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Complexities of Using Graph Partitioning in Modern Scientific Problems and Application to Power System Islanding

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Abstract: The application of graph partitioning to modern scientific problems with various objectives has been attempted by many researchers in a variety of fields. Such applications are many and the following may be mentioned only to name a few examples. Applications such as vulnerability assessment of large power systems, power system islanding, design of VLSI circuits, dynamic system modeling and simulation, innovation graph state estimation, internet-like network partitioning, task mapping of parallel computation, database management, archaeological dating, power system transient studies, load balancing of parallel computing, molecular dynamics, DNA sequencing, categorizing amino acids, circuit netlists partitioning, etc. have been reported in the literature. In this paper, the complexities of the application of graph partitioning in modern scientific applications are thoroughly investigated in order to shed some light on this issue with such a diverse domain of applications. Fundamental graph theoretical and matrix algebraic concepts are discussed with sufficient examples. Application of these concepts to the problem of power system islanding is presented with suggestions to improve the speed and the objective function being used. [Journal of American Science 2009;5(5):1-12]. (ISSN: 1545-1003).

Key words: Graph partitioning, Fiedler vector, eigenvalues, Laplacian, Scientific applications, Power system islanding

1. Introduction

Since the development of graph theory, many applications have been sought by researchers in various fields. Perhaps one of the most important classes of applications of graph theoretic concepts to modern scientific problems is graph partitioning. This application is found under many disguises in the literature. Titles such as splitting, islanding, grouping, clustering, etc. are such names which have been adopted by the researchers in individual fields. The domain of application of these techniques is so vast that it encompasses almost all scientific fields. Therefore, an issue of such general application in science and engineering deserves a closer look.

Once the literature is reviewed, you find that graph partitioning has been applied to many problems such as power systems, electronics, communications, computers, genetics, image processing, etc. The applications are so many that one cannot list them all in one paper. However, a short survey of these applications is presented here in order to indicate the importance of taking a closer look at the complexities involved.

Graph partitioning can be applied in many modern day large scale system problems such as parallel

processing, sparsity preserving orderings for sparse matrix factorizations, circuit placement, routing, system hierarchy, VLSI circuit testing, facility location, scattered network, hierarchical design of VLSI circuits, data mining, dynamic load balancing, parallel test pattern generation, power system islanding, annotation of protein sequence, and fault section estimation in large scale power systems.

To start, one may refer to the area of dynamic system modeling and simulation in the work of Rideout et al. (2009) who applied partitioning to detect weak coupling including one-way coupling or complete decoupling among elements of a dynamic system model. They attempted to partition the problem in order to reduce the models in which weak coupling is found so as to reduce the physical-domain model. This would enable one to perform parallel simulation of smaller individual submodels and reduce the computational time. They applied this method to the partitioning of the longitudinal and pitch dynamics of a medium-duty truck model. The intensity of dynamic coupling and the potential for model reduction are shown to depend on the magnitude of system parameters and the severity of inputs such as road roughness.

In applications to power systems, Bi et al. (2002) proposed a multiway graph partitioning method for partitioning a large scale power network into the desired number of connected subnetworks with the intention of fault section estimation. They proposed the balancing of work burden on each of the subnetworks formed. The proposed partitioning method minimizes the number of elements at the frontier of each subnetwork.

You et al. (2003) proposed a self-healing strategy to deal with catastrophic events when power system vulnerability analysis indicates that the system is approaching an extreme emergency state. They suggested the use of graph partitioning to adaptively divide the power system into smaller islands with consideration of quick restoration. In their approach, it was suggested that a load shedding scheme based on the rate of frequency decline be applied in the islands formed.

Kamwa et al. (2007) addressed the problem of dynamic vulnerability assessment of large power systems using a fuzzy clustering algorithm for partitioning the power system into a number of coherent electric areas. The objective function is imposed by selecting representative buses from the data set in such a way that the total fuzzy dissimilarity within each cluster is minimized. Zhang et al. (2008) used partitioning algorithms for innovation graph estimation to meet the management requirement of large-scale power grid to provide a simplified network in the upper-level control center to replace the original whole grid in two-level cooperative control centers on a provincial electrical network reducing the computational time requirements. Wang X. Z. et al. (2008) proposed an adaptive clustering algorithm based on power system network topology, initial power flow and given architecture to address power system transient stability studies. The sizes of the small cliques are derived using multi-constraint and multi-objective graph partitioning theory where the nodes represent units of computation, and the branches encode data dependencies. In a different work, Wang C. et al. (2008) presented a searching algorithm for islanding using a multilevel reduced graph partition algorithm. Peiravi and Ildarabadi (2009) proposed the use of multilevel kernel k-means partitioning for intentional islanding of power systems.

The applications in electronics are also outstanding. Hagen et al. (1992) addressed the problem of partitioning of circuit netlists in VLSI design. Using the well-known Fiedler vector, they presented a good

approximation of the optimal ratio cut partition cost. Using Lanczos method for the sparse eigenvalue problem was found to be a robust basis for computing heuristic ratio cuts based on the Fiedler vector. They also considered the intersection graph representation of the circuit netlist as a basis for partitioning, and proposed a heuristic based on spectral ratio cut partitioning of the netlist intersection graph which was tested on industry benchmark suites.

Cherng et al. (1999) presented a two-level bipartitioning algorithm combining a hybrid clustering technique with an iterative partitioning process for VLSI circuits. Later on, Cherng and Chen (2003) presented a multi-level bipartitioning algorithm by integrating a clustering technique and an iterative improvement based partitioning process for VLSI circuit design in order to minimize the number of interconnects between the subsets of the circuit in order to reduce interconnect delays in deep submicron technology.

Application in other areas such as genetic engineering and image processing should also be mentioned. Shepherd et al. (2007) used the Fiedler vector for partitioning or categorizing amino acids based on the Miyazawa-Jernigan matrix. Their proposed model splits the amino acid residues into two hydrophobic groups (LFI) and (MVWCY) and two polar groups (HATGP) and (RQSNEDK). Othman et al. (2006) proposed the application of partitioning to assign highly correlated Gene Ontology terms of annotated protein sequences to partially annotated or newly discovered protein sequences. Their proposed method is based on Gene Ontology data and annotations. The first problem considered by them relates to splitting the single monolithic Gene Ontology RDF/XML file into a set of smaller files that are easy to assess and process so that they may be enriched with protein sequences and inferred from Electronic Annotation evidence associations. The second problem involves searching for a set of semantically similar Gene Ontology terms to a given query. Dhillon et al. (2005) and Dhillon et al. (2007) presented a graph partitioning method based on a Multilevel Kernel k-Means approach with a high speed performance in partitioning graphs which they used on large-scale partitioning tasks such as image segmentation; social network analysis; and gene network analysis types of systems.

The support for load balancing simulations that are performed on heterogeneous parallel computing platforms is an important issue and it can only be

effectively achieved if the graph is distributed so that it properly takes into account the available resources such as CPU speed, network bandwidth, etc. One such application is load balancing in parallel computing to minimize communications between the various processors such as the parallel simulation of power system dynamics by Xue and Qi (2007) who used a multilevel graph partition algorithm and introduced regional characteristics into the partition and improved the weights of the nodes and its scheme. Moulitsas and Karypis (2006) developed algorithms that can address the partitioning requirements of scientific computations and can correctly model the architectural characteristics of emerging hardware platforms given that heterogeneous technologies are becoming more widespread.

2. Objectives of Graph Partitioning Applications

In practical applications, nodes and branches of the graphs to be partitioned represent different objects and this must be taken into consideration when developing the graph partitioning algorithm. Moreover, the objectives in mind in various applications of graph partitioning to modern scientific problems are somewhat different based on the demands of the particular application. To cover these differences, it would be wise to consider graphs with weights and costs assigned to the elements as suggested by Aleksandrov et al. (2006) who presented an algorithm for computing cutsets in planar graphs with costs and weights on the nodes, where weights are used to estimate the sizes of the partitions and costs are used to estimate the size of the cutset. They measured the quality of the partitioning by the total cost of the elements in the cutset and the imbalance between the total weights of the parts. In such applications, the weights assigned to the nodes are usually estimates of computational time requirements of the corresponding tasks. Once the node weights are balanced, the total computational burden is balanced amongst the various processors in the system. On the other hand, minimizing the branch cut sets implies minimum communications between the various processors in the system.

As another example of such challenges and complexities, let's consider the problem of power system islanding. The usual weight assigned for the branches in power system islanding applications represents the power flow in the corresponding

transmission line, whereas the nodes represent power system buses. The underlying relationship between the nodes and the branches is also widely different in different applications. These issues must also be taken into consideration in the design of graph partitioning algorithms for a given application. There are, however, subtle difficulties in each application. For example, in the scheme presented by Wang C. et al. (2008), the authors only attempt to make the generation load imbalance in each island as small as possible. This is a minimal requirement for restoration. Blackouts may be caused for various reasons, even though power system partitioning or islanding application is meant to prevent them. Pre-disturbance conditions such as maintenance outages, changes in generation pattern and unexpected events such as misoperation of relays or failure of circuit breakers may pre-expose the system towards blackout after a disturbance. After the system breaks into islands, the load/generation imbalance in the islands could result in blackout in the individual islands. Therefore, it is reasonable to attempt to direct the intentional islanding of the power system towards islands with minimal load/generation imbalance. However, other factors such as voltage collapse, cascading thermal overloads, and dynamic stability could also lead to power system blackout. Therefore, more complexities and more strict conditions must be imposed to achieve a better islanding solution. For example, inherent structural characteristics of the power system should be considered and the choice of the island should be independent of the disturbance as proposed by Rehtanz (2003).

3. Mathematics of Graph Partitioning

Graph partitioning is usually based on graph theoretic concepts. In order to understand the complexities involved in modern scientific applications, a detailed analysis of the current approaches and the underlying algorithms is necessary. Graph partitioning is a well known NP-complete problem in mathematics where a graph is divided into several pieces in such a way that the pieces are of about the same size and there are few connections between them. The unweighted graph partition problem is usually stated as follows:

Given a graph $G(N,B)$ with N nodes and B branches, and given an integer $k > 1$, partition N into k subsets N_1, N_2, \dots, N_k such that the subsets are disjoint

and have equal size, and the number of branches which end in different parts is minimized. In its more general form, weighted graph partitioning problem where both nodes and branches may be weighted, the problem may be stated as follows:

Given a graph $G(N,B)$ with N nodes and B branches, and given an integer $k > 1$, partition the graph into k disjoint subsets of approximately equal weight and the size of the branch cuts is minimized. The size of a cut set is the sum of the weights of the branches contained in it, while the weight of a subset is the sum of the weights of the nodes in that subset. This partitioning problem may be solved by using graph-theoretic heuristics.

The graph's adjacency matrix and the degree matrix are needed to form the Laplacian matrix. The Laplacian matrix of an undirected, unweighted graph $G(N,B)$ where the graph is without any self loops or multiple branches between any pair of nodes is an n by n symmetric matrix with one row and column for each node defined by

$$L = D - A \quad (1)$$

where the degree matrix $D = \text{diag}(d_1, d_2, \dots, d_n)$ and A is the well-known adjacency matrix.

The Laplacian matrix is symmetric and positive semidefinite. This may be extended to weighted graphs. If the eigenvalues of the Laplacian of a graph are sorted by increasing value, the eigenvector corresponding to the second (smallest) eigenvalue of the Laplacian matrix is called Fiedler vector, and it may be used in heuristics for various graph manipulations including spectral graph partitioning. The second (smallest) eigenvalue of the Laplacian matrix is greater than 0 if and only if $G(N,B)$ is a connected graph and the number of times 0 appears as an eigenvalue in the Laplacian represents the number of connected components in the graph. The magnitude of this value that is also known as the algebraic connectivity reflects how well connected the graph is. This may be used in the analysis of network synchronizability which has applications in many fields. Given that the number of nodes of a connected graph is n and its diameter is D , the algebraic connectivity of the graph $G(N,B)$ is bounded below by $\frac{1}{nD}$.

Here, a simple example is used to illustrate the effort required in partitioning a graph using the Laplacian. Consider the simple weighted graph shown in Figure 1.

The Adjacency matrix for this graph is

$$A = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 2 \\ 1 & 2 & 0 \end{bmatrix}$$

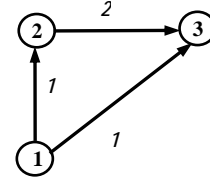


Figure 1 The graph with 3 nodes and 3 branches

The Degree matrix D for this graph is

$$D = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 3 \end{bmatrix}$$

The Laplacian matrix Q is

$$Q = D - A = \begin{bmatrix} 2 & -1 & -1 \\ -1 & 3 & -2 \\ -1 & -2 & 3 \end{bmatrix}$$

Then the eigenvalues should be computed as shown below:

$$\begin{aligned} \det(Q - \lambda I) &= \begin{vmatrix} 2-\lambda & -1 & -1 \\ -1 & 3-\lambda & -2 \\ -1 & -2 & 3-\lambda \end{vmatrix} = 0 \\ &\Rightarrow (2-\lambda)((3-\lambda)(3-\lambda)-4) + (-1)(-1)(-1)(3-\lambda) \\ &\quad - (-1)(-2) + (-1)((-1)(-2) - (-1)(3-\lambda)) = 0 \\ &\Rightarrow (-1)\lambda^3 + (2+3+3)\lambda^2 + (-3-12-18+4+2)\lambda \\ &\quad + 36-8-3-2-5 \Rightarrow -\lambda^3 + 8\lambda^2 - 15\lambda = 0 \\ &\Rightarrow \lambda = 4 \pm \sqrt{16-15} = 4 \pm 1 \\ &\Rightarrow \lambda_1 = 0, \lambda_2 = 3, \lambda_3 = 5 \end{aligned}$$

Next the eigenvectors are computed as follows:

$$\Rightarrow AV_i = \lambda_i V_i \quad i = 1, 2, 3, \quad V_i = \begin{bmatrix} V_{1i} \\ V_{2i} \\ V_{3i} \end{bmatrix}$$

The first eigenvector V_1 will be:

$$\Rightarrow \begin{bmatrix} 2 & -1 & -1 \\ -1 & 3 & -2 \\ -1 & -2 & 3 \end{bmatrix} \begin{bmatrix} V_{11} \\ V_{21} \\ V_{31} \end{bmatrix} = 0 \Rightarrow \begin{bmatrix} V_{11} \\ V_{21} \\ V_{23} \end{bmatrix}$$

$$\Rightarrow \begin{cases} 2V_{11} - V_{21} - V_{31} = 0 \\ -V_{11} + 3V_{21} - 2V_{31} = 0 \\ -V_{11} - 2V_{21} + 3V_{31} = 0 \end{cases}$$

$$\Rightarrow V_{21} = 2V_{11} - V_{31} \Rightarrow \begin{cases} -V_{11} + 6V_{11} - 3V_{31} - 2V_{31} = 0 \\ -V_{11} - 4V_{11} + 2V_{31} + 3V_{31} = 0 \end{cases}$$

$$\Rightarrow \begin{cases} 5V_{11} - 5V_{31} = 0 \\ -5V_{11} + 5V_{31} = 0 \end{cases}$$

$$\Rightarrow V_{11} = V_{31} \Rightarrow V_{21} = V_{11}$$

Suppose that $V_{11} = 1$

$$\Rightarrow V_{21} = V_{31} = 1 \Rightarrow V_1 = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$$

$$\Rightarrow \hat{V}_1 = \frac{1}{\sqrt{3}} \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 0.5774 \\ 0.5774 \\ 0.5774 \end{bmatrix}$$

Normalized

The second eigenvector V_2 or the Fiedler vector is

$$\begin{bmatrix} 2 & -1 & -1 \\ -1 & 3 & -2 \\ -1 & -2 & 3 \end{bmatrix} \begin{bmatrix} V_{11} \\ V_{22} \\ V_{32} \end{bmatrix} = 3 \begin{bmatrix} V_{12} \\ V_{22} \\ V_{32} \end{bmatrix}$$

$$\Rightarrow \begin{cases} 2V_{12} - V_{22} - V_{32} = 3V_{12} \\ -V_{12} + 3V_{22} - 2V_{32} = 3V_{22} \\ -V_{12} - 2V_{22} + 3V_{32} = 3V_{32} \end{cases}$$

$$\Rightarrow \begin{cases} V_{12} = -V_{22} - V_{32} \\ -V_{12} = 2V_{32} \\ -V_{12} = 2V_{22} \end{cases}$$

$$\Rightarrow V_{12} = 2 \Rightarrow V_{22} = -1, V_{32} = -1$$

$$\Rightarrow V_2 = \begin{bmatrix} 2 \\ -1 \\ -1 \end{bmatrix} \Rightarrow \hat{V}_2 = \frac{1}{\sqrt{5}} \begin{bmatrix} 2 \\ -1 \\ -1 \end{bmatrix} = \begin{bmatrix} 0.8165 \\ -0.4082 \\ -0.4082 \end{bmatrix}$$

And the third eigenvector V_3 is:

$$\begin{bmatrix} 2 & -1 & -1 \\ -1 & 3 & -2 \\ -1 & -2 & 3 \end{bmatrix} \begin{bmatrix} V_{13} \\ V_{23} \\ V_{33} \end{bmatrix} = 5 \begin{bmatrix} V_{13} \\ V_{23} \\ V_{33} \end{bmatrix} \Rightarrow \begin{cases} 2V_{13} - V_{23} - V_{33} = 5V_{13} \\ -V_{13} + 3V_{23} - 2V_{33} = 5V_{23} \\ -V_{13} - 2V_{23} + 3V_{33} = 5V_{33} \end{cases}$$

$$\Rightarrow \begin{cases} 3V_{13} = -V_{23} - V_{33} \\ \frac{V_{13}}{3} = -V_{23} - V_{33} \Rightarrow V_{13} = 0, V_{23} = -V_{33} \Rightarrow V_{23} = -V_{33} \\ \frac{V_{13}}{3} = V_{23} + V_{33} \\ \Rightarrow V_{23} = 1 = -V_{33} \end{cases}$$

$$\Rightarrow V_3 = \begin{bmatrix} 0 \\ 1 \\ -1 \end{bmatrix} \Rightarrow \hat{V}_3 = \frac{1}{\sqrt{2}} \begin{bmatrix} 0 \\ 1 \\ -1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0.7071 \\ -0.7071 \end{bmatrix}$$

Normalized

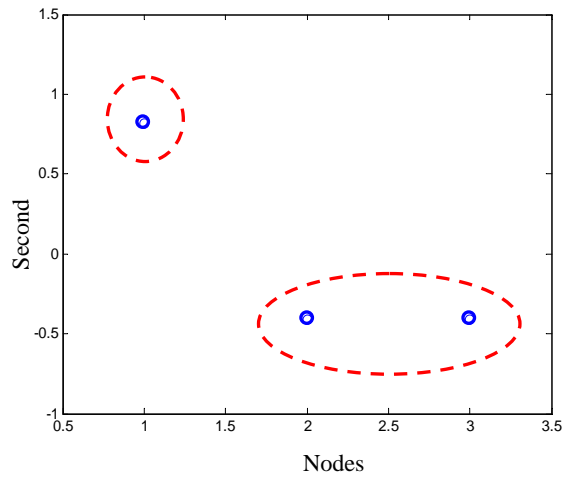


Figure 2 A sketch showing how the graph may be partitioned using the Fiedler vector

$$\Rightarrow V = \begin{bmatrix} 0.5774 & 0.8165 & 0 \\ 0.5774 & -0.4082 & 0.7071 \\ 0.5774 & 0.4082 & -0.7071 \end{bmatrix}$$

The second column of this matrix is the Fiedler vector and it may be used to bipartition the graph as shown in Figure 2.

The bipartitioned form of the graph in Figure 1 is shown in Figure 3 based on the Fiedler vector which indicates that the graph should be partitioned into two partitions with node 1 in one partition and nodes 2 and

3 in the second partition. In this simple illustrative example, it can be seen that the minimum cut set found $\{(n1,n2), (n1,n3)\}$ has a total flow of 2 which is clearly the minimum of all possible cut sets.

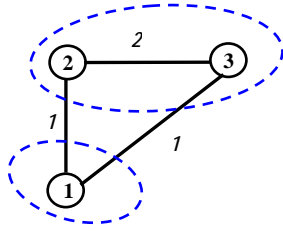


Figure 3 The bipartitioned graph with three nodes and three branches

One complexity involved in this basic procedure is the amount of mathematical effort required to compute the eigenvalues and the eigenvectors as illustrated by the example. In large scale systems where thousands of nodes are involved, the time complexity becomes burdensome and makes a solution practically impossible to obtain. The computational bottleneck of this partitioning procedure lies in the eigenvector calculation. Notice that since only the sign of each component of the Feidler vector is needed in order to partition the graph, an exact answer is not really required. This could be potentially useful in finding a fast solution approach. In applications where the Laplacian matrix is dense, there exist routines such as eig in Matlab that require $(4/3)*|N|^3$ time. However, in applications in which the graph has relatively few connections compared to a complete graph, this would not be computationally wise. In such cases, it is more suitable to resort to the Lanczos algorithm which is an iterative algorithm. For an n-by-n sparse symmetric matrix L, the Lanczos algorithm computes a k-by-k symmetric tridiagonal matrix T, whose eigenvalues are good approximations of the eigenvalues of T. The eigenvectors of T may be used to get approximate eigenvectors of A. The most computationally expensive part of this algorithm is in building T that requires k matrix-vector multiplications with L. Since the largest and the smallest eigenvalues of L including λ_2 converge first, a good approximation can be obtained given k much smaller than n.

The Lanczos algorithm applies to Hermitian matrices and transforms the original matrix into a tridiagonal matrix that is real and symmetric, $T_{mm} = V_m^* L V_m$ whose diagonal elements are denoted by $\alpha_j = t_{jj}$, and the off-diagonal elements are denoted by $\beta_j = t_{j-1,j}$. Moreover, the terms $t_{j-1,j} = t_{j,j-1}$ due to symmetry.

The following iterations should be performed:

Assume that $v_0 = 0$, v_1 is a random vector with norm 1, and $\beta_1 = 0$.

$$\begin{aligned} &\text{For } j=1 \text{ to } m \\ w_j &= L v_j - \beta_j v_{j-1} \\ \alpha_j &= (w_j, v_j) \\ w_j &= w_j - \alpha_j v_j \\ \beta_{j+1} &= \|w_j\| \\ v_{j+1} &= \frac{w_j}{\beta_{j+1}} \end{aligned}$$

Return

The next step would be to find the eigenvalues of the matrix T as follows:

$$T = \begin{bmatrix} \alpha_1 & \beta_2 & & & & \\ \beta_2 & \alpha_2 & \beta_2 & & & \\ & \beta_3 & \cdot & \cdot & & \\ & & \cdot & \cdot & \beta_{m-1} & \\ & & & \beta_{m-1} & \alpha_{m-1} & \beta_m \\ & & & & & \alpha_m \end{bmatrix} \quad (2)$$

The eigenvalues of T are $\lambda_1^{(m)}$ and the corresponding eigenvectors $u_1^{(m)}$ can now be easily computed. The Lanczos vectors $V = (v_1, v_2, v_3, \dots, v_m)$ generated through the above iterative approach may be used to compute them. The eigenvalues thus computed are approximations of the eigenvalues of L.

$y_i = V_m u_i^{(m)}$ where V_m is the transformation matrix whose column vectors are $v_1, v_2, v_3, \dots, v_m$. The set of vectors $v_1, v_2, v_3, \dots, v_m$ forms an orthogonal basis which would yield good approximate eigenvalues and eigenvectors for the original matrix if precise arithmetic is used. However, due to round off errors introduced during the computations, the Lanczos algorithm suffers from lack of numerical stability, and measures to prevent the loss of orthogonality must be adopted. One may periodically reorthogonalize the vector v against all previous ones. Since this would take a lot of time to do, one must estimate the degree of nonorthogonality and reorthogonalize only when needed.

It is interesting to note that although the real eigenvectors are not really needed in partitioning applications, one may compute them from the eigenvectors of T as follows

$$q_i = [v_0 \ v_1 \ \dots \ v_m] w_i \tag{3}$$

where the v 's are the Lanczos vectors. Many researchers have based their partitioning algorithms upon the Lanczos technique which uses the approximate Fiedler vector.

4. Pioneering Graph Partitioning Heuristics

The problem of partitioning nodes of a graph with costs associated with the branches into subsets no larger than a given maximum size with the objective of minimizing the total cost of the branch cutset was first considered by the pioneering work of Kernighan-Lin (1970). A typical application of this heuristic would be the placement of the components of electronic circuits onto various printed circuit boards with the objective of minimizing the number of inter-board connections. The limitation of each board in terms of the maximum number of components which can be placed on it should also be considered. They proposed an iterative, 2 way, and balanced minimum cutset partitioning heuristic. In this procedure,

- a) The node pairs that yield the largest decrease or the smallest increase in the size of the cutset are exchanged.
- b) The nodes are then locked so that they may not participate in any further exchanges.
- c) The above procedure is repeated until all the nodes are locked.
- d) The set with the largest partial sum is found for swapping.
- e) All nodes are unlocked.

The details of this procedure are outlined in Figure 4.

There are several complexities involved in any graph partitioning problem. Kernighan and Lin (1970) introduced the probability that a heuristic procedure finds an optimal solution in a single trial as one such consideration. They concluded that this probability is around 0.5 for matrices of size 30x30, 0.2 to 0.3 for matrices of size 60x60 and from 0.05 to 0.1 for matrices of size 120x120. They assumed 50% dense matrices in these estimates. Although many modern day scientific applications of graph partitioning involve matrices that are much less dense, the size of the matrices involved is much higher than the ones considered in these estimates. This indicates that the challenge still remains a viable one since finding an optimal solution in a short time is a vital issue especially in real time applications. Another

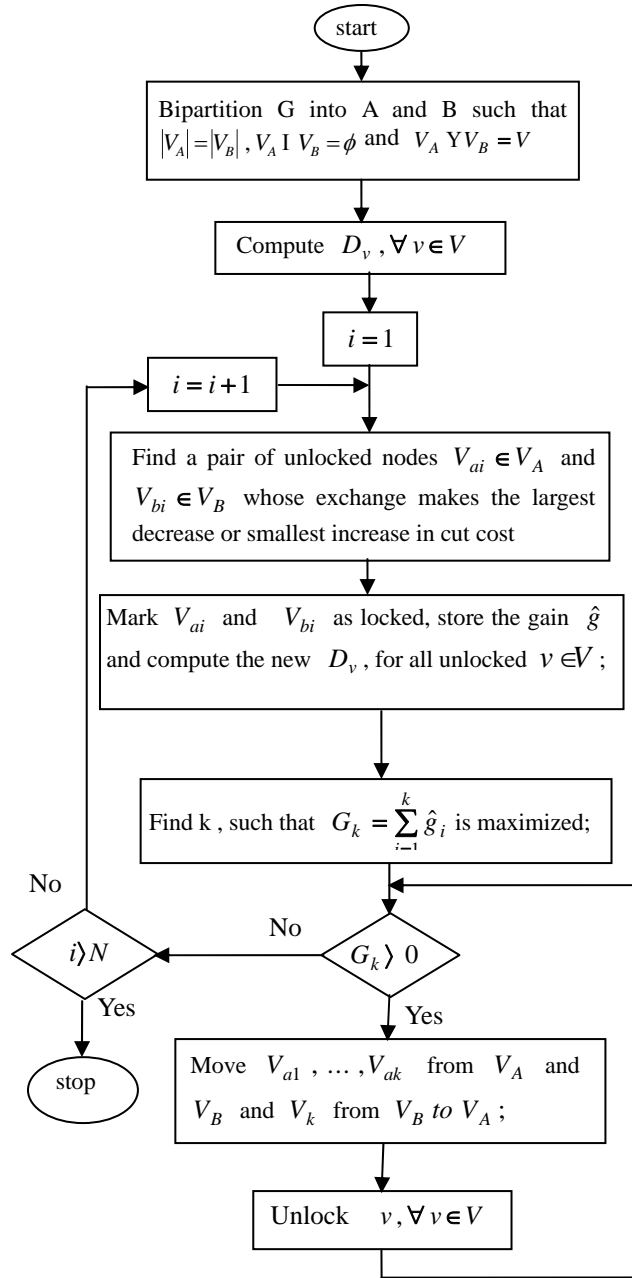


Figure 4 The flowchart of the first phase of Kernighan-Lin partitioning heuristic

complexity is the running time of the procedure in the Kernighan-Lin partitioning procedure. The total time for a single pass involves computation of the D values initially which is in the order of n^2 , updating the D values that is proportional to n^2 , and sorting D values is in the order of $n^2 \log n$. Since the number of passes required is estimated to be a few before a phase 1 optimal partition is found, the total running time for phase 1 is in the order of $n^{2.4}$. Another

complexity of the Kernighan-Lin partitioning heuristic is the restriction imposed in the size of the partitions being exactly equal. Although this may be useful in some applications, it is certainly not a requirement of all modern day scientific applications of partitioning. Other factors exist which are more important than the exact size of the partition. For example, in power

system islanding applications, it is more desirable to have stable islands after partitioning with minimal load/generation imbalance in each island formed than to force them to be exactly of equal size. This restriction may not even be practically possible to enforce in all power networks. Kernighan and Lin (1970) addressed this issue themselves in their original work and proposed partitioning into unequal subsets. Yet a further complexity is the restriction of having two partitions, which should also be relaxed to several partitions in some applications. This was also briefly noted in their work.

5. An example of power system partitioning using the Fiedler vector

To gain a better feel for the complexity of the work, an example is presented here to demonstrate the application of the spectral method for partitioning a power system graph into 3 partitions, using the smallest 3 eigenvalues. The weighted graph of a 14-bus power system is shown in Figure 5.

The Laplacian matrix fro the above graph is as follows where e_{ij} is weight of the branches that connect the two nodes v_i and v_j (note that $e_{ii} = 0$). Therefore, the Laplacian matrix is as shown below:

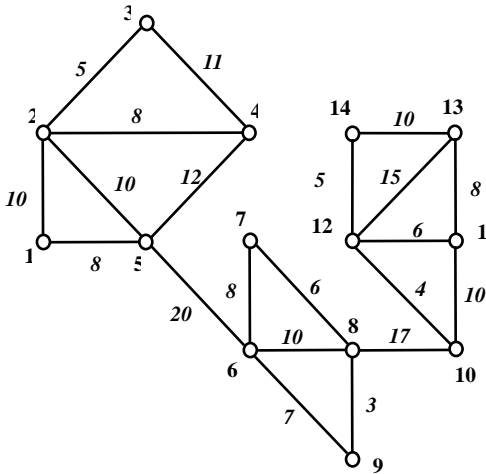


Figure 5 The graph of a 14-bus power system with 21 branches

$$Q_{i,j} = \begin{cases} \sum_{h=1}^{14} e_{ih} & ; i = j \\ -e_{ij} & ; i \neq j \end{cases}$$

$$Q = \begin{bmatrix} 18 & -10 & 0 & 0 & -8 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -10 & 33 & -5 & -8 & -10 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -5 & 16 & -11 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -8 & -11 & 31 & -12 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -8 & -10 & 0 & -12 & 50 & -20 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -20 & 55 & -8 & -20 & -7 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -8 & 14 & -6 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -20 & -6 & 46 & -3 & -17 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -7 & 0 & -3 & 10 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -17 & 0 & 31 & -10 & -4 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -10 & 24 & -6 & -8 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -4 & -6 & 30 & -15 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -8 & -15 & 33 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -5 & -10 & 15 \end{bmatrix}$$

and the eigenvalues are:

$$[\lambda_1 \quad \lambda_2 \quad \lambda_3 \quad \lambda_4 \quad \lambda_5 \quad \lambda_6 \quad \lambda_7 \quad \lambda_8 \quad \lambda_9 \quad \lambda_{10} \quad \lambda_{11} \quad \lambda_{12} \quad \lambda_{13} \quad \lambda_{14}] = [0 \quad 1.62 \quad 5.31 \quad 11.27 \quad 13.67 \quad 14.80 \quad 24.46 \quad 28.94 \quad 33.02 \quad 40.47 \quad 42.95 \quad 47.88 \quad 58.76 \quad 82.83]$$

The second and third eigenvectors of the Laplacian of the graph are shown in Figure 6 which shows that this graph can be divided into three

partitions as follows: [Partition 1: {1, 2, 3, 4, 5}, Partition 2: {6, 7, 8, 9}, Partition 3: {10, 11, 12, 13, 14}]

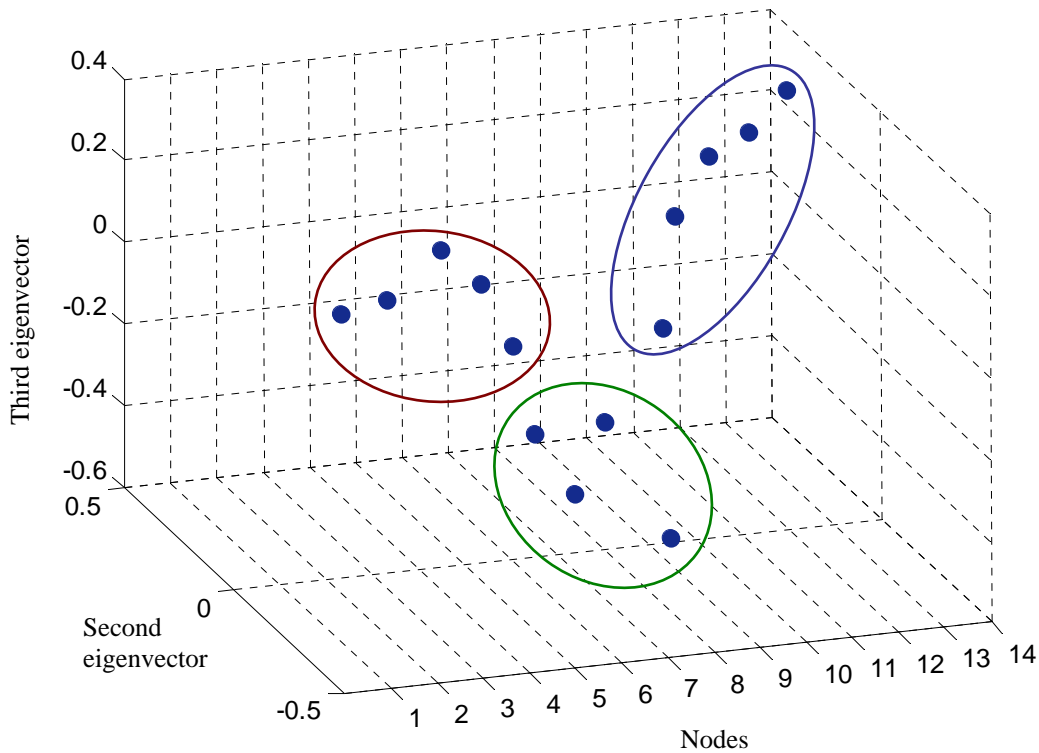


Figure 6 The second and third eigenvectors with respect to the nodes and the three partitions of the power system based on the eigenvectors of the Laplacian of the graph

Various techniques have also been proposed to reduce the complexities of graph partitioning and the computational burden even more. One may mention techniques such as multilevel clustering by Hendrickson et al. (1995), recursive spectral bisection method by Xu et al. (1998) or local clustering by Orponen et al. (2005) as examples of such efforts.

Yang et al. (1994) noted that the complexity of large problems can be efficiently reduced using the concept of divide and conquer. They proposed the use of ratio cut objective function in logic partitioning of VLSI design since it automatically coordinates the two traditional goals of logic partitioning, mincut and equipartition. The complexity in this application is how to reduce the needed number of trials while maintaining the quality of solutions. A preprocessing circuit-clustering procedure to improve the performance is proposed.

Hendrickson et al. (1995) proposed a multilevel

algorithm for graph partitioning where the graph is approximated by a sequence of increasingly smaller graphs. The smallest graph is then partitioned using a spectral method. The partition is then propagated back through the hierarchy of graphs. They periodically applied a variant of the Kernighan-Lin algorithm to refine the partition. They claimed that the entire algorithm could be implemented to execute in time proportional to the size of the original graph. The proposed algorithm used branch and node weights to preserve in the coarse graphs as much structure of the original graph as possible to allow its applicability in physical problems such as the terminal propagation technique used in VLSI layout.

Xu et al. (1998) proposed a fast implementation of the recursive spectral bisection method for k-way partitioning since recursive bisections for k-way partitioning using optimal strategies at each step may not lead to a good overall solution. The relaxed implementation

accelerates the partitioning process by relaxing the accuracy requirement of spectral bisection method. Since the quality of the solution of a spectral bisection of a graph primarily highly depends on the accuracy of its Fiedler vector, they proposed a tight iteration number bound and a loose residual tolerance for Lanczos algorithms to compute the Fiedler vector.

Multilevel versions of the Kernighan-Lin algorithm have been used for partitioning large graphs. In these algorithms, the graph is coarsened until it becomes so small that the processes for the problem at hand may be applied fast. Then the partitions are aggregated. Multilevel versions of the spectral method which are based on applying the spectral method at various levels have also been successfully used. In these methods, it is required to compute the Fiedler vector. Holzrich et al. (1999) proposed a purely spectral approach in which the calculation of the Fiedler vector is done using the Davidson algorithm. The problem at hand is to be set up in the form of a graphical preconditioner to the Davidson algorithm.

Spectral algorithms are usually based on the Fiedler vector of the Laplacian. Determining the Fiedler vector of the Laplacian or adjacency matrices of graphs is the most computationally expensive part of graph partitioning as well as other applications such as graph coloring, envelope reduction, and seriation. In many applications, an approximation of the Fiedler vector is used to speed up the solution.

Barnard (1995) proposed a parallel multilevel recursive spectral bisection algorithm for distributed parallel processing to balance the loads between the processors as well as minimize the interprocessor communication. Noting that the problem of finding a partition that balances the work of all processors and minimizes interprocessor communication is an NP-complete problem and heuristic approaches should be relied upon, recursive spectral bisectioning was chosen since it provides good partitions. In this approach, the eigenvector corresponding to the smallest non-trivial eigenvalue of the Laplacian of the graph is computed first. Then the graph is bisected into two partitions by finding the median of the components of the eigenvector. One partition includes nodes corresponding with the elements of

the eigenvector that are less than or equal to the median, while the second partition includes nodes corresponding with the elements of the eigenvector that are greater than the median.

Several researchers have proposed graph-partitioning algorithms based on heuristics like the Kernighan-Lin method [Kernighan and Lin 1970], spectral methods [Pothen et al. 1990], genetic algorithms [Maini et al. 1994], or combinations of different methods. Although they are reported to work well for the chosen application, they can not guarantee asymptotically optimal bounds on the size of the obtained separators in the worst case. Most of them work on general graphs and are based on relatively simple and easy to code routines.

There are also other approaches for estimating the eigenvectors of the Laplacian of a graph. Srinivasan et al. (2002) proposed the use of Monte Carlo techniques which use an iterative scheme to converge to the correct eigenvalues and eigenvectors for this purpose. The complexities in this approach lie in the fact that Monte Carlo technique requires many iterations to converge; there are no generally accepted acceleration techniques, and it is very difficult to determine when convergence has been achieved.

The authors believe that since the exact values of the eigenvectors are not really necessary in partitioning graphs, better approaches should be sought. The use of multilevel kernel k-means to speed up the partitioning and the modification of objective functions used in order to better reflect the complexities of the application in hand are proposed. Peiravi and Ildarabadi (2009) reported a paper in this respect in the area of power systems intentional islanding to illustrate this perspective. More work is being carried out in order to improve the application to make it more realistic and faster so that it becomes suitable for real time application to controlled power system islanding. It is suggested that the use of directed graphs be followed in order to properly count for the direction of power flow in the transmission lines. It is also suggested that the objective function be changed from just minimum cutest flows to a different measure considering the generation/load imbalance that will exist in the islands being formed as well as the instabilities such as frequency or voltage

instability that may pursue the formation of islands

6. Conclusions

In this paper the various approaches for graph partitioning and their application to modern day scientific problems were presented. The mathematical basis of graph partitioning was discussed along with an example to show the amount of work required to carry out the partitioning even in simple cases.

Since the graph partitioning problem is NP-complete, it may not result in an optimum solution of practical problems. There exist many variations of this approach aimed at improving its performance. However, one should not be very optimistic about these techniques and think that they present a universal solution to partitioning problems since there are certain graphs for which each version of these methods performs poorly. Guattery and Miller (1998) showed that some of the existing spectral algorithms for graph partitioning perform poorly against the usual claim that they work well in practice. They present a generalized definition of spectral methods to include the use of a specified number of the eigenvectors corresponding to the smallest eigenvalue of the Laplacian matrix of the graph and show that even if these algorithms use a constant number of eigenvectors, there are graphs for which these algorithms do no better than they would using just the Fiedler vector. They also show that the use of the Fiedler vector would produce poor partitions.

Heuristics proposed for partitioning tasks were shown along with the complexities involved. Improvements in application to various problems were discussed with an example applied to power system islanding. It is concluded that the challenge still remains until careful attention is paid to the various complexities which exist in the application of graph-theoretic partitioning heuristics to modern day scientific problems.

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Cloning and the Expression of Insulin Growth Factor-II and the Analysis of its Function Research

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Abstract: The insulin-like growth factors (IGFs) I and II are polypeptide hormones related to insulin by structure and function which contribute to the mitogenic properties. In vitro, the mitogenic activities of IGF-I and -II are similar, but in vivo they are different. IGFs are multiple proliferation controlling factors of cells. It is necessary for normal fetal growth and development. In fact, the main function of IGF-II in human is not clear. In our research we got the cloning active IGF-II, and analyzed and predicted the structure and function of IGF-II with bioinformatics. [Journal of American Science 2009;5(5):13-16]. (ISSN: 1545-1003).

Key words: Insulin-like growth factor-II (IGF-II); His-tag; bioinformatics; domain

1. Introduction

Insulin-like growth factor-II (IGF-II) is a protein with 67 amino acids. Its molecular weight is 7.4kD. Human IGF-II locates on chromosome 11 and close to insulin. It has nine exons and four promoters. IGF-II also has four domains, they are domain B,C,A and D. IGF-II plays essential roles in cell metabolism, proliferation and differentiation and to this extent have major effects on fetal and postnatal development and organogenesis in mammals (Underwood, 1984; Humbel, 1990). The main function of IGF-II in humans is not clear. In rodents, IGF-II may be the function as a fetal growth factor; the levels of IGF-II in fetal rat plasma are high and decline after birth.

IGF-II values in adults are about four times higher than those of IGF-I (Vorwerk, 2002). Recently, the studies of IGF-II are associated with its imprinted gene. Genomic imprinting is a gene regulation method whereby a gene is expressed in a parent-of-origin dependent fashion (Catherine, 2001). Paternal expressed IGF-II encodes a critical protein for fetal mitogen, and mice deficient of this growth factor have a dwarf phenotype. IGF-II and H19 are closely linked (Hemberger, 1998; Bartolomei, 1991; Barlow, 1991) imprinted genes located at the centromere end of 1Mb imprinted domain on mouse chromosome 7 (Ishihara, 2002). They are expressed only from the paternal and the maternal allele, respectively.

2. Experimental procedures

2.1 Materials and Reagents

Human placenta: Harbin Red Cross Center Hospital. JM109: Takara biotechnology (Dalian) co, ltd. Plasmid: pGEM-T-Easy; Amp resistance; pET30a (+); Kna resistance, Promega co, ltd.

2.2 Cloning, Expression and Purification of target protein

The RNA was isolated by Trizol extraction from human placenta (Haselbacher, 1987). According to the recorded insulin-like growth factor-II gene in GenBank (NM000612), we designed the primers with the restriction enzyme sites of *NcoI* and *XhoI*, RT-PCR amplification of target gene. Use T₄-DNA Ligase to link the PCR product and pGEM⁺-T-Easy Vector. Transformed the linkage products into *E.coli* JM109 competent cell. Then pave on the flat plate together with X-gal, IPTG for resistance test. Pick out recombinants and inoculate into LB medium with 50mg/ml Amp, 37°C culture about 12 hours, isolated plasmid DNA, restriction enzyme verification for the recombinants plasmid and sequence analysis. The result of the sequencing is the right gene we cloned.

Then construct fusion expression vector, cutted the IGF-II-pGEM⁺-T-Easy and the pET30a (+) use *NcoI* and *XhoI*. Link IGF-II fragment and

pET30a(+). Transform the linkage products pET30a (+)-IGF-II into *E.coli*JM109 competent cell; screen the recombination plasmid with Kna resistance. Isolate the plasmid, by restriction enzyme and PCR verification. The expression of IGF-II fusion protein, we induced the transformed JM109, inoculate it into the LB medium with Kna, 37°C, stay over night, and then inoculate the bacterial in the fresh LB medium with Kna, 37°C cultivate till the OD is 0.6. Add IPTG till the final concentration is 1.0 mM, induced 2 hours and 4 hours respectively, 12000rpm centrifugation one minute, discard the supernatant, add 100 μ l sterile water to suspend the sediment and then add the buffer boiling for three minutes. SDS-PAGE According to the *molecular cloning* protocol.

Due to the target is in the sediment, it needs to wash the inclusion body, then to do the His-tag Affinity Chromatography.

2.3 Insulin-Like Growth Factors Bioinformatics Research

2.3.1 Structure of the Insulin-Like Growth Factor-II Prediction

Utilized the bioinformatics software and Chou-Fasman method to predict and analyze the secondary structure of IGF-II. Chou-Fasman method is an experiencing parameter method based on the statistic of single amino acid residue. Through the statistic analysis, it can be obtained the proneness to present the specific secondary structure of each single amino acid residue, which can be used to predict the protein secondary structure(Sunxiao, 2005).

2.3.2 Function of the Insulin-Like Growth Factor-II Prediction

According to the homology comparison model, analyze the domain of the insulin-like growth factors family; search the active and binding sites of the receptors and the binding proteins. Further, analyze and predict the correlative functions of IGF-II.

3. Result

3.1 Abstraction of human placenta total RNA

The total RNA from fresh human placenta was isolated by TRIzol Kit (QIAGEN). Dissolve the RNA sediment with DEPC treated water.

OD₂₆₀/OD₂₈₀=1.8, shows the good purity of RNA (Fig.1A).

3.2 PCR amplification of IGF-II

We amplified a specific DNA band with the length of 218bp, which is conformity with the expectation, under the grading-up PCR system (Fig.1B).

3.3 Isolation of recombination plasmid and PCR verification

Link the PCR products which have *NcoI* and *XhoI* cohesive end to the pGEM⁺-T-Easy Vector (Fig.1C). Then transform the linkage products into *E.Coli*JM109. Cultivate them on the LB medium which have Amp⁺ X-gal⁺ IPTG over night. Pick out the recombinants and inoculate into LB medium with 50mg/ml Amp cultured, isolate plasmid DNA, restriction enzyme verification for the recombinants plasmid (Fig.1E) and PCR verification. We obtained the target gene with the length of 218bp (Fig.1D). It is shows that the target gene was already inserted into the plasmid.

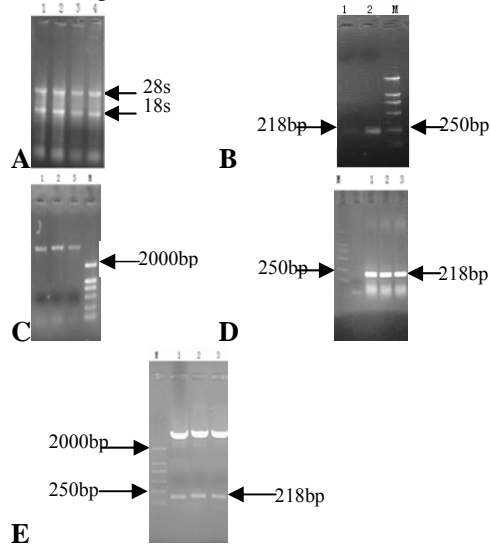


Figure.1 A. Abstraction of total RNA from placenta. B. PCR Agarose gel electrophoresis analysis of IGF-II gene. 1: 50°C, 2: 53.3°C, M: DL2000marker. C. Agarose gel electrophoresis analysis of linking product. 1-3: linking products, M: DL2000marker. D. Identification of recombinant Plasmid pGEM⁺-T- IGF-II by PCR. 1-3: PCR plasmid, M: DL2000marker. E. Identification of recombinant plasmid pGEM⁺-T- IGF-II by restriction enzyme *NcoI*, *XhoI*. 1-3: target gene, M: DL2000marker.

IGFBP-5. Therefore we can predict that IGF-II has the same reaction site with IGFBP-5 and have the similar function.

Some researches showed that IGF-I can mediate hormonal dependent inhibin expression and steroidogenesis through the development of dominant ovarian follicle. Granule cells can create IGFBP-5, which can inhibit this effect and lead to the atrophy of un-dominant ovarian follicle. Therefore we can predict that IGF-II interact with IGFBP-5 to have the similar function as IGF-I.

Also IGF-I interacts with IGF-IR to promote the growth of chondrocyte. So maybe IGF-II can interact with IGF-IR and has the similar function as IGF-I.

4. Discussion

Insulin-like growth factors are the very important growth factors. They interact with the receptors and the binding proteins. Insulin-like growth factors play very important regulated roles in the cell proliferation, growth and pathogenesis of cancers.

There are not so many researches on IGF-II, therefore the study on IGF-II can supply a helpful function during not only the science research but also the clinical research.

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Fungitoxic Effect of Neem Extracts on Growth and Sclerotial Survival of *Macrophomina phaseolina* *in vitro*

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Abstract: In this study, we examined the *in vitro* effect of extracts of different neem (*Azadirachta indica* A. Juss) plant parts such as leaf, bark, oil cake and neem oil on the growth, mycelial yield and sclerotial survival of *Macrophomina phaseolina* (Tassi) Goid. causing charcoal rot of soyabean (*Glycine max* L.) by poisoned food technique. The radial growth of *M. phaseolina* was promoted by the autoclaved neem extracts. Maximum enhancement in growth of the fungus was observed at 10 % concentration of cake extract followed by leaf and bark extracts. However, the neem extracts sterilized through sintered glass filter (G-5) showed inhibitory effect on growth and mycelial biomass yield of *M. phaseolina*. Neem oil was found to be most toxic followed by cake, leaf and bark extracts. Effect of neem extract on sclerotial survival of *M. phaseolina* was found inhibitory after 2 and 4 days of incubation. Sclerotia treated with neem oil did not germinate, hence resulted in 100% inhibition. Volatile and non-volatile fungistatic effects of different neem extracts (5 %) were also inhibited sclerotial germination of the test fungi. Maximum inhibition in sclerotial germination was observed with cake extract after 96 h of incubation followed by leaf and bark extract. The effect of volatile fungistasis was more pronounced than non-volatile fungistasis. Volatile fraction of cake extracts caused 97 % inhibition in sclerotia germination after 96 h but non-volatile effect of cake extract after 48 h was negligible. [Journal of American Science 2009; 5(5):17-24]. (ISSN: 1545-1003).

Keywords: Neem extracts; *Macrophomina phaseolina*; mycelial growth; sclerotial germination

1. Introduction

Neem (*Azadirachta indica* A. Juss.) tree also known as “Indian Lilac”, belongs to the family Meliaceae, has attracted special interest of scientists due to the presence of a variety of bioactive compounds (Tewari, 1992). It has a great potential to control various phytopathogenic fungi and, therefore, has much prospect to be used as a good fungicide. Several neem based commercial products are also available in market. The use of neem cake and neem leaves as a soil treatment measure have produced good results against various soil borne fungi like *Pythium aphanidermatum* and *Rhizoctonia solani* (Khan et al., 1974), *Fusarium oxysporum* (Kannaiyan and Prasad, 1981), *Colletotrichum atramentarium* (Singh, 1986). Effectiveness of neem extracts and oil as a fungicide has earlier been reported by several workers (Ilyas et al., 1997; Sharma and Basandrai, 1997; Lokhande et al., 1998). Dubey and Kumar (2003) found almost similar effect of azadirachtin, mancozeb and bavistin on *in vitro* growth and sclerotial survival of *M. phaseolina*.

M. phaseolina (Tassi) Goid. is an important phytopathogen distributed worldwide and causes charcoal rot on more than 500 plant species. Moreover, this fungus survives in soil by multicellular jet black microsclerotia produced enormously during parasitic phase and/or saprophytic phase (Dubey and Upadhyay, 2001). Sclerotia of *M. phaseolina* are such a potent resting body that each and every cell is potential to germinate and cause disease.

The aim of the present study was to investigate the effect of different neem extract and volatile and non-volatile fractions on germination and survival of *M. phaseolina* sclerotia.

2. Material and Methods

2.1. Isolation of fungus

M. phaseolina was isolated from diseased roots of soyabean (*Glycine max* L.) collected from Imphal and Nainital districts of India. Roots were cut into 1 cm long pieces and were dipped in 0.1 % HgCl₂ solution for 1 min followed by serial washing with sterilized distilled water for 10 times. The pieces were

dried by using sterile filter paper and then placed onto Potato Dextrose Agar (PDA) medium containing Petri dishes under aseptic condition. The plates were incubated for 5-6 days at 30 ± 1 °C. The pathogen was maintained on PDA slants for further use.

2.2. Preparation of neem extracts

Fresh and healthy leaves were collected from neem tree, washed with distilled water and dried in shade. The leaves were used to make a paste with distilled water (1:1, w/v) by using mixer/grinder (Model Maharaj, Whiteline). Bark was gently removed from the tree, dried in shade and powdered in mixer/grinder. Powder was mixed with distilled water in a ratio of 2:1 (w/v) and left overnight to allow the constituents to get dissolved in water. Bark extract was sterilized by sintered glass filter (G-5). Oil cake was collected from an Expeller mill, powdered and mixed with distilled water (1:1, w/v). Thereafter, mixture was squeezed out and extract was collected in sterile glass vials. The extract was sterilized as above. Extract and oil were kept at 4 °C and were used within two days.

2.3. Effect of neem extracts on growth of *M. phaseolina*

Effect of extracts on growth of *M. phaseolina* was studied by poisoned food technique based on radial growth and mycelial yield.

2.3.1. Colony diameter

Czapek Dox agar plates were prepared and 1, 5 and 10% concentration of each extract (leaf, bark and cake) was added separately. The concentration of neem oil was 0.1, 0.5, 1.0 %. Each plate was inoculated with an agar block (5 mm diam) of *M. phaseolina* growing on PDA. The plates were incubated at 30 ± 1 °C for 4 days. Growth inhibition (%) was measured by the formula: $100 \times (C-T)/C$, where C = growth in control, T = growth in treatment.

2.3.2. Estimation of mycelial biomass

Czapek Dox broth was prepared for estimation of mycelial yield and 1, 5, and 10 % concentration of each extract (leaf, bark and cake) was mixed separately *in vitro*. The concentration of neem oil was the same as described above. The flasks were inoculated with 5 agar blocks (each of 5 mm diam) containing mycelial growth of *M. phaseolina*. The

flasks were incubated at 30 ± 1 °C for 10 days. Thereafter, cultures were filtered through pre-weighed Whatman filter paper No. 1. Mycelial yield was determined after drying the mycelial mat at 85 °C for 24 h. Percent loss/gain in mycelial dry weight was calculated by using the formula : $100 \times (C-T)/C$, where C = mycelial dry weight in control, T= mycelial dry weight in treatment.

2.4. Effect of extracts on sclerotia survival of *M. phaseolina*

2.4.1. Sclerotia production

The sclerotia of *M. phaseolina* were harvested by cellophane disc method (Ayanru and Green, 1974). PDA medium was poured into sterile Petri dishes. The cellophane paper discs were cut according to the size of Petri dishes and boiled for 30 min to remove plasticizers. The cellophane discs were gently spread onto the surface of PDA plates, inoculated with an agar block of *M. phaseolina* and incubated at 30 ± 1 °C for 5 days. On the sixth day the cellophane paper was gently removed from the medium and sclerotia were harvested and placed onto sterile filter paper to dry. Dried sclerotia were mashed with mortar and pestle and filtered by a sieve of pour size 150 µm.

2.4.2. Survival of sclerotia

Sclerotia survival study was performed following the standard tube dilution method of Baily and Scott (1974) modified by Dwivedi and Dubey (1986). A small amount of sclerotia prepared as above was transferred into 50 ml sterile distilled water. Five ml of sclerotia suspension was transferred into a sterilized glass tube and centrifuged at 1000 g for 3 min. Supernatant was decanted and 5 ml of each extract was added separately in glass tubes in triplicate. Control set contained only 10 ml distilled water. After 2 and 4 days of incubation at 30 ± 1 °C the sclerotial suspension (in extract) was first decanted and then washed for 4 to 6 times with sterile distilled water to remove traces of the extract from the sclerotial surfaces. Finally 5 ml distilled water was added to prepare sclerotial suspension. One ml of suspension was poured onto 2 % water agar medium, properly spread over and finally incubated at 30 ± 1 °C for 24 h. Total number of sclerotia showing germination in each treatment was counted.

2.5. Fungistatic effect of volatile and non-volatile fractions

Sclerotial suspension was used for the volatile and non-volatile fungistasis

2.5.1. Volatile fungistasis

Volatile fungistasis was studied by inverted petriplate method (Dwivedi and Dubey, 1986). Fifteen ml aliquot of autoclaved water agar (2 %) medium was poured into sterile Petri dishes. In another set, Petri dishes containing 20 g of soil amended with different neem extract (5 %) separately were prepared and sterile distilled water was added to the soil to maintain 20 % water holding capacity. The Petri plates containing soil were kept as such for 4 days to allow the microbial activity and decomposition of neem extracts. Sclerotial suspension (1 ml) was poured onto the surface of Petri dishes containing sterile water agar medium, gently spread over and left for a few minutes to settle down the sclerotia. Excess water was decanted and evaporated and the lid of Petri plate containing 20 g of amended soil was replaced with the bottom halves of plate containing sclerotial suspension. The two bottom halves were sealed together with an adhesive tape and incubated at 30 ± 1 °C in dark. Control set had the similar pairs devoid of soil. Germination of sclerotia was observed under microscope after 24, 48, 72 and 96 h of incubation. Inhibition of sclerotial germination was calculated statistically.

2.5.2. Non-volatile fungistasis

It was studied by agar disc method (Jackson, 1958). Sclerotial suspension was prepared as above. More water was added in amended soil kept in Petri

dishes to bring it in sticky condition. Small pieces of filter paper (2x2 cm) were put onto surface of soil kept in plates. An agar block (1x1 cm) containing fungal sclerotia was kept over each filter disc. All the plates were incubated at 30 ± 1 °C and sclerotial germination was counted after 24, 48, 72 and 96 h of incubation as described earlier.

3. Results

3.1. Effect of neem extracts on growth of *M. phaseolina*

Radial growth of *M. phaseolina* was promoted by all autoclaved neem extracts. Maximum enhancement in radial growth (42.3 %) was observed at all concentration of cake extract followed by leaf extract (33.1 %) and bark extract (29.2 %) (Table 1). Whereas, neem extract filtered through bacteria proof sintered glass filter (G-5) showed a marked inhibition in growth of the fungus. At 10 % concentration growth of *M. phaseolina* was completely inhibited by cake extract followed by leaf extract (70.6 %) and bark extract (52.6 %). Neem oil was found to be most toxic which caused 85.4 % inhibition at 10 % concentration followed by 95.9 % inhibition in radial growth at 5 % concentration of cake extract (Table 1).

Similarly, neem extracts also inhibited mycelial yield of *M. phaseolina* as compared with control. Maximum inhibition in mycelial biomass yield was observed with cake extract (97.8 %) at 10 % concentration. Oil at 1 % concentration was the most effective causing 92.6 % inhibition in mycelial yield followed by cake extract (71.5 %), while bark extract had the minimum inhibitory effect at the same concentration (Table 2).

Table 1. Effect of different neem extracts (autoclaved and unautoclaved) on growth of *Macrophomina phaseolina* *in vitro*.

Treatment	Growth inhibition/ enhancement* (%)					
	1 %		5 %		10 %	
	Autoclaved	Unautoclaved	Autoclaved	Unautoclaved	Autoclaved	Unautoclaved
Bark extract	12.3 ± 0.34	26.3 ± 0.27	18.6 ± 0.06	44.7 ± 0.14	29.2 ± 0.03	52.6 ± 0.06
Leaf extract	15.8 ± 0.20	36.6 ± 0.24	26.8 ± 0.14	45.3 ± 0.06	33.1 ± 0.06	70.6 ± 0.55
Cake extract	19.7 ± 0.12	79.5 ± 0.08	30.6 ± 0.02	95.9 ± 0.06	42.3 ± 0.08	100 ± 0.01
Oil*	-	34.6 ± 0.37	-	67.3 ± 0.08	-	85.4 ± 0.12

Values are mean of three replicates ± standard error. * Concentrations of oil used were 0.1 %, 0.5 % and 1.0 %

Table 2. Effect of different neem extracts on mycelial yield of *Macrophomina phaseolina* *in vitro*.

Treatment	Loss in mycelial dry weight (%)		
	1 %	5 %	10 %
Bark extract	25.1 ± 0.51	35.8 ± 0.01	41.9 ± 0.36
Leaf extract	52.5 ± 0.04	81.2 ± 0.02	92.0 ± 0.02
Cake extract	71.5 ± 1.01	91.1 ± 0.03	97.8 ± 0.98
Oil*	37.8 ± 0.12	63.6 ± 0.06	92.6 ± 0.02

Values are mean of three replicates ± standard error, * Concentrations of oil used were 0.1 %, 0.5 % and 1.0 %

3.2. Effect of neem extracts on survival of *M. phaseolina* sclerotia

Survival of *M. phaseolina* sclerotia was studied after 2 and 4 days of incubation. Only 23 % sclerotia survived upto 4 days when treated with cake extract as compared to control where 96 % sclerotia germination was recorded. Bark extract had least effect on survival of sclerotia permitting only 66 % germination after 4 days of incubation. Very few sclerotia showed good germination (i.e. produced >7 germ tubes/sclerotium in case of cake extract treatment). However, most of them showed poor germination showing 1-3 germ tube/sclerotium or no germination. Sclerotia treated with oil did not germinate, hence it resulted in 100 % inhibition in sclerotia germination (Table 3).

Table 3. Effect of neem extracts on survival of *Macrophomina phaseolina* *in vitro*.

Treatment	Germination of sclerotia (%)	
	2 days	4 days
Control	90 ± 2	96 ± 4
Bark extract	78 ± 5	66 ± 2
Leaf extract	70 ± 3	54 ± 5
Cake extract	50 ± 5	23 ± 2
Oil	NG*	NG*

Values are mean of three replicates ± standard error, *NG denotes no germination of sclerotia

3.3. Volatile fungistasis of neem extracts against *M. phaseolina*

Fungistatic effect of neem extracts (5 %) on *M. phaseolina* is shown in Figure 1A. Sclerotia

germination of test fungi gradually decreased with increase in incubation time. Maximum inhibition in sclerotial germination (97 %) was observed in cake extract after 96 h of incubation. After 24 h of incubation though a little inhibition in sclerotial germination occurred as compared to control, yet most of the sclerotia showed very good germination (>7 hyphae/sclerotium) in each extract. Oil cake extract caused slightly higher decline than the other extracts (Figure 1A). After 48 h of incubation 38, 64 and 77 % sclerotia germinated in case of oil cake, leaf and bark extract, respectively in comparison to control (84 %). Highest germination rate was observed in sclerotia treated with bark extract and also in control set, whereas lower germination rate (4-7 hyphae/sclerotium) was shown by 31 and 15 % sclerotia treated with leaf and cake extracts, respectively. Upon increasing the incubation time most of the sclerotia showed poor germination (1-3 hyphae/sclerotium). Cake extract caused 86 % inhibition in sclerotia germination after 72 h of incubation. Volatile fungistatic effect of neem extracts was more potentiated after 96 h of incubation. Ninety seven percent inhibition in sclerotial germination by cake extract was recorded after 96 h of incubation (Figure 1A).

A similar result was also noticed with neem oil where sclerotial germination gradually decreased with increase in concentration of oil and incubation period (Figure 1B). Maximum inhibition (39 %) was noticed with 1.0 % oil after 96 h of incubation. The number of hyphae/sclerotium was higher after 24 h incubation which gradually decreased with increase in oil concentration and incubation period. Most of the sclerotia showed poor or no germination (1-3 hyphae/sclerotium) after 96 h of incubation.

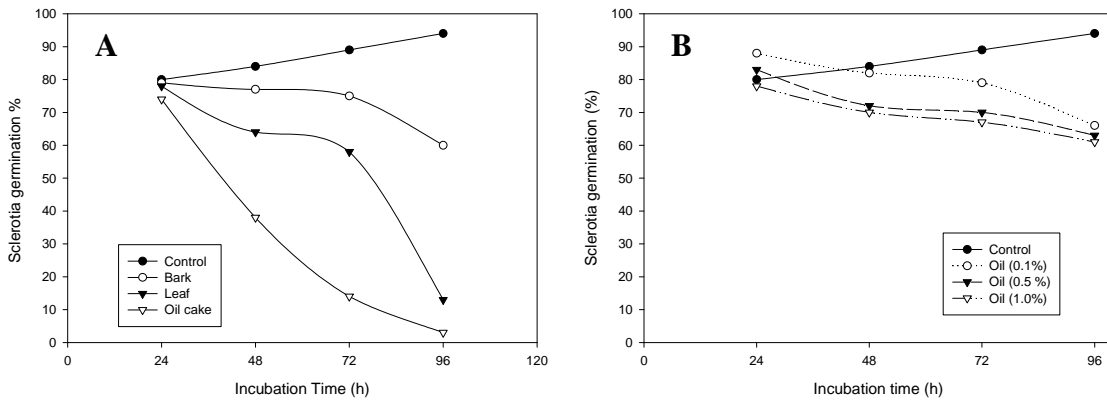


Figure 1. Volatile fungistatic effect of different (A) neem extracts (5% w/w) and (B) neem oil (0.1, 0.5, 1.0 %) on *Macrophomina phaseolina* sclerotia after 24, 48, 72, 96 h of incubation at 30±1°C.

3.4. Non-volatile fungistasis caused by neem extracts

After 24 h of incubation most of the sclerotia showed very good germination producing >7 hyphae/sclerotium (Figure 2A). Oil cake extract posed maximum inhibition on sclerotia germination (77%) after 48 h incubation followed by leaf extract and bark extract that caused 73 % and 66 % inhibition in sclerotia germination. Most inhibitory effect was

found at 1.0 % concentration of neem oil which caused 32 % and 41 % inhibition after 24 and 48 h of incubation, respectively. Most of the germinated sclerotia showed poor germination (1-3 hyphae/sclerotium) or good germination (4-7 hyphae/sclerotium) after 48 h of incubation (Figure 2B).

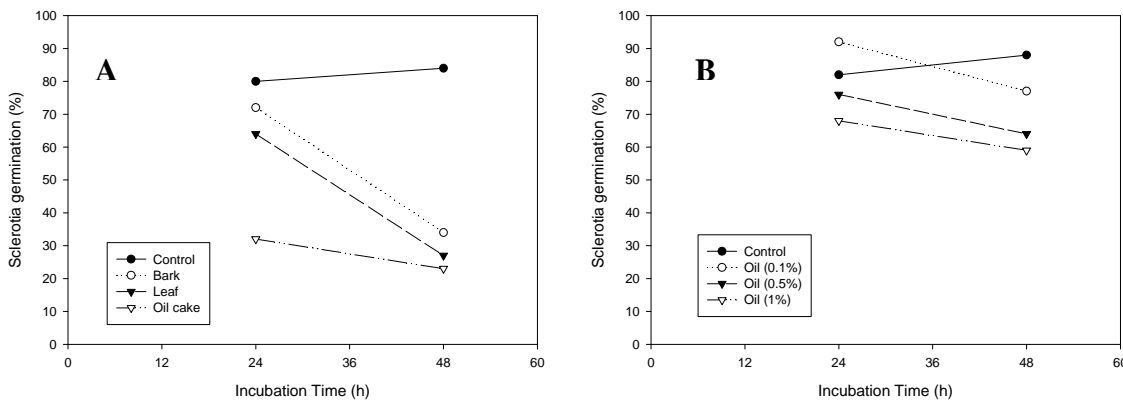


Figure 2. Non-volatile fungistatic effect of different (A) neem extracts (5 % w/w) and (B) neem oil (0.1, 0.5, 1.0 %) on *Macrophomina phaseolina* sclerotia after 24, 48 h of incubation at 30±1°C.

The non-volatile effect could not be studied after 72 h of incubation because counting of germinated sclerotia became difficult due to over growth of fast growing fungi from soil that made difficult to distinguish between hyphae of *M. phaseolina* and other fungi. By comparing it is clear that non-volatile effect on sclerotial germination was greater than volatile effect. Cake extract (5 % w/w) caused 77 % inhibition in case of non-volatile fungistasis, whereas same concentration of cake caused 62 % inhibition in case of volatile fungistasis after 48 h incubation.

4. Discussion

Neem contains a variety of chemical constituents such as nimolincinol, isolimolicinolide, azadirachtin, azadirachtol, nimlinone, nimbocinol, nimbocinone, nimocin, etc. (Tewari, 1992). Dubey and Kumar (2003) reported the fungicidal effect of azadirachtin as good as the fungicides bavistin and mancozeb. These chemicals present in plant cause deleterious effect on the microorganisms. Radial growth of *M. phaseolina* was promoted by autoclaved neem extracts. The inhibitory chemicals present in neem extract would have been denatured at high temperature due to autoclaving, which in turn promoted the growth instead of inhibition because the pathogen used the denatured chemicals as substrates. Maximum enhancement in radial growth was measured at 10% concentration of cake extract followed by leaf and bark extract. A similar result had been reported by Rao et al. (1996) who found mycelial growth promotion of *Verticillium leccani* treated with autoclaved neem extract. Neem extract filtered through bacterial proof sintered glass filter showed inhibitory effect on radial growth as well as biomass yield of *M. phaseolina*. Neem oil was most inhibitory followed by cake extract. Several bioactive compounds have been reported from different parts of neem (Tewari, 1992). The most active principle present in neem oil is azadirachtin and sulphur (Siddiqui, 1992). The presence of sulphur might be responsible for maximum effect of neem oil than the other extracts. Fungitoxic properties of neem oil, cake and leaf extract on radial growth and biomass production in the present study have also been supported by Singh et al. (1980) who reported the inhibitory effect of neem oil against four

pathogenic fungi. Singh et al. (1993) also observed the inhibition in radial growth of *S. rolfsii* by neem oil. Kazmi et al. (1995) and Ilyas et al. (1997) proved the efficacy of neem oil against several soil borne fungi including *M. phaseolina*. Shivpuri et al. (1997) reported the fungitoxic properties of neem leaf extract against several fungi. Aqueous extract of trunk bark though proved inhibitory for radial growth and biomass production of pathogen, it was relatively poor in performance when compared to other employed extracts.

Sclerotia are the primary unit of survival and play a major role in life cycle of *M. phaseolina* (Dubey and Upadhyaya, 2001). Effect of neem extract on survival of sclerotia of *M. phaseolina* was found inhibitory after 2 and 4 days of incubation. Sclerotia treated with neem oil did not germinate, hence resulted in 100% inhibition. The inhibition in germination and viability of *M. phaseolina* may be due to the presence of several bioactive compounds present in neem oil and cake extract. Dubey and Kumar (2003) have found the azadirachtin (30 ppm) as effective as the fungicide mancozeb after 72 h of treatment. Besides sulphur, neem oil contain a bitter yellowish substance which contain alkaloid, resins, glycosides and fatty acids. Sharma and Basandrai (1997) found leaf extract of *A. indica* effective in reducing sclerotial viability of *Sclerotinia sclerotiorum* isolated from beans.

Any amendment in the soil is ultimately subjected to decomposition by indigenous soil microorganism. During the course of decomposition there occurs evolution of some volatiles, which adversely affect the organisms. Fungistatic effects of volatile and non-volatile constituents of different neem extracts (5 %) were found inhibitory against sclerotial germination of *M. phaseolina*. Similar results were noticed for volatile fungistasis of oil. Effect of oil on sclerotial germination was increased with increase in concentration of oil and incubation period. Reduction in germination and viability of sclerotia of *M. phaseolina* may be attributed to the presence of volatile and non-volatile antifungal constituents in neem extracts. Among various fungistatic factors an important one is the increase in alkalinity of soil (Hora and Baker, 1974). Ammonia is evolved during the decomposition of neem oil and seed cake. Increase in pH of soil was found directly

proportional to ammonia production which in turn increased the fungistatic activity of soil (Hora and Baker, 1974). Mycostatic properties of ammonia have been reported mostly from alkaline soil. Volatile inhibitors from neem products may not kill or inactivate all the cells, hence the viable cells of sclerotia showed poor germination. The effect of volatile fungistasis was more pronounced than non-volatile fungistasis. Dwivedi and Dubey (1987) also reported deleterious effect of volatile fractions of hydrodistillate of different neem products on germination of *M. phaseolina* sclerotia.

Thus, it may be concluded that the application of neem cake extract and neem oil posed high fungitoxic effects on *in vitro* radial growth and sclerotial survival of *M. phaseolina* in amended soil.

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Physical Properties of an Ultisol Under Plastic Film and No-Mulches and their Effect on the Yield of Maize

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Abstract: Film mulching is an important agricultural practices used to improve crop productivity .Field experiments were conducted using maize (*Zea mays L.*) to determine the effect of film mulching on soil physical properties and maize yield in 2006 and 2007 cropping seasons. The experiment was a randomized complete block design (RCBD) with four film treatments viz. Black film (BM), white film (WM), Black / white film (BWM) and no-treatment (NM). Seedling from three mulching treatments emerged 2days earlier than those from non-mulched treatments. Film mulching significantly ($P \leq 0.05$) increased soil temperature (taken at different times) and water retention relative to the un-mulched treatments. Results of the study show bulk density decrease of 9% (BWM), 4% (WM) and 17% (BM) at 45 DAP in the first season and 4% (BM), 1% (BWM) and 6% (WM) at 90 DAP in the second season compared to the un-mulched treatment. Yield increase of 55 – 78% (first season) and 108 – 142% (second season) were observed in film mulch treatment relative to the control. Film mulch can be used to increase crop production to meet the food need of the increasing human population.[Journal of American Science 2009; 5(5):25-30].(ISSN:1545-1003)

Key words: *Film mulch, crop productivity, physical properties, human population, agricultural practice.*

1. Introduction

Soil is a fundamental resource for agricultural production and the most important possession and input of farmers (Brady and Weil; 1999). Proper soil management is one key factor threatening sustainability (Smith *et al.* 1995). Intensive and sustainable crop production in tropical soils required soil management practices in order to prevent yield failures. The aim of proper land management could be to determine how best to utilize land resource in the rain fed agriculture, as such there is need to protect the soil and conserve it. Erosion causes fertility decline due to the removal of humus and clay fraction in the soil. The global economic loss due to accelerated erosion is very high (Pimentel *et al.* 1995). In order to stop the destructive force of water and wind it is necessary to cover the soil surface as much as possible. This can only be achieved by using mulch in agricultural (Beegle *et al.* 2000). According to Opara-Nnadi (1989) mulch helps to improve the soil environment for optimum crop growth and yield. Mulches are either organic (derived from plant and animal materials) or inorganic (plastic film).The most frequently used organic materials include plant residues such as straw, hay, peanut hull, and compost; wood products such as saw dust, wood chips/shavings and animal wastes .However, natural mulch materials are often not available in adequate quantities for commercial operations or must be hauled to the place of use (McCraws and Motes, 2004). Again natural materials are not easily spread

on growing crops and require considerable hand labour. Thus expense and logistic problems have generally restricted use of organic mulch to home gardeners and small market gardener with only limited use of a large commercial scale, (McCraws and Motes, 2004).Organic mulches properly utilized can perform all the benefits of any mulch with possible exception of early season soil warming .Similarly excessive use of unsorted organic wastes as mulches may likely lead to changes in soil physical and chemical characteristics .This can distort the inter-relationships among biophysical and chemical soil functions. It may also lead to loading of nitrates and heavy metals in the soil and ground water (Vousta *et al.* 1996) .In order to achieve sufficient food supply the primary requirement is not to research into new method but the increase application of techniques and practices that are already available and approved feasible. In the last three decades plastic film mulch cultivation has gradually become a great break through in agricultural production protected cultivation normally represented by plastic film mulching has greatly improved crop production Gu and Gu,2000 ;Liang *et al.* 1999). However, despite its numerous benefits and World-wide spread in tropical USA, Europe and China, its use in the Sub-Sahara Africa is at infant stage or not at all. This research is aimed at evaluating the changes in soil temperature, bulk density, total porosity, water retention, dispersion ratio, seed emergence / growth and yield of maize associated with the use of plastic

film and no-mulch materials in an ultisol in Abakaliki- South Eastern Nigeria.

2. Materials and Methods

The study was conducted in 2006 and 2007 growing seasons at the Teaching and Research Farm of Faculty of Agriculture and Natural Resource Management, Ebonyi State University, Abakaliki. The area is located at latitude 06° 4' N and longitude 08° 65' E in the derived Savannah of the South East agro-ecological zone.

According to Ofori (1995) the minimum and maximum temperature of the area are 27°C and 31°C, respectively. The area experiences bimodal patterns of rainfall (April – July) and (September – November) with short spell in August. The total annual mean rainfall ranges between 1700 to 2000 mm. The soil belongs to the order ultisol (FDALR, 1985) and classified as Tyic- Haplustult.

2.1 Experimental Layout and Management

The experiments were carried out in 2006 and 2007 growing seasons. It was laid out in Randomized Complete Block Design (RCBD) with plot sizes measuring 3m x 3m replicated four times. A land area measuring 199.5m² (equivalent to 0.01975, ha) was marked out, slashed and cleared of grasses. The field was divided into four blocks with each block having five experimental units giving a total of 20 plots. The experimental units were demarcated by 1m alleys.

A maize variety (Oba – super 11) was planted at a spacing of 0.5m x 0.5m inter and intra-row at two maize plants per hill. The treatments were black plastic film mulch (BM), white plastic film mulch (WM), black / white (BWM) plastic film and no mulch (NM). Before sowing the black, black/white and white plastic film mulch (3x3 cm, wide and 0.0075m thick) were applied on soil surface with the edges tied tightly under the soil. There were six rows of plant in each plot. Among the six rows three were taken for routine sampling area, the others were left for crop yield assessment. Thinning was carried out two weeks after germination to one plant per hole, to give 36 stands/plot equivalent to 53,000 plants/ha. The no-mulched plots were kept relatively weed free by removing the weeds. At the end of the experiment in 2006 the plastic film were removed. The same procedure as described above was repeated in the 2007 planting season.

2.2 Sampling and analysis:

The following soil properties were determined. Particle size distribution was determined by the hydrometer method (Gee and Bauder, 1986). Undisturbed soil core samples were collected from each plot at 45 and 90 days after planting (DAP). The core samples were used to determine the dry bulk density using the core method as outlined by Blake and Hartge (1986). Total porosity was calculated from bulk density data using the formula;

$$Tp = (1 - \frac{bd}{pd}) \times 100 \quad \text{where}$$

Pd = Particle density (assumed to be 2.65gcm⁻³)
Bd = Bulk density.

Volumetric water content of the soil was determined as described by Klute (1986), while dispersion ration was determined using the techniques of Nkidi-kizza *et al.* (1984). Maize emergence was counted at ten days after planting while soil temperature was taken at two points in each plot between 12-1pm at a depth of 5cm using soil thermometer at 14, 40 and 75 DAP. At maturity plant height was taken using meter rule. Similarly maize was harvested and the grain air dried, weighed and expressed on a 12.5% content.

Data collected from the study was analyzed using analysis of variance test based on RCBD according to the procedures outlined by Steel and Torrie (1980).

3 Results:

The particle size analysis (Table 1) showed that the texture of the soil is sandy clay loam.

Table 2 show that plastic film mulching significantly ($p < 0.05$) increased soil temperature in both seasons. In both cropping seasons WM gave the highest soil temperature values at the different periods of measurements.

Table 1: Soil Particle size distribution

Particle size distribution	Values%
Sand	69
Silt	6
Clay	25
Texture	Sandy clay loam

Table 2: Effects on Soil temperature taken on 14, 40 and 75 DAP

DAP	2006			2007		
	14	40	75	14	40	75
BWM	27.6	28.6	29.78	28.0	29.0	29.6
WM	28.1	28.8	30.2	29.0	30.1	30.3
BM	26.0	26.4	27.2	27.0	28.3	29.6
NM	25.0	26.0	26.8	26.6	28.0	28.9
LSD _{0.05}	0.345	0.460	0.399	0.131	0.103	0.140

BM = Black film, mulch, WM = White film Mulch, BWM = Black/White Mulch, NM = No Mulch.

The observed soil temperature values in the WM plots were 28.1°C, 28.8°C and 30.2°C at 14, 40 and 75 DAP in the first season. At 14 DAP the values were 2%, 8% and 12% higher than BMW, BM and non-mulched (NM) plots, respectively. Similarly, soil temperature values in the mulched plots were increased by 9, 2 and 5% relative to the control for WM, BWM, BM and BM, respectively at 14 DAP in the second season. The order of soil temperature increase at 75 DAP in the second season was WM>BWM=BM>NM. Table 3 show higher bulk density values of 1.25 and 1.40gcm⁻³ at 45 and 90 DAP respectively, in the non-mulched plot in the first season. At 45 DAP in the first season bulk density values were smaller in the mulched plots relative to the control by 9% (WBM), 4% (WM) and 17% (BM). Similarly lower bulk density values of 1.34gcm⁻³ (BM), 1.40 gcm⁻³(WM) and 1.34 gcm⁻³ (BWM) were observed in plastic film mulched plots relative to 1.42gcm⁻³ observed in no-mulched plots at 90 DAP in the second season.

Table 3: Effect on Bulk density (gcm⁻³) and total porosity (%).

Treatment	2006				2007			
	BD	TP	BD	TP	BD	TP	BD	TP
BM	1.04	1.61	61	49	1.15	1.34	57	49
WM	1.20	1.34	55	49	1.16	1.40	56	47
BWM	1.14	1.37	67	48	1.10	1.34	58	49
NM	1.25	1.40	57	47	1.24	1.42	53	46
LSD _{0.05}	0.076	0.032	0.779	1.06	0.030	0.015	0.174	1.03

BM = Black film, mulch, WM = White film Mulch, BWM = Black/White Mulch, NM = No Mulch.

Table 3 also show that plastic film mulches increased the total porosity of the soil relative to the control. At both growing seasons the lowest porosity values were observed in non-mulched plots. At 45 and 90 DAP the order of porosity increase were BWM > BM > WM > NM in the first season.

Result of the study on table 4 show that plastic film mulches significantly (P = 0.05) increased soil moisture retention relative to the no-mulched plots in both seasons. In the first season moisture retained at BWM plots (30.2) was higher than WM, BM and NM plots by 11, 5 and 45%, respectively. Similarly higher moisture retention values of 50.1% (BWM), 48.7% (WM) and 43.0 % (BM) were observed in plastic film mulched plots relative to lower value of 40.0% (NM) observed in the control or no-mulched plot. In both seasons the effects of plastic film mulches on dispersion ratio were non-significant (Table 4).

Table 4: Effect on Water retention and Dispersion ratio

Treatment	2006		2007	
	WR	DR	WR	DR
BM	28.7	0.88	43.0	0.89
WM	27.2	0.95	48.7	0.90
BWM	30.2	0.89	50.	0.90
NM	20.8	0.88	40.0	0.87

LSD_{0.05} 0.596 NS 0.371 NS

BM = Black film, mulch, WM = White film Mulch, BWM = Black/White Mulch, NM = Not Mulch.

Plastic film mulching gave significantly higher plant height relative to the non-mulched plots (Table 5). The tallest plants (126.6 and 130.46cm) were observed in BM and BWM plots, respectively, in the first and second seasons. The order of plant height increase in the first season was BM > WM > BWM > NM. In the second season plant height in the no-mulched plot showed 125, 91 and 71% decrease compared to BM, WM and BWM in mulched plots respectively.

Table 5 also show significantly higher yield in plastic film mulched plots relative to the no-mulched plots in both seasons. Yield increase was the highest in WM (2.32) in the first season. The observed values (2.32 t ha⁻¹) in WM plots was 5%, 19% and 78% higher than yield values observed in BWM, BM and no-mulched plots respectively. The order of yield increase was BWM > WM > BM > NM in the second season.

Table 5: Effect on maize growth (cm) and yield (tha⁻¹)

Treatment	2006		2007	
	Growth	Yield	Growth	Yield
BM	126.60	2.02	110.28	2.50
WM	107.04	2.32	73.32	2.62
BWM	96.30	2.20	130.46	1.90
NM	56.20	1.30	50.38	1.20
LSD _(0.05)	1.852	0.163	0.794	0.078

BM = Black film, mulch, WM = White film Mulch, BWM = Black/White Mulch, NM = No Mulch.

Germination count taken at 7DAP-show 95 and 98% seedling emergence on plastic film mulched plots and 78 and 80% in no-mulched plots in the first and second seasons, respectively. Generally, seedling emergence was 2 days earlier in plastic film mulched plots relative to the no-mulched plots.

4. Discussions:

Plastic film mulch increased the soil temperature due to its ability to intercept sunlight which warms the soil. At the different times of reading WM gave the highest soil temperature values in both seasons due to its thermal properties of reflection, absorption and transmission. Study by Larment (1999) showed that white plastic mulch absorbs little solar radiation but transmits 90-95% (depending on the degree and its opacity), while black film mulches absorbs ultraviolet, visible and infrared wavelengths of incoming solar-radiation and re-radiates absorbed energy in the form of thermal radiation or long-wavelength infra-red radiation. Due to higher thermal conductivity in soil relative to that of the air, black plastic transfers much of its absorbed energy to the soil by conduction. According to Schales and Sheldrake (1967) black plastic film mulches losses much of solar energy

through radiation and forced convection thus resulting to lower temperature readings relative to white plastic film. The results of this study conforms with the observation of Anikwe *et al.* (2007) when they evaluated the effects of tillage and plastic mulching on soil properties and yield of cocoyam on an ultisol in Southern Eastern Nigeria.

Katan (1976) showed that using plastic film mulch to achieve high soil temperature helps to destroy soil pathogenic weeds nematodes. The increased soil moisture observed in plastic film mulched plots may be attributed to its ability to prevent soil water loss during dry times and shedding of excessive water from crop root zone during dry excessive rainfall. The observed increased soil temperature and moisture retention resulted to seeding emergence 2 days earlier in plastic – film mulched plots than in the no – mulched plots. Studies by Li *et al.* (1999) and Gan and Stottle (1996) showed earlier seedling emergence in plastic film mulched plots relative to no-mulched plots. The early seedling emergence is crucial for initial dry matter production and growth of crops Gan and Stottle (1996). According to Loy *et al.* (1998) the early growth response of crops on plastic film mulches is due to reflection of PAR into plant canopy, increased photosynthesis and biomass accumulation. The increased growth and yield observed in plastic film mulched plots could be attributed to its ability to increase soil temperature, water retention, soil porosity and decrease soil bulk density. Guo and Gu (2000) and Han and Wan (1993) showed that plastic film mulches raises soil temperature there by promoting faster crop development and increased yields. Bulk density is a soil parameter that is used to quantify soil compactness. Soil

compaction increases bulk density and decreases pore volume (Koistra and Tovey, 1994). Mbah *et al.* (2004) reported that high bulk density results in reduced water infiltration into the soil, reduced aeration and poor root penetration, resulting in reduction in crop yield. The increase porosity and decreased compaction (due to decreased soil bulk density) in plastic film mulched plots may have enhanced aeration and microbial activities in the soil thus resulting to increased root penetration and cumulative feeding area leading to increased plant growth and yield in line with the observations of (Mbah *et al.* (2004),Obi and Ebo, (1995) and Mbah *et al.* (2001).

Conclusion:

Results from the study showed that plastic film mulches improved the soil physical properties such as the soil water content and the temperature in top soil layers, prompting emergence of seedling and greater root distribution in soil. The improved soil physical properties lead to increased plant growth and yield. Film mulch practice had much more room for supporting food to support population. Similarly if utilized by farmers, more

fragile and marginal land, can be utilized for crop production.

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Wildlife corridors and Asian Elephants (*Elephas maximus*): Lessons from Rajaji National Park, North-West India

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Abstract: Presently, most of the mega herbivores are under great threat mainly due to the loss and degradation of their natural habitat and loss of corridors. During the past 50 years most of the forest areas have undergone to drastic changes mainly due to huge amount of anthropogenic and developmental activities like agricultural expansion, human settlements, construction of canals, railway and road network. All these developmental activities lead to degradation of natural corridors for animal's movement and loss of natural connectivity between the different forest ranges of the same protected area. Corridors are valuable conservation tools, which provide connectivity to different landscapes. We reviewed some of the major reasons those are responsible for declining the population viability of Asian elephants (*Elephas maximus*) within their natural habitat. Rajaji National Park and its adjoining forest comprises of many valuable corridors through which elephants performs their long-term migration. During the recent past developmental work along with biotic pressure has affected the elephant's movements in these corridors. Presently elephant's movement in Chilla – Motichur corridor area is quite rare but elephants are currently utilizing Khara – Anjani corridor and this corridor offer urgent need for conservation. Elephants of this area were subjected to move only in few of the forests as anthropogenic barriers are currently restricting their long movements from Rajaji to Corbett National parks. The long-term effects will include genetic isolation, habitat fragmentation within the same forest and enhancement in the human-elephant conflict in adjoining areas. Genetic isolation of elephant populations may also increase the chances of replacement of interbreeding to intra-breeding, and thereby reduce the population persistence even for wide ranging wildlife species. Major threat to most of the wild animals and elephants has been the railway track and national highways, which are passing exactly in between the forests. [Journal of American Science 2009;5(5):31-40]. (ISSN: 1545-1003).

Key words: Asian elephant, conservation, corridors, Rajaji National Park, north-west India

1. Introduction

India has between 21,000 and 25,000 Asian elephants (*Elephas maximus*) in the wild and among them Uttarakhand state harbours 1346 elephants distributed within 14 protected areas. India currently has the largest surviving population of the Asian elephant, approximately 50 % of the total world population of the species (Daniel, 1996). Presently a number of wildlife habitats have undergone or are being threatened with the fragmentation due to various anthropogenic factors and this has adversely affected the large mammal populations residing in them (Johnsingh et al., 1990). Recently, developmental activities and habitat destruction have caused a major decline in the abundance of the terrestrial mega-fauna. As most of the wild animals are presently categorized under threatened

category therefore, there is an increasing concern that the area-wise decline of the elephant will have unexpected and grave consequences for the long-term viability of the terrestrial ecosystems.

The Rajaji National Park was established to enhance the long-term survival of the Asian elephant in a sub tropical moist deciduous forest in India. But during the recent past natural continuous forest ranges of India has been broken up into many parts due to agriculture, urbanization, increasing road traffic and development related activities as well as some other anthropogenic activities. This situation creates many problems for various organisms living in forests especially for large size mammals like elephant. Genetic isolation, limitation of dispersal, migration and the decline of populations of animals requiring large

territories are the most common problems connected with fragmentation of forests and other components of the environment. Shivalik landscape (lesser Himalayan zone) is one of the last few places in the world where elephants exist and offers urgent need for conservation. From conservation point of view Rajaji National Park appears to be India's one of the most successful national park and its development has helped to boost the population of Asian elephant in their natural habitat. Before the Gujjar rehabilitation programme elephants must scarify the feeding grounds in order to feed on the short grasses due to domestic buffaloes being grazed (Joshi and Pande, 2007).

Besides, human settlements in and around the park area have created the shrinking of elephant's natural paths. The human population around the Rajaji National Park alone has doubled during past one decade and with rapid urbanisation and industrialisation has resulted in the loss of many forestlands to townships and to various developmental activities (Joshi and Singh, 2007; Joshi and Singh, 2008a). The factors that contribute to the killing of humans by elephants are the presence of people into elephant's habitat to collect firewood and fodder, conflict over water and cultivation of palatable crops near the forest boundary. In between years 1986 to 2004, elephants have killed 47 persons and injured 43 persons in and around the Rajaji National Park area whereas during the last three years more than 30 people were died due to encounter with elephants in the Rajaji Park and its adjoining protected habitats. On the other hand from 1987 to 2004, more than 134 elephants succumbed in the wild to various reasons (train accident, poaching, electrocution, fallen through hillock, disease, bull fight and natural).

During the recent past natural continuous forest ranges of India has been broken up into many parts due to agriculture, urbanization, increasing road traffic and development related activities as well as other anthropogenic activities. This situation creates many problems for various organisms living in forests. Genetic isolation, limitation of dispersal and migration and the decline of populations of animals requiring large territories are the most common problems connected with fragmentation of forests and other components of the environment. A serious threat was also recorded to European wildlife resulting from the dynamic development of a

transportation infrastructure network within the Trans-European Transportation Network (TEN-T) programme. This transportation network disrupts migration corridors of large terrestrial mammals and causes a fragmentation of their environment on a scale not previously recorded (Nowak and Myslajek, 2005).

2. Methods

2.1 Study Area

Rajaji National Park [29° 15' to 30° 31' North Latitude, 77° 52' to 78° 22' East Longitude] is spread over an area of 820.42 Km² in and around the Shivalik foothills, which lies in the lesser Himalayas and the upper Gangetic plains. Rajaji National Park (RNP) was notified in 1983 by amalgamating three erstwhile wildlife sanctuaries namely, Rajaji, Chilla and Motichur. Spread across Hardwar, Dehradun and Pauri districts of Uttarakhand state, RNP has been designated as a reserved area for the "Project Elephant" by the Ministry of Environment and Forests, Government of India with the sole aim of maintaining the viable population of Asian elephants in their natural habitat. The Shivalik foothills offer the most prominent geomorphic features of this tract. The river Ganges has cut across these hills at Hardwar. The Chilla forest area of the RNP lies in the east of the river Ganges and is attached by the Garhwal Forest Division. The study was conducted in Chilla forest of the RNP and Shyampur forest of the Hardwar forest division (HFD). The altitude lies between 302 and 1000 meter above sea level.

2.2 Flora and Fauna

This protected habitat in India's lesser Himalayan region falls under sub tropical moist deciduous forest type with extensive stands of *Shorea robusta* (Sal), *Mallotus philippinensis* (Rohini), *Acacia catechu* (Khair), *Adina cordifolia* (Haldu), *Terminalia bellirica* (Bahera), *Ficus bengalensis* (Bar) and *Dalbergia sissoo* (Shisham) in its premise besides many other important fodder plant species. This entire belt is natural home of Asian elephants (*Elephas maximus*) besides many other wild animals like *Panthera tigris* (tiger), *Panthera pardus* (leopard), *Melursus ursinus* (Sloth bear), *Hyaena hyaena* (Hyaena), *Muntiacus muntjak* (Barking deer), *Axis axis* (Spotted deer), *Cervous unicolor* (Sambhar), *Sus scrofa* (Wild boar) and *Ophiophagus hannah* (King cobra).

2.3 Data Collection

For analyzing the movement of elephants and assessing the impact of developmental activities on riparian wildlife corridors, two forest ranges (Chilla of the RNP and Shyampur of the HFD) were selected and in-depthly surveyed during 2000 to 2008. The study area was visited at weekly intervals during which observations on elephants were made along the motorable forest track, present in between different forest habitats. Few other connected rough routes, which connect the grassland habitat with motorable road, were also used during the course of study. Besides, all the potential habitats (water dominant areas, cool shaded areas, fodder enriched areas and rough forest routes) were also investigated on foot during early morning, mid-day and evening hours. Cool shaded trees like *Ficus bengalensis*, *Adina cordifolia* and *Ficus glomerata* and dense forest of *Mallotus philippinensis* and other favourite fodder species were examined mostly during mid day (March-June) hours as elephants generally take rest under these cover. Whereas all the water sources (perennial/seasonal) were investigated alternatively during evening hours.

As the elephants in RNP have been known to emerge from the forest predominantly during evenings, all sightings of elephants were made between 1500 hours and 1900 hours. Besides, observations were also done during early morning hours (0600 hours to 10 hours). The data collected was as part of the animal monitoring activities and the daily record was based on direct sighting of animals, indirect evidences like feeding sign, footprints impression time and fresh dung piles. The direct sighting were noted in duly prepared proforma, recording the group composition, age and sex, if observed in groups and also the place of sighting, time and vegetation type. Besides, villagers of adjoining areas, Gujjars (where available), staff of the forest department, the researchers from various scientific institutions and non-government organizations and other individuals working on this problem, were also interviewed. Field binocular was also used for observing their movement behaviour without disturbing the animal from an adequate and safe distance.

3. Results

The population of wild Asian elephants has a discontinuous distribution in the northern, eastern and southern forest ranges in India. In the past the elephant

population of the north used to migrate freely from one end to the other from the river Yamuna to the river Brahmaputra, traveling a maximum distance of approximately 1,300 kilometers as per their requirements in the foothills of Himalayas (Singh and Sharma, 2001). All the major habitats of elephants are very close to perennial rivers that fulfill their water requirements. This entire belt has comprised of all those fodder plant species that elephants like. Generally elephants do not have a fixed territory, but they show various territorial behaviours according to the season and availability of natural food and water. RNP and its adjoining forests are playing an important role in the conservation of elephants especially after the rehabilitation of Gujjar community from few of the forest pockets.

Chilla forest range of the RNP and Shyampur forest range of the Hardwar forest division is well connected forest zone therefore; elephant utilizes both of these forest ranges round the year. These forests also provide connectivity to the Lansdowne forest division for elephant movement towards Corbett National Park. But during the recent past number of construction work along with huge amount of anthropogenic activities has restricted the frequent movement of elephants within their home range. It was observed during the present investigation that most of the elephants in these forest pockets do not represent their long-term migration mainly because of barriers present in between the forest areas. In the course of this study we have encountered many elephant groups and solitary bulls and on the basis of their physical identity it was revealed that they are only restricted to move to some extent in this forest stretch. In this area we have reported two major corridors, which are currently in use by the elephants.

The motor roads, which are adjacent to the forests like Hardwar-Dehradun National Highway, Hardwar – Bijnor National Highway, Rishikesh – Hardwar road (via Chilla) and BHEL road network have heavy traffic pressure. As per a preliminary study, the average number of vehicles passing on Dehradun-Hardwar road per day is 7,929 and all the wild animals, including elephants, are not in a position to cross this track at any time due to the presence of heavy traffic (Singh and Sharma, 2001). Same situation is with other corridors present adjacent to the RNP area. Kotdwar – Lansdowne road runs parallel to the river Kho and crosses the Rajaji-Corbett corridor, the major movement track of northwestern elephant population between the Yamuna

and river Sharda. This road serves as the major transport link between Pauri town and Kotdwar area. The presence of traffic on the road, construction of steep retaining walls and the presence of human population along the entire corridor area have almost restricted the migration of elephants (Johnsingh and Williams, 1999).

Chilla – Motichur corridor

This corridor is about 7 kilometers long beginning at the tail end of Mundal valley and links the Chilla forest range on the eastern portion to the Motichur forest range on the west. Elephants used this corridor traditionally but currently elephants are not utilizing this corridor regularly. Sometimes solo bulls are reported to follow this route and very occasionally group movements was also observed but only up to the island area, which is situated in between river Ganges. This corridor area comprises of many fodder plant species like *Mallotus philippinensis* (Rohini), *Acacia catechu* (Khair), *Dalbergia sissoo* (Shisham), *Tectona grandis* (Teak), *Zizyphus mauritiana* (Ber), *Aegle marmelos* (Bel), *Ficus bengalensis* (Bar), *Ficus glomerata* (Gular), *Grewia oppositifolia* (Bhimal), *Bombax ceiba* (Semal), *Lannea grandis* (Jhingan), *Bauhinia variegata* (Kachnar), *Lagerstroemia parviflora* (Dhauri), *Kydia calycina* (Pula), *Syzygium cumini* (Jamun) and *Ehretia laevis* (Chamror). Besides, elephants also use various grasses and shrubs as their food resources, which includes *Dendrocalamus strictus* (Bamboo), *Helicteres isora* (Kapasi), *Saccharum munja* (Pula), *Saccharum spontaneum* (Kans), *Cynodon dactylon* (Doob Grass), *Eulaliopsis binata* (Bhabhar Grass) etc. Presently Gujjars are completely relocated from Chilla and Motichur forest ranges of the RNP but the programme for resettling them to rehabilitation site from Gohri forest range is still ongoing.

Because, few of the forest pockets of the Gohri forest range also falls under this corridor area, therefore, it will be needed to resettle the Gujjars from this forest range. Elephant's movement was restricted in this area mainly due to biotic pressure and cattle grazing inside the forest area. Before 2002, we have observed large herds of elephants (maximum 38 elephants) in Kunao forest beat and in Binj river but presently their large groups have been subjected to dispersed in small ones.

There are four islands within the river in this region, which form part of the park. However, in the 1950's and 60's a number of developments, having drastic effect of land use came up on the western bank. The BHEL set up a major plant to the west of Ganges in the southern

part of this trans-Ganga corridor for wildlife. Later the IDPL set up a large factory in the northern part of the corridor, also to the west of Ganga. The Army for a large ammunition dump has utilized the area in between and subsequently some remaining land was given away for the rehabilitation of Tehri Dam oustees. Thus, on the west bank most of the corridor stands diverted and rendered unusable.

On the east bank yet another major development activity has all, but destroyed the ecological corridor. A hydro-electric power project was set up in the 1970's. A barrage was constructed across the Ganga at Kunao just outside the park in the middle of the northern boundary. From here a deep power channel runs parallel to the east of Ganga for about 14 kilometers up to Chilla where the powerhouse is located. Although there are a couple of narrow bridges over the channel, these are not generally used by the animals. There have been cases of deer and even elephant mortalities, in attempts to cross these bridges.

Rarely elephant bulls and the group are known to cross, but otherwise there is complete isolation between western and eastern components of an internal ecological unit. The presence of army camp in the elephant corridor has also adversely affected the movement of wild animals. Besides, Khand village (48.5 hectares) is also located in the elephant migration corridor and is an obstacle to their movement. Ganga Bhogpur and Kaudia villages are also situated in eastern side of river Ganges and peripheral to Ganga canal. This area also lies under corridor area and elephants sometimes used to move in these villages in search of cultivated crops. Dudhia forest beat (island) due to its proximity to the Haripur Kala village is one of the most sensitive area as far as elephant casualties are concerned. During the study period occasionally, the movement of only solo bulls was observed in this part of the park. Group movement is almost restricted in this forest pocket mainly due to anthropogenic activities. Despite the fact that Dudhia area is rich in *Dalbergia sissoo* (Shisham) and *Acacia catechu* (Khair) forest, the preferred food item of the elephants. Besides, few of the fodder grass species like *Saccharum munja* and *Desmostachya bipinnata* are also grow in profusion in this area.

A major developmental project, which has divided the Rajaji – Corbett elephant habitat into two regimes is the 14 kilometers long Kunao – Chilla power channel, which was constructed on the east bank of river Ganges.

In the early 1970s, this canal is 22 meter wide, nine meter deep and with full flow of water. The side of the canal is at an angle of 45° and cemented except for 500 meter; therefore, do not offer foot-hold to the elephants (Kumar, 1995). There are three places at which bull elephants and groups cross the power channel and go to Ganges.

- 1) Binj / Been rau – in Gohri forest range.
- 2) 60 meters long aqueduct connecting Dogadda with Ganges – in the edge of Gohri and Chilla forest ranges.
- 3) Bridge across the power channel, 2 kilometers from Chilla – in Chilla forest range (Soni Shroth).

In summer, bulls were observed more to use these tracks for their movements towards river Ganges but occasionally groups also follow this route, when their movement is towards western direction. Elephants generally use the Ghasiram water streams and Soni shroth bridge for interchanging these forest zones.

3.1 Khara – Anjani corridor

This corridor is about 5 kilometers long and connects the Khara forest beat of the RNP with Chandi, Siddh and Anjani forest beat (Shyampur forest range) of the Hardwar forest division. Presently this is one of the major corridor for elephant movement towards river Ganges. The corridor area consists of the fodder species that Chilla forest comprises. The Anjani forest beat is attached with river Ganges and the forest comprises of *Acacia catechu*, *Dalbergia sissoo*, *Bombax ceiba*, *Helictres isora*, *Tectona grandis* and *Ficus bengalensis* trees. Besides, few of the important grass species are also present in the island area. During the last two years, state Government has constructed about four flyovers in Hardwar – Bijnor National Highway and due to this about 18 kilometers forest stretch along both the sides of the highway has got destructed mainly due to huge amount of anthropogenic activities. Besides, agricultural expansion adjoining to river Ganges has lead to the loss of forest wealth, which is also hindering the traditional movement of elephants.

It was observed during the present study that mostly adult bull elephants are utilizing this route. Sometimes few of the male elephants through associating, follow this route to enter the Anjani forest, which is peripheral to river Ganges. Elephants cross the national highway (Figure 1) and river Ganges during evening hours and re-enters to forest area in early morning hours. During this long journey elephants sometimes spent more time to feed on the plant species

those are present in the island situated in between river Ganges. Besides, elephants also utilize Gaziwali bridge (Figure 2), Shyampur bridge and Pili bridge those are situated over east Ganga canal for their outside movement and to feed on the cultivated crops in nearby villages. It was also observed during the study period that elephants also use the Ganga canal for fulfilling their water requirements (Figure 3).

Jagjeetpur, Mishrpur, Panjneri, Ajeetpur and Jaipota village are situated in the western direction of Ganges and village Kangri, Ghaziwali, Shyampur, Sajanpura and Pili are located towards eastern direction of river Ganges and adjoining to forest area and national highway. Once, all of these villages were better known for sugarcane cultivation and production but from last four years few of them have totally bunged the cultivation of sugarcane mainly due to fear of loss by elephants. These crop raids are the indications of attempts by some of the elephants to use their traditional routes leading to their feeding grounds, which are now denied to them and are replaced by human settlements (Figure 4).

Gujjars are still living in Hardwar forest division and it was observed that most of their deras (shelters) are present in this corridor area. Elephants generally follow Siddh shroth river stretch for interchanging the forest areas and most of the Gujjar deras were situated in this part. Gujjars are currently utilizing all the fodder resources frequently as the result of which few forest patches are rapidly replaced by toxicious weeds like *Parthenium hysterophorous* and *Lantana camera*. Whereas in the adjoining forest of RNP Gujjar rehabilitation programme has provided the better opportunity for livelihood to pastoral Gujjars and on the other hand it has promoted the regeneration of forest wealth along with movement related activities of wildlife (Joshi and Pande, 2007). Besides, one temple was also located in this forest stretch and the pressure of workers and visiting devotees sometimes caused hindrance in animal movement.

In the adjoining areas of Hardwar – Bijnor National highway various stakeholders has constructed shopping complexes, check posts, shrines, etc. and all of these spots are working as a barriers as far elephant's movement is concerned. Elephant's movement was quite frequent near to east Ganga canal and irrigation road especially during night period because this area comprises of bushes of *Dendrocalamus strictus* (Bamboo), which is a favourite food item of elephants.

Whereas during the day hour biotic pressure is quite more in this route and cattle grazing is also a very common phenomenon observed in this part.



Figure 1. Bull elephants on the Hardwar - Bijnor National Highway at Shyampur forest.



Figure 2. A bull elephant over to Ganga canal bridge at Shyampur forest.



Figure 3. Elephants drinking water from Ganga canal near to Chilla forest range.



Figure 4. Bull elephant feeding on paddy yield at a village adjoining to forest.

4. Discussion

Since Independence, forest were cleared and felled and bought under the plough on a large scale. Construction work along with developmental activities like establishment of hydro-electric power plants, irrigation canals and national highways entailed deforestation of large tracts and colonization brought in its wake have resulted in a significant shrinkage in the habitat of wild animals (Singh, 1969). Presently most of the elephant habitats are destructed by various developmental activities or for human need purposes. There has been rise in competition among the same species for the food, shelter and other basic requirements. The status of the elephant in the adjoining

countries is equally poor. Nepal, which has the lowest country population, has lost over 80% of its elephant habitat on account of human settlement. Bangladesh, Myanmar, Cambodia, Vietnam, Laos and Sri Lanka are also losing rapidly the natural forest cover, specially the elephant habitats. In Thailand in spite of the elephant having been a protected species since the 18th century, over exploitation of the habitat and the pressure of human population has made the species highly vulnerable (Daniel, 1996).

The Chilla – Motichur corridor and Khara – Anjani corridor linking the Chilla forest with Motichur forest and Shyampur forest are subjected to severe biotic pressures. Livestock grazing, fuel wood collection and movement of local people are the major activities observed in both corridors. These anthropogenic activities have substantially affected the movement of elephant within their home range and have led to the loss of forests connectivity. Grazing by cattle has altered the feeding grounds and has led to increase in exotic weeds. Few of the herbs and shrubs, which are replacing the forest vegetation rapidly are – *Parthenium hysterophorous*, *Lantana camara*, *Cassia tora*, *Cannabis sativa*, *Pogostemon benghalensis*, *Sida rhombifolia* and *Ageratum conyzoides*. These are never used by wild animals as their fodder, and on the other hand these are spreading very fast, reduces the other area in the forest. Weeds like *Parthenium hysterophorous* were more dominant in Motichur forest beat and distributed all over the site. In the month of October and November it shows flowering as well as fruiting stage, while in the month of December and January, it is in seed dispersal stage (Joshi et al., 2000).

Presence of railway track is another major problem, which impedes elephant migration and frequent movement within their home range. 19 elephants are killed due to train accidents since 1987 besides many other wild animals like leopard, spotted deer, python etc. This track is 16 kilometers long and comprises of sharp bends through which train drivers are unable to look the elephants from a safe distance and most of the accidents were occurred during night hours and in dry season (Joshi and Joshi, 2000). Various religious places were also situated inside the forest area and the visiting devotees and workers of the temples hinder elephant's movement. There are many instances when religious banquets on large scale are organized. During last decades the general economic condition of people has bettered, this has led to increase in the purchase

power, social interactions, tourists and religious activities of the people at all levels (Joshi and Joshi, 2006). Fishermen were also reported within these corridors in early morning and evening hours when elephants are more active. They used to cross the Ganges with the help of rubber tube and stay for whole of the day inside the island while moving inside the forest.

Corridors are important conservation tools and need to be preserved to ensure the genetic flow between the populations. If these corridors has got turned to shrink, interbreeding will be replaced by intrabreeding, which may led to loss of genetic material even for wide ranging wildlife species. Land use conflicts have intensified especially in those areas where wildlife movements are more common outside the protected areas. Human habitation and expanded agricultural activities between both of these corridor areas have already increased the number of incidents of conflicts between local communities and elephants. Similar phenomena are very likely to occur in few other internal corridors. Uncontrolled fishing, collection of fuelwood, grazing by cattle and encroachment along the forest edge and river Ganga will ultimately prevent the movement of elephants and other wild animals in this part. The long-term effects will include genetic isolation, habitat degradation within different reserves and intensify the conflicts between villagers and wild animals.

A large mammal like the elephant could be expected to move more considerable distances even with a short period and families of a clan seemed broadly coordinated in their seasonal movements (Sukumar, 1989). In the dry months i.e. from January to April, when no rainfalls occur, the groups seek the neighbourhood of streams and shady forests. From the month of July, after the first shower, they start roaming and feed on the fresh grass. This grass in hill tracts become long and coarse by July and August, the elephants then show their upward movements. The reason for the elephants and other animal's migration is the high lands, continuous and uninterrupted hilly terrain for grazing, assured food, ideal breeding ground and thick population (Sinha, 1981).

The long-term effects will include genetic isolation, habitat fragmentation within the same forest and enhancement in the human-elephant conflict in adjoining areas. Genetic isolation of elephant populations may also increase the chances of

replacement of interbreeding to intra-breeding, and thereby reduce the population persistence even for wide ranging wildlife species. The creation of corridors between two reserves has been proposed to minimize the genetic effects of isolation (Diamond, 1975). Large and medium sized herbivores and carnivores largely depend on corridors for exchange of genes between populations and to search for seasonal foraging grounds and water. Loss of forest cover due to agriculture expansion and construction related work is responsible for the loss of forest connectivity between forested areas in the Nilgiri Biosphere Reserve (Sukumar, 1990). Although the importance of corridors has been accepted widely for management of wide ranging species, only a few studies have been carried out on the impact of human interferences on habitat corridors in India (Johnsingh et al., 1990).

The results from this study provide a sketch of the extent and likely development of human-elephant conflict in Shivalik foothills and major threats. The RNP and its adjoining area is an important biological area and have great potential for wildlife and its conservation. People are also increasingly utilizing these old hamlets and as a result management of these traditional corridors is often uncoordinated and complicated. It is therefore appropriate to develop a scientific based protocol for conducting in depth analysis of these traditional corridors and serious human-elephant conflicts.

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Environmentally Sustainable Traditional Natural Resource Management and Conservation in Ziro Valley, Arunachal Himalaya, India

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Abstract: Arunachal Himalaya is the part of Eastern Himalaya with high ethnic and cultural diversity. It shares 2.5% of the total geographical area of the country, 15.76% of Indian Himalayan region and 43.62% of the Biological Hotspot, Eastern Himalaya. Apatani is one of the major ethnic tribal groups of Arunachal Himalaya inhabiting eco-culturally valued zone in Ziro valley, sharing 2.26% population of the Arunachal Pradesh. The community has distinct traditional land use practices and rich traditional ecological knowledge of natural resources management and conservation, acquired over the centuries through informal experimentation. Forest based land use has been classified into 8 sub-types having a plot size of 0.096 ± 0.006 to 8.602 ± 0.385 ha and agriculture with 6 sub-types of a plot size between 0.015 ± 0.001 to 0.098 ± 0.007 ha. Richness of forest is maintained through traditional ecological knowledge by means of selective harvesting, as well as by conserving the potential, ritualistic and socio-culturally valued species. Ziro Valley, a fascinating piece of land comprises of about 33 km^2 of cultivable areas out of 1058 km^2 of plateau, undulated by small hillocks at an elevation of 1525 m msl to a mountains tract ranging from 1830 to 2900 m in altitude. Only a limited area has been brought under cultivation, whereby the rest is under settlement and forest cover, which signifies the ecologically equilibrium management practices. Resource conservation is not only confined to forestry but also to agriculture with high agro-biodiversity (16 and 4 landraces of rice and millet respectively), and strong sense of soil and water conservation practices through indigenous technologies. Agronomic yield is five times as high as state average with maximum of 55 qha^{-1} , and is further strengthened by integration of fish culture. By appreciating the potential role of biodiversity in rural economy of Apatani and its socio-cultural values, conservation of flora and fauna is in their social norm over centuries. This paper explores the ecological management of natural and human modified ecosystems in Apatani plateau of Arunachal Himalaya in North East India. [Journal of American Science 2009;5(5):41-52]. (ISSN: 1545-1003).

Key words: Eastern Himalaya, Apatani, traditional land use, socio-cultural, agro-biodiversity, fish culture.

1. Introduction

The majority of the mountainous population of the Himalaya depends upon agricultural and forest based natural resources for their livelihood (Ramakrishnan, 1997) while the resources are sustainably maintained with traditional ecological knowledge (Dollo et al., 2005; Dollo, 2007; Farooque et al., 2007). The traditional farming system in the Himalaya is a mixture of crop, forestry and animal husbandry (Gangwar and Ramakrishnan, 1987; Maikhuri and Ramakrishnan, 1990; Ramakrishnan, 1993; Dollo et al., 2006), and more recently horticulture (Dollo and Sundriyal, 2003). The forest is intricately linked with crop farming and livestock domestication, which provides fodder for livestock while firewood, food and medicine for humans and timber for house construction (Maikhuri, 1996; Upreti and Sundriyal, 2001), and nutrient rich runoff from forest floor to valley rich cultivation

(Kumar and Ramakrishnan, 1990). Though the forest is the prime land use, agriculture is the mainstay of upland community (Ramakrishnan, 1997), where more than 85% of the total population of Arunachal Himalayan largely depends on it (Dollo and Sundriyal, 2003). Agricultural practices in upland regions are diverse, ranging from a variety of shifting cultivation systems (Ramakrishnan, 1983), fallow systems (Gangwar and Ramakrishnan, 1987), home gardens (Maikhuri and Ramakrishnan, 1990) to sedentary systems such as valley rice cultivation (Ramakrishnan, 1993; Kumar and Ramakrishnan, 1990). Each type of land use has distinct nature of management and is still sustainable where resources are managed through traditional knowledge, which has evolved through informal experimentations over centuries (Ramakrishnan et al., 1994).

Increased population pressure with consequential demand for food and cash has led the farmers to change

in the land uses as well as agro-ecosystems of the region along with rapid depletion of natural resources (Maikhuri et al., 2001). During recent past as a result, there has been a shift from more extensive to intensive systems of land use and the longer jhum fallow cycle has been replaced by shorter fallow cycle and ultimately to sedentary agriculture (Gangwar and Ramakrishnan, 1987). Animal husbandry integrated with agro-ecosystem is an important component of the tribal economic and the prosperity of a tribal family is assessed on the basis of the number of animals it owns (Gangwar and Ramakrishnan, 1987). However potentiality of livestock management has declined over the year and land degradation has taken place due to dilemma of farmers either to adopt modern or maintain traditional systems. Traditional practices in resources management are basically people's innovations to environmental stress and transformation developed and refined through trial and error (Palni and Choudhury, 2000). Of late, there has been a gradual shift the way science perceives such knowledge, which need further strengthening.

Ziro valley is categorized under sub-tropical and temperate forest with huge diversity of potential flora and fauna. The region is also well known for providing diverse NTFPs and having many places of tourist attraction, and has been considered as a centre of developmental activities during recent years. The Apatani with highly developed age-old valley rice cultivation has often been counted to be one of the advanced tribal communities in the northeastern region of India (Haimendorf, 1962). It has been known for its rich economy for decades, and has good knowledge of land, forest and water management (Chaudhary et al., 1993). The high-energy efficiency of Apatani agro-ecosystems is in contrast with that recorded from jhum in northeast India (Kumar and Ramakrishnan, 1990), and highly evolved traditional forest based natural resources management and conservation is unique in upland India (Sundriyal and Dollo, 2004). They have considerable expertise in land and water resources management. Indigenous integration of pisciculture in valley rice cultivation is distinct characteristic of Apatani agro-ecosystem, which has further boosted up the local economy. A number of studies have been carried out on agriculture system, particularly jhum system, natural resource utilization and livestock managements but there is hardly any data available on traditional natural resources management and conservation in Apatani valley with few exceptions of socio-anthropological investigations. The present paper evaluates the value of traditional natural resources management and conservation practices done by Apatani community in Ziro valley, Arunachal Himalaya of Northeastern India. This study will provide a clear understanding on environmentally sustainable

indigenous resources management, availability and its future potential, which will help the policy planners and resource managers for efficient management of limited resources in fragile Himalaya in particular and other mountain regions in general.

2. Materials and Methods

2.1. Study Area

North-East India comprises of seven states, namely, Arunachal Pradesh, Assam, Maghalaya, Manipur, Mizoram, Nagaland and Tripura, which is known for high ethnic and biological diversity, and is often referred to as "Biological Hotspot" (Myers et al., 2000). Recently Sikkim is included in this conglomeration. Arunachal Pradesh has an area of 83,743 km² with an elevation ranging between 100-7090 m msl. The state is having a total population of 10,91,117, which comprises of 26 major and over 110 sub-tribes. It shares major geographical land area of the Northeast region, and is geo-politically importance as whole of the northern side is bounded by China, the northeastern side by Myanmar, the western by Bhutan, south-western by the state of Assam and on the southern by Nagaland. The Lower Subansiri district is located in the central western part of Arunachal Pradesh and lies between 26° 55' to 28°21' N and 92° 40' to 94° 21' E.

Table 1. Temporal change in demographic of Apatani Tribe and Arunachal Pradesh (Census of India 1961 to 2001)

Year	Population		% to state
	Apatani	Arunachal Pradesh	
1961	10,793	3,36,588	3.21
1971	12,888	4,68,511	2.75
1981	16,580	6,31,839	2.62
1991	22,526	8,64,558	2.61
2001	24,650	10,91,117	2.26

Ziro, a scenic valley, is the home of the Apatani tribe whose unique land use pattern, resource management and culture of conservation have made them a focal point of attraction (Haimendorf, 1962; Kumar and Ramakrishnan, 1990). It is the district headquarters of the Lower Subansiri, and is popularly called as "Rice Bowl of Arunachal Pradesh". It has 35 villages, with a population of 24,650 and a density of 23 people per km² (Table 1). The decadal (1991-2001) growth rate of 8.62 is much lower than the state (26.21%). The Valley has an area of more than 1058 km², of which 33 km² is cultivated land while the rest is under forest, plantations and settlement (<http://lowersubansiri.nic.in/html/forestpractice.htm>). The valley lies between Panior and Kamla (Kuru) river at an altitude that ranges from 1525 m msl in valley to 2900 m msl in hilltops (Fig 1). The region is bounded with the areas traditionally belonging to the neighbouring Nishi and Hill-Miri tribes except south-eastern region

by Assam.

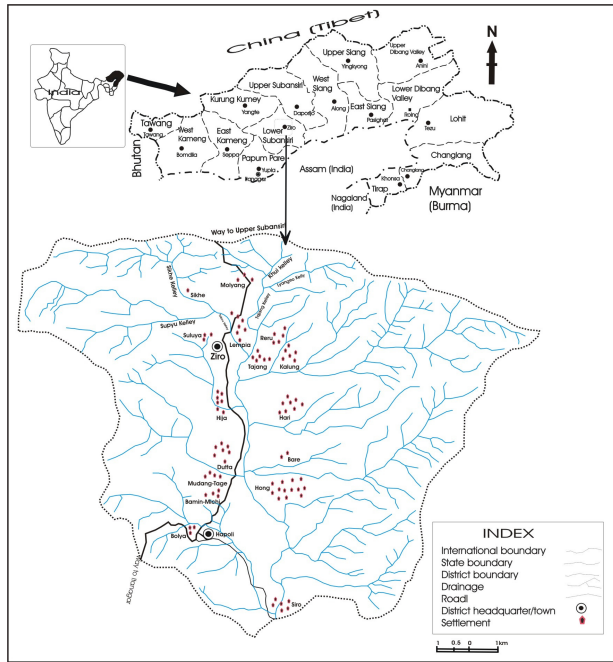


Figure 1. Location map of Ziro Valley (agriculture and settlement land only).

It has a humid subtropical to temperate types of climate with 235 cm of annual rainfall and a temperature ranging from 6.3 to 28.1°C and 1.9 to 18.4°C during summer and winter, respectively (Fig 2). The soils of the valley are humid black and reddish in colour, developed from genesis and schist overlaid on a wide area with older alluvial deposits. The top soils are sandy loam to clay loam in texture, soil pH ranges from 5.10 to 5.64, organic carbon from 1.25-2.87%, available phosphorus from 19 to 32 kg ha^{-1} and exchangeable potassium from 300 to 365 g ha^{-1} .

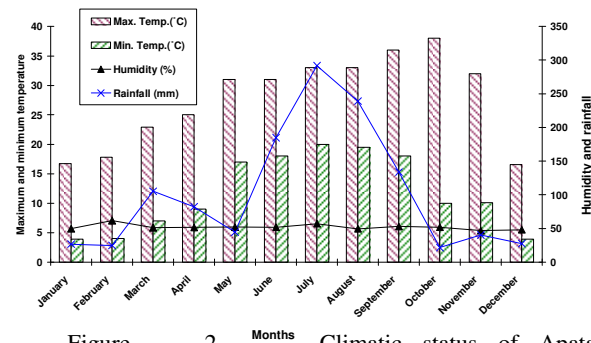


Figure 2. Climatic status of Apatani plateau

2.2. Data collection and analysis

This study is mainly based on field surveys

through pre-tested questionnaire, formal and informal interviews with villagers and farmers of 5 randomly selected villages, and quadrat method for yield estimations. Field survey was made during the year 2005-2007, at least by selecting 1/4 households in each village, and the farmers were interviewed by considering all economic and social backgrounds (stratified method). The data were gathered on indigenous land use, natural resources and its sustainable management, economic yield of agro-ecosystem as well as their historical and cultural backgrounds. All the activities in the villages were closely monitored and quantified over the years for resources management. Economic yield were analysed by using thirty 1m² quadrates lying randomly. Economic yield per hectare was calculated on the basis of the yield from entire plot (Mishra, 1968). Fish production was measured on the basis on total fish output by 15 farmers in each village, which was further calculated into one hectare basis. Soil analyses were done by TSBF methods of Anderson and Ingram, 1993. Data collected were systematically assessed and analysed, and numerical value was treated statistically to assess the standard error, which was interpreted further for drawing conclusions.

3. Result and Discussion

Apatani tribe has been known as an efficient resources manager with rich traditional ecological knowledge, and conservative in nature, which has been attracting the UNESCO to proposed Apatani or Ziro valley as World Heritage Site. They follow a settled pattern of life and are basically agrarian. The community has evolved with unique skill of rice-fish cultivation, and unlike to most other tribal communities they do not practice shifting cultivation (Jhum). Apatanis are efficient managers of land and depend mostly on their plantations rather than on the forest for their basic needs. Such practice distinguishes them from most of the other tribes of the state and defines their distinctive lifestyle and social system. The community still maintains the age-old tradition for resources management and the modern scientific technology has little influence in this context. They have rather strengthened the traditional systems of forest management, bamboo plantation and land and water resource utilization as compared to other northeast tribal communities who have been impacted by the wind of modernization to a large extent.

3.1. Historical and cultural Background

The people of Apatani were originally belonging to

the Tibeto-Mongoloid stock (Haimendorf, 1962). They trace their descent from one legendary ancestor, Abotani. Apatanis have migrated to this magnificent Valley from northern areas beyond Kuru and Kime rivers. This is revealed from finding of three neolithic celts at Parsiparlo and Raga circle, and historical remains at Talle Valley by Archaeological Survey of India (1992). It is, therefore, apparent that they followed the path of Kuru (Kamala), Kime and Tsangpo rivers. They settled at Talle Valley for few decades and ultimately migrated to Ziro valley. Apatanis live in fairly large villages, which are compact and permanent, although during recent years they are dispersed to avoid damage by fire accidents. Housing patterns are long and made of bamboo and timber.

They believe in indigenous religion 'Donyipoloism', and are patriarchal in social system. Earlier, they have prominent tattoo marks on the face, which, however, has been discouraged in recent past, and almost abolished now. The community is sub-divided into numerous clans but all the clans are believed to have evolved from same ancestor. The clan is the main social unit, which acts in solidarity. Like many other tribes of Arunachal Pradesh, they are highly co-operative and mutually linked up by kinship, ritualistic and friendship ties through *Binee Aajing*. The tribe practices clan exogamy and community endogamy, and believes in monogamy. Community has diverse types of ritual ceremonies and dances. Among that *Daminda* and *Pakhu-Ittu* are popular dances while *Dree*, *Yapung*, *Myoko* and *Murung* are major ritual ceremonies. *Myoko*, the most important festival is celebrated each year in the month of March in cycle manner by forming three groups, each comprised of one or numerous villages. The festivals are celebrated mainly to ensure better crop harvest, protect grain from hailstone, insect, pest, disease and wild animals, and also for the well being of individuals or community as a whole. There is Traditional Village Council to regulate the administration, which is of three tiers, namely *Akha Buliyang*, *Yapha Buliyang* and *Ajang Buliyang*. In each tier of council, one or two person should represent from each clan. *Akha Buliyang* hold the highest authority on any decision making body while the role of *Yapha Buliyang* is mediator and interpreter in nature and *Ajang Buliyang* acts as messenger. The position of *Buliyang* is hereditary or selected through democratic means. They are arbiters of tribal law and upholders of tribal justice, however, the individual *Buliyang* are primarily the spokesman of their own clan or village.

Apatanis are agriculturists in nature and have good numbers of traditional ecological knowledge on sustainable management of their limited resources. The exact date and time of initiation of wet rice cultivation is still untraceable but through mythology, it is believed that it might have been started at *Pega-Sarang* (name of

place). Apatani oral literature suggests that *Hinkun Yari* carrying rice crops from mythological place called *Hinkun Lembyan* met *Ato Pussan* and *Ayo Tane* at *Miido Pyagan*. There, she offered varieties of rice seeds to *Ato Pussan* and *Ayo Tane* for cultivation and till now, through several generations the crops are successfully cultivated. Once upon a time, Apatani Valley was believed to be having sporadic mountains, hills and marshy land. It was the sincere and hard working effort of their ancestors to make it suitable for wet rice cultivation.

Ever since most of the Apatani farmers practice rice-cum-fish cultivation with finger millet on the bund (risers) over an area of 3297 ha, while 1003 ha is under rain-fed farming. The wet rice fields are irrigated through well-managed canal systems. It is managed by diverting numerous streams originated in the forest into single canal and through canal each agriculture field is connected with bamboo or pinewood pipe. Socio-economy of the community is mainly based upon agriculture, fishery and bamboo resources, though majority of its land area is under primary and well managed secondary forests more appropriately can be termed as sacred groves. The blue pine and bamboo plantations on the fringes of a wide mosaic of wet rice fields surrounded by thickly forested mountains on all sides, forms a picturesque landscape. Apatanis, though famed for their agricultural practices, high rice yields and forest and bamboo plantations, quantification of this land and plantation based economy has received little attention. Besides agriculture, they rear Mithun (*Bos forntalis*), cattle, pig and poultry.

3.2. Indigenous land use

Indigenous land use classification was evolved out of century old experimentation on resource management and their effective utilizations. Categorization of lands by upland farming community of Apatani was largely based on their perception of most appropriate and sustainable use of their limited land resources. It has been well classified and regulated under the traditional customary norms. Broadly, the land is categorized into four major types and each category has numerous sub-types (Table 2). The major indicators of traditional classification of lands are available today in the forms of widely known land use practices having ecological significance, such as forest, sacred groves, agricultural, grassland, etc.

Forest is invariably managed on sloping lands in the fringe of agricultural and bamboo plantations. While human settlement is in the middle of forest and agriculture that the community can access to both the land use easily, this reduced the labour and time. Agriculture is a prime source of livelihood sustenance, which is highly inter-linked with forest ecosystem. Besides agriculture, bamboo plantations have major role

in the tribal economic and socio-cultural practices. Diversification of land uses is an example of highly successful human adaptation mechanism to the rigor and constraints of upland regions. Among all the land uses, clan forest and village forest have the largest mean plot size with 8.60 ha while granary with lowest of 0.011ha. Meanwhile the most important land use,

agriculture varies from 0.098 to 0.015 ha and bamboo plantation with 0.62 ha. Sacred groves, an important land use for conservation purpose has only an average plot size of just 0.096 ha (Table 2). However, it has an important role in *in-situ* (germplasm) conservation of socio-culturally valuable, economically potential and ecologically significance species.

Table 2. Indigenous land use classification of Apatani community (*value in mean \pm SE.).

Land use Type (Local name)	Plot size (ha)*	Description	Importance
1. Forest			
i) <i>Bije</i>	0.620 \pm 0.013	Individual bamboo forest, mixed with pine & <i>Castanopsis</i> spp.	Bamboo, timber and fuelwood extraction for construction & household requirement.
ii) <i>Sansung</i>	0.871 \pm 0.017	Individual forest (Castanopsis/ pine dominant forest, mostly monoculture)	Extraction of timber, fuelwood and materials for ritual ceremony.
iii) <i>Uru Moreh</i>	2.660 \pm 0.181	Sub-clan forest (mostly mixed forest)	Extraction of timber, bamboo, cane, fuelwood & other NTFPs for household requirement. Collection of materials for ritual ceremony, hunting & rearing of mithun.
iv) <i>Hallu morey</i>	8.602 \pm 0.385	Clan forest (monoculture of pine, castanopsis dominant & mixed forest)	-do-
v) <i>Lemba Booth Morey</i>	8.601 \pm 0.367	Village forest (mixed vegetation forest)	-do-
vi) <i>Supung Booth Morey</i>	-	Community forest	-do-
vii) <i>Polung</i>	0.106 \pm 0.009	Community/village grazing land	Grazing land for cattle
viii) <i>Rantee</i>	0.096 \pm 0.006	Sacred groves (Village land)	Restriction of extraction except for ritual purpose. Good seed bank for varieties of spp.
2. Agriculture			
i) <i>Ballu</i>	0.053 \pm 0.006	Home garden	Varieties of vegetables, pulses, chillies etc., & millet nursery for garden & bund.
ii) <i>Yollu</i>	0.058 \pm 0.005	Vegetable garden	-do-
iii) <i>Lyapyo</i>	0.031 \pm 0.002	Millet field	Millet cultivation
iv) <i>Jaebe-Aji</i>	0.098 \pm 0.007	Wet rice field	Rice-cum-fish culture
v) <i>Ahi-Amii farang</i>	0.054 \pm 0.006	Fruit garden	Apple, pears, plum, peach etc.
vi) <i>Ngvi su-per</i>	0.015 \pm 0.001	Fish pond	Particularly for raising fingerling for rice field.
3. Settlement			
i) <i>Neshu Nechang</i>	0.011 \pm 0.001	Granary	For storing rice, millet and other crops.
ii) <i>Ude Nechang</i>	0.048 \pm 0.002	House	Household settlement
iii) <i>Pede Pilley</i>	-	Farm house	Particularly for agricultural purpose
iv) <i>Alyi giiri</i>	-	Pig pane	Rearing pig
4. Miscellaneous			
i) <i>Sukung</i>	-	Well	For drinking water.
ii) <i>Sugang</i>	-	Canal/streams	Irrigation purpose
iii) <i>Lenti lenda</i>	-	Road	Communication
iv) <i>Killey</i>	-	River	Natural gift of water for Apatani valley

3.3. Traditional forestry

Apatanis are managing the forest and its resources through traditional customary norms under above classification. Each of the forest is sustainably managed and the resources are tapped judiciously as well. The forests of Apatani Valley comprised of four well-defined zones (Table 3). In recent time this zonation is lightly disturbed because less effort is being given on management and successional takeover of *Pinus wallichiana* (*Pessa*) forest. However, it is still maintained well, which is one of the sustainable systems of forest management and is better than government regulated protected forest. The first zone is just above the rain-fed

or wet rice cultivation, which is monoculture of bamboo or mixed vegetation with bamboo, pine and *Castanopsis* spp. The second zone consists of *P. wallichiana* forest followed by third zone, which is a monoculture of *Castanopsis* spp., and or mixed vegetation of *Castanopsis* spp. with *Quercus* spp. etc. The fourth zone is the subtropical broad leaf mixed vegetation that consists of *Quercus lanata*, *Castanopsis* spp. etc., and temperate vegetation such as *Taxus wallichiana*, *Cephalotaxus* sp. etc. (Table 3). Though all forest types are important for the community, there is a high dependency on bamboo and *Castanopsis* spp. forests.

Table 3. Forest zonations and important plant species in Apatani plateau

Forest	Species	Major role
1. Bamboo plantation		
a. Monoculture	<i>Phyllostachys bambusoides</i>	Fuel wood, food, handicraft, housing and ritualistic materials.
b. Bamboo + pine	<i>P. bambusoides</i> , <i>Pinus wallichiana</i> , <i>Alnus nepalensis</i> , etc.	Timber, fuel wood, food, handicraft, housing and ritualistic materials.
c. Bamboo+ castanopsis	<i>P. bambusoides</i> , <i>Castanopsis indica</i> , <i>C. hystrix</i> , <i>C. tribuoides</i> , <i>A. nepalensis</i> , <i>Dendrocalamus hamiltoni</i> , etc.	Timber, fuel wood, food, handicraft, housing and ritualistic materials.
2. Pine	<i>P. wallichiana</i> , <i>Pyrus pashia</i> , <i>Prunus nepalensis</i> , etc.	Timber, fuel wood and wild edible fruits.
3. Castanopsis	<i>C. indica</i> , <i>C. hystrix</i> , <i>C. tribuoides</i> , <i>A. nepalensis</i> , <i>Myrica esculenta</i> ,	Timber, fuel wood, ritualistic materials and wild edible fruits.
4. Mixed forest		
a. Sub-tropical	<i>Quercus lanata</i> , <i>C. tribuoides</i> , <i>C. indica</i> , <i>C. hystrix</i> , <i>Michelia champaca</i> , <i>Terminalia chebula</i> , <i>Exbucklandia populnea</i> , <i>Helicia robusta</i> , <i>Spondias axillaris</i> , <i>Illicium griffithii</i> , <i>Actinidia callosa</i> (wild kiwi), <i>Dendrocalamus hamiltonii</i> , <i>Chimonobambusa</i> spp. etc.,	Timber, fuel wood, ritualistic materials, handicraft, wild edible fruits and herbal medicine.
b. Temperate	<i>Taxus baccata</i> , <i>Pinus wallichiana</i> , <i>Cephalotaxus</i> sp. <i>Cedrus deodra</i> , <i>Tsuga dumosa</i> , <i>Rhododendron arboreum</i> , <i>Pleioblastus simoni</i> , <i>Arundinaria</i> sp. etc.	Timber, fuel wood, ritualistic materials, wild edible fruits and herbal medicine.

All the forests are maintained through century old traditional ecological knowledge of resource management practices, which is sustainable. These forests are maintained not only to meet the fuelwood, fodder, food, and timber need of the community but also for socio-cultural and ritualistic purpose. Bamboo and pine groves meet the requirement of timber for house construction, edible bamboo shoots, fencing, erosion control, fuelwood, handicrafts and materials for ritual ceremonies. The *Sansung* (individual forest) are managed for fuelwood and material source for ritual ceremonies such as *Myoko*, *Murung*, *Subu*, etc. In addition, it has an ethno-medico-botanical resource centre for the community. The bamboo plantations are dominated with a single species *Phyllostachys bambusoides*, though the community uses other bamboo

species mainly collected from primary forest. Maintenance and plantation of bamboo is done with utmost care. The rhizomes are planted during the month of February or early March, and proper weeding and selective harvesting of young bamboo shoots are done to increase the yield. It is normally carried out just a month before the emergence of young shoots, and the young shoots pruning is done by observing the nature and size of shoots. Maturation of bamboo is recognized through the development of a fungus on the surface of main stem. Normally, it is harvested after every third year.

Pine seedlings are planted during February and looping of branch is done after third year of plantation. It is believed that proper looping enhances growth and straightness of plants, beside it supplies fuelwood

requirement. *Castanopsis* spp., *Alnus nepalensis*, *Prunus* sp., *Prunus nepalensis*, *Pyrus* sp. *Quercus* spp. etc. are managed through cutting at the height of 3-8 m. This helps to promote large scale emergence of branches (coppices) and is believed that such type of management gives faster growth of plant in comparison to seedling plantation.

3.4. Farmer groups for sustainable management

It is often thought that underdeveloped or remote regions are inhabited by unorganized farmers but a closer look reveals that these farmers are often knitted together in some way. Traditional farmers groups can play a pivotal role in achieving and maintaining sustainable production in a specific agro-ecosystem. For example, Arunachal Himalaya is globally acknowledged for its rich eco-cultural heritage, and the wealth of traditional ecological knowledge amongst farmers. Shared in farmers groups who form to work on the land together, this knowledge clearly supports sustainable agro-ecosystem management in the region.

The traditional farmers groups of the Apatani people, in the Apatani Valley in the central western part of Arunachal Himalaya, have been successfully managing their natural resources for centuries. The Apatani have different types of traditional farmer groups, which have evolved over the years. There are no written records so it is impossible to trace the exact

history and development of the groups. The traditional agro-ecosystems are intricately linked with nature, and are well-fitted to local environmental conditions and cultural needs. These agro-ecosystems are sustainable, self-sufficient and efficient due to strong organisations and sharing of such ecological knowledge among farmers, which has always been transmitted orally from generation to generation. Indigenous classification of agricultural land use into 7 categories for efficient land management, and to produce enough to sustain the population is an example of innovative ecological design by the farmer groups. Traditional wisdom on crop-soil interaction, ethno-pedology, nutrient management, and soil and water conservation are some examples of ecological knowledge which supports the sustainable production system as it has evolved over the decades, and which cannot be managed by individuals. The Apatani have eight different types of informal farmer organisations (Table 4) and each group has their own task and workload. The groups are valued differently by the community, for example, the *Bogo* (that looks after construction and maintenance of water sources) is seen as the most important group as there are limited water sources for irrigation in the Apatani valley, and good water management is essential for efficient production in the paddy-cum-fish system.

Table 4. Types and working nature of traditional farmer groups of the Apatani tribe (texts in italic are in the local dialect)

Local name	Description	Group Manager	Task
1. <i>Bogo</i>	A farmer group sharing the common water sources. The group manager leads all the activities. Posts can be held for 1-3 year(s) and are selected/ elected from within the group. Group size is between 3-600 households depending on village size.	<i>Bogo Ahtoh</i> (male)	Construction and maintenance of water supply system and regulation of the efficient sharing of water among the group
2. <i>Aji Lenda</i>	A group which has their fields in the same area. The group manager leads all the activities. Tenure is normally for one year only. Group size is 50-350 households.	<i>Lenda Kagenee</i> (male/ female)	Construction and maintenance of foot-paths to allow access to and from fields.
3. <i>Sulu- sikhii</i>	A group, which has their fields in the same area. The group manager leads all the activities. Tenure is normally for one year only. Group size is 50-350 households.	<i>Sulu Kagenee</i> (male)	Construction and maintenance of fencing to protect the agricultural fields from domestic and wild animals.
4. <i>Tanser Patang</i>	Groups organised during field preparation and weeding. Group size is 5-15 households.	<i>Patang Ahtoh</i> (female)	Field and nursery preparation, seed sowing, and weeding.
5. <i>Konchi Patang</i>	This group works in the morning between 5 am to 8 am. Group size is 5-10 households.	<i>Patang Ahtoh</i> (female)	Field preparation, transplantation and weeding.
6. <i>Halying Patang</i>	This group shares labour during seedling transplantation. Group size is 5-15 households.	<i>Patang Ahtoh</i> (female)	Transplantation of seedlings, particularly paddy and millet.
7. <i>Enthee Patang</i>	This group forms to share labour during crop harvesting. Group size is 8-12 households	<i>Patang Ahtoh</i> (male/ female)	Harvesting and carrying of harvests.
8. <i>Bijee Lenda</i>	A group having bamboo garden at same locality. Here also group manager leads all the activities. Tenure is normally for one year only. Group size is 70-300 households.	<i>Lenda Kagenee</i> (male)	Construction and maintenance of foot-path, a way for carrying bamboo, timber and fuelwood.

(source: Dollo, 2007)

The farmers know that traditional practices are very important for maintaining sustainable production systems, and also that the farmer groups are the foundation of these practices. Most farmers recognise that without farmer groups, agro-ecosystem management will easily weaken, and the technical ecological knowledge which supports it will erode fast. In this sense, most farmers think that the groups are effective in managing the agro-ecosystems. Except for financial support, particularly for erosion control, fencing and drainage maintenance, the farmers do not receive or seek any technological interventions or other help from any outside agencies. Outside experts highlighted the Apatani paddy-cum-fish culture system as one of the most efficient crop production systems, which has further encouraged the Apatani farmers to continue their traditional practices.

3.5. Traditional agro-ecosystem

The valley rice cultivation has undergone a steady evolution and modification through the concise management of land that led to well-drained terraces with perfect bunds (*Agher*). Generally the bunds are made up of soil, and supported by splitted bamboo and wooden pieces at base if there is chance of erosion due to splashing of water. The size of riser may vary from 0.5 to 2 m in breadth and 0.2 to 3 m in height depending on the gradient of land and the size and shape of the terraces. Perfect levelling of plots, well-managed irrigation and drainage reduce the soil erosion to a negligible level. Besides, varieties of soil and water conservation are practised by using locally available materials of bamboo, wood and cane. Average plot size is 0.098 ± 0.007 ha, however, the size of plot gradually decreases towards the hills and small valleys. The average area for rice field was recorded as 0.36 ha per family in selected study villages of Apatani Valley.

The valley rice cultivation field can be categorised into three types based on practices, viz. *Jaibee-aji*, *Pitang-aji* and *Miding*. *Jaibee-aji* is the marshy agricultural field, which is normally kept without watering during the fallow period, while *Pitang-aji* is an agricultural land that requires water supply during fallow period, which is essentially required at least for two months otherwise the productivity of the land is considerably low with high weed infestation. *Miding* is a small size (48 m^2) agriculture land maintained for rising rice nursery. In such plots water is maintained round the year though needs to drain out just before the preparation and sowing of seed but always kept with light water supply.

The valley used for cultivation of rice is efficiently irrigated through well-managed water supply canal systems. Since time immemorial, the Apatanis have practiced a scientific system of irrigation through indigenous technique with local materials available in the region. All the diversions are made with wooden

piece, bamboo and cane locally called *Bogo* (small dam/barrier). The maintenance of barrier and irrigation canal systems is managed through cooperative efforts among all the beneficiaries under the supervision of selected person(s) (*Bogo-Ahtoh*). Every stream from the surrounding hills is tapped soon after it emerges from the forest, channelized at the rim of the valley and diverted by a network of primary, secondary and tertiary channels. The discharge of the river during monsoon varies from 4.8, 13.9 and 32.2 cubic meter per second at the entrance, middle and end of the plateau, respectively. In absence of large river, the water from minor river or streams is used in such a way that all the fields get equal benefit of irrigation. To maintain this, a volume of water is diverted in feeder canal (*Segang*) and then to pipe (*Huburs/Siichoo*). The feeder canals or pipes are branched to feed many terraces by blocking or opening the connecting pipes.

Table 5. Classification of indigenous rice (*Oryzae sativa*) landraces

Land races	Duration & cultivation
1. Eamo	
i) <i>Ampu Ahare</i>	Early variety, most commonly cultivated, duration 195-210 days.
ii) <i>Ampu Hatte</i>	Late variety, commonly cultivated, duration 245-256 days.
iii) <i>Radhe Eamo</i>	Late variety, rarely cultivated, duration 235-245 days.
iv) <i>Eylang Eamo</i>	Late variety, most commonly cultivated, duration-230-240 days.
v) <i>Ampu Puloo Hatte</i>	Late variety, extinct, duration-260-270 days.
2. Mipye	
a) Pyate Mipye	
i) <i>Kogii Pyate</i>	Early variety, commonly cultivated, duration-205-215 days
ii) <i>Zeehe Pyate</i>	Early variety, rarely cultivated, duration-205-215 days
iii) <i>Pyate Pyapu</i>	Early variety, rarely cultivated, duration 195-208 days
b) Pyaping Mipye	
i) <i>Tepe Pyaping</i>	Early variety, most common cultivated, duration-205-215 days
ii) <i>Pyapu Pyaping</i>	Early variety, rarely cultivated, duration 195-208 days
iii) <i>Kogii Pyaping</i>	Early variety, rarely cultivated, duration 205-215 days
iv) <i>Zeehe Pyaping</i>	Early variety, rarely cultivated, duration 205-215 days
v) <i>Pyare Mipye</i>	Early variety, cultivated nearby settlement, duration 172-180 days
vi) <i>Mishang Mipye</i>	Early variety, rarely cultivated, duration 205-215 days
vii) <i>Mithu Mipye</i>	Early variety, commonly cultivated, duration 195-208 days
viii) <i>Eylang Mipye</i>	Early variety, rarely cultivated, duration 205-215 days

The cross section of main canal ranges between 0.8 to 1.5 m in width and 0.60 to 1.2 m in depth, while that of feeder canal ranges between 0.48 to 0.85 m in width and 0.45 to 0.75 m in depth. To check the erosion, flow of water in each feeder canal or pipe is regulated by wooden planks or stone. The most important aspect of traditional water management by Apatanis, which appears to be scientific, is to keep water layer on the soil surface at the permissible depth. For that, flow of water from one field to another is maintained through a ditch (*Muhgo*) on bund and two outlet pipes. The ditch is especially for outflow of excess water as well as maintaining the desire depth. The desire level of water is maintained by putting straws/weeds in ditches, where the height of straws/weeds is maintained accordingly. Two outlet pipes is placed in such a way that the upper one is for over flow and lower one is for draining the water completely. Normally, 1-2 cm water is maintained just after plantation, which is increased gradually with respect to rice plant growth and size of fish but is not kept more than 15 cm. In the middle of rice field a small depression or canal (*Siikho/Parkho/Hehte*) is made for water and soil management in olden time but is best suited for fish culture in present day. This canal is constructed in perpendicular as well horizontal to the bund with the help of traditional agriculture implement (*Hiita*). During agro-piscicultural activities water is drained out time to time. For weeding, water is drained twice/thrice, which coincides with harvesting of fish. In later stage, water is totally drained from field for early ripening and increase the yield as well as to make it dry during harvesting. The water from the terraces is finally drained into the *Kale* river, which flows through the middle of the valley.

Table 6. Indigenous millet (*Eleusine coracana*) landraces

Landrace	Duration & cultivation
Sarse	
<i>Surpu Ahare</i>	Early variety, duration 162-176 days, commonly cultivated, average productivity.
<i>Surpu Latha</i>	Late variety, duration 183-195 days, most commonly cultivated, high productivity.
<i>Sartii</i>	Late variety, duration 195-210 days, rarely cultivated, low productivity.
<i>Ahki sarse</i>	Late variety, duration 180-190 days, rarely cultivated, low productivity.

Apatani is having high rice diversity with 16 indigenous landraces (Table 5), which differ in height, grain characteristic, nutrition requirement, duration, productivity and resistance to disease and insect pests. All the indigenous rice landraces except *Ampu Puloo Hatte* are grown. The rice crop duration varies from 172 to 270 days with an average of 221 days (Table 5).

Since 1992 high yielding rice varieties such as IR-36, Mashuri and IET6666 are introduced but with little success. The bunds of the rice fields are cultivated with millet thus leaving no portion of land unutilized. Only the indigenous millet (*Eleusine coracana*) landraces-*Surpu Latha*, *Surpu Ahare*, *Ahki Sarse* and *Sartii* are grown in the valley (Table 6). *Ampu Ahare*, *Eylang Eamo* and *Ampu Hatte* are commonly cultivated in the region, which together cover more than 67.02% of total wet rice fields. These three varieties have high productivity besides socio-religious importance. Among *Eamo* varieties of rice, cultivation of *Ampu Puloo Hatte* is not in practice probably due to its long maturation phase. While *Mipye* has 11 landraces, of this *Tepe Pyaping* is preferred the most by the farmers because of its high yield and that can sustain the marshy land. The *Pyate Mipye* and *Pyare Mipye* varieties are losing importance in recent times due to immature grain falling, which leads to low yield. Normally, the *Eamo* landraces are cultivated in medium fertile soil while *Mipye* varieties are preferred in high as well as very low fertile land. It is believed that the grains of *Eamo* landraces are abortive in highly fertile soils, and at the same time they cannot be sustained in less fertile lands as well. The yield is largely dependent on nutrient flow from villages and recycling of crop residues. Wet rice agro-ecosystems of Apatani largely depend on wash-out from the hill slopes. To sustain the productivity of rice field there is a need to maintain forest cover at high reaches.

The rice is first raised in the nursery (*Miding*) of nearly 48 m², which is further divided into 3-4 nursery beds (*Hohe*) of 4x3 m size. The field for nursery is normally selected in narrow valley or just near to the settlement. This is done because nursery requires more nutrients and high speed flow of wind delay the germination. If the settlement is nearby, the nurseries are fed with small canals carrying human wastes and animal excreta. Each landrace is maintained separately in nursery bed to avoid the possible mixed up of seedlings. The beds are prepared just after the completion of *Murung* festival in the month of February with the help of traditional implement (*Hiita*). The seeds are sown at the rate of 75-80 kg ha⁻¹ that were collected through a selective procedure with high care. The seedlings (*Andee*) are maintained for 55-80 days until they attain height of 12-15 cm and 15-18 cm for lightly wet (*Pitang-aji*) and marshy (*Jaibee-aji*) fields, respectively. The finger millet nursery for bunds and rain-fed millet field is raised at home garden. The sizes, time and preparation technique of nursery beds are almost same as that of rice. After attaining of 12-16 cm height, the transplantation is done with the help of traditional implements (*Dum*). Before transplanting of rice, 5-10 cm apical portion of seedlings are removed to avoid seedling mortality. The *Dum* is used for making hole on bunds for seedlings to be transplanted.

Preparation of agricultural land begins just after the completion of *Myoko* festival in the later part of March. All the land preparations are completed by the end of April. These land operations are done manually by indigenous wooden tools (*Sampeyee*, *Hiita*, etc) and spade. Transplantation of seedlings begins with in the month of April and is completed by the end of May. In hard soil seedlings transplantation is done by traditional implement (*K-du*), which is mainly used for making hole. Single rice seedling is transplanted at a spacing of 12-18 cm. Terrace bunds are used for finger millet cultivation through transplanted seedlings by maintaining a spacing of 9-12 cm.

Weeds (*Ahru-tamii*) are the major problems for farmers. Weeding (*Ahru-hodo*) is done 3-4 times in a year. First weeding is done before soil preparation for transplantation in the month of February followed by second weeding in the month of July or early August, which is coincided with first fish harvesting. Third is in the late August while fourth is in September that also coincides with final harvesting of fish. Weeds are converted into compost through traditional systems by gathering all the weeds in one place, which is then covered with a thin layer of soil for quick decomposition. The weeds collected in February from bunds are used as compost for rain-fed garden, mainly for cultivation of chilies.

Table 7. Area and yield of rice and millet (*value are mean ±SE)

Crop (% cover)	Total Area in ha (%)	Yield (qha ⁻¹)*
Rice (97.03%)		
1. <i>Eamo</i>	2144 (67.02)	54.89±3.12
2. <i>Pyaping</i>	725 (22.66)	49.65±4.86
3. <i>Pyat</i>	330 (10.32)	42.93±3.01
Millet (2.97%)		
1. <i>Surpu Latha</i>	58(59.18)	21.01±1.03
2. <i>Surpu Ahare</i>	28(28.57)	17.23±1.14
3. <i>Sartii</i>	7(7.14)	14.35±0.98
4. <i>Ahki sarse</i>	5(5.10)	12.98±1.26

The different landraces of rice and millet differ in their yields. Productivity of rice varieties is high due to best management practices. An agronomic yield of rice varies from 43-55 qha⁻¹ while that of millet is of 13-21 qha⁻¹ (Table 7). Thus valley rice agro-ecosystem in Apatani Valley is highly productive being about four times higher than the average yield of the rice in the state (11 qha⁻¹) while production of millet is double than that of the state average (9 qha⁻¹). The system is economically viable and environmentally sustainable, cost of cultivation being low with minimal external

inputs. For all agricultural activities 298-328 mandays are required in one hectare of land.

3.6. Indigenous integration of fish culture

Since several decades, composite of rice with fish culture was traditionally practiced with a stocking rate of 2,500-5000 fingerlings/ha by using common carp, grass carp and silver carp fishes. Integrating fish with rice cultivation assures higher per hectare economic productivity and year round employment opportunities for farmers. The plots utilized for rice-cum-fish culture are mainly fed on organic manure with a variety of animals excreta such as poultry dropping, pig excreta, cow dung and plants waste like rice husk, local beer, ashes from household burnt, and compost like decomposed straws and weeds. The Apatanis utilized varieties of domestic waste products to their rice fields to enhance soil fertility and for fish food, which in turn improves crops productivity. These are done during the fallow period of November to February month. After harvesting the crop residue is recycled by burning and natural decomposition.

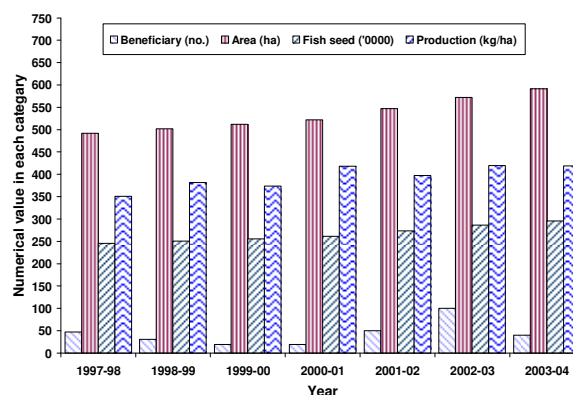


Figure 3. Governmental agency intervention in fish production activity in Ziro valley.

The fish species cultured in the valley are cyprinids viz. common carp (*Cyprinus corpio*), grass carp (*Ctenopharyngodon idelea*), silver carp (*Hypophthalmicthys rodepix*), rohu (*Labeo rohita*), Catla (*Catla-catla*) and Mrigal (*Cinihnus mrigala*). Almost 80% of the fish production in the valley is produced from common carp followed by grass carp. Common carp breeds freely in pond environment and there is no need of hypophysation (artificial breeding). The eggs adhere to sub-merged vegetation and the egg lying capacity being 1.10 to 1.20 lakh/kg of fish, a high fecundity is maintained (Pussang, 1999). In rice-cum-fish culture 2500-5000 fingerlings/ha are cultured in present day. The size of fish increases to 110-150 g after three months and 250-300g after five months. Therefore, the production rate is about 35-42 qha⁻¹. The area under rice-cum-fish culture and total production have slightly increased over the years, while the number of

beneficiaries have slightly decreased from 47 to 40 numbers during 1997-2004 (Fig 3). The growth rate of fishes is generally higher in the first year where they attain 40-50 cm in length and 1.0-1.2 kg in weight, if proper feeding is given. Moreover, these fish species can be handled very easily without much care or expertise. It is possible to generate additional sources of income and employment generation by bringing more and more water resources of the valley under scientific exploitation with external inputs. It would be an alternative venture to obtain protein rich food for fighting against malnutrition and side-by-side generate employment opportunities for many unemployed youths among the rural population of the valley.

4. Conclusion

There is enormous traditional ecological knowledge embedded in the hilly communities of Arunachal Himalaya, particularly in Apatani community. These knowledge is based upon the centuries of informal experimentations with local environment, being adapted to local ecosystem and are effectively functioning in sustainable resources tapping and conservation. The indigenous knowledge of Apatani tribe is unique in nature and effective in functioning. However, if onslaught of modernisation and cultural infestation continue, this will lead to loss of environmentally sustainable traditional ecological knowledge forever. Traditional practices not only promote the integration and maintenance of diverse land use types, but also ensure the continuity of diverse species and varieties within each component, which are observed in traditional agro-ecosystem with diverse varieties of crop species. The local ecological setting and the high degree of dependence on natural resources make such practices exceptionally valuable. All the management practices are highly self reliant with little external input or technologies and low dependency from external resources make it extremely endogenous and sustainable.

Traditional forestry in Apatani valley has been integral part of the local system, which is judiciously guarded and meticulously tended by all community members as it fulfils various basic needs. The rich natural resources combined with traditionally conservationist attitude of the Apatani can provide solution to many economic needs of the people. The Apatanis have a natural inclination towards plantation and ecological conservation, which if properly utilized can have tremendous impact on the development of the area. The traditional knowledge and skill related to management of natural resources by the Apatani is immense and that can be replicated elsewhere.

In the era of globalisation, traditional ecological knowledge of resources management provides a useful rationale for designing new technologies for sustainable management of valuable natural resources and efficient

ways of resource conservation. The ecological traditional technologies of Apatani community, such as fish-cum-paddy cultivation, bamboo and forest resources management are found to be highly effective in resource conservation and management, which are unique in nature, and economically and environmentally sustainable as well. A prerequisite, however, is proper documentation, appreciation and understanding of these ecological practices, which will help to harness the traditional knowledge to develop strategy for sustainable development of the fragile Himalayas. Although few of indigenous knowledge practices of Apatani community have been assessed by scientific world, nevertheless the need of the hour is proper documentation, analysis and in-depth understanding. Besides, sufficient credits need to be given to traditional ecological technologies and the practitioners. The integration of fish-cum-rice culture is unique in nature, and economically and environmentally sustainable. The choice of blending such knowledge with modern scientific technologies for the well being of the local people in particular and north eastern region in general, lies with the scientific communities, policy planners and administrators. However, undermining of the efficient traditional ecological knowledge of resources management and conservation will create disturbance in social as well as ecological setting.

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Physico-Chemical Analysis of Ground Water in Angul-Talcher Region of Orissa, India

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ABSTRACT: The study was carried out to assess the impacts of industrial and mining activities on the ground water quality in Angul-Talcher region of Orissa. The quality was assessed in terms of physio-chemical parameters. Ground water samples were collected from thirteen (13) open well at various locations in study area during pre and post monsoon season. The physico-chemical parameters such as pH, Electrical conductivity, TDS, Total hardness, Ca hardness, Mg hardness, Ca ion, Mg ion, Chloride, and COD were analyzed (APHA, 1998) to know the present status of the groundwater quality. Drinking water quality (IS: 10500) of pre-monsoon season was better than post monsoon season. Few water samples were slightly alkaline along with high dissolved solids.

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Key words: Ground water, physico-chemical parameters, water quality, drinking water standard

INTRODUCTION:

The safe portable water is absolutely essential for healthy living. Ground water is ultimate and most suitable fresh water resource for human consumption in both urban as well as rural areas. The importance of ground water for existence of human society cannot be overemphasized. There are several states in India where more than 90% population are dependent on groundwater for drinking and other purpose (Ramachandraiah, 2004). Ground water is also frequently using as the alternative source for agricultural and industrial sector.

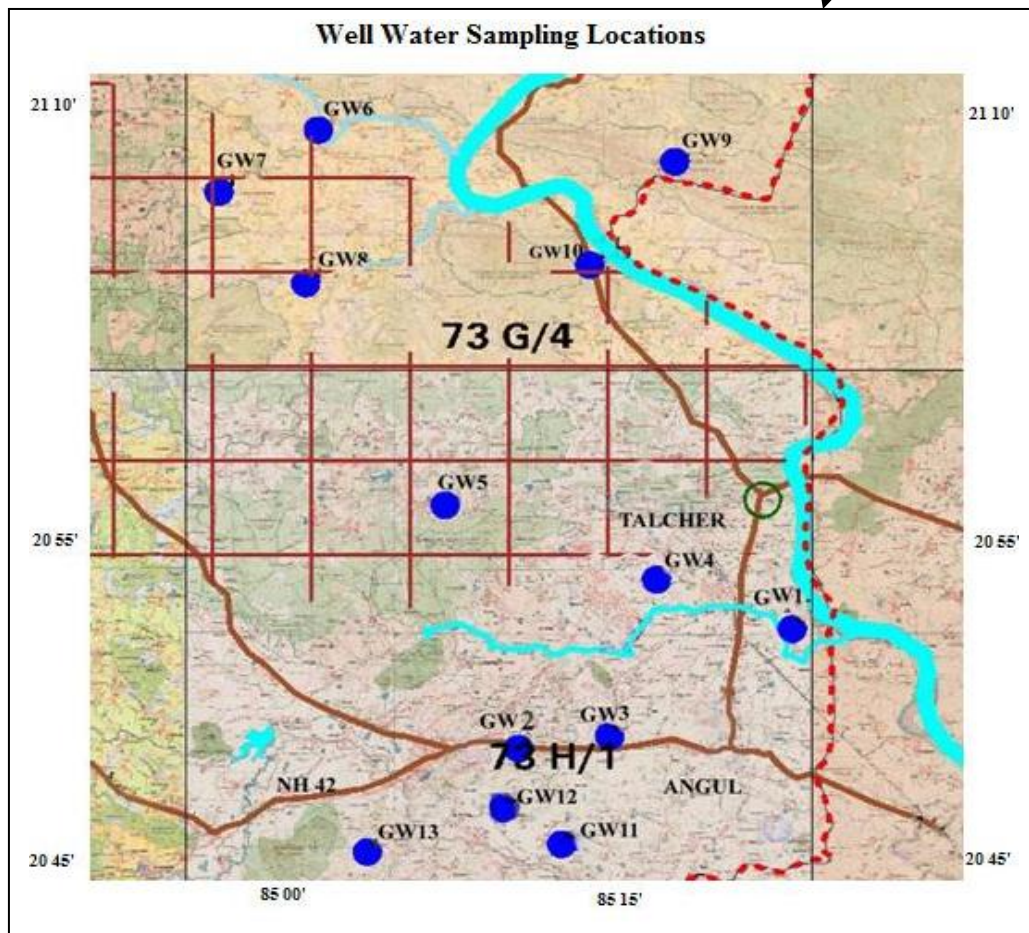
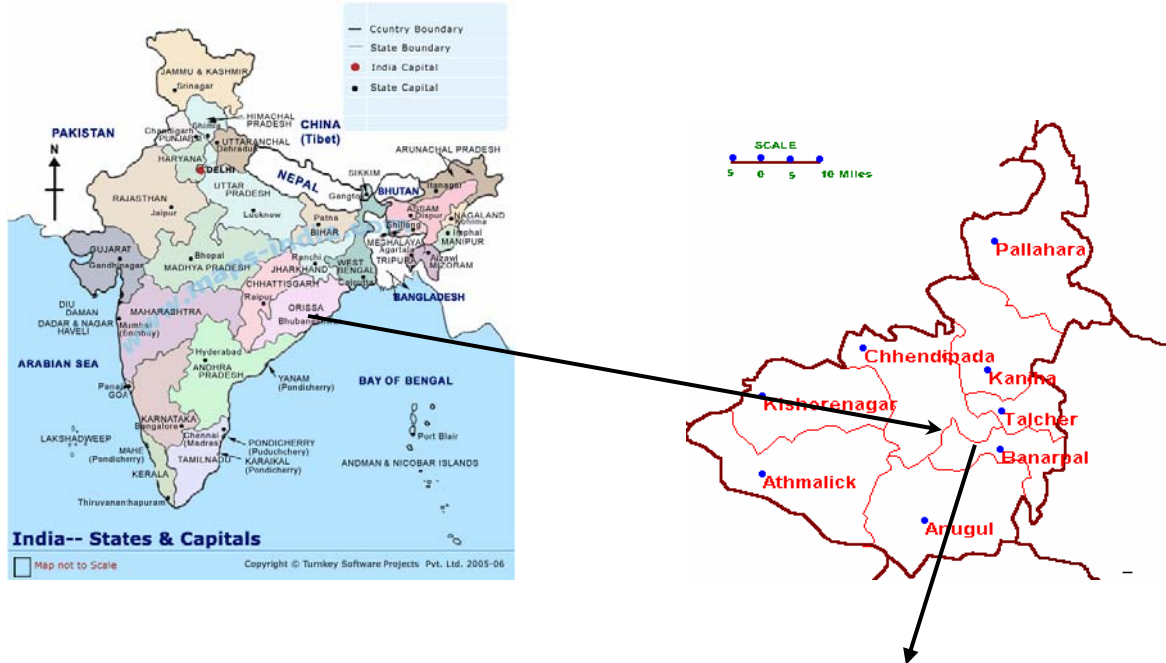
In India, there are over 20 million private wells in addition to the government tube wells (Datta, 2005). The wells are generally considered as the worst type of ground water sources in the term of physio-chemical contamination due to the lack of concrete plinth and surrounding drainage system (WHO, 1997). Over burden of the population pressure, unplanned urbanization, unrestricted exploration and dumping of the polluted water at inappropriate place enhance the infiltration of harmful compounds to the ground water (Pandey and Tiwari, 2009).

There are various ways as ground water is contaminated such as use of fertilizer in farming (Altman and Parizek, 1995), seepage from effluent bearing water body (Adekunle, 2009). Most of the industries discharge their effluent without proper treatment into nearby open pits or pass them through unlined channels, resulting in the

contamination of ground water (Jinwal and Dixit, 2008). The incidence of ground water pollution is highest in urban areas where large volumes of waste are concentrated and discharge into relatively small areas (Rao and Mamatha, 2004). The hydro-geochemical conditions are also responsible for causing significant variations in ground water quality (Mahanta et. al., 2004). The paper makes an attempt to carry out qualitative analysis of some physico-chemical parameters of ground water in study area.

STUDY AREA:

The Angul-Talcher area lies between latitudes 20° 37' N to 21° 10' N and longitudes 84° 53' E to 85° 28' E. and situated at an average height of 139 m above Mean Sea Level(MSL). Vast mineral deposits, availability of water and good infrastructure conducive for industrialization in the Brahmani river basin has resulted in heavy industrialization of the area. Many small, medium and large scale industries such as coal mines (Mahanadi Coalfields Limited), Super Talcher Thermal Power plant (Kaniha), Talcher Thermal Power Stations (Talcher), Nalco smelter and its captive power plant and other iron & steel industries are situated in the region. The ground water quality of the study area is adversely affected by the industrialization. Increased population and improper drainage system have potential to influence the ground water quality. Geographical location of study area is shown in the Figure 1.



SAMPLE COLLECTION:

The sampling locations consist of urban as well rural area. Ground water samples were collected from thirteen (13) well at various locations within study area during pre and post monsoon season. Details of sampling locations along with their latitude and longitude are illustrated in Table1. Samples were collected in plastic container to avoid unpredictable changes in characteristic as per standard procedure (APHA, 1998).

Table 1. Well water Sampling Locations within the study area

Code	Sampling Location	Latitude	Longitude
GW1	Dasnala Village, well water	20° 53' 33"	85° 14' 33"
GW2	Kandasar Village, well water	20° 50' 33"	85° 07' 58"
GW3	Girang Village, well water	20° 50' 52"	85° 10' 08"
GW4	Sharma Chak, well water	20° 54' 44"	85° 11' 15"
GW5	Danara village, well water	20° 56' 36"	85° 06' 12"
GW6	Takua Village, well water	21° 06' 04"	85° 03' 10"
GW7	Baragundari Village, well water	21° 04' 47"	85° 00' 02"
GW8	Kamarel village, well water	21°02'10"	85°02'50"
GW9	Blinda village, well water	21°05'20"	85°11'40"
GW10	Ekgharia Village, well water	21°02'38"	85°09'39"
GW11	Nuashahi village, well water	20°48'10"	85°09'00"
GW12	Tulsipal village, well water	20°49'00"	85°07'40"
GW13	Longibeda village, well water	20°47'50"	85°04'20"

PHYSICO-CHEMICAL ANALYSIS OF GROUND WATER:

The collected samples were analyzed for different physico-chemical parameters such as pH, Electrical conductivity, Turbidity, TDS, Total hardness, Ca hardness, Mg hardness, Ca ion, Mg ion, Chloride, and COD as per the standard methods (APHA, 1998), and the results were compared with the Indian Standards (IS: 10500) for potable water.

RESULTS AND DISCUSSION:

The water quality analysis of different ground water samples have been carried out for pH, Electrical conductivity, TDS, Total hardness, Ca hardness, Mg hardness, Ca ion, Mg ion, Chloride, and COD. The status of water quality of these ground water sources are presented in table 2.

pH value of ground water samples varied between 6.4 to 7.4 and 7.0 to 9.2 during pre and post monsoon season respectively. The pH value of Dasnala village, well water (GW1) was found to be 9.2 which are beyond the permissible limit as per IS: 10500. Turbidity of samples was found within the permissible limits except the Blinda village, well water (GW9) in pre monsoon season. It may be due to absence of bricking of well.

Electrical conductivity varied between 140 to 606 μ mhos/cm to 420 to 839 μ mhos/cm in pre and post monsoon season. The same trend was observed in the case of TDS of various ground water sources. It varied from 69 to 318 mg/l and 172 to 485 mg/l in pre and post monsoon respectively. Total hardness in all the samples were found to be within standard limits (< 300 mg/l as CaCO₃). Values are slightly higher in post monsoon than pre monsoon season. In few samples the ions of calcium and magnesium have crossed the standard limit (IS: 10500) during post monsoon season.

Chloride content of the ground water samples were in the range of 15- 135 mg/l to 18.5-75.5 mg/l in pre and post monsoon season respectively. The COD values of various ground water samples were found from 9.3 – 47.5 and 11.3 – 45.5 mg/l during pre and post monsoon season respectively. Highest values of COD were found 47.5 Kamarel village open well water (GW6) during post monsoon season. It may be due to seepage from sewage drainage or industrial discharge in nearby localities.

Table 2. Concentration of various parameters in pre and post monsoon seasons

Codes	pH		Turbidity (NTU)		Elec. Cond. ($\mu\text{mhos/cm}$)		Total Hardness (mg/l)	
	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon
GW1	6.8	9.2	3.7	6.2	250	465	56	115
GW2	6.4	7.3	3.8	7.4	162	408	46	102
GW3	7.3	7.1	0.9	1.5	146	694	130	146
GW4	6.9	7.0	6.6	4.3	145	497	28	115
GW5	7.4	7.3	4.2	7.1	140	620	28	127
GW6	6.8	7.3	3.6	4.0	170	420	50	112
GW7	6.7	7.1	3.1	5.0	148	642	12	146
GW8	6.9	7.2	8.7	6.5	540	649	164	125
GW9	7.1	7.0	10.2	9.5	295	733	36	205
GW10	7.1	8.2	3.5	4.7	154	839	20	170
GW11	7.2	7.5	8.3	8.0	429	479	120	110
GW12	7.1	7.0	9.4	9.3	331	351	165	170
GW13	7.3	7.1	4.6	4.0	606	696	178	148
Mean	7.0	7.4	5.4	6.0	270	576	79	147
SD	0.29	0.62	2.88	2.32	161.69	148.58	62.04	30.09
IS: 10500	6.5 – 8.5		5.0 – 10*		--		300 - 600*	

* = IS: 10500 Permissible limit in the absence of alternate source

Codes	TDS (mg/l)		Ca Ion (mg/l)		Mg Ion (mg/l)		Chloride (mg/l)		COD (mg/l)	
	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon
GW1	124	265	47.2	203.5	152.1	137.8	34	39.5	9.3	19.2
GW2	80	249	84	172.8	50.8	134.9	24	30.5	15.5	25.5
GW3	172	337	175	266.0	82.0	162.4	135	41	9.3	11.3
GW4	72	272	63	228.3	11.5	97.2	22.5	36.5	12.4	17
GW5	69	307	63	245.0	11.5	118.9	15	32.5	9.3	41.5
GW6	84	270	42	226.5	136.1	87.7	22.5	35.5	12.4	45.5
GW7	72	363	21	260.5	14.8	171.4	27.5	18.5	15.5	36.5
GW8	268	323	200	252.8	244.4	98.0	17	42.5	13.4	22.8
GW9	146	485	57.7	412.8	52.9	163.6	57	58.6	43.5	36.5
GW10	76	400	30	319.8	32.8	172.6	17.5	75.5	15.5	25.2
GW11	228	289	181.7	216.8	193.9	95.5	50.5	33.5	31.5	24.5
GW12	187	397	271.2	321.3	231.7	170.2	62.5	41.5	47.5	22.5
GW13	318	337	331	280.5	187.0	146.8	44.5	30.5	21.4	12
Mean	145.8	330	119.0	262.0	107.8	135.1	40.7	39.7	19.6	26.3
SD	83.67	67.46	97.27	62.01	86.7	32.32	32.49	14.11	12.57	11.13
IS: 10500	500 - -2000*		75 – 200*		30 – 100*		250 - 1000*		---	

* = IS: 10500 Permissible limit in the absence of alternate source

Correlation matrix was prepared within the studied parameters in pre and post monsoon season and tabulated in Table 3 and 4 respectively. The total dissolved solids and electrical conductivity can be used to delineate each other. Conductivity is proportional to the dissolved solids; total hardness was positively correlated with chloride, calcium and magnesium ions. The strong correlation-ship between these parameters could be due to changes in land use, mining and improper effluent discharge in the study area. The correlation among parameters of both seasons has shown the analogous trends of seasonal variation, it may be due to the weathering and heavy rain fall in study area during monsoon.

Table 3. Pearson Correlation Matrix of Pre-monsoon Season

	pH	Elec cond.	TDS	Total hardness	Ca ion	Mg ion	Chloride	COD	Turbidity
pH	1.00	0.24	0.37	0.33	0.39	0.12	0.40	0.23	0.16
Elec cond.		1.00	0.94	0.79	0.78	0.79	0.00	0.36	0.52
TDS			1.00	0.91	0.88	0.80	0.31	0.33	0.38
Total hardness				1.00	0.96	0.86	0.43	0.30	0.30
Ca ion					1.00	0.75	0.40	0.39	0.32
Mg ion						1.00	0.14	0.34	0.44
Chloride							1.00	0.22	-0.14
COD								1.00	0.77
Turbidity									1.00

Table 3. Pearson Correlation Matrix of Post-monsoon Season

	pH	Elec cond.	TDS	Total hardness	Ca ion	Mg ion	Chloride	COD	Turbidity
pH	1.00	-0.01	-0.23	-0.19	-0.25	0.05	0.30	-0.10	-0.02
Elec cond.		1.00	0.57	0.56	0.55	0.42	0.50	-0.09	-0.31
TDS			1.00	0.98	0.97	0.69	0.56	0.10	0.31
Total hardness				1.00	0.98	0.74	0.58	0.03	0.23
Ca ion					1.00	0.58	0.61	0.10	0.27
Mg ion						1.00	0.31	-0.19	0.03
Chloride							1.00	-0.06	0.11
COD								1.00	0.30
Turbidity									1.00

CONCLUSIONS:

In general ground water quality of Angul-Talcher region is not harmful to human beings. Except few instances where some parameters such as COD at Blinda, Danara and Takua Village, well water and turbidity at Blinda Village, well water were crossed prescribed limits of

drinking water (IS: 10500). The reason behind this may be due to industrial and mining activities, weathering and erosion of bed rocks. Most of parameters showed analogous trend in seasonal variation. The values are comparatively high in post monsoon. It indicates that the extent of pollution occurred due to mining, industrial discharge, urbanization and other anthropogenic

activities increased human interventions in the ground water quality. Correlation studies have also indicated the contribution of changes in land use, industrial discharge and runoff during post-monsoon season.

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Chemical stimulation of seed germination in *Angelica archangelica* Linn. (Apiaceae), a threatened high altitude aromatic herb

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Abstract: *Angelica archangelica* (Apiaceae) is threatened aromatic herb for which *ex situ* cultivation is recommended as a conservational tool. However, earlier reports suggested poor seed germination in this species and therefore, domestication was not done. Present paper deals with improvement of germination potential of the species. Seeds from different natural populations were tested in polyhouse and nursery bed conditions by using different soil compositions. Pre sowing treatments of various concentrations of Potassium nitrate (KNO₃), Sodium Hypochlorite (NaHClO₃) and Thiourea (CH₄N₂S) were also used to enhance the germination. Germination potential differed significantly in the laboratory, as well as in the polyhouse conditions of the seeds from different populations. Among the pre sowing treatments, KNO₃ 150 mM and Thiourea 200 µL L⁻¹, germination was improved significantly. Furthermore, mean germination time was reduced under laboratory conditions as well as inside polyhouse condition. Pretreatments of the seeds by these chemicals also improved germination in polyhouse condition. The results of these treatments inside polyhouse and laboratory are presented here and possible reasons for enhancement in germination discussed. [Journal of American Science 2009;5(5):59-70]. (ISSN: 1545-1003).

Key words: endangered, exploitation, germination, mean germination time, nitrogenous compounds.

1. Introduction

Angelica archangelica Linn. (wild Parsnip or European angelica) of family Apiaceae is native to Europe and widely distributed to Austria, Belgium, Denmark, Germany, Greenland, Hungary, Ice-land, Poland and Central Russia. It also has been naturalized in the UK and other parts of Europe (Sarker et al., 2004). In India it is found in Western Himalaya between an altitudes of 1000-3900 m asl in Kashmir and 2600-3900 m asl in Garhwal and Kumaon regions. It is also reported from Sikkim (at 3000-3300 m) in North East Himalaya, India. *A. archangelica* is biennial or short-lived perennial aromatic herb. Leaves ovate, 2-3 pinnate, ultimate pinnate toothed; flowers white in large compound umbels; schizocarps ellipsoid, Oblong or sub-quadrate; seeds dorsally much compressed. (Anonymous, 1985).

A. archangelica has a long history of association with magic and long medicinal history having also been attributed to helping cure the Black Plague of the fifteenth century. American Indian used *Angelica* to help fight respiratory problems and as a tonic after an illness. *A. archangelica* is believed to possess angelic healing power. This plant has been used in traditional and folk medicine as a remedy for nervous headaches, fever, skin rashes, wounds, rheumatism, and toothaches. The roots of this plant have been used internally for digestive problems, including gastric ulcers, anorexia, and migraine, bronchitis, chronic fatigue, and menstrual and

obstetric complaints. It has been shown to stimulate gastric and pancreatic secretions. *A. archangelica* can be used as an antiseptic, expectorant, emmenagogue and a diuretic. The root is aromatic and is reported to possess diaphoretic and diuretic properties, and is used in flatulent colic. The roots from Kashmir yield five furocoumarins. An isocoumarin, angelicin (mp 194°C), a new flavonone, archangelone (mp 148°C; yield 0.005%) and diprenyl maringenin are also present. The coumarins are reported to be useful in curing leucoderma. In Europe, the essential oil from *A. archangelica* is employed in liquors, dental preparations and in high-grade perfumery to impart a musky note, which can not be distinguished easily from that of true musk (Anonymous, 1985; and Sarker et al., 2004).

In the Indian Himalayan region, this species is facing severe threats due to habitat degradation and exploitation for aromatic and medicinal purposes. Recently, natural populations were surveyed in Garhwal region for the determination of threat status of the species (Vashistha et al., 2006) and it was affirmed as endangered species. Increasing biotic interferences has also led to low regeneration of the species in natural habitats. The poor seed germination in the species of Apiaceae is known, probably due to dormancy and plant growth regulators have been used to break the same (Chaudhary et al. 1994). Earlier, Ojala (1985) and Butola et al. (2004 a) suggested dormancy and irregular pattern of seed germination in *Angelica* species.

Therefore, objectives of the present study included (i) to develop effective pre-sowing treatments to stimulate seed germination and reduce mean germination time (MGT) in laboratory condition as well as in nursery condition. (ii) to standardize best sowing depth and soil composition for this species under nursery conditions. (iii) to compare the effect of polyhouse versus open nursery bed conditions on seed germination and MGT. These observations were aimed to develop an appropriate multiplication protocols for the domestication so that commercial cultivation could be carried out in near future and natural populations can be restored.

2. Materials and Methods

Seeds of *A. archangelica* were harvested after ripening during the month of September - October 2003 from four natural populations having altitudes between 3000-4000 m asl. These populations include Tungnath (TN) and Kedarnath (KN) in Rudraprayag district and The Valley of Flowers (VF) and Rudranath (RN) in Chamoli district of Garhwal, Uttarakhand, India (29°26' - 31°28' N and 77°49' - 80°6' E). Harvested seeds were air dried for one week and stored in airtight bags for further observations. Following observations were carried out and method for each observation is described below.

The percentage moisture content of seeds was determined by oven dry method *i.e.* at 103°C for 17 hours as per ISTA rule (1985). For imbibitions test, five seeds from each population were weighted in triplicate and soaked in distilled water. Seeds were wiped with blotting paper to remove excess water and weighted. Imbibitions rate was observed after 24 hrs and 48 hrs as:

$$\text{Imbibition Rate} = \frac{\text{Imbibed weight} - \text{Initial weight}}{\text{Initial weight}} \times 100$$

Impact of storage conditions on seed viability was also observed for one year. Seeds were kept in airtight polythene bags separately, at low temperature (4°C - 6°C) in refrigerator and at room temperature (10-35°C). Viability of these stored seeds was tested by the method of Moore (1962) with pH adjusted at 6.0.

2.1 Germination Study

2.1.1 Under field conditions

Seed germination study was carried out at Pothivasa (PV) nursery site (2200 m, 30°28'N Lat. and 79°16'E Long.) during the month of March- April and Tungnath (TN) at alpine garden (3600 m, 30°14'N Lat. and 79°13'E Long.) during May-June. For experiments, polyhouses were used. Experiments carried out at TN

aimed to compare natural (open beds) versus polyhouse beds for better germination. During experiments, temperature inside polyhouse was ranged between 15.8 ±2.2°C- 29.1 ±2.1°C at PV while it was between 5.0±2°C -18°C at TN. Details of given pretreatments are presented in Table 1.

2.1.2 Under laboratory conditions

Seeds were surface sterilized by dipping in 0.1% aqueous solution of Mercuric chloride (HgCl₂) for one minutes followed by ethanol for two minutes and then rinsed thoroughly (3-4 times) with distilled water. Seeds were kept in glass Petri dishes on single layer of Whatman No.1 filter paper after pretreatments as describe below. All observations were taken in 16 hrs light and 8 hrs dark at 25±2°C conditions. Each treatment contained three replicates of 20 seeds. Details of given pretreatments are presented in Table 2.

2.2 Data analysis

Seeds were considered to have germinated upon the initiation of radicle. Number of seeds germinated was counted daily. Mean germination time (MGT) was calculated following the formula given by Ellis and Roberts (1981) as:

$$\text{MGT} = \frac{\sum D_n}{\sum n}$$

Where n = number of seeds germinated on day;
D = number of days since the sowing of seeds.

During the present observations, mean values of treatments with standard deviation (±) are presented. ANOVA was used to interpret the variation and to identify the best treatment and population for improved germination potential.

Table 1. Details of treatments given inside polyhouse at PV and TN nurseries

SN	Treatments	Methods	Remarks
1	Soil compositions Soil: Sand: Litter	Garden soil (control) 1:1:1 1:2:1 1:1:2	48 seeds with triplicate in Styrofoam seedling trays inside polyhouse for each composition
2	Sowing depth	1.0 cm 0.5 cm	48 seeds with triplicate in Styrofoam seedling trays inside polyhouse
3	Hormonal and chemical pretreatments	As mentioned in Table 2	48 seeds with triplicate in Styrofoam seedling trays inside polyhouse
4	Natural condition at TN (3600 m asl)	Inside polyhouse Soil: Sand: Litter (1:1:1) Open bed condition	48 seeds with triplicate in Styrofoam seedling trays inside polyhouse (0.5 cm) depth In the natural, open-bed condition, 50 seeds were sown in triplicate directly in garden soil

Table 2. Details of pretreatments given in laboratory condition

SN	Pretreatments	Concentration	Remarks
1.	Control	-	Presoaked for 24 hrs in DH ₂ O
2.	Scarified seeds	-	Seed coat removed, no treatment, presoaked in DH ₂ O for 24 hrs
3.	Thiourea (CH ₄ N ₂ S)	200, 400 µL L ⁻¹	Presoaked for 24 hrs washed with DH ₂ O
4.	Potassium nitrate (KNO ₃)	100, 150 mM	Presoaked for 24 hrs washed with DH ₂ O
5.	Sodium Hypochlorite (NaHClO ₃)	5%	Presoaked for 30 and 45 minutes and washed with DH ₂ O

3. Results and Discussion

Germination potential of the species in field conditions were recorded at TN and PV nurseries and in laboratory conditions at Srinagar Garhwal (550 m asl, main central laboratory of HAPPRC). Since, in alpine region, germination was poor and it is not possible to domesticate the species in alpine region (TN) due to arduous climatic conditions, further emphasis was given to test germinability at lower

altitudes (PV) which was found suitable for domestication and for future cultivation. Imbibitions capacity of *A. archangelica* seeds collected from different natural populations are shown in figure 1. Furthermore, maximum (90.7%) viability was recorded in the seeds of the KN while TN seeds had minimum (76.7%) viability at the time of harvesting. Contrary to this, moisture was maximum (11%) in the TN seeds while seed moisture content was only 8.2% in the KN seeds. After one-year storage, viability decreased further (31.3%) in the TN seeds at

room temperature. Low seed viability may be one of the reasons for the poor germination in nature (Nadeem et al. 2000). However, rate of decrease was much slower in refrigerator stored seeds. At the end of first year, 62.7% seeds from the KN were viable.

Similarly, nearly 48% seeds from the TN were also viable after one year. Further, there was slight decrease in seed moisture being 10.2% in the TN and 7.1% in the KN seeds stored at room temperature at the end of a year (Table 3).

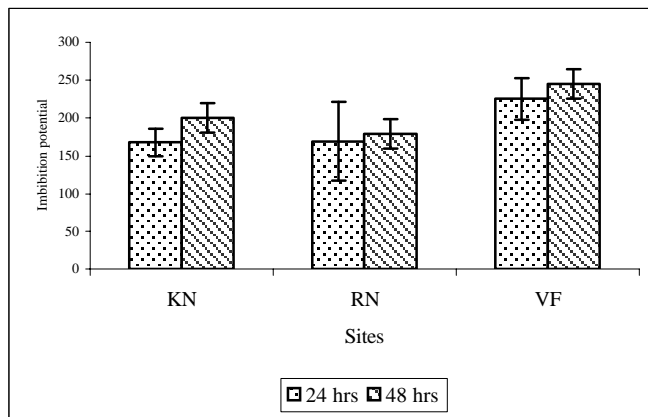


Figure 1. Imbibition potential of seeds of *A. archangelica* after 24 hrs and 48 hrs

Table 3. Percent viability and moisture content in seeds of *A. archangelica* after one year of storage

Populations	% Viability			% Moisture content	
	At the time of collection	At Room temperature	At Low temperature	At the time of collection	At Room temperature
KN	90.7±1.1	42.0±2.0	62.7±3.1	8.2±1.2	7.1±2.7
RN	81.3±2.3	36.0±2.0	56.7±2.3	10.7±0.7	9.7±0.5
VF	88.0±2.0	38.0±2.0	58.7±1.2	10.2±0.3	9.4±0.5
TN	76.7±2.3	31.3±2.3	48.0±2.0	11.0±5.0	10.2±0.2

*Room temperature varied from 10°C to 35°C; low temperature varied from 4°C to 6°C.

Viability test indicated that seeds of *A. archangelica* may not remain viable for extended periods at room temperature and even storage at low temperature (4°C - 6°C) for long. Loss of viability in stored seeds is a common phenomenon (Verma et al, 1996) and it increased with storage duration (Dell Aquilla 1987) with storage condition is another factor. However, it was also observed that seed moisture content did not played key role as population with low seed moisture at the time of harvesting had high viability in *A. archangelica*. Further, seed moisture was slightly decreased after one year storage. Loss of viability as well as variation in seed viability among different natural populations may have the relation with growth and development of embryo which caused morpho-physiological dormancy as suggested by Walek and Hidayati (2004) in another Apiaceae species *Osmorhiza depauperata*.

3.1 Germination study at laboratory condition

Seed germination study conducted under hormonal and chemical treatments revealed that untreated seeds (control) of different populations had varied germination response (Table 4). Scarified seeds from different populations showed improved germination viz., 58.3% (RN) followed by 56.7% (VF) 55.0% (KN) and 53.3% (TN). The RN seeds had maximum germination of 63.3% in NaHClO₃ (45 minutes) treatment. Seeds of the VF population showed minimum germination of 31.6% in NaHClO₃ (30 min) treatment. KNO₃ has been reported to enhance seed germination possibly through oxidized forms of nitrogen causing a shift in respiratory metabolism to the pentose phosphate pathway (Roberts et al., 1977). However, it has also been found to substitute the light requirements for germination for many positively photoblastic seeds (Roberts 1973). Also, it has been used to stimulate the germination of dormant seeds (Mayers et al. 1989). Results further showed a significant difference (p<0.05) among populations and concentrations, which are in agreement with Qaderi and Cavers (2000), who reported that different populations and KNO₃ concentration significantly affect the germination response in *Onopordium acanthium* seeds. Bhatt et al. (2005) also observed enhancement in germination as well as lessening in MGT by KNO₃ pretreatment in *Swertia angustifolia*.

The effect of Thiourea in improving seed germination of alpine plants was reported earlier (Manjkhola et al., 2003). Pandey et al. (2000) revealed that among the nitrogenous compounds, Thiourea increased germination percentage in *Aconitum hetrophyllum* and *A. balfourii* but Potassium nitrate (KNO₃) enhanced germination in *A. balfourii* only. Thiourea is known to promote the germination of chilling requiring seeds (Agarwal et al., 1995).

Detrimental results of thiourea were also observed by Begum et al. (1988) in seed germination trials of *Carica papaya*. Seed germination stimulating ability of Sodium Hypochlorite (NaHClO₃), a common surface disinfectant has been reported (Ho et al., 1995).

Compared to control, certain treatments viz., NaHClO₃ (30 minutes) and Thiourea (400 µL L⁻¹) showed non-significant improvement in germination of the VF seeds. Likewise, seeds of the TN and RN populations did not show significant improvement in Thiourea (400 µL L⁻¹). Other treatments significantly improved germination. In the KN population seeds, barring NaHClO₃ (30 & 45 minutes) and Thiourea (400 µL L⁻¹), all treatments improved germination significantly (p<0.05). MGT was reduced through scarification of the seeds from all populations. Contrary to this, Thiourea (400 µL L⁻¹) treatment increased MGT (Table 4). Comparing expensive plant growth regulators, the use of KNO₃ and NaHClO₃ owing to low cost, was suggested to be beneficial tool to mass multiplication in the cultivation of *Heracleum candicans* (Butola et al., 2004b).

3.2 Germination study at nursery condition

Perez-Garcia et al. (1995) reported that populations of a species differ in their germination responses. The results of the present investigation clearly indicate that the germination response of *A. archangelica* differs among populations, treatments as well as in different soil compositions. Earlier reports suggest that various factors such as, mother plant environment e.g. nutrient, light and water (Baskin and Baskin 1998) and the position of the seeds on a plant influence the germination response of the seeds. Besides these, latitude and elevation could have played an important role in affecting germination responses among different populations. Seeds developing at different positions on the mother plant may not have the same germination requirements (Baskin and Baskin 1998). This could be one of the several factors as seeds of *A. archangelica* are arranged in primary and secondary umbels. These umbels ripened at different time with different set of climatic conditions, a characteristics feature of alpine environment. The study also revealed a moderate effect of Potassium nitrate, Thiourea, Sodium Hypochlorite and scarified seeds on germination of *Angelica archangelica* from all populations in laboratory as well as in polyhouse condition.

Germination potential of seeds harvested from natural populations was observed at alpine garden, TN considering it as a natural site of *A. archangelica*. Seeds were sown in open beds as well as inside polyhouse during May-June for comparative observations as polyhouse provide protective and much humid conditions. Seeds of VF population had poor

germination (44.67%) in nursery beds while it increased up to 58.33% inside polyhouse. Seeds from KN population showed 40.33% germination in open bed and 55.21% in polyhouse condition. Compared to open beds, polyhouse displayed significant improvement ($p < 0.05$) in germination for the seeds of both populations. Germination studies among different populations provide helpful clues on genetic make-up of the species and its existence in the natural population (Baskin and Baskin 1998). MGT of seeds from VF was decreased up to 69.47 days inside polyhouse as compared to 98.87 days in open bed condition. Further, MGT was 101.62 days in open bed and it reduced to 73.27 days inside polyhouse in the seeds of KN (Table 5).

Results on seed germination of *A. archangelica* inside polyhouse at PV are shown in Table 6. Seeds were sown in Styrofoam seedling trays after pretreatments of chemicals as described earlier at 0.5 cm depth having a mixture of soil, sand and litter in 1:1:1 ratio. Among the treatments, maximum germination was observed in Thiourea ($400 \mu\text{L L}^{-1}$) for all populations with germination percentage of 67.7% (VF), 66.66% (KN), 63.54% (RN) and 61.53% (TN). In KN and VF populations, excluding Thiourea ($200 \mu\text{L L}^{-1}$), all treatments improved seed germination. Whereas, NaHClO_3 (30 minutes) and Thiourea $200 \mu\text{L L}^{-1}$ did not improved germination significantly in the seeds of TN and RN populations ($p < 0.05$). Overall, NaHClO_3 (30 & 45 minutes) and KNO_3 (100 & 150 mM) treatments

significantly improved seed germination among all populations ($p < 0.05$). KNO_3 (150 mM) treatment also reduced MGT as compared to control. MGT in KNO_3 (150 mM) treatment was observed 20.03 days in the seeds of KN, 22.07 days in VF, 23.39 days in RN and 24.05 days in TN (Table 6).

Deprive as well as deferred germination was observed at deep sowing depth (1.0 cm) as compared to shallow depth (0.5 cm). Maximum germination (70.42%) at 0.5 cm was recorded in the seeds of VF while only 51.25% seeds from KN were germinated at sowing depth of 1.0 cm (Figure 2). Beside soil, sand and litter in 1:1:1 composition, ratios of 1:2:1, 1:1:2 were also observed for best soil medium to achieve maximum germination with garden soil as control (Table 7). The soil composition with 1:1:1 ratio displayed maximum seed germination (70.42%) followed by 1:1:2 (60.42%) as compared to control (51.25%) in the seeds of the VF. Similar results were recorded for KN seeds although, germination was 63.75%. In general, all soil compositions significantly improved germination ($p < 0.5$) as compared to control in the KN seeds. The soil composition in 1:1:1 and 1:1:2 ratio also significantly improved germination in the seeds of the VF. MGT reduced in soil composition of 1:1:1 (33.23 days) as compared to control soil (35.52 days) for VF population. In case of KN population, MGT also decreased in 1:1:1 (34.22 days) against control soil (36.63 days).

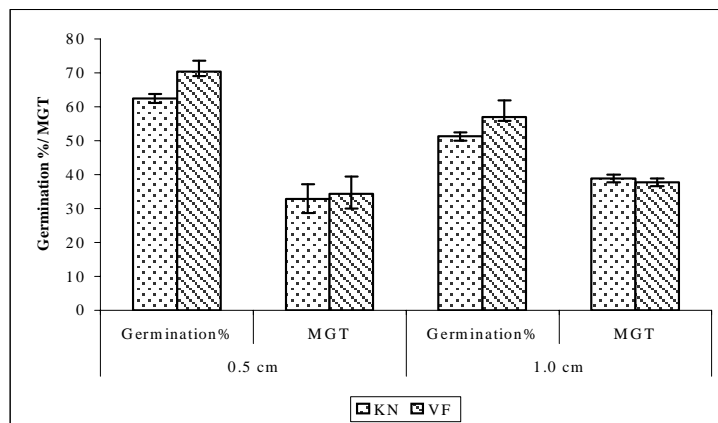


Figure 2. The effect of seeding depth on germination of *A. archangelica* at PV nursery. (Percent germination; MGT, mean germination time in days).

Table 4. Effect of pretreatments of different chemicals on germination and MGT of *A. archangelica* in laboratory condition (25 ±2°C)

Treatments	VF	TN	KN	RN	F value LSD
Control					
% germination	33.3±5.7	35.0±5.0	40.0±5.0	38.3±5.7	0.9, 7.9
MGT	32.1 ±0.6	38.1 ±3.8	38.1 ±3.1	38.8 ±3.5	3.1,4.5
Scarified seeds					
% germination	56.7±3.8*	53.3±2.8*	55.0±5.0*	58.3±2.8*	0.7,6.3
MGT	23.4 ±1.0	26.6 ±1.2	27.4 ±0.9	27.0 ±0.8	9.8*,1.4
NaHClO ₃ (30min)					
% germination	31.6±2.8	46.7±2.8*	46.7±2.9	51.7±7.6*	10.8*,6.6
MGT	26.5 ±2.9	35.2 ±2.6	35.1 ±3.0	34.8 ±3.5	5.9*,4.4
NaHClO ₃ (45min)					
% germination	46.7±2.8*	48.3±10.4*	45.0±5.0	63.3±4.5*	4.8*,9.6
MGT	30.2 ±1.5	30.3 ±1.6	30.7 ±1.5	31.15±0.8	0.3,2.0
KNO ₃ 100 mM					
% germination	43.3±2.7*	46.7±2.9*	50.0±5.0*	48.3±2.8*	1.2,6.2
MGT	30.2 ±3.7	31.8 ±1.6	31.7 ±1.6	32.3 ±1.2	0.5,3.3
KNO ₃ 150 mM					
% germination	53.3±2.7*	51.7±2.9*	56.7±7.6*	52.3±2.9*	0.4,7.6
MGT	30.5 ±0.2	32.6 ±2.1	31.7 ±2.0	31.7 ±2.9	0.5,3.0
Th 200 ppm					
% germination	46.7±5.7*	43.3±10.4*	51.7±7.6*	48.3±7.6*	0.5,11.7
MGT	28.5 ±3.2	34.9 ±0.6	34.83±0.9	34.6 ±0.9	5.4*,3.4
Th 400 ppm					
% germination	38.3±2.8	40.7±2.9	42.7±1.8	41.7±5.7	0.5,5.5
MGT	32.2 ±2.5	38.3 ±1.4	38.2 ±0.8	37.7 ±0.2	11.3*,2.2
F value LSD for % ger	14.2*,7.3	2.9*,8.3	3.7*,7.5	4.4*,7.2	
F value LSD for MGT	5.3*,3.1	10.1*,3.0	9.8*,2.9	8.6*,3.1	

Mean ± standard error for germination at 25°C ± 2°C, MGT is mean germination time in days.

* Significant (p<0.05)

Table 5. Seed Germination in *A.archangelica* in Nursery at TN

Treatments	KN	VF	F value LSD (P<0.05)
	40.33 ±2.52	44.67 ±2.01	5.28
<i>Open Bed</i>			3.79
Polyhouse	55.21 ±4.34*	58.33 ±3.18*	4.90
			6.25
F value	20.60*	16.08*	
LSD (P<0.05)	5.83	4.42	
MGT of <i>A. archangelica</i> in TN Nursery			
	101.62 ±3.43	98.87 ±2.51	1.72
<i>Open Bed</i>			5.82
Polyhouse	73.27 ±2.70	69.47 ±4.22	1.72
			5.82
F value	107.58 *	126.67*	
LSD (P<0.05)	5.71	5.07	

* Significant (p<0.05)

Table 6. Effect of pretreatments of different chemicals on germination and MGT of *A. archangelica* in polyhouse condition in PV nursery.

Treatments	KN	VF	TN	RN	F value & LSD
Control					
% germination	47.5 ±9.4	46.9 ±7.2	45.8 ±6.5	44.8 ±4.7	0.1, 10.5
MGT	31.8 ±3.2	33.3±4.3	33.8 ±3.8	34.08 ±3.4	0.2, 5.4
NaHClO ₃ (30min)					
% germination	54.6 ±1.6*	53.7 ±3.2 [‡]	50.9 ±1.6	48.1 ±1.6	5.7*, 3.1
MGT	25.1 ±1.3	25.7 ±0.8	27.0±1.7	27.4 ±1.4	1.8,2.0
NaHClO ₃ (45min)					
% germination	56.7 ±1.4*	55.8 ±1.4 [‡]	51.7 ±1.4	47.5 ±2.5	17.1*, 2.5
MGT	25.6 ±0.7	24.9 ±0.6	26.2 ±0.8	26.42 ±0.5	2.5,1.0
KNO ₃ 100 mM					
% germination	59.37±3.1*	60.4 ±1.8 [‡]	55.2 ±1.8 [‡]	54.1 ±1.8*	5.7*, 3.2
MGT	23.9 ±1.2	23.4 ±0.6	24.0 ±0.8	24.3±0.6	0.4,1.3
KNO ₃ 150 mM					
% germination	65.6 ±3.1*	66.6 ±1.8 [‡]	59.3 ±3.1 [‡]	57.2±1.8*	9.8*, 3.7
MGT	20.0 ±0.9	22.0 ±0.6	23.3 ±1.5	24.05 ±1.7	5.3*,1.9
Th 200 ppm					
% germination	48.6 ±3.18	50.6 ±2.4	47.9±3.6	45.2 ±2.4	0.7 , 4.3
MGT	25.6 ±0.9	26.2 ±1.2	26.7 ±1.5	27.5 ±2.2	0.7 ,2.3
Th 400 ppm					
% germination	66.6 ±4.7*	67.7±3.6*	63.5 ±6.5 [‡]	61.5±4.7*	0.5, 7.5
MGT	25.3 ±1.7	28.5 ±0.7	29.0±1.0	29.7 ±0.4	8.8*,1.6
F value & LSD for % germination	8.1 *, 6.4	13.3*, 5.1	7.2*, 5.7	13.7*, 4.3	
F value & LSD for MGT	12.8*,2.3	12.7*,2.5	10.3*,2.6	10.7*,2.5	

* Significant (p<0.05)

Table 7. Seed Germination of *A. archangelica* in Selected Media Compositions at PV Nursery

Treatments	KN % G	VF % G	F value & LSD	KN MGT	VF MGT	F value & LSD
Control	48.7 ±0.7	51.25 ±0.72	32.0	36.6 ±2.0	35.5 ±3.3	0.24
(Soil:Sand:Litter)			1.28			4.52
1:1:1	63.7 ±4.5*	70.4 ±3.2*	4.4	34.2 ±3.5	33.2 ±4.9	0.08
1:2:1	57.08±2.6*	55.0 ±4.5	6.4	35.8 ±2.6	34.7 ±3.9	6.98
1:1:2	59.5 ±1.9*	60.4 ±0.72*	0.5	35.6 ±2.3	34.4 ±4.02	0.16
			6.1			5.48
			0.5			0.17
			2.47			5.43
F value	16.2*	25.8*		0.16 ns	0.16 ns	
LSD)	4.0	4.09		5.99	5.99	

*Significant (p<0.05)

Conclusions

Observations reveals variation in seed viability among the populations irrespective of moisture content which may suggests morpho-physiological type of dormancy in this species. Therefore, harvesting time is a

key as time requires for the maturation of embryo may determined viability status of the seeds. The results of this study also indicate that Potassium nitrate and Thiourea (as well as Sodium Hypochlorite) are helpful for reducing the Mean germination time and stimulating seed germination in *A. archangelica*. These treatments

are quite simple and all the chemicals are inexpensive compared to PGRs, these can be widely used by the growers and nurserymen. On the basis of present observations, it is further suggested that seed stored at low temperature remain viable for one year. Likewise, polyhouse conditions beside aforesaid treatment can be used for raising seedlings. Since, there was great deal of inconsistency in nursery based germination results, further observations are needed to overcome morpho-physiological dormancy and bringing uniformity in germination behavior of *A. archangelica*.

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Development and Power Performance Test of a Small three-bladed Horizontal-axis Wind Turbine

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Abstract: The parameterization, installation and testing of a locally developed three-bladed horizontal-axis wind turbine was carried out. The turbine blades were fabricated from **Mansonia Altissima** wood because of its availability, good strength, and resistance to both fatigue and soaking, with a rotor swept area of 3.65 sq. metres and the blade angle of attack was experimentally determined to be 7° . The turbine was installed on the roof top of University of Ilorin, Faculty of Engineering Central Workshop Building at a hub height of 14.9 metres from the ground level while the turbine generator was sourced locally. The direct current (d.c.) power output of the test turbine was measured at the battery bank terminal by a Power Analyzer and a direct current (d.c.) to alternating current (a.c.) inverter converts the d.c. power output to a.c. power and was measured by a digital Wattmeter. An anemometer with a data logger installed on a meteorological tower (MET) measured the wind speed and direction over the test period. The cut-in wind speed, that is, the speed at which the wind turbine starts to produce power was determined to be 3.5 m/s. One minutes averages of wind speed and power output was used to determine the power curve for the wind turbine. Measured power increase consistently with increased wind speed and the power curve obtained compared fairly well with standard power curves. [Journal of American Science 2009;5(5):71-78]. (ISSN: 1545-1003).

Keywords: wind turbine, angle of attack, anemometer, data logger, cut-in wind speed, power curve.

1. Introduction

The development of wind turbines has made a significant contribution to human development and technological achievement through history. With an ever increasing demand for energy resources, and global concern about pollution and environmental damage arising from fossil fuels; wind turbines may begin to assert an ever increasing role during this century and beyond. Recent advances in technology have resulted in current improved wind turbine designs which are increasingly efficient, effective and reliable.

The conversion of wind energy to useful energy involves two processes: the primary process of extracting kinetic energy from the wind and conversion to mechanical energy at the rotor axis, and the secondary process of the conversion of such mechanical energy into useful electrical energy (Ajao, 2008) depicted in Figure 1.

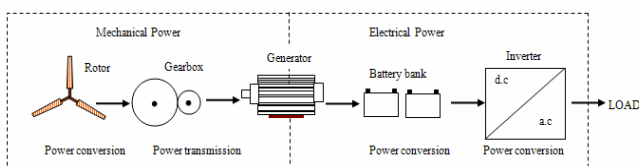


Figure 1: Conversion from Wind Power to Electrical power in a wind Turbine

The major field of science involved in this process is aerodynamics, which needs meteorology (wind description) as an input and system dynamics for the interaction with the structure. The latter is important since all movement of the rotor blades, and the bending of the blades out of their plane of rotation, induces apparent velocities that can influence or even destabilize the energy conversion process (Vermeer et al., 2003).

The aerodynamic research for wind turbines has contributed significantly to the success of modern way of harnessing wind energy. For most unsolved problems engineering rules have been developed and verified. All of these rules have limited applicability, and the need to replace these rules by physical understanding and modeling is increasing. This is one of the reasons that the worldwide aerodynamic research on wind energy shows a shift towards a more fundamental approach, 'Back to basics' based on full scale experiments other than wind tunnel experiment and analytical modeling.

Simplified analyses of horizontal-axis wind turbine flows aimed at overall aerodynamic performance prediction developed for modern rotor theories are available in literature. There have, however, been few thorough tests of the adequacy of such analyses by direct comparison with actual measurements over a wide range of configurations and conditions (Adegoke et al., 1996).

1.1 Wind Power in Nigeria

Nigeria is blessed with a variety of renewable energy resources: solar, small scale hydro, biomass and wind. These resources are well distributed throughout the country. The annual average wind speed range from 3m/s to 7m/s increasing from South to North above the cut-in wind speed of 2.5m/s for most wind turbines (Iloje, 2004). Figure 2 below shows the distribution of annual average wind speed across Nigeria.



Figure 2. Distribution of annual average wind speed (m/s) at 10m height in Nigeria (Iloeje, 2004)

ply of electricity stand at about 40 percent with urban access accounting for over 80 percent of the present recoverable generation capacity of 4000 megawatt. Hence, a shortfall will occur in the medium term and the rural areas will be hardest hit.

The Nigerian power grid network is not very strong due to low generation, low spinning reserve and poor spread of source points in such a vast coverage. In order not to further weaken the grid system and save the huge cost of network extension, it is necessary to supply some areas from isolated power generators usually of renewable type. These include small hydropower stations, photovoltaic solar sources and wind power stations (Okafor et al., 2000).

Adegoke and Anjorin investigated the prospects of wind energy utilization in Nigeria by analyzing available wind data for Akure, Bauchi and Port Harcourt and observed that the average wind speed measured at 10metres height above the ground for Bauchi is 4.78m/s, Port Harcourt is 2.56m/s and that for Akure is 0.76m/s.

It was concluded that Bauchi favours the installation of wind turbines more than Port Harcourt and Akure and that the variation of annual mean wind speed is much lower for Port Harcourt than it is for Bauchi implying that wind turbines installed in Port Harcourt would function more regularly over several years.

2. Energy in the wind

Wind is merely air in motion. It is produced by the uneven heating of the Earth’s surface by energy from the Sun. Since the Earth’s surface is made of different types of land and water, it absorbs the Sun’s radiant energy at different rates. Much of this energy is converted into heat as it is absorbed by land areas, bodies of water and the air over these formations.

The air has mass, though its density is low, and when this mass has velocity, the resulting wind has kinetic energy which is proportional to 1/2[mass x (velocity)²]. The mass of air passing in unit time is ρAV and the

kinetic energy passing through the area in unit time (power available in the wind) is:

$$P_w = \frac{1}{2} \rho AV.V^2 = \frac{1}{2} \rho AV^3 \tag{1.1}$$

ρ = Air density (approx.1.225 kg/m³ at sea level)

V = Velocity of wind (m/s)

A = Area through which the wind passes normally (m²). This is the total power available in the wind (approx. $3.6 \times 10^{12} kW$) obviously, only a fraction of this power can actually be extracted.

The power extracted by a wind turbine can therefore be given as:

$$P = k \cdot \frac{1}{2} \rho AV^3 \tag{1.2}$$

$$k = C_p \cdot N_g \cdot N_b$$

C_p = coefficient of performance or power coefficient

N_g = Generator efficiency

N_b = Gearbox/bearing efficiency

The torque generated by the wind turbine is:

$$T_s = \frac{P}{\omega_s} \tag{1.3}$$

T_s = mechanical torque at the turbine side

P = power output of the turbine

ω_s = rotor’s speed of the wind turbine

The power coefficient C_p is the percentage of power in the wind that can be converted into mechanical power and the ratio of the blade tip speed to the wind speed is referred to as the tip-speed ratio (TSR).

$$TSR = \frac{\omega_s R}{V} \tag{1.4}$$

R is radius of the wind turbine rotor.

Wind turbine operation is limited by its TSR, a larger wind turbine operates at a lower frequency (Muljadi et al., 2002). Basically, rotor movement is a balance between the aerodynamic torque applied by the wind and the electrical torque applied by the generator. The power coefficient is a measure of the mechanical power delivered by the rotor to the turbine’s low-speed shaft. It is defined as the ratio of the mechanical power to the power available in the wind.

$$C_p = \frac{P}{P_w} \tag{1.5}$$

One of the most important points in the design of a wind-driven generator is the ‘rated wind speed’ i.e. the lowest wind speed at which full output is produced. At higher wind speeds the output is limited, by the controlling mechanism to this full rated value (Golding, 1976).

The cut-in wind speed is the speed at which the turbine start producing power and the cut-out wind speed is the speed at which the turbine must either stall or turn away from the wind direction to prevent damages that may occur as a result of turbulent wind (Jonkman, 2003).

3. Characteristics of Small Wind Turbines

All forms of wind turbine are designed to extract power from a moving air stream. The blades have an airfoil cross-section and extract wind by a lift force caused by a pressure difference between blade sides. When air passes over an airfoil section; it travels faster over the top of the blade than it does below it. This makes the air pressure above the blade lower than it is below. Due to the unequal pressures the blade experiences a lifting force (Harnessing the energy of the wind: accessed at <http://www.BWEA.org> on 2nd June, 2007). For maximum efficiency, the blades often incorporate twist and taper.

The mechanical power produced by a rotor is purely a function of the blade geometry and the incident velocity. The design parameters that affect aerodynamic performance include blade pitch (angle of attack), taper, and twist distribution. For a given blade, its geometric shape is usually fixed, i.e. the aerodynamic shape, taper and twist distribution do not change. The C_p for any fixed rotor geometry is a well-prescribed function of the blade tip speed ratio with a single maximum value.

The torque produced by the rotor can be controlled in two ways: changing the geometry by varying the blade pitch angle, or by changing the rotor's rotational speed so that the rotor operates at the optimal blade tip speed ratio.

The angle of attack α , is the angle between the incoming flow stream and the chord line of the airfoil. At low angles of attack, the dimensionless lift coefficient increases linearly with angle of attack and drag is reasonably small. Flow is attached to the airfoil throughout this regime. At an angle of attack of roughly 10° , the flow on the upper surface of the airfoil begins to separate and a condition known as stall begins to develop. The dimensionless lift coefficient peaks and the dimensionless drag coefficient increases as stall increases (Jonkman, 2003).

All wind turbines can be characterized as either Horizontal Axis Wind Turbines (HAWT) or Vertical Axis Wind Turbines (VAWT). In HAWT, the rotor spins about an axis horizontal to the earth's surface. The rotor of a VAWT spins about an axis perpendicular to the Earth's surface.

Vertical axis wind turbines are typically developed only for built environment. Changes in wind direction have fewer negative effects on this type of turbine because it does not need to be positioned into the wind direction. However, the overall efficiency of these turbines in producing electricity is lower than HAWT. VAWTs are categorized as Savonius or Darrieus types, according to the principle used to capture the wind flow. For the Savonius type, the wind pushes the blades, which

implies that the rotation speed is always lower than the wind speed. Contrary to that, the shape of the rotor of the Darrieus type makes it possible for the rotor to spin faster than the wind speed.

Rotors of HAWT are placed on towers to position them where the wind speed is fastest and exhibits most power. A nacelle typically resides atop the tower and contains the support structure for the rotor, the rotor shaft, a gearbox and the electric generator. The gearbox is used to transform the low-speed high-torque power of the rotor to high-speed, low-torque power that can run the electric generator.

Small wind turbine need to be reliable, affordable and almost maintenance free. To meet these criteria, optimal turbine performance is sometimes sacrificed for simplicity in design and operation (Andrew, 2005). Thus, rather than using the generator as a motor to start and accelerate the rotor when the wind is strong enough to begin producing power, small wind turbines rely solely on the torque produced by the wind acting on the blades.

Furthermore, small wind turbines are often located where the generated power is required, which is not necessarily where the wind resource is best. In low or unsteady wind conditions slow starting potentially reduces the total energy generated. Also, a stationary wind turbine fuels the perception of wind energy as an unreliable energy source.

The main technical challenge in the design of a small wind turbine is to come up with a system configuration and control algorithm that maximizes wind energy production from the turbine and also provide favourable charging conditions for batteries. This task is complex because of the variability of the wind, which results in varying wind turbine power output. Ideally, the system configuration and its control should optimize the match between the wind turbine rotor and load, thereby allowing the maximum available power from the wind to be used, while at the same time charging the batteries with an optimum charge profile (Corbus et al., 1999).

The generators of small turbines often cause a significant resistive torque that must be overcome aerodynamically before the blades will start turning. Furthermore, pitch control is rarely used on small wind turbine because of cost. Thus, it is not possible to adjust the turbine blade's angle of attack to the prevailing wind conditions. This problem is particularly acute during starting.

A further major difference is that small turbines usually operate with varying shaft speed in an attempt to maintain maximum performance as the wind speed varies. Many large turbines run at constant speed as this allows the generator to maintain synchronicity with the utility grid.

The IEC 61400-2 (International Electrotechnical Commission) defines a small turbine as having a swept area less than 200m^2 , which correspond to a power output of about 120kW. In addition, there is a further subdivision in that turbine of swept area less than 2m^2 (about 1.2kW)

do not need to have their tower included in the certification process (Introduction to Wind Turbine Technology: accessed at <http://www.wind.newcastle.edu.au/notes.html> on 12th, February, 2007). Clausen & Wood (1999) have made a further subdivision as shown Table1 below.

Table 1. Operating parameters of small wind turbines

Category	Power (kW)	Turbine Blade radius(m)	Maximum rotor speed (rpm)	Generator Type(s)
Micro	≤1.2	1.5	700	Permanent magnet (PM)
Mid-range	1-5	2.5	400	Permanent magnet or induction
Mini	20-100	5.0	200	Permanent magnet or induction

4. Wind Turbine Blade Geometry

In the beginning most wind turbine blades were adaptations of airfoil developed for aircraft and were optimized for wind turbine uses. In recent years development of improved airfoil sections for wind turbines has been on going. The prevailing tendency is to use NACA 63, NACA 44XX, NACA 230XX, NACA63-2XX series, NREL S809 and other airfoil cross-section that may have modifications in order to improve performance for special applications and wind conditions.

Wind turbines and aircrafts, though designed for different objectives, share similar aeroelastic problems. Its rotary blades couple with surrounding air and other system components to influence overall performance, vibration, loads and stability.

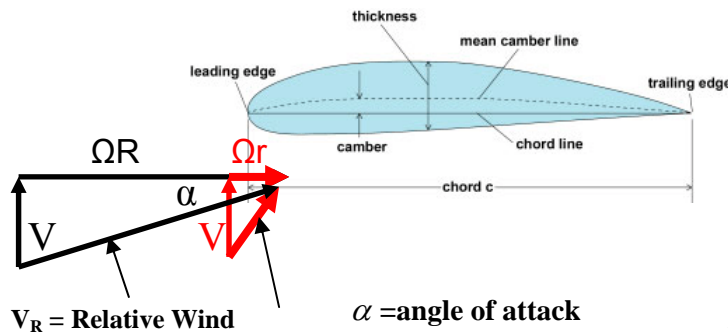


Figure 3. Wind Turbine Airfoil Nomenclature (Walt, 2005)

Somers and Maughmer (2003) carried out theoretical analyses of six airfoils- E387, FX63-137, S822, S834, SD2030 and SH3055 that are candidates for use on small wind turbines. The possession of both theoretical aerodynamic characteristics and wind tunnel test data for the same six airfoils provides the opportunity to compare the performance of wind turbine rotor. In general, the maximum lift coefficient increases

with increasing Reynolds number and the profile-drag coefficient and the width of the low-drag, lift-coefficient range decreases.

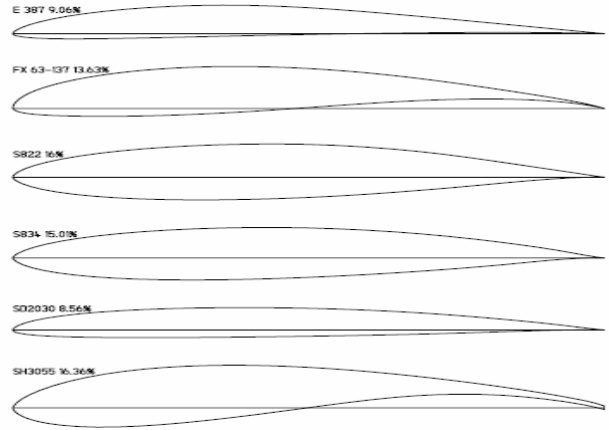


Figure 4 : Wind Turbine Airfoil shapes (Courtesy: Somers et al., 2003)

In the present research work, all blades were designed based on NREL S809 airfoil cross-section which is similar to linear taper blade plan form shown in Figure 5. The chord length and twist angle (relative to the rotor plane) tapering from approximately 0.14m and 13^o and the blade root to 0.06m and 2^o at the tip.

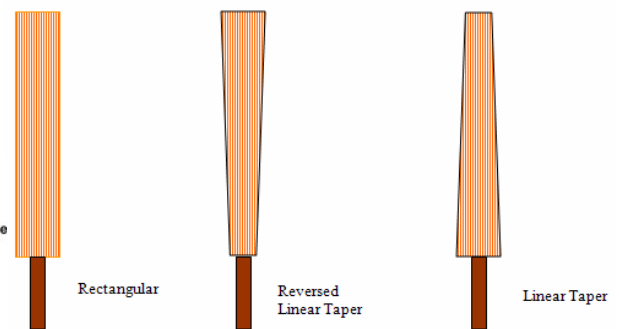


Figure 5. Types of Wind Turbine Blade Plan form (Courtesy: Ajao, 2008)

5. Power Performance Analysis

The wind turbine under test is installed on the roof top of University of Ilorin, Faculty of Engineering Central Workshop at about 14.9m from the ground. Ilorin, Nigeria is on latitude 8.5^oN and the site average temperature and air density are 27^oC and 1.21kg/m³ respectively(Lasode, 2004).

The test turbine shown in Figure 6 has a rotor diameter of 2.15m and a rated power of 110watts at 10m/s. It is a three-bladed, upwind variable speed, horizontal axis having blade pitch angle (angle of attack) of 7^o. It is permanent wind facing at 285^o of compass North.

The turbine uses an automobile alternator (generator) modified to higher rating to produce d.c. power output measured by a FEIGAO Power Analyzer .The output power is stored in two 12V d.c. batteries connected

in parallel. The direct current power is converted to alternating current power by a 12V direct current to 220V alternating current inverter. The inverter output is then measured by a digital Wattmeter.

A Vortex D2 anemometer and another 1-wire anemometer installed at the tail boom of the wind turbine serves as the nacelle anemometers measuring wind speed at hub height and as a wind direction sensor respectively.

Installed at about 8.4m from the test turbine is a meteorological tower (MET). This is more than three rotor diameters from the test turbine in the measurement sector as required by the IEC standard. The MET tower carries an APRS anemometer at hub height transmitting wind data to a data logger housed inside the Data Centre shown in Figure 7. The data logger supports Secure Digital (SD™) card up to 128MB where all the wind data are logged and later transferred to a compatible personal computer (PC) for analysis.

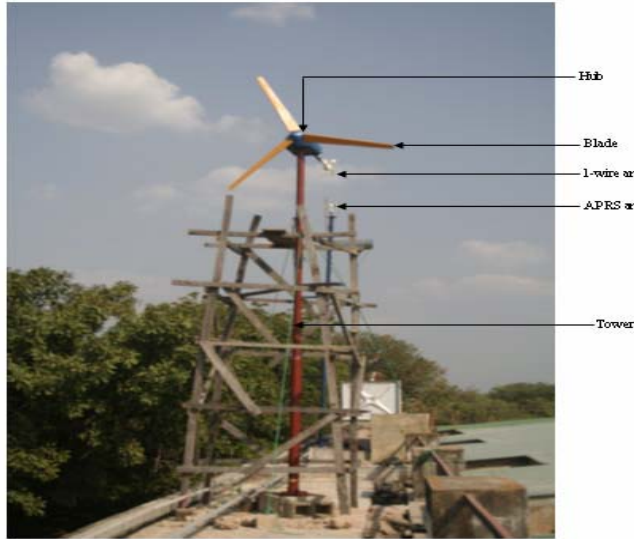


Figure 6. Test Turbine showing anemometers and Meteorological Tower (MET)



Figure 7. Data-gathering Centre showing installed equipment

6. Results and Discussion

6.1 Results

The data gathering for the power performance test commenced on 16th October, 2007 and ended on 5th February 2008 during the Hamattan wind period. Wind speed measurement during the test period was obtained automatically by the APRS anemometer and data logger at a sample rate of one-minute. It measured and logged current wind speed (WS0), maximum wind speed (WG0), prevailing wind direction (DIR) and input voltage to the data logger among other useful data to a 128MB SD-RAM in a spread sheet format as shown in table 2.

Table 2. Wind speed measurement using APRS anemometer

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V		
1																								
2	Date	Time	WS0	WG0	W00	WS1	WG1	WC1	WS2	WG2	WC2	DIR	T(OC)	AD00	AD01	AD02	AD03	AD04	AD05	AD06	AD07	Bat.Volt	CRC	
3	12/21/2007	12:24	0.9	2.3	162	0	0	0	0	0	0	0	0	316	11	4	1023	1023	1023	1023	1023	1023	12.3	3
4	12/21/2007	12:33	2.3	2.9	164	0	0	0	0	0	0	0	0	316	0	15	1023	1023	1023	1023	1023	1023	12.3	10
5	12/21/2007	12:34	2	3.4	203	0	0	0	0	0	0	0	5	316	15	3	1023	1023	1023	1023	1023	1023	12.3	7
6	12/21/2007	12:35	2.1	3	213	0	0	0	0	0	0	0	3	314	10	5	1023	1023	1023	1023	1023	1023	12.2	5
7	12/21/2007	12:36	1.5	2.2	141	0	0	0	0	0	0	0	3	313	11	3	1023	1023	1023	1023	1023	1023	12.2	7
8	12/21/2007	12:37	1.5	3	187	0	0	0	0	0	0	0	0	315	2	13	1023	1023	1023	1023	1023	1023	12.3	8
9	12/21/2007	12:38	2.3	3.6	172	0	0	0	0	0	0	0	5	315	16	6	1022	1022	1023	1023	1023	1022	12.3	11
10	12/21/2007	12:39	0.9	13.1	190	0	0	0	0	0	0	0	4	314	14	8	1022	1022	1022	1022	1022	1022	12.2	57
11	12/21/2007	12:40	2.2	2.6	156	0	0	0	0	0	0	1	0	316	5	10	1022	1022	1023	1023	1023	1022	12.3	2
12	12/21/2007	12:41	1.4	2.3	127	0	0	0	0	0	0	0	0	313	10	5	1022	1023	1022	1022	1022	1022	12.2	0
13	12/21/2007	12:42	1.9	2.5	157	0	0	0	0	0	0	0	0	316	0	15	1023	1023	1023	1023	1023	1023	12.3	8
14	12/21/2007	12:43	2.3	3.5	165	0	0	0	0	0	0	5	0	312	16	3	1023	1022	1023	1023	1023	1023	12.1	2
15	12/21/2007	12:44	0.9	2.7	107	0	0	0	0	0	0	3	0	312	11	3	1023	1023	1023	1023	1023	1023	12.1	10
16	12/21/2007	12:45	1.3	2.7	152	0	0	0	0	0	0	0	0	313	2	11	1023	1022	1023	1023	1023	1023	12.2	1
17	12/21/2007	12:46	1.1	2.9	148	0	0	0	0	0	0	2	0	312	6	8	1022	1022	1023	1023	1023	1022	12.1	57
18	12/21/2007	12:47	3.7	4.2	228	0	0	0	0	0	0	0	0	311	2	16	1022	1023	1023	1023	1023	1022	12.1	15
19	12/21/2007	12:48	1.6	4.5	274	0	0	0	0	0	0	5	0	312	16	1	1022	1023	1023	1023	1023	1022	12.1	8
20	12/21/2007	12:49	1.6	2.3	130	0	0	0	0	0	0	5	0	314	15	3	1023	1023	1023	1023	1023	1023	12.1	14
21	12/21/2007	12:50	1.8	2.5	136	0	0	0	0	0	0	0	0	313	0	14	1023	1023	1023	1023	1023	1023	12.2	10
22	12/21/2007	12:51	2.2	2.8	136	0	0	0	0	0	0	0	0	317	6	15	1022	1023	1023	1023	1023	1022	12.3	15
23	12/21/2007	12:52	1.6	3.6	189	0	0	0	0	0	0	5	0	314	15	7	1022	1023	1023	1023	1023	1022	12.2	7
24	12/21/2007	12:53	0.4	3.3	157	0	0	0	0	0	0	3	0	311	11	10	1023	1023	1023	1023	1023	1023	12.1	43
25	12/21/2007	12:54	1.2	3.2	149	0	0	0	0	0	0	1	0	316	5	8	1023	1023	1023	1023	1023	1023	12.3	68
26	12/21/2007	12:55	2.7	3.4	241	0	0	0	0	0	0	0	0	311	2	16	1023	1023	1023	1023	1023	1023	12.1	3
27	12/21/2007	12:56	1	3.5	196	0	0	0	0	0	0	0	0	311	1	15	1023	1023	1023	1023	1023	1023	12.1	1
28	12/21/2007	12:57	2.2	2.8	133	0	0	0	0	0	0	2	0	316	7	13	1023	1023	1023	1023	1023	1023	12.3	9
29	12/21/2007	12:58	2.8	3.7	247	0	0	0	0	0	0	5	0	313	16	4	1023	1023	1023	1023	1023	1022	12.2	7
30	12/21/2007	12:59	1.3	2.9	176	0	0	0	0	0	0	0	0	314	0	14	1022	1023	1023	1023	1023	1022	12.2	5
31	12/21/2007	13:00	2.3	2.7	152	0	0	0	0	0	0	1	0	313	5	15	1023	1023	1022	1023	1023	1023	12.2	0

The data from the 1-wire anemometer, measuring the wind direction and that of the Vortex D2 anemometer measuring the wind speed in miles per hour (mph) only serve to confirm the correctness of the APRS anemometer data. This was done and confirmed satisfactory.

The direct current power produced by the test turbine during the “good wind” period was measured at the battery bank terminal just before the inverter by a Feigao Power Analyzer and logged automatically to the host laptop computer via a Com Port. The data being logged is displayed on the screen of the host computer by the PowerView software that accompanied this equipment. The PowerView software displays the real-time power in watts, maximum power, minimum power, current, amp-hour, watt-hour and plots the graphs of these values against time in seconds and also record the same data in a spreadsheet format and a sample is shown in Figure 8 below.

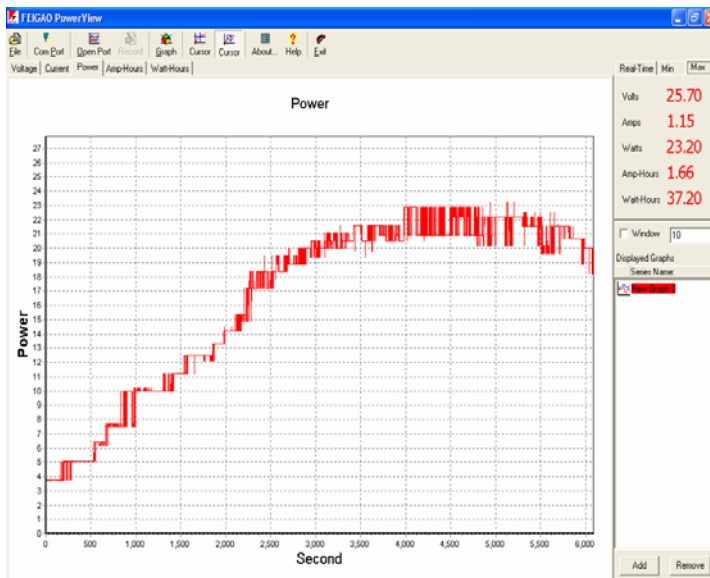


Figure 8. Test Turbine Power measurement using Power Analyzer

The digital wattmeter records the alternating current power produced, measured at the output terminal of the inverter and this data was recorded manually into a logbook because the equipment has no data logger. A bulb point load is connected to the terminal of the wattmeter during measurement.

All measuring equipments are connected to their sources via a control switch to aid the switching on and shutting off of the data gathering equipment in unfavourable conditions. On a weekly basis the data from the measuring equipment are gathered and analyzed and the test turbine and all equipment are also checked for damages.

6.2 Power Curves Analysis

The amount of power that a wind turbine produces depends on the wind speed at the time. The power curve describes the relationship between the wind speed and the power that the turbine generates.

6.2.1 Measured (d.c.) Power

Table 3 below shows the measured direct current (d.c.) power at site average air density (1.21 kg/m³) and normalized to the power at sea level air density (1.225 kg/m³). Normalization to sea level air density is done by multiplying measured power by the ratio of sea level air density to site average air density. Measured wind speed is also binned and normalized. The IEC standard requires at least three one-minute points per bin. This condition was met except for normalized wind speed of 18 m/s, 19 m/s and 20 m/s.

Table 3. Direct current (d.c.) power at site average air density and normalized to sea level air density

Wind Speed (m/s)	Normalized Wind Speed (m/s)	Measured Power (d.c.) at site average air density (W)	Power (d.c.) normalized to sea level air density (W)
1	1.4	0	0
2	2.3	1.33	1.35

3	3.2	2.57	2.61
4	4.3	8.80	8.92
5	5.8	14.54	14.74
6	6.7	23.20	23.53
7	7.4	32.20	32.65
8	8.2	63.00	63.89
9	9.3	97.20	98.57
10	10.1	110.20	111.75
11	11.7	159.00	161.23
12	12.4	166.10	168.43
13	13.5	170.80	173.20
14	14.2	209.94	212.89
15	15.4	275.25	279.12
16	16.2	282.62	286.59
17	17.4	284.19	288.18
18	18.1	285.00	289.00
19	19.8	289.53	293.60
20	20.9	381.10	386.45

The power curves for the measured d.c. power at site average air density and normalized to sea level air density are shown in Figure 9 and Figure 10.

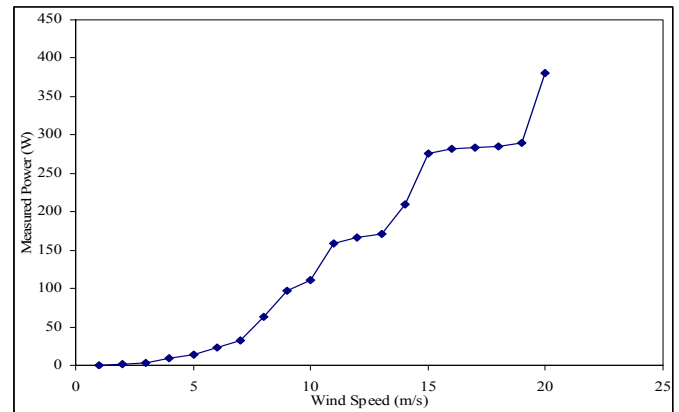


Figure 9. Direct current (d.c.) Power Curve at site average air density, 1.21kg/m³

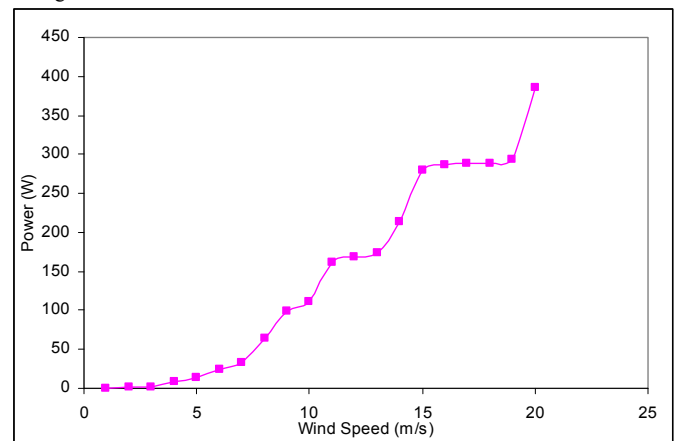


Figure 10. Direct current (d.c.) Power Curve at sea level air density, 1.225kg/m³

6.2.2 Measured (a.c.) Power

Table 4 below shows the measured a.c. power at site average air density (1.21 kg/m³) and normalized to the power at sea level air density (1.225 kg/m³). Normalization to sea level air density is done by multiplying measured power by the ratio of sea level air density to site average air density. Measured wind speed is also binned and normalized. The IEC standard requires at least three one-minute points per bin. This condition was met except for normalized wind speed of 18 m/s, 19 m/s and 20 m/s.

Table 4. Alternating current (a.c.) power at site average air density and normalized to sea level air density

Wind Speed (m/s)	Normalized Wind Speed (m/s)	Measured Power (a.c) at site average air density (W)	Power (a.c) normalized to sea level air density (W)
1	1.4	0	0
2	2.3	10	10.12
3	3.2	10	10.12
4	4.3	16	16.20
5	5.8	20	20.25
6	6.7	23	23.29
7	7.4	31	31.38
8	8.2	52	52.64
9	9.3	93	94.15
10	10.1	97	98.20
11	11.7	138	139.71
12	12.4	146	147.81
13	13.5	150	151.86
14	14.2	153	154.90
15	15.4	153	154.90
16	16.2	240	242.98
17	17.4	245	248.04
18	18.1	248	251.07
19	19.8	254	257.15
20	20.9	305	308.78

The power curves for the measured a.c. power at site average air density and normalized to sea level air density are shown in Figure 11 and Figure 12.

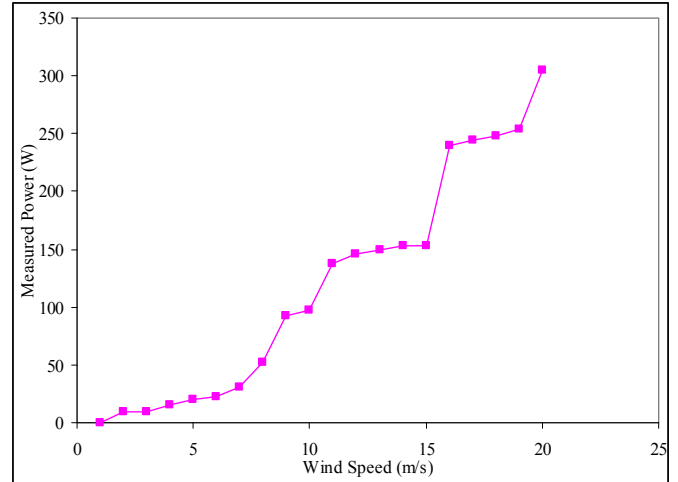


Figure 11. Alternating current (a.c.) Power Curve at site average air density, 1.21kg/m³

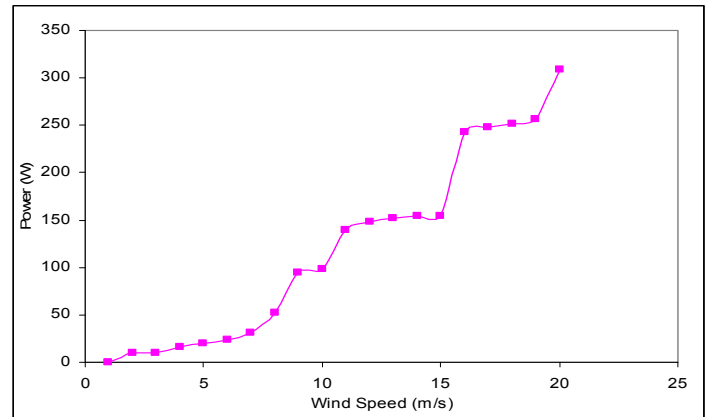


Figure 12. Alternating current (a.c.) Power Curve at sea level air density, 1.225kg/m³

6.3 Discussion

The result of the wind speed measurements indicated that the wind is an intermittent resource that is not available most of the time. The daily average wind speed is lower than the cut-in wind speed and for most part of the day the wind turbine is idling. Normalization to sea level air density has no significant effect on the result. The prevailing wind direction is recorded to be around 4^o of the compass North; the wind turbine though within the measurement sector can perform better if slightly turned towards 345^o-5^o of the compass North.

Measured power increases consistently with increased wind speed. The average output power and the Annual Energy Power (AEP) of the test turbine was determined to be approximately 100Watts and 698Kilowatts respectively. The resulting power curve showed some discrepancies at certain wind speed but compared favourably with standard power curves.

With wind plants in the megawatts range, the topography of Nigeria can be put to advantage. For stability reasons, grid integration of such plants may not be advisable presently. However, the installation of small

wind turbines in the kilowatts range in remote settlements in Nigeria is practicable and viable. Such settlements abound in the riverine areas of the South endowed with ocean wind and in the desert windy areas of northern Nigeria. In areas with low wind resources, a hybrid system with solar photovoltaic energy system is recommended. A balanced system provides stable outputs from these sources and minimizes the dependence of the power output on seasonal changes.

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Effect Of Growth Hormones On Seed Germination And Seedling Growth Of Black Gram And Horse Gram

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Abstract: The experiment was undertaken with an objective to determine how the rate of seed germination and seedling growth can be influenced by various concentrations of growth regulators i.e. GA₃ and IAA in Black gram and Horse gram. The seed material was collected from the agricultural fields of Maletha, a nearby village of Srinagar town, Uttarakhand (India). Seed moisture content was determined and found optimum for seed testing. The seeds were soaked in different concentrations (10, 50, and 100 ppm) of GA₃ and IAA for 24 hours. Four replicates of each treatment with 20 seeds per replicate were arranged for precise analysis. Significant variation was found between the Black gram and Horse gram in all aspects. T₂ (GA₃ 10 ppm) showed highest germination percentage as well as the higher radicle and plumule length in contrast to other treatments. But when considered particularly on the radicle and plumule elongation, these did not show any significant effect on both the crop species. [The Journal of American Science. 2009;5(5):79-84]. (ISSN 1545-1003).

Key words: GA₃, IAA, germination, radicle, plumule, treatment.

Introduction

Black gram (*Vigna mungo*) and Horse gram (*Macrotyloma uniflorum*) is an important short duration pulse crop grown in many parts of India, cultivating both in Kharif and Rabi season. The optimum temperature for better growth of these crops ranges between 25 to 35°C, but it can tolerate up to 42°C which permit to cultivate during summer and winter season. The Horse gram is mainly cultivated in hilly areas and commonly grown up at 1800 msl but the Black gram is cultivated both in hilly and plain regions.

The evidence for hormone involvement comes from correlation of hormone concentration with specific development stages, effects of applied hormones and the relationship of hormones to metabolic activities. Sometimes response on growth or differentiation is inhibited by hormones, especially Abscisic acid. This inhibition is removed by the use of certain growth regulators like Gibberellin and Auxins. The applications of gibberellins increases the seed germination percentage by attributing the fact that they increase the amino acid content in embryo and cause release of hydrolytic enzyme required for digestion of endospermic starch when seeds renew

growth at germination. GA acts synergistically with auxins, cytokinins and probably with the other hormone, is what might be called a system approach, or synergism. The overall development of plant is regulated by the growth hormones, nutrient and environmental factors. They also vary in their germination requirement. It is not known that in which concentrations these hormones will cause a response in the cell. This investigation with growth hormones will help in determining that which of hormonal concentration are suitable for seed germination and seedling growth. This analysis is considered necessary since the beneficial effect of presoaking treatment of seeds with growth regulator and other substances have been reported in the literature repeatedly.

Gibberellic acid (GA₃) is known to be concerned in the regulation of plant responses to the external environment (Chakrabarti and Mukherji, 2003), also, application of another plant growth bio-regulator has increased the saline tolerance of many crop plants (Haroun et al., 1991; Hoque and Haque, 2002). GA₃ has also been shown to alleviate the effects of salt stress on water use efficiency (Aldesuquy and Ibrahim, 2001). Das Gupta *et al.*

(1994) recorded that foliar application of plant growth regulators like IAA and GA helped the plant to restore retardation in water content in Mungbean plants subjected to water stress. Chakrabarti and Mukherji (2002) noticed that GA₃ used to overcome the adverse effects in Mungbean plants. The role of plant growth regulators in overcoming the harmful effects of salinity on growth may be due to the change in the endogenous growth regulators which affects plant water balance. In view of the above background the present investigation was undertaken to study the influence of growth substances by different concentration on seed germination, radicle and plumule elongation to draw the information of timing and control of seed germination and seedling growth of species in nature.

Materials and Methods

The investigation was conducted at the Seed Testing Laboratory, Department of Seed Science &

Technology, H. N. B. Garhwal Central University, with an objective to determine the rate of seed germination and seedling growth which influenced by various concentrations of growth regulators in Black gram (*Vigna mungo*) and Horse gram (*Macrotyloma uniflorum*). Seeds were collected from Maletha, a small village situated near Srinagar town in Uttarakhand (India) in the month of January 2007 which were stored at room temperature till used for the experimentation.

Moisture content of seed was determined by using oven at 103°C for 12 hrs. The moisture percent was found within the recommended value 9.8 and 10.3 for Horse gram and Black gram respectively. The seeds were treated under different concentrations of 10, 50 and 100 ppm of GA₃ and IAA with a separate control set (Table 1). These were soaked for 24 hours in the above concentrations and only double distilled water for the control set.

Table 1. The treatments of GA₃ and IAA with different concentrations

Treatments	Concentration (ppm)	Growth hormone	Seed soaked time (hrs)
T ₁ (control)	---	---	24
T ₂	10	GA ₃	24
T ₃	50	GA ₃	24
T ₄	100	GA ₃	24
T ₅	10	IAA	24
T ₆	50	IAA	24
T ₇	100	IAA	24

Four replicates of each treatment with 20 seeds to each replicate were placed in seed germinator, 20°C. Observation aspects like germination count (recorded for nine days), measurement of radicle and plumule length was measured (recorded for 15 days). Seed germination was recorded by skipping every two days and radicle and plumule length was measured every alternate day till the final day of experimentation. The mean germination percent, radicle and plumule length of each treatment were calculated, and for quantitative evaluation of effect of various treatments, the values were used to compare with the control treatment observation values. The experiment was laid out in a Randomized Block Design (RBD) with 7 treatments. Data collected were analysed statistically using coefficients of variability and least significant difference (LSD) test at 0.05 probability level (Steel and Torrie, 1984).

Results and Discussion

Low germination percentage was observed in control treatment of both the crop (Table 2). The seeds treated with GA₃ showed significant difference to control. The germination percent of treatment GA₃ 10 ppm, was recorded a difference of nearly 4 to 10% to treatment 50 and 100 ppm, in which GA₃ 10 ppm was found most suitable because it showed highest germination percent. Both 50 and 100 ppm concentration of GA₃ did not show any major difference in respect of germination which meant the higher concentration was not as good as the lower concentration rather it decreased the germination percent. Germination percentage under the treatment of IAA at 10 ppm recorded maximum in both the crop. A significant difference was observed between 10 ppm and the other two treatments. The highest concentration of IAA (100 ppm) showed the least germination percentage (38.75%) in Black gram and (46.25%) in Horse gram. Hence from above it is observed that in both the cases whether it is GA₃ or

IAA, the germination percentage decreases when the concentration increased, which shows that higher concentration inhibit germination. Observations revealed both the growth hormones response uniformly to radicle elongation (Table 4). The length of radicle for control treatment on the terminating day of experiment was observed to be 5.3 and 6.1 cm in Black gram and Horse gram respectively. The longest radicle length was observed under T₃, GA₃ 50 ppm (5.97 cm) in Black gram, but same observation of 6.1 cm in both treatments T₁ (control) and T₂ (GA₃ 10 ppm) was recorded in Horsegram. A uniform plumule elongation was observed in the treatments of GA₃ to both the crop species indicating growth hormone GA₃ had good response. But IAA treatments in both the crop species showed great variation among the treatments and moderate difference to GA₃ treatments. When we compared the control treatment to the other treatments particularly to the maximum length, observation showed not any significant difference which meant there was not great effect by the treatment of growth hormones.

Substantial variation on germination and other aspects was found between both the crop species (Table 5). All the treatments were recorded more effective in Horse gram. In the IAA treatments, plumule elongation was found in decreasing trend with the increase of hormonal concentration. It was observed that for germination enhancement of Black gram and Horse gram, GA₃ with lower concentration was best suited, but in case of radicle and plumule elongation, both these hormones did not show any significant effect. When the two hormones were compared, Gibberellic acid (GA₃) was observed more

effective and responsive to the regulation of radicle and plumule elongation which support the report of Chakrabarti and Mukherji (2003). The application of another plant growth regulator could increased the seed germination and other physiological activity by the reason of tolerance to the toxic particles which was found in consistent with the finding of Haroun et al. (1991); Hoque and Haque (2002). With the more effectiveness of low concentration of GA₃ (that is ratio of growth hormone and water) (Table 3) could restore retardation in water content, this may able to tolerance to water stress. The result was considered in parallel to the findings of Das Gupta et al. (1994). As from the Table 2 information have shown that GA₃ could overcome the adverse effects in Black gram and Horse gram than the IAA in the seed physiological activity, the findings supports the report of Chakrabarti and Mukherji (2002). The role of plant growth regulators in overcoming the harmful effects on growth may be due to the change in the endogenous growth regulators (Izumi and Eiji 1996). Although varied in seed germination and root shoot elongation by different treatments, the pre-soaking with different treatments evident that soaked seed could improve in germination and seedling establishment and this observation was found equivalent the observation of Ahmad et al., (1998); Harris et al., (1999). The soaking period of 24 hrs increased the total uptake of water which help the maximum imbibition rate. This in turn aid to the quick biochemical changes and time period was found suitable for seed germination. Same experiment was conducted in Black gram and Horse gram by Mohanty and Sahoo (2006).

Table 2. Range and mean of Black gram and Horse gram seed germination of different treatments. The maximum mean value indicated the maximum seed germination percent.

*showing the maximum germination percent in T₂. T₇ (IAA 100 ppm) was found most unsuitable for seed germination treatment

Treatments	Black gram		Horse gram	
	Range	Mean	Range	Mean
T1 (control)	53.00 – 62.00	57.50	45.00 – 56.75	50.87
T2	83.75 – 98.00	90.87*	96.25 – 99.00	97.62*
T3	81.25 – 88.75	85.00	82.50 – 96.25	89.37
T4	65.00 – 87.50	76.25	95.75 – 98.75	97.25
T5	58.75 – 80.00	69.37	87.5 – 95.75	91.62
T6	26.25 – 68.75	47.50	7.50 – 50.00	28.75
T7	10.00 – 38.75	24.37	2.50 – 46.25	24.37

Table 3. Mean seed germination percent of first count and final count. The maximum first count value indicated the quick and more effective treatment. Note the range differences in the IAA treatments.

*maximum first count value and **maximum final count value in treatment T₂ (GA₃ 10 ppm) to both the crop species

Treatments	Blackgram			Horse gram		
	First count	Final count	Range difference	First count	Final count	Range difference
T1 (control)	53.00	62.00	9.00	45.00	56.75	11.75
T2	83.75*	98.00**	14.25	96.25*	99.00**	2.75
T3	81.25	88.75	7.50	82.50	96.25	13.75
T4	65.00	87.50	22.50	95.75	98.75	3.00
T5	58.75	80.00	21.25	87.50	95.75	8.25
T6	26.25	68.75	42.50	7.50	50.00	42.50
T7	10.00	38.75	28.75	2.50	46.25	43.75

Table 4. Range and mean of Black gram and Horse gram radicle and plumule elongation under different treatments.

*Represented the maximum mean of range i.e., longest radicle or plumule. #Contrast in the length of final lengths and range mean value. The contrast was due to the non-spontaneous effect of treatment

Treatments	Black gram						Horse gram					
	Radicle			Plumule			Radicle			Plumule		
	Range	Mean	Range difference	Range	Mean	Range difference	Range	Mean	Range difference	Range	Mean	Range difference
T1 (control)	2.45 - 5.30	3.87	2.85	3.25 - 7.51	5.38	4.26	4.30 - 6.10	5.20#	1.80	4.53 - 8.20	6.36	3.67
T2	2.75 - 4.88	3.81	2.13	4.65 - 7.92	6.28#	3.27	3.60 - 6.10	4.85#	2.50	6.40 - 9.50	7.95	3.10
T3	3.05 - 5.97	4.51*	2.92*	4.13 - 7.22	5.67	3.09	4.78 - 5.30	5.04	0.52	6.20 - 10.50	8.35*	4.30
T4	2.30 - 5.45	3.87	3.15	5.13 - 7.66	6.39#	2.53	3.80 - 5.50	4.65	1.70	6.73 - 9.20	7.96	2.47
T5	2.20 - 5.60	3.90	3.40	4.65 - 6.62	5.63	1.97	4.33 - 5.90	5.11	1.57	4.95 - 8.50	6.72	3.55
T6	2.23 - 4.10	3.16	1.87	2.03 - 4.78	3.40	2.75	1.40 - 3.00	2.20	1.60	1.13 - 6.80	3.96	5.67
T7	0.85 - 3.38	2.11	2.53	0.80 - 4.33	2.56	3.53	0.50 - 5.00	2.75	4.50	0.57 - 5.90	3.23	5.33

Table 5. Germination percent, radicle and plumule length of Black gram and Horse gram under various treatments.

Treatments	Germination %		Black gram		Horse gram	
	Black gram	Horse gram	Radicle	Plumule	Radicle	Plumule
T1 (control)	62.00	56.75	5.30	7.51	6.10	8.20
T2	98.00	99.00	4.88	7.92	6.10	9.50
T3	88.75	96.25	5.97	7.22	5.30	10.50
T4	87.50	98.75	5.45	7.66	5.50	9.20
T5	80.00	95.75	5.60	6.62	5.90	8.50
T6	68.75	50.00	4.10	4.78	3.00	6.80
T7	38.75	46.25	3.38	4.33	5.00	5.90
Mean	74.82	77.53	4.95	6.57	5.27	8.37
CV% (σ)	26.848	32.296	18.492	22.004	20.575	18.962

Any two means differ significantly from each other at P=0.05

Conclusion

From the above discussion it can be concluded that significant variation was found between the Black gram and Horse gram in all aspects. The higher concentration of IAA showed very least elongation of plumule as this higher concentration always inhibited the plumule elongation. GA₃ 10 ppm showed highest germination percentage as well as the higher radical and plumule length in contrast to other treatments. But in case of radicle and plumule elongation, these hormones did not show any significant effect in both the crops. This indicates that the lower concentration of growth regulators favour the increased enzymatic activity which leads to the favourable environment for the germination as well as the growth of the radicle and plumule.

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Anatomical features of *Lilium polyphyllum* D. Don ex Royle (Liliaceae)

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Abstract: Present paper reports anatomical investigation of *Lilium polyphyllum*, a critically endangered important medicinal herb. Plant samples were collected from Dhanolti, a temperate region in North-west Himalaya, Uttarakhand, India. Transverse sections of plant parts *viz.*, stem, leaf, anther, stigma, ovary, seed, bulb scale, bulb peel and root were investigated. In leaves, stomata are hypostomatic and anomocytic type. Pollen shape was ellipsoid and its surface was reticulate, it also possesses oil drops. Ovary is superior and having axile placentation, ovules are anatropous. Sections of bulb scale show eccentric type starch grains and tracheids. Stem section show scattered vascular bundles. These anatomical features will help to provide information of taxonomic significance. [Journal of American Science 2009; 5(5): 85-90]. (ISSN: 1545-1003).

Key Words: Anatomy; Oil drop; Pollen; Starch grains; Stomata; Tracheids

1. Introduction:

The taxonomic classification divides the genus *Lilium* into seven sections (Comber, 1949; De Jong, 1974) with approximately 100 species distributed throughout the cold and temperate region of the northern hemisphere. The importance of the genus in the world flower market is due to diversity and large number of hybrids and cultivars commercially available (De Hertogh, 1996). However, some species are also known for medicinal and food value (Chang *et al.*, 2000; Wawrosch *et al.*, 2001; Khawar *et al.*, 2005; Dhyani, 2007), which increased its economic importance many folds.

Lilium polyphyllum is a bulbous, perennial herb (Figure 1, 2) and recently reported as critically endangered (Ved *et al.*, 2003). The species found in North-west Himalaya in India to westward of Afghanistan (Hooker, 1894; Gaur, 1999) between 2200 to 3200m asl. It is known as 'White lily' and *Ksirakakoli* in trade. Medicinally, bulb of the species has been used for refrigerant, galactagogue, expectorant, aphrodisiac, diuretic, antipyretic and tonic (Warrier *et al.*, 1997; Dhyani, 2007). In traditional system of medicine, the species reported to restore health immediately and works as antioxidant in the body (Mathur, 2003; Sharma & Balkrishna, 2005; Pandey, 2005).



Figure 1.



Figure 2.

Studies on anatomy of the genus *Lilium* are very limited (Farasam *et al.*, 2003; Kaviani *et al.*, 2008). In addition, there were no anatomical studies on *Lilium polyphyllum* to date. Therefore, the aim of the present study is to investigate the anatomical features of the species which will be of taxonomic significance.

2. Materials and Methods

Plants of *Lilium polyphyllum* in vegetative (May, 2008) and reproductive phase (June, 2008) were collected from Dhanolti region (2200m, 30°25' N, 78°15' E) of Uttarakhand, North-west Himalaya, India. The specimens for anatomical studies were kept in 70% alcohol till the sections were prepared. The cross-sections of the stem, leaf, anther, stigma, ovary, seed, bulb scale, bulb peel and root were taken manually. The sections were stained with safranin and examined under a Nikon Eclipse E800 microscope. Pictures were snapped using a Nikon Digital Sight Camera. Identification of different cells and tissues were fulfilled on the digital images of the specimens in late July, 2008.

3. Results and Discussion

The stem of the plant is hollow and 30-100cm high which aid in distant seed dispersal. Transverse section (T.S.) of stem has following overview; the epidermis is composed of single layer, compactly arranged square cells and is covered with cuticle. Immediately after epidermis, is a three layered parenchyma cells which are almost circular. This is followed by 4-5 layered chlorenchymatous cells. Ground tissues are distributed throughout the space under chlorenchyma which is composed of circular cells. Several pigment cells can be seen in chlorenchymatous tissue. Vascular bundles are scattered throughout the cortex. Endodermis, pericycle and cambium cells are not present. The vascular bundles are surrounded by a bundle sheath composed of sclerenchyma (Figure 3, 4).

Leaves are alternate, spirally arranged, acuminate with parallel venation and 6-12cm long. TS of leaf reveal the presence of epidermis (covered by cuticle) on both upper and lower surface. All the stomata are present on abaxial side of the leaf, therefore, leaves are hypostomatic. Similar stomata position has been reported earlier in *Lilium ledebourii* (Kaviani *et al.*, 2008). Midrib is surrounded by a parenchymatic bundle sheath (Figure 5).

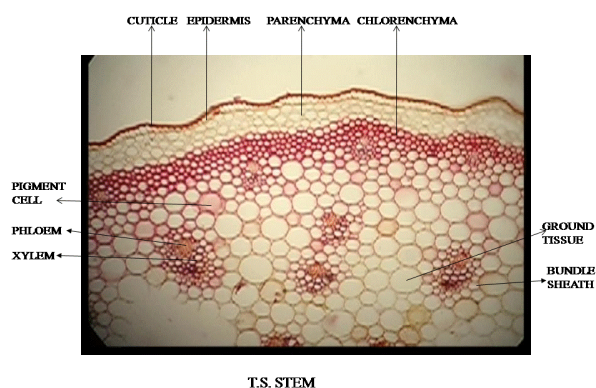


Figure 3.

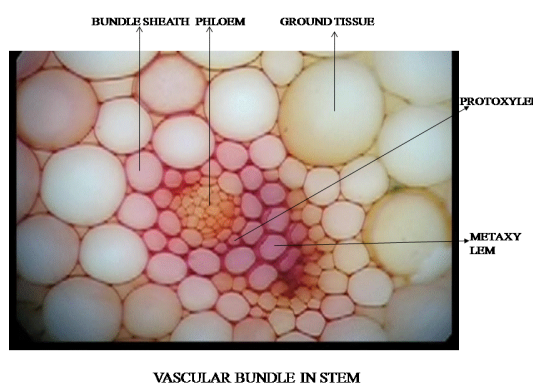


Figure 4.



Figure 5.

In leaf peel, stomata are anomocytic (Irregular – celled type; formerly known as Ranunculaceous type). Each stomata was surrounded by two kidney shaped guard cells with the presence of chloroplast (Figure 6).

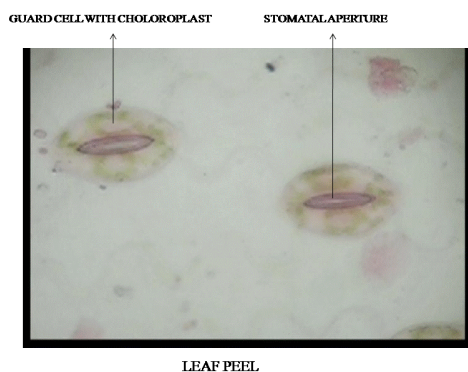


Figure 6.

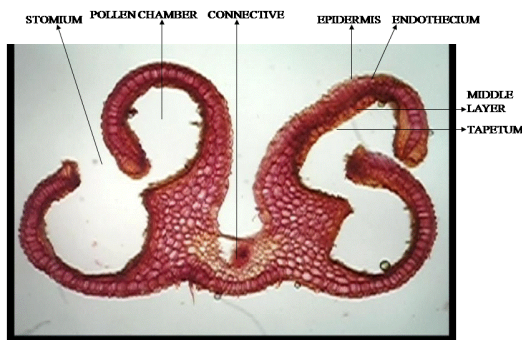


Figure 7.

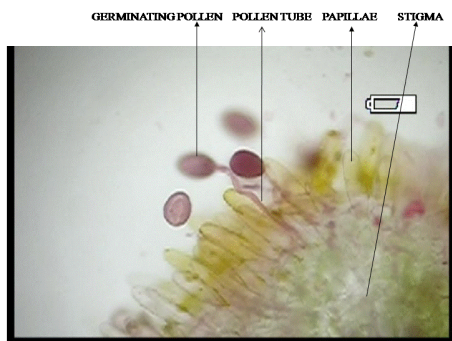


Figure 8.

Similar stomata were earlier reported by Farasam *et al.* (2003) and Kaviani *et al.* (2008) in *L. ledebourii* and in the species of families Boraginaceae, Ranunculaceae and Geraniaceae.

The flowers of this lily are large and showy, fragrant, pendulous, white and speckled with pink, having six tepals in terminal racemes with nectar gland at their bases. Each flower has six stamens and a carpel. T.S. of anther reveals, that it has two lobes with four chambers (ditheous) held together by connective (Figure 7). The wall consists of an outer epidermis, endothecium, one to three middle layers and an innermost tapetum. Tapetum at maturity is multinucleate and contains dense cytoplasm which is finally used by the developing microspores. Pollen grains discharged through stomium. Prior to dehiscence, tapetum and middle layer degenerates.

Pollens are ellipsoid in shape and its surface is reticulate. The pollen grains form in tetragonal tetrads and are therefore, monosulcate, having a single furrow as their aperture. Pollen contains oil drops which assist in pollination. Exine is laid down in a reticulate pattern. *Lilium* is insect pollinated; when pollen is transferred on to the stigma it develops a pollen tube (monosiphonous) down the hollow style. Pollen germinates on stigma, papillae are tubular in shape and fertilizes ovules to produce seed for the season (Figure 8).

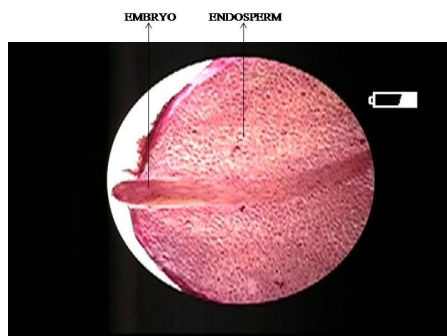


Figure 9.

Ovary is superior and each of its three locules contains many ovules with axile placentation. Similar placentation reported earlier in *Lilium lebebourii*. The ovules are anatropous i.e. they are curved around so that the micropyle is right next to the funiculus. Style is hollow and stigma is three-lobed and papillate (Figure 9). The fruit is a loculicidal capsule.

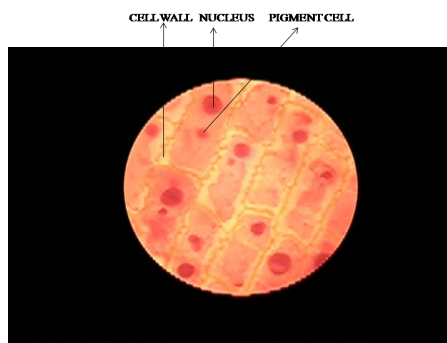
Capsules are oblong, three angled and 3-6 cm long. A capsule holds approximately 100 seeds. Seeds are circular and brown in color. Cross section of seed (average length 7.25mm) shows a small embryo (average length 3.8mm) (Figure 10, 11). Endosperm is also present which acts as a main source of food for embryo till it develops into seedling. Earlier Baskin and Baskin (1998) also reported linear seeds for *Lilium* species.

Bulb is a specialized structure, morphologically underground stem with fleshy scale – leaves and root attached with basal plate with one or more growing points. Scales are modified leaves and stores food for next year growth and provide nutrients for developing plant until it has ample leaf area and root system to do the task. Bulb peel shows cells contain nucleus and pigments (Figure 12). Sections of bulb scale showing eccentric type starch grains (hilum present on one side) deposited in parenchymatous cells (Figure 13). These starch grains are insoluble carbohydrates and having various shape i.e. polygonal, oval, truncated and numbers may be 5-12 in one parenchymatous cell. These are most important reserve material also found in rhizome, tuber, fruits and seeds. They provide energy and thus form an important part of the food. We observe during our field study that people use its scales for vegetable. Starch granules also reported in *Lilium ledebourii* by Farsam *et al.*, 2003.



L.S. SEED

Figure 11.



BULB PEEL

Figure 12.



T.S. SEED

Figure 10.



T.S. SCALE

Figure 13.

Longitudinal section of bulb scale shows tracheids which is composed of narrow, elongated and tubular cells (Figure 14). The lignified secondary cell wall is scalariform i.e. secondary cell wall material is deposited on primary cell wall forming a ladder like pattern. The primary cell wall deposits are cellulose, hemicellulose and pectin. Tracheids are water conducting vascular tissues also reported in other vascular plants i.e. pteridophytes, gymnosperms and angiosperms.

There are two types of roots in *L. polyphyllum* i.e. basal and contractile. Basal roots help in nutrient, water absorption and are important during early spring when the growth starts. The contractile roots function is to anchor and pulling bulb deeper in the soil during harsh climatic conditions to preserve it from frost injury. However, temperature fluctuations at the surface determine how long the contractile roots will continue (Waisel, 1998). T.S. of contractile root indicates that epidermis is composed of single layer of pentagonal cell. Cortex is composed of parenchymatous cells, hexagonal in shape without intercellular spaces (Figure 15). The main function of parenchyma tissue is food storage. Below cortex is a thick walled, single layered endodermis cells. It is selective barrier to movement of water and mineral salts (between cortex and xylem) in roots. Pericycle is present which composed of thin and single layered cells. The primary xylem is distributed towards the pith zone. Thus the main part of pith area is occupied by the metaxylem. Pith is composed of parenchyma cells (Figure 16). Observations suggest general anatomical similarity of *Lilium polyphyllum* root with the roots of other monocots.

Most important findings in this study were stomata type, pollen shape, presence of oil drops in pollen, ovary placentation, eccentric type of starch grains and tracheids. The information put forth the importance of further botanical and medicinal research on the species in spite of its confined distribution.

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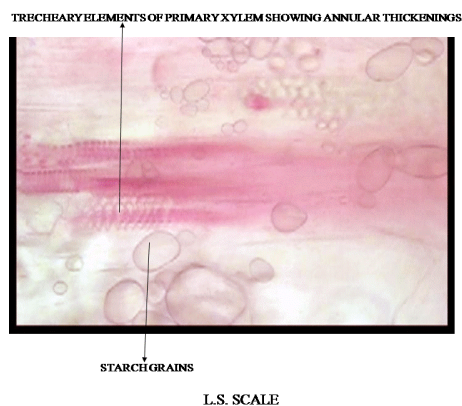
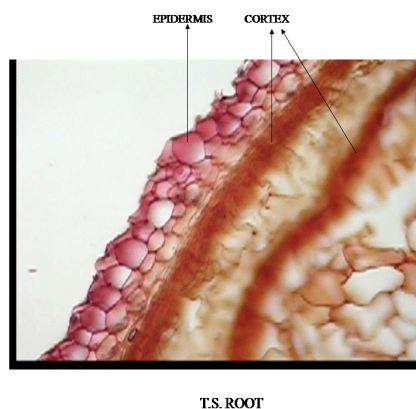
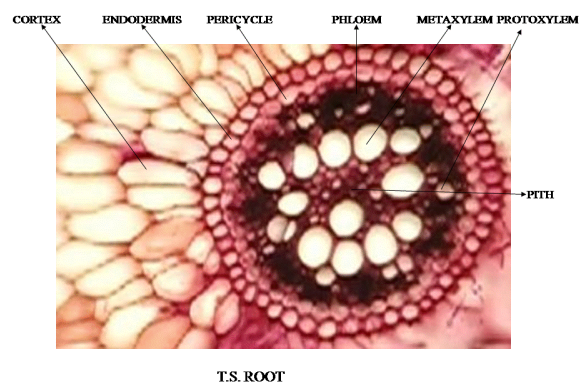


Figure 14.



T.S. ROOT

Figure 15



T.S. ROOT

Figure 16

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Engineering Geophysical Approach to Progressive or Sudden Collapse of Engineering Structures In Lagos, Nigeria.

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Abstract

Every cubic meter removed during excavation, every unusual loading applied to a natural foundation bed, every pile driven into the ground, every construction operation in which the existing condition of the earth's crust is affected is associated with geological features of some kind. Preliminary investigations of the relevant subsurface geology should therefore be of considerable value not only to the resident engineer on construction work but also to the contractor who is undertaking the work. The subsurface engineering geophysical information available at the beginning of a job can be fully effective information during the construction operation as well as post construction works. This paper presents the need for engineering geophysical survey in engineering site characterization. Case studies are cited; "[The Journal of American Science. 2009; 5(5):91-100]. (ISSN 1545-1003)"

Keywords: Electrical resistivity, geophysics, geoelectric, stratigraphy

Introduction

An engineering structure either undergoes progressive or sudden collapse when a primary structural element fails, resulting in the failure of adjoining structural elements. Foundation problems are caused by a combination of soil conditions, the weather, inadequate foundation maintenance and the geological features,

Symptoms of foundation problems include cracks in brick and sheetrock, windows that won't open, doors that won't close, cracks in the foundation, cracks in tile floors and many more. Sometimes some of these symptoms can simply be cosmetically repaired. Complete underpinning of the foundation may not be necessary. It takes an expert to properly diagnose true foundation problems. Just because you have some or all of these symptoms does not mean that you need foundation repair.

In many coastal areas of the world, Lagos as an example, the near surface soil is of expansive clay (Fitterman and Deszez-Pan, 2001). Expansive clay behaves differently than sandy soil. Sandy soil does not expand when it gets wet the water fills the air space between the grains of sand. Because of this, the soil volume doesn't change and there is little movement of structures supported by the soil when

the soil moisture conditions alternate between wet and dry.

Expansive clay soil expands when it absorbs water. Water becomes bound to the clay particles. As the soil goes through wet and dry periods, the soil expands and contracts. Structures sitting on top of the soil rise and fall with the soil. If this happened uniformly across the structures, damage to the foundation and finishes from soil movement would be limited.

Unfortunately, uniform shrinking and swelling doesn't usually happen. The result is "differential" foundation movement, which causes cracking and distress in the foundation and finishes. Although there may be a number of layers and types of expansive clay or other soil under a particular structure, the shrinking and swelling process is usually limited to soil that is near enough to the ground surface to be affected by climatic conditions. Many engineers refer to these upper soil layers as the "active zone", While the depth of the active zone depends on site and soil conditions. Commonly employed geophysical methods include seismic tomography, ground penetrating radar, electrical resistivity method, and electromagnetic method (Olowu,1967, Edwards, 1977, Kontar and

Ozorovich, 2006, Neil and Ahmed, 2006, Susan, 2004 and Oyedele , 2008).

2.0. Materials and methods

2.1. Proposed Measures to be taken to prevent collapse of Engineering structures.

Since every engineering structure is seated on geological earth materials, therefore, it is imperative to conduct pre-construction investigation of the subsurface of the proposed site in order to ascertain the strength and the fitness of the host earth materials as well as the timed post-construction monitoring of such structure to ensure its integrity. Several geophysical methods besides geotechnical techniques are routinely used to image the subsurface of the earth which serve as aids in support of providing information on the precautionary measures to be taken in the prevention of progressive/ sudden collapse of engineering structures. Commonly employed geophysical methods include seismic tomography, ground penetrating radar, electrical resistivity method, electromagnetic method and gravity method (Table 1).

However, in terms of spatial resolution, cost effectiveness and target definition, ground

penetrating radar and electrical resistivity methods ranked first and second respectively.

In an ideal situation, the following data must be readily available, adequately acquired and processed and rightly interpreted prior to the commencement of the engineering construction in an area.

1. Geological data of the site area
2. Geophysical data of the site area
3. Borehole data of the site area
4. Geotechnical data of the site area

Information obtained from the above data has a threefold practical value for engineering construction exercise. First, such information acts as a check on the assumptions made with regard to site conditions so that in the preparation of the final design for the work to be incorporated into the design before it is too late. Second, the revelation of the actual geology of the working site enables the contractor to check the suitability of construction plans and equipment. Third, if the geologic record is kept in a satisfactory manner, it may prove of inestimable value at some future time if further work has to be carried out at the same location, or if there are contract litigation.

Table 1: Most Commonly Used Geophysical methods for Geotechnical Studies

Geophysical Techniques	Measured Parameters	Physical Properties	Geotechnical Site Model
Ground Penetrating Radar (GPR)	Travel times and amplitudes reflected pulsed electromagnetic energy	Dielectric constant, magnetic permeability conductivity and EM velocity.	Geologic, material or structure profile.
Seismic Tomography (ST)	Travel times of reflected seismic waves	Density and elastic moduli, which determine the propagation velocity of seismic waves	Geologic profile
Electrical Resistivity (EP)	Earth resistance	Electrical Conductivity	Geologic/hydrogeologic profile.
Seismic Reflection (SR)	Travel times of reflected seismic waves	Density and elastic moduli which determine the propagation velocity of seismic waves	Geologic profile.
Electro magnetic (EM)	Response to electro magnetic radiation	Electrical conductivity and inductance	Geologic/hydrogeologic profile.

The engineering geophysical information that can be obtained from the methods highlighted above include some of the following:

- Detection of underground pipes, cables (metallic and non-metallic)
- Soil-bedrock interface, shallow geological investigations
- Mining development
- Mineral exploration
- Water table determination
- Cavities and voids (structures – dams, bridges, weirs, barrages, etc.)

- Ground contaminants (environments)
- Road investigations (layer thickness, subsidence)
- Rippability assessment in mines
- Slope stability studies
- Pipeline route studies
- Dam structure analysis
- Landfill
- Contamination source detection
- Identification of features like fault zones and voids
- Mapping of loose zones, sink holes, anomalous zones in structures, like dams
- Detailed study of old foundations
- Estimating clay/mineral content
- Mapping of contaminated plumes
- Locating buried well casings
- Landslide site evaluation

2.2. Engineering Geophysical Site Characterization

The application of suitable geophysical methods can provide useful information about the contrasts in physical properties of the subsurface which can be routinely applied to mining-related problems of a geotechnical nature. Geophysics can be an extremely powerful tool in subsurface mapping, and its effectiveness can be enhanced when there is strong collaboration between geologists and geophysicists from the planning through the interpretation stage. Geophysical data when properly acquired, processed and interpreted, can be translated into subsurface geologic models.

2.3. Field Application /Case study

2.3.1 Geologic setting

The study area is situated in Lagos (figure 1). The surface geology is made up of the Benin formation (Miocene to Recent) and the recent littoral alluvial deposits. The Benin formation consists of thick bodies of yellowish (ferruginous) and white sands (Jones and Hockey, 1964). Multi-layer lithology have been classified by Longe et al, 1987, into three types namely admixtures of sand and clay, coarse sand and clay. The thickness varies from 8 to 35m.

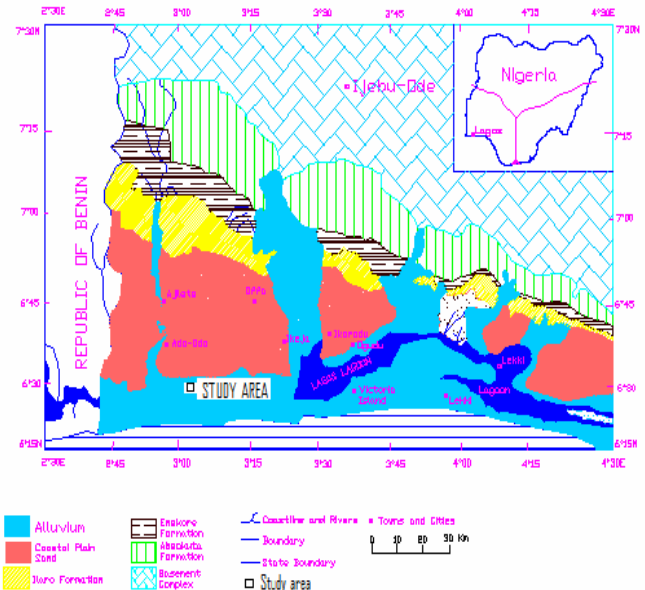


Fig 1: Geological map of Lagos showing the study area (modified from Adegoke, 1969)

2.3.2. Data acquisition and processing

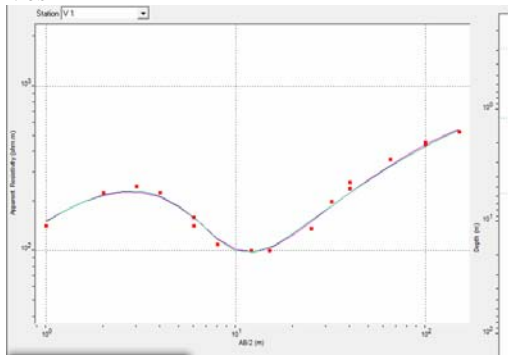
The field data were acquired using Terrameter SAS1000 system. About twenty-four vertical electrical sounding (VES) using Schlumberger electrode array system were conducted. Only results for fourteen VES stations were presented. As a control measure to geographical data, one borehole was drilled to aid lithological delineation.

The acquired data is processed using WinGlink software programme. This is a powerful software package that was designed to read and store data acquired by different geographical surveys carried out in an area of interest, as well as other auxiliary information. By this technique, erroneous interpretations arising from manual techniques are eliminated. The processed data were presented in the form of 1-D resistivity models, inferred sediments and contoured maps.

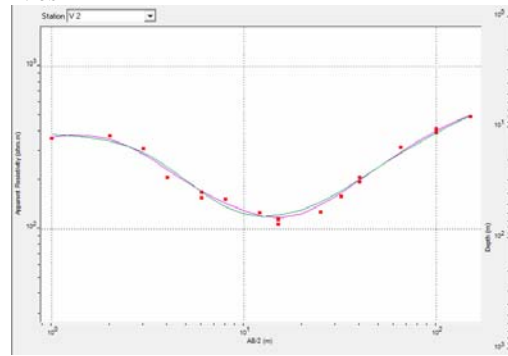
3.0. Results

Figures 2 and 3 show representative samples of 1-D models resistivity field curves obtained from the study area. Visual inspection of the field model curves shows a typical 3 to 5-layered case. The detailed stratigraphic sequence of the area is presented in Table 2. The geoelectric section alongside with the drilled borehole was used to delineate the stratigraphic succession in the study area (Table 2).

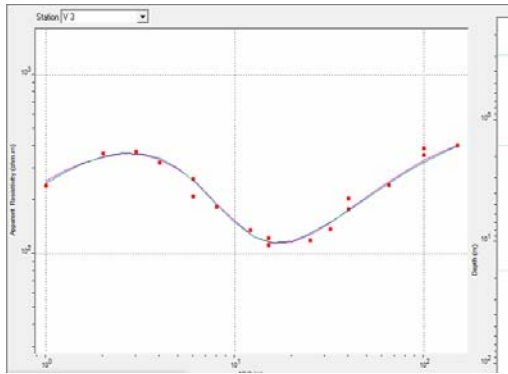
Ves 1



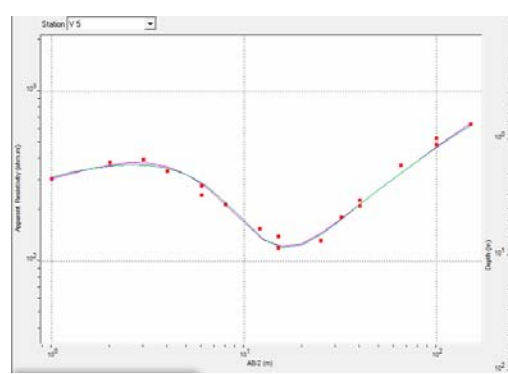
Ves 2



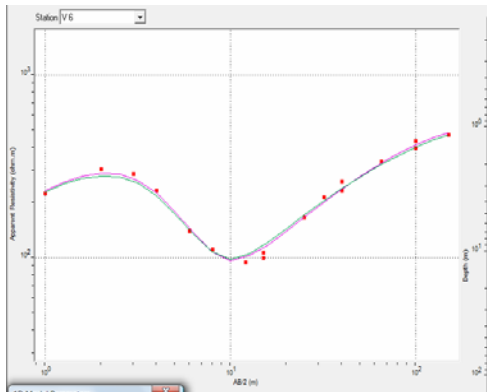
Ves3



ves4



Ves5



ves6

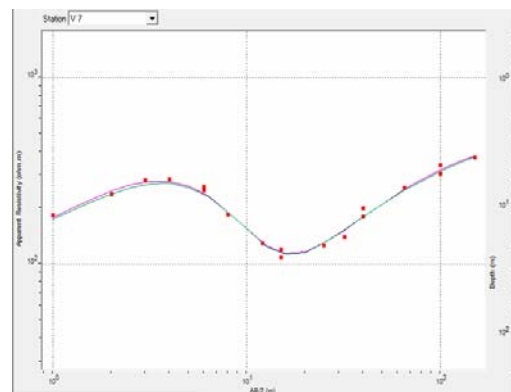


Fig 2: Representative of 1-D model resistivity curves

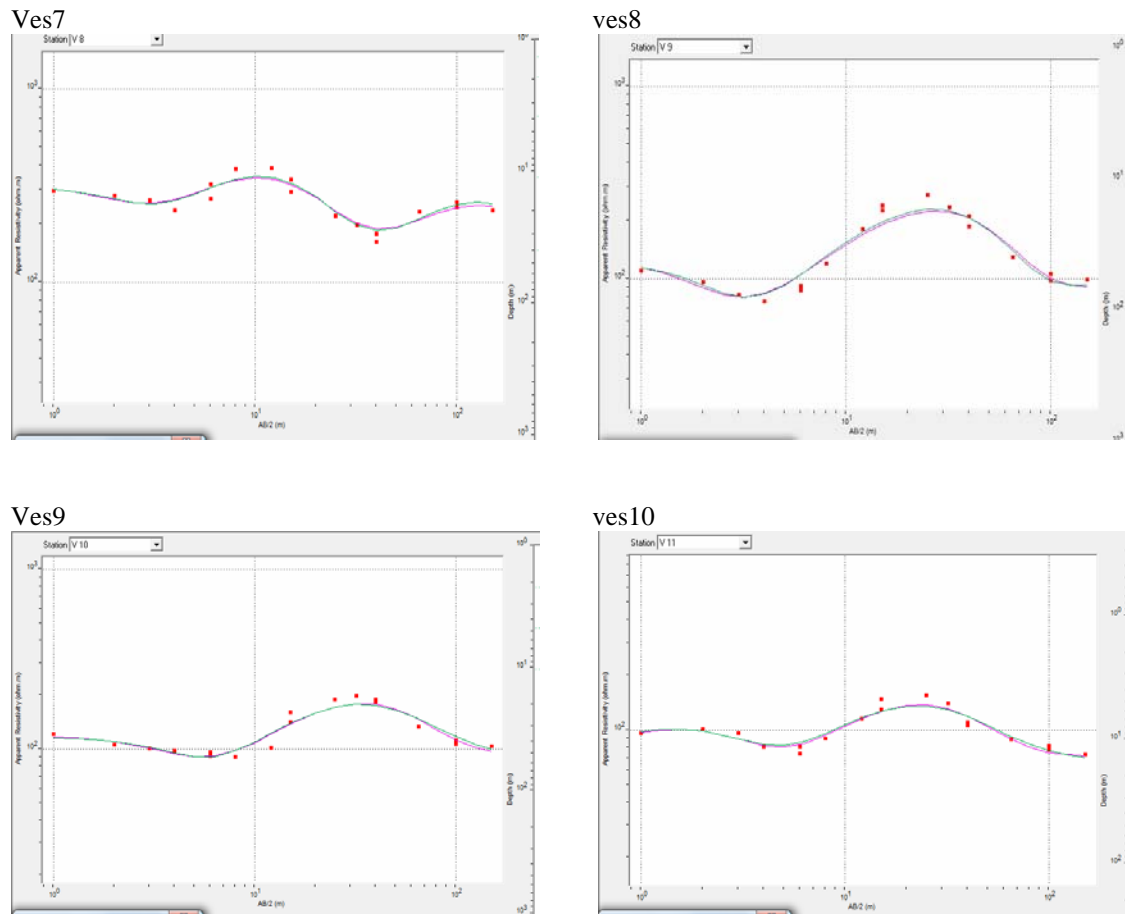


Fig 3: Representative of 1-D model resistivity curves

4.0. Discussion of Results

Beneath VES 1, the lithology consists of topsoil, medium sand, clay and coarse sand. Here the depths to sand layers range from 1.18 to over 5.57m while the average depth to clay layer is 5.57m. Beneath VES, 2 the lithology consists of topsoil, medium sand and coarse sand. The average depth to sand layer is greater than 18.09m. There is no clay layer in this zone as the current terminated in the third layer.

Beneath VES 3, the stratigraphy is made up of top soil, medium sand, clayey sand and coarse sand. The depths to sand layers range from 1.61 to over 17.04m while the depth to clayey sand is 17.604m. Beneath VES 4, the sediment is made up of topsoil, medium sand clayey sand and coarse sand. The depths to sand bodies range from 3.05 to over

21.95m. On the other hand, the depth to clayey sand layer is about 21.95m.

Beneath VES 5, the sediments consist of topsoil, medium sand, clay and coarse sand.

The depths to sand bodies range from 3.74m to over 10.55m, while the depth to clay layer is 10.55m. The sediments beneath VES 6 consist of topsoil, medium sand, clay and coarse sand. The depths to sand bodies range from 1.62 to over 6.15m while the depth to clay layer is 6.15m. The stratigraphy beneath VES 7 is made up of the topsoil, medium sand, clay and coarse sand. Here the depth to sand layers varies from 2.8m to over 11.03m while the depth to clay layer is 11.03. The lithology beneath VES 8 consists of topsoil, clayey sand, medium sand, clay and coarse sand. The depths to clay bodies range from 11.0m to

39.09m while the depths to sand layers vary from 3.77 to 39.09m.

The stratigraphy beneath VES 9 is made up of topsoil, clay, medium sand, clay and coarse sand. The depths to clay layers vary from 7.05 to over 25.14m. The sediments beneath VES 10 consist of topsoil, clay, medium sand and clay. The depth to clay layers range from 4.69 to over 10.26m.

Beneath VES11, the sediments consist of topsoil, medium sand, clay and coarse sand and clayey sand. The depths to sand layers vary from 1.33 to 11.97m while the depth to clay layer is 3.43m. The lithology beneath VES12 consists of topsoil, medium sand, clayey sand, and coarse sand. The depths to sand body ranges from 1.87m to over 18.49m while the depth to clayey sand layer is 18.49m.

The sediments Beneath VES13, consist of topsoil, medium sand, clayey sand and clay .The depth to clay layer is over 23.64m while the depth to sand body is 2.1m. On the other hand, the lithology beneath VES14 is made up of topsoil, medium sand, clay coarse sand, and clay. The depths to clay layer range from 3.91 to over 16.22m while the depths to sand body vary form 1.54 to 16.22. On the whole the thicknesses of the sand layers vary from 0.80 to 28.09m while the thicknesses of the clay layers vary from 3.43 to 25.14m.

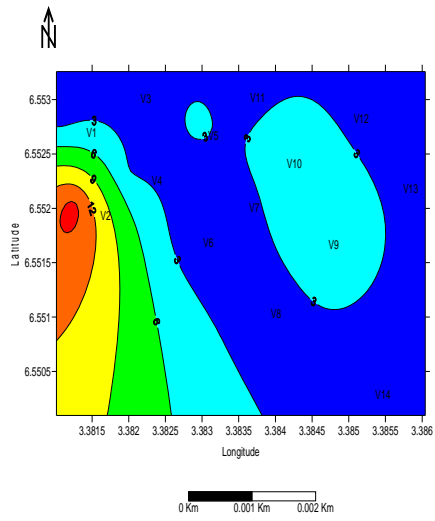
The data in table 2 were used as input into the WinGLink software Programme to produce series of maps (Figures 4and 5). Figures 4a and 4b show the isopach maps of sand bodies between 0 to 15m and 0 to 20m respectively. In figure 4a, the thicknesses of the sand bodies beneath VES 3,4,6,7,8,11,12,13 and 14 range from 1.18 to 3m. The thickness of the sand layers beneath VES 1,5, 9 and 10 vary from 3 to 6m, while the thickness of the sand body beneath VES 2 vary from 9 to 12. Figure 4c shows the isopach map of depths to freshwater layer which vary from 2 to over 22m. On the other hand, figures 5a to 5d show the iso-resistivity depth-slice maps at 5m, 10m, 20m and 30m respectively. On the whole, the resistivity values at these depths vary from 50 to 1000 ohm-m.

Based on the results of the investigations, it is concluded that major parts of the area consist of clay and clayey sands at shallow depths and these might pose a serious threat to the survival of engineering structures in this type of environment if adequate care is not considered.

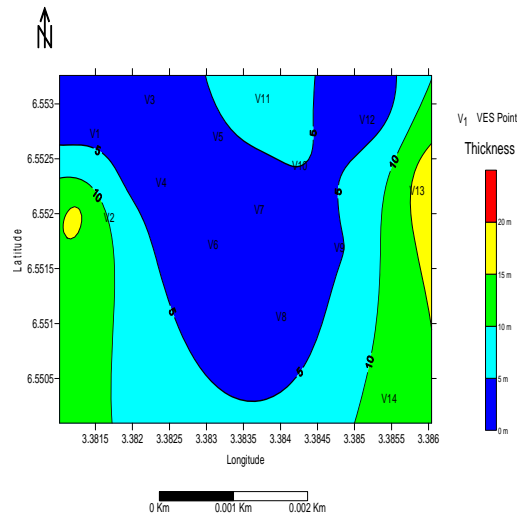
Table 2: Measured parameters/Inferred sediments

VES Station	Layer	Resistivity (Ohm-m)	Thickness (m)	Depth (m)	Lithology
1	1	55.39	0.28	0.28	Topsoil
	2	742.85	0.9	1.18	Medium Sand
	3	32.98	4.39	5.57	Clay
	4	934.95	-	-	Coarse Sand
2	1	388.14	1.94	1.94	Topsoil
	2	102.08	16.15	18.09	Medium Sand
	3	911.54	-	-	Coarse Sand
3	1	101.52	0.29	0.29	Topsoil
	2	763.42	1.32	1.61	Medium Sand
	3	87.65	15.43	17.04	clayey sand
	4	653.12	-	-	Coarse Sand
4	1	386.35	0.48	0.48	Topsoil
	2	666.95	2.57	3.05	Medium Sand
	3	155.25	18.9	21.95	clayey sand
	4	586.5	-	-	Coarse Sand

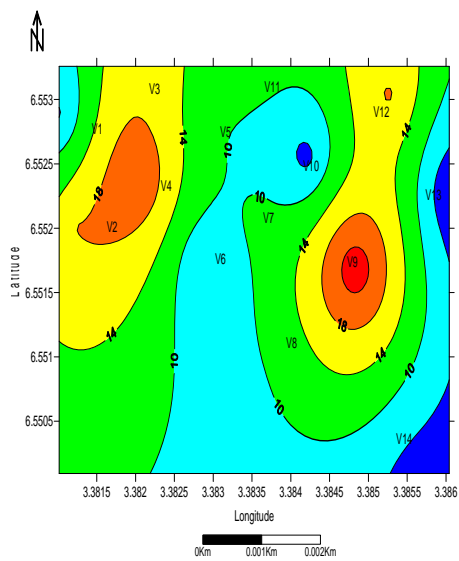
5	1	158.46	0.2	0.2	Topsoil
	2	420.55	3.54	3.74	Medium Sand
	3	43.73	6.81	10.55	Clay
	4	1812.75	-	-	Coarse Sand
6	1	105.39	0.27	0.27	Topsoil
	2	471.89	1.35	1.62	Medium Sand
	3	42.56	4.53	6.15	clay
	4	625.98	-	-	Coarse Sand
7	1	138.93	0.66	0.66	Topsoil
	2	464.08	2.17	2.83	Medium Sand
	3	54.8	8.2	11.03	clay
	4	534.96	-	-	Coarse Sand
8	1	313.92	1.33	1.33	Topsoil
	2	57.88	0.55	1.88	clayey sand
	3	1975.68	1.89	3.77	Medium Sand
	4	34.44	7.23	11	clay
	5	1294.98	28.09	39.09	Coarse Sand
	6	16.71	-	-	clay
9	1	121.34	1.19	1.19	Topsoil
	2	27.4	1.16	2.35	clay
	3	1368.12	4.7	7.05	Medium Sand
	4	22.93	18.09	25.14	clay
	5	143.38	-	-	Coarse Sand
10	1	116.64	2.19	2.19	Topsoil
	2	42.81	2.5	4.69	clay
	3	757.34	5.57	10.26	Medium Sand
	4	89.66	-	-	Clay
11	1	89.08	0.53	0.53	Topsoil
	2	140.3	0.8	1.33	Medium Sand
	3	43.22	2.1	3.43	clay
	4	269.74	8.54	11.97	Coarse Sand
	5	67.62	-	-	clayey sand
12	1	206.37	0.9	0.9	Topsoil
	2	862.39	0.97	1.87	Medium Sand
	3	89.61	16.62	18.49	clayey sand
	4	485.41	-	-	Coarse Sand
13	1	44.01	0.41	0.41	Topsoil



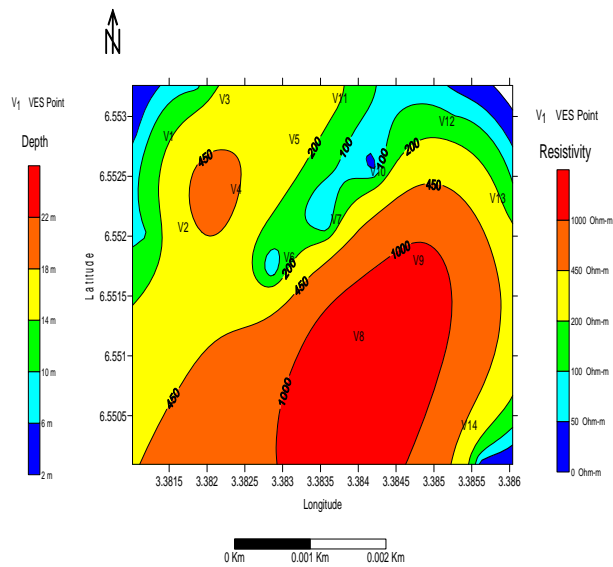
(a) : Sand Isopach Map between 0-15m



(b) : Thickness of sand layer between 0 – 20 m



(c): Depth to Freshwater aquifer layer



(d): Iso-resistivity Depth-slice Map at 3 m

Fig 4: Contoured maps for sand bodies and depth to freshwater layers.

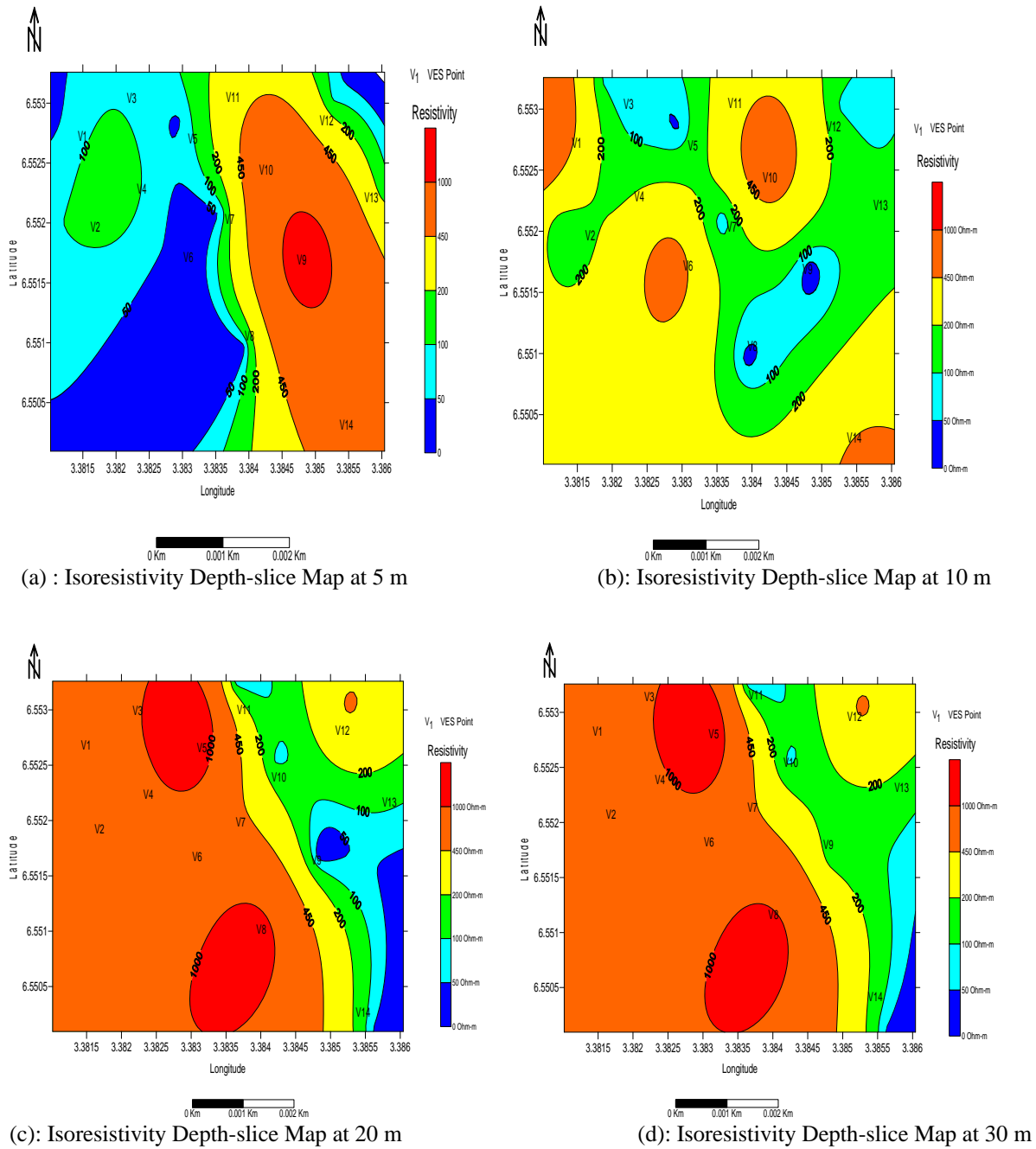


Fig 5: Isoresistivity Depth-slice Map at 5m, 10m, 20m and 30m respectively.

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Creativity, Age And Gender As Predictors Of Academic Achievement Among Undergraduate Students

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ABSTRACT: This study examined creativity, age and gender as predictors of academic achievement. Participants (N= 153, 105 = male & 48= female) completed creativity test. Cumulative grade point average (CGPA) was used to select the participants. A multiple regression analysis revealed creativity, age and gender explained 0.143 of the variance in academic achievement. The significance level was indicated by the F- value of 8.294. Multiple regression analysis showed interaction effects between creativity, age and gender as low predictors of academic achievement. The findings also show a lower correlation of CGPA and the independent variables of this study. No significant difference between CGPA and gender was observed. However implications of the findings to investigate in creativity, age and gender are discussed. [Journal of American Science 2009;5(5):101-112]. (ISSN: 1545-1003).

KEYWORDS: Creativity, Age, Gender, Undergraduate Students

1. Introduction

Achievement is a fundamental aspect of everyday life, affecting people's work, interpersonal relationships, sense of being, and leisure (Struthers, Menec, Schonwetter, & Perry, 1996). The quintessential achievement-oriented domain in education, particularly for college students, includes high performance on tests, passing courses, and completing degrees. However, academic achievement is strongly influenced by demographic and psychological factors.

Research on academic achievement of young students (Komarraju, Karau, & Schmeck, 2008), provides no reliable and consistent indication concerning the extent of creativity, age and gender on academic achievement. A search on academic achievement studies revealed that various variables had been identified as correlates of academic achievement (Abar, Carter, & Winsler, 2008; Curcio, Ferrara, & De Gennaro, 2006; G. M. Johnson, 2008; W. Johnson, McGue, & Iacono, 2006; Layne, Jules, Kutnick, & Layne, 2008; Liew, McTigue, Barrois, & Hughes, 2008; Mizuno et al., 2008; Moller, Stearns, Blau, & Land, 2006; Parker

et al., 2004; Schlee, Mullis, & Shriner, 2008; Thompson & Zamboanga, 2004; Zhang, 2004).

Research has also suggests that academic achievement can be predicted through creativity testing (Cicirelli, 1965; Feldhusen, Denny, & Condon, 1965; Hirsh & Peterson, 2008; Struthers et al., 1996). In Iran for example, researchers have investigated psychological and demographic variables (creativity, age and gender) and academic achievement variables (MehrAfza, 2004), (Nori, 2002), (Karimi, 2000), (Mahmodi, 1998)'s research and (Behroozi, 1997). Additionally, research suggests that as students attain higher levels of education, there is an apparent decline in the relationships between academic achievement and creativity. This indicates that creativity tests account for a smaller portion of the variance in academic achievement. Furthermore, some investigators suggest that the predictive power of creativity and level of the age for academic achievement becomes almost negligible at the university level.

1.1 Definition Issues

1.1.1 Creativity

Researches have been curious about the relationship between creativity and academic achievement for numerous years. However, studies investigative the relationships between these factors have not yielded consistent consequences. (Ai, 1999) For example, studies investigating creativity and academic achievement conclude that creativity is not related to academic achievement. Other researchers established that creativity was related to academic achievement. Additionally, some studies have reported that creativity is related to higher levels of academic achievement, when such achievement needed divergent and productive ability. However, knowing the relationship between creativity and academic achievement is important for education and teaching, and there is a lack of data on the relationship between these variables among students (Behroozi, 2006).

1.1.2 Gender

one of the areas of bias study that have been particularly dynamic in recent years is scoring differences that correlate with gender (David E., 2001). Probably the most publicized differences are in the area of college aptitude, where test scores are supposed to predict the applicants' subsequent college-level performance. Generally, the tests work well, but there are exceptions (p 320). In another study (Kesel & Linn, 1996) found that, in some instances, SAT data may underpredict college- grade for women in mathematics. The scores suggest that females' performance in collage-level mathematics will be lower than they turn out to be.

1.1 3 Age

Age is an independent variable for the present study. When we refer to age relationship to academic achievement (CGPA), we are referring to relation between students at one age and students at another age. Our purpose is to examine the relationship between age and academic achievement stronger or weaker than the relationship between creativity and academic achievement. Do creativity, age and gender predict academic achievement? If yes, what's their level of prediction (low, moderate or high)? These are some questions that were pondered on in this study.

1.2 Past Research

Creativity has been subjected to many different definitions. Academic achievement or academic ability, on the other hand, is relatively more easily defined, measured and interpreted (A. K. Palaniappan, 2005). A myriad of factors have been identified as being related to academic achievement, the three fundamental of which will be addressed in this study: creativity , age and gender (A. K. Palaniappan, 2005; Palaniappan, 2007a, 2007b). In current years, diverse investigators have shown growing interest in the relationship between creativity, gender, age and academic achievement, but there is a lack of data on the relationship between age and academic achievement.

According to Struthers et al (1996)'s study , there is a relationship between creativity and student's performance. The participants were 313 male and female introductory psychology students at The University of Manitoba. This study examined the relationship between students' attributions, action control and creativity and their subsequent motivation and achievement. The study shows the levels of action control and creativity in the unstable attribution condition translated into significantly different grades in students' introductory psychology course. Despite initially being relatively high in motivation (unstable attributions), students who were either state-oriented and low in creativity, or state-oriented and high in creativity, produced lower course grades compared to action-oriented, highly creative students.

This finding indicates a relationship between causal attributions, creativity, and action control orientations and students' performance. Specifically, this shows that students who made unstable attributions for poor academic performances and who were highly creative and action-oriented, were buffered from performance deficits. In contrast, the students who made unstable attributions and who were high in creativity and state-oriented were inhibited from performance increments.

In another study, Fodor & Carver (2000) examined undergraduate students of both sexes in engineering and science from Clarkson University, a predominantly technological university. Students completed the Thematic Apperception Test (TAT), which was scored for achievement motivation and

also for Power motivation. They later participated in the experiment. There were 144 experimental participants, 48 in each of three experimental conditions: positive, negative, or no feedback concerning prior performance on an engineering problem. Achievement motivation correlated positively with creativity score in the positive and negative-feedback conditions ($r_s = .43$ and $.38$) but not significantly in the no-feedback condition ($r = .10$). Power motivation correlated positively with creativity in the positive-feedback condition ($r = .32$), and negatively in the negative-feedback condition ($r = -.25$), but not significantly in the no-feedback condition ($r = .17$).

However, Aitken Harris (2004) examined 404 adults of participants (203 men and 201 women) completed four scales of a timed, group administered, intelligence test, 10 personality scales, and a creativity measures. Finding this study shows achievement has been small to moderate positive correlations with an intelligence factor (which included the creativity scales).

Finally, age is an independent (demographic) variable and is employed as such in our analyses (Ng & Feldman, 2008) refereed Previous research has produced mixed results between age and performance. According to (Ng & Feldman, 2008) there are three most cited quantitative reviews of this literature: one researcher found a moderate positive relationship between age and performance (Waldman, 1986). McEyoy (1989), on the other hand, found that age was largely unrelated to performance, while Sturman (2003) found that the age and performance relationship took an inverted-U shape. Ng & Feldman (2008), however, found that age was not significantly related to creativity.

1.3 Previous Research in Iran

Over the last ten years in Iran, numerous psychological studies have shown that formation of a stable and positive creativity is one of the major developmental challenges of students. (MehrAfza, 2004) conducted a research entitled: "The study of creativity and academic achievement among 384 of students (boys and girls) examined in Tabriz high schools". This research has been done in random and the data collected by Abedi's questionnaire of

creativity and CGPA is used for educational evaluation. The statistical data analysis shows that there is no difference in the overall creativity scores between boys and girls. However, in middle of section boys are statistically higher than girls, but girls are statistically higher in flexibility than boys. Boys and girls are different in academic achievement and the average of academic achievement in girls was more than in boys.

In another investigate, Nori (2002) studied the sex difference according to the type of relationship between creativity and academic achievement among high school of students in Shiraz city. There were 306 high school students (150 boys and 156 girls) in the research. To measure the rate of creativity she used Abedi questionnaire and CGPA for academic achievement. The result was analyzed by CGPA for academic achievement. It revealed that there is no significant relationship between creativity and academic achievement, but the result was different in the sex difference. The finding shows the significant difference in academic achievement of boys and girls. Academic achievement was more in girls than in boys and it is significant ($p < \% 1$).

Karimi (2000)'s research was about the study of relationship between creativity, sex and academic achievement among secondary school students. The result shows significant relationship among these variables is as follows:

There is a 25 relationship in level ($p < \% 1$) between total creativity and academic achievement. Also, the comparison between girls and boys in creativity is indicative of the significant difference between these two sexes. The boys are strikingly excelled the girls in creativity. Besides, the parents' education is significantly related to creativity.

Mahmodi (1998)'s research entitled "personality features, creativity and academic achievement" was done among 106 students in Tehran. The result showed a significant relationship between creativity and academic achievement. Behroozi (1997) studied the relationship between personal features and creativity and also between creativity and academic achievement among 187 university students through Cattell questionnaire of creativity. The result showed no significant relationship between creativity and others variables.

1.4 This Study

The major objective of this study was to examine creativity, age and gender as predictors of undergraduate students' academic achievement. The present study will provide a better estimate of the true association between academic achievement, creativity, age and gender by having creative perception inventory test as predictors and cumulative grade point average (CGPA), applied to undergraduate students. Hence the following hypothesis is examined this study is:

- Controlling for age and gender, creativity explains a significant proportion of the variance in academic achievement.

2. Research Method

2.1 Participants

In the present study we visited 153 students who were tested at ages of 18 to 27 years old. One hundred and fifty three Iranian undergraduate students in Malaysian Universities (31.4% females and 68.6% males) were recruited as respondents in this study. Their ages ranged from 18 -27 years for females and 19-27 years for males.

2.2 Measures

2.2.1 Khatena-Torrance Creative Perception Inventory (KTCPI)

Creative perception was examined using KTCPI (Khatena-Torrance Creative Perception Inventory) (A. K. Palaniappan, 2005). The Khatena-Torrance Creative Perception Inventory is based upon the rationale that creative functioning is reflected in the personality characteristics of the individual, in the way they think or the kind of thinking strategies they employ, and in the products that emerge as a result of

their creative strivings. The scale presents statements to which subjects are required to respond. The responses reflect the extent to which the subjects function in creative ways (A. K. Palaniappan, 2005).

The KTCPI consists of 50 items for some things

2.2.2 Cumulative Grade Point Average (CGPA)

For the purposes of this study, Cumulative Grade point Average (CGPA) has been used as a proxy of academic achievement. The CGPA is calculated by dividing the total amount of grade points earned by the total amount of credit hours attempted. The student's academic achievement used based on their mid year examination result. It is the aggregate or the total grade points in the mid year examination. In this examination, each university subject is graded along one hundred (or four)-point scale, the best grade point being one hundred (or four) and the lowest being zero. Hence the aggregate would range from 75 to 100 (3 to 4); it should be written that the lower the aggregate, the better is the academic achievement (Figure1).

Cumulative Grade Point Average Students (CGPA)		
(3/5- 4) A	85 – 100	High Level
(3- 3/49) B	75 – 84/99	Good Level
(2/49 -2/99) C	60 – 74/99	Satisfactory
(2- 2/ 48) D	50 - 59	Weak
(1/99- 0) F	49/99 and below	Fail

Figure .1 ;CGPA

2.3 Procedure

Undergraduate students participated in this study. The research questions posed for the study required identifying and analyzing the distributions and correlations of certain Khatna-Torrance creative perception inventory test best addressed in the form of a descriptive study. Intelligence levels were assessed by self- report instruments. They were assessed by result of administration office of universities (described below), divided by gender, and calculated by total scores and subscales. The women samples (18-27 years) and men (19-27years) were selected during the regular course time.

Instructions were given written and oral for all participants, and they were ready to answer the upcoming questions in the class. Since multiple significance tests were conducted, data were analyzed by multiple regression. The participants replied the tests and were free to anonymous.

Students received no rewards but they were given the results in the form of a self- referenced level of abilities. Scores for creativity scale's total score were calculated by the SPSS statistical program.

3. Results

The data were analyzed on the basis of academic achievement, and reported descriptive statistics variables and also predictor variables as well as normal P-P plot in tables and figures below.

3.1 Descriptive Statistics

Table.1 shows descriptive statistics of creativity. Finding this result has been shown that the females' mean(33.21) score was greater than the males' mean(31.90) for Creativity, but the standard deviations between females and males were not higher differences (males=4.36& females=4.55). In other words also the ranges of scores between two groups were same (18).

TABLE 1
Comparisons of Creative Perception Inventory Scores of Males and Females (50 items)

Measure	N	Minimum	Maximum	Mean	SD	Range
Total Score	153	21	41	32.31	4.45	20
Male	105	21	39	31.90	4.36	18
Female	48	23	41	33.21	4.55	18

TABLE 2
Descriptive Statistics of CGPA

Measure	N	Minimum	Maximum	Mean	SD	Range
Total Score	153	1.21	4.00	2.97	0.54	2.79
Male	105	2.09	4.00	3.00	0.53	1.91
Female	48	1.21	3.73	2.89	0.56	2.52

Table. 2 shows the females' mean(2.89) score was lower than the males' mean(3.00) for cumulative grade point average; but the standard deviations between females and males were not highly different (males=0.53& females=0.56). In another word the range scores female (2.52) grater than male (1.91).

However, the histogram of dependent variable and Normal P-P Plot graphs (Expected Cumulative Probability by Observed Cumulative Probability) were obtained for CGPA scores are shown in Figure 2 &3.

Normal P-P Plot of Regression Standardized Residual

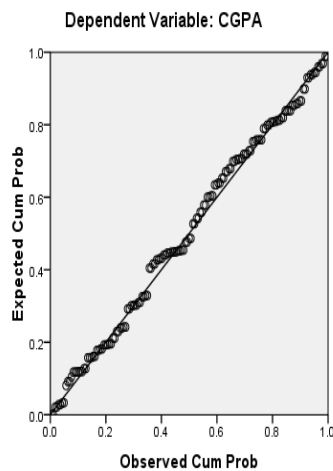


Figure 2. Normal P-P plot of Regression Standardized Residual

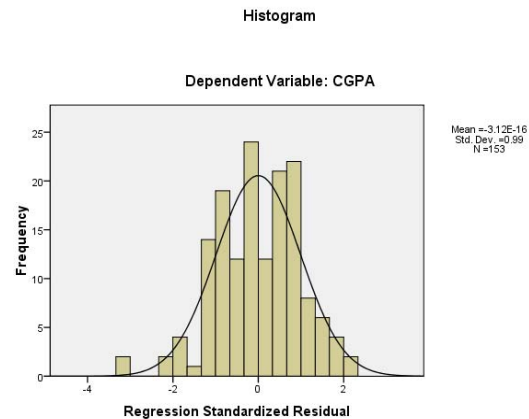


Figure 3. Dependent Variable; academic achievement (CGPA)

3.2 Academic achievement predictors

The following tables show multiple regressions (standard) between CGPA and scores of the creativity, age and gender. Table 3 shows variables entered. Both independent variables (age, gender and creativity) together explain .143 of the variance (R squared) in academic achievement (CGPA), which is significant, as indicated by the F-value of 8.294 in the table 4&5. Finding has been indicating lower correlation CGPA and independent variables this study (scores of the creativity and age). However, table 6 shows t-values indicates that creativity contribute to the CGPA. There were significantly relation creativity to CGPA ($t=2.011$, $p=0.046$) and age to CGPA ($t=4.269$, $p=0.000$).

3.3 Partial correlations

Partial correlations in table 6 showed that independent variables (creativity scores and gender) was not significantly related to academic achievement (CGPA) at $P < 0.05$. According this table correlation creativity to CGPA was (*Zero-order* = .157, $P < 0.05$), and correlation age to CGPA was (*Zero-order* = .345 $p < 0.05$).

3.4 Gender differences in CGPA

Table 7 shows the independent sample of t-test for males and females on scores for CGPA. According to this table, males and females did not differ significantly on CGPA ($t= -1.167$ and $sig=.295$).

TABLE 3

Variables Entered Removed^b

Mode	Variables Entered	Variables Removed	Method
1	Gender, Age Creativity		Enter

- a. All requested variables entered
- b. Dependent Variable: CGP

TABLE.4
Model Summary

Mode	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.378 ^a	.143	.126	.501

- a) Predictors: (Constant, Creativity , Age, Gender)
- b) Dependent Variable: CGPA

TABLE.5
ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig
1	Regression	6.268	3	2.089	8.294	0.000 ^a
	Residual	42.130	149	0.252		
	Total	43.806	152			

- a. Predictors: (Constant, Creativity, Age, Gender)
 - b. Dependent Variable: CGPA
- * p< 0.01

TABLE.6
Coefficients ^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations	
	B	Std.Error	Beta			Zero-order	Partial
1 (Constant)	.632	.487		1.298	.196		
Creativity	.019	.009	.154	2.011	.046*	.157	.163
Age	.071	.017	.331	4.269	.000**	.345	.330
Gender	.059	.090	.051	.658			

a. Dependent Variable : CGPA

*P< 0.05

**P<0.01

TABLE.7

Gender Differences in CGPA- Independent Sample t-test

	Levene's Test for Equality Of Variances		Sig	t*	df	Sig.(2-tailed)
	F					
CGPA	.079		.779	-1.167	151	.245

* P<0.05

4. Discussion

By and large, we found creativity, age and gender low predictors ($R=.378$, $R^2=.143$) by academic achievement (CGPA) in the sample. But there is significance relation ($F= 8.294$, $sig=0.000$, $P<0.01$) between those variables and academic achievement. Another finding the relationship between age and academic achievement is decreased ($r=.345$). We also found the relationship between creativity ($r=.157$) is lowered by academic achievement in the sample, at the same time in the present study there was no significant differences between gender and academic achievement ($t= -1.167$ $sig= .245$).

Generally, previous research has produced mixed results between creativity, age, gender and academic achievement. (Aitken Harris, 2004) found that there existed a small to moderate positive correlation with an intelligence factor (which included the creativity scales), however (Asha, 1980) suggested that the relation between creativity and academic achievement could be different for males and females. According this finding there was highly significantly relation between creativity and academic achievement of males. However her study shows less significant than that for males, also include for females. Asha (1980) also found that creativity is related to academic achievement for both males and females. But in other words, (Nori, 2002) in her study has explained that there was no significant relationship

between creativity and academic achievement, unlike (Mahmodi, 1998)'s research (1998), (Karimi, 2000)'s study and (Behroozi, 1997)'s investigation have mentioned: there was a relation between creativity and academic achievement.

Previous finding shows different relation result between age and achievement. (Waldman, 1986) refereed the positive relationship between age and performance, but in another study (McEvoy, 1989) found that the age was largely unrelated performance.

Previous study also mentioned that boys and girls are different in academic achievement. According to (MehrAfza, 2004)'s study there was a significant difference between boys and girls. Her study shows the average of academic achievement in girls was more than in boys. (Nori, 2002) also found the significant different in academic achievement of boys and girls. Academic achievement was more in girls than in boys.

5. Conclusion and Limitation

In the present study, demographic variables (age and gender) and psychological variable (creativity) were examined. However, there are many other variables that could affect the preference for academic achievement which should be studied in the future: these variables include internal and external locus of control and others are self esteem, self efficacy and cognitive ones (e.g. fluid and crystallized intelligence, emotional intelligence).

The present study was conducted in Kuala Lumpur (capital city) and metropolitan area (Selangor) at Malaysian universities. Thus the extent to which results apply to other cities universities is not known. Therefore, conclusions need to be verified by conducting similar studies

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across other universities in Malaysia. Next, academic achievement was measured using cumulative grade point average (CGPA) in general, this research needs to be extended to include grades given by subjects in mathematics, language, science, others subjects and standardized achievement examination scores. As a final point, as with any cross-sectional researches, such as this one the findings should be viewed with caution.

To conclude, the current study shows that creativity, age and gender the predictors as academic achievement. It may vary by gender and the creative perception inventory and academic achievement (CGPA) measure used. If probable, follow-up study is supposed to appear at other issues that are significant for a better understanding of creativity. For example, what is the creativity measure used in this research really assessment? Will a student's educated parents and social economic status have any effect on his or her predictors as academic achievement? Are there any gender significant differences in creative perception inventory (Habibollah et al., 2009; Palaniappan, 2000)

Acknowledgment

We thank administration officers at University Putra Malaysia, University Malay, University Multimedia, University Lim KokWing, University Tenga Malaysia and University APIT for giving us information about Iranian students at their University. We also appreciate Iranian Undergraduate students for participating in this research who allowed us to collect the necessary data for the PhD study.

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Effect of CO₂ Enrichment on Photosynthetic Behavior of *Podophyllum Hexandrum* Royle, an Endangered Medicinal Herb.

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Abstract: The effect of a doubling in the atmospheric CO₂ concentration on the morpho-physiology of an endangered medicinal herb, *Podophyllum hexandrum* Royle was investigated. Open top chambers (OTCs, 3.0 m diameter, 2.4 m in height) were used to expose plants to ambient and elevated CO₂ concentration (650±50 μmol mol⁻¹) from June to September at an alpine expanse of Garhwal Himalaya. Photosynthetic rate (A, μmol m⁻² s⁻¹) expressed per unit leaf area was stimulated during the first 30 days thereafter a significant decrease in its rate was recorded. Transpiration rate (E, mmol m⁻² s⁻¹) was found decreased significantly throughout the CO₂ enrichment wherein stomatal conductance (g_s, mol m⁻² s⁻¹) have shown a significant reduction initially. At the end of the study, SLA was reduced by 29.45 %, which can partly be explained by an increased dry matter content of the leaves. Total dry matter production significantly increased by 96.40 % after 90 days of CO₂ exposure. This significant increase may be explained by increased RWR. Organic Carbon in aboveground and belowground compartment has shown a significant increment whereas in case of total nitrogen results were found non-significant. Overall study concludes that the medicinally used part of this plant *i.e.* rhizome/root have shown a significant increment. Thus, further studies on impact of elevated CO₂ on principle active component of this endangered plant may be observed. [Journal of American Science 2009; 5(5): 113-118]. (ISSN: 1545-1003).

Keywords: Elevated CO₂, photosynthetic rate (A), transpiration rate (E), stomatal conductance (g_s), specific leaf area (SLA) and root weight ratio (RWR)

1. Introduction

Doubling of present CO₂ concentrations with rising of global air temperature (1.8-4.0°C) over this century are predicted (IPCC, 2007). Increased atmospheric carbon dioxide concentrations associated with increasing temperatures are predicted to have profound impacts on terrestrial ecosystems (Ward and Strain, 1999). The effects of simulated environmental changes, such as temperature, soil water content, nutrient availability, UV-B radiation and CO₂ concentration, on plant growth and productivity have already been studied in arctic, subarctic and alpine regions (Chapin and Shaver, 1996; Havström et al., 1993; Körner et al., 1997; Wada et al., 2002). But, till date no such study have been initiated in alpine and sub alpine regions of India.

Different species respond differently to elevated CO₂. Bazzaz et al., (1995) showed that even individual families might respond differently to elevated atmospheric CO₂, and suggested that future CO₂ levels would lead to increased intensity of natural selection. Likewise, there is a choice to be made whether to represent variation within a species, or to minimize genetic noise by moving from species → provenance → population → half-sib family → full sib family, *i.e.* clone. Gaining knowledge from each genetic level is relevant to the question of up scaling results, and

selection under elevated CO₂ of genotypes for future forests. Plant age and the use of single leaves, single branches, single trees, stands or full ecosystems are of great importance to results and possible interpretations of effects of elevated CO₂ (Saxe et al.,1998).

In various studies, the photosynthetic enhancement that occurred at elevated CO₂ either persisted indefinitely (Ziska et al.,1990) or was partly to fully reversed after days to weeks of CO₂ enrichment (DeLucia et al.,1985; Yelle et al.,1989). Elevated CO₂ directly increases leaf-level net photosynthesis in many plant species (Dahlman 1993), whereas stomatal conductance in usually decreased (Tyree and Alexander 1993).

Podophyllum hexandrum is an endangered medicinal herb of Western Himalaya, belongs to the family podophyllaceae, locally known as Van kakri. In Garhwal, it is found in restricted pockets between 2700-3600 m asl altitudes in sub-alpine and alpine regions between Quercus scrub or between boulders in shady areas. To the best of our knowledge effect of elevated CO₂ on the physiology of this plant in near natural condition has not been assessed. The present study has been conducted with the objectives as how the morphology of selected medicinal plant species will be affected under elevated CO₂? Whether photosynthetic

acclimation will contribute to increased productivity?

2. Materials and methods

2.1 Site description

The selected site for the present work was the alpine field station of High Altitude Plant Physiology Research Centre of H.N.B. Garhwal University, Srinagar, Garhwal, situated at Tungnath (30° 14'N Latitude and 79° 13'E longitude at an altitude of 3600 m asl.).

2.2 CO₂ enrichment

Open top chambers (OTCs, 3.0 m diameter, 2.4 m in height) were used to expose plants to ambient and elevated CO₂ concentrations from June through September 2008. One of the Open Top Chambers (OTC) was treated as Control Open Top Chamber (COTC) in which ambient air was circulated and monitored whereas in other Open Top Chamber (EOTC) elevated CO₂ (650±50 µmolmol⁻¹) was maintained. The pure carbon dioxide was supplied through five (20 Kg gas capacity) carbon dioxide cylinders fitted in a row. Air circulation was done to the chamber via air blowers located near the base of the chamber and CO₂ was added to the incoming air maintaining a positive air pressure and flow within the chambers {design modified from (Upreti 1998)}.

Twenty seedlings of *Podophyllum hexandrum* were transplanted inside both COTC (where ambient CO₂ was provided) treated as control and in EOTC (where elevated CO₂ was provided). In selection of seedling transplantation, most homogeneous seedlings of same age were selected for exposure. CO₂ exposure/CO₂ enrichment was initiated after two weeks of acclimatization inside Open Top Chambers. Morphological and photosynthetic measurements were performed at a three time interval as 30, 60 and 90 days after CO₂ treatment (DAT). Changes in dry matter content of above ground and belowground compartment were done at final harvest (90 DAT).

2.3 Morphological variations

Morphological variations were recorded in marked seedlings for different morphological observations *viz.*, plant height, and number of leaves and leaf area.

2.4 Measurement of photosynthetic parameters

Leaves of each marked plant were randomly selected for leaf gas exchange measurements. The leaf chamber was oriented to obtain maximum light interception, to get light saturated readings by means of a Portable Photosynthetic System (LCPro+, ADC Ltd, UK). The following parameters were assessed per unit leaf area: Photosynthetic rate (A), stomatal conductance (g_s) and transpiration water loss (E). Measurements were performed for cloudless days.

2.5 Shoot-Root dry weight, Specific leaf area (SLA), Leaf area ratio (LAR), Shoot weight Ratio (SWR) and Root weight ratio (RWR)

After 90 days of CO₂ exposure, marked 10 plants

were harvested from both condition i.e. control (ambient CO₂) and elevated CO₂ (650±50 µmolmol⁻¹). Plants were brought to laboratory and separated into above ground and belowground parts. Dry weight (total, leaf, root, shoot dry weight) were recorded after keeping plants inside oven (80°C) for 24 hrs. Leaf area ratio (LAR), Specific leaf area (SLA), Shoot weight ratio (SWR) and Root weight ratio (RWR) were calculated as per Hunt (1982).

2.6 Nutrient analysis (organic carbon and Total nitrogen)

Dried powdered samples of above ground and belowground parts were used for Organic Carbon content as per Okalebo et al. (1993) and Total Nitrogen (%) according to method of Allen, 1974.

3. Results

3.1 Morphological features

Plants exposed to elevated level of CO₂ have shown increase in plant height throughout the experiment (ns, P>0.05). In case of leaf area initially after 30 days of CO₂ enrichment, there was a slight increase in leaf area of plants grown in elevated CO₂ (ns, P>0.05); thereafter a decrease in leaf area of plants grown in elevated CO₂ was found (P<0.01). Leaf numbers were not found significantly differed throughout the experiment. Variations in plant height, leaf area, and leaf number of *P. hexandrum* grown at ambient and elevated CO₂ conditions are shown in Figure 1, 2 and 3 respectively.

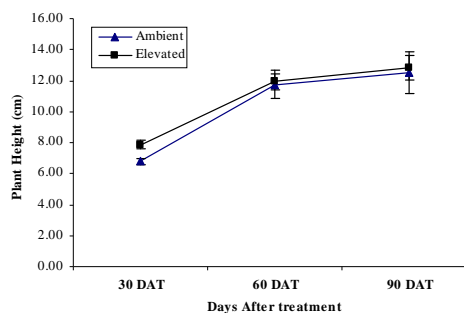


Figure 1. Variation in plant height of *P. hexandrum* exposed to CO₂ enrichment

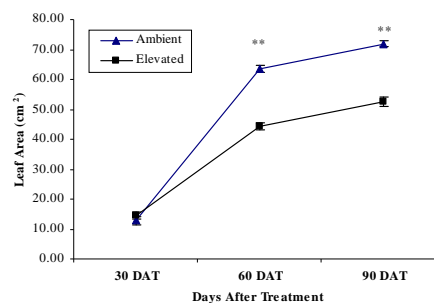


Figure 2. Variation in leaf area of *P. hexandrum* exposed to CO₂ enrichment

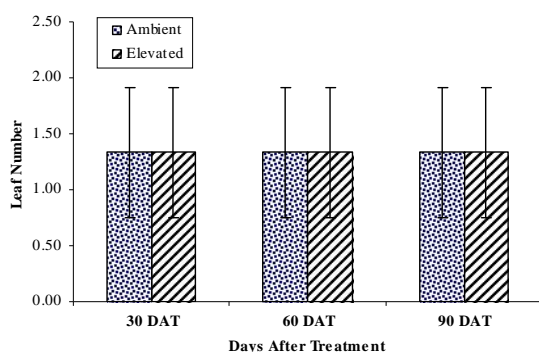


Figure 3. Variation in leaf number of *P. hexandrum* exposed to CO₂ enrichment

3.2 Photosynthetic characteristics

Net photosynthetic rate (A) of the leaves of elevated CO₂-grown plants were found increased initially during 30 DAT as compared to those of ambient CO₂-grown plants (P<0.01, Figure 4), thereafter during 60 DAT and 90 DAT, the A of elevated CO₂-grown plants was found significantly decreased (P<0.01) as compared to those of ambient CO₂-grown plants respectively. Transpiration water loss (E) was found significantly decreased in plants grown in elevated CO₂ (P<0.01) compared to ambient grown plants throughout the CO₂ exposure (Figure 5). Stomatal conductance (g_s) found decreased initially during 30 DAT as compared to those of ambient CO₂-grown plants (P<0.05, Figure 6), thereafter during 60 DAT and 90 DAT, the A of elevated CO₂-grown plants was found increased (ns; P>0.05) as compared to those of ambient CO₂-grown plants respectively.

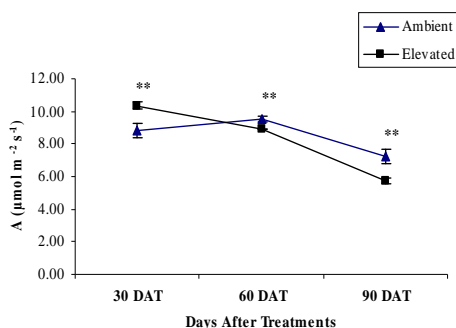


Figure 4. Changes of photosynthetic rates (A) of *P. hexandrum* during CO₂ enrichment.

Values are Mean+ SD (n = 5). Significant differences at the 5% (*) and 1% (**) level were determined with Fisher's protected LSD test.

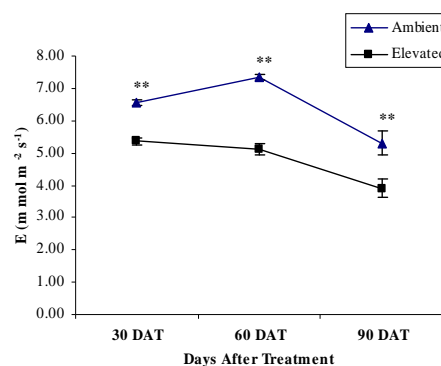


Figure 5. Effect on Transpiration rate (E) of *P. hexandrum* to CO₂ enrichment.

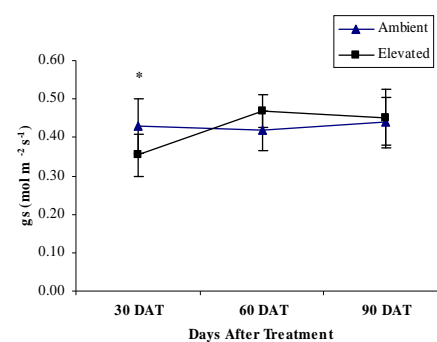


Figure 6. Stomatal conductance (g_s) of *P. hexandrum* in ambient and elevated CO₂ conditions.

3.3 Dry matter distribution, Leaf area ratio (LAR), Specific leaf area (SLA), Leaf weight ratio (LWR), Shoot weight ratio (SWR) and Root weight ratio (RWR)

Total biomass and dry matter partitioning to roots of ambient (330±50μmolmol⁻¹) and elevated (650±50μmolmol⁻¹) CO₂-grown plants were measured at 90 DAT. Total biomass at final harvest was 96.40% greater in elevated than in ambient CO₂-grown plants. Root biomass significantly increased in elevated CO₂-grown plants (P<0.01), whereas shoot biomass did not (P>0.05). CO₂ treatment effect on the allocation of dry matter from stem to roots was seen (Table 1). However, the investment of dry matter in relation to the acquired leaf area was altered, leading to a reduction of the SLA (P<0.01; Table 1). As a consequence of the reduction of the SLA and LWR, the LAR, the product of SLA and LWR, was also reduced at high CO₂. Whereas increased RWR (P<0.05) was found in plants grown in elevated CO₂ (Table 1).

Table 1. Variation in dry matter content, LAR, SLA, SWR, and RWR of *P. hexandrum* exposed to elevated CO₂

Parameters	Ambient	Elevated	Level of Significance
Leaf dry weight (g)	0.27±0.02	0.29±0.03	ns
Shoot dry weight (g)	0.37±0.01	0.40±0.01	ns
Root dry weight (g)	1.29±0.61	2.88±0.18	**
Total dry weight (g)	1.67±0.60	3.28±0.22	**
LAR (m ² g ⁻¹)	46.48±14.22	16.04±0.61	*
SLA (m ² g ⁻¹)	260.83±14.17	183.99±15.55	**
LWR (g g ⁻¹)	0.18±0.05	0.09±0.01	*
SWR (g g ⁻¹)	0.24±0.08	0.12±0.03	*
RWR (g g ⁻¹)	0.76±0.08	0.88±0.03	*

Values are Mean+ SD. Significant differences at the 5% (*) and 1% (**) level were determined with Fisher's protected LSD test. ns non- significant

* significant at LSD<0.05

** significant at LSD<0.01

3.4 %Organic carbon and % total nitrogen in aboveground and belowground compartments

Organic carbon was found significantly increased

Table 2. Variation in % organic carbon and % total nitrogen of aboveground and belowground compartments of *Podophyllum hexandrum* exposed to elevated CO₂

Nutrients	Compartments	Ambient	Elevated	LSD
Organic carbon %	Aboveground	1.60±0.43	2.33±0.13	0.55*
	Belowground	3.45±0.21	5.55±0.37	0.91**
Total Nitrogen %	Aboveground	0.51±0.16	0.37±0.08	ns
	Belowground	0.42±0.14	0.56±0.14	ns

Values are Mean+ SD. Significant differences at the 5% (*) and 1% (**) level were determined with Fisher's protected LSD test.

4. Discussion

The results of elevated CO₂ on *P. hexandrum* Royle indicates that this species responded similarly to elevated levels of atmospheric CO₂ compared to other species previously tested (Kimball 1983, Cure & Acock 1986). Total dry weight was increased by 96.40%, which may be due to a stimulation of the growth during the first thirty days of the experiment. Such a transitory stimulation of the growth rate has been reported for many other species (Bazzaz 1990). The positive response to elevated CO₂ was due to the stimulation of the rate of photosynthesis initially. However constant reduction of the SLA as a transient effect of the CO₂ level on photosynthesis is indicated by the drop of the photosynthesis rate at high CO₂ as duration of exposure increased i.e. 60 DAT and 90 DAT. This time course has been found for many species, although for some the positive effect is maintained for a much longer period

in above and belowground compartments (P<0.05 and P<0.01 respectively), whereas for % total nitrogen results were found non-significant (Table 2).

(Bazzaz 1990).

The increase in photosynthesis is partly offset by a decrease in SLA. Similar to other studies previously done (Poorter et al., 1988). This decrease in SLA is at least partly may be due to accumulation of starch (Wong 1990). Thus, one of the causes of the relatively minor stimulation of high CO₂ concentrations is that the increased photosynthetic supply is not used for investment in new actively growing material (e.g. leaf area) but accumulated as starch in the chloroplasts. The decrease in SLA is a phenomenon which occurs in many plants exposed to elevated CO₂ levels (Bazzaz 1990). This effect is partly explained by the higher dry matter concentration in the leaves.

The product of the SLA and the LWR i.e. LAR was affected similarly as the SLA. This indicates that under high CO₂ conditions these *P. hexandrum* plants acquire a smaller total leaf area relative to the total plant

weight. Whereas RWR was found increased that may be partly due to allocation of dry matter to roots. To date many conflicting information on effects of CO₂ level on dry matter allocation have been published.

Frequently observed response of elevated CO₂ is the production of leaves with a higher C: N ratio than at ambient CO₂ (Luo et al., 1994; Curtis, 1996). Our results correlates with these studies as C: N ratio was increased in elevated CO₂ grown plants as compared to ambient grown plants.

In several experiments where leaf N decreases in plants under elevated CO₂. This is true even when N-Contents are corrected for starch and soluble sugar Accumulation in elevated CO₂ (Curtis et al., 1995), suggesting that C-dilution does not account entirely for this effect. Changes in tissue composition induced by elevated CO₂ can influence forest processes biomass allocation and growth (Luo et al., 1994) and nutrient dynamics (Pregitzer et al., 1995). It might be said that leaf N concentrations are reduced as a result of increased N-use efficiency. However, as species differ in their uptake and allocation of nutrients like nitrogen (Den Hertog & Stulen 1990). In *P. hexandrum*, decrease of the leaf nitrogen concentration due to a doubling of the CO₂ concentration as in other species may therefore show a shift in the balance between root respiration for growth and that for ion uptake, leading to a zero net change (Den Hertog & Stulen 1990). The C-economy of this species under the given growth conditions is alike with that of other species (Den Hertog et al., 1993). This points out that the physiology of the plant is still affected by the higher atmospheric CO₂ level.

Although the elevated CO₂ resulted in increased dry matter, increased root dry weight contributed mainly to this increase, but the effect of elevated CO₂ on medicinal property of the plant is not assessed. Nautiyal and Purohit (2000), in case of aconites found 8 to 11- fold higher production of tubers in plants grown inside polyhouse (4-5^oC higher temperature than open) compared to open field grown plants. They also concluded that percent alkaloids were also higher in plants grown in polyhouse. Accordingly, the role of elevated CO₂ on the medicinal property of this plant requires further attention. It is a challenging goal to try and relate the effects of CO₂ concentration to active constituents of the plant for future mitigation processes under changing climate with increased temperature and CO₂ enriched environment.

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Species richness and diversity along an altitudinal gradient in moist temperate forest of Garhwal Himalaya.

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Abstract: In the present study we have described the impact of altitude on the species richness, species diversity and dispersion behaviour of different tree species in Himalayan temperate forest. We have observed that the values of all the growth indices i.e., Margalef's index (0.17 to 1.14), Menheink's index (0.27 to 0.80), Species diversity (0.99 to 2.34) and Simpson's diversity index (1.49 to 8.73) were maximum at the lower altitudes (2250-1850m asl), medium at mid-altitudes (2600-2400m asl) and lowest at the higher altitudes (2800-2700m asl). Significantly negative correlation of density and species richness with altitude and slope was recorded. The study suggests that the distribution and species richness pattern of different tree species are largely regulated by the altitude and climatic factors. [Journal of American Science 2009;5(5):119-128]. (ISSN: 1545-1003).

Key words: altitude; slope; diversity; species richness; dispersion

1. Introduction

Species richness is a simple and easily interpretable indicator of biological diversity (Peet, 1974). Many types of environmental changes influence the processes that can both augment or erode diversity (Sagar et al. 2003). Ellu & Obua (2005) have suggested that different altitudes and slopes influence the species richness and dispersion behaviour of tree species. Moreover, Kharakwal et al. (2005) have pointed out that altitude and climatic variables like temperature and rainfall are the determinants of species richness. Difference in insolation period may occur according to altitude, thereby forming a range of microclimates in multifaceted landscapes. Diversity of life-forms usually decreases with increasing altitude and one or two life-forms remain at extreme altitudes (Pavón et al. 2000). Altitude itself represents a complex combination of related climatic variables closely correlated with numerous other environmental properties (soil texture, nutrients, substrate stability, etc.; Ramsay and Oxley, 1997). Within one altitude the cofactors like topography, aspect, inclination of slope and soil type further effect the forest composition (Holland and Steyn 1975).

Austin et al., (1996) have analyzed association between species richness, climate, slope position and soil nutrient status. Earlier in a critical literature review on species richness patterns in relation to altitude, Rahbek (1997) viewed that approximately half of the studies detected a mid-altitude peak in species richness and Grytnes and Vetaas (2002) have also reviewed these

aspects in Nepalese Himalaya. Along the altitude, the geographic and climatic conditions change sharply (Kharkwal et al., 2005). Bongers et al., (1999) stated that drought indicating factors (length of dry period and cumulative water deficit) were more important for determining species distribution. Veenendaal et al. (1996) showed that elevation above 2000m asl may accumulate snow and have persistent cold temperature in winter. Along the altitudinal gradient, the upper limit of species richness remains high up to a considerable altitudinal level (2500m asl) and tree richness increases with increasing moisture in the Indian Himalayan region (Rikhari et al., 1989). Singh et al. (1994) found that productivity does not change upto and approximately 2500m asl in the Himalayan region. However, several others explanations have been given for a linear relationship between species richness and altitude (Givnish, 1999).

The present investigation was carried out in a moist temperate forest of the Garhwal Himalaya, which comes under district Uttarkashi of Uttarakhand to reveal (i) the impact of altitude on species richness in various temperate forest types and (ii) Assessment and analysis of change in dispersion behaviour of various tree species along altitudinal gradient for proper management, sustainable utilization and conservation of the forest resources in temperate region of Garhwal Himalaya.

2. Materials and Methods

2.1. Study Area

The study was conducted in Chaurangikhal moist temperate forest (30° 39.125' N latitude and 78° 31.156' E longitude) encompassing an area of about 750ha in district Uttarkashi (8016 km²) of Garhwal Himalaya situated 29 km away from Uttarkashi town, during the years 2006-2007 (Figure 1). The district lies in the upper catchment of two great rivers of India viz, Ganges (called Bhagirathi upto Devprayag) and the Yamuna. Some of the tributaries of these rivers are Jodhganga, Jalandhari, Bhilangana, Duggada and Assiganga. Seven

forest types; (i) pure *Abies pindrow*, (ii) pure conifer (iii) mixed *Abies pindrow* (iv) conifer mixed broad-leaved (v) mixed *Quercus floribunda* (vi) mixed broad-leaved and (vii) mixed *Pinus roxburghii*, were selected between 1850 to 2800m asl at various altitudes and slope gradients (Table 1). Broad land use categories of the area include permanent settlements (villages), irrigated and rainfed agricultural fields, scrub land, mixed broad-leaved forests, sub-alpine Oak-Fir forest, summer camping sites and alpine meadows locally known as “Kharaks” and “Bogyals”, respectively.

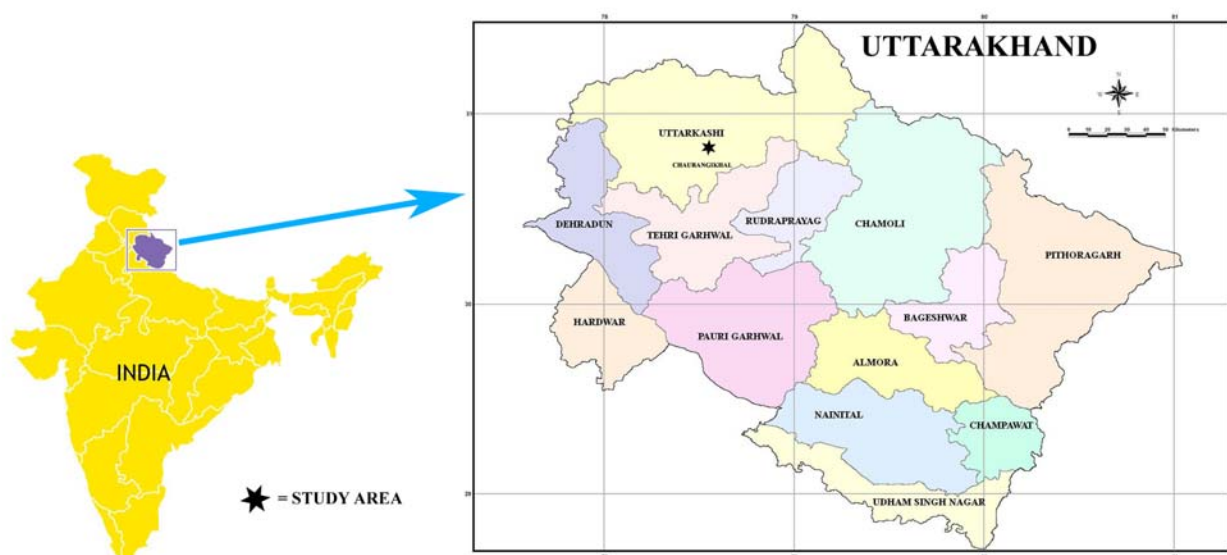


Figure 1. Map of the study area.

Table 1. The environmental variables across different altitudes

FT	Forest Type	Altitude (m asl)	Slope Aspect	Slope (Degree)	Nature of slope	Position
1	Pure <i>Abies pindrow</i> forest.	2800-2700	South-East facing.	38	Very steep	Upper
2	Mixed <i>Abies pindrow</i> forest.	2800-2650	North-East facing.	30	Very steep	Upper
3	Conifer mixed broad-leaved forest.	2700-2600	South-East facing.	25	Steep	Upper
4	Mixed broad-leaved forest.	2700-2600	South-West facing.	25	Steep	Upper
5	Pure <i>Abies pindrow</i> forest.	2600-2500	South facing.	28	Very steep	Middle
6	Pure <i>Quercus semecarpifolia</i> forest.	2600-2500	West facing.	18	Moderate	Middle
7	Conifer mixed broad-leaved forest.	2600-2450	North facing.	14	Moderate	Middle
8	Mixed <i>Quercus floribunda</i> forest.	2600-2400	South facing.	16	Moderate	Middle
9	Mixed broad-leaved forest	2400-2250	South-West facing.	15	Moderate	Lower
10	Pure <i>Pinus roxburghii</i> forest	2250-1850	South-West facing.	15	Moderate	Lower

The climate of the study area is moist temperate type, which receives moderate to high snowfall from December to February. Meteorological details (1998-

2007) of the study area are given in Figure 2. Mean annual maximum temperature was 18.51 ± 3.70 °C, whereas mean annual minimum temperature was 5.71

± 1.81 °C. Mean annual rainfall was 1825.39 ± 417.54 mm. Mean Relative humidity round the year in the study area ranged from 15 % to 86 %. The rainy season accounts for about three-quarters of the annual rainfall. In the study area the year is represented by three main seasons; the cool and relatively dry winter (December to March); the warm and dry summer (mid-April to June); and a warm and wet period (July to mid-September) called as the monsoon or rainy season. Apart from these main seasons, the transitional periods interconnecting rainy and winter, and winter and summer seasons are referred to as autumn (October to November) and spring (February to March). Geologically, the rocks were complex mixture of mainly sedimentary, low grade metamorphosed with sequence capped by crystalline nappe (Valdiya, 1980).

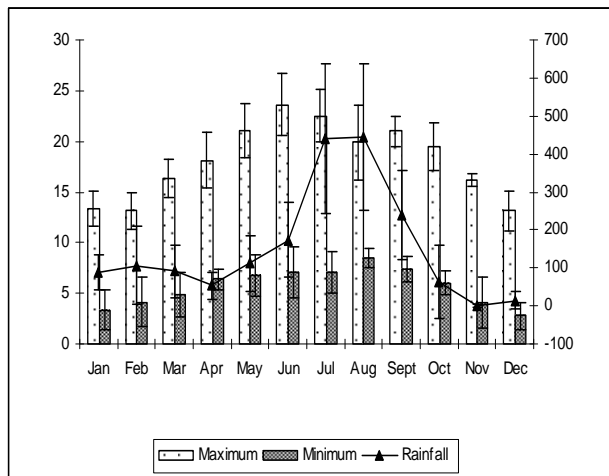


Figure 2. Climatic details of the study area (1998-2007).

2.2. Data Analysis

The study was conducted during the years 2006-2007. After the reconnaissance survey, ten forest cover types having different species compositions, altitudes, slopes and aspects were identified (table 1). Each forest type was named according to the composition of dominant tree species as per Ram Prakash (1986), viz., $\geq 75\%$ as pure; 50-75% as mainly; 25-50% as mixed and $< 25\%$ miscellaneous. Physiographic factors i.e., altitude (m asl), slope steepness (Degree), direction of the slope, slope position (Upper, Middle, and Lower) across different cover types were measured by GPS (Garmin, Rino-130). A total of 120 plots (twenty plots in each forest type) measuring 10m X 10m each, were sampled at the study area. Plots were laid out by stratified random approach; stratification allowed equal repetition. The trees were identified with the help of Flora of the District Garhwal North West Himalaya (Gaur, 1999)

and others. Trees were considered to be individuals ≥ 10 cm dbh (diameter at breast height i.e., 1.37m) (Knight, 1963). Trees were analyzed by 10m X 10m sized quadrats respectively. Total Species Richness was simply taken as a count of number of species present in that forest type. Species richness (number of species per unit area) was calculated as: $SR = S-1/\ln(N)$; where, SR = Margalef (1958) index of species richness, S = Number of species and N = total number of individuals. Menhinik's index of richness (Whittaker, 1977) was calculated as: $Richness = S/\sqrt{N}$, where, S= number of species, and N= total number of individuals of all species. The ratio of abundance to frequency (A/F) for different species was determined for eliciting the distribution pattern. This ratio has indicated regular (<0.025), random (0.025-0.05) and contagious (>0.05) distribution patterns (Whitford, 1949). The diversity (H') was determined by using Shannon-Wiener information index (Shannon and Weaver, 1963) as: $H' = -\sum n_i/n \log_2 n_i/n$; where, n_i was the IVI value of a species and n was the sum of total IVI values of all species in that forest type. Simpson's diversity index (Simpson, 1949) was calculated as: $D = 1/C_d$, where, D = Simpson's diversity and $C_d = \text{Simpson's concentration of dominance} = (\sum n_i/n)^2$.

3. Results

3.1. Species richness and diversity parameters

In the present study, the total species richness and Margalef's index were recorded from 2 to 9 and 0.17 to 1.14, across 1850-2800m asl altitudinal gradient. At the highest elevation (2800-2700m asl), the minimum species richness (2 species) and Margalef's index (0.17) were recorded, while maximum values (9 species and 1.14) of these parameters were encountered at lower elevation (2250-1850 m asl). A peak level of species richness (7 to 9 species) was recorded at a range between 2600-1850 m asl; However, species richness (constant 6 species) and Margalef's index (0.88 to 0.98) did not vary sharply between 2700-2500m asl elevation. Above 2600m asl, the both respective parameters (species richness & Margalef's index) decreased from 5 to 2 species and 0.68 to 0.17 exponentially with increase in elevation and subsequently dropped to a minimum at the highest (2800m asl) elevation (Table 2 and Figure 3). Menheink's index was recorded between 0.272 to 1.039, the minimum value was observed at the highest elevation 2800-2700m asl, whereas the maximum

value was recorded at mid-elevation 2600-2500m asl. Interestingly, second highest value (0.849) was also recorded at upper elevation 2700-2600m asl which declined (0.272) at middle elevation (Table 2 and Figure 3).

Table 2. Total species richness and diversity parameters of tree species along altitudinal gradient.

Altitude (m asl)	SR	MI	MeI	H'	D
2800-2700	2	0.174	0.272	0.992	1.494
2800-2650	3	0.358	0.433	1.003	2.426
2700-2600	5	0.683	0.657	1.923	4.709
2700-2600	6	0.886	0.849	2.094	5.715
2600-2500	6	0.988	1.039	2.137	5.732
2600-2500	5	0.748	0.784	1.852	4.674
2600-2450	6	0.798	0.684	2.089	5.708
2600-2400	7	0.955	0.793	2.379	6.775
2400-2250	7	0.881	0.661	2.313	6.766
2250-1850	9	1.148	0.805	2.349	8.736

Abbreviations: SR= Species Richness; MI= Marglef's Index; MeI= Menheink's Index; H= Shannon Wiener Diversity Index; D= Simpson's Diversity Index.

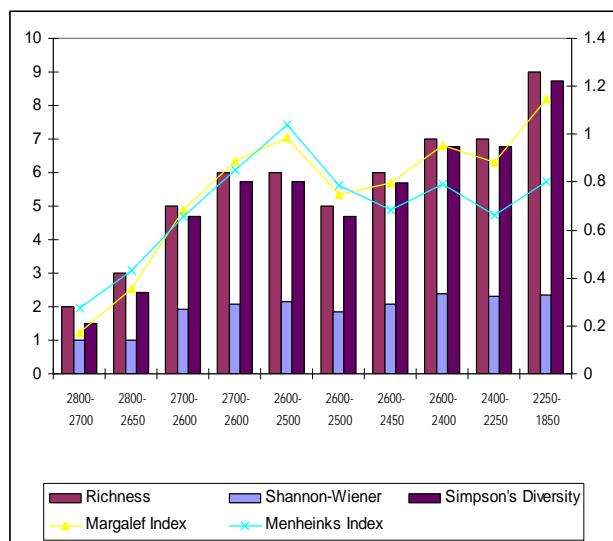


Figure 3. Species richness and diversity parameters along altitudinal gradient.

The low elevation appeared likely to be drier although precipitation varied inconsistently with elevation (Singh et al., 1994). At the highest elevation (2800-2700m asl) the maximum species diversity (0.52)

and Simpson's diversity (0.80) was recorded for *Quercus semecarpifolia*, while minimum species diversity (0.47) and Simpson's diversity (0.69) for *Abies pindrow*. Just beneath this, at 2800-2650m asl elevation the highest species diversity (0.51) and Simpson's diversity (0.99) was recorded for *Q. semecarpifolia* and *Symplocos paniculata* whereas, the lowest values (0.15 and 0.49) of these parameters were observed for *A. pindrow*. At the 2700-2600m asl elevation the maximum species diversity (0.53) and Simpson's diversity (1.00) was recorded for *A. pindrow* and *Buxus wallichiana*. At middle elevation (2700-2600m asl), the highest species diversity (0.52) and Simpson's diversity (1.00) were recorded for *Q. semecarpifolia* and *Lyonia ovalifolia*, while the lowest values (0.10 and 0.80) were recorded for *L. ovalifolia* and *Q. semecarpifolia*. Between 2600-2500m asl, the maximum species diversity (0.53) and Simpson's diversity (0.99) were recorded for *A. pindrow* and *Acer acuminatum* while, minimum values of both the respective parameters (0.15 and 0.84) were recorded for *A. acuminatum* and *A. pindrow*. At 2600-2500m asl, maximum species diversity (0.52) was recorded for *Q. semecarpifolia* and minimum (0.15) for *Persea duthiei*. Between 2600-2450m asl the highest species diversity (0.52) and Simpson's diversity (0.99) were recorded for *A. pindrow* and *L. ovalifolia*, while the lowest values (0.21 and 0.79) were recorded for *L. ovalifolia* and *A. pindrow*. Between 2600-2400m asl, the maximum species diversity (0.53) was recorded for *Q. floribunda* and minimum (0.09) for *A. spectabilis*. At 2400-2250m asl the highest species diversity (0.52) and Simpson's diversity (1.00) were recorded for *Q. floribunda* and *A. pindrow*, while the lowest values (0.09 and 0.90) were recorded for *A. pindrow* and *Q. floribunda*. At lowest elevation (2250-1850m asl) the maximum values of species diversity (0.53) was recorded for *Pinus roxburghii* and minimum (0.08) for *Myrica esculenta*. The overall maximum species diversity (Shannon-Wiener index) (2.37) was recorded at comparatively lower elevation (2600-2400m asl). However, second maximum species diversity (2.34) and the maximum Simpson's diversity (8.73) were recorded at the lowest elevation (2250-1850m asl), whereas, minimum species diversity (Shannon-Wiener index) (0.99) and Simpson's diversity (1.49) were observed at the highest elevation (2800-2700m asl) respectively (Table 2, 3 and Figure 3).

Table 3. Species diversity and Simpson's diversity of tree species along altitudinal gradient.

Tree Species	Altitude (m asl)																			
	2800-2700		2800-2650		2700-2600		2700-2600		2600-2500		2600-2500		2600-2450		2600-2400		2400-2250		2250-1850	
	H'	D	H'	D	H'	D	H'	D	H'	D	H'	D	H'	D	H'	D	H'	D	H'	D
<i>Abies pindrow</i>	0.47	0.695	0.35	0.495	0.53	0.866	0.29	0.993	0.53	0.847	0.41	0.978	0.52	0.794	0.27	0.995	0.09	1.000	-	-
<i>A. spectabilis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.09	1.000	-	-	-	-
<i>Acer acuminatum</i>	-	-	-	-	-	-	-	-	0.15	0.999	-	-	-	-	-	-	-	-	-	-
<i>Alnus nepalensis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.000	0.19	0.998
<i>Betula alnoides</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.14	0.999
<i>Buxus wallichiana</i>	-	-	-	-	0.12	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Carpinus vominea</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.19	0.998	-	-	-	-
<i>Lyonia ovalifolia</i>	-	-	-	-	0.26	0.995	0.10	1.000	0.27	0.995	0.26	0.996	0.21	0.998	0.40	0.980	0.27	0.995	0.50	0.935
<i>Myrica esculenta</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08	1.000
<i>Persea duthiei</i>	-	-	-	-	-	-	0.48	0.949	0.47	0.958	0.15	0.999	0.45	0.966	0.41	0.978	0.16	0.999	-	-
<i>Pinus roxburghii</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.53	0.825
<i>Pyrus pashia</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.28	0.995	0.13	0.999
<i>Quercus floribunda</i>	-	-	-	-	-	-	-	-	-	-	-	-	0.47	0.955	0.53	0.882	0.52	0.909	0.12	0.999
<i>Q. leucotrichophora</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.52	0.914	0.30	0.993
<i>Q. semecarpifolia</i>	0.52	0.800	0.51	0.932	0.52	0.903	0.52	0.806	0.50	0.935	0.52	0.790	0.22	0.997	-	-	-	-	-	-
<i>Rhododendron arboreum</i>	-	-	-	-	0.49	0.945	0.43	0.973	-	-	0.52	0.912	0.22	0.997	0.49	0.942	0.48	0.954	0.35	0.987
<i>Symplocos paniculata</i>	-	-	0.15	0.999	-	-	0.27	0.995	-	-	-	-	-	-	-	-	-	-	-	-
<i>Taxus baccata</i>	-	-	-	-	-	-	-	-	0.21	0.998	-	-	-	-	-	-	-	-	-	-

Abbreviations: H'= Shannon-Wiener index; D = Simpson's Diversity index

The overall pattern of species richness, Margalef's index, Menheink's index, Shannon-Wiener index (species diversity) and Simpson's diversity index showed a sharp decline at the highest altitude (2800-2700m asl). A similar pattern of tree species richness in timberline area was reported by Rawal et al. (1991). Tree species richness increases with increasing moisture in the Indian Central Himalaya (Rikhari et al.1989). In this study, a negative relationship was found between species richness, Margalef's index, Menheink's index, species diversity and Simpson's diversity index vs elevation (Table 2, 3 and Figure 3, 4). Sagar et al. (2008) have suggested that species richness decreases with an increase in species dominance.

3.2. Distribution pattern (A/F) ratio

Hubbell et al. (1999) reported that the dispersal limitation is an important ecological factor for controlling species distribution pattern and a connection between biotic and abiotic ecological factors. A number of tree species found in the Himalaya showed varying patterns of distribution. The extension of climate gradient enabled several species to realize their fullest range of elevational adaptability. An analysis of

dispersion pattern (Table 4) indicated that maximum species had random distribution at the altitude between 2800-1850m asl. At the higher altitude (2800-2600m asl) maximum tree species were distributed in random pattern, interestingly same tendency was observed for the species at lower altitude (2600-1850m asl), while at middle altitudinal range (2600-2450m asl) most of the species were distributed in contiguous pattern and rarely in regular pattern also. The *Abies pindrow* and *Rhododendron arboreum* changed their dispersion pattern from contiguous (2400-2250m asl) to random (2600-2450m asl) followed by again contiguous (2700-2600m asl) to finally random at the higher altitude (2800-2650m asl). *Quercus* species was found distributed in random pattern from lower (2250-1850m asl) to the higher (2800-2700m asl) altitudes. *Persea duthiei* showed contiguous to random distribution patterns while *Lyonia ovalifolia* showed regular and random and finally contiguous patterns along lower, middle and higher altitudinal ranges. The species-aggregation relationship predicts that spatial aggregation of individuals within species results in lower species richness Sagar et al. (2008).

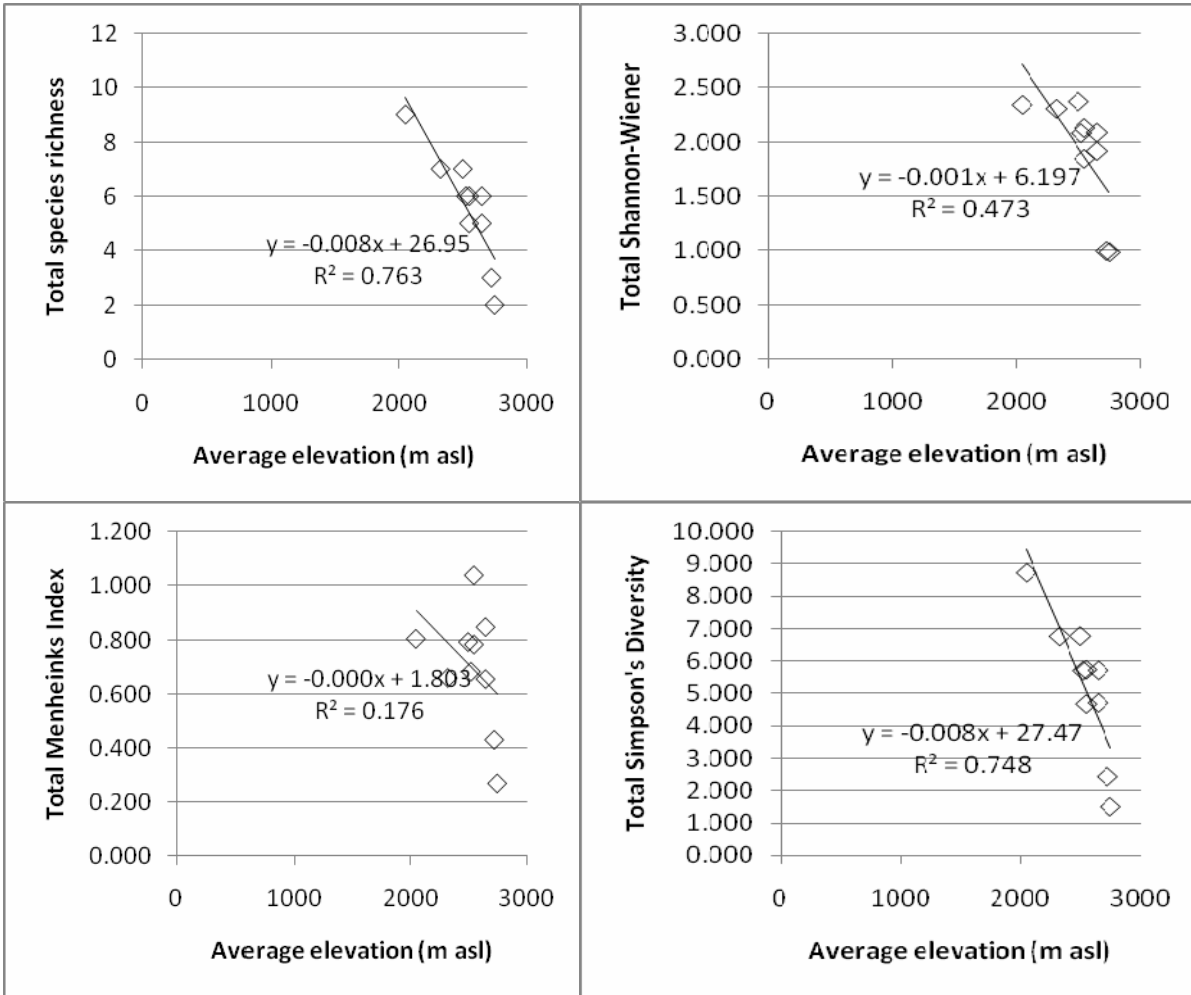


Figure 4. Species richness and diversity parameters of tree species along increasing elevation.

According to Odum (1971), the clumped distribution is common in nature, while random distribution is found only in uniform environments. The clumping of individuals of a species may be due to insufficient mode of seed dispersal (Richards, 1996) or when death of trees creates a large gap encouraging recruitment and growth of numerous saplings (Armesto et al., 1986). Connell (1978) suggested that the uniform dispersion pattern of species in tropical forests largely enable the maintenance of high levels of diversity. The changes in the dispersion patterns may reflect the reactions of species to disturbance as well as to changes in the habitat conditions (Sagar et al., 2003).

4. Discussion

A number of tree species found in the Himalaya exhibit varying patterns of distribution. The extension of

climatic gradient enabled several species to realize their fullest range of elevational adaptability. Distributional ranges of several species were segregated along the widened altitudinal ranges (Kharakwal et al., 2005). He & Legendre (2002) reported species-area relation, which predicts that species richness increases with increasing area. Pausas & Austin (2001) also suggested that over any large region the distribution of species richness is likely to be governed by two or more environmental factors and not by a single factor. Pangtey et al. (1991) argued that the effect of monsoon is not substantially weakened at higher altitudes and also the amount of rainfall is not much different from that of the lower altitudinal range of Central Himalaya. This has also been used to explain the patterns of decrease in species richness with altitude (Rahbek, 1997). In the temperate

Table 4. Dispersion behaviour of tree species along altitudinal gradient.

Tree Species	Family	Altitude (m asl)									
		2800- 2700	2800- 2650	2700- 2600	2700- 2600	2600- 2500	2600- 2500	2600- 2450	2600- 2400	2400- 2250	2250- 1850
<i>Abies pindrow</i>	Pinaceae	0.04(R)	0.05(R)	0.02(Re)	0.07(C)	0.02(Re)	0.04(R)	0.03(R)	0.06(C)	0.10(C)	-
<i>A. spectabilis</i>	Pinaceae	-	-	-	-	-	-	-	0.10(C)	-	-
<i>Acer acuminatum</i>	Aceraceae	-	-	-	-	0.30(C)	-	-	-	-	-
<i>Alnus nepalensis</i>	Betulaceae	-	-	-	-	-	-	-	-	-	0.10(C)
<i>Betula alnoides</i>	Betulaceae	-	-	-	-	-	-	-	-	-	0.08(C)
<i>Buxus wallichiana</i>	Buxaceae	-	-	0.10(C)	-	-	-	-	-	-	-
<i>Carpinus vaminea</i>	Corylaceae	-	-	-	-	-	-	-	0.08(C)	-	-
<i>Lyonia ovalifolia</i>	Eriaceae	-	-	0.04(R)	0.15(C)	0.07(C)	0.19(C)	0.03(R)	0.03(R)	0.02(Re)	0.04(R)
<i>Myrica esculenta</i>	Myricaceae	-	-	-	-	-	-	-	-	-	0.10(C)
<i>Persea duthiei</i>	Lauraceae	-	-	-	0.10(C)	0.04(R)	0.30(C)	0.04(R)	0.03(R)	0.08(C)	-
<i>Pinus roxburghii</i>	Pinaceae	-	-	-	-	-	-	-	-	-	0.05(R)
<i>Pyrus pashia</i>	Rosaceae	-	-	-	-	-	-	-	-	0.05(R)	0.05(R)
<i>Quercus floribunda</i>	Fagaceae	-	-	-	-	-	-	0.04(R)	0.04(R)	0.04(R)	0.05(R)
<i>Q. leucotrichophora</i>	Fagaceae	-	-	-	-	-	-	-	-	0.04(R)	0.03(R)
<i>Q. semecarpifolia</i>	Fagaceae	0.03(R)	0.02(Re)	0.03(R)	0.06(R)	0.03(R)	0.03(R)	0.05(R)	-	-	-
<i>Rhododendron arboreum</i>	Ericaceae	-	-	0.05(C)	0.04(R)	-	0.08(C)	0.04(R)	0.02(Re)	0.03(R)	0.07(C)
<i>Symplocos paniculata</i>	Symlocaceae	-	0.10(C)	-	0.04(R)	-	-	-	-	-	-
<i>Taxus baccata</i>	Taxaceae	-	-	-	-	0.08(C)	-	-	-	-	-

Abbreviations: R = Random; Re = Regular; C = Contiguous

Table 5: Carl Pearson correlation coefficient between different parameters:

	Altitude	Slope	Density	TBC	SR	MI	MEI	H'	Cd	D
Altitude	1.000									
Slope	0.719*	1.000								
Density	-0.848**	-0.635*	1.000							
TBC	-0.207	0.196	0.461	1.000						
SR	-0.874**	-0.817**	0.684*	-0.175	1.000					
MI	-0.750*	-0.750*	0.457	-0.392	0.960**	1.000				
MEI	-0.420	-0.499	0.001	-0.669*	0.723*	0.887**	1.000			
H'	-0.688*	-0.804**	0.501	-0.464	0.932**	0.952**	0.807**	1.000		
Cd	0.590	0.732*	-0.413	0.559	-0.851**	-0.889**	-0.784*	-0.978**	1.000	
D	-0.865**	-0.819**	0.674*	-0.198	1.000**	0.964**	0.732*	0.942**	-0.866**	1.000

** . Correlation is significant at the 0.01 level; * . Correlation is significant at the 0.05 level.

forests mean tree species richness was maximum in mixed broad-leaved forest which decreased from highly to least disturbed forests (Kumar & Ram, 2005). Consequently, our study revealed the maximum species richness of tree species at lower elevation, compared to higher elevational forests as suggested by Kumar & Ram (2005). Rathore (1993) has noticed high species richness and diversity in the *Pinus roxburghii*-mixed broad-leaved forests. In another study Singh et al. (1994) reported that *P. roxburghii*-mixed broad-leaved forests had the highest species richness, while high

elevation forests had the lowest. Burns (1995) and Austin et al. (1996) have found that the total species richness was greatest at lower elevation and warmer sites. The overall pattern of species richness showed a sharp decline as the altitude increased beyond 3000m asl. A similar pattern of tree species richness (deciduous) in timberline area was reported by Rawal et al. (1991).

Between 2450-2600 and 2600-2500 m asl, species richness fluctuated due to change in the climatic conditions (Table 2 and Figure 3). More than 60%

(Maximum) plant species were either present at 1850m asl, where the temperature cover a range from 10°C to 24°C (Champion & Seth, 1968). The low elevational sites were relatively densely populated probably because human interference in these areas facilitates the introduction and establishment of non-native species (Rawal & Pangtey, 1994). The human impact at lower altitudes was evident in the form of open spaces left after selective tree felling. These spaces may exacerbate the establishment of shade-intolerant species and enhance the regeneration of mixed pine-broadleaved forest (Wangda & Ohsawa, 2006). As a result of which the maximum tree species were encountered at lower elevation (Pine-mixed broad-leaved forest) compared to higher elevational sites. In this study the richness of non-native species like *Pinus roxburghii*, *Pyrus pashia*, *Lyonia ovalifolia*, *Betula alnoides* and *Alnus nepalensis* was more prevalent in early successional/ pioneer communities, because the species richness is believed to be more in pioneer communities (Rajmanek, 1989). Occurrence of *Abies pindrow*, *Quercus semecarpifolia*, *Q. leucotrichophora* and *Rhododendron arboretum* community (Table 4) almost on all the sites along the altitudinal gradient suggests their tolerance to biotic pressures and wider ecological amplitude. *Pinus roxburghii* is an early successional species and Oak a climatic climax, while the successional stage of *Abies pindrow* forest is considered to be climax for west-Himalaya (Champion & Seth, 1968). The expected compositional changes in *Q. leucotrichophora* forests are associated with biomass destruction. All *Quercus spp.* are repeatedly lopped for their fuel wood and fodder values. This activity reduces vigour and seed production (Saxena & Singh, 1984) in this species. Large scale extraction of selected species also causes structural change in plant communities (Spurr & Barnes 1980). Heavy browsing by animals at seedling and sapling stages is also responsible for poor representation in recruitment classes of *Q. leucotrichophora*, *Q. floribunda* and *Q. semecarpifolia* (Dhar et al. 1997). Accompanying frequent reproduction and expanding populations of two co-dominant native species, *Rhododendron arboreum* and *Lyonia ovalifolia*, result in structural/compositional changes, because they are unpalatable and less preferred for fuel wood. Poor recruitment of dominant *A. pindrow* and *Q. semecarpifolia* and other species in high elevation forests indicates possible decline in their populations. The prevention of recruitment of dominant natives is

considered to be a causal process resulting in changes in structural and functional aspects of reserve's ecosystem (Macdonald et al., 1989). For analysis of variability in dispersion, about half of the analyzed species in this study showed no effect of disturbance on dispersal behaviour and were characterized by clumped distribution. Clumping in these species may be due to patchy distribution of microhabitats suitable for plant growth in forest soils. The correlation between various parameters is shown in Table 4.

5. Conclusions

The present study highlights a very poor status of total species richness in the entire forest area along with regulation of tree species at various altitudes. Our findings revealed that lower elevational cover-types had comparatively higher number of species than lower number of species at higher elevational cover-types which implies that higher elevational forest types should be conserved with necessary implementations. Lower altitudinal forest types preferred optimum species richness, diversity and related parameters including soil status. At the higher altitudinal forest types species richness and diversity were found lesser prevalent because of high dependency of the people on fuel wood, extraction of NTFPs from the forest for generation of income. Significantly negative correlation of density and species richness with altitude and slope was recorded. The study suggests that the distribution and species richness pattern of different tree species are largely regulated by the altitude and climatic factors.

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Dengue Virus Infections in Patients Suspected of Malaria/Typhoid in Nigeria

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ABSTRACT

Dengue fever is clinically difficult to diagnose especially in the developing countries with no established diagnostic facility and could easily be mistaken for malaria, typhoid etc. This study was designed to determine the significance of these viruses in febrile illnesses. About 1948 serum samples from suspected cases of malaria and typhoid were collected from June 2001 to July 2002 in six ecological zones in Nigeria. 59 pools of *Aedes Spp* from Rain forest were tested by RT-PCR and for virus isolation. MAC-ELISA was used to test all the sera for IgM and IgG antibodies. All IgM positive sera were further analyzed by RT-PCR and Plaque reduction neutralization test (PRNT). Thirteen (0.67%) of the 1948 sera were positive for DEN 1 and 2 IgM from 4 zones. Mixed infections of DEN-2 and WN virus observed in two samples, eventually had neutralizing antibody for WNV. Overall, PRNT and ELISA results for DEN were in concordance. Dengue IgG antibodies in Sahel savanna (81.7%), Rain forest (69.0%), and Wooded savanna (69.0%) were significantly different from Grass (38.15%) and Sudan (32.6%) savanna. One IgM positive serum had detectable RNA to DEN. Fourteen of 59 pools of *Aedes spp* showed viral RNA to DEN 1-4. The prevalence of the antibodies to these viruses and the ages as well as the gender of the patients was not significantly different. Misdiagnosis of DEN infection for malaria/typhoid has been detected. [Journal of American Science 2009;5(5):129-134]. (ISSN: 1545-1003).

Keywords: Dengue, virus, febrile illness, malaria, typhoid and Nigeria.

1. Introduction

The clinical outcomes of DEN virus infection could vary from asymptomatic infection to mild febrile dengue fever (DF) to severe and life threatening dengue hemorrhagic fever (DHF)/dengue shock syndrome (DSS) (Gunther et. al. 2007). The four closely related, but antigenically distinct, serotypes of DENs (DEN-1, DEN-2, DEN-3, and DEN-4) do not cross-protect but cross react. Infection with one of these serotypes provides lifelong immunity to the infecting serotype only. Therefore, persons can acquire a second dengue infection from a different serotype, and second infections place them at greater risk for dengue hemorrhagic fever (DHF), the more severe form of the disease (Morb. Morta. Wkly Rep. 2007). These viruses are transmitted between human and monkey hosts by the mosquitoes of the genus *Aedes*, and principally *Aedes aegypti* (Holmes et al. 1999) and *A. albopictus* popularly known as the 'Asian tiger mosquito'. The early symptoms of arbovirus infections (High grade fever, headache, fatigue, malaise, nausea, vomiting) mimic malaria, typhoid, measles and influenza which are hyper

endemic in the environment, thereby rendering the diagnosis of this viral infections very confusing. In such situations, these infections are quite often misdiagnosed and so, inappropriately treated. Consequently these cases often result in high rate of morbidity, complications and mortality. Yet health Institutions in Nigeria lack appropriate diagnostic facilities for this group of viruses even with the existence of factors (human populations, increased urbanization, incursion of human activity into the new ecosystems, increased global travel, climatic changes, and collapse of vector control and public health programs (Gubler 1988), which favor the emergence of arboviruses globally. This study was designed to survey the epidemiology of arboviral infections, with particular reference to Dengue viruses (DENs) in febrile patients suspected of malaria/typhoid Nigeria.

2. Materials and Methods

2.1 Study Population:

Patients with febrile illness sent to the laboratory for either malaria or Widal tests were used

for the study. The common clinical manifestations on these patients by the time of sample collection include: fever, headache, and abdominal discomfort, and diarrhea, gastroenteritis while enteric fever, hepatitis, and HIV were less common. The commonest of all was fever either intermittent or recurrent.

2.3 Study Areas:

With more than eight ecological zones in Nigeria, six were randomly selected for the study. The selected zones were Guinea/ Grass savanna (Abuja), Rain forest (Ibadan), Wooded / Guinea savanna (Gombe), Deltaic / Swan savanna (Calabar), Sudan savanna (Kano) and Sudan / Sahel savanna (Maiduguri). A brief closed-ended questionnaire was designed to collect demographic data and clinical history of most of these patients.

2.4 Sample Collection A total of 1948 serum samples were collected in June 2001 and July 2002 from febrile patients. About 5ml of blood was collected by venu puncture from febrile patients. The blood was allowed to clot at room temperature and the serum was carefully collected after centrifugation at 2,000 rpm for 10 minutes and stored at -20°C until tested. Most often scoop nets and occasionally, human beings were used as baits in catching mosquitoes from the field. The mosquitoes were caught alive and stored at -20°C in Nigeria and were eventually transported with cold ice pack to Dakar for analysis.

2.5 Serology

Stock antigens were prepared in mouse brain from viruses supplied by WHO Collaborating Centre for Reference and Research on Arboviruses (CRORA), IPD, Senegal. All reactants were appropriately standardized.

2.5.1 Detection of IgM Antibodies:

An IgM capture ELISA (MAC- ELISA) as previously described by Vorndam and Kuno (5) was used for the detection of IgM antibodies against DENs. The virus with a higher Optical density (OD) was considered the infectious agent as reported by Vorndam and Kuno (1977). IgM positive samples were further subjected to PRNT as described by Mangiafico et al. (1988).

2.5.2 Detection of IgG Antibodies. For the detection of IgG antibodies against DENs, an IgG capture ELISA was used as previously described by Chunge et al. (1989). Binding of the IgG antibodies was detected using goat anti-human IgG antibodies labeled horseradish peroxidase. Unfortunately these samples were not confirmed by Plaque reduction neutralization technique (PRNT) because of the large sample size and the cost of the reagents.

2.5.3 Interpretation of Results: The standard

deviation of a battery of negative sera was calculated. A value of three standard deviations from the mean was used as the cut -off value to minimize false results as suggested by Innis et al (Innis et al. 1989)

2.6 Mosquito Processing

The field- caught mosquitoes were identified to the species level when possible. The identified mosquitoes were placed in 12x 75mm tubes in pools of 50. Each pool was tested by RT-PCR assay using a set of primer and with a cell culture technique. The cell culture assay was conducted by inoculating 100 μl aliquot of clarified supernatant from the mosquito pool onto sub confluent AP-61 cell and incubated for 8-10 days. The presence of the virus was determined by the use of indirect Immunofluorescence assay as described by Beckwith et al. (2000)

2.7 RT - PCR in Sera and Mosquitoes

2.7.1 The Extraction of RNA from Serum/Mosquito Suspension/Tissue Culture Extract

RNA extraction was carried out according to the specifications of the kit's (Q1 a Amp viral RNA Mini Kit) manufacturer. For each batch of mosquito suspension/serum/ extracted, positive controls (cell culture of the seed virus concerned) and uninoculated cell as negative control were included.

2.7.2 RT- PCR for Detection and Genotyping of DEN Viruses

2.7.2.1 The First Round of Amplification.

[The method previously described for dengue (Lanciotti et al. 1992) was adopted]

A semi-nested RT-PCR was carried out. All relevant aspects of the RT-PCR (Mgcl₂, primers, RT, Taq polymerase, number of cycles, and annealing temperatures) were initially optimized by using quantitated purified DEN virus RNA to achieve a maximum level of sensitivity before testing the field samples. The reaction product was electrophoresed on a 1% composite agarose gel in 0.4M Tris- 0.05 M sodium acetate- 0.01 M EDTA buffer. The gel was stained with ethidium bromide. The resulting DNA band was visualized on a UV transilluminator. The target viral RNA was converted to a DNA copy (cDNA) prior to enzymatic DNA amplification by using RT and the dengue virus downstream consensus primer (D2), homologous to the genomic RNA of the four serotypes. Subsequently, Taq polymerase amplification was performed on the resulting cDNA with the upstream dengue virus consensus primer (DS1).

2.7.2.2 Dengue Virus Genotyping by

Second-Round Amplification with Type Specific Primers (nested PCR) as previously described by Lanciotti et al. (1992)

In this method, type-specific primers replaced dengue virus downstream consensus primer, while dengue upstream primer was retained. The Tag DNA dependent DNA polymerase amplified the products of the first amplification to generate a DNA strand of different length, which was identified by gel electrophoresis. Thus the second amplification differentiated dengue species into different serotypes.

3.0 RESULTS

3.1 Pattern of Dengue Virus Infections in Nigeria

3.1.1 IgM Capture ELISA for Dengue Viruses

Figure 1 shows the IgM and its corresponding IgG antibodies to the different serotypes of DEN in the four ecological zones. For example in Figure 1, sample 6 appeared to be a recent infection with DEN-2 having a high OD value (1.151) while sample 4 seemed to be a case of anamnestic response.

Thirteen (0.6%) of the 1948 sera were positive for DEN1 and 2 IgM antibodies from 4 of the 6 ecological zones in Nigeria studied. The zones with positive cases were Rain forest (DEN-2), Grass savanna (DEN-2), Deltaic savanna (DEN2), and Sahel Savanna (DEN1 and 2). (Table1).

3.2 Plaque Reduction Neutralization Test on DEN IgM Positive Sera:

All the sera that were DEN IgM positive by MAC-ELISA were found positive by PRNT. (Data not included). Two sera which showed mixed infections of WNV and dengue by MAC-ELISA were later confirmed to be positive for WNV by PRNT. Failure to carry out PRNT for all the samples limits this study from giving the precise status of these patients with regards to dengue virus infections in Nigeria. This is because a negative acute-phase specimen is inadequate for ruling out such an infection underscoring confirmation by demonstrating virus-specific serum IgG antibodies in the same or later specimen.

3.3 The Prevalence of DEN IgG Antibodies in Nigeria

The zonal distribution of DEN IgG antibodies is displayed on Table 2. The prevalence of DEN IgG antibodies and the zones were significantly different with the highest in Sahel savanna (81.7%), followed by Rain forest (69.0%) and Wooded (69.0%) and the least in Sudan savanna (32.6%) and Grass savanna (38.1%).

3.4 Age and Gender Distribution of Patients with Dengue Virus IgM Antibodies

The prevalence of these antibodies and the ages as well as the gender of the patients were not significantly

different ($X^2=P>0.05$).

3.5 Virus Isolation from Mosquitoes

No dengue virus could be isolated from *Aedes* mosquitoes (59 pools) tested.

3.6 RT-PCR on Aedes Mosquitoes/ IgM Positive Sera for WNV

The results of RT-PCR on *Aedes* species are presented on table 2. Fourteen of 59 pools of mosquitoes (*Aedes spp*) tested showed DEN viral RNA and these include one DEN-1, 4 DEN-2, 5 DEN-3 and 4 DEN-4. However, one DEN IgM negative serum was positive by RT-PCR. Samples that showed non-specific bands were not considered. TITAN (Combination of reverse-transcription of viral RNA and subsequent Taq polymerase amplification in a single reaction vessel) seemed to exhibit higher degree of sensitivity and specificity compared with separate reverse-transcription and PCR. Sequencing of RT-PCR results was beyond the scope of this study.

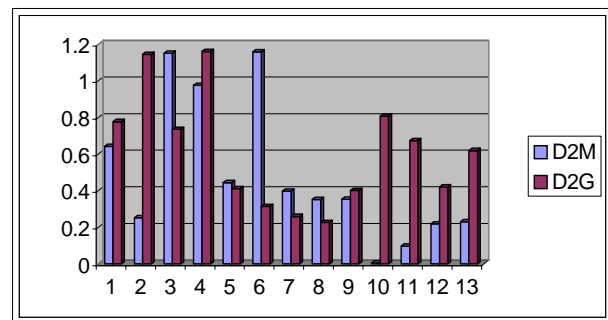


Figure 1: DEN IgM and the Corresponding IgG Antibody

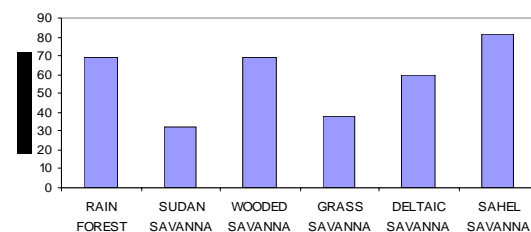


Figure 2: Zonal Distribution of DEN IgG Antibodies

Table 1: Dengue Virus Infections in Different Ecological Zones in Nigeria

	ECOLOGICAL ZONE	TOWN/ CITY	TOTAL NO TESTED	NO POSITIVE (%)	DENGUE SEROTYPE	REACTION WITH NORMAL Ag
1	RAIN FOREST	IBADAN	442	4(0.9)	D2	6(1.4%)
2	SUDAN SAVANNA	KANO	267	0(0)	NONE	6(2.2%)
3	WOODED/GRASS SAVANNA	GOMBE	341	0(0)	NONE	14 (4.1%)
4	GRASS SAVANNA	ABUJA	281	1(0.36)	D2	7 (2.5%)
5	DELTAIC SAVANNA	CALABAR	317	3(0.1)	D2	1(0.1%)
6	SAHEL SAVANNA	MAIDUGURI	300	5 (1.67)	D1 AND D2	5 (1.67%)
	TOTAL		1948	13 (0.67)		39 (2.0%)
	* NO REACTION WITH NORMAL ANTIGEN					
	** REACTED WITH NORMAL ANTIGEN					

Table 2: The Result of RT-PCR ON *Aedes species*

<i>Aedes aegypti</i>	female	27	1	2	0	4
<i>Aedes aegypti</i>	males	7	0	1	2	1
<i>Aedes species</i>	females	12	0	0	1	1
<i>Aedes species</i>	males	9	0	1	1	0
unidentified	not known	4	0	0	2	2
Total		59	1	4	5	4

4.0 Discussion

In Nigeria most febrile cases are routinely investigated for malaria and /or typhoid and not viruses. This study has revealed that, 13 (0.67%) of 1948 febrile patients in four of six ecological zones in Nigeria had DEN IgM antibodies. Although the prevalence rate of DEN infection as revealed in this study is low, it has confirmed the activities of this virus in Nigeria. Like Yellow Fever, a positive case of DEN virus infection in a community, is of epidemiological importance. This is

because, if the mosquito vector feeds on the viremic blood of a DEN infected patient, it could also transmit the virus to a high proportion of susceptible population within the environment. A significant association between the prevalence of DEN virus infections and the ecology has been observed in this study in agreement with a previous report in Nigeria. (Fagbami et al.1977). In both studies, higher prevalence of DEN infections in the Rain forest but low in Guinea savanna was observed.

A report revealed that, a positive DEN IgM by MAC-ELISA on acute serum samples is an indication that infection must have occurred sometime in the previous one or two months before sample collection (World Health Organization, 2001). Another study revealed that, PRNT is more specific than ELISA because it shows a monotypic reaction to the infecting virus through the late convalescent phase of illness (Vorndam and Kuno 1997). This study has shown that, DEN virus infections among those studied, must have occurred within a one or two months before samples were collected.

The prevalence rate of DEN IgG antibodies and the ecological zones were significantly different with the highest in Sahel savanna (81.7%), followed by wooded savanna (69.2%), and Rain forest (69.0%). The least among them were Grass and Sudan savanna with 32.6% and 38.1% respectively. The low percentage of people with DEN IgG antibodies in the two zones is of epidemiological importance. This is because any introduction of an epidemic strain or serotypes of any of the Flaviviruses in these zones could result in epidemic due to the presence of high proportion of susceptible host.

Thein (2003) observed that, levels of anti dengue IgG in acute phase sera collected during a period of high dengue activity correlated with disease severity but low dengue activity showed no association. In this study, because there is no active surveillance for dengue or other arbovirus activities in Nigeria, it is difficult to differentiate periods of high and low virus activities. Also, because there was no follow-up on these cases, correlation of levels of IgG and disease severity was not applicable in this study. Nevertheless the clinical importance of IgG in diagnosis of DEN infections is its usefulness in distinguishing between primary and secondary dengue infections with 100% primary and 96% of secondary being correctly classified (Innis et al. 1989, Vauhgn et al. 1999). Based on these reports, from figure 1 of this study, samples 1, 4, 9, 12 and 13 could be described as suspected cases of anamnestic response to DEN infections. Moreover, these patients could be assumed to be at the risk of developing DSS because the risk of developing DSS following an anamnestic infection was from 82-103 times greater than that of developing DSS following a primary dengue infection (Thein 2003). In addition this author observed a significantly higher rate of anamnestic infections with DEN-2 (which is the most prevalent serotype of DEN in Nigeria) in DSS compared with other serotypes. Lack of surveillance activities for these viruses in the country poses constrain to the precise status of these infections in the community. For instance, in 2003 two suspected cases of viral hemorrhagic fever (based on clinical manifestations) were reported in University of

Maiduguri Teaching Hospital, Maiduguri (a Tertiary Health Institution in Northeastern Nigeria. (Personal communication). These patients died within few hours on the same day they sought medical attention. It could be assumed that, when the infection was at the prodromal phase (the phase at which the symptoms and signs mimic malaria or typhoid), the patients were receiving different malaria treatments (with the assumption that the drugs were resistant to the infecting parasites) till symptoms of haemorrhages appeared. Therefore, since the patients tested in this study were not followed up, associating these cases with DSS was beyond the scope of this study. The need for active surveillance and intensive education on arbovirus activities in the environment cannot be emphasized.

The detection of DEN RNA in *Aedes species* has demonstrated the important role of the vector in the epidemiology of dengue infections in the environment. The presence of DEN RNA in male *Aedes aegypti* and *Aedes Species* is evident of vertical transmission in Nigeria and this compared favorably with previous report in Mexico (Gunther et al. 2007). In agreement with Miagostovich et al. (1988), one of the DEN IgM negative serum was found positive (DEN-3) by RT-PCR, suggesting that, most of the IgM negative samples in this study could have been false. This probably contributed to the low prevalence rate of DEN infections obtained in this study. It could be speculated that, consideration of the time of onset of symptoms during sample collection would have given more precise information on the status of these patients with regards to recent DEN infections in Nigeria. This becomes necessary because specimens taken earlier than six days after onset would have a variable percentage of false negatives due to insufficient time for antibody development. To further support the speculation, a report showed that, a small percentage of patients had detectable IgM antibodies on the day that symptoms began and most patients became positive by the sixth day after onset (Vorndam and Kuno 1977). Therefore the few IgM positive sera in this study yielded no viral RNA probably because the time of sample collection did not favor RT-PCR result. It is therefore imperative to employ the two techniques (MAC-ELISA and RT-PCR) in proper diagnosis of DEN infections.

Similar to this study in the same environment, West Nile virus infections (1.3%) have been misdiagnosed for malaria/typhoid (Baba et al. 2006). Therefore, as the clinical symptoms associated with DEN infections are indistinguishable from those of many other viral, bacterial and parasitic infections, specific diagnostic tests assume critical importance in the unequivocal identification of DEN infections (Hapugoda et al. 2007). It is important to include this virus (and possibly other endemic arboviruses) in the differential diagnosis of febrile illnesses in Nigeria. Surveillance with good

laboratory services serve as an “early warning system” against any impending outbreak of arbovirus infections.

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Cultivation of Straw Mushroom (*Volvariella volvacea*) Using Some Agro-Waste Material

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Abstract: Some agro-waste materials, like paddy straw, oil palm fibre and sawdust were screened for the cultivations of the straw mushroom *Volvariella volvacea*. The experiment consisted of four treatments; paddy straw, oil palm fibre, sawdust, and a mixture of oil palm fibre and sawdust; in a Completely Randomized Design (CRD) replicated three times. The paddy straw served as the control as it is the traditional substrate for the growth of the mushroom. The results showed that the straw naturally supported the mycelial growth and production of fruitbodies. Growth and production of fruitbodies on oil palm fibre was similar to that of paddy straw. The production of fruitbodies on the mixture of oil palm fibre and sawdust was scanty. Sawdust alone as a substrate produced few fruitbodies that were comparatively small in size. [Journal of American Science 2009;5(5):135-138]. (ISSN: 1545-1003).

Key words: Cultivation straw mushroom, agro-waste materials

1. Introduction

Mushrooms are known to be among the largest of fungi that attracted the attention of naturalists before microscopes were invented. Chang and Milles (1991) defined mushroom as macrofungus with definitive fruiting body and large enough to be seen with the naked eyes. They extended this definition by adding that mushrooms do not need to be Basidionmycetes nor aerial nor fleshy. They can grow underground having a non fleshy texture and need not be edible. Davis and Aegertar (2000) defined mushroom as the fruit of certain fungi analogous to apple on a tree. Many fungi that form mushrooms exist in mycorrhizal relationship with trees, and this is one of the reasons why forests are often generous to mushroom hunters (Ogunlana, 1978). Some wild mycorrhizal mushrooms cannot be cultivated unless the tree is also cultivated. The mushrooms are sometimes taken to the market after being collected from the forest (Kuyper *et al.* 2002, Quimio, *et al* 1990) Mushrooms are now grown worldwide as they have been recognized as food (Munjal, 1970)

Edible mushrooms like *Volvariella volvacea* have attracted much attention as source of food and medicine over the years. The paddy straw mushroom is a preferred type of mushroom by most consumers because of its aroma and taste (Tharun, 1993) It grows on almost all cellulosic agricultural waste material like rice straw, banana leaves dried paddy straw etc (Reyes and Abella, 1997) These substrates are used because they contain cellulose and also pose a problem of disposal to the environment (Onuoha, 2008) So the cultivation of mushroom using the agro-waste is a way of reducing environmental waste materials (Reyes and Abella, 1997).

Mushroom in recent times has become a contemporary business enterprise because of its high nutritional and medicinal values, and consequently high societal demand. There is therefore, need to maintain a constant supply of mushroom by cultivating rather than depend on seasonal forest supplies.

It is, therefore, the aim of this study, to determine the suitability of some common agro-waste materials in the growth of *Volvariella volvacea*.

2. Materials and Methods

Sources of Materials: The spawn of the mushroom was collected from Imo State Agricultural Development Programme (ADP) Owerri. The substrates like paddy straw and oil palm fibre were also collected from Imo ADP while sawdust collected from the state timber shed, Owerri.

Species Selection: *Volvariella volvacea* was selected for study because it is particularly common in Nigeria (Zoberi, 1978) It is also mostly preferred by many consumers because of its aroma and taste (Tharun, 1993). The consumption of oyster mushroom and *Volvariella volvacea* has been reported to lower the cholesterol levels in the body (Poppe, 2000).

Growth Substrates: Four agrowaste materials were used as substrates in the study. They include paddy straw, oil palm fibre, sawdust and a mixture of sawdust and oil palm fibre.

Preparation of Substrates: The straw was chopped manually and soaked in water for 24 hours. The soaked straw was rinsed in distilled water twice and drained with a sieve. The oil palm fibre was soaked in distilled water overnight in order to melt the remaining oil in the fibre. Excess water was drained off. Five hundred grammes each of the prepared sawdust and oil palm fibre were mixed up properly. One kilogramme of each substrate was used. The mixture substrates were prepared in equal proportions by weight. This was done using a weighing balance. Sawdust was mildly sprinkled with sterile distilled water.

The four prepared substrates were separately packed into polythene bags and tied up for sterilization. Boiling drum containing stacks of sticks and water up to the level of the sticks was used for sterilization. The substrates were packed into the drum and covered with fresh plantain leaves in order to generate enough heat. The substrates were steam-sterilized for three hours and allowed to cool while still in the drum, they were taken to mushroom house and poured separately on sterile polythene sheets on a table. The spawn was sprinkled on the substrates covered with sterile polythene sheet and watered daily to maintain a high relative humidity of between 75 – 80%.

Data Collection

The following parameters of growth/yield were measured:

1. Number of fruiting bodies: This was done by directly counting the number of fruitbodies produced on each substrate
2. Diameter of the pileus: This was measured by placing a transparent plastic ruler across the centre of the pileus
3. Weight of fruitbodies: Electronic weighing balance was used to determine the average weight of the fruitbodies.

The results obtained were recorded and subjected to statistical analysis. Analysis of variance (ANOVA)

3. Results

Fifteen days after planting and incubation, whitish mycelia colonized all the substrates. Few days later fruitbodies were observed firstly on the paddy straw (control), then oil palm fibre, then 3 days later on the mixture of oil palm fibre and lastly on the sawdust (plates 1 – 4).

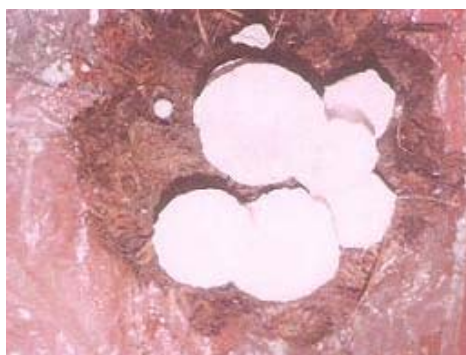


Plate 1: Showing *V. volvacea* mushroom growing on Oil Palm fibre



Plate 2: Showing *V. volvacea* mushroom growing on Paddy Straw



Plate 3: Showing *V. volvacea* mushroom growing on mixture of Oil Palm fibre and sawdust



Plate 2: Showing *V. volvacea* mushroom growing on Sawdust

Table 1: Yield parameters of the straw mushroom

Substrates	Mean no. of fruitbodies	Mean diameter of the pileus (cm)	Mean fresh weight of the fruitbodies (g)	Mean dry weight of the fruitbodies (g)	% of water Content of the fruitbodies
Paddy straw	13.3	3.7	16.3	10.2	37.4
oil palm fibre	11.3	3.7	16.3	10.5	35.6
Saw dust	5.6	1.8	8.0	5.3	33.8
Oil palm fibre sawdust	10.3	2.9	15.3	10.3	32.7

The yield parameters of the mushroom from each of the substrates are shown in table 1. While the mean number of fruitbodies produced was highest in the control (paddy straw) with 13.3, oil palm fibre and a mixture of oil palm fibre and sawdust equally produced good number of fruitbodies with 11.3 and 10.3 respectively. Sawdust yielded only 5.6

The mean fresh weight of the fruitbodies produced on paddy straw, oil palm fibre and a mixture of oil palm fibre and sawdust were high with 16.3g, 16.3g and 15.3g respectively. Also the mean fresh weight of the fruitbodies produced on sawdust was relatively low. The mean diameter of the pileus of the fruitbodies as well as the mean dry weight of the fruitbodies produced on the different substrates also appeared in the order of the earlier parameter mentioned. While the fruitbodies produced on paddy straw had the same mean diameter with those produced on palm fibre (3.7cm) the mixture of oil palm fibre and sawdust produced pileus with a mean diameter of 2.9 cm. Sawdust, however produced the smallest sized fruitbodies with a mean pileus diameter of 1.8 cm.

There is no significant difference ($P \leq 0.5$) between the mean dry weight of the fruitbodies produced on paddy straw, oil palm fibre and a mixture of oil palm fibre and sawdust. But there was a significant difference ($P \leq 0.05$) between these and those produced on sawdust.

The percentage of the moisture content of the fruitbodies produced on the different substrates showed slight variations but they are not statistically significant ($p > 0.05$) except those produced on paddy straw against those produced on the mixture of oil palm fibre and sawdust.

4. Discussion

The four substrates screened, all supported the growth of the mushroom though to a varying degrees. This confirms the report of Keshari (2004) and Tricita (2005) that *Volvariella volvacea* could be grown on

agricultural waste. Apart from the paddy straw which is the traditional substrate for the cultivation of the mushroom, oil palm fibre was equally good. In terms of the number of fruitbodies produced, weight of the fruitbodies and diameter of the pileus it was as good as the control. This agrees with the findings of Isikhemhen (2004) who reported that *Volvariella volvacea* can be cultivated on other unsupplemented agricultural waste. The duration of growth is very short and many fruitbodies could be produced within the period. It was also reported by Landford (2004) that they are not only excellent edible mushroom but also can colonize substrates and grow quickly on some unsupplemented agrowaste. There was statistically no significant difference between ($p > 0.05$) the yield parameters of control (paddy straw) and oil palm fibre. This means that the oil palm fibre as an agrowaste, could be used to produce the mushroom as much as the paddy straw could produce. It might be a way of reducing agrowaste in the environment first as reported by Kuyper *et.al.* (2002) that the cultivation of *Volvariella volvacea* on local agricultural creates a way of reducing environmental pollution.

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Rooting of Stem Cuttings of *Ginkgo* Living Fossil Under Threat

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Abstract: A systematic study were carried out to examine the rooting ability of male and female branch cuttings of *G. biloba* under different microclimatic conditions i.e. polyhouse, polypit, and open while using plant growth hormone (IBA) and a systemic fungicide (Bavistin; containing 50% Carbendazim) for raising maximum number of planting materials. Various concentrations 100, 250 & 500 μM of IBA and 0.1, 0.5 and 1.0% of a systemic fungicide Bavistin were applied to the cuttings. The higher concentration of IBA (500 μM) resulted maximum rooting (50.0%) in male cuttings and Bavistin (1.0%) produced maximum 41.66% in male and 58.33% in female cuttings, respectively, whereas no rooting was recorded in both male & female cuttings kept in all the microclimatic conditions as control. The highest number of roots (7.5) per male cuttings was formed in 500 μM IBA while 5.0 roots per female cuttings was formed in 100 μM IBA treatment. Cuttings planted inside polyhouse and in the open conditions did not survive and died after bud sprouting. Since this is a rare species and has got the status of living fossils being known from rocks as old as 200 million years, growing naturally and only few individuals are reported to exist and therefore vegetative propagation may be viable option for its multiplication and conservation to save this species from extinction. [Journal of American Science 2009;5(5):139-144]. (ISSN: 1545-1003).

Keywords: *Ginkgo biloba*/living fossil/ Rooting/ propagation/ Indole - 3 - butyric acid/ Bavistin/ medicinal tree/ conservation

1. Introduction

Unfortunately, due to legal and illegal exploitation of important plant species from wild, anthropogenic pressure and lack of knowledge about sustainable harvesting of useful bioresources particularly medicinal ones as many of them has been listed under the categories of rare, threatened, endangered or at the verge of extinction. Although the extinction of species is a natural process, the current speed of extinction of species through human interventions is approximately 100-1000 times faster than the natural speed of extinction. In many groups of organisms 5-20% of all species are already extinct (Chaplin et al. 2000). The species currently on earth are the result of a natural selection process over the last three billion years, which has lead to a large degree of specialization. Species diversity is therefore a prerequisite for ecosystem to function. But how important are species and ecosystems for society? This can be researched by investigating the functions and associated goods and services of ecosystems that are important for humans. A central problem is a

continuing loss of biodiversity, but our knowledge about human dimension of biodiversity is still relatively limited. However, there are several plant species growing in this earth but has not still given priority for conservation due to lack of awareness about their usefulness, economic potential and applicable multiplication technology package.

The *Ginkgo biloba* Linn. (MAIDENHAIR TREE; family Ginkgoaceae) is world's oldest tree mostly known as living fossils and only surviving member of seed plant groups. It is found growing naturally in very limited localities in the central Himalayan mountain at an elevation of 6000 ft (Anonymous, 1999). It is a handsome, straight, up to 100 ft. high, sparsely branched when young, bearing clusters of fan shaped leaves and dioecious slow growing gymnosperm and known to have huge medicinal, spiritual and horticultural importance worldwide. The Leaves of this species is extensively used in the form of a concentrated, standardized *Ginkgo biloba* extract (GBE) in different countries (particularly China, Europe, France and Germany) as a source of herbal

Ginkgo is being used to treat circulatory disorders and enhance loss of memory. Its leaves contain two types of chemicals (flavonoids and terpenoids) have potent antioxidant properties. It is also widely used for treating dementia, eye problems, intermittent claudicating, memory impairment, tinnitus and a variety of other ailments including altitude sickness, asthma, depression, disorientation, headaches, high blood pressure, erectile dysfunction, and vertigo (<http://www.umm.edu/altmed/ConsHerbs/GinkgoBilobach.html>).

In central Himalayan Mountains of India, there are very few spots in Uttarakhand (i.e. Ranikhet, Nainital and Dehradun) where the individuals of this species are found growing naturally and require immediate conservation measures. However, countries like China, Europe, France, and Germany have already undertaken initiatives for large-scale propagation and plantation for its conservation so as to maintain its status and population on one hand and to make use of it properly in the field of herbal medicine in near future. Despite of having huge medicinal properties and ornamental value, this species still has not received much attention as far as conservation is concerned particularly in India. Due to poor regeneration, only few individuals exist in the nature particularly in diverse climatic conditions in different places and facing serious threat of extinction from central Himalayan mountains of India. Since this is a rare species and has got the status of oldest living tree fossils and therefore require urgent propagation protocol for large-scale multiplication. Rooting of stem cuttings provides the advantage of greater genetic uniformity and availability of superior stock in a short period of time for afforestation works. This method has been tried sufficiently in number of gymnosperms as well as angiosperms trees (Nandi et al. 1996, Tamta et al. 2000, Nandi et al. 2002, Purohit et al. 2005). The vegetative propagation studies on *Ginkgo biloba* has been reported by Dirr et al. 1987, Doran, 1954 and Natalia, 1994). Using auxins, but there are very few studies or reports available in Indian Himalayan region where phenolic compounds either alone or in combination with auxins were applied (Prakash et al. 2002 and Gopichand et al. 2006). In view of this, an experiment on vegetative propagation using rooting of branch cuttings was carried out to examine the effect of IBA and Bavistin under different microclimatic conditions.

2. Material and methods

The experiments were carried out inside the polyhouse, polypit and in the open conditions (details given below) established in the G. B. Pant Institute of Himalayan Environment & Development, Garhwal, Unit, Srinagar, Garhwal, Uttarakhand, India, (30° 13' 05.8" N and 78° 46' 24.5" E; 584 m amsl). Branch cuttings (semi-hardwood) were excised in the morning and brought to the laboratory in polythene bags in order to prevent desiccation, during the first week of January 2006 from mature single male and female tree of *G.biloba* (of more than 50 years old trees) growing in Kalika (1750 m amsl) and Chaubatia (1850 m amsl) areas of Ranikhet (Distt. Almora, Uttarakhand, India), respectively. The final cuttings (average length 10.52 ±0.88 cm male and 11.14 ±0.32 cm female, dia. 8.82±0.34 mm male and 9.21±0.41mm female, with atleast 3-4 nodes per cutting) were clipped from the branches. The basal 2.0 cm portion of cuttings was dipped in various concentrations of test solutions for 24 h at 22°C. The treatments consisted of Indole - 3 - butyric acid, IBA 100, 250 & 500 µM; HiMedia Laboratories Pvt. Ltd, Mumbai) and Bavistin (0.1, 0.5, 1.0%; a systemic fungicide; containing 50% Carbendazim, a. i.; from BASF India Ltd., Mumbai, India); one untreated set served as control. The IBA was dissolved in 1.5% (v/v) aqueous ethanol; control cuttings were dipped in aqueous ethanol (1.5%, v/v). In each treatment only 24 cuttings were applied.

Following treatment, cuttings were planted vertically in polythene bags (16.0 cm h x 8.0 cm dia; one cutting per bag) containing sieved rooting mixture (equal parts of sand, soil and farmyard manure) and placed in following microclimatic conditions.

2.1. Polyhouse: A small polyhouse of 20 ft length x 9.0 ft width and 7.0 ft height (in the middle) was erected with the help of bamboo poles and covered with a thin semi-transparent polyethylene sheet (thickness: 162.5 µM, UV stabilized) from all the sides. The door could be opened at the front end to access the polyhouse.

2.2 Polypit: A pit dug in the ground (size 10.0 ft L x 6.0 ft W x 3.0 ft D), covered on the top with a semi-transparent polyethylene sheet (thickness: 162.5 µM, UV stabilized) supported by a bamboo frame. On one side, a small mud wall (about 30 cm high from the ground level, sloping on the two sides) was raised. The polyethylene sheet was sealed on higher side with mud, leaving three sides

plastering (even with mud) was carried out. As a routine polyethylene covers from the top of the polypit were partially opened during the daytime after midday for a few hours (see Vyas et al. 1999 for details about its function and benefit).

2.3 Open: Open field space without any cover or modifications.

Observations were taken six months after treatment and planting for estimation of percent rooting, number of roots formed per cutting, root diameter and the length of individual roots. Only those cuttings with one or more clearly visible root initials (≥ 2 mm) and/ or roots were classified as having rooted (Nandi et. al. 1996). Following this the well rooted cuttings were again planted in polybags and moved into the shade house, receiving 50% sunlight for hardening and the plants were watered periodically (Fig. 1E).

Least significant differences (LSD), standard error (SE) were calculated for comparison among the treatments following the methods as described by (Snedecor and Cochran, 1967). Analysis of variance (ANOVA) was performed using the Microsoft excel programme.

3. Results

Rooting ability of male and female branch cuttings of *G.biloba* was examined inside polyhouse, polypit and in the open conditions. Cuttings planted in all the conditions exhibited 70-80% bud sprouting (Figure 1A and B). Based on the random observations, cuttings planted in polyhouse and in

the open were dried up after four months of planting, therefore, details data of both the conditions are not presented. The first root initiation was observed at six months in majority of the cuttings planted inside polypit (average temperature and relative humidity (RH) during experiment period; 25-30°C, with 60 to 80%). The cuttings under control sets failed to root in both male & female even planted under polypit condition. LSD (P = 0.05) indicates significant differences in all the attributes measured for different treatments. IBA (500 μ M) and Bavistin (1.0%) were found very effective for root formation. A maximum 50.0% rooting success was achieved in male cuttings (Table 1 and Figure 1C) with the application of 500 μ M IBA treatment on an average of 6.71 roots per cuttings and average root length of 3.27 cm, while Bavistin 1.0% treatment produce maximum rooting success 41.66% (with an average of 4.83 roots per cuttings and average root length 3.19; Table 1) in male cuttings and 58.33% (with an average of 4.66 roots per cuttings and average root length 4.0 cm) in female cuttings of *G. biloba* (Table 2 and Figure 1D). Other concentration tried 100 μ M IBA was found to be slightly effective with rooting success of 33.33% in female cuttings with an average of 5.0 roots per cuttings and average root length of 3.25 cm. In male cuttings average length of longest root 7.5 cm and 7.32 cm while in female cuttings 6.83 cm and 6.72 cm was recorded with 500 μ M IBA and 1.0% Bavistin treatment, respectively. The maximum root diameter was recorded 1.26 mm for male (Table 1) and 1.53 mm for female cuttings (Table 2).

Table 1. Effect of IB on rooting respons male cuttings insic condition	% Rooting	No. of roots/ cutting (mean \pm SE)	Avg. Root length (mean \pm SE, cm)	Length of longest root (mean \pm SE, cm)	Avg. root diameter (mean \pm SE, mm)
Treatments					
IBA (100 μ M)	20.83	3.77 \pm 0.88	2.61 \pm 0.57	5.0 \pm 0.73	1.22 \pm 0.26
IBA (250 μ M)	25.00	2.5 \pm 0.35	3.48 \pm 1.03	5.35 \pm 1.52	0.94 \pm 0.21
IBA (500 (μ M)	50.00	6.71 \pm 1.30	3.27 \pm 0.36	7.5 \pm 1.02	1.26 \pm 0.06
Bavistin (0.1%)	-	-	-	-	-
Bavistin (0.5%)	29.0	5.28 \pm 0.37	2.90 \pm 0.39	5.41 \pm 0.33	1.04 \pm 0.15
Bavistin (1.0%)	41.66	4.83 \pm 0.60	3.19 \pm 0.41	7.32 \pm 1.25	1.08 \pm 0.08
LSD (p = 0.05)	30.67	4.18	2.08	4.63	0.73

SE = Standard error of mean. All values are an average of 24 cuttings. A dash (-) indicates cuttings did not root.

Source of variation	DF	Mean Square	F-ratio
Treatments	5	112.6579	2.194888 ^{ns}
Parameters	4	742.7473	14.47077**
Error	20	51.32741	

**Level of significance at 0.05; ns: not significant

Table 2. Effect of IBA and Bavistin on rooting response of *G. biloba* female cuttings inside the polypit condition

Treatments	% Rooting	No. of roots/cutting (mean ±SE)	Avg. Root length (mean ±SE, cm)	Length of longest root (mean±SE, cm)	Avg. root diameter (mean ±SE, mm)
IBA (100 µM)	33.33	5.0±2.0	3.25±0.76	4.96±1.56	1.46±0.12
IBA (250 µM)	20.83	2.8±0.86	3.77±1.13	4.96±1.56	1.46±0.12
IBA (500 µM)	12.5	4.0±1.52	5.14±1.13	6.83±1.96	1.35±0.13
Bavistin (0.1%)	12.5	4.33±1.85	3.33±0.63	4.83±1.58	1.12±0.13
Bavistin (0.5%)	20.83	1.5±0.35	1.56±0.23	2.0±0.0	1.34±0.22
Bavistin (1.0%)	58.33	4.66±1.33	4.0±0.58	6.72±0.84	1.53±0.11
LSD (p = 0.05)	30.67	2.35	1.83	2.94	0.24

SE = Standard error of mean. All values are an average of 24 cuttings.

ANOVA Summary Table

Source of Variation	DF	Mean Square	F-Ratio
Treatments	5	72.14717	1.216312 ^{ns}
Parameters	4	643.7649	10.85308**
Error	20	59.31633	

**Level of significance at 0.05; ns: not significant.



Figure 1. Propagation of *Ginkgo biloba*: (A) A mature tree of *G. biloba*, (B) A sprouted male and female cuttings, (C&D) well rooted male and female cuttings, (E) Cuttings raised plants kept inside shade house for hardening.

female cuttings and (E) Cuttings raised plants kept inside shade house for hardening.

4. Discussion

The stimulation of adventitious root formation in stem cuttings with auxins and commercial rooting mixtures is well known in many species those are difficult-to-root (Morsink and Smith, 1974, Blazich, 1998, Nandi et al. 1996, Purohit, 2002). The effect of growth hormone and fungicide on adventitious root formation in semi - hardwood cuttings of *G. biloba* in different microclimatic conditions, was examined for the first time. Although there are several studies available on the propagation of gymnosperms and angiosperms trees using stem cuttings (Nandi et al. 1996, 1997, 2002, Tamta et al. 2000, Purohit et al. 2005). The rooting efficiency observed in *G. biloba* showed satisfactory result within six months of planting inside the polypit conditions whereas reports available reveals that cuttings taking two years to root in natural conditions (Anonymous, 1999),

in the present study the application of IBA (500 μ M) significantly improved the rooting up to 50.0% in male cuttings whereas the application of Bavistin (1.0%) was found more effective in both the cuttings (male and female) with highest rooting response was observed in female cuttings (58.33%). However, on the other hand, the application of growth regulators (catechin and gallic acid) produced 53.3% and 56.7% rooting respectively, in the semi hard woodcuttings of *G. biloba* (Gopichand et al. 2006). Besides, the applications of different phenolic compounds were applied to assess the rooting response in *G. biloba* (Prakash et al. 2002) and they reported that the combination of IBA (500 mg/l) and catechin (5 mg/l) enhanced the rooting upto 96.0%.

IBA and Bavistin have also been reported to be more effective in inducing rooting in stem cutting of *Taxus baccata* (Nandi et al. 1996, 1997) and *Cedrus deodara* (Nandi et al. 2002). The rooting percentage displayed a positive trend with increasing concentrations of chemicals in this study. Applications of auxins enhanced rooting and root quality in many tree species (Hartman and Kester, 1983). The application of IBA may have an indirect influence by enhancing the speed of translocation and movement of sugar to the base of cuttings and consequently stimulate rooting (Haissig, 1974). Treatments with a systematic fungicide, Bavistin were also found effective in this study, however, the mechanism of stimulation of rooting by Bavistin is not clear. It may be related to auxin like activity of benomyl, which is known to be converted into carbendazim in water and in contact with plants (Thurston et al. 1979). Application of 500 μ M IBA and 1.0% Bavistin also enhanced the number of roots developed on each rooted cuttings as compared with another concentrations applied. This may have an advantage by enhancing good anchorage when planted in the field. Besides the effect of IBA and Bavistin, the diameter of cuttings may also have influenced the root formation on the cuttings whereas most of the thin cuttings either dried up or could not develop root even after six months.

In the present study rooting of stem cuttings was carried out in the months of January to June because of the deciduous nature of tree, best sprouting of dormant buds, active growth season which has been reported to favor rooting of cuttings (Loach, 1988). High humidity environments created by means of mist systems or plastic covers are commonly used in vegetative propagation experiments to reduce the

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risk of water stress (Hartmann et al.1990). Generally, spring season when the fresh flush starts is considered to be the best period for rooting.

5. Conclusions

The results of this study are important and low natural regeneration as reported in this species can be supplemented with clonally propagated plants raised through rooting of stem cuttings. Moreover, it is important to note that the cuttings were taken from mature trees from different sources; further trials in different seasons may result in better rooting efficiency and genetically specific-differences. Due to poor economic condition and tough terrain in the mountains the construction of Green houses are difficult, therefore, a low cost polytunnel (poor man growth chamber) can meet out the requirement of rooting of cuttings and raising maximum number of plants. Keeping in view the present status, importance and conservation value of *G. biloba* a multi-faceted efforts is required while involving local communities, scientific institutions and NGOs for its nursery raising and afforestation programmes. Further, well-rooted plants could be obtained within a short time; the method is also inexpensive and easy to perform. It is hoped that it will be acceptable to the involved in the forestry sector.

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The Role Played By Azores High in Developing of Extratropical Cyclone Klaus

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Abstract: On 24 January 2009 southern France and northern Spain were affected by a severe windstorm associated with extratropical cyclone Klaus. This paper investigates the role played by Azores high in developing of extratropical cyclone Klaus. The 6-hour and daily NCEP/NCAR reanalysis data composites for meteorological elements (surface pressure, sea surface temperature, surface wind, surface relative humidity, and geopotential height and wind fields at 500 mb level) over the northern hemisphere for the period of 20-25 January 2009 were used in this study. In addition, satellite images for cyclone Klaus and its damage have been used. The results revealed that, the Azores high pressure system extended strongly and rapidly to the east direction towards the North Africa and it was accompanied with an eastward extension of a deep low pressure system over the northern Atlantic region. The combination of the two opposite pressure systems together over Atlantic Ocean creates a very strong pure westerly air current moving toward the eastward direction. This huge westerly winds set aside the air over the eastern Atlantic region and western European coasts and forced it to sweep and to circulate westward direction and develop cyclonic circulation system which originating in the west of Bay of Biscay, extratropical cyclone Klaus. The development theory and the life cycle of Klaus model are uncovered. Uncover of the life cycle model of cyclone Klaus conduct to a new theory of cyclones development which so called the cyclonic circulation theory. [Journal of American Science 2009;5(5):145-163]. (ISSN: 1545-1003).

Keywords: Azores high; cyclone Klaus; air mass; cyclonic circulation theory

1. Introduction

On the early morning of Friday January 23, a strong low pressure system, extratropical cyclone Klaus was developed over the northern Atlantic region with a minimum central pressure of 1000 mb. On Friday night, it moved eastward across the Bay of Biscay towards southern France bringing damaging winds to the southwest of France and to northern Spain. Klaus landfall strongly crossing southern France and northern Spain and entered the Bordeaux region of France early Saturday morning with a minimum central pressure of 966 mb and intense wind gusts on the order of 150 kph and higher. Surface wind speeds were recorded at 180 kph, and even at 200 kph on the first inland higher ground. These wind speeds correspond to those experienced in Hurricanes Category (III) according to the (Safir-Sampson) scale of hurricane intensity. The storm swept in from the Atlantic Ocean and continued to track east causing significant damage across northern Spain and waves as high as 21 meters off of the Basque coast. However, this storm wreaking havoc across the region. Klaus caused the death of 21 people and left a path of heavy destruction stretching

from approximately Bordeaux to the Mediterranean coast and all along northern Spain. Besides expected substantial damages to property, life lines and electricity networks have also been hit hard. Similarly hard hit have also been forests in south-western France, with reported losses of up to 70% of stock in certain areas. An estimated 60 to 70 percent of the pine trees in Lands Forest, one of Europe's largest, had been uprooted. Storm Klaus caused widespread destruction: building damage, power outages, flooding and travel disruption, and the landscape of the Department of Les Landes was changed for perhaps the next hundred years. Recent assessments by catastrophe modeling firms estimate are ranging as high as €5 billion in respect of this storm. However, this storm was weakening in the afternoon of 24 January 2009.

There are several scientific literatures challenges the developing and life cycle of midlatitude cyclones and extratropical marine cyclones e.g. (Bjerknes (1919); Bjerknes and Solberg (1922); Bottger, et al., (1975); Hadlock and Kreitzberg (1988); Shapiro and Keyser (1990); Davies, et al., (1991); Wakimoto et al., (1992);

Neiman and Shapiro (1993); Neiman et al., (1993); Evans et al., (1994); Schultz et al., (1998) Nielsen and Sass (2003)). These literatures were refereed the development and life cycle of cyclones to the models of Norwegian frontal- cyclone model (Bjerknes 1921; Bjerknes and Solberg 1922) and Shapiro-Keyser life cycle model (Shapiro-Keyser 1990) for extratropical marine cyclones. Cyclonic development in midlatitudes was based on the concept of the polar front theory of atmospheric circulation (Bjerknes and Solberg 1922). In one hand, there are valuable researches challenge the field of hurricanes formation and hazards (e.g. Gray (2001); Zebrowski and Judith (2005); Asbury et al., (2006) and Hafez (2008)). In other hand, the effect of the geopotential height anomalies and blocking systems in the upper atmospheric levels upon the European climate studied by (Rex (1950a, 1950b, and 1951); Cohen et al., (2001); Hafez (2007 and 2008)...etc.). However, the present work aims to uncover the role played by Azores high in the developing of extratropical cyclone Klaus.

2. Data and Methodology

The 6-hour and daily NCEP/NCAR reanalysis data composites for meteorological elements (surface pressure, sea surface temperature, surface wind, surface relative humidity, and geopotential height at the 500 mb level) over the northern hemisphere for the period 20 to 25 January 2009 (Kalnay et al., 1996) were used in this study. In addition, satellite images for extratropical cyclone Klaus and its damage were used. Satellite images were obtained from Dundee Satellite Receiving Station and NOAA. In the present work, these datasets were analyzed using the anomalies methodology. The track of the center of the cyclone, labeled with passing dates, UTC times and minimum MSLP's analyzed by HIRLAM-AEMET numerical model, has been used. In addition to that the 6 hours time step air mass RGB composite satellite images through the developing stages in the life cycle of the cyclone Klaus has been analyzed.

3. Results

3.1 Analysis of synoptic situation of extratropical cyclone Klaus

The current study presents the synoptic regime analysis of the development and life cycle of extratropical cyclone Klaus that exited over middle of the North Atlantic Ocean, west of Bay of Biscay, on 23 - 24 January 2009. The available meteorological data sets as mentioned above in the section of data and methodology had been used in this analysis.

Extratropical cyclone Klaus developed as a system with a clear surface pressure signal approximately started on day 23 about 0000 UTC, in the middle of the Atlantic, at position shown in Figure (1), with a minimum mean sea level pressure (MSLP) value of 1000 mb. Rapidly, reaching its explosive development rates as high as 34 mb in 24 hours, and registered maximum surface wind gusts of the order of 200 km/h. This cyclone moved eastward and its track was purely zonal and its speed was markedly high, reaching values above 100 km/h. A minimum surface pressure of about 964 mb at cyclone center took place on day 24 at about 0000 UTC. Figure (1) shows an approximate 6- hour track of the center of the cyclone, labeled with passing dates, UTC times and minimum [Source; High Resolution Limited Area Model, (HIRLAM-AEMET) Spain Agency of Meteorology]. However, the intensity of cyclone Klaus reached the intensity of hurricanes of category (3), according to Safir - Sampson hurricane scale (Zebrowski and Judith (2005)). However, Klaus formation may be is the start point that Atlantic hurricanes invade Western Europe.

Analysis of the wind field at the surface and at 500 mb level illustrates that the flow of air current is completely from west to east (purely zonal flow) over the northern Atlantic region through the period of 23-24 January. Analysis of the geopotential height at 500mb shows that the flow aloft over the northern Atlantic Ocean is completely westerly flow, and the Rossby wave was completely disappears on the synoptic charts over the northern Atlantic region through the period of 23-24 January 2009 see Figure (2). However, Rossby wave zonal phase propagation is always westward relative to the mean zonal flow, furthermore, the Rossby wave phase speed depends inversely on the square of the horizontal wavenumber. Therefore, Rossby waves are dispersive waves whose phase speeds increase rapidly with increasing wavelength, Holton (2004). Absents of Rossby wave stopped the westward motion of the air currents and this leads to increase of the phase speed of the air current to be completely the mean zonal wind flow. In addition to that, the analysis of the mean sea level pressure and geopotential height at 500mb illustrates that, the Azores high pressure system extended strongly and rapidly to the east direction towards the North Africa and it was accompanied with an eastward extension of a deep low pressure system over the northern Atlantic region through the period of 23-24 January 2009 as shown in Figure (2). The combination of the two opposite pressure systems together over Atlantic Ocean creates a very strong pure westerly air current moving towards the eastward direction. This huge westerly winds set aside the air over the eastern Atlantic region and western European coasts to forced to swept and to circulate

westward direction and initiate the cyclonic circulation system which originating in the west of Bay of Biscay, extratropical cyclone Klaus, not only that but also pushing Klaus itself to landfall strongly crossing southern France and northern Spain. Analysis of the 6-day mean anomaly of the geopotential height at 500 mb for the northern hemisphere for January 2009 revealed that there was an outstanding positive anomaly of more than +175 m over Eastern Atlantic region simultaneously with negative anomalies of less than -200 m over North Atlantic Ocean during the six days from 20 to 25 of January 2009 as clear from Figure (3a). In contradicting to that, the analysis of sea surface temperature over the northern Atlantic region shows no any significant variation of SST through that period, also, there were no positive or negative anomalies in SST temperature over this region through that period as shown in Figures (5 and 4a). Meanwhile, it is clear that, from surface relative humidity analysis that there are outstanding positive anomalies in relative humidity over the northern Atlantic Ocean through that period. See Figures (3b and 6). In addition to that, there are remarkable positive anomalies in the surface wind reached (+ 12 m/sec) at the surface, see Figure (4d). The advection of the different types of air mass over the northern Atlantic Ocean through the period 23-24 January 2009 can be noticed in the RGB satellite images (Figure 7). The composite satellite image is obtained by water vapors and infrared channel differences. The infrared channel is used in determining the temperature of satellite-observed surface. For this reason, the RGB is useful for observing the air mass type. Analysis of The 6 hours time step air mass RGB of the develop and life cycle of cyclone Klaus from 0000 UTC on 23 to 1800 UTC on 24 January 2009 shows clearly the development stages, whereas there is a two different air masses, air mass (1) and air mass (2), and fast moving nature of the cyclonic system, and the nearly zonal path that it followed, as it is illustrated in Figure (7).

3.2. The role of Azores high in developing of extratropical cyclone Klaus

The results from the above mentioned synoptic study revealed that, the Azores high pressure system aloft becomes stronger than usual and was extended rapidly to NE direction towards the north Africa at 35° N and supply the north Atlantic region by westerly air current. This high pressure accompanied with an eastward extension of low pressure system over the northern east of Atlantic Ocean at higher latitudes 65° N through the period of 23-24 January 2009, that supply too the north Atlantic region by westerly air current; see Figures (2 and 3a). The combination of the two distinct pressure systems existed over the middle of Atlantic Ocean creates together a very strong purely westerly air

current which moved toward the eastward direction causing of a wind storm. This huge completely westerly air current set aside the air over the eastern Atlantic region to forced to swept and to circulate westward direction and develop the cyclonic circulation system which originating in the west of the Bay of Biscay, extratropical cyclone Klaus, not only that but also pushing Klaus itself to landfall strongly crossing southern France and northern Spain, reaching northern Italy and even the Adriatic Sea with intensity of hurricanes. It is clear from 500 mb level charts that the Rossby wave completely disappears over the northern Atlantic Ocean whereas, the not exist of Rossby wave add eastward wind to the phase air current speed through the two days 23 and 24 January 2009. In addition to that, analysis of the 6-day mean anomaly of the geopotential height at 500 mb for the northern hemisphere for January 2009 shows that there was an outstanding positive anomaly of more than +175 m over eastern Atlantic region near 30° N simultaneously with negative anomalies of less than -200 m over North Atlantic Ocean at higher latitudes near 65° N during the six days from 20 to 25 of January 2009, see Figures (2 and 3a). However, the strong of Azores high and its rapidly movement toward the north eastward direction creates a circulation between mild and humid air mass (1) in the northern Atlantic to the south and the other (mild to cold) and humid air mass (2) in the middle Atlantic region to the north. This circulation of the two different air masses (1 and 2) formed the cyclonic circulation of extratropical cyclone Klaus. Figures (12 and 13) show constructs of the six phases of Klaus development of 6 hour intervals. Throughout six phases starting from phase (I) at 0000 UTC on 23 January 2009 ended by phase (VI) at 0600 UTC on 24 January 2009, the life cycle of cyclone Klaus has been occurred. Phase (I) is the initiation stage of Klaus, whereas, there were two different air masses (1 and 2) in the north Atlantic region, air mass (1) in the north meanwhile second air mass was in the south of it. See Figure (7a). Phase (II) is considered as the first circulation stage between the two air masses. At this stage, the air mass (2) jumped to the north and second air mass circulated to the west. See Figure (7b). Phase (III) represented second circulation stage; through it the air mass (2) moved to the westward direction and circulated toward air mass (1). Meanwhile the first air mass (I) was continued to circulate southward direction. See Figure (7c). Phase (IV) is the phase of developing of the cyclone, whereas, the two air masses touch each other and started to circulate together. See Figures (7d and 9a). Phase (V) is the cyclonic phase, through this stage the air mass (2) moved faster to the North West direction and going into the air mass (I). Simultaneously air mass (1) moved to the south east direction and all of them becomes a one moving system

and create a cyclonic circulation. Figure (7e) shows the cyclonic circulation of the two air masses. The last phase is the other explosive phase at which the two air masses become circulated faster inside each with a cyclonic circulation. Through this stage, the eye of cyclone Klaus formed. See Figures (7f and 9b). However, the source of the developing of this cyclone was the huge westerly zonal air current aloft over the North Atlantic Ocean which mainly due to the strong and rapidly north east extension of the Azores high. See Figures (4c and 8).

Certainly, the life cycle model of cyclone Klaus is investigated through the present work. This Model is innovated as a result of the analysis of the air mass RGB satellite maps, wind field distribution and a satellite perspective of cyclone Klaus evaluation over the northern Atlantic region respectively, through the period of 0000 UTC on 23 to 1800 UTC on 24 January 2009; see Figures (7, 8, 9, 12 and 13). Whereas, the results

revealed that the developing and life cycle model of Klaus, is a unique model which completely differ than both of Norwegian frontal- cyclone model (Bjerknes 1921; Bjerknes and Solberg 1922) and Shapiro-Keyser life cycle model (Shapiro-Keyser 1990) for extratropical marine cyclones. These two models for midlatitude cyclones development and life cycle had a principle concept of their development on the polar front theory of atmospheric circulation by (Bjerknes and Solberg 1922), see Figures (10 and 11) respectively. Meanwhile, Figures (12 and 13) illustrates the six phases of Klaus development theory from incipient phase, phase (I), to its explosive phase, Phase (VI) which called as; the cyclonic circulation theory. According to this theory, the cyclone developed as a result of the circulation between two different air masses (not from the conversions of the two different air masses in a front like the polar front theory by Bjerknes and Solberg (1922)).

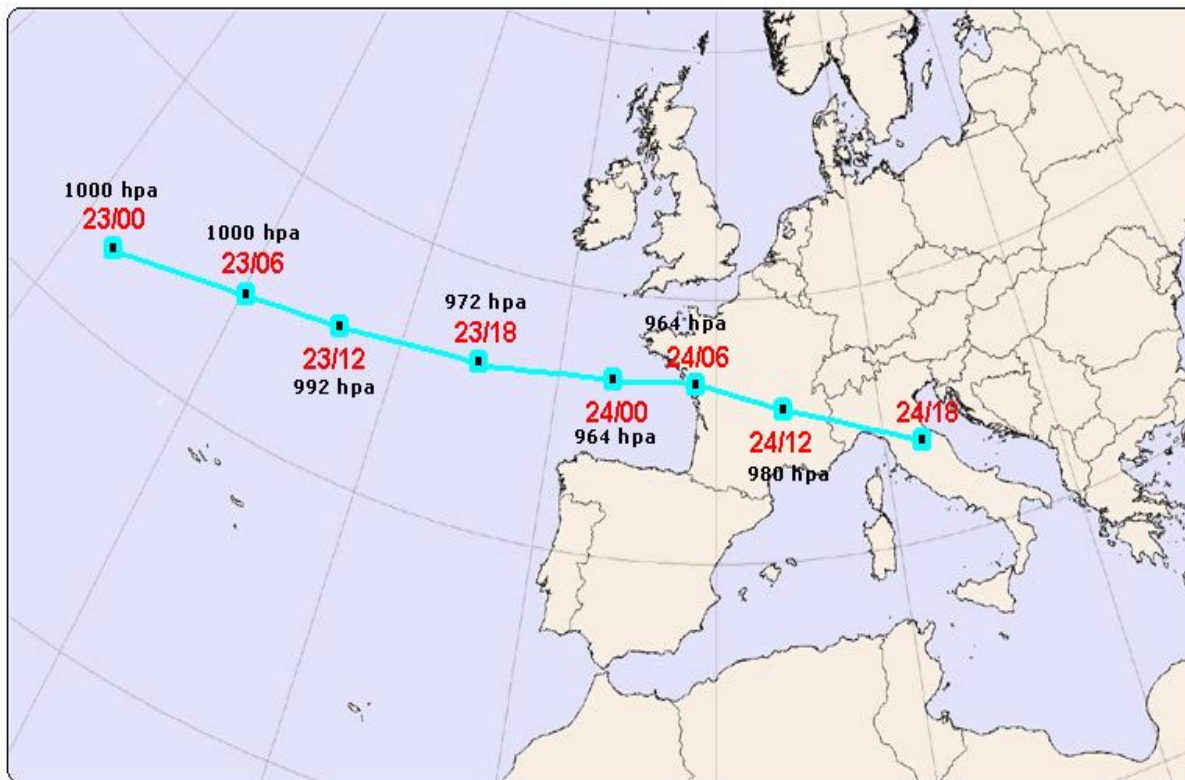


Figure 1: An approximate 6 hour track of the center of extratropical cyclone Klaus, labeled with passing dates, UTC times and minimum MSLP's analyzed by HIRLAM-AEMET numerical model. [Source; High Resolution Limited Area Model, (HIRLAM-AEMET) Spain Agency of Meteorology].

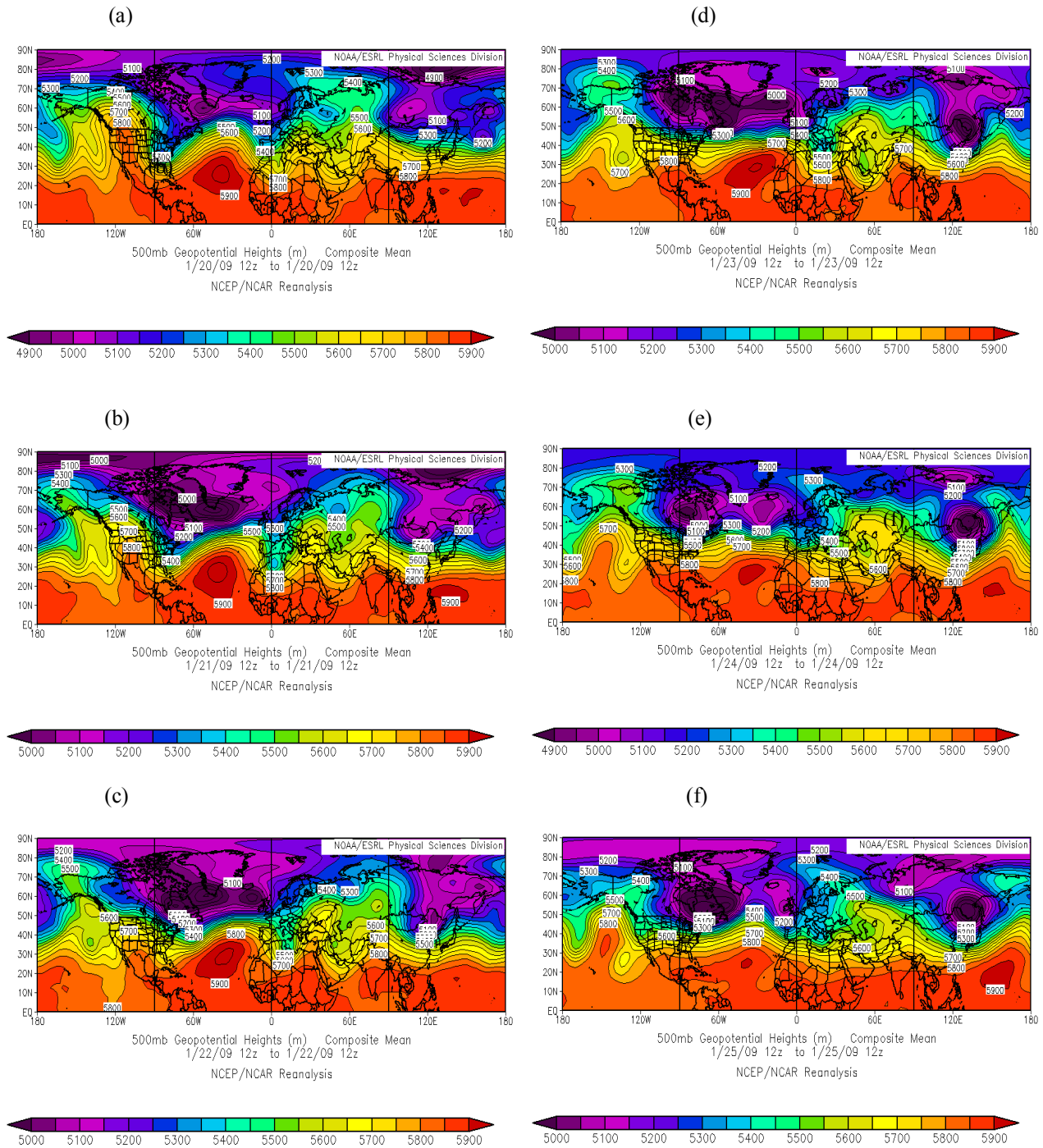


Figure 2: The daily mean of geopotential height (m) at level 500 mb for 1200 UTC over the northern hemisphere through the six days from 20 to 25 January 2009, (a, b, c, d, e, and f, respectively).

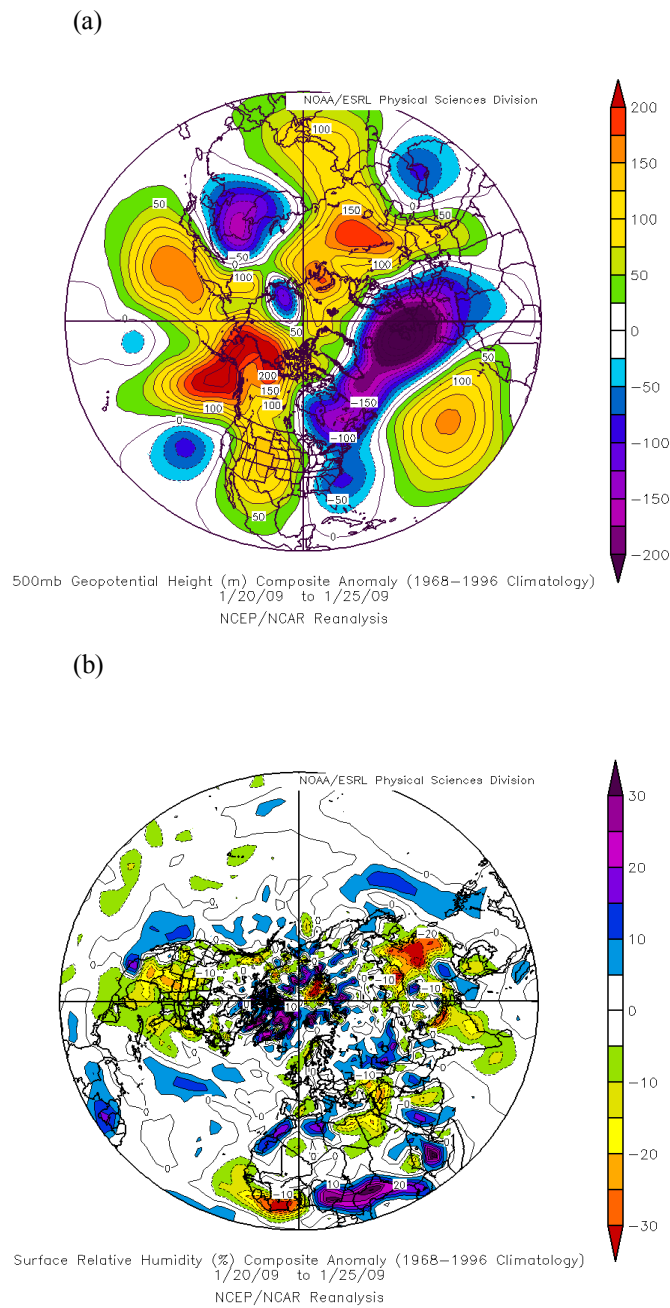


Figure 3: The six days mean composite anomaly over the northern hemisphere through the days from 20 to 25 January 2009. (a) for 500 mb geopotential height (m), and (b) for surface relative humidity.

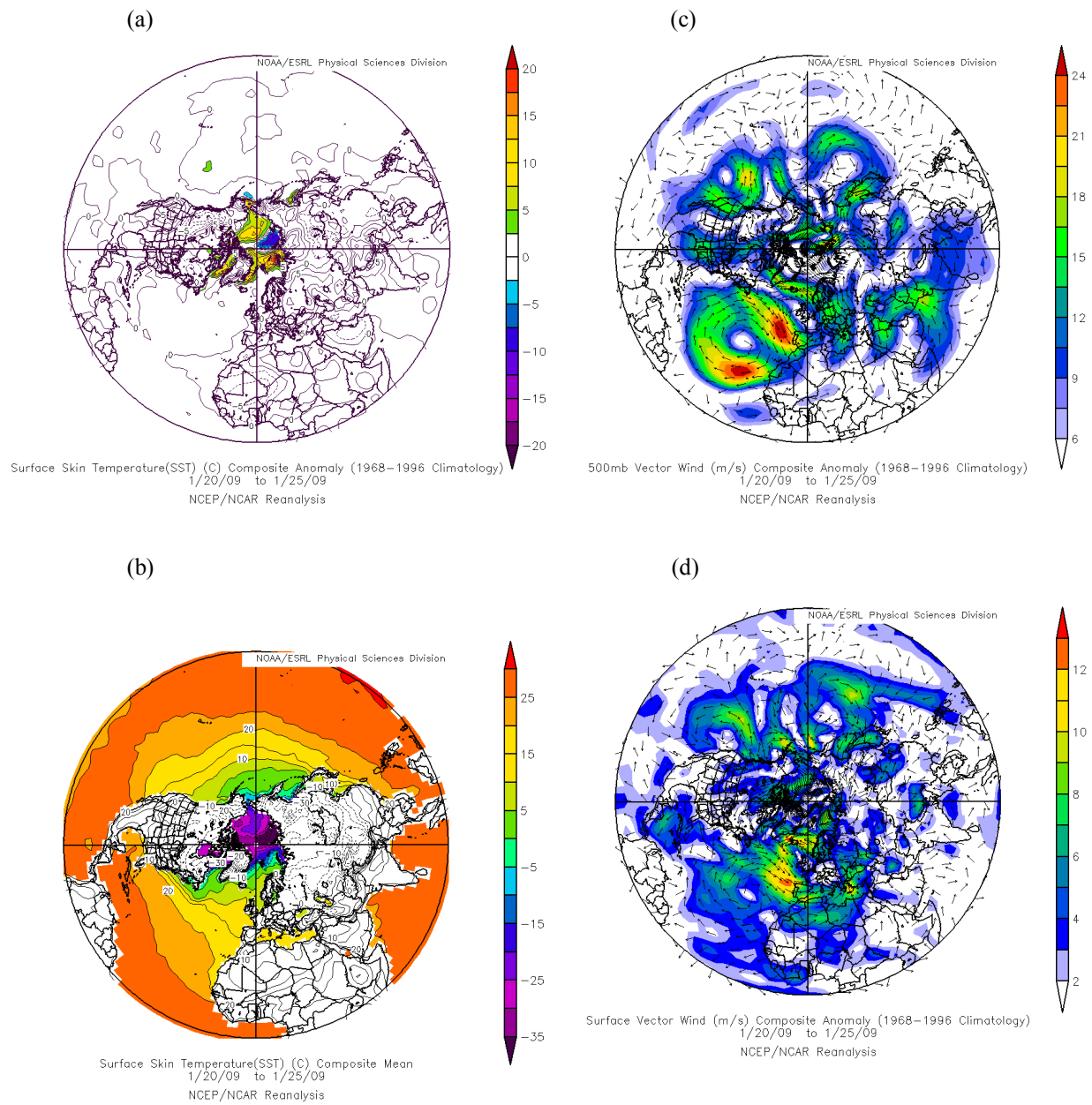


Figure 4: The six days mean composite over the northern hemisphere through the days from 20 to 25 January 2009. (a) for surface air temperature anomaly, (b) for surface air temperature, (c) for surface wind anomaly, and (d) for surface wind.

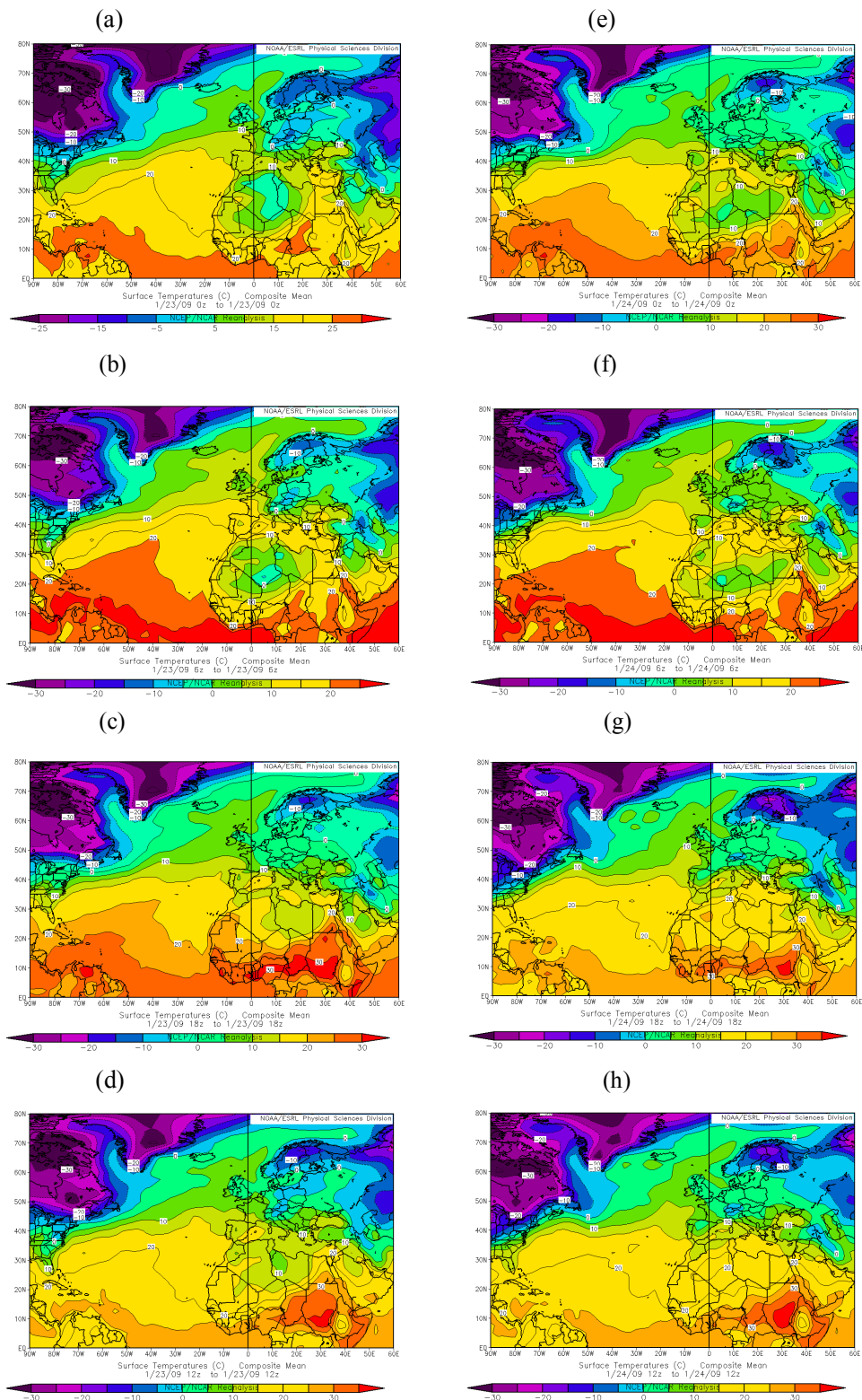


Figure 5: The 6 hour mean surface air temperature (°C) composite mean over the north Atlantic region through the period 23-24 January 2009.

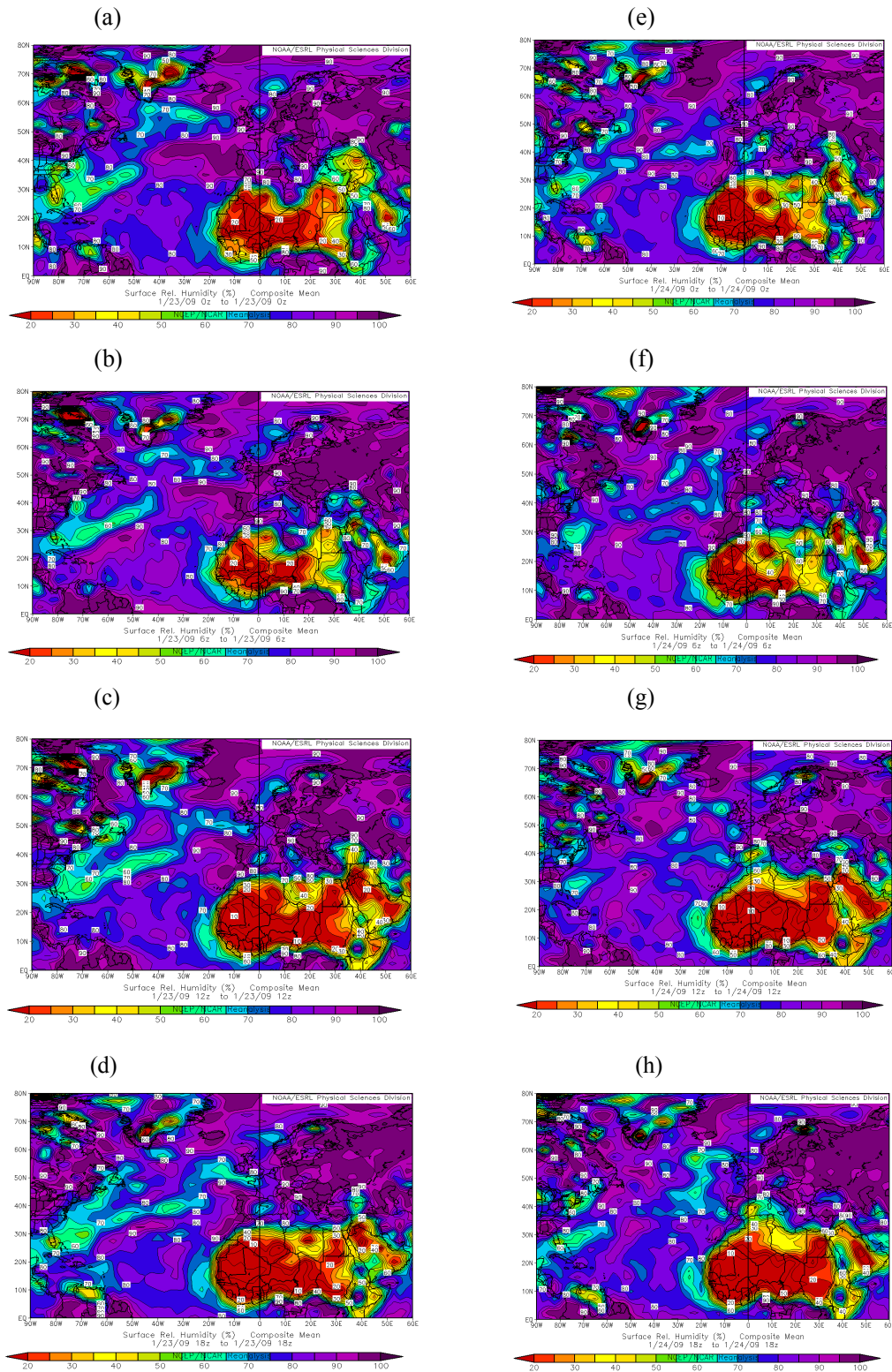


Figure 6: The 6 hour surface relative humidity (%) composite mean over the north Atlantic region through the period 23-24 January 2009.

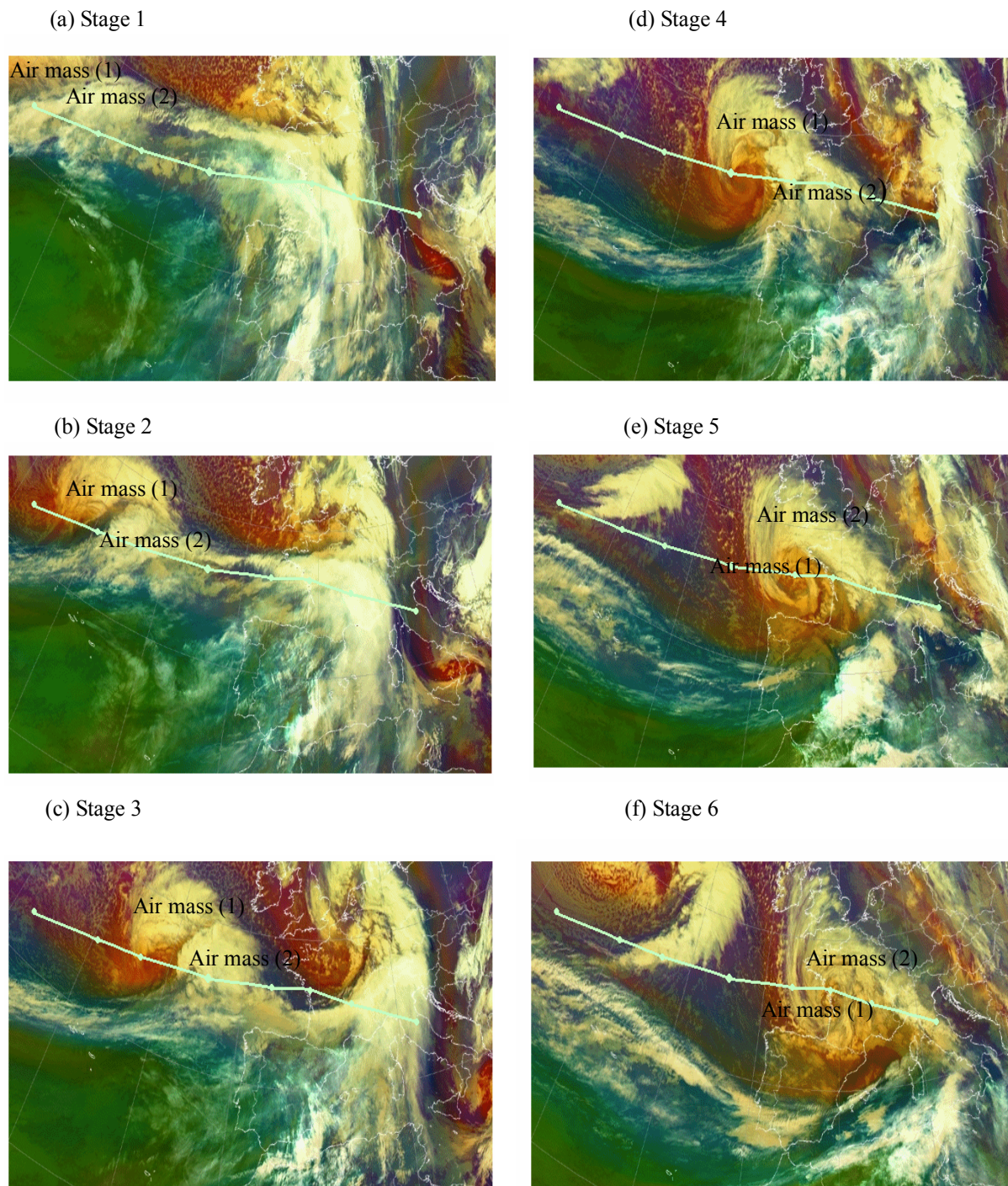


Figure 7: The 6 hours time step air mass RGB composites satellite images show clearly the developing stages in the life cycle, type of two air masses of the system, and the nearly zonal path of extratropical cyclone Klaus.

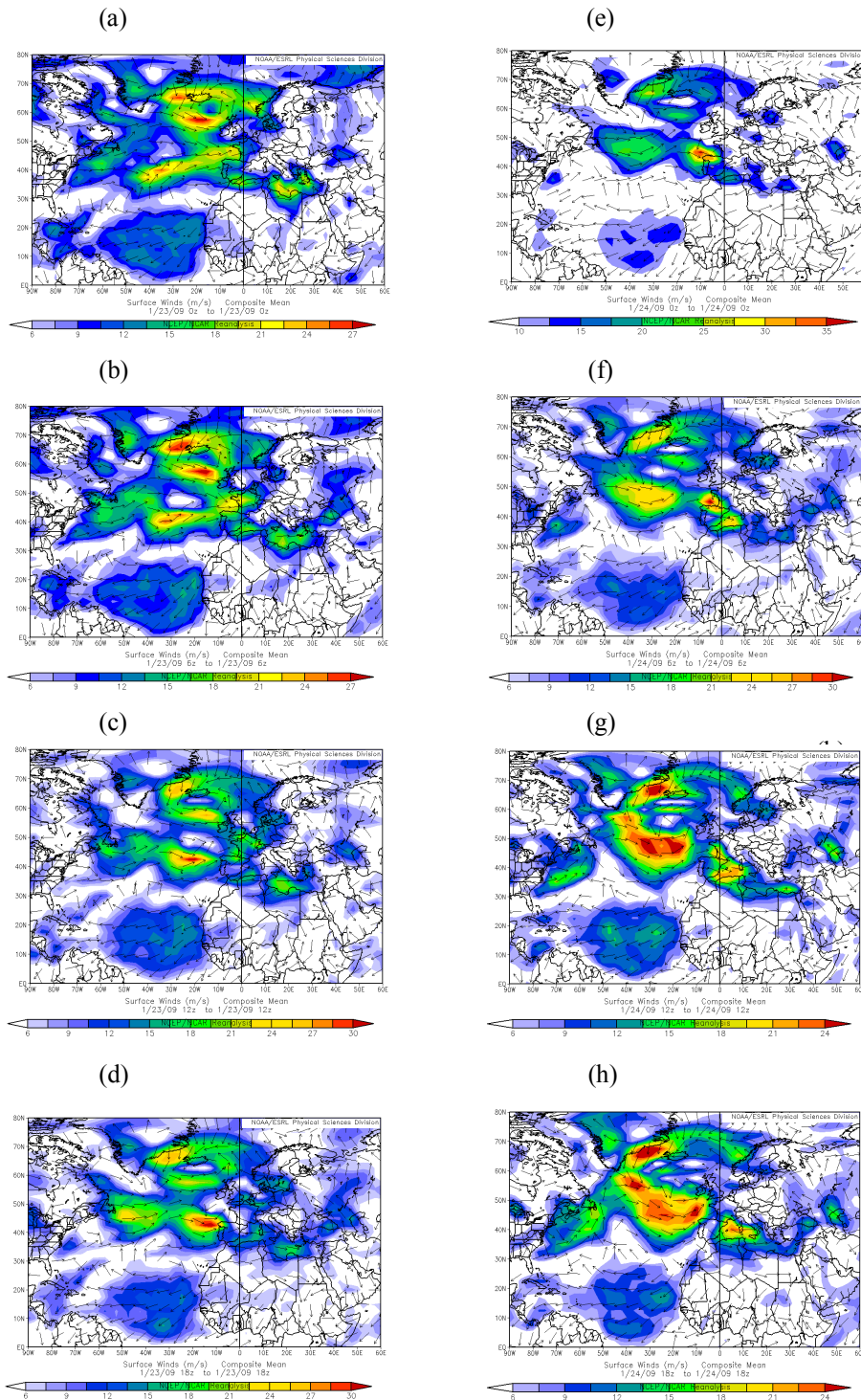


Figure 8: The 6 hour surface wind (m/s) composite mean over the north Atlantic region through the period 23-24 January 2009.

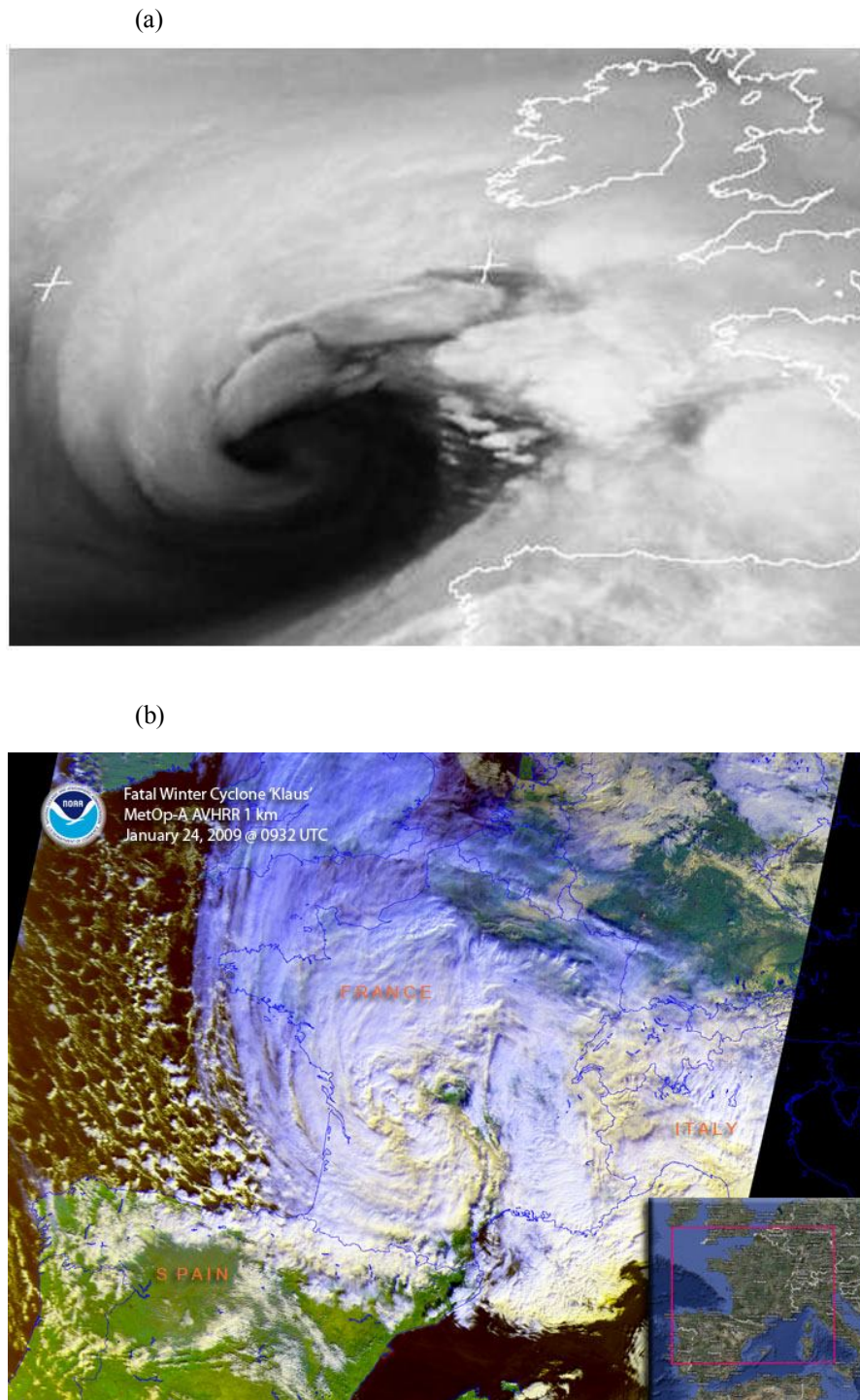


Figure 9: (a) Extratropical cyclone Klaus at 1800 UTC on 23 January 2009 as represented in satellite imagery (Source: Dundee Satellite Receiving Station and NOAA), and (b) Satellite image showing the location of Klaus over France and northern Spain at 0932 UTC 24 January 2009. (Source: MetOp-A AVHRR 1 Km, NOAA).

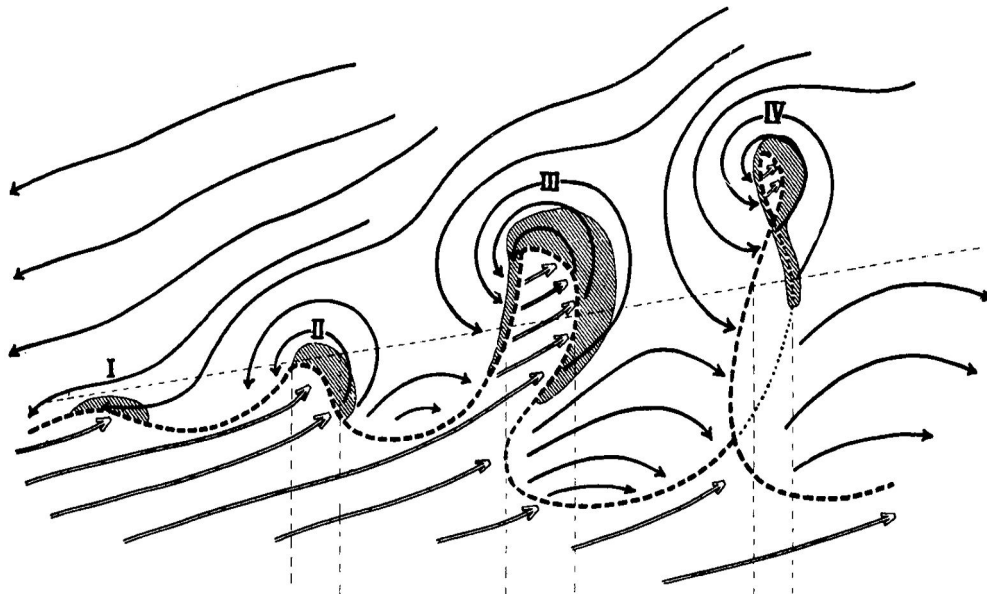


Figure 10: The Norwegian frontal-cyclone model (Bjerknes 1921; Bjerknes and Solberg 1922) describing the amplification of a frontal wave from initiation (I), through cyclogenesis, (II, III), to frontal occlusion (IV). (Neiman and Shapiro, 1993)

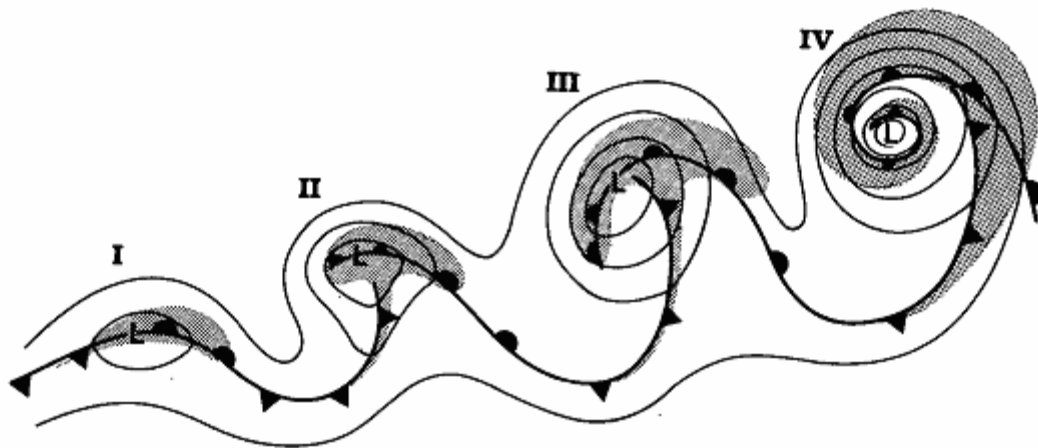
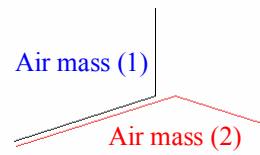


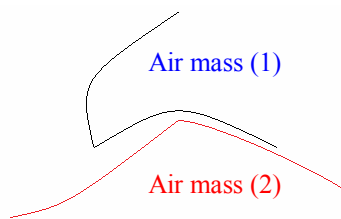
Figure 11: An alternative model of frontal-cyclone evolution (Shapiro, and Keyser, 1990): incipient broad-baroclinic phase (I), frontal fracture (II), bent-back front and frontal T-bone (III), and warm-core frontal seclusion (IV). Sea level pressure, fronts and cloud signature. (Neiman and Shapiro, 1993).

PHASE (I): At 0000UTC 23 January 2009

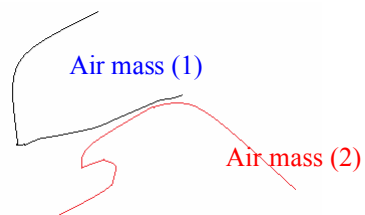


PHASE (II): At 0600UTC 23 January 2009

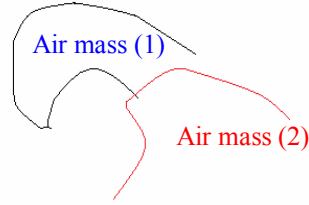
NORTH



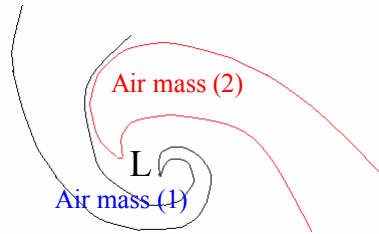
PHASE (III): At 1200UTC 23 January 2009



PHASE (IV): At 1800UTC 23 January 2009



PHASE (V): At 0000UTC 24 January 2009



PHASE (VI): At 0600UTC 24 January 2009

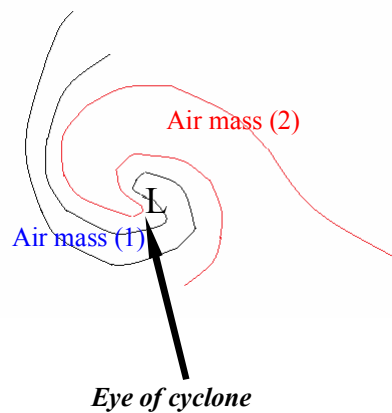
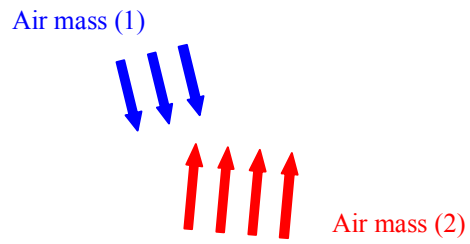
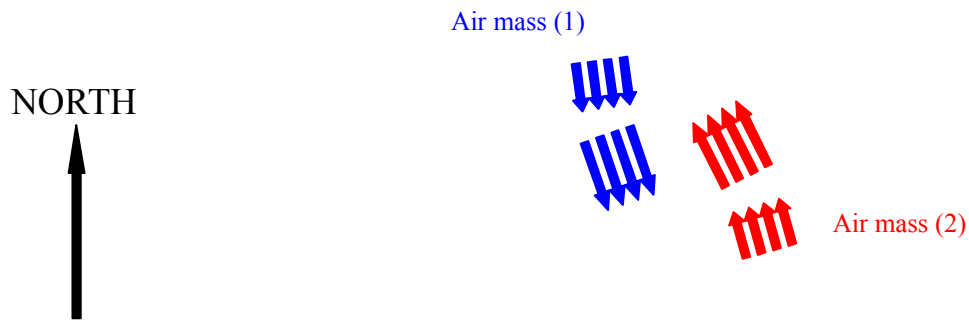


Figure 12: The six development phases and the life cycle model of extratropical cyclone Klaus (the development building upon the air masses). [The cyclonic circulation theory]

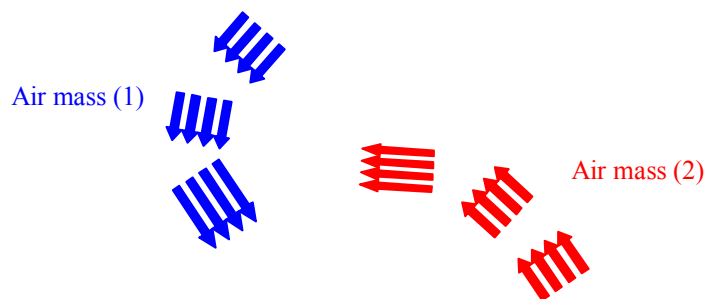
PHASE (I): At 0000UTC 23 January 2009



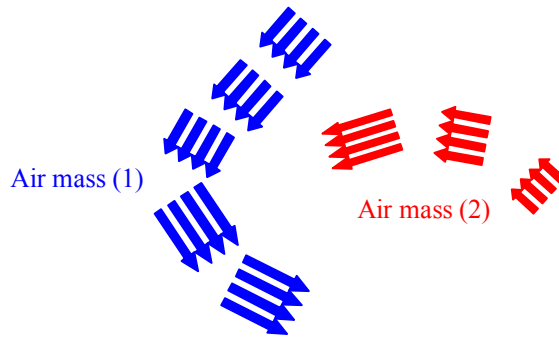
PHASE (II): At 0600UTC 23 January 2009



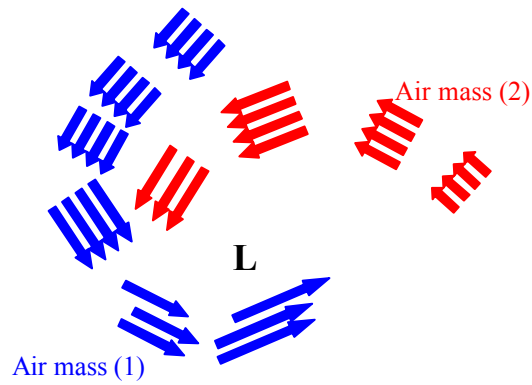
PHASE (III): At 1200UTC 23 January 2009



PHASE (IV): At 1800UTC 23 January 2009



PHASE (V): At 0000UTC 24 January, 2009



PHASE (VI): At 0600UTC 24 January 2009

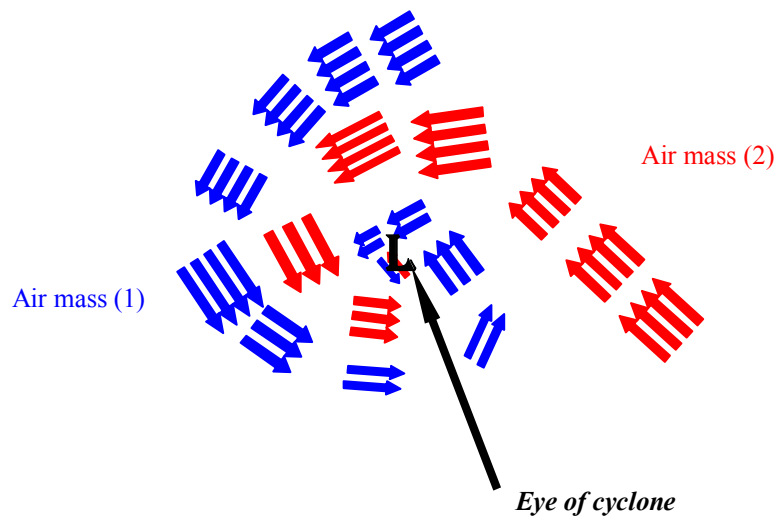


Figure 13: The six development phases and the life cycle model of extratropical cyclone Klaus (the development building upon the circulation of wind field (arrows)). [The cyclonic circulation theory]

4. Conclusions

On 23-24 January 2009, southern France and northwestern Spain were subjected to hurricane-force winds over the weekend, leaving a trail of destruction and disruption. The strong winds, combined with heavy rain, were the result of a deep low pressure system of extratropical cyclone Klaus. At least 23 people were killed during the passage of this storm which caused damage from the Dordogne area to the Pyrenees. Klaus moved across the Bay of Biscay on 23 January and into the Bordeaux region of France on 24 January, bringing powerful winds and torrential rain to southern France and northwestern Spain. Wind gusts of around 160 kmph were recorded in various locations across the region (with gusts reaching 184 kmph in the eastern Pyrenees near Perpignan). Klaus continued to track eastwards across southern France before moving into the Mediterranean Sea. Hundreds of thousands of trees had been flattened by the storm in the Gironde and Landes departments. The Landes forest is reported to have sustained severe damage while the Gironde region in southwestern France has also seen vast forest areas flattened by the storm. The synoptic analysis of the situation over the Atlantic Ocean and the northern hemisphere using of the available meteorological data and using of anomalies methodology was done. The role played of Azores high on the formation of Klaus had been studied. Through the present work there are remarkable results had been achieved.

1. The results revealed that the strong and north eastward movement of the Azores high through the period 23-24 January 2009 causing of a huge westerly air current over the middle of the northern Atlantic region. This huge completely westerly air current set aside the air over the eastern Atlantic region to forced to swept and to circulate westward direction and made the cyclonic circulation that develop extratropical cyclone Klaus.

2. The 6-day mean anomaly analysis of the geopotential height at 500 mb for the northern hemisphere for January 2009 shows that there was an outstanding positive anomaly of more than +175 m over eastern Atlantic region near 30° N simultaneously with negative anomalies of less than -200 m over North Atlantic Ocean at higher latitudes near 65° N during the six days from 20 to 25 of January 2009.

3. Anyalysis of the 6 hour geopotential height and wind fields for 500 mb level appears that the Rossby wave was completely absents over the north Atlantic region through the period of 23-24 January 2009, whereas this absence of Rossby wave push the westerly phase speed, over the north Atlantic region, eastward toward western Europe by the eliminates of westward wind speed of Rossby wave, which also leads to the strong wind storm.

4. The analysis of the 6 hours time step air mass RGB satellite images, wind field distribution, and a satellite

perspective of cyclone Klaus evaluation over the northern Atlantic region through the period of 0000 UTC on 23 to 1800 UTC on 24 January 2009 leads to uncover the development six phases of extratropical cyclone Klaus and to construct its life cycle model.

5. The life cycle model of Klaus is a unique model which completely differs than both of Norwegian frontal- cyclone model (Bjerknes 1921; Bjerknes and Solberg 1922) and Shapiro-Keyser life cycle model (Shapiro-Keyser 1990) for extratropical marine cyclones.

6. Knowing of the life cycle model of Klaus is conduct to innovate a new theory of cyclonic formation is so called; the cyclonic circulation theory.

7. According to the cyclonic circulation theory, the cyclone is develop as a result of the circulation between two different air masses, through a six phases from incipient phase , phase (I), to its explosive phase, phase (IV). See Figures (12 and 13). However, there is no a front between the two air masses or a warm sector existed here.

Finally, one can conclude that the Azores high pressure system played a great role in the developing of the extratropical cyclone Klaus on 23-24 January 2009 over the middle of the northern Atlantic Ocean, west of the Bay of Biscay, by supporting the north Atlantic with a strong westerly air current and swept the air over the eastern north Atlantic Ocean and western Europe to move toward the westward direction and creates the cyclonic circulation over the east of the northern Atlantic region. After a one hundred years since the polar front theory made by Bjerknes, (1919, 1921 and 1922), there is another theory of midlatitude cyclonic formation, the cyclonic circulation theory. The analysis of the development stages of extratropical cyclone Klaus is considered as the practical application which leads to this theory.

Acknowledgment:

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Persistent Organic Pollutants (POPs) in Sea food of China- A review

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Abstract: The coastal zone of China has been undergoing rapid economic growth in the past few years. Large quantities of persistent organic pesticides have been either used in agriculture and public health or released from manufacturing plants in this region. Weak environmental management framework has over the years permitted improper waste disposal use and disposal of pesticides have caused serious environmental problems. This paper attempts to review the state of sea food contamination and evaluate its risk to consumers in China using recent research data. The daily intake of Organochlorine pesticides (OCPs) and Polychlorinated biphenyles (PCBs) ingested by people living in coastal cities in China through fish and shellfish was also estimated. Risk assessment against various standards showed that seafood products have been contaminated by Dichlorodiphenyltrichloroethane (DDTs) and may pose health threat to local residents and the consumers due to the fact that China has been a major producer and consumer of DDTs in the past, and also uses DDT for vector control, resulting in higher background levels of DDTs in different ecological compartments. It is recommended to impose a tighter control on the use of DDT for vector control as well as for agricultural application, conduct regular monitoring of DDT concentrations in different ecological compartments. However, most research in coastal area is limited to a few kinds of POP compounds. [Journal of American Science 2009; 5(5):164-174]. (ISSN: 1545-1003).

Key words: POPs, Risk Assessment, Coastal Zone

1. Introduction

Organochlorinated substances are listed as Persistent Organic Pesticides (POPs) by the United Nations Environment Program (UNEP) in the 1995 Stockholm Convention. Twelve POPs were identified of which, nine are pesticides (aldrin, endrin, dieldrin, heptachlor, chlordane, mirex, toxaphene, Dichlorodiphenyltrichloroethane (DDT) and hexa chlorobenzene (HCB) (Wei et al. 2007). The other substances are industrial chemical products or byproducts including Hexachlorocyclohexane (HCH), Polychlorinated biphenyles (PCBs) and Polychlorinated dibenzo-p-dioxins and furans. Due to their persistence, bioaccumulation, and adverse effects on wildlife and human, production and use of these chemicals were banned in the early 1970s in developed countries (Loganathan and Kannan, 1994).

Large amounts of Organo Chlorine Pesticides (OCPs) were used in past decades to obtain high yield to sustain overpopulation in China. Even after the ban of technical HCH and DDT in 1983, 3200 t of lindane (almost pure γ -HCH) was still in use between 1991 and 2000, and DDT production also

continues due to export demand and dicofol production (Zhang et al. 2002; Qiu et al. 2004; Tao et al. 2005). During past few years, a number of surveys and studies on OCPs and PCBs in various environment phases has been conducted in China (Wu et al. 1999; Zhou et al. 2000; Zhou et al. 2001; Bi et al. 2002; Monirith et al. 2003). The foodstuffs, especially meat, fish and dairy products are important routes of exposure to organic contaminants for human (Yang et al. 2006; Harrison et al. 1996; Dougherty et al. 2000).

The rapid socio-economic development during the past two decades in China, especially the coastal area has given rise to severe economic, environmental and health problems (Wong et al. 2005). According to Wong et al. (2005) and National Implementation Plan (2007), the most pesticide application areas belong to eastern and southern area of China. Many investigation reports have been documented that these contaminants might be transported widely through aquatic environment. Fisheries and Aquaculture activities have been successfully done along the coastal zone of P.R.China. China has been the world's largest producer and exporter of fishery products since

2002(Guo et al. 2007). Fish and shellfish are important food for supplying essential trace elements and certain vitamins; moreover, the polyunsaturated *n*-3 fatty acids in fatty fish species are biologically important and have been associated with a decreased risk for cardiovascular disease (Svensson et al. 1995; Kromhout et al. 1985). This is more important in China, where human dietary habits are changing and widening with the ongoing rapid economic development and changing facets in life-styles. While consumption of grains and vegetables decreased from 1989 to 1997, consumption of meat, fish and dairy products increased during this period. In 1997, consumption of meat, fish and dairy products accounted for about 21% of foodstuffs consumed by Chinese and fish consumption was an important portion of them (Du et al. 2004). Given the importance of China's seafood products to the human health, information regarding the state of OCPs and PCBs contamination in seafood products is needed in order to evaluate risk of exposure to the contaminants

on consumers. Therefore, this paper attempts to review the production, exploitation of pesticidal POPs and PCBs in China and the distribution and the fate of them in marine matrix based on recent research findings in coastal zone in China with emphasis on potential human health risk related to sea food consumption.

2. Production and Exploitation of POPs in China

Being one of the largest agricultural production countries, China has been a major producer and consumer of organochlorine pesticides, until their ban on production and agricultural use were enforced (Yang et al. 2004). In China ten pesticidal POPs were recorded. Seven of them were DDT, HCH, toxaphene, hexachlorbenzene (HCB), chlordane, heptachlor and mirex and they were produced at an industrial scale, and the other three (aldrin, dieldrin and endrin) were produced, only at a pilot plant level, or in research phase during 1950s to 1980s.

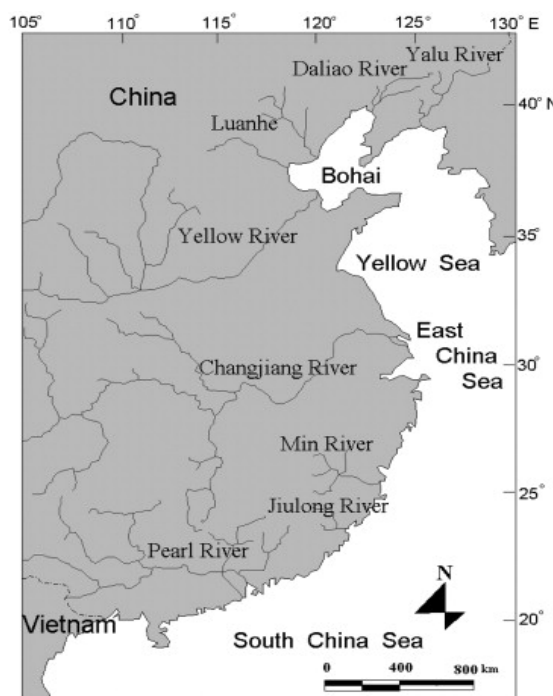


Figure 1. The map showing the coastal zone in China

2.1 Dichlorodiphenyl trichloroethane (DDTs)

The Organochlorine Pesticide DDT was one of the first synthetic chemicals to be produced in large quantities in China for the purpose of agricultural and disease vector control and dispersed widely in the

environment (Li et al., 2005). It was first produced and mainly used in agriculture in 1951 (Wong et al. 2002) for controlling army worm, ball worm, pink ball worm, apple tortrix moth, greenish brown hawk moth on wheat, maize, cotton, orchard, soybean and sorghum (Cai et al. 1992).

The total production of commercial DDT was more than 430 kilo tons (Wong et al. 2002) until its agricultural use was banned in 1983 (Cheng, 1990). Before the ban, China was the third largest consumer of DDT for agricultural purposes (Figure 2) after US and Former Soviet Union and fifth consumer country for overall usage of the chemical (Figure 3). The importation of DDT has also been banned in China since 1994 (Wei et al. 2007). Since 1995, the output of technical grade DDT in China has been maintained at the level of 5,000 - 6,000 tons/year, and the output in 2004 was 3,945 tons (NIP, 2007). However, there remain only two enterprises producing technical grade DDT and one enterprise producing DDT preparations.

Small amount of DDT currently produce in China under the exemption of Stockholm Convention is to use as the intermediate in dicofol production, to export for disease vector control in the tropical regions where malaria breaks out heavily such as Southeast Asia and Africa, and to use in antifouling paint.

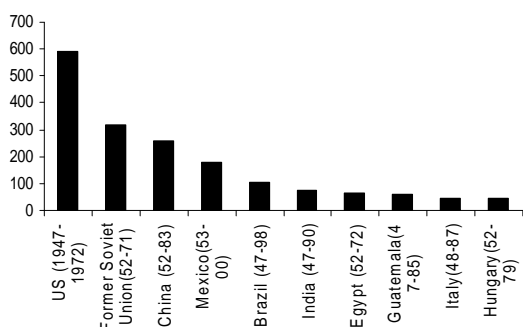


Figure 2. The top 10 countries with historical highest DDT use in agriculture (Source: Li, 2003a, 2003b)

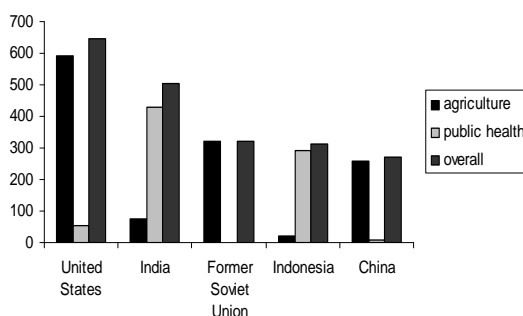


Figure 3. Top 5 countries for overall DDT use (Source: Li et al. 2004)

2.2 Hexachlorohexane (HCHs)

The Organochlorine Pesticide HCH has two formulations as technical hexachlorocyclohexane (HCH) and lindane. Technical-grade HCH consists principally of five isomers, α -HCH (60–70%), β -HCH (5–12%), γ -HCH (10–15%), δ -HCH (6–10%) and ϵ -HCH (3–4%) (Walker et al.1999).

China has consumed the highest amount of technical HCH (Figure 4), accounting for almost half of the total global usage, followed by India to kill pests on rice, wheat, maize, cotton, soybean, sorghum, orchards and some vegetables. Among them, more than half of HCH was used in rice paddies, 25% on wheat, and 10% on each of soybean/sorghum and maize (Cai et al. 1992). China started to produce and use technical HCH in 1952 and its use was banned in 1983. The total amount of technical HCH produced in China was 4.5 million tons by 1983 (Li et al. 1998b). Although technical HCH is no longer used, applications of lindane continue in many countries including China. The total lindane usage between 1970 and 1993 was 720 kilo tons (Voldner and Li, 1995).

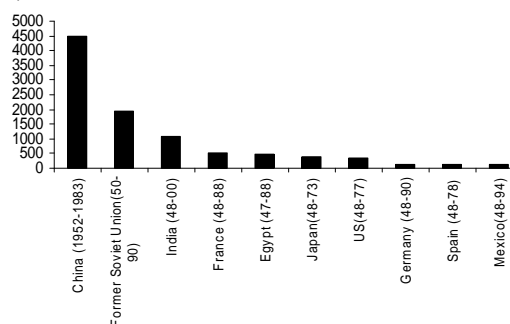


Figure 4. Top 10 countries with highest technical HCH use (Li et al., 1999a, 2004a)

2.3 Chlordane and Mirex

Chlordane and Mirex were used in China due to a lack of highly efficacious and low cost termiticides. China started to produce and use Chlordane in 1950s and the highest production could observe in 1999 accounting 520.6 tons (NIP, 2007). The production of mirex started in 1960s and the highest production could observe in 2000 accounting 31 tons (NIP, 2007).

From 1995 to 2003, about 5000 tons of chlordane and 140 tons of mirex were produced, especially, within 5 years from 1997 to 2001, 2300 tons of chlordane and 14 tons of mirex was used in China (WB, 2005). Most of these pesticides may have been used in the south and south east China, as most of termites severely affected areas belong to these areas.

2.4 Hexachlorbenzene (HCB)

China began to produce HCB in 1958 and in total there were six enterprises. These enterprises used HCHs to produce HCBs and lindane. Due to control of HCH production, the production of HCB was reduced drastically. In 1990, the maximum HCB output of the whole country was 7365 tons. Production was reduced year by year after 2000 and completely stopped in 2004 (NIP, 2007). HCB has not been used as a direct pesticide in China, but as an intermediate for the production of other chlorinated substances such as Na-PCP which used to be employed for schistosomiasis prevention and control.

2.5 Toxaphene, heptachlor and other OCPs

Toxaphene was broadly used for cotton pests, fruit trees pests and maize borer prevention (Wei et al. 2007). The production was started in 1970. The highest production was in 1973 accounting 3740 tons (NIP, 2007).

Heptachlor was mainly used for soil pests, controlling termites in railway crossties and vector pests' prevention. The production was started in 1967 and it was stopped in 1982 (UNEP, 2002). The maximum amount used (20 tons) identified between 1967 and 1978. However, these two chemicals have not been produced or consumed because they were banned in 1982. No production carried out for aldrin, dieldrin and endrin at large scale in China, and the research or trial production has been stopped (NIP, 2007).

2.6 Polychlorinated biphenyls (PCB)

Polychlorinated biphenyls (PCBs) are amongst the more dangerous environmental contaminants due to their persistence, bioaccumulative properties and toxicity. PCBs have been used worldwide as plasticizers, hydraulic and dielectric fluids, fire retardants and paint additives (Kennisch, 1996). The production of PCBs oils began in 1965 in China (NIP, 2007). During the 1950's and the 1980's, China used to import PCBs-containing electrical equipment from other countries without being informed, most of

which were specific transformers and capacitors for large facilities. (Jiang et al. 1997) reported that approximately 8000 tons of PCBs were produced under trade name 1 PCB and 2 PCB during period of 1960s–1970s. Most of them were used as dielectric fluids in electrical appliances and a small portion was used as additives in paints. Even today, large proportion of the original amounts of PCBs, still remain in old transformers and capacitors (Jiang et al. 1997). In January 1974, the Chinese government promulgated the decree on stopping production of capacitors with PCBs, as well as the decree on restricting import of electrical equipment containing PCBs.

3. Sources of OCPs and PCBs in Coastal Zone in China

The coastal zone of China comprises an area of more than three million square kilometers covering, four major Seas; Bohai, Yellow, East China and South China Sea (Figure 1). The area possesses an 18000-km coastline stretching across tropical, subtropical and temperate zones (Cao et al. 2007). The coastal zone is an interface between the land and sea, which comprises of a continuum of coastal land, intertidal area, aquatic systems including the network of rivers and estuaries, islands, transitional and intertidal areas, salt marshes, wetlands, and beaches. Fifty seven per cent of China total population comprise in East, Central and South China (NIP, 2007). Rapid industrialization, urbanization, and conversion of massive agricultural lands to commercial use have accelerated environmental deterioration in coastal region (Guo et al. 2007). Large amount of electrical waste are being carried from many other places to coastal areas in China (Zhao et al. 2007). Since China has been a major producer of seafood, coastal area consists of considerable amount of boats and they are being used antifouling chemicals. Hence, the major sources of OCPs and PCBs in the coastal zone in China are riverine exports of agricultural chemicals from coastal catchments, high shipping activities, heavy manufacturing effluent discharge, and municipal and industrial sewage disposal practices of low standard, used electrical items and atmospheric deposition.

Once discharged into the ocean, these chemicals disperse into three phases, namely water, sediment and biota (Pandit et al. 2002). These contaminants then accumulate in the sediment-dwelling organisms which may be transferred to higher trophic levels through the food chain (Lee et al. 2001).

4 Contamination levels of sea food in coastal zone

4.1 Increasing trend of DDTs towards Pearl River Delta, South China Sea

Many research activities have been carried out in China to investigate the OCPs in marine organisms (Table 1). The results showed that the fish/shell fish species in Chinese coastal zone is contaminated by OCPs. DDTs were at the top level. A recent report launched in Asian countries revealed that the contents of DDTs in the marine benthos along the coastal areas of China were at the top level (Monirith et al. 2003). The highest DDTs could observe in the South China Sea. Results from (Monirith et al. 2003; Chen et al. 1996, 2000, 2002; Fang et al. 2001; Phillips, 1985; Tanabe et al. 1987) also showed that South China is the most contaminated coastal sea among the major seas in China. There are possible reasons behind this observation. The coastal area of Guangdong province in South China has 60,000 fishing ships, which is above 1/5 of the total number in China. It can be estimated that about 30–60 tons of DDT may be introduced to the coastal environment of Guangdong, including the Pearl River Delta. According to Fu et al. 2003, the Pearl River is

believed to carry a considerable load of chlorinated pesticides, up to 863 tones per annum, which is the highest amongst China's rivers. High ratio of DDT/(DDD+DDE) in sediment (Hong et al. 1995; Zhang et al. 2001 ; Mai et al. 2002), as well as water (Zhou et al. 2001; Luo et al. 2004) samples indicated the relatively recent releases of DDT. Previous studies from (Zhang et al. 2002; Luo et al. 2004; Zhou, 2004; Chen et al. 2006) also showed that there were new inputs of DDTs in the PRD. However, comparatively lower level of DDTs found in marine organisms collected from East coast. But the survey of the National Bureau of Coastal Zone Protection during 1980–1987 showed that the organochlorines flux just carried by Yangtze River (the longest river in China) was 239.3 tons per year, which accounted for 19.8% of the total flux by Chinese river catchments into the marine coastal sites. Bohai Sea, Northern China collects pollutants from major rivers namely, Yalu, Daliao, Luanhi and Yellow (Figure 1) and showed comparatively intermediate levels of DDTs among the recent researches. Wu et al. (1999) noted high concentrations of DDTs in the river sediments from Northern China where a factory with high manufacturing capacity of DDT is located.

Table 1. The concentrations of OCPs and PCBs in marine organisms in ng/g (wet weight basis, dry weight basis in parenthesis; Wet weight = 0.16 * Dry weight (Ramesh et al. 1990)) in China.

Coastal region	DDTs	HCHs	CHLs	HCBs	PCBs	Reference
east Xiamen Island, South Eastern China	(75.2 - 2143)	(0.18 - 345)			(n.d. - 234)	Chen et al. (2002)
Minjing Estuary, South Eastern China	(21.5- 2396)	(n.d.-5.07)			(n.d.-6.78)	Chen et al. (2002)
South coast, China	(150–200)					Klumpp et al. (2002)
South China Sea	65.70	< 1.5				Guo et al. (2007)
PRD	(4.1 - 7840)	(10.8)				Guo et al. (2008)
East coast, China	(14.4–640)	(0.17– 9.91)	(0.13– 1.86)		(1.34–13)	Fung et al. (2004)
Bohai Sea	29.40	1.27				Yang et al. (2004)
Dalian, Tianjin and Shanghai	28.9	0.92	0.47	0.38		Yang et al (2006)
northeast coast	(54.8– 2680)	(1.42– 25.5)	(n.d.–2.28)		(3.27– 25.4)	Jin et al., 2008

4.2 Reasons for the different levels of other OCPs and PCBs

The results indicate that the HCHs concentrations were below than concentrations of DDTs. Historically, the usages of technical HCHs were much more (Figure 4) than those of DDTs in China. The discrepancy between the usages of HCHs and

DDTs and their accumulative levels in seafood products may be due to the difference in physicochemical and biochemical properties between HCHs and DDTs, where in HCHs have higher biodegradability and lower lipophilicity compared to DDTs (Guo et al. 2007). The PCB levels in some areas showed high levels while other places had low levels. The physicochemical properties of PCBs vary

widely and depend on the number and position of chlorine atoms in biphenyl rings. Vapor pressure, water solubility and biodegradability decrease with increasing number of chlorine atoms. In contrast, lipophilicity and adsorption capacity show a reverse trend (Loganathan, 1994). Therefore, high levels of PCBs in body tissues explained by accumulation of low chlorinated PCB congeners. PCBs were banned in 1983, yet a large proportion still remains in use at present in older transformers and capacitors. The high assimilative and self-purification capabilities of the estuary against anthropogenic activities and pollution impact via large runoff discharge during wet season and enormous sediment loads might be the major abating factors for high PCBs. However, (Jiang et al. 1997) reported that in the previous decades, only about 8000 tons of PCBs were produced in China. The chlordanes were also observed in marine organisms but the level was low. It was reported that technical chlordane is still being used in China against termites (Xu et al. 2004; Nakata et al. 2005), and trans-chlordane, cis-chlordane, trans-nonachlor are dominant constituents in technical chlordane (Kawano et al. 1988; Kawano et al. 1992; Xu et al. 2004).

4.3 Comparison the OCPs and PCBs in Chinese seafood with different countries

Table 2 summarizes the OCPs and PCBs analyzed in fish/shell fish species in different countries. P.R.China shows the highest DDT value among the sea foods in different countries. The reason behind this statement is high back ground levels in history. A substantial number of studies have focused on the contamination by POP pesticides in different ecological compartments in China, with pesticide residues remaining highly abundant in soils and crops (Wong et al. 2005). These contaminants ultimately reach to coastal environment through water bodies. In contrast, studies on the levels of POPs in the global environment show that emission sources of a number of POPs (including DDT) in the last 20 years have shifted from industrialized countries of Northern Hemisphere to less developing countries in tropical and sub-tropical regions including India and China (Wong et al. 2005). This may be due to the late production ban otherwise DDT is still being used in

agriculture and for the control of disease such as malaria, typhus and cholera (Iwata et al. 1994; Loganathan and Kannan, 1994). But in tropical environment, these POPs compounds biodegrade and volatilize soon due to high temperatures. Therefore, the levels become reduced (Table 2). Hong Kong also shows comparatively high DDT and those values are implying that South China Sea is receiving DDT residues. Li et al. (2006) reported that higher concentrations of HCHs and DDTs in water, sediment, fish, and human breast milk in Hong Kong where no HCHs and DDTs were presently in use. This may due to the dispersion of OCPs in marine matrices and in turn to the uptake of OCPs via aquatic food chain.

The highest PCBs, HCHs, CHLs and HCBs concentrations in Table 2 are in the samples collected from Russia, India, Japan and Malaysia respectively. In the former USSR, technical PCBs mixtures have been used and produced as a dielectric fluid in the manufacture of power capacitors and transformers (Ivanov and Sundell, 1992). Therefore high PCBs level could explain by the presence of local PCB sources. In history, China was the top in use of HCHs. But in the present, the reason for the high level of HCHs in the marine organisms of India may be the usage of certain amount of technical HCHs for public health purposes and on certain food crops after its ban for agriculture in 1983 (Li et al. 1998). The chlordanes had been used largely for termite control until in 1986 in Japan (Loganathan et al. 1993) and high levels in marine organisms implied that they may be still discharged into the marine environment. HCB is not only used as a fungicide, but also generated as a byproduct during the production of agrochemicals and industrial chemicals (Monirith et al. 2003). Furthermore the HCB has been released to the environment by waste incineration (Van-Birgelen, 1998). Those reasons could account to the high levels of HCBs in Malaysia. However, the low residual levels of these pesticides and their low frequency of detection in Chinese coastal environment may be attributed to their relatively low residual levels in coastal environment and in seafood products in China or their relatively low potential for bioaccumulation in the species under consideration.

Table 2. The concentrations of OCPs and PCBs in marine organisms in ng^{-1}g (wet weight basis, dry weight basis in parenthesis; Wet weight = $0.16 * \text{Dry weight}$ (Ramesh et al. 1990)) in different coastal regions in the world.

Country/coastal region	DDTs	HCHs	CHLs	HCBs	PCBs	References
China	240	0.80	3.0	1.3	2.5	Monirith et al. (2003)
Perth (western Australia)	0.2					Sericano et al. (1993)
Taiwan (China)	(0-121)	(0-7)				Ling and Teng (1997)

The marine coastal (USA)	(0.51–27.9)					O'Connor and Beliaeff (1998)
The coast of north Vietnam	(12.0 - 23.3)				(5.1- 25.3)	Nhan et al. (1999)
Taiwan-Machu	(340)					Cheng Han et al. (2000)
Kim-man	(337)					
Coastal water of Thailand	0.05–5.7		0.22–12.0			Boonyatumanond et al. (2002)
Korea entire coast	3.13	0.98	0.62	0.04	3.90	Kim et al. (2002)
Japan	3.5	0.32	6.0	0.08	30	Monirith et al. (2003)
India	4.2	2.0	0.6	0.02	3.8	Monirith et al. (2003)
Black sea coast	<0.12-14			0.364		Ozcok et al. (2007)
Egypt	98.1-629.8					Khalid et al. (2004)

5. Health Risk Assessment

Human epidemiological surveys have been proven that the exposure to chlorinated pesticides make adverse effects on human health (Ribas-Fito et al. 2003 ; Longnecker et al. 2001; Cooper et al. 2004). Table 3 summarizes the acceptable daily intakes of these pesticides issued by some authorities. The results revealed that the DDTs are the predominant contaminant. Most of the studies showed higher levels of DDTs than the Chinese government's first level criterion (10 ng/g) for marine biological quality (GB-18421-2001) (Chen et al. 2002) but conformed to the first level criterion (20 ng/g and 50 ng/g) for HCHs and PCBs respectively. DDT is highly persistent in the environment with a

half life of 2–15 years (USEPA, 1989). In human fatty tissue, the half life of DDT has been reported to be 7–8 years (NACEC, 2001). To assess the human health risk, the estimated daily intakes (EDI) were calculated using the average values per each pollutant and the value for the consumption of fish and seafood in China (30.5 g/person/day) in 1997 (Du et al. 2004). The results (Table 4) reveal that the estimated daily intakes (EDI) for DDTs in South China Sea exceed the maximum admissible DDTs concentration established by the European Union which is more feasible value from the farmer's point of view. Hence, the sea food in South China could consider overloaded with DDTs. However, the exposure levels depend on the lipid content of the fish and on the amount of seafood consumed.

Table 3. The acceptable limit of certain POPs pesticides for humans (ng/g wet weight)

Authority	DDTs	HCHs	PCBs	Reference
Food and Agricultural Organization, World Health Organization	20	8		FAO/WHO (1993)
European Union	50	10		Binelli and Provini, 2003

Table 4. Estimated daily intakes (EDI) of PCBs, DDTs and HCHs through sea food by human (average body wt. 60 kg) in China. $EDI (ng/kg/day) = [daily\ fish\ consumption (g/day)] \times [mean\ OCP\ concentration (ng/g\ wet\ wt.)] / [human\ body\ weight (kg)]$.

Pollutant	Average concentration (ng/g wet wt.)	EDI (ng/kg body wt./day)	ADI (FAO/WHO) (ng/kg body wt./day)
PCBs	China : 2.5	1.27	
DDTs	South China: 65.70 Bohai Sea : 29.40	33.39 14.94	20
HCHs	South China : < 1.5 Bohai Sea : 1.27	0.76 0.64	8

The results confirm that the concentrations of HCHs and PCBs in sea foods are far below to all the maximum admissible limits establish by different authorities. (Nakata et al. 2002) reported that the levels of HCHs in foodstuffs (including aquatic

products) dramatically declined during the last 30 years. Moreover, low residual levels of HCHs suggest that HCHs are no longer an environmentally significant organic contaminant in seafood products from China.

Conclusion

Sea foods in Chinese coastal zone are contaminated with OCPs. Risk assessment against various standards clearly showed that seafood products in South China Sea are contaminated by DDTs and may pose health threat to local residents and the consumers if they totally rely on sea foods as

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Thermodynamic simulation of performance of an endoreversible Dual cycle with variable specific heat ratio of working fluid

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Abstract: An endoreversible Dual heat engine model is established and used to investigate the influence of the variable specific heat ratio of the working fluid on the performance of the cycle. The net work output and thermal efficiency of the cycle are derived and optimized with respect to the specific heat ratio of the working fluid. The results shows that that if compression ratio is less than certain value, the increase of specific heat ratio of the working fluid makes the net work output bigger; on the contrary, if compression ratio exceeds certain value, the increase of specific heat ratio of the working fluid makes the net work output less. The thermal efficiency increases with the increase of specific heat ratio of the working fluid throughout the compression ratio range. One can see that the maximum net work output, the working range of the cycle and the optimal compression ratio corresponding to maximum net work output decrease when specific heat ratio of the working fluid increases. However, the effects of the specific heat ratio of the working fluid on the performance of the cycle are obvious and they should be considered in practice cycle analysis. The results obtained in this paper may provide guidance for the performance evaluation and improvement of real reciprocating heat engines. [Journal of American Science 2009;5(5):175-180]. (ISSN: 1545-1003).

Key words: Finite time thermodynamics; Dual cycle; Variable specific heat ratio; Performance analysis

1. Introduction

Traditional thermodynamics is a theory about equilibrium states and about limits on process variables for transformations from one equilibrium state to another. In order to obtain more realistic limits to the performance of real processes, thermodynamics is extended to finite-time thermodynamics to deal with processes which have explicit time or rate dependencies (Bejan 1996; Aragon-Gonzalez et al. 2006; Zhao and Chen, 2006; Parlak et al., 2008). Thus, significant achievements have ensued since finite-time thermodynamics was developed in order to analyze and optimize the performances of real heat-engines (Chen et al., 1998; Aragon-Gonzalez et al., 2000; Chen et al., 2004). Blank and Wu (1994) analyzed the effect of combustion on the performance of an endoreversible dual cycle. Lin et al. (1999) derived the relations between the net power and the efficiency for the Dual cycle with due consideration of the heat-transfer losses. Wang et al. (2002) modeled Dual cycle with friction-like term loss during a finite time and studied the effect of friction-like term loss on cycle performance. Sahin et al. (2002a, 2002b) optimized the performance of a new combined power cycle based on power density analysis of the dual cycle and made a comparative performance analysis of an endoreversible dual cycle

under a maximum ecological function and maximum power conditions. Hou (2004) studied the effect of heat transfer through a cylinder wall on the performance of the dual cycle. Chen et al. (2004) determined the characteristics of net work and efficiency for Dual cycle with heat transfers and friction losses. It is found that there are optimal values of the cut-off ratio at which the net work output and efficiency attain their maxima. Parlak et al. (2004) optimized the performance of an irreversible Dual cycle: the predicted behavior was corroborated by experimental results. Ust et al. (2005) performed an ecological performance analysis for an irreversible Dual cycle by employing the new thermo-ecological criterion as the objective function. Parlak et al. (2005) optimized the performance of irreversible Dual cycle, gave the experimental results, and compared the performance of Dual and Diesel cycles under the maximum power output. Parlak and Sahin (2006) defined the internal irreversibility by using entropy production, and analyzed the effect of the internal irreversibility on the performance of irreversible Dual cycle. Zhao et al. (2007) defined the internal irreversibility by using compression and expansion efficiencies and analyzed the performance of Dual cycle. The above work was done without considering the variable specific heats of working fluid,

so Ghatak and Chakraborty (2007) and Chen et al. (2006) analyzed the effect of variable specific heats and heat transfer loss on the performance of the dual cycle when variable specific heats of working fluid are linear functions of its temperature. Furthermore, Ge et al. (2009) analyzed the performance of an air standard Dual cycle with nonlinear relation between the specific heats of working fluid and its temperature, by using finite-time thermodynamics.

All of the above mentioned research, the specific heats at constant pressure and volume of working fluid are assumed to be constants or functions of temperature alone and have the linear and or the non-linear forms. But when calculating the chemical heat released in combustion at each instant of time for internal combustion engine, the specific heat ratio is generally modeled as a linear function of mean charge temperature (Gatowski et al., 1984; Ebrahimi, 2006). The model has been widely used and the phenomena that it takes into account are well known (Klein, 2004). However, since the specific heat ratio has a great influence on the heat release peak and on the shape of the heat release curve (Brunt, 1998), many researchers have elaborated different mathematical equations to describe the dependence of specific heat ratio from temperature (Gatowski et al., 1984; Brunt, 1998; Egnell, 1998; Klein, 2004; Klein and Erikson, 2004; Ceviz and Kaymaz, 2005). It should be mentioned here that the most important thermodynamic property used in the heat release calculations for engines is the specific heat ratio (Ceviz and Kaymaz, 2005). So, Ebrahimi (2009) modeled the dual cycle with considerations the variable specific heat ratio during a finite time and only studied the effect of cut-off ratio on cycle performance. Therefore, the objective of this study is to examine the effect of variable specific heat ratio on the net work output and the thermal efficiency of air standard Dual cycle.

2. Thermodynamic analysis

The temperature entropy diagram of a Dual heat engine is shown in figure 1. The compression process is an isentropic process (1 → 2); the heat additions are an isochoric process (2 → 3) and an isobaric process (3 → 4); the expansion process is an isentropic process (4 → 5) and the heat rejection is an isochoric process (5 → 1).

As mentioned above, it can be supposed that the specific heat ratio of the working fluid is function of

temperature alone and has the following linear form:

$$\gamma = \gamma_o - k_1 T \quad (1)$$

where γ is the specific heat ratio and T is the absolute temperature. γ_o and k_1 are constants.

The heat added to the working fluid, during processes (2 → 3) and (3 → 4) is

$$Q_{in} = \int_{T_2}^{T_3} c_v dT + \int_{T_3}^{T_4} c_p dT = \int_{T_2}^{T_3} \left(\frac{R_{air}}{\gamma_o - k_1 T - 1} \right) dT + \int_{T_3}^{T_4} \left(\frac{R_{air}(\gamma_o - k_1 T)}{\gamma_o - k_1 T - 1} \right) dT = \frac{R_{air}}{k_1} \ln \left(\frac{\gamma_o - k_1 T_2 - 1}{\gamma_o - k_1 T_4 - 1} \right) + R_{air} (T_4 - T_3) \quad (2)$$

where M is the molar number of the working fluid which is function of engine speed. R_{air} and c_p are molar gas constant and molar specific heat at constant pressure for the working fluid, respectively.

The heat rejected by the working fluid during the process (5 → 1) is

$$Q_{out} = \int_{T_1}^{T_5} c_v dT = \int_{T_1}^{T_5} \left(\frac{R_{air}}{\gamma_o - k_1 T - 1} \right) dT = \frac{R_{air}}{k_1} \ln \left(\frac{\gamma_o - k_1 T_1 - 1}{\gamma_o - k_1 T_5 - 1} \right) \quad (3)$$

where c_v is the molar specific heat at constant volume for the working fluid.

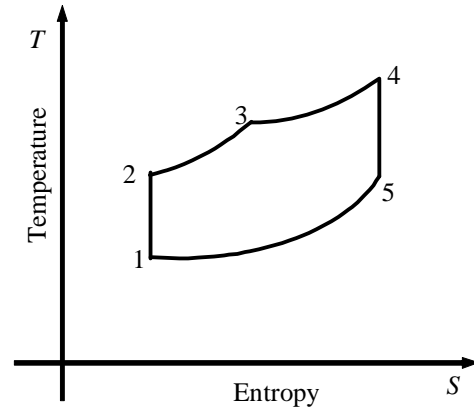


Figure 1. Diagram for the air standard Dual cycle

According to references (Ge et al., 2008a; Al-Sarkhi, 2007), the equation for a reversible adiabatic process with variable specific heat ratio can be written as follows:

$$TV^{\gamma-1} = (T + dT)(V + dV)^{\gamma-1} \quad (4)$$

From Eq. (4), we get the following equation

$$T_i (\gamma_o - k_1 T_j - 1) = T_j (\gamma_o - k_1 T_i - 1) (V_j / V_i)^{\gamma_o - 1} \quad (5)$$

The compression, r_c , and cut-off, β , ratios are defined as

$$r_c = V_1/V_2 \tag{6}$$

and

$$\beta = V_4/V_3 = T_4/T_3 \tag{7}$$

Therefore, the equations for processes (1 → 2) and (4 → 5) are shown, respectively, by the following:

$$T_1(\gamma_o - k_1 T_2 - 1)(r_c)^{\gamma_o - 1} = T_2(\gamma_o - k_1 T_1 - 1) \tag{8}$$

$$T_4(\gamma_o - k_1 T_5 - 1) = T_5(\gamma_o - k_1 T_4 - 1) \left(\frac{T_3}{T_4} r_c \right)^{\gamma_o - 1} \tag{9}$$

The energy transferred to the working fluid during combustion is given by the following linear relation (Zhao and Chen, 2007; Chen et al., 2008).

$$Q_{in} = A - B(T_2 + T_4) \tag{10}$$

where A and B are two constants related to combustion and heat transfer which are function of engine speed. From equation (10), it can be seen that Q_{in} contained two parts: the first part is A , the released heat by combustion per second, and the second part is the heat leak loss per second, $Q_{leak} = B(T_2 + T_4)$.

Thus, the net work output of the Dual cycle engine can be written as

$$W_{out} = \frac{R_{air}}{k_1} \ln \left(\frac{(\gamma_o - k_1 T_2 - 1)(\gamma_o - k_1 T_5 - 1)}{(\gamma_o - k_1 T_4 - 1)(\gamma_o - k_1 T_1 - 1)} \right) + \tag{11}$$

$$R_{air}(T_4 - T_3)$$

The thermal efficiency of the Dual cycle engine is expressed by

$$\eta_{th} = \frac{\frac{1}{k_1} \ln \left(\frac{(\gamma_o - k_1 T_2 - 1)(\gamma_o - k_1 T_5 - 1)}{(\gamma_o - k_1 T_4 - 1)(\gamma_o - k_1 T_1 - 1)} \right) + T_4 - T_3}{\frac{1}{k_1} \ln \left(\frac{\gamma_o - k_1 T_2 - 1}{\gamma_o - k_1 T_4 - 1} \right) + T_4 - T_3} \tag{12}$$

When the values of r_c , β and T_1 are given, T_2 can be obtained from Eq. (8) and T_3 can be found from Eq. (7), then, substituting Eq. (2) into Eq. (10) yields T_4 , and the last, T_5 can be worked out using Eq. (9). Substituting T_1 , T_2 , T_3 , T_4 and T_5 into Eqs. (11) and (12), respectively, the net work output and thermal efficiency of the Dual cycle engine can be obtained. Therefore, the relations between the net work output, the thermal efficiency and the compression ratio can be derived.

3. Results and discussion

The following constants and parameter values have been used in this exercise: $T_1 = 300 K$, $k_1 = 0.00003 - 0.00009 K^{-1}$, $\gamma_o = 1.31 - 1.41$,

$A = 60000 J.mol^{-1}$, $\beta = 1.1$ and $B = 28 J.mol^{-1} K^{-1}$ (Chen et al., 2006; Ghatak and Chakraborty, 2007; Ge et al., 2007; Ebrahimi, 2009). Using the above constants and range of parameters, the characteristic curves of the net work output and efficiency, varying with the pressure ratio, and the net work output versus efficiency can be plotted.

The variations in the temperatures T_2 , T_3 , T_4 and T_5 with the compression ratio are shown in figure 2. It is found that T_2 , T_3 and T_4 increase with the increase of compression ratio, and T_5 decreases with the increase of compression ratio. In figure 2, there are two special states: one is the state with $T_5 \geq T_4$, the another is the state with $T_2 \geq T_3$. In the two special states, the cycle cannot work.

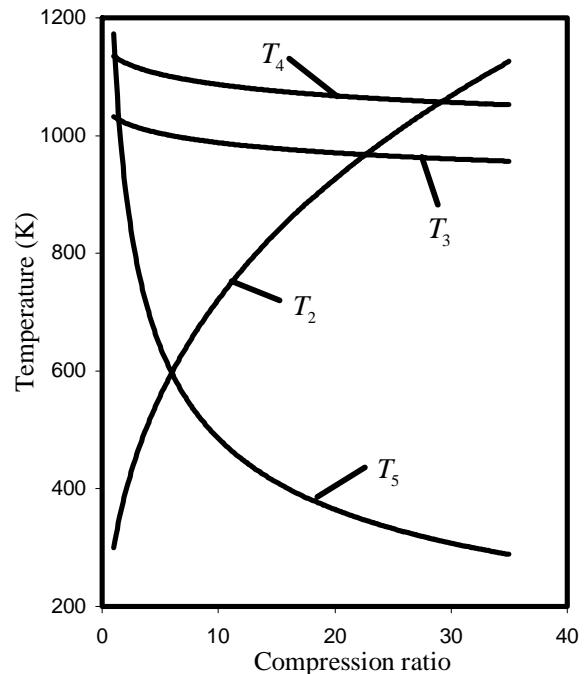


Figure 2. The temperature versus compression ratio for $\beta = 1.1$

Figures. 3-6 display the influence of the parameters γ_o and k_1 related to the variable specific heat ratio of the working fluid on the Dual cycle performance with considerations of heat transfer. From these figures, it can be found that γ_o and k_1 play a key role on the work output and the thermal efficiency. It should be noted that the heat added and the heat rejected by the working fluid decrease with increases of γ_o , while increase with increasing k_1 . (see Eqs. (2) and (3)). It can be seen that the effect of γ_o is more than that of k_1 on the net work output and thermal efficiency. It should be mentioned here that for a fixed k_1 , a larger γ_o

corresponds to a greater value of the specific heat ratio and for a given γ_o , a larger k_1 corresponds to a lower value of the specific heat ratio. It can also be found from these figures that the net work output versus compression ratio characteristic is approximately parabolic like curves. In other words, the net work output increases with increasing compression ratio,

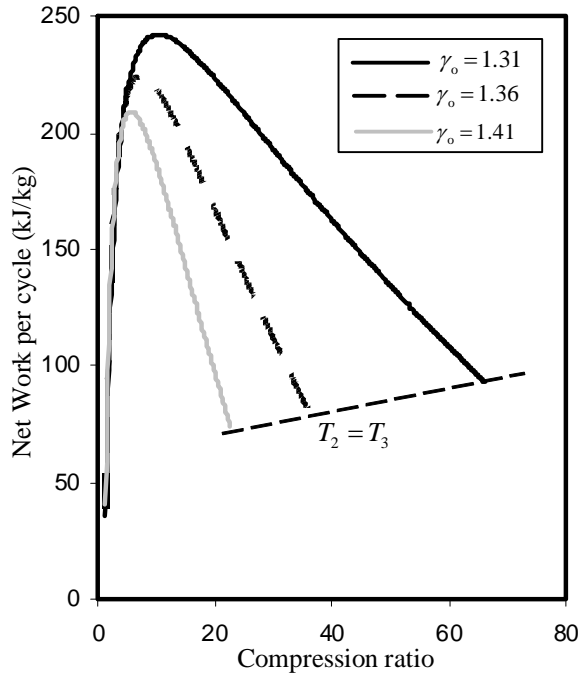


Figure 3. Effect of γ_o on the variation of the net work per cycle (per unit mass of gas) with compression ratio ($k_1 = 0.00006 K^{-1}$)

It can also be found from the figures 3 and 4 that if compression ratio is less than certain value, the increase (decrease) of γ_o (k_1) will make the net work output bigger, due to the increase in the ratio of the heat added to the heat rejected. In contrast, if compression ratio exceeds certain value, the increase (decrease) of γ_o (k_1) will make the net work output less, because of decrease in the ratio of the heat added to the heat rejected. One can see that the maximum net work output, the working range of the cycle and the optimal compression ratio corresponding to maximum net work output decrease (increase) about 13.7% (4.5%) and 67% (33%), 50.5% (21.4%) when γ_o (k_1) increases (increases) 7.6% (200%). This is due to the fact that the ratio of heat added to heat rejected increases (decreases) with increasing γ_o (k_1) in this case. It should be noted here that both the heat added and the heat rejected by the working fluid decrease with increasing γ_o (see Eq.

reach their maximum values and then decreases with further increase in compression ratio. But, the thermal efficiency increases with increasing compression ratio. It is also clearly seen that the effects of γ_o and k_1 on the work output and thermal efficiency are related to compression ratio. They reflect the performance characteristics of an endoreversible Dual cycle engine.

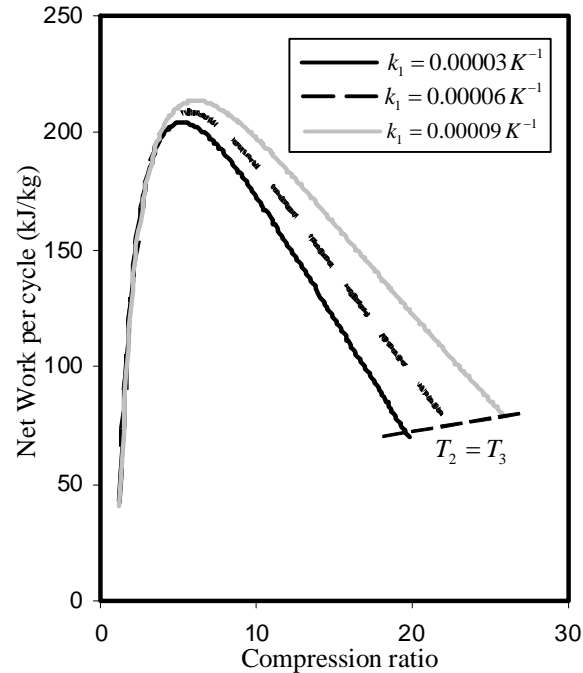


Figure 4. Effect of k_1 on the variation of the net work per cycle (per unit mass of gas) with compression ratio ($\gamma_o = 1.41$)

(4)), and increase with increase of k_1 (see Eq. (5)). Referring to Figures 5 and 6, it can be seen that the efficiency increases with the increase of γ_o and the decrease of k_1 throughout the compression ratio range. On average, the thermal efficiency increases (decreases) by about 23% (6.2%) when γ_o (k_1) increases (increases) 7.6% (200%) over a range of compression ratios from 1.1 to 19.8.

4. Conclusion

In this paper, the effects of specific heat ratio of the working fluid on the performance of an endoreversible Dual cycle during the finite time are investigated. The analytical formulas of work output versus compression ratio and thermal efficiency versus compression ratio of the cycle are derived. The effects of variable specific heat ratio of working fluid on the performance of the cycle are analyzed. The results obtained herein show

that the effects of variable specific heat ratio of working fluid on the work output and thermal efficiency of the cycle are significant and should be considered in the design of practical Diesel engines. The detailed effect

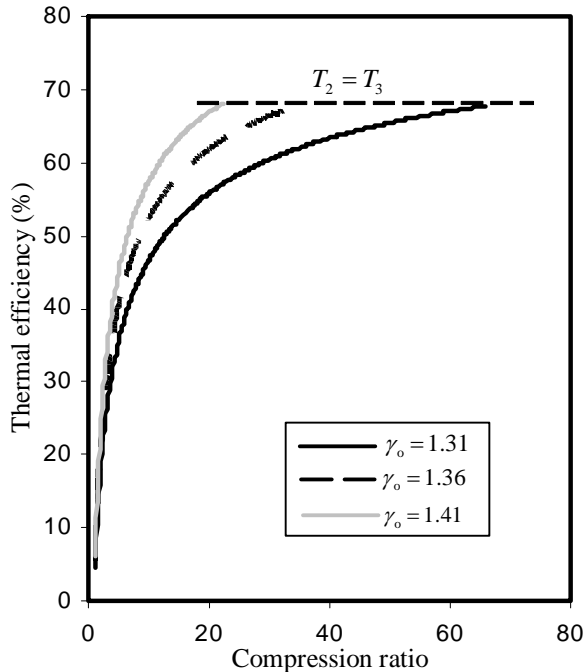


Figure 5. Effect of γ_o on the variation of the thermal efficiency with compression ratio ($k_1 = 0.00006 K^{-1}$)

analyses are shown by one numerical example. The results can provide significant guidance for the performance evaluation and improvement of real Dual engines.

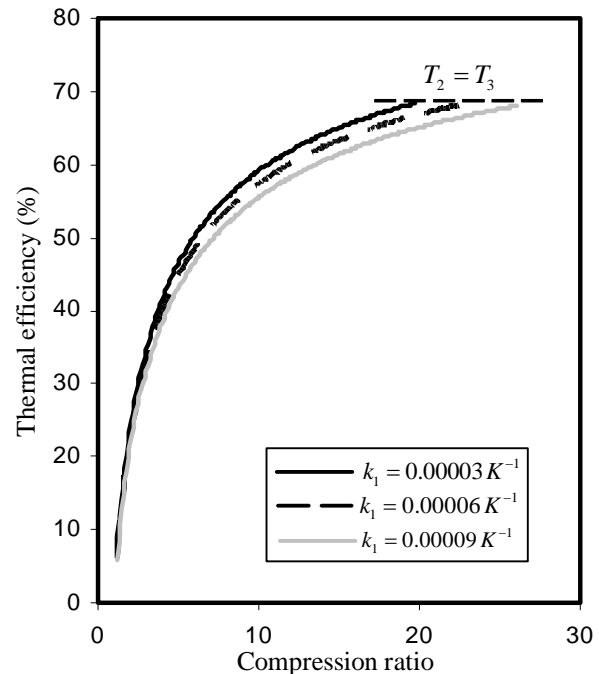


Figure 6. Effect of k_1 on the variation of the thermal efficiency with compression ratio ($\gamma_o = 1.41$)

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Design and Prototyping of a Microcontroller Based Synchrocheck Relay for Improved Reliability

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Abstract: Redesign of traditional relays with microcontroller-based relays can be used to achieve a higher level of reliability. In this study, the results of redesign and prototyping of a synchrocheck relay using an 8952 microcontroller with improved reliability is discussed. These relays are usually used for paralleling two load-generation islands, or for closing an open loop in an electric power system. The designed circuit measures voltage, frequency and phase angle difference between the voltage signal on the two sides of an open circuit breaker; evaluates the existence of necessary conditions for synchronism, and then decides whether or not a command should be issued to allow the circuit breaker to close. If these conditions do not exist when the circuit breaker closes, the power system equipment on the two sides of the circuit breaker may be damaged due to the inrush current at the instant of closing the circuit. The integration of three timer-counters, internal code and data memory plus the single-bit handling and 8-bit divide and multiply instructions of 8952 make it suitable for this application. No external RAM or EPROM are needed and the processor internally performs all the necessary computations. [Journal of American Science 2009;5(5):181-188]. (ISSN: 1545-1003).

Key words: Synchrocheck Relay, Power System, Protection, Microcontroller, Reliability Improvement

1. Introduction

As part of a manual control system, an operator makes adjustments to the generator voltage and frequency using a synchroscope or lamps, and then attempts to manually close the breaker. This manual synchrocheck protection will qualify that the two systems are closely matched before permitting the breaker to close. As part of an automatic synchronizing arrangement, a synchrocheck relay can be used as an independent backup or checking device to ensure that the two systems are suitably matched before the breaker is closed.

Synchronism is referred to the conditions on both sides of an electric connection where the voltages on the two sides are equal to each other, are in phase with each other, and have the same frequency. This requires the measurement and/or determination of voltage, frequency and phase angle difference for the power signals on the two sides of the circuit breaker before closing. The rms value of the voltage is needed.

Conventional synchrocheck relays are of either induction or electronic types. In the induction type of synchrocheck relays, there are two electromagnets each consisting of two coils. In the first electromagnet which is the driver, the coils are connected to each other in

such a manner that the two voltages applied are added together to produce the induced torque in the disc resulting in a closure of the relay's contacts. The failure rate of electromagnetic devices is much higher than that of electronic devices. One of the best approaches to the reliability improvement of protective relays in power systems is the substitution of classical relays with modern ones using integrated electronic circuits. The use of programmable chips that helps reduce hardware is another means of improving reliability. The present study reports the design and prototyping of synchrocheck relays using microcontroller implementation of the sync check relay function.

Synchrocheck relays are usually used to parallel two load-generation islands or closing an open loop of a section of the power system. The first responsibility of a synchrocheck relay is measuring voltage and frequency on both sides of the circuit breaker. Then the voltages and frequencies must be compared with each other to determine whether or not they are close enough to allow the circuit breaker to close. The relay electrically determines if the difference in voltage magnitude, frequency and phase that usually varies with the location on the power system angle fall within allowable limits. Synchrocheck relays usually do not

provide indication of the voltage magnitude, frequency or phase angle, but internally determine whether or not conditions for closing are satisfied. In this design, much of the signal processing and decision making is carried out by software in order to reduce hardware complexity and achieve a higher level of reliability.

Manual closing of circuit breakers is made possible by the use of synchrosopes in power plants. Synchrocheck relays can be used to automate the control of synchronism conditions and allow the closing of the circuit breaker to prevent improper closing. There are also automatic synchronizers in modern power plants that send pulses to the generator exciter and governor to change the voltage and frequency. Then the synchronizer will automatically close the circuit breaker when it is within allowable range. Nowadays, since most circuit breaker operations are done remotely, synchrocheck relays are usually used to supervise closing of breakers.

Voltage zero-crossing has been widely used to measure frequency in power systems. The sensitivity of this approach to noise, DC value and harmonics led to its being abandoned. Curve fitting and data smoothing were used by Begovic et al. [1] who presented zero-crossing, DFT and phase demodulation to measure the instantaneous value of power system frequency, phase and voltage magnitude. They reported that these techniques perform well in the presence of noise and harmonics. Phase angle has also been estimated or measured using transducers or electronic means.

Real time microprocessor-based phasor measurement and its application to obtaining synchronizing information for current differential protection was presented by Thorp et al. [2]. Their focus was on adaptive protection whereby the relay characteristics are modified in response to external signals. However, this is not the case in the problem under consideration in this paper with the goal of redesign of synchrocheck relays to assist in the semi-automatic paralleling of two AC power systems or two sides of a separated power system. The relay contacts should be allowed to change state when the voltage level, phase relationship and frequency are within allowable synchronizing limits. Connecting two power systems that are not closely matched can cause expensive damage to the electrical system. It may even lead to a severe disturbance of the power system. Using synchrocheck relays ensures that such undesirable events do not occur.

Certain equipment including power transformers (PT), lamps, voltmeters, a synchroscope, etc. are used in the process of manual synchronization. In practice, an operator has to check the proper conditions for synchronism before the circuit breaker is closed to connect the two sides together. For an automatic closure, synchrocheck relays are used to verify synchronized conditions on the two sides of the circuit breaker. Once the existence of these conditions is verified, synchrocheck relays automatically issue a signal permitting the circuit breaker to close. The actual act of closure is to be performed by operator, the synchronizer or the auto-recloser. Synchrocheck relays are also used for delayed reclosure after the occurrence of a contingency results in disconnection of a line.

Considering the lower failure rates and programmability of modern microprocessors and microcontrollers, the replacement of traditional relays with microcontroller-based relays can be used to improve reliability. Since much of the necessary signal processing is also possible through software, the reduction of hardware complexity can also help further improvement of reliability.

In this paper, the results of research carried out in the design and prototyping of a synchrocheck relay are presented. These relays are usually used for paralleling two generation and load zones, or for closing an open ring in a section of the power system. The main processor used in this system is an 8952 microcontroller. The integration of three timer-counters, internal code and data memory plus the single-bit handling and 8-bit divide and multiply instructions of this microcontroller make it very suitable for this application. There is no need for any external RAM or EPROM memory, and the processor can internally perform all the necessary computations at a very fast rate. The necessary signal processing functions are done through software, and the availability of proper conditions for synchronism is checked after measurements are made on both sides of the circuit breaker. The code developed senses voltage and frequency on both sides of the circuit breaker, determines the phase difference, and checks for the availability of proper preconditions for synchronization. Once the conditions for synchronism are established, a signal is issued to permit or enable the connection.

2. Hardware Design

The design of hardware for a microcontroller-based synchrocheck relay is shown in Fig. 1. In this design, an

8952 microcontroller is used with 8K EEPROM, 256 bytes of RAM, 4 eight bit I/O ports, 3 sixteen bit timer/counters, serial port interface with 64KB of external addressable memory for code, Boolean

operations on bits, 210 bit-addressable locations and fast 8 bit divide and multiply operations. No external memory was used in the designed system.

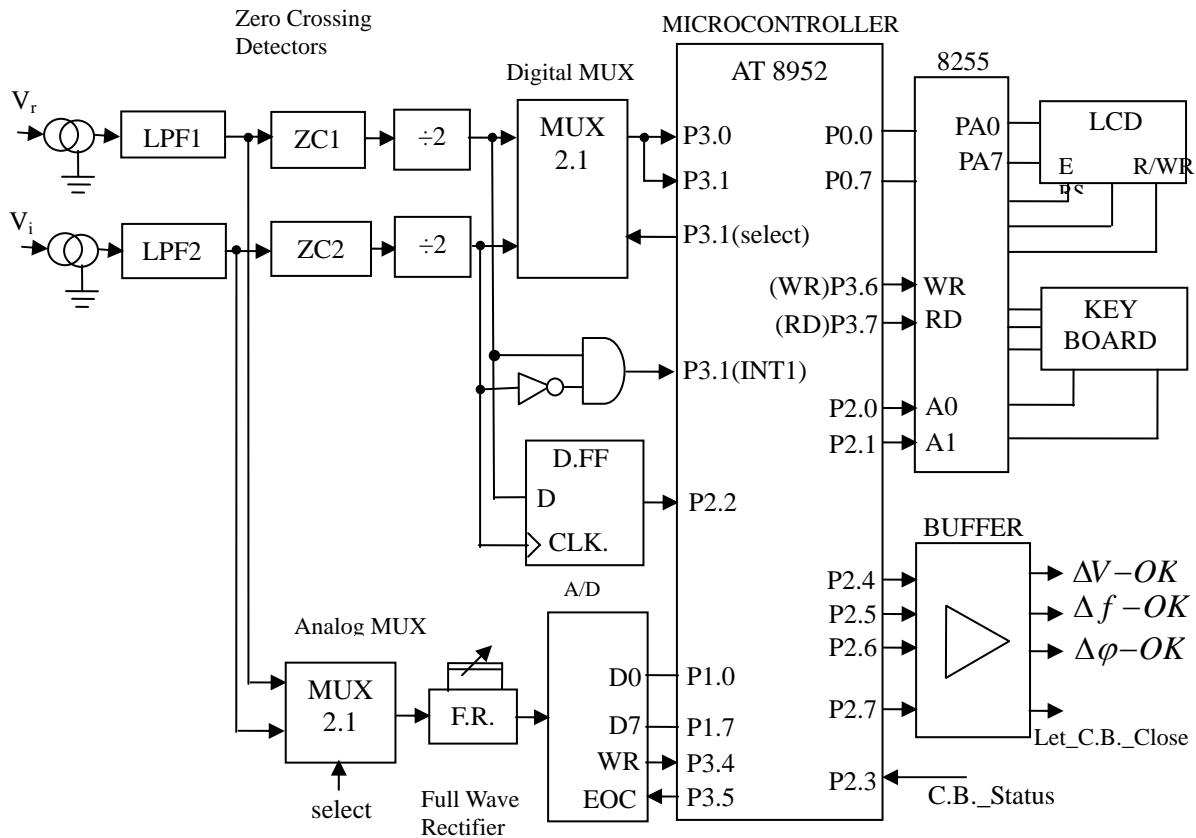


Figure 1. The hardware block diagram of the microcontroller-based synchrocheck relay

3 Voltage Measurement

In this study, the fact that voltage and frequency variations in power systems are slowly changing parameters due to the high inertia of the power system is used to compute these parameters using software. The effective value of the main component of the voltage signal is measured. The rectified voltage measured is first input to an 8 bit A/D converter. Sampling is done during a complete cycle and the effective value of the voltage is computed by the microcontroller based on the results obtained from the A/D conversion of the samples taken as shown in Figure 2.

The voltage on both sides of the circuit breaker is computed using recursive discrete Fourier Transform over the full cycle.

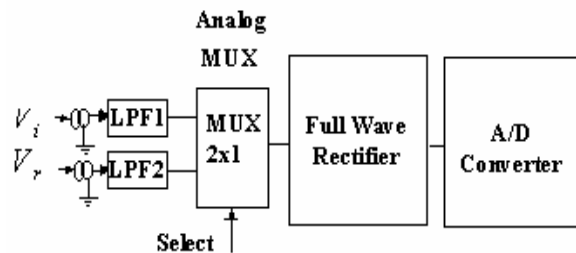


Figure 2 Voltage rectification and conversion to digital value

The real and imaginary parts of the main component of the voltage are computed from the following:

$$V_x = \frac{2}{N} \sum_{j=0}^{N-1} v_j \cdot \cos\left(\frac{2\pi}{N}\right) \cdot j \quad (1)$$

$$V_y = \frac{2}{N} \sum_{j=0}^{N-1} v_j \cdot \sin\left(\frac{2\pi}{N}\right) \cdot j \quad (2)$$

where $N=40$ representing the number of samples used in each cycle ($f=50\text{Hz}$). Then the rms value of the voltage is computed as follows:

$$V_{rms} = \frac{1}{\sqrt{2}} \sqrt{(V_x^2 + V_y^2)} \quad (3)$$

The sampling starts at the beginning of the cycle of a sinusoidal wave at its zero crossing. Therefore, at that instant, equation (3) above may be rewritten as:

$$\begin{cases} V_x = 0 \\ V_{rms} = \frac{1}{\sqrt{2}} \cdot V_y \end{cases} \quad (4)$$

In the system designed, the interrupt service routine for Timer 2 is programmed to compute the rms voltage as shown in Figure 3.

4 Frequency Measurement

Various different techniques have been proposed for measuring the frequency of a power system. Wang et al. [3] proposed a curve fitting approach using digitized samples of voltage at a relaying point. Petrovic et al. [4] proposed a digital method of power frequency measurement using rectifiers, a microcontroller, latch, RAM, EEPROM, a 16 bit A/D converter, etc. and a PC. Lee and Devaney [5] proposed a software-based technique for frequency measurement based on the estimation of zero crossings and measuring the time between an even number of estimated zero crossings with smoothing. Their approach is iterative in nature with an adjusted sample rate to be a multiple of the estimated frequency to allow a progressive refinement of frequency.

The approach adopted in this study to measure the power system frequency on either side of the circuit breaker is based on software to calculate the inverse of the average value of period of the voltage waveform over 40 consecutive cycles. Since the frequency difference between the two sides of the circuit breaker is important, it is computed as follows:

$$f_s = |f_2 - f_1| \quad (5)$$

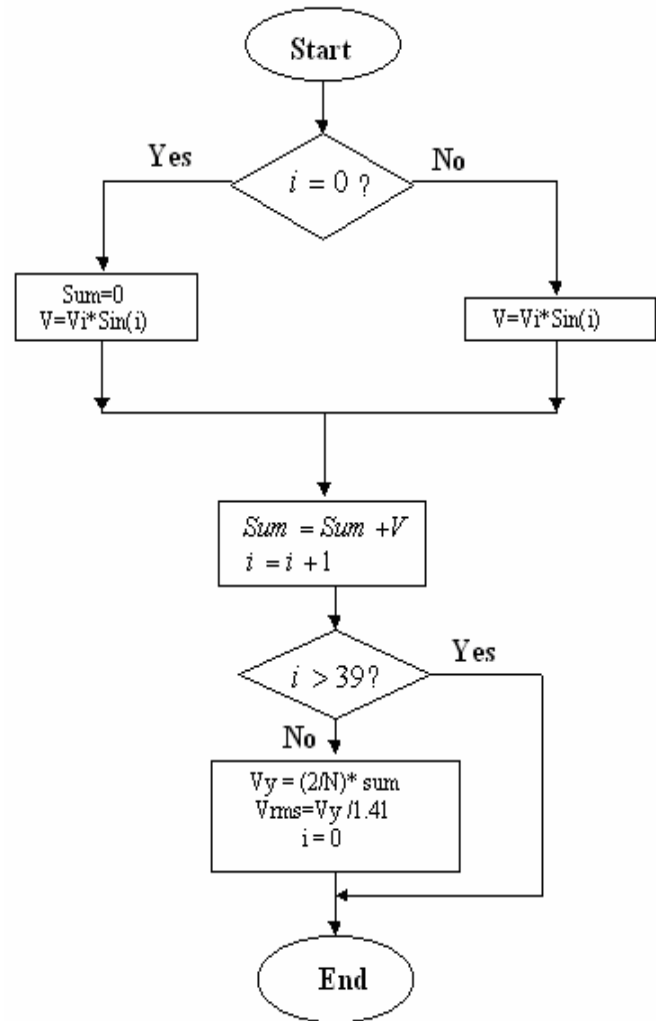


Figure 3 The flowchart of computing the effective value of the voltage

This value is recursively averaged as follows:

$$f_{s_avg} = (f_{s_old} + f_{s_new}) / 2 \quad (6)$$

5 Phase Angle Measurement

It is known that real power flow occurs based on

$$P = \frac{V_s \cdot V_r}{X_L} \sin\delta \quad (7)$$

where V_s is the voltage on one side of the circuit breaker, V_r is the voltage on the other side of the circuit breaker, X_L is the impedance and δ denotes the phase angle between the two sides of the

circuit breaker when closed. Should there be a large phase angle difference between the two sides of the circuit breaker at the time of closing a large power flow may result in damage to the equipment. Therefore, the phase angle should be measured on both sides, and the difference should be computed. One possible application of this measurement would be in real time security monitoring as proposed by Soonee et al. [6] for the Indian electric power system. They made phase angle measurements at various strategic locations in the integrated Indian power system to provide knowledge about the neighboring system for regional control centers in the absence of a national control center. One possible approach to phase angle determination proposed by them is the use of the formula below if the needed parameters are known.

$$\delta = \text{Sin}^{-1} \frac{P \cdot X_L}{V_s V_r} \tag{8}$$

A second approach is to use a voltage/angle transducer. A more sophisticated approach would be to use digital circuits or even benefit from the software/hardware capabilities of microprocessors/microcontrollers. Al-Ali et al. [7] presented an intelligent system to monitor the phase angle continuously and initialized corrective action if the phase angle deviated beyond allowable limits in order to continuously compensate for the difference by continuously changing a variable capacitor. They used an 8 bit microcontroller, an 8 bit D/A converter, zero crossing detectors and programmable capacitance to achieve this goal.

In this study, the voltage signal of each side of the circuit breaker is passed through anti-aliasing low pass filters. Then they are fed to a zero crossing detection circuit which provides a high digital output as soon as the input goes above zero and a low digital output as soon as the input goes slightly below zero, thereby changing the sinusoidal shape of the input to a square wave. This waveform is passed through a frequency divide by two as shown in Fig 4.

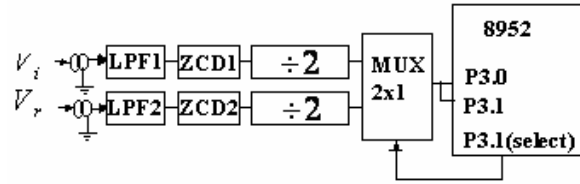


Figure 4 The low pass filter, zero-crossing detection and divide by two operations on voltages

The outputs from the two sides are fed to an AND gate which generates a pulse whose width is proportional with the voltage phase difference. Then this is input to the zero interrupt input of the microcontroller which computes the frequency with software. The waveforms are as shown in Figure 5.

6 Conditions of Synchronism

After the voltage, the frequency and the phase angle on the two sides of the circuit breaker are obtained, the conditions for synchronization must be evaluated. Equations (9) and (10) are used for this purpose.

$$\frac{|V_r - V_i|}{V_n} \times 100 \leq \Delta V \tag{9}$$

$$|f_r - f_i| \leq \Delta f \tag{10}$$

where Δf is the maximum allowable frequency difference between the two sides, ΔV is the maximum allowable percent voltage difference between the two sides, and V_n is the system's nominal voltage. The flowchart of the operation of the designed microcontroller-based synchrocheck relay indicating how a decision is made to close the circuit breaker is shown in Fig 6. The system continuously monitors the voltage difference and only goes on to compute the frequency and the frequency difference if this condition is met. It also only computes phase angle difference after the voltage difference and frequency difference conditions are met.

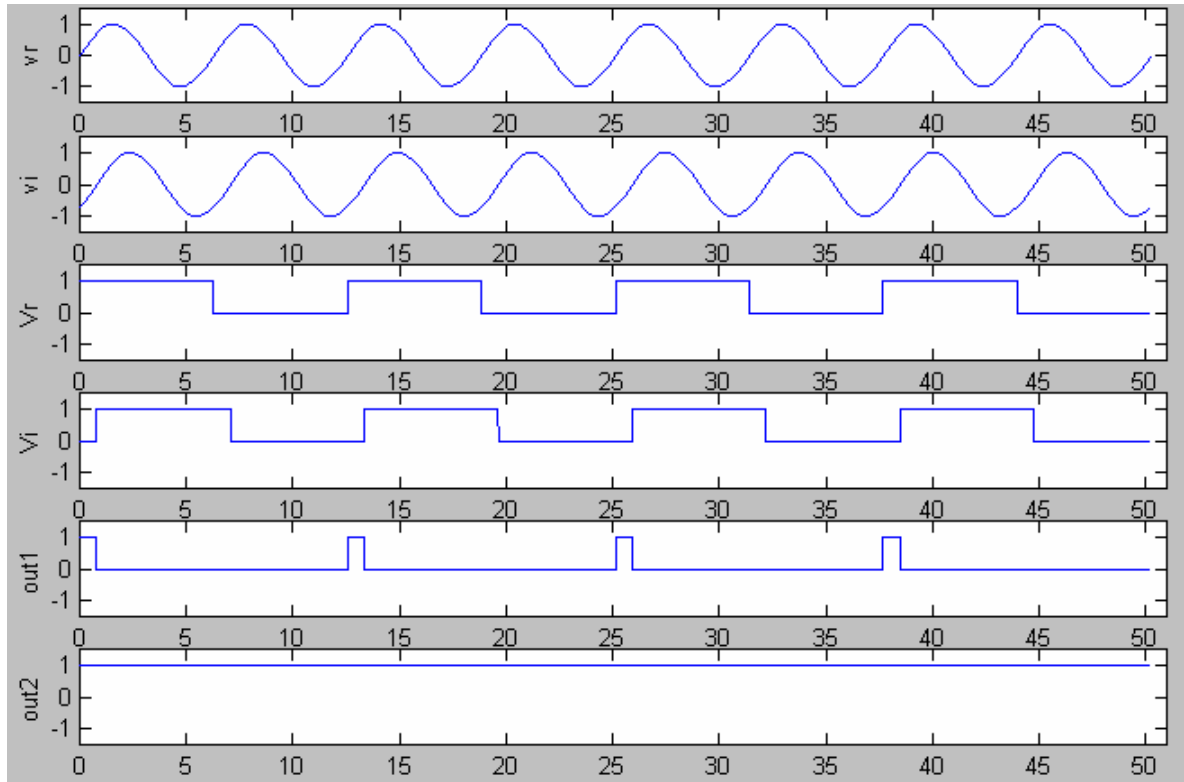


Figure 5 Action of zero crossing detectors for the voltages on the two sides of the circuit breaker. The width of Out1 indicates the time from the zero crossing of Vr to the zero crossing of Vi.

6 Conclusions

A prototype of this design was built using an 8 bit microcontroller, an 8 bit A/D converter, a digital multiplexer, an analog multiplexer, a parallel I/O port, an LCD, a keyboard plus several other gates. The proposed method of measuring frequency, voltage and phase angle used in the design of this microcontroller based synchrocheck relay all work well. The precision used is 0.01Hz for frequency, and 0.1 degrees for phase angle. Discrete Fast Fourier (DFT) transform was used for measuring voltage, and high frequency components were eliminated using hardware low pass anti-aliasing filters. The DFT itself acts as a natural filter for high frequency harmonics, too. The algorithm successfully measures the main characteristics of the voltage on both sides of the circuit breaker. The recursive nature of the algorithm eliminates the need for storing samples taken and by eliminating external RAM and simplifying the resulting circuit greatly improves its reliability. Another major design feature of this relay which also simplifies the circuit

and improves reliability is the use of a precise full wave rectifier so that employing just an 8 bit D/A converter provides sufficient accuracy for the synchrocheck relay. An 8952 microcontroller which has 256 byte RAM, 8KByte EPROM, 128 bytes of bit addressable memory and three 16bit timer/counters is used. The integration of all needed circuits into a single microcontroller chip greatly improves the reliability of the synchrocheck relay. The ability of this chip to perform 8bit multiply/divide operations in only two microseconds plus its bit addressable I/O capability makes it a very suitable choice for a reliable synchrocheck relay design.

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I would like to thank Mr. Ebrahim Sagvandi for carrying out the initial work and his help in the practical aspects of the circuit prototyping and testing. I also like to thank the Office of Vice Chancellor of Research and Technology of Ferdowsi University of Mashhad for the grant project that has assisted me in the preparation of this manuscript.

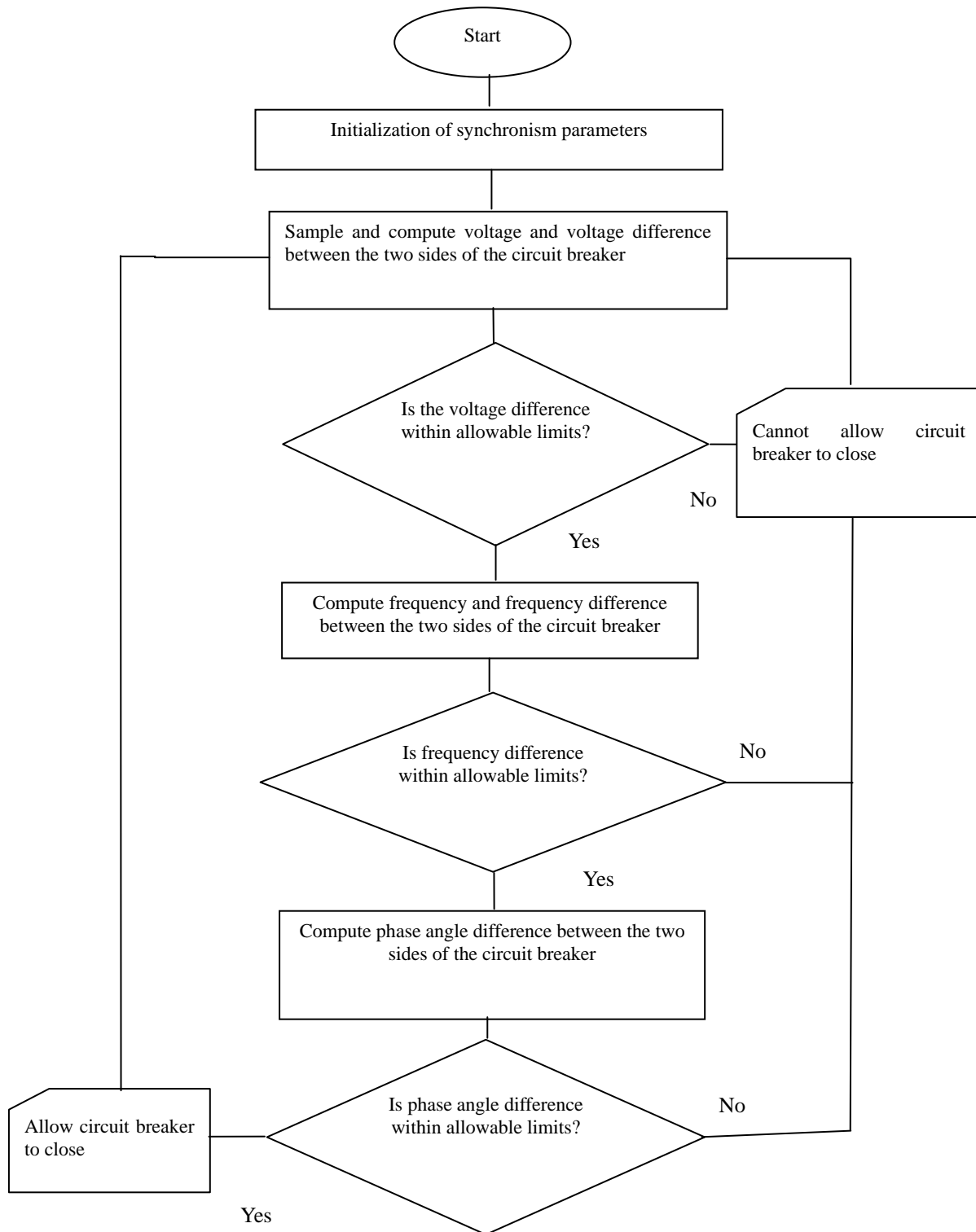


Figure 6 Flowchart of the decision making process of the designed synchrocheck relay

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Yacht Construction In Myanmar

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Abstract: This paper reviews the construction of the yacht Sunshine that influences the Myanmar Shipyards (MS). Historically, the wooden yachts have been built in Myanmar since 19th century. Myanmar Shipyards has been building and repairing the various kinds of ships since 1970. Fortunately, the classic-yacht Moonbeam was repaired in 1998 and approved by the regional Lloyd's surveyor. Interestingly, the owner, Peter Wood, Corvette Shipping Ltd, France, of the yacht Sunshine was seduced by the place where Moonbeam rebuilt. In early 2000, the construction of the Sunshine was started. The hull design plans were supported by the owner. The steel frames and hull plates were cut with CNC machine and there was no human error. Everything on the yacht was made locally, nearly all the fittings are from local foundries and the carpenters made all the wood work. It was challenging and time-consuming for the construction of the latest Fife design in Myanmar Shipyards. For future development and commercialization of yacht constructions, this paper will describe the specifications and functionality enhancement of Myanmar Shipyards. [Journal of American Science 2009;5(5):189-196]. (ISSN: 1545-1003).

Key words: Yacht, CNC (Computer Numerical Control), NDT (Non Destructive Testing)

1. Introduction

This paper sets out to review some of the construction problems of the yacht faced by MS. The restoration of the yacht doesn't need the design process but construction of a new yacht requires the design process. The owner of the yacht Sunshine gave full-size lofted frame templates so that Detail Design stage was eliminated.

There are a large number of processes that are required for the construction of yacht. The design process is the major step to satisfy the customer's requirements because yacht construction is a design-oriented view. To improve the way of the construction of ship is to reduce costs, manhours, and administration and improve quality. For the type of classic-yacht, the cost is not the object. The goal or purpose of the yacht is to win the best 4 of 7 match races around a specific course made up of known angles and distances. So the biggest job is to determine the velocity potential of a design to the wind speed, sailing angle, and the dimensions of the hull and rig. For pleasure yacht, the owners specify a target cost, speed, cruising range, and some description of accommodations for the yacht. Actually, it is difficult to get an optimum design. There are many design phases to consider for the best design.

MS started constructing the first yacht in March 2000. Delivery was late, but quality on the first yacht was excellent. Since that time, MS has built in traditional measurement terms and it is a small shipyards. Now MS is a commercial-oriented shipyard, a second facility, floating dry-dock, and a growing work

backlog from repeat and new customers.

2. Historical Perspectives

In Myanmar, the best hardwoods held out the promise of a slow but faithful restoration by repair. There is no doubt that a wooden deck, interior decoration and superstructure is a beautiful sight from both without and within. The owner of Moonbeam discovered the low labour rates, skilled craftsmen and access to supplies of the best hardwoods in Myanmar. The hull had been copper sheathed and this had protected the wood below the waterline. Moonbeam had only left a steel skeleton which retained its original shape and the keel and deadwood remained attached to stabilize the structure. Two-thirds of the original steel had been saved and the shape was unaltered. The hull shape was fairly straightforward but manhandling.

The whole of the interior was hand-built by local craftsmen with all of the paneling coming from a single tree of padauk on satinwood frames. She has beautiful accommodation for six guests staying on board. While there is space for many more during day racing. The rosewood-pannelled saloon is an absolute feast of traditional woodwork and a great credit to the craftsmen who painstakingly re-created it.

Although there are many survivors in the cutter category few classic schooners still exist today, so it was thought appropriate in building a replica, that should be borne in mind. Also the early 1900's was probably the time when sailing ships and yachts were at the height of their evolution, before steam and diesel engines, and racing rating rules, began to interfere with the purity of their original function and beauty. Looking into the future it is also likely that there will be a

reduction in the numbers of original vessels in existence, due to the high and ever increasing costs of maintaining these few remaining original vessels.[4]

The yacht Sunshine was built in Yangon, as the facility there at MS, is very suitable and the building and handcraft techniques can still be found in Myanmar, that are as close as one could find to the skills originally employed in the England of the early 20th century.

The yacht Sunshine is a two masted gaff rigged identical to the two earlier Fife Schooners. The hull and rig are exactly faithful to the original 1900 design. By early 2000, the boat was plated and ready to be turned over in the yard. Her keel is steel box section with lead poured in from the inside. [3]

Metal yacht construction has been around for a long time, long enough for its benefits and drawbacks to be common knowledge. However, with the acquisition of knowledge and technology, the methods of working with and treating materials change for the better, expanding the benefits and limiting the drawbacks.

Developments in hull shapes and plating techniques have also gone a long way in helping to reduce the prejudice against steel yachts. The secret of a good steel design is clean simplicity, in both the hull and the deck. The more cutting and welding that can be eliminated while maintaining good aesthetics, the more successful the design is likely to be.



Figure.1 Moonbeam



Figure.2 Schooner Sunshine

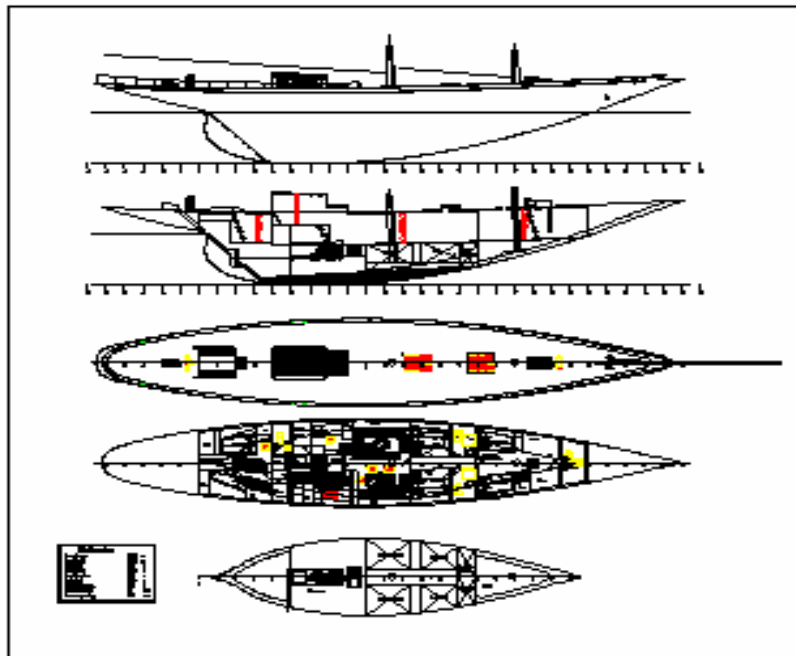


Figure.3 G.A Plan of Sunshine

3. Construction Activities

Construction activities include the followings:

- Material supply
- Fabrication
- Body assembly and shell plate erection
- Overturning
- NDT check
- Outfitting
- Piping and Machinery
- Launching
- Superstructure and Interior Decoration

The steel hull construction, outfitting and piping works were done by employees of MS. It was also performed to test NDT check and some design performance. Some skillful craftsmen from external contractor were hired to do superstructure and interior decorations works.

3.1 Material Supply

Hull materials, machineries, outfitting, anchoring and mooring equipments for construction of yacht and working drawings were approved by Lloyd’s class and supported by owner. Some parts had been cut by CNC

machine and other necessary parts were cut by CNC at MS.

3.2 Fabrication

For fabrication, the parts of frames were assembled and arranged by their numbers and tack-welded the frames together. To strengthen the frames, face plates of 50x6mm were used to become T-frames. After checking against the patterns, make the final welds. A good way to avoid distortion is to follow the same sequence for assembling each frame. To get the camber of main deck, hydraulic press machine was used for deck beams according to template of workshop floor.

3.3 Body assembly and shell plate erection

After fabrication, the frames, girders and bulkheads were arranged to their positions from aft to forward. Upside-down method was used because most of the important hull welding can be done in the down-hand position and made it easier to install the radius plating. Care must be taken to get the correct level, alignment and to fix exact frame situations. First, the deck stringers, deck girders and bulkheads were installed and then bottom centerline girder and tank top plate. When the frames were complete, shell plating was started. Because of the radius chine and bow curvature, the skillful welders had done with much care.

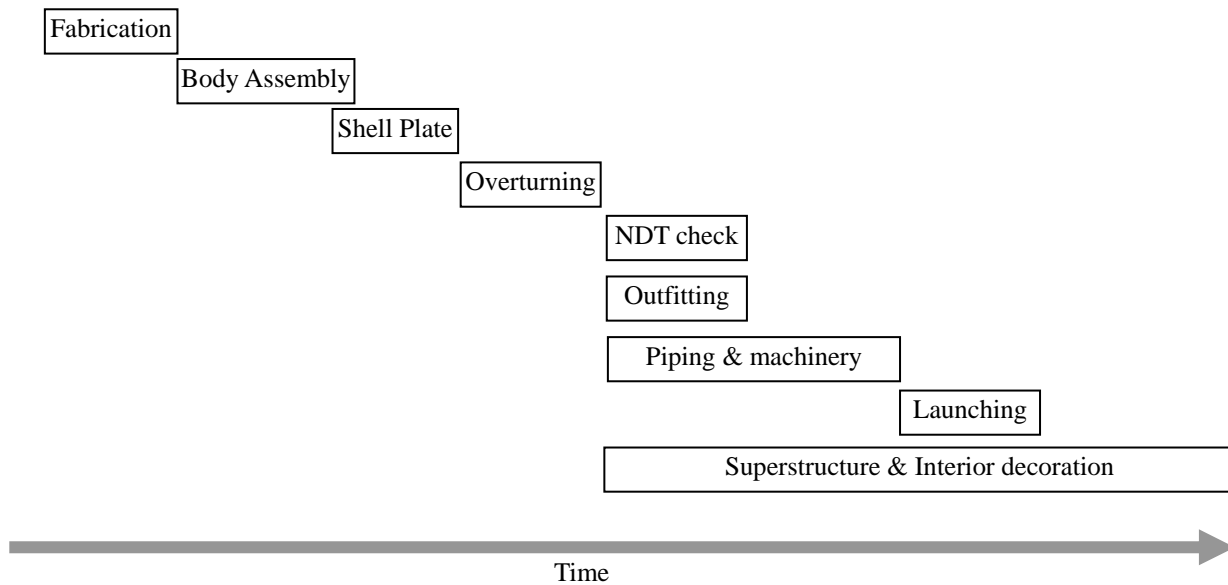


Figure.4 The Construction Time Plan

Table 1. The frames and plates used in this yacht

Material Specification		measurements (mm)	
All Plating Profiles		Grade A Certificate from manufacturer according to grade A	
Transverse Frames			
Hullframe spacing above tanktop		1000 mm	
Hullframe spacing under tanktop		500 mm	
Hull frames above tanktops		120x4 & flange 50x5	
Hull frames below tanktops		120x5 & flange 50x5	
Web frames above tanktops		L120x10+100x8	
Web frames below tanktops		L120x8 & flange 60x8	
Deck beams		Hp 80x5 and Hp 100x6	
Longitudinal members			
Side Shell Stringers		60x6	
Deck girders		100x6 and flange 60x8	
Deck stringer		500x7 and 400x6 (ends)	
Hull Plating			
Keel & side plate till 2000 mm			
Above base		8	
Side plating from 2000 mm above base		6	
Weather deck		45 mm wood	
Tanktop		5	
Bulwarks		6	
Bulkheads			
Fr.0	Plating	4	
	Stiff.	50x5	(Spacing 450)
Fr.5	Plating	4	
	Stiff.	60x8	(Spacing 450)
Fr.15	Plating	4	
	Stiff.	60x8	(Spacing 450)
Fr.21	Plating	4	
	Stiff.	60x40x5	(Spacing 450)
Equipment Number According to LRSSC			
Rules for the Classification – Certification of Yachts			
Engine	62.96		
Anchor	2		
Weight	75/55 kg		
Chain	110 m each	12.5 mm	

3.4 Overturning

The hull turning was a social event and it was done in 12/22/2000. Leveling, alignment and dimensions were checked again. After making some temporary staging, some overhead welding were finished. The hull was pulled out along with the carriage and then lifted with cranes.



Figure. 5 Overturning Process

3.5 NDT check

Shell plate welding joints were checked with radiographic inspection method. Fuel tanks, grey water tank, black water tank and drinking water tank were tested with air pressure test.

3.6 Outfitting

After construction the main body, bulwark, hawse pipe, fairlead, fore-stay, bow sprit heel, echo sounder seating, watertight doors, dolphin striker, main and fore mast arrangement, daily service tank, eye piece, eye bolt, anchor davit socket & crane, manhole cover, side scuttles and zinc anode fittings were fitted. Lead weight 3,466 kg per cubic meter combined with its low melting point of 327°C was used for superior ballast material. 25 ton of lead was melted and then poured into the steel box keel section.

3.7 Piping and machinery

Bilge system, fuel oil service system, fresh water service system, black and grey water system were designed by MS. For bilge piping system, one bilge pump was electrically powered unit situated in the lowest point of the bilge and two hand-operated bilge pumps were fitted on the main deck. Semi-rotary hand pump with Ø32 and one fuel oil transfer pump were used for fuel service system.

Cummins Marine Diesel Engine of Model 6CTA-83 MI, 300 BHP @ 2500 RPM for a good cruising speed and Onan Gen-set of 17.5 KVA were fitted in the engine room. Chockfast was used to fit stern tube and propeller shaft.

3.8 Launching

After fabricating the hull construction, it had to put on the cradle. Because of the high lightship draft, the cradle must be modified from 2 feet to 1 foot in high. After finishing of block assemblies, it was turned over and seated onto the modified cradles which were placed at the auxiliary side slipway. Before side shifting onto the small traverser, special side supports were provided because of having very steep in depth. Then it was released into the basin. Finally it was successfully launched on the day of 22-7-2002.



Figure. 6 Launching Processes

3.9 Superstructure and interior decoration

The interior design of the yacht was built almost entirely of teak wood. The interior which is hand crafted from teak and rosewood has been compromised from the original layout to allow for the required modern safety standards, such as the 4 watertight bulkheads. The deck is laid down in long thick lengths of solid teak planks over the steel frames, and caulked with cotton in the traditional way. The masts and spars are all of Sitka Spruce and the standing rigging is of galvanised steel.



Figure.7 Deck floor



Figure.8 Salon



Figure.9 Hatch, Mast and Boom

4. Improving yacht design and construction

It is often said that there is nothing new in yacht design, that whatever we come up with that is innovative has been done by someone else in the near or distant past. That applies to radius chine hulls as much as to anything else. Each designer or builder has developed his own version of it which works well for his own style of yacht design or construction. Most modern yachts tend to have little, if any, curvature to the topsides near to the bow. Radius chine construction

gives straight sections in this area, with all the radius below waterline. This can give a wet boat if there is not good flare to the hull to prevent the bow wave from coming straight up on deck.

Naval architecture department of MS made some design performance of the yacht Sunshine[1], [2]. Designers always have some ideas on how to improve or optimize an existing design, especially if the previous boat has been built and the designer has had a chance to evaluate the result. For racing yacht, the design improvements and changes are smaller and there is a greater need for an objective analysis of the changes. This is where parametric analysis and design optimization can be used most effectively.

Computer can help the design process by providing an easy way to start with a complete hull shape. Many accurate calculations can be performed. Detailed weight information and the layout of the arrangements and determination of whether everything fits can also be supported by computer.

Designers involved with the computer use both hull design program and a general purpose CAD program. The hull design program is used to create, fair and perform calculations on a 3D mathematical model of the hull. The general purpose CAD program is used to receive either the 3D model of the hull to create a full 3D interior, or to receive several 2D views of the required plans.

In a competitive shipbuilding market, MS wants to improve the construction of ships including yacht. Because of product complexity, such as tank and cargo barges, tug boats, power barges, passenger vessels, offshore vessels and vessel repair, MS wants to improve return on past and future investment decisions.

Since yacht is not mass produced, the synergy of multiple brains and experiences will tend to challenge or reject bad information and concentrate on good information. Management information is critical to productivity. The process tends to build organizational learning, shared vision, team function, and while reducing fear and mistrust and misunderstanding. MS recorded of action assignments, performance measurements, recognized unknowns, and other useful management information of the yacht.

MS has skilled and experienced employees who are very astute concerning their role in acquiring knowledge. Employees can also learn beyond the experience curve. Productivity can increase by the accessible knowledge base, skill and related learning, work organization, communication and leadership, and attitudes, such as willingness to accept change under the tent of corporate culture. MS has facilitated self-directed or conscious learning by encouraging and rewarding employee suggestions and innovation

Technology supports productivity by leveraging human abilities through facilities; suite choices; arrangement of production, support equipment, and tools; communication and information systems; and maintenance and safety equipment. Designers and engineers had thought little about work specification that could be enhanced with computer-aided design or manufacturing technology.

MS business functions depend on external help. MS also hires contractors to perform those functions on new vessels and vessels under repair that are beyond in-house capability. Contractors also provide training and services, such as insurance, accounting, payroll, and so fourth.

The construction cost will depend mainly on the weight of the hull. MS quoted low price to the owner of Sunshine because he gave full-size lofted frame templates. The price will be noticeably lower since the 3D computer hull form model will eliminate all traditional lofting by hand. If MS has to be selected the detail design, the owner has to discuss the exact type of information. The longer the owner waits, the more he increases his chances of having to modify his design and drawings.

Since MS is commercial-oriented shipyard, it constructs and repairs various kinds of vessels and it is not specialized in yacht building. For racing yacht, it is also necessary to design rig. It includes sailplans, respective structural calculations, mast and boom section. All structural elements can be dimensioned to comply with the ABS classification rules for Offshore Racing Yacht or for more efficient structures, finite element analysis can be performed. To complete the detail design, it can take much time on design processes.

5. Conclusion

The shipyards in Myanmar construct and repair mainly the inland waterway transport vessels. MS has been constructed many kinds of classed ships up to 90 m in length. There are many customers from foreign countries. The good management factor, the skillful workers and the advanced technology satisfy the customers.

From the first construction of racing yacht, MS had learnt much knowledge about yacht design and construction from the experiences. Although MS doesn't have well-trained yacht designers, the owners can

discuss their required information about yacht design. If a similar designed metal yacht wanted to build in MS, it would not be time-consuming and well-trained workers and carpenters can work better than the old one.

composting processes. Adjusting operation conditions through changing key factors, optimal operation condition could be determined through comparing the results of numerical simulation. In this study, the optimal way of air supply was designed with the help of numerical model. Real experimental results showed that it could reduce 79.61% of oxygen supply with the same compost efficiency. Therefore, developed numerical model is of great significance to instruct the operation of real composting processes and reduce the operation cost.

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Desalinization of Saline Soils Aimed at Environmentally Sustainable Agriculture: A New Thought

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Abstract: This article describes the desalinization of saline soils aimed at environmentally sustainable agriculture. [Journal of American Science 2009;5(5):197-198]. (ISSN: 1545-1003).

Salinity, defined as the concentration of dissolved mineral salts present in the soil or water, is one of the most severe environmental factors limiting the productivity of agricultural crops. Most of the crops are sensitive to salinity caused by high concentrations of salts in the soil. Salinization commonly occurs as an outcome of agricultural practices. Salinization associated with agriculture occurs when salts build up in the root zone, either because the soil is inherently saline or because the drainage of water from the sub-soil is not adequate to prevent saline waters rising into the root zone.

Increasing salinity is a major abiotic stress affecting approximately 7 % of the world's total land area (Munns, 2005) resulting in billion dollar losses in crop production around the globe (Norbors and Dykes, 1984). Without proper agricultural and ecological practices salt problems and/or salt accumulation can occur under virtually any climate regime. However, arid land climates and poorly draining soils are particularly susceptible to salinization due to evaporation that leaves the salt behind. World wide, approximately one third to one half of all the irrigated lands has salt problems; the majority of which is in less developed arid regions. And, every year, millions of acres of irrigated lands go out of production due to salt. Indeed, there is already twice as much salty land as the irrigated land. If this trend will continue, we will have finally reached the point where there are no new 'virgin' lands left to salinize.

In amelioration of saline-sodic soils, gypsum is used as agricultural lime but it is to some extent expensive. Moreover, the efficiency of gypsum application is reduced because it is precipitated by dissolved CO_3^{2-} and HCO_3^- , forming insoluble CaCO_3 . However, this option applicable only when pH of soil > 8.5 (sodic soil), claimed by many scientists. In recent decades, phytoremediation has also proved to be as efficient,

inexpensive and environmentally acceptable strategy to ameliorate saline-sodic soils (Qadir and Oster, 2002). But it reduces sodicity very slowly than chemical treatments. Moreover, it has very limited application under condition of high level of soil salinity and sodicity ($\text{ECe} > 20 \text{ dSm}^{-1}$, $\text{ESP} > 70$). As a result, farmers often become reluctant to ameliorate saline soils. Unfortunately, fertilizers do not solve the salinity problems. Fertilizers are just plant nutrients and do not remove salt from the soil. However, organic fertilizers and mulching may help reduce soil salinity by improving soil structure and therefore increasing percolation. It may be tempting to remove the surface clay/silt layer as the quickest way to get rid of the salt. However, bear in mind that just one centimeter of sediment per hectare equals 100 cubic meters. One cubic meter is approximately 15 full wheel barrows, and a standard large truck load is eight to ten tons. This option can only be justified under exceptional circumstances, such as clearing for high value cash crops. In this case, the economic cost/benefit should be calculated first. Moreover, appropriate disposal of saline soil is also a great problem; coastal dumping may be effective from a salinity point of view, but carries other environmental risks.

One way to remove salt from soil is to leach it out. Here, a drain system is installed in the field. Large amounts of fresh water are added to the field and the salt dissolves in the water which is moved off the field by the drain system. The collected water can then be treated further to remove the dissolved salt. Moreover, the continuous irrigation over the years has resulted in a rise of the ground water table in turn resulted in development of salinity and water-logging and also leaching the nutrients of the soil. In another way, the soil can be dug up, then literally washed like in a washing machine and then put back into place. Obviously, the last alternative is not very realistic because of costs, however it could

be done.

In improving those saline soils to find out the effective (an efficient and low cost) method is required. Slaking is the process of soil aggregates collapse when they are rewetted after drying. Soil slaking has long been studied from the stand point of stability of aggregates. However, it has not been studied from that of salt removal. Drying followed by rewetting and slaking is commonly found in a natural soil processes. During the process, salt in the soil moves and accumulates to the inter and outer surface of soil blocks and released to outer solution. Recent study revealed that the maximum salt is released at the soil moisture of maximum slaking. In addition, the amount of salt released into equilibrium water after 24 hours slaking was proportional to the slaking rate¹. The EC_{1:5} of the equilibrium water surrounding the slaked soil blocks were measured, which is an exact measure of the amount of salt released² from the soil block. Here, we can find a chance to improve the saline soil by simply rewetting the soil at the proper soil moisture by land drying practice. Moreover, proper amount of water management can limit salinization. This is because the salt concentration and amounts of irrigated water content in soil is dependent each other. If saline soil is irrigated by too much water like ponding irrigation, salt concentration decreases abruptly to cause dispersion and swelling of soil particles and plugging percolation pores. It results in great drop in water movement. On the other hand, if soil is irrigated by small amount of water enough to slake and flush the salt under relatively dry condition, the salt will decrease smoothly because water can moves well without plugging pores by dispersion. It is also environmentally sound and economic as well as saving water resource.

In this respect, it is imperative to focus at soil dryness or soil moisture content at which slaking initiates and is mostly enhanced. Accordingly, the specific points are (1) to identify the optimum soil moisture content for slaking, (2) to evaluate salt released accompanied by slaking and (3) to discuss the effect and mechanism of drying on slaking, which deserve attention due to increasing global water shortage and awareness of the environmental impacts associated with irrigation.

¹Slaking Rate of Soil

The slaking rate was calculated by using the following equation;

$$\text{Slaking rate (\%)} = \frac{\text{Weight of slaked soil}}{\text{Weight of soils (slaked + unslaked)}} \times 100$$

Where, slaked soil refers 'the soils which fell down through sieve with 4.75 mm openings' and unslaked soil refers 'the soils which was left on the sieve' after 24 hours wetting.

²Released Salt

The salt left in the soil blocks (after 24 hours immersion) was calculated using EC_{1:5} of soil and EC of solution by the following equation;

$$\text{Salt in slaked soil} = k (EC_{1:5} \times 5 \times W_s) / \rho_w \dots (1)$$

$$\text{Salt in unslaked soil} = k (EC_{1:5} \times 5 \times W_s) / \rho_w \dots (2)$$

$$\text{The total salt remains in the soil} = (1) + (2) \dots (3)$$

$$\text{Salt released into the water after 24 hours immersion} = k (EC \times V_w) \dots (4)$$

$$\text{Proportion of salt remaining in soil (\%)} = \frac{(3)}{\{(3) + (4)\}} \times 100 \dots (5)$$

$$\text{Proportion of salt released in water (\%)} = \frac{(4)}{\{(3) + (4)\}} \times 100 \dots (6)$$

Where, W_s represents the weight of soil; V_w refers to the volume of bulk water for slaking test; k indicates the co-efficient of proportionality between salt concentration and EC of solution, ρ_w means the density of water.

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Developing a Portable Reading Machine for the Blinds

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Abstract: Prevalence of the causes of blindness, especially cataract, is alarming and most sighted people may get it in their old age. Most blind do not have access to readily transliterated documents such as instructions on food packaging, medication and newspapers. Hitherto existing touch-based methods of Moon and Braille for text cognition by the blind and visually impaired are no longer acceptable technologically. In this work, a reading machine for the blind and visually impaired has been developed enabling them to read novels, newspapers, books and letters. In the development, scanner, optical character recognition, and text-to-speech technologies were employed. The Fourier Transform was involved in signal and image processing. Software implementation made use of XML-based speech synthesis markup language. Orientation of the document/paper does not matter during the scanning process. The SSML (Natural reader software) can still identify the right position of words and read them in a natural sounding voice. Li-Ion batteries used give high energy density and higher voltage ensuring reliability. With the implementation of the reading machine developed, information should be carried indiscriminately to the blind and visually impaired [The Journal of American Science. 2009; 5(5):199-212]. (ISSN: 1545-1003).

Key words: the blind; portable reading machine; natural reader software; Fourier transformation; visually impaired.

1. Introduction

Blindness is particularly devastating in the developing world where it has a profound impact on the quality of life for the blind person and his or her community. Life expectancy of the blind is usually less than half that of someone with eyesight the same age. The desperateness of this situation is augmented by the fact that a blind person is unable to contribute to the family income. Not only does blindness mean a father is unable to work, or a mother cannot collect water or go to market, but someone with eyesight must care for him or her. Effectively two income producing individuals are lost. This creates a devastating economic impact on the family and the community. Restored eyesight allows the individual to return to a normal life of work and a traditional role in the family.

In Ghana, about 4.4% of the population is blind and people above the age of 50 years experience low vision. Pitifully enough, many novels, newspapers, books and letters are not readily transliterated into Braille to convey the information to the blind. Means of communication between the sighted and the blind is chiefly vocal. Therefore, the need for a reading machine is paramount. Out of the 20 million people living in Ghana, it is estimated that 200,000 are blind and over 600,000 more people are visually impaired. Thus, blindness is affecting about 4.4 % of the Ghanaian population and people beyond the age of 50 years experience low vision (Dogbe, 2004). A cross-sectional drawing of the eye is given in Figure 1.

Blindness is the total or partial inability to see due to disease or disorder of the eye, optic nerve, or brain (Microsoft Encarta, 2007). The term blindness typically refers to vision loss that is not correctable with eyeglasses or contact lenses (Microsoft Encarta, 2007). Blindness may not mean a total absence of sight, because, some people who are considered blind may be able to perceive slowly moving lights or colors. The term low vision is used for moderately impaired vision. People with low vision may have a visual impairment that affects only central vision (the area directly in front of the eyes) or peripheral vision (the area to either side of and slightly behind the eyes). Some people with low vision are able to function with their remaining sight while others need help to learn to use their sight more efficiently with training and special tools

Color blindness, for example, does not reduce visual acuity and should more accurately be called color-perception deficiency. Color blindness occurs almost exclusively in males, and the most common form is the inability to differentiate between certain shades of red and green. Night blindness, the inability to see in low levels of light, is commonly associated with a lack of vitamin A in the diet or with inherited diseases such as retinitis pigmentosa, a condition involving progressive degeneration of the eye's retina and abnormal deposits of pigment. In Ghana about a million people are blind (Dogbe, 2004).

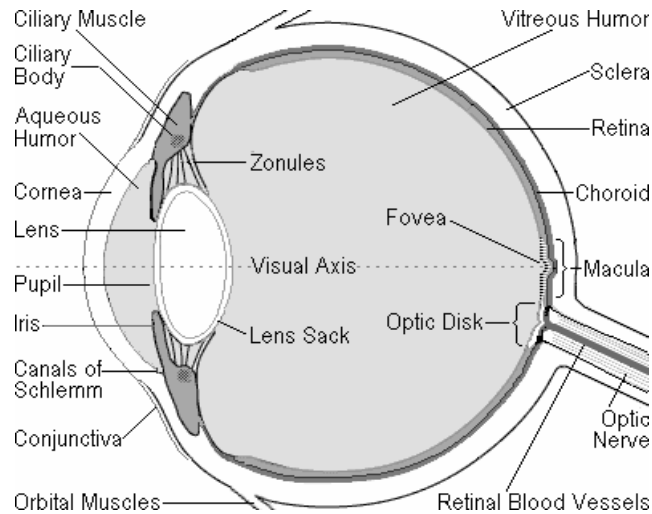


Figure 1. Cross sectional drawing of the eye (side view)

In spite of the progress made in surgical techniques in many countries during the last ten years, cataract (47.9 %) remains the leading cause of visual impairment in all areas of the world, except for developed countries (WHO, 2009a). With the exception of age-related macular degeneration (AMD), the rest are the causes of avoidable visual impairment worldwide. However, in developed countries, AMD is the leading cause of blindness, due to the high life expectancy of over 70 years of age. In the least-developed countries, and in particular Sub-Saharan Africa, the causes of avoidable blindness are primarily, cataract (50 %), glaucoma (15 %), corneal opacities (10 %), trachoma (6.8 %), childhood blindness (5.3 %) and onchocerciasis (4 %) (WHO, 2009a). In Table 1 is given the global estimate of visual impairment.

1.1 Causes of Blindness and Visual Impairment

1.1.1 Cataracts of the Eye

Cataracts are formed in the lens of the eye which is behind the black dot (pupil) in the middle of the eye. It is a clouding of the lens, which prevents a clear, sharp image being produced. A cataract forms because the lens is sealed in a capsule (pupil as shown in Fig. 1) and as old cells die they get trapped in the capsule, with time this causes a clouding over of the lens (Fig. 2.). This clouding results in blurred images. This is when the lenses become opaque meaning that no light goes through.

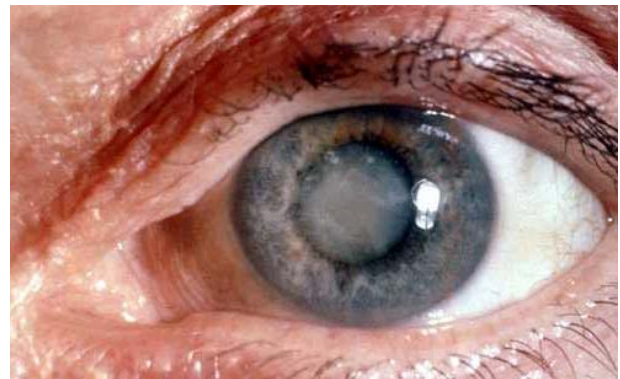


Figure 2. An eye with cataract
(Source: Microsoft Encarta reference library, 2007)

1.1.2 Glaucoma of the Eye

Another disease is called glaucoma (Figure 3). The most common type of this disease occurs in people who are 40 years or older and the other type occurs in babies when they are born. The eye produces a clear fluid (aqueous humor) from the lacrimal gland that fills the space between the cornea and the iris as shown in 3. This fluid produces tears to clean, moisten and lubricate the eyes and then drains the excess fluid into the nose through a complex drainage system. It is the balance

between the production and drainage of this fluid that determines the eyes intraocular pressure (IOP).

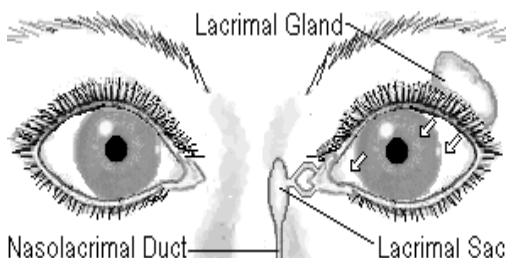


Figure 3. Glaucoma of the eye

1.1.3 Trachoma of the Eye

Trachoma popularly known in Ghana as “Apollo” is one of the oldest infectious diseases known to mankind. It is caused by *Chlamydia trachomatis* – a micro organism which spreads through contact with eye discharge from the infected person (on towels, handkerchiefs, fingers, etc.) and through transmission by eye-seeking flies. After years of repeated infection, the inside of the eyelid may be scarred so severely that the eyelid turns inward and the lashes rub on the eyeball, scarring the cornea (the front of the eye). If untreated, this condition leads to the formation of irreversible corneal opacities and blindness.

1.1.4 Age-Related Macular Degeneration

Macular degeneration makes people not see things at the center of their field of vision. This is a degenerative condition of the macula (the central retina). It is caused by the hardening of the arteries that nourish the retina. This deprives the retinal tissue of the nutrients and oxygen that it needs to function and causes deterioration in central vision. This disease cuts off the circulation of blood in the center of the retina. It can be treated with a laser. This loss of sight often occurs as people’s age increases.

1.1.5 Diabetic Retinopathy

Diabetic retinopathy happens to people who have diabetes mellitus for a few years. Diabetes changes the blood vessel of the retina. The retina is the part of the eye that absorbs light rays. Sometimes the blood vessels will burst and cause bleeding in the eye. Sometimes the retina is detached from the back of the eye. Another case is when fluid leaks from capillaries in the retina. If your retina is detached or you have bleeding in the eye

the clear fluid fills the center of the eye that can cause blindness.

1.2 Distribution of Visual Impairment

Visual impairment distribution is done according to age, gender, and geographical location factors.

1.2.1 Age

Visual impairment is unequally distributed across age groups. More than 82 % of all people who are blind are 50 years of age and older, although they represent only 19% of the world's population. Due to the expected number of years lived in blindness (blind years), childhood blindness remains a significant problem, with an estimated 1.4 million blind children below age 15 (WHO, 2009b).

1.2.2 Gender

Available studies consistently indicate that in every region of the world, and at all ages, females have a significantly higher risk of being visually impaired than males (WHO, 2009b).

1.2.3 Geographical Location

Visual impairment is not distributed uniformly throughout the world. More than 90% of the worlds visually impaired live in developing countries (WHO, 2009b).

1.3 Reading Techniques

Reading is an activity characterized by the translation of symbols, or letters, into words and sentences that have meaning to the individual. The ultimate goal of reading is to be able to understand written material, to evaluate it, and to use it for one's needs. Reading exposes people to the accumulated wisdom of human civilization. Mature readers bring to the text their experiences, abilities, and interests; the text, in turn, allows them to expand those experiences and abilities and to find new interests. In order to read, one must follow a sequence of characters arranged in a particular spatial order. For example, English flows from left to right, Hebrew from right to left, and Chinese from top to bottom. The reader must know the pattern and use it consistently.

Ordinarily, the reader sees the symbols on a page, transmit the image from the eye to the brain and pronounce them in the mind or aloud through the vocal cavity. However, reading techniques for the blind namely the Moon and the Braille are quite different from the sighted person. The technique employed by a blind is shown in Figure 4.



Figure 4. A person reading moon or braille.
(Source: Microsoft Encarta library, 2007)

Table 1. Global estimate of visual impairment

	African Region	Region of the Americas	Eastern Mediterranean Region	European Region	South-East Asia Region	Western Pacific Region	Total
Population	672.2	852.6	502.8	877.9	1,590.80	1,717.50	6,213.90
Number of blind people	6.8	2.4	4	2.7	11.6	9.3	36.9
Percentage of total blind	18 %	7 %	11 %	7 %	32 %	25 %	100 %
Number with low vision	20	13.1	12.4	12.8	33.5	32.5	124.3
Number with visual impairment	26.8	15.5	16.5	15.5	45.1	41.8	161.2

(Source: WHO, 2009b)

1.3.1 Braille

Braille is a writing system which enables blind and partially sighted people to read and write through touch. It was revised by Louis Braille (1809-1852), a French teacher of the blind. It consists of patterns of raised dots arranged in cells of up to six (6) dots in a 3 x 2 configuration as shown in Figure 5. Braille has been adapted to writing many different languages including even Chinese, and is also used for musical and mathematical notations. Each cell represents a letter, numeral or punctuation mark. Some frequently used words and letter combinations also have their own single cell patterns.

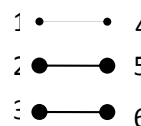


Figure 5. Six dots in 3 x 2 configuration

Braille can be categorized into the grades 1, 2, and 3. Grade 1 consists of the 26 standard letters of the alphabet and punctuation. It is only used by people who are first starting to read Braille. Secondly, grade 2

consists of the 26 standard letters of the alphabet, punctuation and contractions.

The contractions are employed to save space because a Braille page cannot fit as much text as a standard printed page. Books, signs in public places, menus, and most other Braille materials are written in Grade 2 Braille. Last but not least grade 3 which is used only in personal letters, diaries, and notes. It is a kind of shorthand, with entire words shortened to a few letters.

(1) Formation of Letters of the Alphabet in Brail

The formation of letters of the alphabet is best organized as: letters from A – J which are the first ten (10) upper dots followed by the letters from K – T which are letters formed by adding dot three (3) to each of the first ten letters, letters of from U – Z are formed by adding dot six (6). Table 2 gives the summary of table representation of basic letters and abbreviations of some words. Braille representation of words and abbreviations is presented in Table 3.

Table 2. Summarized table representation of basic letters

•	••	•••	••••	•••••	••••••	•••••••	••••••••	•••••••••	••••••••••	•••••••••••	••••••••••••	•••••••••••••
a	b	c	d	e	f	g	h	i	j	k	l	m
••••	•••••	••••••	•••••••	••••••••	•••••••••	••••••••••	•••••••••••	••••••••••••	•••••••••••••	••••••••••••••	•••••••••••••••	••••••••••••••••

(Source: Anon, 1999a)

Table 3. Braille representation of words and abbreviations

•	••	•••	••••	•••••	••••••	•••••••	••••••••	•••••••••	••••••••••	•••••••••••	••••••••••••	•••••••••••••
a	but	can	do	every	from	go	have	just	knowledge	like	more	not
••••	•••••	••••••	•••••••	••••••••	•••••••••	••••••••••	•••••••••••	••••••••••••	••••••••••~	••••••••••••	••••~	•••••
people	quite	rather	so	that	us	very	will	it	you	as	and	for
••••	•••••	••••••	••	•••	••••	•••••	••••••	•••••••	••••••••	•••••••••	••••••••••	••
of	the	with	child/ch	gh	shall/sh	this/th	which/wh	ed	er	out/ou	ow	bb
••	•••	••••	•••••	••••••	•••••••	••••••••	•••••••••					
cc	dd	en	gg; were	in	st	ing	ar					

(Source: Anon, 1999a)

(2) Sample Texts in Braille

The Braille text below in Figure 6 is transliterated to mean, “Be kind to others”



Figure 6. Braille representation of "Be Kind to Others"

Braille text in Figure 7 below is the article 1 of the universal declaration of human rights.

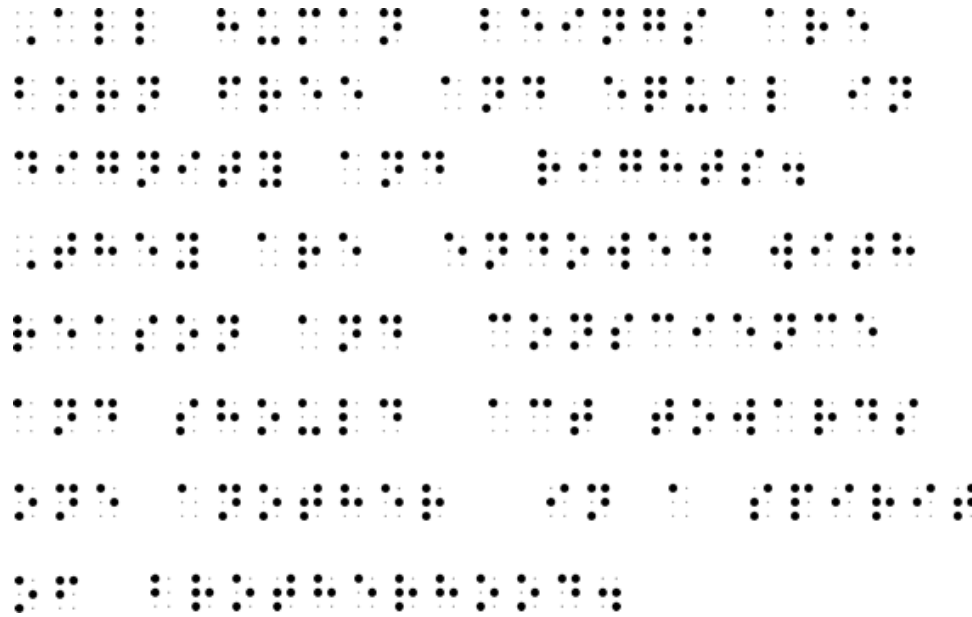


Figure 7. Article 1 of the universal declaration of human rights in braille
(Source: Anon, 1999a)

A	B	C	D	E	F
G	H	I	J	K	L
M	N	O	P	Q	R
S	T	U	V	W	X
Y	Z	AND	THE	?	?
:	,	-	'	<	>

Figure 8. The moon alphabets (Source: Anon, 1999b)

The text in Figure 7 is transliterated as “All human beings are born free and equal in dignity and rights. They are endowed with reason and conscience and should act towards one another in a spirit of brotherhood.”

1.3.2 The Moon Alphabets

The Moon system of embossed reading was invented in 1845 by Dr William Moon of East Sussex.

The Moon is a simple method of reading based upon the standard alphabet. The Moon alphabet is made up of 14 characters used at various angles, each with a clear bold outline. For many elderly blind people especially, Moon is easier than the more complex Braille system, although many people gain confidence from learning Moon to move onto Braille. The Moon alphabets are presented in Figure 8.

2. Materials and Methods

2.1 Signal Processing and Reading Machine Technologies

Signal processing is the extraction of information bearing attributes from measured data, and any subsequent transformation of those attributes for the purposes of detection, estimation, classification, or waveform synthesis. It is observed that the signals typically used in signal processing are functions of time, such as temperature measurements, velocity measurements, voltages, blood pressures, earth motion, and speech signals. Most of these signals are initially continuous signals (also called analogue signals) which are measured by sensors that convert energy to electricity. Some of the common types of sensors used for collecting data are microphones, which measure acoustic or sound data; seismometers, which measure earth motion; photocells, which measure light intensity; optical scanners, which measure printed character representation; thermistors, which measure temperature; and oscilloscopes, which measure voltage.

When continuous electrical signals are collected from sensors, the continuous signal is converted to a digital signal (a sequence of values) with a piece of hardware called an analogue-to-digital (A/D) converter. Once digital signals are collected, computer could be applied to digital signal processing (DSP). These DSP techniques are designed to perform a number of operations such as: removing noise that is distorting the signal, extracting information from the signal, separating components of the signal, encoding the information in a more efficient way for transmission, detecting information in a signal just to mention a few of signal processing techniques. For some applications, an analog or continuous output signal is needed, and thus a digital-to-analogue (D/A) converter is used to convert the modified digital signal to a continuous signal. Another device called a transducer can be used to convert the continuous electrical signal to another form; for example, a speaker converts a continuous electrical signal to an acoustical signal.

In this section the three basic signals processing techniques for a reading machine are presented first from a theoretical point of view, secondly from an implementation point of view, and lastly from an applications point of view. The theoretical point of view includes the development of mathematical models and the development of software algorithms and computer simulations to evaluate and analyze the models both with simulated data and with real data. Real-time implementation can use VLSI (very large scale integration) techniques, with commercial DSP chips, or it can involve custom design of chips, MCMs (multichip modules), or ASICs (application-specific integrated circuits).

2.2 Mathematical Model: Fourier Transform

The Fourier transform is a mathematical tool that is used to expand signals into a spectrum of sinusoidal components to facilitate signal analysis and system performance. The Fourier transform is also used for spectral analysis, or for spectrum shaping that adjusts the relative contributions of different frequency components in the filtered result. In other applications the Fourier transform is important for its ability to decompose the input signal into uncorrelated components, so that signal processing can be more effectively implemented on the individual spectral components. Decorrelating properties of the Fourier transform are important in frequency domain adaptive filtering, sub band coding, image compression, and transform coding.

Classical Fourier methods such as the Fourier series and the Fourier integral are used for continuous-time (CT) signals and systems, i.e., systems in which the signals are defined at all values of t on the

continuum $-\infty < t < \infty$. A more recently developed set of discrete Fourier methods, including the discrete-time (DT) Fourier transform and the discrete Fourier transform (DFT), are extensions of basic Fourier concepts for DT signals and systems. A DT signal is defined only for integer values of n in the range $-\infty < n < \infty$. Fourier methods are particularly useful as a basis for digital signal processing (DSP) because it extends the theory of classical Fourier analysis to DT signals and leads to many effective algorithms that can be directly implemented on general computers or special-purpose DSP devices.

2.2.1 Classical Fourier Transform for CT Signals

The CT Fourier transform is useful in the analysis and design of CT systems, i.e., systems that process CT signals. Fourier analysis is particularly applicable to the design of CT filters which are characterized by Fourier magnitude and phase spectra,

i.e., by $|H(j\omega)|$ and $\arg. H(j\omega)$, where $H(j\omega)$ is

commonly called the frequency response of the filter.

A CT signal $s(t)$ and its Fourier transform $S(j\omega)$ form a

transform pair that are related by the equation (1) for any $s(t)$ for which the integral (1a) converges (Madisetti and Williams, 1999):

$$s(j\omega) = \int_{-\infty}^{\infty} s(t) e^{-j\omega t} dt \quad (1a)$$

$$s(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} s(j\omega) e^{j\omega t} dt \quad (1b)$$

Equation (1a) is simply called the Fourier transform, whereas Eq. (1b) is called the Fourier integral. The

relationship $S(j\omega) = F\{s(t)\}$ denotes the Fourier

transformation of $s(t)$, where $F\{\}$ is a symbolic notation

for the integral operator and where ω is the continuous frequency variable expressed in radians per second. A transform pair $s(t) \leftrightarrow S(j\omega)$ represents a one-to-one invertible mapping as long as $s(t)$ satisfies that condition which guarantee that the Fourier integral converges.

The operation of uniformly sampling a continuous time signal $s(t)$ at every T sec is characterized by Eq. 2 presented below:

$$s_a(t) = \sum_{n=-\infty}^{\infty} s_a(t) \delta(t - nT) \tag{2}$$

$$= \sum_{n=-\infty}^{\infty} s_a(nT) \delta(t - nT)$$

Where, $\delta(t)$ is a symbol used to denote a CT impulse function that is defined to be zero for all $t \neq 0$, undefined for $t = 0$, and has unit area when integrated over the range: $-\infty < t < \infty$. Since $s_a(t)$ is in fact a CT signal, it is appropriate to apply the CT Fourier transform to obtain an expression for the spectrum of the sampled signal:

$$F\{s_a(t)\} = F\left\{\sum_{n=-\infty}^{\infty} s_a(nT) \delta(t - nT)\right\} \tag{3}$$

$$= \sum_{n=-\infty}^{\infty} s_a(nT) [e^{j\omega T}]^{-n}$$

Since the expression on the right-hand side of Eq. (3) is a function of $e^{j\omega T}$ it is customary to express the transform as $F(e^{j\omega T}) = F\{s_a(t)\}$. If ω is replaced with a normalized frequency, $\omega' = \omega / T$, so that $-\pi < \omega' < \pi$, then the right side of Eq. 3 becomes identical to the discrete time Fourier transform that is defined directly for the sequence $s[n] = s_a(nT)$ (Madisetti and Williams, 1999).

2.2.2 DT Fourier Transform

The DT Fourier transform (DTFT) is obtained directly in terms of the sequence samples $s(n)$ by taking the relationship obtained in Eq. (3) to be the definition of the DTFT. By letting $T = 1$ so that the sampling period is removed from the equation and the frequency

variable is replaced with a normalized $\omega' = \omega T$, the DTFT pair is defined by Eq. (4). In order to simplify notation it is not customary to distinguish between ω

and ω' , but rather to rely on the context of the discussion to determine whether ω refers to the normalized ($T = 1$) or to the unnormalized ($T \neq 1$) frequency variable.

$$S(e^{j\omega'}) = \sum_{n=-\infty}^{\infty} s[n] e^{-j\omega' n} \tag{4a}$$

$$s[n] = \frac{1}{2\pi} \int_{-\pi}^{\pi} S(e^{j\omega'}) e^{jn\omega'} d\omega' \tag{4b}$$

The spectrum $S(e^{j\omega'})$ is periodic in ω' with period 2π the fundamental period in the range $-\pi < \omega' < \pi$

sometimes referred to as the baseband, is the useful frequency range of the DT system because frequency components in this range can be represented unambiguously in sample form (without aliasing error). In much of the signal-processing literature the explicit primed notation is omitted from the frequency variable. However, when so many related Fourier concepts are discussed within the same framework.

By comparing (Madisetti and Williams, 1999) Eqs. (3)

and (4a), and noting that $\omega' = \omega T$ we see that:

$$F\{s_a(t)\} = DTFT\{s[n]\} \tag{5}$$

Where,

$$s[n] = s(t) \Big|_{t=nT}$$

This demonstrates that the spectrum of $s_a(t)$ as calculated by the CT Fourier transform is identical to the spectrum of $s[n]$ as calculated by the DTFT. Therefore, although $s_a(t)$ and $s[n]$ are quite different sampling models, they are equivalent in the sense that they have the same Fourier domain representation.

A reading machine relies on three basic technologies as follows:

- Scanner technology to scan an image into computer memory
- Digital image processing or optical character recognition (OCR) technology to convert the image to text
- Text-to-speech (TTS) technology to convert the text into intelligible speech.

3. Results

The reading machine, is the combination of three ubiquitous technologies, namely the scanner technology, the optical character recognition technology, and the text-to-speech technology.

3.1 Composite Parts of Reading Machine

3.1.1 Scanner

The scanner technology comprising the lamp, mirror, lens, CCD, and ADC converts the printed text to a bitmapped signal that is easily interpreted by the processor. The IRIS-Pen handheld scanner is the most fit for this work. It works just like a highlighter. Simply slide it over printed information from books, newspapers, magazines, faxes, letters, spreadsheets etc. and instantly it converts words and numbers into the reading processor application.

3.1.2 Processor

The processor, which engulfs the digital image processing technology and the text-to-speech technology, is the brain behind the entire operation. The output signal from the digital image processing is fed into the front-end compartment of the TTS. This first part has to process the signal through: text analysis, phonetic analysis, and prosodic analysis. A phoneme is

the sound associated with each letter. These signals in turn drive the speech synthesizer circuits in the back-end block compartment. Fig. 9 gives the block diagram representation of the reading machine.

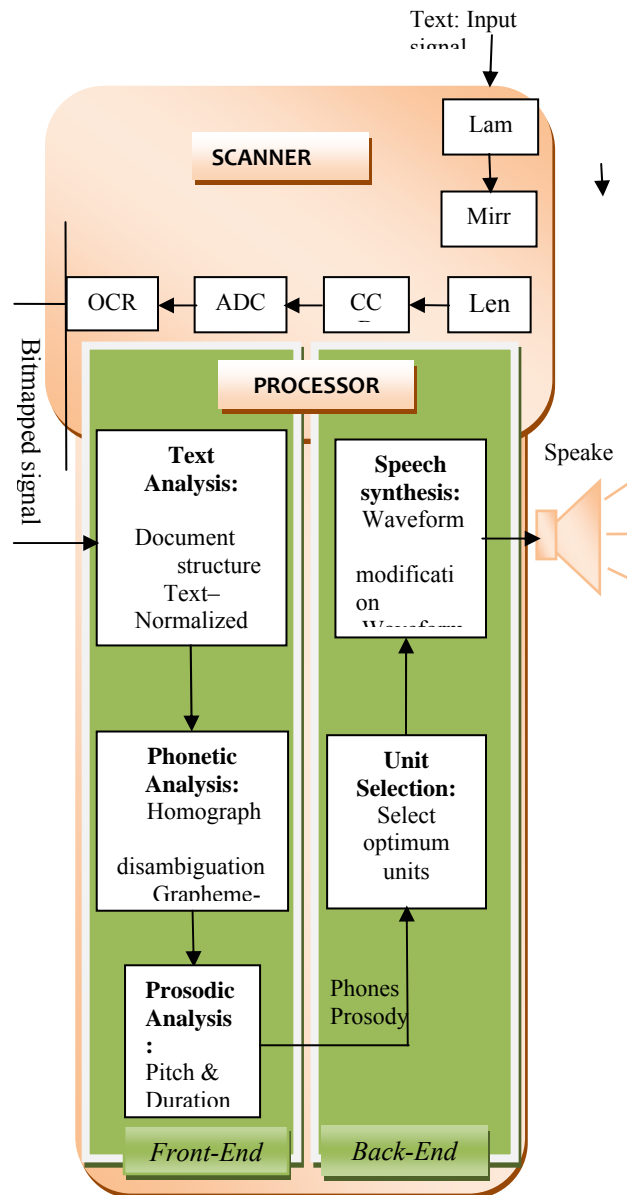


Figure 9. Block diagram of reading

4. Discussion

4.1 Operation of Reading Machine

The sequence of operation of the reading machine begins when the scanner using an integrated scanning array scans the letters in each word and feeds the data directly into the processor. The Euraka handheld scanner and Iris-Pen express 6 handheld scanner are capable of doing this work perfectly. The Iris-Pen hand held scanner has these technical specifications: an universal serial bus (USB) interface, a personal computer platform, 16-bit (64 k colors) maximum color depth and dimensions; width 1.41 inch, depth 0.94 inch, height 5 inch and weight 0.24 lb. Figure 10 shows samples.



Figure 10. Sample of Iris-Pen handheld Scanners (Source: Anon, 2000)

A shape analysis program identifies the words and convert them into bitmap text code. If necessary, other programs using contextual and other clues assist in the identification. The TTS processes are made up of two giant blocks namely the front-end and back-end blocks.

4.1.1 Front-End Processing

The front-end section accepts text as input and produces a sequence of phones and associated prosody at its output. The front-end section can be subdivided into three distinct blocks: text analysis, phonetic analysis, and prosodic analysis.

The text analysis block performs a preprocessing step to analyze the document structure and organize the input sentences into manageable lists of words. In particular, punctuation must be correctly handled. For example, the text analysis block must understand that the colon in '23:45' indicates a time, and to disambiguate between an end of sentence period and decimal point such as in the sentence 'It is 3.14 miles to the city.' Text normalization deals with transforming abbreviations, acronyms, numbers, dates, and times into full text. This requires careful processing. For example, '20/08/1976' must be transformed into 'twentieth of

August nineteen seventy six' and not erroneously as 'twenty forward slash zero eight forward slash one thousand nine hundred and seventy six'. It should be clear from these examples that the performance of the document structure and text normalization tasks is critical for ensuring accuracy of the TTS system. The text analysis block also performs some linguistic analysis. The part of speech category (e.g. noun, verb, adjective, etc.) for each word is determined based on its spelling.

The phonetic analysis block is concerned with grapheme-to-phoneme conversion (also called letter-to-sound conversion). Pronunciation dictionaries are employed at word level to provide the phonetic transcriptions. In order to keep the size of the dictionary manageable, words are generally restricted to morphemes. A set of morphophonemic rules is applied to determine how the phonetic transcription of a target word's morphemic constituents is modified when they are combined to form that word. Automatic grapheme-to-phoneme conversion based on rules is used for words not found in the dictionary as a fallback, though this approach is often error prone. The phonetic analysis block must also provide homographic disambiguation. For example 'how much produce do they produce?' Contextual information can aid in selecting the right pronunciation. A popular approach is to use a trained decision tree called a Classification and Regression Tree (CART) that captures the probabilities of specific conversions given the context.

The prosodic analysis block deals with determining how a sentence should be spoken in terms of melody, phrasing, rhythm, and accent locations – factors critical to ensure both intelligibility and naturalness of the resultant speech. From the perspective of the speech signal, prosody manifests as dynamic pitch changes, amplitude and duration of phones, and the presence of pauses.

4.1.2 Back-End Processing

The back-end stage of a concatenative TTS synthesizer consists of storing, selecting, and smoothly concatenating prerecorded segments of speech (units) in addition to modifying prosodic attributes such as pitch and duration of the segments i.e. subject to the target prosody supplied by the front-end. This section takes into account some of the key design questions such as: what unit of speech to use in the database, how the optimum speech units are chosen given phonetic and prosodic targets, how the speech signal segments are represented or encoded, and how prosodic modifications can be made to the speech units.

Different types of speech unit may be stored in the database of a concatenative TTS system. Obviously, whole words may be stored. However, whole word units are impractical for general TTS due to the prohibitively

large number of words that would need to be recorded for sufficient coverage of a given language. Also, the lack of coarticulation at word boundaries results in unnatural sounding speech.

Modern speech synthesizers have evolved away from using databases with a single, 'ideal' diphone for a given context to databases containing thousands of examples of a specific diphone. By selecting the most suitable diphone example at runtime, and in many cases avoiding making quality-affecting prosodic adjustments to the segment, significant improvements in the naturalness of the speech can be obtained.

4.2 Software Implementation

Speech synthesis markup language (SSML) is a standard, extensible markup language (XML-based), markup annotation for instructing speech synthesizers how to convert written language input into spoken language output employed by NaturalReader software. SSML is primarily intended to help application by controlling aspects of the speech output such as pronunciation, volume, pitch and rate. SSML can also express playback of prerecorded audio.

4.2.1 Document Structure

SSML documents are identified by the media type application/ssml+xml. Table 4 summarizes the elements and attributes defined in SSML. The basic structure of an SSML document is illustrated in Figure 11:

```
<?xml version="1.0" encoding="UTF-8"?>
<speech version="1.0">
```

```
xmlns="http://www.w3.org/2001/10/synthesis"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.w3.org/2001/10/synthesis
http://www.w3.org/TR/speech-synthesis/synthesis.xsd"
xml:lang="en-GB">
Hello world!
</speech>
```

Figure 11. Sample structure of SSML document (Burke, 2007)

All SSML documents include the root element <speech>. The version attribute indicates the version of SSML and is fixed at 1.0. The default namespace for the SSML <speech> element and its children is indicated by the xmlns attribute and is defined as http://www.w3.org/2001/10/synthesis. The xmlns:xsi attribute associates the namespace prefix of xsi to the namespace name http://www.w3.org/2001/XMLSchema-instance. The namespace prefix is defined since it is needed for the attribute, xsi:schemaLocation.

The xsi:schemaLocation attribute indicates the location of the schema to validate the SSML document against. The xml:lang attribute indicates the language for the document and optionally also indicates a country or other variation. The format for the xml:lang value follows the language tag syntax. Table 4 illustrates examples of language identifiers.

The <p> element and <s> element can be used explicitly to demarcate paragraphs and sentences.

Table 4 Elements and Attributes Defined in SSML

Elements	Attributes	Description
<Speech>	Version Xmlns Xml:lang xmlns:xsi xsi:schemaLocation xml:base	Root element for SSML documents.
<lexicon>	uri type	References an external pronunciation lexicon document
<p>	xml:lang	Explicitly demarcates a paragraph
<s>	xml:lang	Explicitly demarcates a sentence
<audio>	src	Inserts a recorded audio file.
<phoneme>	ph alphabet	Provides a phonemic/phonetic pronunciation for the contained text.
<sub>	alias	Provides acronym / abbreviation expansions.
<say-as>	interpret-as format	Used to indicate information on the type of text construct contained within the element.

	detail	
<break>	time strength	Controls the pausing or other prosodic boundaries between words.
<emphasis>	level	Requests that the contained text be spoken with emphasis.
<voice>	xml:lang gender age variant name	Requests a change to the speaking voice
<prosody>	pitch contour range rate duration volume	Provides control of the pitch, speaking rate and volume of the speech output.
<mark>	name	Places a marker into the text/tag sequence.
<meta>	name http-equiv content	Contains metadata for the document
<metadata>	—	Contains metadata for the document

(Burke, 2007)

4.2.2 Interpreting Text

The <say-as> element is used to indicate information about the type of text construct contained within the element and to help specify the level of detail for rendering the contained text. Interpreting the contained text in different ways will typically result in a different pronunciation of the content (although a speech synthesizer is still required to pronounce the contained text in a manner consistent with how such content is normally produced for the language).

The <say-as> element has three attributes: interpret-as, format and detail. The format, and detail attributes are optional. The <interpret-as> attribute indicates the content type of the contained text construct, e.g. date to indicate a date, or telephone to indicate a telephone number. The optional format attribute provides further hints on the precise formatting of the contained text, e.g. a value of dmy could be used to indicate that a date should be spoken in the format of date, then month, then year. The optional detail attribute indicates the level of detail to be spoken although it is not defined for many interpret-as types.

In Figure 12 below are some common examples of <say-as>:

```
<say-as          interpret-as="date"
format="mdy">2/3/2006</say-as>
<!-- Interpreted as 3rd of February 2006 -->
<say-as          interpret-as="time"
format="hms24">01:59:59</say-as>
<!-- Interpreted as 1 second before 2 o'clock in
the morning -->
```

Figure 12. Sample structure of prosodic interpretation. (Burke, 2007)

4.3 Power Management

Li-Ion batteries are leading edge battery technology and are an ideal selection for use on portable computers and cellular phones due to their high energy density and high voltage. A typical Li-Ion cell is rated at 3.6V and this is three times more than the typical NiCd or NiMH cell voltage (1.2V).

4.3.1 Features of Lithium Ion Batteries

These features are as follows:

- High energy density that reaches 400 Wh/L (volumetric energy density) or 160 Wh/Kg (mass energy density).
- High voltage. Nominal voltage of 3.6 V or even 3.7 V on newer Li-Ion batteries.
- No memory effect. Can be charged any time, but they are not as durable as NiMH and NiCd batteries.
- High charge currents (0.5-1A) that lead to small charging times (around 2-4 hours).
- Flat discharge voltage allowing the device to stable power throughout the discharge period.
- Typical charging Voltage $4.2 \pm 0.05V$.
- Charging method: constant current - constant voltage (CV-CC).
- Typical operation voltage 2.8 V to 4.2 V
- Recommended temperature range 0-4 °C

4.3.2 Safety Circuits inside the Li-Ion Battery Pack

Inside a Li-Ion battery pack there is always a safety circuit that consists of four main sections: the controller IC, control switches, temperature fuses, and the thermistor (Figure 13). The controller IC monitors each cell (or parallel cells) voltage and prevents the cells to overcharge or over discharge controlling accordingly the cutoff switches. Also the voltage across the switches is monitored in order to prevent over current. The control switches usually comprise FET

structures that cutoff the charge or discharge depending on the control signals of the controller IC. The temperature fuses cutoff the current if the control switches experience abnormal heating. This fuse is not recoverable. The thermistor, usually called PTC measures the battery temperature inside the pack. Its terminals are connected to the charger so it can sense the temperature of the pack and control the charge current until the battery is fully charged.

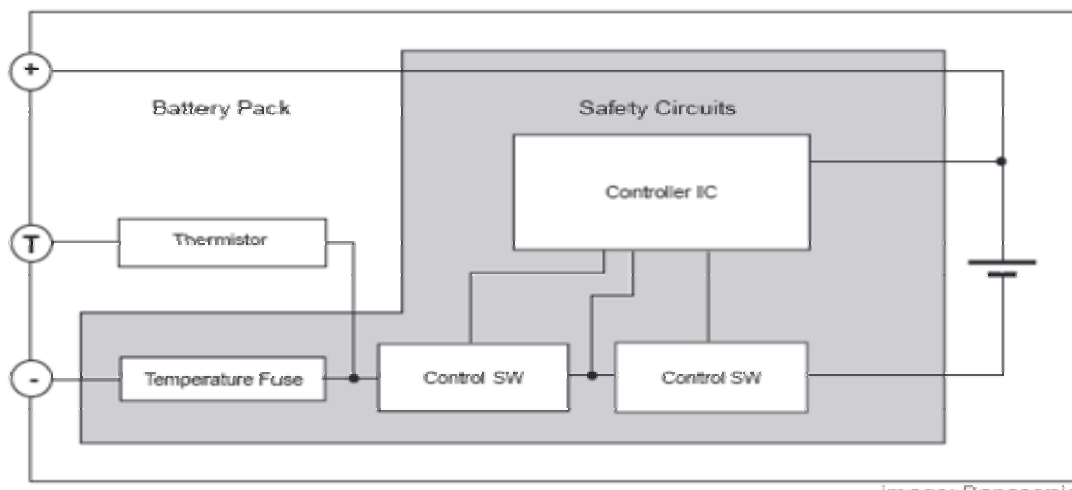


Figure 13. A typical block diagram of Li-Ion battery pack
(Source: Anon, 2004)

5. Conclusions

The architecture of a reading machine designed to achieve a high rate of correct interpretation of text by the blind and visually impaired has been presented. Three ubiquitous technologies were invoked: the scanner, the optical character recognition, and text-to-speech technologies. Multiple algorithms in a Fourier transform domain were used in signal and image processing. With the implementation of the reading machine developed, the feasibility of reading unconstrained printed materials will be achieved and information should be carried indiscriminately to the blind and visually impaired.

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Renal Stem Cell

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Abstract: The renal disease is a common problem in human society. End-stage renal disease is a big health problem in the United States and in all places of the world. Embryonic stem cells, pluripotent derivatives of the inner cell mass of the blastocyst, are the most primitive cell type likely to find application in cell therapy. Their potential to generate any cell type of the embryo makes them to be the most attractive stem cell therapy. It is possible to introduce stem cells into a damaged adult kidney to aid in repair and regeneration. Transdifferentiation offers the possibility of avoiding complications from immunogenicity of introduced cells by obtaining the more easily accessible stem cells of another tissue type from the patient undergoing treatment, expanding them in vitro, and reintroducing them as a therapeutic agent. Adult stem cells may possess a considerable degree of plasticity in the differentiation. Immunoisolation of heterologous cells by encapsulation creates opportunities for their safe use as a component of implanted or ex vivo devices. [Journal of American Science. 2009;5(5):213-222]. (ISSN 1545-4570).

Keywords: stem cell; renal; kidney; disease; treatment

1. Introduction

Normally to say, stem cells could grow to all kinds of cells. In animal tissues stem cells serve as an internal repair system to replace other cells as long as the life is still alive. When a stem cell divides, it could remain a stem cell or become another type of adult cell, such as a muscle, nerve, red blood or a sperm cell. Stem cell is the origin of an organism's life (Ma, 2005).

End-stage renal disease (ESRD) is a big health problem in the United States and it costs more than US\$30 billion each year on ESRD therapy in USA (Arnold, 2000; Mai et al., 2006; Ross et al., 2006). It is estimated that there are over 2 million patients in USA who suffer from ESRD. Chronic kidney disease is increasing at the rate of 6-8% per year in the United States. The acute renal failure (ARF) is even worse. The cause of death by ARF is generally the development of systemic inflammatory syndrome. It is important to know the kidney's role in reclamation of metabolic substrates and there is considerable drive to develop improved therapies for renal failure (Mehta et al., 2007). About 60,000 patients in the United States are waiting for a kidney transplant, and some patients have waited for several years before an appropriate donor can be found. The shortage of donor organs limits treatment for the ESRD patients and requires many patients to make dialysis to extend the life time. At present, dialysis and transplantation are the common treatment options. However, it is possible to use stem cells and regenerative medicine for kidney disease treatment

(Hopkins et al. 2009). The alternate methods stem cell therapy is offering new hope for the renal dysfunction patients (Berzoff et al., 2008; Sirmon, 1990).

The kidney dialysis and transplantation techniques have been proved successful, but are marred by inflammation and limited organ availability and graft survival due to immune rejection. Recently, hope has been placed in the development of stem cell therapies. Possible sources for these cells include differentiated embryonic stem (ES) cells and adult renal stem cells. Using the patient's own stem cells to repair kidney damage could circumvent the problems of immune rejection and organ availability.

Embryonic stem cells are the stem cell that can be grown in large numbers in the laboratory and retain the ability to grow into any type of cells including renal, nerve, heart muscle, bone and insulin-producing cells. Adult stem cells, such as skin, nerve and bone marrow stem cells, normally grow into a limited number of cell types (Snykers et al. 2008). The role of embryonic or adult stem cells, in particular bone marrow-derived stem cells, in regenerating the kidney after injury has been the subject of intensive investigation. Bone marrow-derived stem cells have been shown to give rise to small numbers of most renal cell types, including tubular cells, mesangial cells, podocytes, vascular cells and interstitial cells. Injections of bone marrow-derived cells do improve renal function in many animal models of renal disease. Many stages of nephrogenesis can be studied using cultured embryonic kidneys. ES cells

have unlimited developmental potential and can be manipulated at the molecular genetic level by a variety of methods. ES cell technology may obtain a versatile cell culture system in which molecular interventions can be used in vitro on the normal kidney development program in vivo can be studied (Steenhard et al. 2005).

Stem cells and progenitor cells are necessary for repair and regeneration of injured renal tissue. Many factors influence the stem cell growth in damaged kidney. For example, low levels of erythropoietin induce mobilization and differentiation of endothelial progenitor cells and erythropoietin ameliorates tissue injury. Full regeneration of renal tissue demands the existence of stem cells and an adequate local milieu, a so-called stem cell niche. Stem cell may eventually contribute to novel therapies of the kidney disease (Perin et al. 2008).

Recently researchers used a rat model of chronic renal failure in which one kidney is excised so as to increase the load of the remaining kidney, thus causing a chronic deterioration that resembles the clinical situation of renal failure (Alexandre et al. 2008). In Alexandre's project, the rats were divided into 4 groups: Group 1 were sham operated and both kidneys left in place; Group 2 had a kidney removed but were not administered cells; Group 3 were administered 2×10^6 lineage negative bone marrow cells on day 15 after one of the kidneys was removed; Group 4 were administered 2×10^6 lineage negative bone marrow cells on days 15, 30, and 45 after one of the kidneys was removed. They found: (1) Expression of inflammatory cytokines was reduced on day 16 in the kidneys of rats receiving stem cells as compared to rats that were nephrectomized but did not receive cells. (2) On day 60 rats receiving stem cells had decreased proteinuria, glomerulosclerosis, anemia, renal infiltration of immune cells and protein expression of monocyte chemoattractant protein-1, as well as decreased interstitial area. (3) Injured rats had higher numbers of proliferating cells in the kidney, whereas rats receiving stem cells had less. (4) Protein expression of the cyclin-dependent kinase inhibitor p21 and of vascular endothelial growth factor increased after nephrectomy and decreased after stem cell treatment. (5) On day 120, renal function (inulin clearance) was improved in the rats which were administered bone marrow cells compared to controls. This study supports the possibility of using bone marrow cells for various aspects of kidney failure. Other studies have demonstrated that administered stem cells promote kidney repair by secretion of insulin growth factor-1 (Cornelissen et al. 2008).

Bone marrow stromal cells, also known as mesenchymal stem cells or fibroblastic colony-forming units, are multipotent non-hematopoietic stem cells

adhering to culture plates (Abdallah and Kassem 2009). Mesenchymal stem cells of the bone marrow have the ability to renew and differentiate themselves into multiple lineages of conjunctive tissues, including bone, cartilage, adipose tissue, tendon, muscle, and bone marrow stroma. Those cells have been first described by Friedenstein et al., who found that mesenchymal stem cells adhere to culture plates, look like in vitro fibroblasts, and build up colonies (Friedenstein et al. 1987).

Bone marrow is the site of hematopoiesis and bone marrow transplant has been successfully used for decades as a means of treating various hematological malignancies in which the recipient hematopoietic compartment is replaced by donor-derived stem cells. Progenitor cells in bone marrow are capable to differentiate into other tissues, such as cardiac tissue. Clinical trials have been conducted demonstrating beneficial effects of bone marrow infusion in cardiac patients. It is believed that injured tissue, whether neural tissue after a stroke, or injured cardiac tissue, has the ability to selectively attract bone marrow stem cells, perhaps to induce regeneration. Bone marrow has therapeutic effect in conditions ranging from liver failure, to peripheral artery disease, and the possibility of using bone marrow stem cells in kidney failure has been relatively understudied (Ma et al. 2009).

Mesenchymal stem cells have been brought to the attention of many researchers, because these cells are of great interest for treating various human diseases. Many studies have isolated mesenchymal stem cells and controlled, in vitro, its differentiation into cartilaginous tissue and bone using specific growth factors, with the objective of using this technology for repairing injured tissues of mesenchymal origin (Xian and Foster 2006; Kurdi and Booz 2007).

The origins for renal parenchymal cells could be: (1) re-entry into cell cycle of differentiated cells; (2) direct transdifferentiation of one cell type into another; (3) differentiation from stem cells of the kidney.

2. Native Renal Stem Cells and Renal Regeneration

In embryo, most types of renal parenchymal cells are derived from metanephric mesenchymal cells. In animal models, embryonic metanephroi transplanted into the abdominal cavity of adult animals are colonized by host vasculature, undergo nephrogenesis and produce urine, even if the operation is carried out across species barriers, and with a surprising lack of rejection (Little 2006). Human and porcine embryonic kidney progenitor cells have been isolated and, when injected into mice, can lead to the formation of miniature kidneys producing urine (Dekel et al. 2003), or protect against acute renal failure (Lazzeri et al. 2007). However, there are ethical issues to deal with human ES

cells. It is important to identify the stem cells. In adult mammals, many methods have been used to identify potential multipotent precursor cells, such as label retention in slow cycling cells, identification of a side population, and expression of stem cell markers (e.g. CD133), etc. This has led to the identification of several candidate renal stem cells which are located amongst the tubular cell population (Dekel et al. 2006; Gupta et al. 2006), in the Bowman's capsule, papillary region or cortical interstitium (Bussolati et al. 2005; Sagrinati et al. 2006; Rad et al. 2008). Of note, other studies have not confirmed the presence of a large pool of precursor cells amongst the tubular population and instead argue that regeneration occurs through proliferation of differentiated tubular cells (Vogetseder et al. 2008; Witzgall 2008). Some of the candidate renal stem cells have been shown to enhance recovery after tubular injury, possibly by integration in the tubular epithelium (Rad et al. 2008).

3. Bone Marrow-Derived Stem Cells and Renal Regeneration

Bone marrow stem cells would be an ideal source of multipotent cells: they are an unlimited source of expandable autologous cells, plasticity and easy to harvest. The plasticity has been observed both for the haematopoietic stem cell and for the bone marrow mesenchymal stem cells. There are important discrepancies in the literature addressing the role of bone marrow cells in renal regeneration. The bone marrow transplantation is the most common technique to study bone marrow cell plasticity. The host bone marrow is replaced by donor bone marrow, and after bone marrow chimerism is established, donor cells are tracked down in the kidney. The donor bone marrow cells are distinguished from host cells by virtue of their chromosome content, the expression of a reporter molecule (β -galactosidase, luciferase, enhanced green fluorescent protein), or the performance of a function (re-establishment of a function in a knockout mouse model). The type of host cell that the bone marrow-derived cell has given rise to (tubular, mesangial, etc.) is ascertained most often using immunohistochemistry.

Discrepancies between studies are attributable to several factors: (1) observations in different species (mouse, rat, human); (2) use of different models of renal damage (ischaemia/reperfusion, toxic, immunological); (3) different protocols for bone marrow transplantation (irradiation doses, quantity of cells injected); (4) injection of different subgroups of bone marrow cells (whole bone marrow, haematopoietic stem cell, mesenchymal stem cell); (5) sensitivity and specificity of the detection method for bone marrow cell origin (in situ hybridization for the Y chromosome, detection of reporter molecules,

functional assays), and (6) sensitivity and specificity of the detection method of the renal cell type (immunohistochemistry for specific cell types such as tubular cell, mesangial cells, etc.). Renal failure can be the result of an initial insult directed against the tubular epithelium, the glomerular cells or the vascular compartment. In the search for remedies for these varied renal diseases, studies have therefore addressed potential bone marrow origin for various renal cell types. It is useful to bear in mind these technical variations when analysing results reported in the literature (Roufosse and Cook 2008).

4. Tubular Epithelium

Only a small proportion of tubular cells are bone marrow-derived, and there is disagreement over whether mesenchymal stem cells, haematopoietic stem cells or both are contributing (Humphreys and Bonventre 2008). The predominant source of tubular regeneration is through the proliferation of differentiated tubular cells (Lin et al. 2005). A few authors have not found any bone marrow cells engrafted in tubules, and propose that positive observations of bone marrow-derived tubular cells are the result of artifact (Bussolati et al. 2009). Firstly, under certain circumstances, bone marrow engraftment in tubules can be dramatically increased. Held et al. made use of a transgenic fumarylacetoacetate (FAH)^{-/-} mouse, in which discontinuation of the rescue drug NTBC leads to acute tubular necrosis (Held et al. 2006). After transplanting bone marrow from wild-type mice into FAH^{-/-} mice, a few bone marrow-derived tubular cells are noted. In a subset of the FAH^{-/-} mice, there is, in addition, loss of heterozygosity (LOH) in the liver for homogentistic acid hydrogenase, which induces a more severe, ongoing form of acute tubular necrosis. In FAH^{-/-} animals with additional hepatic LOH, up to 50% of tubular cells are bone marrow-derived cells. Engraftment of these wild-type bone marrow-derived cells leads to morphological resolution of ATN and to disappearance of the aminoaciduria present in control mice. In this model, the bone marrow cells have a strong survival advantage over native tubular cells, due to their ability to metabolise toxic products. It is possible that this strong positive selective pressure is necessary for regeneration to occur through wild-type bone marrow cells. Interestingly, most of the bone marrow-derived tubular cells are derived from cell fusion between bone marrow cells and tubular cells. This is supported by a study by Li et al. in which fusion of bone marrow cells to tubular cells account for part of bone marrow-derived tubular cells after ischaemia/reperfusion (I/R) injury, but not all. In this model without selective pressure, the percentage of bone marrow-derived tubular cells is low (1.8%) (Li et al. 2007b). Secondly, although there is disagreement

concerning the underlying mechanism, injection of bone marrow cells, particularly mesenchymal stem cells, has repeatedly been shown to improve renal function in ATN, whether induced by toxins (cisplatin and glycerol) or I/R (Imai and Iwatani 2007). With the role of actual engraftment of bone marrow cells as tubular cells thought to be minimal or absent, mesenchymal stem cells may exert their beneficial effects through their antiapoptotic, mitogenic, immunomodulatory and angiogenic properties, or through the contribution of the bone marrow cells to endothelial cell replacement in the peritubular capillaries. It is important to know the nature of the mediators involved in these properties, and the mechanisms governing the homing of mesenchymal stem cells to the kidney (Imai and Iwatani 2007). Imberti et al. confirmed the importance of paracrine mechanisms using co-culture of mesenchymal stem cells with tubular cells in a Transwell® culture excluding contact between the two cell types, which led to less cisplatin-induced tubular cell death. mesenchymal stem cells have been shown to produce vascular endothelial growth factor, basic fibroblast growth factor, monocyte chemoattractant protein-1, hepatocyte growth factor, and insulin-like growth factor, as well as immunomodulators TGF- β and PGE₂ (Imai and Iwatani 2007; Imberti et al. 2007). In a recent study, administration of conditioned medium from cultured stromal cells provided the same renoprotective effects as injection of mesenchymal stem cells, suggesting that systemic administration of the beneficial mediators may be just as good as mesenchymal stem cell injection, and safer (Imberti et al. 2007). It is a concern that there have been a few observations of adipogenesis associated with fibrosis and osteogenesis after injection of mesenchymal stem cells (Imai and Iwatani 2007).

Mesenchymal stem cell homing to the kidney has been linked to interactions between molecules upregulated in the injured kidney (SDF-1, hyaluronic acid and PDGF) and ligands expressed on mesenchymal stem cells (respectively, CXCR4, CD44 and PDGF-R) (Imai and Iwatani 2007). Similar beneficial effects on renal function may be induced by mobilizing bone marrow cells from the patient's own bone marrow by administration of growth factors (GF) such as granulocyte colony-forming factor, granulocyte/monocyte colony-forming factor, monocyte colony-forming factor, and stem cell factor. Possible explanations for improved renal function include increased numbers of bone marrow-derived tubular cells, a decrease in neutrophilic infiltrate, or increased cell proliferation and decreased apoptosis in kidneys of GF-treated mice (Roufousse and Cook 2008).

The role the bone marrow-derived tubular cells play in improved renal function is probably insignificant, with intrinsic renal cells, either stem cells

or differentiated, more likely to play the predominant role in regeneration. Administration of bone marrow cells or mobilization of bone marrow cells using GF may be used to protect against renal injury. There may be a therapeutic role for bone marrow-derived cells engineered to replace a defective gene, due to a local strong positive selective pressure. mesenchymal stem cells have emerged as the most promising candidate for stem cell therapy, and appear safe, such that phase I clinical trials of mesenchymal stem cell injection for the treatment of acute kidney injury are scheduled to begin shortly (Imai and Iwatani 2007).

5. Isolation of Kidney Stem Cells

It is difficult to find a definitive marker for kidney stem cells that makes it difficult to isolate and define kidney stem cells. However, kidney stem cells have been isolated from other organs using 4 different ways. For the first method, when the DNA of the cells is labeled with a marker such as bromodeoxyuridine, the cells retain the label for a long period of time. This label retention is used to identify and isolate stem cells. The second method references the side-population (SP) cells that extrude Hoechst dye through the activity of multidrug resistance proteins, which are part of the ATP-binding cassette transporter superfamily. The third method isolates kidney stem cells referencing specific cell surface markers that have been used to identify stem cells in other organs or the metanephric kidney. The markers used to isolate kidney stem cells include Oct-4, Nanog, CD24, CD133 and stem cell antigen-1 (Sca-1). The fourth method uses culture conditions that select stem cells in other organ systems (<http://content.karger.com/produktedb/produkte.asp?typ=fulltext&file=000117311#SA4>).

As Zheng et al described in 2008, any unique characteristic can be used to isolate a pure population of stem cell is still lacking. There is few specific biomarker found for epidermal stem cells alone, but epidermal stem cells and transient-amplifying cells share some biomarkers (Bickenbach, 2003) (Zheng, et al, 2008).

6. Culture of Renal Stem Cell

Shimony et al characterized a new model of renal, stromal and mesenchymal stem cell (MSC) matrix deprivation, based on slow rotation cell culture conditions (ROCK). This model induces anoikis using a low shear stress, laminar flow. The mechanism of cell death was determined via FACS (fluorescence-activated cell sorting) analysis for annexin V and propidium iodide uptake and via DNA laddering. Their results showed while only renal epithelial cells progressively died in STCK, the ROCK model could induce apoptosis in stromal and transformed cells; cell survival decreased in ROCK versus STCK to 40%, 52%, 62%

and 7% in human fibroblast, rat MSC, renal cell carcinoma (RCC) and human melanoma cell lines, respectively. Furthermore, while ROCK induced primarily apoptosis in renal epithelial cells, necrosis was more prevalent in transformed and cancer cells [necrosis/apoptosis ratio of 72.7% in CaKi-1 RCC cells versus 4.3% in MDCK (Madin-Darby canine kidney) cells. The ROCK-mediated shift to necrosis in RCC cells was further accentuated 3.4-fold by H₂O₂-mediated oxidative stress while in adherent HK-2 renal epithelial cells, oxidative stress enhanced apoptosis. ROCK conditions could also unveil a similar pattern in the LZ100 rat MSC line where in ROCK 44% less apoptosis was observed versus STCK and 45% less apoptosis versus monolayer conditions. Apoptosis in response to oxidative stress was also attenuated in the rat MSC line in ROCK, thereby highlighting rat MSC transformation. They concluded that the ROCK matrix-deficiency cell culture model may provide a valuable insight into the mechanism of renal and MSC cell death in response to matrix deprivation (Shimony et al., 2008)

(1) Morphology and proliferation: Mixed population of cells with approximately 70% attached cells and the other 30% in suspension; need to change cell culture media every day after 48 hours of initial cell culture or when the media starts changing color to slight yellow for pink. Fast growing cell culture. Change media with Celprogen's Human Kidney Stem Cell Complete Growth Media with the appropriate Human Stem Cell Extracellular matrix and tissue culture media for differentiation, expansion or maintaining stem cells in their un-differentiated stage. Temperature 37°C in 5% CO₂ humidified incubator. Positive markers could be CD34, Nestin & CD133.

(2) Subculturing

- A. Thaw the vial with gentle agitation in a 37°C water bath or a dry 37°C shaking incubator. For water bath thawing
- B. Keep the O-ring out of the water, thawing time 2-3 minutes.
- C. Remove the thawed vial and wipe with 70% ethanol. Then transfer to the tissue culture hood.
- D. Transfer the vial contents to a 15 ml sterile centrifuge tube, and gently add 7 ml of pre-warmed Human Kidney Stem Cell Complete Media to the centrifuge tube. Use an additional 0.5 ml of Human Kidney Stem Cell complete media to rinse the vial and transfer the liquid to the centrifuge tube repeat this once more to ensure you have all the cells transferred to the 15 ml centrifuge tube. Add 1

ml of Human Kidney Stem Complete Media to bring the final volume to 10 ml in the 15 ml centrifuge tube.

- E. Centrifuge the cells at 100 g for 5 minutes. Remove the supernatant and resuspend the cell pellet in 500 ul of Human Kidney Stem Cell Complete Growth Media.
- F. Add the 500 ul of cells to T75 flask pre-coated with Human Kidney Stem Cell Extracellular matrix with 15 ml of Human Stem Cell Complete Growth Medium.
- G. Incubate the cells in the T75 flask in a 37°C in 5% CO₂ humidified incubator. Perform 100% Media Change every 24 to 48 hours.
- H. Medium renewal every day, and recommended sub-culturing ratio: 1:3.

(3) Freezing Medium: Human Stem Cell Complete growth Medium supplemented with 90% Fetal Bovine Serum with 10% DMSO.

(4) Storage temperature: liquid nitrogen vapor phase (San Pedro, CA 90731, USA, <http://www.celprogen.com>; http://ftp.celprogen.com/Technical_Resources/36100-27%20Human%20Kidney%20Stem%20cell%20data%20sheet.pdf).

7. Application of Kidney Stem Cells

Stem cell has powerful potential application purpose in science, medicine and industry, but it is also potentially danger for its unexpected plasticity. The evidence for bone marrow-derived stem cell contributions to renal repair has been challenged. The research and application for adult renal stem cells are also debated. The use of embryonic tissue in research continues to provide valuable insights but will be the subject of intense societal scrutiny and debate before it reaches the stage of clinical application. Embryonic stem cells, with their ability to generate all of kind of cell in living body, are great chance for our human civilization but have ethical and political hurdles for human use (Brodie and Humes, 2005). Stem cell research has attracted great attention because it could be used for the regeneration of damaged organs that are untreatable by conventional medical techniques, and stem cells (such as endothelial stem cells and neural stem cells) have been discovered to be practical useful in clinical applications. The potential for stem cell gene therapy has increased and many therapeutic applications have already been done. Chronic renal failure is a candidate for stem cell gene therapy. In the application of renal stem cell in medical treatment, mesenchymal stem cells could be transplanted, and in contrast, hematopoietic stem cells may be used for gene delivery for diseases, which need foreign cytokines and

growth factors, such as glomerulonephritis. The stem cell gene therapy for chronic renal failure and the potential of the novel strategy and the major practical challenges of its clinical application are big targets for the stem cell researches (Yokoo et al., 2003). Ectopic expression of the human telomerase reverse transcriptase gene in human mesenchymal stem cells can reconstitute their telomerase activity and extend their replicative life-spans (Li, et al, 2007).

8. Discussion

Kidney is derived from the ureteric bud and metanephrogenic mesenchyme, and these two progenitor cells differentiate into more than 26 different cell types in adult kidney. The ureteric bud contains the precursor of the epithelial cells of the collecting duct and the renal mesenchyme contains precursors of all the epithelia of the rest of the nephron, endothelial cell precursors and stroma cells, but the relatedness among these cells is unclear. A single metanephric mesenchymal cell can generate all the epithelial cells of the nephron, indicating that the kidney contains epithelial stem cells. These stem cells also are present in the adult kidney. Embryonic renal epithelial stem cells can generate other cell types (Al-Awqati and Oliver, 2002). The key important target in kidney stem cell research and application is to get kidney stem cells from other types of the cells, and it is also important to find the better way to change kidney stem cells to other cell types. As the nature will, to live eternally is an extracting dream in all the human history. Stem cell is the original of life and all cells come from stem cells. Germline stem cell (GSC) is the cell in the earliest of the cell stage. It is possible to inject the GSC into adult human body to get the eternal life. This article is to try to describe the stem cell and to explore the possibility of the eternal life with the stem cell strategy. The production of functional male gametes is dependent on the continuous activity of germline stem cells. The availability of a transplantation assay system to unequivocally identify male germline stem cells has allowed their *in vitro* culture, cryopreservation, and genetic modification. Moreover, the system has enabled the identification of conditions and factors involved in stem cell self-renewal, the foundation of spermatogenesis, and the production of spermatozoa. The increased knowledge about these cells is also of great potential practical value, for example, for the possible cryopreservation of stem cells from boys undergoing treatment for cancer to safeguard their germ line (Ma, et al, 2007).

It is possible to introduce stem cells into a damaged adult kidney to aid in repair and regeneration. Transdifferentiation offers the possibility of avoiding complications from immunogenicity of introduced cells by obtaining the more easily accessible stem cells of

another tissue type from the patient undergoing treatment, expanding them *in vitro*, and reintroducing them as a therapeutic agent. Adult stem cells may possess a considerable degree of plasticity in the differentiation. However, the differentiation of stem cells is normally unresolved. Pluripotent cells can be derived from fibroblasts by ectopic expression of defined transcription factors. A fundamental unresolved question is whether terminally differentiated cells can be reprogrammed to pluripotency (Hanna et al., 2008).

Developing nephrons are derived from renal stem cells and transplantation of fetal kidneys may be thought of as a therapeutic stem cell application. There are two bioengineering programs with the aim of producing a device providing full renal replacement therapy in the short to medium term. Both employ biomaterial scaffold structures to overcome the as yet insurmountable difficulties inherent in marshalling cells into organized three-dimensional structures capable of coordinated filtration, resorption / meta- / catabolism / secretion, collection, and disposal of waste. Initial experiments involved adult rabbit renal cortex harvested and fractionated into glomeruli, distal, and proximal tubules, expanded separately *in vitro*, and seeded onto biodegradable polyglycolic acid sheets for subcutaneous implantation into syngenic hosts. The potential impact of advances in stem cell technology on all the prospective cell-based therapeutic approaches for the treatment of renal failure discussed above is enormous. The kidney has a dramatic capacity to regenerate after injury. Whether stem cells are the source of the epithelial progenitors replacing injured and dying tubular epithelium is an area of intense investigation. Many surviving renal epithelial cells after injury become dedifferentiated and take on mesenchymal characteristics. These cells proliferate to restore the integrity of the denuded basement membrane, and subsequently redifferentiate into a functional epithelium. An alternative possibility is that a minority of surviving intratubular cells possess stem cell properties and selectively proliferate after damage to neighboring cells. Some evidence exists to support this hypothesis but it has not yet been rigorously evaluated (Vigneau et al., 2007).

In recent years, it has been shown that functional stem cells exist in the adult bone marrow, and they can contribute to renal remodelling or reconstitution of injured renal glomeruli, especially mesangial cells, and hMSC found in renal glomeruli differentiated into mesangial cells *in vivo* after glomerular injury occurred (Wong et al., 2008). In mice with cisplatin-induced acute kidney injury, administration of bone marrow-derived mesenchymal stem cells (MSC) restores renal tubular structure and improves renal function (Imberti et al., 2007).

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