Chapter 12: How Nature Works in Harmony

Exercises — Keep the Curiosity Alive

Q1 Refer to the given diagram (Fig. 12.19) and select the wrong statement.
(i) A community is larger than a population.
(ii) A community is smaller than an ecosystem.
(iii) An ecosystem is part of a community.

SOLUTION

Fig. 12.19 shows three nested circles: Population (innermost) → Community (middle) → Ecosystem (outermost). This means Population is contained within Community, and Community is contained within Ecosystem.

Evaluating each statement:
(i) 'A community is larger than a population.' — TRUE. The community circle encloses the population circle; a community is made up of multiple populations.
(ii) 'A community is smaller than an ecosystem.' — TRUE. The community circle sits inside the ecosystem circle; an ecosystem includes the community plus all abiotic components.
(iii) 'An ecosystem is part of a community.' — WRONG. The diagram shows the opposite: the community is part of the ecosystem, not the other way around. An ecosystem is the largest unit among the three — it encompasses the community (biotic) along with abiotic components.

Answer: Statement (iii) is wrong. An ecosystem is NOT part of a community — it is the other way around: a community (all biotic populations) is part of a larger ecosystem (which also includes abiotic components).

Q2 A population is part of a community. If all decomposers suddenly disappear from a forest ecosystem, what changes do you think would occur? Explain why decomposers are essential.

SOLUTION

Decomposers (fungi, bacteria, saprotrophic microorganisms) break down dead organic matter — fallen leaves, dead animals, animal droppings — into simpler inorganic compounds (minerals, CO_2, water, nitrogen compounds) and return them to the soil.

If all decomposers disappeared from a forest ecosystem:

1. Dead matter would accumulate: Dead plants, animals, and waste would pile up on the forest floor because nothing would break them down.
2. Nutrient cycling would stop: Minerals and nutrients locked in dead organic matter would not be returned to the soil. Over time, soil nutrient levels would fall sharply.
3. Soil fertility would decline: Plants depend on decomposers to release nutrients (nitrogen, phosphorus, potassium) back into the soil. Without them, soil fertility drops and plants cannot grow well.
4. Producer population would decline: With nutrient-poor soil, green plants (producers) would produce less food via photosynthesis, reducing energy available to all consumers.
5. Cascading collapse: Herbivores (deer, hare) would decline due to fewer plants; carnivores (snakes, eagles) would then also decline — the entire food web would be disrupted.

Why decomposers are essential: They are nature's recyclers. Without them, nutrients would be permanently locked in dead matter, making them unavailable for new growth. The entire nutrient cycle — especially the nitrogen cycle and carbon cycle — depends on decomposers. 'In nature, nothing is wasted — everything is reused' only because decomposers make it possible.

Answer: Dead matter would accumulate, soil nutrients would not be recycled, soil fertility would drop, producers (plants) would decline, and the entire food web would collapse. Decomposers are essential because they recycle nutrients from dead organic matter back into the soil, sustaining plant growth and keeping the nutrient cycle running.

Q3 Selvam from Cuddalore district, Tamil Nadu, shared that his village was less affected by the 2004 Tsunami compared to nearby villages due to the presence of mangrove forests. This surprised Sarita, Shabnam, and Shijo. They wondered if mangroves were protecting the village. Can you help them understand this?

SOLUTION

Mangrove forests are dense coastal forests that grow in the intertidal zones where land meets the sea. Their roots are thick, interlocking, and form a complex underwater network.

How mangroves protected Selvam's village during the 2004 Tsunami:
1. Wave energy absorption: The dense root systems and trunks of mangrove

trees act as a physical barrier. When the tsunami waves hit the coast, the mangroves absorbed and dissipated much of the wave energy before it reached the land.
2. Speed reduction: The thick vegetation slows down the speed of incoming waves, reducing the force with which water strikes buildings and people.
3. Sediment trapping: Mangrove roots trap sediment and stabilise the coastline, reducing erosion caused by the surging water.
4. Buffer zone: The mangrove belt creates a natural buffer zone between the ocean and human settlements, similar to how the Sundarbans slow down strong winds and waves during storms and floods.

Villages with intact mangrove forests experienced significantly less destruction than those where mangroves had been cleared. This demonstrates a key ecosystem benefit — mangroves provide coastal protection (a form of natural disaster risk reduction), which is one of the valuable services a healthy ecosystem provides to humans.

Answer: Mangrove forests acted as a natural barrier: their dense, interlocking root systems and trunks absorbed and slowed the tsunami's wave energy, reducing the force and height of the water that reached the village. Villages without mangroves had no such buffer and suffered greater destruction.

Q4 Look at this food chain:
Sun → Grass → Grasshopper → Frog → Snake
If frogs disappear from this ecosystem, what will happen to the population of grasshoppers and snakes? Why?

SOLUTION

The food chain is: Grass → Grasshopper → Frog → Snake
Frogs are the predators of grasshoppers and the prey of snakes.

Effect on Grasshoppers (prey of frogs):
With no frogs to eat them, grasshoppers lose their main predator. Their population will increase rapidly because they continue to reproduce but face no check from predation. With more grasshoppers consuming grass, the grass population may also decline over time.

Effect on Snakes (predator of frogs):
Snakes depend on frogs as their primary food source in this chain. With frogs

gone, snakes have nothing to eat at that trophic level. The snake population will decline and may eventually die out locally (or be forced to find alternative prey, if any exists in that ecosystem).

This illustrates how the removal of one organism creates a cascading effect — called a trophic cascade — that changes the population sizes at multiple levels of the food chain above and below it.

Answer: Grasshopper population will increase (no predator to control it). Snake population will decrease (loses its food source). The removal of frogs causes a trophic cascade affecting all other levels of the food chain.

Q5 In a school garden, students noticed fewer butterflies the previous season. What could be the possible reasons? What steps can students take to have more butterflies on campus?

SOLUTION

Possible reasons for fewer butterflies:

1. Loss of flowering plants: If flowering plants were removed, trimmed, or replaced with non-flowering species, butterflies lose both nectar sources (food) and host plants for laying eggs.
2. Use of pesticides: Insecticides or herbicides applied in or near the garden kill butterflies directly or destroy the plants their caterpillars feed on.
3. Habitat destruction: Clearing of bushes, grass, and leaf litter removes resting spots and shelter for butterflies and their larvae.
4. Fewer host plants: Butterflies lay eggs on specific host plants (e.g., citrus leaves for swallowtails, milkweed for certain species). If these plants are absent, butterflies cannot complete their life cycle.
5. Climate or seasonal changes: Unusual dry or wet weather may reduce flowering and thus nectar availability.
6. Increased predation: A rise in predator populations (birds, spiders) can reduce butterfly numbers.

Steps students can take to attract more butterflies:

1. Plant native flowering species that provide nectar (e.g., marigold, lantana, hibiscus) — these give butterflies a food source.
2. Plant host plants for caterpillars so butterflies can complete their life cycle on campus.

3. Stop or reduce pesticide use in the garden to avoid directly killing butterflies and their larvae.
4. Create a small water source (shallow dish with pebbles) for butterflies to drink.
5. Leave some leaf litter and undisturbed ground as shelter for pupae.
6. Educate students and staff about the importance of butterflies as pollinators so the garden is managed with biodiversity in mind.

Answer: Fewer butterflies are likely due to loss of flowering plants, pesticide use, removal of host plants, or habitat disturbance. Students can help by planting native nectar and host plants, stopping pesticide use, creating small water sources, and preserving leaf litter as shelter.

Q6 Why is it not possible to have an ecosystem with only producers and no consumers or decomposers?

SOLUTION

An ecosystem requires a balance among producers, consumers, and decomposers. Each group plays an irreplaceable role:

Problem 1 — Accumulation of dead matter without decomposers:
Producers (plants) grow, reproduce, and eventually die. Without decomposers (fungi and bacteria), the dead plant matter would pile up indefinitely. The nutrients locked in this dead organic matter — nitrogen, phosphorus, carbon — would never be returned to the soil. Soil fertility would decline, and eventually the producers themselves would run out of essential nutrients and die off.

Problem 2 — Runaway growth and resource depletion without consumers:
Without consumers (herbivores, carnivores), no organism would eat the producers. The producer population would grow unchecked, competing for the same resources — sunlight, water, soil nutrients, and space. Over-competition would lead to resource depletion and eventually collapse of the producer population.

Problem 3 — Nutrient cycle breaks down:
The flow of energy and recycling of nutrients in an ecosystem forms a loop: producers fix energy → consumers eat producers and release CO_2 and waste → decomposers break down dead matter → nutrients return to soil for producers. Remove consumers and decomposers, and this loop is broken. Carbon, nitrogen, and other nutrients cannot cycle back to support new plant growth.

Conclusion: A functional ecosystem needs all three groups — producers to capture energy, consumers to control population sizes and transfer energy through trophic levels, and decomposers to recycle nutrients. Without consumers and decomposers, the ecosystem would collapse due to nutrient depletion and unchecked competition.

Answer: Without consumers, producers would overpopulate and deplete resources unchecked. Without decomposers, dead matter would accumulate and nutrients would not return to the soil, cutting off the supply needed for new plant growth. The nutrient cycle would break down, collapsing the entire ecosystem.

Q7 Observe two different places near your home or school (e.g., a park and a roadside). List the living and non-living components you see. How are the two ecosystems different?

SOLUTION

This question involves personal observation, so the exact answer will vary by location. A model comparison between a park and a roadside is given below:

Park (example observations):
Biotic (living) components: Grass, flowering plants, trees (neem, peepal), butterflies, bees, earthworms, ants, birds (sparrow, pigeon), squirrels, fungi on fallen leaves.
Abiotic (non-living) components: Soil (fertile, moist), sunlight, air, water (from irrigation or rain), temperature, decomposing leaf litter.

Roadside (example observations):
Biotic (living) components: Hardy weeds, a few drought-tolerant trees (gulmohar, eucalyptus), pigeons, crows, rats, cockroaches, a few insects.
Abiotic (non-living) components: Hard compacted soil or concrete, dust, exhaust pollutants in air, sunlight, noise, high surface temperature from asphalt.

Key differences between the two ecosystems:
1. Biodiversity: The park has greater variety of plants and animals (higher biodiversity). The roadside supports fewer, more stress-tolerant species.
2. Soil quality: Park soil is fertile, loose, and moist — supports earthworms and microbes. Roadside soil is compacted, poor in nutrients, often mixed with concrete debris.
3. Pollution level: The roadside has more air and noise pollution from vehicles; the

park has cleaner air.

4. Food web complexity: The park has a more complex food web (multiple producers, consumers, decomposers). The roadside food web is simpler.

5. Stability: The park ecosystem is more stable because it has more interactions and greater biodiversity. The roadside ecosystem is fragile and more easily disturbed.

Answer: A park has greater biodiversity (more plants, insects, birds), fertile moist soil, cleaner air, and a complex food web. A roadside has fewer species (hardy weeds, crows, rats), compacted or paved soil, higher pollution, and a simpler food web. The two differ in biodiversity, soil quality, pollution levels, and ecosystem stability.

Q8 'Human-made ecosystems like agricultural fields are necessary, but they must be made sustainable.' Comment on the statement.

SOLUTION

Why human-made ecosystems are necessary:

India's population exceeds 1.4 billion people, all of whom need food. Natural ecosystems alone cannot supply the quantity of food required. Agricultural fields, fish ponds, orchards, and parks are human-made ecosystems that have been essential for food security. India's Green Revolution (1960s–1970s) used such managed ecosystems — with high-yielding crop varieties, irrigation, and fertilisers — to overcome a severe food crisis and make the country self-sufficient in food production.

Why they must be made sustainable — the problems with current practices:

1. Monoculture: Growing only one crop type repeatedly depletes specific nutrients from the soil, reduces biodiversity (pollinators decline), and makes crops more vulnerable to pests.

2. Overuse of synthetic fertilisers: These reduce soil fertility over time by lowering organic matter (humus) and killing friendly microorganisms, making soil prone to erosion.

3. Pesticide overuse: Pesticides harm non-target organisms (pollinators, natural predators). Some pests develop resistance, creating an escalating cycle. Pesticide residues enter food, soil, and water, harming human health and aquatic ecosystems.

4. Excessive groundwater extraction: Heavy irrigation is draining underground

aquifers faster than they can recharge, threatening long-term water availability.
5. Soil degradation: Heavy machinery compacts soil and repeated ploughing destroys earthworms and soil structure.

Making agriculture sustainable:
1. Use organic manures (compost, Kunapa Jala — as mentioned in Vrikshayurveda) to restore soil fertility.
2. Practice crop rotation to replenish soil nutrients and break pest cycles.
3. Use integrated pest management (encouraging natural predators like beetles) instead of synthetic pesticides.
4. Maintain hedgerows and wild strips to support pollinators and biodiversity.
5. Reduce water use through drip irrigation and rainwater harvesting.

Conclusion: The statement is balanced and correct. Human-made ecosystems are indispensable for feeding a large population, but unsustainable practices damage soil, water, and biodiversity. Moving to organic and ecologically sensitive farming protects the environment while still meeting food needs — ensuring both human welfare and ecosystem health.

Answer: Agricultural fields are essential for food security but current practices (monoculture, overuse of pesticides and synthetic fertilisers, excessive irrigation) degrade soil, harm pollinators and natural predators, and pollute water. Sustainability means shifting to crop rotation, organic manures, natural pest control, and reduced water use — balancing human food needs with ecosystem health.

Q9 If the Indian hare population (Fig. 12.20) drops because of a disease, how would it affect the number of other organisms?

SOLUTION

From Fig. 12.20, the food web shows these relationships:
Grass and plants → Hare → Fox
Grass and plants → Deer → Eagle

So the hare is a primary consumer (herbivore) that eats grass and plants and is itself the food of the fox. The deer eats the same grass and plants and is the food of the eagle. In this food web the eagle feeds on the deer, not on the hare.

Effects of a drop in hare population due to disease:

1. Fox population — Decreases:
In Fig. 12.20, the fox feeds on hares. With fewer hares available, foxes lose their

food source. Fox numbers will decline due to starvation and reduced reproduction.

2. Deer population — May increase:
Hares and deer both feed on grass and plants, so they compete for the same food resource. With fewer hares, there is less competition for grass and plants, so deer have more food available. Deer numbers may rise.

3. Eagle population — May increase:
The eagle feeds on the deer. As the deer population rises (from reduced competition with the hare), the eagle has more food and its numbers may increase. The eagle is not directly affected by the fall in hares because the hare is not its prey in this food web.

4. Grass and plants — Change is mixed:
With fewer hares grazing, the grazing pressure from hares falls. However, the deer population increases and grazes more, so any relief to the grass and plants may be temporary or offset.

Summary of cascading effects:
Hare ↓ → Fox ↓ (loses its food) | Deer ↑ (less competition for grass and plants) | Eagle ↑ (more deer to eat) | Grass and plants: less hare grazing but more deer grazing.

This shows the interconnected nature of a food web: a disease affecting one species creates ripple effects throughout the entire ecosystem.

Answer: Fox population decreases (the hare is its food, now scarce). Deer population increases (less competition with the hare for grass and plants). Eagle population may increase (it eats the deer, which is now more plentiful — the eagle does not eat the hare in this food web). Grazing pressure on grass and plants shifts from hares to the growing deer population. The hare's decline creates cascading effects through the whole food web.