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Biodiversity as a Major Role in Human Ecology

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ABSTRACT

Biodiversity means the living organisms themselves and the diversity and variability of the ecological complex which living organisms depend on for their survival. We may realize it and arrange it both macroscopically and microscopically into 5 levels, namely: ecosystem diversity, association diversity, species diversitiy, cytological diversity and genetic diversity. Biological resources are the material expression of biodiversity and the material things are evaluated to supply food, medicine, raw and processed materials for industry and energy resources for the existence of mankind and the development of national economy. Yet, the living things, including plants, animals, microbes and human beings, together with their environment, i. e., the atmosphere, water and soil, form an interdependent and interacted circulatory system (the ecosystem) in the biosphere. Nowadays every ecological problem is closely related to human ecology. Whether human as a coordinator in the ecosystem, or as a destroyer depends on what strategy they adopt and what kinds of ecological processes of exploitation and utilization they choose. Therefore the rational utilization and protection of plants should become the key of solving problems of the six ecological crises. These crises we are facing are the consumption of energy, the exhaustion of resources, the explosion of population, the shortage of food and water, the degradation of environment and the imbalance of ecological circulation. From the past geological epochs up to the present, no green plants (especially higher green plants) means no any other living things and no human society, and any irrational cleaning of plant covers on the earth would lead to an ever worsening condition of our environment, and thus cause the six ecological crises successively or simultaneously and seriously, which would result in the extinction of quite many biological species, even including *Homo sapiens* itself. The only way of preventing the degradation lies on the rational use of plants. The degree of the compromise attained between mankind and plant kingdom may be a measurement of rationalization. We believe that modern agriculture is the common goal. In this "Great Agriculture", ecology and economy are combined together, and as many as we can use the multifarious biological resources from different levels of biodiversity. However, their nucleus is agro-forestry, being an ecological arrangment of several kinds of regenerable resources from various biodiversities, with resources in the form of agriculture and forestry playing the major role. The rational measure will be gradually formed during the full application of every kind of modern and scientific means for cultivation.

Biodiversity is one of the basic features of living organisms. Like reproductivity, evolution and sociability, it is evolved from and advanced than the parent inorganic world. So the diffrentiation of living organisms into plants, animals, microbes and human beings is the natural results of living materials in the process of evolution. Biodiversity or biologial diversity means the living organisms

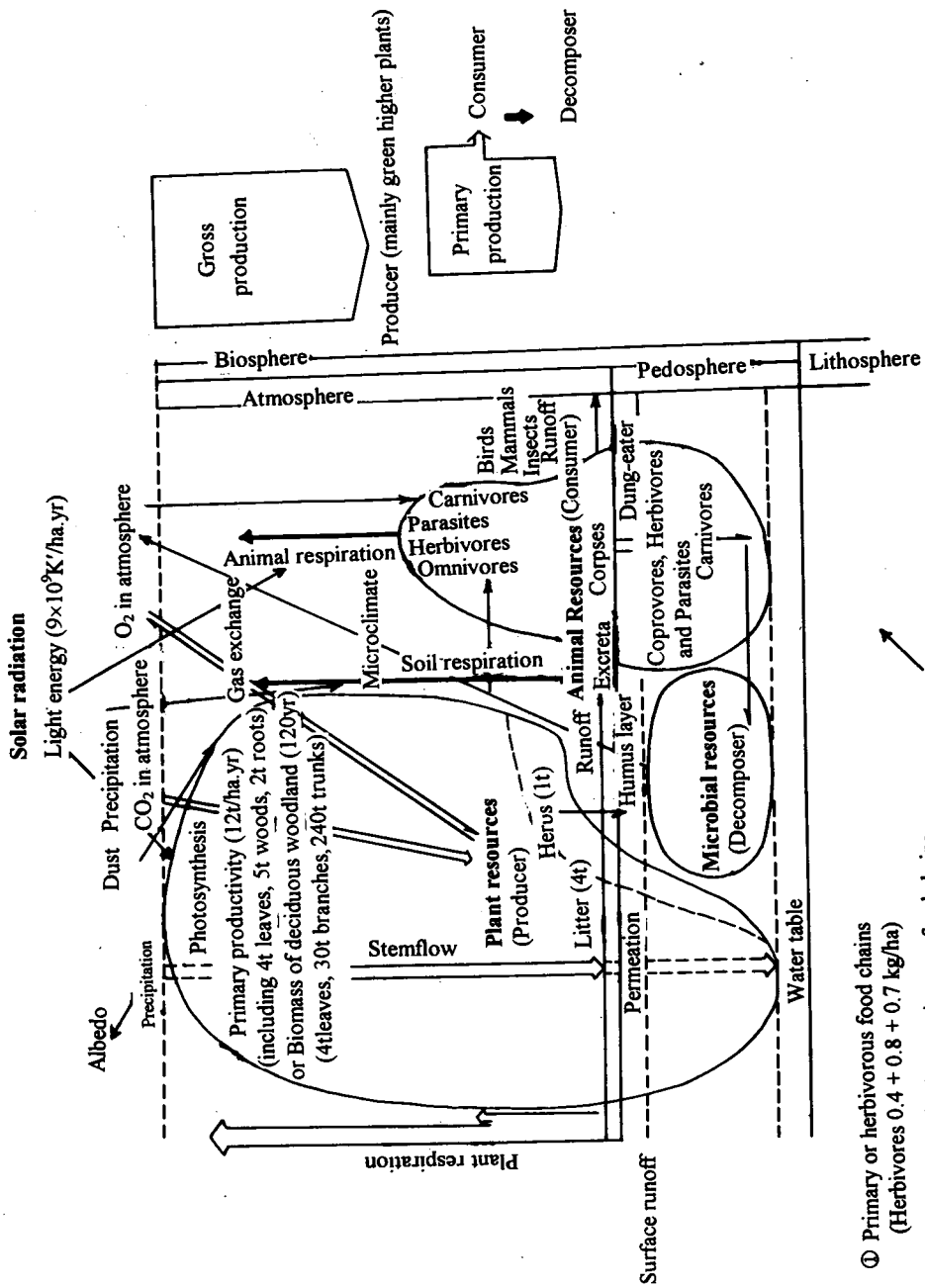

Fig. 1 Diagrammatic representation of form and function of deciduous forest ecosystems in Belgium (combined documentation 23, Belgium, after Joy Tivy 1977, and modified from H. Walter 1979).

themselves and the diversity and variability of the ecological complex which living organisms depend on for their survival. In exact sense, biodiversity is the sum of the biological species, genetic variations within every species and their living environment, including all the species of living orgnaisms, all the genes and all the ecosystems they are associated with. We may realize it and arrange it both macroscopically and microscopically into 5 levels: ecosystem diversity, community diversity, species diversity, cytological diversity and gene diversity. Among them, species diversity is regarded as the most important and basic one, in concrete and substantial sense. As a sum of all the gene, species and ecosystem diversities, biological resources possess actual and potential value. They are the material expression of biodiversity and the material basis for the existence of mankind. More and more multifarious living things are evaluated to supply food, medicine, raw and processed materials for industry and energy sources for the existence of mankind and the development of natioal economy. Howerver, the living things, including plants, animals, microbes and human beings, together with their environment (atmosphere, water and soil), compose an interdependent and interactive circulatory system (ecosystem) in the biosphere. Figure 1 is the diagrammatic representation of form and function of deciduous forest ecosystem in Belgium. Unfortunately, the strong effects of human activities were not manifested here. In this system, plants, especially the green higher plants, are almost the only primary producers, while animals are the second, the tertiary producers and so forth, but all are the consumers (from plant consumers downwards) simultaneously. The microbes, in addition to having more consumers than producers in nature, play an important role as reducers (or decomposers) in the ecosystem. Otherwise the biosphere will perhaps be occupied by corpses and garbages from various living organisms. But human beings, since their evolution into *Homo sapiens* (and *Homo "energetica"*), form the fourth aspect and gradually take a central position in every ecosystem. Nowadays every ecological problem is closely related to human ecology. Whether human as a coordinator or as a destroyer in the same ecosystem, depends on what strategy they adopt and what kinds of ecological processes of exploitation and utilization they choose. They are the greatest consumer of food and energy in the world, and can be the greatest and the most effective producer of food and energy in the world at the same time. They can **cultivate** (including feeding, incubating, educating, etc. in a broad sense) all kinds of renewable resources according to their own demands, and make them sustainable reproduction and constant evolution as well. After all, among different kinds of renewable resources, the green higher plants belong to the most important group for whcih the solar energy can be directly and perpetually used in making food and environment for each kind of living organism. And they may keep the energy in different forms and at different levels. Therefore, the rational utilization and protection of plants should become the key to solve the six ecological crises. These crises we are facing refer to the consumption of energy, the depletion of resources, the explosion of population, the shortage of food and water, the degradation of environment and the imbalance of ecological circulation. All these are interrelated and interdependent. They are different expressions at different development stages of the same problem. The problem is why we are the only consumers and destroyers of plants but not cultivators. While I can foresee the future world is threatened by the conflict between human beings and plants, I am also inspired by the more and more rationalized utilization of plant resources when human beings use plants as a tool to coordinate or

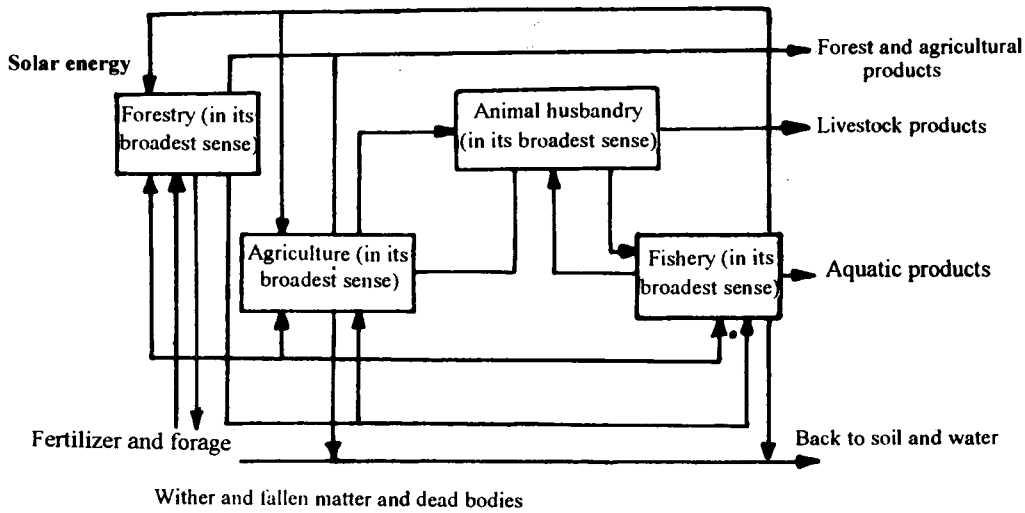

Fig. 2 A primary model of ecosystematical engineering of forestry, agriculture, animal husbandry and fishery (after Ma Shijun, Li Songhua, 1987).

regulate the imbalance in every ecosystem. Anyhow, I am an optimist for ever.

From the geologic epoches upto the present, there would be no any other living things without green plants (especially the higher green plants); neither the human society. If the reproductive rate of plants (especially that of forest trees) in the sense of plant demography is greater than their rate of consumption by human beings and other living organisms, the global ecosystem will be in good circulation. Or ecosystem will be inexorably controlled by a vicious circle as a result of retaliation from the nature. The over-deforestation in different climatic zones, the over-grazing in prairies, steppes and even in deserts, and every irrational cleaning of natural vegetation on the earth would lead to an ever worst environment which human beings rely for existence and development. The six ecological crises would be caused successively or simultaneously and seriously, which would result in the extinction of quite many biological species, even including *Homo sapiens* itself. So the succession within every ecosystem means not only the succession of the plant community itself, but also the successional and continuous changes in all the members within the same ecosystem. The only solution to prevent ecosystem from degradtion lies on the rationlized methodology to exploit and use plant resources.

And then, what does **rational** imply? How can we get **rationalization**? firstly, the rational exploitation and utilization of ecolgical resources and protection of specific plant resources is the sole **rational** result during the long-term struggle between human being and nature. On her side the plant kingdom is the generalissimo in that struggle. The degree of the compromise attained between mankind and plant kingdom may be a measurement of rationalization. It has experienced an endless course beginning from the primeval economic demands in forming a primitive agricultural system. Historically, there occurred a gradual evolution of a series of agro-forestry systems coinciding with the

different social developmental stages. In the earlier clan system, people could only avoid their belly from being empty by hunting, fishing, collecting molluscs and so on, collectively or singly, accompanied by digging and collecting edible or medicinal plants. Mainly, these plants included yams and wild fruits in forests, and then the grains in forest openings or nearby steppes. The eating habit was not quite different from wild omnivorous monkeys and other animals at that time. It was, however, the beginning of understanding biodiversity and bio-resources. Then a nomadic society was developed and a shifting agriculture system (swidden cultivation) was formed at the same time. People tried to cultivate crops and raise livestock in a rather primitive way. Anyhow they started to act as **cultivators** rather than only as consumers and/or destroyers. Then the **culture** began. Under the slavery and feudal system, the agriculture now attained to much larger scale and the annual yield was higher and higher. Cultivation was promoted by the development of irrigaion systems, the building of terraced fields and other methods of intensive and meticulous farming. The farming methods were widely adopted and developed so that formed small scale of agriculture implimented by individual farmer. Until the serfs, or the farm laborers and the tenant farmers were gradually and finally libetrated from the slave owners and landlords. Technically the collective and the capitalist agriculture perhaps will reach the same goal via different routes although the ownership and way of distribution are quite different. We believe that modern agriculture is the common goal. But how can the modern agriculture be defined? So far as we know, the modern agriculture aims at the ecological-economical purposes, is using every kind of modern scientific methods in cultivation and will be based upon the three-dimensional development of **great agriculture**. That is, the agriculture (extensively, it include horticulture, pomiculture, and so on), together with the extensive animal husbandry (including sericulture and beekeeping), forestry, sideline production (mainly in forest by-products) and fishery. In the **great agriculture**, ecology and economy are combined together. The multifarious biological resources from different levels of biodiversity are used as many as possible. However, their nucleus is agroforestry, being an ecological arrangement of several kinds of renewable resources from various biodiversity, with resources in the form of agriculture and forestry playing the major role (Fig. 2).

The rational measure will be gradually formed during the full application of every king of modern and scientific means for cultivation. This method was based on the agricultural practices of farmers. But it can only be evolved and applied through modern experimental researches. In addition to biotechnical hybridization for breeding, cytotechnology for quick propagation, super-cold treatment of seeds, aquaculture or other kinds of soilless culture, drip irrigation, no-till method, air-conditioned climatron-like green factory and fermentational engineering related with the bio-gas, etc., there should be developed side by side a large scale but intensive ecological farming in sufficient utiliztion of agricultural ecological engineering methods such as the system of shelter forest and mixed forest, the usage of cover crops, the rotation and intercropping system in order to build up a multistoried and polyspecific management of various crops and other plants with economic values. The artificial ecosystem will be the final farming system, in which the matter and energy will be in rational circulation (Fig. 3). Those microscopic experiment mentioned above can also be undertaken in every botanic institute, in special experimental station or professional institution such as agriculture,

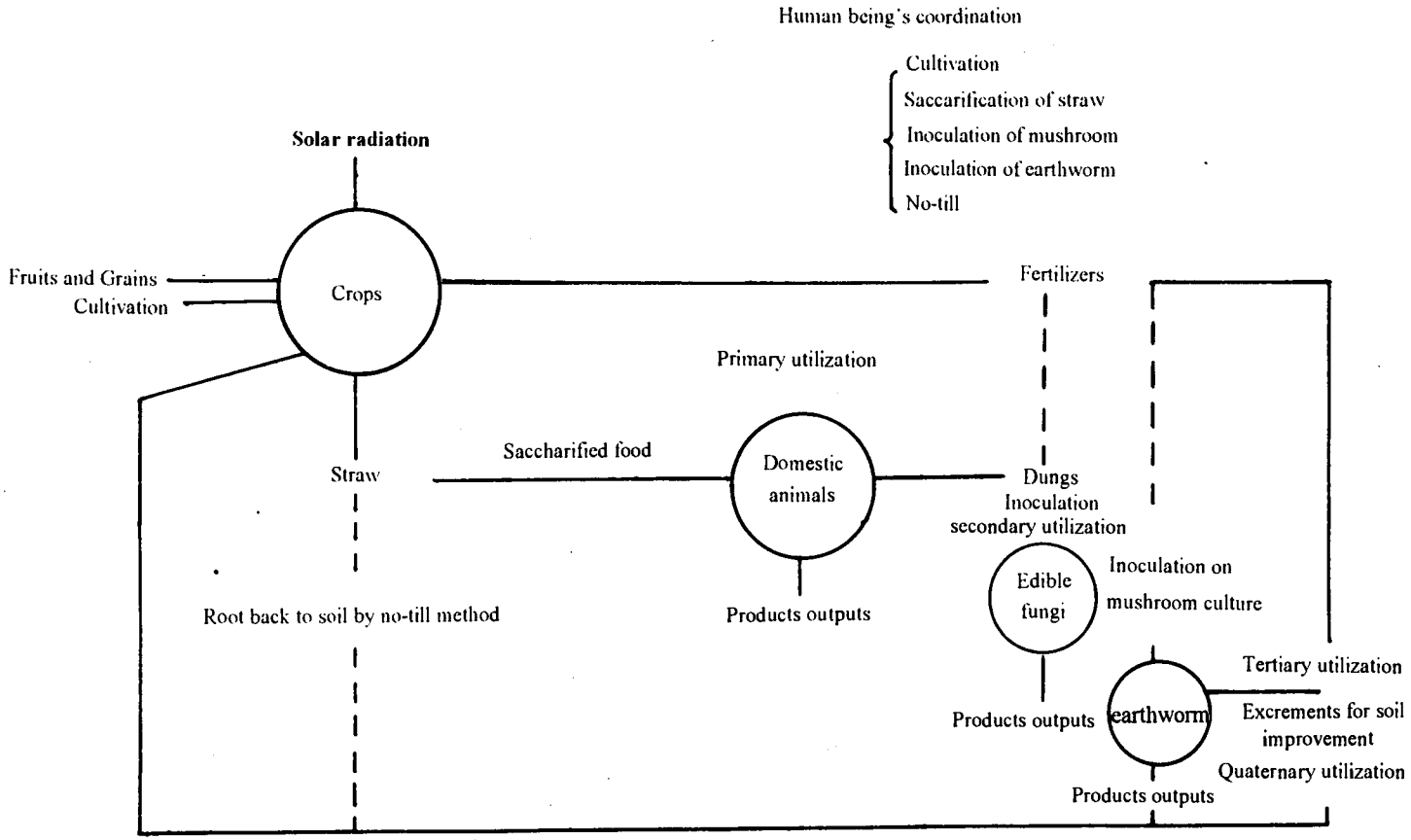

Fig. 3 The multistoried and multistaged utilization of matter and energy — the repeated utilization of crop straw (after Ma Shijun, Li Songhua, 1987, slightly modified).

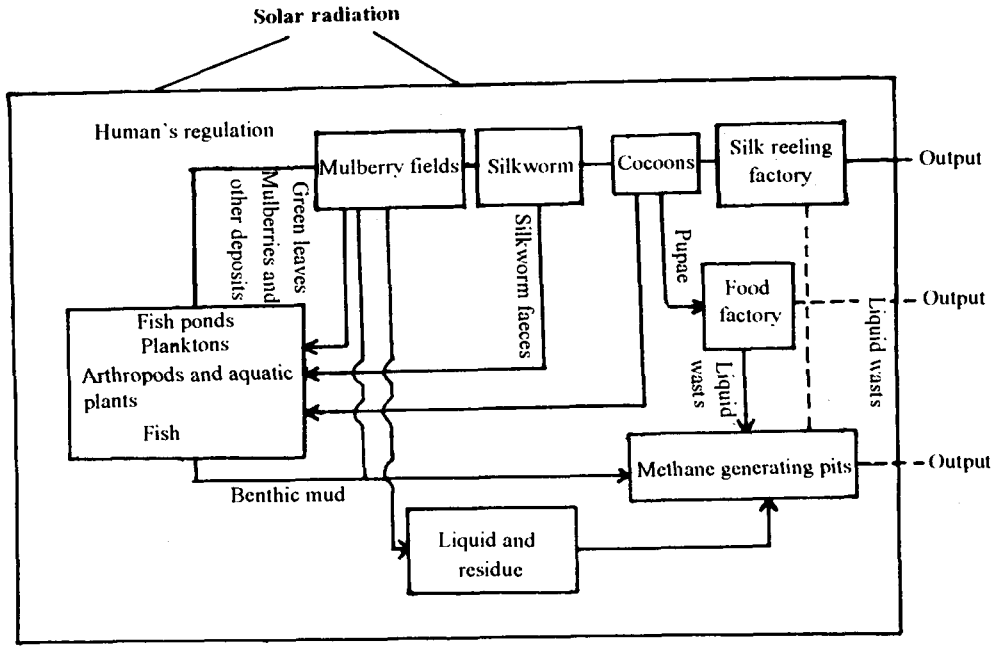

Fig. 4 The matter circulation system of water and land exchange system invented by Chinese Peasants long ago. so-called mulberry field-fish pond or sugarcane field-fish pond system (Adapted from Ma Shijun. Li Songhua. 1987. slightly modified.)

forestry, etc., or by various related departments in universities. As the key in the farming system, the macroscopic researches could and should only be started in modern botanic gardens. The gardens connect with certain nature conservation area or they may have a seed bank or gene pool that can start experiments of introduction, cultivation and acclimatization of various kinds of plants that bear the qualities of gene resources. First priority of all should be the precious, rare and endangered species. Thus the rational protection of gene pools will lay a sound foundation for the experiments and researches of ecological recomposition of various crops and plantations, that will be gradually developed in the future (Fig. 4). These experiments and researches can be developed to be a sustainable gigantic enterprise of agriculture through productive practice and enlarging production scale. Under the condition of improving photosynthesis efficiency effectively and raising crop yields including quantity and quality per unit area, the area of land in use all over the world can be gradually stabilized. The constant increasing demand of matter because of the sustained population pressure will be met. If so, the limited nature sanctuaries in area will be sufficiently conserved. And more bio-species, gene pools, typical biological communities and ecosystems will be stabilized relatively and developed sustainably.

The history of the introduction and propagation of the rubber tree *(Hevea braziliensis)* is a good example to demonstrate the process mentioned as above. When the rubber-mildew almost destroyed

the pure rubber forest in one of its native places, Manaus in the middle reach of Amazon, it is in the Kew Gardens where a perfect scientific cultivation technique was developed that carefully made the introduction of rubber tree into Malaya successful according to the phytogeographical knowledge. Also through the enthusiastic and clever cultivaing efforts by Chinese overseas laborers, the rubber industry from thence and forth was gradually transferred into the different regions in S. E. Asia, afterwards many rubber-research institutes were raised there in order to put this industry ever in progress. The northward introduction and acclimatization of rubber trees passing over 25°N were succeded in China, through the efforts by many botanists, climatologists, pedologists and agronomists in searching for appropriate land for rubber plantation and making design for large scale ecological farming with the comprehensive cultivation technique developed in special institutes in Hainan and Yunnan. Yet the way for solving the problem of forming an ecological farming system in tropics with rubber tree only as one of its major crops, was still taken as a heavy responsibility in tropical gardens of perhaps the whole world. Although the artificial plant community with shelter tree-rubber-tea combination already showed economic, social and ecological benefits in both Yunnan and Hainan, it has only partly answered this question. The process of reforestation on abandoned lands, i. e., the reconstruction of subtropical forest cover on a seriously destroyed desert-like maritime sand flats in Xiaoliang, Dianbai County, Guangdong Province is another example. In the originally dry deserts and steppes region, the reform of sand desert at Shapotou, Ningxia Hui Autonomous Region, and the work of certain desert experimental station in Xinjiang Uighur Autonomous Region, in Inner Mongolia for steppe and desert management are also some of the attempts which have already resulted in preliminary achievements.

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