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Association among *Lepironia articulata* Cyperaceae, peat soil and people in Wanggate, Mappi, Papua

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Abstract. Wanggate is a small village that is surrounded by water like a small island in the wetland area. A creek connecting to a main river is a mean of transportation to reach Mappi or another nearby village. Next to the river, population of grass were living and periodically waterlogged by the river. *L. articulata*, a species under Cyperaceae family, grows abundantly in small lake or pool that has connection to the river. Dark green color is a sign of *L. articulata* presence. The grass could reach up to 2 m tall and lives above water. Relationship among people, plants with peat soil has been present since a long time. The research was undertaken to understand more about the association. The nature of this study was descriptive with interviews to obtain ethnobotanical data. Fifty plot-wise sampling technique was used to collect data. The result shows that *L. articulata* shrub was the habitat of freshwater fishes like nila (*Oreochromis niloticus*), *Channa* sp. and shrimps. People has been dependent to fisheries from the lake and grasses for living. They make bags, arm straps, traditional hats, umbrellas, mats, kitchen utensils like baskets and plates, clothes and roofs from *L. articulata*. Peat soil was found in 31 plots and 28 of those plots were covered by *L. articulata*. Association index between of *L. articulata* and peat soil was 0.875 and dominance index of the plant was 0.868. The other plants, *Melaleuca cajuput*, were found in 3 plots. The research discovered *Paspalum conjugatum*, grass-type vegetation, which associated with mineral soil like sago palm (*Metaxylum sago*).

1. Introduction

Traditional people in Papua live friendly to nature. Wanggate people, who are living surrounded by water and peatlands, have a unique culture built in centuries. They generally have no land to cultivate because of limited uplands. Existing drylands have mainly been used for settlements, yet keeping in harmony with the nature.

Research reports from south Papua remain negligible. Therefore, understanding vegetation, animals, culture and the environment is far to complete. This includes cordial association among parties in the environment, like association among people with surrounding vegetation and peatlands.

The aims of this study were to investigate the association between Wanggate people and peatland vegetation; to understand the characteristics of peat soil and its dominant species using association between plant and peat soil and dominance species.

2. Materials and methods

Field research was done in December 12 – 20, 2021, mainly employing field observation and measurements. First part of this investigation involved ethnobotany, which was done through semi-structured interviews with purposive sampling strategy. Elderly people, village officials, teachers, women and female teenagers, as well as others people who knowledgeable about peat soil-related issues were chosen as respondents.

Secondly, this study investigated peat soil data. They were collected using four transects of 100 m apart, with 12 plots each and additional two plots collected between transects. In total, 50 plots were



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acquired. All plots and transects were drawn beforehand. They were transferred into Avensa software to allow field tracking. Equipment available to this research were peat augers, pH meter and TDS/EC meter to measure dissolved solids (TDS) and electrical conductivity (EC). All peat samples were analyzed in the laboratory.

3. Results and discussion

3.1. Wanggate village

The village is situated in Southern Papua, Indonesia, a part of Bunu-Obaa District in Mappi. It is bordered on the east by Gayu village and on the west, north and south by Kogo, Kotiak and Kadam villages, respectively. While in duty, village leader is supported by village government staffs. Wanggate people build their houses on drylands or small hills, without flooding events. They plant some fruits, such as mango, coconut, banana and papaya, with vegetables in their home yard.

3.1.1. Population, jobs and religion

Inhabited people in this village is Awyu tribe. This tribe spreads around Digi, Mappi and Gundo rivers, mostly areas with rivers and swamps. In general, these rivers are navigable by small boats, known as pioneer boats. Awyu people are well-known with their peaceful attitude, in contrary to other southern tribes, for instance Jughai, Asmat and Marind. The name of Awyu means peace. Awyu people are said to have ancestors who came from foam of water that formed a man named Woutou and a women named Sachasa [1].

Wanggate population in 2020 was 886 households or 3,796 people consisting of 2,215 males and 1,581 females. Majority of their livelihood was agarwood seekers and farmers/fishermen with about nine people was village staffs. They have been gatherers, mostly sago from neighboring forests for carbohydrates with proteins obtained from fishes and animals like deer and pigs. The way they harvest sago is slightly different from the rests of Papuan on the North Coast who live in dry lands. Before cutting down sago palms, stems are firstly drilled until the moist significantly drops and leaving starch out.

All inhabitants are adherent of Catholic. Catholicism was brought into the tribe in 1948 by Dutch pastors named Meuwese and Verschuren.

3.1.2. Education and social institutions

Based on education level, high school graduates were 50 males and 34 females. Meanwhile, 31 males and 29 females were graduated from middle school and 70 males and 30 females were attended and completed their elementary school. Community institutions were in form of PKK (family welfare development), fishermen-farmers, community association, traditional institution and youth organization.

3.1.3. Infrastructure and transportation

Facilities included one water pump with 20 wells, drainage channels and public toilets. There were also one football field, one volley ball field, an elementary school and a Catholic church. Rivers are the only transportation mode to connect villages, districts and Keppi town.

3.2. Forest ecosystem

Four ecosystems were found in the research area, i.e. grass swamp, Melaleuca-Livistona swamp, sago swamp and riparian forest. Grassland swamp was dominated by various types of grass; three dominant ones were *Paspalum conjugatum*, *Cynodon dactylon* and *L. articulata*. These three grass populations form a striking color degradation ranging from bright green, green to dark green. Other grass species included *Paspalum dilatatum*, *Fimbristylis* sp, *Phragmites karka* and *Saccharum spontaneum*.

Melaleuca-Livistona swamp hosts types of vegetation adaptive to flooded and dried conditions; sometimes with a chance of burning. Manarbongs and Purwanti [2] found this type of ecosystem in their research site. *Livistona benthamii* (Figure 1) differed from the others in the same genus because of appearing aerial roots on the stems as high as 2 or 3 m. Lack of nutrients often causes leaves to change their color to yellow, with thin stems.

Sago forests were located adjacent to *Melaleuca* swamps and grass swamps with *Sacharum* or *Phragmites karika*. Selected plot showed the existence of mineral soil in this land cover type. While the dominant tree, almost 90 percent, was sago, the research discovered other types of vegetation, to name a few: *Endospermum moluccanum*, *Dilena papuana*, *Macaranga* sp., *Litsea* sp., *Syzygium* spp, *Calamus* and *Nepenthes* spp. Only five plots were studied, taken from areas near grass ecosystem. According to the locals, in the center of sago forest, peat soil could be found, referred as the shaken soil.

Riparian forest is situated next to rivers and swamp area; sometimes this area is partially flooded, especially in rainy season. Vegetation types observed in this region were *Intsia bijuga*, *Syzygium* spp, *Bambusa bambos*, *Mangifera* sp. and *Hibiscus macrophyllus*.



Figure 1. Population of *Livistona benthamii*

3.3. Peat soil characteristics

Soil survey collected 31 plots and 19 plots in peat and mineral soil, respectively. In the litter, *Paspalum conjugatum*, *Melaleuca cajuputi*, *Metroxylon sago* and *Livistona* were found in ten, four, four and one plots, respectively. All plots containing *L. articulata* were in peat soil and only three plots did not have this type of grass, but combination of *Melaleuca cajuputi* and *Hanguana malayana*.

L. articulata abundantly spread over four spots which were located in surrounding the village. In addition, *Paspalum conjugatum* abundantly lived alongside *Melaleuca cajuputi*. In four peat soil plots, *Melaleuca cajuputi* was found adjacent to *L. articulata*.

Ai grass (the local name of *L. articulata*, Figure 2) grew around a small lake over four sites. The small lake was not clearly visible, because it was covered by Ai grass reaching up to 2 m high. It was often found with *Paspalum* grass or other types of grass living in a frequently inundated environment.

Peat thickness ranged from 2 to 4 m with soil pH spanning from 3 to 5. Total DOD value was in between 900 to 1200m. Bintoro *et al.* [3] argued that high acidity was due to high levels of humic and vulvic phenolic acids produced by decomposition process.

Peat soil in the research area was classified as topogenous peat, which is usually found in lake bed with a thickness of up to 4 m. This kind of peat soil is usually fertile. We found sapric to hemic-type peat across research site.



Figure 2. Population of *L. articulata* in peat soil

3.4. Association between peat soil, *L. articulata* and inhabitants

The association between *L. articulata* grass and peat soil was measured using Jaccard Index as follows:

$$IJ = \frac{a}{a+b+c}$$

IJ = Jaccard Index

a = Number of plots where peat soil and Ai grass were found

b = Number of plots where peat soil found without Ai grass

c = Number of plots where Ai grass found without peat soil

This research found Jaccard Index, the association between peat soil and Ai grass, was about 0.875. High association index value, close to 1, means that the interaction between Ai grass and peat soil was strong. Dominance index was calculated using Simpson index [4]

$$D = \frac{1}{\sum_{i=1}^s [ni/N]^2}$$

D = Simpson Dominance Index

ni = Number of individuals per species

N = Number of individuals of all species

Low dominance index, $0 < D \leq 0.5$, suggests no dominant species exist. Meanwhile, the rests (up to 1), a dominant species can be found. This study obtained dominance index of 0.868, suggesting that there was a dominant vegetation species. High dominance index also indicates low biodiversity. In this research, there were only three species dominating, i.e. *L. articulata*, *Melaleuca cajuputi* and *Hanguana malayana* (Figure 3).

Based on the research at Tasik Bera Swamp in Peninsular Malaysia, *L. articulata* could grow 2.2 g per square meter per day [5]. This rate was relatively low when compared to biomass yield per day produced by *Cyperus papyrus*. Abundance of *L. articulata* may be related to its ability to adapt high soil acidity condition as well as local climate. In four observation plots, *Melaleuca cajuputi* and *Hanguana malayana* were found in peat soil, indicating that there were other sustaining plants but were unable to grow as fast as *L. articulata*. In another site, grass population was challenged by *M. cajuputi* or *M. leucandrea*, although these species do not have ability to sustain waterlogged at all time. Some grass species like *Paspalum conjugatum* and *Cynodon dactylon* were also abundantly found near *L. articulata*, but both species may have a lesser ability to survive on peat soil and prefer dry lands or periodically flooded environment.



Figure 3. Population of *L. articulata* and *Melaleuca cajuputi* (left) and *Cyrtospora dactylon* (right)

We found bamboo, instead of *Pandanus*, as a fiber-producing plant to make daily necessities. For various kinds of weaving, however, *L. articulata* has been exploited for generations and have become a distinctive part of Wanggata culture. This includes *noken*, a traditional woven mat combined with a hanging rope made of strong wood bark, especially *Syzygium* spp. and *Melaleuca* spp. White *Melaleuca cajuputi* bark is chosen to make the bag brighter. Main part of the bag is often decorated with cassowary feathers and/or grass seed (Figure 4).



Figure 4. Traditional bags, skirts, headbands and other products made from *L. articulata* with accessories of cassowary feathers and seeds

Wanggata people use traditional bags in daily basis, or in traditional ceremonies or events. They occasionally offer bags as gifts. Daily used bags are generally larger than the one made for fashion or traditional events. In addition to bags, locals have made traditional hats, armbands and traditional skirts. For traditional hats and armbands, *L. articulata* is woven and decorated with cassowary feathers, with intention for traditional ceremonies and accessories. Meanwhile, skirts are rarely made because they are only worn for traditional events and welcoming guests. Hats, arm straps and bags have become important souvenirs and a complement to local clothing. Other products from *L. articulata* are mats, coats, umbrellas, baskets, hats, roofs and tools for serving foods, usually made from grilled sago and other traditional foods.

In the past, *L. articulata* was used for traditional clothing. This grass were harvested and then sun-dried for 3 to 5 days before weaving into clothes. Women clothing was generally thicker. Its stems have widely been used for mats, bags and baskets in Indonesia, Cambodia and Papua New Guinea. Specifically in Borneo and South Sumatra, tight *L. articulata* mats have been used for packing materials for tobacco, rubber, kapok, cotton, cane sugar and other products, and for drying paddy [6].

L. articulata bush in our peatland site sheltered fishes like nila *Oreochromis niloticus*, *Channa* sp., arowana fish (*Sceloporus jardinii*) and shrimps. Deer (*Cervus timorensis*) and pigs (*Sus scrofa*) were often seen. Those combined acted as a resource for local foraging in a daily basis [7]. While peat ecosystems provide a source of protein and an income to the community, they also disperse fuel as inhabitants often use peat soil as a substitute for wood. With this importance, the people of Wanggata thoughtfully preserve the environment, especially to let *L. articulata* a chance to self-recovery after harvesting. This has been a traditional form of conservation in *L. articulata* and the peat ecosystem.

4. Conclusion

Traditional Papuan live in harmony with the nature. Local wisdom maintains the interaction between the community, *L. articulata* and the peat ecosystem. Association between plants and peat was measured by calculating the association index value, which we found around 0.875. This suggested that there was a close relationship between *L. articulata* and peat soil. Dominance index was measured to observe the existence of prominent plant population in research area. We discovered that high dominance index, i.e. 0.868, indicating that the grass suits peat soil.

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