Topic 4 - data-based questions

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1. Venus fly trap is autotrophic; Euglena is autotrophic; both fix carbon compounds by photosynthesis; though both also feed on other organisms;

2. Ghost orchid is heterotrophic; ghost orchid does not carry out photosynthesis despite being a plant; dodder is heterotrophic; feeds parasitically on autotrophs;

3. Ghost orchid is saprotrophic; feeds on dead organic matter underground; dodder isn’t a detritivore or a saprotroph as it feeds on living plants; dodder is a parasite / not a typical consumer / does not ingest living organisms;

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1. observed values:

<table>
<thead>
<tr>
<th></th>
<th>Heather Present</th>
<th>Heather Absent</th>
<th>Row Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moss Present</td>
<td>57</td>
<td>7</td>
<td>64</td>
</tr>
<tr>
<td>Moss Absent</td>
<td>9</td>
<td>27</td>
<td>36</td>
</tr>
<tr>
<td>Column Total</td>
<td>66</td>
<td>34</td>
<td>100</td>
</tr>
</tbody>
</table>

2. expected values:

Based on the row totals, moss should be present 64% of the time and absent 36% of the time; this should hold in all four cells; based on the column totals, heather should be present 66% of the time and absent 34% of the time;

<table>
<thead>
<tr>
<th></th>
<th>Heather Present</th>
<th>Heather Absent</th>
<th>Row Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moss Present</td>
<td>(64 x 66)/100 = 42.2</td>
<td>(64 x 34)/100 = 21.8</td>
<td>64</td>
</tr>
<tr>
<td>Moss Absent</td>
<td>(36 x 66)/100 = 23.8</td>
<td>(36 x 34)/100 = 12.2</td>
<td>36</td>
</tr>
<tr>
<td>Column Total</td>
<td>66</td>
<td>34</td>
<td>100</td>
</tr>
</tbody>
</table>

3. degrees of freedom = (m - 1)(n - 1) = (2 - 1)(2 - 1); degrees of freedom = 1;

4. the critical region (obtained from a table of chi-squared values) is 3.83 or larger;

5. \[ (57 - 42.2)^2 / 42.2 + (7 - 21.8)^2 / 21.8 + (9 - 23.8)^2 / 23.8 + (27 - 12.2)^2 / 12.2 \]
   \[ = 5.1905 + 10.0477 + 9.2034 + 17.9541 = 42.3957; \]

6. the calculated value of chi-squared is in the critical region, so there is evidence at the 5% level for an association between the two species; we can reject the null hypothesis \( H_0 \);

7. Mosses are mostly confined to damp habitats; on this Shropshire hilltop, the moss *Rhytidiadelphus squarrosus* is associated with the heather because the heather provides shade, humidity and shelter from drying winds; neither species can tolerate trampling on the paths created by hill walkers on this site; in the photo, the heather appears purple-brown in colour and the paths are green;

8. a measuring tape was laid down along one edge of the area; random numbers were used to determine a distance along the tape and then another random number was used to determine a distance at right angles to the tape, where the quadrat was positioned; this procedure was repeated one hundred times;

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1. insolation decreases with increasing distance from the equator / inverse relationship;

2. a) \( 400 \text{ W/m}^2 \)
   
   b) \( 240-260 \text{ W/m}^2 \)

3. different levels of cloud cover / variations in the composition of the upper atmosphere that absorbs sunlight;

4. Tropical rainforests are near equator so supported; rainforests in areas with high insolation, but not the highest in all areas; some high insolation areas are desert, such as Sahara/Atacama deserts; some tropical rainforests in areas of low insolation, like South East Asia;
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a) respiration rate increases with decreasing temperature below 12°C; temperature changes between 12°C and 33°C have no effect on respiration rate; as temperature climbs above 33°C respiration rate begins to increase (sharply);

b) bird is trying to maintain temperature; homeostasis; respiration generates waste heat; rise in metabolic rate undertaken to preserve core temperature; bird may increase motion as well to preserve core temperature;

c) increase in metabolic rate linked to activities designed to keep cool; such as evaporative cooling through increased ventilation rate; becoming hyperthermic / body temperature higher than normal; faster metabolism / enzyme-catalysed reactions including cell respiration;

d) random/experimental error; variation in surface area of birds effects temperature homeostasis; variation in muscle contractions / some birds more physically active than others;

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1. both are top predators; both occupy more than one trophic level; both can be predator/prey of the other; belostoma has higher productivity;

2. Ranatra and Belostama both can be considered as secondary, tertiary and quartenary consumer;

3. a) Metaphyton → Hyalella → Telebasis → Belostoma;
   b) telebasis;

4. first rung is sum of metaphyton and epiphyton energy values; first rung labelled as producers or with species name; Second rung is labelled primary consumers; second rung shown 5% as wide as first rung;

5. \[
\frac{\text{final-initial}}{\text{initial}} \times 100\% = -95.3\%;
\]

6. same organisms can occupy more than one trophic level at the same time; some organisms can occupy different trophic levels at different points in their life cycle; easier to define trophic level in a food chain rather than a food web;

7. determine the fraction of each organism’s diet coming from each specific trophic level;

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1. it is in the spring;

2. a) higher in May than in October;
   b) photosynthesis in Northern Hemisphere forests; depletes carbon dioxide in summer leading to lower concentrations in autumn;

3. a) much higher in Northern Hemisphere;
   b) Southern Hemisphere at the end of summer, but Northern Hemisphere at beginning; photosynthesis reduces carbon dioxide concentrations in summer; greater burning of fossil in Northern Hemisphere (during Northern winter than in Southern summer); more ocean in Southern Hemisphere where carbon dioxide can dissolve; colder water in Southern Hemisphere so more carbon dioxide dissolves; more land area in Northern Hemisphere so higher total respiration rates;

4. a) the Equator;
   b) less fluctuations due to absence of seasons; presence of tropical rainforests to absorb carbon dioxide;
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1. sharp rises and falls are due to artificial light being switched on and off by a timer; fluctuations when artificial light is on are due to variation in natural light / cloudy or sunny conditions;

2. six days;

3. a) pH rises in the light; becomes more alkaline / basic;
   b) absorption of carbon dioxide (which is acidic) from the water; by photosynthesis;

4. a) pH falls in darkness (mostly) / becomes more acidic;
   b) more cell respiration than photosynthesis; carbon dioxide released into the water;

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1. a) increasing the temperature increases the release of carbon; the effect is more significant in moist soils than waterlogged soils;
   b) higher temperature means higher rates of chemical reactions, including respiration which releases CO₂;

2. a) in both cases, carbon release increases with temperature; an increase in carbon release is much higher in moist rather than water logged soils;
   b) in waterlogged soils, more anaerobic respiration in bacteria and fungus; only some have alcoholic fermentation; anaerobic respiration releases adding fertiliser increases release of carbon dioxide; in moist soils, but not in soils saturated with water; adding fertilizer impacts carbon release – in moist soils only;

3. amount of water in the soil has the greatest impact; differences between M and W greater than differences between 7 and 15 or TC and TF;

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1. approximately 210 days of decreasing versus approximately 160 days of increasing;

2. lowest on day 135 which is in April; highest on day 290 which is in October;

3. high rates of photosynthesis in summer due to high insolation and warm temperatures leads to high net ecosystem photosynthesis (NEP); low rates of photosynthesis with cellular respiration

4. annual carbon flux is 17.5 t CO₂ ha⁻¹ because this is the value reached at the end of the cumulative curve;

5. they could capture more carbon dioxide and reduce the concentration in the atmosphere / reduce the greenhouse effect;

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1. direct and indirect measurements are very similar in the years when both data is available;

2. both rise between 1880 and 2008; both rise most steeply from 1970/80 onwards; temperature fluctuates more than carbon dioxide concentration;

3. \[0.22 - (-0.19) = > 2000 - 1900 = 0.41 \quad \text{C} \quad 0.41 - (-0.21) = > 2005 - 1905 = 0.62 \quad \text{C}\]

4. a) some possible explanations: natural variability / solar variability / variations in fossil fuel use; local conditions at monitoring stations vary; feedback systems from the earth triggered by warming;
   b) they suggest that CO₂ is not the only variable influencing temperature; strong correlation both in figure 5 and in the figure 6 + 7;

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1. a) 1990;
   b) 1970;

2. a) the higher the temperature, the earlier the opening of the chestnut leaves;
   b) over the final 10 year period, highest average temperatures occurred; pervious pattern appeared to be cyclical; supports claim of global warming;
1. greater affluence in the US leading to more transportation; more use of air conditioning in the US; no winter so no heating use in Brazil; greater industrial activity in the US;
2. rapid growth in fossil fuel use in the four named countries; cheap oil in countries that produce it; large use of fossil fuel for air conditioning / water purification / construction / oil production;
3. forest fires; to clear land for farming; combustion releases carbon dioxide;
4. farming activities / cattle / sheep / ruminants release methane;

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1. AIFI;
2. minimum 1.1 °C; maximum 5.9 °C;
3. 1.8 °C;
4. 2.1 °C in the Arctic versus 1.8 °C global average; Arctic temperature rise is higher than global average;
5. whether positive feedback cycles will exacerbate the problem; such as melting of polar ice caps; or permafrost melting; or increase in cloud cover;
6. depends on whether data used by centres is the same or independently gathered; more centres means more validity; similar logic applies to positive impact of sample size on certainty in IA experiments;
7. according to precautionary principle strong action called for because consequences of inaction are potentially catastrophic; costs of mitigation should be borne equally; developing nations need assess to carbon production to achieve higher standard of living; will require greater reductions in developed world;
8. forces acting in support of avoiding economic risk are more powerful; some shifts in economic activity possible; local versus global economies; shift to greater degree of subsistence activities; fossil fuel shortage may aid shift.
**Topic 4 - end of topic questions**

1. **a)** respiration loss = gross production – net production = $1 \times 10^2$ kJ m$^{-2}$ y$^{-1}$

   **b)** answer presumes a student draws a pyramid of net production: base of pyramid is 50 units wide; second tier is 6 units wide; third tier is 0.6 units wide; (accept equivalent ratios) tiers labeled as producers, primary consumers, secondary consumers (accept equivalent terms);

2. **a)** greater fraction of incident light energy lost in desert; deserts are less productive/less vegetation to fix energy;

   **b)** large amounts of energy pass to decomposers in dead plant matter; large amounts of energy accumulated in forests in wood;

3. **a)** the late 1960s and the 1990s;

   **b)** (i) the number of years with an infestation is a longer stretch in the 1990s; the number of affected hectares is much higher in the 1990s;
   
   (ii) increase in the number of cycles in one season; population explosion with limited predation due to global warming;

   **c)** data suggests increased destruction of spruce trees in future; warmer temperatures will reduce life cycle to one year / increase reproduction rates; rates of destruction may remain stable / decrease; if there is an increase in predation of the spruce beetle;

4. **a)** all are in remote areas/areas uncontaminated by local pollution;

   **b)** both increase over time; greater annual fluctuations at Alert than at Baring Head;

   **c)** smaller annual fluctuations at Baring Head because it is in the southern hemisphere; less land mass / more ocean; so less photosynthesis and respiration / more storage and release of carbon dioxide in seawater;

5. **a)** (i) between 330 and 340 ppm;

   (ii) 310 to 330 ppm;

   **b)** (i) 0–7 hours;

   (ii) carbon dioxide produced by cell respiration in the soil; furthest from leaves that reduce the carbon dioxide concentration by photosynthesis in the day; lower speeds of wind that cause mixing of air; carbon dioxide is a dense gas so it sinks;

   **c)** 8.00 hours;

6. **a)** all organisms living above the surface of the soil (including plant shoots and animals);

   **b)** equatorial forest;

   **c)** little nitrogen stored in the soil; growth of crop plants will be limited by lack of nitrogen/mineral nutrients in the soil; high rainfall leaches nitrogen/mineral nutrients out of the soil;

   **d)** cell respiration;

   **e)** low biomass of plants above ground / small maximum plant size / organic matter accumulates in the soil due to slow rates of decomposition;

   **f)** melting of permafrost allowing diffusion of gases / carbon dioxide; faster rates of cell respiration in saprotrophs / bacteria / fungi; faster metabolism / enzyme activity.