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Synergistic influence of iodine and hydrogen peroxide towards the degradation of harmful algal bloom of *Microcystis aeruginosa*

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ABSTRACT

Cyanobacterial blooming due to the influence of temperature and increased nutrients in ponds/lakes aided by the runoff from agricultural lands, is a serious environmental issue. The presence of cyanotoxins in water may poison the health of aquatic organisms, animals, and humans. In this study, we focus on chemical assisted degradation of *Microcystis aeruginosa*– an alga that is of special relevance owing to its consistent blooming, especially in tropical regions. The study aims to ascertain the individual iodine (I) and hydrogen peroxide (H_2O_2) and their combination (hereinafter referred to as IH) effects on the degradation of *Microcystis aeruginosa*. *As expected, the collected pond water revealed the presence of metal ions viz., Ni, Zn, Pb, Cu and Mn, which enriched the blooming of M. aeruginosa. Interestingly, a complete rupture of the cells – pigment loss, biochemical degradation and oxidative damage–was observed by the IH solution after exposure for ~9 h under ambient conditions.* In comparison to control (original water without chemicals), the addition IH completely eliminated the pigments phycocyanin (99.5%) and allophycocyanin (98%), and degraded ~81% and 91% of carbohydrates and proteins, respectively due to the synergistic action of I and H. Superior degradation of algae through a simple and eco-friendly approach presented in this study could be *explored more effectively towards its large-scale applicability.*

1. Introduction

The global availability of freshwater resources accounts to just 2.5%, among which only 1% is accessible for drinking, agriculture, irrigation, industry and power generation (Hotloś, 2008; Ray et al., 2018). Similarly, about 10% of the world's animal species survive exclusively in freshwater with oligo or mesotrophic conditions. In this context, freshwater is a precious resource that needs to be conserved and protected. However, the cyanobacterial blooms observed globally pose a significant threat to the freshwater resources and in particular the blue-green algal blooms are reported to be one of the major issues that deteriorate the water quality, making it unfit for drinking (Avagyan, 2011). The common bloom forming blue-green algae species are *Anacystis, Anabaena, Aphanizomenon, Merismopedia, Spirulina, Nostoc, Oscillatoria, Cylindrospermum, Microcystis, Limnothrix, Planktothrix, Arthrospira, Phormidium, Lyngbya,* and *Raphidopsis* (Tiwari and Chauhan, 2008). Among these, the bloom of *Microcystis* has been reported in more than 100 countries (Avagyan, 2011; Mirasbekov et al., 2021). Notably, the *Microcystis* produce toxic microcystin –a complex mixture of cyanotoxins, is reported in more than 80 countries (Tang et al., 2018). The produced toxic microcystin not only deteriorate the water quality, but also inhibits embryo development in fishes (Quesada et al., 2004) and increase the risks humans run by eating these fish and other animals from contaminated waters (Avagyan, 2011). Further, the consumption of pond/lake water with *Microcystis* bloom containing the toxic microcystin causes hepatic damage, hepatocellular cancer, liver cancer, renal damage, and internal hemorrhage (Herrera et al., 2018; Li et al., 2016; Milutinović et al., 2003) in animals and humans. Unfortunately, the pond/lake water with *Microcystis* bloom becomes unfit even to be used for bathing or washing as it is reported to cause severe skin irritation (Mirasbekov et al., 2021). Notably, the sustainable development goals (SDG) framework of United Nations compeising the17 global priorities

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Occurrence and Ethnic Uses of *Cryptocoryne consobrina* Schott, A Lesser-Known Endemic Aroid, in Kerala and Tamil Nadu

Review Article

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Abstract

Cryptocoryne consobrina Schott, a narrow endemic and threatened plant species of the Western Ghats, is described. Notes on distribution, ethnobotanical uses along with photographs and illustrations are also provided. The present collection of this species, from Idukki District and Tiruppur District, confirming its occurrence in Kerala and Tamil Nadu respectively. The plant grows in thickets along the riverbank and exposed areas of the riverbed. The plant forms a preferred leafy vegetable for the local inhabitants, especially the Malappulaya Tribe of Marayur apart from being a herbal remedy for peptic ulcer.

Keywords: Araceae; *Cryptocoryne*; Endemic, Kerala; Malappulaya Tribe; Tamil Nadu

Introduction

The genus *Cryptocoryne* of family Araceae is represented by about 50 species in the tropics embracing Asia and Malaysian Archepelago (Mayo *et al.*, 1997) [1], including six species reported from the Indian subcontinent (Sunil and Sivadasan, 2009) [2]. *Cryptocoryne consobrina* was originally recognised and named by Schott in 1857 based on a collection from 'Nilgherries' (Nilgiris), India in Hooker and Thomson's herbarium (K). Branes collected the species from Parambikulam and adjacent Karappara river basin of Kerala in 1934, after which no collection was known from Kerala. Though a specimen of *Cryptocoryne* collected from Malappuram District in Kerala was misidentified as *C. consobrina* (Sivadasan, 1985; Jacobsen *et al.*, 1989a, 1989b) [3,4,5], it turned out to be a new species *C. sivadasanii* on detailed investigation by Bogner (2004) [6]. Sabastian collected the species from Aliyar submergible area of Coimbatore District, Tamil Nadu in 1962, after which no collection was known from Tamil Nadu. The species, which was considered extinct until recently has been rediscovered by Sunil and Sivadasan (2009) [2] from Coorg District in Karnataka State. The present collection of *Cryptocoryne consobrina* Schott, from Marayur in Idukki District and Kodanthoorkkudi in Tiruppur District, while confirming its occurrence in Kerala and Tamil Nadu respectively forms distributional record from new localities of the two southern States of India.

The location of the collection in Kerala (10° 15' 12.5" N latitude and 77° 10' 21.6" E longitude) at an altitude of ~865 m above MSL is within Pambar River basin, one of the three east-flowing rivers of

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Original Article : Open Access

Effect of heavy metals on *Boerhavia diffusa* L. and SDS-PAGE profiling of protein

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Abstract

Heavy metals are class of elements in which no biological role in plants, at the same time it is imparting toxicity in plants especially metabolic activities. Toxic effect of different concentrations of heavy metals such as cadmium, chromium, mercury and lead was studied by cultivating rooted propagules of *Boerhavia diffusa* L. for a period of twenty days in Hoagland nutrient medium, artificially contaminated with known concentration of those heavy metal ions. Toxic effect of these heavy metals are negatively influencing the metabolic activity of the plants. Protein profiling of root, stem and leaves of *B. diffusa* are traced by using the techniques SDS-PAGE. Protein profiles of cadmium, chromium, mercury and lead stressed proteins showed significant difference when compared each metals and tissues, respectively.

1. Introduction

In recent years, heavy metal (HM) toxicity has become a global concern which always imposing a severe threat to the environment and human health. In the case of plants, a higher concentration of heavy metals, above a threshold, adversely affects cellular metabolism because of the generation of reactive oxygen species which mark the key biological molecules. Moreover, some of the heavy metals such as mercury and arsenic, among others, can directly alter the protein/enzyme activities by targeting their – SH group to further impede the cellular metabolism (Noctor *et al.*,2012; Shahid *et al.*, 2014; Riyazuddin *et al.*, 2022). *B.diffusa* (Common name-Hogweed) belonging to the family of Nyctaginaceae, is a diffused perennial herbaceous medicinal plant growing prostrate or ascending upward in habitats like grasslands, agricultural fields, fallow lands, wastelands and residential compounds (known also under its traditional name as 'Punarnava' in sanskrit and "Chuvannathazhuthama" in malayalam). The plant was named in honour of Herman Boerhaave, a famous Dutch Physcian of the 18th Century (Chopra, 1969). *B. diffusa* plant has a long history of uses in Ayurvedic or natural herbal medicines (Dhar *et al.*, 1968). The major active principle present in the root is alkaloidal and is known as 'punarvavine'. The medicinal value of this plant in the treatment of a large number of human ailments is mentioned in Ayurveda, 'Charaka Samhita', and 'Sushruta Samhita'. About 45 Ayurvedic preparations inclusive of 'Dhanvantaaristam', 'Chyavana parasam,''Ashokarishtam', 'Punarnavasavam', 'Rasanadikasayam', 'Narasimharasayam', *etc.*, contain the roots, leaves or entire plant of *B. diffusa* (Sivarajan and Balachandran, 1994). The roots, leaves or the whole plant of *B. diffusa* have been employed for the treatment of various disorders in the Ayurvedic herbal medicine in India, Nepal, Sri Lanka and China. The root is mainly used to treat gonorrhoea, internal inflammation of all kinds, dyspepsia, odema, jaundice, menstrual disorders, anaemia, liver-gallbladder and kidney disorders, enlargement of spleen, abdominal pain, *etc.* (Kirtikar and Basu, 1956). It was also demonstrated that the drug decreased the albumin urea, increased the serum protein and lowered serum cholesterol level (Ramabhimaiah *et al.*, 1984). Singh and Udupa (1972) reported that the dried root powder showed curative efficiency for the treatment of helminth infection.

B. diffusa is a medicinal plant widely used as an important ingredient of many Ayurvedic preparations. These plants grow profusely as wild plants and are well adapted to polluted areas such as road side, railway track, banks of drainage, vicinities of public comfort station, *etc.* By trial and error experiments, the present author observed that *B. diffusa* plants grow well in Hoagland nutrient medium under hydroponic system. So, simulated experiments were set up to analyse the responses of *B.diffusa* by cultivating rooted propagules in Hoagland solution artificially contaminated with known quantities of cadmium chloride ($CdCl_2$), potassium dichromate ($K_2Cr_2O_7$), mercuric chloride ($HgCl_2$) and lead acetate $(CH_3\text{-}COO)_2Pb\ 3H_2O$.

Eventhough, effect of Cd, Cr, Hg and Pb have been investigated in a number of plants. Effect of these heavy metals on medicinal plants in general and *B. diffusa* in particular have not yet been

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A New Species of *Memecylon* (Melastomataceae) from Western Ghats, India

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ABSTRACT: *Memecylon travancorense* Sivu, N. S. Pradeep, Pandur. & Ratheesh, a new species of *Memecylon* from Agastyamala Biosphere Reserve of the southern Western Ghats is described herewith illustration and photographs. Its distinctive characters are discussed and comments made on differences between this and its allied taxa. This new species is similar to *M. wightii*, but clearly distinct by having sub-terete, greyish white branchlets, broadly elliptic to oblong leaves with slightly cordate to rounded leaf base, umbellate inflorescence with quadrangular peduncles and shortly pedicellate flowers. Information on habitat, distribution, and conservation status are provided.

KEY WORDS: India, Kerala, Melastomataceae, *Memecylon*, New species, Western Ghats.

INTRODUCTION

The genus *Memecylon* L. consists of more than 300 taxa, distributed mainly in the Old World tropics (Renner *et al.* 2007 onwards). In Peninsular India, the genus includes 35 species with 19 Western Ghats endemics Santhosh Kumar *et al.*, 2003; Rajendra Prasad *et al.*, 2006; Sivu *et al.*, 2012a, b, 2014a, b, 2015 & 2016).

During the taxonomic studies on the genus *Memecylon* in Western Ghats, the first author collected one interesting specimen from Ponmudi hills in the Agasthyamala Biosphere Reserve of Thiruvananthapuram District, Kerala State and Keerippara forest areas of the Kanyakumari District, Tamil Nadu State, at an altitude 700 to 760 m. Further studies and perusal of relevant literature showed that this taxon to be quite distinct from the hitherto known taxa and apparently belong to a new species, which is described and illustrated here as *Memecylon travancorense* sp. nov.

TAXONOMIC TREATMENT

Memecylon travancorense Sivu, N. S. Pradeep, Pandur. & Ratheesh, ***sp. nov.*** **Figs. 1 & 2**

Type: **INDIA**: Western Ghats, Kerala, Thiruvananthapuram, Ponmudi, way to Kowdiyar Mottai, evergreen forest, 30 December 2009, ± 700 m, *A. R. Sivu, 65148* (Holotype TBGT; Isotype MH)

Glabrous shrubs, upto 0.5 m tall; branchlets sub-terete; bark greyish white. Leaves opposite, elliptic to broadly oblong, 11–15 × 4–6 cm, subcoriaceous, shining above, pale beneath, base rounded to slightly cordate, margin entire, apex broadly acuminate; intramarginal nerves prominent above, straight nerves with midrib; petiole *ca.* 2 mm long. Inflorescence in short pedunculate umbels, in leaf axils and at leafless nodes, 10–12 flowered, 12–20 mm across; peduncles 3–4 mm long, quadrangular; pedicels slender, 1–3 mm long, yellowish green; bracteoles scaly, lanceolate, *ca.* 0.5 mm long, light green. Flowers 4.5–6 mm across, pinkish blue; buds obtuse. Calyx campanulate, *ca.* 2.5 mm across, shallowly 4-lobbed, pale pink, disc rays faint. Petals 4, broadly obovate, *ca.* 1.5 × 2 mm, blue. Stamens 8, equal, incurved in buds; filaments slender, bluish, *ca.* 2.5 mm long; anthers curved, white, connective with a gland, *ca.* 1 mm long. Ovary unilocular, 5-ovuled, placentation free-central; style filiform, *ca.* 4 mm long, pinkish blue; stigma pointed. Berries globose, 7–8 mm across, greenish yellow, bluish black when mature. Seed 1.

Phenology: Flowering and fruiting occurs during September-April.

Distribution & Habitat: *Memecylon travancorense* grows in medium altitude evergreen forests at elevations of 700–760 m a.s.l. in Agasthyamala Biosphere Reserve. It is known from the Ponmudi Ghats of Thiruvananthapuram district, Kerala State and Keeripara of Kanyakumari district, Tamil Nadu. The populations in both the areas are small and fragmented.

Etymology: The specific epithet '*travancorense*' refers to "Travancore", the famous Princely Kingdom once ruled the high ranges of southern Western Ghats beyond south of Palaghat Gap, which is now recognized as one of the hotspot areas of the Western Ghats.

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Euploca Nutt. (Boraginaceae)- A new species record for India reveals Biogeographical link with Gondwana Super Continent

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Abstract

The species *Euploca baclei* (DC.) Diane & Hilger (2003) of *Boraginaceae*, found in tropical Africa, America and Australia, is reported for the first time in India from the lateritic plains of Kannur district in northern Kerala. The discovery is of great phytogeographical significance and further strengthens the theory of "Biotic Ferry" by sharing floristic and faunistic elements common to Africa and Indian subcontinent and also the overall bio geographical link with Gondwana land mass of Mesozoic era belonging to Cretaceous period (approximately 132 - 72 mya).

Keywords: *Euploca,* Boraginaceae, Biotic Ferry, Gondwana, Continental drift.

Introduction

During the course of botanical exploration in the lateritic plains of Kannur district in northern Kerala, an interesting specimen of *Euploca* Nutt. (1836) was collected from a mud-covered open marsh of a drying seasonal pool. Detailed studies of the specimen confirmed it as *Euploca baclei* (DC.) Diane & Hilger, hither to known from tropical Africa, South America and Australia. Thus, the species is reported from India for the first time which deserves lot of phytogeographical importance and also strengthens the theories of the Continental Drift (Alfred Wegener, 1912) and Biotic Ferry by sharing common genetic stock of plants and animal species in Africa, Madagascar and India (Hedges, 2003). In this case, the common genetic stock of *Euploca* is spread across continents as a result of breaking away of the Southern Super Continent, the Gondwana into two lands mass viz Western Gondwana contains Africa and South America and Eastern Gondwana land with Antarctica, Australia and India with Madagascar (Biju and Bossuyt, 2003; Hedges, 2003). The inferred geological events and subsequent reconstruction of continents may be the possible answers to the present-day distribution of the genus *Euploca* in four continents as mentioned.

The genus *Euploca* was established by Nuttall (1836), but later Gray (1874) reduced it to a synonym of *Heliotropium* L., based on the systematic treatment of De Candolle (1845). Subsequent phylogenetic studies on these two genera by using the ITS1 gene spacer, found that the *Heliotropium* is paraphyletic and *Euploca* constitute a monophyletic clade, including *Heliotropium* sect species such as *Orthostachys* R. Br., *Hilgeria* Förther and *Schleidenia* Endl. (Diane *et al.*, 2002; Hilger and Diane 2003). Based on these findings proposed new combinations and now, the genus *Heliotropium* encompasses only the species incorporated into *Tournefortia* Sect. *Tonrnefortia* (genus *Tournefortia* s. str.) (Diane *et. al.*, 2003 & 2016). Besides the molecular data, *Euploca* and *Helitropium* are separated based on significant morphological characteristics like presence or absence of bracts, nature of anthers (free or fused), number of nutlets, shape of embryo,

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Review Article : Open Access Special Issue1 (COVID-19)

Healthcare management through mitigation of COVID-19 pandemic with leafy vegetables

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Abstract

COVID-19 pandemic becomes one of the leading challenges across the world. To fight against the virus, compulsory maintenance of nutritional status is very important. Age, sex, health status, medications and lifestyles are the important factors affecting individuals regarding their nutritional status. Due to the COVID-19 pandemic, the nutritional status of individuals is destabilized. To survive the current situation, a sustainable nutritional dietary should be maintained for strengthening the immune system. One of the most important ways to maintain the immune system is to supplement enough vitamin C. A spectrum of viruses that belongs to the coronavirus in humans usually causes the common cold, which is recently severe acute respiratory syndrome (SARS). SARS considered a major threat to public health, which is an emerging infectious disease. According to WHO, COVID-19 caused by the coronavirus, in which most people probably have low immunity. Eighty-five per cent of the immune system has been made by plant-based food supplements, which increase beneficial intestinal bacteria. Minerals like zinc, magnesium, micronutrients, herbal foods and vitamins C, D and E and plenty of water promote health, which is highly helpful to overcome the infection. Many studies revealed that COVID-19 infection prevented by the powerful antioxidant glutathione and bioflavonoid quercetin; to control COVID-19, plant-based foods playing a very important role to increase the immunity of people. Leafy greens and vegetables play a very important role in food and nutritional safety. Green leafy vegetables are an excellent source of vitamins, phenolic compounds and minerals. Calcium and iron are rich in leafy vegetables than that of staple food grains. Folic acid is also present in leafy vegetables. Different leafy greens, especially *Moringa oleifera* leaves, contain a high amount of folic acid compared to other leafy and non-leafy vegetable plants. This review paper aims to explore the nutritional and antinutritional factors of some important leafy vegetables. The content of nutritional and antinutritional factors varies among the genera and species of most of the edible leafy vegetables. Antinutritional factors are considered the important compound in the plant, in which they determine the absorption capacity of nutrients in human beings. Important dietary factors such as phytates, oxalates, nitrates, glycosides and cyanogenic are fruitful in many health-related problems. This article mainly explores the significance of nutrition and the use of leafy vegetables to boost up the immunity system in human beings and provide reliable dietary strategies about food safety and nutrition to survive COVID-19 pandemic around the world, especially in India.

1. Introduction

The COVID-19 disease attacked the people with a low immune system, in which people were coming under overages. Due to the inadequate responses of the immune system, it will be an open invitation for different diseases, mainly heart disease, diabetes, cancer, *etc.* To increase the body's immune system, plant-based food support and help intestinal beneficial bacteria and the gut microbiome (Casanova, 2006; Chen *et al.*, 2020). Corona patients need plenty of water which will help to keep their mucous membrane moist, which help to lower the chances of affecting flue and cold. Natural preparations like coconut water, homemade fruit juice, green tea are helpful to sense thirst and smell. The morphological and chemical composition of the COVID-19 virus is similar to human surrogate coronaviruses (Liang, 2020; Chen *et al.*, 2020). Data are available to both sustainability in the environment and effective coagulation methods regarding the COVID-19 pandemic (Baudoin and Fresco, 2002; Aguilar *et al.*, 2017; Ahern *et al.*, 2020; WHO, 2020). World Health Organisation (WHO) and CDC (Centers for Disease Control) states that elderly people having health probles, especially diabetes, lung disease and heart disease are more succeptable to COVID-19 disease. Such people are very difficult to fight against this deasese. Precautions must be taken youth and healthy individuals since this disease is easy to spread. Important symptoms of COVID-19 disease are cough, breath and brevity. Proper nutrition and hydration are vitally important in this

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Research Article

Occurrence of *Lepidagathis clavata* Dalzell (Acanthaceae) an endemic species of the Western Ghats, in the lateritic plateau of Northern Kerala

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Abstract: *Lepidagathis clavata* Dalzell is not so far reported from Kerala. Studies in the lateritic plateau of Northern Kerala showed the occurrence of this Western Ghats endemic species.

Key words: *Lepidagathis clavata*, Laterite, Acanthaceae.

Introduction

The genus *Lepidagathis* Willd. is mainly distributed in the tropical and warmer parts of the world [7]. In India, it is represented by 24 species and 8 varieties [4, 5] and 18 species and 5 varieties in the Western Ghats [4, 9]. Among them 8 species including *Lepidagathis benojiana* and 3 varieties occur in Kerala [4,10]. *Lepidagathis clavata* Dalzell was originally described by Dalzell based on a collection from the Chorla Ghat ('Ghaut') in the Sahyadri Mountains in Karnataka (Belgavi District, then part of Bombay Presidency) [3]. Kolte *et al.* rediscovered the species after a lapse of 166 years from Chorla Ghat, the type locality, Chaukul plateau in Maharashtra and lectotypified [6] the name.

During an exploratory survey conducted in the slopes of a lateritic hillock of northern Kerala found a small population of *Lepidagathis clavata* Dalzell. The present finding assumes significance, as it testifies the occurrence of the species in Kerala, particularly in the lowland lateritic/ferricretes, one of the threatened ecosystems. The locality is in the proximity of Ananthapura Lake Temple, Kumble in Kasaragod district of Kerala State at the geographical coordinates of 12° 35.027′ N and 74° 59.175′ E.

The nomenclature, description, illustration and other details are given below to facilitate easy identification.

Nomenclature

Lepidagathis clavata Dalzell in Hooker's Kew J. Bot. 2: 340.1850; C. B. Clarke in Hook. f., Fl. Brit. India 4: 518. 1885; T. Cooke, Fl. Bombay Pres. 2: 472. 1958 (Repr. ed.); Santapau, Univ. Bombay Bot. Mem. 2:73. 1952; Moorthy in Singh *et al.*, Fl Maharash. 2:645. 2001; Kolte *et al.*, Phytotaxa 265(3): 297-300. 2016.

Lectotype: India, Karnataka: Chorla Ghat [as 'Ghaut'], s. dat., Dalzell *s.n.* (K000950054, image!).

Erect, decumbent or prostrate perennial subshrub, 30-50 cm tall with woody root stock. Stems 4 - angled, woody, pubescent, branches zig-zag, terete towards base with prominent leaf scars, inter node 2.0–2.5 cm long. Leaves sessile, opposite, decussate, rigid- plicate, oblong-lanceolate, 2.0–2.5 x 0.6–0.8 cm, truncate at base, margin entire, c.5 mm long, sharply pointed spine at apex, sparsely bulbous, base hairy on upper surface and densely on lower surface especially on nerves; nerves 4–5 pairs, prominent.

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Research Article

Two New Records of *Dimeria* R. Br. (Poaceae) from Kerala

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Abstract

Dimeria gracilis Nees ex Steud. and *D. hohenackeri* subsp. *kodaguensis* Kiran Raj, Sivad & Dileep have been recorded for the first time from the State of Kerala. Detailed description with relevant notes, illustrations and photographs are provided.

Key words: Taxonomy; Poaceae; *Dimeria*; Lateritic hillocks; Kerala

Introduction

The genus *Dimeria* R. Br. comprises about 65 species worldwide [1]. They are mainly distributed in the tropical and subtropical regions of the world. In India the genus is confined to Peninsular India and represented by about 34 species, four subspecies and one variety [2, 3] of which 27 species, four subspecies and one variety are occurring in the Western Ghats [2, 4]. Among them 23 species, four subspecies and one variety found in Kerala.

While carrying out floral analysis of the lateritic hillocks of northern Kerala, the authors came across few interesting specimens of *Dimeria* collected from Kannur and Kasaragod districts. On critical observation, two specimens of the genus, showed distinct morphological variation from the species

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Neanotis prabhuii, a new species of Rubiaceae from Western Ghats, India

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Neanotis prabhuii, a new species from the Western Ghats of Kerala, India, is described. The species resembles *N. wightiana* in its compressed, glabrous and indehiscent capsule, but differs in having quadrangular broadly winged stem, large leaf lamina with cordate to amplexicaule base and conspicuous 4–6 pairs of lateral veins, dichasial corymbose cyme, large and heterostylous flowers with bristly hairs on corolla lobes, long staminal filament and style. Notes on distribution, phenology along with comparison of its allied species are also provided.

Introduction

The genus *Neanotis* Lewis (1966: 32), is a monophyletic group containing three combinations and one synonym from *Hedyotis* Linnaeus (1753: 101) (Wikström *et al.* 2013). *Neanotis* is mainly distributed in high elevation areas of tropical Asia to Australia. Govaerts *et al.* (2014) demonstrated that *Neanotis* represented by 31 species, all over the world, recent statistic from POWO (2020) reported 34 species at present.

Hooker f. (1880) recognized 18 species of *Anotis* Candolle (1830: 431) in Flora of British India. While creating new genus, Lewis (1966) transferred 28 species from the Asian members of the invalid genus, *Anotis* to *Neanotis*. Eventually, all species of *Anotis* in Flora of British India came under the new genus which are found within the present political boundaries of India. Currently, there are 21 species of *Neanotis* reported from India (POWO, 2020), with the highest diversity of 16 species and 3 varieties from the Western Ghats (Nayar *et al.*, 2014), out of which 10 species are endemic. In Kerala, the southwest part of India, the genus is represented by 8 species (Sasidharan, 2013).

The genus *Neanotis* is characterized by annual or perennial herbs, often fetid when bruised, brevicolporate pollens with (5) 6–12-aperture, 2–4-loculed ovary, capsular or rarely indehiscent fruit, seeds few to numerous, peltate, disciform to planoconvex, rounded or rarely winged.

During the systematic inventory of the genus *Neanotis* of Western Ghats, an interesting specimen was collected from Chembra Peak grasslands of Wayanad district, Kerala, India, at an altitude 1900 m. Detailed observations and study revealed its novelty and distinctness from the hitherto known species, and is described here as a new species. It is closely similar to *N. wightiana* (Wallich ex Wight & Arn. 1834: 480) Lewis (1966: 40) but differs from which in some significant characters as shown in Table 1.

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Research Article

A New Species of *Eriocaulon* L. (Eriocaulaceae) from Lateritic Plateaus of Northern Kerala, India

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Abstract

A new species, *Eriocaulon sunilii* Shaju, Rijuraj, Rajendraprasad, Rasiya Beegam & Ratheesh, from lateritic plain of Vypirium in Kasaragod district of Kerala, India, is described and illustrated. It is morphologically allied to *E. periyarense* and *E. tuberiferum*. Information on habitat, distribution, phenology, and conservation status are provided.

Keywords: *Eriocaulon, laterite, endemic, Kasaragod, Kerala, Vypirium*

Introduction

The genus *Eriocaulon* (*Eriocaulaceae*) was described by Linnaeus (Linnaeus, C. *et al.*, 1753).Species of the genus is considered to be very difficult to distinguish due to uniformity in vegetative parts and difference in floral parts (Fyson, P. F. 1919-1922). It is mainly distributed in North West Europe, tropical and sub tropical Old World to Russia, Far East and America with about 476 species (POWO. 2019). In India the genus is represented by ca. 80 species grouped under 12 sections (Ansari, R. and Balakrishnan, N.P., 2009) and the main centre of distribution is Peninsular regions. In recent years several new species have been described from India by different workers (Yadav, S. R. et al., 2008; Shimpale, V.B. et al., 2009; Shimpale, V.B. and Yadav, S.R., 2010; Vivek, C.P. et al., 2010; Nampy. S., et al., 2011; Biju, P. et al., 2012; ; Swapna, M.M. et al., 2012; Sunil, C.N. et al., 2013; Rashmi, K.and Krishnakumar, G., 2014; Sunil, C.N. et al., 2014; Sunil, C.N. and Kumar, V.N., 2015; Manudev, K. M. et al., 2017; Naveen, K. V. et al., 2017;Sunil, C.N. et al., 2017 & 2018).

During a recent floristic survey on the lateritic plateaus of northern Kerala, a tuberous specimen of the genus *Eriocaulon* was collected from a fragmented lateritic plain of Vypirium in Kasaragod district of Kerala. Critical examinations and detailed studies with available literature and authentic specimens revealed its novelty and distinctness from the hitherto known species, and is described and illustrated here as a new species. The species is allied to *E. periyarense* Naveen *et al.* and *E. tuberiferum* Kulkarni & Desai, two endemic species of Peninsular India. Key to the species, detailed description, illustration, photographs and important notes are provided to facilitate easy identification.

Taxonomic Treatement

Eriocaulon sunilii Shaju, Rijuraj, Rajendraprasad, Rasiya Beegam & Ratheesh sp. ***nov.*** (Fig 1–2). *Type:* India: Kerala State, Kasaragod District, Vypirium, open areas in lateritic plateau, (12°10'16.8"N 75°4'30.1"E ± 78 m),, 24 November 2017, *T. Shaju, M.P. Rijuraj & M.K. Ratheesh Narayanan 91778* (Holotype TBGT!; Isotypes MH!).

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New Record of an Endemic *Arthraxon* P. Beauv. from Lateritic Hillocks of Northern Kerala

Review Article

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Abstract

Arthraxon raizadae Jain, Hemadri & Deshp. (Poaceae) an endemic species in Maharashtra, Goa and Karnataka, is reported for the first time from the lateritic plains of Kasaragod district in northern Kerala. The species was first described by Jain, Hemadri & Deshpande from Mahabaleshwar, Maharashtra. The present collection figured its extended distribution and forms new record to Kerala. Nomenclature, a brief description along with illustration and photograph are provided to facilitate easy identification of the species..

Keywords: *Arthraxon*; Poaceae; Endemic; Laterite

Introduction

The genus *Arthraxon* was described by P. Beauv. It belongs to the tribe Andropogonoideae of Poaceae with about 27 species [1] and mainly distributed in Old World Tropics. In India the genus is represented by 15 species and 2 varieties [2] of which 2 species are endemic to the Western Ghats [3].

During the floristic explorations in lateritic regions of northern Kerala, authors could collect few grass specimens from Palathadam, near Kannur University Campus, Nileswaram, a floristic diverse lateritic area in Kasaragod district. Detailed examinations and critical studies of the specimen showed it to be the genus *Arthraxon*. Specific checking and observations were identified and confirmed it as *Arthraxon raizadae*. The species was first described by Jain, Hemadri & Deshpande from Mahabaleshwar and is endemic to Maharashtra (Satara, 1972), Karnataka [4] and Goa [5]. So the present collection figured its extended distribution and forms new record to Kerala. Nomenclature, a brief description along with illustration and photograph (Figures 1, 2) are provided to facilitate easy identification of the species. Arthraxon raizadae [6 -12, 5].

Description

Annuals: Culms decumbent to geniculate, 30-80 cm high, nodes bearded, rooting at lower nodes. Leaves ovate-lanceolate, 2.5-3 x 1-1.5 cm, rounded or amplexicaulous at base, margin coriaceous, undulate, ¾ part with bulbous- based hairs and finely serrate towards apex, scabrid on both surfaces with bulbous based hairs: leaf sheath 2-4 cm, ribbed, bulbous-based hairs thickly at base and towards apex, margins ciliate; ligules 1-1.5 mm long, membraneous with fimbriate margin. Racemes digitate, strictly 2 in number, each 4-6 cm long, joints sub-crustaceous, sub turbinate to linear-clavate, 3-3.5 mm long, densely ciliate. Sessile spikelets oblong-lanceolate, 6-7 x 1-1.5 mm long; callus densely bearded. Lower glume oblong-lanceolate, chartaceous to sub-coriaceous, acuminate to aristate at apex, 7- nerved, dorsally tomentose, keels with 2 rows (marginal and sub-marginal) of broad-

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