Edubiotik: Jurnal Pendidikan, Biologi dan Terapan
ISSN 2528-679X (print), ISSN 2597-9833 (online)
Vol. 7, No. 02, September 2022, pp. 167 – 176

Available online at:
http://ejurnal.budiutomomalang.ac.id/index.php/edubiotik

Research Article

OPEN ACCESS

Composition and diversity of riparian vegetation of the Talau river, Belu Regency

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Article Information
Submitted: 2022 – 08 – 11
Accepted: 2022 – 10 – 26
Published: 2022 – 10 – 26

ABSTRACT

Riparian vegetation has a very important ecological role i.e. maintaining water quality, as a supplier of litter, as a habitat, and as a natural filter for various pollutants. Riparian vegetation is found along the side of the river, such as along the Talau, Belu river. The purpose of this study was to determine the composition and diversity of riparian vegetation. The research area consisted of three riparian types, namely teak plantations (A Station), mixed forest (B Station), and processed land (C Station). The method used was the quadrant method. Determination of sample size was based on the species-area curve. Data were calculated using the Shanon-Wiener diversity index. The research results revealed that at A station there were 29 species consisting of 24 families; at B station there were 53 species consisting of 31 families, and at C station there were 25 species consisting of 21 families. The highest diversity (H') was found at station B with a good diversity category, followed by A station with medium and low categories, and C station with a low category.

Keywords: Diversity; riparian vegetation; talau river.

Publisher
Biology Education Department
IKIP Budi Utomo, Malang, Indonesia

How to Cite
Liunima, V., Banilodu, L., & Semiun, C. (2022). Composition and diversity of riparian vegetation of the Talau river, Belu Regency. *Edubiotik : Jurnal Pendidikan, Biologi Dan Terapan*, *7*(02), 167 - 176. https://doi.org/10.33503/ebio.v7i02.2073

INTRODUCTION

Riparian vegetation has an important ecological impact on rivers. Riparian vegetation functions to maintain river water quality by regulating water temperature, and supplying litter, and habitats for organisms (Siahaan & Ai, 2014). It also functions as a natural filter for various pollutants originating from surface runoff and flood flows (Semiun et al., 2020).Despite having an important role in ecosystems and biota diversity, riparian areas are vulnerable to exploitation because of their strategic location (Semiun, 2013). This area is widely used by the community as plantation land (Aswin et al., 2019). The influence of anthropogenic activities on river ecosystems has encouraged the development of the concept of biological indicators to determine the health status of an aquatic ecosystem (Sudarso et al., 2013). Anthropogenic activities can affect inputs of organic matter, nutrients, and heavy metals into river ecosystems through land use changes and urbanization. The increasing population and increasing development result in higher intensity of land use changes, and these changes will have an impact on riparian vegetation ecosystems (Bando et al., 2016).

The ecological phenomena described above are also found in the Talau river. The Talau River is one of the rivers that originate on Mount Lookeu, West Tasifeto sub-district, and empties into Motaain, East Tasifeto sub-district, which flows through South Atambua sub-district. This river supplies clean water for Atambua city which is characterized by clean water treatment facilities, in bron A, bron B, and bron C located in the district of South Atambua. The community uses this river for their daily life, starting from cooking, washing, watering the vegetable crops, and supplying the Wematan swimming pool.

The use of riverbanks for transportation, sandstone extraction, making cattle pens, and processing stone construction along the river has an impact on river sedimentation, loss of water biota, and river pollution due to local people often throwing garbage in the river and its surroundings. Various physical development activities along the Talau river riparian ecosystem directly or indirectly impact habitat fragmentation and deforestation, which further affects the loss of the Talau river riparian ecosystem. The loss of riparian vegetation is a significant factor in the decline and extinction of aquatic fauna (Oktaviani & Yanuwiadi, 2016).

One of the natural resources is a natural spring with abundant diversity of riparian vegetation. The diversity of riparian vegetation around water sources plays an important role in water quality (Mamulak & Semiun, 2021). Riparian is a particular conservation area that needs to be preserved in its original vegetation. If the riparian vegetation shrinks, it will impact the decline in biodiversity and the loss of function of the riparian vegetation. This is in line with the research conducted by Sholikhati et al., (2020) which revealed that the diversity of riparian plants (trees, shrubs, herbs) in the Yogyakarta river area decreased due to land changes, resulting in a decrease in the ecological services of riparian vegetation.

Information on the diversity of riparian vegetation is necessary. The data will benefit the government and the community in managing and conserving river bodies and riparian ecosystems. Previous research on the diversity of riparian vegetation that grows in the spring area in Belo and Labat around Kupang City, East Nusa Tenggara Province, Indonesia, has also been conducted by Semiun and Lenggur (2018). This research is a descriptive study that applies a systematic random sampling method. The results showed that the species richness index in Belo was higher (3.1) than in Labat (1.6). However, the riparian tree diversity index in Belo (1.83) and Labat (1.45) was categorized as low. Riparian tree vegetation has been degraded due to the influence of high anthropogenic activities. Increasing anthropogenic pressure in the river areas quickly eliminated natural riparian vegetation (Shah et al., 2015).

Based on the survey results, the Talau river has suffered damage to the riparian ecosystem due to human disturbances (anthropogenic) such as the frequent processing of construction stones, settlements, transportation, and sandstone extraction. This series of causes and effects have a peak impact on the decline in the functions and services of the Talau river riparian ecosystem. This study aimed to determine the composition and diversity of riparian vegetation in the Talau river, Belu district.

RESEARCH METHODS

This was an experimental research which was conducted in November 2019 - February 2020. This research was conducted in the riparian ecosystem of the Talau river, Fatukbot sub-district, South Atambua sub-district, Belu district. Based on the survey results, the Talau river is located in Fatukbot sub-district, South Atambua sub-district, and Belu district. The Talau river position is 340^0, for the firststar point is taken in the middle of the river at 124^{0}53'30''BT and 9^{0}8'1" South Latitude with a river width of 128 m. The Talau River is also where PDAM Atambua takes clean water and the water source to the Wematan pond. By these two essential activities, the riparian location in this study is the Talau riparian ecosystem.

There are some tools used in this research. First, GPS to measure the coordinates of the research location. Second, a compass for direction. Third an altimeter for measuring altitude. Next, camera for documenting. Fifth, 100 meter roll, 50 meter roll, and 5 meter roll to make line transects. Sixth, raffia rope for plotting. Next, label paper to provide information on the sample. Eight, plastic as a base for taking pictures of plants. Last, scissors as a raffia rope cutting tool, and stationery. Meanwhile, the materials used in this study were plants found in riparian ecosystems. The closure of the Talau riparian ecosystem consists of several main types of closure, namely, teak plantation ecosystem (A station), mixed forest (B station) located west of the Talau river, and processed land (C station) located east of the Talau river. The length of the riparian ecosystem in the west and east is ± 1200 m. Illustration of plotting at the research site can been seen in Figure 1.

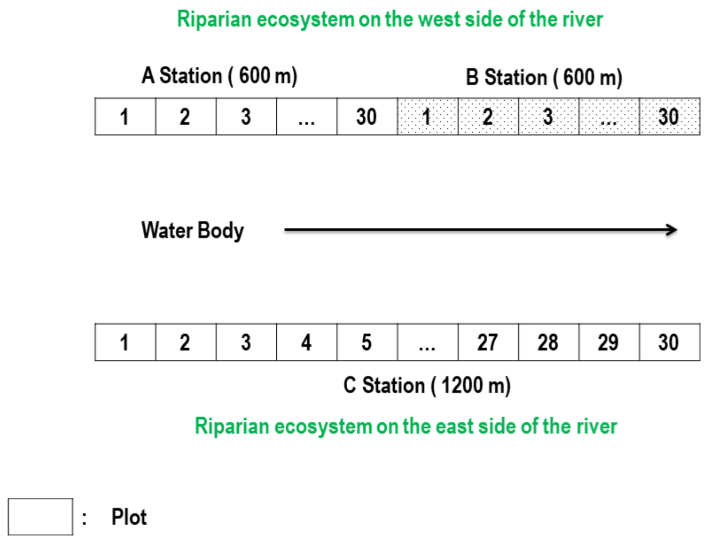

Figure 1. Illustration of Plotting at The Research Site

The method used is the quadrant method (Figure 1). The procedure for laying the quadrant (plot) is as follows: (1) Determine a reference point for station A in bron C at position 340^0 West-North, in the middle of a river body which has a width of 200 m with coordinates 124^{0}54'11.12"E, 9^{0}8'51.84"S. From the reference point, a perpendicular line is drawn at the position of 2500 South-West and measured approximately 30 m from the riverbank into the riparian ecosystem to determine plot point 1. Then, calculated from the first reference point with an interval of 20 m at a position parallel to the first cut line for determining the second plot point. To determine plot points 3 to 30, follow the same procedure for laying plots 1 and 2. Then, for riparian ecosystems to the east of the river body, a perpendicular line is also drawn to place plots 1 to 30 on community-processed land with the same procedure for plotting on the riparian ecosystem on the west side of the river. Thus, for station A there are 30 plots on the west side of the river and 30 plots on the east side of the river. (2)The reference point for station B is at position 340^0 West-North with coordinates 240^{0}54'6.46''E and 9^{0}8'44.45''S. From the reference point, a perpendicular line is drawn at the position of 250⁰ South-West and measured from the edge of the river into the riparian ecosystem to determine plot point 1. To select the second plot point, measured from the first reference point with an interval of 20 m at a position parallel to the first cut line. To determine plot points 3-30, the same procedure was done for laying plots 1 and 2. (3) Placing the plot at station C is done as following procedure. Starting from the first reference point, draw a perpendicular line to the east side of the river body at positions 240⁰54'17.59''E and 9⁰8'51.49''S. From the river bank, 30 m is drawn into community land to determine plot point 1. Return to the reference point along the main line in the middle of the river body at 30 m. A perpendicular line is drawn to the east side and from the river bank is measured 40 m into community land to determine plot points 2. Next, for determining the points of plots 3 to 30, the procedure is the same as deciding plot points 1 and 2.

The researchers identified plants in each plot. The plants are identified in local language (Tetun) with the local guider. Then, the name of plants in Tetun would be reffered to the scientific or binomial name and be checkked the current name level to Google. Furthermore, the researchers counted the number of individu in each species of the plants. The speciment then taken to be documented as "Digital Herbarium". One plot point carried out the measurement of abiotic factors such as geographical position, altitude, temperature, light intensity, soil pH, soil moisture, and soil organic carbon.The data collected was then analyzed for diversity using the Shannon-Wiener Diversity Index (Bando et al., 2016). Here's the formula:

$$H' = -\sum P_i Ln P_i$$

Note:
H' : Shanon-Wiener diversity index
Pi : Proportion of density of i type = (ni/N)
ni : Density of the type i
N : Density of all types

The diversity index range from the most damaged to the most stable community is 1.5–3.5. Based on the degree of this diversity index, the researchers classified in Table 1.

Table 1. Categories of Diversity Index

Value	Category
<1.5	Very poor
1.5–2.0	Poor
2.6–3.0	Moderate
2.6–3.0	Good
>3.0	Very good

FINDING AND DISCUSSION

The findings in three stations, i.e., A station (Teak Plantation), B station (Mixed Forest), and C station (Cultivated Land) of the Talau River, Fatukbot sub-district revealed that there were 77 plant species belonging to 40 families (Table 2). At A station, there were 29 species consisting of 24 families. At B station, there were 53 species consisting of 31 families, and at C station, there were 25 species consisting of 21 families. In identifying plant species in riparian ecosystems, several references have been used, namely the digital herbarium book "Species of Trees, Shrubs and Herbs in the Old Church

(Former Village Tajo) Nginamanu Village, Wolomeze District, Ngada Regency, NTT Province" and browsing the internet through the PlanNet application and related articles.

Table 2. Riparian Plants Found in the River Talau

No	Name of plants	Family	∑ Individu					
			SA		SB		SC	
			Tree	Bush	Tree	Bush	Tree	Bush
1	Kecibiling	Acanthaceae	-	-	-	22	-	-
2	*Saurauia mandersiss*	Actinidiaceae	-	-	-	21	-	-
3	Mangga	Anacardiaceae	2	-	35	-	-	-
4	Sirsak	Anonaceae	3	-	5	-	-	-
5	Kasturi hutan	Anacardiaceae	-	-	2	-	-	-
6	Pulai hutan	Apocynaceae	-	11	-	-	-	-
7	Pulai hutan	Apocynaceae	-	-	5	-	-	-
8	Biduri	Apocynaceae	-	-	-	-	-	72
9	Bunga lonceng	Apocynaceae	-	-	-	5	-	-
10	Gewang	Arecaceae	9	-	15	-	-	-
11	Rotan	Arecaceae	-	-	18	-	-	-
12	Bunga putih	Asteraceae	-	-	-	7	-	188
13	Ketul	Asteraceae	-	29	-	107	-	-
14	Sembung	Asteraceae	-	3	-	-	-	-
15	*Canaria annua* L.	Asteraceae	-	-	-	84	-	-
16	Bandotan	Asteraceae	-	-	-	2	-	-
17	*Blumeria riparia* Dc.	Asteraceae	-	-	-	7	-	-
18	*Canna indica* L.	Cannaceae	-	-	-	-	-	8
19	*Lonicera Periccymenum*	Caprifoliaceae	-	-	-	4	-	-
20	Pepaya hutan	Caricaceae	-	-	-	-	-	10
21	Cemara laut	Casuarinaceae	149	-	48	-	108	-
22	Ketapang hutan	Combretaceae	3	-	-	-	5	-
23	*Diopia virginiana* L.	Cyperaceae	-	-	-	7	-	-
24	Jarak pagar	Euphorbiaceae	-	-	5	-	-	-
25	Kemiri hutan	Euphorbiaceae	5	-	9	-	-	-
26	*Baccharis halimflora*	Fabaceae	-	-	-	3	-	-
27	Angsana	Fabaceae	7	-	3	-	-	-
28	Gala-gala	Fabaceae	4	-	-	-	1	-
29	Pohon saga	Fabaceae	-	-	5	-	-	-
30	Trambesi	Fabaceae	-	-	8	-	30	-
31	Lamtoro	Fabaceae	-	-	-	101	-	109
32	*Carina annua* L.	Fabaceae	-	-	-	7	-	84
33	Asam	Fabaceae	-	-	8	-	-	-
34	Orok-Orok	Fabaceae	-	-	-	106	-	-
35	Kepuh	Fabaceae	-	-	-	1	-	-
36	Putri Malu	Fabaceae	-	-	-	53	-	74
37	*Hyptis suaveoleus*	Lamiaceae	-	-	-	5	-	-
38	*Mentha aquatica* L.	Lamiaceae	-	-	-	-	-	3

No	Name of plants	Family	∑ Individu					
			SA		SB		SC	
			Tree	Bush	Tree	Bush	Tree	Bush
39	*Hyptis suaveolens* L.	Lamiaceae	-	-	-	-	-	3
40	*Persea americana*	Lauraceae	-	-	-	2	-	-
41	Kemangi hutan	Lamiaceae	-	-	-	45	-	-
42	Jati putih	Lamiaceae	13	-	-	-	-	-
43	Putat	Lecythidaceae	-	2	-	-	-	-
44	Paku	Lomariopsidaceae	7	-	62	-	-	-
45	Mamejava	Gentianaceae	-	3	-	-	-	-
46	Bunga kupu-kupu	Malvaceae	97	-	24	-	-	-
47	Walikukun	Malvaceae	-	-	-	14	-	-
48	Pulutan	Malvaceae	-	-	-	3	-	2
49	Mahoni	Meliaceae	6	-	18	-	-	-
50	Jambu biji	Mytraceae	36	-	-	-	8	-
51	Ampupu	Mytraceae	1	-	-	-	-	-
52	Kayu putih	Mytraceea	7	-	-	-	-	-
53	Jambu air	Mytraceea	-	-	24	-	-	-
54	*Ficus variegata* Bl.	Moraceae	-	-	-	5	-	-
55	Awar-awar	Moraceae	-	-	-	8	-	-
56	Nangka	Moraceae	-	-	2	-	-	-
57	Pachira	Moraceae	-	1	-	-	-	-
58	Kersen	Muntingiaceae	38	-	14	-	14	-
59	*Scordocarpus borneensis*	Olacaceae	-	-	-	4	-	-
60	*Syringa vulgaris* L.	Oleaceae	-	-	-	-	-	1
61	Anggrek unggu	Orchidaceae	-	1	-	4	-	-
62	Pandan hutan	Pandanaceae	12	-	-	52	-	-
63	Dadap duri	Papilionaceae	1	-	-	-	-	-
64	Rambusa	Passifloraceae	-	27	-	30	-	-
65	Meniran	Phyllanthaceae	-	-	-	1	-	-
66	Sirih hutan	Piperaceae	-	-	-	40	-	-
67	Rumput gajah	Poaceae	-	-	-	-	-	64
68	Bambu pering	Poaceae	-	-	20	-	26	-
69	*Diodia virginiana* L.	Rubiaceae	-	-	-	-	-	2
70	Mengkudu	Rubiaceae	-	-	1	-	-	-
71	Kesambi	Sapiandaceae	89	-	25	-	30	-
72	Terung duri	Solanaceae	-	-	-	-	-	2
73	*Gompahandra mappiodes valenton*	Stemonuraceae	11	-	4	-	-	-
74	*Lantana camara* L.	Verbenaceae	-	-	-	-	-	25
75	Jati	Verbenaceae	217	-	4	-	-	-
76	Kunyit	Zingiberaceae	-	-	-	-	-	3
77	Lengkuas	Zingiberaceae	-	-	-	-	-	2
	Total		**717**	**77**	**364**	**750**	**222**	**652**

Note: SA = A Station (Teak Plantation); SB = B Station (Mixed Forest); SC = C Station (Cultivated Land)

Based on the composition and amount of riparian vegetation in the Talau river, the most common families found were Casuarina, Asteraceae, and Fabaceae. It is because plants from these three families can adapt to habitat conditions (Basrowi et al., 2018). Plants of this family are usually scattered in temperate climates but are also found in tropical and sub-tropical climates. Members of this tribe have greater adaptability than other species, allowing this family to survive in various conditions (Bando et al., 2016). One of the Casuarina families, namely sea fir (*Casuarina equisetofolia*), shows the number of individuals at station A is 149 individuals, at B station is 48 individuals, and C station is 108 individuals. It explains that the Sea Fir has good growth ability and a wide range of habitats and can grow well in wetland ecosystems such as rivers and dry land such as savannas and grasslands (Albasri et al., 2016).

Besides the Casuarina family, there is also the Asteraceae family. It consists of *ketul* (*Bides pilosa*) with 136 individuals, *sembung* (*Blumea riparia*) with three individuals, *bunga putih* (*Chorolaena odorata*) with 246 individuals, *Carina annuna* with 84 individuals, *bandotan* (*Aregatum conizoies*) with two individuals and *Blumeria riparia* with seven individuals. This plant has wide adaptability and can grow well in the shade of sufficient sunlight and moist soil conditions.The Fabaceae family consists of several species, namely Angasana (*Pterocarpus indicus*), Asam (*Tamarindus indica*), Gala-gala (*Gala festa*), Putri Malu (*Mimosa Pudica*), Saga tree (*Adenatera pavonia* L.), Trambesi (*Samanea sanan*), Lamtora (*Leucahena leucocephala*), Carina annuna, Snorkel (*Crotalaria juncea* L.), Kepuh (*Sterculia foetidal*), and *Baccharis halimflora*. The Fabaceae family is a member of the Fabales (Angsana dan Trembesi) that have high economic value so plants from this family have been widely cultivated for their benefits, such as food crops, insecticides, and erosion control (Nurika et al., 2019).

In addition to the families of Casuarina, Asteraceae and Fabaceae, there are several relatively few individuals, namely, Phyllantacaeae, Portulacaceae Stemonuracea, Lauraceae, Cyperaceae, Capritolia, and Gentianaceae with the least number of individuals. This is caused by ecological factors. Species from this family are endemic species that grow in swamp habitats and are also very tolerant species (Basrowi et al., 2018). At A Station (Teak Plantation), B Station (Mixed Forest), and C Station (Cultivated Land), each habitat with different characteristics will affect the diversity of riparian vegetation. In addition, the diversity of riparian vegetation is influenced by human activities along the Talau river for example residents living along the river utilize the riparian zone as agricultural land. This causes natural trees to be challenging to find. The diversity of riparian vegetation of the Talau River needs to be maintained considering the essential functions and benefits of riparian vegetation in maintaining the quality of the water used by local communities. The decrease in riparian vegetation diversity can also impact water quality degradation (Bental et al., 2017). According to Yirigui et al., (2019) anthropogenic activities, such as land use and land cover modifications in riparian areas, can alter the degree of fragmentation of riparian vegetation, lead to the degradation of stream habitats, and affect biological communities in the streams.

The diversity of plant species in riparian ecosystems was analyzed using the Shanon-Wiener diversity index. This index has a diversity index ranging from the most damaged community to the most stable community, which is 1.5–3.5 (Magurran, 2004). The species diversity index is important information about a community. The wider the sample area and the more species found, the higher the species diversity index value tends to be. Relatively low diversity index values are common in communities that have reached a climax (Nurika et al., 2019).

The highest diversity value is occupied by B station with good diversity category, followed by A station with medium and low categories, and the lowest is C station with low category (Table 3). The high and low diversity of plants in the riparian ecosystem at each station is influenced by abiotic factors and habitat factors (Basrowi et al., 2018). At B station, in terms of habitat, the level of diversity is classified as good. The environmental conditions around B station contribute to the value of H' which is better presumably because it is in a shaded area. It is a dense forest so the number of plant species is more varied when compared to A station and B station, therefore plant species in the riparian ecosystem at this station have a good level of diversity. A good level of diversity can occur because the abundance of individuals in each family is evenly distributed (Belhiouani et al., 2019). The family in B station which has the greatest abundance is Arecaceae. However, there is no distribution of Arecaceae abundance at B station when compared to p at A and C station.

Table 3. Shannon-Wiener Diversity Index Value (H') of Riparian Vegetation

No	Station	Stratum	H'	Category
1	A (Teak plantation)	Tree	2.23	Moderate
		Bush	1.91	Poor
2	B (Mixed forest)	Tree	2.77	Good
		Bush	2.73	Good
3	C (Cultivated land)	Tree	1.93	Poor
		Bush	2.00	Poor

C station shows a low diversity index, namely for the tree stratum (H'=1.93/low diversity), and bush stratum (H'=2.00/low diversity). Similar to B station, C station is processed land that has been used by the surrounding community as agricultural land (vegetable plantations), making cattle pens, and roads for vehicles. It will result in an abundance of plants in the riparian ecosystem found. Anthropogenic activities can change the structure and function of organisms that live in river ecosystems. Usually, the ecological response caused by pollution or other disturbances is a decrease in the number of taxa richness, abundance, and a shift in the composition of taxa from sensitive to tolerant taxa (Sudarso et al., 2013). At this station there is a family that has a large abundance, namely Casuarinacaea, when compared to A station and B station, the Casuarinaceae family also has a high abundance. Station A has a moderate diversity index. The reason is the habitat factor. It is a teak plantation area, so the dominant plant is teak (*Tectona grandis*). In addition, at this station, all types of plants are very far apart. More tree stratum than bush stratum was found at station A.

Of all the stations observed, the highest diversity index value was found at B station for the tree stratum (H'=2.77) and the bush stratum (H'=2.73), while C station had the lowest diversity index value for the stratum tree (H'=1.93) and bush stratum (H'=2.00). And A station has a moderate diversity index value, namely for the tree stratum (H'=2.23) and the bush stratum (H'=1.91). Differences in the structure and composition of the constituents of an ecosystem cause differences in the character of the ecosystem that affect the diversity of biota that live in it (Paramitha & Kurniawan, 2017). Riparian vegetation at each station shows a difference. Each area has its own characteristic riparian vegetation areas that distinguishes it from others (Ainy et al.,2018).

CONCLUSION

The composition of species and families of riparian vegetation in the Talau river is 77 species, which are classified into 40 families. There were 29 species found in A station (Teak plantations) consisting of 24 families, At B station (Mixed forest) there were 53 species consisting of 31 families, and at C station (Cultivated land) there were 25 species consisting of 21 families. The highest riparian vegetation diversity in the Talau river is occupied by B station (Mixed Forest) for tree stratum (good diversity), bush stratum (good diversity), followed by A station (Teak Plantation), for tree stratum (medium diversity), shrub stratum (low diversity) and C station (Cultivated land), for tree stratum (low diversity), bush stratum (low diversity).

ACKNOWLEDGEMENT

The authors would like to thank all those who have assisted in this research so it could be conducted well. The gratitude goes to Tirta society that have been permitted research team to observe and conduct the research there.

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