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FOREST SOILS OF JUNGLE MAHAL

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Abstract: Jungle Mahal, though vague in its existence either in the representation in the geographical mapping or in the government records, still the term of Jungle Mahal is yet immensely popular for its numerous forest patches, elephant corridor and man-elephant conflict with the local inhabitants. The forest area of the Jungle Mahal (composed of four districts and part of two districts) once is in depleting status, which is now reviving as reported by the Forest Survey of India in 2019. The probable reasons for this increasing scenario of Jungle Mahal are the impact of climate change, change of soil chemical parameters and local people's direct participation with the forest department for forest restoration. As the study of the impact of climate change is continuing, a pilot survey has been taken up to review the physico-chemical parameters of soil in the selected areas from the Jungle Mahal. Results obtained from the soil chemical analysis of the sampled soils up to rooting depth of 30 cm show status quo as recorded before for the forest stands of the south-east part of West Bengal.

Keywords: pH, NPK, Organic Carbon, EC, Acidic soil, Jungle Mahal.

1. INTRODUCTION

Jungle Mahal (literally meaning of Jungle Mahal is Jungle estates) was formed by the rulers of the British East India Company in 1805 as a district comprising 23 Parganas and Mahals in the Bengal Province of the British India in terms of Regulation XVIII of 1805. After 28 years of its existence officially, the British rulers abolished the district in 1833 by the implementation of Regulation XIII of 1833 due to several inconveniences caused for its vague jurisdiction for managing administration and collection of revenue. There is no existence of such a district in the name of Jungle Mahal in West Bengal since then, but the name of Jungle Mahal is still popular to the people of West Bengal. At present, forest areas of Purulia, Bankura, Paschim Medinipur and Jhargram districts and part of Paschim Bardhaman and Birbhum districts form Jungle Mahal in the south-west part of West Bengal (Fig. 1, 2, 3), though the major portions of the forest areas of the then Jungle Mahal of the eighteenth century are now reclaimed and converted into agricultural land. A few forest patches are still in existence under the jurisdiction of the forest department, and they are classified as Reserved Forests and Protected Forests according to their importance of wildlife conservation [1]. Topographically the area is characterized by an alluvial plain in the east with maximum elevation of 150 m and covered with red soil in the west with maximum elevation of 200 m [2]. The area is basically hot and humid with a small duration of cold weather and rainy days. Temperature ranges between 60C in the winter and about 440C during hot summer days [3]. Annual average rainfall ranges from 900 to 1500 mm and the percentage of relative humidity varies between 49%, minimum in the month of April and 85%, maximum during the month of August. In this climatic condition and physiographic set up, the physio-chemical properties of forest soils play an important role for forest restoration. Analysis of such chemical properties of forest soils and their influences on the vegetational pattern of the forests is the objective of the present study.

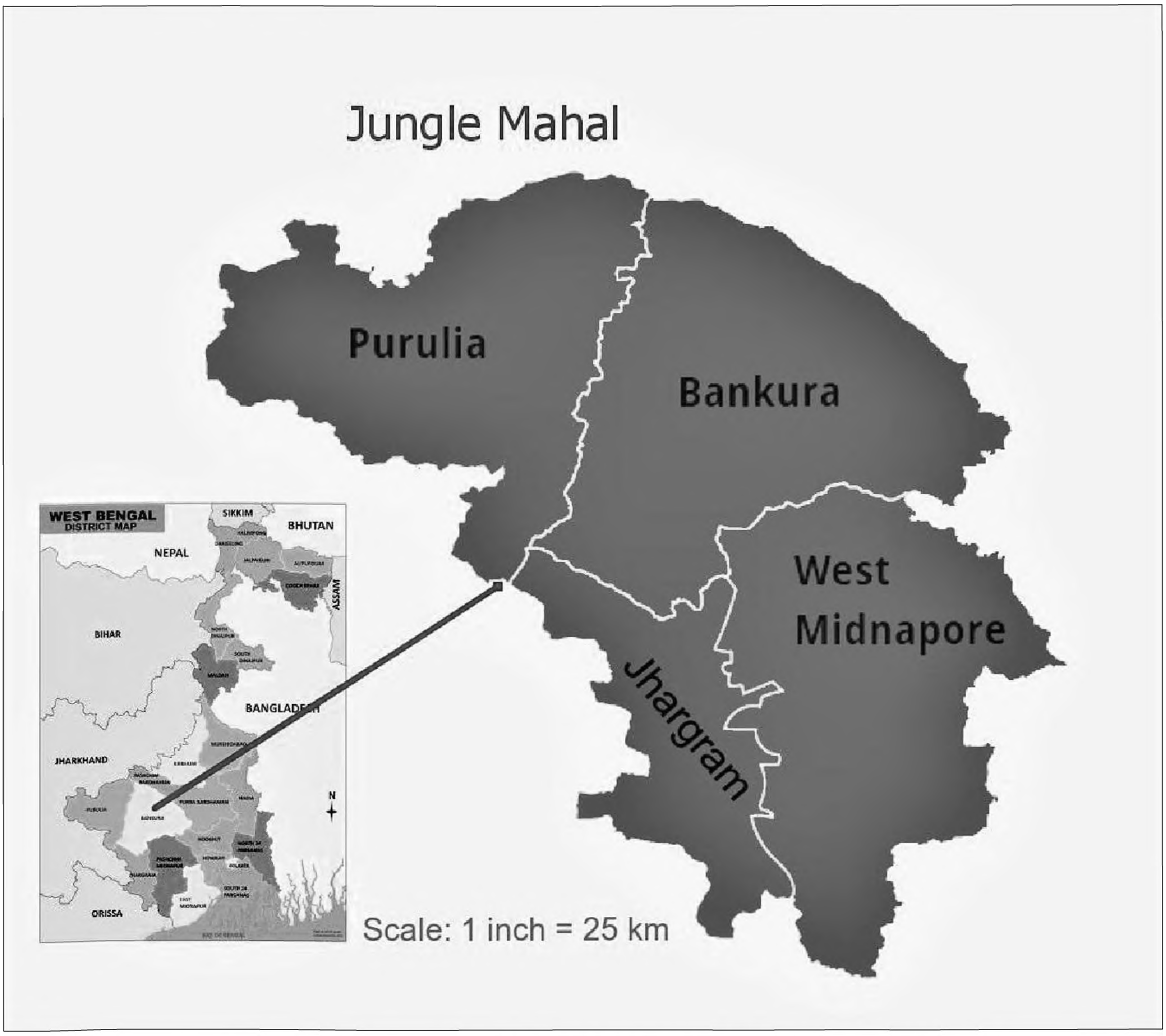

Fig. 1 : Location map of the Jungle Mahal at the south-west part of West Bengal

2. SOIL CHARACTERISTICS

Forest soils of Jungle Mahalat its east side are characterized with Alfisol with slight admixture of red soil. Alfisol, a typical forest soil, composed of aluminum and iron as main components. The prefix 'Alf' of Alfisol is derived from aluminum (Al) and iron (Fe). Alfisol offers relatively native fertility to the forest vegetation through moderate leaching of clay minerals and soil nutrients from the surface layer to subsoil that enable food and fiber production of plants [4, 5]. Abundant occurrences of calcium, magnesium and potassium in the soil turns Alfisol saturated into at least 35% base composition that lead

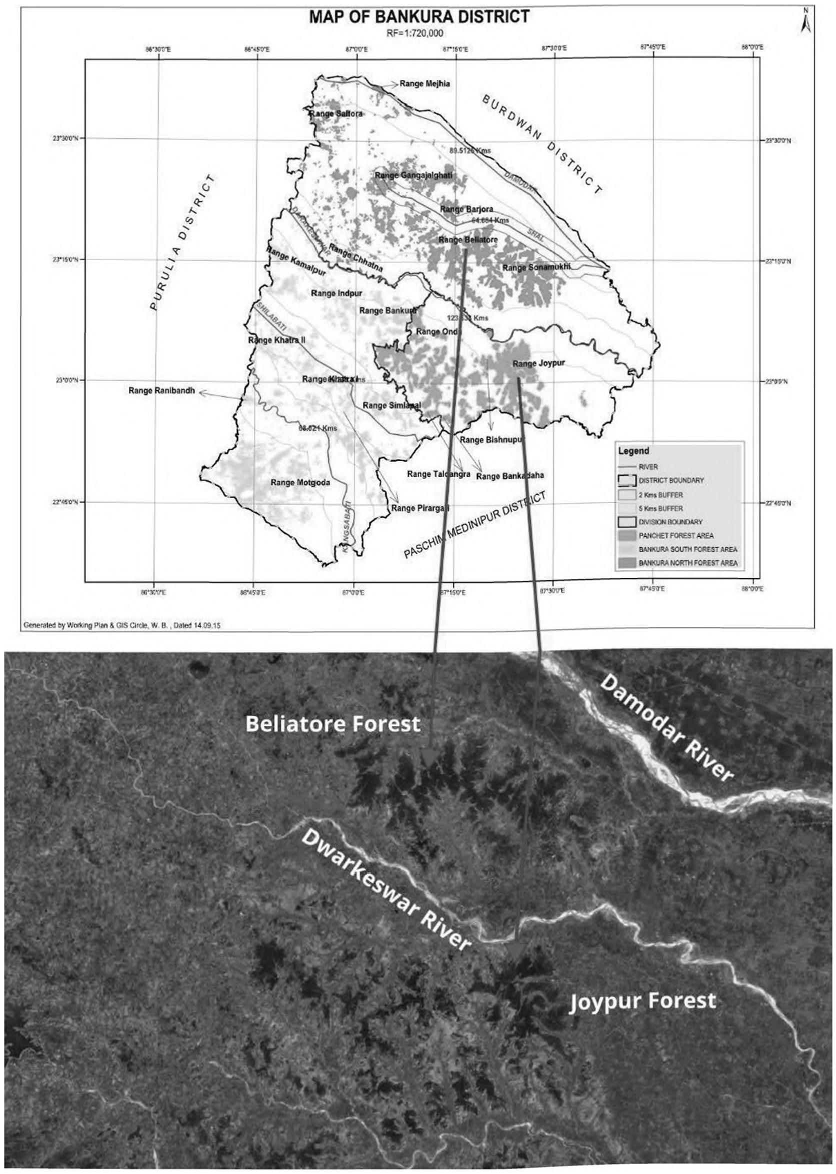

Fig. 2 : Location map of Joypur forest and Beliatore forest in the district of Bankura

to high productivity and keep it fertile than other humid-climate soil. Alfisol is associated with semiarid to moist areas of relatively cooler, drier climates and younger landscapes of forest cover where rapid leaching, weathering and removal of bases are generally not occurred [6, 7]. These physicochemical properties along with presence of inherently fertile parent materials of Alfisol assist luxuriant growth of the floral assemblages in the forest.

The forest soils of western part are predominantly red soil derived from disintegration of rocks and stones of Chotanagpur plateau region. The common forest soils are yellowish in colour on the upper layer and reddish in depth of 30 cm with non-calcareous and low concentration of soil nutrients [8-10]. Soils are relatively low in pH value indicating slight to moderate acidic nature of red soils. Available iron, manganese and copper are high with respect to low percentage or almost deficient occurrence of available boron, molybdenum, and zinc in the soils of the forest floors where soils are generally cemented by iron and aluminum oxides. Overall, the soils are characterized with low pH, high exchangeable acidity, and low base exchange capacity. Concentration of soil nutrients like NPK (nitrogen, phosphorus & potassium) and organic carbon content depends on the elevations, derived parent materials that control the pattern of vegetation in the forest stands of the west part of Jungle Mahal. NPK availability as plant nutrients to the forest stands exhibits low in availability in the soils, characteristics of lateritic soils. Physico-chemical properties of soil and soil organisms present in the forest floor as independent or dependent variables have decisive influence on forest vegetation [11-14]. Denser the forest, more soil-health potential is gained through improvement of soil characteristics by litter fall on the forest floor [15]. Texturally, soil exhibits a medium to coarse grain size distribution that contains a high amount of acid-soluble ferric oxide. Average soil texture varies a little for the soil samples of different parts of Jungle Mahal. In an average, coarse sand ranged from 2 – 20%, fine sand 14 – 22%, very fine sand 11 – 24%, silt 21 – 39%, and clay 14 – 34% constitute the forest soils of the Jungle Mahal.

Forest plants usually uptake available nutrients, ready for absorption and assimilation, derived from weathering and biomass decomposition. Weathering contributes calcium, magnesium, potassium, and sodium (base cations) along with iron, aluminum, and manganese (acid cations) to the forest soils. Trees are very much selective in choosing elements for absorption from among these elements. Forest plants absorbs NPK and manganese, whereas aluminum, chlorine and sodium are in their list of discrimination [16, 17]. For the decomposition process, microorganisms, agents for decomposition of forest biomass, classified as four major groups – bacteria, fungi, Actinomycetes and algae, cause microbial decomposition and contribute microbial biomass [18].

Forest lands have higher soil carbon content than the agricultural land due to production of detritus from leaves, bark, fruit, flower, seeds, flosses, and others from the plants. The soil carbon content becomes low with the conversion of forest land into agricultural land for decomposition of soil organic matter through the oxidation process. Decomposi-tion of litter fall such as leaves, bark, flosses, seeds, flowers, and fruits produce organic carbon and extract available nutrients to the forest vegetation. Amount of organic carbon in forest floor of Sal (Shorearobusta) forests is relatively lower (1.07%) as the Sal leaves are frequently collected by the local people particularly the tribal community for its different uses and low rate of decomposa-bility of Sal (Shorearobusta) tree leaves and their loss in the runoff water during rainy days [19]. The plantation forests enrich soils in organic carbon and thus improve the forest floor with increasing amounts of organic carbon. Calcium, magnesium, phosphorus, and nitrogen with maximum quantity returns to the soils of the forest floor of Sal forests through leaf litter. Mixing the maximum content of such calcium with soil depends upon the nature of tree species in the forests and the amount is determined with the content of calcium present in the tree leaves. Sal forests have higher content of exchangeable calcium and lower content of exchangeable magnesium in the plantation site with mixed vegetation [20].

3. RESULTS AND DISCUSSION

Soil samples from a rooting depth of 30 cm were collected during the period from February 2020 to November 2020 from 19 points selecting randomly distributed 19 pedons from some selected districts of Jungle Mahal. Pedons were selected in the experimental stations to study the characteristics of soil as 'pedon' in the forest land surface is considered as the smallest unit [21]. As the concentration of soil nutrients and other chemical properties are rather higher up to the depth of 30 cm and changes of soil chemical properties at soil depths are insignificant in the forest landscapes, all soil samples were collected at the depth of 30 cm from the top surface layer [22]. Soil samples from the study area are collected and soil chemical parameters are analyzed following the standard methods for interpreting their correlation with the growing stock vegetation of the forests (Table1).

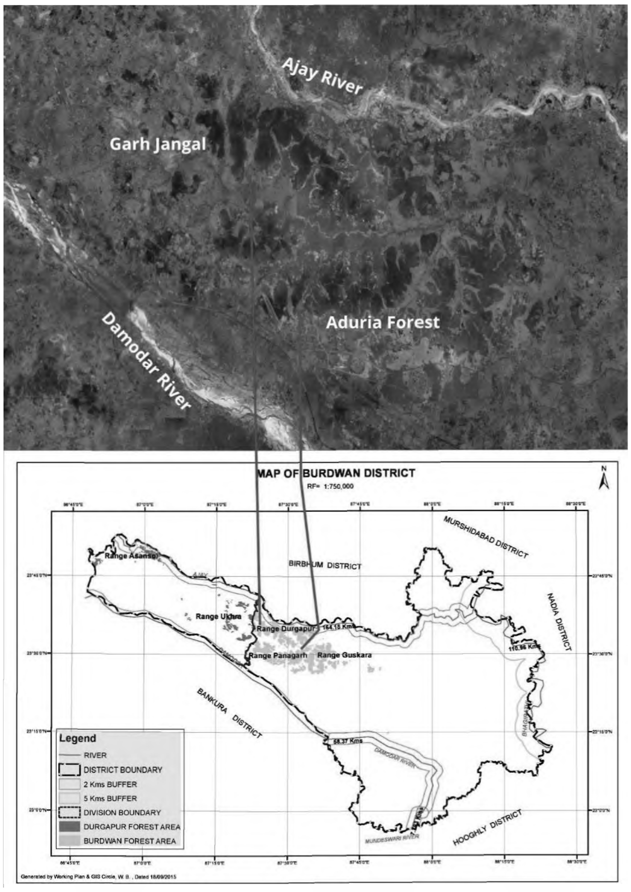

Fig. 3 : Location map of Aduria forest and Garh Jangal in the district of Paschim Bardhaman

3.1 Data analysis

Organic carbon of forest soils of Jungle Mahal varies from 0.16 to 0.81% (Table 1 & Figure 4). The soil organic carbon shows higher value in Beliatore forest (0.50 to 0.81%) and this happens for aggregation of more litter at forest floor as the soil carbon content and forest floral assemblage density is directly correlated. Electrical Conductivity (EC) varies from 0.02 to 0.07 dS m-1 of the forest soils of Jungle Mahal. Composition and nature of humus present in the forest soils controls the EC having higher content of calcium cation (Ca++) in Sal forests. Presence of calcium cation in the soil increases base saturation, exchangeable cations and EC in the soils covered with trees in the forests. Maximum EC in the forest soils was reported in the plantation sites with imported species like Eucalyptus and Acacia rather than the forest areas covered with indigenous species like Shorearobusta, Buchananialanzan, Lagerstroemia parviflora, andMadhuca indica etc. [23]. Soil pH varies from 4.43 to 5.76 indicating acidic nature of soil and low base exchange capacity. Soil pH, acidic in nature for all the samples, has a major impact over nutrient availability and fertility of soil. Soil pH is recorded higher in the forests covered with Sal trees (Shorearobusta), though litterfall, and its decomposition contribute weak acids to the forest floor [24].

Table1 Soil physicochemical parameters of the soil samples collected at selected pedons of the forest stands of Jungle Mahal

Sample No	Location	Soil pH	Electrical Conductivity (dS m^{-1})	Organic Carbon (%)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
J 1	Joypur forest	5.42	0.03	0.25	140	95.82	67.35
J 2		4.43	0.03	0.44	245	25.98	70.05
J 3		5.24	0.07	0.66	455	19.49	205.58
J 11		5.76	0.07	0.78	595	26.21	361.65
J 12		5.73	0.06	0.75	560	23.52	397.04
J 13		5.51	0.03	0.38	210	62.50	371.73
J 14		5.10	0.04	0.41	227.50	22.85	419.78
J 15		5.41	0.03	0.69	490	27.55	671.89
B 1	Beliatore forest	5.45	0.07	0.50	280	4.87	166.50
B 11		5.28	0.03	0.63	420	133.06	99.23
B 12		5.09	0.03	0.63	420	24.86	226.46
B 13		5.75	0.05	0.81	630	26.21	441.17
B 14		5.42	0.04	0.72	525	35.62	486.30
B 15		5.14	0.04	0.66	455	34.27	212.46
G 1	Garh Jangal	4.65	0.04	0.16	87	17.86	93.38
A 1	Aduria forest	5.53	0.03	0.18	89.50	27.61	55.20
A 11		5.14	0.05	0.22	122.50	28.90	202.27
E 1	11-Mile forest	5.11	0.02	0.56	350	102.14	164.75
E 2		5.15	0.03	0.38	210	63.17	220.86

Available nitrogen content of all samples varies from 87to 630kg/ha in the forest floors of Jungle Mahal as red soil is reported to be poor in available nutrients like NPK(nitrogen, phosphorus, and potassium). Available nitrogen is generally considered as the most important factor limiting the growth of the trees. Content of available nitrogen in the mineral horizons of forest soils are recorded higher than the amount accumulated in the organic horizons and the rate of accumulation of available nitrogen differs from one forest to another forest stand due to presence of different tree species phosphorus in the forest soils of Jungle Mahal varies from 4.87 to 133.06kg/ha. Phosphorus cannot alone improve forest-health, but it works well in combination with nitrogen for the forest stands. Available phosphorus accelerates growth of trees and thus is significantly correlated with the forest growth. In Perhumid climatic conditions, forest soils contain low amounts of available phosphorus [24, 25]. Available potassium in the study area ranges from 55.20 to 671.89kg/ha and it exhibits high content of potassium in the forest soils of the Jungle Mahal (Table 1 & Figure 4).

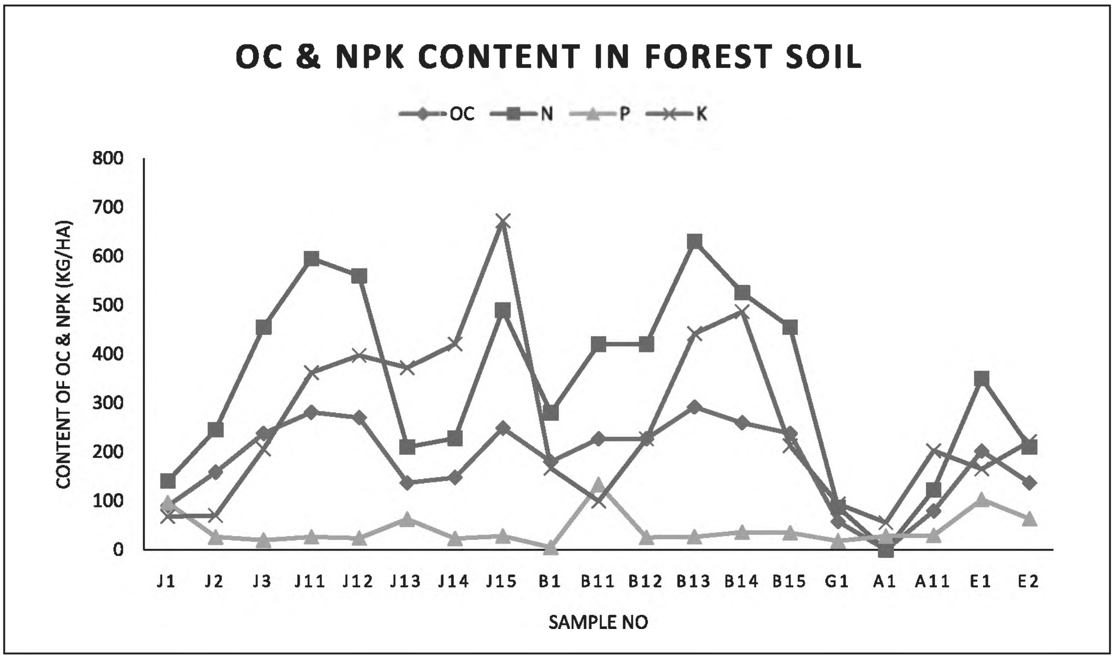

Figure 4 Diagrammatic representation of the soil chemical parameters of different forest patches of Jungle Mahal

composition and different physico-chemical properties of forest soils [25]. Available nutrients are generally higher in the vegetation-covered forest areas than the available nitrogen, phosphorus, and potassium in open spaces. Available

4. CONCLUSION

The results of the chemical analysis of the soils sampled in the different forest patches of the Jungle Mahal comes out to be constant as usual for the nutrient concentration and physico-chemical parameters which are characteristics for the red soil and Alfisol of the forest stands. Data obtained from the soil chemical analysis for nutrient concentration and other chemical parameters reveals that the nutrient uptake by the forest vegetation from the microbial biomass decomposition and mineralization thereon in the forest floors, are almost equal to the return of the same by means of litterfall at constant and usual rate by the trees in the forest stands situated at different topographical areas within the Jungle Mahal in the state of West Bengal.

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