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THE DIVERSITY AND ABUNDANCE OF SPECIES FAMILY OF POACEA IN THE FLOOD PLAIN OF GAJAHWONG RIVER, YOGYAKARTA, INDONESIA

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Graphical abstract

Abstract

The Poaceae family is one of flowering plants with the most abundant groups of species, many species usefull for human life. The aim of this research was to study the diversity and species abundance of Poaceae Family in the banks of Gadjahwong River using quadrate method that covering different altitudes as well as upstream, middle and downstream area. Samples were collected from the plots of 1 m x 1 m, that positioned through stratified random sampling. Data analysis was conducted using Canonical Correspondence Analysis (CCA). The results showed that 47 species were identified, with the highest number of species and diversity index were found in the midstream. The species abundance was varied in each location, and among them, a high abundance of Axonopus compressus was found in all locations. Based on the influence of physical-chemical factors, the presence of Poaceae species identified in this study could be categorized under the influence of (1) soil pH and potassium, (2) C-organic,(3) temperature, solid humidity, light intensity and nitrate,(4) the presence of phosphate and air temperature.

Keywords: Diversity index, Gadjahwong river, physical – chemical, stratified random sampling

1.0 INTRODUCTION

Gajahwong River is one of the sub watersheds of the Opak River, located in the special District of Yogyakarta and passing through Sleman and Bantul Regency, Yogyakarta. The existence of this river is very important for community, particularly for a wide range of household needs, home industry, and agriculture. However, some locations are used as garbage dumps. Many industrial activities, ranging from small to large industries can be found along the river, including from dairy factory, leather factory, golf glove factory, and industry of *tempe* (fermented soybean) [1]. In addition, the river also passes through Gembira Loka Zoo and inhabited areas with high community activities. Consequently, the development of river environment, human life and the patterns of community life around them, added by the dynamic of river flow the spring until the downstream, the season, and the characteristics of river channel, will change either the quantity or the quality of river ecosystem accordingly. The formed condition is highly influential to the surrounding biodiversity, including the species of Poaceae family [2, 3]. In response to this, this research aims to examine the diversity and abundance of Poaceae family in the banks of Gajahwong river Yogyakarta, Indonesia, as well as its relation to physical - chemical factors in the banks.

2.0 LITERATURE REVIEW

Poacaea or Gramineae, is a family of flowering plants with the most abundant groups of species. As the fourth largest family of flowering plants in the

world, this family covers more than 800 genera and 11.000 species [4, 5]. However, there are still many species that have not been identified. The Poaceae family consists of herbaceous grasses that propagate through stolon or rhizome, the plants have fertile stems with panicle inflorescence as their largely characteristic [5, 6]. Their lowers or fruits are protected by structures such as scales or husks. They also have a root system capable of absorbing nutrient sand water efficiently [4, 7], and highly tolerant to drought [2].

Poaceae grow rapidly and widely distributed in the most of part of the world [5]. The wide distribution is highly influenced by environtmental factors, plants response and human activities [8]. Though cosmopolitan, this family is mostly abundant in the tropical areas and the northern part of temperate zones with sufficient rain fall to form meadow [9]. The Poaceae family also plays important role in maintaining soil stability [5, 7] and protecting riverbank ecosystem through minimizing the potential of erosion caused by river flow, especially in the rainy season [5]. In addition, they also possess an important economic value for human life, such as a staple food, building material and livestock food. One of the habitats containing a high abundance of Poaceae is a riverbank.

3.0 METHODOLOGY

3.1 Study Area

This research was conducted from December 2013 to July 2014, on the banks of Gajahwong River. Three locations were determined, including the upstream area located in Sleman Regency, midstream located in Yogyakarta municipality, and the downstream area located in Bantul Regency with the elevation of 501 m, 187 m and 21 m above sea level, consecutively. The distance between location was one kilometer and the size of each sampling area was 1000 m^2 (Figure 1). The equipment used including camera, paper labels, Global Positioning System (GPS), soil tester, and soil thermometer. All plant materials found in the plot areas were identified with the book of "*The Mountain Flora of Java*" by DR. C.G.G.J Van Steenis; "*Atlas of 220 weeds of sugarcane fields in Java*" by C.A. Backer.

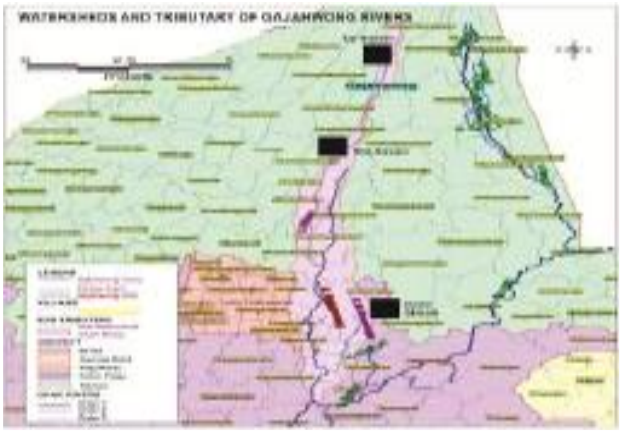

Figure 1 Location of Research Area in Flood Plain of Gajahwong River in Upstream, Midstream and Downstream location

3.2 Data Collection and Analysis

The data was collected using through stratified random sampling using quadrate method. There were 5 stations in each location that containing 5 plots of 1x1 meter. Species identification was carried out, followed by calculating the total number of species and individual of each species. Then, the density, frequency, important values and the index of diversity using the formula of Shannon-Weiner were calculated. The physical factor that was measured including soil and air temperature, soil humidity, light intensity, soil texture, and the elevation. Meanwhile, the chemical parameters included soil pH and the level of C-organic, Nitrogen (N), Phosphor (P) and potassium (K). The nutrients content in soil was measured using Calorimetry method. Canonical Coresspondence Analysis (CCA) was used to analyze the correlation between the species abundance and the influential chemical-physical factors [10].

4.0 RESULTS AND DISCUSSION

4.1 Species Diversity

Fourty seven (47) species of Poaceae family was identified on the bank of Gajahwong river (Figure 2). those species were variously distributed in the upstream area (25 species), midstream (30 species), and downstream area (22 species). The presence of species was highly dependent upon the ability to adapt to the formed environment factor [11], hence the variation in distribution. Moreover, each location contained different endemic species. On the upstream areas, there were 14 endemic species. Meanwhile, nine endemic species on the midstreams and only 5 endemic species on the dowsntream areas (Figure 2). This suggests that the elevation factor is highly influential on the presence of

Poaceae species. On the other hand, eight species (*Andropogon nardus, Axonopus compressus, Eleusine indica, Oryza sativa, Panicum distachyum , Panicum luzonense, Pennisetum purpureum* and *Pollinia ciliata*) were found in all plot areas, indicated them as the most adaptable Poaceae species (Figure 2 Group D).

Panicum muticum or *Brachiria mutica* (also known as Kolonjono in Javanese Language), was the only species that presence in upstream and downstream area with notice able differences in elevation (510 meter as opposed to 21 meter above sea level, see Figure 2, Group F). This species is the annual species used for livestock feed. The plant is productive in humid environment, shade-tolerant, preferring full sunlight but intolerant to prolonged dry condition, and growing well in sandy clay soil with pH of 5 to 6.5. The ability to grow in different elevation is probably caused by the same pH in those two locations [9], indicating that pH is a limiting factor for the presence of Poaceae species (Figure 3).

The most abundant species was found at the elevation of 178 meter above sea level or on the midstream as opposed to the other two locations. This is probably due to human activities and the formed environment conditions such as pH (7.02). The normal pH leads to optimal absorption of macro and micro nutrient as well as the optimal activities of soil microbial and the chemical characteristics of soil. As presented in Figure 3, the midstream also contained high level of C-organic (2%), Nitrate (0.7 ppm), and potassium (1mg/l). The three minerals are very essential for soil fertility. In addition, those minerals are also important to the building structure of plant cell membrane. The high availability of

Nitrogen and Potassium are also used by plants to accelerate growth of young tissues, seedlings and reproductive organs, to optimize the reproductive and photosynthetic process, as well as highly influential to the abundance of species in an ecosystem [12].

4.2 Species Abundance

The species abundance level at three locations was varied. The overall density value was 3.108.800 individuals/ha (ind/ha). The highest value was found in the upstream area at 1.050.800 ind/ha, followed by mid-stream at 1.048.400 ind/ha and the lowest one was found in downstream area at 1.009.600 ind/ha (Figure 4). The species abundance on the three locations was unevenly distributed. This was indicated by the non significant differences of absolute frequency values between the three areas (up-stream at 38.000 ind/ha, mid-stream at 39.200 ind/ha, and downstream at 34.000 ind/ha). The high abundance level on upstream area is probably due to the rather closed canopy, which results in low light intensity and humidity, enable the Poaceae species to grow well. Interestingly, the highest species distribution was found in the midstream area, the dense inhabited area with many human activities. This indicated a good role of community directly or indirectly toward the distribution of Poaceae species. Moreover, this area is located next to the farming areas, hence the midstream area is likely affected by the use of fertilizer with high level of N, P and K (Figure 3). The existence of those three chemical elements highly determined the plant reproduction and yields.

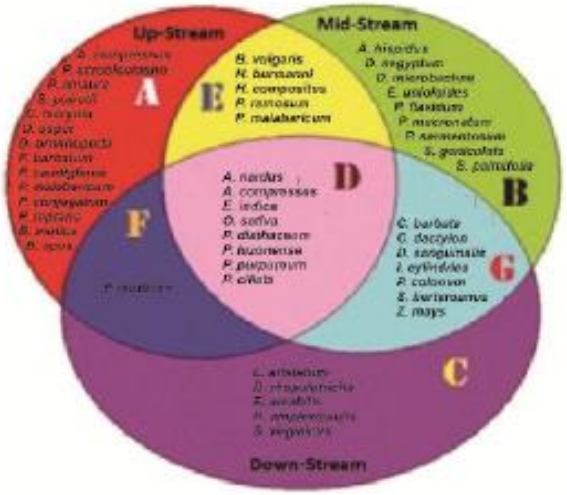

Figure 2 Diagram of Species Distribution in the flood plain of Gajah Wong River. **A**. species in upstream; **B**. in mid-stream; **C**. in downstream; **D**. in upstream, mid-stream and down-stream; **E**. in upstream and midstream and, **F**. in upstream and downstream

The species with the highest abundance in the three locations was varied, but *Axonopus compressus,* an invasive species from North America and Mexico, was present in those locations with various levels. *A. compressus* is easily found in tropical and subtropical areas, propagating through vegetative reproduction or through the seeds, and able to grow in the soil with low N and P. In addition, this species is also able to grow in sandy or clay soil with pH at 5 to 7. In the downstream area, *Axonopus compressus* had the lowest level of abundance. It is probably caused by the high light intensity (620 lux), few canopy, and intentional homogenization of elephant grass for livestock food by the natives. Additionally, the downstream area had disadvantageous physical-chemical environment for the growth of species Poaceae. The soil contained low level of C-Organic (0,829%) and potassium (1.00mg/l), and high temperature (33.8^{0}C) (Figure 3).

The highest important value index in all locations was belonged to *A. compressus* at 72.9% in the upstream, 24.02% in the midstream and 31.8% in the downstream area. Next, was *P. purpureum* with the value of 15.3% in the upstream, 20.33% in the midstream and 19.1% in the downstream area. Both

species dominated all locations with different abundance values. *A. compressus* was dominant in the upstream, while *P. purpureum* Shumach was dominant in downstream area. The level of important value index shows that the species play important role in its community and that they dominate the ecosystem of Gajahwong Riverbank.

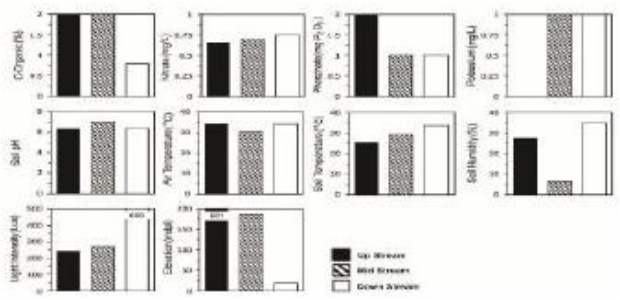

Figure 3 the measured physical-chemical parameter in the research location

The diversity index values were various in every location. The upstream and downstream areas had moderate diversity index values (2.24 and 2.7, consecutively); while, the midstream area had a high diversity index value (3,055). This suggests that the midstream has the most supporting environmental condition for the growth of Gramineae species compared to the other two locations (Figure 4). The higher the value of vegetative diversity index, the more stable the community [6]. In addition, the community in midstream area was the oldest, and the number of populations and their sizes are higher compared to that in the other two locations.

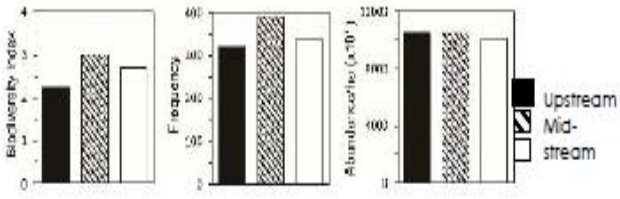

Figure 4 The Index Diversity, Abundance and Frequency of Species in Flood Plain of Gajahwong River

4.3 Correlation Spesies Abundance and Chemical-Physical Factor

The result of Canonical Coresspondence Analysis (CCA) showed the species clustering was influenced by the formed physical-chemical conditions (Figure 5). Group 1 was referred to the group of species that influenced by the soil pH between 6.8 -7 shows the stable condition for chemical reaction, in which the nitrogen in soil will be available in the form of NO_3^- and NH_4^+, and ready to be absorbed by plant roots [6]. In addition, this group was also affected by the presence of potassium that probably resulted from the litter layer. Potassium can affect the rapid growth of *Anthraxon hispidus, Dactyloctenium aegyptum, Digitaria microbachne, Setaria palmifolia, Panicum malabaricum, Digitaria rhopa lotricha., Imperata clyndrica, Panicum reptans, Panicum colonum, Chloris barbata, Sporobolus bertanous, Oryza sativa, Zea mays, Panicum ramosum, Panicum mucronulatum,* and *Panicum luzonense*. The Group 1 was dominated by species that only grow well in midstream area (11 species).

Group 2 was identified as the group of species that influenced by the presence of C-organic that was probably produced from decomposed litters or *humus*. The species clustered in Group 2 icluding *Hoplismenus compasitus, Pollinia ciliata* and *Panicum muticum*. Group 2 was also dominated by species that grow well in the upstream and midstream areas. The only species from this group that present in all locations was *Panicum muticum*.

Group 3 was the group of species that highly influenced by the presence of sodium, soil temperature, light intensity and soil humidity. Light intensity is a critical factor for photosynthesis and soil temperature. On the other hand, Sodium was probably resulted from the fertilizing activities. The species categorized in Group 3 including *Pennisetum purpureum, Digitaria sanguinalis*, *Cynodon dactylon, Hymenachne amplexicaulis, Panicum caudiglume, Sporobolus virginicus, Eragrostis amabilis, Ischaemum aristatum, Panicum distachyum* and *Eleusine indica*. Group 3 was consisted of species that mostly found in the midstream and downstream areas. The only species from this group that present in all locations was *Eleusine indica.*

Group 4 referred to the group of species that was highly determined by the existence of Phosphate, latitude and air temperature. The high level of phosphate contributes to the process of generative growth. In addition, it also important to accelerate the flowering and the grain ripeness. Phosphate is required in a macro-nutrient and considered as the key of life in view of its central function in the living process. The main function of P in plants is to store and transfer energy in the form of ADP ad ATP. The energy, obtained from the photosynthesis and metabolism of carbohydrate stored in the phosphate mixture, then will be used in the growing and production process [12]. The species clustered in this group including *Andropogon nardus, Axonopus compressus, Panicum ambiguum, Paspalum conjugatum, Coix lacryma, Dendrocalamus asper, Panicum sarmentosum Panicum barbatum, Polytrias amaura, Paspalum scrobiculatum , and Sporobolus poiretii.* The Group 4 is dominated by the species that mostly found in the upstream area (9 species) and the only species present in allocations was *Axonopus compressus* and the two species present in the

midstream and downstream areas were *Panicum ambiguum* and *Sporobolus poiretii.*

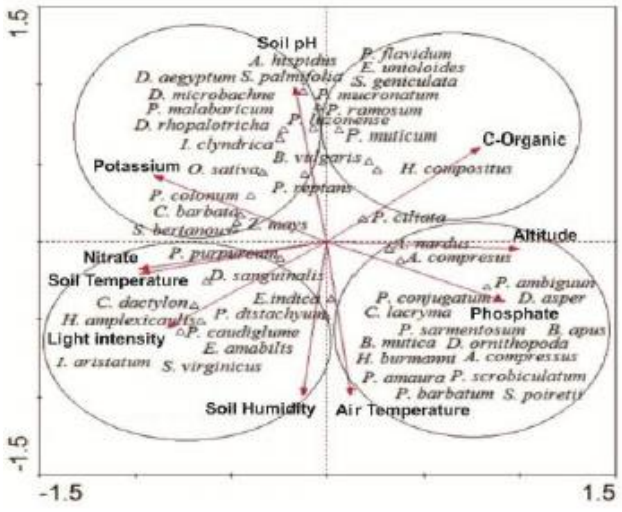

Figure 5 The Categorization of Species affected by measured physical-chemical factor

5.0 CONCLUSION

The Gajahwong riverbank was an ecosystem for the 47 species of Poaceae family that randomly distributed from upstream to downstream areas. Also, each sampling areas contained different endemic each sampling areas contained different endemic species. Midstream area had the most fertile soil and the most stable community. This area also had the highest value of species abundance and diversity index. The presence of species was determined by the physical-chemical factor. Those factors resulted in the clustering of species into different groups.

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