



The Role of Ethnobiology in Responding to Current Problems in the Management of Biological Resources and Ecosystems in Indonesia

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ABSTRACT

Ethnobiology is defined as the scientific study of the cultural knowledge possessed by various communities. It is also related to the techniques used in the management of biological resources, and the position of those communities in their cosmic cultural vision. This study discusses the role of development and perspectives of ethnobiology in Indonesia for managing the diversity of biological resources and their ecosystems sustainably. The results of ethnobiological studies can describe the problems, potentials, and opportunities to develop the diversity of biological natural resources and their ecosystems as a source of life for the community in a sustainable manner. The current problems faced in the management of biological resources are socio-culture, limitations and disregard for science and technology, weak institutions, inability to arrange spatial planning, inaccurate determination of development priorities, misperceptions and misconception about biodiversity, policy fragmentation and inability to manage biological resources, enforcement of certification, and climate change. Therefore, ethnobiological studies must be able to reveal the benefits and potentials of biological resources and their ecosystem and provide a foundation for the management and advancement of biodiversity sustainably to increase national prosperity and development.

Keywords: Ethnobiology – Biodiversity – Management – Sustainability

SIGNIFICANCE STATEMENT

We hereby declare that this study is our own work and to the best of our knowledge it contains no materials previously published or written by another person, or substantial proportions of material that have been presented in the Indonesian Academy of Sciences (AIPI) meeting. This study identified current problems faced in the management of biological resources in Indonesia, and we consider that ethnobiological studies are able to bridge the management and development of biodiversity in a sustainable manner in order to increase national prosperity and development.

INTRODUCTION

Ethnobiology is essentially a study of the knowledge system of the community about the management of plant-based biological resources and their ecosystems. Its topic of discussion is holistic and interdisciplinary between the social and cultural sciences and life sciences. Therefore, an ethnobiology researcher is required to master knowledge that is broad in scope, ranging from social science to advanced sciences and technologies related to plant life sciences. Ethnobiological studies can provide a reference about the community's knowledge system in managing plant-based biological resources, including a discussion about plant life adaptation patterns on natural resources and their ecosystems. Local communities have the same views about all forms of life, natural resources, and the ecosystem. In essence, the knowledge system they have is an effort to improve life and maintain a sustainable life. For example, the Javanese have a motto "*memayu hayuning bawana lan hangelar budi hangrungkepi sesami*", which becomes a symbol of care for the universe and fellow humans. It means that each community group has a specific adaptation technology to manifest their identity towards a prosperous life through the life motto "*memetri hardaning jati diri*", which is a hope indicating to always want to be more prosperous.

One of the objectives of ethnobiological studies carried out in Indonesia is to prove that community knowledge has benefits and advantages based on the validity of science and technology. The results of these ethnobiological studies will then serve as written evidence of the wealth of local knowledge possessed by the Indonesian people. In the end, ethnobiological studies will provide valid and scientific evidence about Indonesian cultural wisdom in interpreting the importance of biological resources and ecosystems to be used sustainably. This interaction includes the life struggle and the process of survival in the ecosystems.

POTENTIAL AND APPLICATION OF ETHNOBIOLOGICAL DATA

In essence, the potential, role, and application of ethnobiological data cover three aspects: (1) bio-economy, (2) ecology, and (3) ethics (science and technology) (Cotton, 1996; Purwanto, 2007, 2010). In general, the bioeconomic includes the aspect of the use of various types of biological resources by the community for subsistence interests and the household economy (Friedberg, 1996). The ecological aspect has a role to analyze the influence of humans on their efforts to utilize and manage the diversity of plant species and their ecosystem. Meanwhile, the ethical aspect concerns the local knowledge of the management and utilization of biological resources based on ethnobiological studies. The results of ethnobiological studies can be used to develop the management and utilization of biodiversity that benefits the community socially, culturally, economically, and ecologically. The utilization of local biological resources as an economic source is proven to have advantages and resilience from economic crisis shocks because the bio-economy using biological resources provides unique traits for each region

(Saragih, 2000). Biological resources will be more attractive when their potential and superior uses are known and recognized globally, for example as raw materials for drugs, cosmetics, stimulants, and others.

In addition, the results of ethnobiological studies can also provide an overview of their role in the use of environmental and sustainable biological resources (Purwanto, 2010, 2020). Ethnobiological studies discuss not only biodiversity that is useful for subsistence and community economic interests but also ecological aspects as a parameter whether the subsistence and bioeconomic activities of a community group have ecological benefits or vice versa. Therefore, the results of ethnobiological studies must be able to solve economic and ecological problems faced by the community in a certain location where the study is carried out and can become a model for collaborative and participatory management of biological resources and their ecosystems.

THE DEVELOPMENT AND ROLES OF ETHNOBIOLOGICAL STUDIES

The development of ethnobiology is very fast along with the advancement in science and technology. The scope of ethnobiology has grown, in which it is previously only the utilization of plant species diversity by local communities. At present, it also covers an interdisciplinary scope encompassing various fields. The scope of present-day ethnobiological studies includes several fields of study that analyze all aspects of the interrelationship between traditional societies and plants. Cotton (1996) and Purwanto (2010, 2020) stated that there are several fields of study that are the main scope of ethnobiological studies, i.e., ethnoecology, ethnobotany, ethnozoology, traditional agriculture, cognitive ethnobiology, material culture, traditional phytochemistry, paleo-ethnobiology, and other fields of study that link community's life with the diversity of biological resources and the ecosystems.

At present, the development of science and technology is prioritized on the development that has a direct role in economic growth, informatics, and communication as the main choices (Purwanto, 2021). The development of life science is still important because it touches human interests directly and fundamentally. However, the development of science and technology in the biological sector is still being neglected. Indonesia, which has the superiority of richness in biodiversity and culture, should prioritize the development of life sciences because it can result in superior products (Purwanto and Sukara, 2008). Indonesian people have local knowledge of the use of biological resources that other countries do not possess (Rifai, 2002). This local knowledge can be used as a starting point for the development to obtain superior products. Therefore, the development of biological resources must be based on the support of science and technology (Purwanto *et al.*, 2017; Purwanto *et al.*, 2020). The use of genetic engineering technology developed by biotechnology can be used to develop various types of potential Indonesian plants (Sukara, 2003). Likewise, the development of medicinal plants based on ethno-direct sampling, phylogenic targeting, and random sampling (Cotton, 1996; Purwanto and Munawaroh, 2002; Purwanto, 2002) have been shown to provide tangible results. For example, the results of studies on biological resources based on local knowledge have found new compounds for modern medicinal ingredients. Specifically, there have been more than 50 types of active ingredients in modern medicine found. Some of them are aspirin which comes from *Filipendula ulmaria*, morphine from *Papaver somniferum* (Rudgley, 1993; Cotton, 1996; Cox, 1994), quinine from *Cinchona officinalis* (Lewington, 1990), betacyanin from the pigment of *Beta vulgaris* (Hendry, 1993), and azadiractin from *Azadirachta indica* which is useful as an

anti-pest (Ley, 1990; Sujarwo *et al.*, 2016). In addition, *Eurycoma longifolia* has known its benefits as an aphrodisiac and a medicinal substance for malaria. *Alstonia scholaris* and *Alstonia macrophylla* are alkaloid-producing types that have the potential to produce new medicinal compounds. *Calophyllum cannum* and *Calophyllum lanigerum* are suspected to contain bio-anticancer substances. Likewise, *Derris*, *Milletia*, *Tephrosia*, and several species of *Leguminosae* contain rotenoids (insecticidal substances). Reserpine is also from *Rauwolfia* breed, diosgenin is from *Dioscorea* spp. (Lowry, 1973; Hendry, 1993), and others.

The development of Indonesia's biodiversity is believed to be able to overcome various problems currently faced by Indonesia (Purwanto, 2020; 2021). The main obstacle to the development of biodiversity in Indonesia is the lack of policy support for the research and development of science and technology in this field. For this reason, the development of biodiversity needs to be accompanied by research and development in science and technology as an effort to increase the fulfillment of basic human needs, such as food, clothing, shelter, health, and education. Furthermore, the development of biodiversity should be handled more intensively because it touches the needs of many people who are generally not able to subsidize their needs (Purwanto, 2013).

From this brief description, it can be seen the opportunities and roles of ethnobiology to be able to explore the development of biodiversity in the context of increasing national prosperity and development. Therefore, ethnobiology is required to be able to provide data sources that can support the development of applied science, such as agriculture, biotechnology, ecology, and other applied sciences. Because of that, ethnobiological studies must be able to reveal traditional knowledge and turn it into useful and valuable knowledge by relating it to the actual problems faced by modern Indonesian people (Sujarwo *et al.*, 2014; Purwanto, 2021). For example, ethnobiological studies on traditional medicine must be able to reveal and develop local knowledge about traditional medicine, which has the power to cure hypertension, obesity, cholesterol, diabetes, cancer, and even AIDS. In the same way, studies in traditional agriculture must be able to reveal local cultivars of food plants that have high production, are resistant to pests and diseases, and others. Therefore, the results of ethnobiological studies must be a very valuable basic instrument to help in solving the latest problems that are being tried to be tackled globally (Purwanto, 2020; 2021).

The richness of Indonesia biodiversity and its relation to ethnobiology provide many advantages as we can see, understand, and observe its systems directly around us. Therefore, the goals and objectives from the efforts to develop science and technology that utilize the richness of biodiversity and local knowledge as the main capitals can be more easily achieved. Various kinds of local technologies possessed by Indonesian in utilizing biodiversity can be used as the basis for promoting, developing, and mastering biotechnology. For example, efforts to extract the natural chemical elements for medicinal substances are carried out by a molecular biology approach with high-through put screening technology associated with knowledge of the human disease genome to find new drugs from natural sources (Soedjito *et al.*, 2009).

The biodiversity that Indonesia possesses has benefits that cover three main dimensions: (1) the ecological dimension, (it is biodiversity related to its role in the ecosystem), (2) the economic dimension, (it is biodiversity encompassing two things, namely use-value and

ecological value of biodiversity, in which both of them provide direct and indirect benefits to human life), and (3) the ethical dimension (it is biodiversity related to science and technology, in which biodiversity is a legacy for future generations). In these dimensions, biodiversity contains the elements of science and technology regarding diversity, management, and utilization of biological diversity, in which those can be used as a basis for further development (Lévêque, 1994). Furthermore, in these three dimensions, ethnobiology also shows the roles and potentials in the management of biodiversity (Purwanto, 2008).

If being studied more deeply, modern ethnobiological studies have three main topics that become an international interest.

(1) The identification of types of wild biological resources and local types of cultivation that have commercial value

The results of the ethnobiological study generate detailed information of the types of local biological resources that have advantages and the potential to be developed as cultivated plants and domesticated animals that are economically profitable.

(2) The application of traditional techniques in the conservation of biological resources

The concept of biodiversity conservation of natural resources applied by local communities in Indonesia is basically to protect an area based on socio-cultural aspects, namely by making it sacred (Purwanto, 2009; Soedjito *et al.*, 2009; Sujarwo *et al.*, 2020). This traditional conservation system can be found in various regions in Indonesia, in which each of them possesses its unique characteristics (Purwanto, 2004). If being studied more deeply, the traditional conservation concept of the Indonesian people has advantages and scientific reasons that can be justified in terms of conservation and sustainable use. In those regions, the ecosystems are even managed in a sensible manner so that the results can be enjoyed by the surrounding community (Purwanto *et al.*, 2004).

The concept of cultural-based conservation is absolutely very operational in the community. However, this concept does not get attention and recognition from the government, thereby eroded by many unfortunate changes. Therefore, it is necessary to make an inventory of these cultural-based biodiversity conservation practices by testing, adapting to the current development, and adopting them as a future policy. In this position, ethnoecology can explain the relationship between human culture and biological resources and their ecosystems. Ethnoecological studies on local communities in Indonesia show that each community or ethnic group has very wise knowledge in managing its resources and ecosystems (Purwanto, 2004). For example, Baduy people have a sacred area named '*Sasaka Domas/Arca Domas*' (Iskandar, 2009). Dayak Kenyah people have an area called *tana' ulen* (Soedjito, 2009; Purwanto *et al.*, 1999), Dani people also possess a sacred area named *wesama*, *wusama*, or *wakunmo* (Purwanto, 1997; Purwanto and Munawaroh, 2008). Furthermore, Balinese people have a concept called *Trimandala* (Purwanto and Munawaroh, 2008; Sujarwo and Keim, 2017). Dayak Benuaq people have an area called *eweï teweletn* (Hendra, 2009). In addition, Maluku people apply a protection system called *sasi* (Purwanto *et al.*, 2004). There are still many concepts related to it, scattered all over Indonesia.

Through the scientific approach taken by researchers on traditional conservation areas mentioned above, the results indicated that those locations have several advantages, as described in the following:

- (a) It is proven that those locations have a high conservation value, namely (1) they have high biological diversity (Erdelen, 2003), (2) they serve as protected areas for species whose ecological status is rare, threatened, and endemic, (3) they serve as water source areas, and (4) they become indicators of the richness of biological resources in the area.
- (b) Those areas can serve as a model for a participatory area management strategy, both conceptually and practically, because those local conservation areas are more holistic, especially in the aspects of a close relationship between humans and natural resources as a form of integration between culture and natural values in the biological resources management system.
- (c) Those areas can serve as a protection and safeguarding of local knowledge.
- (d) Those areas can be a cultural manifestation and cultural diversity, meaning that those local conservation areas have cultural values and are also a reference for culture, religion, the identity of a community group, and even the identity of a nation.
- (e) Those areas can serve as ecotourism, meaning that sacred areas are part of the cultural and natural resources of a community group that has their uniqueness which can be used as an object of ecotourism.
- (f) Those areas possess sacred values, meaning that the sacredness of the area has religious values that must be respected and protected as a fundamental manifestation of a traditional belief, spirituality, and specific philosophical values of the local culture.

Although traditional conservation areas have several roles, functions, and advantages, these areas also have drawbacks, weaknesses, and threats, namely as follows:

- (a) These areas have no legal recognition from the government and society in general. The ecological and economic benefits shown have not been considered important and are not integrated with government policies, especially those regarding conservation areas. In addition, these areas are under pressure, which some people consider ancient and unscientific.
- (b) The secrecy of the sacredness of traditional conservation areas is one of the weaknesses of the value of these areas to be recognized and understood by other communities.
- (c) The selection of traditional conservation areas is arbitrary and does not follow a systematic procedure in determining conservation areas for biological resources.
- (d) Some of the traditional conservation areas are artificial ecosystems and not always pristine areas.
- (e) The dynamic changes in human culture due to the level of education, technology, modernization, and other cultural interventions may cause changes in views of local beliefs, especially concerning the management of biological resources.
- (f) Management of biological resources that is more oriented towards economy results in reducing the value of the interests of traditional conservation areas.
- (g) When ecological knowledge is applied to traditional conservation areas, the study and analysis of traditional knowledge about ecology are only viewed from a

scientific aspect based on the point of view of western knowledge so that the spiritual value loses its sacredness.

Local conservation systems that are linked to religious views and local beliefs are more respected and valued than formal conservation systems. Local communities in Indonesia have high respect for matters of a religious nature so that it is common that sacred places are still less disturbed than other conservation places that are not sacred. However, the factor that makes local conservation areas more secure is that the community as a whole takes part in protecting them and feels they possess them. In addition, the belief that violating the area will be subject to customary or social sanctions is psychologically very embarrassing for the offenders and their descendants. Therefore, violations against the areas are highly avoided (Purwanto, 1998; Purwanto et al., 2004; Purwanto and Munawaroh, 2008; Soedjito et al., 2010). The problems faced by the existence of social norms that protect natural resources are subject to various inevitable pressures that can undermine the public belief system. These pressures include population growth, agricultural expansion, technology transfer, cultural transformation, education, and knowledge system intervention that comes from outside.

Efforts that need to be carried out so that the aforementioned local conservation areas remain sustainable are as follows.

- a) There must be a recognition concerning customary rights over the area as the property of the local community.
- b) Government must support those areas through policies that strengthen the status of local conservation areas as protected areas.
- c) Spatial planning programs must support the protection of those local conservation areas.
- d) There must support from scientific data that those areas have ecological, socio-cultural, and socio-economic values.

(3) Traditional conservation of germplasm of cultivated plants for future breeding programs

Agricultural experts and conservation biologists should thank traditional farmers who have an important role in managing and maintaining a diverse source of germplasm. The richness of these cultivars is a genetic source that can be exploited in future breeding. It will be a great work if biotechnology is able to bridge the formation of new species, which are the recombination of beneficial gene traits from various local cultivars.

In an effort to preserve local plant species that have certain advantages, *ex-situ* and *in-situ* conservation efforts are required. This conservation effort provides benefits for breeders and is needed as genetic source material to find species that possess superiorities.

THE NEGLECTED BIODIVERSITY AND CULTURAL DIVERSITY POTENTIALS

Indonesia has abundant biodiversity, not only flora and fauna but also ethnicity and culture. Indonesia is one of the megadiversity areas possessing 10% of flowering plant species in the world and around 47 ecosystem types. Although the area of Indonesia is only 1.3% of the earth's surface, more than 12% of the types of living things on earth can be found in Indonesia (Rifai, 1998; 2002). It is estimated that Indonesia has about 3,000 species of plants useful as foodstuffs from 200,000 types of plants and about 200 of them have been domesticated into cultivated

plants. However, only four species are the main foodstuffs for the world's population, namely wheat, rice, maize, and potatoes (Hawkes, 1983).

The wealth of biological resources is the basic capital for Indonesian national development, which is very strategic and is an ecological comparative advantage (Rifai, 1998). Even though Indonesia is rich in biodiversity and culture, in reality, Indonesia is still lagging behind other countries in developing these biological resources. It is because Indonesian people are less concerned with exploring the potential, use-value, and future prospects of the rich biodiversity that they have. Biodiversity is green gold, which is an alternative for Indonesian people to emerge from a multi-dimensional crisis (Sukara, 2003). However, its people currently still neglect, ignore, and even forget about it.

To date, Indonesian people still ignore their local knowledge developed by their ancestors since hundreds of years ago. In essence, a lot of local knowledge and technology is very useful and scientifically proven. For example, the sweet potato cultivation technique from the Dani tribe in the Baliem Valley is agronomically advanced, compared to the sweet potato cultivation technique possessed by other ethnic groups in Indonesia (Purwanto, 1997). They are able to develop sweet potato cultivation techniques that are adapted to three different types of ecosystems, namely swamps, flat land areas, and mountains. Furthermore, each of these cultivation techniques can be agronomically accounted for (Purwanto, 1997). Other examples are the Dayak Kenyah community having an area conservation strategy called '*tanah ulen*' (Purwanto, 2002; Soedjito, 2009); the Krui community in Lampung with the '*agroforestry damar*' system (Michon *et al.*, 1995), and the Dayak community in East Kalimantan with a '*lembo*' agroforestry system (Sardjono *et al.*, 2003). The local knowledge of the aforementioned communities has a conservation, socio-economic, and cultural function.

To catch up in the development of biological resources, Indonesia needs a specific policy concerning the development of indigenous Indonesian plant species that are intact and sustainable as an effort to develop rural farming communities. For this reason, granting autonomy rights to the regional government to develop their wealth of potential biodiversity that is tailored to local characteristics, needs, and wisdom can provide opportunities for local communities to develop superior local species they have. However, facts in the field show that the policy of introducing new types of cultivated plants has resulted in the extinction of local cultivated plant species. Furthermore, the results of studies in several local community groups, such as the Dayak Kenyah community in East Kalimantan, the Badui community in Banten, the Kajang community in South Sulawesi, and the Kasepuhan community in West Java, which have autonomy in managing living natural resources, indicate that those community groups are able to provide their daily needs.

There are four advantages of granting special autonomy in the management of biological resources: (1) making local communities more independent from the introduction of superior species, (2) reviving local power in the management of biological resources, (3) reducing development uniformity by considering aspects of the adaptation strategy of local communities based on different biophysical conditions, and (4) conserving the diversity of useful and potential plant species. Therefore, the development of biodiversity will be rooted in local wisdom that leads to optimal utilization and sustainability at the same time.

The role of ethnobiological studies is very important as the spearhead in identifying the species diversity and local cultivars of cultivated plants that are possessed by each community or ethnic group in Indonesia. The results of the ethnobiological studies in the Mukoko community (Walujo, 2008) and the Dani tribe in the Baliem Valley (Purwanto, 1997) are able to reveal the species diversity and local cultivars in those respected areas. More than 100 local cultivars of sweet potato (*Ipomoea batatas*), 15 local cultivars of banana (*Musa* spp.), eight local cultivars of sugarcane (*Saccharum officinarum*), 22 local cultivars of taro (*Colocasia esculenta*), five local cultivars of lesser yam (*Dioscorea esculenta*), four local cultivars of red fruit (*Pandanus conoideus*) which are suspected having 33 local cultivars throughout Papua, and others cultivars have been recorded. In essence, there are many other types and local cultivars that are possessed by Indonesian. All of them are sources of germplasm that can become capital for the development towards the creation of new cultivars that have higher quality and are more profitable both economically and ecologically.

The main factor that causes changes in the existence of biodiversity on earth in the present day is human activity. Human activities can influence conditions globally, regionally, and locally (Barbault, 1993). Globally, it can cause very unpredictable climate change. Regionally, it causes changes in the ecosystem and population dynamics. Furthermore, locally, it causes environmental damage, the formation of new environmental units, and degradation of biological resources because the way they are managed does not respect the principles of ecosystem balance.

Related to the aforementioned above, six main aspects must be considered in handling biodiversity, namely as follows:

- a) Use-value and its potential. Indonesia has biodiversity richness that possesses high economic value and has not been developed optimally, for example, Dragon's blood rattan (*Daemonorops* spp.), Sumatra benzoin (*Styrax* spp.), agarwood (*Aquilaria* spp.), cinnamon (*Cinnamomum* spp.), tengkawang oil (*Shorea* spp.), Amboyna pine (*Agathis* spp.), *Eurycoma latifolia*, and others (Purwanto *et al.*, 1999; Munawaroh and Purwanto, 2009).
- b) Research and development. This aims to increase use-value and refers to sustainable use that is economically profitable. For this reason, the implementation must begin with the determination of the priority scale: (1) related to ecology, such as peculiarities, uniqueness, endemcity, and threatened status (extinction), (2) related to the use-value, potential, and benefits, and (3) related to science and technology.
- c) Biodiversity conservation. To date, the adoption of western concepts regarding the conservation of biodiversity and its habitats, such as national parks, wildlife reserves, protected forests, and nature reserves, has not guaranteed the preservation of the nature contained therein. For this reason, the implementation of the concept of biosphere reserves in managing an area through an ecosystem approach for conservation purposes and sustainable fair use must be realized immediately (Kartawinata *et al.*, 1981; Purwanto and Sukara, 2009; Soedjito, 2004).
- d) Quality of human resources. Efforts to improve the quality of human resources through appropriate knowledge building are absolutely necessary to transform society from being characterized as 'unskilled and natural resources-based' to be 'skilled labor and knowledge incentives' by utilizing the support of strong research institutions (Sukara, 2003). The mastery of science and technology is an asset to utilize, study, and conserve

biodiversity. According to Rifai (2002), biodiversity education specifically needs a new paradigm. It is no longer enough for people to only study classical theories of biology. What people need is to investigate biodiversity with multidisciplinary studies. Therefore, their studies are able to solve biological problems with science and technology that are more efficient, profitable, and more grounded based on the richness of biodiversity and the cultural diversity which become the advantages of Indonesia.

- e) Institutionally. The abundant and potential biodiversity wealth possessed by Indonesia needs to be managed by an institution that has the ability to develop this wealth to become the capital for the development of Indonesia. An institution will be strong if it has an institutional form that suits its needs, has a good program and a legal aspect.
- f) Legal aspects. Legal aspects that provide support and are not a limitation in the management and development of biodiversity are highly needed.

PROBLEMS IN MANAGING THE DIVERSITY OF NATURAL RESOURCES AND ECOSYSTEMS

Essentially, Indonesia faces three big problems in developing biodiversity, the richness of the nation's noble traditions and culture, the superiority of fertile volcanic lands, abundant sunlight, and the strategic geographical location: political constraints, investment constraints, and mastery of science and technology constraints. Government policies that have not put the management and development of biodiversity as a priority are one of the major problems in addition to limited investment activities and insufficient mastery of knowledge and technology in developing the richness of these natural resources. In more detail, the current problems Indonesia faces in the management and development of biodiversity are described in the following.

(1) Socio-cultural aspects

One of the socio-cultural aspects is people's behavior in considering the biodiversity in their surroundings. Rifai (2002) called it a 'cultural barrier', in which people always want to get fast results without going through a long process and taking into account the long-term disadvantages and benefits. Communities tend to have behaviors that do not respect the richness of their biodiversity so that they carry out various illegal activities that may cause changes in the ecosystem (such as encroachment, conversion, fragmentation, fires, etc.). Changing the way of life is also one of the challenges in the management and development of biodiversity.

(2) Limitations and the ignorance towards science and technology

The culture to rely on science and technology has not yet penetrated the lives of Indonesian people (Rifai, 2002). Furthermore, the limited science and technology mastery has become a barrier to the development of biodiversity. The ignorance of science and technology in the management of natural resources and ecosystems does not only occur at the lower strata of society but also occurs at almost all levels of life. All these phenomena occur because of the low level of education and the level of life of the community so that the interest in fulfilling the necessities of life is a top priority. Besides that, some people in rural areas still depend on the availability of natural resources in their surroundings.

(3) Weak institutions

To date, it is not clear whom and which institutions are responsible for biodiversity. Therefore, there are often conflicts of interest between sectors in dealing with natural resource

management. The institutions that manage biodiversity need to be reorganized so that they can provide a strong management basis in order to continue to increase the added value of the richness of the biological resources.

(4) Spatial arrangement

Spatial planning is one of the main keys in the management of an area so that the arrangement of spatial planning must be based on its designation and through scientific studies. If it is conducted well, it will be the key to the successful management of biological resources and ecosystems. The main problem Indonesia faces regarding spatial management is the inability to compile a good spatial plan according to its potential, designation, and sustainability rules. One of the indications is that the spatial planning arrangement has not been going well so far and there are still overlapping interests. Such conditions may cause damage to biological resources and their ecosystems.

(5) Inaccurate determination of research priorities and development concerning biodiversity

Studies on biodiversity have not received institutional and cultural support so that the implementation of biodiversity research has been delayed. In addition, the planning of research and development activities for biological resource diversity has not been integrated so that the results are not useful for outlining national policies. Indonesia has never prioritized the development and research on certain plant species that have the potential to be the superior species. Indonesia is still struggling with the development of major food crops, such as rice, and secondary crops, such as corn, soybeans, and cassava. Indonesia has not yet developed other main types of plants, such as sago, taro, and tubers, which are abundant and are the main food of some people in Indonesia. Relying on one type of main food, such as rice, is very dangerous when supplies are reduced and people think that food is not available in sufficient quantities. If it happens, then catastrophe may come at any time. Indonesia should take advantage of the leap forward in the field of biotechnology, which has proven that biological resources are chemical and gene libraries that have great potential in bioprospecting for agriculture and health (Sukara, 2003).

(6) Misperceptions and misconceptions about biodiversity

The richness of biological resources is seen as a mere source of income (economic aspect) so that it is explored and exploited on a large scale without considering its consequences. Indonesia should consider biological resources as capital that must be developed to obtain optimal and sustainable benefits. Biological resources have an important role and high competitiveness because other nations do not have them. Only with a simple touch of technology, biological resources can be developed to contribute as a source of food and business capital (Sukara, 2003).

(7) Policy fragmentation and inability to manage biological resources

If we trace recent natural disasters, especially floods, landslides, drought, coastal abrasion, degradation of biological resources, and others, in various regions in Indonesia, the main cause is that Indonesian people are unable to manage biological and natural resources and do not apply the principles of ecosystem balance. For example, in the forestry sector, management of forest areas through Indonesia's Basic Forestry Law (Law No. 5/1967) allows a person to be able to exploit and extract forest resources through the mechanism of granting Forest

Concession Rights. The granting of exploitation rights for forest resources, especially timber, has neglected the rights of local communities to gain access and economic benefits from forests. This policy has also led to an increase in the deforestation of millions of hectares of natural forests (Wiradi, 2000). Likewise, in the agricultural sector, the policy of implementing a monoculture, homogeneous, uniform system using new cultivars that are responsive to fertilizers and pesticides only benefits several concerned parties and, on the contrary, marginalizes traditional farmers. This policy has significantly contributed to the destruction of nature, the dwarfing of traditional systems, and the ignorance of cultures that are developed based on the wisdom of local communities from generation to generation for centuries (Sukara, 2003).

(8) Enforcement of certification

Certifications designed and standardized by developed countries have put Indonesian people in chains. This certification is proof of Indonesian people's carelessness that is not able to make their own standards. For example, meranti (*Shorea* spp.), which has 160 species, is only divided into three types: red meranti, yellow meranti, and white meranti. In fact, each species has its characteristics and qualities that can be used as a basis for determining prices. No one has researched this subject so that Indonesian people only accept the price set by the buyer, as a result, they experience large losses.

The certification with special standards made by developed countries is actually aimed at strengthening the competitiveness of their products so that Indonesian people will not be able to fulfill the criteria of the certification. As a result, Indonesian people will not be able to export biodiversity products to developed countries, such as the United States and European countries (France, Germany, England, Italy, and others) because of these certification standards.

(9) Climate change (climatic variable)

Global climate change has a major influence on the management of biological resources and ecosystems so that a strategy is needed to deal with climate change, both adaptation and mitigation strategies. Climate change has significantly affected the sustainability and management of biodiversity. For example, changes in the climatic variable, such as drought, have caused a decline in the production of several species of plantation and food crops around the Lore Lindu biosphere reserve area (Purwanto, 2011). Likewise, climate change has made it difficult to determine marine navigation for traditional fishermen.

INTEGRATION OF ETHNOBIOLOGY IN THE FUTURE BIODIVERSITY MANAGEMENT

People who live in rural areas have the confidence to fulfill their necessities from the surrounding environment. The ethnobiological knowledge of the community has the role of expressing the potential, benefits, and possibilities of developing biological resources and their ecosystems for the future welfare of the community through the sustainable use of biodiversity. The disclosure of community production systems in several ecotones, such as yards, rice fields, horticultural gardens, mixed gardens, agroforestry, coffee and cacao gardens, secondary forests, and primary forests, is highly needed. The disclosure of rice field production activities as an agricultural system can be carried out by inserting potential plant species. Community yards as an agro-silvicultural system can be conducted by developing a combination of agricultural plant species and forest tree species. Mixed gardens (coffee and cocoa gardens) can be developed using the concept of agro-silviculture by inserting NTFP plants that have the

potential to be developed, resulting in coffee and cocoa gardens can become the main commodities of the local community. Coffee and cocoa crops can generate economic income. Therefore, this mixed garden will provide economic value with fruit-producing plants as food. The disclosure of the advantages of local technology can strengthen efforts to use natural resources in a balanced manner for the economy and the ecology. In general, proving local knowledge and wisdom has a high beneficial value because it can be directly felt by the community.

The disclosure of knowledge related to production activities developed by the community through ethnobiological studies not only provides benefits but also reveals the level of knowledge and culture of the community in managing their biodiversity richness.

Ethnobiological studies related to the disclosure of natural and anthropic environmental units show scientifically the benefits for the community as providers of their daily necessities, such as food, medicinal materials, clothing, dyes, building materials, and others. Likewise, the disclosure of the value of natural environment units, such as customary forests, can reveal its economic, social, religious, and cultural values. The disclosure of these values has positive consequences for sustainable management. The disclosure of agroforestry systems developed by communities through ethnobiological studies can reveal the values of agroforestry systems related to economic, ecological, knowledge, and technology enhancement and innovation.

The disclosure of ethnobiological knowledge possessed by the community can be used as a standard for the success of management and conservation activities of biological resources and the ecosystems. The role of the community knowledge in utilizing and managing biodiversity can provide great benefits in sustainably managing biodiversity.

The disclosure of community roles, knowledge, and local wisdom can help efforts to conserve biodiversity in the area where the community resides. Local knowledge and wisdom are equivalent to the existence of biodiversity in the area. If the local community knowledge decreases, the existing biodiversity will also decrease. The use of technology and the utilization and management of biological resources can affect the preservation of biodiversity. However, if science and technology are used excessively, their utilization and management will affect the preservation of biodiversity. For example, the development of monoculture cultivation has eliminated local species and cultivars from the surface of the earth. The loss of this genetic resource is a permanent loss of the source of germplasm for the development of selection and breeding to gain excellence into the future.

Through ethnobiology studies, the community will gain a synergistic system for the use and management of biological resources based on local knowledge by minimizing existing conflicts. These studies can reveal the customary institutions and social institutions of the community that serves as policymakers in the management and development of biological resources and the environment for the future generation. Strong biodiversity management institutions at the local, regional, and national levels can increase the use-value and sustainability of biological resources and their ecosystems.

Efforts to conserve and address biodiversity need to include the opinions, needs, and knowledge of local communities. In this phase, the relationship between ethnobiology

researchers, local communities, and stakeholders in the area cannot be avoided because local knowledge and wisdom, society, and every aspect of the network need to contribute specifically to achieving sustainable management. At the academic level, the study of pure ethnobiology should be included in broader disciplinary research (transdisciplinary) and brings together as many natural and social science disciplines as possible to provide a solid basis for its implementation. The study for the disclosure of community knowledge (ethnobiology) to strengthen the main findings of such ethnobiological studies must be accessible in local languages. Only management and conservation actions that are based on such an integrated strategy can last in the long term.

Ethnobiological studies are needed to explore the potential for biodiversity to be used for utilization and development purposes. Unsustainable use of biodiversity, such as those obtained from wild sources, can lead to a serious population decline of biological resources. Therefore, it is advisable to formulate management, development, and cultivation techniques, especially for the important species of biological resources that can be widely utilized and traded internationally. Ethnobiological knowledge discussed in this study belongs to the community so that the benefits obtained from this knowledge must be developed for the interest of the community.

CONCLUSIONS

1. Ethnobiology has the following roles: (a) providing basic data on the utilization of biodiversity for local communities for further development, (b) providing scientific support to increase the competitiveness of local products, (c) presenting local superior products to be meaningful at the national level, (d) proving scientifically the concept of local conservation in order to improve the biodiversity conservation system and environmental functions, (e) taking an active role in safeguarding the ability of the intellectual property rights of local communities, (f) being the spearhead in scientifically proving useful local knowledge, (g) providing baseline data for policies on the management of biological resources that are economically, ecologically, and culturally beneficial, (h) taking part in preserving the culture of the Indonesian people through documentation of local knowledge of the community in managing biological resources, and (i) improving the capacity and quality of human resources.
2. Granting the regional government autonomy to manage biodiversity can provide opportunities for local communities to develop their superior local species. There are four things that can be gained from the implementation of autonomy in the management of biological resources, namely (1) making local communities more independent from the introduction of superior species, (2) reviving local power in the management of biological resources, (3) reducing development uniformity by considering aspects of the adaptation strategy of local communities based on different biophysical conditions, and (4) conserving the diversity of useful and potential plant species.
3. The biodiversity that Indonesia possesses has benefits that cover three main dimensions, namely (1) the ecological dimension, (2) economic dimension, and (3) ethical dimensions. In these three dimensions, ethnobiology shows its roles and potentials in the management of biodiversity.
4. The traditional conservation concept applied by the Indonesian people, if being examined more deeply, has advantages and can be scientifically justified, including (a) having high conservation value, (b) being a model for the management of an area, (c)

- being protection and safeguarding of local knowledge, (d) being a cultural manifestation and cultural diversity, (e) serving as eco-tourism, and (f) having sacred values.
5. The potentials, roles, and application of ethnobiological data cover three aspects, namely (1) bio-economy, (2) ecology, and (3) ethics.
 6. Ethnobiological studies must be able to bridge the management and development of biodiversity in a sustainable manner in order to increase national prosperity and development.

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