PLANT ECOLOGY

Plant Ecology is a book that discusses in a complex and structural manner about the phenomena that occur in the plant world and its relation to the environment. The phenomenon is packaged in a conceptual principle by raising a series of empirical facts in it. The book also describes the overall scope of ecology which includes all aspects of the world of ecology. Dimensionally, the discussion of ecology in this book raises the study of the implications of ecological factors on plant life. The study starts from the lowest structures, such as biotic and abiotic factors and components related to plants, to more complex exposures such as ecosystems and the biosphere. The discussion is arranged in a systematic hierarchy, making it easier for readers to understand the material contained in the book.

In addition to theoretical explanations, the book also presents the principles of restoration in plant ecology. The principle in question is in the form of a succession mechanism and an analysis of environmental parameters. The discussion is useful as a basis and basis for carrying out a series of scientific procedures to further investigate indicators that have a significant effect in the world of plant ecology.

Supplementary information in this book lies in additional literature recommended for a more comprehensive review of the material presented. Material supporting literature can also be applied in such a way in the implementation of ecological research. So, in addition to getting to know the theoretical discussion of ecology, the reader is also able to develop science relevant to the study interest in plant ecology.

This book is also equipped with material substances that are arranged in an integrated manner with the need for learning competencies in the scope of ecology. This is a schematic description and inductive preparation of the material, starting with an introduction to general ecology, ecological principles, the characteristics of each ecological component, to a more comprehensive description of the study and the specific environmental mechanisms that support plant life processes.

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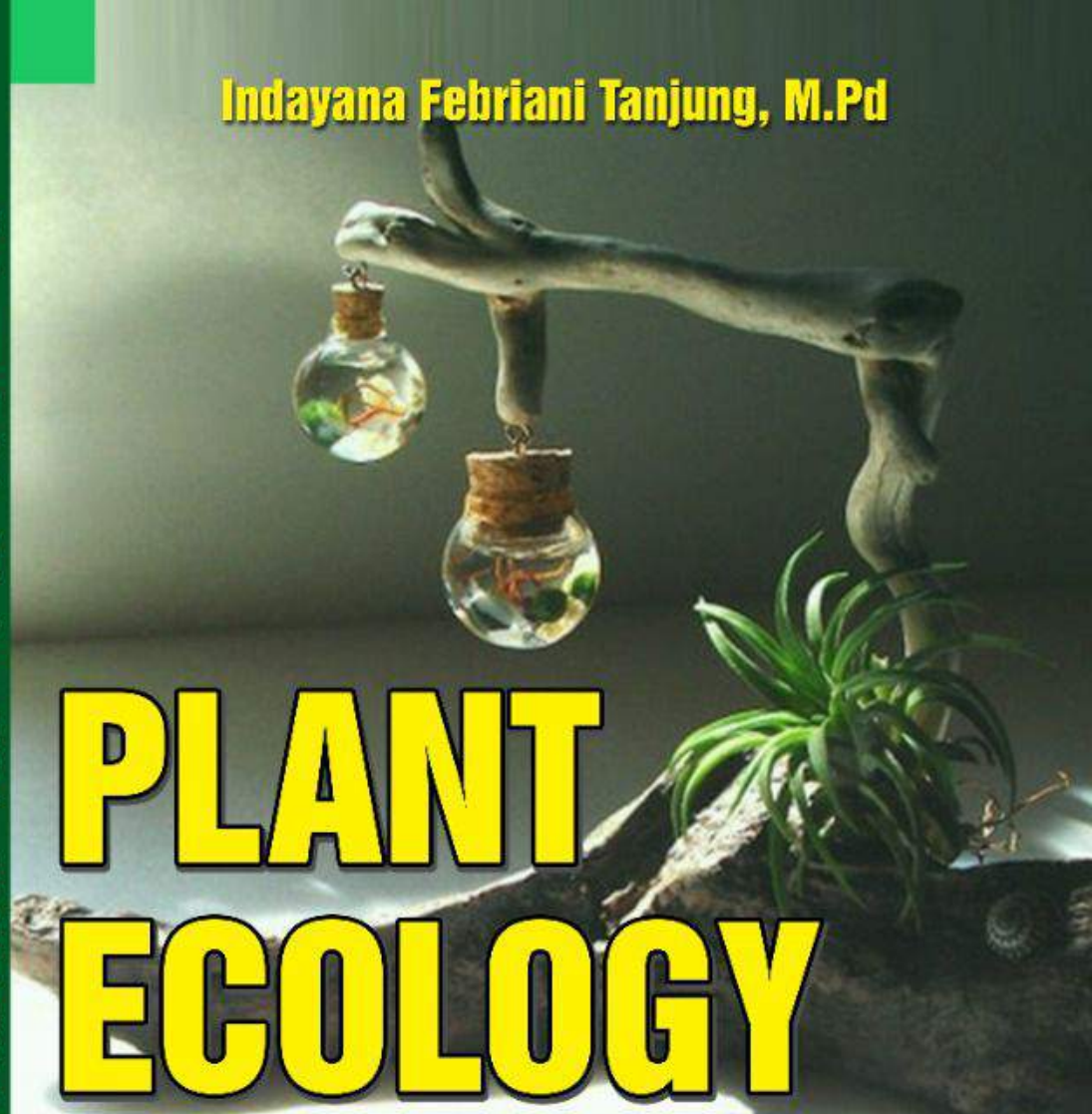

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Kemudian, Buku ini hadir dihadapan pembaca budiman, merupakan salah satu hasil usaha positif dari upaya pencarian solusi alternatif dalam mengatasi masalah lingkungan dengan menempatkan keselaraan antara manusia sebagai khalifah dengan lingkungan alam serta makhluk hidup lainnya, sebagai suatu kesatuan yang membentuk kesalehan lingkungan.

Dalam proses penulisan dan penyelesaian buku ini, tentunya masih memerlukan penyempurnaan, oleh sebab itu, masukan dan saran dari berbagai pihak sangat diharapkan semoga buku ini bermanfaat bagi pembaca mahasiswa, dosen, peneliti, praktisi dan pemerhati lingkungan sekaligus menambah khasanah buku ini menjadi karya yang diridhai Allah SWT. Amin

Medan, Oktober 2021

Penulis,

DAFTAR ISI

DAFTAR GAMBAR

CHAPTER I

INTRODUCTION TO ECOLOGY

A. Understanding Ecology

What do you think about ecology? Understanding ecology in general is the science that studies the interrelationships between organisms and their environment. While the etymological understanding of ecology is "Ecology" comes from the Greek "Oikos" which means a place to live and "Logos" which means science. Then the notion of ecology in language is the science of the relationship between organisms and their environment. According to some ecologists is a comprehensive science of the relationship between organisms and their environment (Ernest Heackel; 1866) while according to C.J. Krebs (1972) ecology is a branch of science that studies the way organisms interact and their abundance.

B. Definition of Plant Ecology

Plant ecology is a branch of science that deals with the spectrum of interrelationships between similar plants and other plants and the physical environment in which they live.

This understanding leads to that, plants influence each other's life activities. Plant ecology has a distinctive feature, plants can convert chemical energy into potential energy and convert inorganic materials into organic matter.

Discussing plant ecology, plant ecology cannot be separated from ecosystems. Ecosystems are influenced by the presence of abiotic factors

(temperature, water, soil, humidity and light) and biotic factors (living things consisting of humans, animals and plants and microbes).[1]

C. Ecological Scope

The ecological scope is as follows:

1. Individual: a single organism of each particular species. Examples are a human, a lion, a cat, a fish and so on.
2. Population: a group of individuals of the same species inhabiting a particular place and time. For example, a collection of humans, a collection of ants, a collection of trees and so on.
3. Community: a collection of populations that interact with each other. For example, prairie communities, bird populations, caterpillar populations, snake populations and so on.
4. Ecosystem: there is a reciprocal relationship between living things and their environment. for example forest ecosystems, marine ecosystems and others.
5. Biosphere: the highest level of organization in which there is life on earth [2].

D. Aspects About Plant Ecology

According to the book I have read which says that ecology has three main aspects, of which the three aspects are:

a. Agronomic aspects

The science or study that discusses how to manage production and the surrounding environment with the aim of obtaining better and more optimal production or results than before is called the agronomic aspect. This aims to find out how a place or location can be used as a location for production processing and its relationship to the environment and the impact factors it gives to the environment itself.

[1]Rai. Wijana. Arnyana, *Buku Ajar EkologiTumbuhan*, (Singaraja: STKIP Singaraja:.1998).
[2]Ardhana, IPG. *EkologiTumbuhan*.(*Denpasar* : Udayana University press. 2012).

Agronomy itself has a lot of negative factors or fatal consequences, because when managing and utilizing the place it can disturb the organisms that are in the place or even the soil used and managed is not good and cannot produce properly.

From this, there are still many factors that can occur when using the agronomy method itself, which is not yet known by the public, especially the people who existed in ancient times or at the time before modern technology was introduced. In ancient times people only wanted to take the produce they had cultivated and did not care about the place that had been used. When they get the results of the processing with less than the maximum income, they have to move places or move locations to match crops.

Habits carried out by ancient people until now who do not know what the factors are if a place that has been processed and then abandoned can cause fatal damage and it may be that all the places they use cannot produce a better product. Because it has been damaged and not treated so that it can be used again.

b. Aspects of Plant Physiology

Based on the journals that I have read which state that plant physiology is a study that discusses and studies and applies that processes or methods that occur in the plant body or its internal parts that cannot be seen directly without injuring or examining the internal organs involved. found in plants themselves, especially higher plants.

From the "karim" statement, I can conclude that in the science of plant physiology it develops from the results of structural observations and how the observations that have been obtained will be associated with the function of the plant itself, so that it can be easier to know the characteristics and characteristics of the plant itself. the grouping of the plants themselves so that after finding things related to the plant, it can be seen what factors limiting the yield of the plant such as what affect its growth and knowing how to increase the potential yield of the plant so that later the potential that has been obtained can be used or used to improve the way and quality of the plant itself and then the influence of what is around the plant itself that makes the plant can live.

c. Agricultural Climatological Aspects

Climatology itself is a science that discusses the ilkim condition in the environment with other environments and what things distinguish that place from other places so that the growth of a plant is different then the relationship that has been established is associated with human activities around it. . Then what factors can affect the plant itself based on the state of the surrounding environment and geographical location that affects the state of the plant. This climatology also discusses why the climate and weather in various places are different, what influences these conditions and what factors cause these conditions to occur.

This climatology is very influential in the growth period of a plant because it is directed to the climate and the measurement of climate control itself on the growth rate experienced by a group of plants so that it can be said that this climatology has many benefits for agriculture, forestry, transportation, transportation, telecommunications, tourism, trade.

Based on these three aspects, it can be said that the three aspects are interconnected, which gradually explains how the management process is then how to know the characteristics of the plant itself and it can be seen how the internal organs contained in the plant and the climate or weather that affect the growth of the plant itself[3]

E. Plant Ecological Benefits

The use of plant ecology for humans is as follows:

1. **Knowing Biodiversity**

   Ecology provides understanding to humans about the variety of living things on earth accompanied by their respective places of residence. For example, camels are able to live and adapt to high desert temperatures and penguins which are adapted to live in very low temperatures.

[3]Koesmaryono, Yonny dan Askari, Muhammad. 2014. *Klimatologi Pertanian Dalam Pengertian dan Ruang Lingkup Klimatologi Pertanian dan Pengaruh AtmosferTerhadap kehidupan dan Pertanian*. (Jakarta :Uinversitas Terbuka) hlm 1-24

2. **Knowing the Behavior of Living Things**
   Ecology can make humans know the types of behavior of other living things so that they can be useful for human life. For example, in the behavior of bats that can adapt to submarine solar systems.
3. **Knowing the Role of Humans in the Environment**
   With ecology, humans can know the impact of a product produced on an environment. For example, the use of High Level Disinfection (DTT) which is used to eradicate pests and can pollute the environment in humans and other organisms.
4. **Mapping Food Consumption**
   Humans can know the structure and scale of food in every living thing. For example, plants as producers, herbivores as first-level consumers, carnivores as second-order consumers, humans as third-order consumers, decomposers will produce decomposition which will be re-consumed by producers as a source of energy.
5. **Solving Problems in Agriculture**
   Humans can help solve agricultural problems they have faced. For example, maintaining soil fertility can add some microbes that can produce ammonium and nitrate.
6. **Solving Energy Problems**
   Humans can help ensure the availability of energy to support life. For example, the use of alternative energy through solar power that can produce electrical energy.
7. **Solving Health Problems**
   Humans can help solve the health problems they have faced. For example, the Aedes aegypti mosquito can cause dengue fever which can be eradicated by humans with a treatment or action.

F. Ecology Types

The types of ecology are as follows:

1. **Human Ecology**

Human ecology is a branch of ecology that studies the state of the human environment. The concept of human ecology was first introduced by sociologists named Robert E Park and Ernest W Burgess. According to Hawley (1950), states that the scope of human ecology is the ecology of plants and animals that can represent the special application of a general view in a life.

2. Plant Ecology

Plant ecology is a branch of ecology that studies plants as organisms and ignores humans and animals. According to Keddy (2004), plant ecology is examining all environmental factors that affect the existence of a plant species (species ecology), or a plant community (community ecology) in a certain area. Environmental factors that affect plant ecology are plants, animals, humans and microorganisms.[4]

3. Animal Ecology

Animal ecology is a branch of ecology that deals with animals as organisms and ignores both humans and plants. The goal of animal ecology is to understand the basic elements of the performance base of animals as individuals, populations, communities, and inhabited ecosystems, such as recognition and patterns in a series of interactions.
The scope of animal ecology is synecology and autecology. Synecology is a community where interactions between populations occur within a community. For example, examining the abundance of a particular type of fish in a tidal area. While autecology is an ecological aspect of individuals or populations of animal species. For example, researching the ins and outs of Drosophila sp life, ranging from food, habitat, reproduction, behavior, response and others.

4. Population Ecology

Population ecology is a branch of ecology that studies the relationship between groups of organisms and the number of individuals and the determinants of population size and distribution. For example, fish populations and sumpil populations are from river ecosystems, because these two types of living things have met the requirements as

[4] Edi Muhammad Jayadi. *EkologiTumbuhan.* (Mataram : CV. Sanabil, 2015), Hlm. 2.

populations. The population can use survey and observation methods or experiments for more accurate data.

5. Habitat Ecology

Habitat ecology is a branch of ecology that deals with the nature of a habitat. According to Sambas Wirakusumah, habitat is the tolerance in the orbit in which a species lives so that it includes environmental factors. Orbit is the living space of a species against a broad geographic environment, while habitat is the living space of the environment in which it lives.

6. Social Ecology

Social ecology is a branch of ecology that deals with the relationship between humans and the natural environment and technology. The theory of social ecology is known as the Chicago school by Mr. R.E Park (1864-1944). Social ecology theory deals with the structure of the inter-city in terms of the ways in which the parts of the city. Social ecology theory explains that society has two levels, namely the biotic and social levels. The biotic level is the basis of society and the sub-social structure that applies to the competitive and dependent principle, so that society develops in certain patterns. While the social level is related to the socio-cultural in society that has been regulated by communication, values, norms, and community, structures, functions and changes that occur in society.[5]

7. Language Ecology

Language ecology is a branch of ecology that studies the relationship between language and the human environment as found in ethnolinguistics and sociolinguistics. According to the dialectical ecolinguistic view (Steffensen, 2007), language is a part that forms and is shaped by social praxis. The concept of social praxis refers to all actions, activities, and behavior of the community, both towards fellow communities and the surrounding natural environment.

[5] Paulus Hariyono. *Perencanaan Pembangunan Kota dan PerubahanParadigma.* (Yogyakarta PustakaPelajar, 2010).

8. Space Ecology

Space ecology is a branch of ecology that studies ecosystems capable of sustaining human life during flight in space. Space ecology is a branch of ecology that deals with the development of ecosystems that can partially or completely regenerate to support human life during long-term flight in space.[6]

G. Relationship of Ecology with Other Sciences

Ecology is gradually developing, and it is becoming increasingly apparent that ecology is related to almost all other sciences. In order to understand the scope and implications of ecology, the problem must be viewed in relation to other sciences. To understand the relationship between organisms and the environment, all fields of science that can explain the components of living things and the environment are needed.

Plant Ecology as a natural science that is still new requires other sciences as a tool to explain the interaction of plants with their biotic and abiotic environment. Plant Ecology is also a science that can be used and applied to human life, for example for the exploitation of natural resources, the effect of damage to forest vegetation on the earth's ecosystem, environmental damage due to pollution of plants, which requires other knowledge.

Plant ecology can not be separated from other sciences such as physics, chemistry and Earth and Space Sciences. The characteristics of Physics towards Ecology are in the knowledge of physical processes such as sunlight, heat conduction and so on in the soil, groundwater drainage processes and so on. The role of Chemistry in Ecology is the chemical process in the circulation of macro nutrients N, P, Ca, Mg, CO2 and so on. Ecology is also affected by changes in day and night, seasons and so on.

Social sciences are also related to ecology in terms of humans which are included in the scope of ecosystems. Human behavior affects ecosystems and vice versa. So from this explanation, it turns out that ecology is very broad in scope.

Plant ecology as a branch of ecology has a broad scope, its study and study can cover various levels in the biological organization of living things, which includes various types, populations, plant communities, and their

[6]Steffensen, Sun Vork. "Language, Ecology and Society : An Introduction to Dialectical Linguistics".DalamSteffensen, S.V dan J. Nash (Eds). Language, Ecology and Society-a Dialectical Approach. London : Continuum.

ecosystems. To understand the interaction between biotic components and abiotic components in the ecosystem requires other scientific disciplines related to the names of plants and their habitats, soil and chemical properties, climate influences, various physiological and metabolic processes, reproduction, and distribution patterns of plants. the plant.

1. Natural Science
   a. Physical science, its role in bodily ecology as physical factors, soil density, sunlight, temperature changes, absorption, rainfall, air humidity, and its functions are very important.
   b. Chemistry plays a very important role, because in plant ecology various chemical processes that take place, both inside and outside the plant body require chemical studies to be able to formulate various chemical processes that take place, as well as qualitative and quantitative predictions of various ecological processes;
2. Biological sciences in addition to distribution ecology, adaptation, aspects of the role and function of plants, and the structure of vegetation communities are widely studied in plant ecology. There is a close relationship with other biological disciplines, such as taxonomy, morphology, physiology, phytogenetics and so on.
   a. Taxonomy: is to know the name and recognize the types of plants to be studied.
   b. Plant structure: its role is very important, because from the plant structure you can see the anatomy and morphology of the plant.
   c. Plant physiology and biochemistry: is to know a variety of plant physiology and biochemistry information is very useful for studying various metabolic processes and plant life processes.
   d. Phytogenetics or plant genetics is needed to study how a plant species with a very wide distribution often shows differences according to geographic location and environmental conditions.
   e. Biogeography is discussing the distribution of living things which is called biogeography. Biogeography that studies plants is called phytogeography, which is a study that specifically studies and discusses the distribution of plants in various regions around the world.[7]

[7]Kusmana, C. dan Istomo. 1995. EkologiHutan. Bogor. Lab. EkologiHutan, IPB. hlm: 14-19.

When we are talking about forest pollution, population development, food problems, energy use, the increase in earth's temperature due to the greenhouse effect or global warming and others, this means also having to talk about chemistry, physics, agriculture, forestry, nutrition, climatology and others. It can be said that nowadays ecology is increasingly being felt with almost all existing fields of science.

Dispersal, adaptation and aspects of the function of organisms from the community are widely studied in ecology and are closely related to other biological sciences such as taxonomy, morphology, physiology, genetics. Meanwhile, climatology, soil science, geology, and physics provide information about the state of the environment. Thus knowledge of physics and biology is needed for an ecologist to be able to reveal the relationship between the environment and the living world.

Natural sciences other than biology and ecology, such as physics, chemistry, and mathematics really help plant ecologists in explaining various biotic and abiotic components based on physical, chemical structures as well as mathematical measurements and weights. And other biological sciences besides ecology can be utilized in plant ecology to understand plant species and their composition, distribution and diversity, various physiological and reproductive processes through a scientific approach to plant structure, plant taxonomy, physiology and genetics and biogeography..[8]

[8]Hanum, Chairani. 2013. Ekologi Tanaman. Medan : USU Press. hlm: 5-7

CHAPTER II

ORGANISM

A. Definition of Organism

Organisms have the meaning of all types of living creatures, be it animals, plants, or microorganisms that interact and need each other. Organisms are etymologically derived from the Greek word "organon" which means "tool".

Every organism needs nutrients (food), grows, reproduces, excretes waste, and eventually dies. The most important part in the food chain is in plant organisms. Plants are termed "producers" of life, because these organisms use sunlight to convert it into chemical energy (oxygen). The process is called photosynthesis, the process that ensures all living organisms and the entire food chain function.

The characteristics of organisms are, require energy/food, can move, reproduce, breathe, adapt, are sensitive to stimuli, and excrete feces/waste substances. However, these characteristics are not comprehensive to all types of organisms, there are several types of organisms, such as microorganisms. Microorganisms do not have respiratory organs but excrete chemicals from their bodies. There are several types of microorganisms that cannot move freely or independently and there are several types of microorganisms that cannot reproduce.

One type of organism that is very diverse is bacteria, because bacteria can be found in all corners of the earth. Bacteria are very simple types of organisms, and bacteria are the first organisms to exist on earth. Other types of organisms are protozoa, algae, and fungi. Complex organisms are organisms that have two or more cells.

B. Classification of Organisms

Organisms are divided into five kingdoms, namely Monera, Protista, Fungi, Plantae and Animalia.

1. **Monera Kingdom**

   The characteristics of this kingdom are: Has a body structure with primitive cells that lack a nuclear membrane (prokaryotic). Most of the Monera kingdom is unicellular but some are multicellular. Has 2 main phyla namely bacteria and blue algae.

2. **Protista Kingdom**

   Its characteristics are that it has a membrane around the cell nucleus (eukaryotic) most of these protists are unicellular organisms. Has two main phyla: namely protozoa (heterotrophs) and algae (plant autotrophs.)

3. **Fungi Kingdom**

   The characteristics of the kingdom of fungi are, foraging for food by absorbing food that is in the vicinity or heterotrophic. The functional kingdom has a membrane around the cell nucleus (eukaryotic) and the organisms belonging to fungi are arranged in filaments that have many nuclei. Examples are mold, yeast mold, and yeast.

4. **Plantae Kingdom**

   Plantae kingdom has a membrane around the cell nucleus (eukaryotic). Kingdom plantae includes multicellular organisms and photosynthetic organisms.

5. **Animalia Kingdom**

   Animalia kingdom is the largest of the five kingdom classifications. Kingdom animalia has a membrane around the cell nucleus (eukaryotic) and kingdom animalia is a multicellular organism.

C. Examples of Organisms

One way to determine the level of soil fertility is to utilize soil organisms. These soil organisms are used as bioindicators, the more soil organisms are in good condition and the fewer soil organisms the soil is in poor condition. As we already know that these soil organisms have a certain role in the ecosystem, such as decomposition and maintaining the nutrient cycle in the soil and maintaining the structure of the soil. Soil organisms are quite good for use as soil bioindicators because they have several properties, including having a sensitive response to practices in land management and climate, good

correlation with beneficial soil properties and ecological functions such as storing water, decomposition and nutrient cycling, neutralizing toxic materials and suppression of pathogenic and harmful organisms.

Soil organisms and plants have a very close relationship. Soil as a place to live for better conditions if there is activity from soil organisms, while the population of soil organisms is determined by the plants above the soil, and while the population of soil organisms will be able to affect plant growth which will ultimately determine the productivity of an agricultural land.

Along with the progress of the development of the world of agriculture and the demands for fulfilling food that must be met quickly, farmers are more focused on how to get the best agricultural products in a faster time so that to further fertilize the soil, farmers are more likely to choose to use organic fertilizers which in fact have an effect on the level of abundance. declining soil organisms.[9]

Plants refer to organisms that belong to the Regnum Plantae. All organisms that are very familiar to everyone such as trees, shrubs, herbs, grasses, ferns, mosses, and some green algae. Recorded about 350,000 species of organisms included in it, and not including green algae. Of that number, 285,650 species are flowering plants and 18,000 species of mosses. Almost all plant members are autotrophs, and get energy directly from sunlight through the process of photosynthesis. Because the green color is very dominant in members of this kingdom, another name used is Viridiplantae (green plants). Another name is Methaphyta.

A very easily recognizable feature in plants is the green color which is more dominant because of the content of the chlorophyll pigment which plays a vital role in the process of capturing energy through photosynthesis. Thus, plants are generally autotrophs. There are some exceptions, such as the number of parasitic plants, which are the result of adaptation to a unique way of life and environment. The nature of plants is autotrophs, plants always occupy the first position in the chain of energy flow through living organisms in the food chain.

Plants are stationary or cannot move of their own accord, although there are some green algae that are motile (capable of moving) because they have a flagellum. As a result of this positive nature, plants must adapt physically to environmental changes and disturbances they receive. The morphological variation of plants is much greater than in other members of the kingdom. In

[9]Soerodikoesoemo,Wibisono,dkk, 1993, Anatomi dan FisiologiTumbuhan, Penerbit Universitas Terbuka. Depdikbud Jakarta

addition, plants produce a lot of secondary metabolites as a survival mechanism against environmental changes or attacks from intruders.

At the cellular level, cell walls composed of cellulose, hemicellulose, and pectin are characteristic, although in simple plants they are sometimes only composed of pectin. Only plant cells have plastids and large vacuoles that often dominate the cell volume.[10]

[10]Hidayat,E.B. (1995). AnatomiTumbuhanBerbiji.Bandung: ITB

CHAPTER III

POPULATION

A. Definition of Population

Population comes from the Latin "populus" which means people, meaning population. The population referred to in ecology is the population of species or types of organisms. Population includes a collection of individual organisms in one place that have similar characteristics, have the same origin, and nothing prevents their individual members from relating to each other, developing offspring freely.[11]

Population is a group of individuals of the same species living in the same region at a certain time. Populations, like single organisms, have unique characteristics and/or attributes such as growth rate, age structure, sex ratio and mortality rate. These individuals are heterosexual groups. It is currently estimated that on earth there are 5,000,000 plant species, 10,000,000 million animal species and 2-3 million or less microorganisms and only 10% of all organisms have been identified and named. Meaning the other 90% is a very large number that has not yet been named.[12]

Populations always experience changes from time to time due to factors of birth, death, and migration or the dispersal of individuals between separate populations. If the resources needed by organisms are abundant and environmental conditions suitable, the population can increase rapidly. The ability of a population to increase maximally under optimal conditions is called biotic potential. In most instances, limited resources, suboptimal environmental conditions, climate, food, habitat, water availability, and other factors that support population growth are always limited due to environmental resistance. The environment can only support a limited number

[11]R. Utina 2009. Ekologi dan LingkunganHidup. Gorontalo
[12]S. Sumarto, .2016.Ekologi Hewan.Cv Patra Media Grafindo Bandung : Bandung

of individuals in a population. The number of individuals that can live in a habitat or environment is known as carrying capacity.

There are several population characteristics related to ecology, namely population growth, population, and the structure of the population itself.

B. Population Growth

Living things have the characteristics of growing and developing, as well as the plant population will increase new individuals to preserve the species from extinction. The rate of population growth expressed in terms of the number of individuals, which is divided by the time period in which the population increases, the time these additions occur, which can be expressed by the formula:

Number of individuals from the original population: time

If an individual experiences a reduction or increase in number due to migration or moving to another area, or entering from a new area, then surely the population will only be filled by his descendants. There is a way to calculate the natality or birth of an individual, but this will always be associated with the death or mortality rate, because the creature will always reproduce, and there will be a time to die. So that the type will be preserved by the next generation, something like this is called the growth rate. The basic concept of the phenomenon of population growth is exponential growth.

C. Population Density

The number or size of the population of a plant or animal in a particular area usually depends on migration, or the movement of individuals themselves. The size and number of each species in an area will never be the same, this is influenced by the physical environment and also food. When the environmental conditions do not support the habitat of animals and plants and the plants are unable to adapt to the environment that is less supportive, then by themselves these types of plants will decrease and die.
This density can also be calculated using the formula;

Density = total number of individuals/area (ha)[13]

[13] R. Utina 2009. Ekologi dan LingkunganHidup. Gorontalo

D. Population Structure

An important demographic trait for any member of the population is the fact that the population is in a state of reproductive equilibrium. Because in general the population is divided into 3 categories, namely pre-productive, reproductive, and post-reproductive, it is usually studied through age pyramids. Study of population structure is very important to do to determine how the status or a population in a habitat can be categorized into 3 parts, namely: crisis, threatened and safe. After knowing the status of a population growing in an area, action can be taken against the population so that it does not become rare and extinct.

The population structure of a plant is influenced by several factors, namely:

a. Birthrate

The natality rate of a plant is influenced by the plant's ability to fertilize because with the growth of a fruit, individual regeneration will take place and link a plant to be able to maintain its population from time to time.

b. Mortality

With environmental disturbances such as forest fires, automatically all plant activities will be disrupted, the seedling phase of poles and trees will drop drastically. And this will affect the number of individual density in certain areas.

c. Environmental factor

The measurement of environmental parameters is known, there are three environmental conditions that are the determining factors, namely air temperature, humidity, and soil pH. The existence of these factors will cause the growth and development of a plant. Like the palm tree, the conditions for growing sugar palm plants are soil moisture, light intensity, wind speed and altitude. According to Paramentan (2013) regarding the cultivation of sugar palm plants, the air temperature of sugar palm plants suitable for growth and development as well as reproduction ranges from 20-25 C. This is a limiting factor for sugar palm plants. Humidity for sugar palm is a moist air condition, because it will maintain the water content of a plant. If the humidity is too high, it will cause a plant to quickly lose its air content or quickly evaporate. Sugar palm plants will grow well with high rainfall ranging from 1,200mm-3,500mm/year. Rainfall like this can be said with humid conditions. pH below 7 is not good for the growth and development of sugar palm, because it affects the difficulty of growth in the seedling, weaning and

pole phases because the pH of the soil is slightly acidic due to the high acid content in the soil.[14]

E. Population Characteristics

The population has two underlying characteristics, namely biological characteristics and statistical characteristics. Biological characteristics are characteristics possessed by individuals making up the population, while statistical characteristics are unique characteristics as a set or group of individuals who interact with one another.

1. Biological features

   The biological characteristics of the population based on the characteristics that make up the population are:

   a. Has a certain structure and organization in which some are constant and some fluctuate over time
   b. Ontogenetic, which has a history of life
   c. Can respond to the environment
   d. Integrated by genetic and ecological factors

2. Statistical traits (group traits)

   Statistical characteristics are group characteristics that cannot be applied to other individuals, but are the result of the encounter of the individual characteristics themselves. Statistical features include:

   a. The density or size of the population and the main parameters that influence it, such as natality, morality, and migration,
   b. The age distribution, which can be expressed in the form of a pyramid,
   c. Genetic composition,
   d. Dispersion,
   e. Natalis, and
   f. Mortality[15]

[14]Noor Syahdi,.2016. StrukturPopulasiTumbuhanAren (Arenga pinnata merr di Sekitaran Sungai UyitLoksadoKabupaten Hulu Sungai Selatan. Jurnal. Banjarmasin FKIP Universitas LambungMangkurat.

[15]Binarimanurung. 2012. EkologiHewan. UNIMED : MEDAN hlm. 72

F. Individual Spread Pattern

According to Begon et al. (1990) and Smith el al (1990) in the book on plant ecology (Binari. 2011) the distribution pattern of living things in nature, including the plants in it, basically shows three distribution patterns, namely:

1. **Random or arbitrary spread**

   Which distribution with this pattern is rare in nature. This kind of distribution usually occurs when the environmental factors are very uniform throughout the area where the population is located, besides that there are no group characteristics of the organization.

2. **Even distribution (regular, unity)**

   This distribution pattern is common in plants, where there is strong competition among individuals in the population. In plants, for example, competition for nutrients and space. Which is the pattern of trees in a plantation that are planted at regular distances from each other is an example of an even or regular distribution pattern.

3. **Clustered spread (aggregate dumped)**

   This pattern is the most common pattern in nature. This grouping is mainly caused by various things, namely:

   a. Responses of organisms to local habitat differences
   b. Responses of organisms to seasonal weather changes
   c. As a result of the way or process of reproduction
   d. The nature of organisms with vegetative organs that support the formation of groups or colonies[16].

In population ecology, a method has been developed to understand the distribution pattern of individuals in the population, one of which is by utilizing the Poisson distribution with the first assumption that individuals are randomly distributed. It should be reminded that this method will give good results if the number of individuals per square meter is low. Based on the assumption that the individual distribution is random, it can be defined that the variance (V) is the same as the average price (X), so if the variance is greater than the average price then the individual distribution is in groups, and vice versa if the variance is smaller than the average price. then the distribution is even.[17]

[16]BinariManurung. 2011. *Panduan TeoriEkologiTumbuhan*. UNIMED : MEDAN hlm. 55
[17] Tim Penyusun. 2006. *EkologiTumbuhan*. FMIPA USU : MEDAN hlm. 11

CHAPTER IV
COMMUNITY

A. Definition and Nature of Community

Community is a collection of several populations that interact with each other in the same area, for example, a prairie community inhabited by several populations including horses, bulls, snakes, grasshoppers, lions, tigers. Between the prairie and river communities there is an interaction in the form of the circulation of organisms from the two communities. In this case, plants have several interactions with others, such as interactions between plants and plants, interactions between plants and animals, interactions between plants and the environment and interactions between plants and microorganisms.

Community is one level of biological organisms directly below the ecosystem, but one level above the population. A community can be said to be good if the constituent elements are also good, which consists of the quality and quantity of the population, other biotic and abiotic factors that interact with each other. Community structure is a collection of populations of different species that together inhabit a place.[18]

Living things or organisms in nature cannot live separately, these individuals will gather into a group to form an association which is usually called a community. Therefore, the community can be defined as a collection of certain species that live together in a habitat type (Manurung, 2011).

Groups of plants together or plant communities are often referred to as plant or vegetation communities. A type of vegetation that extends and covers a large area is called a formation. For example, a tropical rainforest is a formation. Vegetation or community is not equivalent to the flora of an area.

[18]Utina, Ramli dan Dewi Wahyuni K. Baderan, *Ekologi dan Lingkungan Hidup,* (Gorontalo:2009), hal. 20.

Flora in its simplest form refers to a list of plant species or taxa that live in the area. Flora usually does not provide information about the abundance, importance and uniqueness of a community (Manurung, 2007).

Community is all populations of various types of organisms that occupy a certain area. In this area, each population interacts with one another.[19] Community is one level of biological organisms directly below the ecosystem but one level above the population. This position shows that population-level rules must influence community concepts, then community rules will also influence ecosystem concepts. The community structure is a collection of populations of different species and together inhabit a place. For example the ferns community, the tropical forest community of Ahumida, and so on. A community has a certain diversity. Diversity itself is the number of species and the number of individuals of each species in a community. A certain community lives in a certain place due to the influence of the abiotic environment. How the community interacts, and how the community changes in such a way that the community has additional characteristics to the individual components and their functions.

Based on the nature of the community and its function, biotic communities can be divided into major/major communities and minor communities. The major community is a community that is large enough in its completeness so that it is relatively independent from other communities. Meanwhile, minor communities are communities that are more or less dependent on other communities. Communities not only have a certain functional unit with a distinctive tofic structure and energy flow, but also a unity in which there are opportunities for certain species to coexist and coexist. However, there is still competition between them so that certain populations will be found that act as the dominance of a community.

The dominating population is a population that can control most of the energy flows and strongly influences the environment for all species that exist in the community within the same community. Analysis of communities in certain geographic areas in the landscape has prioritized two opposing approaches, namely: 1) a zoning approach. And 2) the gradient analysis approach. Each of these approaches has its own specific objectives that are

[19]SuyudWarnoUtomo,Sutriyono, Reda Rizal, *Pengertian, Ruang LingkupEkologi dan Ekosistem.* (Bandung:IPB, 2012), hlm. 4

suitable for measuring community analysis in a particular area. In general, the steeper the environmental gradient, the more visible and/or discontinuous the communities will be. On the other hand, the gentler the environmental gradient, the more continuous the communities. Communities in fairly uniform environmental gradients in the same ecosystem tend to have relatively non-uniform levels of species diversity.[20]

The community structure is a collection of populations of different species and collectively inhabit a place. All populations in areas of concern including communities, such as all plants and animals and microorganisms. Narrowly it is often exemplified, for example the fern plant community, the wet tropical forest community, or the grain-eating bird community in the rice fields. The unique characteristic of a community is diversity, namely the number of species and the number of individuals of each species in a community. The existence of a certain community living in a certain place is due to the existence of an appropriate abiotic environment in which interactions occur between communities. A community is an organism with a limited type of composition and has a number of lives. Community is one level of biological organisms directly below the ecosystem, but one level above the population. This position shows that population-level rules will influence community concepts, and in turn community rules must be considered in understanding ecosystem concepts.

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Communities, like other levels of organization of living organisms, experience and undergo a life cycle, meaning that the community is born,

[20] Ramli Utina dan DewiWahyuniK.Baderan. *Ekologi dan LingkunganHidup*(Gorontalo : Universitas Negeri Gorontalo, 2009), hlm. 20

grows up, and then grows older and older. The difference is, natural communities never die. If a community is born on a boulder of larvae of a volcano that has recently erupted, then initially the community was only pioneer plants such as algae, lichens and ferns. The difference is, natural communities never die. These pioneer plants will change environmental conditions in such a way that other plants and animals can move and live in that place. Over time, the community will be dominated by species that can live superior, stable and independent in it. This process is called "succession". Meanwhile, a community that has reached stability is called a community that has reached its peak or climax.

Natural communities can have a large number of species. However, only a few species control the community, and these species are called "dominant species" this does not imply that the rarer species are not important. Because this rare species determines the diversity (diversity) and aspects of community structure.

According to Sastroutomo (1990) plant communities found in a habitat generally have certain characteristics, such as the following:[21]

1. Type composition, for example type differences. Species that are few and rare or have a certain relative importance.
2. Physiognomy, which has a certain plant form or architecture, life form, canopy closure, leaf area index and phenology.
3. Species distribution pattern, for example wide spatial distribution or overlapping niches.
4. Species diversity, for example abundance, richness, diversity, and species diversity.
5. Nutrient cycle, for example the need for nutrients, the ability to store and the speed of nutrients into the soil.
6. Changes and developments in space and time scales, for example the succession process, response to climate and microenvironment.
7. Productivity of each type, for example biomass, primary productivity, allocation and efficiency of productivity.

Vegetation is basically formed as a result of the existence of two important phenomena, namely:

- There are differences in tolerance to the environment and
- There is heterogeneity of the environment

[21] Nasir Hadi, *Buku Ajar EkologiTumbuhan.* 2011, hlm. 47

Based on these two phenomena, vegetation is often also defined as the green layer covering the earth, to distinguish it from the soil which is commonly called the red layer.

Vegetation in nature is formed as a result of the total interaction of various environmental factors. Thus mathematically it can be expressed as a function of soil, climate, animals and flora (Srasana Syafei, 1994)

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b. There is heterogeneity of the environment

Based on these two phenomena, vegetation is often also defined as the green layer covering the earth, to distinguish it from the soil which is commonly referred to as the red layer. Vegetation in nature is formed as a result of the total interaction of various environmental factors. Thus, vegetation can be systematically expressed as a function of soil, climate, animals and flora.[22]

Basically, there is a difference between a community and a population, where a population is a collection of several individuals, a community is a collection of these populations and forms what is called an ecosystem. In this case, the ecosystem is a reciprocal relationship between plants and the surrounding environment, if the community only interacts with each other.

Communities have ecological concepts, such as the concept of habitat and niche. A community consisting of individuals who make up a living population in a certain habitat that can be used as a place to live and a place for their productivity. In addition to habitat, individuals and populations in a community also have niches, namely abiotic and time-related factors. Each species inhabits a specific niche which is determined by its feed and size. There are various types of communities, namely:[23]

a. Aquatic Community, which is a community found in waters, such as lakes, rivers, seas, etc.
b. Terrestrial Community, which is a community that is on land, such as grasslands, deserts, botanical gardens, etc.

[22]BinariManurungmdkk. *EkologiTumbuhan*. (Medan : FMIPA Unimed, 2018) hlm, 81.

[23]Utina, Ramli dan DewiWahyuni K. Baderan, *Ekologi dan LingkunganHidup,* (Gorontalo: 2009), hal. 21.

Basically, the study of vegetation will try to reveal various things about the properties of vegetation, namely (Srasana Syafei, 1994)

- The floristic composition of a plant society
- Structural characteristics
- Function characteristics
- The relationship between plants and environmental factors
- Status in development (succession)
- Distribution, both types and associations
- Classification

Vegetation as an object of study has in fact given birth to various approaches, which eventually resulted in a separate study in ecology with different emphases from one another. Likewise, the naming of vegetation studies uses the term vegetation science and some uses the term Vegetation Ecology.

Regarding the nature or character of a community or vegetation, (Barbour et al 1987):

1) *Physiognomy, Species Composition and Spatial Patterns*

Physiognomy is a combination of the external appearance of the vegetation, its vertical structure (architecture or biomass structure) and the growth form of the dominant taxa. Physiognomy cannot be estimated or estimated with precision only from a list of all plant taxa present in the community.

Life form or growth form includes various plant characteristics such as size, length of life, degree of wood, degrees of freedom, general morphology, leaf properties, location of shoots or buds, and phenology. Vertical structure refers to the height and canopy cover at each layer in the community.

Canopy cover can be expressed as a percentage of the land covered by the canopy if the canopy is projected onto the ground surface. Canopy cover can also be expressed as a leaf area index (LAI).

The species composition of a community is also very important because the community is partly determined on a floristic basis. Several communities can have the same physiognomy but differ in the identity of the dominant species or the constituent species. The abundance, importance, or dominance of each species can be expressed in numerical or numerical terms, so that

different communities can be compared on the basis of species similarities and differences.

2) *Species Richness, Evenness and Diversity*

Species richness is simply the number of species in several areas of a community. Each species in a community however often has an unequal number of individuals. One species may be represented by 1000 plants, another by 200 plants, while another may be represented by only a single plant.

The distribution of individuals between species is called species evenness or species equitability. Evenness will be maximum when the number of individuals making up the species in a community is the same.

Species diversity or diversity is a combination of species richness and evenness. In this case, species richness is weighted by evenness. There are many formulas that can be used to calculate community diversity expressed in a single index number.

It is important to emphasize that species richness is different from species diversity. Even though the two are positively correlated. Decreasing species richness on the one hand can increase species diversity. Community A, for example, with five species but the distribution of the number of individuals is not the same, has a lower diversity or diversity than community B, which only consists of four species, but the distribution or bill of numbers of individuals is the same. However, community A still had higher species richness. Biologically, diversity is a measure of the population heterogeneity of a community (Manurung, 1997).

CHAPTER V

EFFECT OF ABIOTIC FACTORS ON PLANTS

A. Abiotic Factors and Their Effect on Plants

Plant ecology is a material that discusses very close phenomena in the life of a plant species, a plant in one area, these symptoms as a biotic factor of plants, and all creatures on earth. In addition to biotic factors, there are abiotic factors that greatly affect the life of plant species, such as soil, water, fire, and climatic factors.

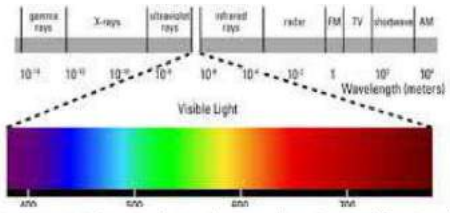
1. Light

A phenomenon that is very close to the life of plants, animals and even humans. There are three aspects that must be understood from the light factor, namely:

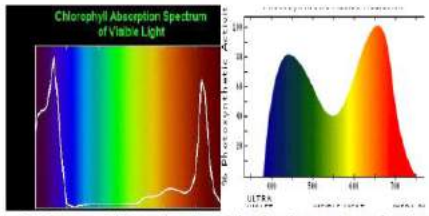
Sunlight contains a spark of electron cells that are not the same in each color, and not all of them can come down to earth. Fundamentally the difference is between regions. Basically, plants can process sunlight whose micron cells are between 0.39 – 7.6 microns. The green substance of the leaves absorbs red and blue cell rays which are beneficial for the cooking of plant food.

The intensity of light is a micron cell that greatly influences a power plant to control a variety of plants, and varies from space to time. The intensity of light that is very much between day and night in 24 hours is also very influential on the body of the plant, such as on flowers, the fall of fragile leaves, and the growth of seeds.[24]

[24] Ardhana, IPG. *Ekologi Tumbuhan.*(*Denpasar* : Udayana University press. 2012.)



Gambar 3.10: Spektrum radiasi matahari yang digunakan untuk fotosintesis[10]



Gambar 3.11: Aktivitas fotosisntesis berdasarkan panjang gelombang[11]

2. Water

Water is a substance or matter that is: liquid, solid, and gas. As a liquid, its form is clear. the substance can flow freely without a fixed form; freezes at 0°C (32°F) and boils at 100°C (212°F).

Various functions, including: protecting cell enlargement for structure, leaf growth; transport nutrients and organic compounds to all parts of the plant; constituent of cell protoplasm; as a raw material for various chemical processes in the plant body, including photosynthesis and transpiration, and supports or maintains plant temperatures against fluctuating air temperatures (The Pennsylvania State University, 2003)

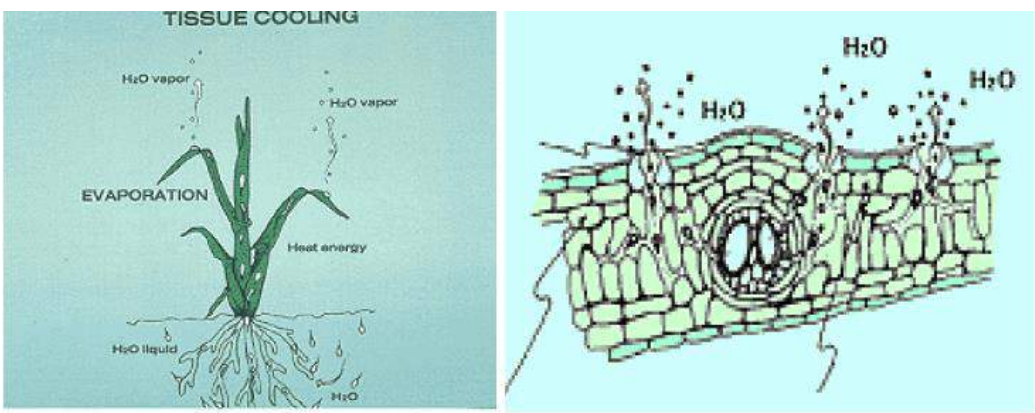
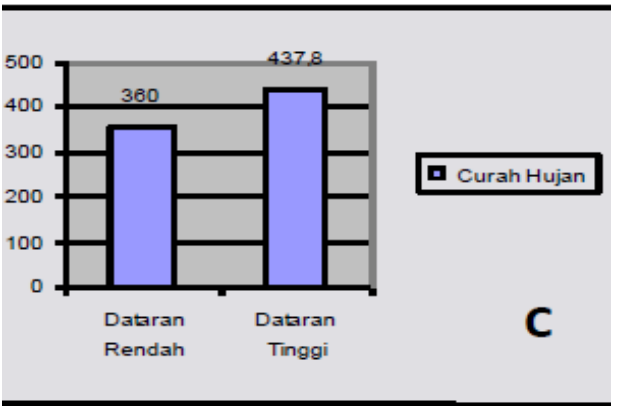


Figure 2 : The function of water for plants (The Pennsylvania State University, 2003).[25]

[25]Jayadi, Edi Muhamad, *EkologiTumbuhan,* (Mataram : Institut Agama Islam Negeri (IAIN) Mataram. 2015) hal, 25-27

The amount of rain on the upper land (437.8 mm/month) is 77.8 mm, which is a lot more than the lower land (360 mm/month).



The amount of rain and soil density coincide with the occurrence of taking advantage of the soil along with the absorption of water. The leaves are thick and have water, sansevieria plants can live in conditions with the lowest amount of rain.

Rahajeng said the availability of water for Sansevieria is 30 mm/plant/week. If the amount of rain on the lowest land is 360 mm/month and on the highest land is 437.8 mm/month, the amount of rain in that area is greater for Sansevieria's water needs, but is reluctant to kill it because the soil density is high with lots of rocks, sand that exceeds the limit.[26]

3. Temperature

In addition to humidity, temperature is one of the important factors in the environment which is determined by time, season, latitude, ctopography, sunlight, human activities and soil texture.

Temperature can play a direct role (controlling the rate of chemical processes in plants) or indirectly (affecting other factors, especially water supply) to plants. Temperature will also affect the rate of evaporation and cause not only the effectiveness of rain but also the rate of plant water loss.[27]

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[26]Raharjeng, Anita Restu Puji, Pengaruh Faktor Abiotik Terhadap Hubungan Kekerabatan Tanaman *Sansevieria Trifasciata*L*,* (Palembang: *UIN Raden Fatah Palembang*. Vol , I No. 1, 2015)

[27]Binari Manurung, Rosita Tarigan, *Panduan TeoriEkologiTumbuhan*,(Medan: FMIPA Unimed, 2011)

From the influence of temperature can affect the existence and life of a plant, so that plants are divided into four types, namely:

a) Megathermal plants, namely plants that like hot climates throughout the year.
b) Mesothermal plants, namely plants that like habitats where the temperature is not too hot and not too cold.
c) Microthermal plants, namely plants that like cold or low temperature habitats. However, when exposed to high temperatures can also still live.
d) Hekistothermal plants, namely plants that like cold temperature habitats and cannot tolerate hot environments.

Extreme temperatures are temperatures that can damage plants, namely temperatures that are too high or too low. Which, the damage occurs not only inhibits plant growth, but can kill plants. This is because the physiological processes of the plant itself are hampered due to decreased enzyme activity.[28]

The influence of minimum temperature for plants, namely:

a) Since enzymatic activity is controlled by temperature, when the temperature is low, plant growth will slow down or stop.
b) If the temperature decreases, the respiration process will also decrease, and usually if the respiration process runs slowly, the photosynthesis process will also decrease.
c) Low temperatures will cause damage to young stems and leaves.

The effect of maximum temperature on plant growth, namely:

a) Plant tissue will die
b) High temperatures will cause damage to the mitotic division system during the formation of generative cells.
c) At high temperatures will cause gene mutations in plants.[29]

4. Land

We discuss the meaning of land a little. This soil is the end result of the activities of organisms and climate, one of which is the most important in plant organisms. We know that soil is very important not only for the process of plant growth, but also for living things to survive, because soil stores and

[28] Edi Muhammad Jayadi, *EkologiTumbuhan*,(Mataram: IAIN Mataram,2015)
[29]WayanWiraatjama. *Suhu, EnergiMatahari,dan Air DalamHubunganDenganTanaman.* (Bali, FakultasPertanianUNUD : 2017)

provide the needs of living things such as nutrients and minerals. And below we can see what the abiotic factors in the soil are:

a. Earth color

   Soil color is very important to determine the level of fertility in the soil, the darker brown the color is, the more fertile the soil is and suitable for growing plants. Besides that, the color of the soil also has a mixture of other color components due to the influence of various factors or compounds contained so as to provide certain types of soil.

   - Surface soil contains a lot of nutrients and soil that is useful for plant growth.
   - Middle ground is land that has started to dry
   - Subsoil is rock and sand, there are no nutrients there. Not able to grow plants.

b. Soil Temperature

   Soil that is left open will be hotter because the soil absorbs the earth's temperature. Temperature is important for plant life if the soil is too hot then plants are difficult to grow well.

c. Soil Texture

   Soil texture is a state of fineness in the soil that occurs due to differences in the composition of the content of the sand, dust and clay fractions contained in the soil. The state of this soil texture can affect the state of other soil properties.

d. Water in the Ground

   Groundwater is contained in a layer of soil and rocks below the ground surface. Ground water is one of the water resources, in addition to river water and rain water, groundwater also has a very important role, especially in maintaining the balance and availability of water raw materials for household (domestic) and industrial purposes.

e. Air in Ground

   CO2 levels in the soil are higher than O2 because plants draw CO2 from the soil for the process of photosynthesis.

f. soil pH

Soil pH that is too high or low can damage plants. Therefore, it is important that we maintain the pH with a soil pH meter or by adding certain materials to maintain soil pH stability.

g. Soil Organic Matter (SOM)

Soil organic matter comes from the remains of dead plants or organisms. Soil with high productivity does not only consist of solid, liquid and gas but is influenced by the organic matter contained in it.

4. The Effect of Soil on Plants

The condition of a soil greatly affects the growth process of plants, which we can see below:

1) Place of growth process in plants
2) A place for air supply for plant root respiration and microorganism life
3) A place for supplying nutrients for plant growth, both in the form of organic and inorganic substances

Based on the explanation above, soil that supports plant fertility is soil that contains organic, inorganic, water, and air substances in sufficient condition and is available in accordance with plant growth. Organic substances are substances formed from the weathering or decay of plant and animal remains. Usually organic substances are found in the top soil layer to a depth of + 15 cm and are black in color. While inorganic substances are substances that come from crushed rocks and minerals, usually scattered in the subsoil at a depth of more than 15 cm. Soil is said to be fertile if it contains these materials with a composition of 45% organic matter, 5% inorganic substances, 25% water and 25% air.

In addition to being influenced by the content of elements in the soil, plant growth is also influenced by the structure of the soil or lumps of soil constituent particles.

- Loose soil is the best type of soil for plants because it has sufficient cavities to store nutrients, water and air and is suitable for the life of microorganisms.

- Clay, not suitable for plants because the soil particles are too dense so that the circulation of water and air does not run smoothly and plant roots are also difficult to penetrate.
- Sandy soil, is also not good for plants because the soil particles are too hollow so it is difficult to store water and nutrients.

Soil fertility from year to year is always changing. Fertile soil can become thin if it is not cared for, on the other hand, thin soil can become fertile if it is properly cared for. Factors causing the decline in soil fertility are:

- Soil is planted continuously, so that many nutrients are absorbed by plants and transported at harvest.
- The land is used for grazing livestock continuously, so that the trampled soil becomes compact and the grass does not grow anymore.
- The existence of natural disasters such as floods, erosion, landslides, and volcanic eruptions, causing erosion or loss of top soil layers.
- Long dry season, which causes plants and some organisms to be unable to live, as a result the soil does not receive sufficient organic matter.
- Pollution of the environment, causing microorganisms that decompose organic matter to become poisoned and the soil to become unproductive.[30]

5. Topography

Topography is the difference in height or shape of an area, including the difference in slope, slope length, slope shape, and slope position. Topography in the process of soil formation affects: 1) the amount of rainwater that is absorbed or retained by the soil mass; 2) the depth of groundwater; 3) the magnitude of erosion; 4) the direction of movement of water and dissolved materials in it from one place to another.

Slope conditions (slope steepness and length) affect the rate of erosion. Therefore, its use must be adjusted to the applicable provisions. Land with a slope of 30-45% (steep) has a greater influence of gravity than land with a slope of 15-30% (slightly steep) and 8-15% (sloping). The reason is that gravity is getting heavier and heavier in line with the slope of the ground surface from the horizontal plane. This gravity is an absolute requirement for the process of erosion (detachment), transportation (transportation), and deposition (sedimentation).

[30]Hanafia,A,K,.*Dasar-dasarIlmuTanah*,Jakarta.Rajawali Pers,2013.

Based on this, it is assumed that the decrease in soil physical properties will be greater on slopes of 30-45%. This is because in areas with steep slopes (30-45%) there is continuous erosion so that the soils have shallow soils, low organic matter content, high soil density, and low soil porosity compared to soils in flat areas with low slopes. The groundwater is deep, the difference in slopes also causes differences in the amount of water available to plants so that it affects the growth of vegetation in that place.

Rain is one of the links in the hydrological cycle. The amount of rainfall in the world varies according to zone and climate. The amount of rainfall determines the geographical conditions and vegetation in each zone.

In Indonesia what is meant by precipitation is rainfall (shower). Precipitation itself is defined as a form of liquid and solid water (ice) that falls to the earth's surface. The forms of precipitation that are commonly known are rain, drizzle, snow, and hail, the most common rainfall is actually sunny rain, which is a form of hydrometeor consisting of drops of water with a diameter is larger than the diameter larger than the diameter of ordinary rain drops (>0.5 mm) with a rainfall intensity of 1.25 mm/hour.

Indonesia, like other tropical regions, rainfall is an important meteorological element compared to other elements. The variation of rainfall in the Indonesian region is very high, both specifically and temporally, the pattern is influenced by the monsoon pattern which is characterized by the rainy and dry seasons. Overall, the rainfall patterns in Indonesia are divided into three monsoon patterns, characterized by the peak of the rainy season around December, January, February (DJF) and the dry season around June-July-August (JJA); the equatorial pattern is characterized by the presence of two peaks of the rainy season in a year, and the local pattern is characterized by the presence of rainy and dry seasons such as the monsoon pattern, only when the season occurs the time is reversed.[31].

One of the general patterns of rainfall in Indonesia is influenced by spatial patterns or geographical locations. The details are as follows :

1. The west coast of each island gets more rain than the east coast.
2. Rainfall in western Indonesia is greater than eastern Indonesia. For example, a series of islands of Java, Bali, NTB, and NTT which are connected by narrow straits, the highest amount of rainfall is in West Java.
3. Rainfall also increases with altitude. Most rainfall is generally at an altitude between 600-900 m above sea level.

[31]DR.Ir. Edi Muhammad Jayadi.2015. EKOLOGI TUMBUHAN. MATARAM: Institut Agama Islam Negeri(IAIN) hlm: 45

4. In the interior, on all islands the rainy season falls in the transition season. The same is true in large swampy areas.
5. The maximum month of rain according to the location of DKAT
6. When it starts to rain it shifts from west to east like: a). The west coast of the island of Sumatra to Bengkulu gets the most rain in November, b) Lampung Bangka, which is located to the east, gets the most rain in December, c) northern Java, Bali, NTB, and NTT in January-February.
7. East South Sulawesi, Southeast Sulawesi, Central Maluku, the rainy season is different, namely May-June. At that time, other areas were experiencing a dry season. The boundary of the rainy regions of western and eastern Indonesia lies at approximately 120 east longitude.

Under normal conditions, rainfall has a positive effect on plant growth. Some of the benefits of rain for plants, including as a source of water for seed germination and other vegetative and generative growth, cooling the body temperature of plants by lowering the temperature of the micro-climate around the plant, cleaning the leaf blades of dust that can interfere with photosynthesis, and with raindrops it will kill aphids attached to leaves.

The negative impact of rainfall on plants is more related to extreme climatic conditions. This condition is characterized by an anomaly, namely rainfall that is below, or above normal. Heavy rains, which are usually accompanied by strong winds, will knock leaves, breaking branches and tree branches. Even at a certain speed it can uproot the trees it hits[32].

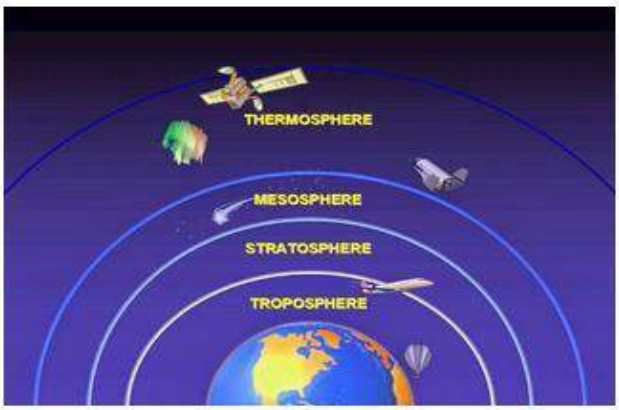
6. Atmosphere

If we listen to the word bungkin atmosphere, what we immediately think of is the layers in outer space that have a function as a function of protecting or covering the earth from various kinds of foreign objects in outer space. In general the atmosphere comes from the Greek "atmosphere". The word “atmos” means steam and “sphaira” means layer. The atmosphere is a layer of air that surrounds the earth in the form of thick smoke (fog). The atmosphere layer is needed and very important for human life and other living things when breathing. Humans can survive up to one day without water in a dry area or desert, but humans will not be able to survive even a few minutes without air. The atmosphere is a medium that has dynamic properties because of its ability to move the atmosphere. Atmospheric movement is a big factor. The small

[32]DR.Ir. Edi Muhammad Jayadi.2015. EKOLOGI TUMBUHAN. MATARAM: Institut Agama Islam Negeri(IAIN) hlm:47

presence of pollutants other than emitted from the emission source (Ruhiyat: 2009)[33].

On a larger scale, the atmosphere has a function as a blanket or protector of the life of living things on earth from the hot and strong solar



radiation during the day and to prevent or reflect heat into space at night. The atmosphere is also a barrier to the entry of celestial bodies that move through it, therefore meteors that pass through the atmosphere will become hot and will be destroyed before reaching the earth.

The atmosphere as a protective layer of the earth has the following properties:

a. It has no color, has no smell, and has no form (fog) and can only be felt by the human senses in the form of wind.
b. Has weight, so it creates pressure.
c. It has dynamic and elastic properties that allow it to expand and contract.

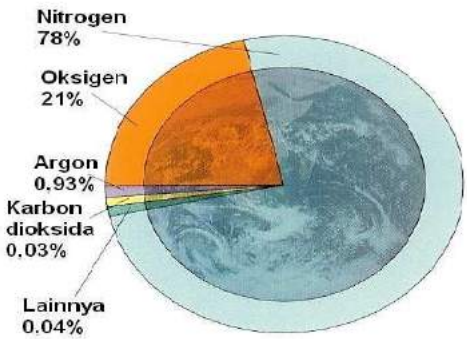


Figure 3. Main Gases in Dry Air

[33]Ruhiyat,Y, 2009. *Model PrediksiDistribusiLajuPenyebaran Sulfur Dioksida (So2) dan Debu Dari Kawasan Industri ,Disertasi, Program PascaSarjana.*Bogor .InstitutPertaian Bogor.

Naturally, the composition of the atmosphere is in the form of gases, the amount of which can decrease or increase, along with the activities of living things on the surface of this earth that contribute certain substances into the atmosphere. The air contained in the troposphere is relatively homogeneous, because it is mixed evenly and quickly if the air is not polluted. The gas elements in the atmosphere are oxygen (21%), carbon dioxide (0.03%), nitrogen (78%) in the formation of living things except nitrogen gas. These gases have a cycle whose mechanism can be in the form of direct absorption by organisms, and changes into more complex compounds, or in the form of ions that are soluble in water. (Jasin: 2009)[34].

The elements in the gas in the air are very useful for the life of living things. According to Lukmat (2006) Nitrogen is very beneficial for life because it is needed by plants with nodules (such as soybean roots) and several types of algae. The benefits of oxygen are very clear, namely to breathe living things that breathe with lungs, including humans. The benefit of carbon dioxide is to assist in the photosynthesis process of green leafy plants to produce carbohydrates that are accommodated in plant fruit or in plant parts. The element ozone is also very useful. The depletion of ozone in the atmosphere is called the leakage of the ozone layer. The ozone layer is an element of air at an altitude of 15-35 km above the earth's surface.

The thickness of the atmospheric layer reaches up to 1000 km which can be measured from above sea level. Besides having a very large thickness. The atmosphere layer also weighs 6 billion tons. The layers of the atmosphere are distributed differently in the troposphere, stratosphere, mesosphere and thermosphere. There are those who add layers another is ionosphere and exosphere.

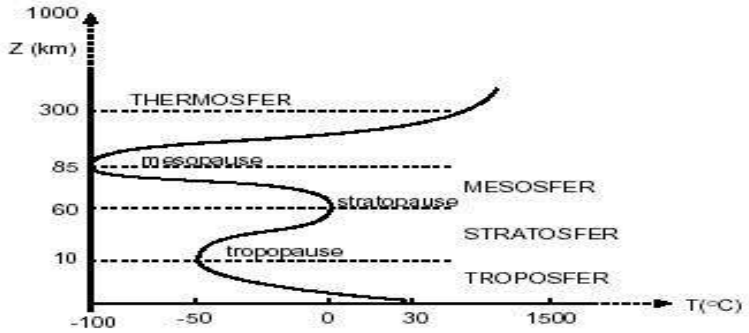


Figure 4. The division of the layers of the atmosphere based on temperature

[34]Jasin, Maskoeri. 2009. *Ilmu Alamiah Dasar*. Jakarta : PT Grafindo Persada.

a. Troposphere

It is a weather phenomenon where it will look like the presence of clouds, lightning, hurricanes, storms and also rain that occurs in this layer. In the troposphere there is a decrease in temperature which results in very little troposphere absorbing short wave radiation from the sun. On the other hand, if viewed at the ground surface, it provides heat to the troposphere layer above it through conduction, convection, and condensation events released by atmospheric water vapor. Heat exchange that occurs in the lower troposphere, therefore the temperature decreases with increasing altitude in meteorological situations (the science of weather). The values range between 0.5 and 1o C per 100 meters with an average value of 0.65o C per 100 meters.

The air in the troposphere is very cold, so it is heavier than the air above the tropopause which results in the air in the troposphere not being able to penetrate. At the equator, the tropopause is located at an altitude of 18 km with a temperature of -80o C, while at the poles the tropopause only reaches an altitude of 6 km with a temperature of -40oC. The tropopause is a layer of air between the troposphere and the stratosphere (Bayong: 1999)[35]

b. Stratosphere

The atmospheric layer above the tropopause is an inversion layer, meaning that the air temperature is getting higher or hotter, and along with the increase in altitude. Also called isothermic layer. This temperature increase is caused by the ozone layer which absorbs ultraviolet radiation from the sun. The upper part of the stratosphere is bounded by a surface of temperature discontinuity called the stratopause. Stratopause is located at an altitude of 60 km with a temperature of 0o C. c.Mesosphere. The mesosphere is characterized by a decrease in the order of temperature by 0.4o C every 100 meters, because this layer has a negative radiation balance. The upper part of the mesosphere is limited by the mesopause, the layer in the atmosphere that has the lowest temperature, about -100o C. Its height is about 85 km.

c. Thermosphere

This layer is a layer located at an altitude of 85 and 300 km. The presence of this layer is characterized by an increase from -100o C to hundreds or even thousands of degrees. The upper part of this layer is bounded by a thermopause that extends from an altitude of 300 km to an altitude of 1000 km. The thermopause temperature is constant with altitude, but changes with time, i.e. with insolation. Temperatures at night range between 300 and 1200o

[35]Bayong Tjasyono. 1999. *Klimatologi Umum*. Bandung: FMIPA - ITB.

C and during the day between 700 and 1700o C. The density of the thermopause is very small, about 10 times the density of the ground atmosphere. The ionosphere is part of the thermosphere layer. The function of this layer is to reflect radio waves as a means of communication to the entire surface of the earth. Above the ionosphere layer is the outermost exosphere layer which has a height of more than 700 km above the earth's surface. The layer will be higher in the air and closer to outer space. The horizontal distribution of atmospheric conditions is only in the troposphere and the conditions vary from one place to another. The difference results in different symptoms of weather and climate on the earth's surface.[36]

[36]Strahler, Athur. 1976. *Physical Geography*. United States of America: Wiley International Edition.

CHAPTER VI

INFLUENCE OF BIOTIC FACTORS ON PLANTS

Biotic components are part of an ecosystem consisting of living things. Based on the function in an ecosystem, the biotic components can be grouped into 3 types, namely producers, consumers, and decomposers (decomposers).

It can be seen that the relationship between living things and their environment both biotically and abiotically is a reciprocal relationship or interaction that is difficult and complex. An ecosystem can be balanced if there is a reciprocal relationship or interaction between the components of the ecosystem. Plants are the producers whose numbers are the most abundant. If there is damage that causes changes in the environment, then all types of organisms will experience changes. On the other hand, if the number of organisms is not controlled, it will harm other organisms.[37]

Biotic factors are all living factors, which means that all living things and organisms that exist on this earth. In the ecosystem, plants have an important role, namely as producers (food producers), while animals as consumers, and microorganisms as decomposers (decomposers). The biotic factors include the level of organisms consisting of individuals, populations, communities, ecosystems, and the biosphere. These levels in an ecosystem will interact and influence each other in a system that shows unity.

A. Effect of Plant Interaction with Plants

There are many biotic influences on plants, one of which is plants with other plants. This interdependence between biotic components occurs between one living thing and another living thing in an ecosystem. The

[37]Netty Demak H. Sitanggang Yulistiana. 2015. *Peningkatan Hasil Belajar Ekosistem Melalui Penggunaan Laboratorium Alam.* JurnalFormatif. Vol, 5 (2): 156-167.

interdependence between biotic components is further divided into interdependence between similar living things and interdependence between dissimilar living things. There is also an interaction between biotic components. These interactions can occur between organisms, populations and communities.

B. Interaction between Organisms

In nature, in general, a community consists of several populations of both plants and animals. Among these individuals, there will be various types of possible types of biological interactions between one individual and another. Mutualism is a form of obligate (violent) interaction. If it is "On" then both parties will benefit, while if it is "off" then both parties will lose (depressed). Example: symbiotic nitrogen fixation between rhizobium bacteria and root nodules of legumes. Another example is mychorrizae, which are hypae of certain fungi that cover the tips of tree roots and form absorbent webs that carry out the absorption of nutrients by the tree. The fungus gets its food supply (the result of photosynthesis) from the tree. Mychorrizae there are two kinds, namely ectomychorrizae and endomychorrizae.

As in the journal Simamora (2017) he argues that the higher the number of seedlings, the higher the growth of Rafflesia meijerii. This is in accordance with Lestari (2013) that the higher the number of understorey plants will be a threat to R. zollingeriana because it will cause competition between the host and understorey in terms of taking soil nutrients because understorey plants and Tetrastigma both have shallow root systems. The reduced nutrition obtained by the host can interfere with the growth of the host, and the growth of R. zollingeriana will also be disrupted because it is very dependent on the availability of nutrients in the host's body.

C. The Effect of Animal-Plants Interaction

Based on the interaction between animals and plants can occur in various forms. The interactions between plants and animals can be grouped into 2 parts, including the following:

1. Herbivore

   Herbivory is a process of predation of plants with animals. In this case, animals can eat part or all of the plant, thus having an impact that is not only destructive but can be completely depleted. Not all animals eat plant species, there are some types of animals that only choose certain parts of

plants to eat. According to the part of the plant they eat, herbivores can be grouped, such as:

a. Granivores, grain eaters or some rodents.
b. Graminivores, grass eaters or eg zebras.
c. Frugavores, fruit eaters such as bats.
d. Foliovores, leaf eaters such as koalas.
e. Nectivores nectar eaters, honey eaters / suckers such as hummingbirds.
f. Palynivore, pollen eaters / pollen eaters or for example insects.

It can be seen that physical defense is an external system found in plants in defending themselves from the predation of herbivores. Some forms of adaptation are as follows:

a) There are thorns on plants that prevent them from being eaten by animals. Examples are lantana, rose, acacia, and cactus leaf backs.
b) There are fine hairs on the upper surface of the leaves and pods, such as on young leaves and pods of soybean plants that can block insect stylets so that it will cause damage to the sucker of soybean pods Chemical defenses are chemical substances that are owned or released by plants with a view to defending themselves from predation by herbivores in the form of secondary metabolites. Examples include the content of HCN in gadung tubers (Dioscoreahispida denust.), and nicotine in tobacco.

2. Symbiosis and Non-Symbiosis

There is an interaction between plants and animals with the aim of obtaining both benefits or only one of them. Interactions that can be mutually beneficial or are said to be very close interactions are symbiotic mutualism, while the existence of tenuous interactions is also called non-symbiotic mutualism. One example of a very classic mutualism interaction between animals and plants is such as ants and acacias. From ants and acacia, both can benefit from this interaction. It can be seen that the ants will depend on the acacia for food and shelter, from the swollen or hollow acacia, the ants will make holes so as to produce a place to live for them, and all will get food or as the main source of protein, fat, and juice. honey by eating the tips of acacia leaves. The axia will depend on the ants, in this case the protection against herbivores and neighboring plants. Please note that not all ants and acacia can live in symbiosis like this.

The results of research by Jansen (1966) in Hadisubroto (1990) regarding the interaction between ants and acacia show that the survival and increase in

length of acacia "without the help of ants" will be shorter than "with or with the help of ants". will continuously guard the leaves and branches of acacia, and can immediately attack herbivores if the tree is disturbed. Ants can also sting and damage other plants that touch the acacia and can clean all the plants under the acacia. Thus, acacias often grow in circles free from other plants. The results of the latest research from Arsan (2015) in a savanna in Kenya (Africa), found that one of the acacia species, namely Whistling thorn or Ant-galled Acacia (Acaciadrepanolobium) or known as one of the nectar-producing species in symbiosis with 3 species from genus Crematogaster, such as: Crematogastermimosae, C. sjostedti, C. nigriceps and there is one species of the genus Tetraponera, namely T. Penzigi.

In addition to a very close or specific relationship (symbiosis), there is also a tenuous and non-specific relationship, but mutually beneficial to both parties. This relationship can be seen, for example, during pollination and seed dispersal. Almost all plant pollination in the tropics is assisted by insects. Likewise with the distribution of seeds, almost entirely assisted by animals.

Predation is predation that can occur in plants against animals. Examples such as in carnivorus plants, for example:

a) On Venus lytrap (Dionaeasp.: Droseraceae), which has leaves that can close quickly to pinch and digest insects trapped inside.
b) Sundews (Droserasp.: Droseraceae), have glandular hairs that can paralyze sticky insects.
c) Giant pitcher trap (Nephentessp.: Nepenthaceae), has a bag and cover, which functions to trap and digest insects or trapped prey animals.[38]

D. Interaction of Plants with Microorganisms

Basically, microorganisms make a type of plant as a host for a place to live and a place to get food which in this interaction can give benefits to both and some are only one who benefits so that it can be said to be symbiotic mutualism and parasitism.

One type of beneficial fungi or microorganisms is mycorrhizal arbiscula which is a form of mutualism symbiosis that occurs in plant roots. According to Wu, 2013 in the journal Biosciences, the association that occurs between fungi and plants can benefit plants, especially by increasing the uptake of phosphate ions, this is because mycellia on fungi outside for phosphate depletion can

[38]Edi Muhammad Jayadi. 2015. *EkologiTumbuhan.* Mataram: Institut Agama Islam Negeri (IAIN) Mataram. Hlm. 61

occur rapidly growing around the roots. And in return the fungus obtains carbon from its host plant.[39]

For example, the interaction between legume plants and Rhizobia bacteria can benefit legume plants in the nitrogen fixing process, in which these groups of bacteria will infect plant roots so that root nodules are formed in which nitrogen that has been bound by legume plants will be converted into amino acids which will then be converted to amino acids. into nitrogen compounds that plants need to grow and develop. The advantage of Rhizobium in this interaction is that Rhizobium obtains carbohydrates from its host plant which are used as an energy source.[40]

Then, the interaction of plants with microorganisms is also harmful. One example is the bacteria Raistonia solanacearum and the fungus Fusarium and oxyforum which if these microorganisms live in potato soil can cause wilting of potato plants which can reduce plantation yields that should be obtained.[41]

E. Plant-Human Interaction

According to the journal on the diversity and use of understorey plants with agroforestry systems. It turns out that the journal has many benefits for the surrounding community. The discussion discussed is about the diversity of understorey species obtained and the benefits of each type of understorey obtained. Including the ethnobotany of medicinal plants which is a form of interaction between the natural environment and the surrounding community. There is a link between community culture and plant resources, either directly or indirectly. People need plants for their daily needs as food, medicine and textiles.

Underplants can also be consumed by humans For cooking ingredients, for example, can be used to be cooked as vegetables to meet their daily needs.

There are many types of understory obtained, including from the Zingiberaceae family. Other understorey plants can be used by the community as medicines, stamina enhancers, and insecticides. Where the medicines are

[39] Ahmad Shafwan, *Jurnal Ekosens*, (Medan: Unimed Press), hal. 17

[40]Balai Litbang, *Rhizobium Pemanfaatan sebagai Bakteri Penambat Nitrogen*, (Makassar: Badan Penelitian Kehutanan Makassar

[41]Tarkus Suganda*, Deteksi Jamur Verticilium dahlia* Kelebihan Penyebab Penyakit Layu Tanaman di Sentra Budidaya Kentang Lembang dan Pangalengenan,(Bandung: Ilmu Hama UNPAD,2003),hal. 39

formulated to help cure diseases, including for skin diseases, fever, cough, stomach and some degenerative diseases such as hypertension, cancer, gout, asthma and so on.[42].

Types of plants can also be used as community income. Where these plants can be sold and can also be used as building materials / materials for the manufacture of household furniture [43].

Humans need plants to share needs such as a source of food, as medicine, as a place to live and others. So the interaction between plants and humans is very closely related, where both help each other for their survival. Humans need many types of plants to know the diversity of plant species that are around them and can know the benefits of each type of plant, especially on lower plants and can develop its benefits and apply it in everyday life.

[42]Subagus wahyuono, dkk. 2016. *Keanekaragaman dan PemanfaatanTumbuhan Bawah DenganSistem Agroforesti Diperbukitan Menoreh, Kabupaten Kulon Progo.* Vol 23 (2). Hal : 206-215.

[43] Antoni Ungirwalu, dkk. 2016. *Pengelolaan Adaptif Pemanfaatan Buah Hitam (Haplolobus monticola* Blumea) *Etni sWandamen-Papua.* Vol 23 (2). Hal : 266-275.

CHAPTER VII

ECOSYSTEM

A. Definition of Ecosystem

Ecosystem is an ecological system created by the alternating relationship that occurs between every living thing (biotic) to the surrounding environment (abiotic) and also between the constituents experiencing the transfer of energy, material cycles and productivity. The characteristics of the integrity of the ecosystem are energy, which is a level in which there is a trophic level, a food level, a producer level, a consumer level, and a reducer level, then nutrient recycling, and productivity, which includes the overall results that occur in the system.

Many of the concepts that exist in ecosystems are basically existing and have been realized long ago, which was carried out by ecologists in 1877 which later developed again in 1935 and was increasingly in demand by people and then more used and developed again so that it was accepted. by the general public at that time until now.[44]

In the unit of living things in an ecosystem there are individuals, populations, and communities. The individual is a single living being. Examples can be taken, such as the presence of rabbits, cows, wolves and others.

B. Components In Ecosystem

Ecosystems will always experience changes every time and will not stay forever, between biotic factors and abiotic factors will always experience interaction, and this is one of the changes in an ecosystem that can be caused naturally or by human intervention.

In general, abiotic components are components that control organisms that can carry out their roles in the ecosystem. Inorganic materials are

[44]Heddy, S dkk. *Prinsip-Prinsip Dasar Ekologi.* (Jakarta: Raja GrafindoPersada). 1996

indispensable to producers for their survival. This material will also be a constituent of the body's material for organisms. And so is the case with organic matter. Organic materials are needed by consumers as a source of food. Producers that undergo photosynthesis are components that produce chemical energy or food. Meanwhile, the decomposers will be responsible for returning various chemical elements back to the soil and the soil will later be used by producers and the ecosystem will run safely and well. If there is an inappropriate role that is not going well, the immediate impact is that the sustainability of the existing ecosystem will not experience balance so that if there is an imbalance, the existing ecosystem will be threatened. Then if there is an ecosystem that runs fast or too fast and inappropriately or then what happens is that the balance of the ecosystem will be disturbed.

An ecosystem is a combination of all the components that make it up. Within these ecosystems, there are continuous processes that are interrelated and influenced by the existing components. Within a component there must be living or interacting (biotic) and non-living (abiotic) components. Biotic components have several roles, namely:

1. Green plants are producers or providers of food sources that can synthesize organic substances
2. Living things or humans here are only consumers or only use and are not able to synthesize their own organic substances
3. Predators here are predatory animals such as tigers that prey on other consumers
4. Organisms are decomposers which will later function to break down the remaining substances of living things.

The concept that exists in the ecosystem is a broad concept. Because it is a basic concept in ecology. This concept will emphasize the relationship that occurs, namely the reciprocal relationship and interrelationships between a living organism and its non-living environment.

Often times in autotrophic and heterotrophic processes occur, namely the microorganisms that will be responsible for the separation process should run according to time and space. For example like this, in the forest as we know that the forest is autotrophic which will experience more photosynthesis which will then occur in the canopy, then in heterotrophic what happens is more on the surface of the forest floor and then this is what is referred to as separate by space as already explained, then also in the heterotrophic process there must be something that happens during the day and there is also

something that will happen at night so this is what will be called the separation based on time.[45]

The abiotic components consist of:

1. Land

   Here the soil is very important for plants, animals, and humans. The role of the soil itself is as a place for living creatures to live and also as a source of nutrients (nutrients) contained in the soil that function for plants.

2. Water

   Here water plays a role in every living thing and has a volume that suits their individual needs and how to save water according to certain circumstances. Water has an important role in the balance of nature and also the organisms that exist on this earth.

3. pH

   The degree of acidity (pH) of the soil is what will determine the type of plant that will be in accordance with the pH to be determined. Changes in pH greatly affect the survival of plants and organisms in the soil.

4. Air

   Air is a component that is so important for life on this earth to live. Air can be influenced by several factors, namely sunlight, humidity, temperature, and wind.

5. Sunlight

   Sunlight is a very important source of energy for all living things because light is so important for green plants and photosynthetic bacteria as well as for all herbivorous animals. The uneven distribution of sunlight to the earth requires living things on earth to adapt to their environment, where the intensity of the light varies from time to time.

6. Temperature

   Temperature plays an important role in indicating the species at any given time. The point is that living things on earth have a minimum, optimal, and maximum limit to a certain temperature. Temperature can affect body conditions in organisms that have a narrow range. therefore

[45]Hadisubroto, Trisno. *Ekologi Dasar.* (Jakarta: Departemen Pendidikan dan KebudayaanDirektoratJenderal Pendidikan Tinggi). 1989.

organisms are always trying to adjust by getting the optimal environmental temperature.

Based on the structure of the ecosystem has six other components as follows:

1. Inorganic material

   So this organic material includes C, N, CO_2, H_2O, and so on. Then this material will experience what is called recycling.

2. Organic

   Organic materials here of course in the form of carbohydrates, fats, proteins, and so forth. Then this organic material will be the connecting material between the biotic and abiotic components later.

3. Climatic conditions

   In climatic conditions of course lead to rainfall, temperature, and wind.

4. Producer

   Producers here are autotrophic organisms whose plants will produce chlorophyll. These organisms are able to live with only inorganic materials, because later these organisms will be able to live only by relying on their own food. One of them is photosynthesis. In addition to plants with chlorophyll, bacteria are also included in one that is capable of producing chemical energy through chemical reactions. However, the role of this one bacterium is not that big of a role when compared to photosynthetic plants.

5. Microconsumers

   Microconsumers here are heterotrophs, especially in animals such as goats, insects, snakes and crabs. Then this organism will depend on other organisms for its life, and also its life cycle can feed on its own genetic material.

6. Microorganisms

   Microorganisms here include heterotrophs, autotrophs, and osmotrophs, especially those that occur in bacteria and fungi. Because this plant will break down genetic material that was not useful and not needed will decompose it so that it breaks down into elements of organic matter.

According to the function of the ecosystem, it can be observed that according to the six processes in it, namely:

1. Energy channeled through the trajectory
2. Food chain

3. How to spread diversity over time and conditions
4. Cycles that occur biogeochemically
5. Changes that occur over time
6. Who is capable of being a controller

C. Interaction Patterns in Ecosystem

The existence of a reciprocal relationship in the ecosystem causes the system to be shaky if there is damage to one of its components. Interactions in ecosystems can occur between biotic and abiotic components.

1. Interactions between biotic components

   Interactions between biotic components are interactions that occur between populations of organisms that make up the ecosystem. The interactions that occur often influence each other. Several types of interactions between biotic components:

   a. Mutualism (Mutual Benefit)

      Mutualism is a form of relationship or interaction between organisms of two different species. Mutualism relationship will be mutually beneficial for both individuals or organisms involved in it. A relationship that can exist without its mutualistic partner organism is called faculative mutualism.

      The relationship that occurs between the two types of organisms that can only live by mutualism is called mandatory mutualism.

   b. Commensalism

      Commensalism is a form of relationship or interaction between living things of two different or different species. In which only one living being benefits while the others have no effect.

   c. Neutralism

      Neutralism is a relationship between organisms of different species that do not affect each other, or do not result in gain or loss even though the organisms are in the same habitat. Example: the interaction between cats and chickens in the garden.

   d. Allelopathy

Allelopathy is a relationship or interaction between living things in which the presence of one living thing can inhibit the growth or development of other living things through the release of antoxin or poison.

e. Predation

Predation is a relationship or interaction between living things in which one living thing eats another. Organisms that eat are called predators. Organisms that are eaten are called prey. Animals that prey on the same sex are called connibalism.

f. Competition

There is competition or resistance to get a limited resource that causes a relationship or interaction in the form of competition. Competition that occurs between individuals of the same species or organism is called intraspecific competition. Competition that occurs between individuals of two different species is called interspecific competition.

g. Parasitism

Parasitism is a relationship between organisms or living things of different species, in which one type of organism (parasite) lives together or rides with another organism (host) and causes harm to the organism it hosts.

2. Interaction Between biotic Components with Abiotic Components

The life of organisms on land and waters cannot be separated from the influence of the abiotic components that make up the ecosystem. The ability of an organism to live under certain environmental conditions is called the tolerance range. Each species in the ecosystem has a tolerance limit.

There are times when a population in an ecosystem is strongly influenced by one type of abiotic component or limiting factor. Example: phosphorus content in soil for corn growth. If the soil contains too much phosphorus, the growth of corn plants will be stunted.

Organisms in aquatic ecosystems also have limiting factors, namely: temperature, sunlight, dissolved oxygen, and nutrients. Another limiting factor is salinity (amount of inorganic minerals or salts dissolved in water).

D. Ecosystem Types

There are three types of ecosystems, namely, terrestrial ecosystems, aquatic ecosystems and artificial ecosystems. Which we will discuss one by one and examples that are included in the ecosystem.

1. Terrestrial ecosystem

a. Mangrove forest

Forests that mainly grow on alluvial mud soils in coastal areas and river mouths that are affected by tides. The area of mangrove forests in Indonesia is the largest in the world (2.5-3.5 ha, 18-23% of the world's mangroves and wider than Brazil). The ecological functions of the mangrove ecosystem include:

1) As a wave absorber
2) As a protector of coastal areas from abrasion
3) As a nutrient absorber
4) As a place of animal habitat around it
5) As a balance on the beach

b. Tropical Rainforest Ecosystem

Tropical rain forests are found in the tropics and sub-tropics. What we know is the rainfall of 200-225 cm per year. There are relatively many species of trees that grow around it and the types that grow also differ from one another, which is influenced by geographical location factors. The main tree height is between 20-40 m, the branches are high and have dense leaves to form a hood. In this tropical rain forest ecosystem, there are often typical plants, namely lianas and orchids as epiphytes.

c. Savanna

This area is found with rainfall between 40-60 inches per year, which is a differentiator from other terrestrial ecosystems but has temperature and humidity depending on the season. The largest savanna in the world is located in Africa.

d. Desert

Deserts are located in the tropics bordering grasslands which have characteristics of arid ecosystems and very low rainfall, the temperature difference between day and night is very large. Grown. In addition, in the desert there are also leafy perennials such as thorns such as cacti, or leafless and have long roots and have tissues to store water. Animals that live in the desert include rodents, ants, snakes, lizards, frogs, scorpions, and several other nocturnal animals.

e. Grasslands

Grasslands are plants that are overgrown by grass and plants that do not have wood or do not have wood. Grasslands are found in areas that stretch from the tropics to the subtropics. Its characteristics are rainfall of approximately 25-30 cm per year with irregular rain conditions with very fast water flow. The plants that live in it are herbaceous plants and grasses whose life depends on the humidity of their habitat.

f. Karst (Limestone / Cave)

Karst comes from the name of the limestone region in the Yugoslav region. On average, karst areas in Indonesia have almost the same characteristics, namely, the soil is less fertile for agriculture, sensitive to erosion, prone to landslides, prone to low aeration pores, slow permeability and dominated by micro pores. . Karst ecosystems experience their own uniqueness, with a variety of biotic aspects that are not found in other ecosystems.

g. Taiga

The taiga is found in the northern hemisphere and in the mountains of the tropics. Its characteristics are low winter temperatures, taiga is a forest composed of one species such as conifers or spruce, pine and the like. Very few wet shrubs and plants.

h. Tundra

Tundra is found in the northern hemisphere within the arctic circle and is found on the tops of high mountains. The growth of this plant in this area just 60 days. Examples of dominant plants are sphagnum, lichen, annual seed plants, shrubs, and weeds. In general, the plants are able to adapt to cold conditions.

i. Autumn Forest

Deciduous forests are found in temperate climates which have four seasons in the ecosystem, while the characteristics are stable or even rainfall throughout the year which can be said to be constant or the same. The types of trees that grow in it are very few and not too dense.

2. Aquatic Ecosystem

a. Freshwater Ecosystem

Aquatic systems that cover part of the earth's surface are divided into two main categories, namely freshwater ecosystems and seawater ecosystems. life activities.

Freshwater ecosystems are generally divided into 2, namely flowing waters (lotic water) and stagnant waters (lentic water). Lotic waters are characterized by continuous currents with varying speeds so that the mass transfer of water takes place continuously, for example: rivers, streams, canals, ditches, and others. Stagnant waters are also called calm waters, namely waters where water flow is slow or even non-existent and water masses accumulate over a long period of time. Examples of lentic waters include:

1) Lake

   The lake is a naturally tapering waters, and consists of volcanic lakes, namely lakes formed due to volcanic eruptions, and tectonic lakes, namely lakes formed due to tectonic events such as earthquakes. There are many volcanic and tectonic lakes in Indonesia because Indonesia is its territory.

   The lake has a very deep depth, clear water, relatively slow fertilization, low primary productivity and in the early stages of development the diversity of organisms is also low. Volcanic lakes at the beginning of their formation had high water temperatures, rich in sulfur, poor in organic matter, so that only certain organisms that had special adaptability such as the Cyanophyta algae group became pioneer organisms there.

2) Reservoir

   Reservoirs are stagnant waters due to the deliberate damming of several rivers for certain purposes. Based on the type of dammed river and its function, the types of reservoirs are known, namely irrigation reservoirs, field reservoirs and multipurpose reservoirs. Irrigation reservoirs originate from intermittent river dams, have an area of between 10 – 500 Ha and are used for irrigation needs.

3) Swamp

   It is a relatively shallow stagnant water ecosystem, sloping walls and very productive littoral areas. Swamps are formed due to the silting process of lakes, reservoirs, or due to other processes such as due to an earthquake that causes an area to sink but not deep, or due to wind activity, and tides (salt/brackish marshes).[46]

4) River

[46]Satino.*Diktat BiologiKelautan*. *JurnalEkosistemPerairan* (Yogyakarta : FMIPA UNY 2010)

A river is a body of water that flows in one direction. The river water is cold and clear and contains little sediment and food. The flow of water and waves constantly provide oxygen to the water. The water temperature varies with altitude and latitude. The river ecosystem is inhabited by animals such as fish, carp, turtles, snakes, and other animals.

b. Seawater Ecosystem

Marine habitats (oceanic) are characterized by high salinity (salt content) with CI- ions reaching 55%, especially in tropical ocean areas, due to high temperatures and large evaporation. In the tropics, the sea temperature is around 25 °C. The difference in temperature at the top and bottom is high, so there is a boundary between the hot water layer at the top and the cold water at the bottom, which is called the thermocline. Marine habitats can be distinguished based on their depth and horizontal surface area.

1) Estuary Ecosystem

Estuary (estuary) is a place where the river meets the sea. Estuaries are often lined by extensive intertidal mud slabs or salt marshes. Estuary ecosystems have high productivity and are rich in nutrients. The plant communities that live in the estuary include salt marsh grass, algae, and phytoplankton. The animal community includes various worms, shellfish, crabs, and fish.

2) Coastal Ecosystem

It is so named because the plant that grows the most in the sand dune is Ipomoea pes caprae which is resistant to waves and wind. Plants that live in this ecosystem spread and have thick leaves.

3) Coral Reef Ecosystem

This ecosystem consists of corals located near the coast. Various types of invertebrates, microorganisms, and fish, live among sea corals and marine algae. Herbivores such as sea urchins, snails, fish, become prey for octopuses, carnivorous fish, and starfish. The existence of coral reefs in the coastal ecosystem makes the beaches have white sand. The following is a list of benefits from the existence of coral reefs:

a. Play an important role in the growth of fishery resources (as feeding ground, fishing ground, spanning ground and nursery ground)
b. Prevents beach erosion (abrasion)
c. As a marine tourism attraction

d. Globally, coral reefs function as calcium sinks that flow from rivers to the sea
e. As an absorber of carbon dioxide and other greenhouse gases (GHG).

4) Deep Sea Ecosystem
Its depth is more than 6,000 m. Usually there are sea catfish and sea fish that can emit light. As producers, there are bacteria in symbiosis with certain corals.

5) Seagrass Ecosystem
Seagrass is the only group of flowering plants that live in marine environments. This plant lives in shallow coastal water habitats. Like grasses on land, they have erect leafy shoots and creeping stalks that are effective for reproduction.[47]

c. Artificial Ecosystem:
The definition of an artificial ecosystem is one where an artificial ecosystem is created by humans to meet the needs for their survival. The artificial ecosystem is an energy subsidy from outside. Plants or pets are controlled or dominated by humans themselves and have low diversity.
a. Dam
b. Industrial Plantation Forest (HTI)
c.Agroecosystems, such as rice fields, plantations, ponds, ponds, fields and yards.
d. Residential ecosystems such as cities and villages

E. Factors Affecting Ecosystem

If an environment or habitat changes, the ecosystem in it will experience changes as well. Environmental changes can occur naturally and changes caused by human activities.

1. Natural Ecosystem Change

It seems as though we know that natural disasters often occur, such as volcanic eruptions or earthquakes, landslides and so on. The disaster can certainly cause changes in the ecosystem itself. For example, in the forest around Mount Merapi there are many animals, plants, and other living things. If a catastrophic volcanic eruption occurs, many living things will experience death or extinction. The same is true when there is an earthquake. With the

[47]Rahardjato. *EkologiTumbuhan.* (Malang: UNM. 2001)

occurrence of these natural disasters, the ecosystem will change completely. In terms of ecosystems, when one living thing dies, it will have an effect on the state of other living things. Another natural disaster that can also disrupt the balance of the ecosystem is forest fires. Forest fires will cause damage to the ecosystem or habitat in it. It can even kill and destroy living things and the organisms in them. For example, when the Tsunami and Tanah Lomgsong can damage the ecosystem around the environment, such as soil damage during landslides.

2. Ecosystem Changes Due to Human Activities

Humans always try to fulfill their needs. One way to meet their needs, humans take advantage of nature and the environment. However, it is this weakness in humans that we cannot prevent, such as: excessive use without thinking about the impacts and effects. The following things that will affect ecosystem changes and cause damage are:

a. Pollution. (pollution of air, water, soil, and sound) as a result of the existence of industrial areas.
b. The occurrence of flooding, as a result of poor drainage or water disposal systems and errors in maintaining watersheds and the impact of forest destruction.
c. The occurrence of landslides, as a direct impact of forest destruction.
d. Illegal logging (deforestation)
e. Illegal hunting.
f. Destroy the mangrove forest.
g. Hoarding of swamps for settlement.
h. Throwing garbage in inappropriate place.
i. Illegal buildings in watersheds (DAS)
j. Use of organic fertilizers and pesticides
k. Use ofMotorized Vehicles

3. The Effect of Chemical Use on the Environment

The environmental damage that has occurred recently is quite serious. Environmental pollution has occurred in several areas. Indonesia as a developing country has a high level of environmental damage. In addition to the consequences of natural and human-made events that intentionally damage the environment for personal and group interests, the use of chemicals in the environment around us, without us knowing it, can damage

the environment and its ecosystem. For example, the use of artificial fertilizers that are not in accordance with the proper dose. Farmers usually use fertilizers to fertilize crops. Because of the desire to produce high agricultural production, farmers often use excessive fertilizers. Although given in large quantities, agricultural plants have their own ability to absorb fertilizer. As a result, the excess fertilizer will settle in the soil. If it rains, then the fertilizer that is not used will be included in the flow of water. For example, the flow of water empties into a river or lake. At first the fertilizer in the lake will fertilize aquatic plants. However, if the number is very large, the growth of these aquatic plants becomes uncontrollable. The uncontrolled growth of aquatic plants will close the waters so as to hinder or interfere with water transportation, accelerate silting of waters, clog irrigation canals and installations of hydroelectric power plants.[48]

[48]Parjatmo, Widjaja. *BiologiUmumi.* (Bandung: Angkasa). 1987.

CHAPTER VIII
SUCCESSION

A. Definition of Succession

Succession can be defined as a change in plant species and structure which coincides with a change in the place of growth. This change will continue until it reaches a climax state, which is the culmination of the plant succession process, with the formation of good plant life and being in a dynamic balance with their habitat.

According to Spur (1964), states that succession is a process that occurs continuously so that there will be many changes in a vegetation, soil and microclimate. Not only that, with the occurrence of a change it will allow the entry of new types of life continuously until a climax level is reached. Changes or changes in plants in the succession process are caused by the tendency of the first plant life to change the physical environment so that there is a suitability of other plant habitats and the continuity of the biotic and abiotic environment.[49]

Succession is an important aspect of ecology and restoration. Recovery to soil and vegetation conditions may take longer depending on soil formation conditions, vegetation recovery process and colonization level. [50]

[49]Gago,cornelio. *Suksesi Alami Paska Kebakaran Pada Hutan Sekunder Di Desa Fatuquero, Kecamatan Railoca, Kabupaten Ermera-Timor Leste.* (Bogor : IPB, 2011), hal 5-6.

[50] Afrianto, Whisnu. *Komunitas Floristik Dan Suksesi Vegetasi Setelah Erupsi 2010 Di Gunung Merapi Jawa Tengah*. Vol 12 No. 2, 2016 Hal 265-266.

B. Types of Succession

There are several types of succession, including:

1. Primary Succession

Primary succession is a disturbance in the community that occurs naturally without human intervention. This succession will result in the total loss of the community in an area. For example, the process of change that occurs due to volcanic eruptions, tsunamis, and other natural events. [51]

The occurrence of a volcanic eruption is an example of primary succession. After the eruption, part of the forest land that was previously lush with various types of mountain vegetation became open land due to the brunt of hot clouds which was soon overgrown with pioneer vegetation types. Pioneer Vegetation is a type of vegetation that is able to adapt to nutrient-poor environmental conditions. With this character, pioneer vegetation will immediately invade locations previously affected by the eruption, which can then be overgrown by other types of vegetation.[52]

2. Secondary Succession

Secondary succession is a disturbance that exists in a community, but only causes damage to part of the community or not in total damage. This succession can also occur naturally and intervene from humans. Examples of natural disturbances such as strong winds, floods, etc. Meanwhile, human interference is in the form of forest burning, illegal logging.[53]

C. Factors Affecting the Succession Process

Succession is influenced by many environmental factors, including edaphic conditions, climatic patterns and water availability, interactions between biotic and abiotic factors, species distribution patterns, and habitat dynamics. These environmental factors are interrelated and in many cases

[51] Jayadi, Edi. *Ekologi Tumbuhan*. (Mataram : CV. Sanabil, 2015) Hal. 71-72
[52] Yuniasih, betti. *Suksesi Gunung Merapi Menggunakan Indeks NDVI*. Hal. 102
[53]Jayadi, Edi. *EkologiTumbuhan*. (Mataram : CV. Sanabil, 2015) Hal.72-73

occur in combination or interdependence and ultimately affect the composition and pattern of vegetation diversity.[54]

There are several factors that influence the succession process, including:

a. The original community damaged by natural disturbances or human intervention.
b. With the occurrence of disturbances in the community, it will result in the types of plants that are around it.
c. With disturbance in a community, spores, ovules, and fruit will arise.
d. Abiotic factors help disperse spores, seeds, ovules.
e. Then a new type of substrate will be formed around the place of succession.[55]

D. Succession Stages

In the succession process, there is a gradual change in the process towards a balance in an ecosystem. Which stage of the process of succession is also strongly supported by abiotic and biotic factors that exist in an area. Where the succession process itself is divided into 5 phases rationally, from Clement's statement succession is divided into 5 phases, including:

1. Nudation phase, which is the initial process of growth on open/empty land. The growth that occurs starts from low-level plants to high-level plants. The growth that occurs is the growth of the land that has occurred successively until the process of vegetation growth begins to grow step by step.
2. Migration Phase, which is the process of the presence of plant seeds, spores and others. This process is the process of plant a vegetation that has grown on land where succession has occurred and begins to grow to maturity by growing seeds or spores as a means of reproduction or multiplying the offspring of an existing vegetation.
3. Ecesis phase, which is the process of steady growth of the seeds. Where this process is a maturation process or a process where the seeds or

[54]Afrianto, Whisnu. *Komunitas Floristik Dan Suksesi Vegetasi Setelah Erupsi 2010 Di Gunung Merapi Jawa Tengah*. Vol 12 No. 2, 2016 Hal 266

[55]Jayadi, Edi. *EkologiTumbuhan*. (Mataram : CV. Sanabil, 2015) Hal 75

potential candidates for a plant are ready to be produced as new vegetation.

4. Reaction Phase, is the process of competition or competition that occurs between plant species that have lived or exist in an area, and their effect on the surrounding habitat where the succession occurs in an area.
5. Stability phase, which is the process where the population of plant species has reached the end point of a balanced condition (equilibrium), in which there has been a balance with growing habitat conditions both locally and regionally.[56]

The next phase of the succession process is composed of a series of travel routes for the formation of a transitional vegetation community to a community in balance. The succession phase here is where the succession process occurs from the formation of a vegetation community that changes from the process of a damaged land to a succession process that gives rise to new vegetation from a state that does not exist or is destroyed and begins to come back into existence in a gradual process leading to the process of forming a community that has been balanced in its growth.

E. Change of Type in the Succession Process

Ecological succession that occurs is the acquisition of the spread and stabilization of an individual in plants. In the growth and spread of vegetation from the succession process, a strategy for changing species in the succession process itself is needed, which helps the succession process occur more quickly and optimally. The strategy for changing types in the succession process is divided into 2, namely

1. Opportunist Strategy

   This strategy is a group of plants adapted to dominate an open environment and in an ecosystem that is still in the process of development. This process is also said to be a plant that begins to occupy a succession area as a pioneer plant in the succession process. In this strategy group,

[56]Dr. Ir. Edi Muhammad Jayadi, *Ekologi Tumbuhan.* (Mataram :Institut Agama Islam Negeri Mataram, 2015), hal. 74-75

they are divided into several types of plants that are able to occupy an area, including:

a. Pioneer plants are one of the opportunistic plants adapted to dominate an open area, namely an area exposed to direct sunlight or a place where an open succession occurs. Produces a large number of seed plants that are easy to spread which helps the succession process more evenly. These pioneer plants must be more productive and their energy utilization shown for the dispersal process in the succession process.
b. The opportunist type, which means itself is small. This is because the net productivity is mainly for seed production, in which this type of opportunity is not required to become large plants and is required for seed production which helps the process of spreading individual vegetation more quickly in the succession process. This occurs in competition in open areas, and relatively small plant forms.
c. Opportunistic species are short-lived, plants in the form of annual plants whose life cycle is influenced by the growth of the season which allows the plant to store a certain amount of energy in the reproductive process.

2. Balance Strategy

This strategy is a group of plants adapted to control ecosystem conditions that have matured or have begun to experience balance in the succession process.

a. The type of balance which is the type of plant that grows in the final phases of the succession process and in the climax phase. Adapted to live in a stable and predictable environment
b. Equilibrium species can compete effectively against other species in which this plant is the dominant plant.
c. The type of balance that is able to have a low ability to spread, which produces few seeds and spreads slowly
d. The type of balance is a specialist who controls certain environmental conditions[57]

In the final phase, plant traits that occur from a succession process from the initial to the final phase use different strategies.

F. Succession Process Towards Climax

This ecological succession process will lead to a stable last community, namely by heading towards a climax. Then, which is where this climax phase has different properties, the most important point in this climax phase include:

1. This climax phase is a very regular or stable system in balance between the scientific environment and the non-scientific environment.
2. Then the composition and type of a climax phase is relatively constant or does not change.
3. Then in this climax phase there is no excessive accumulation of organic matter, therefore there is no change from that phase.
4. Furthermore, in this climax phase, you can manage yourself.

At this time there are several climax theories that we already recognize, where the theories are, among others, the monoclimax theory, then the polyclimax theory, and the last one is the theory of biotic potential or hypothetical climax patterns.

a. Monoclimax Theory

In this theory, the one who proposed this theory was Clements (1974-1945). The climax community for an area is only a function of that climate. He predicts that, given sufficient time, free communities to be affected by external disturbances, in a general form of climax vegetation that will simultaneously form in each region and the same climate. Therefore, this climate greatly determines the boundaries of the climax formation. Clements and all his supporters they do not see the fact or reality because there is too much local variation in a vegetation which is already in one form of climax in a given climate area. These variations are always considered a seral phase even though they are in a normal state or are called stable.

b. Polyclimax theory

It was at this phase that the polyclimax theory was created by Tansley (1939) who was an English botanist and as an alternative to this monoclimax theory. His opinion is that the monoclimax theory is too passive or rigid and he

[57] Dr. Ir. Edi Muhammad Jayadi, *Ekologi Tumbuhan.* (Mataram :Institut Agama Islam Negeri Mataram, 2015), hal. 76-77

does not give the possibility to explain local variations within a community of plants.[58]

In these climax conditions, these species will be able to regulate their conditions and be able to carry out their habitats so that they are more directed against new innovations. Clements in the concept of this climax opinion, among others:

1. This succession begins with very different environmental conditions, but ultimately has the same climax.
2. At this Climax he can only reach with different climatic conditions where the climax and climate are interconnected with each other. This climax is known as climatic climax.
3. All groups have a climax.

Then the next succession is that which is arranged in a series of journeys leading to the formation of transitional vegetation communities leading to communities in equilibrium. Which is where Clements gives a term for the community level of transitional vegetation with the name Sere / seral, and the final balanced condition is called climax vegetation..[59]

G. Benefits of the Succession Process

The benefit of this succession process is the process where the alternation between levels in the primary succession level to reach this climax takes a very long time, ranging from tens, hundreds, to thousands of years. Then in secondary succession, the time required is faster than the primary succession time. The rate of change in a community takes place in a very small period with very rapid development, because the habitat of soil and water has been formed to help the growth of vegetation. The succession process is:

1. A rapidly growing community becomes more complex.
2. An increase in productivity goes hand in hand with the development of the community and the development of its land.

[58]Manurung Binari. (2019).*PanduanTeoriEkologitumbuhan.*Medan:Universitas Negeri Medan(UNIMED)

[59]Muhamad, Edi Jayadi. (2015). *Ekologitumbuhan.*Mataram:Institut Agama Islam Negeri (IAIN)Mataram

3. A progressive development of soil substrate, which we know is for example the occurrence of an increase in organic matter content along with community development.
4. The better the community structure, the higher the density and height of a plant will be.
5. An increase in the number of species up to the stage of succession.
6. An increase and utilization of this environmental resource in accordance with an increase in the number of its kind.

So the benefits of this succession process are very influential on the occurrence of a process of development and improvement of the succession, which factors that affect this succession process include:

1. The extent of an original habitat which is damaged
2. The types of plants that exist in the vicinity of the disturbed community.
3. The speed of emission of seeds (seeds) in the plant ecosystem.
4. Climate, which is especially the direction and speed of the wind that greatly helps the spread of spores, seeds, seeds, and rainfall.
5. The type of new substrate that is formed becomes new.
6. The characteristics of the types of plants that exist around this place is the process of succession.[60]

H. Example of Success

There are two examples of succession types that describe a process of succession, namely primary and secondary succession.

1. Primary succession

This succession occurs if the first one gets damaged or disturbed so that it will result in the first community being completely lost, or better known as primary succession, this is a total damage and will not return to the way it was at the beginning, so where it was completely destroyed it will be formed. new community. This disturbance or damage occurs because there are two reasons, namely the first naturally, which for example is a Tsunami, Landslide, Mount Eruption and so on. The second disturbance or damage is due to human actions, for example house fires, waste mining, petroleum mining and so on.

2. Secondary succession

This succession occurs when a community suffers damage or disturbance, but results in damage to several communities. In this community the old substrate and some old life are still available. From this secondary succession resulted in two effects, namely the first naturally and caused by humans. Examples of natural damage or disturbance are floods, forest fires and so on. Then the disturbances caused by humans themselves are logging, making land and burning forests.

An example of succession in Indonesia is the occurrence of a volcanic eruption on Krakatoa. We know that after Mount Krakatoa erupted, the only remaining part of the island was covered by pumice and thick ash from Mount Krakatoa reached a depth of 30 meters. So according to De Neve 1984, the eruption of Mount Krakatoa was 21,574 times the power of the atomic bomb that melted Hiroshima, and could destroy all the islands of Krakatoa. Mount Krakatoa is not just destruction, but Krakatoa is also a symbol of life in nature. Changes in the composition of plants or flora that occur during the succession process are changes in the composition of the vegetation composition, the assumption is based on the plant community that appears more often in that place. Estimated order of plant communities during the succession process, namely mosses, shrubs, herbs, and tree stands. Some experts categorize succession into two types, this type of succession occurs from areas that are all new and organisms have not been found in that area, so this succession is called primary succession. So after the Krakatoa eruption, the island just became a "desert" where there was no plant life, and around 1886 the vegetation consisted of a bottom layer of blue green algae and an upper layer of ferns, the ferns consisting of 26 vascular plant species.

[60]Muhamad, Edi Jayadi. (2015). *EkologiTumbuhan.*Mataram:Institut Agama Islam Negeri (IAIN)Mataram

CHAPTER IX

VEGETATION AND VEGETATION CHARACTERISTICS

A. Definition of Vegetation

Vegetation is the diversity of plant species that live in an area simultaneously. All types of plants in the vegetation interact with each other and adapt to their habitat environment as a form of self-defense.

The general definition of vegetation is a collection of several plants that usually consist of several types and live together in one place. Among these individuals there are close interactions between the plants themselves and with the animals that live in the vegetation and environmental factors.[61]

Thus, vegetation is not just a collection of plants but is a unit in which the individual constituents depend on each other and are referred to as plant communities.[62]

The plant community or vegetation is a system that lives and grows or is a dynamic society. Plant society is formed through several stages of plant invasion, namely: adaptation, aggregation, competition and domination, reaction to growth and stability.[63]

While the characteristics are the characteristics of the vegetation of plant species that surround the area, usually characterized by biotic and abiotic factors that influence it such as temperature, climate, topography, rainfall, plant diameter, plant height, and others.

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[61]Marsono. 1997. *Deskripsi Vegetasi Dan Tipe-Tipe Vegetasi Tropika.* Yogyakarta: Fakultas Kehutanan UGM

[62]Djoko.S, Matono .2012. *Analisis Vegetasi Dan Asosiasi Antara Jenis-Jenis Pohon Utama Penyusun Hutan Tropis Dataran RendahDitaman Nasional Gunung Rinjani Nusa Tenggaa Barat.* JUrnal Agri-tek. V0l.13, No. 2, Hal19.

[63]Soeinegara,I. 1972. *Ekologi Hutan Indonesia.* Bogo: Departemen Management Hutan Fakultas Kehutanan IPB

Therefore, it can be concluded that the characteristics of vegetation are the dominant characteristics of a vegetation, both from the biotic and abiotic components that affect it. Each plant has certain characteristics such as there are only a few plants that can live in a certain place or habitat, so that it will cause differences in the vegetation that makes up the ecosystem in each environment.

B. Vegetation Characteristics

1. Vegetation Ecosystem Land Environment

a. Tropical rain forest

Tropical rainforests can also be referred to as forest biomes that have humid or wet conditions. Tropical rainforest ecosystems are forests located in areas with rainfall of about 2,000 mm per year or more. But no more than four months in a row its lowest rainfall. In addition, the monthly temperature is relatively stable, with a temperature of approximately 18°C. Comparison of the temperature in the hottest month with the temperature in the coldest month below 5°C. And the variation in annual temperature is relatively small.[64]

There are three main zones of tropical rainforest in the world, including the zone in the United States, which is the main zone, and is the largest zone from Veracruz to the Caribbean region, then to the south, namely Orinocco and the Amazon Basin in Brazil. This direction still continues to the territory of Peru. The second zone after the United States is the zone in Southeast Asia, covering Indochina, Burma, to the Queensland region. And the last zone is in the African region, centered on the Zaire Basin.

The vegetation characteristics of a tropical rain forest are, as follows:

1. Conditions in the tropical rain forest area have many tree species.
2. The average tree height is 20-40 m, has dense leaves that form a hood (canopy).
3. In the hood get enough sun sources, variations in temperature and high humidity.
4. Around 25°C temperature throughout the day.

[64] (Morley, 2001; Jermy& Chapman, 2002).

5. Has two distinctive plants, namely Liana or rattan and orchids.

b. Savannah Ecosystem

Savannah forest is a grassy field that is formed between the tropics and subtropics. This savanna forest is filled with various kinds of shrubs, shrubs, and trees that are widely spread. There are several continents that have savanna forests including South America, Africa, and Australia.[65]

Savannas can arise due to drought factors, or lack of rainfall, so these savannas are known as tropical grasslands. Which for the climate, the savanna is not too dry, and also not wet enough to be a forest.

The temperature and humidity of the savanna, depending on the season. Savannas are found in dry areas with rainfall levels in one year less than 1,000 mm. Savannahs in Indonesia exist in areas that have high temperatures with relatively low rainfall, such as in West Nusa Tenggara, Central Sulawesi, and East Nusa Tenggara. The characteristics of the vegetation of the Savannah Ecosystem are as follows:

1. If the rainfall intensity is lower, then the savanna vegetation that leads to the area of rain intensity will turn into more thickets.
2. If the intensity of the rain is higher, the savanna vegetation will turn into a wet forest.
3. Vegetation found in the savanna, including woody plants, for example found in Acacia nilotica Lam (Mimosaceae) Opuntia sp, Lantana sp.
4. In addition, the vegetation found in the savanna is found in herbaceous plants, for example in Chloris sp, Cenchrus ciliaris L. (Poaceae), and Stylosanthes sp.
5. Vegetation found in the savanna is also present in various species of legumes.

c. Grassland Ecosystem

Grasslands are areas that have an average rainfall of about 25-30 cm per year, irregular rains, high water infiltration or porosity, and fast water flow or drainage. Grasslands are found in areas that stretch from the tropics to the subtropics. In Indonesia, scattered grasslands have very

[65]Arif, A. (2001). Hutan dan Kehutanan. Yogyakarta: Kanisius.

little rainfall, but the air temperature is high, namely in the areas of Central Sulawesi and West Nusa Tenggara. Vegetation characteristics of the Grassland Ecosystem include the following:

1. In the savanna there are still large trees and shrubs, although their numbers are very small.
2. In the grasslands there are almost no trees, but there are some plants such as livestock and grass, which are equally dependent on humidity.
3. In the prairie area, the dominant vegetation is grass. Its size reaches three meters and gets wet late, an example is Bluestem grass (Andrology gerandi Vitman). Meanwhile, grass in dry meadows has a short size, for example Buffalo grasses (Bouteloua dactyloides Nutt).
4. The height of the grass vegetation in the meadow can be determined by the amount of rainfall. Areas that receive little rain, the grass remains low to the ground, and vice versa. Areas that receive high rainfall or more, then the grass is also high.
5. It has a rainfall of about 25-30 cm per year.

d. Desert Ecosystem (Desert)

Desert areas are areas bordering grasslands and are found in the tropics. Usually the natural state of the grasslands towards the desert the farther away, the more barren it will be. In this area, the rainfall is quite low, which is around 250 mm/year.

In this desert area heavy rains are rare and the timing is also irregular. The heat generated from the sun's rays is felt in desert areas during the day, due to direct sunlight and high evaporation. In summer, temperatures can reach 40°C. There is a huge difference between the temperature during the day and at night. Even so, it does not rule out the possibility that plants can still live in the desert. Plants that are able to live in the desert are plants that are able to adapt to lack of water and also to rapid evaporation.[66]

Characteristics of vegetation in the Desert Ecosystem are as follows:

1. Generally, plants that are able to live in deserts are plants that have small leaf sizes, or do not have leaves. Examples are thorns.

[66] 16Gillani, A. (2011). Which is a Famous Desert in Africa. Retrieved from http://www.einfopedia.com/which-is-a-famous-desert-in-africa.php

2. Only a few plants can survive in this area, because the soil conditions are very dry.
3. The most important xeromorphic trait for xerophytic plants or drought-resistant plants is the ratio of external surface area to volume, which is of small value. The decrease in cell size is accompanied by a decrease in the area of the outer surface, in addition to that it is also influenced by the increase in wall thickness, and the density of the vascular tissue system and stomata, and other supporting factors are the increase in the number of pole tissue, while the spongy tissue decreases.
4. Xerophytic plants are plants that have long roots, so they can take water from deep places. The leaves are covered by hair, its nature is succulent, namely as a water storage network.
5. If the leaf size decreases, it will be considered as a trait related to the reduced speed of transport, and also retains water in the spongy tissue.

e. Autumn Forest

Deciduous forest is a forest that is between the climatic conditions of tropical forests and coniferous forests where the forest has a moderate climate. The vegetation characteristics of deciduous forests are:

1) In deciduous forest, the tree species that fill it are relatively few, ranging from 10 to 20 tree species.
2) The position or place of the tree is not too close.
3) There are trees that can drop their leaves in summer (usually in deciduous forests in the tropics), and in winter (usually deciduous forests in temperate regions).
4) Some of the plants have broad leaves as a form of adaptation to extreme environments.
5) Plants that grow in deciduous forest areas will grow as soon as possible when environmental conditions are favorable. This is also done by plants in deciduous forests as an impact of adaptation to their environment.

6) Some trees in deciduous forest have deep and wide roots that are usually about the size of the canopy to maximize water absorption.
7) The leaves change color, from red to golden in autumn and in winter they will slowly drop their leaves. Examples are oak, hickory, maple, poplar, sycaraore.
8) In deciduous forest there are five zones:
   a) The first zone: the forest canopy consisting of relatively tall trees ranging from 60-100 meters. For example: maple tree.
   b) The second zone: consisting of short or small young trees that are more tolerant of shady conditions.
   c) The third zone: the bush zone, which is usually overgrown with rhododendros, azaleas, and others.
   d) Fourth zone: the herbaceous zone, which is usually overgrown with wildflowers, mosses and ferns.
   e) The fifth zone: also known as the ground zone which is usually overgrown with moss and lichens.

f. Taiga Forest

The taiga forest is also a forest that can be said to have a temperate climate, because it is located between subtropical and polar forests. The characteristics of the vegetation of the taiga forest are:

1. Vegetation in the taiga forest is low, because the taiga forest has extreme conditions.
2. Usually the vegetation in the taiga forest is composed of coniferous trees, so it is often referred to as coniferous forest. For example: spruce tree.
3. Having a conical canopy like a pine tree is a form of adaptation so that tree branches do not break when exposed to snow.
4. Usually the type of tree vegetation in the taiga forest has needle-like leaves and has a waxy substance that serves to counteract the rate of water shortage during transpiration.

g. Tundra Ecosystem

Finland is derived from Tundra which means an open area that is not forested and then used to describe all forms of vegetation that do not

have trees at high latitudes.[67] The vegetation characteristics of the Tundra Ecosystem are:

1. The growth of the type of tree vegetation in it is relatively small, due to the inhibition of plant growth due to the low temperature factor in the surrounding environment.
2. In the tundra ecosystem there is no tall tree vegetation, even if there are trees, the trees look short like shrubs.
3. In the tundra ecosystem, the more dominant plants are mosses, especially Sphagnum and Lichenes (lichens).
4. Usually the plant vegetation that fills the tundra ecosystem has a short, grouped tutu or shield to protect it from wind and extreme weather.
5. Has a short period of development and then dormancy. As in small seed plants, namely willow and bich trees.
6. Types of vegetation flowers from some plants will increase heat efficiency and move towards the direction of stimulation, namely sunlight as a form of adaptation to the environment.
7. Some types of vegetation in the tundra:
   a) Swampy areas: overgrown by vegetation of nut grass, cotton grass, and peat.
   b) Wet basin area: overgrown by vegetation of salic shrubs and bentulas.
   c) Slightly dry areas: overgrown by vegetation of mosses, nut grass, and plants that have broad leaves.
   d) Rocky slope area: overgrown with moss and algae vegetation.

2. Aquatic Ecosystem

a. River

Rivers are fresh water that flows from a lower place to a higher place. According to Nursal, et al in the journal of biogenesis that the existing vegetation conditions in the lake and riverside areas (riparian) still show unspoiled plant species consisting of trees and shrubs. Trees have various characteristics, some have a large stature and a height of about 40 meters. However, some are smaller than 10 meters. Likewise,

[67] Tim Penyusun. 2006. *EkologiTumbuhan.*Medan :USU

tree branches and leaf shapes vary from one another. Some are in the form of a shady canopy, and some are not lush.[68] The vegetation characteristics of the river are:

1) Usually the type of plant vegetation in the river area is filled with large and tall trees which are usually called riparian forests (river banks) for example: ironwood (Eusidroxilon zwageri), Merbau (Intsia palembanica), and other tall trees.
2) Has a type of vegetation that is able to adapt to the aquatic environment (hydrophilic plants).
3) In parts that are usually frequently flooded, overgrown with vegetation types that are more adapted to the aquatic environment. For example: Bintaro (Cerbera sp), Terentang (Campnosperma auriculata), and other plants.
4) In the upstream area of the river the types of vegetation that exist are shrubs, for example: amethyst mountain (Burgmansia sp) and shrubs. However, there are several trees that grow with different types such as kepayang (Pangium edule).
5) In flatter areas it is often overgrown by tree vegetation whose tree crowns are intertwined with one another which forms a hood over the river. For example on the banyan tree.

b. Lake

Lakes are waters that have accumulated in a fairly large area, which usually occurs due to melting glaciers, river flows, or caused by springs, and the whole surface is surrounded by land. Lake characteristics are:

1) The lake has abiotic and biotic factors that are very relatively stable.
2) The lake also has the possibility to photosynthesize in the photic section which will penetrate direct sunlight.
3) The lake also turns out to be experiencing a very drastic thermocline (temperature)

[68]Nursal,dkk. 2013. *Karakteristikkomposisi Dan StratifikasiVegetasi Stata Pohon Komunitas Riparian Di Kawasan Hutan Wisata Rimbo Tujuh Danau Kabupaten Kampar Provinsi Riau. Jurnal Biogenesis: Vol.9 No.2. Hal:40*

4) Many species of animals and plants that live in the lake habitat according to the depth and distance from the lake shore.
5) There are only two types of plant groups that can grow in the lake area.
6) In addition to the two types of plant groups, it turns out that many vascular plants can live and adapt to the lake area.[69]

c. Swamp

A swamp is a watery organic community, where the position and location of its existence is in an area that has a watery soil form. The characteristics of the swamp are:

1) Swamps are more dominant with inundation of several types of primary forest
2) Swamps are usually located in the hydrology of very large rivers.
3) Types of plants or vegetation that usually grow around swamps, namely plants whose root structure is a riding root
4) The position or layout of the tree is very close
5) There are some types of plants that have leaves that are wide and some are not wide
6) There are various types of vegetation, namely shrubs, shrubs and trees.
7) Plants that are able to live in swamp areas are plants that can adapt to their habitat, namely in watery communities.[70]

d. Estuary

Estuaries are coastal waters where the mouth of the river meets the sea and where fresh water mixes with salt water from sea water. The characteristics of the Estuary are:

1) The water in the estuary contains salt but it is not the same as the sea water
2) The types of plants found in the estuary include high-level plants which are rich in diversity.
3) Water conditions greatly affect land areas that have fresh water flow and contain sediment.

[69] Edi Muhamad Jayadi,

[70] Diva Yudha Utama Rangkuti, 2013Studi KarakteristikFisik Muara Sungai Batang Natal KabupatenMandailing Natal. vol.2 No.3

4) Estuaries contain many ecological niches in areas that cover small aerial areas
5) The estuary is very dependent on the habitat of the location and the area in its environment. [71]

e. Sea

The sea is also called a marine ecosystem, this ecosystem is found throughout the world. The characteristics of the sea are:

1) The marine ecosystem is divided into several parts, namely: rock beaches, sand beaches, mangrove forests, estuaries, coral reefs, and the deep sea.
2) Stone beach: the type of plant vegetation that fills the rock beach ecosystem is usually brown algae and red algae.
3) Sand beach: the most dominant types of plant vegetation that fill the sand beach are Pas-capre and Baringtonia. Usually also overgrown by soft-trunked plants, shrubs and trees
4) Mangrove forest: the type of plant vegetation that fills the mangrove forest is dominated by mangroves, such as Rhizophora sp.
5) Estuary: as previously explained, the type of vegetation in the estuary is dominated by mangroves
6) Coral reefs: types of plant vegetation that fill Coral reefs are dominated by algae and seagrass species, where seagrass is a flowering plant with covered seeds.

[71] Ibid

CHAPTER X
VEGETATION ANALYSIS

A. History of the Development of Vegetation Science

Vegetation science has been a tradition for more than three centuries. Activities related to vegetation are related to the description of the landscape (landscape) and its vegetation.

In the twentieth century, there have been attempts to simplify the description of vegetation to increase accuracy and to find basic standards for quantitative calculations. Many different vegetation analysis methods have been developed which provide detailed and tabulated data.

The pioneers of vegetation science did not limit their efforts to the description and analysis of land in plant communities. The innumerable vegetation in plant forms and combinations required clear systems for presentation and discussion of plant communities from a particular point of view.[72]

1. Developments before the 19th century

Hart Meeriem, a natural biology researcher in 1889, proposed a plant distribution model based on variations in altitude on Mount San Francisco from the foot to the peak. Meeriem concluded that the type of plant is affected by temperature. Then it was proved that the humidity factor was more important than the temperature factor. High rainfall is needed to support the growth of large plants. On the other hand, as we move to areas of low rainfall

[72]Rohman, Fatcher dan I Wayan Sumberartha. 2001. *Petunjuk Praktikum Ekologi Tumbuhan*. JICA: Malang.

the plants will be dominated by small plants, shrubs, meadows, and finally cacti or other desert plants.[73]

3. Developments in the 19th century

Shortly after graduation, Humbold met Johann Foster visiting the new tropics. For a decade they brought the best equipment to measure latitude, elevation, temperature, humidity and other physical factors. For five years, they travel from steamy lowland rainforests to cool paramoal alpines and arid desert sands to thorn bushes. They crossed Cuba Cuba, Venezuela, Ecuador, Peru, Mexico, and Orinoco and the Amazon River, they almost climbed to the top of Mount Chimborazo (5900), they collected 60,000 specimens of the plant. Jefferson himself was very interested in the response of plants to climate and studied the phenology of garden plants along latitude gradients.[74]

The minimum area or curve of the species area is the first step used to analyze a vegetation by using a sample plot (squared). The minimum area is used to obtain the area of sample plots or sampling areas that are considered representative of a vegetation type in a particular habitat being studied. The area of the sample plot has a close relationship with the diversity of species found in the area. The higher the diversity of species found in the area, the wider the sample plots used.[75]

The quadratic method is one of the methods with a sample shape that can be in the form of a rectangle or a circle with a certain area. For each distributed plot, the variables of density and frequency were calculated. This method is used to determine the composition, dominance of trees and estimate their volume. Species diversity can be taken to indicate the number of species in a given area or as the number of species among the total number of individuals of all species present. This relationship can be expressed numerically as an index of diversity or an index of significance.[76]

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[73]Osgood, H Wilfred. 1994. *Biographical Memoir of Clinton Hart Merriam*.USA: National Academy Of Sciences.

[74]Barbour,M.G . 1980. *Terestrial Plant Ecology*. California: B . Curning.

[75]Sugianto, A. 1994. *Ekologi Kualitatif, Metode Analisis dan Komunitas*. Usaha Persada: Malang.

[76]Rahardjanto, A. 2001. *Ekologi Tumbuhan*. UMM Press: Malang.

The area of the sample plot has a close relationship with the diversity of species found in the area. The higher the species diversity found in the area, the wider the sample plots used. The shape of the minimum area can be square, rectangular and can also be in the form of a circle. The minimum area of the sample plot that represents the minimum area of vegetation will be used as an example in the vegetation analysis using the quadrant method.[77]

B. Definition of Vegetation

Vegetation is the diversity of plant species that live in an area simultaneously. All types of plants in the vegetation interact with each other and adapt to their habitat environment as a form of self-defense.

The general definition of vegetation is a collection of several plants that usually consist of several types and live together in one place. Among these individuals there are close interactions between the plants themselves and with the animals that live in the vegetation and environmental factors.[78]

Thus, vegetation is not just a collection of plants but is a unit in which the individual constituents depend on each other and are referred to as plant communities.[79]

The plant community or vegetation is a system that lives and grows or is a dynamic society. Plant society is formed through several stages of plant invasion, namely: adaptation, aggregation, competition and domination, reaction to growth and stability.[80]

While the characteristics are the characteristics of the vegetation of plant species that surround the area, usually characterized by biotic and abiotic factors that influence it such as temperature, climate, topography, rainfall, plant diameter, plant height, and others.

Therefore, it can be concluded that the characteristics of vegetation are the dominant characteristics of a vegetation, both from the biotic and abiotic components that affect it. Each plant has certain characteristics such as there are only a few plants that can live in a certain place or habitat, so that it will

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[77] Sugianto.Op.cit

[78] Marsono. 1997. *Deskripsi Vegetasi Dan Tipe-Tipe Vegetasi Tropika*.Yogyakarta: Fakultas Kehutanan UGM

[79]Djoko.S,Matono.2012. *AnalisisVegetasi Dan Asosiasi Antara Jenis-JenisPohon Utama PenyusunHutanTropis Dataran RendahDitaman Nasional GunungRinjani Nusa Tenggaa Barat.*JUrnal Agri-tek.V0l.13, No.2, Hal19.

[80]Soeinegara,I. 1972. *EkologiHutan Indonesia*. Bogo: Departemen Management HutanFakultasKehutanan IPB

cause differences in the vegetation that makes up the ecosystem in each environment.

C. Vegetation Characteristics

The following are the characteristics of Vegetation seen from the Ecosystem:

1. Vegetation Ecosystem Land Environment

a. Tropical rain forest

Tropical rainforests can also be referred to as forest biomes that have humid or wet conditions. Tropical rainforest ecosystems are forests located in areas with rainfall of about 2,000 mm per year or more. But no more than four months in a row its lowest rainfall. In addition, the monthly temperature is relatively stable, with a temperature of approximately 18°C. Comparison of the temperature in the hottest month with the temperature in the coldest month below 5°C. And the variation in annual temperature is relatively small.[81]

There are three main zones of tropical rainforest in the world, including the zone in the United States, which is the main zone, and is the largest zone from Veracruz to the Caribbean region, then to the south, namely Orinocco and the Amazon Basin in Brazil. This direction still continues to the territory of Peru. The second zone after the United States is the zone in Southeast Asia, covering Indochina, Burma, to the Queensland region. And the last zone is in the African region, centered on the Zaire Basin. The vegetation characteristics of the tropical rain forest are, as follows:

1) Conditions in the tropical rain forest area have many tree species.
2) The average tree height is 20-40 m, has dense leaves that form a hood (canopy).
3) In the hood, there is sufficient sunlight, variations in temperature and high humidity.
4) Around 25°C temperature all day long.
5) Has two distinctive plants, namely Liana or rattan and orchids.

b. Savannah Ecosystem

[81](Morley, 2001; Jermy& Chapman, 2002).

Savannah forest is a grassy field that is formed between the tropics and subtropics. This savanna forest is filled with various kinds of shrubs, shrubs, and trees that are widely spread. There are several continents that have savanna forests including South America, Africa, and Australia. [82]

Savannas can arise due to drought factors, or lack of rainfall, so these savannas are known as tropical grasslands. Which for the climate, the savanna is not too dry, and also not wet enough to be a forest.

The temperature and humidity of the savanna, depending on the season. Savannas are found in dry areas with rainfall levels in one year less than 1,000 mm. Savannahs in Indonesia exist in areas that have high temperatures with relatively low rainfall, such as in West Nusa Tenggara, Central Sulawesi, and East Nusa Tenggara. The characteristics of the vegetation of the Savannah Ecosystem are as follows:

1) If the rain intensity is lower, then the savanna vegetation that leads to the rain intensity area will turn into a thicket.
2) If the rainfall intensity is higher, the savanna vegetation will turn into a wet forest.
3) Vegetation found in the savanna, including woody plants, for example found in Acacia nilotica Lam (Mimosaceae) Opuntia sp, Lantana sp.
4) In addition, the vegetation found in the savanna is found in herbaceous plants, for example in Chloris sp, Cenchrus ciliaris L. (Poaceae), and Stylosanthes SPP.
5) Vegetation found in the savanna is also present in various Legumes species.

c. Grassland Ecosystem

Grasslands are areas that have an average rainfall of about 25-30 cm per year, irregular rains, high water infiltration or porosity, and fast water flow or drainage. Grasslands are found in areas that stretch from the tropics to the subtropics. In Indonesia, scattered grasslands have very little rainfall, but the air temperature is high, namely in the areas of Central Sulawesi and West Nusa Tenggara. Vegetation characteristics of the Grassland Ecosystem include the following:

[82]Arif, A. (2001). Hutan dan Kehutanan. Yogyakarta: Kanisius.

1) In the savanna there are still large trees and shrubs even though their numbers are very small.
2) In the Grasslands almost no trees are found, but there are some plants such as livestock and grass, which are equally dependent on humidity.
3) In the grassland area, the dominant vegetation is grass. Its size reaches three meters and gets wet late, an example is Bluestem grass (Andrology gerandi Vitman). Meanwhile, grass in dry meadows has a short size, for example Buffalo grasses (Bouteloua dactyloides Nutt).
4) The height of the grass vegetation in the meadow can be determined by the amount of rainfall. Areas that receive little rain, the grass remains low to the ground, and vice versa. Areas that receive high rainfall or more, then the grass is also high.
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d. Desert Ecosystem (Desert)

Desert areas are areas bordering grasslands and are found in the tropics. Usually the natural state of the grasslands towards the desert the farther away, the more barren it will be. In this area, the rainfall is quite low, which is around 250 mm/year.

In this desert area heavy rains are rare and the timing is also irregular. The heat generated from the sun's rays is felt in desert areas during the day, due to direct sunlight and high evaporation. In summer, temperatures can reach 40°C. There is a huge difference between the temperature during the day and at night. Even so, it does not rule out the possibility that plants can still live in the desert. Plants that are able to live in the desert are plants that are able to adapt to lack of water and also to rapid evaporation.[83]

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2. Aquatic Ecosystem

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[87]Haryono,dkk. 2013. LahanRawaPenelitian dan Pengembangan.

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The sea is also called a marine ecosystem, this ecosystem is found throughout the world. The characteristics of the sea are:

1) The marine ecosystem is divided into several parts, namely: rock beaches, sand beaches, mangrove forests, estuaries, coral reefs, and the deep sea.
2) Stone beach: the type of plant vegetation that fills the rock beach ecosystem is usually brown algae and red algae.
3) Sand beach: the most dominant types of plant vegetation that fill the sand beach are Pas-capre and Baringtonia. Usually also overgrown by soft-trunked plants, shrubs and trees
4) Mangrove forest: the type of plant vegetation that fills the mangrove forest is dominated by mangroves, such as Rhizophora sp.
5) Estuary: as previously explained, the type of vegetation in the estuary is dominated by mangroves
6) Coral reefs: types of plant vegetation that fill Coral reefs are dominated by algae and seagrass species, where seagrass is a flowering plant with covered seeds.

[89] Ibid

D. Vegetation Analysis Method

Syafei (1990) says that there are several methods of vegetation analysis. And they are grouped into two, namely:

1. Destructive method

   This method is carried out for simple vegetation, this method is carried out to determine the amount of organic matter that can be produced by the plant community. The size of the sampling area is in the range of $1m^2$-$5m^2$. Weighing is based on the fresh or dry weight of an organism.

   This method is usually carried out on an open grassland to determine its quality and capacity. The approach in this method is floristically based on knowledge of plant taxonomy.

2. Non-destructive method

   The non-destructive method is an approach by studying living organisms or plants so that it is known as a non-floristic approach. The approach based on the taxonomic study of plant organisms is called the floristics approach. Non-destructive methods are divided into two, namely:

   a. Non-destructive non-floristic method

      The experts who developed this method are Du Rietz (1931), Raunkier (1934) Dansereau (1951), the essence of the thoughts of these experts is that they try to reveal vegetation based on its life form.

   b. Non-destructive method of floristics

      The floristic non-destructive method is a method that can determine the floristic richness and diversity of various forms of vegetation. The study was carried out on all populations of these plant-forming species, including:

      1) Density, Density is a variable that describes the number of individuals from a similar population
      2) Density, denseness is a variable that describes the area of a population cover in an area. Density can also describe the area controlled by a particular population or its dominance.

3) Frequency, frequency is a variable that describes the distribution of the population in an area. Some of the methodologies used in vegetation analysis are:
   a) The quadratic method, the shape of this sample is in the form of a circle or a rectangle which is measured in the form of density, density, frequency and significant value.
   b) Line method, this method is in the form of a line. For shrubs, a line of about 5-10 m is needed. The analysis system is in the form of density, importance, frequency and density.
   c) The quaternary method of footage in this method is in the form of points, so this method is often referred to as the method without the sample area. The analysis system in this method points is created and distributed randomly or systematically. These points are the center of an observation area which is abstractly divided into 4 observation sectors (4 directions method) according to the cardinal directions. Region I is the north-west area, area II is the north-east area, area III is the east-south area, and area IV is the south-west area. close to the observation center (central point). The data collected is the distance of the tree to the center point, the diameter of the tree and also the height of the tree.

According to other references there are several methods applied in data analysis, namely:

1. Plotless Sampling Technique

The plotless sampling technique is a technique introduced by forest management experts to determine the difficulty of practitioners in making quadrants (samples plots) in the field. Basically, this method uses the measurement of the distance between one plant and another, which is chosen randomly with the closest individual plants assuming the plants are randomly distributed.

Using this method will save time, because it does not require making sample plots in the field, sampling errors in making sample plots and determining whether individuals are inside or outside the square can be reduced. In the sampling technique without sample plots, there are at least four types of methods based on the sample unit in the form of points which are placed in the field when systematically randomized.

2. Random Pair Method

In the random pair method there are several implementation procedures, the procedure for implementing this technique is as follows:

a. Placing sample points randomly or regularly (at a certain distance along the path line),
b. Selection of one individual (plant) tree closest to the sample point. Then draw an imaginary line through the selected sample points and individual trees and another imaginary line perpendicular to the first imaginary line. The next step is to select an individual plant that is closest to the first individual plant, but is located in another sector (outside the 180o sector where the first tree is located which is bounded by the first imaginary line).
c. Measurement of the distance between trees (individual plants) first and second. After that the desired vegetation parameters can be measured on the two individual plants mentioned above.
d. To facilitate data analysis in the field, it is better to make a tally sheet table.
e. After the data is collected, field data analysis is carried out using the following formulas:
   - Density (K) of a species $= \frac{Density\ of\ a\ species\ x\ density\ of\ species}{100}$
   - Relative density of a species (KR) $= \frac{\sum \text{individual of a species}}{\sum \text{individual whole species}} \times 100\%$
   - Density of whole species $= \frac{\text{area}}{0{,}8\ x\ average\ between\ trees}$
   - Dominance of a species = density × average value of dominance of a species
   - Relative dominance (DR) $= \frac{\text{dominance of a species}}{\sum \text{domination of all kinds}} \times 100\%$
   - Frequency of a type (F) $= \frac{\sum \text{the point where a species is found}}{\sum \text{total dominance of all species}} \times 100\%$
   - Relative frequency (FR) $= \frac{frequency\ value\ of\ a\ species}{\sum \text{total frequency of all types}} \times 100\%$
   - INP = KR + DR + FR

3. Point Centered Quarteted Method

Based on the results of Cottam and Curtis (1956) research, this is one of the sampling methods without plots, for example in the field it

takes less time, so it does not require correction in estimating the results of individual plant density. However, in practice this method has two kinds of limitations, namely:

a. Each quadrant must contain at least one individual plant
b. Each individual (same as the Random Pair Method) cannot be counted more than once.

In applying this method in the field there are several procedures including:

a. The placement of a number of sample points at random in the plant community Cottam and Curtis (1956) suggested that at least 20 sample points should be selected to increase the sampling accuracy of this technique.
b. The division around the sample point area into four equal-sized quadrants. This can be done with a compass or if a series of trailing lines is used the quadrants can be formed using the trailing line itself and a line perpendicular to the trail line through the sample point.

In this method, at each measurement point, an imaginary abscission line and ordinate are made, so that at each measurement point there are four quadrants. Select one of the trees in each quadrant that is closest to the measurement point and measure the distance from each tree to the measurement point. Measurement of tree dimensions was only carried out on the four selected trees (Soerianegara and Indrawan in Husamah., et al., 2013).

Quantitative calculations of vegetative parameters are as follows:

- Average distance of individual trees to measurement point: $d = \frac{d1+d2+\cdots dn}{n}$

Information:

d = individual tree distances to measurement points in all quadrants

n = Number of trees

d1, d2,.. dn = the average area/individual chapter, which is the average land surface area occupied by one individual plant.

- Total density of all types (K) $= \frac{Area\ units}{d^2}$
- Relative density of a species (KR) $= \frac{Number\ of\ individuals\ of\ a\ species}{the\ number\ of\ individuals\ of\ all\ types} \times$ 100%
- Density of a type (KA) $= \frac{K\ X\ KR}{100}$
- Dominance of a species (D) = KA × average dominance per species
- Relative dominance of a species (DR) $= \frac{The\ dominance\ of\ a\ jneis}{The\ dominance\ of\ all\ types} \times$ 100%
- Frequency of a type (F) $= \frac{Number\ of\ no\ species\ found}{Sum\ of\ all\ measurement\ points} x100\%$
- Relative frequency (FR) $= \frac{F}{\text{all kinds of frequency}}$
- INP = KR + FR + DR

CHAPTER XI

WATER ECOSYSTEM

A. Definition of Aquatic Ecosystem

Excerpted from the book (Ecology of tropical waters by Husain Latuconsina). It is said that liotic waters are river waters. And in the book it can be explained that the river is a body of water that flows in one direction or only one direction, and it can be seen that the river water itself has characteristics, namely the water is clear and also contains little sediment and food. And in the book it is explained that water and waves can constantly provide oxygen to the water itself. And in this book it is also explained that the river is a form of aquatic ecosystem that plays an important role in the hydrological cycle and for the surrounding area so that the condition of a river has a big influence on the surrounding environment. And it is also explained that the ecosystem of brackish waters or estuaries that describes broadly a characteristic of estuarine waters.[90]

From the book (Oceanography by Widya Prarikeslan, M.Si). It is said that the notion of oceanography is a science that studies the ocean or the science that tells about the sea, both the form of organisms, and all the phenomena that occur and relate to the sea. And in the book oceanography also covers other sciences, namely: chemistry, physics, biology, and geology.[91]

Excerpted from the book (Ecology of aquatic systems by Andi Kurniawan). It was explained that the notion of aquatic system ecology is a living system in which the dominant medium occupied by organisms in the system is water. And it is also explained that the presence of water in this environment is free and open water.

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[90]Husain latucconsina. 2019. *Ekologi perairan tropis.* Yogyakarta: Gadjah Mada University Press.

[91]Widya prarikeslan. 2016. *Oseanografi*. Jakarta: kencana

Quoted from the journal (fishery journal entitled: family biotic index as an indicator of water quality in the Gajahwong River, Yogyakarta. By Djumanto, Namastra Probosunu and Rudy Ifriansyah). Which they quote from (welcomme, 2001). It was explained that the river is a liotic ecosystem that plays a very important biological, ecological and economic role for mankind. And it is also said that the people there take advantage of the existence of the river as a means of transportation, sports, fishing and hunting for biota. And in the journal it is also explained that the quality of river water is influenced by water quality.

Quoted from the journal (Journal of Management of Aquatic Resources entitled: Seketak river water quality based on the composition and abundance of phytoplankton) which they quote from (Odum 1993). It was explained that the freshwater ecosystem is flowing water, and has a characteristic that is the presence of currents which is a controlling factor and also a limiting factor. [92]

While the quote from (Fachrul 2007) also explained that the river ecosystem is a collection of abiotic components (physics and chemistry) and biotic (organisms) where they are interconnected with each other and interact to form a functional structure.

Quoted from the journal (environmental science entitled: study of water quality and the use of dug wells by the community around the Kaliyasa river, Cilacap district) which they quoted from (Arsyad. 1989). It was explained that water is a natural material needed for human, animal and plant life. namely as a medium for transporting food substances, and is also a source of energy and for other purposes.

Quoted from the journal (analysis of the water quality of the Raman river in Pujodadi Trimujo village as a source for high school biology learning on ecosystem materials). Which they quote from (Soetjipto. 1999:97). It was explained that the river is flowing water because the quality of the water always changes from time to time or is dynamic. This is stated because freshwater ecosystems have a very significant importance in human life because freshwater ecosystems are a practical and inexpensive source for domestic and industrial purposes.[93]

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[92]Suryanti, siti rudianti, susi sumartini. *Kualitas perairan sungai seketak semarang berdasarkan komposisi dan kelimpahan fitoplankton.* Jurnal of management of aquatic resources. Vol 2, no 2. Hlm 38-45, 2013.

[93]Agus susanto, purwasih. *Analisis kualitas perairan sungai raman desa pujodadi trimurjo sebagai sumber belajar biologi SMA pada materi ekosistem.* Jurnal bioedukasi vol: 3, no 2. 2012

Quoted from the journal (Oceana, volume XXVIII, no 3, 2003: 17-25) which is explained in this journal that water is the most abundant chemical compound in nature, but it is in line with the increasing standard of human life so water is very expensive.[94]

Quoted from (Schroeder, 1977). It is explained that water is a chemical compound in the form of a colorless, odorless and tasteless liquid. And water has a freezing point of 0c at a pressure of 1 atm, a boiling point of 100c and a density of 1.0g/cm at 4c.

Quoted from (Whitfield, 1975). It was explained that water is hydrogen between two adjacent water molecules and it is this polarized nature of water molecules that contributes to the unique chemical and physical properties of water that occur in the water.[95]

B. Characteristics of Aquatic Ecosystems

Aquatic systems cover 70% of the earth's surface which are divided into two main categories, namely freshwater ecosystems and marine ecosystems. Of the two aquatic systems, sea water has the largest share, which is more than 97%, the rest is fresh water which is very important for humans for their life activities.[96]

What is meant by freshwater ecosystem is the environment found on land. Where the characteristics of the waters found on the land surface and generally located higher than sea level, contain only a small amount of mineral solution, low salinity, small temperature variations, less penetration of sunlight, and this ecosystem is still affected by land climate, such as seasons. rain, drought, wind and so on.

Meanwhile, the characteristics of marine ecosystems are the aquatic environment that separates the land. Almost 70% of the earth's surface consists of marine waters so that the main feature of these marine waters is that their habitat is not isolated and related to each other. Thus, with this situation the spread of the organisms in it is not limited.[97] Having high mineral levels in the tropics (around the equator) and low mineral levels in areas far

[94]Djumanto, namastra, probosunu, rudy ifriansyah. *Indek biotik famili sebagai indikator kualitas air sungai gajahwong*. Jurnal perikanan. Fakultas Pertanian Universiatas Gadjah Mada

[95]Andi kurniawan. 2018. *Ekologi sistem akuatik*. Malang : UB Press

[96] T.A. Barus, *MetodeEkologisUntukMenilaiKualitasSuatuPerairanLotik,* (Medan : FMIPA USU)

[97]SuyudWarnoUtomo dan Syahrir A. Chalif, *Modul EkologiTumbuhan*, (Jakarta : Universitas Terbuka, 2014) hlm : 1.2-1.9

from the equator, different sea surface temperatures, in tropical areas the temperature is around 250oC, and water flows that cause the spread of chemical compounds needed by organisms, affecting temperature and salt content.

It can be concluded that the characteristics of the aquatic ecosystem as a whole are that the environment is dominated by water, inhabited by creatures that live in water, limited sunlight, not too extreme temperature changes, and there are producers and consumers.

C. Aquatic Ecosystem Components

Natural ecosystems and artificial ecosystems are formed by two components, namely biotic components and abiotic components. The biotic component of an ecosystem consists of all living things in an ecosystem, such as humans, animals, plants, and microorganisms. Based on their role in the ecosystem, biotic components can be grouped into three, namely:

1. Producers in the biological sense are living things that are able to produce their own food. Of the various kinds of living things that exist, only chlorophyll organisms are able to make their own food. Through the process of photosynthesis there is a change from water, carbon dioxide, and mineral substances into carbohydrates and oxygen.
2. Consumers in the biological sense are living things that cannot make their own food. Animals and humans are not able to make their own food, but use materials produced by producers.
3. Decomposers are living things that break down the substances contained in waste and the remains of living things that have died. For example, in dead animals and plants, bacteria, fungi or other microorganisms grow that are saprophytic. Well, these saprophytic creatures are living things that live in garbage or the rest of other living things.

The abiotic component of an ecosystem consists of all non-living things around living things. For example, water, soil, air, sunlight, temperature, and humidity.[98]

[98]Saktiyono, *Biologi*, (Jakarta :Erlangga, 2004) hlm : 80

Aquatic ecosystems are ecosystems whose abiotic components are mostly water. Living things (biotic components) in aquatic ecosystems are divided into several groups, including the following.

1. Plankton

The term plankton comes from the Greek word meaning wanderer. Plankton are organisms (plants or animals) whose lives are free to float, drifting in water whose mobility is limited so that they are easily carried away by water currents.[99]

Plankton has a very small size, approximately 0.45 mm which is invisible to the naked eye. Plankton are divided into two major groups, namely phytoplankton and zooplankton.[100]

Plankton is a type of organism that is able to live floating in the water. Plantons are organisms in the form of animals or plants that have the ability to carry out limited movements so that plankton are always carried by the current.[101]

The presence of plankton in an aquatic ecosystem is very important, because of its function as primary producers or because of its ability to synthesize organic and inorganic compounds through the process of photosynthesis.[102]

2. Phytoplankton

According to Thurman (1984) in a book entitled Waters, Phytoplankton is the primary producer (main and first producer) so that the presence of phytoplankton in the waters is absolute. This opinion is corroborated by Sachlan (1982: 17), Meadows and Campbell (1993: 59), Sumich (1999: 46) that phytoplankton are the first chlorophyll organisms in the world and are a food source for zooplankton as primary consumers, as well as other aquatic

[99]YudhiGarno S., Kualitas Air dan DinamikaFitoplankton di PerairanPulau Harapan. *JurnalHidrosfir Indonesia*. Vol.3 (2), pp 87-94.

[100] O.H. Arinardi, dkk, PengantarTentang Plankton Serta KisaranKelimpahan dan Plankton Predominan di SekitarPulauJawa dan Bali, (Jakarta :Puslitbang-LIPI, 1994) hlm : 24

[101] A. Nontji, Laut Nusantara, (Jakarta :Jambatan, 1987) hlm : 8

[102] S. Heddy&Kurniati,M., Prinsip-Prinsip Dasar Ekologi : SuatuBahasanTentangKaidahEkologi dan Penerapannya, (Jakarta : PT. Raja GrafindoPersada, 19976)

organisms. so that the zooplankton population and the consumer population with a higher trophic level generally follow the plankton dynamics.

Reynolds et al (1984), said that the phytoplankton that live in fresh water consists of seven major groups of phyla, including Cyanophyta (blue algae), Cryptophyta, Chlorophyta (green algae), Chrysophyta, Pyrhophyta, Raphydophyta, and Euglenophyta.[103]

As organisms that are autotrophs, phytoplankton obtain energy through a series of processes called photosynthesis. Named photosynthesis because they are required to be on the surface called the euphotic zone. In aquatic ecosystems, the result of the photosynthesis process carried out by phytoplankton with aquatic plants is called primary productivity. With the existence of photosynthesis, phytoplankton are able to produce large amounts of oxygen so that it fills the earth's atmosphere. With their abilities, they can synthesize their own organic materials, making them the main ingredients for most of the food chains in marine and freshwater ecosystems.[104]

Apart from photosynthesis, phytoplankton also need nutrients to increase their growth. Each species in plankton has a different response to the ratio of nutrients that are able to dissolve in water bodies. For example, macronutrients such as nitrate, phosphate, or silicic acid, the levels of which are regulated by a balance between a mechanism called a biological pump and upwelling in deep, high-nutrient water. Besides being influenced by macronutrients, phytoplankton is also influenced by the levels of iron micronutrients in water bodies. So to maintain their life, phytoplankton carry out a process called photosynthesis and respiration which is influenced by the surrounding environment, this causes an effect on the abundance of phytoplankton in water bodies.

There are several things that can affect the distribution of phytoplankton abundance in waters such as currents, nutrient content, predators, temperature, brightness, turbidity, pH, dissolved gases, and competitors. The distribution of phytoplankton in a waters is related to the benefits of nutrients and radiation from the sun. In addition, the abundance of phytoplankton is

[103] C.S. Reynolds, The Ecology of Freshwater Phytoplankton, (Cambridge : Cambridge University Press, 1984) hlm : 78

[104] T.A. Barus, Limnologi, (Medan : FMIPA USU, 2002) hlm : 45

also influenced by temperature, environment, and predation by zooplankton.[105]

a. Nekton

Nekton are organisms that can swim and can fight the water currents. Examples of organisms that move actively (swim) are frogs and fish.

b. Neuston

Neuston is an organism that rests or swims on the surface of the water. Or in other words organisms that float on the surface of the water, such as water hyacinth, water bugs, algae, and lotus.

c. Benthos

Benthos are animals attached to or resting on the bottom or living on the bottom of sediments (waters), such as worms, shrimp, algae, and crabs.[106]

Darojah (2005) stated that this animal is a key organism in the food web because in the aquatic system it functions as a predator, suspension feeder, detritivor, scavenger and parasite. Benthos is one of the important groups in aquatic ecosystems. In general, they live as suspension feeders, detritus eaters, carnivores or as plankton feeders.[107]

Benthos is an organism that underlies the bottom of the water and lives in or in the sediments of the bottom of the water. Payne (1986) in Sinaga (2009) states that benthos is part or all of its life cycle at the bottom of the waters, either sessile, creeping or digging holes. Benthic animals are more commonly found in stagnant waters (lentik) than in flowing waters (lotik).[108]

Based on the way of life, benthos are divided into 2 groups, namely: infauna and epifauna. Infauna is a group of macrozoobenthos

[105] J. Basmi, PerkembanganKomunitasFitoplanktonSebagaiIndikasiPerubahanTingktKesuburanKualitasPerairan, (Bogor : ITB, 1988) hlm : 68

[106] E.P. Odum, Dasar-Dasar Ekologi, TerjemahanTjahjonoSamingan. EdisiKetiga. (Yogyakarta : Gadjah Mada University Press, 1993)

[107] Y. Darojah, KeanekaragamanJenisMakrozoobentos di EkosistemPerairanRawapeningKabupaten Semarang. Skripsi. (Semarang : UNNES, 2005)

[108] A.I Payne, The Ecology of Tropical Lakes and Rivers, TerjemahanSinaga, (New York : John Wiley & Sons, 1986)

that lives immersed in the mud (located in the substrate), while epifauna is a group of macrozoobenthos that lives attached to the surface of the bottom of the waters.

Benthos that feeds on deposits tends to be abundant in clay sediments and soft sediments which are areas that contain high organic matter, while benthos that eats suspensions is more abundant in substrates that are sandy and has less organic matter. The condition of the bottom substrate is a factor that greatly determines the composition of benthic animals in a waters. The basic substrate structure will determine the abundance and composition of macrozoobenthos species. The dominant group of macrozoobenthos in the waters with mud substrate are Poychaeta, Bivalvia (shellfish), and Crustaceans.

Benthic communities can also be distinguished based on their movement, namely groups of benthic animals whose lives are sedentary (sessile), and benthic animals whose lives are nomadic (motile). Sessile benthic animals are often used as indicators of water conditions.[109]

d. Periphyton

Periftons can only be seen using a microscope, this is because periftons are very small (microscopic) organisms. Perifton are aquatic organisms that live attached to submerged objects or attached to substrates such as rocks, wood and others. Examples of these organisms are snails and algae.[110]

D. Aquatic Ecology Types

The types of aquatic ecology (aquatic), namely:

1. Freshwater Ecosystem

Freshwater ecosystems are often referred to as terrestrial aquatic ecosystems [111]. Freshwater ecosystem is a comprehensive form or arrangement found in fresh water and its surroundings which consists of living things in the water and the freshwater environment itself. Living

[109] I. Setyobudiandi, Makrozoobenthos, (Bogor : ITB, 1997)

[110] Aditya, S.P, dkk, ProsidingKarakteristikEkosistemPerairanMenggenang di Situ Gede, (Bogor : ITB, 2011) HLM : 6

[111]SuyudWarnoUtomo,dkk. Modul Pengertian,RuangLingkup, Ekologi,danEkosistem. Universitas Terbuka.

things that live in fresh water in general have adapted. As for plant adaptations, plants that live in water are usually single-celled and have strong cell walls such as green algae and blue algae. Water enters the cell to its maximum and will stop itself. Higher plants, such as lotus have anchor roots.

Animals and also lower plants that live in water habitats, the osmotic pressure is the same as the environment. Whereas in animal adaptation, a number of nekton live in freshwater ecosystems. Nekton are animals that move actively using strong muscles. Tall animals that live in freshwater ecosystems, such as fish, in overcoming differences in osmotic pressure, fish do osmoregulation to maintain water balance in their bodies through the excretory system, gills, and digestion.

a. The characteristics of freshwater ecosystems can be explained as follows:
    1) Salinity (salt content) is low, lower than the cytoplasm.
    2) The presence of currents, this greatly determines the distribution of vital gases, mineral salts and small organisms.
    3) The temperature variation between day and night is not that great.
    4) The entry of sunlight is so limited
    5) Freshwater ecosystems are still influenced by climate and weather, although the effect is relatively small when compared to terrestrial ecosystems.
    6) Changes in water level look so real. For example, during the rainy season the river water is high and the dry season looks a little (drought).
    7) Dissolved oxygen levels in freshwater ecosystems tend to be higher, although due to various factors the penetration of light into the water is slightly reduced.
    8) Physically and biologically, freshwater ecosystems are the intermediaries of terrestrial and marine ecosystems, which are often referred to as brackish water (estuarine environments), where estuaries are semi-enclosed aquatic environments on the edge of land that are influenced by tides.

9) Most of the plants are algae, while others are seed plants.

b. Classification of Freshwater Ecosystems Based on Their Shape

Based on the shape of freshwater ecosystems can be classified into:

1) Pond

The pond is an artificial ecosystem and a shallow enough water for sunlight to penetrate to the bottom. Plants that live in the pond habitat include lotus and water hyacinth. The other organisms that live in the pond are various types of plankton, small crustaceans, molluscs, several types of fish, to insects.

2) Lake

Lakes are land waters whose size is larger than ponds, and the boundaries of their size are abstract. Some experts also mention that lakes are inland waters that have water depths in such a way that the bottom of the waters is always dark and cannot be penetrated by sunlight. Ecosystem components are composed of biotic and abiotic components, where the biotic components in a lake ecosystem consist of all types of living things such as humans, animals, plants, and microorganisms. Abiotic components in the lake ecosystem include temperature, water, sunlight, wind, rocks, and soil, as well as the level of acidity/pH of the soil.

a) Kinds of Lakes Based on the Type of Water

(1) Freshwater lakes are lakes that contain fresh water, this type of lake has a release characteristic in the form of rivers, for example Lake Toba.

(2) Salt water lakes are lakes that contain salt water where this type of lake has no release, because it is the end of the river and the release is only evaporation. Example: Sentani Lake in Papua.

(3) Acidic water lake is a lake where the water comes from sulfur, as well as having characteristics that are usually a volcanic crater filled with rainwater and the

water is yellowish green. An example of Tangkuban Perahu Lake.

b) Based on Water Capacity

Lakes based on their water capacity are divided into:

(1) Permanent lakes are lakes whose water capacity is not affected by seasons.

(2) Temporary lakes are lakes whose water capacity is overflowing during the rainy season and receding during the dry season.

c) Based on Organic Matter Production

Lakes based on the production of organic matter, which are as follows:

(1) Oligotropic lake

Oligotropics are deep lakes and lack of food, because the phytoplankton in the linmetic area are not productive. Its characteristics are very clear water, inhabited by few organisms, and organisms are found in deep areas.

(2) Eutropic lake

Eutropics are shallow lakes and abundant in food, due to the highly productive phytoplankton. It has the characteristics of the water being so cloudy, there are various organisms, as well as oxygen in the frofundal area.

d) Based on the Forming Process

Based on the process of formation, lakes are divided into several types, namely as follows:

(1) Tectonic lakes, namely lakes formed by endogenous forces originating from tectonic movements such as basins due to faults and folds. For example, Lake Towuti in Sulawesi.

(2) Volcanic Lakes, namely lakes formed from former volcanoes. Lake water that comes from rainfall that is accommodated in the crater hole. For example, Mount Kelud Crater Lake

(3) Vulcano-tectonic lakes, namely lakes formed due to the merging of volcanic and tectonic processes which are faults on the post-eruption part of the earth's surface, besides the empty magma chamber becomes unstable so that it sinks or breaks, so that a basin is formed due to the fault then filled with water for example Lake Toba in Sumatra.

e) Regional Division in Lake Ecosystem

(1) littoral area

This area is a shallow area. Sunlight penetrates optimally. The warm waters adjacent to the edge. The plant is an aquatic plant that has roots and leaves sticking out above the water surface. The community of organisms is very diverse including the types of attached algae, various snails and mussels, crustaceans, amphibians, aquatic and semi-aquatic reptiles such as turtles and snakes, geese, and ducks, as well as several mammals that often forage in lakes.

(2) deep area

This area is a deep area, namely the aphotic area of the lake. Some microbes and other organisms use oxygen for cellular respiration. The area is inhabited by worms and microbes.

(3) benthic area

This area is a lake bottom area where benthos and the remains of dead organisms are found.

a) River

A river is a body of water that flows in one direction. River water is cool and clean and contains little sediment and food. The flow of water and waves constantly provide oxygen to the water. Water temperature varies according to altitude and latitude.

b) Swamp

Freshwater ecosystems in the form of swamps have habitats that have characteristics of low temperature, low

salt content and less penetration of sunlight, and are influenced by the climate and weather around the swamp, there are dicotyledonous and monocot plants, low-level plants which function as producers. In addition, Tiu also has freshwater fish which can be used as a source of animal protein food.

c. Based on the state of the water, freshwater ecosystems are divided into two types, namely lentic freshwater ecosystems (calm) and lotic freshwater ecosystems (flowing).

1) Flowing Waters (lotic)

Flowing water has a certain shape that clearly distinguishes it from stagnant water even though both are freshwater habitats. From these differences, of course, affect the form as well as the life of plants and animals that inhabit it. One basic difference between rivers and lakes is that lakes are formed because of their basins and there has been water that filled the basin, but every time it is filled with sediment so that it becomes dry land. On the other hand, rivers occur because there is already water so that water forms and causes the channel to remain as long as there is still water to fill it.

The flow of water in the lotic ecosystem is a limiting factor for the organisms in it, which organisms cannot adapt to the flow of water that will be eliminated. The flow is also a determinant of the type and composition of biotic components in the ecosystem. The flow of water depends on the topography of the size of the river and the flow of water flowing. For example, the types of organisms on the banks of rivers are different from the types of organisms on the bottom or in rivers.

The water of the lotic ecosystem is not constant, changing depending on the season. On the island of Java, it is said that the river water is cloudy and floods in the rainy

season, while in the dry season the water is small and even dries up. This situation is a determinant of the damage to terrestrial ecosystems in the upstream area.

2) Stagnant Waters (Lentik)

Stagnant waters are divided into natural waters and artificial waters. Based on the process of formation of natural waters, they are divided into waters formed due to tectonic activity and volcanic activity. Some examples of natural slender waters include lakes, swamps, ponds, while artificial waters include reservoirs.

2. Seawater Ecosystem

The marine ecosystem as one of the ecosystems in the world itself, in which there are processes and components of life that are similar to the processes that occur in terrestrial ecosystems. Seawater ecosystems cover more than 2/3 of the earth's surface because of their breadth and enormous potential. Seawater ecosystems are also called marine ecosystems in marine waters, which consist of deep water ecosystems, shallow sand beach ecosystems, and tidal ecosystems.

Marine habitats (oceanic) are characterized by high salt content with Cl- ions reaching 55%, especially in the tropics, because of the high temperature and evaporation. In the tropics the sea temperature is around 250C. The temperature difference between the top and bottom is very high. In cold areas, the sea water temperature is evenly distributed so that the water can mix, so that the sea surface area remains fertile and there are lots of fish and plankton. The movement of water from the coast to the middle causes the upper water to sink downwards as little as possible, allowing the formation of a food chain that runs well. Marine habitats can be distinguished according to their depth and surface area horizontally.

a. The characteristics of the marine ecosystem environment are as follows:
    1) In the tropics high salinity and low in cold areas.
    2) Climate and weather do not affect marine ecosystems.
    3) The difference in temperature and the rotation of the earth makes the ocean currents always rotate.

    Organisms that live in marine water ecosystems have certain characteristics, such as low-level plants and animals that have the same cell osmotic pressure as the osmotic pressure of seawater so that their adaptation is not too difficult. While many-celled animals, such as fish, the adaptation method is done by drinking a lot, but releasing a little urine, which is the excretion of water by osmosis, while mineral salts are actively excreted through the gills. Seawater ecosystems are divided into oceans, beaches, estuaries, and coral reefs.
b. Division of Seawater Ecosystem Area

The division of marine zones based on depth. The sea is a very large area, approximately two-thirds of the earth's surface. The marine ecosystem area is very open so that the influence of sunlight is so great. The penetrating power of the sun's rays is limited, so the marine ecosystem is divided into two areas, namely the sea area that is still exposed to sunlight, called the photic area, and the dark sea area is called aphotic. Between the two is a dimly lit area called a dysphotic. Based on the distance from the coast to its depth, marine ecosystems are divided into littoral, neritic, and oceanic zones. Vertically into the sea it is divided into epipelagic, mesopelagic, pelagic bath, abyssal pelagic, and hadal pelagic.

1) Littoral zone/tidal water ecosystem

   In general, the diversity of living communities in deep waters is not as high as ecosystems elsewhere. The communities that exist are only consumers and decomposers, there are no producers because in this area the sun's light cannot penetrate. Consumer food sourced from plankton that settles and vectors that have died. So that in this sea there is an event of eating and being eaten.

2) Neritic zone/shallow sand beach ecosystem

   The neritic zone is the area along the coast. The tidal boundary area is called the littoral zone, while the area with a depth of more than 200m from the tidal zone is called the sublittoral zone. The communities in this area are producers, plankton, consumers, and decomposers. Shallow sand beach ecosystem communities are located along the coast at high tide. The community in it is dominated by various types of algae or grasses.

3) Pelagic zone

   The pelagic zone includes areas of high seas ecosystems where sunlight cannot penetrate to the bottom, so that the bottom is darkest. As a result, the water on the surface cannot mix with the water below, due to the temperature difference. The boundary of the two layers of water is called the Thermocline region, including areas that have a lot of fish.

Based on the depth, the marine ecosystem is divided into 4 zones as follows:

a. Literal, is an area that borders on land.
b. Neritik, is an area that can still be penetrated by sunlight to the bottom which is 300 meters deep.
c. Batial, is an area whose depth ranges from 200-2500 m.
d. Abisal, is a deeper area, which is between 1,500-10,000m

The sea is a vast collection of salty water that separates one continent from another, and also separates islands from one another. The sea is a collection of salt water with a large number and deep and wide and inundate and divide the land over continents or islands. The ocean which is a water area is generally divided into 3 parts:

a. Ocean surface
b. In the ocean
c. Bottom of the ocean

The sea has many functions or roles for human life and other living things because in and above the sea there is a wealth of natural resources that we can use, including:

a. Place of recreation and entertainment
b. Where we live our food source
c. Wave power plant
d. A place for fish, pearl shells, and seaweed farming
e. Where the mines are located
f. As a place for the earth's water reserves
g. As the earth's transportation route
h. As an object of research research and education

The successive plant communities from the tidal area to the western area are distinguished as follows:

a. Pes-caprae Formation

   It is so named because the *Ipomea pes-caprae* plant is a creeping plant with thick leaves, many live on sand dunes that are resistant to waves and wind.

b. Baringtonia Formation

This plant is dominated by baringtonia. If the soil in the tidal area is muddy, then this area is a mangrove forest that has breath roots. Breath roots are plants that live in muddy areas that lack oxygen. In addition to having a function as an oxygen taker, the roots are used as a barrier from tidal waves.

Estuaries or estuaries are places where rivers and seas join. Estuaries are often lined by extensive, salt-prone interdial mud slabs. An important abiotic factor in this ecosystem is salt content. The salt content of the water changes gradually from the fresh water area to the sea. In addition, tides also affect salt levels by daily cycles. Nurient sourced from rivers enriches the estuary. The plant communities that live in the estuary include swamp grass, algae, and also phytoplankton. Animal communities include various worms, shellfish, crabs, and fish, and there are even some marine invertebrates that use the estuary as a place of reproduction and migrate to freshwater habitats. Estuaries are also feeding grounds for semi-aquatic vertebrates, such as crocodiles. Estuaries can be classified based on characteristics, including:

a. Coastal land estuaries are the most common, where their formation occurs due to rising sea levels that inundate the rivers on the coast that they follow.
b. The lagoon (Gobah) or semi-enclosed bay, is formed due to the presence of sand shoals that are located parallel to the shoreline so that they block directly and openly with sea waters.
c. Fijords, are deep marshes, formed by glister activity that causes the inundation of ice valleys by sea water.
d. Tectonic estuaries, formed by earthquakes or volcanic eruptions, which cause the land level to subside and will be inundated by seawater at high tide.
    a. Plant adaptation

        Plants that live in water are usually single-celled and have strong cell walls such as green algae and blue algae. Water enters the cell to its maximum and will stop itself. Higher plants, such as lotuses have anchor roots. Animals and also

lower plants that live in water habitats, the osmotic pressure is the same as the environment.

b. Animal adaptation

A number of nekton live in freshwater ecosystems. Nekton are animals that move actively using strong muscles. Tall animals that live in freshwater ecosystems, such as fish, in overcoming differences in osmotic pressure, fish do osmoregulation to maintain water balance in their bodies through the excretory system, gills, and digestion.

CHAPTER XI
LAND ECOSYSTEM

A. Definition of Land Ecosystem

Land ecosystems are types of ecosystems that have a physical environment consisting of a stretch of land. In general, there are 7 main biomes of terrestrial ecosystems on this earth, namely Tropical Rain Forest, Savana, Grasslands, Desert, Deciduous Forest, Tundra and Taiga. Each environmental ecosystem is inhabited by certain vegetation with their own characteristics and uniqueness.

B. Land Ecosystem Vegetation Type

There are several types of vegetation in terrestrial ecosystems, namely:[112]

1. Tropical Rainforest Ecosystem

Ecosystems of tropical rain forests are in areas with rainfall of more than 2000 mm/year. Monthly temperature in this forest is relatively constant with an average temperature of 18℃ and the temperature difference between the hottest and coldest months is less than 5℃. The annual temperature variation in this forest is also relatively small. There are three main zones of tropical rain forest, namely:

a. The main largest zone in South America starts from Veracrus (Mexico), the Caribbean, then southwards to the Orinocco and Amazon Basin in Brazil, continues to the Andes (Columbia), Ecuador and Peru.
b. The second largest zone is in Southeast Asia, covering Indochina, Burma, Papua New Guinea with Southwest India and Queensland as the outermost region.

[112] Edi Muhammad Jayadi. 2015. *EkologiTumbuhan*. Mataram: CV. Sanabil. Hal 106

c. The third largest, is in Africa, centered on the Zaire Basin, with the outermost region extending from Dahomey to Siera Leone in the South in the south, and Madagascar in the west.

The largest amount of tropical rain forest in the world is in the interior of the Amazon river (South America) half of this area is owned by Brazil and 20% of the world's tropical rainforest area is owned by the Democratic Republic of the Congo and Indonesia.

Tropical rainforests are synonymous with relatively large number of tree species around them. The tree height reaches 20-40 m with high branching conditions and dense leaves to form a hood (canopy). The average temperature a day reaches 25℃. In this type of forest there are plants that are characteristic, namely Liana, often called rattan or orchid plants.

In tropical rain forest vegetation there are several adaptation strategies carried out by the forest to disadvantaged environmental conditions, including:

a. Undergrowth, usually found in humid environmental conditions and usually have relatively wide leaf blades to intensify the transpiration process and maximize the potential of the leaves to capture sunlight to reduce the effect of shade. In certain understorey there are plants that are equipped with the ability to climb by vines / wrapped around other plants in order to get sunlight according to their needs, for example in lianas, namely rattan (Calamus axillaris).
b. In tropical rain forest plants to reduce the rate of transpiration in the dry season, tropical rain forest plants usually drop their leaves, for example in teak plants.

2. Savanna Ecosystem

The type of ecosystem that is formed between the tropics and subtropics consisting of grasslands filled with shrubs is called savanna forest. In this savanna there are various types of trees that grow. There are several continents that have savanna, namely, the African continent, the southern American continent and the Australian continent.

The cause of the existence of a savanna ecosystem is the low rainfall in an area so that the savanna is known as a tropical prairie. Savanna has the type of climate that is not too dry to be called a desert and not wet enough to be

called a forest. Savanna contains CO2 with a very large variation, from 1.8 t C ha-1 without tree cover, to more than 30 t C ha-1 with trees as a filler.[113]

This savanna ecosystem is found in areas with a dry period of 4-6 months, with 1 year rainfall of less than 1000 mm. The temperature and humidity levels of the savanna still depend on the season. The largest savanna ecosystems in the world are found in Africa and in Australia. In Indonesia, there are savanna ecosystems, namely in areas with high temperatures with little rainfall, for example in West Nusa Tenggara (NTB), East Nusa Tenggara (NTT) and in Central Sulawesi.

There are 8 types of savanna in Indonesia, especially the Maluku and Nusa Tenggara regions based on the dominant tree species in the savanna, which are as follows:

a. Savana Albizia chinensis, is a type of savanna in West Nusa Tenggara which is generally resistant to fire.
b. Savana Palms, which are dominated by lontar (Borrasus flabellifer) and gewang (Corypha utan Lamarck) are the dominant types of savanna found on the islands of Komodo, Rote, Sawu and most of Timor.
c. Savana Eucalyptus alba is found in Central Flores to the east to Wetar. It is the predominant type of savanna in Timor, occurring together with associations of shrubs and trees.
d. Savanna Melaleuca cajuputi, more often seen starting from Central Flores extending east to Maluku.
e. Savana Acacia leuchopholea is a characteristic of trees in the savanna of NTT.
f. Savana Casuarina junghuhniana, is a typical savanna character in Sumba and Timor.
g. Ziziphus mauritiana savanna, seen throughout the NTT region that grows sporadically.
h. Tamarind savanna, found along NTT.[114]

When the formation of plant vegetation leads to an area that has lower rainfall intensity, it results in plant vegetation from the savanna to turn into

[113] Grace, J. J.S Jose, P. Meir, H.S. Miranda and R.A. Montes. 2006. *Productivity and Carbon Fulxes in Tropical Savannas.* Journal of Biogeography, 33, 387-400.

[114] Hery Kurniawan dan DhanyYuniati. 2015. *PotensiSimpanan Karbon Pada TigaTipe Savana Di Nusa Tenggara Timur.*JurnalPenelitianKehutananWallacea. Vol. 4. No. 1. 51-62

shrubs. Vice versa, when plant vegetation leads to areas that have higher rainfall intensity, it causes plant vegetation to turn into wet forests. The following types of vegetation on plants that are usually often found in the savanna are:

a. Woody plants, for example Acacia nilotica Lam (Mimosaceae), Cryptostegia grandiflora (Apocynaceae), Prosopis sp, Lantana sp and Opuntia sp.
b. Herbaceous plants, for example Chloris sp, Cenchrus ciliaris L (Poacea), Sporobolus pyramidalis, Parthenium hysterophorus L (Asteraceae) and Stylosanthes sp
c. Various species of Legumes

Transpiration is carried out to reduce water loss as one of the strategies carried out by vegetation in the savanna area. This vegetation usually dominates plant species that have thorny stems, small leaves, and epidermal tissue covered by a relatively thick cuticle in order to reduce the evaporation process. On the other hand, for herbaceous or herbaceous plant species, they usually have soft tissue types and contain water that can be used as food and water reserves.

3. Meadow

a. Geographical Conditions and Distribution Area

The intensity of rainfall of approximately 25-30 cm per year is owned by the grassland ecosystem. Usually rain is able to fall irregularly, has a high water infiltration (porosity), and the flow of water or so-called (drainage) so quickly. Grasslands can be found in areas that stretch from the tropics, namely areas that are geographically around the equator or which are limited by two latitudes, namely the Tropic of Cancer and the Tropics of Tropics to the subtropics, namely the areas that are in the North and South after the tropics. . In Indonesia, there are areas that have very little rainfall and high air temperatures, namely in the areas of East Nusa Tenggara (NTT) and Central Sulawesi (Sulteng).

b. Vegetation Characteristics

Often we find it difficult to distinguish between grasslands and savanna, in the grasslands there are almost no trees, while in the savanna there are still large trees and shrubs even though they are

very few in number. Where there are plants consisting of herbs and grasses, and both depend on humidity

The dominant vegetation in the grassland area is grass. The size of grass that lives in grassland areas is the size of grass that is relatively wet and reaches three meters, for example, Bluestem grass (Andropogon gerardii Vitman) and Indian Grasses (Sorghastrum nutans L.). Meanwhile, in areas that have dry grasslands, grass species that live in these areas have short sizes, for example, Blue Garma (Bouteloua dacylodides Nutt.

In the book Plant Ecology Dr. IR. Edi Muhammad Jayadi wrote that the amount of rainfall will determine the height of grass vegetation in grassland areas. And in areas that receive less rainfall, grass remains low to the ground, while in warm areas that receive more rainfall, grasses of relatively higher size can be found.

c. Adaptation Strategy

It can be seen that the prairie is a place for the growth of tall plants such as woody shrubs and trees, because the rainfall in the grassland ecosystem is relatively low, making it difficult for woody plants to grow. Grasses in grassland areas have adapted or adapted to cold temperatures, drought, and occasional fires. They adapt by forming a deep root system, which sinks into the soil. This is done to allow the grass to remain firmly rooted in the ground in order to reduce water evaporation.

3. Desert

a. Geographical Conditions and Distribution Area

In desert ecosystems or desert areas, there are many in the tropics and bordering grasslands. From the desert to the prairie, usually the farther away the more arid that is the natural state of the desert to the grass. And in this ecosystem the rainfall that occurs in it is very low, which is only about 250 mm per year or even less than 250 mm per year.

In the desert itself heavy rains are very rare and also irregular. The sun's rays are very hot and evaporation is high so that the daytime temperature is very hot. In summer, the temperature can be over 40 degrees Celsius. There is a very large difference in day and night temperatures (daily amplitude). Plants that can live chronically in the desert are plants that can adapt to water shortages and rapid evaporation.

b. Characteristics of vegetation

The characteristics found in desert areas have unique characteristics. Where in general, the characteristics of plants that live in desert areas have small leaves like thorns or even no leaves. One of the most important xeromorphic properties of xerophytic plants is the ratio of external surface area to volume, which is of little value. Then the decrease in area on the outer surface is accompanied by a decrease in the size of the cell, an increase in wall thickness and an increase in the density of the system in the vascular tissue and stomata, then the amount of tissue on the pole increases, while the spongy tissue decreases.

It can be seen that in some types of xerophytic plants have long roots so they can take water from deep places. The leaves are often covered with hair, then they are succulent, meaning that a group of plants that have a structure that almost all of them can store water where the water storage is used as nutrient storage in the event of a long drought, succulents are also plants that develop easily, therefore these plants are said to be Plants that are succulent are water-storing tissues. The decrease in leaf size is considered a trait associated with decreased transpiration rate and can store water in spongy tissue.

c. Adaptation strategy

Various kinds of adaptation strategies are carried out by plants that live in desert areas to cope with very extreme environmental conditions, including:

1) Have small leaves like thorns, or even no leaves, this is in order to reduce evaporation, for example as in cacti.
2) It has very long roots, this is in order to be able to take water in a deep place.
3) There are certain types of plants that can take full advantage of minimal rainfall, in order to complete their life cycle in the shortest possible way (ephemeral plant). When it rains, the plant will grow, flower, and bear fruit quickly. This can happen within a few days about 10 days after the rain, but has time to produce seeds to grow again in the following season. One example is the plant Boerhavia repens L.

4. Autumn Forest

a. Geographical Conditions and Distribution Areas

Deciduous forests are located or are in temperate zones, namely between tropical forests and coniferous forests, with a range of 30-40 degrees latitude LU/LS. The region is located in a temperate climate which has four seasons, namely autumn (fall), winters (winter), springs (spring), and summers (summer).

Deciduous forests have the following characteristics:

1) It has very low temperatures in winter and very hot in summer (with a range of -30 degrees Celsius to 30 degrees Celsius).
2) The average annual temperature in deciduous forests is 10 degrees Celsius.
3) High and even rainfall throughout the year.
4) There are trees that can drop their leaves in the summer, namely the location of the forest in the tropics, and in winter the location of the deciduous forest with a temperate climate.

b. Vegetation Characteristics

Deciduous forests have relatively few tree species, ranging from (10-20) and not too dense. Most of the plants have broad leaves, and change their color to golden red in the fall, then shed their leaves in the winter. Examples are oak, hickory, maple, popular and sycamore trees. In deciduous forests the vegetation consists of five zones, namely:

1) The first zone, which is a canopy, is a forest with relatively tall trees ranging from 60 to 100 m, consisting of: oak, beech, maple, chestnut, hickory, elm, basswood, linden walnut, and sweet gum.
2) The second zone, which is small and sapling trees, and in this zone is more tolerant of shady conditions, consisting of young trees of short size.
3) The third zone, is a bush zone consisting of mountain laurels, rhododendrons, azaleas, and hucklebrrries.
4) The fourth zone is the herb zone, where in this zone there are wild flowers, mosses and ferns.
5) The fifth zone, referred to as the Ground zone, consists of lichen and mosses.

c. Adaptation Strategy

There are several kinds of adaptation strategies carried out in deciduous forest areas, this is in order to adapt to the extreme environment. Some of them are as follows:

1) Grow as soon as possible when environmental conditions are favorable. This is done by some wildflowers which are undergrowth or shrubs that grow on the forest floor. These plants will grow quickly in early spring, when the large trees above are not yet leafy so that sunlight can still penetrate the forest floor before being shaded by the canopy of large trees above it.
2) Most trees in deciduous forest areas have deep and wide roots, which are the same size as the width of the canopy. This is intended to maximize the potential of these roots in absorbing water.
3) Most of the trees in deciduous forest areas also have relatively large leaves, wide and thin strands, these characteristics are the same as the leaves of plants in deciduous forest areas. This is to aim to be able to absorb more solar radiation for photosynthesis purposes in the summer.
4) In winter most plants will lose their leaves in response to lack of water and cold temperatures, for example, oak, hickory, maple, poplar and sycamore trees.

d. Taiga biome

Taiga is a forest composed of one species such as conifers, pines and others. South of the tundra is a forest formation consisting mainly of coniferous members, so the taiga is often called coniferous forest. Which is where the taiga is found in the northern hemisphere, for example in the territory of Russia and Canada. The boundary between the two areas is often called a tree trunk because it is the boundary between an environment that still allows trees to grow and those that do not. The taiga is an evergreen forest, although winter temperatures can reach tens of degrees below zero. Wet taiga is a forest composed of one species such as conifers, pines and the like. Only a few shrubs and wet plants were found. The wood produced from the forest is mainly used for making paper, matches and others.

The characteristics of the taiga biome are that the difference between summer and winter temperatures is quite high. In summer the temperature is high, in winter the temperature is low. Plant growth occurs in the summer which lasts between 3 to 6 months.

Typical flora are coniferous trees or coniferous trees, an example of a conifer tree is the merkusi pine tree. The vegetation is almost uniform, the forest is called a homogeneous forest. The plants are green all year round. Even in winter with very low temperatures. The fauna contained within is blackbirds, invites, wolves and birds that migrate towards the tropics when winter arrives. One of the uniqueness of the taiga forest is that there are not too many animal and plant species that are able to adapt in the ecosystem. The difference in climate on earth makes living things such as animals and plants unable to survive in the same area. Although able to adapt and adapt to the environment, animals and plants still need a long time to do so.

e. Tundra biome

Tundra is an area where the temperature is very cold. Therefore the tundra biome is an area. Especially kutunb which can not be grown by various types of trees. The tundra biome covers the area around the Arctic islands around Antarctica. The landscape of the tundra biome is a low, flat area filled with dwarf shrubs.

This region is located around the north pole with very cold temperatures. Plants that are able to live in this area only consist of weeds, especially various plants such as grass and moss. The dominant plants are sphagum, iken, annual seed plants, short woody plants and grass. The condition of the vegetation is similar to desert vegetation but is found in cold climate areas. That's why the tundra is often called the cold desert. Animals that inhabit this biome include muscox, reindeer, polar bears, and insects, especially mosquitoes and black flies. The tundra distribution area is found in the northern part of Scandinavia, Finland, Russia, Siberia, and Canada.

The process of formation of the tundra biome is caused by the natural environment being very dark, for a long period of time, so that sunlight cannot reach the tundra area. As for areas where there is sunlight, there are only a few dwarf trees in the area, and even moss. Especially mossy plants will produce crust (lichens).

The characteristics of the tundra biome are very extreme regional climates with low average temperatures, namely the temperature

reaches -57 degrees C. Rainfall is less than 250 mm/year. The average plant is strikingly colored and short.

The characteristics of the tundra biome are long winters that can last for nine months with a dark atmosphere and get little solar radiation energy. Short and bright summer. Summer lasts for three months, during which vegetation grows.

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