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Microecology and floristic diversity of seasonal wetlands of a lateritic plateau of South India

C. Pramod[1]*, A.K. Pradeep[1], C.C. Harilal[1] & S. Sandeep[2]

[1]Department of Botany, University of Calicut, Calicut University P.O., Kerala–673 635, India

[2]Department of Soil Science, Kerala Forest Research Institute, Peechi, Thrissur, Kerala– 680 653, India

*Email: cpramod4@gmail.com

Abstract: An analysis of the microecology and floristic diversity of the seasonal pools on the Madayippara lateritic plateau, located in Kannur District of Kerala, South India, was conducted. Temporary wetlands of varying sizes are formed during the rainy season, supporting a large number of habitat-specific flowering plants, a greater number of which are endemic, and a few belong to various threat categories. The seasonal pools vary in their size, soil cover and texture, and are subjected to extreme diurnal changes in temperature due to the high surface-to-volume ratio. They are characterised by high variation in soil temperature and water pH between pools and between seasons, extreme variation of water temperature in different seasons and in different hours of a day, and also hold maximum moisture content with extreme variation in different seasons. The soil type in most of the seasonal pools is sandy loam, and is the richest with respect to soil nutrients. The occurrence of high diversity of carnivorous plants in these nutrient-rich habitats is ascribed to the limitation in nutrient absorption, resulting from factors such as low pH, inundation and low phosphorus levels. Seasonal pools are highly specialised microhabitats active only in the monsoon period to support several specialised species showing a high degree of endemism owing to their characteristic microecology.

Keywords: Biodiversity, Conservation, Ecology, Ephemeral pools, Laterite flora, Northern Kerala.

Introduction

Laterite was first described by Francis Buchanan in 1807 from Angadippuram village in the Malappuram District of Kerala, South India, and is very common in the western coast of India, along Maharashtra to northern Kerala, and in the Deccan Plateau. In Kerala, laterite areas are mainly confined to the coastal plains and adjacent hillocks, lying between the Western Ghats and Arabian Sea, notably from Malappuram to Kasaragod (Varghese & Byju, 1993). The plateaus of northern Kerala are characterised by an extremely harsh environment, leading to the development of unique vegetation, many of which are showing special adaptations for the environment. These severe conditions play a decisive role in the development of seasonal vegetation, where most of the plant species complete their life cycle during the monsoon period (Pramod & Pradeep, 2020; 2021).

Among the numerous lateritic plateaus and hillocks scattered in northern Kerala, Madayippara is iconic with respect to the richness of biodiversity it holds and the ecological characteristics it portrays. Madayippara is a midland lateritic plateau, located in Madayi Panchayath, near Payangadi town, Kannur District, Kerala, South India, between 12°01’ - 12°03’ N latitudes and 75°14’ - 75°16’ E longitudes, extending to 3.65 square kilometres, with a maximum elevation of 50 m. This plateau forms a complex of microhabitats resulting from differences in its variable terrain and soil cover, which support diverse forms of plants, mostly herbaceous taxa. Three seasons, viz., pre-monsoon (March–May), monsoon (June–November) and post-monsoon (December–February) are recognised on the hillock. The climatic conditions vary from hot dry to warm humid in different seasons, these factors, together with varying

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edaphic factors, account for the development of characteristic vegetation and associated flora (Pramod & Pradeep, 2020). This article aims to explore the flowering plant diversity shown by the seasonal wetlands of the plateau with reference to the microclimatic and edaphic characteristics shown by the microhabitats.

Materials and Methods

Extensive field visits were conducted at Madayippara lateritic plateau (Fig. 1) from 2008 to 2023 to document the microclimatic conditions and floristic diversity of the seasonal wetlands. Specimens were collected for laboratory studies and for herbarium documentation. Voucher specimens were prepared following wet method (Fosberg & Sachet, 1965), and are deposited at Calicut University Herbarium (CALI).

Microclimatic data and soil and water samples for further analysis were collected in 12 months, between November 2012 and October 2013, from 13 quadrats of 1 m × 1 m size, established randomly in seasonal pools on the plateau. Temperature of soil and water in the seasonal pools at peak temperature hours (1–3 p.m.), water pH, diurnal variation of water temperature, soil moisture content, water holding capacity, soil texture, soil pH and the quantity of soil micro and macronutrients were analysed using standard methods. The pH of water in the seasonal wetlands was measured in the field using Eutech eco Tester pH2 model pH meter (Trivedy *et al.*, 1987). The surface temperatures of the substratum (soil) in the seasonal pool quadrats at peak temperature time (1–3 pm) were measured by inserting a toluene thermometer just below the level of the soil surface (Trivedy *et al.*, 1987). For the analysis of physical and chemical properties, soil samples were collected from permanent quadrats. For the analysis of parameters such as pH, water holding capacity and moisture content, samples were collected every month. For all other physicochemical parameters, samples collected in summer (May) alone were used. Collected soil samples were sieved with a 2 mm sieve, air dried and stored in polypropylene bags. For organic carbon content analysis, the samples were further sieved through 0.5 mm sieve. The physical properties analysed were moisture content and water holding capacity (Subramanyan & Sambamurty, 2006). Chemical parameters studied were pH (McLean, 1982), organic carbon content (Walkley & Black, 1934; Walkley, 1947), total nitrogen (Tel & Jansen, 1992), available potassium (Jackson, 1958), available calcium and magnesium (Lanyon & Heald, 1982), iron, manganese, zinc and copper (Sims & Johnson, 1991) and boron (Berger & Truog, 1939). Soil texture was determined using a Bouyoucos hydrometer and classified into distinct textural classes with a textural triangle (Rai, 1981; Trivedy *et al.*, 1987).

Results and Discussion

Seasonal ponds and small ephemeral pools

With the commencement of the rainy season, small and shallow ephemeral pools and some large ponds are formed on the plateau, which support a number of aquatic plants, including endemic species. The seasonal pools in the plateau vary in their area extension, depth, soil cover and soil texture (Fig. 2). The pools are generally depressions on the plateau, either on laterite rock or on areas with shallow soil cover. Thin layers of soil rich in organic matter have been found on rocks, which support the habitat specialist plant species. The pools get dried up in the pre-monsoon and post-monsoon seasons. They become waterlogged with the onset of the southwest monsoon and dry up after the retreat of the northeast monsoon. Four stages can be recognised in the seasonal ponds and ephemeral pools on the plateau: a wetting phase, an inundation phase, a waterlogged phase and the drought phase, as explained by Keeley and Zedler (1998) in annual vernal pools. Dick and Gilliam (2007) have shown that the intermittent inundation of seasonal wetlands, which is associated with changes in O^2 availability and soil oxidation-reduction status, influences various

Fig. 1. Views of Madayippara Lateritic Plateau in different seasons. **a** & **b**. in monsoon; **c**. in summer.

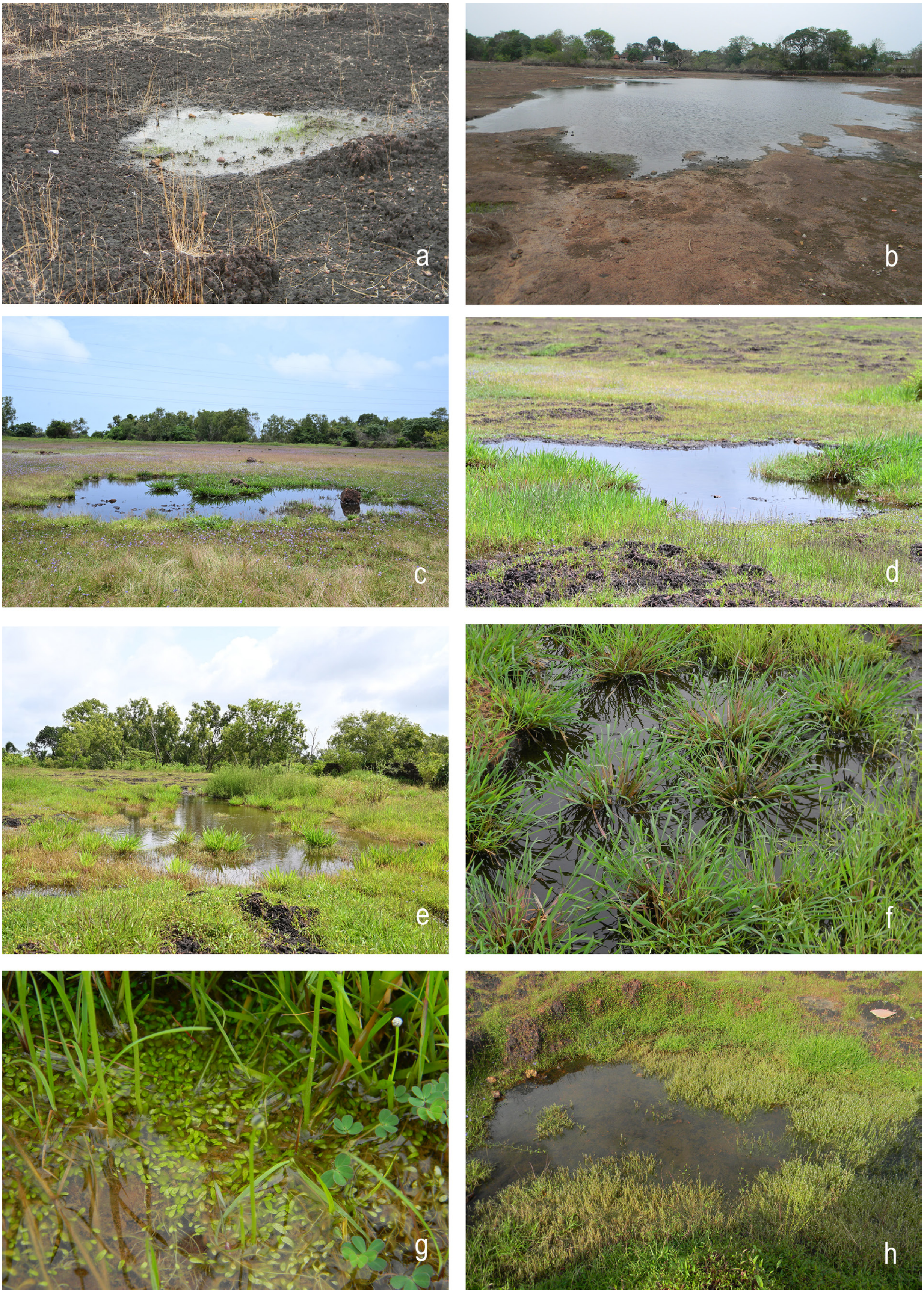

Fig. 2. Views of different seasonal pools in Madayippara in monsoon. **a** & **b**. Early monsoon; **c-g**. Monsoon proper; **h**. Late monsoon.

soil characteristics and plant species composition. Water in the seasonal pools is subjected to extreme diurnal changes in temperature due to the high surface-to-volume ratio. Krieger *et al.* (2003) observed that the few species that are capable of withstanding the hostile abiotic conditions colonise the seasonal pools in granitic outcrops. According to Porembski (2007), the rock pools of granitic outcrops form an unreliable habitat for higher plants because they dry out even in the rainy season during short rainless periods. Jocque *et al.* (2010) suggested that seasonal rock pool communities may provide a suitable monitoring system for tracking environmental change and the effect of climatic change on biological communities, as the seasonal pool communities are completely dependent on the length and frequency of inundation, and reflect the prevailing climatic conditions.

Germination of the characteristic ephemeral species in these seasonal wetlands is noticed after the early rains in May or early June every year. After this, a series of species emerge progressively until these ponds are dried in October and November. All the species in these ephemeral wetlands are herbaceous, and most of them complete their life cycle in a short period, as the pools dry up (Fig. 3). The notable and dominant species in the seasonal pool are *Geissaspis cristata*, *G. tenella*, *Isachne veldkampii*, *Murdannia ochracea*, *M. semiteres*, *Neanotis subtilis*, *Rotala malabarica*, *R. malampuzhensis*, *Utricularia cecilii*, *U. graminifolia*, *Blyxa aubertii*, *B. octandra*, *Drosera indica*, *Nymphoides krishnakesara*, *Oryza rufipogon*, *Rhamphicarpa longiflora*, *Wiesneria triandra*, *Hydrilla verticillata*, *Pontederia vaginalis*, *Eriocaulon cuspidatum*, *E. reductum*, *Schoenoplectiella articulata*, *S. lateriflora*, *Coelachne madayensis*, *Dopatrium junceum*, *Lindernia hyssopioides* and species of *Fimbristylis*.

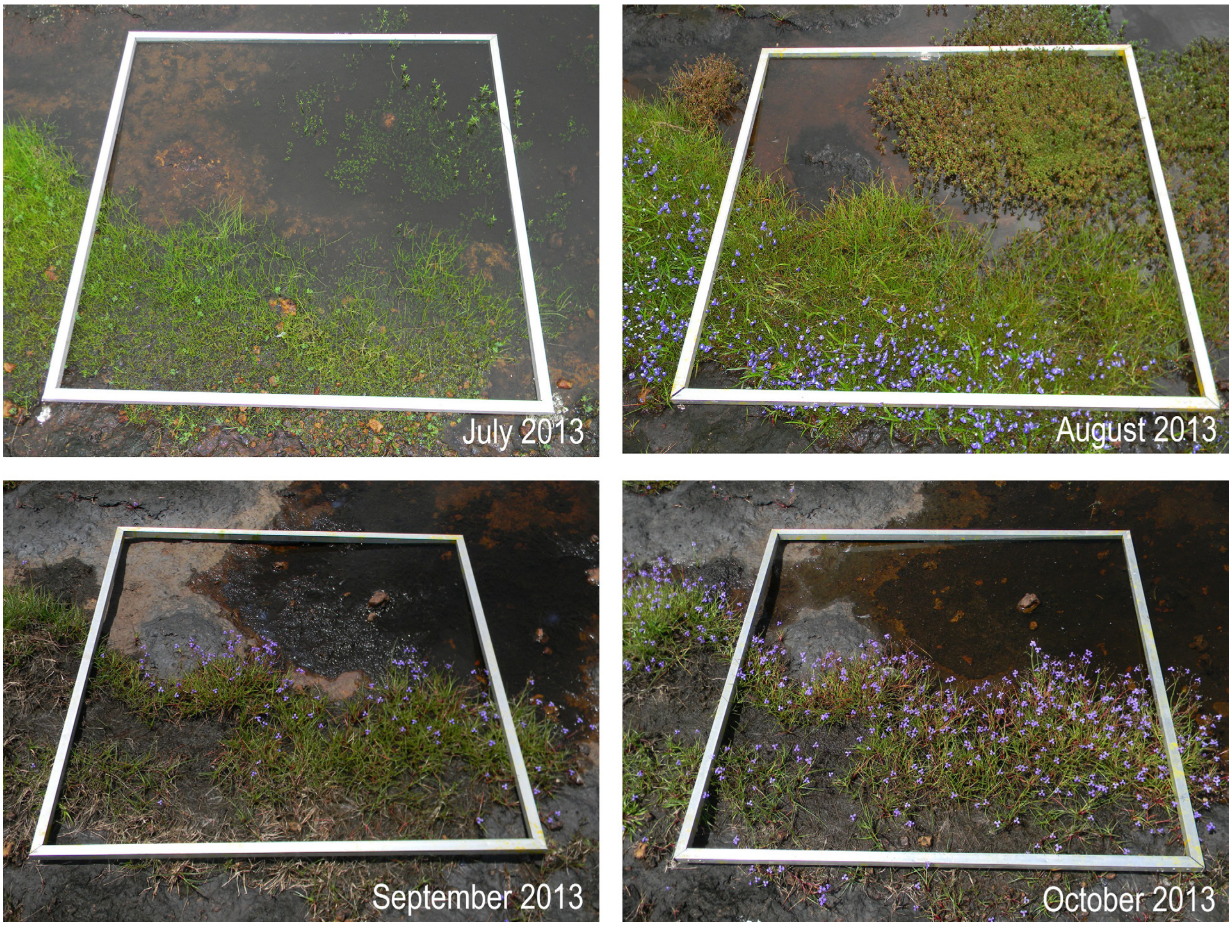

Fig. 3. Variations in flora in the wet phase of a seasonal pool.

Microclimate

The microclimatic parameters of the seasonal pools play a decisive role in the development of the plant community. The result of a study in the urban wasteland in Belgium (Godefroid *et al.*, 2007) showed that species composition is mainly driven by soil factors such as nutrient content, soil moisture, soil pH and light intensity. In their study, air temperature and humidity showed a significant contribution to the variation in species composition; some plants responded to small variations in air temperature or humidity. Microclimatic conditions such as atmospheric and soil temperatures, relative humidity, light intensity, precipitation, soil and water pH, soil moisture content, soil texture and availability of soil nutrients have a significant effect on determining the peculiar plant communities.

Peak soil temperature

Soil temperature is an important parameter that affects the germination and growth of plants. Soil temperature is affected by several factors such as soil composition, soil moisture content, exposure to sunlight and shade by plants. The average of peak temperature of soil in seasonal pools showed extreme variation between seasons (Fig. 4).

Water pH

Water pH is an important factor that determines the growth of aquatic plants in the seasonal pools. The average pH of water samples collected from the seasonal pools is 7.02 and is variable between plots and within plots at different seasons (Fig. 5). It has been observed that water bodies with higher pH tend to be occupied by species such as *Blyxa octandra, Schoenoplectiella lateriflora* and *Eriocaulon cuspidatum.* Species such as *Murdannia semiteres, Geissaspis tenella, Utricularia cecilii, Eriocaulon kolhapurense, E. eurypeplon* and *Coelachne madayensis* tend to occur in pools with lower pH. Maximum diversity in the seasonal pools along the plateau is observed towards pH 7, provided other edapho-climatic conditions remain uniform.

Peak water temperature

The plant communities of the seasonal wetlands are largely affected by the temperature of the water in the pool. The seasonal pool is normally flooded with water in the early monsoon months (June and July), and water recedes gradually in the subsequent months, depending on further precipitation in the months of October and November. When water recedes from the pool, the water temperature shows a proportionate increase, as the atmospheric temperature also increases in a similar way. The maximum peak water temperature (average) was recorded in the month of September (37.63°C) and the minimum in July (29.74°C) (Fig. 4). The temperature of water shows wide variations between different pools on account of the depth and area extension of the pool. Mostly, the herbaceous elements complete their life cycle by September. However, aquatic species such as *Geissaspis tenella, Blyxa octandra, Eriocaulon reductum, Echinochloa colona* and species of *Ischaemum* thrive in the seasonal pools during that time.

Diurnal variation of water temperature

The day-night variation of water temperature is correlated with the solar light intensity. The maximum average temperature was recorded at 1 and 2 p.m. (35.75°C), and the minimum at 6 a.m. (24.08°C) (Fig. 6). Maximum day average temperature was recorded in October (30°C) and minimum in July (26.23°C) (Fig. 4).

Soil analysis

Together with the moisture level and climatic characteristics, chemical and physical properties of the soil substrata in different microhabitats determine the variation of community development in different habitats (Messias *et al.,* 2013). The analysis of soil as a complex environment is more important than the individual role of each variable and its correlation with each species. All the variables of the soil interact themselves constituting a complex pedoenvironment that influence the vegetation structure.

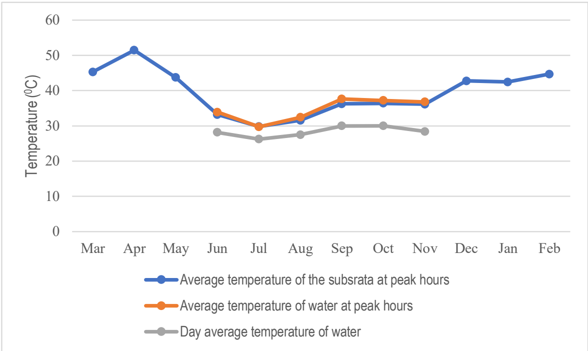

Fig. 4. Comparison of the average temperature of soil and water in the seasonal pools in 12 months.

Moisture content

Moisture content of the soil has been recognised as the major factor that determines the vegetation of lateritic habitats, and the change of moisture regime over the long term may affect the distribution of the ephemeral endemic species (Joshi & Janarthanam, 2004; Bhattarai *et al.*, 2012). Average moisture content recorded in the seasonal wetlands was minimum in the months of April and May and maximum in the months of July and September. There was considerable variation in moisture content between non-monsoon and monsoon months (Fig. 7).

Water holding capacity

Normally, the water holding capacity is constant for a given soil sample. In the present investigation, the water holding capacity (additional water to be added to the soil to make it water saturated or the moisture deficit required for saturation, here not in the usual sense) was inversely proportional to moisture content. As with the soil moisture content, the soil water holding capacity also showed large variations between habitats. The average water holding capacity of soil in the seasonal pools was high during the dry season (Fig. 7). As they are waterlogged in the rainy season, the water holding capacity is practically zero.

Soil texture

Soil texture is significant in determining the composition of plant communities. The percentage of soil particles (sand, silt and clay) in the soil samples from the seasonal pools studied on the plateau showed that the substrata vary from rocky surface to sandy clay loam. The relative percentage of sand, silt and clay is very important in the formation of vegetation, especially ephemeral flush communities. Out of the 13 seasonal pools studied, substrata of 9 pools are represented by sandy loam, 2 by loamy sand and 1 each by sandy clay loam and sand. A seasonal pool with sand as the substratum is occupied by species such as *Nymphoides krishnakesara, Schoenoplectiella lateriflora, Blyxa octandra* and *Eriocaulon cuspidatum.* Habitats with sandy clay loam are characterised by species such as *Geissaspis cristata, Isachne miliacea, I. veldkampii, Murdannia ochracea, Schoenoplectiella lateriflora, Eriocaulon reductum, Dopatrium junceum* and *Rotala malampuzhensis.*

Soil pH

According to Parmentier (2003), soil depth and pH are very important factors in determining the vegetation structure of granitic outcrops. All the samples have acidic pH (Fig. 5).

Soil nutrients

Plant nutrients are highly variable with respect to different microhabitats and also in different regions in the same habitat type. Seasonal pools are the richest habitats on laterite with respect to most of the soil nutrients. Occurrence of carnivorous plants in the lateritic plateaus is a common phenomenon, and it was generally ascribed to the scarcity of nitrogen, phosphorus and sulphur in the soil (Lekhak & Yadav, 2012), as also described in the inselbergs and lateritic crusts (Muller, 2007).

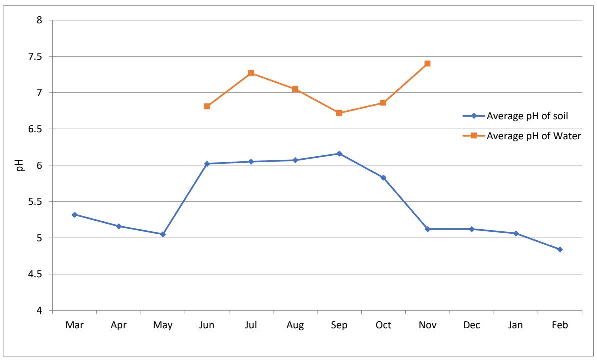

Fig. 5. Average pH of soil and water in the seasonal pools over different months.

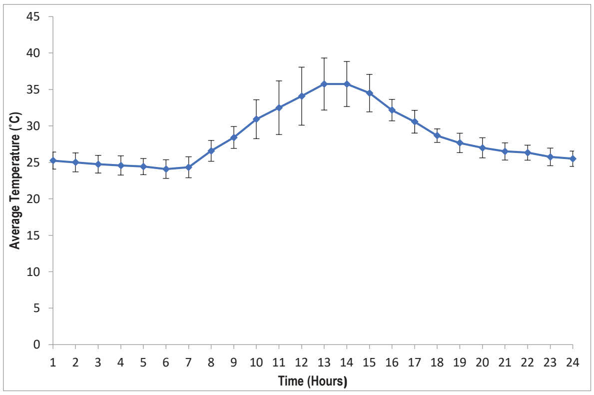

Fig. 6. Pattern of variation in average temperature of water in seasonal pools in a day.

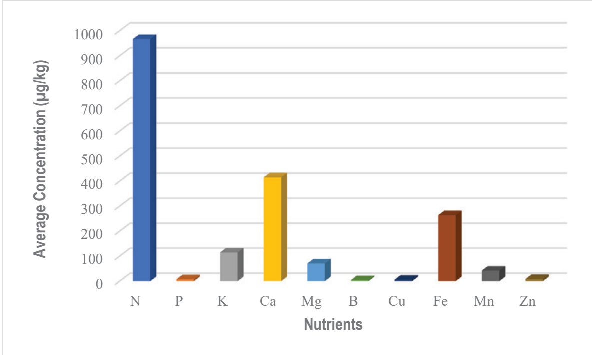

Fig. 8. Comparison of average macro- and micronutrient content in the seasonal pools.

The present analysis of soil nutrients shows that seasonal pool habitats that are showing high density of carnivorous plants are rich in nutrients, including nitrogen (Fig. 8). The average of organic content was also found to be very high (5.73%). This observation agrees with the observations made by Zwarg *et al.* (2012) on Sudanian laterite crusts, and Watve (2013) on lateritic plateaus of the Northern Western Ghats and the Konkan region. The nutrient absorption in the inundated habitats is limited, possibly due to factors such as low pH, inundation and low phosphorus level.

Floristic Diversity

The plateau harbours a total of 665 taxa of flowering plants, including 161 endemic species (Pramod & Pradeep, 2020; 2021), associated with various microhabitats such as exposed rock surfaces and crevices, seasonal ponds and small ephemeral pools, soil-covered areas and grasslands, tree cover and scrub patches. The plant species adapted to different microhabitats are provided with certain traits to help them overcome the adverse environmental conditions, such as seasonal drought, high temperature and nutrient scarcity. It should be noted, as stated by Watve (2013), there is an overlap between most of the species in microhabitats - they can grow in different microhabitats, but with varying degrees of dominance. But some species are always restricted to a particular habitat. Most of the endemic species on the plateau are noted in specialised microhabitats. For example, species such as *Lepidagathis keralensis* is restricted to hard lateritic rocks with extreme xeric and poor nutrient environment; *Coelachne madayensis* occur in seasonal pools in well exposed sunny locations with submerged foliage and emergent panicles; *Euphorbia deccanensis* grows with its roots firmly attached to the humus rich small cavities and fissures of laterite rocks and species of *Utricularia* in seasonal pools or shallow soil areas with high moisture content.

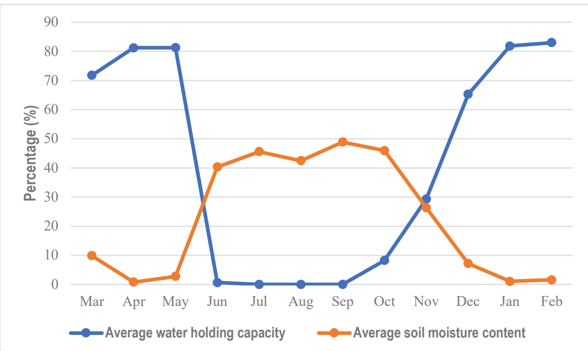

Fig. 7. Comparison of average moisture content and water holding capacity (%) of soil of the seasonal pools in a year.

Seasonal pools form one of the most important, highly specialised microhabitats supporting many endemic angiosperms. The fragile seasonal wetlands of Madayippara are the type locality of five very narrow endemic species, viz., *Coelachne madayensis* Pramod & Pradeep (Poaceae), *Justicia ekakusuma* Pradeep & Sivar. (Acanthaceae), *Lindernia madayiparensis* Ratheesh, Sunil & Nandakumar (Linderniaceae), *Nymphoides krishnakesara* K.T.Joseph & Sivar. (Menyanthaceae) and *Rotala malabarica* Pradeep, K.T.Joseph & Sivar. (Lythraceae). Table 1 gives the flowering plant diversity of the seasonal wetlands of Madayippara. Out of the 60 species documented from the seasonal wetland microhabitats, 18 species are endemic, including five taxa belonging to IUCN threat categories: 2 species are critically endangered, 2 species are endangered, and 1 species is vulnerable. Some species growing in seasonal wetlands are also adapted to other moist microhabitats, but many species, such as *Blyxa aubertii, B. octandra, Coelachne madayensis, Dopatrium junceum, Eriocaulon cuspidatum, Nymphoides indica, N. krishnakesara, Pontederia vaginalis, Rotala malabarica, Rotala malampuzhensis, Schoenoplectiella articulata* and *Wiesneria triandra,* are seasonal pool specialists, as they are exclusively found in the characteristic ephemeral wetlands of laterite plateaus. Among these, the population of some species are very rare (eg., *Wiesneria triandra*) or the habitat of some (eg. *Nymphoides krishnakesara, Coelachne madayensis*) are facing a high degree of threat (Fig. 9), on account of anthropogenic activities.

Fig. 9. **a-c**.*Nymphoides krishnakesara*: **a**. habitat in September 2013, **b**. habitat in September 2023, **c**. population; **d-f**. *Coelachne madayensis*: **d**. habitat in September 2013, **e**. habitat in September 2023, **f**. population.

Table 1. List of aquatic flowering plants collected from the seasonal wetlands of Madayippara laterite plateau.

Sl. No.	Species	Family	Endemism & IUCN status
1	*Aeschynomene aspera* L.	Fabaceae	LC
2	*Alysicarpus bupleurifolius* (L.) DC.	Fabaceae	LC
3	*Ammannia verticillata* (Ard.) Lam.	Lythraceae	LC
4	*Blyxa aubertii* Rich.	Hydrocharitaceae	LC
5	*Blyxa octandra* (Roxb.) Planch. ex Thwaites	Hydrocharitaceae	LC
6	*Bonnaya ciliata* (Colsm.) Spreng.	Linderniaceae	LC
7	*Coelachne madayensis* Pramod & Pradeep	Poaceae	Kerala/NE
8	*Cyanotis axillaris* (L.) D.Don ex Sweet	Commelinaceae	LC
9	*Cyperus substramineus* Kük.	Cyperaceae	NE
10	*Dopatrium junceum* (Roxb.) Buch.-Ham. ex Benth.	Plantaginaceae	LC
11	*Drosera indica* L.	Droseraceae	LC
12	*Echinochloa colona* (L.) Link.	Poaceae	LC
13	*Eriocaulon cuspidatum* Dalzell	Eriocaulaceae	Western Ghats/LC
14	*Eriocaulon eurypeplon* Körn.	Eriocaulaceae	Peninsular India/LC
15	*Eriocaulon gopalakrishnanum* K.Rashmi & G.Krishnak.	Eriocaulaceae	Kerala/NE
16	*Eriocaulon kolhapurense* S.P.Gaikwad, Sardesai & S.R.Yadav	Eriocaulaceae	Western Ghats/VU
17	*Eriocaulon redactum* Ruhland	Eriocaulaceae	Western Ghats/NE
18	*Eriocaulon xeranthemum* Mart.	Eriocaulaceae	LC
19	*Euploca marifolia* (J.Koenig ex Retz.) Ancy & P.Javad	Boraginaceae	NE
20	*Fimbristylis aestivalis* (Retz.) Vahl	Cyperaceae	NE
21	*Fimbristylis dichotoma* (L.) Vahl subsp. *podocarpa* (Nees) T.Koyama	Cyperaceae	LC
22	*Fimbristylis ferruginea* (L.) Vahl	Cyperaceae	LC
23	*Fimbristylis quinquangularis* (Vahl) Kunth	Cyperaceae	LC
24	*Geissaspis cristata* Wight & Arn. var. *cristata*	Fabaceae	LC
25	*Geissaspis cristata* Wight & Arn. var. *tenella* (Benth.) M.R.Almeida	Fabaceae	Western Ghats/LC
26	*Glyphochloa acuminata* (Hack.) Clayton var. *woodrowii*	Poaceae	South India/NE
27	*Glyphochloa acuminata* (Hack.) Clayton var. *acuminata*	Poaceae	Peninsular India/NE
28	*Hydrilla verticillata* (L.f.) Royle	Hydrocharitaceae	LC

29	*Hydrolea zeylanica* (L.) Vahl	Hydroleaceae	LC
30	*Isachne globosa* (Thunb.) Kuntze	Poaceae	LC
31	*Isachne veldkampii* K.G.Bhat & Nagendran	Poaceae	South India/CR
32	*Ischaemum barbatum* Retz.	Poaceae	NE
33	*Ischaemum ciliare* Retz.	Poaceae	NE
34	*Ischaemum rangacharianum* C.E.C.Fish.	Poaceae	South India/NE
35	*Justicia ekakusuma* Pradeep & Sivar.	Acanthaceae	Kerala/NE
36	*Lindernia hyssopioides* (L.) Haines	Linderniaceae	NE
37	*Lindernia madayiparensis* Ratheesh, Sunil & Nandakumar	Linderniaceae	Kerala/NE
38	*Ludwigia hyssopifolia* (G.Don) Exell	Onagraceae	LC
39	*Melochia corchorifolia* L.	Malvaceae	LC
40	*Murdannia crocea* (Griff.) Faden subsp. *ochracea* (Dalzell) Faden	Commelinaceae	Peninsular India/NE
41	*Murdannia semiteres* (Dalzell) Santapau	Commelinaceae	Peninsular India/LC
42	*Neanotis subtilis* (Miq.) Govaerts ex Punekar & Lakshmin.	Rubiaceae	South India/NE
43	*Nymphoides indica* (L.) Kuntze	Menyanthaceae	LC
44	*Nymphoides krishnakesara* K.T.Joseph & Sivar.	Menyanthaceae	Kerala/EN
45	*Oryza rufipogon* Griff.	Poaceae	LC
46	*Pistia stratiotes* L.	Araceae	LC
47	*Pontederia vaginalis* Burm.f.	Pontederiaceae	LC
48	*Rhamphicarpa longiflora* (Arn.) Benth.	Orobanchaceae	NE
49	*Rotala indica* (Willd.) Koehne	Lythraceae	LC
50	*Rotala macrandra* Koehne	Lythraceae	Western Ghats/LC
51	*Rotala malabarica* Pradeep, K.T.Joseph & Sivar.	Lythraceae	Kerala/CR
52	*Rotala malampuzhensis* R.V.Nair ex C.D.K.Cook	Lythraceae	Western Ghats/LC
53	*Rotala rosea* (Poir.) C.D.K.Cook	Lythraceae	LC
54	*Schoenoplectiella articulata* (L.) Lye	Cyperaceae	LC
55	*Schoenoplectiella lateriflora* (J.F.Gmel.) Lye	Cyperaceae	LC
56	*Trigastrotheca stricta* (L.) Thulin	Molluginaceae	NE
57	*Utricularia aurea* Lour.	Lentibulariaceae	LC
58	*Utricularia cecilii* P.Taylor	Lentibulariaceae	Western Ghats/EN
59	*Utricularia graminifolia* Vahl	Lentibulariaceae	LC
60	*Wiesneria triandra* (Dalzell) Micheli	Alismataceae	Peninsular India/LC

Conclusion

The lateritic plateaus of northern Kerala are unique in their vegetation due to the nature of the substratum and the prevailing extreme environmental conditions. Various microhabitats support a rich floral diversity with a large number of rare and endemic species. The species richness of this area is mainly contributed by the presence of many specialised microhabitats and associated flora. Various microclimatic conditions play a collective role in the development of a particular plant community in a microhabitat. Seasonal pools are highly specialised microhabitats active only in the monsoon period to support several specialised species with a high percentage of endemism and are characterised by very high soil moisture content, high amounts of nutrients except phosphorus, and an average soil pH, nearly 7. Madayippara lateritic plateau, which is the type locality of many taxa and a habitat for many endemic and threatened species (Pramod & Pradeep, 2021), is under various anthropogenic disturbances, and urgent measures are needed for the conservation of the biodiversity-rich microhabitats. Any slight disturbance in these fragile microhabitats may result in the disappearance of several short-lived herbaceous species, which cannot be easily conserved outside their natural habitat.

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