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The Islamic perspective on actinomycetes bacteria's role in mangrove ecosystem

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ABSTRACT

On the coast of Langge Village, Anggrek Subdistrict, North Gorontalo Regency, there is a mangrove forest covering an area of approximately 1,441.04 hectares, accounting for 5.29% of the total 27,218.79 hectares. Actinomycetes are heterotrophic bacteria crucial in decomposing mangrove leaf litter into organic matter. These bacteria are capable of oxidizing ammonia or nitrogen into nitrites or nitrates. They also serve as a source of nutrition in the mangrove ecosystem and help maintain the balance of aquatic organisms and marine ecosystems. The results found that the highest number of Actinomycetes bacteria were found in Rhizopora mucronata with a density of 4.1X102 CFU/g on stems, 4.0X10 CFU/gr on roots, and 1.0X10 CFU/gr on the soil. Thus, the higher the IVI value, the greater the amount of leaf litter, and the higher the leaf litter production, the higher the density of decomposing microorganisms, in this case, the Actinomycetes bacteria. In addition, the greater the number of decomposing bacteria, the more stable the mangrove ecosystem becomes. Allah did not create everything in vain, even for the billions of planets in the universe. In the past, humans were only aware of the macroscopic creatures. However, with the development of science and the invention of the microscope, humans began to recognize tiny invisible creatures. This study found several Quranic verses that examine the smallest creatures (microorganisms), such as the word *zarrah* in Surah Saba' verse 22, and the word *dabbah* in Surah Al Baqarah verse 164 and Hud verse 6, al Jathiyah verse 4, and Al Anam verse 38 Thus, the Qur'an has indicated the existence of other creatures on earth whose life cannot be seen by the naked eye, yet they provide benefits to other creatures.

Keywords: Mangroves, bacteria; actinomycetes

1. INTRODUCTION

Allah outlined man's destiny on earth for the first time by providing all the best facilities for all earth's inhabitants. Every living creature created by Allah SWT has a role in life, as stated in Surah Ali Imran verse 191.

> *"(They are) those who remember Allah while standing, sitting, and lying on their sides, and reflect on the creation of the heavens and the earth (and pray), 'Our Lord! You have not created (all of) this without purpose. Glory be to You! Protect us from the torment of the Fire." (*Surah Ali Imran Verse 191*).*

In this regard, mangrove forests have various functions: physical, chemical, biological, and socio-economic functions. The physical function of mangrove forests is to maintain the stability of the coastline, protect beaches and river cliffs from abrasion, reduce and withstand tsunami waves, and become a buffer area for the process of intrusion or seepage of seawater onto land. Chemically, mangrove forests function as a recycling process that produces oxygen, absorbs carbon dioxide, and is a processor of waste materials from industrial pollution and ships at sea. From a biological point of view, mangrove forests function as a result of weathering materials (decomposers), spawning ground or nursery ground for shrimp, crabs, shellfish, and the like. Furthermore, it also functions biologically as a refuge, nesting, and breeding area for birds and other animals, as a source of germplasm, and as a natural habitat for various types of other land and marine biota. Socio-economically, mangrove forests are producers of fuel, industrial raw materials, medicines, home furnishings, cosmetics, food, textiles, glue, tanneries, producers of fish seeds, shrimp, shellfish, and crabs, and are areas of tourism, conservation, education, and research (Saparioto, 2007).

A mangrove ecosystem is a natural system where life occurs that reflects the reciprocal relationship between living things in coastal areas and between living things and their environment. The system is affected by tides, is dominated by typical tree or shrub species, and can grow in salty or brackish waters (Sahoo et al., 2008).

In mangrove ecosystems, there are generally two types of food chains: direct and detritus food chains. In mangrove ecosystems, the food chain for aquatic biota is the detritus food chain. Litter that falls will undergo a decomposition process by microorganisms into detritus. The more litter produced in a mangrove area, the more detritus is produced. This detritus is a highly nutritious food source for various aquatic organisms (especially detritivores) that can be utilized by higher organisms (large fish, birds of prey, snakes, or humans) in the food web. One of the microorganisms that play a role in the detritus food chain is bacteria, which, in this discussion, is heterotrophic Actinomycetes bacteria. These bacteria can oxidize ammonia or nitrogen into nitrite or nitrate (Sylvia et al., 1990). These bacteria are also one of the providers of nutrient sources in the mangrove ecosystem and a balance maintainer for the life of aquatic organisms and marine ecosystems.

Gorontalo Province has an extensive mangrove area. One of them is located in the northern part of Gorontalo Province, precisely in the coastal area of Langge Village, Anggrek Subdistrict, North Gorontalo Regency. The mangrove forest in this area is at least ±1,441.04 Ha, or 5.29% of the total area of 27,218.79 Ha (Usman et al., 2013). Langge Village has an area of 573.45 Ha and a mangrove forest area of 40 Ha. Mangroves that grow in this area are *Rhyzophora mucronate, Bruguiera gymnorrhiza, Avicennia alba, Rhizophora apicolata, and Cariops Tagal.*

Langge Village has a large mangrove forest area in good condition and has not suffered significant damage. This condition is by data from the local Forestry, Mining, and Energy Service in 2015 that the area of mangrove forests reached 5,483.93 hectares, of which 2,484 hectares were severely damaged. In 2017, mangrove tracking tourist attractions began to be built in this area. Mangrove areas are generally environments rich in organic matter and are habitats supporting marine biota growth, including microorganisms. In mangrove ecosystems, bacteria are essential in reducing mangrove leaf litter into organic matter, a source of nutrition for organisms that inhabit mangrove forests (Zamroni & Rohyani, 2008; Mahmudin, 2010). Therefore, the high productivity of mangroves in an ecosystem depends on the activity of the decomposing bacteria.

2. METHODS

a. Method and Design

The research employed a qualitative descriptive method to provide a systematic, factual, and accurate description of the facts, characteristics, and relationships between the investigated phenomena. This research also used a normative theological approach that views knowledge from the science of divinity based on the Quran.

b. Data Source

Data were obtained from various literature, such as journals, articles, and scientific books.

1. Primary Data: Primary data were sourced from the Quran, tafsir books, and Actinomycetes isolation testing.
2. Secondary Data: Secondary data came from hadith books, journals, articles, and textbooks related to the research.

c. Testing Stages

1. Tools and Materials

a. Tools

The research employed the following tools: laminar airflow, oven, incubator, autoclave, erlenmeyer, mortar, micropipette, test tube, spectrophotometer, highperformance liquid chromatography (HPLC), centrifuge, shaker incubator, colony counter, vortex, ph-meter, salinometer, ose, microscope, slide, paper disk, Bunsen lamp, and camera.

b. Materials

The research used the following materials: rhizosphere sediments, stems and leaves of Rhizophora mucronata, Rhizophora stylosa, Avicennia marina, Soneratia alba, and Bruguiera sp, Starch Casein Agar medium, Nystatin, seawater, distilled water, 70% ethanol, purple violet, lugol, 90% alcohol, safranin, Escherichia coli, Staphylococcus aureus, Candida albicans, Nutrient Agar, Nutrient Broth, Streptomycin, and medium for fermentation.

2. Sample Testing

Samples for Actinomycetes isolation were obtained from rhizosphere sediments as well as roots, stems, and leaves of Rhizophora mucronata, Rhizophora stylosa, Avicennia marina, Soneratia alba, and Bruguiera sp. The sample is placed in a sterile vial and taken to the laboratory for further observation.

3. Sediment Physicochemical Measurement

Physicochemical measurements of sediment samples include pH and salinity.

4. Isolation and Observation of Actinomycetes Morphology

1) Rhizosphere sediment isolation

Actinomycetes were isolated from mangrove rhizosphere sediment samples by preparing a sample dilution series (Ravikumar et al., 2011). One gram of wet sediment sample was added to 5 ml of sterile seawater (10-1 dilution). Dilution was carried out up to a level of 10-4. From each dilution, 0.25 ml of sediment sample suspension was taken and planted on Starch Casein Agar medium using the surface method. The medium was supplemented with 25 µg.ml-1 of Nystatin to prevent fungal growth. It was then incubated at 28 0 C for 7 – 10 days.

2) Endophytic Actinomycetes Isolation

Samples of roots, stems, and leaves of Rhizophora mucronata, Rhizophora stylosa, Avicennia marina, Soneratia alba, and Bruguiera sp. were surface sterilized using 70% ethanol and dried in laminar airflow. The outer surface of the stem sample was removed using a sterile knife, and the inner tissue of the stem and leaf samples was smoothed using a sterile mortar. A series of dilutions were then carried out on the sample, which had been refined to 10-4. From each dilution, 0.25 ml of sample suspension was taken and implanted in Starch Casein Agar medium using the surface method. It was then incubated at 28oC for 7-10 days (Ravikumar et al., 2010).

3) Observation of microbial morphology

Actinomycetes colony morphology was studied by inoculating Actinomycetes isolates on a Nutrient Agar medium and incubating them at 27°C for seven days. The growing actinomycetes were observed using a microscope for their morphological characteristics, such as colony characteristics and cell morphology. The results were then documented as morphological data (Nanjwade et al., 2010). Observation of cell morphology was based on the staining method using gram staining.

d. Technique of Data Collection

The results of tests on Actinomycetes bacteria that play a role in the mangrove ecosystem are described based on an Islamic perspective according to the Quran and Tafsir books. In the next stage, the description is correlated with scientific explanations and current social conditions.

e. Technique of Data Analysis

Data were analyzed through the following procedure:

1) Describing data based on Islamic perspective in general.
2) Providing information about the verse or surah to be used.
3) Explaining the meaning of each verse to be used.
4) Explaining the correlation between research results with verses and science.
5) Analyzing the interpretation of the verses of the Quran.

3. RESULTS AND DISCUSSION

The observations showed various types of mangroves at each station, including *Rhizophora mucronata, Rhizophora apiculata, Sonneratia alba, Ceriops tagal, Avicennia lanata, Bruguiera gymnorrhiza, Ceriops decandra, Xilocarpus granatum*. Each mangrove species found has a varying IVI. The highest IVI value was found in *Rhizophora mucronata* at station I (176.06%), while the lowest IVI value was found in *Ceriops tagal* at station III (106.93%). Actinomycetes density was divided into mangrove ecosystems at three stations.

At Station I, Actinomycetes were successfully isolated from five mangrove stands: *Rhizophora mucronata, Rhizophora apiculata, Sonneratia alba, Ceriops tagal, and Avicennia lanata.*

Table 1. Actinomycetes Density in Mangrove Ecosystem Station I

No	Species	Organ	Dilution					TPC
			10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	(CFU/gr)
1	*Rhizophora mucronata*	Leaf	-	-	-	-	-	-
		Stem	41	-	-	-	-	$4,1X10^2$
		Root	4	-	-	-	-	$4,0X10^1$
		Soil	1	-	-	-	-	$1,0X10^1$
2	*Rhizophora apiculata*	Leaf	-	-	-	-	-	-
		Stem	-	-	-	-	-	-
		Root	-	-	-	-	-	-
		Soil	4,0	-	-	-	-	$4,0X10^2$
3	*Avicenia lanata*	Leaf	-	-	-	-	-	-
		Stem	-	-	-	-	-	-
		Root	14	-	-	-	-	$1,4X10^2$
		Soil	-	-	-	-	-	-
4	*Ceriops tagal*	Leaf	4	-	-	-	-	$4,0X10^1$
		Stem	-	-	-	-	-	-
		Root	-	-	-	-	-	-
		Soil	6	2	-	-	-	$6,0X10^1$
5	*Sonneratia alba*	Leaf	-	-	-	-	-	-
		Stem	2	-	-	-	-	$2,0X10^1$
		Root	-	-	-	-	-	-
		Soil	-	-	-	-	-	-

Table 1 shows the successful isolation of Actinomycetes bacteria in each species in soil, roots, stems, and leaves. Isolation of Actinomycetes bacteria from *Rhizophora mucronata* was successfully carried out on soil ($1,0X10^1$ CFU/gr), roots ($4,1X10^4$ CFU/gr), and stems ($4,1X10^4$ CFU/gr). Isolation of Actinomycetes bacteria from *Avicennia lanata* was successful on roots ($1,4X10^6$). Isolation of Actinomycetes bacteria from *Ceriops tagal* was successful in soil ($6,0X10^2$ CFU/gr) and leaves ($4,0X10^2$ CFU/gr). Isolation of Actinomycetes bacteria from *Rhizophora apiculata* was successful in soil (4.6 CFU/gr). Meanwhile, the species with the lowest Actinomyecetes density was *Sonneratia alba* ($2,0X10^1$ CFU/gr), which was successfully isolated from stems.

At station II, Actinomycetes was successfully isolated from seven mangrove stands: *Rhizopora mucronata, Rhizophora apiculata, Sonneratia alba, Bruguiera gymnorrhiza, Cerips tagal, Ceriops decandra, Avicennia lanata.*

Table 2. Actinomycetes Density in Mangrove Ecosystem Station II

No	Species	Organ	Dilution					TPC
			10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	(CFU/gr)
1	*Ceriops tagal*	Leaf	-	-	-	-	-	-
		Stem	-	-	-	-	-	-
		Root	5	-	-		-	$5,0X10^1$
		Soil	6	1	-	-	-	$6,0X10^1$

2	*Rhizophora mucronata*	Leaf	-	-	-	-	-	-
		Stem	26	-	-	-	-	$2,6X10^2$
		Root	-	-	-	-	-	-
		Soil	4	1	-	-	-	$4,0X10^1$
3	*Rhizophora apiculata*	Leaf	-	-	-	-	-	-
		Stem	2	-	-	-	-	$2,0X10^1$
		Root	-	-	-	-	-	-
		Soil	10	-	-	-	-	$1,0X10^1$
4	*Bruguiera gymnorrhiza*	Leaf	-	-	-	-	-	-
		Stem	-	-	-	-	-	-
		Root	6	2	-	-	-	$6,0X10^2$
		Soil	1	-	-	-	-	$1,0X10^1$
5	*Sonneratia alba*	Leaf	-	-	-	-	-	-
		Stem	-	-	-	-	-	-
		Root	-	-	-	-	-	-
		Soil	-	-	-	-	-	-
6	*Ceriops decandra*	Leaf	-	-	-	-	-	-
		Stem	-	-	-	-	-	-
		Root	6	3	-	-	-	$6,0X10^1$
		Soil	5	-	-	-	-	$5,0X10^1$
7	*Avicennia lanata*	Leaf	-	-	-	-	-	-
		Stem	-	-	-	-	-	-
		Root	1,8	4	-	-	-	$1,8X10^2$
		Soil	-	-	-	-	-	-

Table 2 shows the successful isolation of Actinomycetes bacteria in each mangrove species in soil, roots, stems, and leaves. The isolation of Actinomycetes bacteria on Bruguiera gymnorrhiza was successful on soil ($1,0X10^4$ CFU/gr) and roots ($6,0X10^3$ CFU/gr). At the same time, on Rhizophora mucronata, it was successful on soil ($4,0X10^2$ CFU/gr) and stems ($2,6X10^3$ CFU /gr). On Ceriops decandra, the isolation of Actinomycetes bacteria was successful on soil ($5X10^4$ CFU/gr) and roots ($6,0X10^2$ CFU/gr), while on Avicenia alanata, it was successful on roots ($1,8X10^3$). Meanwhile, in the species Rhizophora apiculata and Ceriops tagal Actinomycetes, bacterial isolation was successful in soil ($1,0X10^4$ CFU/gr and $6X10^2$ CFU/gr) and on stems ($2,0X10^4$ CFU/gr and $5,0X10^1$ CFU/gr). In Sonneratia alba, Actinomycetes bacteria were not found in all sections.

At station III, Actinomycetes were successfully isolated from three mangrove stands: *Rhizophora apiculata, Xilocarpus granatum,* and *Ceriops tagal.*

Table 3. The density of actinomycetes in the Mangrove Ecosystems Station III

No	**Species**	**Organ**	**Dilution**					**TPC (CFU/gr)**
			10^{-1}	**10^{-2}**	**10^{-3}**	**10^{-4}**	**10^{-5}**	
1	*Ceriops tagal*	Leaf	3	-	-	-	-	$3,0X 10^1$
		Stem	-	-	-	-	-	-
		Root	-	-	-	-	-	-

		Soil	5	-	-	-	-	5,0 X 10^{1}
2	*Rhizophora apiculata*	Leaf	4	-	-	-	-	4,0 X 10^{1}
		Stem	-	-	-	-	-	-
		Root	10	-	-	-	-	1,0 X 10^{1}
		Soil	3	-	-	-	-	3,0X10^{1}
3	*Xylocarpus granatum*	Leaf	11	-	-	-	-	1,1X10^{1}
		Stem	14	3	-	-	-	1,4X10^{2}
		Root	-	-	-	-	-	-
		Soil	2	-	-	-	-	2,0X10^{2}

Table 3 shows the successful isolation of Actinomycetes bacteria in each mangrove species in soil, roots, stems, and leaves. The isolation of Actinomycetes bacteria on *Xilocarpus geinatum* was successful on soil (3X10^{1} CFU/gr), stems (1,4X10^{2} CFU/gr), and leaves (1,1X10^{2} CFU/gr). At the same time, on *Rhizophora apiculata*, it was successful on soil (3,0X10^{1} CFU/ gr), roots (1,0X10^{4} CFU/gr), and leaves (4,0X10^{1} CFU/gr). Meanwhile, the isolation of Actinomycetes bacteria on *the Ceriops tagal* was successful in soil (5X10^{2} CFU/gr) and leaves (3,0X10^{2} CFU/gr).

Rhizophora mucronata has a high IVI value since it can grow in areas of high or low inundation. This ability is supported by the body's structure, where the roots have lenticels, which absorb dissolved oxygen from water, soil, or air by diffusion to adapt to an environment lacking nutrients. As Duke (2006) stated, Rhizophora has strong supporting roots surrounding the main stem to support its growth in muddy and anoxic areas. Hogarth (2007) added that Rhizophora roots have lenticels, which absorb dissolved oxygen from water, soil, or air by diffusion to adapt to a nutrient-poor environment.

The *Rhizophora mucronata* IVI value affects the amount of litter produced. Lestarina (2011) states that type, density, and age influence mangrove litter production. The same species with different ages will produce different litter production. In addition, Moller (2003) stated that tree density affects litter production. Thus, the higher the density of *Rhizophora mucronata*, the higher the litter production, and vice versa; the lower the tree density, the less litter production.

Leaf litter is a significant component in the primary productivity of mangroves as an essential carbon source in the decomposition process. Mangrove species with different nutrient and water content strongly influence litter decomposition ability. The thicker the mangrove leaves, the longer it decomposes (Gartner & Cardon, 2004).

Bacteria play an essential role in the mangrove ecosystem, especially as decomposers of leaf litter into organic matter as nutrients for organisms. In the process of decomposition in mangrove waters, the active role of bacteria is compulsory (Kamal, 2011 in Kurniawan, 2012). Bacteria will decompose litter enzymatically through the active role of proteolytic, cellulolytic, and chitinolytic enzymes. The proteolytic group of bacteria that play a role in the protein decomposition process is Pseudomonas, those that play a role in the cellulose decomposition process are Actinomycetes, Chytophaga, and

Sphoracytophaga, and those that decompose chitin are Basilus, Pseudomonas, and Vibrio (Lyla & Ajmal, 2006).

Isolation of Actinomycetes bacteria from samples of roots, stems, leaves, and soil in mangroves in Langge Village showed that most Actinomycetes bacteria were found in Rhizopora mucronata with a density of 4.1X102 CFU/gr in stems, 4.0X10 CFU/gr in roots, and 1. 0X10 CFU/gr on the soil. Meanwhile, the quality and quantity of litter in the ecosystem strongly influence the catabolic activity of decomposer organisms (Mooshammer et al., 2012). Thus, the higher the IVI value, the higher the amount of litter, and the higher the litter production, the higher the density of decomposing microorganisms, Actinomycetes bacteria.

Bacteria are microorganisms whose primary function is as decomposers of organic compounds, while Actinomycetes are heterotrophic bacteria. These bacteria can oxidize ammonia or nitrogen to nitrite or nitrate (Sylvia et al., 1990). Phosphate and nitrate nutrients are some of the links in the food chain that are needed and affect the growth and development of living organisms in the sea. The ability of bacteria to decompose organic compounds causes phytoplankton to thrive in oceans where the concentration of inorganic nitrogen and phosphate is deficient. Bacteria are vital in transferring energy from primary productivity to consumers in the marine food web.. Bolter & Rheinheimer (2003) stated that bacteria and placards are always related. Bacteria decompose organic compounds into nutrients that phytoplankton will use for their growth, while phytoplankton provides organic material for bacterial growth. All of these conditions occur in the detritus food chain.

The detritus food chain is also called the indirect food chain. More organisms are involved in this food chain than the direct food chain. Mangroves act as producers, producing leaf, twig, and flower litter that fall into the waters. Detrivores/decomposers will decompose this litter. Crustaceans, bacteria, algae, and mollusks will eat detritus containing organic compounds, which act as first-level consumers. Bacteria and algae will be eaten by protozoa as second-level consumers. These protozoa will be eaten by amphipods as third-level consumers. Then, crustaceans or amphipods will be eaten by small fish (fourth-level consumers) and then will be eaten by big fish (fifth-level consumers). Furthermore, the sixth-level consumers, consisting of large fish and fish-eating birds, will eventually die and be decomposed by detritus so that they will produce compounds that the mangroves can utilize.

The Quran mentions the creation of the universe, where Allah created it in stages. He could create them all at once, but He wanted to teach His creatures that everything has to go through a specific process. In the Quran surah Al-Baqarah verse 117, Allah says:

> *"He is the Originator of the heavens and the earth; whenever He decrees (to create) a matter, He (merely) says: "Be," and it is.."*

Allah did not create everything, including the billions of planets in the universe, in vain. In the past, humans were only able to identify visible creatures. Along with the development of science and the invention of the microscope, humans began to recognize small invisible creatures such as microorganisms. Therefore, there must be wisdom behind each of these creations. Allah says in Al Baqarah Verse 164:

> *"Indeed, in the creation of the heavens and earth, and the alternation of the night and the day, and the [great] ships which sail through the sea with that which benefits people, and what Allah has sent down from the heavens of rain, giving life thereby to the earth after its lifelessness and dispersing therein every [kind of] moving creature, and [His] directing of the winds and the clouds controlled between the heaven and the earth are signs for a people who use reason."*

Nothing preceded the creation of the heavens and the earth and everything in it, nor will it experience any delays, even if it was in the twinkling of an eye. Just as the sun cannot overtake the moon, the night cannot precede the day because everything revolves in its orbit. The verse shows the affirmation of the sign of the oneness and greatness of Allah. Interestingly, the sign was deliberately intended for those who understood. In this verse, Allah also mentions "various animals," which refers to the various shapes, colours, and benefits of animals. Allah has ordained all these animals; none are unreachable or hidden from Him. There are two kingdoms in biology: Animalia (animals) and Plantae (plants). Some creatures are visible in everyday life, such as chickens, cows, cats, birds, or fish. However, there are also invisible animals, not supernatural beings, which require special tools such as a microscope to see them because they are so small. They are commonly referred to as microscopic, sub-microscopic, or ultra-microscopic creatures.

Furthermore, the verse also contains the word *dabbah*. This word is usually translated as 'climbing creatures,' which means 'all moving creatures, including humans and animals and all creatures that humans have or have not known. Asy-Sya'rawiy argues that *dabbah* are all moving creatures on earth, including tiny creatures that can only be seen with the help of a magnifying glass or microscope. As in the surah al-Baqarah verse 164, which was previously mentioned. In another surah, Surah Hud (11) verse 6, Allah says:

> *"There is no moving (living) creature on earth, but its sustenance depends on Allah: He knows the time and place of its definite abode and its temporary deposit: All is in a clear Record (lawh mahfuz)."*

In Surah Al-Jathiyah (45) verse 4, Allah says:

> *"And in the creation of yourselves and what He disperses of moving creatures scattered (through the earth), are Signs for those of assured Faith."*

The word *dabbatin* in Surah Hud verse 6 is defined as 'climbing creatures,' or all creatures that walk, crawl, or creep, including humans, four-legged and many-legged animals, insects, and other creatures contained in the word *dabbatin*. The word *dabbatin* in surah Al-jathiyah contains the same meaning. The many kinds of animals can be studied in temperament to be compared with humans. For example, organizational order in bees, united strength in ants, or courage in tigers. All these are called by the Sufis as *Mashhad*, the testimony at the end of the fourth verse: signs for those of assured faith."

As one of the microorganisms that live on Earth, Actinomycetes are often found in various soil types. Actinomycetes distributed in nature or the human-made environment play a vital role in the biodegradation of organic matter, contributing to industry, agriculture, forestry, and medicine. Actinomycetes also play an essential role in the mangrove ecosystem; one is to decompose leaf litter into organic matter that provides nutrition for other organisms.

Allah has emphasized in the Qur'an that the grace given to humans, which includes the territory and everything in it, does not legitimize humans to do anything at will or arbitrarily to other living things. Humans also do not have unlimited rights to use everything in nature that can disturb the ecological balance.

Thus, the Quran indicates the existence of other creatures on earth that benefit humans, not visible to the naked eye. Although some cause disease in humans, medicine is also created from these invisible creatures. This information about beings invisible to the naked eye is only one of the many miracles the Quran reveals. In the past, people thought the most miniature creatures/objects were ants or mosquitoes. The Quran has revealed since 14 centuries ago that there are much smaller creatures. They have their role in this life, especially in maintaining the balance of nature on earth. For example, the nitrogen cycle is a biological process essential for the formation of life on earth that is only possible with the involvement of bacteria or certain bacteria in the human mouth that can prevent poisoning by foods containing nitrates.

The researchers would like to end this discussion with the Quran surah Adh-Dhariyat Verses 20-21:

> *"And on the earth are signs for those of assured faith, and (also) in yourselves. Then will you not see?"*

CONCLUSION

We often find this kind of verse in the Quran. Looking at nature, especially the earth we step on, a heart with faith will see a sign that Allah exists. The earth is full of extraordinary and astounding evidence. After we see all the possibilities that arise on it, "then will you not see?". Contemplating the contents of the earth will increase faith. After seeing the universe, man will reflect on who he is, where he came from, and where he is going. After contemplating the contents of heaven and earth and who we are, we will conclude, "Everything is evidence that He is the One."

REFERENCES

Abdullah bin Muhammad bin Abdurahman bin Ishak. 2005. *Tafsir Ibnu Katsir (terj)* Cet. Pertama, Terjemahan : Abdul Ghoffar dan Abu Ihsan al-Atsari. Bogor: Pustaka Imam Asy-Syafi'i.

Kementerian Agama Republik Indonesia. 2019. *Terjemah Makna Al Qur'an Bahasa Indonesia*. Madinah Al Munawwarah: Percetakan Al Qur'an Raja Fahd.

Lajnah Pentashihan Mushaf Al-Qur'an. 2015. *Jasad Renik Dalam Perspektif Al-Qur'an dan Sains*. Jakarta: Lajnah Pentashihan Mushaf Al-Qur'an.

Lyla, P.S & K.S. Ajmal. 2006. Marine Microbial Diversity and Ecology: Importance and Future Perspectives. *Current Science*. 90:1325-1335.

Ngatirah. 2017. *Mikrobiologi Umum.* Yogyakarta: Instiper Yogyakarta.

Nur Metta Chumairoh Azzuhro. 2021. Makna Zarrah Dalam Al-Qur'an dan Tafsirnya dan Tafsir Ilmi Kemenag RI. *Academic Journal of Islamic Principles and Philosophy* Vol. 2 No. 1, pp. 111-134

Pratiwi, Sylvia T. 2008. *Mikrobiologi Farmasi.* Fakultas Farmasi Universitas Gadjah Mada. Jakarta: Erlangga.

Prof. Dr. Hamka. 2015. *Tafsir Al-Azhar : Jilid 1.* Depok: Gema Insani.

_________________. *Tafsir Al-Azhar : Jilid 4.* Depok: Gema Insani.

_________________. *Tafsir Al-Azhar : Jilid 6.* Depok: Gema Insani.

_________________. *Tafsir Al-Azhar : Jilid 8.* Depok: Gema Insani.

Ravikumar S, M. Fredimoses, and R. Gokulakrishnan. 2011. Biodiversity of Actinomycetes in Manakkudi Mangrove Ecosystem, Southwest coast of India. *Annals of Biological Research*. Vol. 2(1), pp. 76-82.

Sahoo. K and N.K Dhal. 2008. *Potential microbial diversity in mangrove ecosystems: A review*. Indian Journal of Marine Science. Vol. 38 (2), pp. 249–256.