



**Requirements for this paper:**

Multiple-choice cards:  No      Non-programmable calculator:  No

Graph paper:  No      Laptop:  No

Open book examination?  No

<b>EXAMINATION/TEST</b>	Main Examination	<b>PROGRAMME:</b>	BSc Hons
<b>MODULE CODE:</b>	NBOT84620	<b>DURATION:</b>	3 Hours
<b>MODULE DESCRIPTION:</b>	Plant Evolutionary Ecology	<b>MARKS:</b>	100
<b>EXAMINER(S):</b>	Dr James Rodger	<b>DATE:</b>	Oct/Nov 2025
<b>MODERATOR(S):</b>	Dr Caroline Machaba	<b>TIME:</b>	
<b>EXTERNAL MODERATOR(S):</b>	Dr Ethan Newman		

**IMPORTANT INSTRUCTIONS**

1. Answer all questions.
2. Use the answer sheets provided to answer each question.
3. The use of laptops is not permitted.
4. The use of cellphones is not permitted.
5. Stationery may not be shared.

### **Question 1 (10)**

Evaluate whether each of the following studies falls within the field of Evolutionary Ecology. Justify your answer. (10)

**Study A** investigates the influences of soil conditions and pollinators on speciation in plants in the Greater Cape Floristic Region in South Africa from 20 million years ago up to the present, using phylogenetically controlled analyses for a dataset of approximately 1500 species.

**Study B** compares populations of a plant species that occurs on mine dumps to populations that occur on adjacent natural soils (not affected by mining) to assess whether populations in these different habitats have local adaptation to soil conditions and if there are genetic differences between them. The mine dumps are about 150 years old, and the mine dump soil is high in concentrations of heavy metal. This study uses experiments in a greenhouse and transplant experiments to assess adaptation to soil conditions, and it uses molecular analyses to test for genetic differences.

**Study C** investigates whether large herbivore abundance decreases when the abundance of alien plants like *Lantana camara* increases. It is an observational study using transects to document plant abundance and herbivore abundance.

### **Question 2 (20)**

Scientists carry out a phylogenetic comparative study of plant shape by analysing the relationships between different plant measurements, environmental variables and growth form. They have a dataset on these variables for over 5000 plant species from all over the world. One of the key questions in this study is, “Do plant species that grow in more arid regions evolve to have bigger or smaller plant height and rooting depth, compared to plant species growing in less arid regions?”

**2.1** Do you think it is likely that phylogenetically controlled analyses are needed to answer this question? Justify your answer by explaining how the reliability of results can be affected if the wrong kinds of analyses are used. **(10)**

**2.2** How can it be determined whether phylogenetically controlled analyses are necessary in this case? **(4)**

**2.3** Name (give the abbreviation and the name in full) and describe two kinds of phylogenetically controlled analyses, explaining how phylogenetic information is used in each. **(6)**

### **Question 3 (20)**

**3.1** Two species of palm trees (*Howea forsteriana* and *Howea belmoreana*) grow on Lord Howe Island, a small Island of 15km<sup>2</sup> in area. They are both descended from a single ancestral species that colonised this island from Australia and have no other close relatives. *H. belmoreana* grows only on volcanic soils whereas *H. forsteriana* grows on all soil types on the island. The species flower at different times and there is no evidence of hybridisation. Examine the map (Fig 1) of soil types on Lord Howe Island.

In your opinion, can this be considered a conclusive case of sympatric speciation? In your answer, mention both arguments for and against this being a case of phylogenetic speciation, and explain how you reach your conclusion based on all the arguments. **(10)**

**3.2** When two lineages that have diverged in allopatry come together again, what determines if they will remain separate or if they will merge? **(10)**

#### **Question 4 (10)**

O'Meara et al. (2016) studied the evolution of flower morphology and found that the evolution of a package of three traits – bilateral symmetry, reduced anther number and the presence of the corolla – was associated with increased diversification rates. In the excerpt provided below, they argued that this trait package was a key innovation.

Read the excerpt from O'Meara et al. 2016 and evaluate whether this claim is justified, in light of their findings (shown in underlined text) and the argument they make.

#### **Excerpt from O'Meara et al. (2016)**

“Increased diversification is strongly associated with three key character states – corolla present, bilateral symmetry and few stamens. These floral features facilitate animal pollination, and their well-studied effects on plant-pollinator interactions are consistent with a role in shaping patterns of diversification. Bilateral floral symmetry is frequently proposed as a key innovation [14,53]. Critically, however, symmetry does not operate in isolation to influence diversification. The inclusion of two additional traits, corolla presence and stamen number, in the top models demonstrates that the positive effect of symmetry hinges on the state of other floral characters\*. Ecological studies show that both bilateral symmetry and reduced stamen number increase the precision of pollen placement and facilitate specialization for particular pollinators [54–56]. Bilateral floral symmetry modulates pollen placement by constraining the approach of pollinators and positioning them with respect to the stamens [55]. Reductions in stamen number increase precision by promoting correspondence between the positions of pollen placement and stigma contact [54,56–58]. The inclusion of corolla presence among the key features suggests that bilateral symmetry is most important in flowers that have a perianth which includes a corolla, or that having a corolla provides greater flexibility of function for the calyx. Together, the potential for both more specialized and more precise interactions with pollinators may increase opportunities for prezygotic isolation and thus speciation in lineages with bilaterally symmetrical corollas and few stamens [14,23,59,60], although lower extinction rates may also play a role [60]. The many origins of this combination across the phylogeny suggest that its association with diversification is not spurious [61,62], or limited to a single major clade, but instead that it is a key innovation.”

\*This statement means that their analysis shows strong evidence that it is the combination of the three traits, not bilateral symmetry alone, that leads to increased diversification. /

Square brackets refer to this paper's reference list and indicate where the authors use evidence or ideas from other papers in their argument.

**Question 5 (20)**

Differentiate between the Succulent Karoo Biome and the Nama Karoo Biome with respect to both their plant communities and their environmental conditions (including disturbance regimes). Use paragraph format.

**Question 6 (20)**

The reasons for the remarkable diversity of the Cape Floristic Region are still a matter of scientific research and debate. Describe the different evolutionary and ecological explanations that have been proposed as contributing to this high diversity, and give details of the evidence supporting these explanations (20)

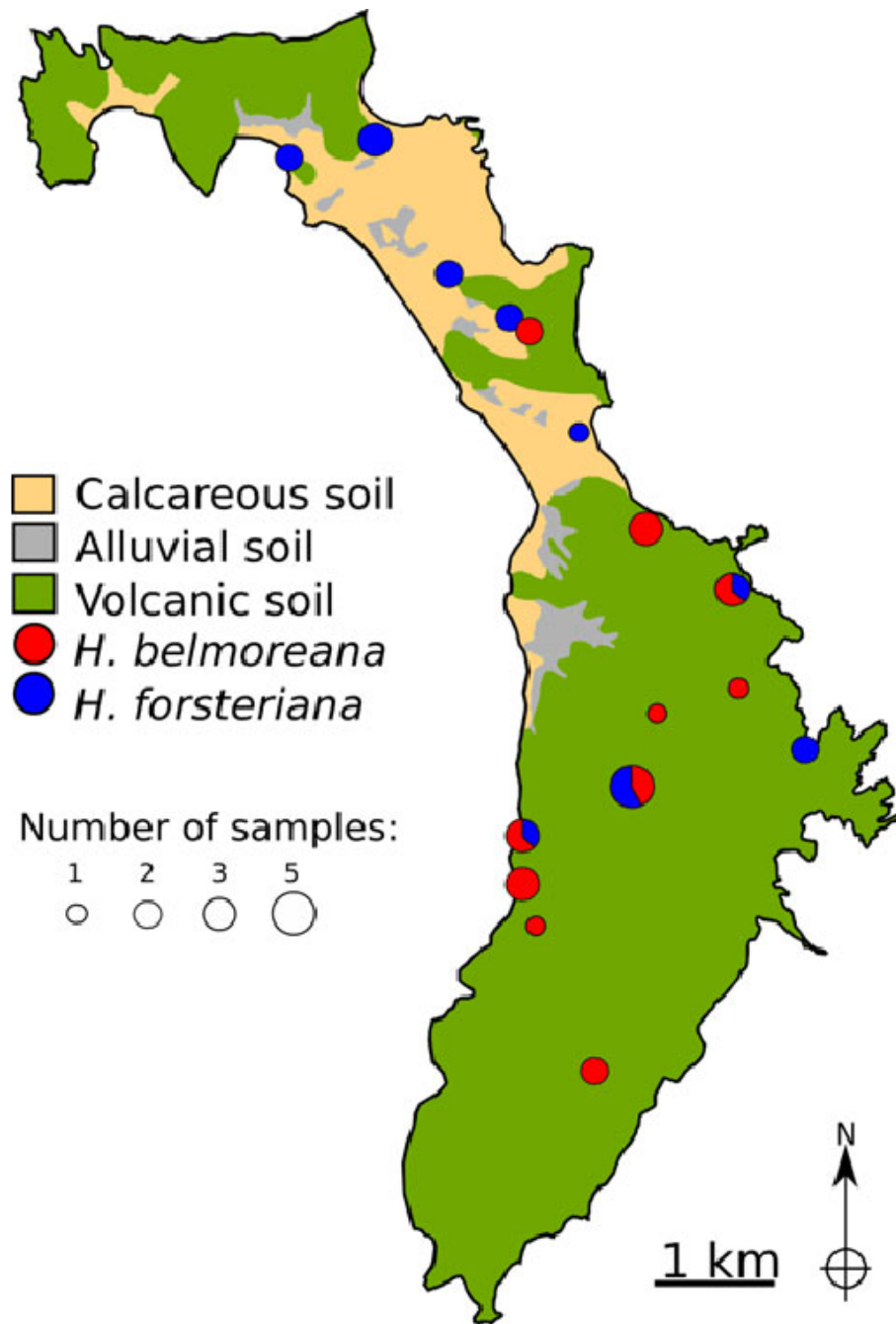


Figure 1. Soil types of Lord Howe Island. *H. belmoreana* grows only on volcanic soils whereas *H. forsteriana* grows on all soil types on the island. Circles show sampling locations for a genetic study by Dunning et al. (2016). Circles with both blue and red sites represent sites which contain both species.