The effect of colour of light and light intensity on ant finding food

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Problem to Investigate

The effect of colour of light and light intensity on ant finding food

Aim

To find out which colour and light intensity is the most sensitive to the photoreceptor cells of ants.

Background

Karl von Frisch(famous bee biologist):

Honey bees could see color: blue, yellow and green, as well as ultraviolet and polarized light (which we can't see).

Honey bees did not appear to be able to see red.

Because ants and bees are closely related, everyone assumed their vision was similar.

However, the eyes of different species of ants vary in size and complexity.

Reason to investigate

Want to prove whether ants have similar vision with bees

e.g. similar colour vision, similar light intensity dicrimination etc.

Hypothesis

1. Ants only have certain photoreceptor cells that respond to certain colour of light.
2. Ants are attracted by certain colour of light.
3. Light intensity will affect ants to search food.

Sampling Method

Special sampling--Polyrhachis dives and Diacamma rugosum

23 ants randomly picked in woodland.

Polyrhachis dives

Polyrhachis dives is found in open woodlands and swampy coastal plains, where it builds a characteristic carton structure on the lower branches of trees and shrubs, joining the foliage and twigs with silk to form the nest

Diacamma rugosum

Diacamma rugosum, also known as Bornean queenless ant, is a species of ant of the subfamily Ponerinae. It is found from many countries throughout the world. 20 subspecies are recognized.

Experiment

Set up 1 The attractiveness of food on ants

2 transparent straws, 2 transaparent plastic cups(one with food), Ant

Experiment procedure (set up 1)

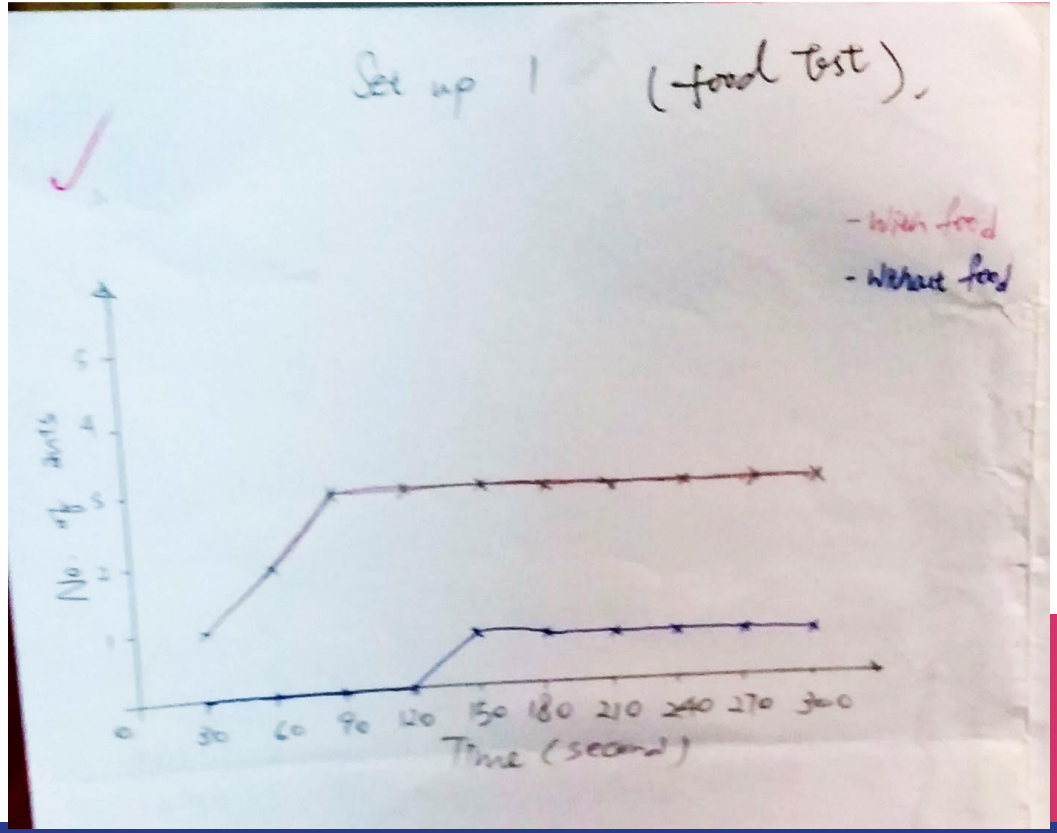
1. Intensity discrimination experiments were performed in a horizontal choice apparatus.
2. 3 cups are joined by 2 5cm transparent straws
3. 5 ants are put into the cup at the middle.
4. One transparent cup is placed with melted sugar and one is not.
5. The test will be hold for 5 minutes. Every other 30 seconds, check the number of ants in each cup.
6. After 5 minutes, if there’re more ants in the cup with food, it means ants are attracted by food.
7. If there’re more ants in the cup without food, it means ants are not attracted by food.

Result (set up 1)

	With food		Without food	
Number of ants per 30s	1)1	2)2	1)0	2)0
	3)3	4)3	3)0	4)0
	5)3	6)3	5)1	6)1
	7)3	8)3	7)1	8)1
	9)3	10)3	9)1	10)1

Conclusion: Ants are attracted by food.

Graph for set up 1



Experiment

Set up 2 The effect of light intensity on ants finding food

4 transparent straws, 4 transaparent plastic cups(all with food), 3 lamps(no cover, 1 piece of paper, 2 pieces of paper, dark cover) 9 ants

Experiment procedure(set up 2)

1. Light intensity experiments were performed in a radial pattern apparatus with 4 transparent plastic cups joined to 1 transparent plastic cup at the middle.

2. Place some melted sugar under the 4 cups by the side.

3. 1 of them is directly shined by a lamp, the 2nd one is shined by a lamp covered by 1 layer of paper, the 3rd one is shined by a lamp covered by 2 layer of paper, and the last one is covered by a piece of black paper.

4. 20 ants are put into the middle cup.

5. Set the timer to 5 minutes.

6. Count the number of ants in the plastic cups every 30 second.

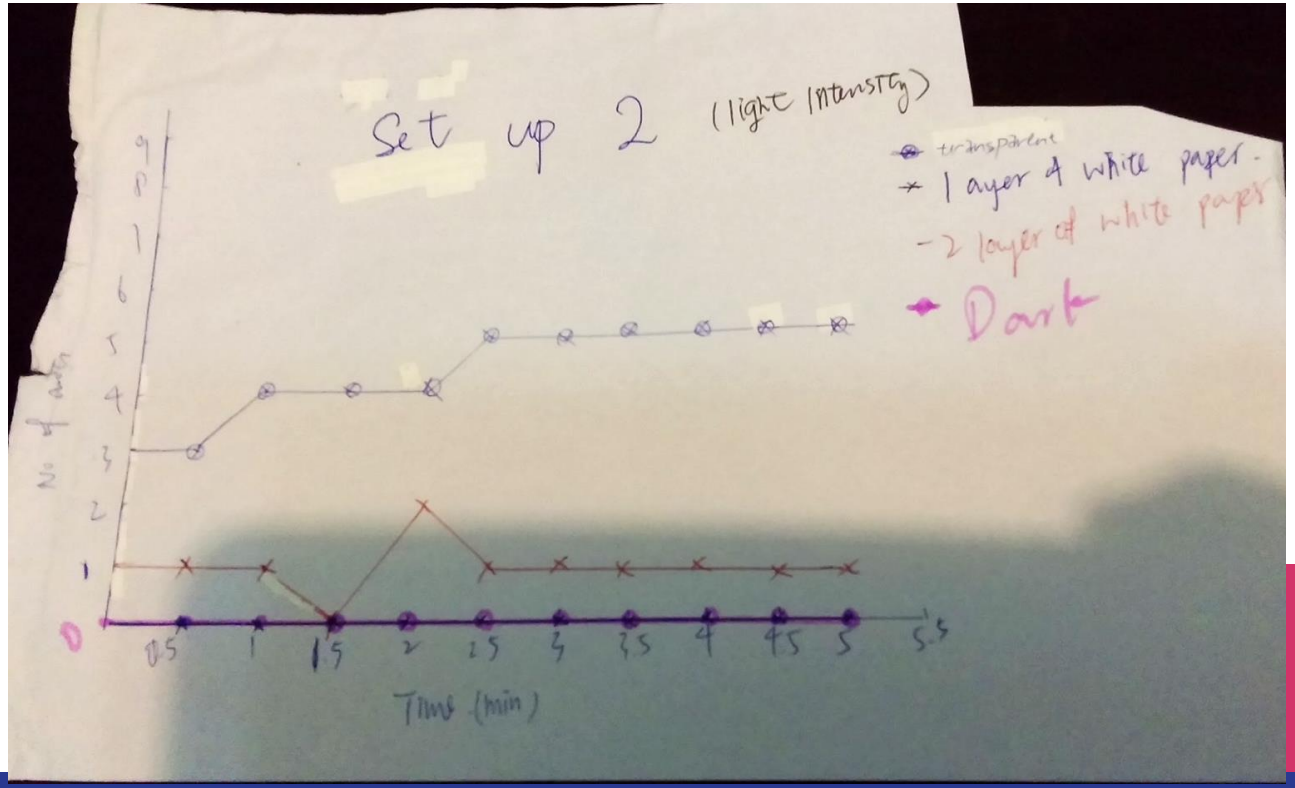
7. After 5 minutes, the cup with the most number of ants indicates that ants are mostly attracted by that light intensity.

Result

colour	without cover		1 layer of white paper		2 layers of white paper		Dark	
number of ants per 30 seconds	1)0	2)1	1)0	2)0	1)0	2)1	1)0	2)0
	3)3	4)4	3)0	4)0	3)1	4)2	3)0	4)0
	5)4	6)4	5)0	6)0	5)1	6)1	5)0	6)0
	7)5	8)5	7)0	8)0	7)0	8)0	7)0	8)0
	9)5	10)5	9)0	10)0	9)1	10)1	9)0	10)0

Conclusion: Ants are attracted by higher light intensity.

Graph for set up 2



Experiment

Set up 3 The effect of colour of light on ants finding food

5 transparent straws, 5 transaparent plastic cups(all with food), 5 lamps(covered by red, blue, yellow glass paper respectively, no cover, covered by black paper), Ant

Experiment procedure (set up 3)

1. Colour vision experiments were performed in a radial pattern apparatus with 5 transparent plastic cups joined to 1 transparent plastic cup at the middle.

2. Place some melted sugar under the 5 cups by the side.

3. 4 of them are covered with coloured glass paper(red, blue, yellow, green) and1 with black paper.

4. Light shined through the cups from the top of five cups except the one covered with black paper.

5. 11 ants are put into the middle cup.

6. Set the timer to 10 minutes.

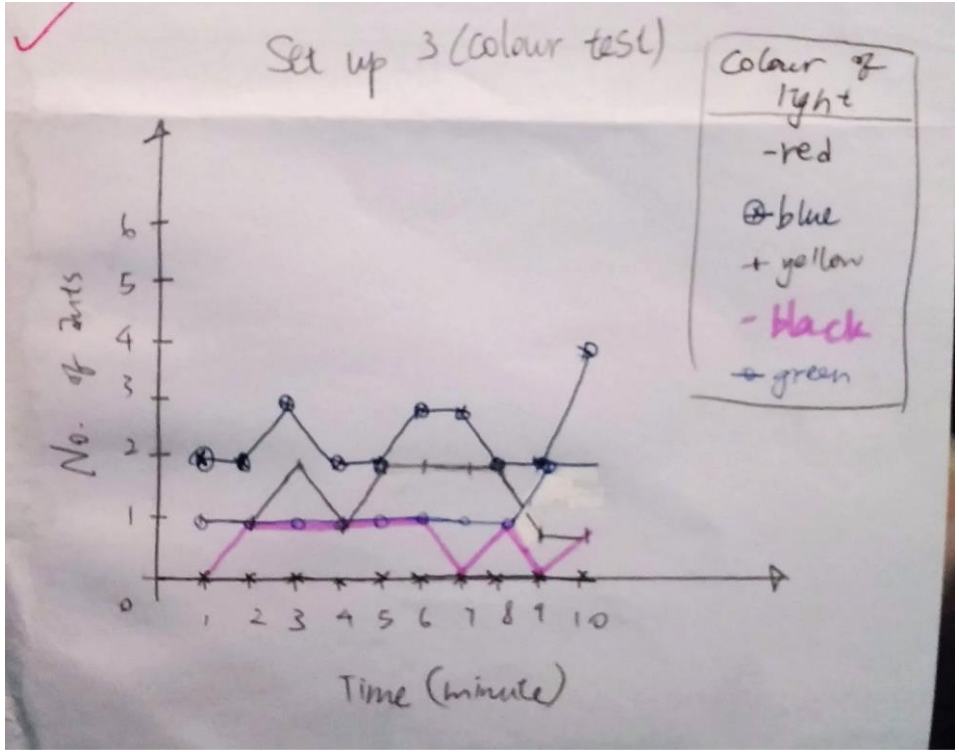
7. Count the number of ants in the plastic cups every 30 second.

8. After 10 minutes, the cup with the most number of ants indicates that ants are mostly attracted by that light colour

Result

colour	red		blue		yellow		green		black		centre	
number of ants per 30 second	1) 0	2) 0	1)1	2)2	1)1	2)1	1)1	2)1	1)0	2)1	1)5	2)4
	3) 0	4) 0	3)2	4)2	3)2	4)1	3)1	4)1	3)1	4)1	3)3	4)5
	5) 0	6) 0	5)3	6)3	5)2	6)2	5)1	6)1	5)1	6)1	5)5	6)4
	7) 0	8) 0	7)3	8)2	7)2	8)2	7)1	8)1	7)0	8)1	7)5	8)5
	9) 0	10)0	9)2	10)4	9)1	10)1	9)2	10)2	9)0	10)1	9)6	10)3

Graph for set up 3

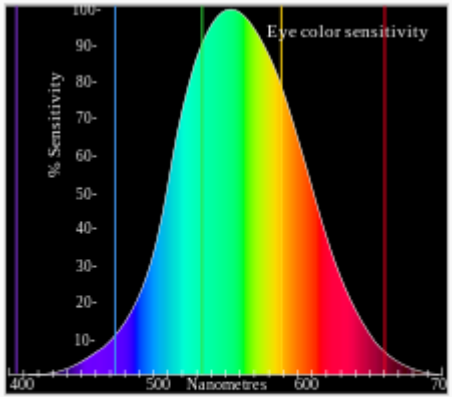


Conclusion

1. Ants are sensitive to blue light most, following by green and yellow light.
2. Ant photoreceptor cells are more sensitive to blue and green colour.
3. Ants are more active during daytime.The higher the intensity of light, the more the chance that ants can detect food.
4. The sensitivity of sharp colour to ants might help them to distinguish predators.

Supporting investigation

Falkowski at UWA and visual ecologist Jochen Zeil at ANU we show from intracellular and extracellular recordings that ant photoreceptors have three spectral sensitivities, sensitive to UV, blue and green wavelength – that allows for trichromacy.



Relative brightness sensitivity of the human visual system as a function of wavelength

Supporting investigation

Young–Helmholtz theory, proposed in the 19th century by Thomas Young and Hermann von Helmholtz, as mentioned above, states that the retina's three types of cones are preferentially sensitive to blue, green and red.

Ewald Hering proposed the opponent process theory in 1872.It states that the visual system interprets color in an antagonistic way: red vs. green, blue vs. yellow, black vs. white.

the main groups of hymenopteran insects excluding ants (i.e., bees, wasps and sawflies) mostly have two types of photoreceptor, with spectral sensitivities similar to the honeybee's which is more sensitive to blue and green.

References

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