2 The buff-tailed bumblebee, *Bombus terrestris*, is an insect that uses its tongue to feed on the nectar and pollen of flowers.

Buff-tailed bumblebees can feed on the nectar and pollen of flowers by either gripping (holding) onto flower petals or by hovering (flying) in front of the flowers.

Fig. 2.1 shows the buff-tailed bumblebee.

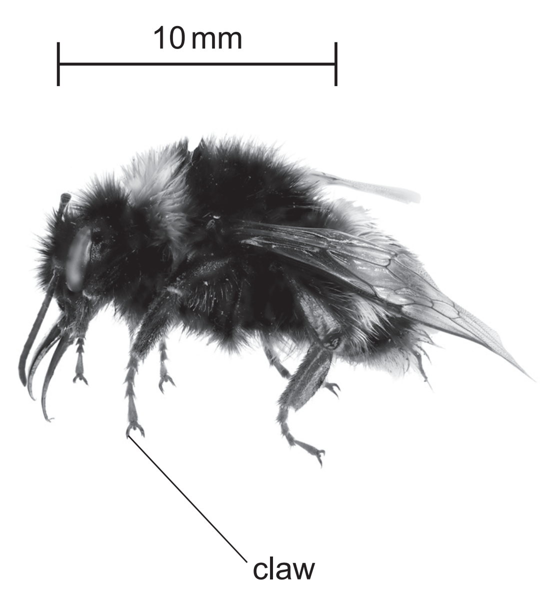

Fig. 2.1

The buff-tailed bumblebee has adaptations, such as claws, to help it to grip on to flower petals to obtain nectar and pollen.

Fig. 2.2 shows the buff-tailed bumblebee using its claws to grip on to the flower petals as the bee feeds.

Fig. 2.2

Fig. 2.3 is a magnified image of the claw of a bee.

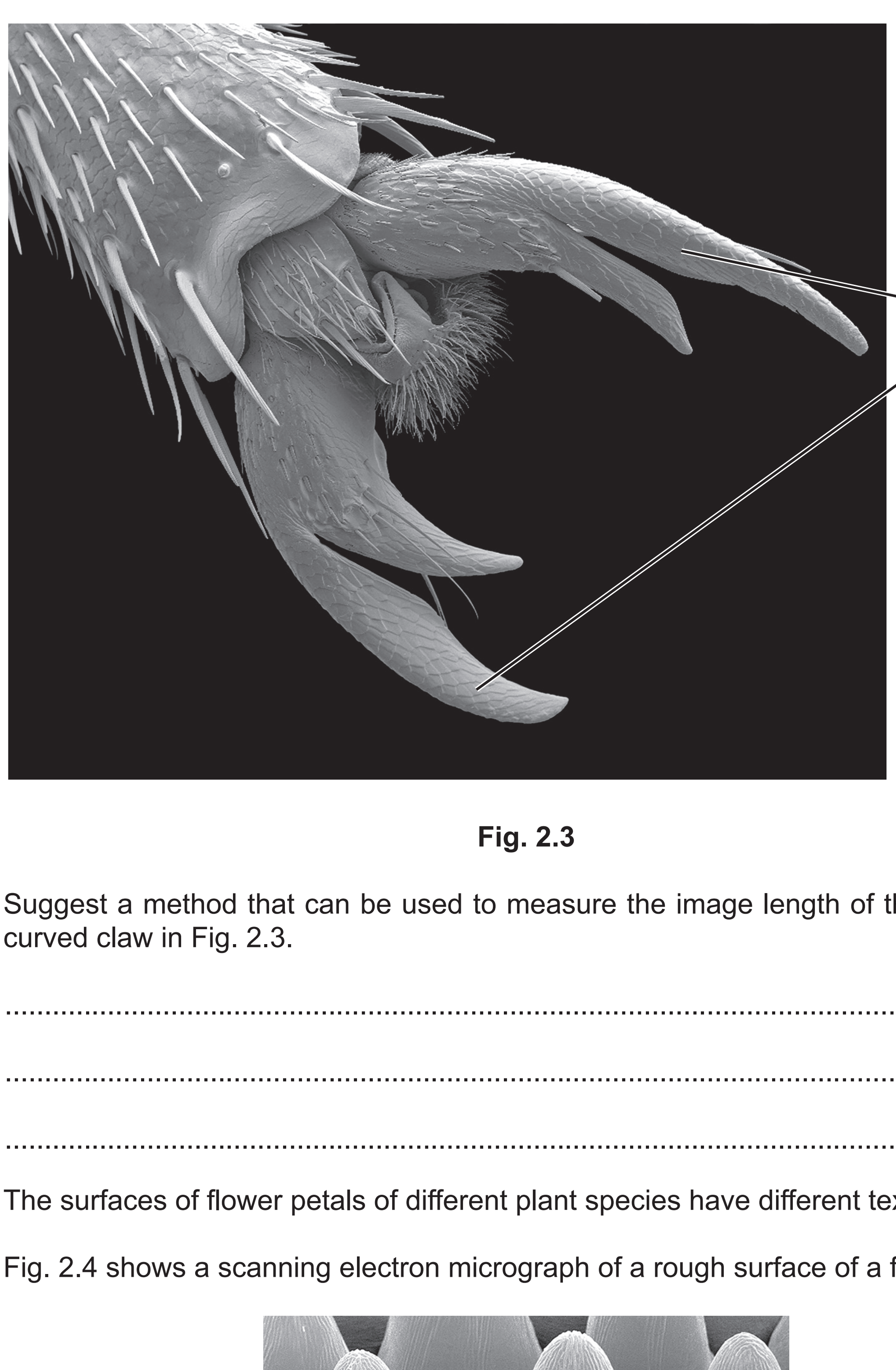

Fig. 2.3

(a) Suggest a method that can be used to measure the image length of the longest part of the curved claw in Fig. 2.3.

....

....

.... [1]

(b) The surfaces of flower petals of different plant species have different textures.

Fig. 2.4 shows a scanning electron micrograph of a rough surface of a flower petal.

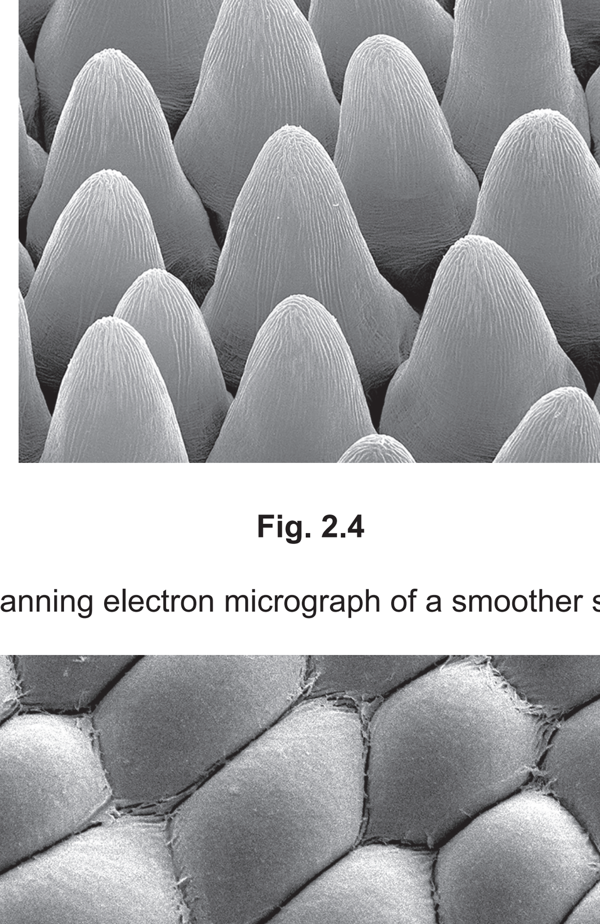

Fig. 2.4

Fig. 2.5 shows a scanning electron micrograph of a smoother surface of a flower petal.

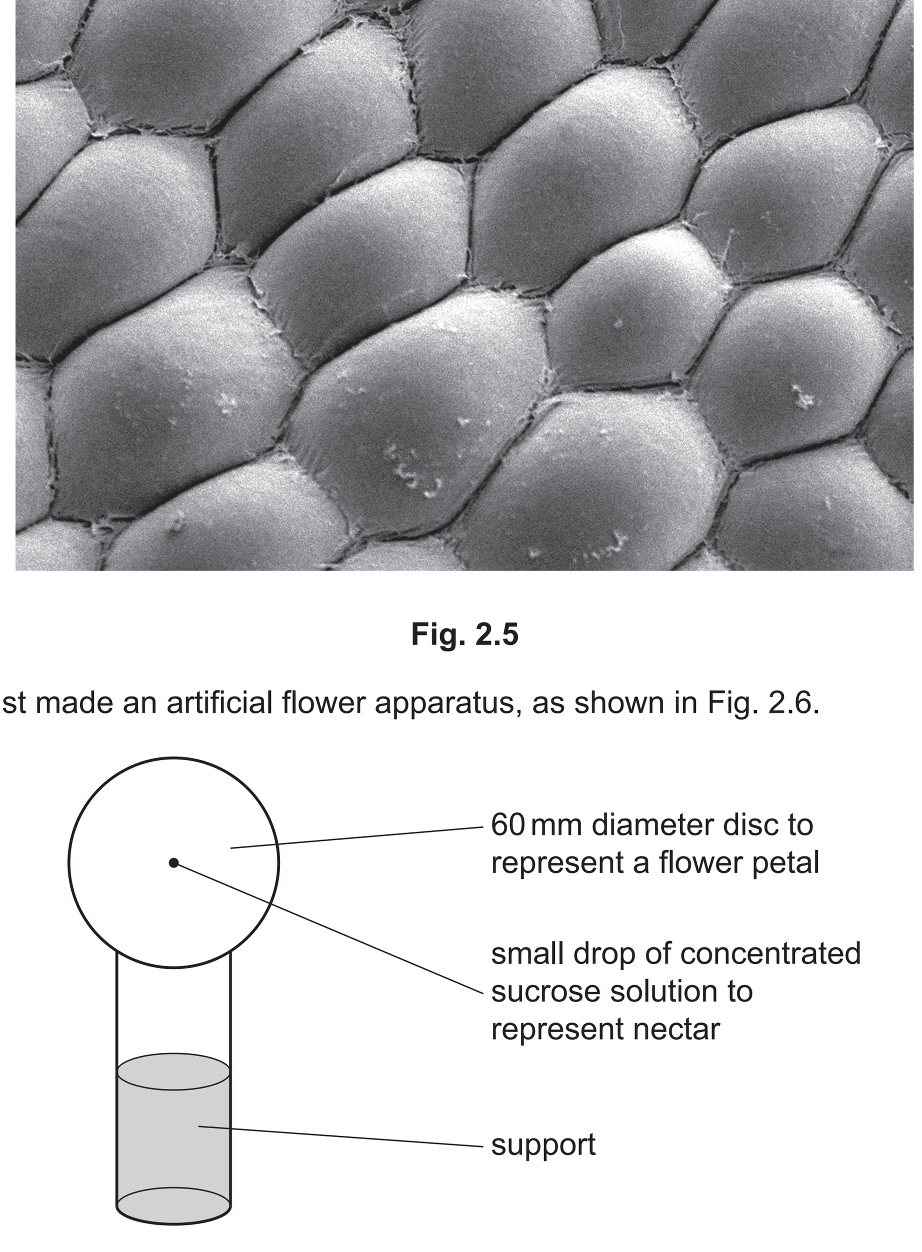

Fig. 2.5

A scientist made an artificial flower apparatus, as shown in Fig. 2.6.

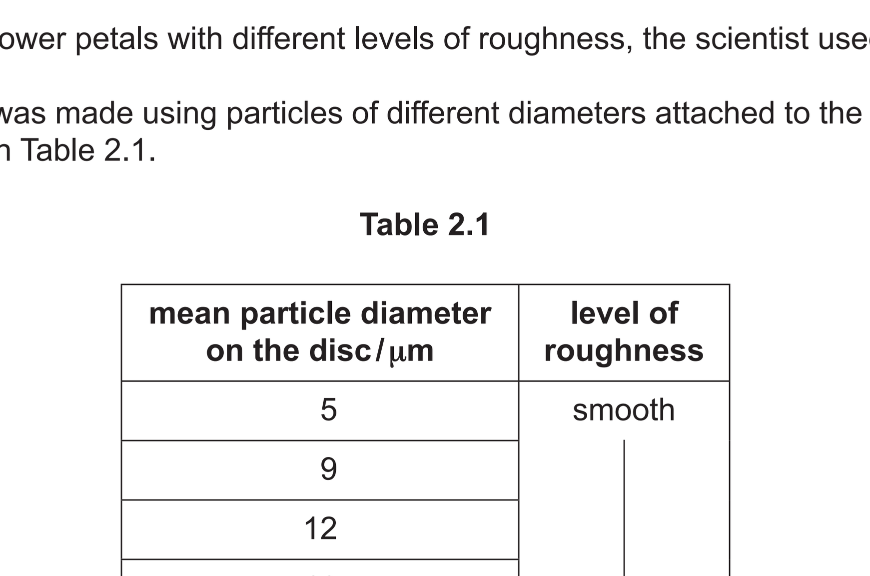

Fig. 2.6

To model flower petals with different levels of roughness, the scientist used different discs.

Each disc was made using particles of different diameters attached to the surface of the disc, as shown in Table 2.1.

Table 2.1

mean particle diameter on the disc / μm	level of roughness
5	smooth
9	↓
12	
16	
30	
53	rough

(i) The diameter of each disc was standardised as 60 mm.

Identify **one** other variable the scientist should standardise when making the discs.

....

....

.... [1]

(ii) The scientist investigated if the level of roughness of the discs affects whether buff-tailed bumblebees grip on to the disc or hover when they feed (feeding visit) from the small drop of concentrated sucrose solution.

For each disc, the scientist:

- recorded the number of feeding visits when the buff-tailed bumblebees gripped on to the disc
- recorded the number of feeding visits when the buff-tailed bumblebees hovered in front of the disc
- calculated the percentage of feeding visits when the buff-tailed bumblebees gripped on to the disc.

State the **independent** variable in this investigation.

....

.... [1]

(iii) For the disc with a mean particle diameter of 16 μm, the scientist calculated that the buff-tailed bumblebees gripped on to the disc for 79% of their feeding visits.

The total number of feeding visits was 117.

Calculate the number of feeding visits when the buff-tailed bumblebees hovered in front of the disc.

Give your answer to the nearest whole number.

number of feeding visits when the buff-tailed bumblebees hovered = ... [1]

(iv) Fig. 2.7 shows the results of the investigation.

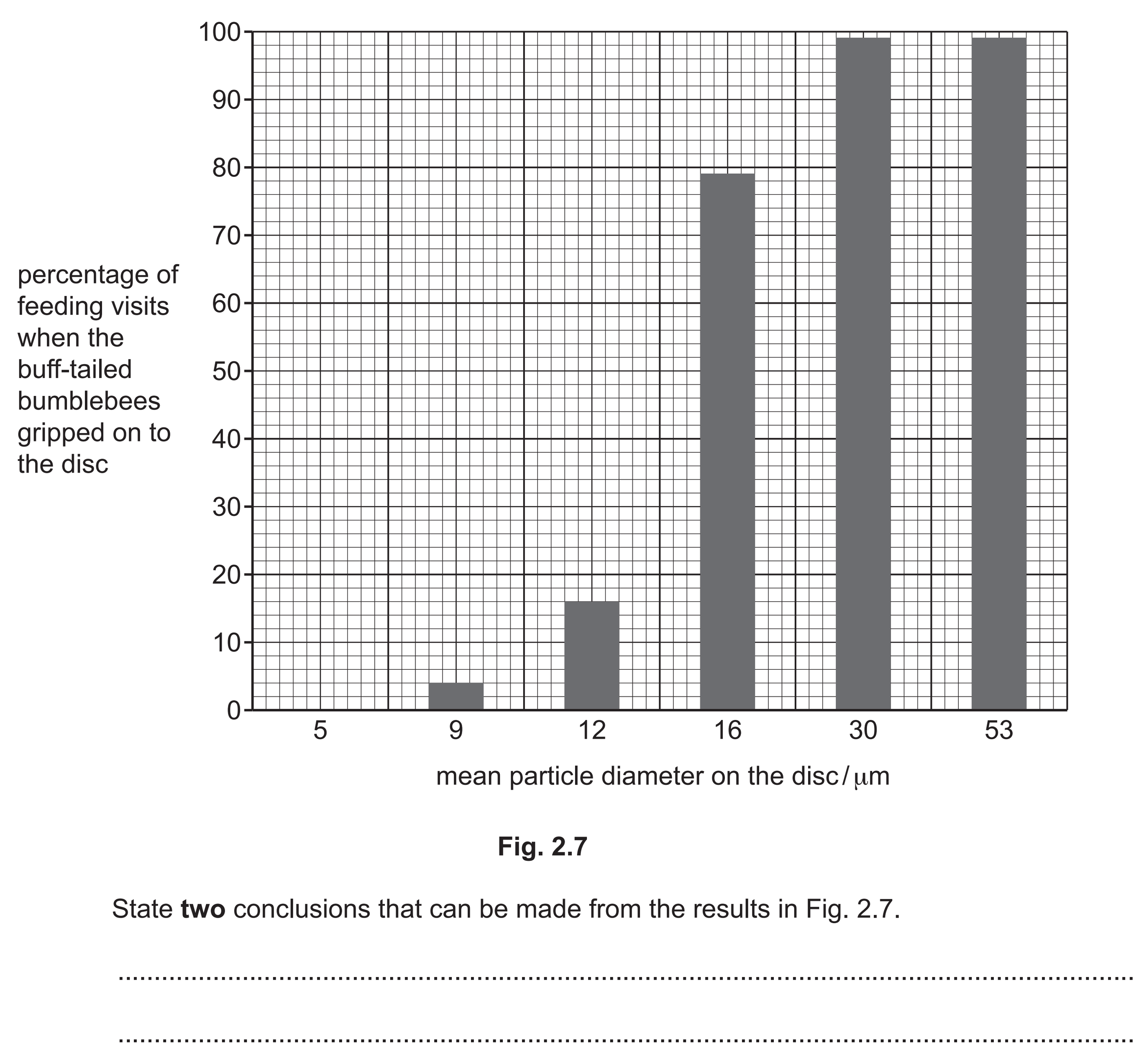

Fig. 2.7

State **two** conclusions that can be made from the results in Fig. 2.7.

....

....

....

....

.... [2]

(c) A student used the Spearman's rank correlation to analyse the data in Fig. 2.7.

The student stated the null hypothesis as:

There is no correlation between the mean particle diameter on the disc and the percentage of feeding visits when the buff-tailed bumblebees gripped on to the disc.

The formula for Spearman's rank correlation (r_s) is:

$$r_s = 1 - \left(\frac{6 \times \Sigma D^2}{n^3 - n} \right)$$

key to symbols:
D = difference in rank between each pair of measurements

n = number of pairs of items in the sample

(i) Complete Table 2.2 to calculate ΣD^2.

Table 2.2

mean particle diameter on the disc / μm	rank of mean particle diameter on the disc	percentage of feeding visits when the buff-tailed bumblebees gripped on to the disc	rank of percentage of feeding visits when the buff-tailed bumblebees gripped on to the disc	Difference in rank, D	D^2
5	1	0			
9	2	4			
12	3	16			
16	4	79			
30	5	99			
53	6	99			
				$\Sigma D^2 =$	

[2]

(ii) Use the calculated value for ΣD^2 from Table 2.2 to calculate r_s.

r_s = ... [1]

(iii) Table 2.3 shows the critical values of r_s at the 0.05 probability level.

Table 2.3

n	5	6	7	8	9	10	11	12
critical value of r_s	0.90	0.83	0.71	0.64	0.60	0.56	0.54	0.50

Use the data from Table 2.3 to explain why the student rejected the null hypothesis.

....

....

.... [1]

[Total: 10]