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EDAPHOLOGICAL DESCRIPTION OF THE TYPE HABITAT OF *COPTIS TEETA* WALL. — AN ENDANGERED SPECIES OF MEDICINAL IMPORTANCE IN ARUNACHAL PRADESH

J. N. SINGH AND V. MUDGAL

Botanical Survey of India, Howrah

ABSTRACT

The edaphic conditions of the habitat of *Coptis teeta* Wall. have been discussed. The soils, where this species grows either under cultivation or in wild are moderately acidic to highly acidic, poor in surface porosity, very rich in silica content and possess insufficient amount of inorganic binding agents. However, the soils in cultivated fields are satisfactory in organic carbon status, water-holding ability and cation exchange capacity but inadequate presence of liming material and temperate climate adversely effect their energy materials. The soils at Malenja where this species is growing wild have textural limitation and anthropogenic interference. In the end the paper is concluded with suggestions. Results depict that the reasons for rarity and depletion of this species are not only anthropogenic but also environmental.

INTRODUCTION

The economic value of *Coptis teeta* Wall. (Ranunculaceae) rests in its rhizome extract which is best noted for its efficacy in intermittent fever and stomach diseases. On an average a 20 to 25 cm long plant along with an average 5 to 7 cm rhizome has limitation to grow beyond the temperate regions of Mishmi hills in Arunachal Pradesh. Recently, owing to the excessive exploitations its number per unit area and vigour have significantly been reduced in its own ecological niché and therefore, it is kept in the concurrent list of the threatened flora. Climatically the area may be described as a temperate and humid region. Within its habitat system the species is growing under the shade of higher trees and demonstrating a strong association with the mosses namely *Campylium lacerulum* (Mitt.) Broth., *Trachyopodopsis* sp., *Eurhynchium dumosum* (Mitt.) Jaeg., etc. Viewing economic significance of the species and inadequate knowledge about its habitat system under the present investigation an attempt has been made to examine its edaphic conditions of its original niché where it is turning rare in order to augment its natural rejuvenation for conservation sake.

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MATERIALS AND METHODS

With aforesaid objective five composite samples (four from surface soil, depth 0-15 cm, and one from subsurface soil, depth 15-30 cm) were collected where *Coptis teeta* is growing either wildly or under cultivation as follows :

1. Cultivated land (Private) Ching-dong (nearly 15 km from Hayuliang, Lohit).
2. Cultivated land (Forest deptt.) 56 km from Roing, Dibang valley.
3. Growing wildly in Malenja west, Kibithoo block, Lohit.
4. Growing wildly in Malenja east, Kibithoo block, Lohit.
5. Subsurface from Malenja east, Kibithoo block, Lohit.

These samples were studied for their mechanical make up, physico-chemical characteristics, HCl extract composition and saturation extract properties following the methods described by Jackson (1958) and Piper (1966).

RESULTS AND DISCUSSION

The results on edaphic characteristics of *C. teeta* are given in Tables 1-4. The mechanical composition of the soils is reported in Table 1. A perusal of the data clearly depicts that the soils under investigation differ significantly in their physical make up. The Malenja soils, the type habitat for *C. teeta* in real sense, have a loamy sand texture at surface followed by a sandy loam subsurface whereas the soils of cultivated fields of *C. teeta* range from silty clay loam to clay loam in their broad textural classes. It is significant to note from the mechanical composition of soils that the clay dominated cultivated soils can sustain moisture requirement of the species because of their higher water holding capacity than their counterpart in Malenja soils which are prominent in sand content and, therefore, are lower in water holding capacity.

The physico-chemical characteristic of the soils are presented in Table 2. A careful scrutiny of the table reveals that the cultivated fields of *C. teeta* are highly acidic (pH 4.4 and 4.8) whereas the Malenja soils, harbouring wild communities of *C. teeta* are feebly acidic to moderately acidic (pH 6.5 and 5.0) at the surface but feebly alkaline (pH 7.6) at subsurface. The organic carbon status (energy materials) is also variable within the soils which ranges from the highest 6.24% in the cultivated soil (Forest Deptt.), to the lowest 1.92% in the subsoil at Malenja. Barring the low temperature of the region, the pH and the anthropogenic activities appear to be the main causative factors for such variation in the energy materials which are influencing the other physico-chemical characteristics of the soils. It is further apparent from the table that the soils are very poor in porosity which varies from a minimum of 22.9% in Malenja soil to a maximum of 41.1% in the cultivated soil (Private). The values of bulk density are variable between a minimum of 0.685 gm/cc in the cultivated soil (Private) to 1.035 gm/cc as high in the Malenja soil. The observations on bulk density clearly indicate that the cultivated soils are comparatively lighter than the Malenja soils. The range for water holding capacity for these soils is minimum at 51.52% in the subsoil of Malenja to a maximum at 97.9% in the cultivated soil (Private). The organic carbon status and clay content are the responsible factors for variable water holding capacity. From the observations recorded for available nitrogen and phosphorus for these soils, it is clear that these nutrients are sufficiently rich in cultivated soils than its counterpart in Malenja soils. Their values vary from 0.049% and 0.0027% minimum in the Malenja soil to 0.174% and 0.0056% maximum in the cultivated soil (Private) respectively for top soils. The subsoil shows a further decrease in value for these nutrients than what is measured minimum at the top. The values of cation exchange capacity vary from a maximum of 44.5 m.e.% in cultivated soil (Forest Deptt.) to a minimum of 18.0 m.e.% in the Malenja soil within the top level. The cation exchange capacity of the subsoil shows further decrease in value (11.0 m.e. %). The variable status of the organic carbon and clays appears to be the responsible factors for varied cation exchange capacity of the soils.

Table 3 presents the HCl extract composition. It is apparent from a close look of the table that both soils where *C. teeta* is growing either wildly or under cultivation are very rich in silica content but the subsoil is vehimently lower in this constituent. Its values range between a minimum of 81.92% in Malenja soil to 92.87% maximum in cultivated soil (Forest Deptt.). The subsoil possesses 75.7% content of the silica. It may be noted from the values of sesquioxide recorded in the table that its content in the subsoil is significantly high (17.72%) than the top where it is ranging from 5.55% minimum in the cultivated soil (Private) to 10.225% maximum in the Malenja soil. It is further noticed with much interest that sesquioxide status is comparatively low than silica in the top soil and consequently showing a high silica sesquioxide ratio which is ranging between 8.01 : 1 minimum in the Malenja soil to 15.9 : 1 maximum in the cultivated soil (Private) but subsoil possesses significantly low silica sesquioxide ratio *i.e.* 4.2 : 1. The high silica-sesquioxide ratio particularly in the top soil of *C. teeta* signifies the presence of insufficient amount of inorganic binding agents. Consequently this results into loose structure. The ferric oxide component varies from 3.92% (minimum) in the cultivated soil (Private) to 7.68% (maximum) in the Malenja soil within the top level but at the subsurface its value is relatively high (8.40%). The divalent cations *viz.*, calcium and magnesium so far analysed in the form of oxides are recorded in the same table. It is clear from the data that the cultivated soils are comparatively poor for these cations than Malenja soils. It is further observed that the subsoil possesses significantly high value of calcium oxide than the surface soil. Within the top layer their values vary from 0.244% and 0.186% as minimum in the cultivated soil (Forest Deptt.) to 1.54% and 0.986% as maximum in the Malenja soil respectively. The low status of liming material particularly in the cultivated soils appears to be the causative factor for slow oxidation of organic materials which is further slackened by low pH and low temperature and consequently the release of energy in the system seems to be very meagre. The range for total phosphorus within the surface soils is in between 0.214% as minimum in the Malenja soil to 0.386% as maximum in the cultivated soil (Private). The subsoil shows further decrease in value of total phosphorus (0.198%).

The saturation extract characteristics are presented in table-4. It is explicit from the table that the calcium ion dominates in the soil solution of these soils and particularly subsoil is very rich for this cation. It is further noticed that in cultivated lands sodium is the next dominant cation whereas in Malenja soils magnesium occupies the second position after calcium. In the cultivated and Malenja soils these cations can be arranged as per their dominance as : $Ca^{++} > Na^{+} > Mg^{++} > K^{+}$ and $Ca^{++} > Mg^{++} > Na^{+} > K^{+}$ respectively. Within the anions, the bicarbonate dominates in all the soil solutions followed by chloride. The carbonate ion is conspicuously absent in all the soil solutions. In the soil solution of surface soil, the calcium and magnesium ions vary within the limits of 3.2 m.e./L and 0.8 m.e./L minimum in the cultivated soil (Forest Deptt.) to 10.4 m.e./L and 7.2 m.e./L maximum in the Malenja soils respectively.

The range for sodium and potash ions falls within a minimum of 1.0 m.e./L and 0.29 m.e./L in the Malenja soils and 3.8 m.e./L and 0.42 m.e./L maximum in the cultivated soil (Private) respectively within top layer. The variation of bicarbonate ion in surface soil solution is in between a minimum of 6.3 m.e./L in the cultivated soil (Forest Deptt.) to 12.5 m.e./L maximum in the Malenja soil whereas the chloride ions range within the limit of 3.2 m.e./L minimum in Malenja soil to 5.3 m.e./L maximum in the cultivated soil (Private). The subsoil solution is comparatively more concentrated than the surface soil and it has the highest value for calcium ion (14.6 m.e./L) followed by sodium (4.6 m.e./L) within cations and bicarbonate (8.1 m.e./L) and chloride (7.1 m.e./L) within the anions. The total salinity of the soil solutions is exhibited by electrical conductivity values recorded in the same table. It is apparent from the observations that within surface soils Malenja soils are more saline (E.C.

3.7 m. mhos/cm) than cultivated soil (1.7 m. mhos/cm). The subsurface soil solution has been observed to be more saline (E.C. 3.7 m. mhos/cm) than the surface. From the data recorded for saturation percentage in the same table it is obvious that cultivated soil (Private) has maximum saturation percentage (110%) whereas the other soils including subsoil vary within the limit of 50.4% minimum in the Malenja soil to 98.5% maximum in cultivated soil (Forest Deptt.). On the basis of the formula (0.36 × E.C. in millimhos/cm), given in Hand Book No. 60 of USDA (Richards, 1954) an attempt has been made to compute the osmotic pressure of the soil solution wherefrom the plant derives the minerals. Observations reveal the fact that the osmotic pressure of cultivated soil solutions is lower than Malenja soils. Further, subsoil solution shows greater value of solute pressure. The varied osmotic pressure of the soil solutions of these soils may be affecting the germination and other physiological activities of the plants growing under such edaphic conditions.

Table 1 : Mechanical composition of the soils

S. No.	Coarse sand %	Fine sand %	Silt %	Clay %	Textural class
1.	2.206	9.47	42.60	38.52	Silty clay loam
2.	3.192	13.79	38.25	35.56	Clay loam
3.	4.698	67.04	12.36	11.30	Loamy sand
4.	8.846	63.80	14.56	9.68	Loamy sand
5.	0.068	40.86	36.25	18.35	Sandy loam

Table 2 : Physico-chemical characteristics of the soils

S. No.	Organic carbon %	pH	Bulk density in gm/cc.	Porosity %	Water holding capacity %	Available N%	Available P_2O_5 %	Cation exchange in m.e. %
1.	4.41	4.8	0.685	41.1	97.90	0.175	0.0056	43.5
2.	6.24	4.4	0.733	38.7	89.57	0.126	0.0049	44.5
3.	2.97	5.0	0.956	27.5	68.39	0.063	0.0035	18.5
4.	2.16	6.5	1.035	22.9	53.96	0.049	0.0027	18.0
5.	1.92	7.6	1.037	23.9	51.52	0.035	0.0018	11.0

Table 3 : HCl extract composition of the soils

S. No.	HCl in soluble %	Sesquioxide %	Iron oxide %	CaO %	MgO %	Total P_2O_5 %	Silica Sesquioxide ratio
1.	88.32	5.55	3.92	0.448	0.295	0.386	15.9 : I
2.	92.87	9.75	6.85	0.244	0.186	0.375	9.5 : I
3.	85.44	9.58	7.16	0.714	0.536	0.295	8.9 : I
4.	81.98	10.225	7.68	1.540	0.986	0.214	8.01 : I
5.	75.70	17.72	8.40	5.160	0.136	0.198	4.2 : I

Table 4 : Saturation extract characteristic of the soils

S. No.	Composition in m.e./L							E.C. in m. mhos/cm at 25°C	Osmotic pressure in atmosphere	Saturation %
	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}			
1.	5.1	2.0	3.8	0.42	—	10.2	5.3	2.5	0.90	110.0
2.	3.2	0.8	2.6	0.38	—	6.3	4.3	1.7	0.61	98.5
3.	7.5	4.1	1.0	0.34	—	12.5	5.2	2.4	0.86	50.4
4.	10.4	7.2	2.9	0.29	—	10.4	3.2	3.7	1.33	52.8
5.	14.6	0.9	4.6	0.36	—	8.1	7.1	3.8	1.37	66.5

CONCLUSION

From the results so far achieved through examination of edaphic characteristics of habitat of *C. teeta* it may safely be concluded that the soils under investigation are very rich in silica content at their surface level. Sesquioxide status is comparatively lower than silica and consequently resulting into high silica sesquioxide ratio. Owing to the insufficient presence of inorganic binding agents in the surface soils, the structure has been noted to be highly unstable. The porosity of the surface soils is very poor. Since *C. teeta* rhizome is reared inside the soil system, the poor porosity might be affecting its normal growth and development.

The cultivated soils are very satisfactory in organic carbon status, water holding capacity, available nitrogen, phosphorus and cation exchange capacity characteristics. But these soils have been observed to be highly acidic in reaction alongwith the low status of liming material in their surface level. Owing to the temperate climate and lower status of liming material, the organic carbon status gradually increases in the surface soil which is further favoured by low pH, because these factors are diminishing oxidation rate of organic materials and simultaneously retarding energy materials to play adequate role in the system. It is suggested, therefore, that for overcoming this problem, liming material should be added in the cultivated soils which may not only enhance the oxidation rate of organic materials but also aid the system for correcting other major defects and may help in quick rejuvenation of *C. teeta*.

The Malenja soils, on the other hand, are satisfactory in liming material content in the surface soil but owing to the sand dominant texture its water holding capacity and cation exchange capacity are comparatively low.

It is recommended, therefore, that anthropogenic activities in the area may immediately be checked up which is not only affecting the organic carbon status in the system but also their constant trampling are severely influencing the surface soil porosity. In the surface layer of these soils organic carbon status has also to be raised which is the only natural remedy for overcoming aforesaid defects for rapid rejuvenation of *C. teeta*.

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