HOW COMPUTERS FUNCTION

N.U. YAPA
Librarian
IIMI
Colombo

Introduction

Advent of the computers in Mid 20th century has been widely recognized as an event which could be consi- dered parallel or even overshadowing the events such as discovery of fire and invention of the wheel. The computer continues to change the way we work, learn and even think. Impact of the computer is visible in technical, economic, social, political and cultural activities of mankind.

The industrial revolution substituted mechanical power for human muscle power in the production of the goods. The computer substitutes electronic power for human brain power. The computer would perform several tasks more comprehensively, more speedily, more accurately and far more efficiently than the human brain. Its ability to store, retrieve and process data to produce information appears to give it powers previously thought to be uniquely possessed by the man. It helps us to solve our problems that we could not solve by ourselves. It has enhanced the capacities, accelerated development and re-defined the objectives of social, cultural and economic systems.

The computer keeps our accounts, plays games with us, directs our machines, helps to explore the universe and solve complex mathematical problems.

The computer technology and accompanying telecommunication technology are now propelling the world into an "information age" that will alter the entire course of man's development and the world works. During the last three decades the growth of the computer has shown remarkable progress. It has merged from a mere mathematical calculator to an automated equipment that performs complex jobs.

One would see the computer as a highly intelligent machine superseding the human brain and as a highly skilled machine which overpowers human talents. However, when looking closely, one would realize that the computer is unable even to recognize any similarity between "Iam" and "I am". Also it is unskilled and unable even to do two simple tasks simultaneously.

Computer is a machine and hence it has to be operated. It cannot perform any task without instructions. Computers need electricity to work. Moment the power is disconnected, it becomes a dead machine. Computers can do only one task at a time. It can sense only two things; whether electricity is present or absent.

In contrary to the statements given in the introductory paragraphs, one would decide that computer is an electric machine which performs a single instruction at a time by recognizing the existence of electricity. On the other hand, one should not dispute the power of the computer to do complicated and complex

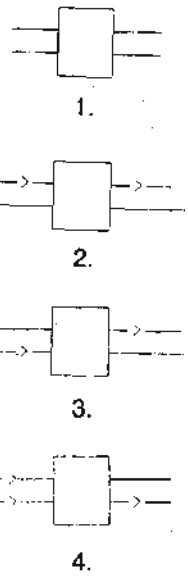
jobs effectively and efficiently. Power of the computer comes from accuracy and speed; simple tasks are carried out at a lightning speed with 100% accuracy.

1. Electronic Circuits

Early computers were built with valves or tubes. They were extremely large, needed a large volume of electricity and were unreliable. The invention of the transistor changed computers and other electric machines as well. Transistor was smaller, more reliable and consumed less electricity compared to the valve.

Transistors are built with substance having properties of neither a good conductor nor a good insulator. These substances which are called semiconductors makes the transistor act like a gate which allows only a little electricity to pass through it. Amount of current permitted to flow through the transistor depends on the substance used as the semiconductor. On the other hand a semiconductor could increase the electricity which flows through it. By combining various types of semi conductors, it is possible to create a transistor which allows a smaller current to pass through it in one direction while stops passing current in the reverse direction. By connecting other electronic components such as resistors, capacitors etc., an electronic circuit could be built. Design of a circuit can be changed by including different types of transistors, capacitors and resistors. It became clear that the production of electronic circuits could be made more efficient if the electronic components are built together. Circuits could be integrated using modern techniques. Thus the size of the electronic circuit was made smaller by inventing integrated circuits (IC). With the advancement of electronics the number of circuits in an integrated circuit was increased. Today, it is possible to build millions of circuits on a single chip of silicon crystal. A photolithographic process is used to print these integrated circuits.

Modern computers is composed of integrated circuits. Flow of electric current through the circuits can be manipulated by using different types of integrated circuits. Following diagram could illustrate how the flow is manipulated by one type of IC.



The first output line carries current if either one of the input wires carry current (2,3) and the second output line carries current only when both input lines carrying current (4). Various types of electronic circuits are used by the computer to manipulate data.

2. Binary Codes

Data is generally expressed in symbols. These could be characters of an alphabet, punctuation marks, numbers, graphic symbols etc. The human eye has the capability of identifying different symbols by their shape. It could recognize minute changes in the shape of a symbol. Instead of using hundreds of different symbols, we could use a numeric code to represent symbols. For example, A = 001, B = 002, ? = 123, * = 126, etc. Hence data can be expressed in numeric codes which use only 10 symbols 0 - 9. For example, data 'LANKA' would be expressed in the numeric code as

L	A	N	K	A
0	0	0	0	0
1	0	1	1	0
2	1	4	1	1

In place of a numeric code, a binary code having only two symbols, '0' and '1' can be used. The binary code needs more digits to represent different symbols.

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L	A	N	K	A
0	0	0	0	0
1	1	1	1	1
0	0	0	0	0
0	0	0	0	0
1	0	1	1	0
1	0	1	0	0
0	0	1	1	0
0	1	0	1	1

Electronic devices are largely two status devices. For example a switch is either on or off, a spot on the surface of a magnate tape is either magnetized or not magnetized, a particular location on a punched card or punched paper tape is either a hole or it is not, and a particular point on a wire at a particular instant either contains an electrical impulse or it does not. It therefore seems natural and reasonable to use the binary numbering system as the basic data representation method in the computer.

3. Data Representation

The main component of the computer is called the Central Processing Unit (CPU) which functions as its brain. The processing unit containing millions of electronic circuits which are integrated into units such as integrated circuits (IC), large scale integrated circuits (LSI), very large scale integrated circuits (VLSI) etc. These are arranged systematically in the processing unit so that any particular circuit in a given location (address) can be activated by supplying current to that circuit. Data expressed in a binary number is translated into a series of active/inactive circuits. If data 'L' is expressed in a binary number having binary digits 01001100, it can be 'stored' in the processing unit by activating/deactivating 8 circuits in a given location. Binary digit '0' is represented by an inactive circuit while 'I' is represented by an active one. Data stored in the processing unit remain unchanged until new data is stored by changing the activeness of circuits or by disconnecting power supply.

The processing unit can store millions of data values expressed in binary digits. In computer technology the word 'binary digit' is abbreviated as 'bit'.

Standard codes are used to express data in bit patterns. American Standards Code for Information Interchange (ASCII) is widely used for this purpose.

It should be noted that to each binary code the computer adds an additional bit which is used to ensure correctness of the pattern. This additional bit is called the parity bit.
Hence, the ASCII code would generate a pattern having 9 bits. Generally, when binary codes are discussed, for convenience, the parity bit is ignored.

Data is entered into the processing unit through the input component of the computer. Keyboard is the most used input unit. Each key in the keyboard is assigned a symbol. Data expressed in symbols can be 'key-in' to the processing unit by pressing the relevant keys. When a key is pressed a pattern of electric pulses is generated. This pattern is transmitted to the processing unit through a series of wires or a bus. The key 'L' which is represented by ASCII code 01001100 will generate electric pulses in the second, fourth and fifth wires of the bus.

A bit pattern is collectively referred to as a 'byte'. Usually a byte contains 8 bits. A byte generally represent one character.

Data stored in the processing unit can be used to generate new data or it can be copied into a new location. A data value can be changed by changing the Bit pattern. For example, Data 'L' which has ASCII code 01001100 can be changed to Data 'M' by changing the last bit to 1 or in other words by activating the last circuit. Copying of data is done by regenerating the pattern of electric pulses and transmitting it through a bus.

Data stored in the processing unit is output through an output unit such as the monitor or the printer. In the case of the monitor, a symbol is reproduced on the screen by illuminating a given position. In a printer, the pulse pattern will activate a key pr the print head to produce the relevant symbol.

Data stored in a given location of the processing unit is erased when new data is stored in the same location or when the power is discontinued. Hence the processing unit is used to store data temporarily. If data is required for future use, it should be stored permanently. A storage devise attached to the processing unit is used for this purpose.

Magnetic media such as a tape or disk is used as permanent storage of data. The surface of the disk or tape is coated with a magnetized material. Any spot on the surface can be magnetized by supplying electricity to that spot. Once a spot is magnetized, it would not change until electricity it supplied again. A magnetized spot can generate an electric pulse in a wire placed immediately over it. This phenomena is used for transmitting data from the processing unit to the storage unit

and for copying data in storage unit to the processing unit. A bus linking the processing unit and the storage unit communicates data.

Magnetic tape carries 9 tracks to record the 8-bit byte plus a parity bit. Spots on the magnetized surface of the tape represent data in the form of '0' and 'l' bits. Each vertical column of the tape represent a byte or a character of data. In a magnetic tape to access a date in a given location the tape has to be read sequentially until the location is reached. This process retards the processing speed.

Magnetic disks overcome this problem as any location on the disk surface can be accessed directly. Magnetic disk has several hundreds of circular tracking on its surface. Data is recorded along the tracks on strings of magnetized spots representing '0's and 'l's. Each track stores the same number of bytes even though the outer tracks are longer than the tracks near the centre of the disk.

4. Machine Language

Transmission of data from one unit to another and processing of data is done according to the instructions given to the computer. Instructions are codes expressed in binary digits. For example, binary code 1101 would be used to express the instruction to 'ADD' two numbers while 1011 would be used to display data on the screen.

Program is a set of instructions arranged logically to carry out a given task. In programming the desired task is analysed into minute actions. These actions are then sequentially arranged. Instructions are given to carry out each action. When the program is executed, the computer follows sequentially the list of instructions.

A hypothetical program for adding two numbers keyed-in to the computer and displaying the result on the screen is given below. First, the task is analysed into single action. These actions are then arranged logically. Instructions for carrying out each action is then written.

1. Connect keyboard and processing unit.
2. Transfer data from keyboard to location A in the processing unit.
3. Transfer data from keyboard to location B in the processing unit.
4. Transfer data in location A to location C.
5. Add data in location B to location C.
6. Connect monitor and procesiing unit
7. Transfer data in location C to monitor.

Above instructions should be given in binary codes as the computer can 'understand' only bit patterns. Codification is done according to a standard machine code. When expressed in a machine code, the program would appear as shown below:

1001	00101110
1010	01000100
1010	01000101
1100	00101110
1101	01000100
1001	00101111
1010	01000110

The machine code is the first programming language. Since writing program in machine language is cumbersome, more simplified lguage called assembling language is used. Assembly Language uses symbols instead of binary codes. In a Assembly language program, the word ADD rather than the binary code would be used. Above program could be written in Assembly as:

LDA	A
LDA	B
STA	C
ADD	A B
DPL	C

Programs written in assembly language has to be translated into the machine language. A conversion program named Assembler

However, the computer has limitations like any other machine. No matter how good it is, a computer will not make you more organized, will not make its own decisions, will not accept responsibility for any thing, will not improve basic data, can not define problems or set objectives. It will only perform things that you command it to do. If you get wrong output from the computer do not put the blame on the computer; you have given wrong instructions or wrong data.

is used for this purpose. Assembler will translate ADD into 1101 and LDA to 1010 and so on.

Assembly programs are less difficult to write than programs in machine language, for the need to remember storage locations and contents is eliminated. Also alphabetic operation codes are easier to remember than numeric codes. However attempts were made to further simplify the assembly language by replacing the symbolic codes with words.

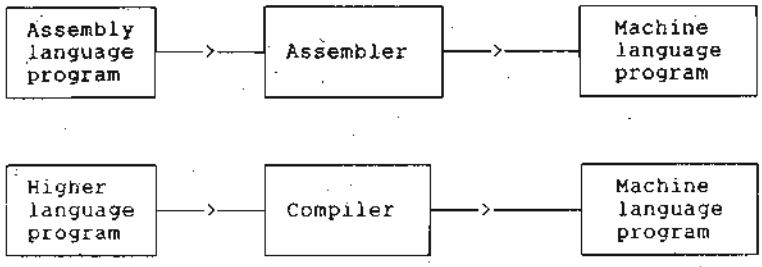
As a result, high level language which uses words for programming were introduced. As with assembly language, translation of the instruction into machine language had to be done. A special program called Compiler was used for this purpose. BASIC (Beginner's All-purpose Symbolic Instruction Code), COBOL (Common Business Oriented Language), FORTRAN (Formula Translation), PASCAL, C language are some of the higher level computer languages.

Above program written in BASIC would read as:

```
10      INPUT  A
20      INPUT  B
30      LET C  = A + B
40      PRINT  C
```

5. Structure of a Computer

As mentioned above, various components or units of the computer handles different functions such as accepting, storing, changing and output data. The Input unit is used to enter data into the system. Data entered to the system is temporarily stored in the Processing Unit until it is changed, output or stored permanently. The Storage Unit of the computer is used to keep the data for the future use. When data is



needed for output or processing, it is first transferred to the Processing Unit. The Output Unit allows data to flow out of the Computer system either by displaying on the screen or by printing on paper.

The main component of the computer and data flow between units are shown below.

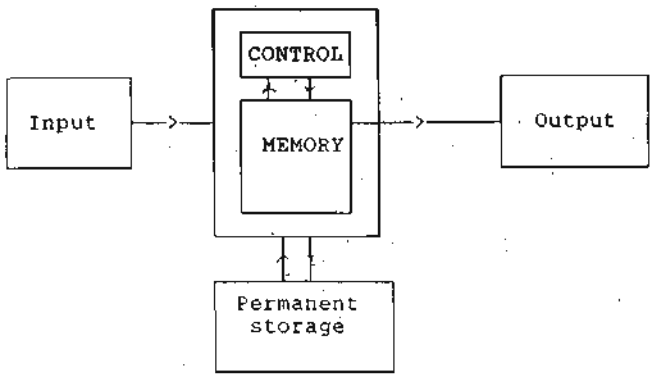
As illustrated in the above diagram, four main data paths are visible in the Computer system.

(i) Input ----> Process ----> Output
(ii) Input ----> Process ----> Store
(iii) Store ----> Process ----> Outut
(iv) Store ----> Process ----> Store

Keyboard is the common input device. Data is input to the System by pressing appropriate keys in the keyboard. Video Display Unit (VDU) or monitor and the printer are the popular output devices. Hard disk and Floppy disk (diskette) are the common devices for storage. Equipment in a Computer system are generally referred to as hardware.

The hardware components of the System and the data flow are shown in the following diagram : As discussed above the processing unit is the key unit of a computer. the Processing unit is divided into four main components:

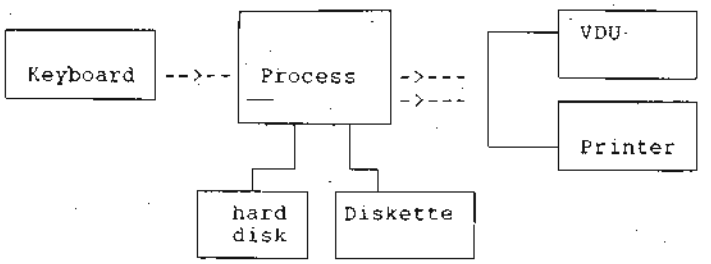
(a) control - Links various components of the computer system and selects the operation that should be executed.



(b) arithmetic and logical unit (A/L unit) - Handles mathematical calculations and comparison of data.

(c) Random Access Memory (RAM) Stores instructions and data input from the keyboard and transferred from the storage unit. Processing takes place in RAM.

(d) Read Only Memory (ROM) - Store instructions and data



provided by the computer manufacturer. When the computer is switched on, these instructions and data are transferred to ROM from the storage unit.

RAM and ROM are collectively referred to as Memory of the computer.

Since a Computer system can handle more than one storage unit it is possible to transfer (copy) data from one storage device to another.

Hard disk ----> process----> diskette
diskette----> process----> Hard disk

6. Computer Files

Computer storage is organized into files. A file is given a name for its identification. The computer system keeps a list of files (directory of files) in its storage with their location. Hence the computer can locate any file by the name.

A file can store programs or data. Hence two types of computer files are used : (a) program files (b) data files

Data files are associated with program files. A data file is useless without the relevant program file. Creation, storage, amendment, deletion, copying of data is done according to the programs. Data stored in the data file is interpreted into information by the program.

A program file should be loaded to the memory before execution. If the program is long, it needs more space in the memory.

When a program is executed it is processed sequentially. If data is required by the program, relevant data file is located and relevant data is copied to the memory.

7. Software

Programs and data are collectively referred to as software. Programs carry instructions for the processing of data to obtain the desired output. Four main types of software are used in a computer system.

(i) Operating systems - Operating system is the basic software required for the operation of a computer system. When the computer is switched on, the operating system software is automatically transferred to the memory from the storage unit and starts execution. The operation system helps to load other software, copy computer files from one storage unit to another, organize computer files logically in storage units. It links various components of the computer system and facilitate transfer of data.

(ii) Compiler/interpreter - A user who wishes to compile a program for a specific application is required to write the program using a computer language. Compilers and interpreters are software which facilitate writing application programs. For example, if the user wants to write a PASCAL program the computer should have a PASCAL compiler. The operating system can be used to transfer the PASCAL compiler from the storage unit (hard disk) to memory.

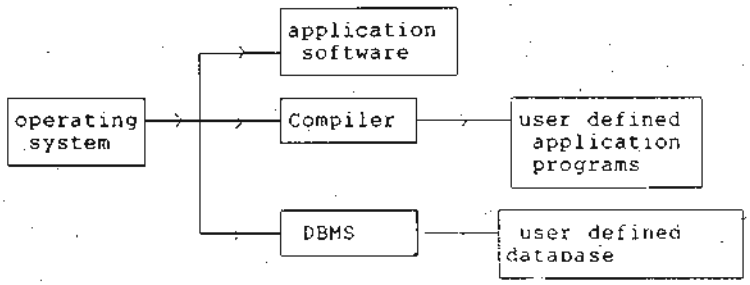
(iii) Application Software - Program compiled for a specific application is called an application software. There are two types of application software:
(a) User compiled program
(b) Software packages

User compiled programs are written by the user with the help of compiler/interpreter.

Software packages are those written on common applications. Most software packages are compiled using machine language (direct binary codes). Hence they do not require compilers,

(iv) Database Management Software (DBMS)
DBMS is a software package which allows the user to define the data files, retrieval methods and output designs. DBMS needs no programming knowledge for its operation but provides an advantage of an user compiled application program.

Organization of the software systems in the computer is illustrated below :



8. Conclusion

The computer can perform a lot of functions and tasks depending on how you know the systems and how many application programs (software packages) you are familiar with. Using several user friendly (easy-to-use) software you can command the computer process and store enormous quantity of information. One can record, to store or manipulate data efficiently and faster.

However, the computer has limitations like any other machine. No matter how good it is, a computer will not make you more organized, will not make its own decisions, will not accept responsibility for any thing, will not improve basic data, can not define problems or set objectives. It will only perform things that you command it to do. If you get wrong output from the computer do not put the blame on the computer; you have given wrong instructions or wrong data.

THE EVOLUTION OF THE COMPUTER ELECTRONIC

ALEX JAYASUNDARA
System Analyst
Auther C. Clerk Centre
Katubedda
Moratuwa

During the last four decades computer industry has rapidly grown (expanded) and today computer scientists are conducting research to make the computers more efficient, more reliable and more simple to use. We can classify this rapid growth in to four generations.



The present day electronic computer plays an important role in the society. It is very different from other machines used today.

Normally machines are designed to perform a specific task. But the computer is a multipurpose tool which help businessmen in their business activities (eg. keeping accounts and stocks), artists in drawing pictures, children in learning their subjects, scientists in research and development, mathematicians in model formulations etc. That is why the computer has become popular, and popular with types of people.

The brief description that we can give of the computer is to say that " a computer is a machine in many ways similar to other machines which run on electricity. It contains a number of parts that work together. It is designed to perform certain tasks."

A Computer has more features than the other machines. Some of them are speed, reliability, receiving and storing of data (memory), processing data and interactivity.

From Early History

History of the electronically based calculators is relatively new about 40 years old. But if we talk about the history of computers it runs up to 1600 years.

The abacus, first used in Asia about 2000 years ago, is one of the earliest known devices to assist man in performing calculations but it merely acted as a storage medium using beads mounted on a frame.

It was as early as 1642 that the Frenchman Blaise Pascal developed a mechanical adding machine with rotating gear wheels. This principle was extended by Gottfried Leibnitz a German Mathe-

matician who demonstrated a machine capable of multiplication and division in 1694. These machines had to be prepared for each separate operation by its user. That is if the machine was expected to add, it gears had to be physically positioned for that function, a tedious process at the best.

In early 1800s J. M. Jacquard perfected a series of "punch cards" to alter loom settings and create a view patterns without further human invention. This was a recognizable forerunners of computer programs because they are affected what the machine did without changing the machine, in any way.

In 1823 Charles Babbage proposed to build a machine which was to use a 'mill' for calculating and punched cards for inputs.

However, the technology of the day was insufficient to complete the machine. That is man and the ideas are ahead of technology of that time.

For the 1890 US Census, Dr. Herman Hollerith developed a device that coded population data as punched holes: in a card while another device was able to sense and read this encoded data.

In 1896, Dr. Hollerith formed the Tabulating Machine Company to manufacture punched card equipment which together with some other Companies, became the Computing Tabulating Recording Company (CTR) in 1911. Thomas J. Watson became CTR President in 1914 and 1924 the Company's name was changed to International business Machines Corporation (IBM).

Until 1939, much of the computing machines were controlled by wired control panels, banks of switches, wheels, layers and relays.

Electronic Computer

At this time (In 1930's -1940's) the electronic value (known as vacuum tube) was widely used as a component in radio receivers.

Between 1939 and 1946 the university of Pennsylvania developed the first large scale computer - the eniac (electronic numerical intergrater and calculator). It occupied 1500 sq. feet and weight was about 20 tons. It used about 19,000 values. Main thing of this computer was the replacement of the electro magnetic relays by vacuum tubes. This was the birth of electronic data processing. Any how eniac was quite Fast, it could do 5000 addings per second. But it was not able to store instructions such as modern computers do. Instructions were outside and lay on the switches and plugged wires, instead it had to give directions through a manual setting of switches.

The great mathematician John Ven Numann collaborated with another two to build the electronic Discrete Variable Automatic Computer (EDVAC) which was the first stored program computer. What he does was he puts instructions to the computer just like data. It was the principal model of the digital computer.

The new electronic computers were powerful, large and very costly. Analysis observed that the entire needs of Britain could be served by 03 such machines and that of USA by 06.

The first computer produced on a commercial scale was the Univac I in 1951 which was first used in business by the General Electric Appliance Park, Kentucky 1954.

Commercial production of electronic computers became a success later when IBM which was selling punch card tabulating machines commenced marketing of computers.

Development of the Computer Industry

During the last four decades computer industry has rapidly grown (expanded) and today computer scientists are conducting research to make the computers more efficient, more reliable and more simple to use. We can classify this rapid growth in to four generations.

First Generation (1951-1958)

First generation computers were large, costly to buy, expensive to power and often unreliable. They used vaccum tubes but they are faster than earlier mechanical devices and very slow compared to today's computers. (Eniac contains 18,000 vacuum tubes and is rumoured to have dimmed lights of Philadelphia when it was turned on.) Instructions and data were entered into these computers through the medium of punch cards..The instructions on the cards were coded in a 'symbolic language'. Symbolic language must be translated into machine language before being executed by the computer. The machine code was recorded as a series of tiny magnetized spots on a 'magnetic drum'. Once all the instructions are translated the computer could execute the program.

The first computer produced on a commercial scale was the Univac 1

in 1951 which was first used in business by the General Electric Appliance Park, Kentucky in 1954.

Second Generation (1959-1964)

The introduction of transistors (which is a type of electrical circuitry, smaller, faster and more reliable than vacuum tubes) into computer technology led to the second generation of computers which were compact and more reliable than their vacuum tube predecessors. Computers of the second generation were smaller, faster and having a large storage capacity than first generation computers. To get larger storage the 'magnetic drum' was replaced by the 'magnetic cores'.

Magnetic Core

Tiny iron oxide cores could be mag-netized clockwise or counter clockwise to represent bits of information. Second generation computers helped user with the languages such as COBOL and FORTRAN.

Third Generation (1965-1971)

In mid 1960s new techniques of miniaturization gave rise to Solid Logic Technology (SLT) which had circuits etched on silicon chips. This was dawn on the third generation of the computers. In 1964 IBM System/360 (a series of 6 different computers with 6 different main storage capacities) was introduced and it was considered as a revolution in computer technology.

Third generation computers were the first to be accessible buy remote terminal (a terminal that is placed at a location distance from the central computer) - input / output devices that are electronically linked to main computers but located at long distances from them. Such terminals are called on-line terminals, which communicates directly with the computer.

Another example - NCR 395, Burroughs B 5500

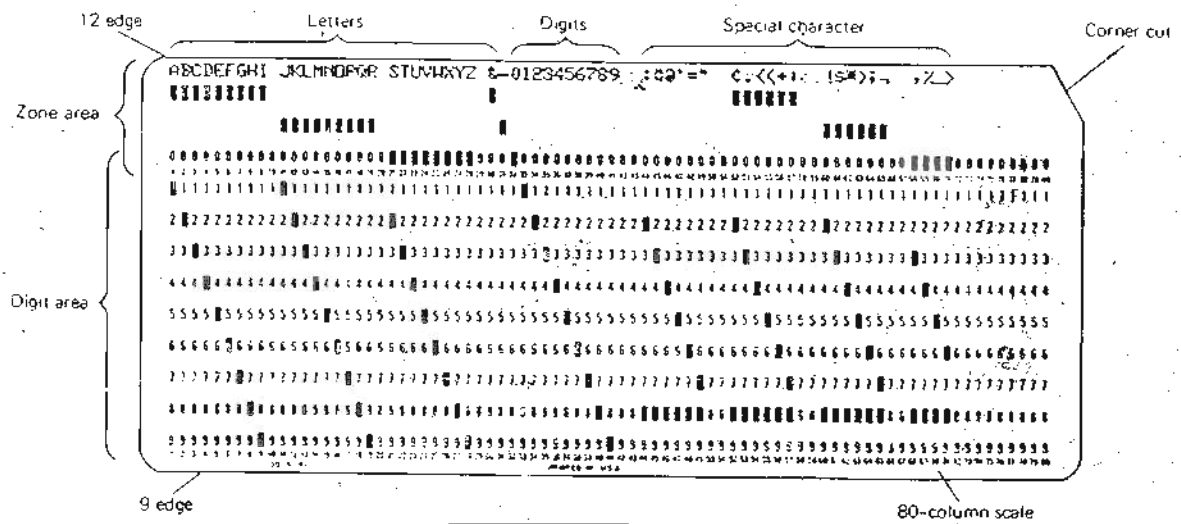
Forth Generation (From 1972)

Miniaturization continues and reliability increases. Now semiconductor circuitry is used for main storage replacing the magnetic core and Medium Scale Integration (MSI) and Large Scale Integration (LSI) has allowed for smaller and cheaper computers to be marketed.

From the LSI technology sprang the very tiny devices called microprocessors (the central processing unit of a microcomputer; fits on a small silicon chip) which governs the functions of microwave ovens, sewing machines, thermostats and automobiles.

Development In Storage Media

As we saw the size of the computer was reduced by using semiconductors, IC's MSI "technology & LSI technology. Let us examine how the storage media was developed.



80 Column Punch Card

Today we use diskettes to store our data or documents. But diskettes are not the only possible storage media. If we try to talk about storage media we should go back to the storage where Dr. Hermen Holanth used punch cards to store data. Let us go back to that point and discuss how and why storage media has changed and developed.

In 1887 Dr. Holenth - a young statistician was assigned the task to speed up the tabulation of data to be collected by the 1890 Cencus. As a result of that he developed an 80 column punch card which is given in the figure below.

The above punch card has 12 rows and 80 columns. 10 of those rows are numbered from 0 to 9. Other rows are not labelled and they are called 11th row and 12th row, and they use the area above the 0 row. The code that Holanth invented uses a zone area and a digit area. The digit area consists of the rows 0-9. The zone area is made up of the rows 0-12. Thus, 0 can be either a digit or a zone indicator.

Code rules are given below :

Character	Holenth Code Rule
Digits 0-9	Digit punched in any column
A-I	12 zone punch + digit punch
J-R	11 zone punch + digit punch
S-Z	0 zone punch + digit punch
Special symbols	1,2 or 3 punches

Main problems of using the punch cards were :

a. Not reusable
b. Lot of space was taken to store cards

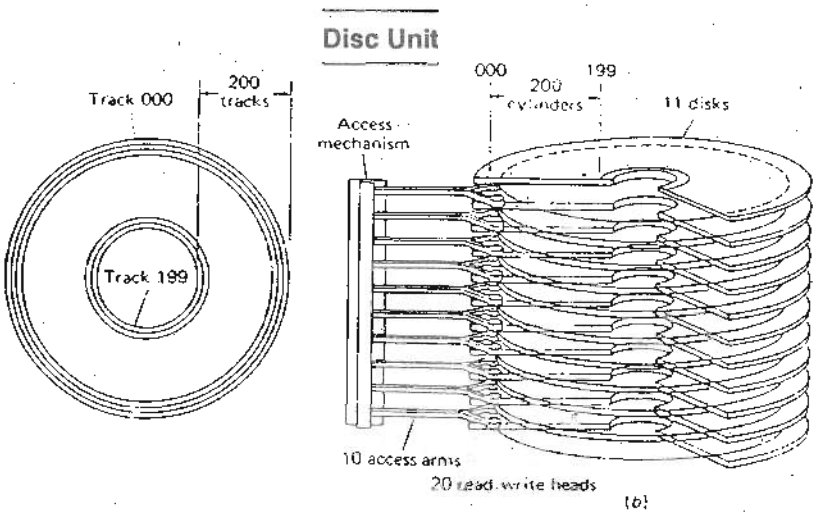
As a result of minimizing space birth of the 'punched paper tape' happened. Punched paper tape is a medium that can be used for inputs, sorting and outputs. Paper tapes became more popular since they were cheaper than punch cards.

Although we have solved the problem of spacing still the reusability problem is there. Because of that people thought about the magnetic tapes.

Magnetic tape was invented by the Germans during World War 11 for sound recording. Data were recorded on tapes in the form of small magnetized dots that can be changed to represent coded patterns of bits. Data recorded on a tape were stored on reels, cassettes or cartridges.

Now we feel the problem of reusability and space was solved. Since human beings try to make the output sophisticated they thought about the time that we spend to retrieve data. Their main point was if we want to access data at the end of the reel we have to read the whole tape to read data. As a solution to this, magnetic disks were introduced to the computers.

Magnet disks are thus circular metal plates coated on both sides with a recording material similar to that used in tapes. Data are stored in a code pattern of 0s and 1s. "1" represents the magnetized spots and "0" represents the absence of spots. As shown in the figure kits are aligned along tracks that forms concentric circles on a disk surface. In some systems tracks are divided into sec- tors like blocking on tape blocking of records on disks makes them more efficient.



Now the problem arises that moving a magnetic disk is quite difficult. It says people requested for movable storage media. As a result of that diskettes came to our hands in the sizes of 8", 5 1/4" and 3 1/2".

Here I have discussed the development of the storage up to now. Tomorrow's storage media may be even more advanced.



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INDIGENOUS THE PEST THE DRY ZONE

Introduction

After the introduction of High Yielding Varieties (HYV), crop damage by pest has become a very serious problem in the paddy producing sector of Sri Lanka.. Consequently, the use of chemical pesticide has become inevitable. Now, Sri Lanka is one of the major pesticide users in Asia. However, there is a growing recognition that the heavy use of pesticide bring ill-environmental effects, and also the escalating price of pesticides adversely affect the farmers income. Therefore, there is a need to look for alternatives to these conventional pesticides. In this case, it is advisable to explore the indigenous knowledge of pest control because the traditional pest control methods which have been used for centuries are time-tested, ecologically sound, economically viable, and therefore they have greater potential for sustainability. This study is an attempt to explore the indigenous knowledge of pest control with respect to the paddy cultivation in Sri Lanka.

Traditional pest control methods which have been used for centuries are time-tested, ecologically sound, economically viable, and therefore they have greater potential for sustainability.

APPROACH TO MANAGEMENT HAZARDS IN OF SRI LANKA

ROHANA ULLUWISHEWA
Associate Professor
Sri Lanka Resource Centre for Indigenous Knowledge (SLARCIK)
Department of Geography
University of Sri Jayewardenepura

Methodology

The methodology adopted to collect data for this study involved discussions with old aged farmers, group discussions, interviews with key informants, and direct observation. Informants were selected from Ratnapura, Badulla and Hambantota districts in consultation with field officers of the Department of Agriculture. Published data was also used on supplementary basis.

Results and Discussion

Indigenous knowledge is a sum of experience and knowledge of a given ethnic group that forms the basis for decision-making in the face of familiar and unfamiliar problems and challenges (Warren, 1988). In the face of the pest problem, the traditional paddy farmers made decisions on the basis of the knowledge and experience which were brought down from generation to generation over centuries. They used various botanical, biological, and mechanical pest control methods which were developed on the basis of the indigenous knowledge. They were aware of a wide range of plant species with pesticide effects, and animal species which predate on harmful insects. They were also aware of various materials and devices which could be used to trap, chase or destroy the pests or to keep the pests away from the crops. Besides, they performed some religious ceremonies to protect their crops from pests. Although these practices are purely religious, close observations reveal that they have some practical values. It has been evident that some of these religious ceremonies have botanical, biological or mechanical pest control effects. All the indigenous pest control methods can be categorized as (1) botanical methods, (2) biological methods, and (3) mechanical methods.

Botanical Pest Control Methods

Many plants have a natural protective mechanism which assists them in resisting and repelling pests. Some plant species produce substances which repel or poison the insects. The traditional paddy farmers possess a sound knowledge about such species. They identify a wide range of plant species which can be used effectively to control pests. Most of these plant species are naturally grown in jungles and scrublands on communal lands. They use various products of these plants i.e. fruits, leaves, bark, seeds etc., in various ways to control pests. They identify which parts of the plants contain substances which have repelling and poisoning effects. In some cases, leaves or barks are used, in some other cases fruits or seeds are used. While such vegetative matter of some species are

incorporated into paddy soils,Some are added to the standing water in paddy fields. In some cases, they hang leaves or twigs of some plant species around the affected paddy fields to control pests.

Among the species which are added to the standing water of the paddy fields to control pests, *Derris scandens* (Kaluwel) *Lycopersicon esculentum* (Tiththawel), Pineapple leaves and *Euphobia antiquorum* (Daluk) are common. These vegetative matter are chopped crushed and placed at the point of impounding water (*wakkada*) so that their poisonous substances spread everywhere in *liyadde*. While the first three species are believed to be effective in controlling the flies such as *Orceolia oryzae* (Gop Massa) and *Atherigona exigua* (Kanda Massa), the last is believed to be effective in controlling *Tryporisa insertulas* (Puruk Panuwa). Furthermore, to control a certain kind of pest (Madarilla), *Derris uliginosa* (makkala wel) and *Entada phaseoloydes* (Pus wel) are kept on the point of impounding water (*wakkada*) and crushed. The farmers believe the seeds of *Garayota urents* (Kitul) has pesticide effect. They crush the seed of this species and add it to the impounded water in the field to control pests. The plant called 'Mahapatta' is used in the same way to control hoppers. To destroy worms which cause damage to the paddy plants, leaves of *Cinnamomum campohora* (Karadha) are underearthned at the time of land preparation. It is widely believed that the *Cinnamomum campohora* (Karadha) leaves develop some poisonous effect to worms. In some cases, dried leaves of *Croton laciferus* (Keppitiya) are added to the paddy soil to control pests.



Figure 1: Owls control rats in paddy fields.

The traditional farmers identify some plant species which have a repelling smell. *Cycas circinalis* (Madu) and *Cymbopogon citratus* (Seru) are examples in this regard. They believe that the *Cycas circinalis* (Madu) flower generates a repelling smell, and therefore they plant *Cycas circinalis* (Madu) trees near the paddy fields. In some cases, *Cycas circinalis* (Madu) flowers are cut into pieces and joined to sticks which are planted in the paddy fields. Branches of *Cymbopogon citratus* (Seru) which generate a repelling smell are hung in and around the field. They also believe that insects dislike yellow colour flowers,and therefore such plants are planted around and near the field to repel the insects. Although its effect is not clear, it is worthwhile to mention that some farmers hang *Areca catechu* (arecanut) flowers and young *Cocus nucifera* (coconut) leaves on ropes used to demarcate the insect affected area.

Damage to the harvest by rats is a serious problem during the ripening period. To control rats, raw papaya is chopped, and pieces are spread in the paddy fields. It is believed that the raw *Carica papaya* (papaya) has a chemical substance which causes wounds in rats mouth when they eat it. When rats eat the pieces of raw papaya., their mouth gets wounded so that they cannot eat paddy any more. Farmers can harvest the paddy yield before the rats wounds are recovered. Wood ash is popularly used by traditional farmers to control a wide range of pest species. In this case ash is put into a clothe bag, and it is tied to the end of a long stick. Then the ash bag is held over the crop and ash is sprinkled on the crop by beating the stick with another. The farmers believe that the ash of cymbopogonnardus plants are particularly effective in controlling *Spodoptera mauretia* (Godawella). To protect the field from the wild boar, some farmers crush *Coleus amboinicus* (Kapparawalliya) leaves and keep them around the field. It is believed that the wild bores do not approach the field due to the strong smell spread from the crushed Kappara leaves.

Biological Pest Control Methods

The farmers identify a large number of vertebrates, reptiles, birds and mammals predating on pests. They, therefore, protect the habitat required for these beneficial species. Birds are the major biological agents which traditional farmers use for pest control. They have developed various methods to attract birds which feed on harmful insects to attract such beneficial birds to the field, places are provided for the birds to perch in the field. In this case, either coconut fronds larger ends up or sticks joined to the coconut husks are planted so that the birds can perch on them. It is believed that these methods attract owls which feed on rats (Figure 1). Supply of food for birds is another method to attract the benefical birds to the field. For instance, to attract the bird called 'Seven Sisters' (Demalichcha), coconut refuse is crushed and spread in each corner of the paddy field. This bird would come to feed on the crushed coconut and at the same time would eat paddy bugs and worms that happen to be living around. They also protect the habitat required for these beneficial species. Big trees are allowed to grow in and around the paddy fields to provide nesting places and safe breeding grounds for the beneficial birds.

Apart from these devices, it has been found that some religious practices that they perform to protect their crops from pests, also attract such beneficial species to the field. A few examples are given below.

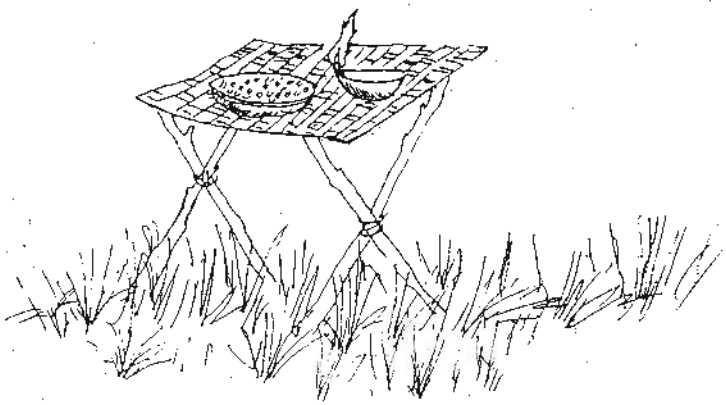


Figure 2: Offering to local deities has practical values.

(1) Offering to local deities : The offering consists of a mixture of roased pulse, food, flowers, and lighted oil lamps. While the roasted pulses and food attract birds, the lighted oil lamps attract insects (Figure 2). Then birds feed on insects, reducing the insect population.

(2) Offerings of food and lighted oil lamps are placed on unstable plantain disk fitted to a stake (Figure 3). When the birds attracted by the food and light attempt to perch on the plantain disk, the food falls. Then when the birds go after the fallen food, they find caterpillars, and eat them.

(3) To control worms which eat paddy leaves, the farmers boil a pot of milk before the sun rise, and milk-rice is prepared. Then the milk-rice is spread in the affected part of the paddy field. The birds which come to the field to eat milk-rice, tend to eat the harmful worms too.

The traditional farmers recognize the *Ptyas mucosus* (rat snake) which feed on rats as a beneficial creature. In fact, the farmers welcome the snake as it comes into the fields at grain ripening time to feed on rats and mice. It has been estimated that a single rat snake can consume over twenty rodents per month (Senanayake, 1983). This snake has been deemed as one of the most important biological control agent of the small mammalian pests of paddy farmers. The snake which is non-venomous is always left unharmed by the farmers, and

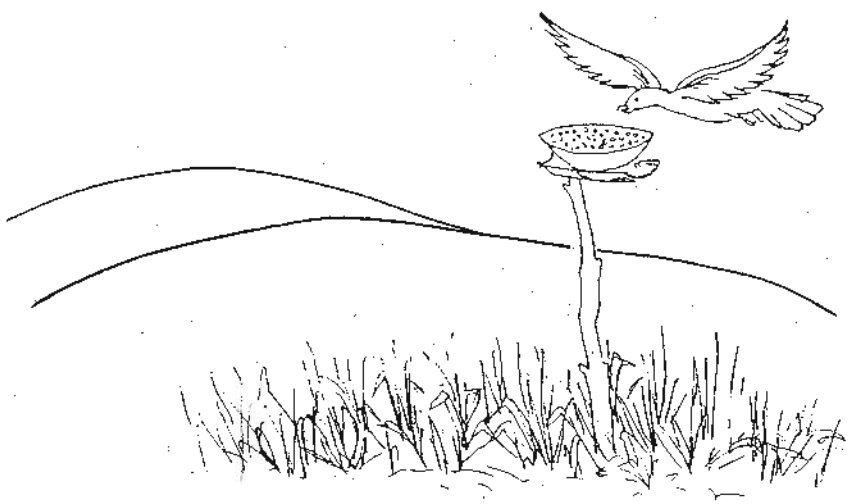


Figure 3: Offering attract beneficial birds.

also they maintain the habitat required for breeding of this snake. The rat snake is incapable of breeding or maintaining its population in paddy fields and open areas. It requires a wooded habitat or dense thicket to serve as a safe nursery area for the juveniles. Such a habitat is found around the pool which was maintained at the end of paddy tract where the water drained from the paddy tract was accumulated. This same habitat is used by the lizard *Varanus salvator* which feed on the fresh water crabs that weaken and destroy the bunds of the paddy fields.

The farmers encourage the growth of aquatic fauna in paddy fields. Paddy fields are normally kept flooded during the early stage of the growing season, and this practice provides a habitat required for a large number of fish species. The pool that farmers maintain at the end of the paddy tract contains water throughout the dry season and it contributes to the continuous existence of fish in the paddy fields. As the paddy fields dry out completely during the harvest season, majorityof the aquatic fauna in the paddy fields die out. At the onset of the rains the fish in the pool migrate upto the newly formed streams to breed. The juvenile fish quickly colonize all the paddy fields and grow to adulthood during the paddy growing period. The insectivorous fish species act as a biological agent control pests. Speiders are also allowed to survive in the paddy fields so that spiders would catch insects into their webs. The farmers also encourage the growth of frog population in the paddy fields since they feed on a wide range of harmful insects. It is said that some farmers catch frogs when they happen to find them elswhere, and throw the caught frogs to the paddy fields. The farmers consider Order passeriformes (Wehi Lihiniya) as another beneficial species because it feed on *Nilapawata lugens* (Keedewa) which cause serious damages to the paddy plant. When the farmers notice that these birds are in their paddy fields, they keep away from the paddy fields to allow the birds to feed on the pest without any disturbances.

Mechanical Pest Control Methods

Food traps and light traps are major mechanical methods which are popularly used to control pests. Rodents which damage paddy are controlled by the use of food traps, while insect pests are caught in light traps (Widanapathirana, 1983). In the case of light traps, a bright light is used to attract insects to a certain point where they can be trapped. A light trap consists of an oil lamp which is hung on a container of water, placed out in the field (Figure 4). In the night insects attracted by the light get trapped in water surrounding the oil lamp. The farmers set light traps in various ways to control harmful insects. Some of these methods are as follows:

(1) A oil lamp is hung upon a lower point in the field which is filled with water. The insects attracted by the light get trapped in water under the lamp.

(2) A oil lamp is kept in a big pot with a lot of holes on it, and the pot



Figure 4

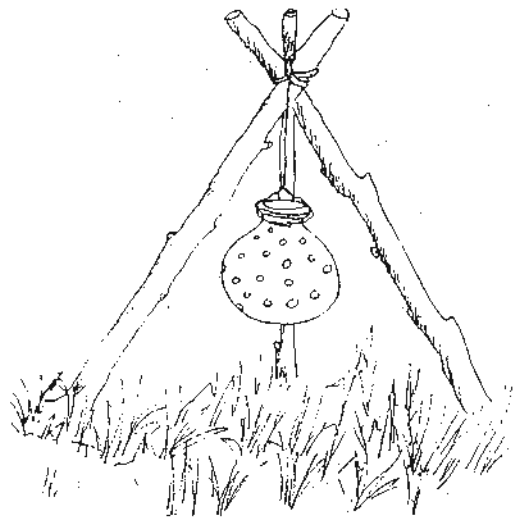


Figure 5

Insects attracted by the light get trapped.

is hung somewhere in the field. The rays of light which spread from the holes attract the insects into the pot where they eventually get trapped (Figure 5).

(3) Oil lamps are kept around the field, and the insects resting on paddy are chased by dragging a long rope across the field. The insects which rise into the dark are attracted by the light and get destroyed.

(4) The litter around the field are collected and burned at night. The light of the burning litter attract the insects and destroy them, and also it clears the breeding grounds of the insects.

Lighting oil lamps has a religious significance too. The vilages offer oil lamps in the shrine of the temple and around the sacred Bo tree. In the same way, when their paddy harvest is threatened by pests, they light oil lamps in and around the affected area of the paddy field in the night, and pray. In this case, Mee oil, oil extracted from the seeds of Mee tree *(Madhuca longifolia)* and wicks made of saffron robes are traditional used to light the oil lamp. In some cases, a flame which is made by tying up pieces of saffron robes soaked in Mee oil is lighted in the affected area. In both cases, the use of saffron robes accentuates the religious background of these practices, However, these practices are said to be effective in controlling insects. It seems that the bright light of the oil lamp and the flame attract the insects and destroy them.

They also use a very sticky substance derived from *Artocarpus heterophyllus* (Jak) to destroy some harmful insects. To control flies, they apply this sticky substance on the winnowing fan and it is dragged along on the crop so that flies get stuck on it. This has to be done twice a day every morning and evening during the grain ripening period. It is, therefore highly time consuming, and not practical in the case of large fields. In such cases, a long rope impregnated with the sticky substance is dragged across the field so that hugs in the field get stuck to it (Figure 6). The same substance is applied on sticks which are planted in the field to get flies stuck on them. The farmers are also in the habit of causing physical disturbances to chase the harmful insects. To chase flies, they brush the standing crop with a rough large broom made of bamboo tops or strong twigs. In some cases, to chase flies, a long bamboo is drawn across the field by two persons who walk on both sides of the field. The farmers are very much affiliated to the village temple, and they believe that the sand collected from the base of the sacred Bo tree in the temple is effective in controlling insects. So, they throw such sand at the crop and control insects. The truth behind this may be different. When sand is thrown hard at the crops, insects may fall into the water and die.

The traditional farmers have developed various devices which provide frightening sounds to chase harmful animals. While some of these devices are operated by the power of blowing wind, some are operated by the power of flowing water. For example, the Water Ghost (Sulang holmana) is operated by the blowing wind, the

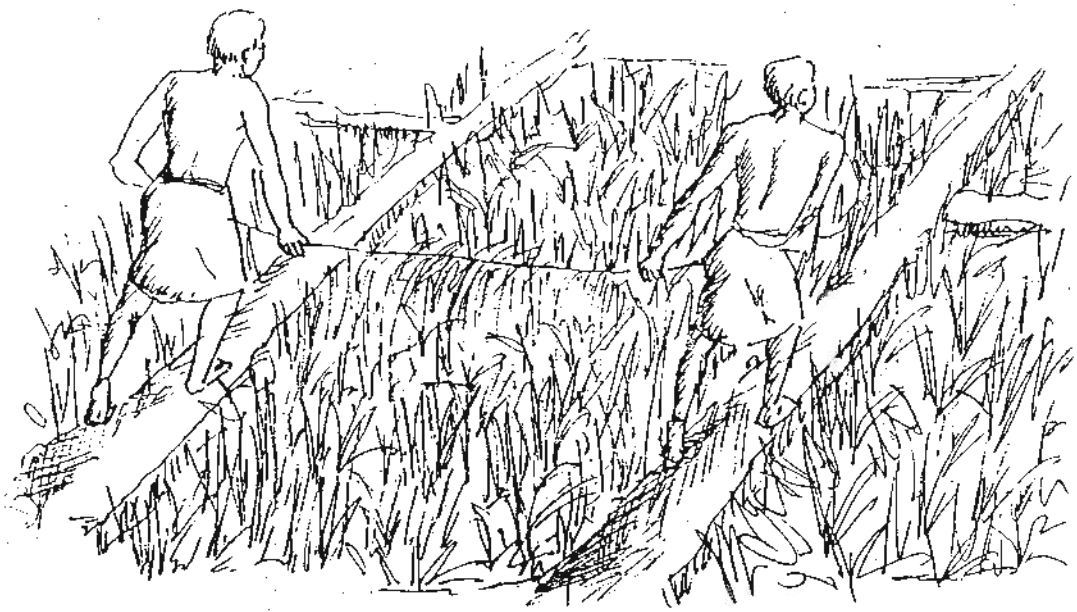


Figure 6: Controling hugs by dragging a rope impregnated with a sticky substance.

Wind Ghost (Diya holmana) is operated by flowing water (Figure 7). Both provide an intermittent beat that scares rat and birds. To frigthten hamful birds and rats, the farmers keep puppets or scarecrows on the field. While some puppets are given human appearance, some puppets are given the appearance of the natural enemies of some pests. For example, cat-like puppets are kept in the field during the grain ripening period to frighten and chase rats. To chase wild boars, some specific methods are adopted. One of these methods is to draw a twine rubbed with sulphar around the farm. It is believed that sulphar generates a repelling smell which keeps the wild boars away from the farm. In some cases, a black twine is drawn around the farm. It is said that the boar refrains from entering the farm fearing it to be a death trap. In the same way, to keep rats away from the field, pineapple leaves are kept around the field. The farmers believe that the rats see the pineapple leaves like snakes which feed on rats, and therefore they refrain from entering the farm. The farmers also often walk through their fields in order to observe the insects in their fields, and to chase other harmful animals.

Indigenous Approach and Sustainability

The indigenous methods of pest control which have so far been discussed, had been in use over thousands of years and have proven their efficiency. The long existence of these methods itself prove their validity. Even today, some old aged farmers are quite confident in the effectiveness of these traditional methods. It is evident that most of these methods are in consistence with the natural ecological processes. For instance, while some methods make use of natural enemies of pests some methods make use of the repelling effects which have naturally developed in certain plant species. In contrast to the modern chemical pesticides, the traditional methods do not generate poisonous substances. Therefore, use of traditional pest control methods keep the environmental pollution at the minimum level. For all these traditional methods, locally available materials are used. Most of the herbs which are used for pest control are locally available within the village. Hence, these methods do not involve any cost, and therefore they are economically viable. All these characteristics inherent in traditional pest control methods contribute to the sustainability.

It is evident that although the traditional methods of pest control were efficient to control pest in the past when old rice varieties were planted, they are inadequate to deal with present pest problem because now almost all paddy farmers plant HYVs which are highly vulnerable to pests. Therefore only the chemical treatment can control the present pest problem. The modern chemical pest control methods are effec-

Figure 7: Water Ghost.

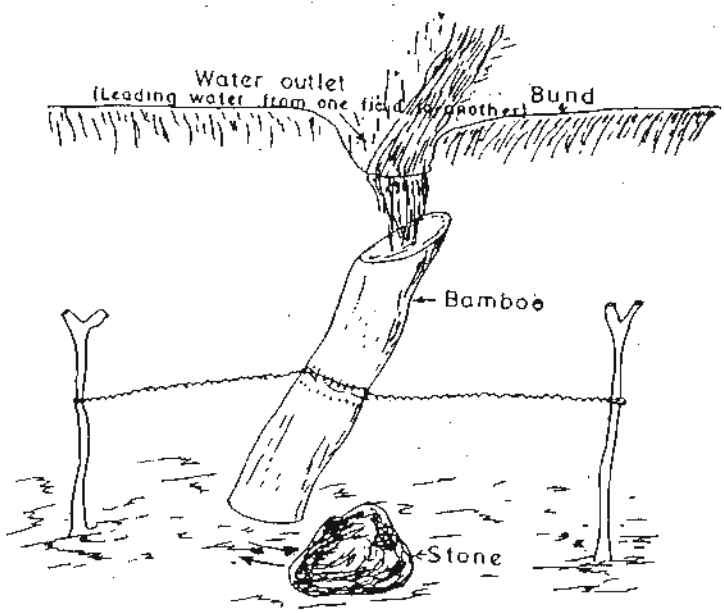
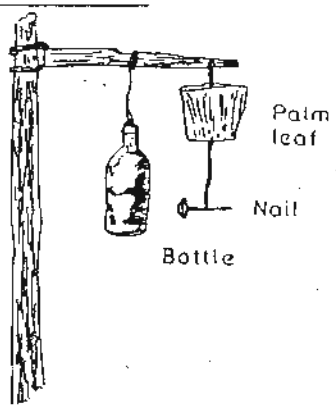


Figure 8: Wind Ghost.



tive but ecologically disastrous. On the other hand, the traditional methods of pest control are ecologically sound but less effective under present circumstances. Therefore, some sort of combination of modern and traditional methods of pest control may lead to an effective and ecologically sound alternative. Integrating new technology into indigenous knowledge would increase the effectiveness of the latter. For instance, modern technology, i.e. machinery and sprayers, could be used to process and spray the traditional botanical pesticides in a better way. In the same way, modern technology could be used to promote the efficiency of traditional mechanical and biological methods of pest control.

Conclusion

The indigenous knowledge which has been brought down from generation to generation has now reached to its end because it is now suppressed by the modern scientific knowledge. The present young generation who are already accustomed to the modern technology are not prepared to carry the indigenous knowledge to hand over to the next generation. Therefore, in view of its value with respect to the sustainability of the farming systems, immediate steps should be taken to collect, document and to preserve the indigenous knowledge relating to all aspects of farming. Such steps will permit to use the traditional wisdom to establish sustainable farming systems.

Acknowledgements

The author wishes to thank Mr. S. Rajapakse and Mr. Rodrigo Seneviratne who have helped with the data collection.

The modern chemical pest control methods are effective but ecologically disastrous. On the other hand, the traditional methods of pest control are ecologically sound but less effective under present circumstances. Therefore, some sort of combination of modern and traditional methods of pest control may lead to an effective and ecologically sound alternative.

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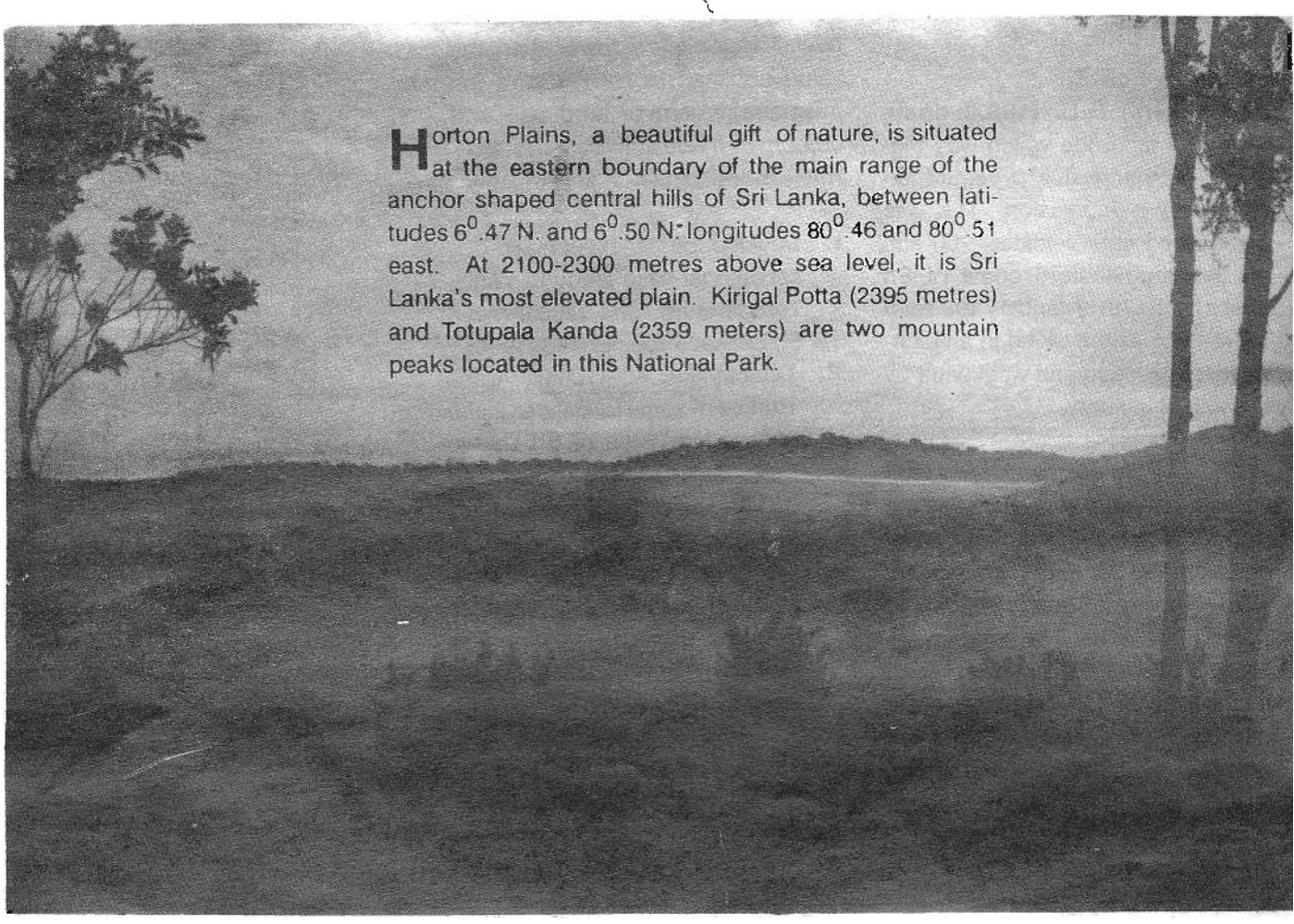
VASABA S. VATTALA
Assistant Director (Park Planning)
Department of Wild Life Conservation

HORTON PLAINS

-A NATIONAL HERITAGE AT A HIGH ALTITUDE



Horton Plains, a beautiful gift of nature, is situated at the eastern boundary of the main range of the anchor shaped central hills of Sri Lanka, between latitudes 6^0.47 N. and 6^0.50 N: longitudes 80^0.46 and 80^0.51 east. At 2100-2300 metres above sea level, it is Sri Lanka's most elevated plain. Kirigal Potta (2395 metres) and Totupala Kanda (2359 meters) are two mountain peaks located in this National Park.

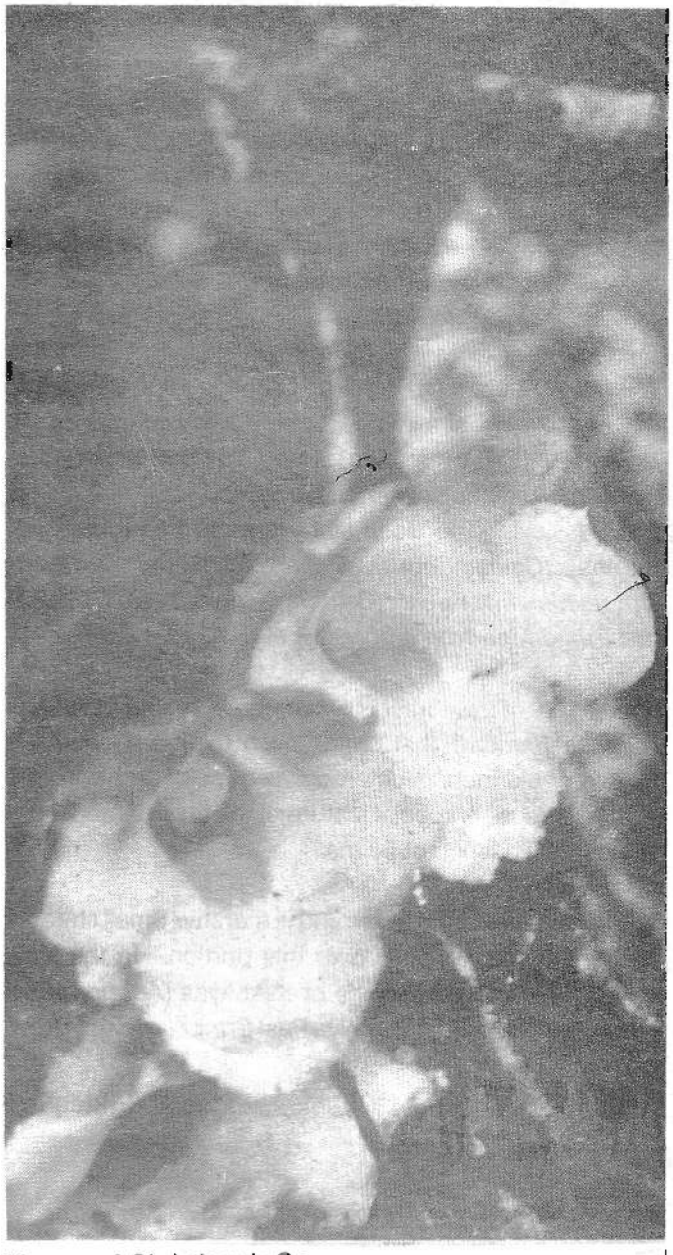
History does not record any information about the Horton Plains other than that it served as a hunting-ground. It is believed that Sir Robert Horton named the plains after him in 1836 during the British occupation. In January that year he had made arrangements to tour Nuwara-Eliya and meet his friend the Rate Mahattaya of Sabaragamuwa. They decided to meet each other in some place between Nuwara-Eliya and Ratnapura. This place was Mahaweli or Mahatenne (Great Plain). River Mahaweli originates in the Horton National Park. Therefore it is possible to presume that the river took its name from the place 'Mahaweli'.

In 1969 Horton Plains National Park was declared a natural reserve for the first time. This plain which is 31600 hectares in extent is bounded on the east by the Samanala Kanda Peak Widerness Sanctuary. When the necessity to protect this area arose it was raised to the status of a National Park in 1988.

Records of weather or climatic conditions of the plains have not been kept for any considerable length of time. Although there is a regular incedence of rainfall throughout the year. During this season midday temperature is about 27^0C, and the night temperature 5^0C or less. In 1971 Muller Dombis and Perera have recorded an average February temperature of 12^0C. Annual rainfall in the region is about 2540 mm (Wijewansa, 1983) but for Horton Plains, may exeed 5000 mm (Ratnayake & Balasubramaniam, 1989). Rain occurs throughout most of the year but there is a dry season from January to March. In February and March dew forms on the grass in the early mornings. In the rainy season there is mist throughout the day. The strong winds and the ceaseless drizzle which fall during the South-West Monsoons is a climatic condition not experienced in most other parts of the country.

In 1961 seed potato was cultivated in parts of the Horton Plains. But due to the efforts of environmentalists it was possible to put a stop to this. However the environmental destruction caused during the 9 years have created many problems within the National Park.

A recent study reveals that 7 major habitat types can be observed within the National Park (Wijesundara, MFC, 1992), namely:



Flower of *Christisonia* Sp.

- Upper Montane Rain Forest (including the pigmy or cloud forest).
- Wet Patana Grasslands.
- Marshy and aquatic areas.
- Forest-grassland Ecotone.
- Open areas (gaps) in the forest.
- Disturbed areas in the grasslands.
- Roadsides and around buildings.

The upper Montane Rain Forest is the most dominant habitat type in Horton Plains National Park. Forests are present as continuous ranges as well as isolated patches in the grasslands. The dominant families of flora in the National Park are Lauraceae, Myrtaceae, Rubiaceae, Symplocaceae and Euphorbiaceae.

Among the large trees of the rain forests can be identifies 101 different species of trees. Of these 49 are endemic to Sri Lanka. Hence in the Horton Plains National Park's Upper Montain rain forests about 48.54% of these varieties can be seen. Only in Sri Lanka and no where else is this possible. The dominant plants in this forest are, Kurundu *(Cinnamoum ovalifolim)*, Karan damba *(Syzgium revolutum)*, Keena *(Calophyllum walkeri)*, Maharatmal *(Rhadodendron arboreum)* etc.

The beauty of this forest is enhanced by a kind of lichens *(Usenea barbara)* that hangs from their branches like beards of old men. Numerous varieties of orchids grow on these trees. A special feature of the environment here is the total absence of palms.

The lower parts of the grassland is marshy. Small streams and springs flow slowly over this portion. In the slow moving rivulets many kinds of Kekatiyas *(Aponogetova jacobseuli)* Diya Pasi, Beraliya Pasi *(Ntricularia* sp.) grow.

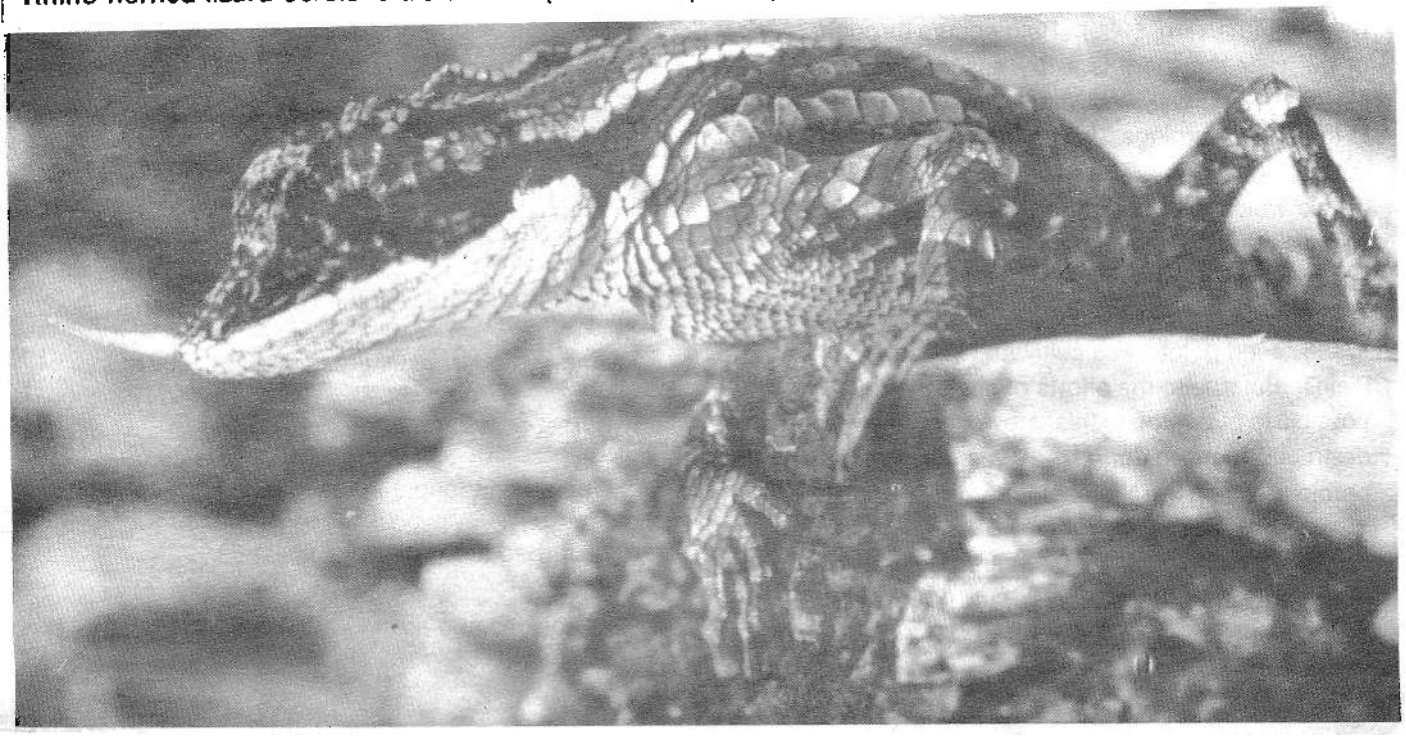
On the bands of the rivulets and brooks grow thick bushes of bamboo *(Chimanobamusa devisifolia)*. Near the marshes grow different kinds of grass. The more prominent are *Gavnotia mutica Denmistaedtia seabva, Ericanlon* sp., *Exacume maeravithum* grasses.

The dominant species of grasses that grow in the main grasslands are *Arundinella villose*, and *Chysopogon zeylanicus*. Fire resistant Maha Ratmal trees *(Rhododendron arboreum)* grow interspersed on the grasslands. Hence these grasslands resemble the Savannas. Various kinds of shrubs grow on the road clearings. Among them are kinds of Bovitiya (*Osbeckia* sp.).

Large mammals except the elephant inhabit the Horton Plains. Nowhere in Sri Lanka could one see so many sambur *(Cervus unicolor)* roaming about as on the Horton Plains National Park. There are herds comprising more than 50 animals at times. The spotted deer is absent here, but the Barking deer *(Muntiacus muntjak)* and Mouse deer *(Tragulus meminna)* are a common sight.

A large number of endemic fauna of Sri Lanka could easily be seen here. Of the 23 endemic Sri Lankan birds 17 could be found on the Horton Plains.

Rhino-horned lizard *Ceretohora stoddartii* **(Endemic Species)**



The special identy of its environment is exhibited by the presence of Rhino-horned lizard *(Ceratophora stoddartii)*, Purple-faced leaf monkey *(Presbytis senex)*. Several species of insects and animals have been discovered in this National Park. its zoological phenomena may be treated under a different heading.

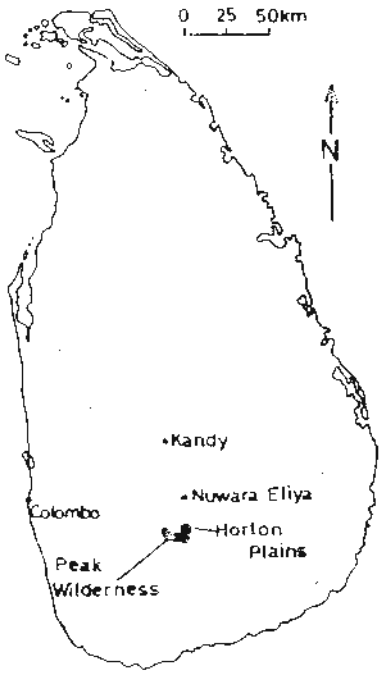
Today the Horton Plains National Park is a reserve which protects our wildlife and plants. Large water resources like the Mahaweli and the fate of our hydro electric power plants depend on the catchment area of the Park.

The catchment of rivers Mahaweli, Walawe, Kelani, Belihul Oya, Uma Oya and Bagawantalawa Oya which joins the Castlereigh reservoir is based in this National Park. Hence is should be protected not only for wildlife but also as a catchment.

At present there are environmental problems in the National Park. On some parts there is a forest die back. This phenomenon was first observed in 1978 (Perera), is the dying of the cloud forest on all peripheral aspects of the plateau (Ratnayake and Balasubramanium, 1989). This has reached serious proportions, with a 50% reduction of forest cover in some places. Water deficit is believed to be the main cause of the die-back, droughts having become noticeably more frequent during the last few decades. Regeneration of cloud forest is impeded by forest, which may be becoming increasingly more severe (Werner, 1988; Ratnayake and Balasubramanium, 1989).

Other problems include increasing disturbance from visitors, poaching for meat, gemming around the park, annual fires caused by miscreants, localised spread of introduced exotics and the great increase of the number of sambur.

The scarcity of pure drinking water is a major worldwide environmental problem now and is one of Sri Lanka's foremost problems in the protection of this National Park.



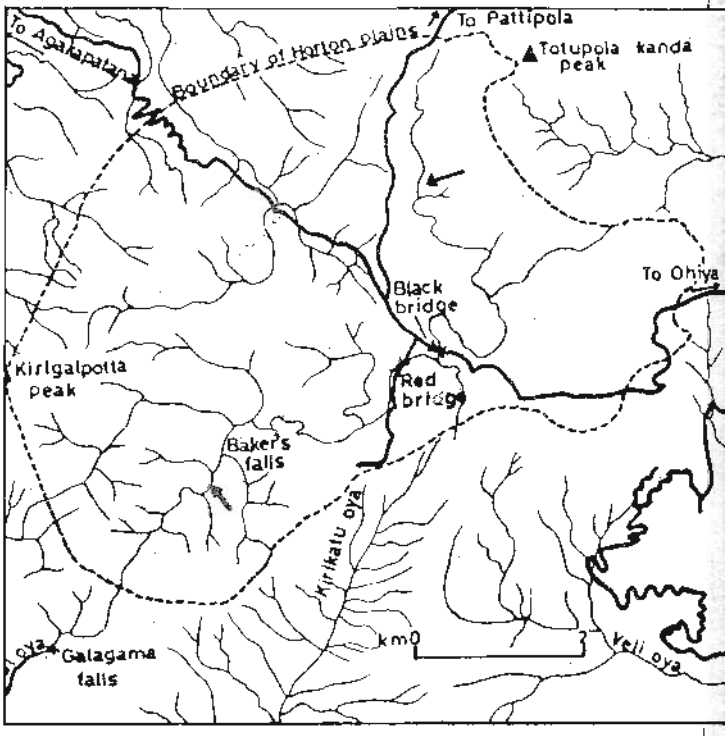


Plate 2: Debris and rock slides during excessive rains in 1989 damage to the Kandy - Mahiyangana road at Hunnasgiriya. (B) Landslide in a rubber estate at Pantiya (Matugama) in the Kalutara district.



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AROMA THERAPY

UPALI M. SENANAYAKE
Natural Products section
CISIR
Colombo 7.

Out of man's five sensory organs, the one regarding which we have the least knowledge of its functioning is said to be the nose. When we mention the nose most of us think of its shape, size and its secretions etc. Other than when stimulated by a pleasant or unpleasant smell or by the aroma of tasty food, we generally do not pay much attention to the nose. However according to current research in biological science the olfactory power of the nose is the focal point of a special therapeutic system.

The sense of smell performs an important function in the existence of all living beings. Animals that have evolved only up to a certain level, have special olfactory organs. It assists them in many functions such as finding food, recognizing other members of the species, finding routes, finding the lodging place, escaping from the enemy etc. Although the olfactory organ is useful to many animals which are lower than man in evolution, it appears that man himself pays little attention to it. The main reason for this is man's ability to be guided by intelligence and sight rather than by smell.

The Olfactory tissue in our noses which senses a smell is about 2.5 metres in area. In one square m. metre of this tissue there are about 40,000 olfactory cells. Each of these cells have a fine hair protruding from it. The olfactory tissue and the hair is constantly covered with a layer of liquid. Essential or aromatic components, atoms or molecules float in the air. These enter the nose while breathing and come into contact with the olfactory tissue and hair. The stimulation which takes place is transmitted to the nerve centres along the olfactory nerve in the form of signals. The interpretation of these signals is known as a smell.

Although this action is explained in such simple terms it is a very complex process which has still not been properly understood. It has been discovered that the shape of the olfactory nerve ends and the shape of essential molecules fit and an action similar to the way in which a door lock is unlocked when the correct key is applied, takes place.

It has also been observed that when the shape of an essential molecule which gives a particular smell is changed even slightly, it's scent undergoes change.

According to available research data our ability to sense a smell is 10,000 times more than the ability to sense the taste of a food. It is possible to identify nearly 400 different scents. Scents or smells have been divided into six main categories. These can be called fruity, flowery, ... spicy, burnt, and offensive or bad odours.

In this paper we make an effort to focus attention on research now being carried out on a particular therapeutic system which is based on the use of these different scents and odours. Empirically it is known that it is not possible to associate with a person who has a smell which is offensive. Current research has been able to prove this fact. It has been shown that an infant can recognize its mother from amongst a thousand mothers. An infant's olfactory organ has the ability to recognize the smell of its mother's milk.

Certain smells have the ability to maintain alertness in people engaged in various activities. It has been shown that certain smells are able to keep vehicle drivers awake on long journeys. Some smells tend to make people quarrel while some other smells help to calm mind. Research is now being done to find out whether perfumes can reduce aggressiveness in a person. It has been proved beyond doubt that smells can change the mental state of individuals.

Middle aged people, both men and women are often in despondent moods, with either the spouse having died or loved ones having left them. The American Institute of Perfumes, is conducting special researches in this area. Unlike in Asian countries in European countries middle aged parents receive scant affection from their off-springs.

As mentioned earlier, research into the types of smells which are able to control the mental state of a person have yielded a large amount of important data. Meditation helps to calm the mind. It has been found that certain perfumes too are able to bring tranquillity to the mind. The



use of perfumes for healing is known as "aroma therapy". Positive results have been obtained through the inhalation of essential oils scented with different scents, as therapy for different illnesses.

The ability of perfumes not only to calm the mind but also to stimulate feelings and gradually awaken the senses was realized in ancient times. It has been proved beyond doubt that perfumes will help to arouse the feelings of ones lover or husband. Emperors used to pay attention to the woman who attracted him most out of hundreds of harem women. Perhaps for the same reason, even the 'Arabian Nights' mentions that in Arabia perfumes were given an important place. History has it that even Queen Sheba of Egypt bathed in a tub of water filled with rose petals before meeting her husband.

Aroma therapy starts with the inhalation of a suitable aromatic oil. Thereafter different kinds of oil according to the illness concerned are softly massaged into the body.

Aroma therapy is specially designed to bring a person to a specific mental state. It has been determined through tests that a specific aromatic oil is capable of producing a particular mental state. The smell of geranium, honey suckle, and pine resin, provide a certain amount of mental rest. Camphor, cardamom, lavender and eucalyptus smells, it has been shown are stimulating. Certain other scents have aphrodisiac properties as well as stimulating qualities. Cardamom, Cinnamon sandalwood, and Jasmine scents are among these.

Modern methods of analysis and computers have given a boost to aromatic therapy. We mentioned earlier that there is a connection between the shape of the atom or molecule and the scent. Changing the structure of the atom and observing on a screen how it comes into contact with the nerve end, and the chemist's enacting it in the laboratory, and the training of persons to inhale the molecules constructed in this way and to determine the stimulation caused by it can be called a chain reaction. On one hand this is a technology, on the other it is an art. It is more appropriately called an artistic technology.

With the advancement of the technology, the sensibility of smells has intensified. Therefore when manufacturing a delicate refined perfume, over a hundred different raw materials are mixed together. The primary scent of each raw material combine to produce an attractive perfume. What takes place is not dissimilar to the creation of an attractive picture by a skilful artist by combining a large numbers of colour pigments.

Cosmetics have already been accepted as part of daily life. Ordinary colognes,perfumes, cosmetic powders, shaving lotions, fragrant soaps, antiperspirants, deodorants, Air freshers, Air sprays, and thousands of other products can be mentioned.

It is clear that a prescription for a decoction comprising hundreds of medicinal components makes a complex compound. Similarly a multicoloured drawing creates a pleasing picture. A scent which has hundreds of chemicals takes a slightly different form. If a colour does not match it can be removed. However even a single trace of a wrong scent which gets mixed into a perfume cannot be removed. The mixture has to be discarded and a new formulation has to be prepared. The skill of a clever perfume maker lies in his ability to combine the exact number of traces of a specific chemical required to produce a specific smell.

Cosmetics have been identified as an essential item of daily life. The power in perfumes to change human feelings is mostly exploited by businessman. The use of perfumes which are attractive to customers in business places has today become a fine art. Some perfumes are released into the air with the help of computers. One objective of this is to make the customer remain longer within the business premises. Not only the perfuming of business premises but perfuming of

Although this action is explained in such simple terms it is a very complex process which has still not been properly understood. It has been discovered that the shape of the olfactory nerve ends and the shape of essential molecules fit and an action similar to the way in which a door lock is unlocked when the correct key is applied, takes place.

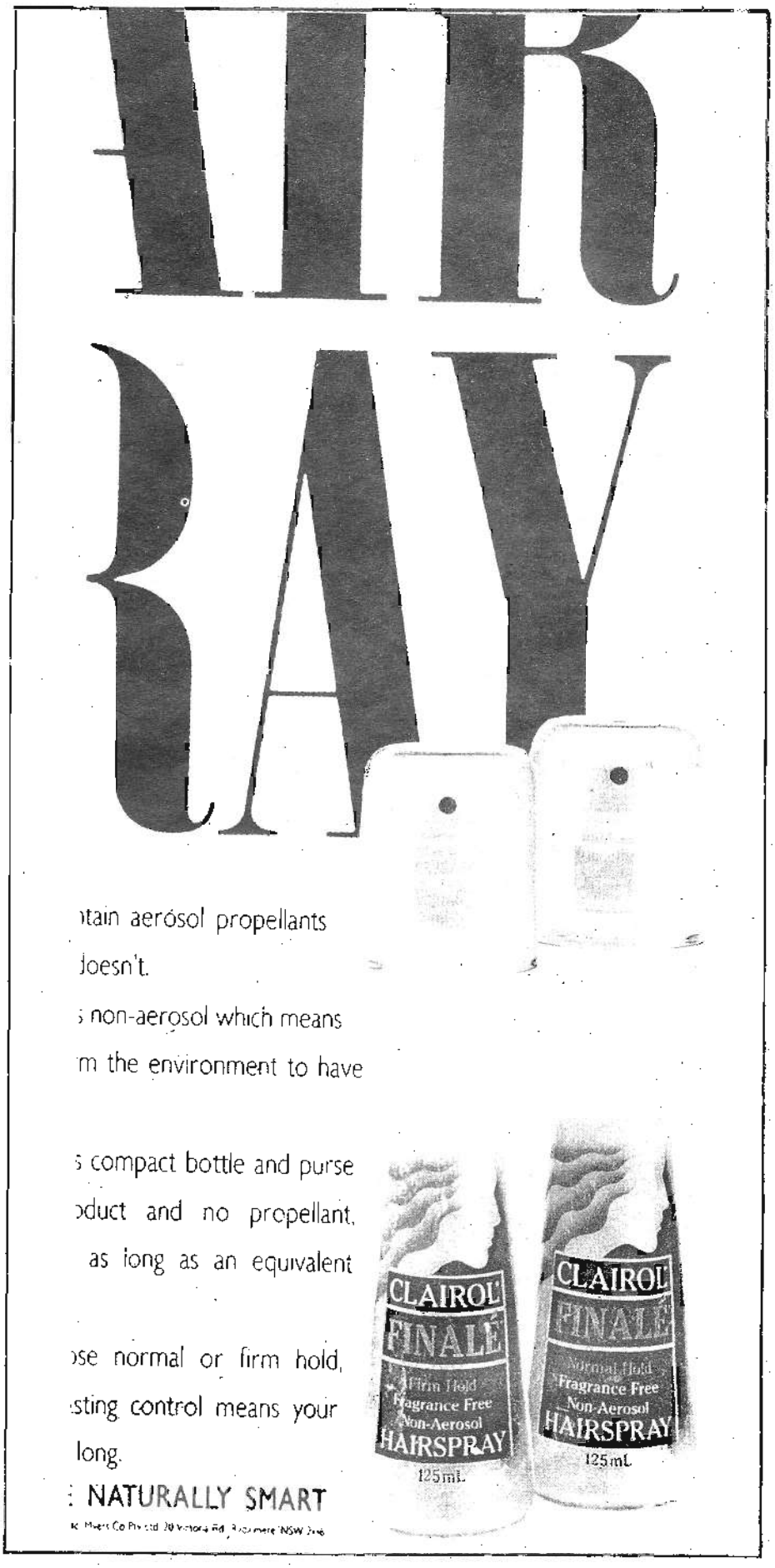
ordinary households, offices, hospitals, market places, restaurants and even prisons is among the services undertaken by one technical firm in Japan.

Perfumes can tempt a person not only to look twice at an attractive woman wearing them but even to follow her. Today on television there are plenty of advertisements which are based on this phenomenon. Today the scenting of not only the body but of textiles invitations, love letters and other utility items has become an art.

Colour contributes to the creation of a natural environment in a movie scene. Scenting it would add to this quality. Unfortunately, a scent cannot be changed within a second the way colour can be changed. Therefore adding scent when screening a film still remains problem.

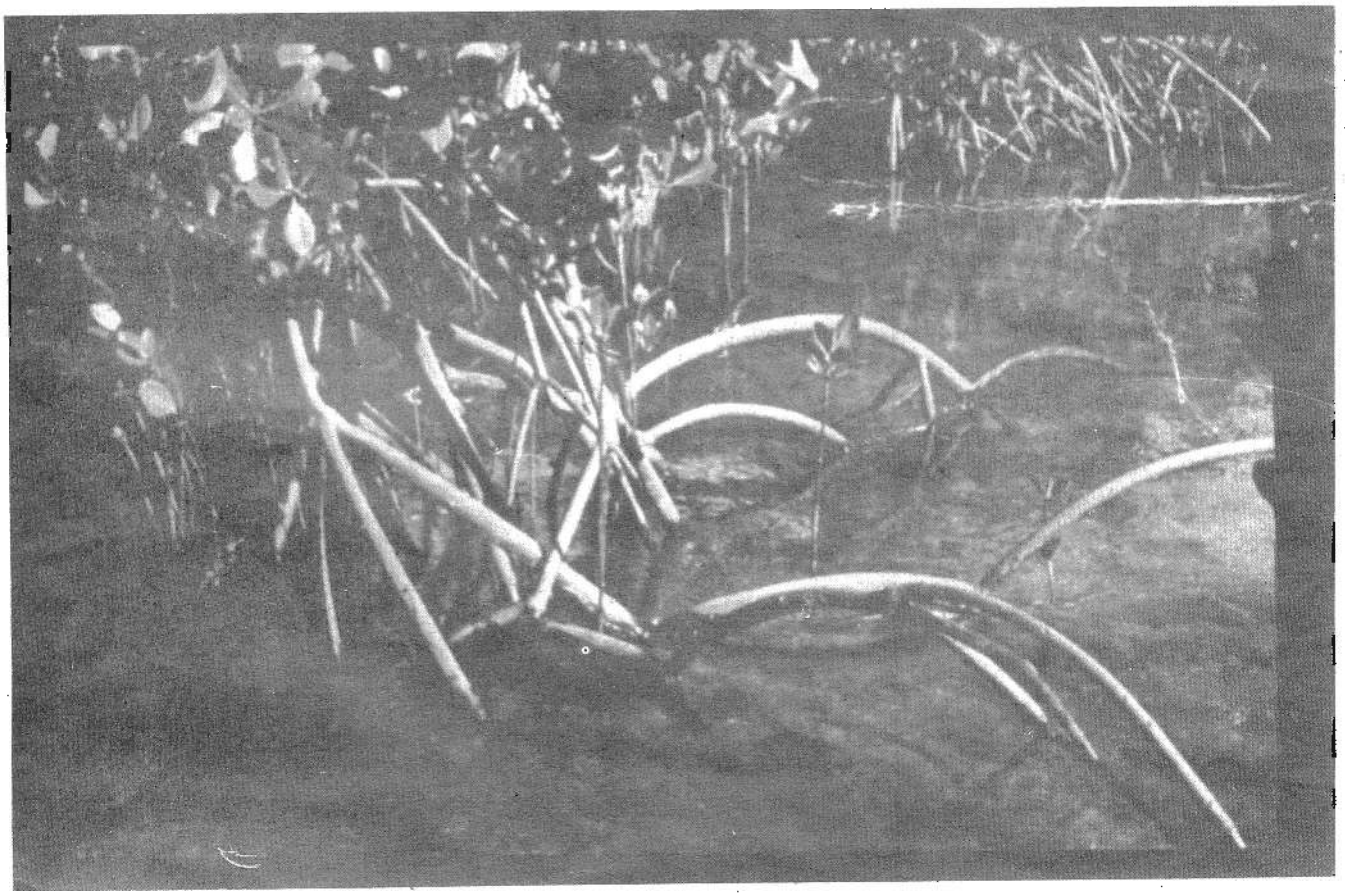
Many houses have a room in which gadgets producing music one likes can be enjoyed. In the same way that one can step into such a chamber and reach mental tranquillity, it is possible to attain mental serendipity by entering a scented chamber, according to present day aroma therapists.

It is now clear that these therapeutic systems allow everyone to select the preferred scent and use it to change ones own health or behavioral patterns.



MANGROVE – – FLORA & FAUNA

MANOHARI SANDANAYAKE
Assistant Director
NARESA



Mangroves improve the coastal micro climate, protects the land from erosion and cyclonic conditions, prevents sand dune formation and sedimentation. Because of their prop roots, Mangroves accelerate the process of sedimentation. Solid particles coming down the streams tend to flocculate at river mouths and get deposited due to the differences in salinities and densities.

Mangrove ecosystem is considered to be one of the most ancient ecosystems of the world. The extent of mangroves in Sri Lanka has been estimated to be between 8,000 to 10,000 acres. They are confined mainly around lagoons and in the entrediant shores near the river mouths.

The most extensive mangroves occur in Puttalam - Kalpitiya area in association with estuaries. Dense localized stands also occur in the Southern, South western and North eastern coasts. Eg: Koggala lagoon, Kalpitiya lagoon and Kokilai lagoon.

Benefits of the Mangrove Resource*

Mangrove plant species and mangrove associate plant species form a unique forest ecosystem. Mangroves improve the coastal micro climate, protects the land from erosion and cyclonic conditions, prevents sand dune formation and sedimentation. Because of their prop roots, Mangroves accelerate the process of sedimentation. Solid particles coming down the streams tend to flocculate at river mouths and get deposited due to the differences in salinities and densities.

Mangroves provide optimum conditions for breeding of fish, prawns, crabs, molluses, etc., nesting places of aquatic birds and a habitat for a varied fauna.

Mangroves plants are used for Brush - pile fishery ("Mas athu") in Sri Lanka. The fishermen leave the branches of mangrove plants in the lagoon. After a few weeks when fish have gathered in this "artificial mangrove", the brush pile is encircled with a net, the branches are removed and the fish caught. *Avicennia* branches are preferred for brush piles. The fish and crustaceans caught in the brush pile are sold as sea food. In addition, ornamental fish are also caught and they are sold to exporters.

The shells of mangroves molluscs are collected and sent to kilns to produce lime. Lorry loads of *Telescopium telescopium* are collected from Kalpitiya weekly. Annually about 150 m·tons of cockle and clams and 10 m tons of *T. telescopium* are extracted from the mangroves for lime.

Polychaetes especially the large *Marphysa boradellei* (S. Kalandanpanuwa) are dug out of the soil for fish baits. Since they are rich in proteins, there is a demand for polychaetes as fish food. The flesh of *T. telescopium* is also used as fish baits.

The leaves of mangrove plants especially those of *Avicennia* are used in agriculture as a manure.

Mangrove areas are good for

* This article was written at the request of G.C.E. (Advanced Level) science students.

aquaculture, especially for prawns. Acid sulphate of the mangrove soils, sometimes adversely affect the prawns or fish.

Cattle and goats feed on mangrove leaves. Perhaps the salt in the leaves make it more palatable to them. Even the thorny *Acanthus ilicifolius* is liked by goats.

The pneumatophores of *Sonneratia* are porous. Hence they are used as bottle stoppers and floats.

Mangrove plants are used as indigenous medicines. *Rhizophora* bark is used to cure fractures. Barks of *Bruguiera* is crushed and used as a poultice on minor cuts. Juice from Sonneratia fruit is used for bleeding piles and *Excoecaria* latex for skin rashes.

Mangroves provide fuel wood, poles, and domestic timber to the coastal poor. Mangrove timber is highly priced for telegraph posts because of its strength. It is naturally protected from insects due to the high percentage of tannins. These tannins are used by the fishermen to dye their nets and sails to give additional durability. Mangrove timeber is also used for the production of good quality charcoal and ornamental goods. The leaves of *Nypa fruticans* are used for tatting mats and making baskets.

Nypa fruticans (Ginpol) flower is tapped to obtain a type of wine. The fruits of *Sonneratia caseolaris* (Kirila) can be used to prepare a delicious *Sonnaratia caseolaris* fruit drink. *Avicennia spp.* is called as "honey mangroves" in which beekeeping is practised.

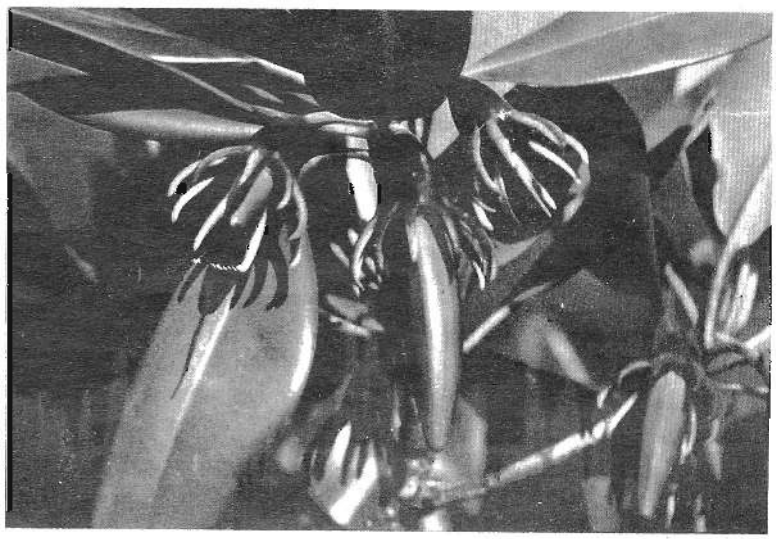
Adaptations of Mangrove Flora

Two major problems that mangrove plants are faced within the environment are difficulties in obtaining water and air. Although there is plenty of water, the salt conditions of the environment makes it difficult for the plants to absorb it. Some mangrove plants (eg. *Avicennia* spp.) have salt secreting glands to secrete salt from the water. Most of the mangrove plants have a thick cuticle and fleshy small leaves to conserve water.

Soil oxygen is necessary for the respiration of roots. But mangroves live in a soil, poor in oxygen. The special roots known as pneumatophores are developed in some mangrove plants (*Avicennia* Spp., *Bruguiera* Spp.) to obtain air from the atmosphere. These roots originate from the underground root system and protrude above the level of tide water, providing a continuous air passage to the submerged root system.

Since mangroves live on a loose substrate, they have developed extra roots other than the underground root system. They are prop roots arising from the branches and stilt roots arising from the main stem to anchor the plant to the substrate.

To meet the hostile conditions of the mangrove environment, an adaptation known as viviparity has developed. (eg.:- *Rhizophora* Spp., *Bruguiera* Spp. and *Ceriops* Spp.) The seeds grow to juvenilhood on the mother plant. When the grown embryo is released, it adheres to the mud with it's spit like hypocotyl.



Fruit and Flower of *Bruguiera gymnorhiza*

Mangrove Flora

Mangrove plants do not belong to the same family. There are 55 mangrove species in the world and 28 have been reported in Sri Lanka, both true mangroves and mangrove associates.

1. Family - Rhizophoraceae

1.1 Genus : *Rhizophora*

Mangrove trees with prop roots and stilt roots, growing along the muddy shores. The flower has 4 sepals and 4 white petals. The leaves are thick.

Rhizophora apiculata has sessile flowers while *R. mucronata* has long stalks. Thus the viviperous fruits of *R. mucronata* hang gracefully where as the viviperous fruits of *R. apiculata* found are clumsy and often curved. common name - Kadol.

1.2 Genus : *Bruguiera*

Bruguiera plants do not have prop roots but knee roots. They also have viviperous fruits but the hypocotyl of the fruit is not so long as in *Rhizophora spp.*

B. gymnorhiza can be identified by the red coloured calyx with 12-16 sepals. In *B. sexangula* there are 10-12 sepals which are yellow or orange. *B. cylindrica* which has 7-8 green sepals looks different from the above two species. Its hypocotyl is small and slender.
Common names - Malkadol, Sirikanda

1.3 Gunus - *Ceriops*

Ceriops occur as short bushes with stilt roots in Sri Lanka. The flowers are small and greenish yellow in colour. There are 5-6 petals and sepals. Although the flowers of *C. roxburghiana* are sessile, *C. tagal* have short stalks. The petals of *C. tagal* have 3-4 club shaped append ages while the petal apex of *C. roxburghiana* is Lacerate.
Common names - Punkanda, Rathugas.

2. Family - Sonneratiaceae

Sonneratia are small trees with stumpy pneumatophores. The fruit is a spherical berry, with a persistent calyx and style.

In *S. caseolaris*, 2-3 flower buds are found together but in *S. alba*, the flowers occur singly. There are 6-9 green sepals and 6 petals in the flower. *S. caseolaris* flowers are red and *S. alba* flowers are white.
Common name - Kirilla.

3. Family - Avicenniaceae (Verbenaceae)

3.1 *Avicennia: Avicennia* can be identified by the large number of pencil like pneumatophores. The underside of the leaves have a shade of white. In *A. marina*, the leaf apex is pointed and in *A. officinalis*, it is rounded.

The yellow sessile flowers are borne on a penicle. They give an odour like that of bee's honey. Fruit is a capsule. In mature fruits two large cotyledons are present. The fruits of *A. marina* are comparatively smaller than those of *A. officinalis*.
Common name - Mada gas.

3.2 *Clerodendron*: *Clerodendron inerme* is a small shrub with small leaves. White flowers occur on a cyme. Stamen and style are exerted.
Common name - Wal gurenda, Gowinda

4. Family - Myrsinaceae

Aegiceras corniculatum is the only species belongs to Myrsinaceae, found in Sri Lanka. It is a highly branched shrub.

The white flowers are fragrant and borne on slender stalks. There are 5 petals and 5 stamens inserted in the corolla tube. The viviparous fruit is curved.
Common name - Heen kadol.

5. Family - Acanthaceae

Acanthus ilicifolius is the only mangrove species belongs to the family Acanthaceae present in Sri Lanka. It is a creeper or a shrub with small prop roots and thorny leaves which have very short petioles.

The sessile flowers are purple in colour. They are borne on spikes and are surrounded by 2 bracts and a bracteole. Calyx has 4 sepals and the fruit is a capsule.
Common name - Ikili, Katu-ikili, Mulli

6. Family - Combretaceae

Lumnitzera are shrubs or small trees, evergreen with smooth purplish bark, and spirally arranged leaves. Flowers are white with 5 petals. Calyx is green with 5 sepals. There are 5-10 white stamens. The fruit is woody, green, oblong, and narrow at both ends, with a single seed.
Common name - Bariya

7. Family - Euphorbiaceae

Excoecaria are diocelous trees with latex, which is believed to be very poisonous. The mature leaves are red in colour. Flowers are very small. Female flowers occur on branches as spikes, and are few in number. The male flowers are found on spikes which grow singly in the axils of leaves. There are 3 sepals, 3 stamens and no petals in flowers.
Common name - Thela

8. Family- Meliaceae

Xylocarpus are small trees with a dark brown bark. Flowers are borne on long branches. They have 4 sepals and 4 petals. The fruit is large and round with corky, leathery

covering which splits into 4 pieces as it dries.

The fruit of *X. molluccensis* is about the size of a small orange whereas the fruit of *X. granatum* is 17-25 cm. in diameter. The fruit of *X. granatum* is light coloured, globose and smooth while that of *X. molluccensis* is dark brown, compressed and wrinkled.
Common name - Mutti Kadol

9. Family - Palmae

Nypa fruticans is the only palm growing naturally in the mangroves. The inflorescence is very characteristic with large globose fruiting heads. The fruit is a fibrous drupe and it takes about 4 months to ripen.
Common name - Gin pol

10. Family - Pteridaceae (Polypodiaceae)

Acrostichum aureum is the only mangrove fern with erect and stout rhizome. Leaves are pinnate and leathery. Sori are found along the veins.
Common name - Karen Koku

11. Family Sterculiaceae

Heretiera littoralis is a tree with leaves, green upper surface and silvery below. The unisexual flowers are yellowish green and bell shaped. The flower has 5 sepals but no petals. The fruit has a keel.
Common name - Etuna

12. Family - Bignoniaceae

Dolichandrone spathacea is a tree with glossy leaves. Three or four flowers occur in clusters. Flowers are white with a long corolla tube. The fruit is a follicle, about a foot long.
Common name - Diya danga.

Mangrove Flora

1. **Family : Rhizophoraceae**
   - 1.1 *Rhizophora apiculata*
   - 1.2 *Rhizophora mucronata*
   - 1.3 *Bruguiera cylindrica* *(Bruguiera caryophylloides)*
   - 1.4 *Bruguiera gymnorhiza* *(Bruguiera conjugata)*
   - 1.5 *Bruguiera sexangula* *(Bruguiera eriopetala)*
   - 1.6 *Ceriops tagal* *(Ceriops candolleana)*
   - 1.7 *Ceriops roxburghiana* *(Ceriops decandra)*
2. **Family Sonneratiaceae**
   - 2.1 *Sonneratia apetala*
   - 2.2 *Sonneratia alba*
   - 2.3 *Sonneratia caseolaris* *(Sonneratia acida)*
3. **Family - Avicenniaceae (Verbenaceae)**
   - 3.1 *Avicennia officinalis*
   - 3.2 *Avicennia marina*
   - 3.3 *Clerodendron inerme*
4. **Family - Myrsinaceae**
   - 4.1 *Aegiceras corniculatum*
5. **Family - Acanthaceae**
   - 5.1 *Acanthus ilicifolius*
   - 5.2 *Acanthus ebracteatus*
6. **Family - Combretaceae**
   - 6.1 *Lumnitzera racemosa*
   - 6.2 *Lumnitzera littorea*
7. **Family -Euphorbiaceae**
   - 7.1 *Excoecaria agagalocha*
8. **Family -Meliaceae**
   - 8.1 *Xylocarpus granatum*
   - 8.2 *Xylocarpus molluccensis*
9. **Family - Palmae**
   - 9.1 *Nypa fruticans*
10. **Family - Pteridaceae (Polypodiaceae)**
    - 10.1 Acrostichum aureum
11. **Family - Sterculiaceae**
    - 11.1 *Heretiera littoralis*
12. **Family - Bignoniaceae**
    - 12.1 *Dolichandrone spathacea*
13. **Family - Apocynaceae**
    - 13.1 *Cerbera manghas*
14. **Family - Leguminoseae**
    - 14.1 *Derris scandens* *Derris uliginosa*

13. Family - Apocynaceae

Cerbera manghas is a tree with alternatively arranged leaves. Flowers are large and white in colour, with 5 petals & 5 sepals. Fruit is smooth and rounded.
Common name - Gon Kaduru

14. Family - Leguminoseae

Derris scandens is a creeper common in the mangrove vegetation. White flowers are borne on a slende peduncle. *D. uliginosa* has pink flowers.
Common name - Kala wel.

Mangrove Fauna

There are lot of species of animals live in the mangrove enviorenment. Annelids, arthropods, molluses and chordales are the most common visible phyla living in the mangroves. These animals show diversity and adaptation to the environment. Oysters are attached to the roofs of the mangrove plants. Most of the crabs live in association with oysters. Prawns are normally found in the mangroves close to the sea. The mud-lobster lives in a complex burrow, building mounds in the mangroves. They are active only at night and never leave the

burrow. The mud skipper can be easily identified by its protruding eyes and the modified fins.

No account is given on the birds and the fishes of the Mangroves. Birds that occasionally found are Rajaliya, Sili watuwa, Waturan-duwa, Pilihuduwa, Kadol koka, Hota kalu koka, Diya kawa are frequently found in Mangroves.

The mangrove fish community is euryhaline, since the salinity of the mangrove water is subjected to high fluctuations.

Reference

Pinto, Leonard; *Mangroves of Sri Lanka*. (NARESA Publication).

Mangrove Fauna

1. **Phylum -Arthropoda**
   Class - Crustacea
   Order - Decapoda

(1) **Suborder - Brachyura (Crabs)**

(a) **Family - Portunidae (Swimmung crabs)**
Thalamita crenata (Sinhala - Kaberiya)
Portunus pelagicus
(S - Sinnakkali)
Scylla serrala
(S. Kalapu Kakuluwa)

(b) **Family - Ocypodiadae (Fiddler Crabs)**
Macrophthalmus depressus
Uca lactea
Uca dussumieri

(c) **Family - Grapsidae**
Neosermatium malbaricum
Metapograpsus messor
Chiromantes indiarum
Chiromantes bidens
Chiromantes darwinensis

(11) **Sub order -Macrura (Lobsters)**
Burrowing macruran
Swimming macruran
Thalassina anomala

Tribe - Penaeida

Family - Penaeidae (Prawns)
Penaeus indicus (Kirissa)
Penaeus mondon (Kalissa)
Penaeus semisulcatus (Kurutiissa)
Metapenaeus dobsoni (Malissa)
Metapenaeus monoceros

Tribe - Caridea
Macrobrachium rosenbergii dissa)

2. **Phylum - Mollusca**

(1) **Class - Gastropoda** (Gastrodes)
Pleuroploca trapezium
Fatnus ater
Telescopium telescoplum
Nerita polita
Ceithidea cingulate
Cerithidea quadrata
Littorina scabra
Cassidula musterina

(11) **Class - Lamellibranchiata** (Biralvia)
Graffrarium tumidum
Perna spp.
Pinna bicolor
Marria sp.
Geloina coaxans (Matti)
Meretrix casta (Matti)
Saccostrea spp. (Kawati)
Crassostrea madrasensis
Crassostrea cucullata

3. **Phylum - Chordata**

Class - Actinopterygii
Order - Perciformes
Family - Gobiidae
Genus - Periophthalmus
(Mud Skipper)

Periophthalmus Koelreuteri
Periophthalmus Sobrinus

VIDA 15-2-32

ORAL CANCER

(Cancer of the Mouth)

General Description

K.A.A.S. WARNAKULASURIYA
Department of Oral Medicine
Dental School
University of Peradeniya



Homogeneous Leukoplakia

The word cancer is of latin origin meaning 'crab'. In the medical literature a cancer is described as a disorderly growth of new cells arising in a tissue. This comparison that cancer is similar to a crab was made because like the claws of a crab burrowing into the earth, cancer cells invade neighbouring tissues.*

In the normal body, cells are well controlled by regulators inherent in each system. A cancer arises when there is lack of control in the growth of cells and cancer cells do not respond to the laws controlling activities of normal cells. As a result these affected cells continue to grow and multiply and produce new cells at the site of a cancer. This newly formed mass of cells do not function as normal tissue. The final outcome usually is a lump or a persistent ulcer (sore area) which results from the breakdown of newly produced cancer cells. These cancer cells may spread to adjoining tissue or travel to and invade remote areas of the body commonly destroying the sites where they go to; therefore the outcome of uncontrolled cancer is fatal. This is more so when the growth is known to be malignant (meaning rapidly spreading and invading other parts of the body). The term cancer includes all forms of malignant growths and ulcers, many varieties being known. Cancer generally manifests in the over 40 age groups.

Incidence of cancer is on the increase. This may be attributed to improved methods of diagnosis. More deaths from cancer are reported each year. It now accounts for a common cause of death in the over 40 age group and is only second to heart disease which is the major killer.

Oral cancer, one of the mutilating diseases afflicting man, is the most common form of cancer seen in India and Sri Lanka. A study of admission figures to Maharagama Cancer Institute reveals that approximately 30-40 per cent of all cancers of the body occur in the mouth in Sri Lanka (Nissanga, 1976). This figure may be a little exaggerated by the fact that cancers of the other parts of the body are sometimes treated outside Maharagama Cancer Institute. Sri Lanka has the second highest prevalence rate, (Pindborg, 1977), when oral cancer is expressed as a percentage of total body cancer.

As a result, oral cancer should be considered a major health problem in Sri Lanka. Unfortunately people are still not fully aware of the facts and figures of this terrible disease affecting the mankind. Majority of the people are ignorant of the nature of cancer. First we shall discuss how one could become aware of the presence of the disease.

Eighty to Ninety per cent of cancers of the mouth involve the covering surface (the lining) of the mouth. Therefore we shall deal with this type of cancer in this monograph. Majority of these cancers usually arise as a raised patch, growth (lump) or an ulcer (break in the surface). All these changes occur in the soft covering (lining surface called 'the epithelium' which in some respects is similar to your skin. As it involves the surface, if any change occurs it should be visible, except in the most posterior part of the mouth.

In a normal person the surface covering of the mouth is pink in colour and has a smooth contour. This covering surface can be divided into several areas for descriptive purposes such as lips, cheek (buccal), gums, tongue, roof (palate) and floor of the mouth (Figure 1).

Causes of Oral Cancer

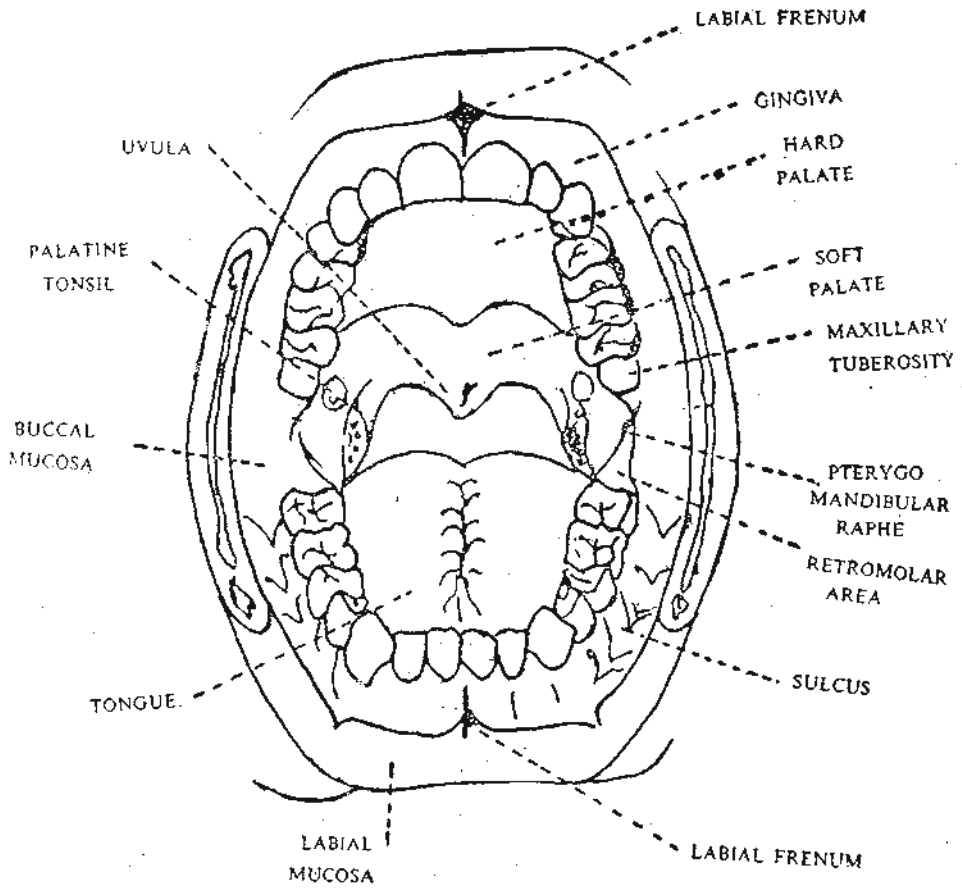
The actual cause for development of cancer is still not known. However, there are many factors which are commonly associated with Cancer and now we shall consider in detail some of these factors as related to oral cancer.

Smoking

Smoking is commonly associated with lung cancer but also appears to have some influence on the development of oral cancer. Although direct evidence from experimental work is lacking, it is commonly found that cancer of the mouth is more common in smokers than in nonsmokers. More convincing evidence comes from the fact that the site of the cancer is usually related to the type of smoking practised. For instance in a beedi smoker oral changes are commonly seen near the commissure (corner) of the mouth, where the beedi is commonly held and in a pipe smoker precancerous areas in the mouth are described in the palate (roof of the mouth - figure 1), where the pipe stems is directed to. In Andra Pradesh in India where women practice 'Chutta' smoking with the burnt end of the cigar inside the mouth, cancer of the palate is commonly seen.

* Reprinted from "ORAL CANCER (Cancer of the Mouth) - a Monograph for Public Education.

Figure 1: ORAL CAVITY



It is therefore now believed that tobacco smoking in any form either beedi, cigarette, cigar or pipe can result in changes in the covering surface of the mouth, which with continuous usage of tobacco may become a cancer.

Betel/Tobacco Chewing

One of the important factors related to the high prevalence of cancer in Sri Lanka appears to be the habit of chewing betel with other additives such as tobacco. The actual component in the betel quid (whether it is betel, betel nut (arecanut), tobacco or lime) which causes the change is still not known. The author of this booklet is presently undertaking a research study on the effects of these components of the quid on human oral mucosa.

From the clinical experience it is very clear that those who practice betel chewing are more prone to develop mouth cancer and the site of the cancer is often related to the position in the mouth where the betel quid is kept commonly the lower grooves inside the mouth adjacent to the cheeks opposite the molar teeth. Those who have the habit of keeping the quid overnight are prone to cause more damage to their tissues.

Studies in India in Kerala District (Mehta *et al.*, 1978) have shown a clear relationship between the betel/tobacco chewing habit and development of precancer in the mouth which may later transform to cancer. In a prospective study in Kerala district these authors reported 11 oral cancers developing over a ten year follow up period among individuals engaged in Betel/Tobacco chewing, while among a control sample consisting

of non-chewers a single cancer was not detected over the same period.

Alcohol

Relationship of alcohol to development of oral cancer is still not clear. Only evidence we have at present, is that in France where spirit drinking is more common than in other parts of the western countries, oral cancer figures tend to be higher. It has been observed that mortality from oral cancer is much lower among the Seventh Day Adventists who abstain from both alcohol and tobacco.

Obviously those who consume crude types of alcoholic drinks are more at risk than those using bottled alcohol.

Irritation

Irritation of tissues specially for a long duration is a factor which has been identified as a cause for development of cancer, although this has not been conclusively proved in human beings. A common source of irritation of soft parts of the mouth in Sri Lanka occurs from broken down teeth which have sharp edges. These cause damage specially during mastication and continued irritation over the years can produce a cancer.

The other factor which is more commonly over stressed is irritation from a bad fitting denture. A properly constructed denture normally does not irritate or damage covering tissue, when poorly constructed, the edges of the denture may cause damage. Another common problem is usage of a denture without proper adjustments over a prolonged period of time. As the tissues in the mouth change with time, when a denture is worn for over five to ten years, the edges of the denture would dig into tissues thereby causing damage. There are instances when denture wearers try to adjust a poorly fitting denture and as a result end up with rough margins which further traumatise the soft tissue.

It is necessary to stop wearing a non fitting denture which irritates and cuts into the mouth. Professional advice should be sought if a denture continually irritates soft tissues of the mouth.

Sun Light

Continued and prolonged exposure to ultra violet rays from the sun, has been identified as a cause for initiation of lip cancer in white skinned Australian farmers. Fact that lip cancer is much more common in males who tend to work more out doors than females and that the lower lip which is more exposed to sunlight is the common site of cancer rather than the protected upper lip suggests that environmental factors would be playing a role in lip cancer. However, dark skinned people are protected by the presence of pigment and rarely develop lip cancer.

Sepsis

Oral sepsis has been suggested as a cause of mouth cancer even at the beginning of this century (Power, 1918). Even at the present time we are not fully aware of the effect of poor oral hygiene on the development of mouth cancer. Most patients afflicted with oral cancer commonly have sepsis in the mouth. Whether this is the cause for cancer development or is the result of inability to clean the mouth amongst the complications which set in cannot be clearly established.

Other Causes

Venereal diseases appear to predispose to tongue cancer. Lack of iron in the body, a nutritional disorder commonly found in Sri Lanka (specially among the females who have had multiple pregnancies), has been reported to be of some importance in pharyngeal and oral cancer.

Signs of Oral Cancer

In the very early stages oral cancer is insidious, meaning one may not know or be unaware that he is affected by this disease. This is because pain and bleeding are not common signs of this disease in the early stages. It is the opinion of many that if pain and bleeding were early markers of this disease majority would come up for treatment much earlier. Unfortunately both these symptoms appear quite late in mouth cancer.

Early Signs

In the early stages, oral cancer may have any of the following appearances:

(a) Raised patch with a surface colour change to white, opaque white or red.

(b) Loss or peeling of the surface.

(c) Deep crack/s or fissure/s on the surface.

(d) Growth protruding out from the surface.

(e) Break or an ulcer of the surface.

During these early stages apart from the presence of any of the

above changes in the mouth a patient may be unaware of the of the disease as one does not encounter functional problems.

If one carefully examines the mouth in front of a mirror these changes can be observed and picked up early or another person may find them if you open the mouth wide and allow for a careful examination using a torch. Although these changes are not quite specific for cancer, their presence or detection should arouse the necessity for a professional opinion.

Late Signs

It is only later on as the cancer progresses, (that is the patch or the growth enlarges in size or the ulcer spreads and breaks down), that the more serious complications may occur. These are listed below.

(a) Pain, discomfort and bleeding
(b) Burning sensation in the mouth and inability to tolerate spicy food
(c) Difficulty in swallowing and speech
(d) Difficulty in opening the mouth
(e) immobility of the tongue
(f) Excessive mobility of teeth near the affected area
(g) Socket following extraction of teeth in the area of cancer does not heal within the normal period of 7-14 days
(h) Mouth odour
(i) Denture does not fit anymore
(j) Numbness of the lip
(k) Lumps in the neck
(l) Perforation of cheek
(m) Weight loss, weakness and inability to eat.

When the signs mentioned above appear the cancer has usually progressed to a late stage. Now the cancer cells are not limited to the surface covering but are invading deeper tissue like muscle. But nevertheless it is important to seek treatment at least now as a cancer specialist may be able to save the life of a patient even in the late stages, by advanced treatment procedures.

It is necessary to warn the reader that these signs we have mentioned are shared by many diseases and presence of any one or more of them does not always mean that a cancer is present. Only a qualified person would be able to correlate these changes to the disease and confirm presence or absence of cancer.

Commonly Affected Sites of the Mouth

We have learnt that the covering surface of the mouth which is normally pink in colour is the site on which a cancer may start. The different areas of the mouth are illustrated in Figure 1 and any of these areas may be a site for a cancer to develop. However, certain sites have predilection for cancer development, mainly depending on the smoking and chewing habits prevalent in each country. For instance those who smoke clay pipes in Gujarat in India develop cancer of the lips.

The commonest site in which mouth cancer occurs in Sri Lanka is inside the cheek, called 'buccal cancer'. This can be related to the habit of keeping or carrying the betel quid adjacent to the cheek. The area behind the last standing tooth (Wisdom tooth) in the lower jaw called 'retro-molar area' is another common site, where the quid may stagnate and thereby predispose to cancer.

Although a cancer may start inside the mouth, in late stages it may perforate through the cheek into the face giving rise to an ugly looking ulcer of the skin.

What should be done if Cancer is Suspected?

If you think there is a slightest indication that any of these signs mentioned have appeared in your mouth recently or have been there for sometime you must immediately seek medical advice. As dental surgeons are trained to examine the oral cavity, it is appropriate that you consult the dental surgeon practising in the area where you live, where you live, and complain what you have noticed or felt in the mouth. A delay is unwarranted as it is always dangerous to do so. It is not advisable to go to a quack (who are not professionally qualified, but still

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extract teeth) as they may not possess the fundamental knowledge required to make a diagnosis.

Precancerous Conditions of the Mouth

(1) A raised white patch which cannot be rubbed off (Leukoplakia).

(2) Red or White nodules on a raised white patch (nodular leukoplakia)

(3) A red area with a velverty surface (Erythroplakia)

(4) Long standing non-healing ulcers.

(5) Tightness of cheek and tongue (Submucous fibrosis)

Self examination of the mouth or examination by a health worker may reveal the presence of above conditions especially among tobacco betel consuming population. A knowledge of these conditions is warranted.

Initial Steps in Diagnosis of Oral Cancer

If a dental surgeon or a doctor suspects that a patient has a cancer in the mouth a detailed recording of all related factors would be taken down and the mouth would be examined under good illumination. Some may proceed to remove a piece of tissue from the suspected area for a special laboratory examination. This is called a biopsy. Others may refer the patient to a hospital consultant who specialises in the area.

The patient must immediately report to the consultant who will re-examine the patient. If a piece of tissue is required for special tests, this would be done as early as possible to avoid any delay. Patient may stay in the hospital until the necessary information is available from this special test. If presence of cancer is confirmed. usually the patient or a close relative is informed of the result, and the case would be taken up for treatment at a specialised centre.

What Treatment is available?

Generally oral cancer is treated by radiotherapy, surgery or chemotherapy. Sometimes these methods are combined to get a good result. Radiotherapy means use of irradiation to kill cancer cells. There are many forms by which radiotherapy can be applied. Tele cobalt therapy or use of radium needles are commonly practised in Sri Lanka. Method of application would depend on the type and site of the cancer and the facilities available. Radiation is given in divided doses, and the radiotherapist plans the treatment in such a given in divided doses, and the radiotherapist plans the treatment in such a way that adjoining normal tissues receive minimal damage during treatment.

Teeth in the adjoining areas to the cancer are usually removed before radiation therapy is commenced.

Surgical removal is mainly done either for very small initial lesions of cancer which can be completely removed without mutilation or for late advanced cancers which cannot be controlled by radiotherapy.

There are no special pastes or tablets which can cure cancer.

For treatment of oral cancer most patients have to go the Maharagama Cancer Hospital, as it is there that the specialists are available and radiotherapy units are installed. In the central province, Kandy General Hospital also has facilities for radiotherapy treatment in the Cancer Unit.

Some of the big hospitals in the island are also undertaking treatment of patients for oral cancer.

Can Oral Cancer be Cured ?

Cure for oral cancer mainly depends on the stage and type of the cancer. If reported early majority of the patients survive and could lead normal lives with minimal disability. As the condition becomes more and more advanced the cure rate rapidly falls. In such cases a cancer may reappear soon after a time lapse following completion of treatment. This is called a recurrence of cancer. It may take months or few years after initial treatment, for reappearance of a cancer. Therefore a patient once treated should be carefully observed for further changes which may occur in the treated area and report back to the clinic if something is in suspect.

Survival Rates

Survival rates from oral cancer for Sri Lanka are not available in the medical literature at the present time.

In the United States, in 1973, estimated survival rate of oral and pharyngeal cancer cases obtained by comparing deaths vs registrations was around 50 per cent (American Cancer Society, 1973).

A more reliable guide is obtained by studying survival of new registered cases and following them over a period of about ten years to assess the number of people surviving at each follow-up period. In England and Wales in the early sixties, the five year survival rate for oral cancer was about 50 per cent when the cancer was detected early, and this figure fell rapidly to only 20 percent of patients surviving if the cancer was detected in late stages (Binnie, 1975).

Cancer of the tongue, seems to have a worse prognosis than other sites of the mouth. Females have a better five year survival rate than men for intra oral cancer, suggesting that cancers of the mouth in women are having a better response to treatment.

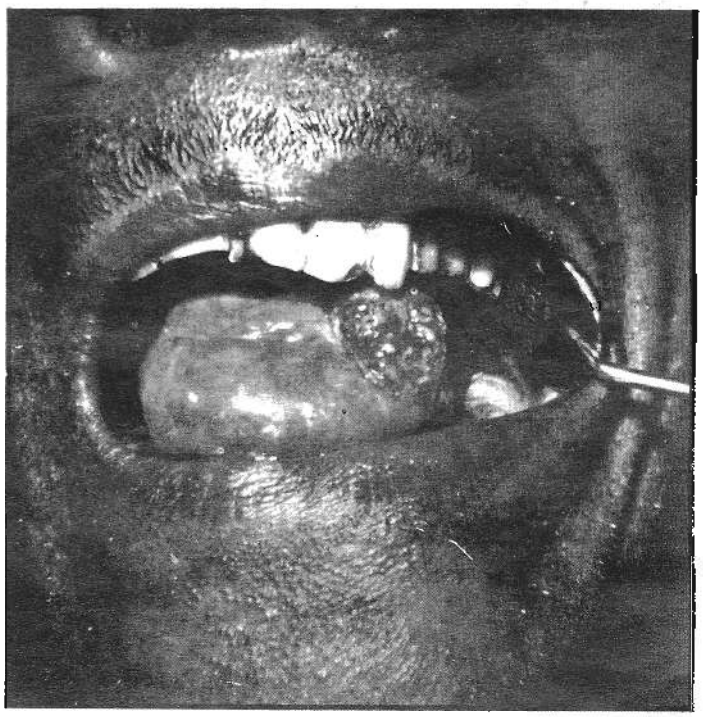
What Happens if a Patient does not Go for Treatment ?

Cancer if untreated, spreads and invades other normal adjoining tissues rapidly. Buccal cancer may spread to the face and erode through the skin. In addition to local invasion, cancer may also spread to the other parts of the body through channels such as lymphatic vessels.

The bad odour which emerges from a late lesion is rather unbearable. If untreated, death is certain as a result of complications which set in due to the presence of a growing cancer.



Speckled or Nodular Leukoplakia



Submucous Fibrosis with Cancer of Tongue