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Review Article

MICROBIAL DIVERSITY AND ITS IMPORTANCE IN MICROBIAL GENETIC RESOURCES PRESERVATION AND ITS ROLE IN NATURAL

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ABSTRACT

Biodiversity has been very common to almost every one. However, a comprehensive understanding on the concept of biodiversity might be less common to many discussing parties. Likewise, microbial diversity is even less common to most of academician, ex-cept of course to microbiologists. In fact, a correct and clear concept of biodiversity is prerequisite for serious and appropriate discussion of the matter. In this paper, the concept and understanding of microbial diversity is fundamentally described as well as their genetic potential by reviewing the development and application of species concept based on molecular biological approach. It is an undeniable fact that molecular biology has provided a powerful tool for microbiologists as well as evolutionists to unravel the biodiversity of microbial world which play a paramount important to conserve the basic function of any natural environments in the biosphere since microbes live and flourish in all ecosystems, including extreme habitats. The ubiquity of microbes clearly underpins by their diversity, including physiological and metabolic diversity, ability to live in anaerobic environments, and their small size. Molecular biology development and application in microbiology have transformed the three areas in microbiology, namely microbial ecology, microbial diversity, and microbial evolution from weakness into the strength, in unraveling and understanding microbial diversity and its genetic potential as well as its role in nature, especially their role to keep work the biogeochemical cycle in the Earth. Only by having an adequate understanding of microbial critical role in preserving nature that the environmental conservation issue could be carried out, understood and realized meaningfully.

Keywords: *microbial diversity, microbial genetic resources, natural environment*

INTRODUCTION

Biodiversity term refers to 3 level of diversity according to The World Conser-vation Centre, they are genetic diversity, species diversity, and ecological diversity (Anonymous, 1992). Genetic diversity refers to genetic variations of individual unit in a species. Species diversity is the number of different species in a community. Ecological diversity refers to the number of community in an ecosystem (Norse et al., 1986; Harper & Hawksworth, 1994; Sands, 1994). Study about microbes including archaebacteria, eubacteria, fungi, algae, and virus called as microbial diversity.

Ecological value of microbial diversity correlates to earth living system balance (Lovelock, 1988; Stolz et al., 1989; Trüper 1992). Microbial abundance on nature supports ecological processes continuance such as photosynthesis. Microbial diversity role on terrestrial ecosystem has not clearly revealed yet, although its role on pyramid power has already known. Microbial has important role on plant development in agriculture (Stolz et al., 1989; Hawksworth, 1991; Trüper, 1992; Bull et al, 2000). Whereas the important role of microbes has known, it was only small fraction which has been identified and described on species diversity (Table 1).

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THE DISAPPEARANCE OF MICROBIAL DIVERSITY

Microbial preservation through in situ and ex situ

Ecosystem destruction, ecosystem conversion, and decreasing of ecological function threaten the preservation of biodiversity and can cause biodiversity disappearance. Error management of the environment often occur such as chemical contamination, overexploitation of natural resources, and physical intervention on natural environment that cause change in land and water usage (Bull et al., 1992).

The estimation found that a quarter or half of biodiversity will extinct in about year 2030 if the destruction of ecosystem keep happening (Myers, 1979; Ehrlich & Ehrlich, 1981; Anonymous, 1992; Wilson & Peter, 1988; McNeely et al., 1990; Anonymous, 1992; Wilson, 1992). The extinction of microbe report is rarely because of least evidence. One of the reports from Indonesia study show that the extinction of *Penicilliopsis clavariaevormis* mold from Bogor Botanical Garden has correlation to the extinction of its host. The extinction of some mold species in Europe also has been reported by Jeanike (1991). There is possibility that some of microbe groups can adapt to their environmental changes, but for endemic microbes which have specific host probably unable to resist the changes. It make the endemic microbes threatened with extinction (Bull et al., 1992; Bull et al., 2000; Lovejoy, 1994).

Table 1. The number of species of each taxa

Group	Number of described species	Estimated number of species	Percentage of known species (%)
Microbes			
Fungi	72 000	1 500 000	5
Prokaryotes	4 760	40 000 to 3 500 000	0.1 to 12
Protozoa	40 000	100 000	40
Viruses	5 000	130 000	4
Plants			
Algae	40 000	60 000	67
Moss & liverworts	17 000	25 000	68
Ferns	10 000	-	-
Dicotyledons	170 000	-	-
Monocotyledons	50 000	-	-
Animals			
Nematodes	15 000	500 000	3
Insects	800 000	2 to 80 millions or	1 to 40
		5 to 10 millions	8 to 16
Fish	19 000	21 000	90
Amphibians & reptiles	9 000	9 500	95
Birds	9 000	9 100	ca. 100
Mammals	4 000	4 000	ca. 100

*Stork (1988), Wilson (1988), Hawksworth (1991), dan Bull et al. (1992, 2000).

Tropical rain forest has high biodiversity index both of in flora and fauna (Myers, 1988, 1990). For fact, tropical rainforest has high microbe diversity according to its function such as provide organic matter sustainability, complex organic matter decomposition (resin, lignin, phenolic compound, and xenobiotic compound), while the information of it still least (Hawksworth et al., 1994). It has already known that there is huge destruction of tropical rainforest by farming activities, land conversion, logging, and mining (Myers, 1989, 1991; Sayer & Whitmore, 1991). The rapid destruction process must be stopped for natural environment conservation with high index of endemic organism (Myers, 1988, 1990; Anonymous, 1991; Bibby et al., 1992; Bull et al., 2000).

Biodiversity disappearance causes the reduction of genetic diversity in global gene pool. It will affect significantly on earth living system. Microbial gene variation contributes on the gene pool and has important role in ecosystem that cause microbe conservation need to do (Bull et al., 1992, 2000; Hawksworth & Colwell, 1992; Zed-an, 1993). Microbial conservation through ex situ is hard to do (Bull et al., 1992, 2000). One of traditional method of microbe conservation is culture collection, while taxa of isolated microbes are in high number but the laboratory capacity is limited (Table 2). Because of least capacity of microbe genetic variation which can be conserved, it will need continuity of conservation through both of ex situ and in situ (Wilson, 1992; Bull et al.,1992, 2000).

MOLECULAR BIOLOGY ON MICROBIAL DIVERSITY

The important role of molecular biology on microbial diversity study and its ge-netic potentials

Species number of microbe on an ecosystem represents the species diversity. The term of species in microbial systematic is not simple and controversy (Goodfellow & O'Donnell, 1993; Claridge & Boddy, 1994; O'Donnell et al., 1994; Vandamme et al., 1996; Brasier, 1997; Goodfellow et al., 1997b). Species definition refers to monothematic classification according to some certain phenotypic characters which chosen subjectively. This classification system has weakness if used for microbial classification because of many variations of microbial strains with special characters which sometime difficult to be identified. (Goodfellow & O'Donnell, 1993; O'Donnell et al., 1994; Goodfellow et al., 1997a). Taxonomical status of Bacillaceae represesnt underspeciated group and Enterobacteriaceae taxonomical status represents over-speciated group (Rainey et al., 1993; White et al., 1993). Enterobacteriaceae has been classifies into some genera, such as *Escherichia coli* and *Shigella sp*. (Brenner et al., 1972, 1973; Brenner, 1984). It should be emphasized that species term is unique because it is the only one taxon hierarchy.

Species term in bacteriology not clearly described yet. Species term usage is to differentiate some bacteria strains with high similarities into taxospecies, bacteria strains with genetic exchange ability into genospecies levels, and bacteria strains with similar score of DNA relatedness into genomic species (Ravin, 1961; Wayne et al., 1987; Sneath, 1989). The concept of species has known as nomenspecies concept (Sneath, 1989).

Subjective traditional concept of species described by Cowan (1978) as a group of organisms defined more or less subjectively by criteria chosen by the taxonomist to show to best advantage and as far as possible put into practice his individual concept of what a species is. Molecular biology development has contributed on fundamental definition of species which more objective.

DNA relatedness approach is basic concept of phylogenetic introduced by Wayne et al (1987) which described that phylogenetic definition of a species generally would include strains with approaximately 70% or greater DNA-DNA relatedness and with 5°C or less Tm. Both values must be considered. DNA relatedness score often considered as the gold standard for the circumscription of bacterial species even it has to be evaluated using other taxonomical methods. Nowadays, novel bacterial taxa are recommended to be identified through both of phenotypic and genotypic methods called as polyphasic (Wayne et al., 1987; Murray et al, 1990). Polyphasic identification method is introduced by Colwell (1970). Polyphasic systematic is expected can be better tool to identified taxa and nomenclature (Goodfellow et al., 1997a, 1999).

Table 2. Identified microbes compare to culture collection

Group	Number of species		Material held in culture collections		
	Known	Estimated	Total number	Known species (%)	Estimated Species (%)
Algae	40 000	60 000	1 600	4	3
Fungi	72 000	1 500 000	11 500	16	1
Prokaryotes	4 760	40 000 - 3 500 000	2 300	48	1 - 6
Viruses	5 000	130 000	2 200	44	2

*(Nisbet & Fox, 1991)

The development of Information and Communication Technology (ICT) pro-vides rapid data acquisition systems and improved data handling procedures (Canhos and Manfio 2000; Vandamme et al., 1996; Goodfellow et al., 1997b). Polyphasic identification method has been used widely, but nowadays researchers tend to choose what they really interest in. Identification of 16S ribosomal RNA through sequencing is a method to identify the suprageneric correlation between bacteria taxa, but it will not effective to identify taxa below genus (Goodfellow et al., 1997b, 1999).

However, recent studies revealed that this method is also can be used to identify correlation in species and infrasubspecific levels of some bacteria in Indonesia. These studies investigate the microbial diversity and its potentials. These studies involve the investigation of association between streptomyces with rizhosphere in *Albizia chinensis* plant, endophytic and diazotrophic on sugarcane, detergent degrading bacteria, identification of Bacillus thuringensis strains, cellulose producing bacteria, lactic acid bacteria in bakasang fermentation, and polyhydroxybutyrate (PHB) producing bacteria as basic material of biodegradable plastic (Sembiring et al., 2009; Sembiring, 2012; Widayati et al., 2006; Suharjono et al., 2008; Salaki & Sembiring, 2009; Sembiring et al., 2012; Lawalata et al., 2011; Yanti et al., 2013). On the contrary, DNA hybridization method, molecular fingerprinting, and phenotypic procedures are considered to be more effective in microbial taxa classification in species and infrasubspecific levels (Stackebrandt & Goebel, 1994; Wayne et al., 1996; Goofellow et al., 2007).

MICROBIAL DIVERSITY VALUE

The Important Value of Microbial Diversity on Natural Environment Conservation

Microbial existence in everywhere and whenever (ubiquity) caused by its phys-iological diversity. Different live survival ability allows microbes in their habitat with relative small space. There are 3 fields of study in microbiology because of the advancement and application of molecular biology, they are microbial ecology, microbial diversity, and microbial evolution. Before that, these field studies are weak points of microbiology but now they can be used as main field to reveal microbial diversity and microbial roles in nature, especially microbial role in biogeochemical pathways in earth (Woese, 2002).

Global warming is becoming a global issue lately because it related to natural function of ecosystem to maintain the natural elements transformation, especially carbon. Carbon has significant role in nature which related to biogeochemical cycles in nature or carbon cycle. Microbial diversity has an important role to keep these cycles occur. Wide range of microbial habitat allow them to survive and take role in those cycles. Microbes naturally can be found as anaerobic, psycrophylic, thermopy-lic, acidophilic, halophylic, and barophilic on their habitat. Otherwise, they are also can be found associated with other organism such as rhizosphere, phyloplane, endophytic, lichens, fish lighy organs, and gastroistestinal in animal and human.

Microbial role in biogeochemical cycles are wide, they are found has role in cycle of carbon, nitrogen, oxygen, hydrogen, phosphor, and sulphur (Staley, 2002). Carbon cycle starts with the transformation of organic carbon into anorganic carbon (CO2) which need role of some bacteria groups. Anorganic carbon will be transformed back into organic form through fixation process in photosynthesis.

Generally, microbial roles in biogeochemical cycles are organic matter decom-position an biosynthesis. Without microbial role, carbon cycle will not take place. Natural function of biogeochemical pathways are to maintain the earth living system through maintaining the energy flow and material cycle in natural ecosystem.

CONCLUSION

Microbial diversity has an important role in natural environment. The devel-opment of molecular biology has improved the microbiology field study, such as mi-crobial ecology, microbial diversity, and microbial evolution. Microbial diversity is closely related to ecosystem function also it represents gene pool. The other function of microbial diversity is maintaining the biogeochemical cycles in nature.

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