Hemisphere are the classical model for Mullerian mimicry.

Auto mimicry

The phenomenon of auto mimicry involves the advantage gained by some members of a species from its resemblance to others of the same species. Males of many bees and wasps, although defenceless, are protected from predators by their resemblance to females that are equipped with stingers. Some butterflies are able to gain protection against predators through the ability to absorb, tolerate, and retain in the immature (larval) stage, poisons from the plants on which they feed. Individuals or even subpopulations of such butterflies may fail to acquire such protection, as a result of feeding on non-poisonous plants, but they are avoided by predators that have sampled protected individuals of the same species.

Observations

Mimicry evolves if a receiver (such as a predator) perceives the similarity between a mimic (the organism that has a resemblance) and a model (the organism it resembles) and as a result changes its behaviour in a way that provides a selective advantage to the mimic. The resemblances that evolve in mimicry can be visual, acoustic, chemical, tactile, or electric, or combinations of these sensory modalities. Mimicry may be to the advantage of both organisms that share a resemblance, in which case it is a form of mutualism; or mimicry can be to the detriment of one, making it parasitic or competitive. The evolutionary convergence between groups is driven by the selective action of a signal-receiver or dupe. Birds, for example, use sight to identify palatable insects, whilst avoiding the noxious ones. Over time, palatable insects may evolve to resemble noxious ones, making them mimics and the noxious ones models. In the case of mutualism, sometimes both groups are referred to as "co-mimics". It is often thought that models must be more abundant than mimics, but this is not so. Mimicry may involve numerous species; many harmless species such as hoverflies are Batesian mimics of strongly defended species such as wasps, while many such well-defended species form Mullerian mimicry rings, all resembling each other. Mimicry between prey species and their predators often involves three or more species.

Fig.4

Fig.5

Fig.6

Mimesis in *Ctenomorphodeschronus*,camouflagedas a eucalyptus twig as conceal mimicry (Fig.4). Common hawk-cuckoo(Fig.5) resembles a predator, the shikra.In Batesian mimicry the mimic shares signals similar to the model, but does not have the attribute that makes it unprofitable to predators (e.g., un-palatability).

Many insects including hoverflies and the wasp beetle(Fig.6) are Batesian mimics of stinging wasps.There are many Batesian mimics in the order Lepidoptera. *Consul fabius* and *Eresiaeunice* imitate unpalatable *Heliconius* butterflies such as *H. ismenius*imitate the poisonous pipeline swallowtail (*Battusphilenor*). Several palatable moths produce ultrasonic click calls to mimic unpalatable tiger moths.Octopuses of the genus *Thaumoctopus* (the mimic octopus) are able to intentionally alter their body shape and coloration to resemble dangerous sea snakes or lionfish.

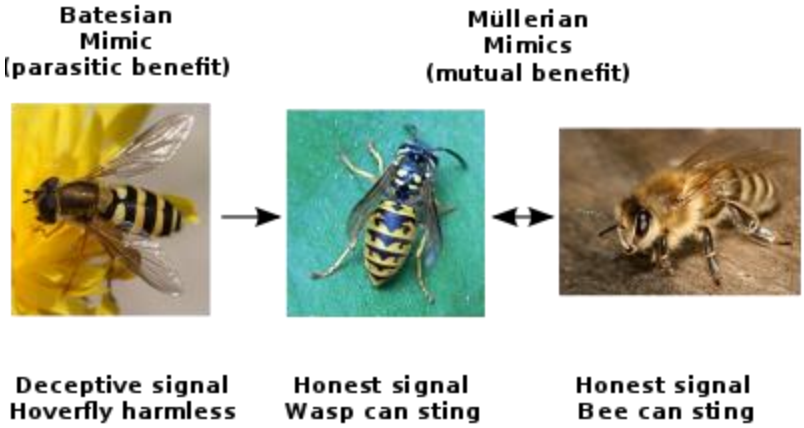

Fig.7

Comparison of Batesian and Mullerian mimicry, illustrated with a hoverfly, a wasp and a beethemonarch butterfly (*Danausplexippus sp.*) (Fig.7) is a member of a Mullerian complex with the viceroy butterfly (*Limenitisarchippus sp.*), sharing coloration patterns and display behaviour. The viceroy has subspecies with somewhat different coloration, each closely matching the local *Danaus* species. For example, in Florida, the pairing is of the viceroy and the queen butterfly, whereas in Mexico the viceroy resembles the soldier butterfly. The viceroy is thus involved in three different Mullerian pairs. This example was long believed to be Batesian, with the viceroy mimicking the monarch, but the viceroy is actually the *more* unpalatable species. The genus *Morpho* is palatable, but some species (such as *M. amathonte*) are strong fliers; birds – even species that specialize in catching butterflies on the wing – find it hard to catch them.

In an unusual case, planidium larvae of some beetles of the genus *Meloe* form a group and produce a pheromone that mimics the sex attractant of its host bee species. When a male bee arrives and attempts to mate with the mass of larvae, they climb onto his abdomen. From there, they transfer to a female bee and from there to the bee nest to parasitize the bee larvae.

Evolution

It is widely accepted that mimicry evolves as a positive adaptation. The most widely accepted model used to explain the evolution of mimicry in butterflies is the two-step hypothesis Balogh et al. (2008). The first step involves mutation in modifier genes that regulate a complex cluster of linked genes that cause large changes in morphology. The second step consists of selections on genes with smaller phenotypic effects, creating an increasingly close resemblance. This model is supported by empirical evidence that suggests that a few single point mutations cause large phenotypic effects, while numerous others produce smaller effects. Some regulatory elements collaborate to form a supergene for the development of butterfly colour patterns.

Some mimicry is imperfect. Natural selection drives mimicry only far enough to deceive predators. For example, when predators avoid a mimic that imperfectly resembles a coral snake, the mimic is sufficiently protected. Mimicry can result in an evolutionary arms race if mimicry negatively affects the model, and the model can evolve a different appearance from the mimic. Morphological or structural adaptations are additional to foremost behavioral adaptations (Mayr, 1970).

The importance of mimicry in Speciation

The mimicry hypothesis emerged in the middle of the Darwinian controversy and provided an ideal test case for the views of Charles Darwin and his contemporary Alfred Russel Wallace on the operation of natural selection in the evolutionary change of living organisms. It is now quite evident that the basic theory of natural selection is correct and that the theory is strengthened by many detailed studies of the process by which a mimetic resemblance is brought about and selected for(Jiggins et al., 2001 & Jiggins, 2001).

Speciation is how a new kind of plant or animal species is created. Speciation occurs when a group within a species separates from other members of its species and develops its own unique characteristics.

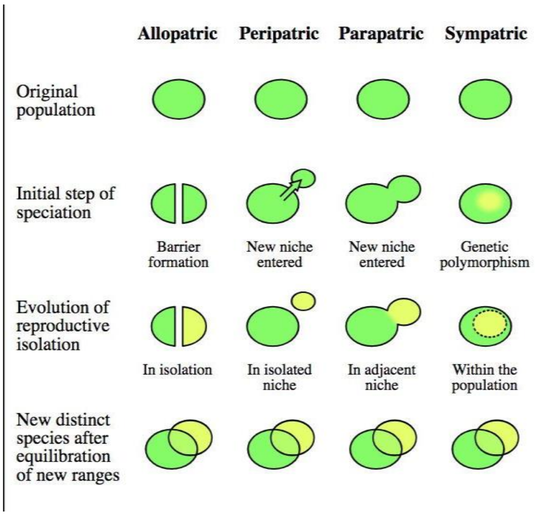

Fig.8: Speciation process

Mimicry has had a significant historical influence as a tractable system for studying adaptation and is known to play a role in speciation. Despite renewed interest in the role of natural selection as a catalyst for the origin of species, the developmental and genetic basis of speciation remains poorly understood. Mullerian mimicry in *Heliconius cydno* and *H. melpomene*, sister species that recently diverged to mimic other *Heliconius*. This mimetic shift was a key step in their speciation, leading to pre and post mating isolation. Epistasis is found at many levels: phenotypic interaction between specific pairs of genes, developmental canalization due to polygenic modifiers so that patterns are less sharply defined in hybrids, and overall fitness through ecological selection against non-mimetic hybrid genotypes. Most of the loci are clustered into two genomic regions or "supergenes," suggesting colour pattern evolution is constrained by pre-existing linked elements that may have arisen via tandem duplication rather than having been assembled by natural selection. Therefore, although developmental and genomic constraints undoubtedly influence the evolutionary process, their effects are probably not strong in comparison with natural selection.
(Source: https://www.ncbi.nlm.nih.gov/pubmed/12752766)

Conclusion

In evolutionary biology, mimicry is an evolved resemblance between an organism and another object, often an organism of another species. Mimicry may evolve between different species, or between individuals of the same species. Often, mimicry functions to protect a species from predators, making it an anti-predator adaptation. Batesian mimicry can only be maintained if the harm caused to the predator by eating a model overshadows the benefit of eating a mimic. The nature of learning is weighted in favour of the mimics, for a predator that has a bad first experience with a model tends to avoid anything that looks like it for a long time, and does not re-sample soon to see whether the initial experience was a false negative. The mimic may have a particular significance for duped prey. One such case is spiders, amongst which aggressive mimicry is quite common both in luring prey and disguising stealthily approaching predators. In this context, mimicry represents an excellent example of a trait in which ecological selection driven by predation can lead to divergence, with reproductive isolation and speciation as a side effect. Due to pollution effect many species lose its natural habitat like Industrial melanism, that affect the mimicry phenomena and model-mimic association had dissociated which lead many fauna in extinction in nature.

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