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Thailand-Korea-Japan SSH Exchange Program
Biology

Ecosystems explored from dried small sardines

Name（ ）

Group Members（ ）

Introduction

Living organisms do not live in isolation. If we study organisms in their natural habitat, we invariably find that they live with other members of their species and with populations of their species, in what ecologists refer to as a community. There are many obligatory relationships between the organisms living together as a community. Living organisms cannot live in isolation for another reason – they depend on their environment, whether it consists of air, water, soil or rock. There are many types of relationships between organisms and their environment.

The community of organisms in an area and their non-living environment can be considered to be a single highly complex interacting system, known as an ecosystem. Ecologist study both the components and the interactions between them.

Food sources

All organisms need a supply of organic molecules, such as glucose and amino acids. They are needed for growth and reproduction. Methods of obtaining organic molecules can be divided into two types:

- some organisms make their own organic molecules from carbon dioxide and other simple inorganic substances – they are **autotrophic**, which means self feeding;
- some organisms obtain their organic molecules from other organisms – they are **heterotrophic**, which means feeding on others.

There are several different ways of obtaining organic matter from other organisms and of digesting it so that it can be absorbed;

- by ingesting organisms and digesting them inside the gut – organisms that do this are **consumers**;
- by ingesting dead organic matter derived from living organisms and by digesting it inside the gut – organisms that do this are **detritivores**;
- be secreting digestive enzymes into dead organic matte derived from living organisms and by absorbing the products of external digestion – organisms that do this are **saprotrophs**.

Key Words;

Autotroph *an organism that synthesizes its organic molecules from simple inorganic substances*

Heterotroph *an organism that obtains organic molecules from other organisms*

Consumer *an organism that ingests organic matter that is living or recently killed*

Detritivore *an organism that ingests non-living organic matter*

Saprotroph *an organism that lives on or in non-living organic matter, secreting digestive enzymes into it and absorbing the products of digestion*

Food chains

A food chain is a sequence of organisms, each of which feeds on the previous one. There are usually between two and five organisms in a food chain. It is rare for there to be more organisms in the chain.

Producers are autotrophic. They are usually photosynthetic organisms, such as terrestrial green plants and phytoplankton. As they do not obtain food from other organisms, producers are always the first organisms in a food chain.

The subsequent organisms are consumers feed on producers, secondary consumers feed on primary consumers, tertiary consumers feed on secondary consumers, and so on. No consumers feed on the last organisms in a food chain.

Consumers obtain energy from the organic matter of the organisms on which they feed. The arrows in a food chain therefore indicate the direction of energy flow.

Figure 1 is an example of a marine food chain. In the most accurate food chains, each stage consists of one species, but, as it is sometimes only possible to give a group of species, for example phytoplankton. Terms such as fish and tree should not be used as they include too wide a range of species.

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Figure 1 A marine food chains

Trophic levels

The categories of organisms, producer, primary consumer, secondary consumer and so on are called trophic levels. The word “trophic” is derived from the ancient Greek for nourishment. Examples of food chains are shown in Figure 2, with the trophic levels of

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Figure 2 Examples of food chains

each organisms.

Food webs

Trophic relationship within ecological communities tend to be complex and web-like. This is because most species are fed on by more than one species and most consumers feed on more than one species.

Figure 3 shows a simplified food web for pond.

When a food web is constructed, organisms at the same trophic level are often shown at the same level in the web. This isn't always possible, as some organisms feed at more that one trophic level.

The data in table 1 could be used to construct a food web.

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Figure 3 A pond food web

Species	Feed on
1. caribou	4
2. ground squirrels	4
3. jaegers	1,4,8
4. grasses and sedges	-
5. grizzly bears	4,2
6. gulls	8
7. owls and hawks	2,8
8. voles and lemmings	4
9. weasels	2,8
10. wolves	1,2,8

Table 1

Energy flow in food chains

For most biological communities, the initial source of energy is light captured by plants undergoing photosynthesis. Plant convert light into chemical energy. A portion of this energy is used by the plant in cellular respiration and is ultimately released as waste heat to the environment. Energy stored in plant tissues is passed to the next trophic level if plant

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matter is eaten by primary consumers. Alternatively, a portion of the plant material may become detritus, in which case stored energy can be passed on to saprotrophs or detrivores.

The energy stored in plant matter eaten by primary consumers can be used directly as a source of energy for cellular respiration. This will ultimately result in waste heat being released from the primary consumers. Alternatively, organic matter containing stored energy in the primary consumer can be eaten by a second consumer. In addition, undigested plant matter released as feces by the primary consumer contains available energy for saprotrophs and detrivores to utilize.

Energy is passed from consumer to consumer in a food chain, but with every transformation energy is lost from the community in heat generated by respiration. One of the laws of physics states that energy transformation are never 100% efficient. Further, when an animal eats, a portion of its food is never absorbed and is egested as feces. Some material, such as bone or hair, may not be eaten. Energy contained in uneaten or undigested material can be utilized by saprotrophs and detrivores.

Pyramids of energy

The amount of energy converted to new biomass during a given time period by each trophic level in an ecological community can be represented by a pyramid of energy. The width of the bars is proportional to the energy in that trophic level. Figure 5 shows an example of a pyramid of energy for an aquatic ecosystem, showing the loss of energy through the food chain. To be more accurate, the boxes should be drawn to have relative widths that match the relative energy content at each tophic level, as in Figure 6.

Pyramids of energy show how much energy is lost between trophic levels. The reasons for the losses are explained above. Typically only between 5% and 20% of the energy in one trophic level is passed on to the next. As a result, there is less and less energy available to each successive trophic level. Eventually there is too little energy to sustain a population, or territories would have to be unreasonably large to obtain enough energy. For this reason, food chains are limited in length.

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Figure 5 An energy pyramid for an aquatic ecosystem (not to scale)

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Figure 6 Pyramid of energy for for grassland

Experiment

Objectives

To figure out ;

・what sardines eat

・what relationship they have with other living things.

1. Dissection of dried small sardines

Equipment and materials (per group)

sample dried small sardines

instrument mount, scotch tape

Instructions

1. Cut the body to divide into 2 parts like picture shown below.

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2. Put each part on a mount by scotch tape.

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2. Observation and identification of gastrointestinal content

Equipment and materials (per group)

sample dried small sardines

instrument tweezers, toothpicks, dissecting needles, a beaker, slides, cover slips, hot water, microscopes

Instructions

1. Pick a stomach up with tweezers.
2. Put a stomach on a beaker that contains the hot water (about 10 minutes is enough).
3. Take out contents of stomach with tweezers and dissection needle on the slide slip.
4. Observe contents of stomach with a microscope.
5. Identify gastrointestinal content.

Questions

1. The diagram is a model representing different feeding interactions. Which organism could be saprotrophs?

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A. V and W B. W and Z C. V only D. Z only

2. A mesocosm experiment was set up to evaluate how the presence of the tiger fish (*Hoplias malabaricus*) affects the plankton structure of a lake in South America.

Twelve experimental units were set up. Each mesocosm was filled with groundwater, including sediment and free-floating plants and the plankton *Daphnia obtuse*. In some cases *Jenynsia multidentata*, a fish eaten by the tiger fish, was added with or without tiger fish of different sizes. The four different treatments were randomly assigned.

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Control: plankton (*Daphnia obtuse*) (no fish)
JM: plankton (*Daphnia obtuse*) + *Jenynsia multidentata*
HMs: plankton (*Daphnia obtuse*) + *Jenynsia multidentata* + *Hoplias malabaricus* (small tiger fish)
HMb: plankton (*Daphnia obtuse*) + *Jenynsia multidentata* + *Hoplias malabaricus* (big tiger fish)

The abundance of plankton (*Daphnia obtuse*) remaining in the mesocosm was recorded as individuals per litre at different times.

a) (i) State the amount of *Daphnia* in the JM mesocosm at the start of the experiment.

(ii) Calculate the percentage change in *Daphnia* in the JM mesocosm from the start to the end of the experiment.

b) State one variable that is not kept constant in these mesocosms.

3. The diagram is of an ocean food web.

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a) State a producer in this web.

b) State the trophic level(s) of the gull.

c) Predict what would happen to this web if a disease killed most guillemots.

4. The diagram is a trophic pyramid of energy (not shown to scale).

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a) Label X and Y.

b) State the units used in a pyramid of energy.

c) Explain the loss of energy from one level to the next in a pyramid of energy.

5. Figure 7 shows a simplified food web from open ocean in the southern hemisphere. The arrows indicate the direction of energy flow.

ⅰ State the trophic level of nanophytoplankton.

ⅱ Identify two primary consumers in the food web.

ⅲ Identify in the food web:
a) the shortest food chain
b) the longest food chain
c) the species with the most predators
d) the species with the greatest number of different types of prey

ⅳ Discuss the trophic level to which emperor penguins should be assigned.

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Figure 7

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