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Assessment of Phytoclimate of a Habitat through Life-Form Analysis and Biological Spectrum – A Case Study of the Freshwater Bodies of Canchipur, Manipur, India

*Ch. Umabati Devi and N. Bijaya Devi
Department of Botany, G.P. Women's College,
P.G. Section, Dhanamanjuri University,
Imphal – 795001, Manipur, India

Abstract: *The present work deals with the assessment of the life-forms and biological spectrum of the freshwater bodies of Canchipur, Manipur. Altogether 50 aquatic plant species were enumerated, out of which 43 genera and 28 families were recorded. The plants were categorised into submerged (8 species), rooted with floating leaves (7 species), free floating (4 species) and emergent groups (31 species). Five live-form categories were recorded viz. Therophytes – 19 species (38.00%), Geophytes (Cryptophytes) – 11 species (22.00%), Errant Vascular Hydrophytes – 10 species (20.00%), Hemicryptophytes – 9 species (18.00%) and Chamaephytes – 1 species (2.00%). The biological spectrum of the study site revealed the dominance of therophytes over other life-forms. Therefore, the study area may be designated as thero-geophytic type of phytoclimate.*

Keywords: *Life-form, biological spectrum, freshwater, aquatic, phytoclimate.*

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I. Introduction:

Life-form of a plant community refers to the association of plant species which are acclimatized along environmental gradients and other ecological parameters that surround them. A life-form is determined by plants' adaptation to certain ecological conditions. It is an important physiognomic attribute that have been widely used in vegetation studies.[1] It indicates micro and macroclimate as well as human disturbances of a particular area. [2][3] The life-form is the ultimate manifestation of the sum of all the adaptations undergone by a plant to the climate in which it resides.[4] The concept of life-form was first formulated based on the physiognomic basis.[5] The vegetation may be classified according to growth-form or life-form which refers to the sum total of adaptations to a specific climate manifesting a specific form and structure and is reflected in the physiognomy or general appearance of the vegetation.[6][7] Raunkiaer's system is the most widely accepted and universally followed for life-form classification.[6]

A comprehensive life-form spectrum of the different regions of India has been compiled.[8] There are ten (10) identified phytoclimate types in India based on Raunkiaer's life-form classes.[9] Life-forms are mainly classified into five (5) major types viz. Chamaephytes (with surviving buds near to the ground), hemicryptophytes (with surviving buds exactly on the soil surface), geophytes/cryptophytes (with surviving buds perfectly hidden in the ground or at the bottom of the water), therophytes (finishing their life-cycle within a season and remaining dormant as seed during the contrary time) and phanerophytes (with surviving buds projecting freely into the air). The modified form of classification has the advantage of including other life-forms like mosses, lichens, algae and other thallophytic forms based on the functional, anatomical, support structures and perennial or annual nature of the plants under study.[10][11]

'Biological Spectrum' has been proposed to express both the life-form distribution in a flora and the phytoclimate under which the prevailing life-forms evolved.[6] Therefore, it is pertinent to study the life-forms to determine the phytoclimate of an area.[8] Several workers have highlighted studies on the life-forms and biological spectrum of different regions of India.[12][13][14][15] Few authors have also done some contribution on the life-form spectra and biological spectrum of freshwater bodies of Manipur.[27][28][29][30] However, no such study has been conducted from this project area. In the present study, attempt has been made to characterize the phytoclimate of the freshwater bodies of Canchipur, Manipur with the help of life-form and biological spectrum.[6]

II. Objective

The main objectives of the present study are mainly focussed on the following areas – to determine the life-form spectra, to provide a base line data for future life-form references of the same habitat, to compare the

obtained biological spectrum with Raunkiaer's normal spectrum and with that of others and lastly to infer the phytoclimate of the present study area.[6]

III. Materials And Methods:

The present study was conducted at Canchipur, which is about 7 km from Imphal City and located between 24.75ºN Latitude and 93.93ºE Longitude. The climate of the study site is sub-tropical, monsoonal with moderate temperature, rainfall and relative humidity and lies at an elevation of 782 m above sea level. The present work is carried out at 4 randomly selected sites (S1, S2, S3 and S4). Extensive field tours were conducted during January 2016 to December 2018 on monthly basis. The floral species were identified using standard literature.[16][17] Herbariums of different plant species were also prepared following standard literature at G.P. Women's College, Imphal, Manipur.[18]

The growth form, habit, and nature of the different plant species were recorded and classification was done accordingly.[6] For preparation of biological spectrum, the number of species in each life-form is calculated and the percentage of species belonging to each life-forms is determined by the following formula –

$$\textbf{\% Life-form} = \frac{Number\ of\ species\ in\ any\ life-form}{Total\ number\ of\ species\ in\ all\ life-forms} \textbf{ x 100}$$

Also, Jaccard's Generic Coefficient[19] was calculated to infer the microclimatic nature of the macrophytic species by the following formula: Generic Coefficient = No. of genera/No. of species x 100.

IV. Result:

A total of 50 (fifty) aquatic plant species were recorded from the study area. The plant species were categorised into submerged (8 species), rooted with floating leaves (7 species), free floating (4 species) and emergent group (31 species). Their families, life-form, life-span, habit, dicot and monocot group is presented in Table 1. All the plant species belonged to the herb category with 28 families and 43 genera. Dicots recorded 15 families, 18 genera and 20 species, while the monocots were represented by 9 families, 20 genera and 24 species (Table 2). In addition to this, 4 species of fern (*Azolla pinnata, Marsilea quadrifolia, Salvinia culcullata, Salvinia natans*), 1 species of algae (*Chara aspera*) and 1 species of bryophyte (*Riccia fluitans*) were also recorded from the freshwater bodies of Canchipur. The Generic Coefficient was determined as 86.0% for the plant species of the study area which indicated a high intergeneric competition in the area.

The flora of the present study showed highest percentage of Therophytes (38.00%) with 19 species. Other groups of life-forms in order of importance were Geophytes/Cryptophytes (22.00%) with 11 species, Errant Vascular Hydrophytes (20.00%) with 10 species, Hemircryptophytes (18.00%) with 9 species. Significantly, only 1 species belonged to Chamaphytes (2.00%) which was represented by *Andropogon ascinodis*. (Figure-1)

A comparison of the percentage of the life-form classes of the flora of the freshwater bodies of Canchipur with Raunkiaer's normal spectrum is shown in Table 3. It reveals that Therophytes showed maximum divergence from the normal spectrum of Raunkiaer, accordingly, the phytoclimate of the area may be termed as thero-geophytic.

Table 1: General attributes of the aquatic plants in the freshwater bodies of Canchipur.

Sl. No.	Family	Name of species	Life Form	Life Span	Dicot/ Monocot	Habit
1.	*Alismataceae*	*Sagittaria trifolia* L.	TH	P	D	EMER
2.	*Amaranthaceae*	*Alternanthera philoxeroides* (Mart) Griseb.	TH	A	D	EMER
		Alternanthera sessiles (L) R.Br. ex. DC	TH	A	D	EMER
3.	*Apiaceae*	*Centella asiatica* (L) Urban	H	P	D	EMER
		Hydrocotyle javanica Thunb.	H	A	D	EMER
		Oenanthe javanica Dc.	TH	P	D	EMER
4.	*Aponagetonaceae*	*Aponageton crispus* Thunb.	EVH	P	M	SUBM
5.	*Araceae*	*Alocasia macrorrhizos* (L) G. Don.	G/C	P	M	EMER
		Colocasia esculenta (L) Schott.	G/C	P	M	EMER
6.	*Asteraceae*	*Enhydra fluctuans* Lour.	H	A	D	EMER
7.	*Characeae*	*Chara* aspera f. A. Braun	TH	A	AL	SUBM
8.	*Commelinaceae*	*Commelina benghalensis* L.	TH	P	M	EMER
		Commelina longifolia Lam.	TH	P	M	EMER
		Murdannia nudiflora (L) Brenan	H	A	M	EMER
9.	*Convolvulaceae*	*Ipomoea aquatica* Forsk.	H	A	M	EMER
10.	*Cyperaceae*	*Carex cruciata* Wahlenb.	TH	P	M	EMER
		Cyperus difformis L.	G/C	P	M	EMER
		Cyperus procerus Rottb.	G/C	P	M	EMER
		Cuperus rotundus L.	G/C	P	M	EMER
		Schoenoplectus articulatus (L.) Palla.	TH	A	M	EMER
		Schoenoplectus litoralis (Schrad) Palla.	TH	A	M	EMER
11.	*Euryalaceae*	*Euryale ferox* Salisb.	G/C	A	D	Rooted with floating leaves
12.	*Hydrocharitaceae*	*Hydrilla verticillata* (L.f.) Royle.	H	P	M	SUBM
		Najas minor All.	EVH	A	M	SUBM
		Vallisneria spiralis L.	EVH	P	M	SUBM
13.	*Lentibulariaceae*	*Utricularia aurea* Lour.	EVH	P	D	SUBM
		Utricularia exoleta R.Br.	EVH	P	D	SUBM
14.	*Linderniaceae*	*Lindernia crustacea* (L) F. Muell.	TH	A	D	EMER
15.	*Lythraceae*	*Rotala densiflora* Roemer & Schultes	TH	A	D	EMER
16.	*Marsileaceae*	*Marsilea quadrifolia* L.(Pteridophyte)	EVH	P	PT	Rooted with floating leaves
17.	*Menyanthaceae*	*Nymphoides cristata* (Roxb.) Kuntze.	G/C	P	D	Rooted with floating leaves
18.	*Nelumbonaceae*	*Nelumbo nucifera* Gaertn.	G/C	P	D	Rooted with floating leaves
19.	*Nymphaeaceae*	*Nymphaea stellata* Willd.	G/C	P	D	Rooted with floating leaves
20.	*Onagraceae*	*Ludwigia adscendens* (L)H.Hara.	TH	P	D	EMER
		Ludwigia octovalvis (Jacq.) RH. Raven	TH	P	D	EMER
21.	*Plantaginaceae*	*Limnophila heterophylla* (Roxb.) Benth.	TH	A	D	Rooted with floating leaves
22.	*Poaceae*	*Andropgen ascinodis* C.B. Clarke	CH	P	M	EMER
		Cyrtococcum accrescens (Trin) Stapf.	TH	A	M	EMER
		Echiunochloa stagnina (Retz.) P. Beauv.	TH	A	M	EMER
		Hygroryza aristata (Retz.) Nees. ex. Wight & Arn.	H	P	M	EMER
		Oryza officinalis Wallich ex G Watt.	TH	P	M	EMER
		Pseudoraphis minuta (Mez.) Pilger.	H	P	M	EMER
23.	*Polygonaceae*	*Polygonum glabrum* Willd.	TH	A	D	EMER
24.	*Pontederiaceae*	*Monochoria hastata* (L) Solm.	G/C	P	M	EMER
25.	*Potamogetonaceae*	*Potamogeton crispus* L	H	P	M	SUBM
26.	*Ricciaceae*	*Riccia fluitans* L. (Bryophyte)	EVH	P	BR	Free floating
27.	*Salviniaceae*	*Azolloa pinnata* R.Br. (Pteridophyte)	EVH	P	PT	Free floating
		Salvinia cucullata Roxb. (Pteridophyte)	EVH	P	PT	Free floating
		Salvinia natans All. (Pteridophyte)	EVH	P	PT	Free floating
28.	*Trapaceae*	*Trapa natans* L.	G/C	P	D	Rooted with floating leaves

(TH=Therophyte, **CH**=Chamaephyte, **G/C**=Geophyte/Cryptophyte, **H**=Hemicryptophyte, **EVH**=Errant Vascular Hydrophyte, **P**=Perennial, **A**=Annual, **D**=Dicot, **M**=Monocot, **AL**=Algae, **BR**=Bryophyte, **PT**=Peridophyte, **EMER**=Emergent, **SUBM**=Submerged**)**

Table 2: Comparative account of the aquatic plants in the study area.

	Family		Genera		Species	
	No.	**%**	**No.**	**%**	**No.**	**%**
Dicots	15	53.57	18	41.86	20	40.00
Monocots	9	32.14	20	46.51	24	48.00
Algae	1	3.57	1	2.32	1	2.00
Bryophyte	1	3.57	1	2.32	1	2.00
Pterdophyte	2	7.14	3	6.67	4	8.00
Total	28		43		50	

Table 3: Comparison of biological spectrum of study area with Raunkiaer's (1934) Normal Biological Spectrum

Life-Form	**TH**	**G**	**H**	**CH**	**PH**	**EVH**
Percentage of life form (present study)	38.00	22.00	18.00	2.00	-	20.00
Percentage of life form in normal spectrum	13.00	6.00	26.00	9.00	46.00	2.00
Percentage Deviation	+25.0	+16.0	-8.0	-7.0	-46.0	+18.0

Table 4: Comparison of biological spectrum of the present study area with those in different water bodies.

	Biological Spectrum %					
	CH	G/C	H	TH	EVH	Phytoclimate
Freshwater bodies of Canchipur (Present study)	2.00	22.0	18.00	38.00	20.00	Thero-Geophytic
Kharungpat	12.96	22.22	16.67	24.07	24.07	Thero-Errant Vascular Hydrophytic
Awangsoipat	-	27.78	13.89	33.33	22.22	Thero-Geophytic
Kongba River	3.44	17.24	14.00	37.93	27.58	Thero-Errant Vascular Hydrophytic
Potsangbam River	10.52	10.52	23.68	39.47	15.78	Thero-Hemicryptophytic
Tam Dil Lake	6.25	12.50	18.75	43.75	18.75	Therophytic

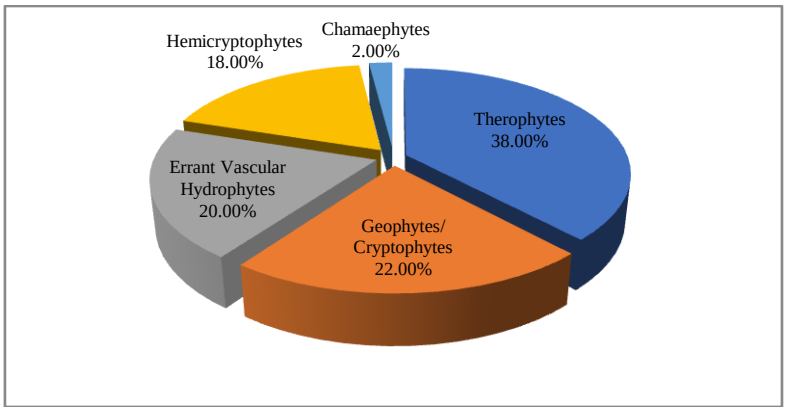

Figure 1: Biological spectrum of the freshwater bodies of Canchipur

V. Discussion

The outcome of the present study reveals that the biological spectrum shows the highest percentage (38.0%) of therophytes. Hence, the area falls under the category of therophytic type of phytoclimate, which is similar with the conclusions drawn by.[20] This type of phytoclimate is also congenial for the growth of annuals and herbs.[21] When compared with the biological spectra of different freshwater bodies of Manipur and those of an adjoining State (Table-4), it reveals that among all life-forms, therophytes contribute the highest percentage in all the findings including the present study. The predominance of the therophytes indicates a warm climate, biotic disturbance, aridity factors and disturbed areas.[22][23][24] The higher percentage of therophytes occurring in the present study area is characteristic of subtropics and often related to soil conditions and climate.[25] Several workers have also advocated the occurrence of high percentage of therophytes to various factors like prevalent macroclimate of the region, anthropogenic activities, and nutrient rich water.[26][6]. Similar findings were also recorded from other freshwater bodies of Manipur and an adjoining State.[27][28][29][15] The phytoclimatic association of the present study is also in conformity with the works of other authors.[30]

VI. Conclusion

The present study served the purpose of determining the life-form spectra and providing a base-line data for future life-form references of similar habitat. In the present work, therophytes and geophytes share considerable importance in depicting the phytoclimate of dual character i.e. warm-dry climate. The study area experiences a warm moist climate with moderate rainfall and being in close proximity to populated area, these conditions are responsible for thero-geophytic type of phytoclimate. This type of phytoclimate is characteristic of disturbed areas due to anthropogenic activities and further biotic interferences would elevate the structure of the biological spectrum. The present scenario reveals that these natural freshwater bodies require a conservation strategy with a proper management system to endure its resources which will help in the betterment of the present as well as future generation.

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CONFLICT OF INTEREST:

The authors declare no conflict of interest.

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