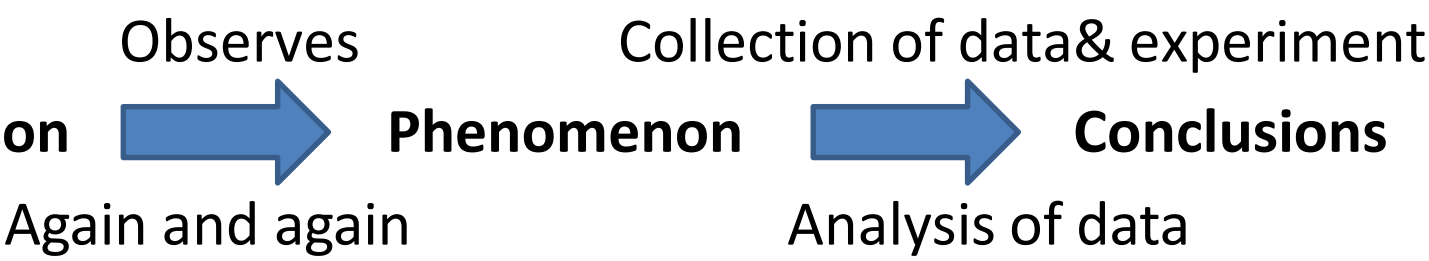
Research Methods in Ethnobotany

What is Research?

- Research is the most important **process for advancing knowledge, promoting progress** and to **enable man to relate more effectively to his environment** to accomplish his purpose
- The term 'Research' consists of **two words**:

  Research = Re + Search

- 'Re' means **again and again** and 'Search' means to **find out something**
- Research process:



What is research contd....

- Research is an **endeavour** to **discover, develop and verify** knowledge.
- It is an **intellectual process** that has developed over hundreds of years, ever changing in purpose and form and always searching for truth
- Research is **an honest exhaustive, intelligent searching for facts** and their meanings or implications **with reference to a given problem**.
- The product or findings of a given piece of research should be an **authentic, verifiable and contribution to knowledge** in the field studied
- Research can also be defined as **an organised scientific investigation to solve problems, test hypotheses, develop or invent new products**

Specific Characteristics of Research

1. Research is based on **insight and imagination**
2. Research requires an **inter-disciplinary** approach
3. Research should come out of a **desire to do things better**
4. Research is not the field of the specialist only
5. Research is based on the **subjectivity and intangibility** of social phenomena
6. Research is based on **inter-dependence of causes and effect**
7. Research **cannot be a mechanical process**

- Based on these characteristics **a researcher must**:
  - **resists** the **temptation to seek only the data that support ones hypotheses**
  - **eliminate personal feelings and preferences**

Choosing the Research Approach

- In ethnobotanical research **choosing the right research approach** is a **key to success**

- **Determining the ultimate goal of research** is a **priority** before selecting the right research approach

- The researcher **should plan whether his/her research is a short-term** or a **long-term** one

Choosing the Research Approach contd...

- ***General points to consider when planning Ethnobotanical research:***

❖ **Pre-preparation** before travelling to the research site. Addressing tasks like **collecting secondary information** about the study area (Map, Literature, Population, Land use, Altitude, Economic activity, Flora, Fauna etc...)

❖ Forming **multi-disciplinary team** consisting of botanists, chemists, anthropologists, health professionals, etc... **If independent basic knowledge of each subject is mandatory**

❖ Ensuring **community participation** through out the research

❖ Be **selective in the choice of techniques** to gather the information needed

❖ Be **systematic** to save time and scientific rigour

Basic Research ethics in Ethnobotanical research

- Consider **nationally defined research priorities** of countries, and **develop a written agreement** outlining the elements of the collaboration among researching institutions including **responsibilities**, **potential benefits**, **intellectual property agreements** and **disposition of results**

- Respect the right of local people to be **informed**, **consulted** and above all to **participate** in the research process (There is a need to **discuss the objectives, methods, the likely outcomes and finally the results of research** with local communities)

Basic research ethics in EB cont...

- **Confidentiality** of some forms of the **intellectual information obtained** from local specialists, plant users as well as the genetic and chemical information from plants needs to be **confirmed**

- **Recognition** of the unique **intellectual contributions** made by **research colleagues** and their extended **communities** is a central theme of the ethical standards and unique perspectives of ethnobotanists

- **Equitable distribution of benefits** from the use of wild plants, crops, or their genetic or chemical structures **to assist people and plant conservation** in the region of origin

- **Compensation** to be made when extensive use is made of **local people's time, resource and expertise.**

Basic Research Ethics in EB cont...

- **Purchase of information is not allowed**, as it could tempt respondents into giving nonsense answers and resources for a material gain

- Ethnobotanists have a responsibility to ensure that their studies **donot cause a devastating change** in local values and lifestyles of indigenous people

Two Basic Research Approaches in Ethnobotany

1. Qualitative research

- is important to study **people and their thoughts** in their **natural settings**, attempting to **make sense of**, or interpret, phenomena in terms of the **meanings of the local people**
- Involves finding out **what the local people think**, and **how they interact** with the **biota**
- involves **fieldwork**, hence the researcher physically goes to the people, setting, site, or institution to **observe or record the interactions** in their natural settings
- Qualitative research is **descriptive** in that the researcher is interested in **process, meaning, and understanding** gained through words or pictures

Research methods in Ethnobotany contd

- Qualitative research information is **subjective** and involves commonly **feelings, impressions and local cultural practices**, rather than numbers
- The process of qualitative research is also **inductive** in that the researcher builds **abstractions, concepts, hypotheses, and theories** from details
- Such researches in ethnobotany employ more **subjective approaches** and **frequently use interviews, focus groups, or single case designs** that lack objective measurement
- The study methodology of **basic ethnobotany** is dominated by this qualitative approach, which is considered weak as the scientific interest in ethnobotanical fields increased

Research methods in Ethnobotany contd

2. Quantitative researches

- Quantitative ethnobotany is defined **“as the application of quantitative techniques to direct analysis of contemporary plant use data ”**
- Quantitative ethnobotany arose as a response to the perceived “subjectivity” of descriptive approaches
- The scientific rigor of ethnobotanical research has increased dramatically in the past two decades due to the adoption of quantitative methods
- Widely implemented due to their **scientific and reproducible methods**, including **testable hypotheses**, and **statistical measures of variation**
- Currently, **mixing up** of qualitative and quantitative approaches is coming very popular and seen as a **good indicator of modern ethnobotanical research.**

Methods of Ethnobotanical Data Collection

- For ethnobotanical research the **initial steps prior to data acquisition** include:
  - Defining the **study problem**
  - Setting **objectives**
  - **Identifying the data to be collected**
- The **type of data to be collected** depends on the **ultimate goal** of the researcher
- **Ethnobotanists may aim** to achieve **one or more of the following goals**:
- 1. **Basic documentation** of traditional botanical knowledge
- **2.Quantitative evaluation** of use and management of biological resources
- 3. **Experimental assessment** of benefits derived from plants and animals

Methods of Ethnobotanical Data Collection contd..

- 4. Seeking to **maximise the value** that local people attain **from their ecological knowledge**
- **5. Studying how the ancestral people** were using natural resources

What type of Data do we collect for EB research?

- **Major forms of Ethnobotanical data** to be collected, for instance. in any Ethnobotanical research may include:
- Local peoples' **perceptions and classifications** of diverse aspects of the natural environment
- Cultural or **traditional information** of the people
- List of **traditional remedies** for specific illness and treatment methods
- **Specimens** of all culturally important plant species
- **Local name** of the plant
- If used **medicinally**, the information on **disease type, symptom, response to therapy, and antidotes**

What type of Data do we collect for EB research contd...

- Additives and **other ingredients** used in preparation
- Adjunct **therapies**
- **Other local uses** of the plant
- **Status** of the plant
- **Conservation** practice of the plant
- **Distribution, reproduction, phenology and plant animal association** of the subject of study

Ethnobotanical Data Collection contd..

❖ There are **two basic data types** in Ethnobotanical research

1. Qualitative data ***2. Quantitative data***

<u>Qualitative data</u>

- A data collected in **non-numerical** form
- Also known as **binary/two-state data**
- A kind of **yes/no** or **present/absent** data
- Can be **nominal** or **multi-scale** data with different categories
- **Can also be collected** in the form of **pictures, audio-videos or sound recordings**

Ethnobotanical Data Collection Contd...

Quantitative data

- Presented in **numerical** form
- Can be **discrete** obtained by counting (frequency, abundance etc...)
- Can be **ordinal scale** (Ranking order)
- May also be collected in the form **of ratio or interval scale**
- It is also **possible to generate** quantitative data from the qualitative one
- **Both qualitative and quantitative data** are **used in many ethnobiolgical research**

TYPES OF ETHNOBOTANICAL RESEARCH METHODS

- There are different methods to gather ethnobotanical data
- The major ones include:

❖ **Anthropological method**

❖ **Botanical method**

❖ **Herbarium method**

❖ **Ecological method**

❖ **Ethnopharmacological method**

❖ **Linguistic method**

Anthropological methods

- The **centre of focus in Ethnobotanical research** is the **information obtained from local community** of a study area
- Anthropological methods are **employed to investigate the way indigenous people interact with the natural environment**
- These methods include

A. Informant selection

- **Informants** are **local people who share their cultural and ecological knowledge**
- Informants are **also** called **Interviewees**, **subjects**, **participants, respondents, collaborators or local counter parts**
- Have **to be selected in a systematic way**
- **Random sampling** of informants is recommended when the intention of the research is to collect **general ethnobotanical data**

Anthropological methods contd...

- **Purposive sampling** can also be applied to **include knowledgeable people** or **elderly people** of certain social groups

B. Talking with People

- A **necessary step** to gather ethnobotanical information
- Can be **performed by formal interview or informal conversation**
- It is the **basis of data collection method in ethnobiology**
- It could be **individual type** or **group type**
- **Individual interview is more appropriate** for Ethnobotanical research

Anthropological methods contd.

- Talking with people demands **question and answer** approach

Q, **How many types of techniques of inquiry do you know?**

- Interview
- Participant observation
- Guided field walk/ walk in the woods

Anthropological methods contd...

1. Interviewing

- An interview is the **basis of most ethnobotanical data collection methods**
- Ethnobotanists collect data through interview **from the local people** who share their cultural and ecological knowledge
- The **interviewees** are also referred to as **informants**, **subjects**, **participants**, **respondents**, **collaborators**, **local counterparts** and **local experts**
- The way a researcher constructs his interview questions and conducts an interview determines the **quality**, **quantity**, and **meaning** of ethnobtanical data
- In interviewing, researchers need to **target** to know as much about the **local IK** as possible in a given time

Anthropological methods contd...

- An ethnobotanist who conducts **an interview** needs:

- to get **prior information about the local rules of conversation** in the study area including visual eye cues, eye contact and posture

- to explain **clear motives and research interests** during the early stages of relationship with the interviewee

-to develop **sensitivity and respect** when individuals show shyness or reticence on certain subjects

-to be **aware of the place and condition** at which people feel **comfortable** in sharing their knowledge

-to **respect individual decisions** not to participate in an interview

- to formulate and pass questions in culturally meaningful and appropriate way

Anthropological methods contd...

- Using **native language** in ethnobotanical interview is a prerequisite to get the **maximum of an interview**
- **Cultural competence** of the researcher with those in the study area is very useful to construct and phrase culturally **legitimate and answerable questions**, as well as to get **meaningful data** (Alexiades, 1996)

Anthropological methods contd...

- Interviewers need to avoid **the most common mistakes of interviewing** during ethnobiological researches:

  - asking leading questions

  - disrupting interviewees

  -asking complicated or too short, or ambiguous questions

  - expressing **feeling of judging interviewees** idea while the interview is going on
  - Conducting interview with **more than one individual at a time** with on lookers present

Anthropological methods contd...

Forms of interview questions

- One of the key skills in interviewing is selecting **the right type of question** in the right time
- Interview questions have **four different forms**
- **Direct questions- Wh** form questions. They **exert considerable control over the response** than other forms of interview questions
- **Indirect questions-**ways of **'beating around the bush'** to find out what is in the bush. Commonly used in dealing with **sensitive subjects in the community**like sex, abortion and death
- **Open ended questions-** are those which are very useful at the beginning of an interview to **'break the ice'** and **identify topics of interest. They exert little control over the response**

Anthropological methods contd...

- **Close ended question** -These questions need a **yes or no type** of answer and usually are **asked using fixed phrasing**. Such questions **exert most control** over the response so need to be employed carefully
- The researcher can use **probing techniques** while one or more of the questioning is going on
- The techniques include **nodding**, **repeating the last phrase of the informant with a rising inflection**, a **period of silence with eager facial expression** following informants' reply, and **projective aids**

Types of interviews

Individual interview

- Personal viewpoints, disagreements
- No interruption
- Quantitative data
- Sensitive information

Group interview

- Effective & stimulating
- Wealth of data & lead to discovery
- Transmission of cultural knowledge
- Individuals may be reluctant
- May not be compatible w/certain research goals
  - ➢ Distribution & variation of ethnobotanical knowledge
  - ➢ Statistical tests that require the recording of "independent events"

Types of interviews

Informal interview

- lacks any structure or control
- after casual conversation/ observation
- common at early stage of a study
- no specific & topic targeted Q's

Unstructured interviews

- to get an informant on to a topic
- general sense of the topics
- flexible but controlled
- building initial rapport
- develop formal guidelines for other interviews

Semi-structured interview

- a list of Q's that can be modified
- interview guide
- selected key topics = *quantitative*
- open for discussion = *qualitative*
- most common

free listing, Triad tests, Ranking order, pile sorting

Structured interviews

- a set of fixed Q's
- direct & closed Q's=bias
- at later stage of the study period
- data subjected to quantification & statistical analysis

more amenable to statistical analysis

Anthropological methods contd...

2 Direct or participant observation and guided field walk

- Ways of data collection by **observing plant-human interaction**
- The **ethnobotanists accompany the people**, with whom he or she is doing research, often directly participating in diverse activities
- needs also to **record observations**, **ask question** and **voucher specimen collection**
- highly **reliable data collection method** specially in studying plant use

Anthropological methods in contd...

3. *Market survey*

- Markets are **rich sources of ethnobotanical information**, since they are sites at which **medicinal, ornamental , edible and other useful resources are sold**
- Ethnobotanists can **trace the path** of locally useful plants **from their growing sites to local, regional and central markets** where gatherers and intermediate traders operate
- Ethnobotanists must be able to **identify local plant collectors, local traders, brokers, whole sellers and even exporters.** The business channel is sometimes **complicated** and many hidden stakeholders may get involved
- One can use the information from a market survey to **describe the economic value** of useful plants, and recommend those which need **prior conservation and mass production** efforts

Market survey

Anthropological methods contd...

4. Recording

- Data collection using **electronic recording devices** such as portable computers, audio, photo and video recorders

- These devices are useful in that they are **faster and more accurate than note taking** and **allow a free flow of conversation** during an interview

- Recording **should not be done without obtaining a prior consent of the informant**, since it is not only **unethical** but also being discovered taping results more suspicion and **mistrust**

Anthropoogical methods contd...

Sampling

- In collecting ethnobotanical data researchers need to **define** the **sample universe**, i.e, what and who will be studied, based on **geographical**, **ecological** and **social** criteria
- Once the sample universe is defined the researcher needs to **choose a representative sample** from this universe
- The **sample size** can be determined based on:

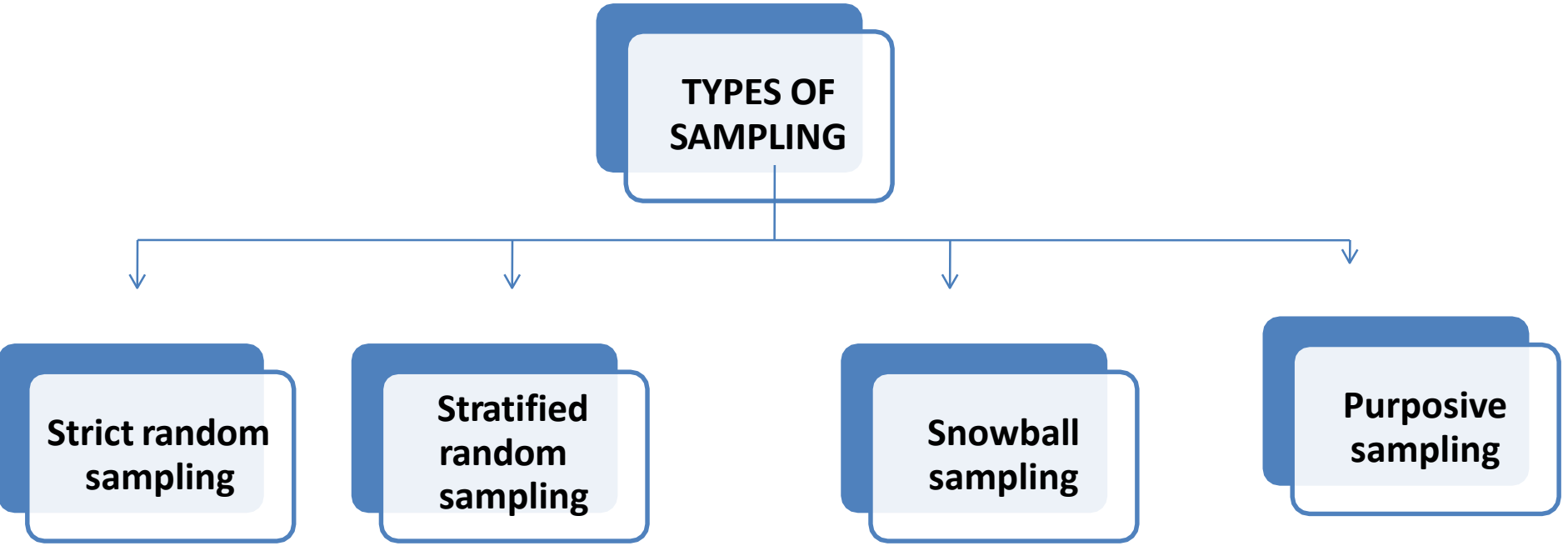
  - the **total population size** **-degree of accuracy** needed

  -the **depth** to which individual knowledge is to be explored

  -the **type of data** analysis to be performed

  -the **scope, objectives and characteristics** of the study, and the site

Types of Sampling



-Every individual in a population has equal chance of being selected (Alexiades, 1996)

-Selection criteria must be truly objective and involve no conscious or unconscious selection on the part of the researcher

Involves in subdividing the sampling universe beforehand in to important Subgroups (strata)

Subjects with desired traits or characteristics give names of further appropriate subjects for the research

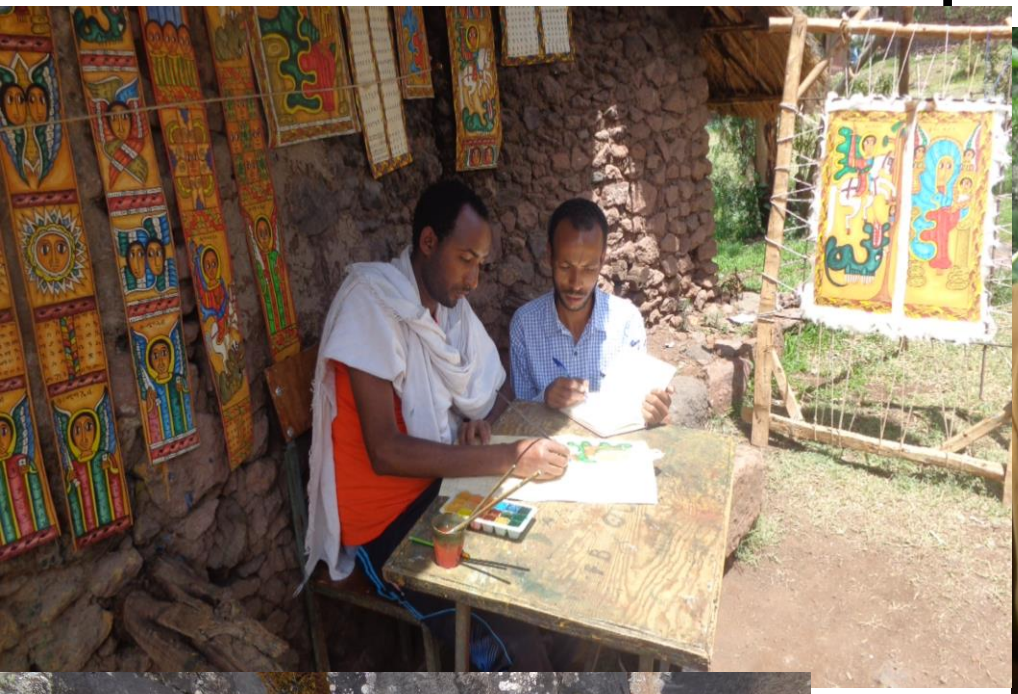
Sampling technique by hand-pick of subjects on the basis of specific characteristics

Types of sampling contd...

- **Strict RS**-Researchers may use a **random number table** or **choosing the nth person** from the sample universe.

  -The short coming of **Strict RS** method is that it **cant be achieved without complete list of population members**
- **Stratified RS**-Researchers may face **difficulty** in practicing this method since it is more **complex in the field** and requires greater effort than strict random sampling
- **Snowball sampling-**The shortcoming of this method is that there is **no way of knowing whether the sample is representative** of the population
- **Purposive Sampling-**the samples are **not easily defensible as being representative of populations** due to potential **subjectivity** of researcher

Some techniques of inquiry



Participant observation

Some techniques of inquiry

Individual interview

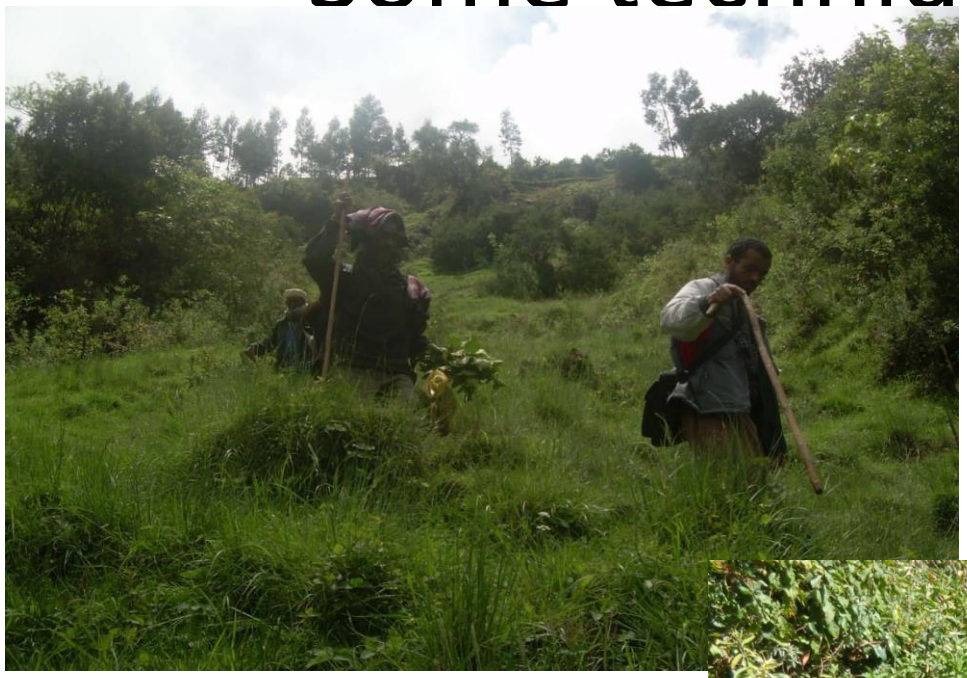
Some techniques of inquiry

Semistructured Interview

Some techniques of inquiry

Structured interview

Some techniques of inquiry



Guided field walk

Some techniques of inquiry

Participant observation

Some techniques of inquiry

Informal interview

Some techniques of inquiry

group interview

Botanical methods
Voucher specimen collection


Out in the field, collecting voucher specimen.

Collecting Voucher Specimens (Trees)

Vouchers specimen collection contd...

- Ethnobotanical information without **adequate voucher** specimen has **little scientific value**
- The common equipments and tools used in voucher specimen collection are **clippers, secateur, extendable tree prunner, field press, pocket press, news papers, plastic bags, alcohol, water proof jars, paper tags, pencils, water proof pens, camera, measuring tape, pocket handlens, masking and duct tape, tree climbers, diggers and blotters**
- The researcher needs also to have a **first aid kit** for hazards during the field
- The Voucher specimens have to be selected based on their **representativeness** of the plant part in question, and have to be collected in **duplicates**

Voucher specimen collection contd...

- Collecting **fertile specimens** than sterile ones is preferred
- Basic information regarding the voucher specimens includes **local name**, **collection number**, **date of collection**, **collectors name**, **geographical readings** (latitude and longitude), **altitude**, **locality and description of the plant, associated plants, soil type** (Given and Harris, 1994).
- Specimens need to be **properly pressed**, **dried**, **identified** and **deposited in a herbarium** to serve as a permanent record of information that can be reviewed or reassessed.

How to collect voucher specimen?

- **Herbs**: Must dig up atleast one entire plant to show root or rootstock (e.g.,bulb, rhizome….)

- **Shrubs, trees, vines**: One branch sufficient.

- Collect a **representative specimen** that shows vegetative and reproductive parts (in flower, fruit, cone, with sporangia, etc.)

Voucher specimen collection

If no leaves and flowers, collect the available part, plant it and identify

Voucher specimen collection

Collection of flowers and fruits for better identification

Voucher specimen collection

Collection of flowers and fruits for better identification

Collection of flowers and fruits for better identification

Voucher specimen collection

Use digger and collect herbaceous plants with their roots

Voucher specimen collection

Collect herbaceous plants with their roots for better identification

Data collection

Use GPS and record geographical location of your study site

How to collect contd…

- Put the collected voucher specimens to a News paper, then place it in a **Portable Field Press** used in field
- Fold specimen to fit ca. 11.5” x 16.5” fill up area

1) Cut to **fit** & to **prevent too much overlap**; **slice rootstocks**; **flowers**, **fruits** to show morphology
2) Put at least **one leaf up, one down** in the press
3) Collect **extra material**, if possible.
4) Divide into **2 or more sheets**, if necessary.
5) **Succulents**: cut/slice out tissue, soak in alcohol (if needed)


Doing the initial pressing,
in the field

How to collect contd….

Q. How do we press specimens?

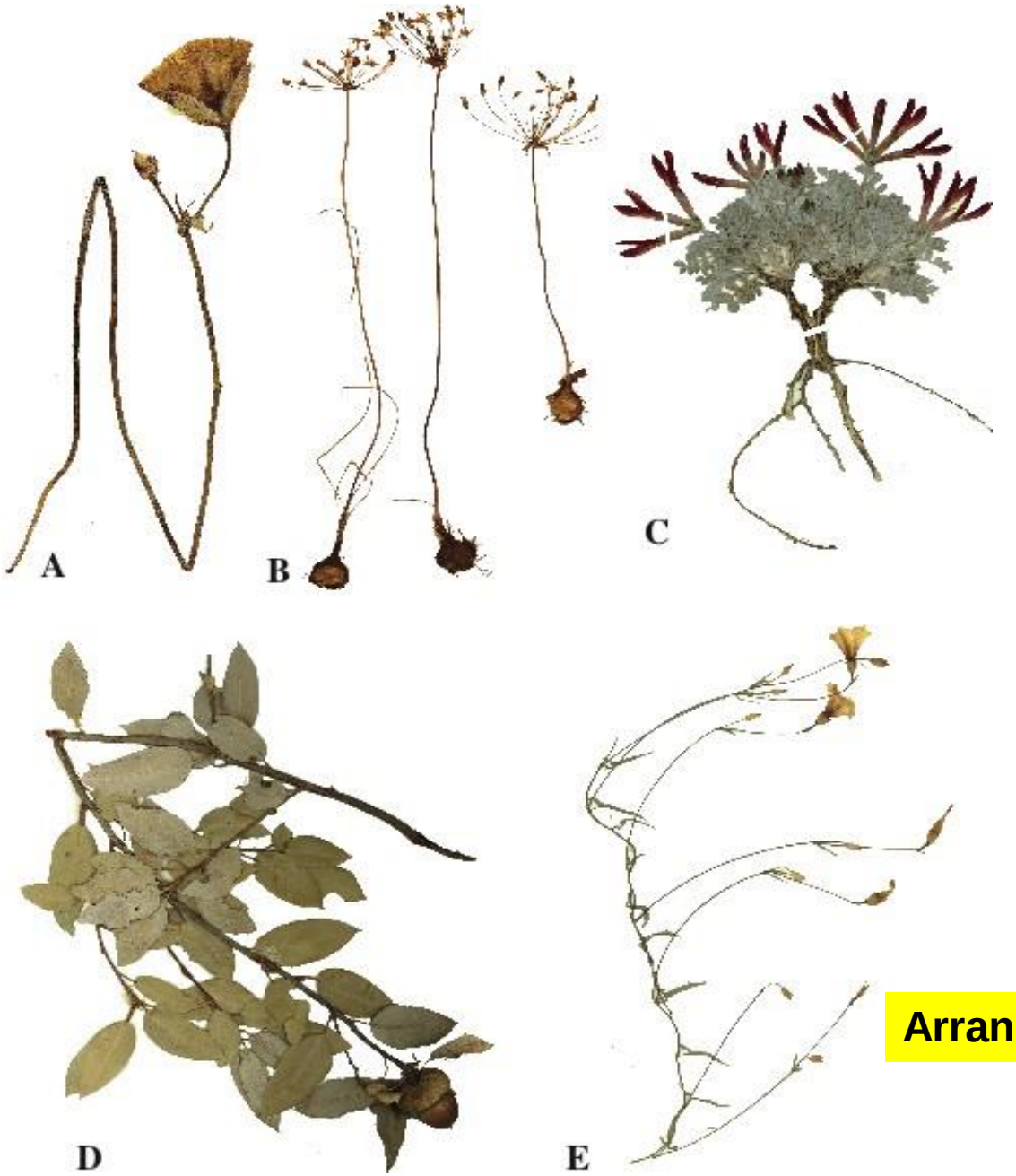
Composing and arranging the specimens for pressing

- Each specimen should be **as complete as possible**
- Do not put all the **flowering and fruiting branches** in one or two of the duplicates, leaving the others sterile
- Select a **sufficient amount of plant material** to fill the paper
- Plants **should not hang out beyond the edges** of the paper nor should much empty space be left inside
- **Do not allow** leaves, flowers and other plant **parts to overlap**
- If some overlapping leaves are cut off, **leave their stem intact** to show how they were attached to the twig
- **Large leaves should be folded** in such a way as to show the tip, base and overall form of the leaf
- The specimens must be **completely flattened** and no part of it should be thicker than **2-3cm**

How to press specimens...

Composing and arranging the specimens for pressing

- Fruits, roots or stems which are **thicker than 2-3 cm** should be sliced and excess tissue removed to facilitate drying
- **Long stems** should be bent into a **“V” or an “N”** shape so that they can fit in the newspaper, where as **vines may be left in a “U” shape** to show their twining habit
- **Almost all** plants can be dried **in a press**
- Some plant organs such as **fleshy roots, succulent stems, and fruits** may be placed directly on the screen inside the drier.
- Screen – dried plant parts should be **later placed in paper bag** marked in permanent ink with same collection number as the main plant
- Once each set of plant is ready, the **collection number is written on the newspaper** (in the same position on each newspaper)



Arranging specimen

Composing and arranging the specimens for pressing

Composing and arranging the specimens for pressing

Pressing the plants

The plant press consists of **four elements**

a) The press ends (**wooden/metal frames**), which help keep the press rigid and square

b) The **straps** used to bind the press tightly

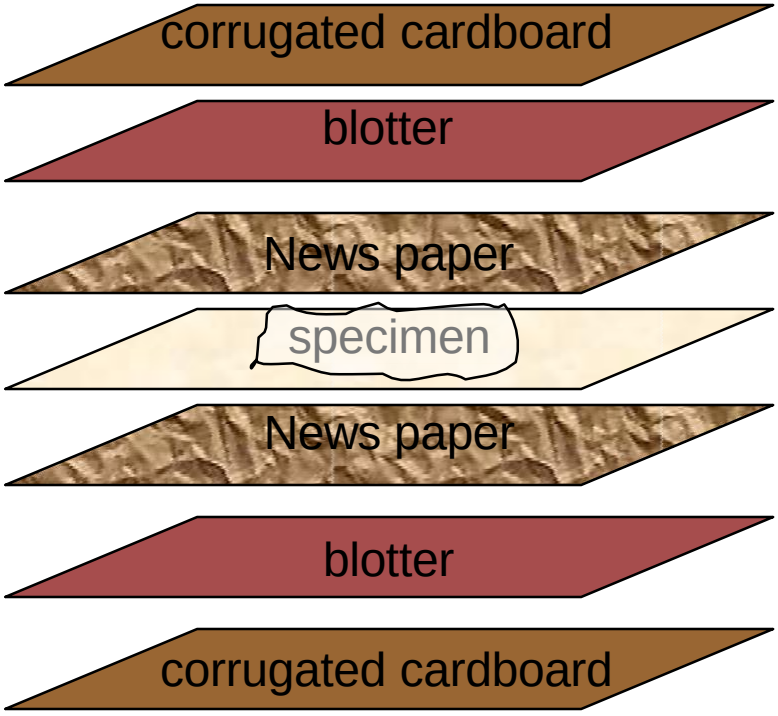
c) Ventilators, which allow the hot air to pass through the press

d) Blotters, which extract the moisture away from the plants and keep the ventilators from becoming damaged and flattened.

Pressing the plants

Pressing the Plants

- Herbarium preparation



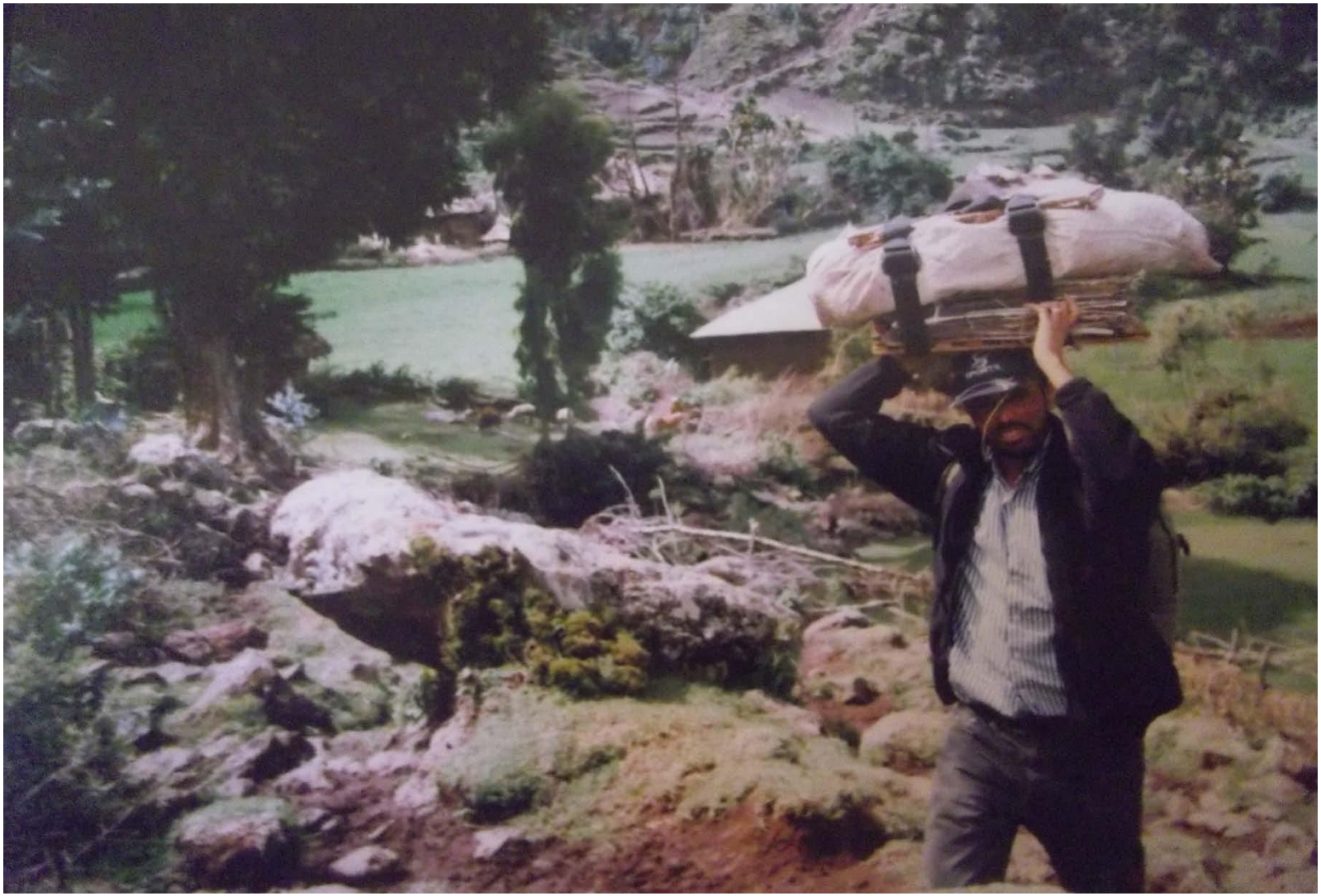
Press ends: wooden/metal frame

Press ends: wooden/metal frame

Pressing contd…

When collecting plants in the field you need to press and dry them straight away to keep them in good condition

Back from field



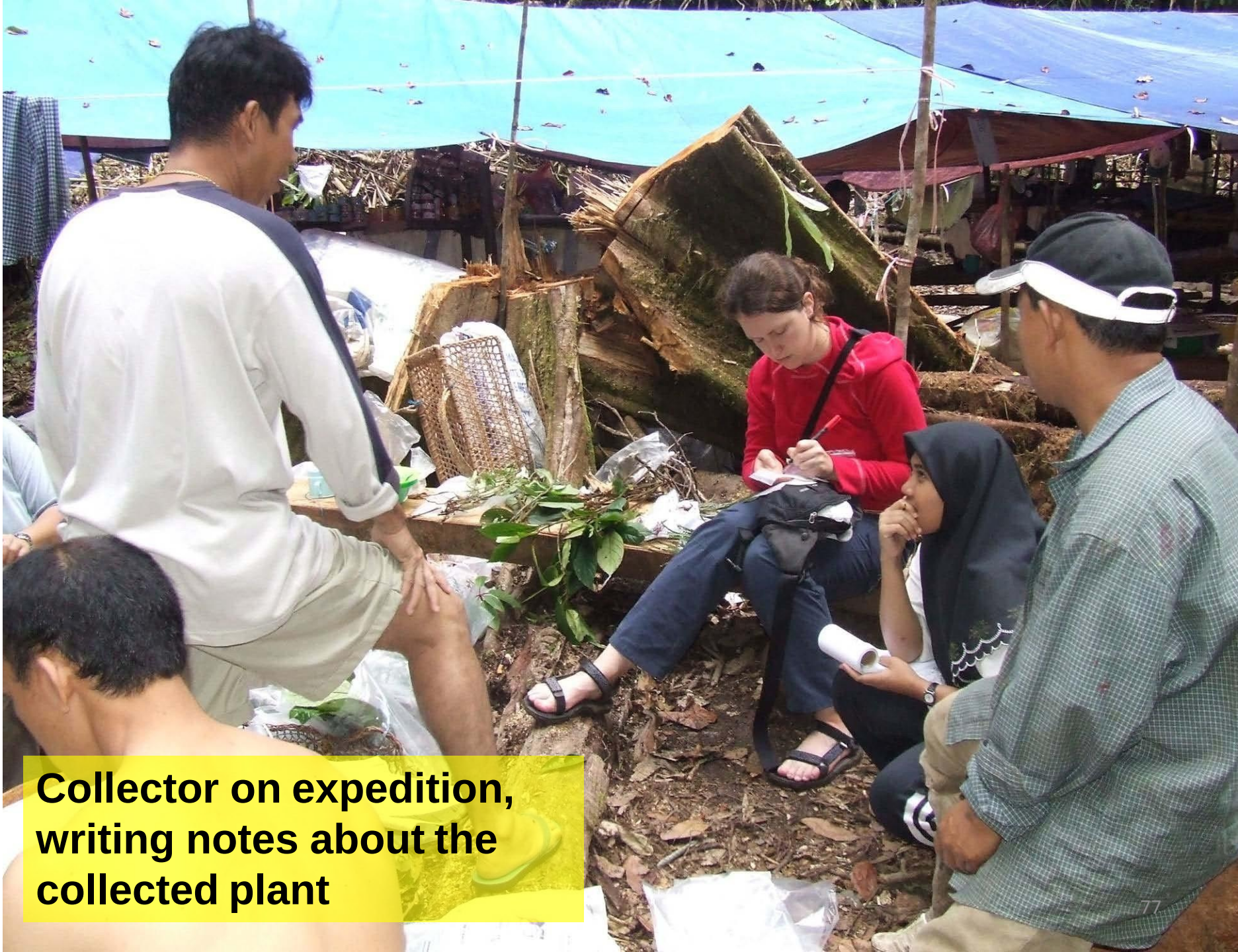
Back from field

Drying the plants

- When drying, the filled **plant press** is placed inside a **dryer**
- A **press stays** in the dryer for days depending on the **quality of the dryer** and **the press** as well as the **succulence of the plants** collected.
- It is good to **turn the press in it at least every 12 hours** so that both sides of the plant can dry evenly

Labelling the specimens

- After the task of collection is completed, **each specimen** has to be labelled
- The **label contains information recorded in the field notebook**.
- When the dried plant is glued to mounting paper in the herbarium, the **label is attached in the lower right hand corner**
- The **label is highly useful** in providing all the necessary **information about the species** whenever referred by other researchers



Collector on expedition, writing notes about the collected plant

Data that should be collected with the plant

- Locality - including the country, region, GPS reading
- Habitat, associated Spp., Soil type
- Altitude
- Field identification- Local/scientific name
- Collector’s name
- Date of collection
- Plant description

Herbarium methods

Q. What is herbarium?

- A **herbarium** (plural: **herbaria**) is a collection of preserved plant specimens and associated data used for scientific study

- The term can also refer to **the building or room where the specimens are housed**, or to the scientific institute that **not only stores but uses them for research**.

Herbarium methods contd...

- The specimens may be **whole plants or plant parts**; these will usually be in **dried form mounted on a sheet of paper** but, depending upon the material, **may also be stored in boxes** or kept in alcohol or other preservative.

- The specimens in a herbarium are often used as **reference material** in describing plant taxa; some specimens may be types.

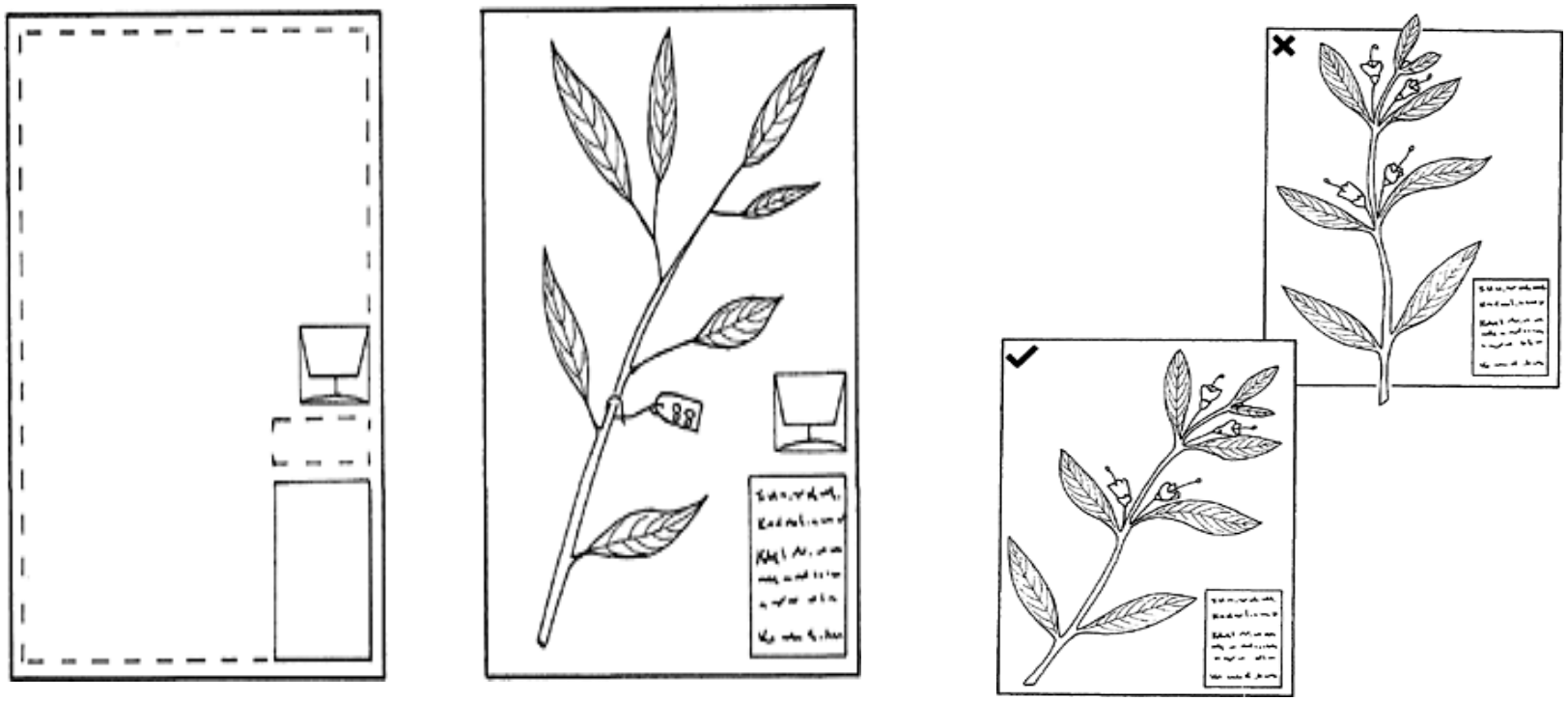
Herbarium methods contd...

- Herbaria are commonly known as **institutions where botanical specimens are kept**
- **Identification of specimens** is confirmed in the herbarium where type specimens are already found
- Once labelled specimens are received by the herbarium, the **curation** or care of the specimens begins
- The plants get **fumigated** and **deep frozen** to kill insect pests
- They are then **glued/mounted** on-to-acid-free **mounting paper** to which the **label** is attached
- The specimen has to be **checked before mounting**

Checking the specimens before mounting them onto a herbarium sheet

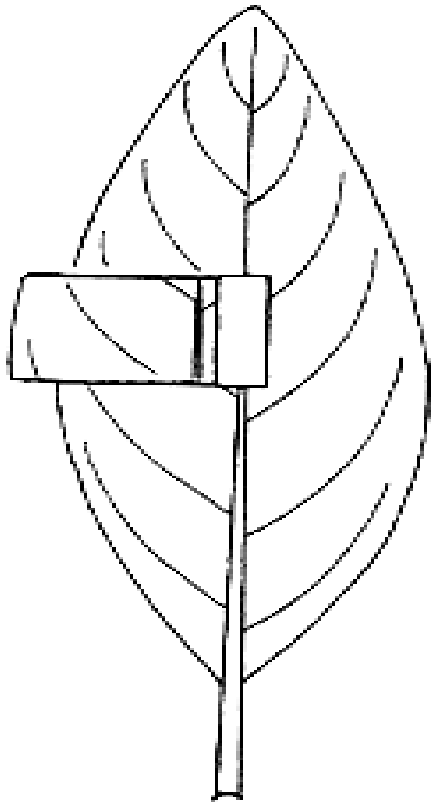

Checking the specimens
before mounting them
on to a herbarium sheet

Layout of a herbarium specimen



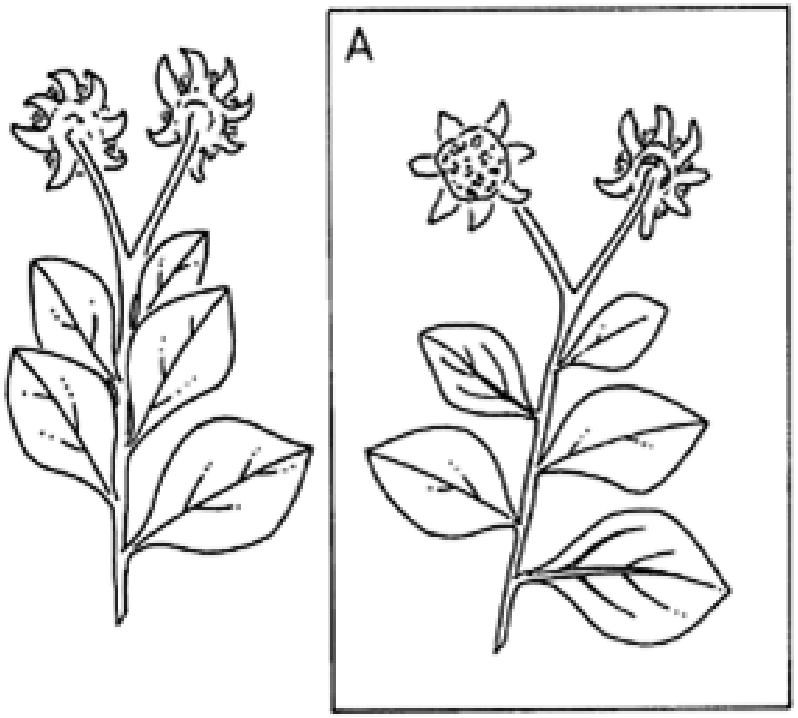
• **Label** in bottom **right hand corner**, with other labels and capsule above.
•**Plant to left of label**. If the specimen is large you can attach the label on the right hand side to flap over the specimen
• Turn specimen to fit on page

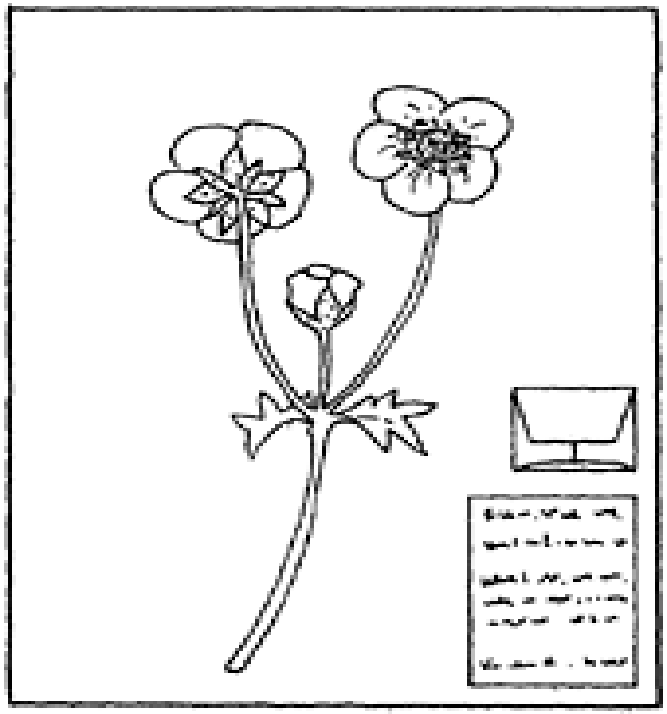
Leaves



Both sides of the leaf should be shown on the herbarium sheet during mounting

Flowers



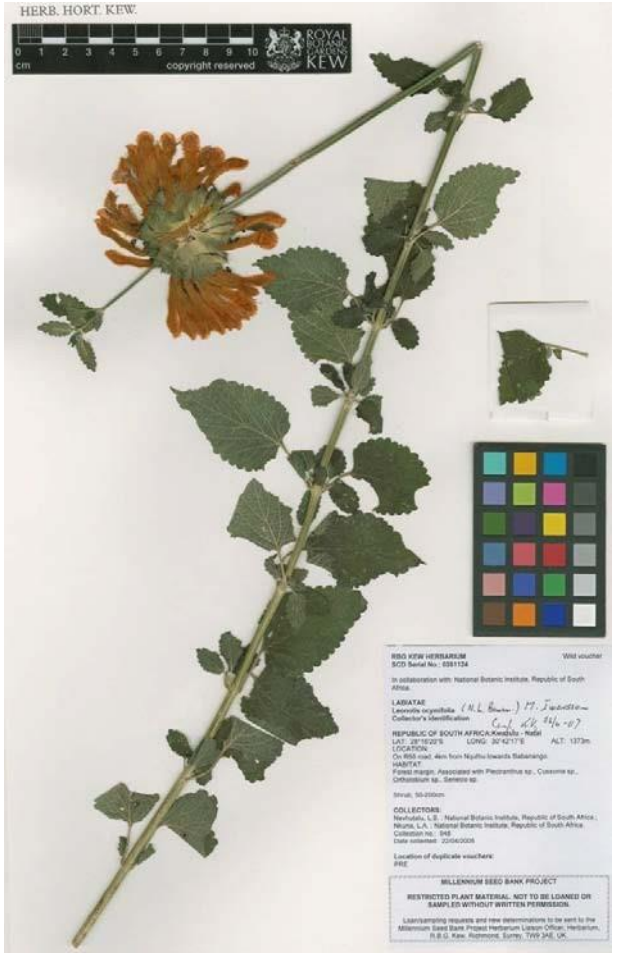


- Show the front and back of flowers if possible
- Try to open mature flowers out so that the inside is clearly visible
- If there is plenty of material, keep some in an envelope

Herbarium specimens

What next after mounting?

- After being fully identified and mounted **the specimens are indexed** and **filed in a cabinet, in a herbarium** where they are protected from insects, dust, sunlight and other damaging agents



There are **over 3,382** herbaria worldwide, representing **over 300 million** specimens contained in herbaria

Kew Herbarium, England where over 7 million pressed plants are kept

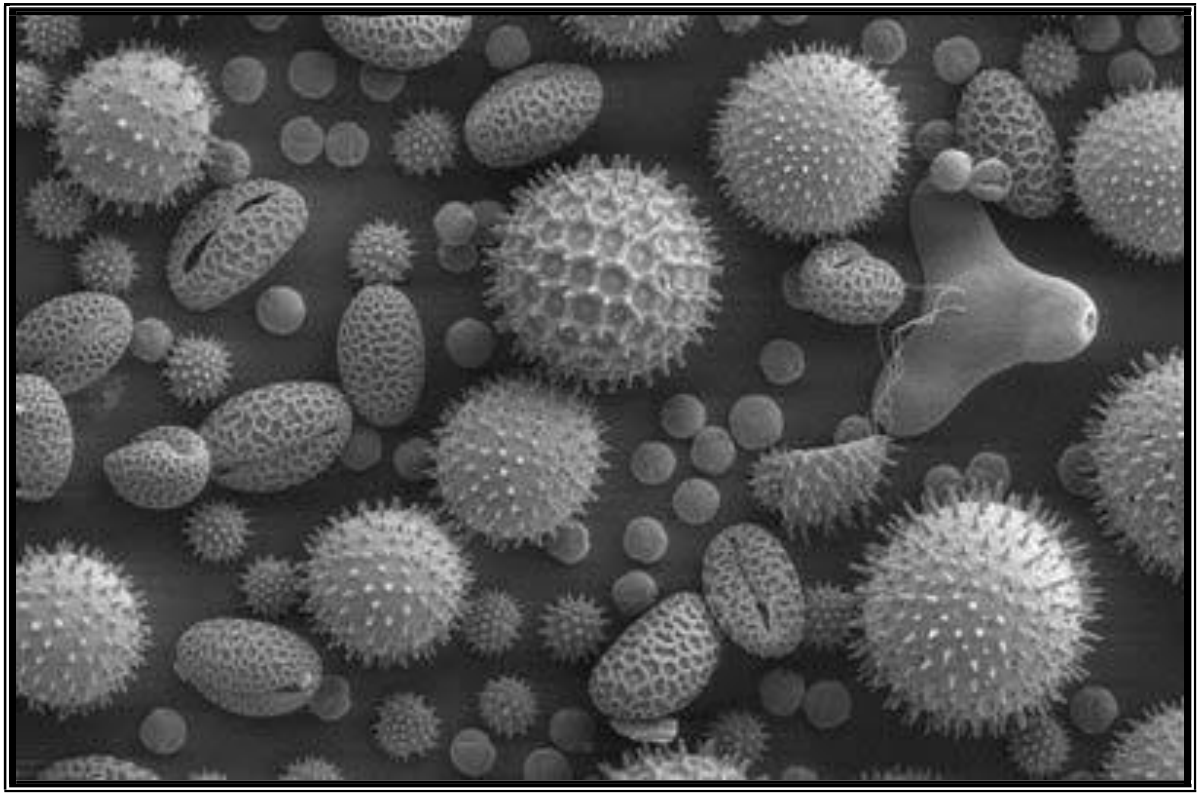
Hamburg Herbarium, Germany

What is the scientific relevance of herbarium specimen?

Herbarium specimens provide biological material for scientists to study such as:

- External form and structure

Herbarium specimens also provide biological material for scientists to study



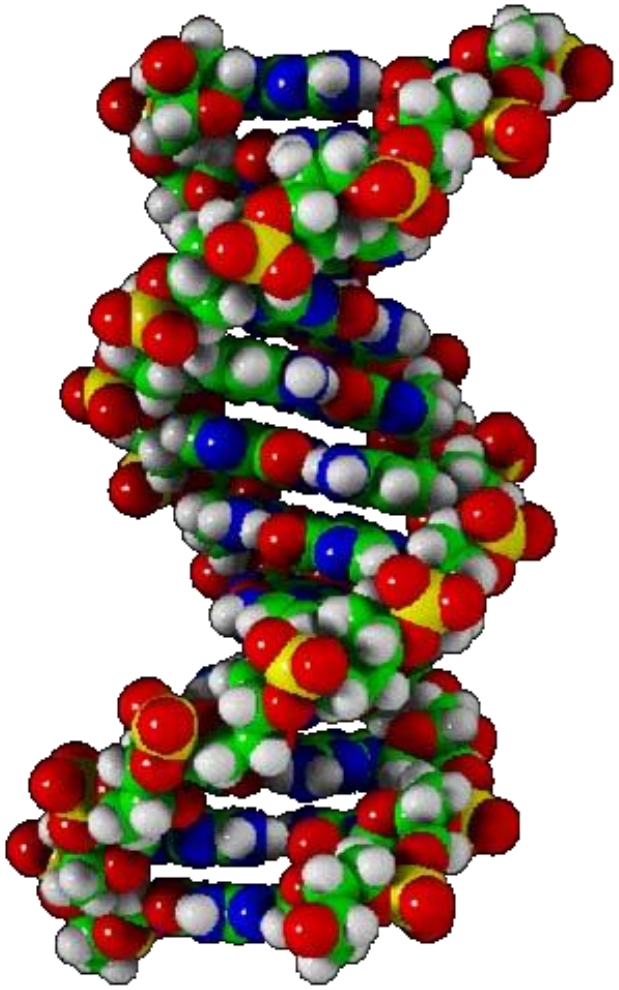
- Microscopic features like pollen

Herbarium specimens also provide biological material for scientists to study

- Variations within a particular kind of plant

Herbarium specimens also provide biological material for scientists to study

- Even DNA itself!



Herbarium specimens are also useful resources to write Flora of a country

Published volumes of flora of Ethiopia and Eritrea

Ethnopharmacological methods

Selection of medicinal plants

- Medicinal plant species with relatively **high informant consensus value** for treating ailments will be selected for further ethnopharmacological study

Preparation of extracts

- Take **15 g of air-dried plant material** of each selected species
- **Ground it** finely using a **Grindomix** apparatus
- **Extract active cpds** at room temperature **in 80% ethanol** using a **laboratory shaker** for 24 hrs
- **Filter** the extracts and **concentrate it to dryness using a rotary evaporator** R-200 (Buchi, Switzerland) *in vacuo* **at 40 ^{0}C**
- **Dissolve dry residues** in 100% **dimethyl sulfoxide** (**DMSO**) and **store** each extract in a tube **at -20°C** until tested

Ethnopharmacological methods contd...

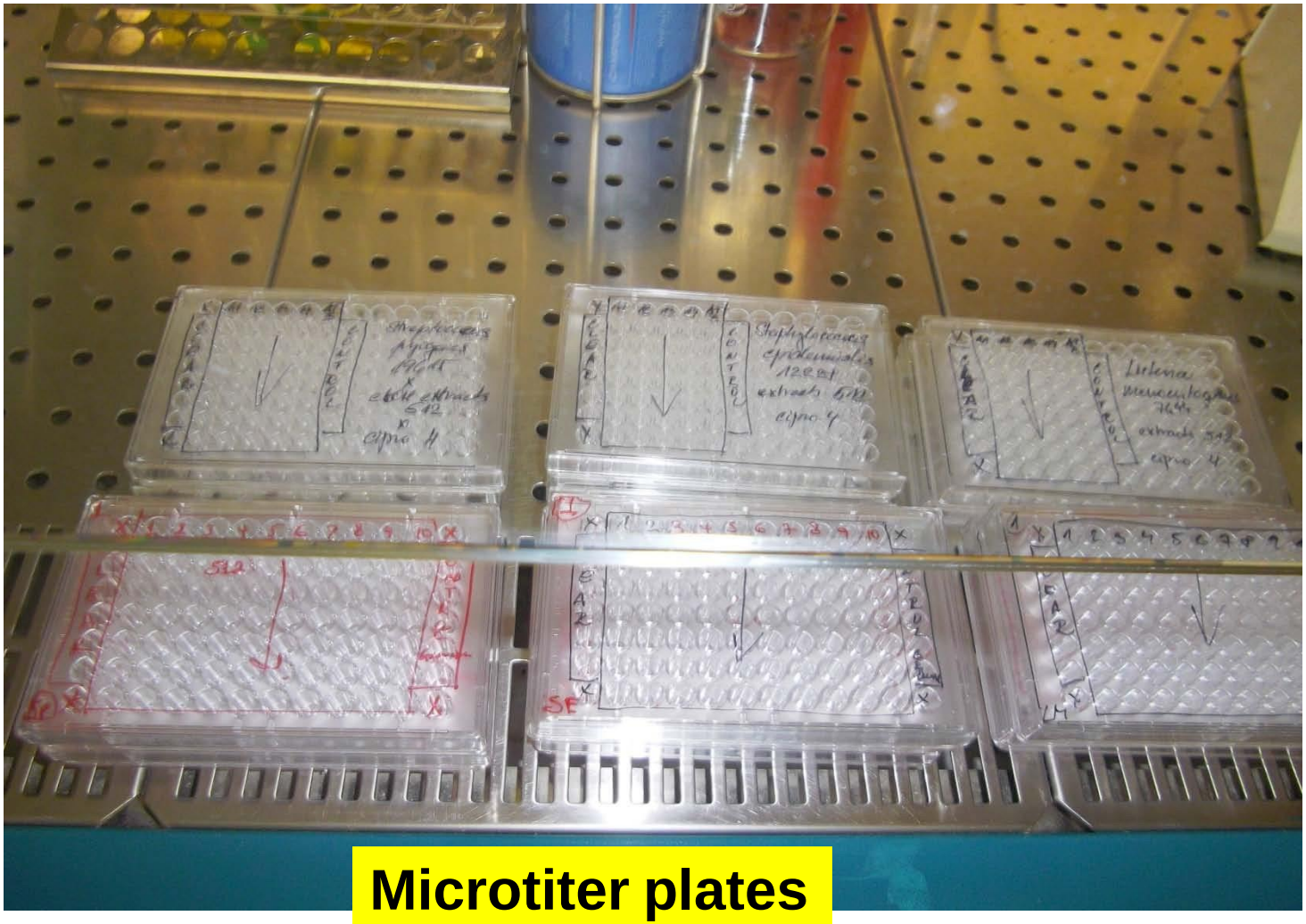
Microorganisms

- **Collect bacterial or fungal strains** from suppliers such as the American Type Culture Collection (**ATCC**) and the German Resource Centre for Biological Material (**DSM**)
- Cultivate the strains in different **growth media** for experiment

Antimicrobial assay

- Determine *In vitro* antimicrobial activity by the **broth microdilution method** using **96-well microtiter plates** or **disc diffusion** method if no microtiter plates
- Check all plates or discs for **Minimum Inhibitory Concentrations** (MICs) or **the lowest extract concentrations that results in ≥ 80% reduction in bacterial growth** compared to that of the extract-free growth control

Ethnopharmacological methods contd...



Microtiter plates

Ethnopharmacological methods contd...

Weighing plant specimen and grinding it using Grindo mix

Weighing specimen powder and weighing in laboratory shaker

Ethnopharmacological methods contd...



Filtering, evaporating and collecting medicinal plant extracts



Testing plant extracts against microorganisms

Ethno nutritional methods

Ecological methods

- Ecological methods are **applied** in studying the **overall interaction of human beings with the natural environment**

- By employing ecological method it is possible to measure the **frequency, density, dominance, Importance value, use value** of **useful plant species** in a measured quadrat or **transect**

Ecological methods contd...

- **Frequency** of a species is computed as **the proportion of samples within which a species** is found, and **density** is computed by **converting the count from the total quadrats into a hectare basis**
- Important in **ethnobotanical studies in forest areas specially to quantify useful species mentioned by informants for their presence in forests**

Q. Do you remember how to compute these ecological parameters from your UG course?

Ecological methods contd...

Ecological methods contd....

Linguistic methods

- **Interviews and questionnaires** should be prepared in **local languages**
- Phoneticians **analyze the pronunciation** of **each distinctive sound** unit, referred to as a **phoneme**
- **Phonology** is the **study of the sounds** and the set of rules that determine **how words and sentences are pronounced**

Analyzing the meaning of words

- Linguistic analysis involves **analyzing the meaning of words**, which helps to analyze the meanings of plants and animals
- Local names of plants and animals **may reflect the morphology** or may be related to some **historical events**, **flavor** or **texture** of the organism

Linguistic methods contd...

- **Example**: *Thalyctrum rhyncocarpum (Sire Bizu) Pterolobium stellatum (Kontir) Hagenia abyssinica (Kosso)*

  Ruta chalepensis (Tena Adam)
- *Chacha –Dracena steudneri*
- *Kombolcha- Maytenus arbutifolia*

Linguistic methods contd...

Detecting Cognates

- One of the **main tasks** of language analysts
- **Terms of different vernacular** are called **cognates** when they **refer to the same object**
- Example: **Shilalit, menshlalit, enshelalit** all refer to lizard

:Night (Eng), Nacht (German), Nuit (French). Natt (Swedish). Nat (Danish), Noch (Russian)

- Do you know **any other cognates** from your experience?

Quantitative Ethnobotany

Quantitative Ethnobotany

- The **multidisciplinary nature** of ethnobotany allows for a **wide array of approaches** and applications, and
- It presents a **challenge** to researchers **approaching the field** from **any one** discipline.

Quantitative Ethnobotany

Defn: "The application of quantitative techniques on the direct analysis of plant use data."

Main Areas of Quantitative Ethnobotany

- **Ethnobotanical quantification:** refers to **quantification of plant uses** or applications through **repeated interviews on use patterns of the same botanical species** with **multiple informants**
- **Ecological quantification:** Focuses on **useful plant species** it combines ***ethnobotanical quantification and plot- or transect-based sampling of vegetation***

Ethnobotanical Quantification

- **Underlying thought**: "the **more participants interviewed**, the **more reliable data** on plant use knowledge"
- **Selection of participants crucial** and it **depends** on research goals
- **Because:** ***local knowledge is not evenly distributed among traditional societies*** *and that* ***this distribution is not random but patterned***

Ethnobotanical quantification contd...

- **Example: Project** on plants managed in **homegardens**: more directed to **women**
- **Project** on **general plant knowledge**: **representatives** of **all knowledge strata** and as **much** as possible
- because... plant use knowledge is **extremely heterogenic**/idiosyncratic **among forest people**; even participants from same age, sex or social status

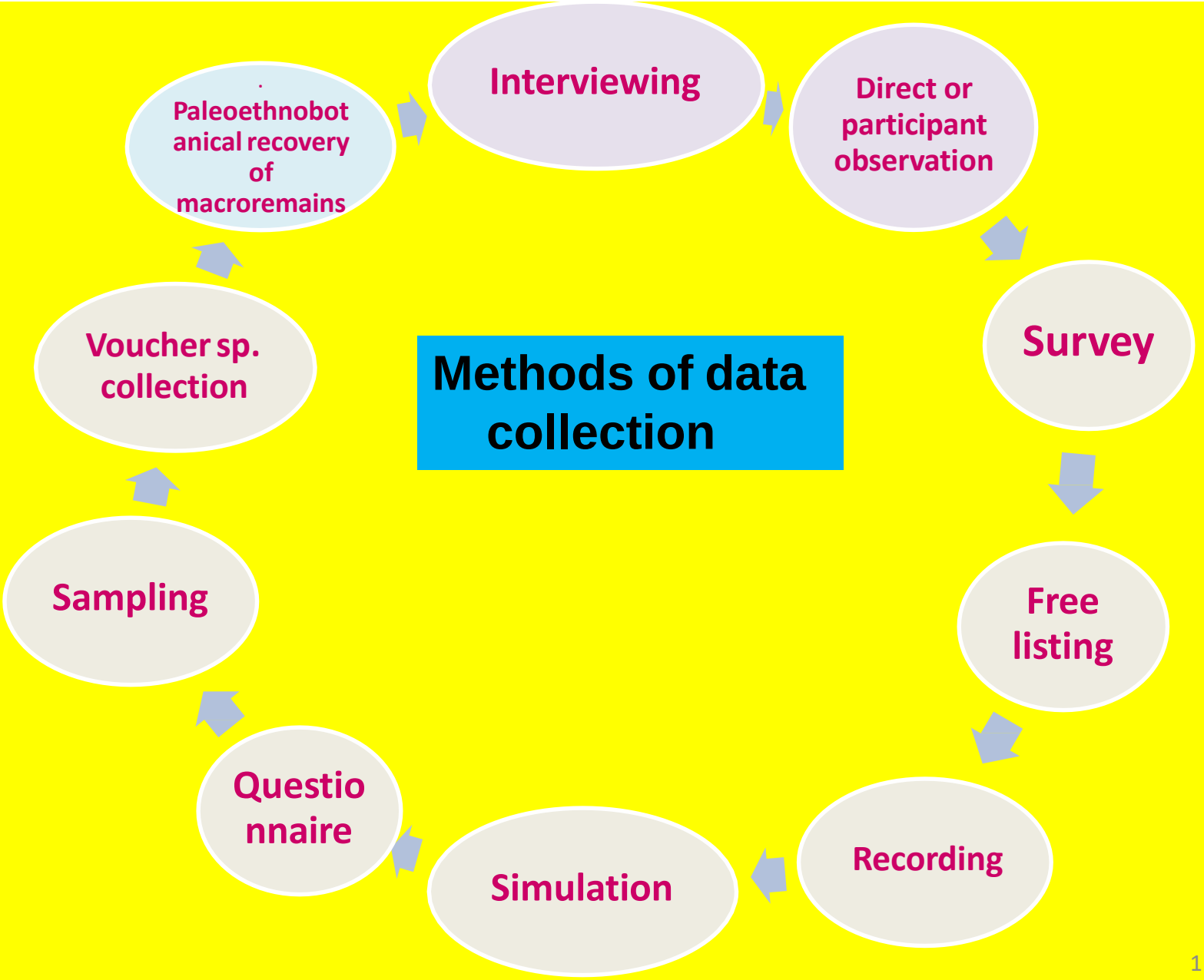
Ethnobotanical quantification contd..

- **Selection of plant experts is also useful to get reliable plant use data**: via **peer referencing/snow ball sampling**, i.e. ask as many people as possible who they think have most knowledge on particular plant uses
- if **overall range and distribution of information is unknown**
  - **Strict random sampling** = no bias in sociological variables;
    e.g. based on location houses nth house, *all* mothers in all houses, or eldest child per family ....
  - **result = representative cross-section of the information held by a community**

Data collection

- EB data collection **depends** on the **concrete field situation**: practical constraints, such as available **time**, **financial and/or human resources** **willingness of informants** to collaborate,…
- Scientist has to **decide before** start of fieldwork how data should be collected.
- **Quantitative analysis demands** that data are collected as **repeatable** and **systematic** as possible (e.g. minimum number of informants or households needed).
- Which plant sampling method to chose?

Data collection contd...



Plant collection

- Walk-in-the-woods: local participants lead field trips and shows useful plants
- Homegarden sampling: village and crop fields
- Plot or transect sampling: *all* recorded plants discussed with participants; time-intensive!

Plant use data collection

- Use data **prior to plant collection**
  - Interview
  - Participant observation/plant artifacts/handicrafts
  - Free listing
- Use data **simultaneous or after plant collection**
  - ✓ Ethnobotanical interviews (simult./after)
  - ✓ Simulation (simut./after)
  - ✓ Preference ranking (after)...also analysis
  - ✓ Direct Matrix ranking (after)....also analysis

Free listing

- Asking community members **to list** e.g. any plants which might be used **for a particular purpose**
- Principle: those plants that are **more significant** **are more likely to be mentioned** **by several informants**, and are **likely to be mentioned** **earlier in the list**
- Assigning a numerical value determined by the order in wich a given plant appears on the list → *index of saliency*

Paleoethnobotanical data collection

- Paleoethnobotany which is also known as **archaeobotany**,is the study of **relationships between people and plants**, using **archaeological records** (Deborah, 2000)
- Paleoethnobotany is a branch of archaeology which **studies how people in the past used plants**
- **Plant remains** found in archaeological sites can tell us a great deal about the people who once lived there
- Paleoethnobotanists use different **methods** to identify and recover plant remains, the common one is **Flotation**
- **Flotation**- A method used to **recover macroremains by sieving excavated material** manually in **a water bath** in order to allow the organic material to float to the surface (Deborah, 2000)

Paleoethnobotanical methods contd...

-The **matrix** (the soil from a suspected archaeological feature) is slowly added to agitated water

-The entire **soil sample is slowly poured** into the barrel on top of the mesh and gently agitated with hands to break up any clumps and wash the material through the mesh.

The water is allowed to flow steadily through the weir and into the sieves, taking any floating or suspended material with it. The water remains running until no further carbonized material floats to the surface

Paleoethnobotanical methods contd...

- The soil, sand, and other heavy material, known as ***heavy fraction***, will **sink** to the bottom
- The **less dense organic material** such as **charred seeds, Pollen, wood and bone** will tend to **float** to the surface

- The material that floats to the top, called ***light fraction***, is gathered with a sieve
- The organic **light fraction** is then available for examination
- Samples of the **heavy fraction** are also gathered for later analysis
- Paleoethnobotanists recover and analyze microremains, **phytoliths, pollen**, **paleofeces** (sometimes called **coprolite)**

(Deborah, 2000)

Paleoethnobotanical methods contd...

Flotation results

- **Macrobotanicals**
  - Plant remains that can be seen with the naked eye
  - Nuts, seeds, charcoal, fruit pits
- **Microbotanicals**
  - Plant remains that can only be observed microscopically.
  - Pollen, phytoliths, fossil cuticles, diatoms

Agave pollen from a Texas coprolite.

http://www.unl.edu/Reinhard/paleonut.html

Simulation

- a technique used to get participants to **run activities that are no longer performed** or to **perform them out of context** (Clammer, 1982)
- This method is taken **valid as long as participants are able to remember accurately what to do** and provided it is socially or psychologically possible to perform the actions given the artificial context
- Ethnobotanical simulation could include **observing the manufacture of out model plant based artifacts** or preparation of **rarely used remedy** (Clammer, 1982)

EB Data Analysis Methods

- Ethnobotanical data analysis has to be broad, resulting in an explanation that is **valid for an entire data set**
- Martin (1995), stated that in ethnobotany the most **successful analysis** are those which can help us understand **the use or classification of biological resources across the entire set of specimens** collected or categories elicited
- **Statistics** is the common tool of analysing ethnobotanical data, in which the data is mathematically summarised and interpreted
- Ranges from **calculating a simple index** to complex computational techniques of **multivariate analysis**

Data Analysis Methods contd

- The **selection** of a particular technique for application to the data is **based on the effectiveness of the technique** for sound **interpretation of the results** and **identification of the interrelationships** that may exist among the variables studied

  (Hoft et al., 1999)

- In ethnobotany researchers make frequent use of **descriptive statistics** to portray trends of the collected data

- For deeper analysis of ethnobotanical data, a more complex set of statistics called **inferential statistics** is commonly used

Data Analysis Methods contd...

- The **common ways of analytical tools of ethnobotanical data**

1. Preference ranking

- This method involves **asking informants to think of commonly five to seven items** in a category, which is the **focus of the research or of an issue which is being discussed** in the community (Martin, 1995)
- Each informant **ranks the given items** according to his/her personal preference or **perceived importance** in a community
- The **most important** in the set is given **the highest number**, **decreasing in number** as the members of the set decrease in importance
- The **least preferred** or important item is given the lowest number which is **'1'**

Preference ranking contd...

- The **given number are finally summed up** for all respondents, giving an **overall ranking** of objects by the sample group of respondents
- Finally, **those with the highest scores are considered as the most important** or preferred ones in the community

Example:

- Preference ranking conducted by Ermias Lulekal et al. (2014) *Journal of Ethnobiology and Ethnomedicine 2014, 10:21 doi:10.1186/1746-4269-10-21*
- The **preference ranking was conducted** for 7 medicinal plants which were reported as **effective for treating livestock diarrhoea**, in Ankober District , Ethiopia

Preference ranking contd…

- 15 key informants were asked to **compare** medicinal plants that **were reported** to be used against diarrhoea, the most frequently reported livestock disease under the gastro-intestinal disease category, **based on their efficacy** and give the **highest number** 7 for the medicinal plant which they thought **most effective** in treating diarrhoea and the **lowest number** 1 for the **least effective** plant in treating diarrhoea
- The result of the preference ranking helped to identify the **most effective plant in treating diarrhoea** (*Euclea divinorum*) than other medicinal plants of the study area

Example: preference ranking **Source: Ermias Lulekal et al., (2014)**

Medicinal plants for diarrhoea	Key informants labelled A-O														Total	Rank
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O		
Dodonaea angustifolia L. f.	1	3	3	2	2	3	1	2	3	4	2	3	4	7	7	47	5
Gomphocarpus fruticosus (L.) Ait. F.	2	1	2	3	1	1	5	3	1	3	1	4	2	3	2	34	6
Zingiber officinale Roscoe	6	7	6	5	5	6	4	4	5	7	5	7	6	4	4	81	3
Clutia abyssinica Jaub. & Spach	3	2	1	1	3	4	2	1	2	2	3	2	3	1	1	31	7
Ocimum lamiifolium Hochst.	4	4	4	6	4	2	3	6	7	1	4	1	1	2	3	52	4
Rubus steudneri Schweinf.	5	6	5	7	6	5	7	5	4	5	6	5	5	5	6	82	2
Embelia schimperi Vatke	7	5	7	4	7	7	6	7	6	6	7	6	7	6	5	93	1

Preference ranking of six zay medicinal plants based on their degree of scarcity in the local environment (6 – most preferred, 1 – least preferred)

List of medicinal plants	Key informants coded (A to J)										Total Score	Rank
	A	B	C	D	E	F	G	H	I	J		
Acacia sieberiana	3	3	2	2	2	2	1	2	2	4	23	5th
Acokanthera schimperi	**5**	**4**	**6**	**6**	**5**	**5**	**6**	**6**	**5**	**5**	**53**	**1st**
Asparagus africanus	1	1	3	3	1	6	2	5	3	2	27	4th
Carisa spinarum	4	6	4	5	4	3	3	3	4	1	37	3rd
Cordia monoica	6	5	5	4	6	4	5	4	6	6	51	2nd
Euclea divinorum	**2**	**2**	**1**	**1**	**3**	**1**	**4**	**1**	**1**	**3**	**19**	**6th**

Data analysis methods contd....

2. Direct matrix ranking

- A more **complex** version of preference ranking
- Analysis using **preference ranking** technique is based on a **single dimension**, where as **direct matrix ranking** draws, **explicitly** up on **multiple dimensions** (Cotton, 1996).
- The **criteria used and the names of items are listed on X and Y** directions on a table
- Informants then **rank items according to each criterion** using **a numerical scale** in which the **highest number is equal to the best object** and the **lowest number to the worst**

- The **results** of numerous individual responses can be **added together to create a matrix** that is representative of the community

Direct matrix ranking contd....

- Example

- Ermias Lulekal et al. (2013), used direct matrix ranking technique to **rank** ten **multipurpose medicinal** species so as to identify which of the multipurpose plants is under **greater pressure** than other species in the area along with the respective factors that threaten the plants

- For this exercise fifteen key informants were chosen to conduct the activity and each key informant was asked to assign values based on use criteria (5 = best, 4 = very good, 3 = good, 2 = less used, 1 = least used, 0 = not used) for each species

Example: Average DMR score of fifteen key informants for ten medicinal species

Source: Ermias Lulekal et al., (2013): Journal of Ethnobiology and Ethnomedicine 2013, 9:63 doi:10.1186/1746-4269-9-63.

Use diversity	*Bersama abyssinica*	*Cordia africana*	*Croton macrostachyus*	*Dombeya torrida*	*Ekebergia capensis*	*Eucalyptusglobulus*	*Juniperuspro cera*	*Olea europaea* subsp. *cuspidata*	*Podocarpus falcatus*	*Prunus africana*	**Total**	**Rank**
Agricultural tool	3	1	2	4	4	2	1	3	5	3	**28**	**5**
Construction	2	4	2	4	4	5	5	5	5	5	**41**	**1**
Lumbering	2	2	2	4	5	1	4	4	5	5	**34**	**3**
Firewood	4	3	4	5	4	5	4	5	3	3	**40**	**2**
Charcoal	2	3	1	3	3	0	3	3	4	1	**23**	**6**
Medicine	4	2	5	2	3	5	3	4	3	2	**33**	**4**
Total	**17**	**15**	**16**	**22**	**23**	**18**	**20**	**24**	**25**	**19**		
Rank	**8**	**10**	**9**	**4**	**3**	**7**	**5**	**2**	**1**	**6**		

Based on use criteria (5= best; 4= very good; 3=good;2= less used; 1=least used and 0= no value)

Direct matrix ranking contd…

- **The DMR showed that, *Podocarpus falcatus* ranked first (most - threatened) followed by *Olea europaea* subsp. *cuspidata* and *Ekebergia capensis***
- **Results indicated that these multipurpose medicinal plant species are currently exploited more for construction, firewood and lumbering purposes than for their medicinal uses.**

DMR performed on 7 selected medicinal plant species of Mana Angetu –SEE

Direct Matrix Ranking of 7 medicinal plant species

NO	Use diversity	Plant species						
		Acacia tortilis	*Warburgia ugandensis*	*Euclea divinorum*	*Cordia africana*	*Croton macrostachyus*	*Olea europaea*	*Asparagus africanus*
1	**Fire wood**	**5**	**5**	**3**	**3**	**4**	**5**	**5**
2	Charcoal	5	1	0	2	2	3	3
3	**Medicine**	**3**	**5**	**5**	**4**	**4**	**4**	**4**
4	Building	3	4	2	5	3	5	3
5	Forage	3	1	2	1	1	1	2
6	Furniture	2	2	0	4	2	5	1
	Total	21	18	12	19	16	23	18
	Rank	2	4	7	3	6	1	4

(Source: Table from Ermias Lulekal *et al.*, 2008)

3. Paired comparison

PAIRED COMPARISONS: FIVE FRUITS TO BE COMPARED

1. LIST FRUITS ALPHABETICALLY
    1. Apple
    2. Banana
    3. Grapefruit
    4. Orange
    5. Pear
2. ARRANGE FRUITS IN PAIRS FOLLOWING ALPHABETICAL ORDER

Check Maximum number of pairs

- Total No. of pairs = $\frac{n(n-1)}{2}$

Since $n = 5$

$$\frac{n(n-1)}{2} = \frac{5(5-1)}{2} = 10$$

1	1,2
2	1,3
3	1,4
4	1,5
5	2,3
6	2,4
7	2,5
8	3,4
9	3,5
10	4,5

3. RANDOMIZE THE PAIRS USING TABLE OF RANDOM NUMBERS

9 5 6 8 10 1 4 2 7 3

4. RANDOMIZE ORDER WITHIN EACH PAIR BY FLIPPING A COIN, TABULATE PAIRS, ORDERS AND ITEMS, PRESENT PAIR TO RESPONDENTS, WRITE SELECTED FRUIT IN BOLD FACE

PAIR	ORDER	ITEMS
9	5,3	**Pear**, Grapefruit
5	3,2	Grapefruit, **Banana**
6	2,4	Banana, **Orange**
8	4,3	**Orange**, Grapefruit
10	5,4	Pear, **Orange**
1	1,2	**Apple**, Banana
4	1,6	**Apple**, Pear
2	1,3	**Apple**, Grapefruit
7	5,2	Pear, **Banana**
3	4,1	Orange, **Apple**

5. PREPARE RANKING MATRIX FOR FIVE FRUITS

Apple	Banana	Grapefruit	Orange	Pear		Score	Rank
XXX	Apple	Apple	Apple	Apple	Apple	4	A 1
	XXX	Banana	Orange	Banana	Banana	2	C 3
		XXXXX	Orange	Pear	Grapefruit	0	E 5
			XXXX	Orange	Orange	3	B 2
				XXXX	Pear	1	D 4

6. PREPARE A MATRIX OF SCORE OF RANK DATA

Item	Respondents														Score	Rank
Apple	4	2	0	3	1	4	3	4	4	4	3	3	4	4	43	B 2
Banana	2	3	4	2	3	2	4	2	2	2	2	1	1	2	32	C 3
Grapefruit	0	1	2	0	2	1	0	0	0	0	0	2	1	0	9	E 5
Orange	3	4	1	4	4	3	2	3	3	3	4	3	2	3	47	A 1
Pear	1	0	3	1	0	0	1	1	1	1	2	0	0	1	12	D 4

7. DATA ANALYSIS BY A STATISTICAL TOOL CALLED CLUSTERING/CLUSTER ANALYSIS

Data analysis methods contd....

4. Informant Consensus Factor (ICF)

- In Ethnomedicinal study ICF is computed to **determine the most important human and livestock ailment categories in a study area**, and identify **potentially effective medicinal plant species** in the respective disease categories.

- The researcher first groups traditional remedies and corresponding diseases into **different categories** , so as to compute ICF

Informant consensus factor contd…

- ICF will then be computed by using:

  $$\mathbf{ICF = n_{ur-}\, n_{t/}\, n_{ur-1}}$$

- $\mathbf{n_{ur}}$ = the number of use citations in each disease category
- $\mathbf{n_t}$ = the number of times a species is used
- $\mathbf{n_{ur-1}}$ = the number of use citations in each category minus one (Heinrich, 1998)

ICF values of medicinal plants for treating human ailments in Ankober District

Source: Ermias Lulekal et al., (2013): Journal of Ethnobiology and Ethnomedicine 2013, 9:63 doi:10.1186/1746-4269-9-63.

No	Disease category	No of Species	% all species	Use citations	% all use citations	ICF
1	Gastro-intestinal and parasitic (Intestinal parasites)	20	14.81	65	19.75	0.70
2	Dermatological	13	9.62	41	12.46	0.70
3	Respiratory	7	5.18	18	5.47	0.65
4	Oral, dental and pharyngeal	6	4.44	14	4.25	0.62
5	Sensorial	8	5.92	17	5.16	0.56
6	Urogenital and venereal	15	11.11	30	9.11	0.52
7	Febrile	11	8.14	21	6.38	0.50
8	External injuries, bleeding and snake bite	13	9.62	19	5.77	0.33
9	Musculoskeletal and nervous system	21	15.55	28	8.51	0.26
10	Blood and lymphatic system	18	13.33	24	7.29	0.26
11	Evil spirit	21	15.55	22	6.68	0.05
12	Others	29	21.48	31	9.42	0.06

Data analysis methods contd....

4. Index of Fidelity Level (FL)

- One of the commonly used methods in Ethnomedicinal research
- Helps to compare and determine relative healing potential of medicinal plants
- Index of Fidelity level (FL) is computed by

  FL=Ip/Iu X 100, where **Ip** is the number of informants who independently cited the importance of a species for treating a particular disease and **Iu** the total number of informants who reported the plant for any given disease (Alexiades, 1996),

Example: Relative healing potential of ethnoveterinary medicinal plants in Ankober District, Ethiopia

Source: Ermias Lulekal et al. (2014) Journal of Ethnobiology and Ethnomedicine 2014, 10:21 doi:10.1186/1746-4269-10-21

Fidelity level values of medicinal plants commonly reported against a given veterinary ailment category

Medicinal plant	Therapeutic Category	IP*	IU*	FL Value (%)*
Embelia schimperi	Gastro-intestinal	36	40	90.00
Rubus steudneri	Gastro-intestinal	26	31	84.00
Croton macrostachyus	Dermatological	25	30	83.00
Achyranthes aspera	External injuries, bleeding and poisoning	39	48	81.00
Phytolacca dodecandra	Ecto- and endo-parasites	23	29	79.00
Cissampelos mucronata	Respiratory	24	32	75.00
Trichocladus ellipticus	Sensorial	19	27	70.00
Withania somnifera	Musculo-skeletal	28	39	71.00
Aeonium leucoblepharum	Reproductive	17	23	74.00
Ocimum lamiifoium	Gastro-intestinal	30	38	66.00

*FL= Fidelity Level, Ip = number of informants who independently cited the importance of a species for treating a particular disease, Iu = total number of informants who reported the plant for any given disease

Data analysis methods contd....

5. Use values (UV)

- (UV) is important to run quantitative assessment of the relative cultural importance of any individual species
- It is valuation of species based on interview data

- UV= cccccc
- where: UVs= Use value of species s;
- Uis = number of uses of species s mentioned by informant i;
- ns = total number of informants/participants consulted on use of species

Use Values (UV_s) contd...

- Makes efficient use of all available information
  - every interview contributes to calculation, also if data are *negative* (plant not used or plant not recognised)

$$UV_s = \frac{\sum_{i}^{n} U_{is}}{n_s}$$

Phillips and Gentry (1993a)

  - Where: **UVs**= Use value of species s;
  - **U_{is}**: number of uses of species s according to informant i
  - **n_s**: total number of informants/participants interviewed/consulted about use of species s

Example 1: use value

- **5 informants** interviewed about **1 plant species** (uses per informant given between brackets):
  - uses **for species 1** according to **informant 1: <u>wood for fuel</u>**, **<u>fruits eaten raw</u>**, **<u>leaves for healing wounds</u>**, **<u>leaves for fodder</u>**, **<u>flowers for aromatic tea</u>** = 5
  - If Informant **2 mentioned no use**, **I3 mentioned 2**, **I4 mentioned 4** and **I5 mentioned 2**. Then UV of species 1

$$\mathbf{UV} = (5) + (0) + (2) + (4) + (2) = 13/5$$

$$= 2.6 \text{ uses on } \textit{average}$$

- <u>remark:</u> every interview contributes to UV, even if plants has no use or is not recognised by informant!

Example2: use value

Informant	**Construct**	**Food**	**Medicine**	**Technology**	Total (U_i)
1	0	0	1	0	1 UV_1
2	1	1	2	1	5 UV_2
3	0	0	0	0	0 UV_3
4	0	0	1	0	1 UV_4
Total	1	1	4	1	7 (Σ U_i)
Mean	0.25 UV_{const}	0.25 UV_{food}	1.00 $UV_{medicine}$	0.25 $UV_{technology}$	1.75 (UV)

Data analysis methods contd...

6. Analysing relative knowledge of informants

- Uses to compare the relative knowledge of different informants in a given community
- The formula used is **RUVi = (∑UVis/UVi)/nis,**
- Where **RUVi** is **Standardised relative use value** for each informant;
  - **UVis** refers to the **use value of each species** for each informant i;
  - **UVi** indicates the **overall use value for each species**(for all informants combined)
  - **nis** for each informant indicates the **number of species** with data from three or more other informants

◉ Important to **compare the knowledge** held by different social groups such as women, youth and elders.

Data analysis method contd…

7. Triadic comparison

- In this method **items are presented** to informants in **sets of three**
- **After defining the domain and identifying its most important members**, **triads are set up so that each item appears in every possible combination of three** with other items (Martin, 1995)
- After the **sequence of the triads** and the order within each triads are **randomised,** informants are shown each set of three and are asked to **rank items** most preferred to least preferred

Data Analysis contd...

- The **total number of possible triads** in such comparison is given by **n!/3!(n-3)!;** where n is the number of the items being compared (Martin, 1995)
- The responses for comparison can be tailed in a matrix and an **overall ranking is made** by adding together the ranks given in each triads

Data analysis methods contd...

8. Paired comparison

- Items should be arranged in **pairs** at all possible combinations
- After **randomizing the order of the pairs**, the items are presented to the interviewee to **choose the one** which he prefers the most important e.g major cause of deforestation, scarce medicinal plant, etc....
- By **adding responses** of the informants the researcher can make statements on **general trends** of the subject of study

- The method is used relatively with **few items** because the time needed to carry out the task increases exponentially as one adds additional objects
- The **total number of possible pairs** required is given by the formula **n (n-1)/2**; where n is equal to the number of items being compared (Martin, 1995).

9. Index of agreement ailments (IAR_a)

- **calculated for ailments (original definition)**: measure of consensus between participants regarding specificity of remedies used for treating illness

$$IAR = \frac{n_a - n_{ra}}{n_a - 1}$$

  - n_a: number of times an **ailment** is mentioned by informants
  - n_{ra}: number of different plant **remedies** that are mentioned to treat this **ailment**

example: index of agreement

- e.g. fever
  - fever is mentioned 15 times during interviews;
  - there exist 10 plant species to cure fever;

    → IAR = (15-10)/(15-1) = 5/14 = 0.36;
  - **low specificity** of plant remedies to treat fever.
- e.g. cough
  - cough is mentioned 24 times during interviews;
  - there exist 3 plant species to treat cough;

    → IAR = (24-3)/(24-1) = 21/23 = 0,91;
  - **high specificity** of plant remedies to treat cough.

10. Index of agreement species (IAR_s)

- **calculated for species (adjusted)**: measure of consensus between participants regarding medicinal use of plant species

$$0 < IAR_s = \frac{n_s - n_a}{n_s - 1} < 1$$

  - n_s: number times species *s* is mentioned by participants to be used medicinally;
  - n_a: number of ailments that are treated with species s.

example: IAR_s

- e.g. species 1
  - mentioned 15 times to be used for ethnomedical preparation during interviews
  - used for curing 10 ailments

    → $IAR_s = (15-10)/(15-1) = 5/14 = 0.36$
  - **low consensus** on medicinal uses species 1
- e.g. species 2
  - mentioned 24 times to be used for ethnomedical preparation during interviews
  - Used for curing 3 ailments

    → IAR = (24-3)/(24-1) = 21/23 = 0,91
  - **high consensus** on medicinal uses species 1

11. Proportion of agreement (PA)

- amount of agreement between pairs of informants

$$PA_1 = a_1 / n_s$$

  - PA_1 : agreement index for informant pair 1
  - a_1 : number of times pair 1 agrees on a given stimulus
  - n_s : total number of stimuli presented to pair 1

example: proportion of agreement

Andes: 8 informants $\Rightarrow$ n*(n-1)/2 = 28 couples

	Teofilo	Agustin	Cristina	Francisco SL	Francisco SV	Joaquin	Sabino
Jose	0.163	0.125	0.154	0.183	0.192	0.077	0.250
Teofilo		0.183	0.163	0.231	0.202	0.163	0.240
Agustin			0.163	0.183	0.173	0.115	0.221
Cristina				0.173	0.183	0.144	0.212
Francisco SL					0.279	0.212	0.413
Francisco SV						0.125	0.385
Joaquin							0.279

Data analysis method contd..

12. Ethnoecological data

- Ethnoecological data are important to study the overall interaction of the local people with the natural environment; and **vital for decision making and sustainable resource management** (Zemede and Tigist, 2007)
- By employing **ecological methods** it is possible to measure **frequency**, **density**, **dominance** and **value** of resources in measured quadrat or transects
- **Frequency** of a useful species can be **computed by measuring the proportion of samples with in which that species is found**; and its **density** can be **computed by converting the count of the species from total quadrats in to a hectare basis** (Kent and Coker, 1994)

Ethnoecological methods contd...

Ecological methods contd

Note

- **Frequency of a species is calculated** in the following way:

Frequency (%) = No of sampling units or quadrats in which the species occurred X 100
Total number of sampling units or quadrats studied

- **Relative Frequency = Frequency of species A / total frequency of all species X 100.**

Ecological methods contd

Note

- **frequency of a species is calculated** in the following way:
- **Density** = the number of individuals of species **A** /area sampled in **a hectare** basis

Frequency (%) = No of sampling units or quadrats in which the species occurred X 100
Total number of sampling units or quadrats studied

- **Relative Density** = Density of species A /total density of all species X 100.
- **Relative Frequency = Frequency of species A / total frequency of all species X 100.**

Ecological methods contd…

- The **commonly used numerical values** and scales given for **cover-abundance** are listed below.

Values

1: rare, generally one individual

2: sporadic, with less than 5% cover of the total area

3: abundant, with less than 5% cover of the total area

4: very abundant, with less than 5% cover of the total area

5: 5-12% cover of the total area

6: 12-25% cover of the total area

7: 25-50% cover of the total area

8: 50-75% cover of the total area

9: 75-100% cover of the total area

Ecological methods contd…

- **<u>Basal area</u> (BA)** refers to the **ground actually penetrated by all stems** and is readily seen when the **leaves and stems are clipped** at the ground surface

- **BA** is one of the chief characteristics to determine **dominance**.

- Basal area (in m^2 per hectare) of trees is **computed** using **$(DBH/200)^2$ x 3.14** to measure dominance (degree of coverage of a species as an expression of the space it occupies)

Ecological methods contd...

- **Relative density** =(Density of species A/Total density) x 100
- **Relative frequency** = (Frequency of species A/Total frequency) x100
- **Relative dominance** = (Basal area of species A/Total basal area) x100 and then
- **Importance value index** = Relative density +Relative frequency + Relative dominance
- **% frequency** = Number of quadrats in which species A occurs/Total number of quadrats examined) x 100

Ecological methods contd

Exercise on Ecological Methods