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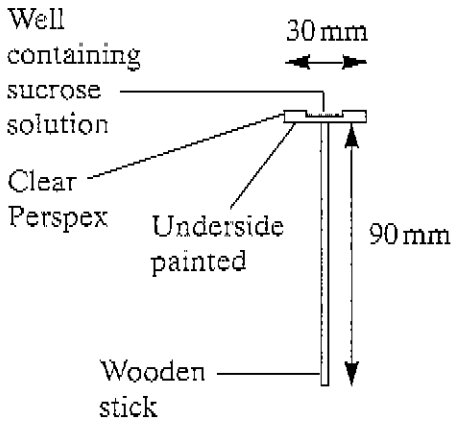
5 Artificial flowers were used in a series of investigations to study the colour of flowers visited by honeybees. The diagram shows the structure of the 'flowers'.



Honeybees (with no previous experience of the apparatus) were encouraged to fly approximately 30 metres to a dish containing peppermint-scented 1 M sucrose solution. The dish was then removed and replaced by a patch of similar artificial flowers in which equal numbers of blue and yellow flowers were arranged randomly in a 6 x 6 grid. The blue flowers contained 10 mm^3 of unscented 2 M sucrose solution in the centre well and the yellow flowers contained 10 mm^3 of unscented 1 M sucrose solution.

Ten individual bees were studied over a two-hour period, noting the flower colour from which each bee first drank and the flower colour to which it made subsequent drinking visits. The investigation was then repeated using a different ten bees, but with the sucrose concentrations reversed in the blue and yellow flowers. The distribution of the flowers in the 6 x 6 grid was changed every 15 minutes.

(a) What was the reason for using the dish containing peppermint-scented sucrose solution at the beginning of this investigation?

.....

..... *(1)*

(b) What was the reason for changing the distribution of the coloured flowers during the investigation?

.....

..... *(1)*

The results of the investigation showing the number of drinking visits made by each individual bee are given in Tables 1 and 2.

Table 1

Bee number	Yellow flowers (10 mm^3 1 M sucrose)	Blue flowers (10 mm^3 2 M sucrose)
1	103*	0
2	93*	1
3	0	108*
4	108*	0
5	0	94*
6	4	98*
7	108*	0
8	100*	0
9	90*	0
10	0	115*

Table 2

Bee number	Yellow flowers (10 mm^3 2 M sucrose)	Blue flowers (10 mm^3 1 M sucrose)
11	80*	5
12	94*	1
13	0	136*
14	0	112*
15	0	137*
16	123*	0
17	0	125*
18	0	90*
19	105*	0
20	96*	0

* represents the initial colour preference of each individual bee

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(c) (i) Suggest a null hypothesis for the initial colour preference of the honeybees.

.....

..... *(1)*

(ii) Use the formula $\chi^2 = \Sigma \frac{(O-E)^2}{E}$

to determine the range of probabilities for this null hypothesis.

Use the space below for your calculation and Table 3 which shows the values of χ^2 for different degrees of freedom.

Table 3

Degrees of freedom	Probability										
N	0.99	0.98	0.95	0.90	0.75	0.50	0.25	0.10	0.05	0.02	0.01
1	0.00	0.00	0.00	0.02	0.10	0.45	1.32	2.71	3.84	5.41	6.64
2	0.02	0.04	0.10	0.21	0.58	1.39	2.77	4.61	5.99	7.82	9.21
3	0.12	0.19	0.35	0.58	1.21	2.37	4.11	6.25	7.82	9.84	11.34
4	0.30	0.43	0.71	1.06	1.92	3.36	5.39	7.78	9.49	11.67	13.28
5	0.55	0.75	1.15	1.61	2.67	4.35	6.63	9.24	11.07	13.39	15.09

..... *(2)*

(iii) What can be concluded from your answer in (c) (ii)?

.....

..... *(1)*

Question 5 continues on the next page

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(d) (i) What do the results shown in Tables 1 and 2 indicate about the effect of the initial flower colour preference on subsequent visits by the bees?

.....

..... *(1)*

(ii) Does the energy value of the sucrose reward affect the initial flower colour preference? Give the evidence for your answer.

.....

.....

..... *(1)*

(e) Explain how the behaviour of honeybees during this investigation could be an advantage to plants that are visited.

.....

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..... *(1)*

(f) The honeybee is a social insect, living in a colony where all the collected food is shared.

Explain how the behaviour of honeybees observed during this investigation might be advantageous to the colony as a whole.

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..... *(1)*

(10)