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Research article

SPECIES ACCOUNT OF MANGROVES IN THE COASTAL AREAS OF PANGAYAWAN, GITAGUM, MISAMIS ORIENTAL, PHILIPPINES

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ABSTRACT

The inventory of mangroves in Pangayawan, Gitagum, Misamis Oriental was assessed for species composition, diversity, and dominance using the transect method. The vegetation in the area consisted of seven species: *Avicennia marina, Avicennia rumphiana, Rhizophora apiculata, Rhizophora mucromata, Sonneratia alba, Lumnitzera racemosa* and the mangrove associate *Nypa fruticans*. Rhizophoraceae species dominated the seaward zone while *Nypa fruticans* is a mangrove found only in landward zone. This was attributed to the mangrove's typical zonation pattern based on inundation and the common seedlings of *Rhizophora* species used in replanting activities in the area. The mangrove area in Pangayawan is relatively stable, with low human disturbance. The relatively low species diversity of the mangroves at Pangayawan, Gitagum, Misamis Oriental, needs to do intervention programs aimed to increase species richness. This is to achieve an ecologically-stable mangrove ecosystem that provides economic benefits to the community and to enhance the biodiversity of the coastal areas.

Keywords: species account, tropical mangroves, Northern Mindanao, conservation and management

INTRODUCTION

Mangroves are a group of trees and shrubs that live in the coastal intertidal zone. There are about 80 different species of mangrove trees. All of these trees grow in areas with low-oxygen soil, where slow-moving waters allow fine sediments to accumulate. Mangrove forests only grow at tropical and subtropical latitudes near the equator because they cannot withstand freezing temperatures.

Many mangrove forests can be recognized by their dense tangle of prop roots that make the trees appear to be standing on stilts above the water. This tangle of roots allows the trees to handle the daily rise and fall of tides, which means

that most mangroves get flooded at least twice per day. The roots also slow the movement of tidal waters, causing sediments to settle out of the water and build up the muddy bottom. Mangrove forests stabilize the coastline, reducing erosion from storm surges, currents, waves, and tides. The intricate root system of mangroves also makes these forests attractive to fish and other organisms seeking food and shelter from predators (Tomlimson, 1994).

Mangrove forests presently cover an area of 20 million hectares worldwide. They are sources of valuable plant products used as food, traditional herbal medicine, and other wood and forest products. They provide many of the resources upon which coastal people depend for their survival and livelihood. At low tide, people can walk across the tidal flats to collect clams, shellfish, and shrimp (Sambu et al., 2014). At high tide, fish move in to feed among the protection of mangrove roots, turning the marshy land into rich fishing grounds. The mangrove trees themselves provide fuel, medicines, tannins, and wood for building houses and boats. The Philippines has an estimated of 500,000 hectares of mangrove forest.

Mangroves protect both the saltwater and the freshwater ecosystems they straddle. Mangrove roots collect the silt and sediment that tides carry in and rivers carry out towards the sea. By holding the soil in place, the trees stabilize shorelines against erosion. Seedlings that take root on sandbars help stabilize the sandbars over time and may eventually create small islands. The mangroves' complex root systems filter nitrates and phosphates that rivers and streams carry to the sea. They also keep seawater from encroaching on inland waterways (Primavera et al., 2006).

Mangrove forest has significant ecological, environmental, and socio-economic value. It also produces large amounts of organic matter, which in turn are used by many animals. However, mangrove forest faces a serious problem, the mangrove deforestation is the major driving force of mangrove forest loss in Southeast Asia

Mangrove reforestation programs have been popular, from international development assistance programs, government-sponsored projects to community initiatives. Consequently, a mangrove reforestation effort exists in the Province of Misamis Oriental in Mindanao, Philippines. This is specifically located in the coastal Barangay of Pangayawan, Misamis Oriental.

Before, Gitagum, Misamis Oriental was endowed with native mangrove species (*Sonneratia alba*). In those times, the area was not protected and some of mangroves were cut for lumber and for other purposes. For this reason, in 2015, the local government unit of Gitagum together with the Department of Environment and Natural Resources (DENR), Bureau of Fisheries and Aquatic Resources (BFAR), Philippine Coast Guard (PCG), Misamis Oriental Provincial Government, ventured to a joint project to rehabilitate the mangrove area.

Barangay Pangayawan, one of the coastal communities in the place with 4 hectares of the mangrove reforestation project, the Barangay Council of Pangayawan sought and received the technical assistance of the DENR Regional Office. Mangrove area in Barangay Pangayawan was selected as the area of the study because its diverse mangrove trees, which is the focus of this study.

This study, therefore, is aimed to determine the species of mangroves inhabiting the coastal areas of Pangayawan, Gitagum, Misamis Oriental, specifically, to identify and document the mangrove species based on its taxonomic characters, assess the ecological status of mangroves species distributed across the area, and determine mangrove species composition and diversity. Results of the study could be a useful reference through information on the status of mangrove in the area. Determination of taxonomic characters, dominance and conservation status of species can provide information that would be useful for the conservation and rehabilitation efforts in the area.

MATERIALS AND METHODS

Entry Protocol

In order to conduct the study, a letter requesting for the permission to conduct the study and to comply for gratuitous permit were forwarded to the Office of the Punong Barangay of Pangayawan, Gitagum, Misamis Oriental, Office of the Mayor of Gitagum, Office of the CENRO, Initao, and the DENR Regional Office 10. All necessary environmental and health protocols were deliberated and taken into consideration upon conducting the study.

Research locale

The study was conducted at the Mangrove Area in Pangayawan, Misamis Oriental, and Philippines from October to November 2021 (Figure 1). Barangay Pangayawan is one of the coastal communities of Gitagum, with a mangrove area 4 hectares.

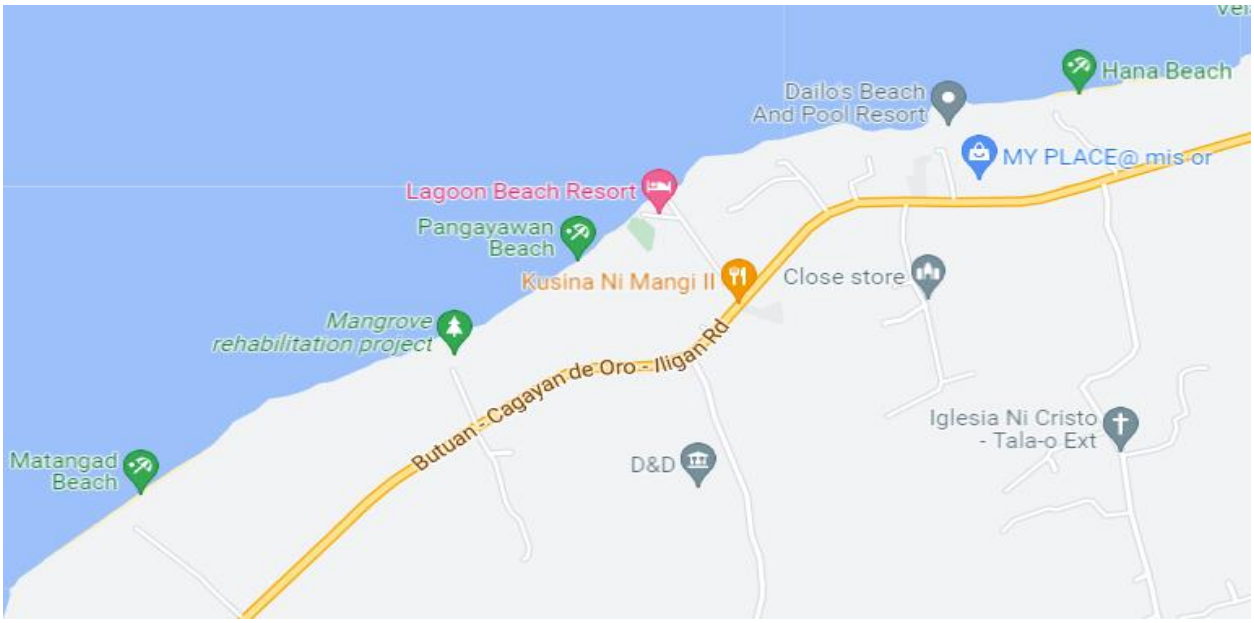

Figure 1. Map showing the Mangrove Rehabilitation Site in Pangayawan, Gitagum, Misamis Oriental

Establishment of the sampling site and collection of samples

The inventory of mangrove species in Pangayawan, Gitagum, Misamis Oriental was done through the Quadrat method (BMB 2017). Quadrats measuring 10mx10m were laid out to represent the eastward zone, middle zone and westward zone. Several field trips were made to select the field stations (Table 2).

Table 2: Select sampling stations with coordinates

Stations	Zone	Status	Latitude	Longitude
1	Eastward zone	Intact	8.58621^0	124.374915^0
2	Middle zone	Intact	8.588156^0	124.3793983^0
3	Landward zone	Intact	8.588083^0	124.37953^0

Morphology and habitat description

Each specimen collected was described in terms of the leaf, flowers and propagules. Those parts had represented in the herbarium preparations. The gathered plants were numbered and record in the filed notes regarding the collector, date of collection, locality, common name, habitat, diameter breast height and height of the mangrove.

Ex-situ conservation

Two live representative specimens of each species were collected during sampling.

Documentation

Photograph was made from actual observation in the field site as to the mangrove species natural habitat using camera.

Preparation of herbarium specimen

Field notes were taken and preliminary identification of mangrove species and habitat description was conducted. Morphological characteristics of leaf, flowers, and propagules were noted and used in the identification of species. Key guides such as the Field guide to Philippine Mangroves by Primavera 2006 and other published works were used. Photographs were made from actual observation in the field site to the mangrove species natural habitat using high-resolution camera.

Species diversity was determined using the Shannon index of diversity, with the formula for the computation based on Magurran (1988):

$$\text{Shannon index } H+ = -\sum[n_1/N)[\ln(n_1/N)]$$

Where: H' = Shannon index of diversity
n_1 = frequency of occurrence of species within the plots
n = the total number of occurrences of all species in all plots

Ethical Considerations

The researcher ensured that the study was guided by ethical principles. The ethical principle emphasized in this study is informed consent. A gratuitous permit was secured, approved letter from the Barangay Captain, Mayor, CENRO and DENR Region 10 were secured as requirements to obtain the gratuitous permit.

RESULTS AND DISCUSSION

Taxonomy and Morphology of Mangroves at Pangayawan, Gitagum, Misamis Oriental

Table 1 presents a total of seven (7) species of mangroves collected in the study site and pre-identified until species level and confirmed by the experts. The collected mangroves belong to five (5) families, namely Avicenniaceae, Combretaceae, Rhizophoraceae, Sonneratiaceae and Palmae.

Family: Avicenniaceae
Scientific Name: *Avicennia marina*
Common Name: Bungalon, Api Api, Miapi
Conservation Status: Threatened
Distribution and habitat: Grow inland side of tropical and subtropical coastal swamps
Description: Small to the medium-sized tree (3-11 m), main trunk straight, up to 76 cm in diameter, with a much-branched, rounded crown. Bark pale yellowish-green, with raised dots, flaking. Extensive underground root system with 'pencil roots' (pneumatophores or breathing roots) up to 90 mm long, sticking up out of the mud in dense stands spreading out from the tree. Leaves opposite, 30-100 x 12-40 mm, thick, leathery, shiny olive-green above, with dense grey hairs beneath, margin entire with sharply or bluntly pointed tip, base narrowing, petiole short (5 mm long). Flowers creamy yellow, small, dense round heads in leaf axils or terminally, on

short, square stalks, sweetly scented. Fruit a green, oval, two-valved capsule 20-25 mm diam.; seed developing on the tree, fruit usually splitting after falling; water-dispersed

Family: Avicenniaceae
Scientific Name: *Avicennia rumphiana*
Common Name: Bungalon, Api Api, Miapi
Conservation Status: Threatened
Distribution and habitat: Grow inland side of tropical and subtropical coastal swamps
Description: Grey mangroves grow as a shrub or tree to a height of 3 to 10 m (9.8 to 32.8 ft), or up to 14 m in tropical regions. The habit is a gnarled arrangement of multiple branches. It has smooth light-grey bark made up of thin, stiff, brittle flakes. This may be whitish, a characteristic described in the common name. The leaves are thick, 5 to 8 cm (2.0 to 3.1 in) long, a bright, glossy green on the upper surface, and silvery-white, or grey, with very small matted hairs on the surface below. As with other Avicennia species, it has aerial roots (pneumatophores); these grow to a height of about 20 cm (5 in), and a diameter of 1 cm. These allow the plant to absorb oxygen, which is deficient in its habitat. These roots also anchor the plant during the frequent inundation of seawater in the soft substrate of tidal systems. The flowers range from white to a golden yellow colour, are less than 1 cm across, and occur in clusters of three to five. The fruit contains large cotyledons that surround the new stem of a seedling.

Family: Combretaceae
Scientific Name: *Sonneratia alba*
Common Name: Pagatpat
Conservation Status: Threatened

Distribution and habitat: Grow inland side of tropical and subtropical coastal swamps
Description: ***Sonneratia alba*** grows up to 40 metres (130 ft) tall with a trunk diameter of up to 70 centimetres (30 in). The cracked to fissured bark is brownish, turning grey below the tidal mark. The flowers are white, pink at their base. The dark green fruits measure up to 5 cm (2 in) long.

Family: Combretaceae
Scientific Name: *Lumnitzera racemosa*
Common Name: Tabao, Culasi
Conservation Status: Threatened
Distribution and habitat: Grow inland side of tropical and subtropical coastal swamps
Description: ***Lumnitzera racemosa*** is a small to medium-sized evergreen tree, growing to a maximum height of 37 m (121 ft). It develops pneumatophores and often has stilt roots. The leaves are arranged spirally at the tips of the shoots; they are simple and obovate, with slightly toothed margins.

Family: Rhizophoraceae
Scientific Name: *Rhizophora apiculata*
Common Name: Bakhaw Lalaki
Conservation Status: Least Concern (Population Decreasing)
Distribution and habitat: Grow inland side of tropical and subtropical coastal swamps
Description: Tree 20-30m tall. Bark dark grey and chequered. It is conspicuously arching stilt roots that can extend 5m up of the stem. Often also with lots of aerial roots emerging from the branches so that the tree appears to have a skirt of roots under the leave. Leaves eye-shaped (8-15cm long), glossy green and stiff, with tiny evenly distributed black spots on the underside. A stipule is usually (but not always) red. Flowers (1-2cm) in pairs on very short stalks so they appear to be stuck directly onto the branch. Calyx globular hard thick,

brown on the outside yellow inside. Petals yellow to white, flat membranous and hairless, falling off soon after blossoming. The fruit looks like a brown, upside-down pear (about 2cm) and is crowned by short persistent sepals. The cylindrical hypocotyl can be up to 38cm long, somewhat smooth, green ripening purple.

Family: Rhizophoraceae
Scientific Name: *Rhizophora mucromata*
Common Name: Bakhaw babae
Conservation Status: It is declining due to harvesting and habitat degradation; it is not threatened with extinction but should be monitored.
Distribution and habitat: Mangrove forest swamps, along the coast. This mangrove is widely distributed in tropical and subtropical Africa, Asia, and America.
Description: The tree's size is from small to medium, and it measured 2–5 m, even up to 10 m tall, with strong apical dominance. Stem up to 400 mm in diameter, straight, with distinctive aerial roots or what is also referred to as knee-roots (breathing roots), with rough reddish, brown to almost black bark and extending, bristled, light grey branches. Leaves compact, simple, oppositely arranged, broadly elliptic to oblong-elliptic, leathery, hairless, glossy, dark green to yellowish-green, crowded towards the end of branches; margins smooth with pointed apex and distinctive hair-like tip of up to 5 mm long; tapering at both ends; main vein prominent and with distinguishing black dots underneath the leaves. Creamy white flowers, few arranged in axillary heads, leathery with short thick stalks; calyx persistent. The fruit is single-seeded, up to 70 mm long, germinating while still on the tree (viviparous). It is said that its seeds do not last long in storage.

Family: Palmae
Scientific Name: *Nypa fruticans*
Common Name: Nipa
Conservation Status: Least Concern (Population Decreasing)
Distribution and Habitat: Nipa palms grow in soft mud and slow-moving tidal and river waters that bring in nutrients. The palm can be found as far inland as the tide can deposit the floating nuts. It is common on coasts and rivers flowing into the Indian and Pacific Oceans, from India to the Pacific Islands. The plant will survive occasional short-term drying of its environment. Despite the name "mangrove palm" and its prevalence in coastal areas, the nipa palm is only moderately salt-tolerant and suffers if exposed to pure seawater. Instead, it prefers the brackish
Description: The nipa palm's trunk grows beneath the ground, and only the leaves and flower stalk grow upwards above the surface. Thus, it is an unusual palm tree, and the leaves can extend up to 9 m (30 ft) in height. The flowers are a globular inflorescence of female flowers at the tip with catkin-like red or yellow male flowers on the lower branches. The flower produces woody nuts arranged in a globular cluster up to 25 cm (10 in) across on a single stalk. The ripe nuts separate from the ball and are floated away on the tide, occasionally germinating while still water-borne.

Species composition

Table 2 shows the species composition of mangroves in Pangayawan, Gitagum, Misamis Oriental, distributed in three (3) transect lines within the established 10mx10m quadrats. The mangroves belong to five (5) families, namely, Avicenniaceae, Combretaceae, Rhizophoraceae, Sonneratiaceae and Palmae. A total of eight (7) mangrove plants species comprised the mangrove forest, such as *Avicennia marina, Avicennia rumphiana, Lumnitzera racemosa, Rhizophora apiculata, Rhizophora mucronata, Sonneratia alba* and the mangrove plant associate *Nypa fruticans.*

Nypa fruticans made up 33% was the only mangrove in the transect three since this mangrove does not occur on shores overexposed wave action and never in hypersaline conditions to Tomlinson (1994).

The seaward part of the forest was dominated by *R. mucromata* at 26%, *R. apiculata* at 6%, *Sonneratia alba* at 21%, and *Avicennia marina* at 8%. These mangroves mostly observed at the seaward part of the forest, which can tolerate wave action and hypersaline conditions.

Species richness of mangrove in Pangaywan, Gitagum, Misamis Oriental is very low compared to those recorded in other parts of Mindanao such as in Panguil Bay which mangroves consisted of a total of eleven, Davao Gulf with eight (Lumasag et al., 1991, 1996) and Pangasinan in Gingoog Bay which mangroves consisted of eighteen species (Dalogdog, 2006). However, this observation should be taken with caution since these mangrove forests have been reforested. There are several factors attributed to it, such as the size of the mangrove area and the number of trees present and mangrove planting activity provided only particular species of mangrove to plant which are suitable to the condition of the area such as *Rhizophoraceae sp*. is the most common and often used in replanting activities. Most of the seedlings of *Rhizophora* (Bakawan) are planted and cannot be attributed to natural regeneration. At the same time, *S. alba* (Pagatpat) tress is probably from natural recruitment.

However, Shah, Kamal, Rosli, Hakeem, and Hoque (2016) identified nine mangrove tree species from eight families at the Sibuti mangrove forest. Sarawak was the dominant mangrove species in the forest and also *Rhizophora apiculata*. Like *R. apiculata*, *Xylocarpus granatum* was also found in all three transects, and *Nypa fruticans* was observed on the river bank.

Table 2. Species composition of mangroves in Pangayawan, Gitagum, Misamis Oriental

Family	Common name	Species	Local Name	Transect 1			Total	Transect 2			Total	Transect 3			Total	%
				Q1	Q2	Q3		Q1	Q2	Q3		Q1	Q2	Q3		
		Avicennia marina	*Bungalon, Apiapi, Miapi*	5	4	4	13	0	2	1	3	0	0	0	0	8
Avicenniaceae	Black mangrove	*Avicennia rumphiana*	*Bungalon, Apiapi, Miapi*	2	3	3	8	0	0	0	0	0	0	0	0	4
Combretaceae	White mangrove	*Lumnitzera racemosa*	*Tabao, Culasi*	1	2	0	3	0	0	0	0	0	0	0	0	2
		Rhizophora apiculata	*Bakhaw laki*	3	2	2	7	0	0	5	5	0	0	0	0	6
Rhizophoraceae	Red Mangrove	*Rhizophora mucronata*	*Bakhaw Babae*	1 5	1 3	1 0	38	0 2	0 1	1 5	15	0	0	0	0	26
Lythraceae	Apple Mangrove	*Sonneratia alba*	*Pagatpat*	3	2	2	7	0	0	5	35	0 2	0 2	0 2	0	21
Palmae	Mangrove Palm	*Nypa fruticans*	*Nipa, Sasa*	0	0	0	0	0	0	0	0	2	0	5	67	33
Total No. of Species							7				4				1	10 0
Total No. of Individuals							76				58				67	20 1

Species diversity

Estimates of Shannon- Wiener Diversity Index (Table 3) shows that the species diversity of the mangrove communities in the three transects within the mangrove forest of Pangayawan, Gitagum, Misamis Oriental is relatively weak with H+ values ranging from 0- 1.51. Transect 1 obtained the low diversity with 1.45, which indicates that it has the most diverse mangrove composition, followed by Transect 2 with 1.19. In contrast, transect 3 with 0, which was located at the landward side of the forest, showed the least different transect in terms of mangrove composition because only *Nypa fruticans* dominated the transect.

The index is used to measure the diversity that accounts for the number of species present in the area and the relative abundance of each species. Hence, if the species richness increases, the diversity increases (Barcelona Field Study Centre, 2015). The Transect 3 has the lowest index of evenness due to the least number of species richness and the predominance of *Nypa fruticans*. Aggregating the data from the three transects indicates an overall diversity index of H= 0.88, which indicates low diversity. The mangrove community of Pangayawan is relatively poor in terms of species diversity, due to low species richness and abundance of most species. Another factor affecting the diversity measure of Pangayawan mangroves is the dominance in the number of a few species, notably *N. fruticans* and *Rhizophora sp*., while other species are rare. The current study is similar to the study of Cañizares and Seronay (2016). They conducted a survey of the diversity and species composition of mangroves in Barangay Imelda, Dinagat Island, and the Philippines. They concluded that Barangay Imelda, Dinagat Island, falls under very low diversity (H category) with ten true mangrove species, belongs to six families.

Additionally, according to Sambu, Rahmi, and Khaeriyah (2014), the species composition of mangrove vegetation in their three study sites shows that heterogeneity or biodiversity is very low since they only found four (4) mangrove vegetation. The above authors further claimed that based on their findings, the adaptability of mangrove vegetation differs either in versatility to zonation or resilience level. Species of *Rhizophora* is more adaptive to zonation, and it can be restored fast compared to other vegetation.

Table 3: Shannon- Wiener index of the three transects within mangrove forest in Pangayawan, Gitagum, Misamis Oriental

Study Site	Shannon-Wiener Index (H)	Interpretation
Transect 1	1.45	Low Diversity
Transect 2	1.19	Low Diversity
Transect 3	0	Low Diversity
Overall	0.88	Low Diversity

Interpretation: Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon Index increases as both the richness and the evenness of the community increase

CONCLUSIONS AND RECOMMENDATIONS

As for the study results, it can be concluded that the mangrove area in Pangayawan is conducive to the growth of several mangroves. It was mostly dominated by mature mangrove trees with large basal areas indicating that it had less human disturbance and was relatively stable.

Mangrove Reforestation and rehabilitation project in Barangay Pangayawan was observed to be successful and has a positive impact on mangrove conservation in the area. The project becomes highly essential to the residents because changes are evident. Such changes include the control of dynamite fishing partly attributed to the organization's visibility; involvement of fishermen who are now protecting the mangrove. The community headed by the organization also keep the cleanliness of the area by conducting "pahina," a communal cleanup drive regularly. To sustain the program, they make a follow-up to check if the planting is in place. This effort of conservation highly shows a significant part of the people's organization in mangrove rehabilitation in Barangay Pangayawan. Today, the mangrove forest serves as a sanctuary of fishes and eggs and a tourist spot of the municipality.

Based on the study's findings, it is recommended to sustain the effort by strengthening the organization through training related to reforestation by the DENR. The local community should be encouraged to participate in these activities actively. Furthermore, regular monitoring of the mangrove status should be conducted at regular periods, e.g., annually, to determine improvements from any rehabilitation activities. It is also recommended that residents in the area participate in reforestation programs and planting another species. Strict implementation of laws should be done to minimize if not stop the cutting of mangroves in the area to allow trees and seedlings to grow. The increase in species richness is significant for achieving ecologically-stable mangrove flora associates that may provide economic benefits to the community.

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