SCIENTIFIC NOTE

HOVERFLY MIMICRY; THE HIGHEST FORM OF FLATTERY?

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Summary

Syrphid flies, otherwise known as hoverflies, are capable of mimicking bees and wasps. The current known purpose of this is so that hoverflies can avoid being eaten by predators, as they appear as a more undesirable option. The mimicry that the hoverflies exhibit is more complex as simply just looking like bees, as often visual cues are combined with behavioural cues to trick other animals. Other factors can result in trade-offs with their mimicry, such as thermoregulation. What results is often what humans would consider an imperfect mimic, but ultimately is still sufficient, as they are able to deceive predators such as spiders. However, there is still much to be learned on the topic of mimicry and hoverflies, with new theories arising that mimicry may also assist in reducing competition over infloresences.

Key Words: mimicry, hoverfly, Batesian, predation, competition

INTRODUCTION

Syrphid flies (hoverflies) can mimic the colour and behaviour of bees and wasps (Edmunds and Reader 2014; Penney *et al.* 2014). Not everything is understood yet about the purpose and the impacts of mimicry. Some of the possible impacts of mimicry include less predation and less competition (Edmunds and Reader 2014; Rashed and Sherratt 2007). Both influence their likelihood of survival. Those that survive can then pass on these successful traits to the next generation (Morris and Reader 2016). Despite having clear benefits and purposes, the world of mimicry can still be complex. By looking into the world of mimicry, we can begin to understand how mimic hoverflies have adapted to survive.

BATESIAN MIMICRY

One benefit of mimicry behaviour and visual appearance is to avoid being eaten (Edmunds and Reader 2014). The insect will mimic a visual feature of another insect, deceiving the predator (Edmunds and Reader 2014). This results in the predator avoiding the insect, as they think they may be toxic or undesirable (Edmunds and Reader 2014). This type of mimicry is called Batesian mimicry (Edmunds and Reader 2014).

One typical mimicry method of hoverflies is to look like bees (Edmunds and Reader 2014). In one study, the hoverflies that looked like bees were found at the same frequency levels in the environment as the bees (Edmunds and Reader 2014). This suggests that the hoverfly mimics frequency in the environment, is dependent on how frequently the bee occurs (Edmunds and Reader 2014). For example, if the bee population frequency were to decrease, it is expected the hoverfly mimics would also decrease. As well as this, it emphasises that the presence of the bee in the environment is needed for the benefit to occur (Edmunds and Reader 2014).

IMPERFECT MIMICRY

Despite the population's dependence on bees and mimicry, not all hoverflies are perfect mimics (Morris and Reader 2016). Hoverfly species that look more like bees or wasps are more likely to survive (Morris and Reader 2016). Even though perfect mimics are less likely to be predated on, we still see mimics fall short of their goal (Taylor *et al.* 2016). In the environment, there is more than one aspect impacting their ability to survive (Taylor *et al.* 2016). This can affect the visual mimicry displays, such as by reducing the colour intensity of mimics (Taylor *et al.* 2016). What results is a trade-off occurring, to attempt to maximise survival in all aspects (Taylor *et al.* 2016).

One trade-off that occurs is between mimicry perfection and thermoregulation (Taylor *et al.* 2016). Hoverflies' thermoregulation can be negatively affected if their body colour is not black (Taylor *et al.* 2016). Hoverfly colouration when mimicking bees and wasps results in yellow and orange colours (Taylor *et al.* 2016). These lighter colours reduce their ability to absorb heat as fast (Taylor *et al.* 2016). This will result in hoverflies whose colour does not exactly match bees, as they need to be darker (Taylor *et al.* 2016). So, while they may not be perfect mimics, this trade-off allows for more efficient thermoregulation (Taylor *et al.* 2016). This increases the hoverflies' chance of survival, as the trade-off between the two means they won't be negatively impacted.

Despite falling short of being the perfect mimic, predators still avoid hoverfly mimics (Morris and Reader 2016). For example, crab spiders will avoid insects resembling a wasp (Morris and Reader 2016). This means that the crab spider can place an evolutionary pressure on the hoverflies (Morris and Reader 2016). Since the spider refuses to eat hoverflies that look like wasps, this means the

hoverflies can pass on the successful traits to the next generation (Morris and Reader 2016).
This same study highlighted that we still have much to learn about how spiders see insects (Morris and Reader 2016). Despite humans seeing the hoverfly mimicry as imperfect, the spider was still duped (Morris and Reader 2016). This reveals the need to study how spiders observe prey and determine if they are seeing different cues that we are not (Morris and Reader 2016). This supports that mimicry can trick predators and increase survival. Although, mimicry is not always used to avoid being dinner.

COMPETITIVE MIMICRY

While the most common explanation for mimicry is to trick predators, this is not the only one. It is possible when mimicry occurs, it is to reduce competition with other insects (Rashed and Sherratt 2007). Competitive mimicry occurs to reduce competition over a shared and limited resource (Rashed and Sherratt 2007). For this purpose, hoverflies have also been seen mimicking wasps (Rashed and Sherratt 2007). Since wasps can pose a high risk to other insects, mimicking them could decrease competition over inflorescences (Rashed and Sherratt 2007). This is because other insects are less likely to compete with the insect they see as high risk (Rashed and Sherratt 2007). Behaviour is another important part of mimicry (Rashed and Sherratt 2007). Currently, there is no significant evidence that visual cues reduce competition (Rashed and Sherratt 2007). Although, this study is limited, as they excluded behavioural cues (Rashed and Sherratt 2007). This study used fake pinned hoverflies that copied the colours of real hoverflies, which restricted the cues tested (Rashed and Sherratt 2007).
Only allowing insects to display visual cues does not accurately reflect what would happen in nature. While behavioural mimicry does not replace visual mimicry, it does help (Penney *et al.* 2014). Hoverflies that displayed behavioural mimicry were classified as good mimics by humans (Penney *et al.* 2014). Again, as humans view hoverflies differently than predators, what we see as a good mimic, may not always be the case (Morris and Reader 2016). Yet, this still supports that hoverflies with visual and behavioural mimicry should be more convincing. Examples of behavioural mimicry can include moving wings, waving their legs, and pretending to sting (Penney *et al.* 2014). With further study on mimicry and behaviour, we might find support for competitive mimicry. Currently, there is only support for Batesian mimicry. With further study and focus on all forms of mimicry, we can learn more about how they benefit.
Currently, the evidence for Batesian mimicry indicates its importance in survival against predators. Through predatorial selection, this also places selective pressure on future generations. There is not yet enough evidence to support that competitive mimicry can occur, but further research is needed. If competitive mimicry does occur, this means that hoverflies could have a competitive advantage. Despite the known benefits of mimicry, there are still aspects of it we don't fully understand. For example, how mimicry may impact other bodily processes, like how it affects thermoregulation. As well as this, little is still known of how the hoverflies are selected for predation, and how this impacts their evolution. One thing we do know at least, is that hoverflies have developed a fantastic and successful way to help them survive.

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