Chapter 2

1. Using Figure 2.4 as an example, devise a key to classify the following insects according to the characteristics listed in the table below. Seek to use the minimum number of steps.

Characteristic	Insect Type					
	Wasp	Beetle	Butterfly	Fly	Grasshopper	Ant
Wings present	Y	Y	Y	Y	Y	N
Number of wings	4	4	4	2	4	0
Hard wing case	N	Y	N	N	N	N
Large dusty wings	N	N	Y	N	N	N
Large jumping legs	N	N	N	N	Y	N

Answer

1. Wings present .....go to 2
   Wings absent .....ant

2. More than 2 wings .....go to 3
   2 wings .....fly

3. Hard wing cases present .....beetle
   Hard wing cases absent .....go to 4

4. Large dusty wings present .....butterfly
   Large dusty wings absent .....go to 5

5. Large hind legs for jumping .....grasshopper
   No large jumping legs.....wasp

2. Match the following modes of speciation with their correct descriptions

(i) Allopatric

(ii) Parapatric

(iii) Sympatric

(a) Divergence within populations which share the same range but become adapted to local conditions.

(b) Geographical isolation within a population leading to the formation of new species.

(c) Speciation arising within a population as a result of a genetic change that restricts gene flow.

Answer

i-*b*, iii-*c*, ii-*a*

3. What are the advantages of using mitochondrial DNA in genetic analysis?

Answer

Mitochondrial DNA (MtDNA) has an advantage over nuclear DNA as it is found in all cells (including red blood cells). Because there can be thousands of mitochondria in a cell there is more MtDNA present and therefore more chance of getting a suitable sample for analysis in old and/or degraded samples. The MtDNA genome is smaller than that of the nuclear DNA and has less functional redundancy, making it easier to sequence and type the sample. This makes it particularly useful in piecing together the evolutionary history of a species and other forms of identification (such as forensic analysis). As MtDNA is inherited from the mother (matrilinearly) it can be useful for working out the parentage of hybrids (see Box 2.2).

4. Match the following types of reproductive barriers with their appropriate description. Then group them into either pre- or post-zygotic barriers.

(a) Behavioural isolation
(b) Ecological isolation
(c) Gametic isolation
(d) Hybrid breakdown
(e) Hybrid inviability
(f) Hybrid sterility
(g) Mechanical isolation
(h) Temporal isolation

(i) Anatomical differences can prevent fertilization as reproductive organs need to complement each other for the exchange of gametes.
(ii) Although the offspring are fertile and may reproduce, their young fail to develop properly, cannot reproduce or are poorly adapted to new habitat.
(iii) Embryonic development may be impaired so a hybrid never reaches the adult stage.
(iv) Offspring are produced but they are infertile, producing either dysfunctional gametes or no gametes at all.
(v) Populations are separated by distance or barriers (such as mountains or water bodies).
(vi) Populations may be reproductively active at different times; they may flower at different breeding seasons.
(vii) Unless the sperm and the egg recognize each other fertilization may be prevented by a failure of them to fuse.
(viii) Without the correct signals to initiate reproductive activity, males and females of different populations may never interbreed.

Answer

a-viii, *b*-v, *c*-vii, *d*-ii, *e*-iii, *f*-iv, *g*-i, *h*-vi

d,e,f are post-zygotic barriers and all the others pre-zygotic barriers

5. The following measurements of niche breath were made for four species along a resource gradient and its overlap with neighbouring species:

(Note - 1.0 indicates maximum niche breadth across the entire resource spectrum. 1.0 also indicates complete niche overlap with other species)

	Niche breadth	Niche overlap
Species A	0.7	0.8
Species B	0.2	0.1
Species C	0.2	0.8
Species D	0.7	0.1

Identify

(i) Specialist species likely to be suffering intense competition
(ii) Generalist species likely to be suffering intense competition
(iii) Specialist species likely to be little competition
(iv) Generalist species likely to be little competition

Which species may have a realized niche almost as large as its fundamental niche?

Answer

(i) *C*, (ii) *A*, (iii) B, (iv) *D*

If its small overlap indicates little competition, *D* has a wide range and is largely unconstrained by its neighbours. *B* could also have little competition. The high overlap values for *A* and *C* would suggest their realized niches are smaller than their fundamental niches. *A* has a large breadth, so it would be worth investigating whether it was indeed being constrained by its large overlap on this resource spectrum.

6. Explain what is meant by:

a. the morphological species concept;
b. the biological species concept;
c. the ecological species concept.

In your answers indicate the limitations of each concept.

Answer

a. This defines a species on the basis of its appearance. Key to the concept is the assumption that organisms sharing similar characteristic are related. This is a useful concept when the group of organisms is well-understood. However, difficulties might arise in the case of sexual dimorphism, where different sexes within the same species appear different and might end up being classified as separate species. Conversely, in convergent evolution unrelated individuals may appear to be related when, in reality, they are evolutionarily very different.

b. A biological species is a group of individuals that are able to successfully interbreed and are reproductively isolated from other groups. This is a useful concept but requires a clear

understanding of what constitutes successful interbreeding. Is this successful mating, fertilization, the formation for an embryo, viable and fertile progeny? Although this may be clear-cut in animals it is less so with plants as some are able to produce viable and fertile interspecific and intergeneric hybrids.

c. The ecological species concept defines species according to their adaptations and acknowledges their ecological niche. One example is the variety of Hominins described in the first Chapter where we have evidence for their different ways of life as well as their anatomical differences. It is often difficult for us to decide when a fine distinction in an ecological niche represents a different evolutionary trajectory and hence a new species.