



**ST PAUL'S SCHOOL
JUNIOR SCHOLARSHIP EXAMINATION**

MAY 2016

BIOLOGY

Answer the questions in the spaces provided.

Name.....

Of all the insects, ants have evolved the most astonishingly complex societies. As a result, they have colonised the world in fantastic numbers – there are estimated to be at least a million times as many ants as human beings.



Fig 1 A queen ant (centre) surrounded by her many smaller workers.

Their colonies are built around a giant queen who lays eggs, most of which become sterile female workers who raise the young but don't lay eggs themselves. Once the new colony has reached a certain size, a few of these female eggs become queens. The males produced by the queen do no work to help raise the young and just leave the nest to mate with another queen.

Charles Darwin was puzzled that evolution had resulted in colonies built by sterile workers.

1. Why do you think Darwin was puzzled by this?

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.....
..... [2]

Over millions of years of evolution, some ants have become expert gardeners, tending particular plants that provide them with useful nutrients. For example, certain acacia trees in South America secrete a chemical which attracts stinging *Pseudomyrmex* ants and they even produce special protein-rich nodules on their leaves to feed them.



Fig 2 *Pseudomyrmex* ant harvesting one of the protein-rich bodies on an acacia tree.

2. The acacias also provide a source of sugar. Suggest where on the plant the ants get the sugar.

.....
..... [1]

In return, the ants attack any animal that touches the tree, and even periodically drop to the forest floor to cut back any other plant growing too close.

In a dramatic demonstration of how important the ants are to the acacia, when trees in one area of the forest were repeatedly sprayed with ant killer, the acacias died.

3. Suggest **two** reasons why the absence of ants might have such a negative effect on the acacias.

1:
.....
2:
..... [2]

Once a year, when the acacia is in flower, the plant stops secreting the chemical attractant, and instead secretes a substance that repels the ants.

4. Suggest why the plant does this.

.....
..... [1]

Leaf cutter ants have also become expert gardeners – tending carefully to underground gardens of fungi growing on chewed up leaf fragments that the ants bring back to their nest. The fungi are then fed to the larvae.



Fig 3 Leaf cutter ants carrying leaf fragments back to the nest.

5. In the space below draw a food chain for this ant species. [2]

6. Suggest why the ant does not feed the chewed up leaves directly to its larvae.

.....

.....

.....

..... [2]

Each species of leaf cutter ant uses only one specific species of fungus – and the ants manage to prevent any other fungi from growing in the warm damp conditions of the nest.



Fig 4 Ants tending the leaf mulch with fungus growing on it.

7. Suggest TWO questions that scientists might have about how this relationship between a fungus and a leaf cutter ant is maintained.

- 1.....
.....
.....
- 2.....
.....
..... [2]

Although the leaf cutters remove a lot of leaves from plants around the nest, the ants also have beneficial effects on plant growth. There are higher levels of nutrients and the soil is better aerated around ant colonies.

- 8. Why would better soil aeration improve plant growth?
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.....
.....
..... [2]

9. Suggest how the ants could help to recycle nutrients in the plants they harvest, back into the soil.

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..... [1]

We now know that a peculiarity of their genetics explains how these complex ant societies could have evolved, with workers who never reproduce.

Evolution favours behaviours that maximise the total number of copies of an organism's genes that get passed on to the next generation – either by reproducing yourself or by helping close relatives who share your genes to survive and reproduce. Children are 50% genetically identical to each parent.

10. A famous scientist once claimed that he would jump into a river and risk drowning if he could save two of his children, but if it was his cousins, he would only jump if he could save eight of them. Why would he say that?

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..... [2]

11. How genetically similar does this suggest a cousin is to you? Show your working.

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.....
.....
..... [3]

Male ants only have half the total genetic material that female ants have in their cells.

As a result, a queen’s daughters are 75% genetically identical to each other – more than they would be to their own offspring if they could reproduce.

12. How might this help explain the existence of colonies built by sterile workers, who cannot reproduce, and even sacrifice their lives to defend their queen?

.....
..... [1]

The strange genetic make-up of male ants creates a conflict between the workers and their queen.



Fig 5 Worker ants tending to the eggs

From a genetic point of view, the queen’s best strategy is to create equal numbers of male and female eggs, and that’s what she lays. The female workers do best if the colony has three times as many females as males – which is the ratio usually found.

13. Suggest two things the workers might do to alter the sex ratio of the colony and maximise their success.

1
.....
2
..... [2]

The queen of some ant species, such as *Bothriomyrmex regicidus*, is a slave-maker. She gets accepted into the colony of another species and, once inside, she kills the resident queen and enslaves the workers, who then raise her brood.



Fig 6 A *Bothriomyrmex regicidus* queen uses her strong mouthparts to cut off the head of the host queen.

14. Circle any of the following statements that, from the information given, you would expect to be true:

- a) The colony which has been invaded will eventually consist entirely of *Bothriomyrmex* ants.
- b) The host ants tend to be closely related species to *Bothriomyrmex*, who smell similar.
- c) As soon as the *Bothriomyrmex* larvae emerge from the eggs, the enslaved workers detect they are invaders and remove them.
- d) *Bothriomyrmex* are very common.

[2]

[Total for paper: 25 marks]

END OF PAPER