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AQUATIC ECOLOGY

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Macrophytic Features of Wular Lake (a Ramsar Site) in Kashmir

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ABSTRACT

The paper deals with the macrophytic composition and production of Wular Lake, Kashmir. The macrophyte dominated lake is of open drainage type with permanent inflow and outflow channels. The lake, being marshy in the littorals, is well-buffered, alkaline in nature, following the same sequence of major ions as $HCO_3^- > Ca^{++} > Mg^{++} > Cl^-$ like other Kashmir Himalayan water bodies. The ecosystem supports aquatic plant communities (emergents, rooted floating leaf type, free floating leaf type, submergeds) marked by striking variability in composition, frequency and extent of colonization. The net annual primary production of macrophytes recorded during the study period was 9.47 $gm^{-2}yr^{-1}$. The important invasion of a tropical macrophytic species (*Azolla pinnata*) into the wetland of International Importance is a great concern for the management of the ecosystem.

***Key words*:** Macrophytes, *Azolla pinnata*, *invasion, Ramsar Convention, wetland, Kashmir*

INTRODUCTION

Wular lake, like other inland lakes of Kashmir Himalaya, is the vital resource to provide water, food and recreation for human beings as well as habitat for many species of plants and animals. Being the largest freshwater lake of Indian sub-continent it has been designated as Ramsar Site in 1990 (ICUN– Ramsar Convention 1971). It is a rural lake in the north-west of Kashmir, about 35 km from Srinagar city and lies in the flood-plains of River Jhelum between 34° 16/-34° 20/ N latitude and 74° 35/-74° 44/ E longitudes and at an altitude of 158m (a.m.s.l). The present paper deals with the macrophytic composition, production and there has been a recent invasion of a biological species (*Azolla pinnata*), being tropical in nature.

MATERIAL AND METHODS

Macrophytes were collected throughout the study period (March, 2002 to February, 2004) and were brought to laboratory for floristic studies which followed Zutshi and Gopal (2000). For biomass calculation quadrat method was applied in which plants were first washed and then extra moisture content removed with filter paper for estimating fresh weight and then oven dried at 105°C for 24 hours for calculating dry weight biomass. For biomass estimation, the measurements were made for each species according to procedures described by Milner and Huges (1968).

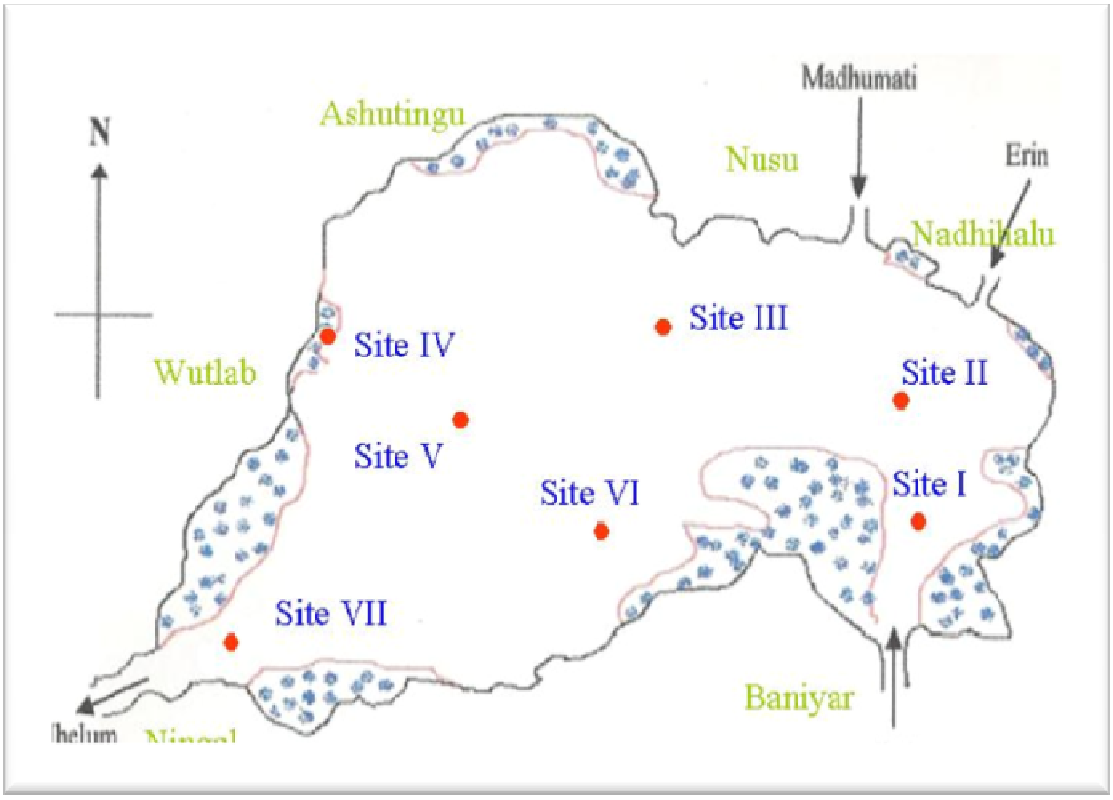

Fig. 1. Map showing various study sites

RESULTS AND DISCUSSION

Macrophytic Composition and Distribution

Wular, a wetland of International Importance, is represented by about 25 macrophytic species belonging to 17 families (Table 1). The vegetation does not form monospecific meadows but grows intermixed resulting in complex physiognomy. There were, however, variations in dominance pattern of various species in different vegetation stands.

The macrophytic vegetation in the wetland can be classified into four distinct groups: emergents, rooted-floating type, free floating leaf type and submergeds.

(i) Emergents

The whole littoral region of the wetland is fringed with diverse emergent macrophytes. The emergent community of the wetland was represented by nine species, which include *Alisma plangtago aquatica, Carex* sp., *Myriophyllum verticillatum, Nasturtium officinale, Phragmites australis, Polygonum amphibium, Sagittaria sagittifolia, Sparganium ramosum* and *Typha angustata.*

(ii) Rooted floating-leaf type

The shallow waters of the wetland are dominated by rooted floating leaf type community represented by six species namely *Hydrocharis dubia, Nelumbo nucifera, Nymphoides peltatum, Potamogeton natans* and *Trapa natans.*

(iii) Free floating type

The distribution pattern of free-floating types of macrophytes is mainly determined by hydrological fluctuations and patterns of water flow. This type of aquatic flora form thick, mat-like scum, which dominate the side channels of the wetland rich in organic matter. The high water level helped by wave action drifts the species towards the littorals, through water flow favours their accumulation at the semiclosed main outlet at Ningali (Sopore). The free floating community was represented by *Lemna gibba, Lemna minor, Salvinia natans* and the newly introduced tropical exotic species of *Azolla pinnata* reported for the first time from the waterbody (Mir, 2007).. The thick mat of the exotic species in certain areas totally hinders the penetration of sunlight into the waterbody, which restricts the submerged growth, thus creating an alarming situation for the wetland.

(iv) Submergeds

The submerged type of macrophytic community was again represented by six species namely *Ceratophyllum demersum, Hydrilla verticillata, Myriophyllum spicatum, Potamogeton crispus, Potamogeton lucens* and *Potamogeton pucillus.*

Table 1: Macrophytic species recorded from Wular lake during the study period (March 2002 to February 2004)

S. No	Name of Species	Family
Emergents		
1	*Alisma plantago-aquatica* L.	Alismataceae
2	*Carex* sp.	Cyperaceae
3	*Myriophyllum verticillatum* L.	Haloragaceae
4	*Nasturtium officinale* R. Br.	Brassicaceae
5	*Phragmites australis* Trin.	Poaceae
6	*Polygonum amphibium* L.	Polygonaceae
7	*Sagittaria sagittifolia* L.	Alismataceae
8	*Sparganium ramosum* Huds.	Sparganiaceae
9	*Typha angustata* Bory and Chaub	Typhaeceae
Rooted floating -leaf type		
10	*Hydrocharis dubia Bacquer*	Hydrocharitaceae
11	*Nelumbo nucifera Gaertn.*	Nelumbonaceae
12	*Nymphaea alba* L.	Nymphaeceae
13	*Nymphoides peltatum Kuntze*	Menyanthaceae
14	*Potamogeton natans* L.	Potamogetonaceae
15	*Trapa natans* L.	Trapaceae
Free floating type		
16	*Azolla pinnata*	Salviniacea
17	*Lemna gibba*	Lemnaceae
18	*Lemna minor*	Lemnaceae
19	*Salvinia natans* L.	Salviniaceae
Submergeds		
20	*Ceratophyllum demersum L.*	Ceratophyllaceae
21	*Hydrilla verticillata* Royle	Hydrocharitaceae
22	*Myriophyllum spicatum* L.	Haloragaceae
23	*Potamogeton crispus* L.	Potamogetonaceae
24	*Potamogeton lucens* L.	Potamogetonaceae
25	*Potamogeton pucillus* L.	Potamogetonaceae

Biomass and Production

Macrophytic biomass per unit area was worked out on monthly basis throughout the growing season (March to October). Very significant temporal as well as spatial variations were observed in biomass

accumulation in the wetland. In general, irrespective of sites, the lowest biomass was recorded in March and the highest values were recorded during August (Table 2).

The net annual primary production was worked out on the basis of biomass calculated over the growing season for the whole study period. The lowest net annual production of 7.42 $gm^{-2}yr^{-1}$ was registered for site VI as against a highest of 12.5 $gm^{-2}yr^{-1}$ at site III. The net annual primary production a site I, II, IV and V during the study period was 8.58 $gm^{-2}yr^{-1}$, 8.17 $gm^{-2}yr^{-1}$, 9.0 $gm^{-2}yr^{-1}$ and 11.17 $gm^{-2}yr^{-1}$ respectively (Fig. 2). *Azolla pinnata* was not so scarce as it contributed both to biomass as well as production.

Table 2: Monthly variation in macrophytic biomass and annual primary production at different selected sites of Wular lake during 2003

	Macrophytic Biomass (gm^{-2})					
Year 2003	**Site I**	**Site II**	**Site III**	**Site IV**	**Site V**	**Site VI**
March	37.00	54.00	41.00	72.00	47.00	68.00
April	39.00	58.00	62.00	76.00	70.00	87.00
May	52.00	79.00	91.00	103.00	81.00	96.00
June	75.00	112.00	119.00	127.00	106.00	115.00
July	97.00	137.00	154.00	172.00	147.00	128.00
August	123.00	129.00	178.00	168.00	157.00	133.00
September	134.00	118.00	142.00	139.00	125.00	108.00
October	101.00	87.00	93.00	78.00	81.00	69.00
Net annual primary productivity ($gm^{-2}yr^{-1}$)	8.58	8.17	12.50	9.00	11.17	7.42

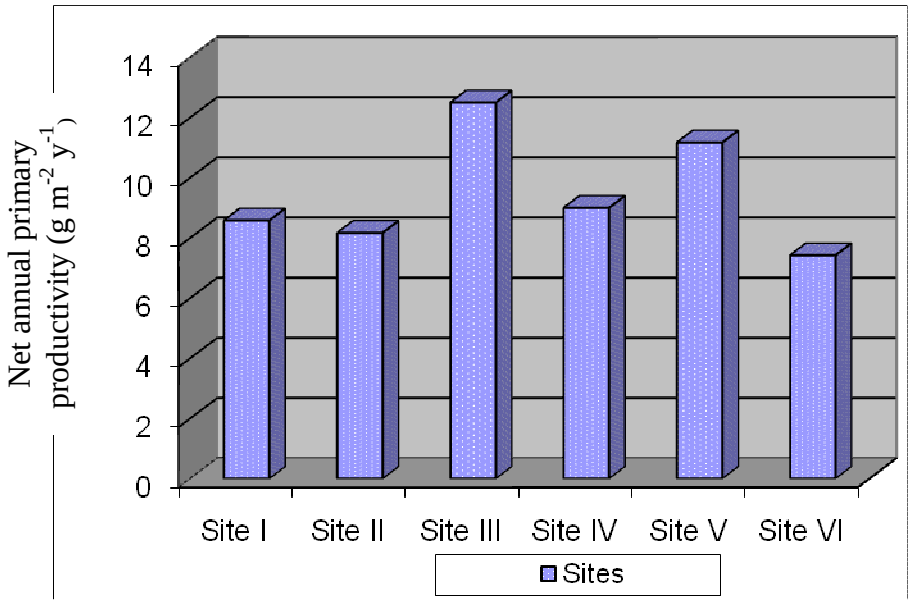

Fig. 2. Macrophytic variations in net annual primary prodoctivity ($gm^{-2}yr^{-1}$) in Wular lake at seven selected sites during the year 2003

Wular, lake having a greater littoral area, sustains a dense growth of macrophytes (Fig.3-6). In all 25 macrophytic species belonging to 17 families were encountered from the lake. The macrophyes does not form monospecific meadows especially towards the littorals but grow intermixed resulting in complex physiognomy. Among the four life classes, the emergents out numbered all other classes throughout the study period. Structure and species composition of the wetland is purely governed by various ecological stresses including flooding, erosion and depletion. The accumulation of heavy loads of silt, as a result of excessive and frequent flooding in the previous few years (Pandit, 1991; 1999), seems to be a quite reasonable attribute for fast spreading of some macrophytes in the wetland.

Though open water areas of the wetland exhibited the growth of all the four types of macrophytes growing intermixed, the rooted floating leaved species and a few emergents dominated throughout the growing season, which is purely attributed to the decreasing depth of the wetland. Despite moderate water depth in the wetland submergeds except a few did not show any luxuriant growth probably because of greater water turbidity during the growing season.

Fig. 3. Luxuriant growth of macrophytes (rooted floating-leaf types and emergents) growing in the littorals of Wular near Watlab site

Fig. 4. Lake littorals with rooted floating leaf vegetation (*Hydrocharis dubia*)

Fig.5. Free floating vegetation in open water areas of the lake

Fig. 6. Macro–vegetation chocking the littorals of the lake

However, *Ceratophyllum demersum* showd a vigorous growth being adapted to the low irradiation (Vandervalk and Bliss, 1971). Pandit, 1999 related the growth and abundance of *Ceratophyllum demersum* to the eutrophic conditions of water.

The abundant growth of free floating exotic species *Azolla pinnata* even blocks the navigation channels. The introduction of the species may be due to the heavy motorable boats shifted from other waterbodies of the country to the Kashmir lake, an observation made by Mir (2007). The exotic species to so expanding in growth that it will become a serious threat for the indegenic species if not controlled immediately.

Macrophytic productivity yet forms another important criterion to establish the dominance of any species in an ecosystem. Macrophytic productivity is most commonly evaluated by measuring changes in biomass (Westlake, 1965). In general, irrespective of sites, the lowest biomass ($37gm^{-2}$) was recorded in March and the maximum ($178\ gm^{-2}$) during the month of August (Table 2).

Macrophytes have been used as indicators of water pollution by various workers including Wetzel (1978), Varshney (1981) and Pandit (1984). The most commonly used method for biological assessment of water pollution in aquatic ecosystem are based on the kind of species present, number of species, abundance, productivity etc. (Cairns *et al.*, 1979). In the present study many such indicator species of macrophytes were recorded including *Sparganium ramosum, Myriophyllum verticillatum, Potamogeton lucens, Potamogeton crispus, Potamogeton pucillus, Alisma plantogo aquatica, Lemna* sp. and *Salvinia natans*. Pandit (1984) envisaged the presence of these species to eutrophic conditions of the waterbody. Kaul (1984) also correlated *Lemna-Salvinia* association with excessive eutrophication bringing about the replacement in underwater vegetation.

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Problems and Prospects of User Participation in Manasbal Lake, Kashmir

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ABSTRACT

Biophysical and ecological features of Manasbal lake ecosystem specifically those that affected and altered its processes along with its unique entitlement system are presented. The study focusing on stakeholders of the system highlights the significance of the lake in relevance to user's livelihood. Problems and other constraints of the administration as well as users in the conservation of the lake through community participatory approach are highlighted. The multitude of direct functions of the lake and the changing patterns in lake fishing, tourism and Nadru cultivation are a serious concern for its sustainability. Stakeholders, their institutional priorities and property right regimes are analyzed through Key Informant Technique. Partially defined property rights, the working system and limitations of the institutions for a participatory mode are major hindrances for community participation. However, small groups of users their social similarity, cultural homogeneity and language, geopolitical and legal systems should harmonize any future co-ordination.

Key words: Conservation, participatory management, property regimes.

INTRODUCTION

The man-lake association in Kashmir since ancient times is not only for preservation, conservation and utilization values but has also remained a focal point of Kashmir's illustrious history, art, culture and tourism. Nevertheless these ecosystems have suffered a multitude of anthropogenic disturbances resulting in negative effects on their structure and function. Lake ecosystem degradation as a manifestation of increased population growth, high rate of urbanization, tourism development and mismanagement practices were reported by various authors (Kaul, 1977; Kaul and Handoo,1987). In lake Manasbal, degradation occurring both as a consequence of catchment practices as well as partially defined property rights is manifested in different ways like excessive weed growth (Zutshi *et.al.,* 1978), decreasing country catch (Yousuf, 1979), red algal blooms and other related processes. Though the government made several efforts, the constant pressure on these ecosystems and the enforcement limitations are inadequate to facilitate their sustained use. The involvement of resource users who directly use these resources or the attempt to know their perceptions in making decisions is essential (Pyrovetsi and Daoutopoulos,1989). The present study focuses on the conservation and management of Lake Manasbal –a rural lake- in a participatory manner. Though definitions and concepts of participation have evolved over time (Arnstein, 1969; Creighton, 1981; World Bank Report,

1993, 2000 and Avramoski, 2004) and though a consensus on what the term connotes is lacking there is a wide acceptance that in resource management the most potential participants are the *resource users* and thus achieving meaningful community-level participation in lakes is not always a straightforward task. Within Kashmir the concept of participation in conservation process is still in embryonic stage as is indicated by the limited number of studies and participatory conservation programs run by different agencies. This paper presents the human-resource linkage in Lake Manasbal, highlights different stakeholders and problems involved particularly of users in the conservation of the lake and also suggests scope for such participation for long term conservation of the lake.

STUDY AREA

Manasbal lake (Fig.1) Kashmir's deepest lake is located at Safapur village at 34°15́N and 74°40́ E latitudes, 30 km to the north–west of Srinagar and has the hamlets of Kondabal, Jarokabal and Gratabal overlooking it. The lake measuring 2.80 km^2 in area and oblong in outline is the only lake in Kashmir that develops summer stratification and is classified as warm momictic lake. The lake has no major inflows and its water supply is chiefly derived from internal springs and precipitation. From spring to early autumn the Laar Kul- a small irrigational stream which takes off from Sindh Nallah and irrigates the agricultural fields through out its course, drains in to the lake on its eastern side. The natural beauty of the lake internationally recognized with its deep clean water and pink lilies besides grand mountain behind it forming an effective contrast to its gentle beauty has it labeled as the "Supreme Gem of all Kashmir lakes" (Dewan, 2004). Although the lake does not possess the same importance as does the Dal and the Wular lakes, it is unique, with a complex water body and is abundant in various natural products like fish and Nadru- a local vegetable, which the local communities particularly the Hanji-local fishermen use. Boating, navigation and transportation besides tourism are other benefits derived as it contributes a sizeable share to the regional economy. Community participation itself defined by entitlement system of the users is primarily based on the potential stake of different users within the broader context of activities. Though in India lakes are generally common pool resources (Marothia,1997; Agarwal, 1992) this water body does not fit into one property regime whole year around owing to the changing property patterns.

Under a broader framework, water body is the State property- owing to the rights of exclusion and having the role and responsibility of protecting the interests of those holding- to a few degrees, but these are diluted by the absence of defined and collective action for managing this resource. Moreover boating is open for the general public by policy, although on ground it is being practiced by Hanji community only. During the period of Nadru cultivation (locally cultivated vegetable) the organization takes a shift. Though an authority system exists to provide access to this resource, with lack of working rule –the critical factor for the formation of social responsibility, the choice of alternative policies are hindered.

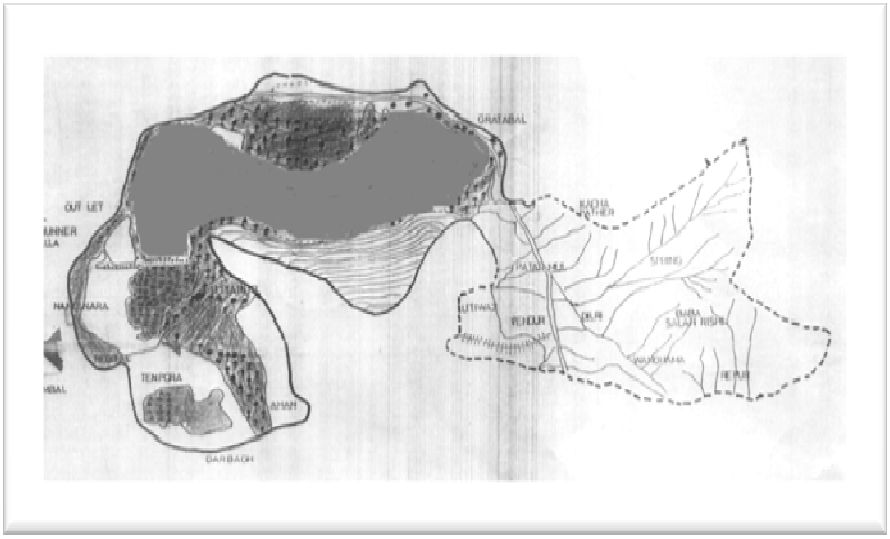


Fig 1. Map of Lake Manasbal

Source: Department of Environment and Remote Sensing (DoERS) J &K

MATERIAL AND METHODS

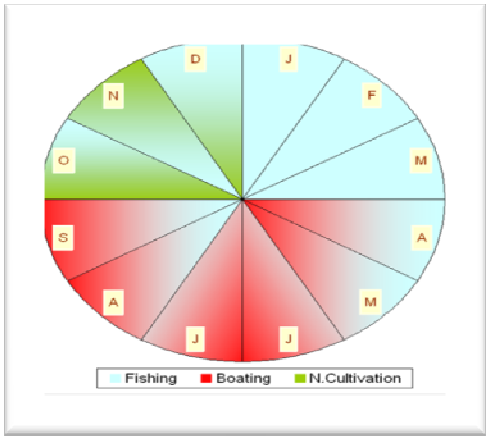
The study was conducted between January and May 2006. Data related to demographic details, resource use pattern, stakeholder analysis and other socio-economic activities was collected through a semi structured questionnaire. Information from governmental and other agencies was by both structured and unstructured interviews. Data from the Department of Fisheries (DoF) and Department of Tourism(DoT) indicated that currently 380 people posses fishing licenses, out of which 200 people also have licenses for Nadru cultivation from DoF while 45 people have boating licenses but from DoT. Thus in effect only one set of people were involved in carrying out all three activities. Information on different users was obtained through a detailed questionnaire which included both closed and open ended questions. Simple statistical analysis was used to calculate the percentage and mean. The results are presented through tables, graph and chart.

RESULTS AND DISCUSSION

Human-Resource Linkage

Study of human resource linkage in a system is imperative because user's utilization of resources ultimately determines future of resources. The results indicated that lake fishing, boating and Nadru cultivation are the major occupations (Fig.2), while the agricultural labor and stone querying act as subsidiary occupations, especially in the lean period for those people involved in only one or two of these occupations. The main occupation had been fishing, but over the years the other two have also been taken up is indicated by the number of people applying for the licenses for boating. It increased from 32 in 2003 to 45 in 2006, (DoT – personal communication) which indicated that boating is more income-earning than the other two. Same is reflected in that the average fishing experience is 8.52 years, while for Nadru cultivation and boating it is 4.81 and 4.25 years respectively (Fig. 3). Hence the current use pattern depicted in Fig. 2 is liable to get changed and what will be its implications will be a matter of future research.

However, the rapid entry of people into boating is a matter of concern. Earlier studies have also highlighted the threat of tourism to Manasbal lake (Rather, 2002) and is likely to get aggravated as this activity is open to the general society and requires permission of DoT alone with no inputs from other stakeholders notably DoERS.



J- D= January to December

Fig. 2. Current resource use pattern in the lake

Contribution to users from different occupations varies. At present the cultivation of Nadru restricted to the latter trimester of the year, is the largest contributor when taken on an efficiency basis. Contrary to the common belief that fishing is practiced all year round, it is restricted strictly to 4-5 months with few overlapping periods. This change is a consequence of both diminishing resources as well as alternate

occupation. The marketing of the fish and Nadru is mostly to other places adjacent to the lake with only a little utilized for self subsistence and another small amount is marketed in the local village and district (Table 1).

Table 1. Characteristics of the resource users (sampled population)

Characteristics	Numbers
Mean age (years):	
16-25	8
26-35	13
36-45	14
46-56	3
Mean experience in fishing (years):	8.52
Mean experience in Nadru cultivation (years):	
Mean experience in boating (years):	4.81
Percentage of fish marketed in:	4.25
Village	
Local district	
Other districts	28%.
Percentage of Nadru marketed in:	8%
Village	64%
Local district	10%
Other districts	8%
	82%

Out of the current fish catch 28% is marketed at village level, 8% in the local district while the rest 64% is marketed in other districts, mostly Srinagar, which is again with the assistance of a middle man. For Nadru, 10% is marketed in village, 8% in local district and remaining 82% in other districts which can be attributed to the presence and the production capacity of the Wular in local district. This factor has a strong implication on any participatory approach, because this will invite the attention of various other regulators – more particularly communities of interest (Kusel *et. al.,* 1996).

The occupations also differ in that while boating is practiced in a pooled manner wherein the daily income gets distributed among the members, the cultivation is carried out jointly with other family members mostly the younger ones but fishing is carried out individually. Also the harvesting of Nadru in this lake is completely different from the same in Dal lake- both from a policy point as well as from the method employed. In the latter the cultivators have well defined areas to harvest while in Manasbal lake although it requires prior permission from DoF, it is more of an open access nature because there are no regulations as to what should be the maximum quantity to be harvested per day. Though no direct association between the over exploitation of this resource and the subsequent decrease in the *Euryale ferox* has been reported so far,

there are reports for its conservation especially in Manasbal lake where it grows abundantly with *Nelumbo nucifera* (Khan, 2000). The absence of any collective action for the management of the lake, on part of the users has been attributed to incomplete property rights structure (Bronmark and Hansson, 2002). In this lake such absence can also be attributed to the fact that though the community (at least for fishing and Nadru cultivation) has been identified still they are passive recipients of the government imposed regulations.

Hindrances in user participation

The overall environmental protection of Kashmir including lakes, lies with the DoERS, but the many administrative departments involved create bewilderment among the users in identifying the key stakeholders**.** Different stakeholders exercising claim on the lake are DoT, DoF, Department of Public Health Engineering (DoPHE), Department of Floriculture (DoFL), DoERS and State Pollution Control Board (SPCB) besides the users. The current participation or interaction of these institutions Vis a Vis the users are depicted in Fig.3.

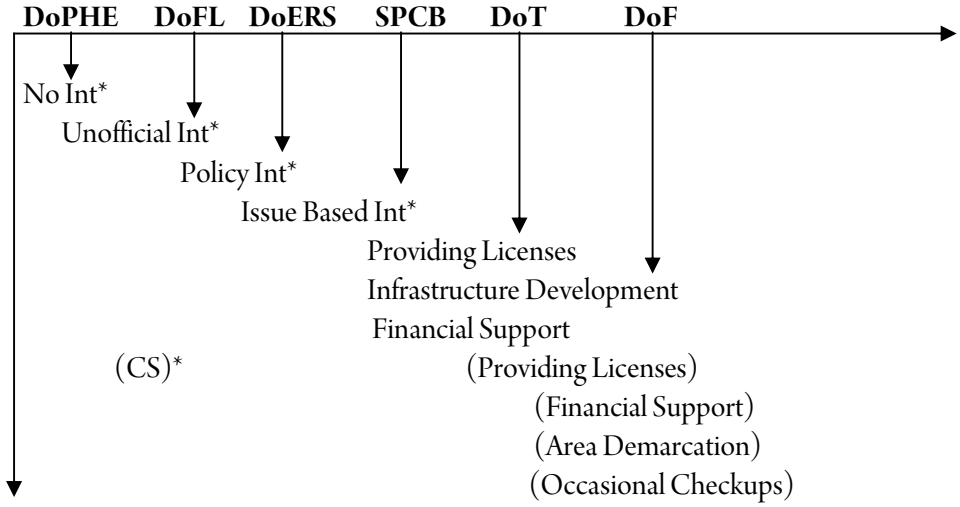


Fig.3. Current status of participation (information sharing) between externa stakeholders vis-à-vis Community Stakeholders

Indicators for the diagram: (a) Awareness among people (b) Placement of institution within institutional hierarchy (c) Policy of institution d) Type of support
CS* Community Stakeholders, Int* --- Interaction

Abbreviations Used: DOERS—Department of Environment and Remote Sensing DoT –Department of Tourism, DoFL – Department of Floriculture, SPCB- State Pollution Control Board, J and K. DoF – Department of Fisheries, DoPHE- Department of Public Health Engineering.

Presently DoF has larger interaction with the community stakeholders as evidenced from the awareness level of the users. But interaction as a unit limits the conservation of the lake because of policy priorities. At policy level the priority of DoERS is overall conservation of the lake as a whole unit and not on a component basis. The situation is and only 10% of the people had a clear idea of the authority looking into the matters of the lake at policy level.

The perception of the users related to benefits and the problems of the lake is essential. The results of the present study revealed that younger people are more sensitive to different problems than other age groups. People in age group of 36-45yrs viewed *Euryale ferox* as the most serious problem as it hinders their occupation, while the older age group are more concerned about the decrease in the country fish, which is not so with younger generation (Fig.4).

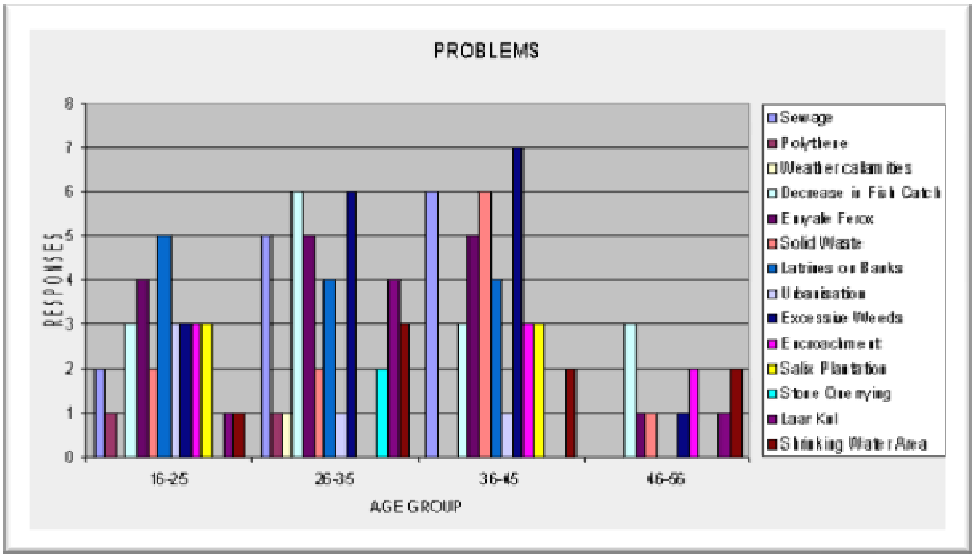


Fig. 4. Awareness regarding problems of the lake

Fishing as the major source of income is decreasing as people shift to other occupations like boating for additional income. Such attitudinal changes reflect also the increased awareness on environmental issues, ongoing political changes and a shift in priorities and developmental policies (Heinen and Sah, 2001). The low awareness among key stakeholders, their social backwardness and weak representation is indicated by the absence of any formal or informal representative (NGO) on part of people. In addition the conventional approach of the authorities hinders information sharing between the stakeholders. The significance of these

formal /informal groups in such information sharing is necessary (Avramoski, 2004). Since lack of information sharing manifests itself in differences in certain areas as presented in the matrix (Table 2).

Table 2. Matrix highlighting the areas of differences between present stakeholders in Lake Manasbal, Kashmir (Responding in a vice-versa manner).

	Institutional Measures	**Research Institutions**	**Communities**
Institutional Measures	*Priority Differences (1)*	*Low Interaction (2)*	*Authoritative Nature*
Research Institutions	*Subjective Oriented Short Research*	*No Joint efforts*	*Predefined Agenda*
Communities	*Un-Cooperative*	*Low Scientific Knowledge*	*No Collective Action*

(1) Attributed to Govt. working. (2) Attributed to anarchy in the state.

The priority difference in the organization not only affects but governs the role and responsibility of the people in a participatory program. The analysis of the matrix makes it evident that despite the fact that the group is less and homogenous (intra group), collective actions are wanting, which corroborates the views of Olsen (1965). At present the role of people in the conservation process is too narrow but presents a better promise. The small nature of the group involved (Olsen, 1965) and their social similarity—if this is nourished it will turn more advantageous due to lessened transaction costs involved in bringing the fragmented stakeholders together, for which a formal or informal representation of the people is essential. The similarity in the geopolitical and the legal system will also ease co-ordination. In addition the homogeneity in culture and languages are also the future prospects which can ease the information sharing between the stakeholders. The positive expectations of the user on the future economic potential of the lake is a fact which if used well can be for the collective gain of both authorities and the resource users. But prior to it, the objectives and means of such collective gain should be made available to every stakeholder so that no duplication and overlapping of efforts emerge.

CONCLUSIONS

Lake Manasbal, the unique but complex water body has significant use and non-use benefits. But over the years as it suffered severe losses, the resource use pattern of the users is affected which is evident from the shortening of the fishing period and subsequent new entry of boating as occupation. During the course of this study it was revealed that the user perception on several aspects of the lake ecosystem, particularly the *Euryale ferox* is conflicting with the conservation objectives for which a change in the perception of the people that in turn substantiates the need to promote information sharing between the stakeholders is essential.

It is also observed that the partially defined property rights have hindered the user participation which is indicated by the absence of collective action mechanism and when present it again is in conflict with the conservation objectives. Therefore future efforts that would link and co-ordinate the human systems with these ecological systems are wanted. The linking of the ecological system with the human system although has several limitations, like the difference in the time frames yet various authors have argued to club this with the specifications of rights, which create an expectation of long term tenure and protection from the coercion of short term decisions. Establishing such linkages therefore should be the priority.

For the long-term conservation of the lake, an interaction and integration of the stakeholders is proposed. Interaction based mechanism to promote long-term co-ordination and co-operation among various stakeholders and decision-making bodies needs to be encouraged. Community role in such a participation arrangement in this sensitive state needs to be clearly defined for the long term and sustained conservation of the lake.

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Changes in Physico-chemical Characteristics of a Warm Monomictic Lake over a Period of Two and a Half Decade

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ABSTRACT

Present paper detects the change in various physicochemical characteristics of a warm monomictic Manasbal lake over a period of more than two decades. Vertical variation in the physico-chemical parameters in an off shore region of the lake was analyzed during a three months period of stratification and was compared with the previous observations made by Wanganeo (1980). A significant change in various parameters has been observed. Bottom waters were anoxic during the month of June in comparison to the values obtained by Wanganeo during June, 1980. Specific conductivity, Ammonical nitrogen, phosphate phosphorous and nitrate nitrogen etc. also showed enhancement in its values over a period of more than two decades.

Key words: Physico-chemical characteristics, temporal variation, warm monomictic lake.

INTRODUCTION

Present investigation was conducted on Manasbal lake (34^0 15′N and 74^0.40′E) during a brief period of three months from April to June. This oxbow type, warm monomictic lake is situated at an altitude of 1583m. a.s.l., about 32 Kilometers away towards North west of Srinagar city (the summer capital of Jammu and Kashmir State). Manasbal lake is having a maximum length and breadth of 3.5 and 1.5 km respectively. The lake covers an area of 2.81 km^2 and its volume and maximum depth are 0.0128 km^3 and 13m respectively (Wanganeo 1980). The observations made during the present study period (i.e. from April to June, 2005) clearly demonstrate that the thermal stratification predominantly affects the vertical distribution of various chemical features in this warm monomictic lake (Manasbal).

MATERIAL AND MEHODS

The methods employed for analysis of various physico chemical characteristics of water were after APHA (1995). For the purpose of physico-chemical analysis of water, sampling was done in the pelagic zone at a site of maximum depth (Fig.1). A fortnightly schedule has been followed for sampling purpose.

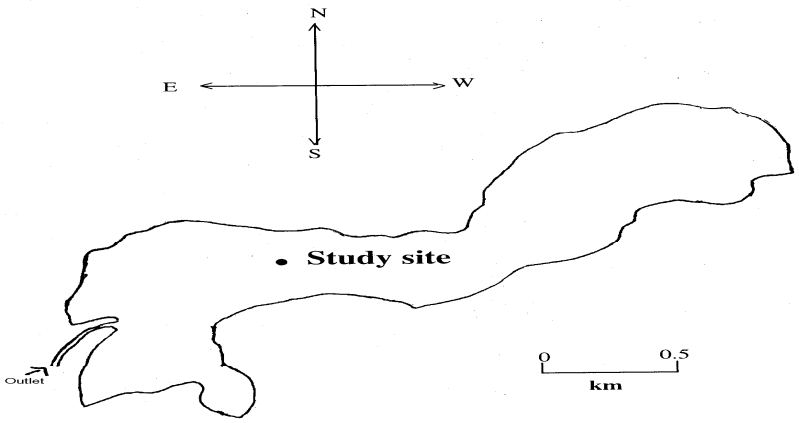


Fig. 1. - Outline Sketch of the Manasbal lake showing the study site.

RESULTS AND DISCUSSION

Air and surface water temperature showed a close relation however, during the year 1979 (Wanganeo, 1980) air temperature was more in comparison to the year 2005 (Fig.2a,b,c). Column variation in water temperature has been presented in Fig.2a, b. During both the years the lake was thermally stratified. Wanganeo (1980) categorized this water body among warm monomictic lakes.

As reported by Wanganeo (1980), water temperature in the month of April was found to be uniform upto a depth of 3.5 m which in the month of June extended upto 4.5 m (Table 1 and Fig.2a,b),below that it fell sharply till 7.5m depth. On the other hand during present study, uniformity in water temperature was found vertically extending upto a depth of 3.5 m. Thereafter, water temperature recorded a uniform pattern throughout the study period.

The Secchi transparency values observed by Wanganeo (1980) fluctuated from 3.75m (April) to 4.75m (May) while as, during present investigation the mean minimum transparency values varied from 4.25m (June) to 4.67 m (April). The change observed in Secchi transparency is on account of the variation in climatic condition besides the cloud cover (Fig.2d).

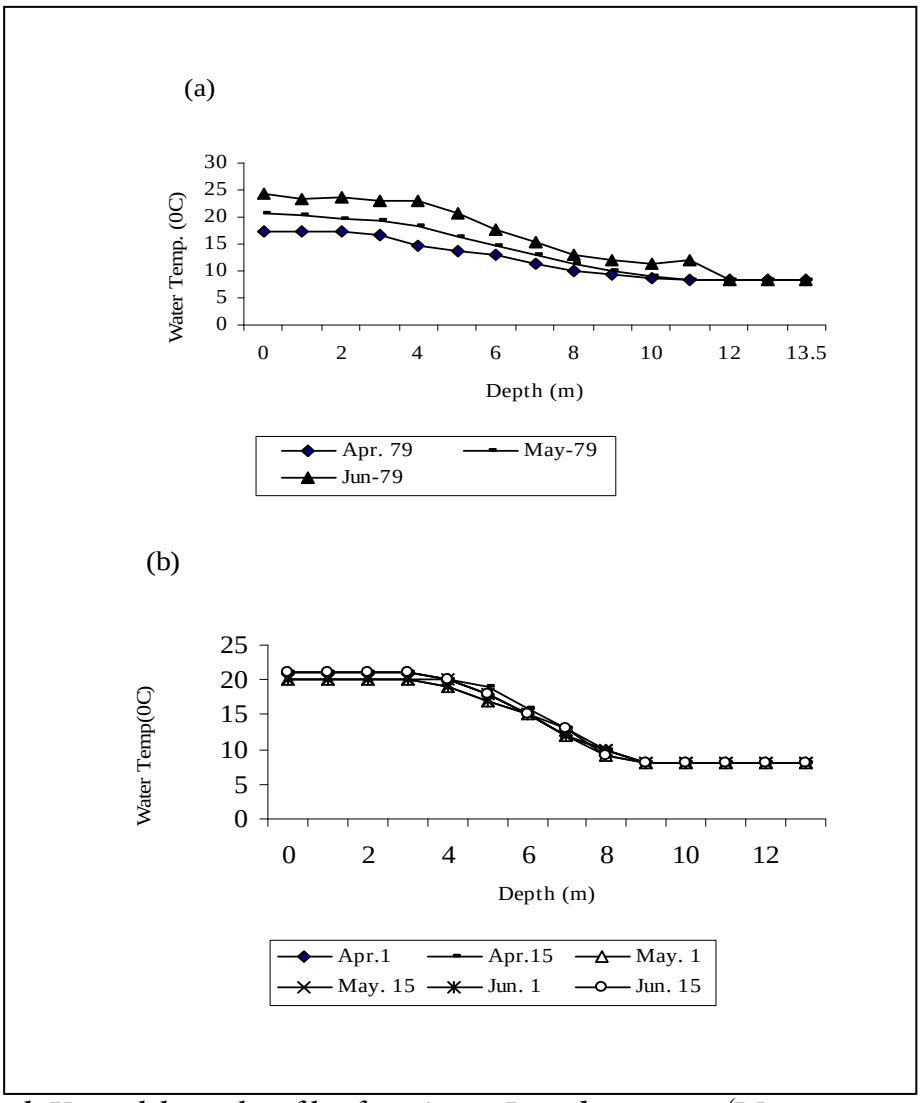


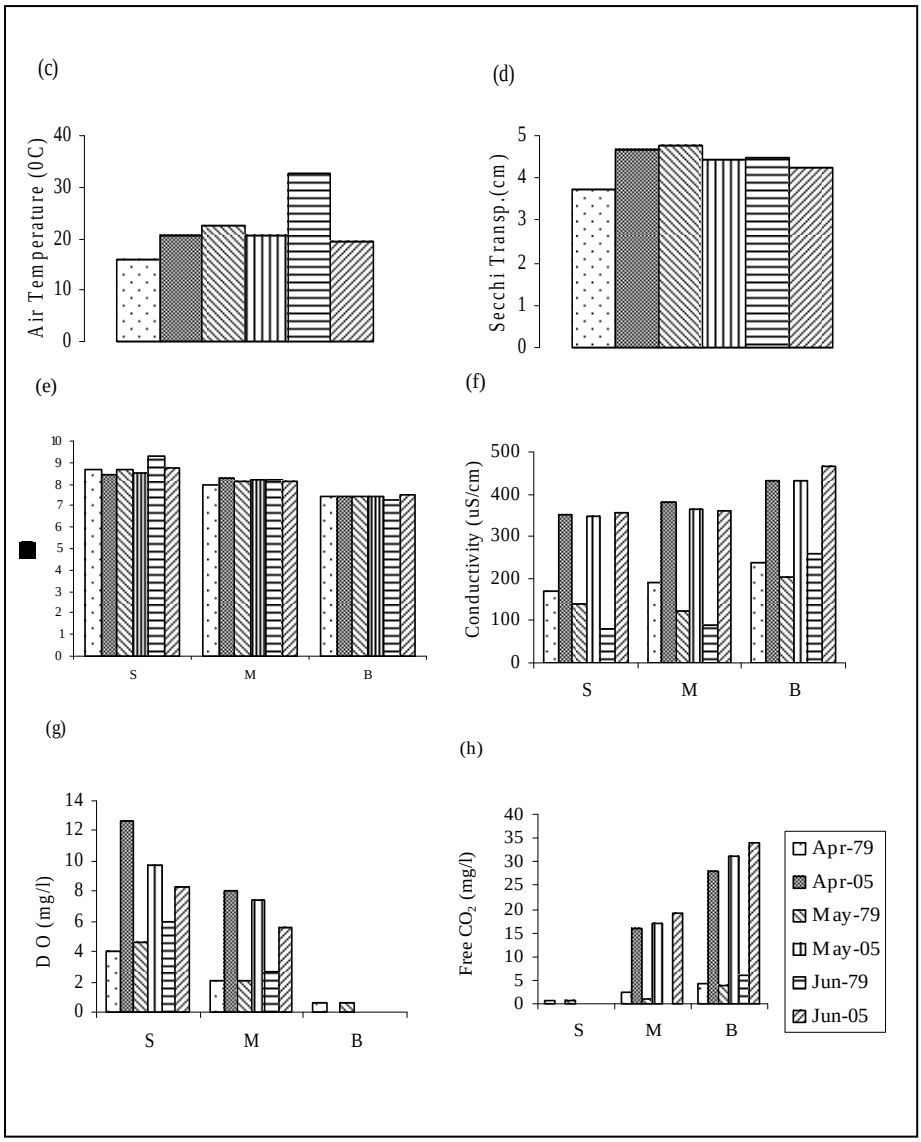
Figure 2a,b. Vertical thermal profiles, from Apr. to June, during 1979 (Wanganeo, 1980) and during 2005 in Manasbal lake.

The pH in surface, mid and bottom waters during previous observation (Wanganeo, 1980) varied from 8.7 units (April) to 9.3 units (June), 8 units (April) to 8.2units (June) and 7.30 units (June) to7.39 units (April and May) respectively (Wanganeo, 1980), while as during present study the monthly mean values of pH fluctuated from 8.4 units (April) to 8.7 units (June) and 8.1 units (June) to 8.2 units (April) in the surface and mid water respectively. No prominent variation in the mean values for pH was observed from April to June in case of bottom samples.

The comparative study reveals that conductivity values as recorded by Wanganeo (1980) varied from 80 µS/cm (June) to168 µS/cm (April), 87.5 µS/cm (June) to191 µS/cm (April) and 202.5 µS/cm (May) to 260µS/cm (June) in surface, mid and bottom waters respectively. However, during present study the mean Conductivity values in surface and mid waters ranged from 347 µS/cm (May) 357.6 µS/cm (June) and 361 µS/cm (June) to 383 µS/cm (April) respectively. while as in bottom waters it varied from 430.5 µS/cm (April) to 466.5 µS/cm (June). Increase in the conductivity values with depth is on account of increase in the concentration of dissolved substances inthe deeper waters. Kulshrestha *et al.*'s (1989) findings also support such contention.

Early observation (Wanganeo, 1980) revealed that DO concentration in surface and mid waters varied from 4 mg/l (April) to 5.94 mg/l (June) 2.04 mg/l (May) to 2.64 mg/l (June), respectively (Fig.2g), while as, during present work the monthly mean value of DO content (Table 1 and Fig.2g) in surface and column waters ranged from 8.3 mg/l (June) to 12.7 mg/l (April) and 5.6 mg/l (June) to 8 mg/l (April). DO content of bottom waters during previous work (Wanganeo 1980) varied from below detection level (June) to 0.66 mg/l (April). However, it remained below detection level throughout the present investigation period. As revealed in the previous work (Wanganeo 1980) free CO_2 in surface, mid and bottom waters fluctuated from below detection level (June) to 0.66 mg/l (April and May), below detection level to 2.44 mg/l (April) and 3.96 mg/l (May) to 5.94 mg/l (June) respectively (Fig.2h). However, during present work free CO_2 in surface waters was found absent. The mean CO_2 concentration varied from 16 mg/l (April) to 19 mg/l (June) in column water and from 28 mg/l (April) to 34 mg/l (June) in bottom water (Fig.2h). Wanganeo and Wanganeo (1994) further reported that the hypolimnic anoxia and clinograde type of oxygen profiles support the contention that the lake is undergoing accelerated eutrophication.

Phenolphthalein alkalinity remained absent during both the study periods except in the surface waters (Fig.3a). Total alkalinity in the surface waters during 1979 (Wanganeo,1980) and present work ranged from 75.25 mg/l (May) to 122 mg/l (April) and 126 mg/l (June) to 135 mg/l (April) respectively while in mid and bottom waters it fluctuated from 91 mg/l (May) to 122 mg/l (April) and 130 mg/l (April) to 168 mg/l (June) respectively during 1979 (Wanganeo,1980)and from 138 mg/l (June) to 146 mg/l (May) and 172 mg/l (April) to 178 mg/l (June) respectively during present work (Fig. 3b).



Where : S, M and D represent the surface, mid (Z=6m) and bottom (Z=12m) waters respectively.

Figure 2 c-h. Variation in some Physico-chemical parameters in Manasbal lake

The values of total hardness in surface waters during 1979 (Wanganeo, 1980) and present investigation periods ranged between 24 mg/l (May) to 46 mg/l (June) and 136 mg/l (June) to 177 mg/l (April) respectively. In mid waters, during 1979 (Wanganeo, 1980) and present work it fluctuated from 28

mg/l (May) to 67 mg/l (June) and 162 mg/l (June) to 177 mg/l (April) respectively. Total hardness in the bottom waters during 1979 (Wanganeo, 1980) and present investigation ranged from 33 mg/l (May) to 55 mg/l (June) and from 258 mg/l (June) to 276 mg/l (April) respectively (Fig. 3c).

The values of calcium hardness in surface, mid and bottom waters during 1979 (Wanganeo, 1980) varied from 12 mg/l (May) to 14 mg/l (April), 9 mg/l (April) to 18 (June) and 9.4 mg/l (April) to 21 mg/l (May) respectively. During present investigation the minimum and maximum mean values for this parameter in surface, mid and bottom waters were 114.4 mg/l (June) and 155.3 mg/l (April); 132 mg/l (June) and 138.6 mg/l (May) and 207.9 mg/l (May) and 216.3 mg/l (June) respectively (Fig.3d).

Magnesium hardness of surface, mid and bottom waters during 1979 (Wanganeo, 1980) varied from 3 mg/l (May) to 8 mg/l (June), 3 mg/l (May) to 12 mg/l (June) and 3 mg/l (May) to 11 mg/l (April and June) respectively. During present work the mean values of magnesium hardness ranged between 21.7 mg/l (May) and 23.7 mg/l (April) in surface water, while in mid and bottom waters these ranged from 38 mg/l (June) to 42.6 mg/l (April) and 47.9 mg/l (June) to 66 mg/l (April) respectively (Fig.3e).

As observed by Wanganeo (1979) the chloride content in surface, mid and bottom waters varied from 13.5 (April) 19.5 (June) 7.84 mg/l (May) to 20.42 mg/l (Mg/l) and 8.3 mg/l (April) to 16.5 mg/l (June) respectively. On the other hand during present work chloride concentration of water fluctuated within a narrow range of 12 mg/l to 14 mg/l only (Fig**.** 3f).

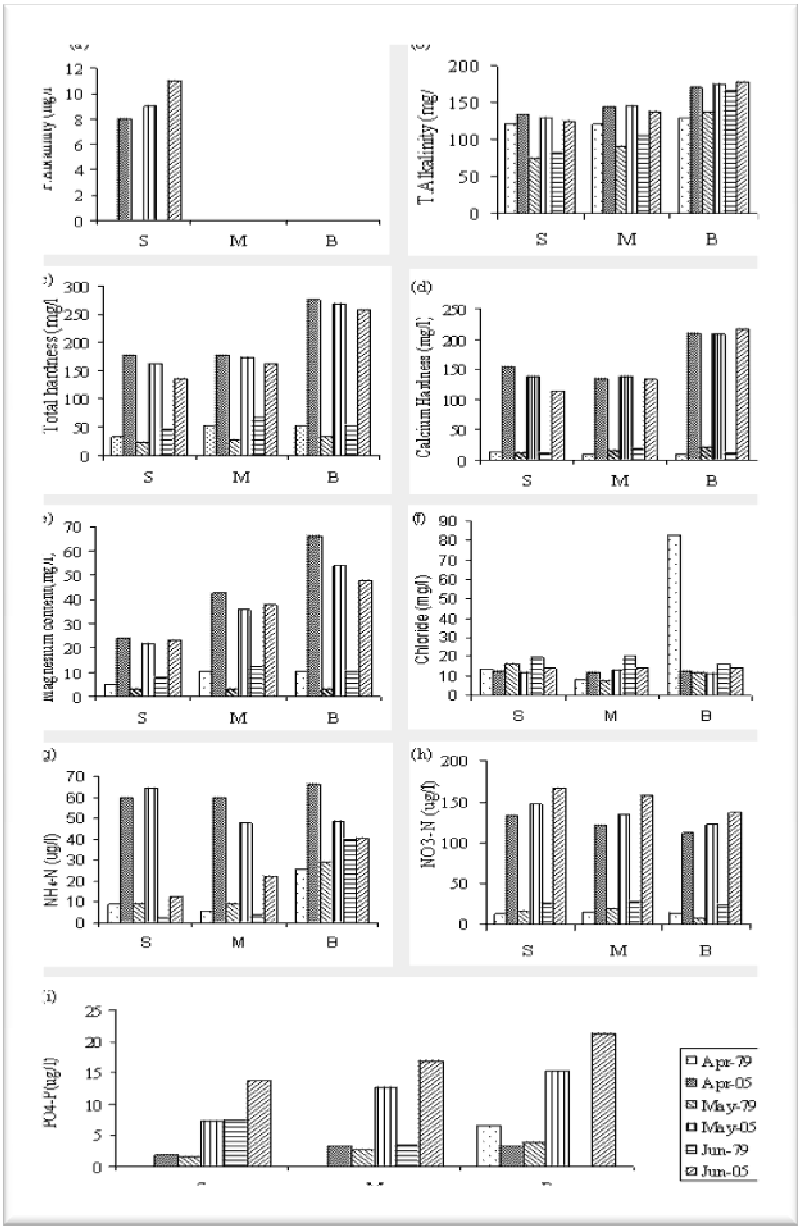
Ammonical nitrogen concentration in the surface, mid and bottom waters varied from 1.87 µg/l (June) to 9.37 µg/l (May), 3.62 µg/l (June) to 9.05 µg/l (May) and 25.34 µg/l (April) to 39.82 µg/l (June) during the year 1979 (Wanganeo, 1980). The monthly mean concentration of NH_3-N in surface mid and bottom waters during present work, however, varied from 12.22 µg/l (June) to 64.27 µg/l (May), 22.49 µg /l (June) to59.83 µg/l (April) and 40.58 µg /l (June) to 66.36 µg /l (April) respectively.

In an observation made by Wanganeo (1979) (Fig.3h) Nitrate nitrogen in surface, mid and bottom water, from April to May, fluctuated from 13.12 µg /l (April) to 26.18 µg /l (June), 16 µg /l (April) to 28 µg /l (June) and 8 µg /l (May) to 24 µg /l (June). On the other hand during present work (Fig.3h) the mean concentration of nitrate nitrogen in surface, mid and bottom waters ranged from 121.24 µg/l (April) to 151.84 µg/l (June) and 112.44 µg/l (April) to 137.36 µg/l (June) respectively. A significant increase in the concentration of NO_3-N content of water seems to be on account of agricultural wastes and sewage contamination (Walmsley *et al.*, 1979).

The comparative study reveals that 2.7 decades ago (Fig.3i), the concentration of phosphate phosphorus ranged from below detection level (April) in surface and mid water to 7.5 µg/l (June) and 3.45 µg/l (June) respectively (Wanganeo, 1979). While as during present study (Fig.3i) the mean concentration of this inorganic form of phosphorus in surface, mid and bottom waters fluctuated from 1.84 µg/l (April) 13.61 µg/l (June); 3.17 µg/l (April) to 16.97 µg/l (June) and 3.2 µg/l (April)) 21.23 µg/l (June) respectively.

The perusal of data reveals that a marked increase in PO_4-P concentration has occurred in the pelagic region of this thermally stratified lake since last two and half decades. Such an increase in reactive PO_4-P content may be on account of addition of detergents from the growing population besides release of additional phosphate from dead and decayed phytoplankton cells and concentration of zooplankton excreta (Gainey and Loard, 1952 and Heron, 1961). The other potential internal phosphorus sources to the lake include anaerobic sediments (Lijklema, 1994 and Garber and Hartman, 1985). Benthic invertebrates also mediate in the transfer of phosphorus from the sediments (Gardner *et al.,* 1981) while active phosphorus transport by macrophytes in the littoral zone has also been assessed by DeMarte and Hartmen (1974). Another reason for enhancement of nutrients in the lake water is low renewal rate (Zutshi and Wanganeo, 1989).

Based on the foregoing discussion a vivid enhancement in various parameters has been obtained on account of the infringement of the catchment area by way of anthropogenic activity. Since the water body is having surface outlet only, resulting in removal of surface waters only the cumulative impact in terms of anoxic hypolimnion can very well be understood in this unique warm monomictic Kashmir Himalayan water body. Present paper warns further infringement and suggests banning of all sorts of human activities detrimental for this pristine water body, a store house of biodiversity.



Where : S, M and D represent the surface, mid (Z=6m) and bottom (Z=12m) water respectively.

Figure 3a-i. Variation in some chemical parameters in Manasbal lake

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TERRESTRIAL ECOLOGY

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Vegetation Analysis of Woody Species of Forests of Langate Forest Division in Kashmir, Jammu and Kashmir

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ABSTRACT

In the present study the community features of tree species in four different forest ranges of the Langate Forest Division in Kashmir Valley were assessed. A total of 19 tree species were recorded from all the selected sites during the study period. The total tree density varied between 3.33 to 4.20 trees $100m^{-2}$ and the total basal cover ranged between 5942.17 to 21997.09 cm^{-2} $100m^{-2}$. The distribution pattern was contagious for most of the species. The species diversity was greatest at Site II (Mawar range), followed by Site I (Rafiabad range). However, the value of concentration of dominance exhibited inverse relationship with the species diversity.

Key words: Community features, Langate Forest division, basal cover, dominance, species diversity, Kashmir valley.

INTRODUCTION

Knowledge on the composition of a community is a pre-requisite to the understanding of overall structure and functioning of an ecosystem. The composition, when evaluated in terms of species structure, also includes species diversity. While discussing the importance of species diversity, Odum (1963) stresses that the number of species reflects the adaptation potential of the community. The world vegetation cover under natural growth forests has been fast receding and a significant portion of this area is being converted to the man-made plantation forests, mainly timber trees to meet the growing need of the ever-increasing human population. The recurrent interventions into the forest communities for large-scale collection of fuel wood and minor forest products and the practices of grazing and trampling alter the habitats of many species. The impact of increasing human activities on the forest diversity influences the ecosystem functioning (Wilson, 1992), which has triggered interest in the studies related to the importance of diversity on ecosystems (Schulze and Mooney, 1993) and ecosystem services (Daily, 1997).

The vegetation of the study area (Langate Forest Division) is generally classified as Kashmir valley temperate forests, Kashmir valley sub-alpine forests and Kashmir valley alpine forests (Champion and Seth, 1968). The plant diversity of the Langate Forest Division has been studied by Khuroo *et al.* (2003), Lone and Pandit (2005, 2007) but extensive studies are still lacking both qualitatively and quantitatively. Therefore, the

present study was aimed to understand the structure, composition, pattern of distribution and diversity of woody species of the forests of the region.

STUDY AREA

The study area (Langate Forest Division) falls in the north-west part of the Kashmir valley (Fig. 1). The Division is situated between 34º 15´ and 34º 45´ N latitude and 73º 45´and 74º 35´ E longitude with most of the area in district Kupwara and a small area in district Baramulla. The Division extends over an area of 36, 061 hectares and occupies north–eastern slopes of Kazinag and Shamsabari ranges. The drainage of most of the area is eastward with Pohru stream forming its eastern boundary.

The entire area of Langate Forest Division comprises of four territorial ranges- Rafiabad, Mawar, Rajwar and Magam. The Rafiabad range falls in tehsil Sopore of district Baramulla while as the remaining three ranges fall in tehsil Handwara of district Kupwara. The altitudinal gradient varies from 1,590 – 4,093m a.s.l. with Kazi-Nag Dhar forming its highest peak, while the principal forest extends up to 3,500m a.s.l. The climate of the area is, in general, conformity with the climate of the Kashmir Valley, being sub-Mediterranean type with marked seasonality having four distinct seasons. The selection of the study sites within each range was based on altitude, floristic composition, drainage pattern, accessibility, distance from nearest habitation and other characteristics. Four study sites I, II, III and IV were respectively selected in Rafiabad, Mawar, Rajwar and Magam ranges of the Forest Division.

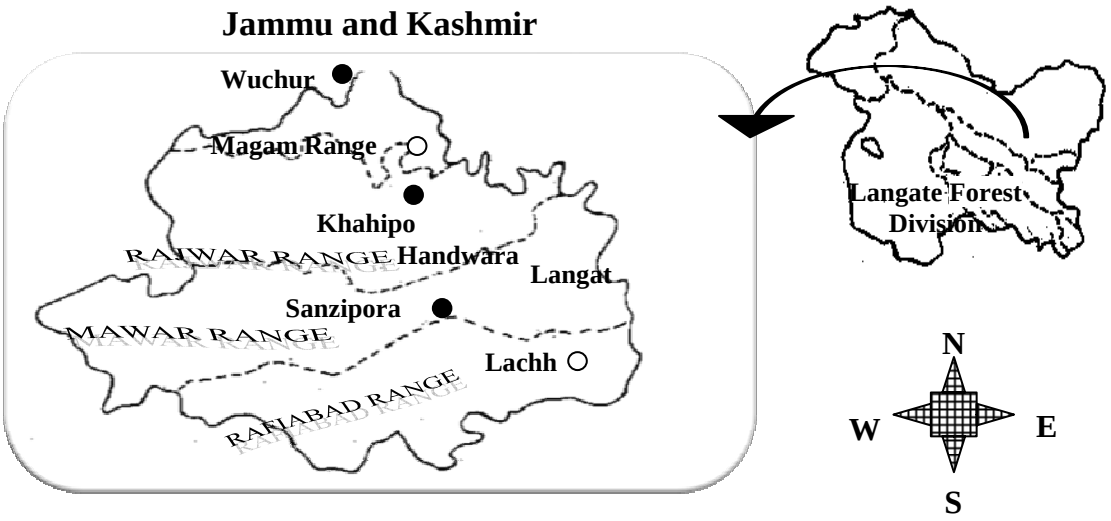


Fig. 1. Map showing location of study sites.

MATERIAL AND METHODS

The phytosociological studies of woody species were conducted by laying quadrats randomly at and around the study sites, almost covering the whole study area. Forty quadrats of varied sizes (10mx10m) were laid for different vegetation types. The size and the number of the quadrats were determined respectively by species area curve (Misra, 1968) and runnings mean method (Kershaw, 1973). The vagetational data was quantitatively analyzed for density, frequency and abundance according to Curtis and McIntosch (1950). The relative values of density, frequency and dominance were summed up to get Importance Value Index (IVI) of individual species in order to express the dominance and ecological success of the species. The ratio of abundance to frequency (A/F ratio) was used to interpret the distribution pattern of the species (Whitford, 1949; Curtis and Cottam, 1956). The basal cover was calculated following Ralhan *et al.*, (1991) and species diversity following Shannon-Weiner (1963). Index of Dominance (C) was calculated according to Simpson (1949) and species richness was determined by using Menhinick Index (Menhinick, 1964). The species evenness or the equitability component (E) was determined after Pielou (1975) while as the index of similarity (S) to compare the forest of two stands was calculated following Sorenson (1948).

RESULTS AND DISCUSSION

There was a marked variation in the phytosociological features of woody species at different sites in the Langate Forest Division. A total of 19 species of trees were recorded from all the selected sites during the entire study period, but with significant spatial variations. Sites II and III recorded 15 species each while as 13 species each were registered from sites I and IV. Except at Site I where *Pinus wallichiana* recorded highest frequency, *Cedrus deodara* was the most frequent species at other three sites (Table 1). The most dominant species at site I in terms of cover was *Abies pindrow* (7589.88cm^2 100m^{-2}), followed by *Cedrus deodara* (5051.72 cm^2 100m^{-2}), *Pinus wallichiana* (4279.69 cm^2 100m^{-2}) and *Piceae smithiana* (3023.00 cm^2 100m^{-2}) in a decreasing order while as the maximum value for Importance Value Index (IVI) was recorded for *Pinus wallichiana* (79.30) and a minimum of (3.12) for *Ailanthus altissima*. Except *Pinus wallichiana*, which depicted A/F ratio of 0.05 and thus showed slightly random distribution, all the other species showed contagious distribution.

Table 1. Community features of trees at Site I of Langate Forest Division

S. No	Name of the species	Frequency (%)	Density $100m^{-2}$	Abundance $100m^{-2}$	A/F Ratio	TBC cm^2 $100m^{-2}$	IVI
1	*Abies pindrow*	20.00	0.68	3.38	0.17	7589.88	63.60
2	*Cedrus deodara*	35.00	0.85	2.42	0.07	5051.72	65.55
3	*Pinus wallichiana*	50.00	1.18	2.35	0.05	4279.67	79.30
4	*Picea smithiana*	7.50	0.22	3.00	0.40	3023.00	23.94
5	*Betula utilis*	5.00	0.20	4.00	0.80	203.06	8.98
6	*Robinia pseudoacacia*	7.50	0.13	1.66	0.22	297.56	9.03
7	*Acer caesium*	5.00	0.08	1.50	0.30	340.75	6.45
8	*Aesculus indica*	7.50	0.13	1.66	0.22	189.31	8.54
9	*Ailanthus altissima*	2.50	0.05	2.00	0.80	81.33	3.12
10	*Fraxinus excelsior*	5.00	0.05	1.00	0.20	173.73	5.06
11	*Juglans regia*	5.00	0.05	1.00	0.20	404.73	6.11
12	*Populus ciliata*	5.00	0.13	2.50	0.50	143.17	6.82
13	*Salix alba*	10.00	0.25	2.50	0.25	219.18	13.33

Table 2. Community features of trees at Site II of Langate Forest Division

S. No	Name of the species	Frequency (%)	Density $100m^{-2}$	Abundance $100m^{-2}$	A/F Ratio	TBC cm^2 $100m^{-2}$	IVI
1	*Abies pindrow*	27.50	0.65	2.36	0.09	5162.72	68.97
2	*Cedrus deodara*	65.00	1.25	1.92	0.03	6016.23	112.61
3	*Pinus wallichiana*	42.50	0.95	2.22	0.05	1218.56	58.52
4	*Picea smithiana*	7.50	0.13	1.66	0.22	937.11	14.13
5	*Betula utilis*	2.50	0.10	4.00	1.60	73.29	4.64
6	*Robinia pseudoacacia*	2.50	0.10	4.00	1.60	101.53	4.83

Cont…

7	*Acer caesium*	2.50	0.05	2.00	0.80	85.92	3.37
8	*Aesculus indica*	2.50	0.08	3.00	1.20	94.68	4.11
9	*Ailanthus altissima*	2.50	0.03	1.00	0.40	46.55	2.42
10	*Celtis australis*	5.00	0.05	1.00	0.20	78.81	4.75
11	*Juglans regia*	5.00	0.08	1.50	0.30	176.47	6.10
12	*Populus ciliata*	2.50	0.05	2.00	0.80	45.52	3.09
13	*Salix alba*	2.50	0.08	3.00	1.20	51.57	3.81
14	*Taxus wallichiana*	2.50	0.05	2.00	0.80	151.22	3.82
15	*Ulmus wallichiana*	2.50	0.05	2.00	0.80	268.84	4.63

Table 3. Community features of trees at Site III of Langate Forest Division

S. No	Name of the species	Frequecy (%)	Density 100m-2	Abundance 100m-2	A/F Ratio	TBC cm2 100m-2	IVI
1	*Abies pindrow*	22.50	0.45	2.00	0.09	1489.45	49.40
2	*Cedrus deodara*	55.00	1.05	1.90	0.03	2766.17	106.58
3	*Pinus wallichiana*	45.00	1.10	2.44	0.05	1690.30	86.15
4	*Robinia pseudoacacia*	2.50	0.08	3.00	1.20	43.10	4.45
5	*Cupressus* sp.	2.50	0.03	1.00	0.40	17.56	2.58
6	*Morus alba*	2.50	0.05	2.00	0.80	42.17	3.69
7	*Acer caesium*	2.50	0.08	3.00	1.20	76.14	4.93
8	*Aesculus indica*	5.00	0.05	1.00	0.20	32.19	5.13
9	*Ailanthus altissima*	2.50	0.05	2.00	0.80	33.64	3.56
10	*Celtis australis*	2.50	0.03	1.00	0.40	23.62	2.67
11	*Juglans regia*	2.50	0.03	1.00	0.40	64.41	3.26
12	*Populus ciliata*	2.50	0.13	5.00	2.00	96.46	6.72
13	*Salix alba*	5.00	0.15	3.00	0.60	107.65	9.24
14	*Platanus orientalis*	2.50	0.05	2.00	0.80	309.55	7.56
15	*Ulmus wallichiana*	2.50	0.03	1.00	0.40	106.11	3.86

Table 4. Community features of trees at Site IV of Langate Forest Division

S. No	Name of the species	Frequency (%)	Density $100m^{-2}$	Abundance $100m^{-2}$	A/F Ratio	TBC cm^2 $100m^{-2}$	IVI
1	*Abies pindrow*	7.50	0.25	3.33	0.44	756.11	24.64
2	*Cedrus deodara*	65.00	1.75	2.69	0.04	3675.54	153.42
3	*Pinus wallichiana*	45.00	1.00	2.22	0.05	1088.68	75.71
4	*Robinia pseudoacacia*	5.00	0.13	2.50	0.50	65.20	7.85
5	*Aesculus indica*	2.50	0.05	2.00	0.80	30.10	3.52
6	*Ailanthus altissima*	5.00	0.05	1.00	0.20	37.80	5.26
7	*Acer caesium*	2.50	0.03	1.00	0.40	22.87	2.69
8	*Celtis australis*	2.50	0.03	1.00	0.40	14.19	2.54
9	*Morus alba*	5.00	0.08	1.50	0.30	30.48	5.96
10	*Juglans regia*	2.50	0.03	1.00	0.40	46.24	3.08
11	*Populus ciliata*	5.00	0.05	1.00	0.20	37.41	5.25
12	*Ulmus wallichiana*	2.50	0.03	1.00	0.40	88.72	3.80
13	*Salix alba*	5.00	0.75	1.50	0.30	48.83	6.16

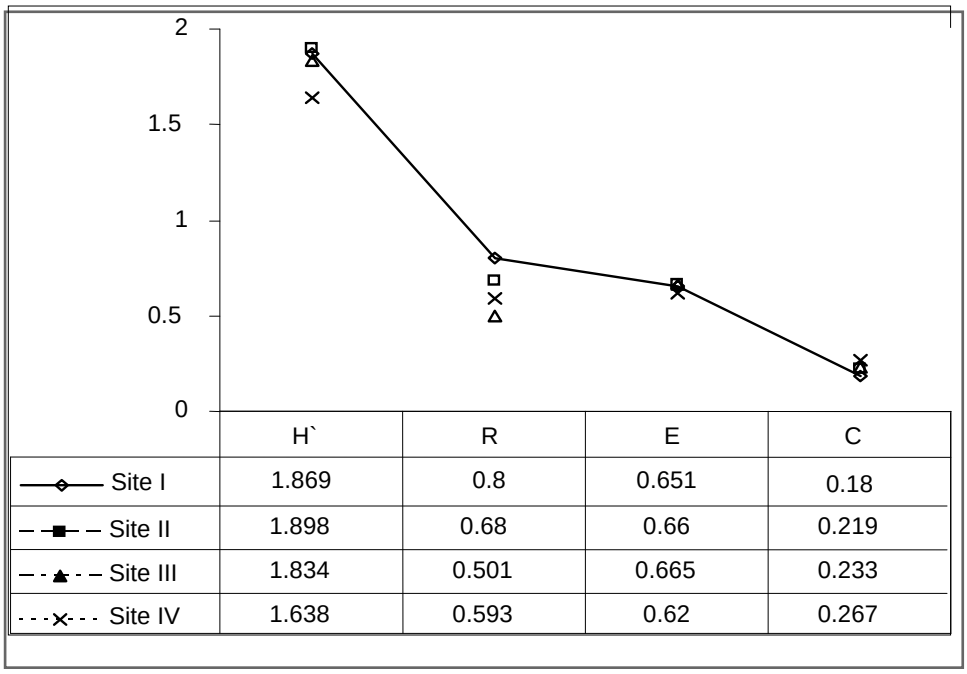
Except *Cedrus deodara* and *Pinus wallichiana,* which depicted slightly random distribution, all the other species at site II showed contagious distribution as revealed by their A/F ratios. The highest basal cover of trees at the site was recorded for *Cedrus deodara* (6016.23 cm^2 $100m^{-2}$) against the lowest of 45.52 cm^2 $100m^{-2}$ for *Populus ciliate* (Table 2). Trees like *Abies pindrow* (5162.72 cm^2 $100m^{-2}$) and *Pinus wallichiana* (1218.56 cm^2 $100m^{-2}$) occupied the intermediate position between the two extremes. The highest overall IVI for the site was, however, reported for *Cedrus deodara* (112.61), followed by *Abies pindrow* (68.97) and *Pinus wallichiana* (58.52).

Cedrus deodara dominated site III in terms of frequency (65.00), total basal cover (2766.17 cm^2 100^{-2}) and overall IVI (106.58). The other noteworthy species at this site in terms of overall IVI were *Pinus wallichiana* (86.15) and *Abies pindrow* (49.40). All the other 12 species depicted insignificant IVI values of less than 10.00. The distinctive feature of the site III was the slightly random distribution of *Cedrus deodara* and *Pinus wallichiana* and the highly contagious distribution of all other species (Table 3).

Cedrus deodara, Pinus wallichiana and *Abies pindrow* contributed almost 85% to the overall Importance Value Index at site IV (Table 4). All other species except *Abies pindrow* revealed insignificant values for overall IVI. The maximum total basal cover for the site was reported for *Cedrus deodara* (3675.54 cm^2 $100m^{-2}$) against the minimum for *Celtis australis* (14.19 cm^2 $100m^{-2}$). The species like *Cedrus deodara* and

Pinus wallichiana showed random distributional pattern against the contagious pattern of *Abies pindrow* and *Piceae smithiana.*

The diversity indices for tree vegetation revealed marked spatial variations (Fig. 2). The index of dominance values ranged from 0.180 (Site I) to 0.267 (Site IV) while as species richness varied between 1.03 (Site I) and 1.30 (Site III). The species were more evenly distributed at site I with an index value of 0.502 as against the least even distribution at site III (0.44). The diversity index species varied from 1.638 (Site IV) to 1.898 (Site II). The maximum similarity was observed between Site III and Site IV registering index value of 92.85 % and the minimum between Site I and Site III (71.42 %).



	H`	R	E	C
Site I	1.869	0.8	0.651	0.18
Site II	1.898	0.68	0.66	0.219
Site III	1.834	0.501	0.665	0.233
Site IV	1.638	0.593	0.62	0.267

Fig.2. Spatial variations in diversity, richness, evenness and dominance indices of trees in Langate Forest Division

In general, the Langate Forest Division is dominated by three coniferous species viz., *Cedrus deodara, Pinus wallichiana* and *Abies pindrow,* which together contribute about 80% of the overall Importance Value Index of the tree community. Despite the lesser number of species of conifers, they comprised the dominant component of the forest vegetation extending throughout its length and breadth. The broad-leaved species are restricted in distribution and generally lie along the gorges and moist depressions. The density of the forest stands varied from 3.33 to 4.20 trees $100m^{-2}$. The higher values for density were recorded at site IV and the

lower values at site III. The total basal cover (TBC) of trees ranged from 17.19 to 7589.88 cm^2 $100m^{-2}$. The higher values for TBC were found at site I and the lower values at site IV. Generally, the higher values for TBC were recorded for coniferous species and the lower values for broad-leaved species at all the sites. The values of TBC at different forest sites in the present study were recorded to be more than the values reported for other Himalayan forests while as the density values in the present study were lower than those of the tropical and temperate forests (Saxena, 1979; Ralhan *et al.*, 1982; Saxena and Singh, 1982; Singhal *et al.*, 1986; Negi and Nautiyal, 2005). The tree layers, in general, were more or less similar among different sites as revealed by community coefficient values.

In the present study, the species diversity ranged from 1.63 to 1.89. Low species diversity for trees may be due to low species richness as the forests are dominated by coniferous species especially *Cedrus deodara, Pinus wallichiana* and *Abies pindrow* associated with few broad-leaved species scattered unevenly within the forests. These values are comparable with the values generally reported for temperate forests (Monk, 1967; Singh and Singh, 1987). The diversity of the tree stratum tended to level off after reaching maximum value of 13 to 15 species. In a deciduous forest community, Monk (1967) observed that diversity tended to reach a maximum level after a community is composed of 12-15 species. The lower diversity and consequently greater concentration of dominance in temperate vegetation could be due to lower rate of evolution and diversification of communities (Fischer, 1960; Simpson, 1964) and severity in the environment (Connel and Orias, 1964).

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Impact of Three Different Individual Tree Species on the Chemistry of Mineral Top Soil in Kashmir Himalaya

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ABSTRACT

Influence on chemistry of the mineral top soil of two coniferous gymnosperm trees, *Pinus wallichiana* and *Cedrus deodara*, and a deciduous angiosperm tree *Platanus orientalis*, growing in the northeastern side of University of Kashmir campus and lying in the immediate catchment of the world famous lake Dal was studied. The trees were more than 50 years old and all the study sites were situated within 100m of each other. Composite soil samples from two depths (0-10cm and 10-20 cm) collected in the months of August, October and December, 2006 were compared in terms of different physical and chemical parameters. Highly significant differences were obtained for parameters like pH, Conductivity; extractable ammonium-nitrogen, nitrate-nitrogen, nitrite-nitrogen, calcium, magnesium, sodium, potassium, phosphorus, total phosphorus, total carbon and total Kjeldhal nitrogen. The differences although more distinct in the upper 0-10cm soil layer had percolated to the lower 10-20cm soil layer also.

Key words: Soil chemistry, tree species, extractable nutrients, carbon, nitrogen

INTRODUCTION

Tree species can influence the chemical properties of the soil by several mechanisms. Differences in litter quantity and nutrient status, root nutrient uptake and activity, interception of atmospheric deposition, canopy interactions and leaching as well as alterations to the microclimate and the soil's biological community can cause differences in the physical and chemical characteristics of top soils under various species (Binkley and Riehter, 1987; Binkley *et al.,* 1989; Finzi *et al.,* 1990; Binkley, 1995; Hagen-Thorn *et al.,* 2004; Reich *et al.,* 2005). Globally a number of studies have been carried out to study the impact of different tree species on soil properties and there is a difference of opinion as to the scale at which overstory vegetation influences soil properties (Ovington, 1953 and 1954; Nihlgard, 1971; Finzi *et al.,* 1990; Binkley and Valentine, 1991; Sow and Gower, 1992; Binkley, 1995; Raulund-Rasmussen and Vejre, 1995; Brandtberg *et al.,* 2000; Sanborn, 2001; Berger *et al.,* 2002; Hagen-Thorn *et al.,* 2004).

Given the dynamic and interactive nature of plant-soil interactions, increased understanding of the role of different plant traits and of the generality of species effects are critical to the understanding of the plant-soil system and in the management of terrestrial and aquatic ecosystems.

In the present study we investigated the top soils which had developed under closely situated (within 100m of each other), >50 year old tree species of coniferous gymnosperms *Pinus wallichiana* and *Cedrus deodara* and a deciduous angiosperm *Platanus orientalis*. The underlying hypotheses were that the chemical characteristics of the soil will be different under different tree species and the differences will be more distinct in the upper soil layer.

STUDY AREA

The study area is located in the northeastern side of the University of Kashmir campus lying in the immediate catchment of the world famous Dal lake. Only a few coniferous trees are present in the study area and they are well protected from anthropogenic interferences including the removal of litter being restricted.

MATERIALS AND METHODS

Top soil produced under individual tree species of *Pinus wallichiana* (Himalayan blue pine), *Cedrus deodara* (Himalayan cedar) and *Platanus orientalis* (oriental plane) were studied for their chemical characteristics. Soil sampling was conducted in the months of August, October and December, 2006. Composite soil samples were collected from each study site by using an all stainless steel augur. At each point the soil sample was separated into two layers of 0-10cm and 10-20cm depth. Prior to soil collection, the organic layer and loose litter were removed. For each layer, samples from ten points at each site were pooled together to make one composite sample per site and <2mm fraction was analysed for different parameters. pH and conductivity were determined by electrometric method using 1:2 soil: water (w/v) suspension. NH_4 –N, NO_3 –N and NO_2 –N were extracted by 2M KCl solution and analysed by indophenol blue method, modified salicylate method and modified Gries-Ilosvy method respectively. Extraction of P, Fe, Ca, Mg, Na and K was done by Mehlich-3 reagent and then extractable phosphorus was determined by ascorbic acid method and total extractable Fe by KSCN method after digestion with HCl and H_2O_2, extractable Ca and Mg were analyzed by titration method and extractable Na and K by flame photometry. Total Kjeldahl nitrogen (TKN)

was determined by Nelson and Sommers modified method, total phosphorus by ascorbic acid method after perchloric acid digestion, and total carbon and organic matter (OM) were estimated from Walkley-Black method. All the analyses were done on field moist samples and results expressed on oven dry basis (Jackson, 1958; Page *et al.*, 1982; Yang *et al.*, 1998; Burt 2004).

RESULTS AND DISCUSSION

Except for total extractable iron, for all other chemical parameters highly significant differences were detected under different tree species both in the upper (0-10cm) soil layer (Table 1) and in the lower (10-20cm) soil layer (Table 2). The differences were more prominent in the upper soil layer.

Differences in pH were prominent in both the soil layers, with the lowest pH recorded in the soil under *Pinus*, both in the upper and the lower layer. The highest pH for the upper layer soil was shown by *Platanus* and for lower layer it was for *Cedrus*. Conductivity was lowest for *Platanus* soil while it was highest for *Cedrus* soil in both the layers. Among the inorganic forms of nitrogen, NH_4 –N was lowest under *Cedrus* and recorded the highest value under *Platanus* in both the layers. NO_3 –N was lowest under *Platanus* and highest under *Pinus* while the reverse was true for NO_2 –N in both the layers

Table 1 Average values, standard deviations (in parentheses), F-values and P-values for different physical and chemical characteristics of the upper soil layer (0-10cm) under different tree species

S. No.	Parameter	*Pinus wallichiana*	*Cedrus deodara*	*Platanus orientalis*	F value	P
1	pH	6.12 (0.07)	6.95 (0.09)	7.24 (0.04)	213.16	<0.001
2	Conductivity (μScm^{-1})	161.33 (6.11)	169.00 (6.00)	138.33 (7.09)	18.54	0.003
3	NH_4-N(ppm)	30.29 (3.70)	17.96 (2.01)	34.29 (2.61)	26.59	0.001
4	NO_3-N (ppm)	25.09 (2.92)	19.42 (2.40)	16.75 (2.01)	8.88	0.016
5	NO_2-N (ppm)	1.05 (0.04)	1.75 (0.09)	2.86 (0.11)	359.10	<0.001
6	Fe (ppm)	109.40(13.33)	89.26 (6.70)	94.57 (10.13)	2.02	0.124
7	Ca^{2+} (ppm)	3211.1 (284.2)	4029.1 (221.4)	4446.5 (205.2)	20.68	0.002
8	Mg^{2+} (ppm)	834.3 (73.8)	719.2 (39.5)	851.5 (39.3)	5.44	0.045
9	Na^{+} (ppm)	102.3 (8.5)	145.7 (10.0)	99.8 (5.8)	29.27	0.001
10	K^{+} (ppm)	525.1 (9.3)	322.6 (5.8)	798.1 (13.0)	1780.90	<0.001
11	Extractable PO_4-P (ppm)	145.07 (11.07)	30.43 (3.66)	37.77 (6.00)	215.53	<0.001
12	Total PO_4-P (ppm)	1827.33 (45.65)	996.10 (14.46)	1216.03 (26.77)	554.82	<0.001
13	TKN (ppm)	5779.3 (90.5)	4100.0 (59.6)	6226.7 (110.2)	473.91	<0.001
14	Total C (ppm)	81749 (1280)	57641 (838)	71276 (1261)	334.59	<0.001
15	OM (%)	14.1 (0.2)	9.9 (0.1)	12.3 (0.2)		
16	C:N ratio	14.1	14.1	11.4		

Table 2 Average values, standard deviations (in parentheses), F-values and P-values for different physical and chemical characteristics of the lower soil layer (10-20cm) under different tree species

S. No.	Parameter	*Pinus wallichiana*	*Cedrus deodara*	*Platanus orientalis*	F value	P
1	pH	6.21 (0.03)	7.36 (0.03)	7.29 (0.03)	1355.72	<0.001
2	Conductivity (μScm^{-1})	137.33 (5.86)	134.67 (3.06)	123.67 (4.73)	7.16	0.026
3	NH_4-N (ppm)	30.04 (2.32)	28.94 (1.28)	33.09 (1.18)	4.95	0.054
4	NO_3-N (ppm)	15.33 (0.72)	11.98 (0.81)	9.91 (0.64)	42.63	<0.001
5	NO_2-N (ppm)	0.89 (0.24)	1.93 (0.42)	2.15 (0.58)	7.20	0.025
6	Fe (ppm)	105.41 (14.73)	86.12 (11.08)	89.67 (7.39)	2.41	0.171
7	Ca^{2+} (ppm)	2760.4 (135.6)	3487.4 (234.2)	3470.8 (133.2)	17.05	0.003
8	Mg^{2+} (ppm)	837.0 (41.1)	987.5 (66.3)	280.6 (10.8)	201.43	<0.001
9	Na^{+} (ppm)	146.7 (15.8)	127.2 (15.5)	88.8 (6.7)	14.59	0.005
10	K^{+} (ppm)	332.2 (12.0)	168.3 (5.9)	766.0 (10.8)	2920.52	<0.001
11	Extractable PO_4-P (ppm)	64.69 (10.22)	9.62 (0.95)	16.64 (0.70)	76.37	<0.001
12	Total PO_4-P (ppm)	336.50 (11.29)	977.20 (12.40)	1085.97 (9.87)	3898.54	<0.001
13	TKN (ppm)	4447.0 (91.7)	4024.7 (58.8)	5541.0 (50.1)	383.41	<0.001
14	Total C (ppm)	35235 (726)	29718 (434)	35043 (317)	108.08	<0.001
15	OM (%)	6.1 (0.1)	5.1 (0.1)	6.0 (0.1)		
16	C:N ratio	7.9	7.4	6.3		

Among the cations, Fe showed the highest value under *Pinus* and the lowest under *Cedrus* in both the layers. Na recorded lowest values for *Platanus* for both the layers while the highest value in upper layer was for

Cedrus and in the lower layer, it was for *Pinus*. Differences in K concentrations were very prominent with the lowest values being obtained for *Cedrus* and the highest for *Platanus* in both the layers. Soil under *Pinus* had the lowest Ca concentrations in both soil layers while the highest Ca concentration in upper soil layer was for *Platanus* and in the lower soil layer it was noticeable for *Cedrus*. Mg concentrations were highest in the 0-10cm layer for *Pinus* and in the 10-20cm layer for *Cedrus* while the lowest concentrations in the 0-10cm soil layer were registered for *Cedrus* and in the 10-20 cm soil layer it was obtained for *Platanus*. Total carbon had a higher variability in the upper 0-10cm soil layer with the highest value for *Pinus* and the lowest for *Cedrus* while in the lower 10-20cm soil layer the varribility was comperatively lesser with Pinus higher value as against *Cedrus* which showed a lower value. The total Kjeldahl nitrogen was highest under *Platanus* and lowest under *Cedrus* in both the layers. The 0-10cm soil maintained a higher C: N ratio as compared to the 10-20cm soil layer under all the tree species. Total and extractable phosphorus were markedly higher under *Pinus* in the upper soil. The situation was different for the lower soil layer with *Pinus* showing the lowest total but highest extractable phosphorus and *Platanus* showing the lowest extractable but highest total phosphorus.

The results of the present study showed that there were considerable differences in chemical characteristics of the soils under different tree species. The differences although more prominent in the upper 0-10cm soil layer had percolated down to the lower 10-20cm soil layer, because of the older age of the tree species. All the parameters except for total extractable iron showed highly significant differences under different tree species (Tables 1 and 2).

The differences in soil chemistry are more likely to be caused by the differences in foliage properties, the amount and quality of litter and by differences in processes taking place in soil floor, than differences in root activity and turnover. Evidencing this are the studies in which soil differences in younger stands were only detected in the upper soil layers (Raulund-Rasmussen and Vejre, 1995; Alrickson and Erickson, 1998; Vesterdal and Raulund-Rasmussen, 1998; Hagen-Thorn *et al*., 2004). The changes seem to percolate to lower layers of soil under older stands (Norden, 1994a) as also evidenced by the present study.

The significantly lower pH under *Pinus,* compared to other species, can be explained by slower litter decomposition which leads to the production of organic acids and also delays the return of base cations to the soil. The concentration of Ca was significantly lower under *Pinus* in both soil layers. The concentration of Mg in the soil under *Cedrus,* again a coniferous gymnosperm, had the minimum concentration; K concentration was also lowest under *Cedrus*. On the other hand, *Platanus,* a deciduous angiosperm, had the highest Ca and K concentrations in the upper layer. Studies by Brandtberg *et al.* (2000) and Sanborn, (2001) have also reported a higher pH and base cation concentrations in the birch forest floors as compared to pine forest floors. In the present study, soil under *Pinus* showed highest concentration of total extractable Fe, possibly because of the lower pH.

The extractable phosphorus concentration was highest in the 0-10cm soil layer under *Pinus* which seems to be influenced by the lower pH of the soil induced by the tree species. The greater mobilization of phosphorus under *Pinus* seems to degrade the total phosphorus pool in the lower soil.

The present study showed distinct differences in the soil C, N and organic matter pools under different tree species and the conclusion that there were not any differences in the soil C, N and organic matter pools in the soil under different tree species (Raulund-Rasmussen and Vejre, 1995; Norden, 1994c; Berger *et al.,* 2002; Hagen-Thorn *et al.,* 2004) does not seem to hold true here. The variation in the size and distribution of C and N pools under different tree species may be regulated by a combination of interspecific differences in litter production and the rate of litter decomposition as reported by a number of other studies (Melillo *et al.,* 1982 and 1989; Prescott *et al.,* 1993; Stump and Binkley, 1993; Finzi *et al.,* 1998).

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AGRICULTURE AND FLORICULTURE

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Comparative Performances of Power Tiller and Bullock Farming Systems in Hilly Regions of Kashmir Valley

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ABSTRACT

Experiments were conducted during the year 2003-04 at Wanigambala (Pattan) District Baramulla and New Theed (Harvan) District. Srinagar to compare the performances of 12.5 H. P. power tiller (Mitshubshi make) and bullock operated farming systems. The experiments were conducted for wheat crop with three treatments and four replications. The implements used for sowing and field preparation were zero till drill, Shalimar plough and triangular plough. It was observed that there is a significant saving in cost, time and energy when the seed bed was prepared with power tiller systems as compared with the bullock systems. The cost analysis revealed a saving of 83.6%, 52.3% and 105.2% in cost of cultivation with power tiller as compared with bullock operated systems for the three implements used namely zero tillage seed drill, Shalimar plough and triangular plough.

***Key words**:* Agricultural engineering, tillage, farming, hilly regions, Kashmir

INTRODUCTION

Most of the agricultural land in hilly regions of Kashmir valley is under small terraces. The width of terraces at certain places is so small that a pair of bullocks alongwith implement can hardly turn at end of the terrace. Thus, the need of farm equipments is quite different from that of the plains. In order to increase the agricultural production and productivity through efficient use of farm inputs like high yielding varieties seeds, fertilizers, pesticides and irrigation water, the appropriate level of farm mechanization in hill regions has to be prompted on priority basis.

Topography and size of land holdings are the two major constraints which restrict the introduction of tractors in these areas. About 36% of the total land holdings in India are below 5 ha. which occupies 46% of the total cultivated area(Gupta,1988). Majority of the farmers having less than 5 ha. of land holdings also cannot afford to own tractors because of their higher initial investment. On the other hand, raising of draft animals is becoming very costly resulting in enhanced cost of farm operations and ultimately decreasing the net return to the farmers. The farmers tend to share their bullocks during ploughing season to reduce the cost of

cultivation as each family only tends to have one bull(Gupta, 1989). In order to overcome the problem light weight power tillers and medium sized power tillers could be effectively used for farm operations. Its use can be diversified by adopting it for a number of farm operations like ploughing, sowing, deweeding, pesticide application, water lifting etc. This will increase the utilization on farms, thereby reducing the cost of operations.

MATERIAL AND METHODS

Two field experiments were conducted out to compare the performance of power tiller and bullock farming systems. Field experiments were carried to compare the performance of power tiller V.S.T Shakti (12 H.P) and bullock farming system for wheat crop with (three row) zero tillage seed drill Shalimar plough and triangular plough (Fig 1-3). The field experiment on wheat crop was conducted during the Rabi season of 2002-03. Irregular shaped plots of size <50m^2 and 50-100 m^2 were utilized for sowing of the crop. The field performance and cost analysis of power tiller and bullock operated implements are given in Table 1. A suitable hitching system was developed for attachment with the power unit. In addition, a depth control mechanism was also developed to control the depth of operation and provide stability to the power tiller during operation.

Fig1: Zero Tillage seed drill

Fig 2: Triangular plough

Fig3: Power tiller

RESULTS AND DISCUSSION

The comparative field performance of power tiller and bullock drawn implements are given in Table 1.

Table 1. Comparison of power tiller with bullock farming system for wheat crop

S.No	Parameter	Power tiller			Bullock drawn		
		Zero-Till Drill	Shalimar Plough	Triangular plough	Zero-Till Dril	Shalimar plough	Triangular Plough
1.	Total area, m^2	970	510	510	490	480	510
2.	Actual operating time 'hr'	30.0	43.34	39.23	32.13	71.4	87.0
3.	Travelling speed 'Km/hr'	3-5	4-6	4-6	2-3	2-3	2-3
4.	Depth of cut 'cm'	8	14	16	9	15	17
5.	Field capacity 'ha/hr'	0.195	0.0706	0.078	0.0715	0.0301	0.0251

S.No	Parameter	Power tiller			Bullock drawn		
		Zero-Till Drill	Shalimar Plough	Triangular plough	Zero-Till Dril	Shalimar plough	Triangular Plough
6.	Field efficiency '%'	60-65	70-75	65-70	65-70	70-75	70-75
7.	Human energy (man-hr/ha}	10.27	16.42	17.52	20.71	32.62	36.7
8.	Fixed cost (Rs/hr)	14.74	13.24	13.89	4.62	2.67	3.36
9.	Variable cost (Rs/hr)	37.2	37.2	37.2	30.36	30.07	30.17
10	Total cost Rs/hr	51.94	50.44	51.09	34.98	32.74	33.73
11.	No of men engaged	2	1	1	2	1	1
12.	Effective width 'cm'	60.2	30.5	34.7	60.2	30.5	34.7
13.	Total cost Rs/ha	266.5	714.4	655.0	489.3	1087.7	1343.9

The field capacity of power tiller operated zero till seed drill, Shalimar plough and triangular plough are 0.195ha/hr, 0.0706ha/hr and 0.078ha/hr respectively. The field capacity of bullock operated zero till seed drill, shalimar plough and triangular plough as 0.0715ha/hr, 0.0301ha/hr and 0.0251ha/hr respectively. The total cost of land preparation with power tiller operated zero till seed drill, Shalimar plough and triangular plough was Rs 266.5/ha., Rs 714.4 /ha., and 655.0Rs/ha respectively. The total cost of land preparation with bullock operated zero till seed drill, shalimar plough and triangular plough was 489.3Rs/ha., Rs 1087.7/ha., and Rs 1343.9/ha. respectively. The power tiller besides being used in field preparation can be utilized for performing wide variety of operations like sowing, deweeding, irrigation, pesticide application and thrashing.

CONCLUSIONS

1. There is a significant saving in cost, time and energy when the seed bed is prepared with power tiller as compared to the bullock operated system.

2. No significant differences in yield were obtained under the two systems.

3. The cost analysis revealed a saving of 83.6%, 52.3% and 105.2% saving in cost of cultivation with power tiller as compared with bullock operated systems for the three implements

4. The power tiller can be effectively used for performing other operations like sowing pesticide application, water lifting, puddling, thrashing of manually operated implements

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Small Scale Mechanization for Increasing Productivity in Maize Crop

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ABSTRACT

Maize is one of the important crops for cereal and fodder production in the state and occupies the largest area under cultivation in J &K. Most of the rain fed areas in the state is under maize cultivation as it requires minimal water for its growth. In the study to improve the productivity of maize and reduce the associated drudgery with maize cultivation a number of implements were fabricated by the division The implements fabricated and tested included maize planter, wheel hoe, harvesting seat, horizontal and vertical maize shellers. The implements fabricated performed a wide variety of operations in maize cultivation like sowing, hoeing, ease in harvesting and maize shelling. The field testing of the implements showed considerable reduction in drudgery and increase in productivity of the crop.

Key word: Mechanization, productivity, maize crop.

INTRODUCTION

Maize (*Zea mays* L.) also called as corn, is the second highest produced cereal grain crop of the world. It is one of most intensively cultivated crop in India. In J& K state the area under cultivation of maize is highest than any other crop. It has gone up from 203 in 1955-56 to 330.21(000 ha.) in 2000 -2001(Anonymous, 2001). The state of mechanization with regard to maize production in the Kashmir valley especially in the hilly regions of valley temperate zone is still in its infant stages.. Mechanization of farms helps in reduction of human drudgery besides ensuring the timeliness of operation and solving the problem of scarcity of labours during peak cropping season(Annual report, 2004). It is an important means of increasing agricultural productivity through efficient utilization of biological and chemical inputs besides helping to achieve timeliness of operations and improving the quality of crop. Though modernizations and technology advancement is taking place at a rapid pace, yet there exist a large mechanization gaps in the region.

MATERIAL AND METHODS

Due to undulating topography and fragmentation of land in small pieces, the mechanization in Jammu and Kashmir State is very limited. In the region traditional tools and implements evaluated and developed in isolation by small group of farmers had remained as the only mechanical gadgets available for cultivation practices. Desi plough, Shalimar plough, tangroo, shovel, sowing by kera and broadcasting etc are still used by the farmers in these regions . Animal power continues to dominate as the most frequently used source of power. Much of the labour and inputs is wasted when indigenous implements are used for field preparation, sowing, weeding, harvesting and thrashing (Sahay, 2002). A number of small tools and implements were fabricated at the university for performing a wide variety of operations like sowing, deweeding, harvesting and shelling

Maize Planter

Manually operated maize planter can be effectively used for sowing of the maize seed. The maize planter is provided with small cup which moves in a circular motion along with the rotation of the maize planter(Fig.1). The cup like small bucket holds three to four seeds at a time and drops them at regular intervals. Both plant to plant spacing and row to row spacing can be maintained with the use of maize planter. The working of the maize planter was done at Dara, Harvan area of Srinagar district in the year (2003-04). The testing of the implement(Fig. 2) was done for the following variety, treatments and replications:

1) Variety: C-15

2) Treatments: 3
   (i) Sowing by Maize Planter (M1)
   (ii) Line sowing (making line with local tool, tangroo and sowing manually,(M2) (iii) Broadcasting (M3)

3) Replication: 4

Wheel Hoes

A shovel type single and double row wheel hoe can be efficiently used for intercultural operations in maize. In order to provide more power to the operator a larger diameter wheel can be preferred to minimize the application of force and for ease in its operation. Human being can operate the single row wheel hoe(Fig. 3), The dimensions of the wheel hoe are as below:
Overall dimensions: Length – 1560mm, width – 470mm and height – 800mm
Ground wheel: Diameter – 650mm, width – 40mm
Beam: Rectangular section, length – 430mm
Weight of single wheel hoe: 12.2 kg

Harvesting Seat

The drudgery associated with the harvesting operation has been effectively reduced by a wooden harvesting seat (Fig. 4). The seat is attached to a labourer by belts on the torso and either sides of the hips. During the harvesting operation the labourer can tie this seat to his rear and helps in dissipation of load of the worker.

Maize Shelling

It is a common practice among the farmers especially in the hilly regions that maize is thrashed either by beating and by hand rubbing of cobs. Beating operation damages the grains and rubbing requires more energy and time and also large shelling machines are not found economical for the farmers due to small land holdings, high price and lack of technical know –how. It was also found out during different surveys that the farmers were not aware of the right time of harvesting as they were lacking the scientific techniques to determine the moisture content of maize cobs. The Horizontal Maize sheller is 6.1cm in diameter and 7.0 cm length with tapered fins and can be effectively used for shelling of maize cobs(Fig: 5). The vertical maize sheller is provided with with bevel gear mechanism for transferring horizontal motion into circular motion. The material used in fabrication of the sheller is M.S. pipe with tapered fins and a handle(Fig. 6).

Fig 1. Maize Planter

Fig 2. Working of maize planter

Fig 3. Wheel hole

Fig 4. Harvesting seat

Fig 5. Horizontal Maize sheller

Fig 6. Vertical maize sheller

RESULTS AND DISCUSSION

The feasibility testing of the manually operated maize planter with respect to sowing by tangroo and traditional method of harvesting are given in table 1 to 5. The average capacity, plant height, number of cobs per plant, length of the cobs (cm), Average grain yield (q/ha.) and labour requirement (man-hr/ha) for maize planter were found to be 1.71, 1.80, 11.81, 42.78 and 38.46 respectively of maize

Table 1. Plant height (m) of maize crop at maturity stage

Treatments	Replication				
	R1	R2	R3	R4	Mean
M1	1.76	1.74	1.69	1.65	1.71
M2	1.70	1.67	1.60	1.63	1.65
M3	1.69	1.59	1.62	1.59	1.62

Table 2. No. of Cobs per plant of maize crop.

Treatments	Replication				
	R1	R2	R3	R4	Mean
M1	1.80	1.90	1.70	1.80	1.80
M2	1.90	1.75	1.82	1.70	1.79
M3	1.3	1.1	1.0	1.5	1.22

Table 3. Length of Cobs (cm.) of maize crop.

Treatments	Replication				
	R1	R2	R3	R4	Mean
M1	11.90	10.85	12.50	12.00	11.81
M2	12.50	12.80	11.90	13.50	12.67
M3	10.50	9.50	11.00	9.50	10.12

Table 4. Average grain yield of maize (q./ha)

Treatments	Replication				
	R1	R2	R3	R4	Mean
M1	45.10	42.50	41.10	42.0	42.78
M2	44.10	43.0	41.0	42.5	42.65
M3	39.50	38.0	39.0	38.10	38.65

Table 5. Labour requirement for maize sowing under different methods of sowing.

Methods of sowing	Operating speed (km./hr.)	Field capacity (ha./hr.)	Labour requirement (man-hr./ha.)
M1	2.69	0.052	38.46
M2	2.37	0.039	51.28
M3	-	-	-

Hand operated two tyne maize hoe was also evaluated for interculture operations in maize crop. The percentage saving of labour in comparison to traditional method was 73.6% and percentage increase in yield in comparison to traditional method was 8- 10%.

The average shelling capacity of horizontal maize sheller was found to be 15.33 kg per hour. The cost of shelling per kg with the implement is 1.01Rs/kg. The percentage saving in cost of operation in comparison to conventional method of shelling is 60.23. The percentage increase in shelling rate as compared to traditional method of shelling was 64.0%. The average shelling capacity of vertical maize sheller was 17.40 kg per hour. The cost of shelling per kg with the implement is 0.90Rs/kg. The percentage increase in shelling rate is 66.50.

CONCLUSIONS

- The use of the Maize Planter helps in maintaining optimum plant density and constant row to row and plant to plant spacing provided the soil is in good tilth.
- Considerable saving of seed, labour and time is achievable by making use of the planter.
- Deweeding operations can be easily undertaken with a manual deweede.
- The average yield, number of cobs, plant height, and length of the cobs with maize planter is greater than that obtained with conventional methods of sowing.
- The drudgery and low efficiency associated with manual methods of maize cultivation can be reduced to a great extent by use of these small tools and implements.
- Harvesting seat can be used quite effectively during harvesting operations

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Cultivation of Rose Scented Geranium (*Pelargonium* sp.) and their Industrial Value and Economical Importance

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ABSTRACT

Essential oil of scented Geranium is widely used in high grade perfumery and cosmetic industries. It is also employed as a flavoring agent in many major food categories, alcoholic and soft drinks. Traditionally Geranium is used to staunch bleeding, healing of wounds, ulcers and skin disorders and also in the treatment of diarrohea, dysentery and colic. The oil has antibacterial and insecticidal properties and is profusely used in Aromatherapy. India imports 150t of geranium oil annually. Scented Geranium (*Pelargonium* sp.) was grown successfully in Kashmir. Experiments conducted at R.R.L field Station Bonera Pulwama, revealed that the morphological characters, growth behavior, herbage and oil yield/ha were more or less similar to the hilly areas of South India. The aerial parts (fresh flowers, Stalks and leaves) on steam distillation yielded an essential oil 0.15% on fresh weight basis. Fifty three chemical, constituent representing >96% of the oil were identified by GC and GC-Mass analysis. Major Constituents were citronellol (25.55%) geraniol (20.81%), citronellyl formate (8.04%) and isomenthone (7.59%). Linalool content was comparatively higher (11.94%) as compared to south Indian Oil (6.7%). It is quite evident from the analysis that the oil produced under Kashmir conditions is quite competitive to best geranium oil produced in south India. Moreover, the odour and evaluation study by a leading perfumer has found that the oil is highly acceptable to the user industry.

***Key words**:* Rose scented geranium, essential oil, citronellol, geraniol

INTRODUCTION

Rose scented Geranium (family Geraniaceae) is an important high value perennial, aromatic shrub originated from South Africa as well as reunion Madagascar, Egypt and Morocco. The plant was introduced to Italy, Spain and France in 17th century. There are 700 different species and only 10 are utilized for production of geranium oil viz. *Pelargonium odorantissimum, P.asperum, P.graveolens, P. crispum, P. radula, P.capititum, P. rosues, P. tomentosum, P. zonale and P. roseum.* It is generally believed that the present day cultivars cultivated for distillation of oil rich in citronellol of geraniol content are referred as *Pelargonium* species (Kaul *et al.,* 1996). However other botanical names such as *Pelargonium graveolens and P. roseum* are also in use. Geranium was introduced in India in 1900-1915 by two France nationals and got acclimatized to South Indian climate. Presently two types of geraniums called Algerian or Tunisian and Bourbon or Re- union are

identified in India. Another cultivar Kelkar has been recently introduced by M/S SH Kelkar and Co. Mumbai, a leading flavour and fragrance company in India (Ram *et, al.*, 2003) In India geranium is being grown in Niligiri Pulney Hills of Tamil Nadu plain of Andrapradesh, Karnataka, Maharashtra and Utter Predesh. Rose Geranium is cultivated as a rainfed perennial crop in hilly areas of South India and an annual crop in plains of Northern India (Rajeshwara *et al.,* 1990). Significant data is available on scented geranium cultivated in different parts of India and its processing for essential oil (Jain *et al.*, 2001).

Essential oil obtained by distillation of aerial parts (fresh flowers, leaf and stalks) is extensively used in perfumery and cosmetic industries. It is employed as a flavoring agent in many major food categories, alcoholic and soft drinks. Traditionally it is also used to staunch bleeding, healing of wounds, ulcers, skin disorders, diarrhoea, dysentery and colic. The oil has anti bacterial, insecticidal properties and substantial use in aromatherapy. The current international demand is more than 600 tons mostly met by countries like China, Morocco, Egypt, Re-union Island and South Africa.

As part of Institutes program to develop the agro and) - processing technologies of high value crops and to spread the area under cultivation to other climatic zones of country, rose scented geranium cv. Bourbon was successfully grown in Kashmir Valley.

MATERIAL AND METHODS

Geranium cuttings cv. Bourbon were made in the first Week of November, and grown in the nursery beds of Conventional poly houses (18x4m). About 16-20 DS Cuttings took 60-70 days for rooting. The plantlets arising from the cuttings that survived (up to 85%) were transplanted in the first week of March healthy cuttings were obtained from reserve plants obtained from Bangalore field plots at a spacing of 0.5x0.5m at RRL field station, Pulwama. A light irrigation was done immediately by rose canes after planting. A uniform basal dose of 50 kg ha^{-1} each of P_2O_5 and K_2O was applied through DAP and muriate of potash respectively at the time of planting. Nitrogen was applied through Urea fertilizer as per treatment in four equal split doses. The crop received four flood irrigations. The plants were returned in the fields as per standard agronomical practices. Climate, soil factors and other experimental details are presented in Table1. Harvesting was done by a sickle after 150 days of planting at a height of 15 cm from the ground. The essential oil content in the fresh herbage was estimated by hydro distillation using Clevenger apparatus on the laboratory scale also by steam distillation followed by cohabitation on pilot scale.

Table 1. Climate, soil and experimental details at RRL field Station, Pulwama

Soil Texture	Clay Loam
1660	Altitude (m)
Mean maximum Tem (C^0)	20-30
Mean maximum Tem. (C^0)	8-15
p H of soil	6. 8
Peak solar radiation	15-20000 Lux
Date of Planting	07-03-2003
Date of harvesting	4-08-2003 and 15-10-2003
Average weight per plant	800 g
Moisture (%)	70-80
Oil content (%)	0.15-0.24
Relative humidity (%)	50-66
Precipitation (%)	100

Gas Chromatography (GC): GC analysis of an oil sample was carried out on PE gas chromatograph 8500 series with flame Ionization Detector (I.D) using a fused silica capillary column(30x0.32 mm ID) coated with dimethyl- siloxane (BP-I). Oven temperature was programmed from 60-220 ^{0}C at 5.5 ^{0} C min^{-1}. Injector temperature 250 ^{0}C and detector temperature 300 ^{0}C, carrier gas nitrogen at 8psi, split ratio being 1:80.GC-MS data obtained on PE mass spectrophotometer using a PE wax (60x0.32mm, id, film thickness 0.25 um); carrier gas helium; temperature programming, 5 min at 70 ^{0}C then rising at 2 ^{0}C min and 3 ^{0}C min-1µ to enrichment on co-injection with standard compounds and comparison of mass spectra of peaks with published data (Jennings and Shipmate, 1980; Admas, 1990).

RESULTS AND DISCUSSION

The herbaceous parts of scented Geranium (Pelargonium sp.) cv Bourbon gave an oil 0.15% yield on fresh weight basis on steam distillation followed by cohabitation of distilled waters which is higher as compared to South and North Indian conditions (Rajeshwara *et al.*,.1990; Jain *et al.,* 2001). GC and GC-MS analysis led to the identification of 53 constituents representing 96% of total oil. The relative concentration of the identified constituents is presented in Table 2 according to their elution on BP-1 column.

Table2. Chemical composition of essential oil of rose Geranium percentage

Name of the compound	Kashmir	Southern hills*
(Z)-3-hexanol	0.09	0.1
a-pinene	0.51	0.3
Sabinene	0.1	0.7
Myrcene	0.20	0.7
a-phellandrene	0.7	p-
cymene	0.09	0.1
Limonene	0.34	0.3
(z)-B-ocimene	0.18	0.2
(E) B-ocimene	0.15	0.3
Cis-linalool oxide	0.30	0.1
Trans linalool oxide	0.18	T
Terpinolene	0.11	T
Linalool	11.94	6.7
Cis-rose oxide	0.82	0.4
Trans-rose oxide	0.92	0.2
Isomethone	7.58	--
a –terpeniol	1.03	0.3
Citronellol+nerol	25.55	26.7
Geraniol	20.81	24.1
Geranial	0.90	0.5
Citronellyl formate	8.04	8.2
Geranyl formate	5.18	3.1
Linalyl propionate	0.06	___
Citronellyl acetate	0.26	0.2
Neryl acetate	0.20	0.1
Geranyl acetate	0.52	3.1
a- yalangene	0.36	___
a-copaena	1.38	0.1
B-Bourbonene	0.06	0.5
2-phenylethyl Butyrate	1.05	___
a-cadenene	0.56	___
B-caryophyllene	0.23	0.5

Table 2 contd.…..

Name of the compound	Kashmir	Southern hills*
Citronellyl propionate	0.03	—
Guaia- 6,9-diene	0.13	0.1
Geranyl propionate	0.30	0.5
a-humulele	0.23	0.1
(E)- B-farnesene	0.13	—
Aoallo-aromadendrene	0.69	—
Gerranyl isobutyrate	0.32	—
a-selinene	0.04	—
y-elemene	0.05	—
citronellyl butyrate	0.12	—
y –cadinene	0.31	—
Geranyl butyrate	0.15	0.2
(E)-nerolidol	0.14	—
2-phenyl etyl tiglate	0.49	0.9
10 *y* –epi-eudesyol	2.89	7.6
t-cadimol	0.07	—
Geranylvalerate	0.09	0.1
Citronellyl tiglate	0.15	1.5
Geranyl tiglate	1.31	1.6
Geranylheptanoate	0.05	—

Tt= traces ; * source: Kaul *et. al.,* 1996

The major constituents from Kashmir and Southern India of India are citronellon (25.77 and 26.7%) Gerenion (20.81 and 24.1%), Linalool (11.94 and 6.7%), Citronellyl format (8.04 and 8.20%) Isomenthone (7.58 and 7.90%). The percentage of linalool was higher in Kashmir sample. On the contrary percentage of 10 *y* –epieudesmol was lower in our sample which may be due to the variation in agro climatic and geographical condition (Ram *et al.,* 1995). The aerial parts on lab. scale yielded an essential oil of 0.22 % on fresh weight basis while on pilot scale the aerial parts yielded an essential oil of 0.15 %on fresh weight basis. Herbage yield from the first harvest was 28t and essential oil yield recorded 37kg ha^{-1} on pilot scale which is comparable to south Indian data. The IInd harvest was taken in the IInd week of October in Kashmir, the herbage yield from the IInd harvest was 9.33t which is one third of the first harvest and the essential oil yield recorded in the IInd harvest was 7kg ha^{-1}. Preliminary experiments initiated at RRL field station Pulwama further revealed that geranium can be suitably grown in targeted with major Horticulture Crops like apple as companion crop and thus permit increased harvest per unit area land, thereby higher economic returns. The freshly laid apple crops take several years till fruiting. During this period there are no returns. To make it more remunerative the land between the rows can be utilized by cultivating this high value crop. On the basis of above findings it is quite evident that the oil produced in the temperate climate of Kashmir is quite competitive with the best geranium oil produced in South India. Percentage composition of major constituents also shows the stability of Bourbon cultivar.

Given proper conditions, like creation of market linkages, better distillation facilities, development of cost effective agro technologies, incentives to farmers and increased Govt. user industry interaction J&K State can become major producer of geranium oil.

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PARASITOLOGY

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Effect of *Haemonchus contortus* on Haematological Profile and Eye Colour in Sheep

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ABSTRACT

The influence of *Haemonchus contortus* on hematological profile and ocular mucus membrane colour of sheep was studied from March 2005 to December 2005 under controlled condition. Eight local sheep used for the experiment were divided in two groups. Group 1st animals were kept as uninfected control and group 2nd animals were infected orally by L_3 larvae of *Haemonchus contortus*. After the establishment of infection the faecal samples were regularly screened for *Haemonchus contortus* eggs and eyes were examined for mucous membrane colour. Blood samples were collected from both the groups of animals for haematological studies. Low haematocrit values and pale colour of eyes was observed in infected sheep compared to control. Raised ESR, decreased RBC count and Hb values were observed in infected animals corresponding to control.

Key words: Haematocrit; ESR, eye, colour, nematodes

INTRODUCTION

The nematode parasites of the digestive tract of domestic ruminants are having major economic importance. The nematode worms which parasitize the sheep belong to 2 main families (Trichostrongylidae and Strongylidae).

The domestic ruminants are usually parasitized by several species which occupy the different parts of the digestive tract. Among the worms found in sheep *Haemonchus contortus* is blood feeding parasite commonly called Barber poleworm. Haemonchosis is an important cosmopolitan disease of small domestic ruminants caused by *Haemonchus contortus*. *Haemonchus contortus,* a parasitic nematode inhabits abomasae of sheep and goats, causes significant economic loses world wide due to its blood feeding and wandering behaviour (Stoll *et al.,* 1943). Losses occur due to subclinical parasitism through mortalities, reduced production and decreased weight (Ploeger *et al.,* 1990a, b; Ploeger and Kloosterman 1993) decreased milk production (Gross *et al.* 1999) and fertility (Ankers *et al.,* 1998). The worm inhibits in the abomasum of the sheep. Depending on several factors (number of parasites and age of host) the presence of *Haemonchus contortus* worms could lead to clinical diseases characterized by a digestive or an anaemic syndrome which in heavy infections, could sometimes end by the death of host. However, this nematode infection is usually associated with subclinical parasitism including major consequences on animal production. The economic losses due to the parasites have been largely documented in sheep, goats and cattle. Moreover, serious affects on the host reproduction

are also suspected. Several works have well documents the haemtobiochemical changes in small ruminants due to helminth parasites (Kadhim 1976; McGregor *et al.,* 1940 Ayesha *et al.,* 1990 and McDogall *et al.,* 1991). Nematode infection is usually associated with anemia and alteration in other haematobiochemical parameters (Ansari and Ahmad 1989). The state of health of any organism can be expressed by a set of numerical values of its variables. The haematobiochemical parameters in a normal range play a vital role in sustaining life and maintaining good health.

This work was designed to contribute to the understanding of potential alterations at sub-clinical level by observing changes in Hb, PCV, TLC, Total RBC count and ESR.

MATERIAL AND METHODS

Eight local sheep aged below 6months used for this study were allocated into groups Group 1 served as uninfected control and group 2nd were orally inoculated by infective L_3 larvae of *Haemonchus contortus.* Faecal samples were regularly screened in both the groups. After establishment of infection ocular mucus membrane was investigated in both the groups and blood was collected from each group for haematological analysis. Part of blood was used to make smear on grease free slides without adding an anticoagulant. The DLC slides were stained with Leishman's stain and then observed under microscope. For determining haematocrit, Hb levels, RBC counts and WBC counts, techniques recommended by Blaxhall and Daisley (1973) were employed.

RESULTS

No remarkable differences in haematological parameters were observed in control group whereas decreased haematological values (except ERS) were observed in infected group. Lowest haemoglobin concentration was observed in at 31st day of infection. Statistical analysis showed a significant decrease ($p<0.05$) of haemoglobin in infected group compared to control. Significant reduction in haematocrit was observed in infected group corresponding to the control being lowest at 31st day of infection. Reduction in haematocrit value observed due to infection was statistically significant ($P<0.01$). Total serum protein levels observed in infected and uninfected control groups were 4.9 ±0.6 and 6.7±.52 respectively. Though the value of total serum protein in infected group was lowest at 29th day of infection. Marked decease in the total leucocyte count was observed at 27th day of experiment in infected group in comparison to the same day of the control group. Increase in the lymphocytes and eosinophils whereas decrease in neutrophil and monocyte count was observed in infected group over the control. Significant fall in the total RBC count and raised ESR as observed in the present study which coincided with the 4th week of infection. The colour of ocular mucus membrane observed in the infected animals was comparatively paler than uninfected control animals. The results of the various haematological parameters observed during the present study are given in Table 1.

Table 1. Mean and standard deviation of sheep experimentally infected with *Haemonchus contortus*

Haematological values	Uninfected(control)	Infected
Hb(mg)	14.4±2.3	11.75±3.4
PCV(%)	36 .6± 3.24	30.3± 4.1
Total serum protein (g/l)	6.7 ± 0.52	4.9± .6
ESR/hr	2.0±.22	8±.63
TLC (10^3/mm^3)	9.42±1.6	7.82±1.84
RBC count(10^6/mm^3)	12.24±2.1	8.95±2.4

DISCUSSION

The present experiment revealed a marked reduction in haematocrit, haemoglobin and RBC count which confirmed the observations of early workers (Misra *et al.,*1996) who observed decreased values of haematocrit, haemoglobin and RBC counts in lambs in relation to nematode and Paramohistomum infection. The reduced RBC counts, Hb and PCV values in infected group may be attributed to the weekly bleeding of abomasums due to injuries caused by the parasites similar to that described by Abdel (1992) and Ansari and Ahmed (1989). However, marked blood loss in the infected animals is to be attributed to the blood sucking activities of *Haemonchus contortus*. Decreased leucocyte count observed in the present study might be due to the blood loss. Eosinophillia and increased lymphocyte count observed in present investigation is in agreement with the findings of (Ackerman *et al.,* 1981; Baker 1962; Bhat and Sharma 1990) who concluded that Eosinophillia is associated with antigenic stimulation or parasitic burden. Increased lymphocyte count might be due to proliferation of lymphocytes due to excretory secretory product of *Haemonchus contortus*. Decline in total serum proteins in infected animals opposed to control animals was similar to (Kuttler and Marble 1960; Knox *et al.,* 1993) and Raisinghani *et al.,* 1971) who described decrease in the total serum protein values in sheep haemonchosis in lambs. Decrease in total serum proteins observed in the present study may be attributed to haemodilution, a compensatory mechanism for the abomassal haemorrhages caused by the invading larvae, and later on due to loss of large quantities of serum proteins into gut and consequent increased fractional catabolic rate of albumin

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TAXONOMY

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Taxonomic Significance of External Genitalia and Last Tergum in Females in Stink Bugs (Pentatomidae: Pentatominae)

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ABSTRACT

In the present study taxonomic significance of external genitalia and last tergum in females in some tribes and genera of pentatomid bugs has been shown.

Key words: Taxonomic significance female genitalia last tergum stink bugs

INTRODUCTION

Many workers have studied female genitalia in pentatomid bugs such as Leston (1953a, 1953b, 1954), McDonald (1963, 1966) and Ghauri (1975a, 1975b, 1977) but none of them has shown taxonomic significance of various plates found in female genitalia in the classification of these bugs. Pendergrast (1957) for the first time has shown taxonomic significance of reproductive organs in heteropterous bugs and Azim (2000) has shown suprageneric significance of spermathecae in pentatomid bugs.

A careful study of genitalia and last tergum in females in some genera of the subfamily pentatominae reveals that these structures do possess some characters which have taxonomic significance of genus group taxa. These characters are described and illustrated. The genera studied are arranged under the respective tribes.

MATERIAL AND METHODS

To study the female genitalia and last tergum the apical end of the female body was removed and boiled in a test tube containing 10% KOH solution till the material became transparent. This was later washed thoroughly with water for complete removal of KOH. Later, the normal process of dehydration was adopted and clearing was done in clove oil. Then, the genitalia and last tergum were separated and placed over a drop of Canada balsam to prepare the permanent slides. The slides were examined under the microscope. Drawings were made with the help of Camera Lucida.

RESULTS AND DISCUSSION

Tribe Gynenicini

Genus *Gynenica* Dallas (Fig. 1): Female genitalia laciniate type with two elongated plates converging apically, which are not distinguishable into 1st gonocoxae, 8th and 9th paratergites. Last tergum (Fig. A) triangular

pointed apically. These characters are not found in any other tribe of the subfamily pentatominae. So these characters have suprageneric significance.

Tribe Strachiini

Genus *Eurydema* Laporte (Fig. 5): 1st gonocoxae speculate type; paratergites 8th triangular, 9th oblong not reaching beyond apex of abdomen. Last tergum (fig. E) quadrate anterior margin almost straight, posterior margin convex, lateral angles acute.

Genus *Bagrada* Stal (Fig. 6): 1st gonocoxae very large and broad; paratergites 8th and 9th very small. Last tergum (fig. F) with anterior margin moderately convex, posterior margin with a notch medially, lateral angles obtuse.

Tribe Sciocorini

Genus *Sciocoris* Fallen (Fig. 7): 1st gonocoxae; paratergites 8th and 9th triangular, paratergites 9th very small not reaching up to apex of abdomen. Last tergum (fig. G) with anterior margin slightly concave, posterior margin convex, lateral angles acute.

Tribe Eysarcorini

Genus *Eysarcoris* Hahn (Fig. 8): 1st gonocoxae broadly triangular; paratergites 8th elongated and triangular, 9th oblong not reaching up to apex of abdomen. Last tergum (fig. H) with anterior margin almost straight, posterior margin convex, lateral angles acute

Genus *Stollia* Ellenrider (Fig. 9): 1st gonocoxae broad and triangular; paratergites 8th and 9th triangular, paratergites 9th not reaching up to apex of abdomen. Last tergum (fig. I) with anterior and posterior margins convex, lateral angles acute.

Genus *Hermolaus* Distant (Fig. 10): 1st gonocoxae broad and triangular, acutely produced laterally; paratergites 8th triangular; paratergites 9th oblong small not reaching up to apex of abdomen. Last tergum (fig. J) anterior and posterior margins convex, anterior margin with a cleft on each side, lateral angles sub acute.

Tribe Halyini

Genus *Halys* Fabricius (Fig. 11): External plates punctuate; 1st gonocoxae broad and triangular; paratergites 8th large, triangular, 9th oblong, small not reaching up to apex of abdomen. Last tergum (fig. K) with anterior and posterior margins much convex, lateral angles acute.

Genus *Dalpada* Amyot & Serville (Fig. 12): 1st gonocoxae rounded, acutely produced laterally; paratergites 8th triangular, 9th oblong reaching beyond apical margin of abdomen. Last tergum (fig. L) with anterior and posterior margins convex, anterior margin with a cleft on each side, lateral angles acute.

Tribe Rhynchocorini

Genus *Rhynchocoris* Westwood (Fig. 13): 1st gonocoxae quadrate acutely produced laterally; paratergites 8th almost quadrate, pointed apically, 9th oblong small not reaching up to apex of abdomen. Last tergum (fig. M) almost rounded; anterior and posterior margins convex, lateral angles rounded.

Tribe Pentatomini

Genus *Nezara* Amyot & Serville (Fig. 14): 1st gonocoxae small, triangular pointed laterally; paratergites 8th almost quadrate, 9th oblong reaching up to apex of abdomen. Last tergum (fig. N) quadrate, anterior margin convex, posterior margin straight.

Genus *Acrosfernum* Fieber (Fig. 15): 1stgonocoxae small, triangular, pointed laterally;
paratergites 8th triangular, 9th oblong not reaching up to apex of abdomen. Last tergum (fig. 0) with anterior margin convex, posterior margin almost straight, lateral angles acute.

Genus *Plautia* Stal (Fig. 16): 1st gonocoxae small acutely produced laterally, anterior margin deeply concave, posterior margin rounded; paratergites 8th triangular, 9th oblong large, reaching beyond abdominal apex. Last tergum (fig. P) with anterior margin convex having cleft on each side, posterior margin convex, lateral angles acute.

Tribe Tropicorini

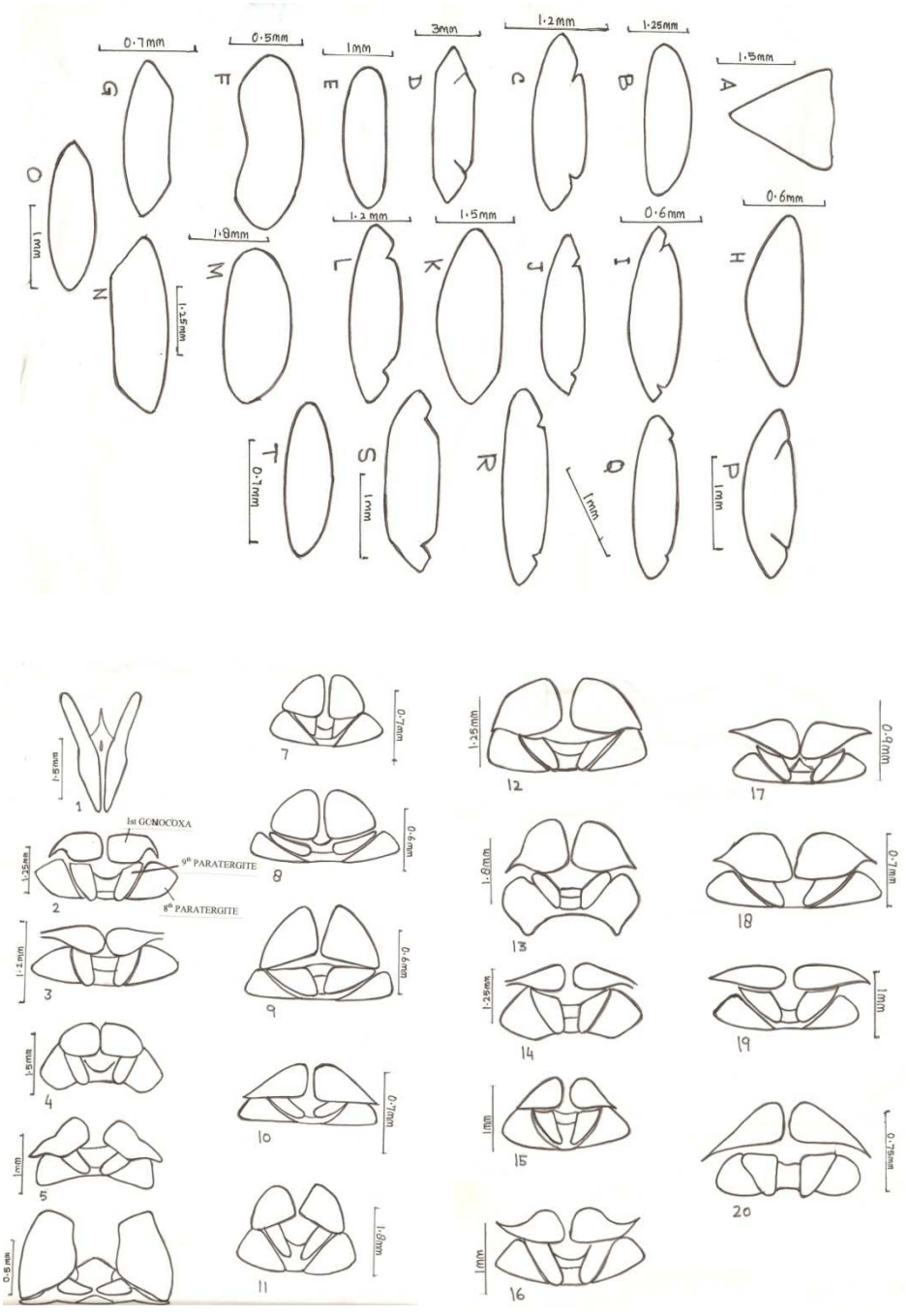
Genus *Menida* Motschulsky (Fig. 17): 1st gonocoxae large, triangular, pointed laterally: paratergites 8th triangular, small 9th oblong reaching up to apex of abdomen. Last tergum (fig. Q) anterior and posterior margins convex, anterior margin with a cleft on each side, lateral angles acute.

Genus *Cresphontes* Stal (Fig. 18): 1st gonocoxae large, pointed laterally; paratergites 8th triangular, small, 9th oblong just reaching unto apex of abdomen. Last tergum (fig. R} anterior and posterior margins convex, anterior margin with cleft on each side, lateral angles acute.

Genus *Piezodorus* Fieber (Fig. 19): 1st gonocoxae very small, triangular, pointed laterally; paratergites 8th triangular, 9th oblong not reaching up to apex. Last tergum (fig. S) with anterior and posterior margins slightly convex, lateral angles acute.

Tribe Aeliini

Genus *Adria* Stal (Fig.20): 1st gonocoxae large, triangular, acutely produced laterally; paratergites 8th rounded, 9th triangular reaching beyond apex of abdomen. Last tergum (fig. T) anterior and posterior margins convex, lateral angles rounded.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P
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1
7
0·7mm
1st GONOCOXA
9th PARATERGITE
8th PARATERGITE
2
1·25mm
8
0·6mm
1·2mm
3
9
0·6mm
1·5mm
4
10
0·7mm
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11
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17
0·4mm
13
1·8mm
18
0·7mm
14
1·25mm
19
1mm
15
1mm
20
0·75mm
16
1mm

Fig. 1-20

Genus	External genitalia, ♀	Last tergum, ♂
1. Gynenica Dallas	Fig. 1	Fig. A
2. Carpocoris Kolenati	Fig. 2	Fig. B
3. Dolycoris Mulsant & Rey	Fig. 3	Fig. C
4. Degonetus Distant	Fig. 4	Fig. D
5. Eurydema Laporte	Fig. 5	Fig. E
6. Bagrada Stal	Fig. 6	Fig. F
7. Sciocoris Fallen	Fig. 7	Fig. G
8. Eysarcoris Hahn	Fig. 8	Fig. H
9. Stollia Ellenrieder	Fig. 9	Fig. I
10. Hermolaus Distant	Fig. 10	Fig. J
11. Halys Fabricius	Fig. 11	Fig. K
12. Dalpada Amyot & Serville	Fig. 12	Fig. L
13. Rhychocoris Westwood	Fig. 13	Fig. M
14. Nezara Amyot & Serville	Fig. 14	Fig. N
15. Acrosternum Fieber	Fig. 15	Fig. 0
16. Plautia Stal	Fig. 16	Fig. P
17. Menida Motschulsky	Fig. 17	Fig. Q
18. Cresphontes Stal	Fig. 18	Fig. R
19. Piezodorus Fieber	Fig. 19	Fig. S
20. Adria Stal	Fig. 20	Fig. T

CONCLUSIONS

The structure of various plates of female genitalia and last tergum in females can be used as a suprageneric character to differentiate tribe Gynenicini from other tribes of pentatominae, in the rest of tribes the structure of female genitalia is almost the same, but the shape and size of different plates viz. 1st gonocoxae; paratergites 8th and 9th along with the shape of last tergum in females can be used as a supporting character for genus group taxa.

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PLANTS TISSUE CULTURE

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Enhanced Axillary Shoot Proliferation in *Ocimum sanctum* Linn. via Shoot Tip Culture Using Various Concentrations of BAP

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ABSTRACT

Preliminary studies on micropropagation of holy basil (*Ocimum sanctum* L.), an Indian medicinal herb, have been conducted via enhanced axillary branching on Murashige and Skoog (MS) medium utilizing in vitro raised shoot tips. Of various levels of BAP tested (0.5 to 5.0μM) maximum number of enhanced axillary shoots was observed at the concentration of 1μM. Rooting of the main elongated primary explant was also observed on same medium. Isolated axillary shoots also behaved in a similar manner on the said medium. 80% plantlets when transplanted to vermiculite + peat moss mixture survived under laboratory conditions.

Key words: Shoot tip, enhanced axillary branching, micropropagation, rooting, *Ocimum sanctum*, BAP

Abbreviation: BAP- 6-Benzyl Amino Purine, MS- Murashige and Skoog medium, TDZ-Thidiazuron.

INTRODUCTION

Ocimum sanctum (Syn *O. tenuiflorum*) also known as holy basil is a well known aromatic plant in the family Lamiacae. It is an erect sweet scented pubescent herb, 30-100 cm in height. This herb is found through out India and cultivated mostly for ceremonial purposes. The plant is held sacred by Hindus all over the world besides having great medicinal value. The leaves on steam distillation yield a bright yellow volatile oil possessing a pleasant odour, characteristic of the plant, with an appreciable note of cloves. This oil possesses antibacterial and insecticidal properties and inhibits *in vitro* growth of *Mycobacterium tuberculosis* and *Micrococcus pyogenes* var. *aureus*. Besides oil, leaves also contain ascorbic acid and carotene. The juice of leaves has diaphoretic, antiperiodic, stimulating and expectorant properties. It is also used in catarrh, bronchitis and is considered to have adaptogenic properties. It is anti-inflammatory, analgesic and a tonic for central nervous system.

The conventional method for propagation of *Ocimum sanctum* is only via seed. However, poor germination potential restricts its multiplication and does not retain the pure line. Unfortunately, this plant cannot be vegetatively propagated (Pattnaik and Chand, 1996). *In vitro* micropropagation is an effective means for rapid multiplication of species in which conventional methods have limitations (Arora and

Bhojwani, 1989; Kartha, 1985; Nehra and Kartha, 1994; Sen and Sharma, 1991; Sudha and Seeni, 1994). Although many *in vitro* studies have been conducted on other members of the family Lamiaceae (Sahoo et al., 1997; Sen and Sharma, 1991; Sunnichan and Shivanna, 1998; Khosla, 1995), there are few reports on this plant in which micropropagation has been achieved (Pattanaik and Chand, 1996; Singh and Sehgal, 1999). Present study is an attempt to use shoot tips for micropropagation through enhanced axillary branching of the plants under the conditions prevailing in the valley.

MATERIAL AND METHODS

Seeds of *O. sanctum* were thoroughly washed using lab wash, surface sterilized in aqueous 0.1% $HgCl_2$ for 10-15 minutes and finally sterilant was removed by repeatedly washing in sterile double distilled water. These seeds were then germinated on autoclaved moistened filter paper in petriplates. Shoot tips excised from these seedlings were cultured individually under aseptic conditions on Murashige and Skoog's (1962) medium containing 3% sucrose as a carbon source and 0.8% agar for gelling. This served as basal medium. The medium was supplemented with a range of 0.5 to 5.0 µM concentrations of 6- benzyl amino purine (BAP). The pH of the medium was adjusted between 5.2 to 5.8 using 0.1N NaOH or 1% HCl before autoclaving. The medium was dispensed into culture vials which were plugged with non absorbent cotton and sterilized by autoclaving at a temperature of 121°C and 15lb pressure for 20 min. Each experiment was repeated at least twice and observations were recorded at weekly intervals. Mean ± SD was calculated for number of shoots/ roots formed and length of shoots/ roots observed.

RESULTS AND DISCUSSION

The shoot tips failed to show any response and yellowing of explants was observed on MS basal medium after 3 weeks time. Such results have also been observed by Singh and Sehgal (1999) using young inflorescence in *O. sanctum* meaning thereby that endogenous levels of hormone present in the explants are not sufficient enough to initiate and sustain their growth on the basal medium which otherwise when enriched with different concentrations of cytokinin, BAP (0.5 to 5.0 µM) proved effective to show the results which are summarized in Table 1.

Mild callus formation was recorded at the base of the shoot tip explant followed by its elongation and axillary shoot formation from the tiny nodal buds of the elongated main shoot tip and thereafter regeneration of thin and long adventitious roots was also noticed from the main explant after 6 to 7 weeks of inoculation by using 0.5 µM BAP. Most of the early reports pertaining to organogenesis in members of the family lamiaceae have also suggested the effective role of BAP in the shoot initiation, either individually or in combination with other growth regulators (Singh and Sehgal, 1999; Begum *et al.*, 2002).

Table 1: Response of in vitro raised shoot tips (primary explants) and isolated axillary shoots of primary cultures of O. *sanctum* to different concentrations of BAP.*

BAP (µM)	Response	Cultures forming shoots/ roots (%response)	No. of shoots formed ± SD	Shoot length ± SD (cm)	No. of roots formed ± SD	Root length ± SD (cm)
0.5	Mild callus formation at the base of the explants followed by its elongation and subsequent enhanced axillary shoots formation. The cultures also formed thin and long adventitious roots from the main explants.	90	2.4±0.5	2.5±0.5	2.5±0.4	3.8±0.8
1.0	-do-	90	11.6±1.6	14.8±0.8	14.5±1.9	3.6±0.5
1.5	-do-	90	4.4±0.8	2.1±0.8	7.2±0.8	2.6±0.4
2.0	-do-	80	2.1±0.5	1.6±0.1	2.4±0.8	1.8±0.3
2.5	Mild callus formation at base	-	-	-	-	-
3.0	Browning of explants	-	-	-	-	-
	-	-	-	-	-	-
3.5	-	-	-	-	-	-
4.0	-	-	-	-	-	-
4.5 5.0	-	-	-	-	-	-
	-	-	-	-	-	-

Data scored after 8 Weeks of culture period: 10 replicates/ treatment, the results are mean of two repeated experiments.

Various levels of BAP tested (0.5 – 5.0µM) MS+BAP 1µM proved to be the most effective for enhanced axillary branching, as the length and number of shoots and roots per explant were maximal (Fig 1&2) compared to its lower concentration (0.5µM). Similarly, on increasing the concentration of BAP above 1µM (1.5 & 2.0µM), the length as well as number of axillary shoots and roots again got reduced drastically (Fig 3).

Fig 1.

Fig 2.

Fig 3.

Fig 4.

Fig 5

Fig. 1-5 Shoot tip culture of *Ocimum Sanctum*

Fig 1.Enhanced axillary shoot formation on BAP (1µM).

Fig 2. Reduced axillary shoot formation on BAP (1.5 µM).

Fig 3. Complete plantlet formation with roots and axillary shoots from the primary explant on BAP(1µM).

Fig 4. Complete plantlet formation with roots and axillary shoots from the isolated axillary shoot on the same medium containing BAP (1µM).

Fig 5.Survived plantlet after transplanting to plastic cups filled with vermiculite and peatmoss (1: 1).

Further increase in the strength of BAP concentration (2.5, 3.0, 3.5, 4.0, 4.5 & 5.0μM) resulted in only mild callus formation at the base of the explant with 2.5μM and rest of the indicated concentrations favoured no signs of growth and thus eventually explants showed necrosis and browning after 4 weeks. Similar results have also been observed in leaf explants of *Pogostemon cablin* (Misra, 1996), axillary shoot bud explants of *Ocimum sanctum* (Pattnaik and Chand, 1996) and young inflorescence of *O. sanctum* (Singh and Sehgal, 1999). Begum *et al.,* 2002 also achieved maximum number of shoots from nodal and shoot tip explant of *Ocimum basilicum* on lower concentration of BAP (0.8μM) while as Siddique and Anis (2007) achieved rapid micropropagation of *O.basilicum* shoot tip explants in liquid MS medium supplemented with different concentrations of TDZ.

The axillary shoots produced from the primary cultures were then isolated and again transferred to the fresh medium of the same composition for rooting. But along with rooting, axillary shoots proliferation was recorded in the same manner as in primary cultures (Fig 4). In vitro raised plantlets were subsequently transferred individually to plastic cups filled with vermiculite and peat moss (1: 1 ratio). These plantlets resumed normal growth and 80% survived in pots under laboratory conditions (Fig 5).

CONCLUSIONS

In the present preliminary tissue culture study of *O. sanctum* it was observed that the high frequency of enhanced axillary shoots can be accomplished on MS + BAP (1μM) using proper micropropagation procedure. In addition, rooting of the main shoot tip explant can be achieved on the same medium at the same time which can save the time involved in raising the plantlets. Hence the protocol is simple and quite reproducible.

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ECOLOGICAL MODELLING

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On Extension of Weibull Model with an Application

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ABSTRACT

This paper Studies a new Statistical model, which yields well known weibull and exponential probability models as a particular case. The estimation of the Parameters has been found by the method of maximum Likelihood. The application part has been exploited by a numerical illustration of average maximum temperature (degrees in Celsius) and relative humidity (percentage) averaged over ten years(1997-2006) for district Srinager of Kashmir valley with the help of Software package.

Key words: Statistical model, estimation, probability density function, temperature, relative humidity

INTRODUCTION

In the literature, we come across different models e.g., Linear Models, Non-Linear Models, Regression analysis Models, Generalized Linear Models, Generalized Additive Models, Analysis of Variance Models, Stochastic Models, Simulation Models, Operation Research Models, Catalytic Models, Markov-based Models etc. Out of large number of methods and tools developed so for analyzing the data the Statistical modeling is the latest innovations Gilchrist warren (1984).Models are considered as the back bone of modern Statistics and data analysis. There exists a large number of distributions of continuous type [e.g., Hogg & Craig; Johnson & Kotz and Lawless J.F.] Since a discrete as well as distribution stands on some stimulated assumptions and any variation in these assumptions leads to a different situation. It is natural to study a modification and revision of a distribution depending upon the nature of change in the situation or violation of assumptions which give rise to a new class of distributions. In general, it is possible to improve the fit of a distribution by the incorporation of extra parameters or variation in the parameters. Mudholkar *et. al.,* (1993,1995) and Bilal *et al.,* (2005) proposed models with the probability density function of Weibull type. In this paper, we also propose a model as.

PROPOSED STATISTICAL MODEL

THEOREM 1. For any real numbers $\alpha,\ p, \theta$ *and* β, the function

$$f_X(x) = \frac{p}{\theta}\left(\frac{\alpha x+\beta}{\theta}\right)^{p-1} \alpha \exp\left[-\left\{\frac{\alpha x+\beta}{\theta}\right\}^{p}\right]; \quad \ldots\ldots\ldots\ldots\ldots \quad (1.1)$$

$$p, \theta, \alpha > \text{o } \textit{and } \beta \geq 0$$

$$= 0, \text{ elsewhere}$$

is the probability density function of of the random variable X of continuous type. Where $p, \theta, \beta, and \alpha$ are the parameters of the model.

PROOF OF THEOREM 1. To prove $f_X(x)$ is a probability density function, following conditions are to be satisfied:

(i) $f_X(x) \geq 0$ and (ii) $\int_{-\infty}^{\infty} f_X(x)dx = 1$

Since p, $\theta > 0$; $\alpha \geq 0$, $\beta > 0$, therefore it follows that $f_X(x) > 0 \ \forall\ x$. Also $f_X(x) = 0$ elsewhere. Hence $f_X(x) \geq 0 \ \forall\ x$, which proves condition (i).

clearly $f_X(x) \geq 0$

Also to establish condition (ii), we have

$$\int_{-\infty}^{\infty} f_X(x)dx = \int_{-\infty}^{\infty} \frac{p}{\theta}\left(\frac{\alpha x+\beta}{\theta}\right)^{p-1} \alpha \exp\left[-\left\{\frac{\alpha x+\beta}{\theta}\right\}^{p}\right]dx \ \ldots\ldots \quad (1.2)$$

we suppose $\left(\frac{\alpha x+\beta}{\theta}\right)^{p}$ = y.

$$\frac{dy}{dx} = p\left(\frac{\alpha x+\beta}{\theta}\right)^{p-1} \cdot \frac{\alpha}{\theta}$$

$$\frac{dy}{p\alpha}.\theta = \left(\frac{\alpha x+\beta}{\theta}\right)^{p-1}.dx$$

It gives on differentiation, $\frac{px}{\theta}\left(\frac{\alpha x+\beta}{\theta}\right)^{p-1} dx = \frac{\theta}{\alpha p}$ dy.

Hence from (1.2), it follows that

$$\int_{-\infty}^{\infty} f_X(x)dx = \int_0^{\infty} e^{-y}dy = 1.$$

Thus, we have proved that

(i) $f_X(x) \geq 0$ for all x and

(ii) $\int_{-\infty}^{\infty} f_X(x)dx = 1.$

This completes the proof of Theorem 1.

ESTIMATION OF THE PARAMETERS

There are different methods for estimating the parameters available in the literature e.g., the method of moments, the method of maximum likelihood, the method of Bayesian estimation, the method of least square, entropy method etc. It is interesting to note that researchers are trying to find out which estimation method is preferable for the parameter estimation of a particular probability distribution in order to get reliable estimates of the parameters.

The Maximum Likelihood is the most efficient and most preferred method for estimating the parameters but, sometimes, it involves complicated forms of Maximum Likelihood equations which are difficult to solve for Maximum Likelihood Estimators. In such case, some other efficient estimators are to be find out. In this section, we will study the Maximum Likelihood Method for estimating the parameters of the model (1.2) as follows:

Consider a random sample $x_1, x_2, \ldots, x_n$ of size n from the population (1.2). Then, the likelihood Function L is given by

$$L = \prod_{i=1}^{n} f(x_i)$$

$$= \prod_{i=1}^{n} \left[\frac{p}{\theta} \left[\frac{\alpha x + \beta}{\theta} \right]^{p-1} .\alpha. \exp\left[- \left\{ \frac{(\alpha x_i + \beta)}{\theta} \right\}^{p} \right] \right]$$

Therefore

$$\text{Log L} = \sum_{i=1}^{n} \log p - \sum_{i=1}^{n} \log \theta + \sum_{i=1}^{n} (p-1)[\log(\alpha x_i + \beta) - \log \theta]$$

$$+ \sum_{i=1}^{n} \log \alpha - \left\{ \frac{(\alpha x_i + \beta)}{\theta} \right\}^{p}$$

The likelihood equation for the estimation of the parameters , p, θ, α *and* β, will be as

$$\frac{\partial}{\partial p} LogL = 0 \ldots \ldots \quad (2.1)$$

$$\sum_{i=1}^{n} \frac{1}{p} + \sum_{i=1}^{n} ((Log(\alpha xi + \beta) - Log\,\theta) = 0$$

$$\sum_{i=1}^{n} \frac{1}{p} + \sum_{i=1}^{n} Log\left\{\frac{\alpha xi + \beta}{\theta}\right\} = 0 \ldots \ldots \quad (2.2)$$

$$\frac{\partial}{\partial \theta} LogL = 0 \ldots \ldots \ldots . \quad (2.3)$$

$$-\sum_{i=1}^{n} \frac{1}{\theta} - \sum_{i=1}^{n} \frac{p}{\theta} + \sum_{i=1}^{n} \frac{1}{\theta} - p(\theta)^{-p-1}(\alpha xi + \beta)^{p} = 0..$$

$$-\sum_{i=}^{n} \frac{p}{\theta} - \frac{p}{\theta^{p+1}}(\alpha xi + \beta) = 0 \ldots \ldots \ldots \quad (2.4)$$

$$\frac{\partial}{\partial \beta} LogL = 0 \ldots \ldots \ldots \ldots \ldots . \quad (2.5)$$

$$\sum_{i=1}^{n} p \frac{1}{(\alpha xi + \beta)} . \frac{1}{\beta} - \sum_{i=1}^{n} \frac{1}{(\alpha xi + \beta)} \frac{1}{\beta} - p\left\{\frac{\alpha xi + \beta}{\theta}\right\}^{p-1} \frac{1}{\theta} = 0 \ldots \quad (2.6)$$

$$\frac{\partial}{\partial \alpha} LogL = 0 \ldots \ldots \ldots . \quad (2.7)$$

$$\sum_{i=1}^{n} p. \frac{1}{(\alpha xi + \beta)} . x - \sum_{i=1}^{n} \frac{1}{(\alpha xi + \beta)} . x + \sum_{i=1}^{n} \frac{1}{\alpha} - \mathrm{p}\left\{\frac{(\alpha xi + \beta}{\theta}\right\}^{p-1} . \frac{xi}{\theta} = 0 \ldots (2.8)$$

Estimation of the parameters $p, \theta \ \beta, and \alpha$ are obtained for solving equations (2.2), (2.4), (2.6) and (2.8).(e.g Rao,C.R)

DERIVATION OF VARIOUS DISTRIBUTIONS

In fact, a number of well-known distributions follow from the model (1.1) for a suitable choice of the parameters $p, \theta \ \beta, and \alpha$. Here we mention only a few

REMARK 3.1. Taking α = 1, p =1 and β = 0 in (1.1), we have

$$f(x) = \frac{p}{\theta}\left(\frac{x}{\theta}\right)^{p-1} \exp\left[-\left\{\frac{x}{\theta}\right\}^{p}\right],$$

= 0, elsewhere

which is the p.d.f of well-known Weibull Distribution with parameters $p(>0)$ and $\theta(>0)$.

REMARK 3.2. Taking α = 1, p =1 and β = 1 in (1.1), we have

$$f(x) = \frac{1}{\theta}\exp\left(-\frac{x}{\theta}\right)$$

= 0, elsewhere

which is the p.d.f of well-known Exponential Distribution with parameter $\theta(>0)$.

Similarly as above, many more distributions can be shown as a particular case of the proposed statistical model (1.1) for a suitable of choice of the parameters

APPLICATION

The fitting of two-parameter Weibull distribution and exponential distribution on maximum temperature(degree in Celsius) and relative humidity (%) averaged over ten years(1997-1998 to 2006-2007) for district Srinager in Kashmir valley has been exploited (Table 1.)

Table 1. Depicting the average maximum temperature (degrees in Celsius) at Srinager

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1997	3.2	10.8	14.2	19.4	22.5	27.4	31.9	29.1	27.8	19.9	13.7	8.4
1998	5.8	10.9	16.2	21.2	25.4	28.9	30.6	29.6	27.6	23.1	16.4	9.5
1999	5.9	10.7	15.5	24.7	26.0	30.3	31.6	29.9	29.7	24.7	15.4	12.6
2000	7.6	10.2	15.2	23.1	29.1	30.1	30.0	29.6	27.1	25.6	17.2	11.0
2001	11.7	13.7	18.0	21.7	28.4	29.6	30.1	30.2	26.9	24.4	15.5	10.6
2002	9.3	9.5	16.8	20.6	26.5	28.9	30.5	29.8	25.1	23.3	18.5	10.0
2003	11.2	10.3	13.7	21.0	22.2	30.1	30.9	28.6	26.9	23.0	15.4	10.0
2004	7.1	13.0	21.7	20.7	25.4	27.8	29.4	29.3	29	20.6	17.9	9.7
2005	7.5	6.5	14.7	20.7	21.8	29.3	28.9	30.4	29.3	22.7	15.8	9.9
2006	4.3	13.4	16.0	21.1	28.2	27.6	30.9	28.7	25.9	22.9	15.0	8.4
G.M	7.50	10.90	16.20	21.42	25.55	29.00	30.48	29.52	27.53	23.02	16.08	10.06

(Source:- Regional Metrological Centre, Srinager; Digest of Statistics(2006-2007).

Table 2 Depicting the average relative humidity in (percentage) at 1730 hours at Srinagar

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1997	67	60	50	46	46	45	50	58	58	62	61	70
1998	65	58	51	51	45	45	52	59	54	65	60	67
1999	58	57	46	48	45	46	53	60	55	62	62	66
2000	57	59	48	49	48	47	50	56	59	64	64	69
2001	58	49	44	47	43	52	56	55	52	55	61	69
2002	62	60	47	51	44	48	51	60	58	80	53	65
2003	56	62	57	50	51	47	50	60	62	63	62	69
2004	70	52	34	56	46	50	51	55	49	63	73	74
2005	67	78	61	41	58	44	60	56	50	56	56	64
2006	79	61	52	42	44	46	54	61	60	61	68	75
G.M	63.90	59.60	49.00	48.10	47.00	47.00	52.60	57.80	55.70	63.00	62.00	68.85

(Source:- Regional Metrological Centre, Srinager; Digest of Statistics(2006-2007))

Using Minitab (14 version, http://www.minitab.com) for the analysis of the data.
Distribution Analysis: Maximum temperature

Distribution: Weibull
Estimation Method: Maximum Likelihood

Table 3 depicting the parameter estimates for maximums temperatures (^{0}C)

		Standard	95.0% Normal CI	
Parameter	Estimate	Error	Lower	Upper
Shape	1.98815	0.223895	2.48585	3.36687
Scale	24.0888	0.764928	21.6979	24.6984

Log-Likelihood = -419.300
Goodness-of-Fit
Anderson-Darling (adjusted) = 3.856

Table 4 Characteristics of distribution for maximum temperature (^{0}C)

		Standard	95.0% Normal CI	
	Estimate	Error	Lower	Upper
Mean(MTTF)	21.3506	0.704229	19.3051	22.0677
Standard Deviation	11.2203	0.500560	6.82823	8.79564
Median	20.0334	0.757707	18.9627	21.9355
First Quartile(Q1)	15.0491	0.804293	13.5525	16.7110
Third Quartile(Q3)	30.5668	0.818247	24.3614	27.5709
Interquartile Range(IQR)	15.5177	0.709797	9.56161	12.3516

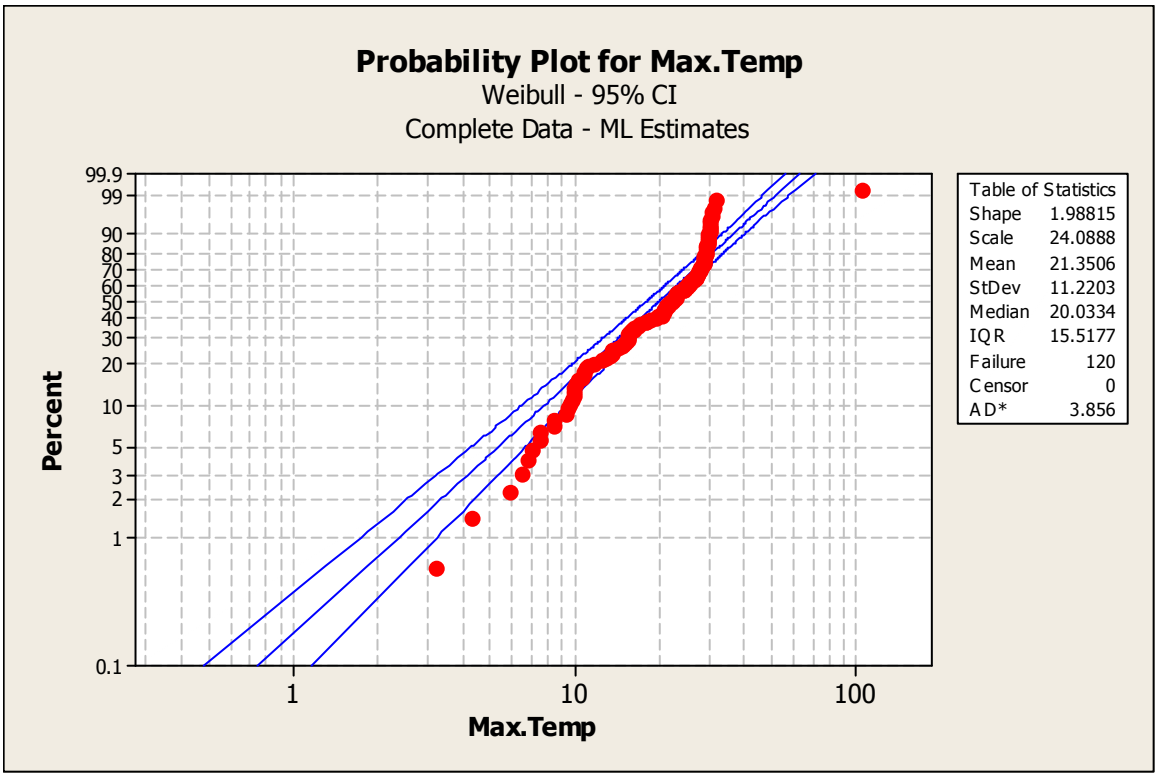

Fig. 1 Probability plot for maximum temperature (^{0}C)

Estimation Method: Maximum Likelihood

Table 5 Parameter estimates for relative humidity

Parameter	Estimate	Standard Error	95.0% Normal CI Lower	Upper
Shape	6.67887	0.444077	5.86282	7.60850
Scale	59.9703	0.869169	58.2907	61.6982

Log-Likelihood = -436.011
Goodness-of-Fit
Anderson-Darling (adjusted) = 1.559
Characteristics of Distribution

Table 6 Characteristics and distribution of relative humidity (%)

	Estimate	Standard Error	95.0% Normal CI Lower	Upper
Mean(MTTF)	55.9602	0.896360	54.2306	57.7449
Standard Deviation	9.82113	0.539879	8.81800	10.9384
Median	6.7680	0.912800	55.0068	58.5855
First Quartile(Q1)	49.7647	1.09424	47.6656	51.9562
Third Quartile(Q3)	62.9761	0.866413	61.3006	64.6973
Interquartile Range(IQR)	13.2114	0.779537	11.7685	14.8311

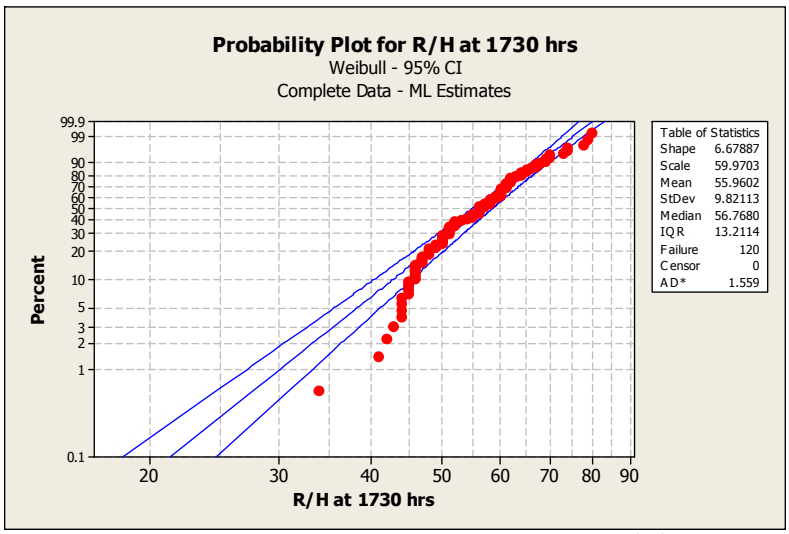

Fig 2 Probability plot for relative humidity (%)

Estimation Method: Maximum Likelihood
Distribution: Exponential

Parameter Estimates

Parameter	Estimate	Standard Error	95.0% Normal CI Lower	Upper
Mean	21.3975	1.95332	17.8920	25.5898

Log-Likelihood = -487.593
Goodness-of-Fit
Anderson-Darling (adjusted) = 18.202
Characteristics of Distribution

Table 8 Characteristics of distribution for maximum temperature (^{0}C)

	Estimate	Standard Error	95.0% Normal CI Lower	Upper
Mean(MTTF)	21.3975	1.95332	17.8920	25.5898
Standard Deviation	21.3975	1.95332	17.8920	25.5898
Median	14.8316	1.35394	12.4018	17.7375
First Quartile(Q1)	6.15568	0.5619	5.14721	7.36172
Third Quartile(Q3)	29.6632	2.70787	24.8036	35.4750
Interquartile Range(IQR)	23.5076	2.14594	19.6564	28.1133

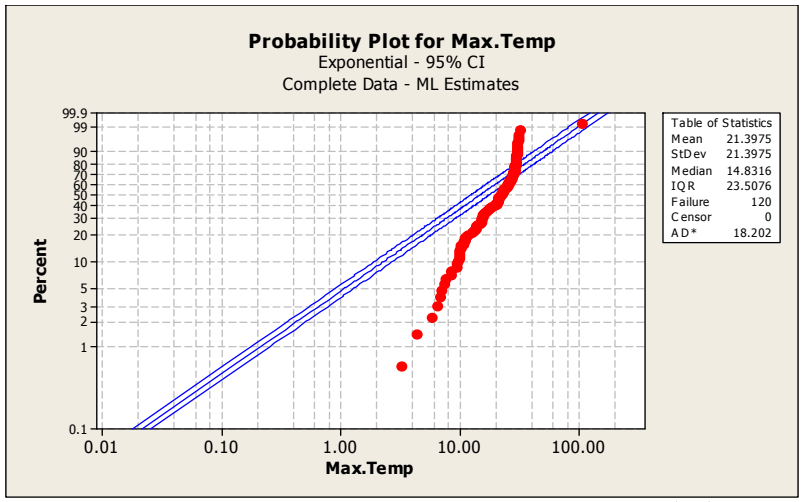

Fig 3 Probability plot for maximum temperature (^{0}C)

Distribution Analysis: R/H at 1730 hrs

Estimation Method: Maximum Likelihood

Distribution: Exponential

Table 9 Estimates for relative humidity (%)

Parameter	Estimate	Standard Error	95.0% Normal CI Lower	Upper
Mean	56.1833	5.12881	46.9790	67.1910

Log-Likelihood = -603.434

Goodness-of-Fit

Anderson-Darling (adjusted) = 39.542

Table 10 Characteristcs of distribution for relative humidity (%)

	Estimate	Standard Error	95.0% Normal CI Lower	Upper
Mean(MTTF)	56.1833	5.12881	46.9790	67.1910
Standard Deviation	56.1833	5.12881	46.9790	67.1910
Median	38.9433	3.55502	32.5634	46.5733
First Quartile(Q1)	16.1629	1.47547	13.5150	19.3297
Third Quartile(Q3)	77.8866	7.11004	65.1267	93.1465
Interquartile Range(IQR)	61.7237	5.63458	51.6117	73.8169

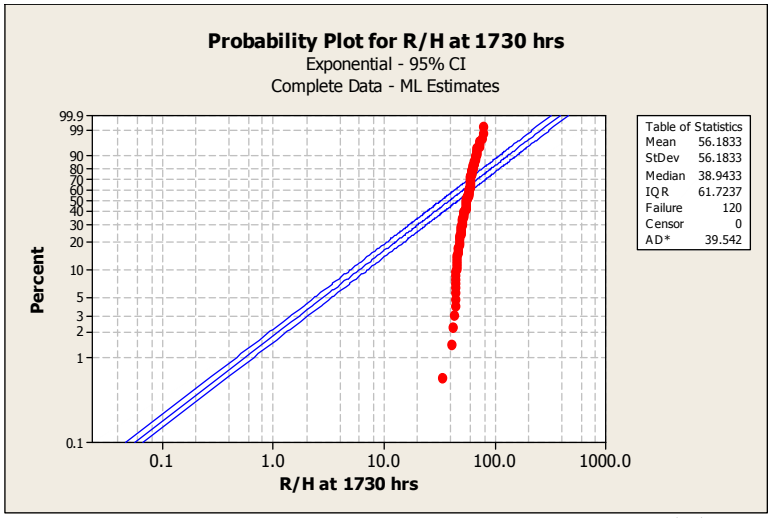

Fig 4 Probability plot for relative humidity (%)

The analysis of the data giving summary statistics(i.e mean, median, standard deviation, first quartile, third quartile, inter quartile range) and parameter estimation (i.e shape and scale) along with the graph of the probability plot shows that Weibull distribution fits well to the metrological data (i.e maximum temperature and relative humidity (%)).The estimation of the Statistical parameter particularly Anderson Darling Chi-Square is minimum through Weibull distribution for maximum temperature and relative humidity and the model is considered to be a good fit.

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SHORT COMMUNICATION

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Ethnomedical Plants of Purulia District of West Bengal

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Key words: Ethnomedical plants, survery, tribals, Purlia district

Purulia is the westernmost district of West Bengal and is located between 22 ^{0} 42' 35" to 23^{0} 42'^{0}" North Latitude and 85^{0} 49'25" to 86^{0} 54'37" East Longitude. The district constitutes a transit zone between young alluvial plain of West Bengal and ancient plateau of Jharkhand. The climate of Purulia is characterized by hot summer and well distributed rainfall, Purulia receives about 1400 m.m rain every year. Temperature ranges from 13^{0}C to 46^{0}C Natural vegetation of Purulia can be described as tropical moist deciduous forest but the same has significantly changed because of various anthropogenic reasons. Still about 82% of total area is rural and has got various types of vegetation. Purulia has got remarkable presence of tribal who constitute nearly 18% of total population. Major tribes include Santhals, Oraons, Mundas and Koras,. Tribal people of Purulia have been using various herbs for their therapeutic purpose from ancient period. The present study was aimed at collecting some first hand information's regarding the ethnomediincal plants popular among tribal of Purulia. Tribal dominated area of this district was regularly visited and villages medicine man, elderly, people and merchants of herbs were consulted. Information's collected from them were documented. Plants collected were identified with the help of available literature (Chopra and Chopra, 1992; Sharma, 1996).

PLANT DESCRIPTION

1. BOTANICAL NAME : *Adhatoda vasica* (Nees)
   LOCAL NAME : Basak
   FAMILY : Acanthaceae
   CONVENTIONAL USE : Fresh leaf juice with honey is used as a remedy for cough and for loosen the cough. About 3 fresh leaves fried with 3 china rose (*Hibiscus rosa* sinensis) bud and consumed every day with rice to cure piles. The smoke of dried leaf is advised to inhale to cure asthma.

2. BOTANICAL NAME : *Aegle marmolos* (L.)
   LOCAL NAME : Bel
   FAMILY : Rutaceae
   CONVENTIONAL USE : Leaf extract with honey is used in treating jaundice. Fruit pulp is given in case of dysentery.

3. BOTANICAL NAME : *Alostonia scholaris* (R.)

LOCAL NAME : Chhatim
FAMILY : Apocynaceae

CONVENTIONAL USE : The latex is applied in gums to prevent tooth-decay and tooth-ache. Bark paste is boiled with 2 cup of water and reduced to ½ cup and applied onto the mammary glands of women to increase lactation.

4. BOTANICAL NAME : *Andrographis paniculater* (Wall.)
LOCAL NAME : Kalmegh
FAMILY : Acanthanceae

CONVENTIONAL USE: Half spoon of eaf juice with 4-5 cardamom seed powder is used to treat liver and digestion complaints. Leaf extract mixed with turmeric juice and sugar is taken to cure worms. leaf juice with water and fried cardamom seed powder is administered for dysentery.

5. BOTANICAL NAME : *Argemone mexicana* (L)
LOCAL NAME : Sialkanta
FAMILY : Papaveraceae
CONVENTIONAL USE : The yellow latex of the stem is taken orally for seven days for healing of wounds

6. BOTANICAL NAME : *Azadirachta indica* (A)
LOCAL NAME : Neem
FAMILY : Meliaceae
CONVENTIONAL USE : Leaf paste is applied externally for skin disease (allergy). Pieces of fresh branch are used as tooth brushes to keep mouth clean. It also prevents tooth decay, bad breath and gum diseases. 4-5 gm of Neem bark is left for night in warm water and advised to take early in the morning to cure.

7. BOTANICAL NAME : *Boerhaovia repons*(L)
   LOCAL NAME : Punarnaba
   FAMILY : Nyctginceae

   CONVENTIONAL USE: Root powder is used to treat bronchial asthma. Leaf juice is given to jaundice patients.

8. BOTANICAL NAME : *Cajanus cajan* (L.)

   LOCAL NAME : Aorhor
   FAMILY : Papilionanceae

   CONVENTIONAL USE : Fresh young leaves are chewed to cure tongue ulcer. Leaf extract or root bark juice is warmed and used to treat diabetes.

9. BOTANICAL NAME : *Calotropis procera* (R. Br.)
   LOCAL NAME : Akanda
   FAMILY : Asclepiadaceae

   CONVENTIONAL USE : Decoction of leaves is used for relieving pain in rheumatism. Latex is used internally in curing piles, intestinal worms etc. Latex is also applied in case of scorpion sting.

10. BOTANICAL NAME : *Carica papaya* (L.)
    LOCAL NAME : Pepe
    FAMILY : Caricaceae

    CONVENTIONAL USE : Infusion of latex and honey is given to children for expelling round worms. Latex is also helpful to get relief from pain of burns. It is also applied on wounds to check haemorrhage.

11. BOTANICAL NAME : *Cassia occidentales* (L.)
    LOCAL NAME : Kalkasunde
    FAMILY : Caesalpinaceae

    CONVENTIONAL USE : About 1 gm of fruit powder is advised to eat twice daily to reduce acidity till cured the leaf powder is mixed with sugar solution and taken in case of whooping cough. Few drops of leaf extract are dropped in nose to get back the sense from senselessness (Faint).

12. BOTANICAL NAME : *Catheranthus roseus* (L.)
LOCAL NAME : Nayantara
FAMILY : Apocynaceae

CONVENTIONAL USE : Leaf infusion is taken to cure indigestion, control blood pressure and also to check diabetes. The decoction of stem and leaves are used for regulation of menstruation. The leaf paste is used in case of insect (ant, honeybee) bite.

13. BOTANICAL NAME : *Centella asiatica* (L.)
LOCAL NAME : Thankuni
FAMILY :Umbelliferae

CONVENTIONAL USE : Leaves are boiled in water, and the water is applied on wounds to get quick recovery, this water is also given for gargling for sore throat. Decoction of the leaves is administered for dysentery.

14. BOTANICAL NAME : *Cinnamomum tamalo* (Nees)

LOCAL NAME : Tejpata
FAMILY :Lauraceae

CONVENTIONAL USE : The leaf paste is rubbed to cure prickly heat . Leaf powder is applied on gums to relieve pain from toothache.

15 . BOTANICAL NAME : *Coriandrum satinum* (L.)
LOCAL NAME : Bhane
FAMILY : Umbelliferae

CONVENTIONAL USE : Coriander leaf chutney serves as an excellent remedy for abdominal pain caused by indigestion. The paste of seeds ground with some water applied to forehead to get relief from headache.

16. BOTANICAL NAME : *Croton bonplandianum* (Baill.)
FAMILY :Euphorbiaceae

CONVENTIONAL USE : Oil obtained from seeds is used as strong purgative.

17. BOTANICAL NAME : *Curcuma longa* (L.)
LOCAL NAME : Halud
FAMILY : Zingiberaceae

CONVENTIONAL USE : About I gm of Halud (Amlaki) powder, Neem leaf powder and emblic powder is advised to eat early in the morning in case of allergy. Inhalation from boiling water or warm taken with milk relieves sore throat Halud powder, salt is lime mined and warmed and is applied on swellings of sprain.

18. BOTANICAL NAME : *Cynodon daclylon* (L.) Pres
LOCAL NAME : Durba
FAMILY :Poaceae

CONVENTIONAL USE : Decoction of leaf with sesame seed oil is administered for scabies.Leaf paste along with turmeric paste is used to cure scars caused due to any skin infection.

19. BOTANICAL NAME : *Datura metel* (L .)
LOCAL NAME : Dhutra
FAMILY :Solanaceae

CONVENTIONAL USE : The leaf juice is warmed and then applied externally to the swelling of the body. It is also used in asthmatic complaints. Leaf extract minced with mustard oil is used in rheumatism.

20. BOTANICAL NAME : *Emblica officinalis*(Gaertn)
LOCAL NAME : Amlaki
FAMILY : Euphorbiaceae

CONVENTIONAL USE : The fruit poultice is used to stop bleeding from cuts. The fruit juice is useful in indigestion. Young fruit pulp (paste) is for applied on scalp for growing new hair.

21. BOTANICAL NAME : *Eucalyptus globosus* (Labill.)
FAMILY :Myrtaceae

CONVENTIONAL USE : Oil obtained from dried leaves is used in the treatment of nose, throat disorder, asthmatic complaints and bronchitis.

22. BOTANICAL NAME : *Foeniculum vulgare* (Mill.)
LOCAL NAME : Mouri, Panmouri
FAMILY :Umbelliferae

CONVENTIONAL USE : The decoction of leaves strengthen the eye-sight. Seeds of this plant facilitate digestion

23. BOTANICAL NAME : *Hemidesmus indicus* (L .)
LOCAL NAME : Anantamul
FAMILY :Apocynaceae

CONVENTIONAL USE : The root decoction (About 10 ml) is used thrice a day for one month as blood purifier and in skin disease also. It is also helpful in lactation of mammary gland. The root powder along with honey is administered for dysentery.

24. BOTANICAL NAME : *Herpestis monnieria* (L .)
LOCAL NAME : Bramhi
FAMILY :Scrophulariaceae

CONVENTIONAL USE : Leaf – decoction is used as a nerve tonic, and also in epilepsy and insanity. The leaf juice is warmed, then cooled and mixed with honey, and taken to get relief from chocked throat.

25. BOTANICAL NAME : *Holarrhena antidysentrica* (Linn.) wall
LOCAL NAME : Kurchi
FAMILY :Apocynaceae

CONVENTIONAL USE : 5 gm bark powder boiled in 2 cup of water and reduced to ½ cup, this solution is administered for diarrhoea and dysentery. The seed

powder is mixed with honey and used to cure worms. The paste of the bark is slightly warmed and applied on abscesses to cure it.

26. BOTANICAL NAME : *Hygrophila spinosa* (T .)
LOCAL NAME : Kulekhara
FAMILY :Acanthaceae

CONVENTIONAL USE : Leaf extract is consumed everyday to increase the amount of haemoglobin in blood. Leaf juice is warmed and taken with honey to get relief from foot swelling and to reduce muscle pain.

27. BOTANICAL NAME : *Leucas aspera* (speng.)
LOCAL NAME : Dronpuspa
FAMILY :Lamiaceae

CONVENTIONAL USE : Decoction of the flower along with warm water is taken to loosen the cough. 3-4 drops of leaf juice is advised to be take n orally by the children to cure worms.

28. BOTANICAL NAME : *Madhuca indica* (Gmel.)
LOCAL NAME : Mahua
FAMILY :Sapetaceae

CONVENTIONAL USE : A tincture of leaves is used in rheumatism and gout. A tea of boiled branches is used to treat cold.

29. BOTANICAL NAME : *Mentha arvensis* (L .)
LOCAL NAME : Pudina
FAMILY :Labiatae

CONVENTIONAL USE : The leaf juice is used in stomach disorders, liver and spleen diseases. A solution of leaf juice, salt, black pepper powder and lemon juice is taken orally to reduce aversion or tastelessness.

30. BOTANICAL NAME : *Nerium indicum*(Mill.)
FAMILY :Apocynaceae
CONVENTIONAL USE : Extracted oil from root bark is used in skin disease of a scaly nature . Fresh leaf juice is applied in eyes for inducing lachrymator in opthalmia.

31. BOTANICAL NAME : *Ocimum sanctum* (L .)
LOCAL NAME : Tulsi
FAMILY :Labiatae
CONVENTIONAL USE : Leaf juice is mixed with honey and used in cough, cold, stomach trouble and diabetes. Decoction of leaf is applied in case of insect bite.

32. BOTANICAL NAME : *Paderina foetida* (L .)
LOCAL NAME : Gandal
FAMILY :Rubiaceae

CONVENTIONAL USE : Leaf paste with sesame seed oil is applied externally to reduce muscle pain.The prepared soup with leaf, is taken to get relief from cough and cold. Leaf juice along with fresh honey is taken orally to cure dyspesia.

33. BOTANICAL NAME : *Piper longum* (L .)
LOCAL NAME : Pipul
FAMILY : Piperaceae

CONVENTIONAL USE : The dried unripe fruit powder is useful in cold, cough, chronic bronchitis and diarrhoea

34. BOTANICAL NAME : *Ricinus communis* (L .)
LOCAL NAME : Reri
FAMILY :Euphorbiaceae

CONVENTIONAL USE : Oil obtained from seed is rubbed on to the boil or burns to get quick relief. One drop of leaf juice is warmed and dropped on eyes to cure conjunctivitis. Leaf paste is rubbed on to the joints to get relief from pain.

35. BOTANICAL NAME : *Strychnos nux-vomica* (L .)
LOCAL NAME : Kuchila
FAMILY :Loganiaceae

CONVENTIONAL USE : Stem bark along with lime juice is taken orally to treat cholera. Seed is used as tonic and taken in the treatment of paralysis and nervous disorders.

36. BOTANICAL NAME : *Swertia ciliata* (L .)
LOCAL NAME : Chirata
FAMILY :Gentianaceae

CONVENTIONAL USE : Dried stem and branches are added in water and left for whole night ,this water is advised to be taken early in the morning to reduce acidity, till cured. One gm of powdered leaf and stem is mixed with sugar and water and is taken to reduced vomiting during pregnancy.

37. BOTANICAL NAME : *Taraktogenos kurzii* (king)
LOCAL NAME : Chalmugra
FAMILY : Flacourtiaceae
CONVENTIONAL USE : Seed oil is used in the treatment of leprosy and skin diseases.

38. BOTANICAL NAME : *Trigonella foenumgraceum* (L.)
LOCAL NAME : Methi
FAMILY : Leguminaceae

CONVENTIONAL USE : The flower is recommended for dysentery, diarrhoea. The seed is used to resolve inflammatory tumors. ½ gm of seed powder is taken with warm water to reduce joint pains.

39. BOTANICAL NAME: *Vitex negundo* (Linn.)
LOCAL NAME : Nisindha, Buan
FAMILY : Verbenaceae

CONVENTIONAL USE : Boiled leaf water mixed with Neem leaf and is used to cure wounds. The boiled leaf water is taken to cure joint pains. Leaf

juice with warm oil is rubbed onto the scalp to remove dandruff and also to promote hair growth on bald.

40. BOTANICAL NAME: *Zingiber officinales* (Rose)
LOCAL NAME : Ada
FAMILY : Zingiberaceae
CONVERTIONAL USE : Juice of underground part is used in cold and cough. Plant extract also acts as an antibiotic. Dried powder is applied on wounds to check haemorrhage.

Various earlier workers like Bhattacharjee (1977), Sarkar and Gupta (2000) and Robin (2004) have reported earlier that ethno medicine constitute back bone of health service among tribal of west Bengal. West Bengal state gazetteer further confirms this condition. Results of this research work also runs in same direction. Tribal people of Purulia district of West Bengal have adequate information about plants and they properly use these ethno medicine to treat various diseases.

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Prevelence of Anaemia Among Girls in Age Group of 13-25 Years

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Key words: *Anaemia, Severe, Socioeconomic.*

Anaemia is defined as qualitative deficiency of haemoglobin. It is most common disorder of the blood .It is not a diseases itself but a result of a malfunction somewhere in the body. This blood condition is common, particularly in female. Estimate suggested that around one in five menstruating women are anemic (http.en.wikipedia org/wiki/Anemia).

Anaemia can be caused by a wide range of events, including certain diseases condition and medications .Iron deficiency is the most common cause. In India it affects an estimated 50% of population (Seshadri, 1998).

Present study was undertaken to find out the prevalence of anaemia among girls in age group of 13 to 25 years belonging to different socio-economic group in out patient department of Regional Research Institute of Unani Medicine, Srinagar. The data was collected during the year 2005-2007. Informal consent of the parents of each girl has been obtained before estimation was done in laboratory of RRIUM, Srinagar using Acid haemitine method on the blood sample obtained by the finger prick. Anemia was diagnosed according to WHO guidelines (Demaeyer, 1989), 621 girls participated in the study.

It is evident from Table 1 that out of 621 girls selected for the study, only 189 (30.18%) were normal and 432 (69.82%) affected with various grades of Anaemia ie. mild, moderate and severe. As per WHO guidelines (Table 2), 189 (43.4%) girls were severely anaemic, 126 (29.2%) girls mildly and 117 girls (27.08%) moderately anaemic.

In low income group the prevalence of severe anaemia in group was 13-25 years (41.9%) Similarly in middle income group prevalence of severe anaemia was 58.1 %. High prevalence of anaemia has also been noted by various studies (Malhotra & Srivastava, 1982; Gopal Das and Kale , 1985) among children of economically weaker sections and rural school children. In a multi country study (Kunt and Johnson, 1994) on the nutritional centre for research on women , anemia was found to be the wide spread nutritional problem and its prevalence ranged from 32-55%, (Agarwal, 1998) .Higher percent prevalence of anaemia in adolescent girls were also reported from other countries. (Rajarathan and Rajarathan, 2000).

Table 1 Number and percentage prevalence of Anaemia among girls with different age groups

Age group in years	Sample Size.	Normal	Anaemic	Severity of Anaemia		
				Mild	Moderate	Severe
13 – 15	201	75 (36.9)	126(63.1)	44(34.6)	26(20.5)	56(44.9)
16 – 18	117	38 (32.9)	79(67.1)	28(35.5)	18(24.0)	33(40.5)
19 – 21	83	24 (29.0)	59(71.0)	15(25.0)	18(30.5)	26(44.5)
22 – 23	111	29 (26.1)	82(73.9)	19(23.0)	30(36.5)	33(40.5)
25 years	109	23 (21.09)	86(78.91)	20(23.0)	25(28.5)	41
Total	621	189(30.18)	432(69.82)	126(29.2)	117(27.8)	189(43.4)

In both groups percent prevalence of severe anaemia was higher in girls whose age ranged from 13-15 years which may be due to the menstruation effect and puberty –Menorrhagia. Other researchers had reported similar findings.(Vasanthi *et. al.*,1994.)

This study also shows a high prevalence of severe anaemia among girls from low income group (Table 3) which finds significant association between anaemia and occupation of father

Table 2. Degree of Anaemia as per WHO guidelines

Severe Anaemia	:	Hb< 8.0 gm /dl.
Moderate Anaemia	:	Hb< 10.0 gm/dl
Mild Anaemia	:	Hb< 12.0 gm/dl.
Normal Anaemia:		Hb > 12.0 gm

Table 3 Number and percentage prevalence of Anaemia among girls with different age and income groups

Age group	Sample Size	Low income group	Middle income group	Low income group		Middle income roup	
				Normal	Anaemic	Normal	Anaemic
13 – 15	201	65(32.34)	136(67.66)	10(13.33)	55(43.65)	65(86.67)	71(56.35)
16 – 18	117	51(43.59)	66(56.41)	13(34.21)	38(48.1)	25(65.79)	41(51.9)
19 – 21	83	44(53.1)	39(46.9)	17(7.9)	27(45.8)	7(2.1)	32(54.2)
22 – 23	111	36(32.43)	75(67.57)	8(27.58)	33(42.6)	21(72.42)	49(57.4)
25years	109	25(22.93)	84(77.07)	4(17.4)	28(32.5)	19(82.6)	58(67.3)
Total	621	221(35.6)	400 (64.4)	52(27.5)	181(41.9)	137(72.5)	251(58.1)

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