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## How far could a mayfly travel in a day?

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**Abstract**
This paper aims to determine how far the common mayfly, *Ephemeroptera*, could travel within its 24-hour subimago phase. This was achieved through two methods; both the analysis of literature values and by scaling down the known velocity of a comparable insect – the ruddy darter dragonfly, *Sympetrum sanguineum*. The velocity of the common mayfly was found to be 4.065 $ms^{-1}$, meaning that the maximum distance that could have been covered in 24 hours was approximately 351.22 km.

**Introduction**
The common mayfly (*Ephemeroptera*) is hemimetabolous, meaning that they undergo several different transitional stages before reaching their final mature form. Their penultimate form, the subimago, survives only for 24 hours before undergoing a final transformation to the sexually mature imago, whereupon it lives just long enough to mate and lay its eggs [1].

This paper aims to investigate how far a subimago would be able to travel if it began flying immediately after emerging from the water and did not stop until it had to metamorphose into the imago.

**Theory**
When mayflies emerge from the water, they enter a stage in their lifecycle called the subimago. During this stage, they have wings but are not sexually mature. The duration of this stage varies from species to species, but typically lasts no longer than 24 hours [1]. For the purposes of this investigation, the duration of the subimago will be assumed to be 24 hours.

Insect flight speed has been found to be affected by the following variables:

- Mass
- Volume
- Amount of feeding
- Temperature
- Humidity
- Solar radiation
- Wind

This paper will focus on the influence of volume on the velocity of insect flight.

As mayflies lose the ability to eat during the subimago and imago phases, it is possible to assume that the insect will not need to stop for the 24-hour duration. It will also be assumed that its velocity will not vary over time and that the ambient conditions remain favourable and consistent.

Initially, the velocity of a mayfly was assumed to be $0.5\ ms^{-1}$ [2]. Using Equation 1, this gave a maximum theoretical travel distance of $43.2\ km$. However, the source of this estimate did not give details of their methods and therefore could not be considered entirely credible. Due to this, it was necessary to calculate a more accurate velocity using a simple model.

$$v = \frac{s}{t} \qquad (1)$$

To get a more accurate estimate of velocity, the mayfly was compared to the 'ruddy darter' species of dragonfly (*Sympetrum sanguineum*). The ruddy darter was chosen as a comparator as its speed of flight is definitively known and has been verified [2], and its mode of flight is the same as that of a mayfly. Unlike most other insects, both dragonflies and mayflies utilise the 'direct flight' method of flying,

meaning that their wing muscles insert directly at the wing bases and are hinged so that a small movement of the wing base downwards lifts the wing itself upwards, in a motion much like rowing through the air [3].

On average, ruddy darters tend to have a length of between $34$ and $36\ mm$, and a wingspan of $60\ mm$. The diameter of the head is approximately $5\ mm$ [4]. Mayflies can vary in length from $5\ mm$ to $20\ mm$, so for the purposes of this investigation it will be assumed that the length of the mayfly is $15\ mm$. The average wingspan of a mayfly is also $15\ mm$ [5].

If both insects are modelled as cylinders (assuming the wings are negligible in terms of volume), it is possible to use Equation 2 to calculate the volume of each. Using this, it was found that the volume of an average ruddy darter was $706.86\ mm^2$ and the volume of the average mayfly was $577.27\ mm^2$.

$$V = \pi r^2 h \qquad (2)$$

This makes the volume of the mayfly approximately $81.67\%$ of the volume of the ruddy darter. If it is assumed that the volume is directly related to velocity, the mayfly would travel at $81.67\%$ of the speed of a ruddy darter. As the speed of the ruddy darter has previously been found to be around $5\ ms^{-1}$ [6], this means that the speed of a mayfly would be approximately $4.065\ ms^{-1}$.

If the mayfly were to travel at a constant velocity of $4.065\ ms^{-1}$ for 24 hours, it would be able to cover approximately $351.22\ km$. This would enable the insect to travel from London to the following destinations: Antony (France), Polzeath (Cornwall), Uithoorn (Netherlands) and Middlesbrough (Cleveland).

**Conclusion**

Using the assumptions detailed above, it was determined that a mayfly could travel a maximum of $351.22\ km$ over the course of 24 hours (if it maintained a constant velocity of $4.065\ ms^{-1}$). However, due to the simplicity of the model and the realities of the real-world physiological constraints acting on the mayfly, it is unlikely that it would be able to reach that far in a field trial.

**References**

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