Activity 24A: Sampling techniques and distribution patterns

1. **a.** Define the following terms:
   i. distribution
   ii. density.

   b. Explain the difference between uniform, clumped and random distribution patterns, and suggest reasons why these different patterns occur.

2. Green-lipped mussels (*Perna canaliculus)* are shellfish that can be found on the intertidal rocks of west coast surf beaches.

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Green-lipped mussel *(Perna canaliculus)*

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A typical West Coast rocky shore

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Part 1

a. Describe a sampling technique that could be used to collect data on the distribution of the green-lipped mussels between high and low tide. The data collected needs to be *sufficient* to clearly show the distribution pattern.

b. Give the evidence that would say whether the distribution was random, uniform or clumped.

c. Describe how the collected data could be processed to find the density of the mussels.

d. Describe one graphical or diagrammatic method that could be used in processing the collected data.

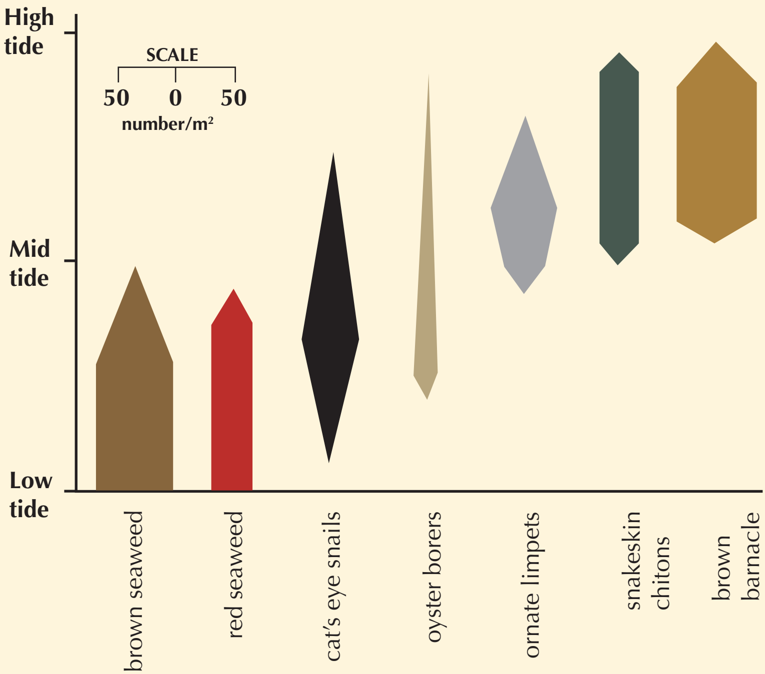
e. Describe any **i**. biotic **ii**. abiotic factors that might be important in determining the distribution of the mussels.

f. Suggest adaptations of mussels that might be important in determining their distribution pattern.

Part 2

Another study of the same rocky shore sampled a range of species living there. The processed data is shown in the kite diagrams following.

Kite diagram showing the distribution of certain rocky-shore organisms



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a. Name the community pattern illustrated by these results.

b. Name the main environmental factor determining this pattern.

c. Name two species that probably have a low tolerance to dehydration.

d. Name two species that are probably tolerant of high temperatures and dehydration.

e. Suggest an adaptation that both chitons and limpets have to prevent them being washed off the rocks by wave action.

f. Suggest an adaptation of the cat's eye snails, limpets and oyster borers to prevent damage by wave action.

g. Describe how the distribution of species on the shore can be affected by:

i. interspecific competition

ii. predation.

3. A group of students making a study of plants on coastal sand dunes prepared a transect across the dunes. They recorded a number of environmental factors at five stations along the transect, and presented the data in the following table.

Station number	**Distance along transect (in metres)**	**Form of dominant plant species**	**Average height of plants (in metres)**	**Factor**		
				% cover of surface litter	Relative amount of moisture in surface soil, taking 'Station **V**' as 100%	Relative light intensity at surface of soil taking 'Station **I**' as 100%
I	1	Bare sand dune	nil	0	1	100
II	10	Dune grasses	0.2	1	5	90
III	20	Low shrubs, some with root nodules	1.2	70	30	20
IV	30	Tall shrubs	4.5	85	60	15
V	40	Dune forest	7.0	98	100	10

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a. Identify other biotic and abiotic environmental factors (apart from those given on the table) that are likely to change from station **I** to station **V**.

b. Marram grass is a typical sand dune grass that could be found at station **II**. Suggest possible adaptations shown by marram grass to living in this area of the dune.

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Marram grass

c. Draw a graph showing the average height of the plants in relation to distance along the transect. Describe the pattern shown in the graph, and suggest reasons for it.

Activity 24A answers: Sampling techniques and distribution patterns

Some of the answers given here are not definitive in that, for example, there may be other sampling techniques that would also be suitable in obtaining the necessary data; there may be other environmental factors that could influence distribution; similarly, other adaptations.

1. a. i. The pattern of the individuals across their habitat; the range of their occurrence in the habitat.

ii. The number of individuals in a given area, such that:

$$\text{Density} = \frac{\text{Number of individuals}}{\text{Area of habitat}}$$

b. *Uniform distribution* – individuals are distributed evenly across their habitat; typical of territorial animals (such as colonies of nesting gannets).

Clumped distribution – individuals occur together (in groups) in certain areas of their habitat; typical of social animals that live in groups (e.g. all animals that live in herds, such as horses). Clumping also occurs in favourable environmental conditions – such as a food source, high light intensity, or high nutrient levels.

Random distribution – individuals are neither uniform nor clumped in their habitat but scattered throughout; rare, but can be seen in certain plant species in forest communities.

2. Part 1

a. Place a transect line from high to low tide down the shore. At 3-metre distances down the line, place a 25 cm × 25 cm quadrat and count the green-lipped mussels found in it. To ensure sufficient data, a minimum of 5 transect lines should be used along the shore.

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b. If the distribution was *clumped*, then, within individual quadrats, there would be areas where mussels were living close together and areas where they were not, and/or in any particular tidal zone some quadrats would have large numbers of mussels living close together while other quadrats would have none. If the distribution was *uniform*, the mussels would be regularly spaced within quadrats throughout their tidal zone and the count for each quadrat would be the same (or nearly so). If the distribution was *random*, the occurrence and spacing of mussels in each quadrat would be random, as would the numbers counted in the quadrats (could cover a range from high to low with no apparent reason for it).

c. In processing the data, the counts from the 5 transects would be averaged to give the numbers per 25 cm × 25 cm. It would be preferable if the averages were converted to numbers per m^2 by multiplying by 16.

d. Numbers per m^2 could be shown on a *distribution graph*, with numbers/m^2 on the vertical axis and distance (in m) from high to low tide along the horizontal axis.

A *kite diagram* could be used to show the distribution pattern. Distance (in m from high to low tide) is put on the vertical axis, and an appropriate scale for numbers/m^2 (e.g. 5 mm = 10 mussels) put on the horizontal axis. The completed 'kite' is shaded in.

e. **i.** Intraspecific (other green-lipped mussels) and interspecific (e.g. oysters, barnacles, seaweeds, black mussel) competition for space on the rocks to attach and grow; selective predation (e.g. oyster borers, whelks, starfish) can also influence distribution.

ii. Tidal height; type of substrate to attach to; wave action; time exposed to sun/temperature/dehydration; feeding time.

> Zones on the shore are largely determined by the tidal height because this determines the time organisms are exposed to the heating and drying effects of the sun. Organisms that inhabit the higher tidal zones need to be more tolerant (physiologically) to temperature extremes/dehydration. Because the organisms feed only when covered by water, those in higher tide zones need to be tolerant/have adaptations for shorter feeding times.

> Animals attached to the rocks (e.g. barnacles, mussels, oysters) are all filter feeders and have devices to filter microscopic organic material from the water. They open their shells/coverings when covered by water, to feed. Seaweeds attach to the rocks by 'holdfasts' and are photosynthetic organisms.

f. Have hard shells to prevent damage from wave action and the shells close tightly when the tide is out to prevent dehydration; cement themselves to the rocks to prevent being swept away; open their shell when the tide is in and filter the water using gills; have a low tolerance to exposure (problems with dehydration, feeding, gas exchange, temperature extremes) and are therefore restricted to the low-tide zone.

Part 2

a. Zonation.

b. Tidal height.

c. Brown seaweed, red seaweed, cat's eye snails.

d. Ornate limpets, snakeskin chitons, brown barnacles.

e. Have a strong muscular foot that grips very firmly to the rocks.

f. Species all have hard shells (they are molluscs) to prevent damage from wave action.

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g. **i.** Interspecific competition can occur for space on the rocks (e.g. mussels, oysters, barnacles) also for food (e.g. grazers on algae such as the cat's eye snails, limpets, chitons). Those individuals/species that are not successful may end up living in a non-preferred zone (e.g. high up the shore that their adaptations do not particularly fit them for), placing them at the limits of their tolerance range.

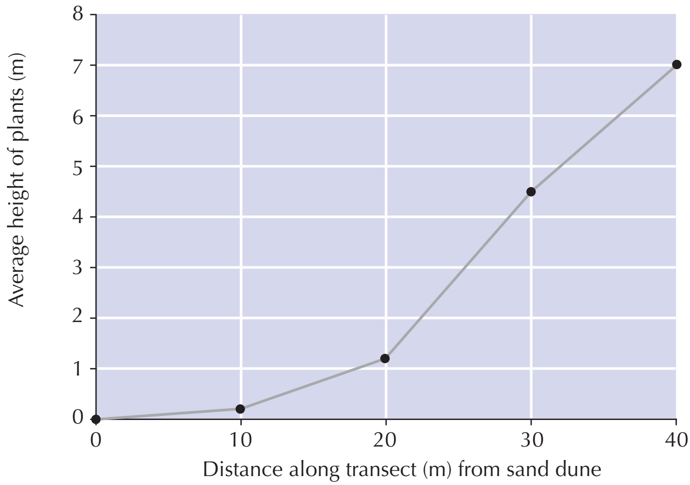
ii. Predation will limit the population sizes of the prey and may affect zones. Those individuals/species that have the tolerance to live outside their preferred zone and that of their predator may do so, thus reducing the effects of predation.

3. **a.** Temperature/wind speed/exposure would decrease; humidity/soil nutrients/animal species and numbers/variety of plant species would increase.

b. Marram grass is a hardy plant that is a coloniser of sand dunes. Marram grass has rolled leaves to reduce water loss; a strong fibrous root system to securely anchor the plant and obtain (scarce) water/nutrients; it puts out runners to bud off new plants (asexual reproduction), rapidly increasing the population and assisting anchorage of the individual plants and stabilising the sand. It has a high physiological tolerance to high temperatures/wind/sand abrasion/salinity, and to low water and nutrient levels.

c. Need to draw a line graph with *average height of plants in metres* up the vertical axis and *distance along transect in metres from sand dune* along the horizontal axis. The heights are plotted and connected with a smooth curve. Graph is titled.

Average heights of plants along a transect from bare sand to forest



The height of the plants increases from the fore dunes to the rear dunes and forest, as the environment becomes much less harsh (lower temperatures/wind/exposure, higher humidity) and the substrate is now soil rather than sand (much more stable, better supplies of water/nutrients); animals are present to assist pollination; stratification is occurring. All these factors allow for an increased variety of plant life with the presence of tall trees.

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