ECOLOGY AND ENVIRONMENT

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THE SIGN OF  A GOOD BOOK

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はじめに

"ECOLOGY"（生態学）という語は，今日では様々な意味と形を持って意識されている言葉であると言えます．環境にやさしい製品や，リサイクル，自然保護の問題などの話題が常にエコ・ブームに乗じた形で提供されています．しかし，これは単なる一時的な現象ではないと思われます．我々人間にとって深刻な問題であるために，"ECOLOGY" は環境問題と密接に結び付きながら広く浸透しています．R. CARSON の *SILENT SPRING*（『沈黙の春』）(1962) や，ローマ・クラブによる *THE LIMITS TO GROWTH*（『成長の限界』）(1972) に始まる書物の普及や，行政，企業，市民レヴェルに至るまでの様々なムーヴメントなどによって，人間の自然に対する行為への反省の意識が深まっていることも確かです．しかし，本書における "ECOLOGY" とは，様々な生物の生態を生態系の中で位置付けるような厳密な意味での生態学にまで内容を発展させているわけではありません．なぜ敢えてそのように述べるかというと，"ECOLOGY" と銘打っている以上はその「生態」という語の持つ意義を本書なりに固定する必要があるからです．あくまでも本書の目的は，生態学の中でも最も基本的な項目を基盤として英語の読解と表現の力をつけることにあります．

時事的な英語の題材の1つとしてよく扱われる環境問題は，今では英語のテキストとしてかなり取り上げられるようになりました．地球温暖化現象，放射性廃棄物質，オゾン層の破壊，酸性雨，人口過剰，生物多様性の減少などの問題が英語テキストによく取り上げられています．どれもが実際に新聞や雑誌などに掲載され，よく知られている TOPIC であり，読者の関心を引き付ける刺激的なものと言えます．

原題を *ECOLOGY AND ENVIRONMENT* (1995) とする原典は，OXFORD UNIVERSITY PRESS より出版されている SCIENCE ENCYCLOPEDIA シリーズの1冊です．このシリーズには天文学，化学，動物学，物理学から

遺伝学などがあり，どれも豊富なイラストや写真と，わかり易い説明で構成された親しみやすい科学小百科辞典となっています．科学的で明晰な英文は非常に読みやすいものです．原典はエネルギー伝達，食物連鎖，元素の循環，個体群，自然保護などの一連の生態系に関わる項目を通じて，地球・自然の仕組みを体系的に説明しています．本書はこの特色を活かすために，EXERCISE には原典で使用されているイラストを多用しました．体系的な内容は，各章の TECHNICAL TERM を記憶し易いので学習に効果的です．本書では最初に本文を提示し，次に復習と語彙／表現の学習という意味で練習問題を付してあります．EXERCISE の A は主に本文に関する英語での質疑応答であり，口頭ないしは作文による応答が可能です．B は主にイラストを使用した空欄補充問題で，本文の復習と語彙の学習を意識させるようにしてあります．C は本文の内容に即した DICTATION としました．また，巻末に ECOLOGY 関連の単語についての簡単な GLOSSARY を付しました．本書が理系／文系の学生はもとより，広く “ECOLOGY” に関心のある方々に少しでも役に立つことを願っています．

最後になりましたが，本書を作成するに当たり，編集部の宇治正夫氏をはじめとして，英宝社の皆様には大変お世話になりました．この場をお借りして心から感謝の意を表します．

1997 年 8 月

編 注 者

CONTENTS

1

THE GLOBAL CLIMATE

The Earth is the only planet that supports life. The first organisms appeared more than 3.5 billion years ago; today there are millions of species inhabiting the biosphere—the part of the planet where life is found. Climate is among the most influential factors that determine their survival.

The Earth relies on a constant supply of light and heat energy produced by the Sun, which is absorbed both by Earth's atmosphere and by the land and oceans below. The amount of heat that reaches the surface varies, creating climatic zones: tropical, temperate and polar.

The climatic zones are linked to areas of high and low atmospheric pressure. When air near the ground is heated, it expands and becomes less dense, creating an area of low pressure. The warm air rises, while cool air flows in to replace it. The result is a convection current of circulating air. The rising warm air cools as it gets higher in the atmosphere and increases in density. It begins to sink back down, forming a high-pressure area. Global temperature differences cause a circulation of air currents, with warm air rising from the tropics and moving toward the Poles, distributing heat energy along the way. In general, there are areas of low pressure over the Equator and the temperate regions; high-pressure areas cover the polar regions and the

semitropical regions immediately north and south of the Equator.

The uneven distribution of rainfall is another important aspect of the different climatic zones, and it depends on both temperature and air movements. Tropical regions receive the greatest amount of incoming heat energy from the Sun, which evaporates huge amounts of water from the oceans and (to a lesser extent) the land. Warm air can hold more moisture than cool air, which tends to be dry—the warm air has a higher humidity.

As the tropical air rises, it cools and loses moisture, much of which falls back on the tropics as rain. The cooler, drier air then continues moving north, depositing little moisture in the warm temperate zone. As it passes over the warm land, it is warmed again, and more moisture is released in the cool temperate zone. By the time the air reaches the Poles, it is dry and cold.

Climate determines what vegetation can grow in a region, and how much. Tropical regions receive the most heat and moisture, and have the highest productivity—the total vegetation grown, usually measured in kilograms per square meter (kg/m^2). Rainforest produces about 3.5 kg/m^2 per year, compared with less than 0.1 kg/m^2 in deserts and polar regions. Productivity in deserts is limited by lack of water and in polar regions by lack of heat and light.

NOTES

3 **biosphere** 「生物圏」 10– **atmospheric pressure** 「気圧」 13 **convection current** 「対流」 35 **vegetation** 「植生」

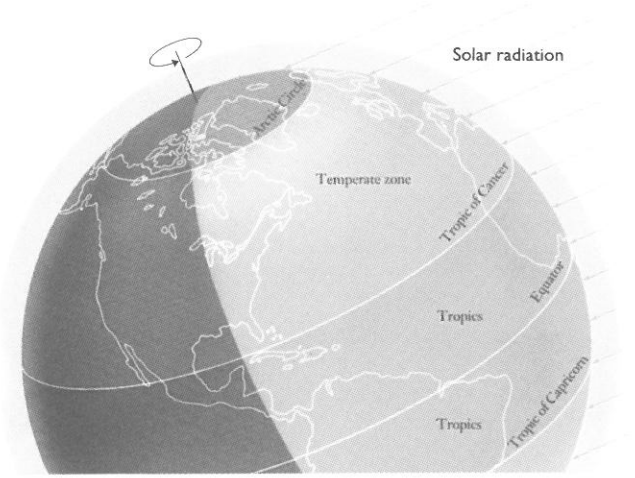
A Answer the following questions in English.

1. When did the first organisms appear ?

2. What do global temperature differences cause ?

3. Explain the dominant feature of Tropical regions.

B For each set of parenthesis in the following sentences which explain the illustration, choose an appropriate word from the column below.



△ At the ( ), the Sun is overhead for much of the year and its rays strike the ground almost ( ). Little heat is lost as the rays pass through the atmosphere so most reaches the ground. The ( ) receive much less energy because the Sun is low in the sky for much of the year and the rays have a lot of atmosphere to pass through. The movement of air and water ( ) the heat from the Equator toward the Poles.

A. transfers	B. vertically	C. Equator	D. Poles

C Listen to the tape carefully and write the sentences down.

1. _____

_____

2. _____

_____

2

WEATHER PATTERNS

The daily pattern of conditions such as temperature and rainfall is called weather. It may change from day to day or even from hour to hour. Climate is based on the average weather conditions over a long period—about 30 years—and changes very slowly.

Weather begins with air movements. Warm air is less dense than cold air, so it tends to rise (convect), causing a reduction in atmospheric pressure. Wind blows from high-pressure to low-pressure areas. If the Earth did not rotate, cold, high-pressure air would simply flow from the Poles toward the Equator, while warm, low-pressure air from the Equator flowed toward the Poles. However, convection currents in the atmosphere are affected by the spin of the Earth on its axis. The warm, rising air spins more slowly than the Earth. Because of this, it moves along a curved path. In the northern hemisphere it is deflected to the right, and in the southern hemisphere it is deflected to the left. This is called the Coriolis effect. It also influences the direction of high-pressure systems (anticyclones) and low-pressure systems (cyclones). Anticyclones are associated with calm weather, cyclones with disturbances such as tropical storms.

At the Equator is a region of calm, warm, low-pressure air called the Doldrums. When it rises, it causes streams of high-pressure air to

move toward the Equator from the north and south to replace it. These high-pressure streams are the trade winds. They do not blow directly north and south, for they are influenced by the Coriolis effect. The trade winds span nearly half the globe and dominate the weather systems of the tropics and semi-tropics.

Next to the zone of the trade winds, between about 30° and 60° latitude (the temperate zone), are the westerlies, the second major global wind system. Westerlies blow toward the Poles and are particularly strong in the southern hemisphere, where there is less large land mass to lessen their force. In the temperate zone, cold air from the Poles (called easterlies) meets the warm air from the tropics. These do not mix easily. The interaction of cold and warm currents and the spinning of the Earth result in high, fast-moving winds called jet streams. They are found 8–10 kilometers above the surface of the Earth, travelling at 200 km/h. A jet stream is rather like a snaking tube that weaves an unsteady path, creating a series of areas of low and high pressure.

Unlike the Doldrums, which are a permanent fixture at the Equator, the large belts of winds—the trade winds and the jet stream—shift with the changing seasons as the Earth heats up and cools down. This is among the chief factors that produce weather conditions. For example, when the jet stream moves north, the air beneath becomes less dense and the tropical warm air can move north too, creating an area of low pressure. If it drifts to the south, denser, cold air moves south, creating a high-pressure area. The changing patterns of low- and high-pressure areas give countries in the temperate zones their changeable weather patterns. Hot, sunny weather results when the jet

stream moves north in summer, allowing warm tropical air to cover the land. When the jet stream moves south in winter, cold polar air moves south too, bringing cold winds and clear skies. Long-range weather forecasts attempt to predict the path of the jet streams because they have such a significant influence on the weather.

The trade winds move north and south over the Equator by about 5°— except over India, where they move by as much as 30°. This is partly due to the high temperature of the continent, which warms the air and creates low-pressure zones. These conditions are reinforced by shifts in the local jet stream, which moves to the south in the winter, bringing dry, high-pressure air down to India from the Tibetan plateau; in the summer it recedes back to the north, and the local low-pressure system resumes.

NOTES

15 **Coriolis effect** 「コリオリの効果」 上空の運動体を地上で見るとき，地面に対して見かけのふれを起こすこと．このふれは実際は地球の自転が引き起こす偏向の力によるもので、北半球は右へ、南半球は左へ起こる．
18 **disturbance** 「擾乱」 局地的な低気圧． 18 **tropical storm** 「熱帯暴風」 20 **the Doldrums** 「赤道無風帯気象」 33– **jet stream** 「ジェット気流」 偏西風帯の上層で風速の極大点を中心とする強風帯．

A Answer the following questions in English.

1. What is the daily pattern of conditions such as temperature and rainfall called ?

2. What is a region of calm, warm, low-pressure air at the Equator called ?

3. Name the three major wind systems flowing over the Earth.

B For each set of parenthesis in the following sentences, choose an appropriate word from the column below.

The Coriolis effect, caused by the Earth's ( ) on its axis, ( ) winds to the right in the ( ) hemisphere and to the left in the ( ) hemisphere. This complicates the basic pattern of warm air flowing north and cool air flowing south.

A. southern	B. deflects	C. rotation	D. northern

C Listen to the tape carefully and write the sentences down.

1. _____

_____

2. _____

_____

3

THE WORLD'S BIOMES

Life exists in only a small part of the Earth—in the lower atmosphere, on the surface and in the oceans. Together these form a single large ecosystem called the biosphere. Within it, organisms may live on land or in the water. These two different environments may be divided further into biomes, which are characterized by the kinds of plants that grow there.

Land covers less than a third of the surface of the planet, but 90 percent of all species live on it. The characteristic plants of a biome support typical groups of animals. This distribution of life forms around the globe is far from random. It is closely linked to the climatic zones—polar, temperate and tropical—because climate is a major factor that determines whether an animal or plant survives.

The two most important factors that influence which species can live in which land biome are the temperature and the amount of rainfall. These produce three main categories of terrestrial biome—grassland, forest and desert—in each of the climate zones. A forest, for example, may be cold (northern Canada), temperate (the Black Forest in central Europe) or tropical (the rainforest of central Africa). Biomes are often similar on different continents: African grassland looks like that of South America or Australia.

Biomes do not have precise boundaries, but blend into one another across broad geographical regions. Their patterns vary with climate, so that parts of the North African desert are at the same latitude as the temperate forests of the southeastern United States. The detailed climate of an area depends, to a large extent, on the arrangement of land and sea. Because land masses warm up and cool down more rapidly than bodies of water, continental land masses experience quite different climates than do islands at the same latitudes. Continental climates have cold winters and warm summers, whereas maritime climates, which are influenced by the ocean currents, often have milder winters but wetter summers.

Climate is much less important in aquatic biomes. The single most important factor that determines what life can flourish in water is the amount of salt it contains. Salt-water aquatic biomes cover a much larger area of the Earth than any other biome, but they do not support as much life. Most marine life is found in the shallower water—down to about 200 meters in depth— over the continental shelves and slopes, where ultimately it depends on the abundance of plankton.

NOTES

3 **ecosystem** 「生態系」　3 **biosphere** 「生物圏」 地球上で生物が生活している全範囲とそこに生息する全生物からなる生態系.　15 **terrestrial** 「陸地の」　24 **detailed** 「複雑多岐な」

A Answer the following questions in English.

1. What percentage of all species live on land ?

2. Name the two most important factors that determine the kind of species living on land ?

3. Why does the climate of an area depend on the arrangement of land and sea ?

B For each set of parenthesis in the following sentences, choose an appropriate word from the column below.

In the Arizona desert, scientists have built a $ 30 million artificial ( ) to carry out experiments with self-sustaining ( ). Biosphere contains the main natural biomes — rainforest, tropical grassland, ( ) , ocean — as well as two artificial systems, ( ) and urban.

A. agriculture	B. desert	C. biosphere	D. ecosystems

C Listen to the tape carefully and write the sentences down.

1. _____

_____

2. _____

_____

4

ENERGY TRANSFORMATION

The Earth depends on a continuous supply of heat and light from the Sun. A few organisms can use the heat energy directly—as when reptiles bask in sunlight to absorb heat—but the only organisms that are able to make use of light energy to make food are green plants and a few bacteria. The light energy captured by the green plants is converted to chemical energy, which can be utilized by animals. This can be thought of as a flow of energy from the Sun through an ecosystem.

When animals eat plants, they obtain both chemical energy and essential nutrients. Chemical energy is the "fuel" that drives the biological processes of life, whereas nutrients are the components that make up not only food but also living tissue itself. Both are passed from plant to animal or from animal to animal. Nutrients are chemical elements such as nitrogen and are part of the abiotic (nonliving) component of an ecosystem. Eventually, all nutrients are returned to the ecosystem and recycled. Energy conversion is less efficient. No animal can convert its total food intake into an equal amount of energy. Some energy is lost as heat and waste products and cannot be recycled back into the ecosystem. Decomposers, such as bacteria and worms, use the chemical energy and nutrients locked in the waste

products and bodies of dead animals on which they feed. They play a key role in recycling nutrients through the system.

The conversion of energy in an ecosystem may be traced from one level to another. Primary producers (plants) are eaten by primary consumers (animals such as herbivores). These animals may in turn be eaten by other animals—secondary consumers—which, in turn, are eaten by tertiary consumers. The energy originally obtained by the primary producers is passed along, forming a food chain.

Each level in the chain is called a trophic level. The first level is occupied by the primary producers, and the second trophic level by the primary consumers. Consumers from different species may be at the same level in the chain, and share the same feeding habits. Plants are nearly always at the bottom of a food chain; therefore all animals are dependent, directly (in the case of herbivores) or indirectly (in carnivores), on plants for their energy requirements. An ecosystem can more easily support a large base of primary consumers than secondary or tertiary consumers, because the available energy decreases at each level.

NOTES

3 **reptile** 「爬虫類」　12 **tissue** 「組織」　14 **abiotic** 「無生物の」　19 **Decomposer** 「分解者」　25 **herbivore** [hə́ːrbəvɔ̀ːr] 「草食動物・草食獣」　28 **food chain** 「食物連鎖」　30 **trophic** 「栄養の」　35 **carnivore** [káːrnəvɔ̀ːr] 「肉食動物・肉食獣」

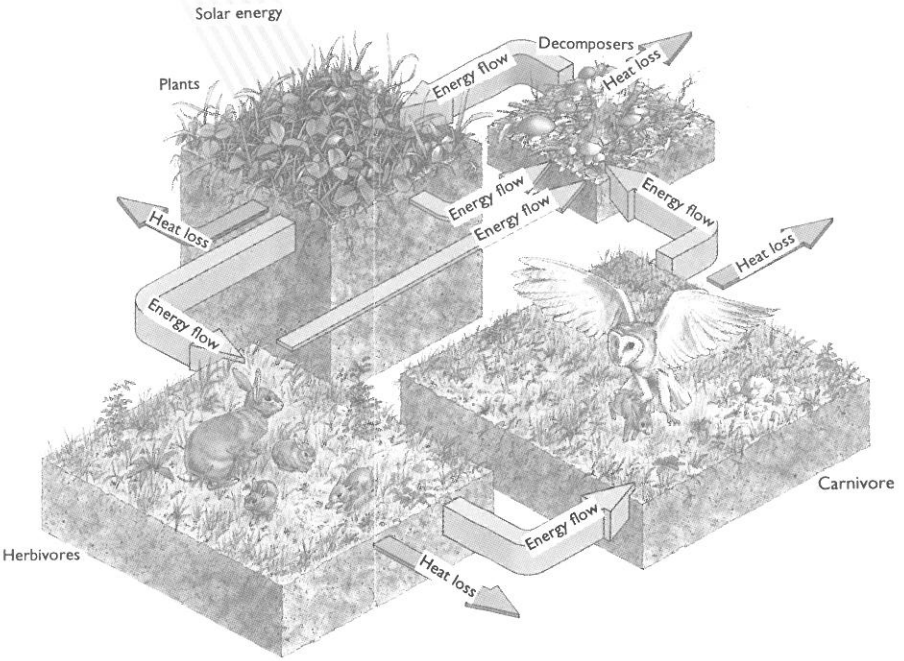
A Answer the following questions in English.

1. What organisms are able to use light energy to make food ?

2. How do decomposers play a role in recycling nutrients through the system ?

3. Do owls directly depend on plants for their energy requirements ?

B For each set of parenthesis in the following sentences which explain the illustration, choose an appropriate word from the column below.



△ Sunlight is the basis of the Earth's food supply, but its energy can be transferred to animals only through green plants (primary producers) such as grass. When animals such as rabbits (primary consumers) eat the grass, they gain chemical energy and essential ( ). Rabbits attract predators such as owls, which are the secondary consumers in this ecosystem. Scavengers feed on dead and dying animals. All the wastes of the animals, together with the remains of the plants, are ( ) by micro-organisms which recycle the nutrients back into the soil. At each stage there is a transfer of energy between plant and animal, or between animal and animal. However, up to 90 percent of this energy is ( ) between one level and the next, usually in the form of heat loss. Eventually, all the energy entering the living components of an ecosystem will be lost in this way. Unlike elements such as carbon and nitrogen, which flow through the ecosystem in ( ) cycles, the flow of energy —which is needed to drive the natural cycles—is linear. Energy ( ) as it passes along from one level to another. All energy is eventually lost as heat and must be replaced by energy from the Sun.

A. wasted	B. diminishes	C. nutrients
D. continuous	E. decomposed	

C Listen to the tape carefully and write the sentences down.

1. _____

_____

2. _____

_____

5

PYRAMIDS AND WEBS

Most animals eat a variety of foods for a good reason: if anything reduced the supply of a particular food source, the consumer of that food would be affected by a shortage. By feeding on a range of foods, animals can avoid shortages. However, there are some animals that rely exclusively on a single source of food. For example, many of the sea birds of the North Atlantic around the Shetland Isles feed only on sand eels. Due to climatic change and over-fishing, the sand eel population has plummeted, and the sea bird populations have decreased dramatically as a result of starvation. This is an example of the interrelated feeding relationships that form a food chain.

There are different types of food chain. In a sequence in which plants are eaten by herbivorous animals (grazers), which in turn are eaten by carnivorous predators, the chain may be called a grazing food chain. There is also a detritus food chain, in which dead plants are consumed by decomposers. In a well-developed ecosystem, such as a forest, more than 90 percent of primary production is eventually consumed by the organisms in the detritus chain; less than 10 percent is consumed in the grazing chain. In contrast, in a less developed ecosystem such as a fishpond or farmland, 50 percent or more of production is consumed in grazing. Studies of grass-cow-human food

chains in pasture farming have shown that future productivity depends on retaining at least 50 percent of the total annual production within the system; if less is retained, nutrient recycling and moisture cannot be maintained, and within ten years the ecosystem becomes severely depleted.

In the study of a particular ecosystem, it is possible to build up a complex food web that shows all the different feeding relationships. In such a food web, an animal may be both a primary and secondary consumer, feeding on both plants and animals; it may also be both a secondary and tertiary consumer, depending on which animal it feeds on at a given time.

A different way of illustrating a food chain is by using a pyramid of numbers. This display is designed to show the number of organisms at each feeding level. The pyramid begins with a large base and decreases sharply with each higher level because the number of creatures is fewer in higher levels of the chain than in lower levels. In most cases, the pyramid is a reasonable representation, because there are always fewer carnivores than herbivores.

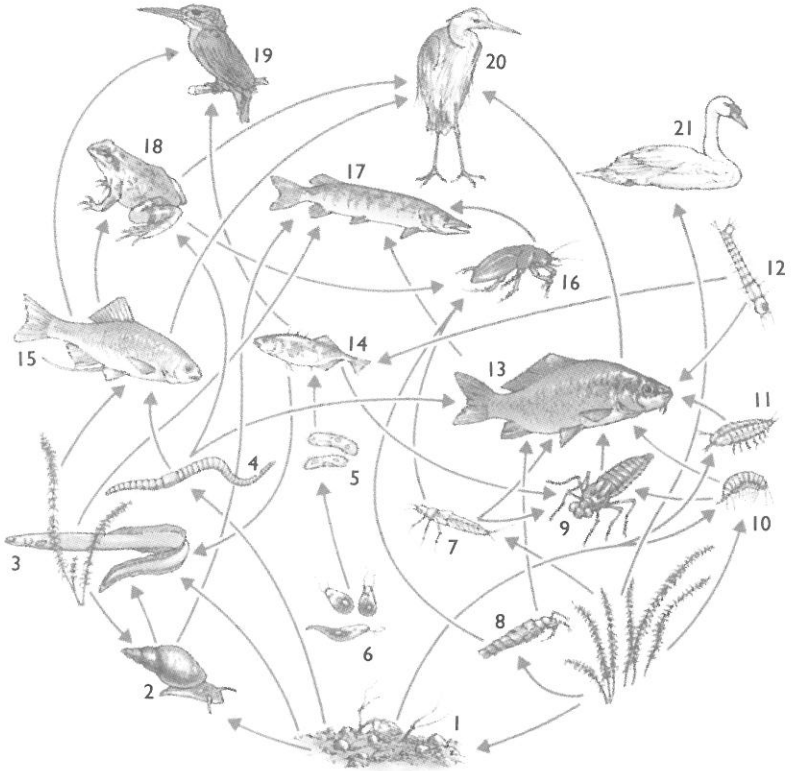
But the use of numbers alone to represent a food chain can be misleading. A large tree and a single small plant both count as one plant, even though there is an enormous difference in their sizes. For this reason, it is more appropriate to plot a pyramid of biomass —the mass of living matter at each level of a food chain. Sometimes the pyramid of biomass may be inverted: there is a greater mass of primary consumers than producers. This happens in marine food chains, in which zooplankton (consumers) often outnumber the short-lived, rapidly-reproducing phytoplankton (producers).

Pyramids of numbers and of biomass, however, can only provide a limited amount of information, because other critical information such as the availability of energy is missing. A pyramid of biomass does not indicate if any animals had large amounts of energy stored in their bodies as fat, or how much energy in the bodies of herbivores is passed on to carnivores. All this can be represented by a pyramid of energy. This shows the energy content of all organisms at each trophic level. It takes into account the number of organisms, their biomass and their energy content.

NOTES

6 **Shetland Isles** 「シェトランド諸島」およそ100の島から成る，シェトランド県を成す群島で，Great Britainの最北部． 7 **sand eel** 「イカナゴ」砂中に生息する細長い海水魚． 14 **detritus** 「有機堆積物」 27 **food web** 「食物網」生物の捕食・被捕食および消費者・供給者の関係の総称． 42 **biomass** 「生物量」一地域内の単位面積 [堆積] 当たりで表した生物の現存量． 46 **zooplankton** 「動物プランクトン」 47 **phytoplankton** 「植物プランクトン」

A Fill in the following blanks from the column below.



1 ( )
2 Water snail
3 ( )
4 Lumbricoid worm
5 Zooplankton
6 ( )
7 Mayfly larva
8 Caddisfly larva
9 ( )
10 Amphipod
11 Isopod
12 ( )
13 Carp
14 Stickleback
15 Bitterling
16 Water beetle
17 ( )
18 Frog/tadpole
19 Kingfisher
20 Heron
21 ( )

Swan	Pike	Eel	Dragonfly larva	Detritus
Mosquito larva	Phytoplankton			

B For each set of parenthesis in the following sentences which explain the illustration, choose an appropriate word from the column below.

△ Only a small amount of food is needed at the first level of a food web in an ( ) ecosystem such as a temperate pond, as long as the pond remains well supplied with ( ). A large base of primary consumers feeds on this small base, ( ) in turn a surprisingly large number of higher consumers, up to the top of the food web. The first level of a land-based food web usually ( ) to be much larger.

A. light	B. needs	C. supporting	D. aquatic

C Listen to the tape carefully and write down the sentences.

1. _____

_____

2. _____

_____

6

THE WATER CYCLE

Although Earth may be accurately described as a watery planet because so much of its surface is covered by oceans, water as a resource is far from abundant. This is because about 97 percent of the world's water is salt water, which is unsuitable for drinking, for irrigation, and even for many industrial purposes. Fresh water accounts for only about 3 percent of the total supply. Of this, less than 0.5 percent is readily available from rivers and lakes, which nevertheless provide 80 percent of the water used in industry and agriculture worldwide. The water supply may appear to be increased by natural means such as rain, or by artificial means such as drilling wells, but the amount available on the planet is constant. It is continuously recycled in the water cycle.

The oceans are the most important source of water, providing four-fifths of the total water in the cycle. Water evaporates from the surface of the oceans, leaving behind the salt. Some water also evaporates from rivers, lakes, the leaves of plants and the skin of animals as they sweat. The vapor rises in the atmosphere and cools. As it does so, it condenses to form water droplets high in the atmosphere. These droplets come together to form clouds. Their weight causes them to fall from the clouds as rain, snow or sleet—some of which falls on