

Others Filum:

Filum	Total Bacteria	Abundance (%)
Actinobacteria	17	0,0230
Cyanobacteria	67	0,0908
Tenericutes	0	0
Verrucomicrobia	9	0,0122
Acidobacteria	0	0
Saccharibacteria	0	0
Chloroflexi	0	0
Spirochaetes	0	0
Latescibacteria	0	0
Elusimicrobia	0	0
Parcubacteria	0	0
Total Others Phylum	93	0,103

Figure 1. Absolute Abundance at the Phylum Level

The results of the abundance of bacteria in catfish (Figure 1) showed Fusobacteria (79.96%), Bacteroidetes (15.24%), Proteobacteria (3.71%), Firmicutes (0.94%) and other phylum (0.10%). This is in accordance with the research of Li [8] who examined 8 species of fish with differences in carnivores, herbivores, omnivores, and filter feeding, found that the phylum that dominates each fish is the phylum fusobacteria. This phylum fusobacteria in the intestinal bacteria of Channel Catfish in America, the abundance is dominated by the phylum firmicutes (38%), proteobacteria (37%), fusobacteria (11%), and cyanobacteria (6%) [5].

In addition, the species most commonly found is *Cetobacterium somerae* from the phylum Fusobacteria [9]. This genus is found to be abundant in several freshwater fish species [10,11]. This species is known to produce high amounts of vitamin B12 [12], can ferment peptides and carbohydrates [13] and can inhibit the growth of potential pathogens [14]. This is supported by the results obtained by Sullam [15] stated that the diversity and community of bacteria in the fish gut is influenced by differences in water salinity.

In the results of the abundance at the phylum level, it can be seen that there are many unidentified phyla. Apart from environmental and habitat factors, one of the factors that causes this to happen is that there are bacteria that are not classified. These unclassified bacteria is due to a lack of references in the database regarding bacterial samples so that the taxonomy of these bacteria is incomplete [16].

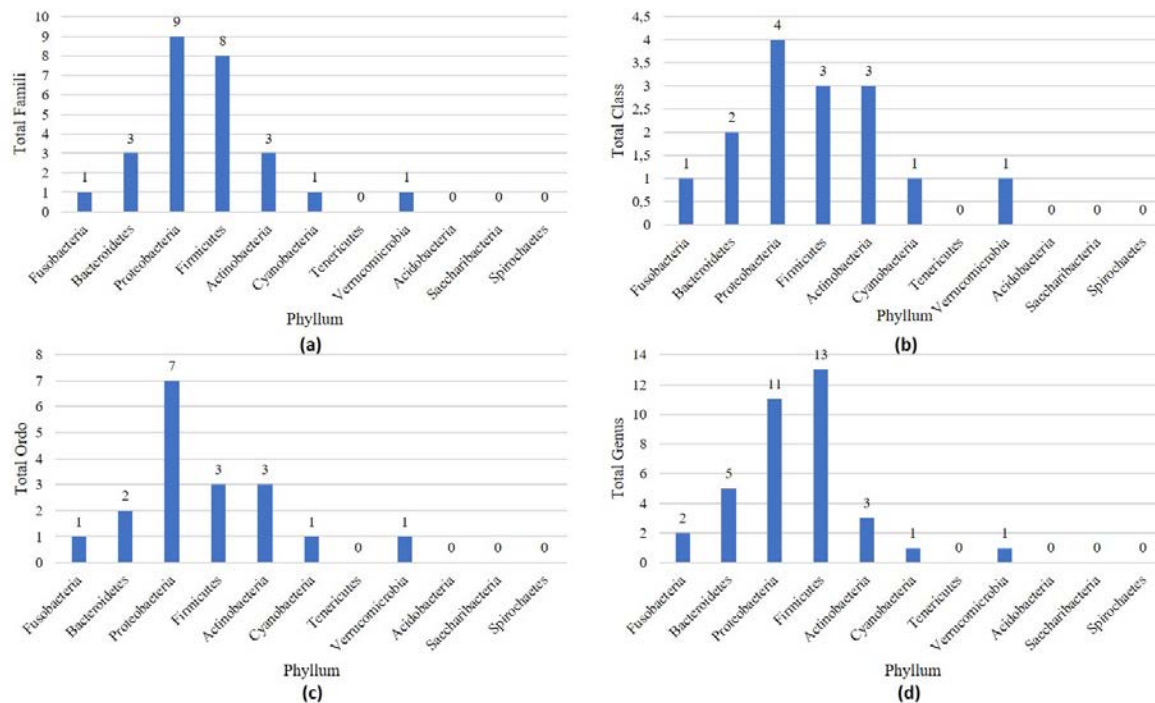


Figure 2. Number of Taxons in Each Identified Phylum
 (a = Famili; b = Class; c = Ordo; d = Genus)

Based on Figure 2. It was identified that the highest number of taxon in each phylum is generally in the proteobacteria phylum. Where the total identified family was 9, the total identified class was 4, the total order identified was 7, and the total identified genus was 11. While the highest number of genera was found in the phylum firmicutes. Other phyla such as bacteroides, fusobacteria, cyanobacteria, tenericutes, verrucomicrobia, acidobacteria, sacccharibacteria, spirochaetes have a small number of genera compared to the phylum firmicutes, proteobacteria and actinobacteria. This is in line with previous studies which stated that the highest diversity in catfish species was generally in proteobacteria with the genus Cetobacterium. The several genera found to have various functions can be seen in Table 1.

Table 1. Table of Functions of Genus / Family Level Bacteria in Catfish

Genus / Family	Phylum	Function	Reference
<i>Bacteroides</i>	Bacteroidetes	The fermentation of carbohydrates results in a collection of volatile fatty acids which are reabsorbed through the large intestine and utilized by the host as an energy source, providing a significant proportion of the host's daily energy requirements.	[17]
<i>Cetobacterium</i>	Fusobacteria	It is known to produce vitamin B12 and is found in plant food in the intestines of fish.	[12, 14, 18]
<i>Clostridium_sensu_stricto_1</i>	Firmicutes	It is an anaerobic obligate gram-positive bacteria with many pathogenic species. These bacteria have been shown to contribute to host nutrition, especially by supplying fatty acids and vitamins.	[19]
<i>Desulfovibrio</i>	Proteobacteria	Sulfate reducing bacteria and in large numbers can become pathogens.	[20]
<i>Enterovibrio</i>	Proteobacteria	Producing indole acetic acid which can be harmful to lactic acid bacteria in the intestines if in excess amounts.	[21, 22]
<i>Flavobacterium</i>	Bacteroidetes	Causes fry syndrome and cold water bacterial disease, which causes high mortality rates in young fish.	[23, 24]
<i>Lactobacillus</i>	Firmicutes	Produces extracellular degradative enzymes and is dependent on other microorganisms to provide certain nutrients.	[25]
<i>Pseudomonas</i>	Proteobacteria	Anti-pathogenic bacteria in aquaculture	[26]
<i>Turicibacter</i>	Firmicutes	It contains butyric acid, an important short chain fatty acid with antimicrobial properties	[27]
<i>Vibrio</i>	Proteobacteria	Fermentation, pathogens and found in fish	[18, 28]

In catfish, there are several genera that can be pathogenic in fish, one of which is *Enterovibrio* and *Vibrio*. *Enterovibrio* functions to produce indole acetic acid which can be harmful to lactic acid bacteria in the intestine if in excess amounts [21,22]. The amount of enterovibrio as much as 2% in the intestines of catfish will not be bad for the lactic acid bacteria in the catfish intestines as well as vibrio bacteria which are present in the intestines in small amounts.

Several other detected bacteria, among others, from the genus *Lactobacillus*. These bacteria are known to be used as probiotics. The enzymes produced by these bacteria can be used as probiotics for fish feed, especially in the larval stage. According to Feliatra [29] several types of probiotic candidate bacteria include *Lactococcus sp.*, *Carnoacterium sp.*, *Bacillus sp.*, *Eubacterium sp.*, *Pseudomonas sp.*, *Lactobacillus sp.*, *Micrococcus sp.* and *Bifidobacterium sp.*

3. Conclusion

The results of the abundance of bacteria in catfish showed Fusobacteria (79.96%), Bacteroidetes (15.24%), Proteobacteria (3.71%), Firmicutes (0.94%) and other phylum (0.10%). It was identified that the highest number of taxon in each phylum is generally in the proteobacteria phylum. There are several genera that can be pathogenic in fish, one of which is *Enterovibrio* and *Vibrio* and Several other detected bacteria, among others, from the genus *Lactobacillus*. These bacteria are known to be used as probiotics.

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