HABITAT ECOLOGY

- Animal habitat is the arrangement of food, cover and water required to meet the biological needs of species
- Space and environment suited to a particular species component

COMPONENTS OF A HABITAT

- **Cover/shelter**
- **Space (physiography, extent, alt; Lat.; Long.)**
- **Energy (food & water)**
  - **Time (succession, history, evolution)**
  - **Diversity**
  - **Associations**
  - **Interspersion**

THREE MAJOR HABITAT

1. **FRESH WATER (LIMNOBIOTIC)**
   - **LENTIC (STAGNANT)**
   - **LOTIC (RUNNING WATER)**
2. **MARINE (HALOBIOTIC)**
   - **PELAGIC (OCEAN SURFACE)**
   - **BENTHIC (OCEAN FLOOR)**

3. TERRESTRIAL HABITATS

A. **WETLAND HABITATS**: ***areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters***

i) **ESTUARY AND COASTAL ZONES**

ii) **SEASONAL SWAMPS / FLOOD VALLEYS**

iii) **MARSHES** <

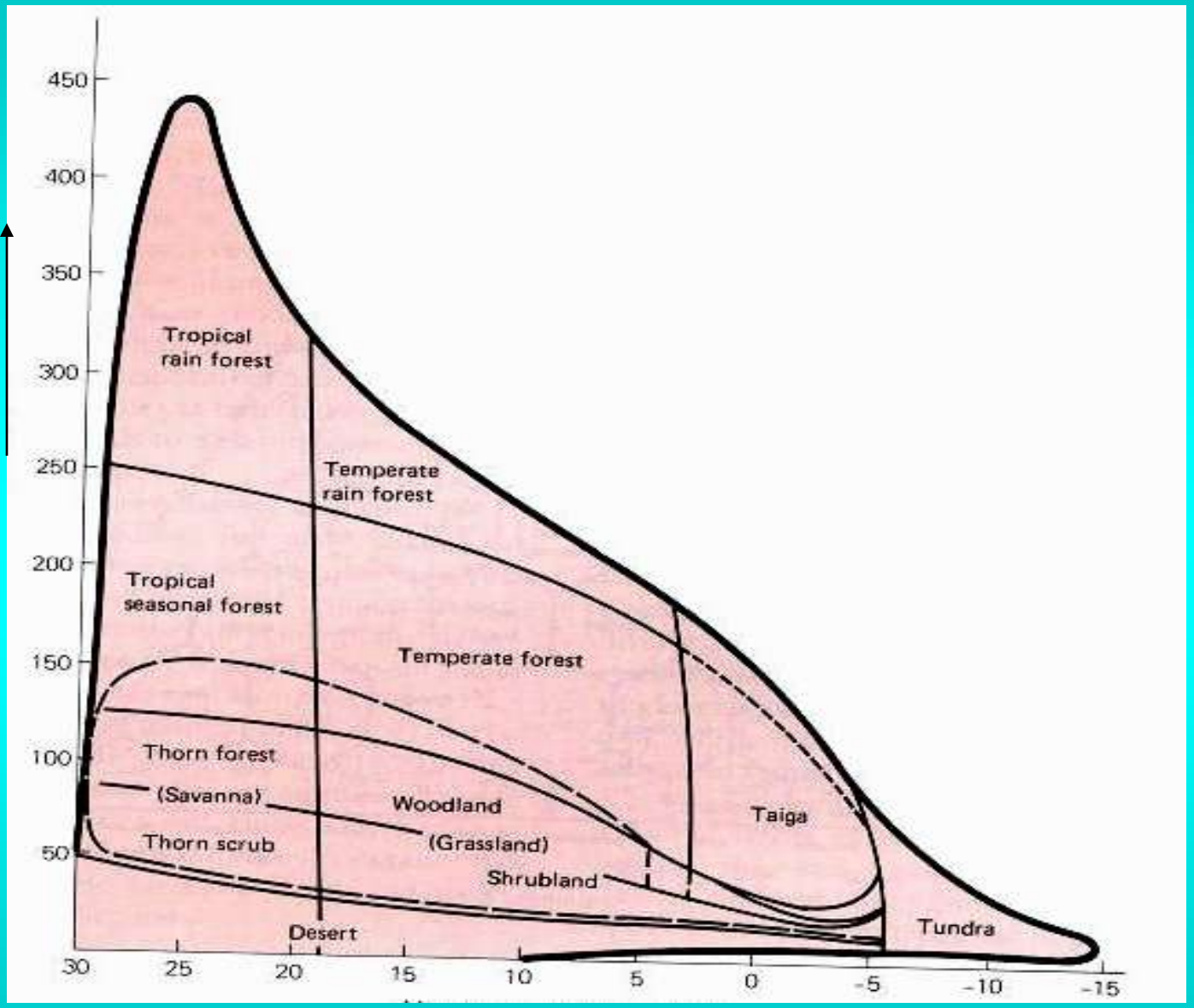
- **SALT MARSHES**
- **COASTAL AREAS**

B. FORESTS

Champion & Seth, 1968

1. Tropical
2. Sub-tropical
3. Temperate
4. Sub-alpine
5. Alpine

MEAN ANNUAL PPT *CMs*



MEAN ANNUAL TEMPERATURE *CEN.*

C. GRASSLAND HABITATS

i) Natural

1. **Flood valley grasslands & *terai***

   Flood plains of Brahmaputra & other large rivers

2. **Alpine grasslands**

ii) Anthropogenic grasslands

Grazing, recurrent fires, cultivation etc.

WHYTE 1957: 8 ASSOCIATIONS IN INDIAN GRASSLANDS

i. ***Sehima- Dicantheum***

black cotton soils: central India

ii. ***Dicantheum- Cenchrus***

sandy alluvium: punjab, rajasthan , haryana

Iii. ***Phragmites - Saccharum***

terai region; Late appearing sp. Imperata-Vetiveria

iv. ***Bothrichloa - Themeda***

clayey soils of U.P., M.P., Bihar

v. ***Cymbopogon - Themeda***

nilgiris, high western ghats

vi. ***Arundinella; Nereudia- Chrsysopogon***

Siwaliks of UP & HP

vii. ***Deyeuxia - Festuca***

2500m + altitude in Himalayas *Danthonia* in disturbed areas

viii. ***Deyeuxia - Arundinella***

sub tropics & temperate Himalayas (below 2500m)

***Heteropogon & Chrysopogon* associated in drier parts of n.W. Himalayas**

D. DESERTS

i) **Cold deserts - N.W. Himalayas mainly Ladakh, Lahaul Spiti**

- Physiological dryness due to low temperature

- scarcity of water (precipitation)

common plants species with hot deserts

Aeluropus villosus.; Aristida sp.

Ii) **Hot desert - Thar**

COMPONENTS OF A HABITAT

1. **Cover**

   - **usually implies hiding place: shelter and protection from the weather and other mortality factors**

   - **it is any physical and/or biological arrangement of features that provide shelter from weather & predators**

COVER AS A WILDLIFE CONCEPT

- **Absence, sparseness and poor distribution of cover affects wild animal populations**
- **For cover management - habitat manipulation is done (burning, clearing planting)**
- **Cover requirement of animals involves several different arrangement of vegetation or other geomorphic features**

TYPES OF COVER

- **Protective cover**
  - **Breeding cover, Escape cover**
- **Hunting related cover**
  - **Ambush cover**

Types of Cover (by constitution)

- **Vegetal covers**
  - **thick vegetation, large trees, grasslands**
- **Non-vegetal covers**
  - **Caves, rocks, burrows, cliffs**

ESCAPE COVER

- **Escape from predator and hunters - open ground, forest edges, rocks, cliff, dense vegetation**

- **Distance of prey-predator provides flight response time**
  - **Ibex: never > 100 meters from cliffs**
  - **Gorals: 80% pellets on slopes>60%**

BREEDING COVER /FAWNING COVER

- **Carnivores - dens**
- **Herbivore - thick vegetation, nests,**

  Hard ground Barasingha: In 1960s & 70s population crashed because of lack of fawning cover (tall grass)

Fussorial: live & feed in the burrows eyes & ears become vestigial sensory organs on the chin. e.g. Naked mole rat

Burrowing: live in burrows but come out to feed e.g Pythons, Porcupines, Hyena

Thermal cover: to escape high temperature; Goral rests under *Bauhinia vahlii* thickets.

Chinkara under *P. cineraria*

Ambush (Hunting) cover

Carnivores - Tiger, Lion , Leopard ; primarily required by stalking predators

TREE CAVITIES:

Bird nesting covers

- **Primary users**

  : Woodpeckers, Barbets

- **Secondary users**

  : Parakeets, Mynas, Hornbills

ROOSTING COVER

- Day-time (for nocturnal animals)
  - Owls, Civets, Flying squirrels
- Night-time (for diurnal animals)
  - Trees, dens, cavities, open ground

FOOD

- Source of material for
  - Energy
  - Growth
  - Reproduction
  - Disease Resistance

ENERGY REQUIREMENT OF ANIMALS

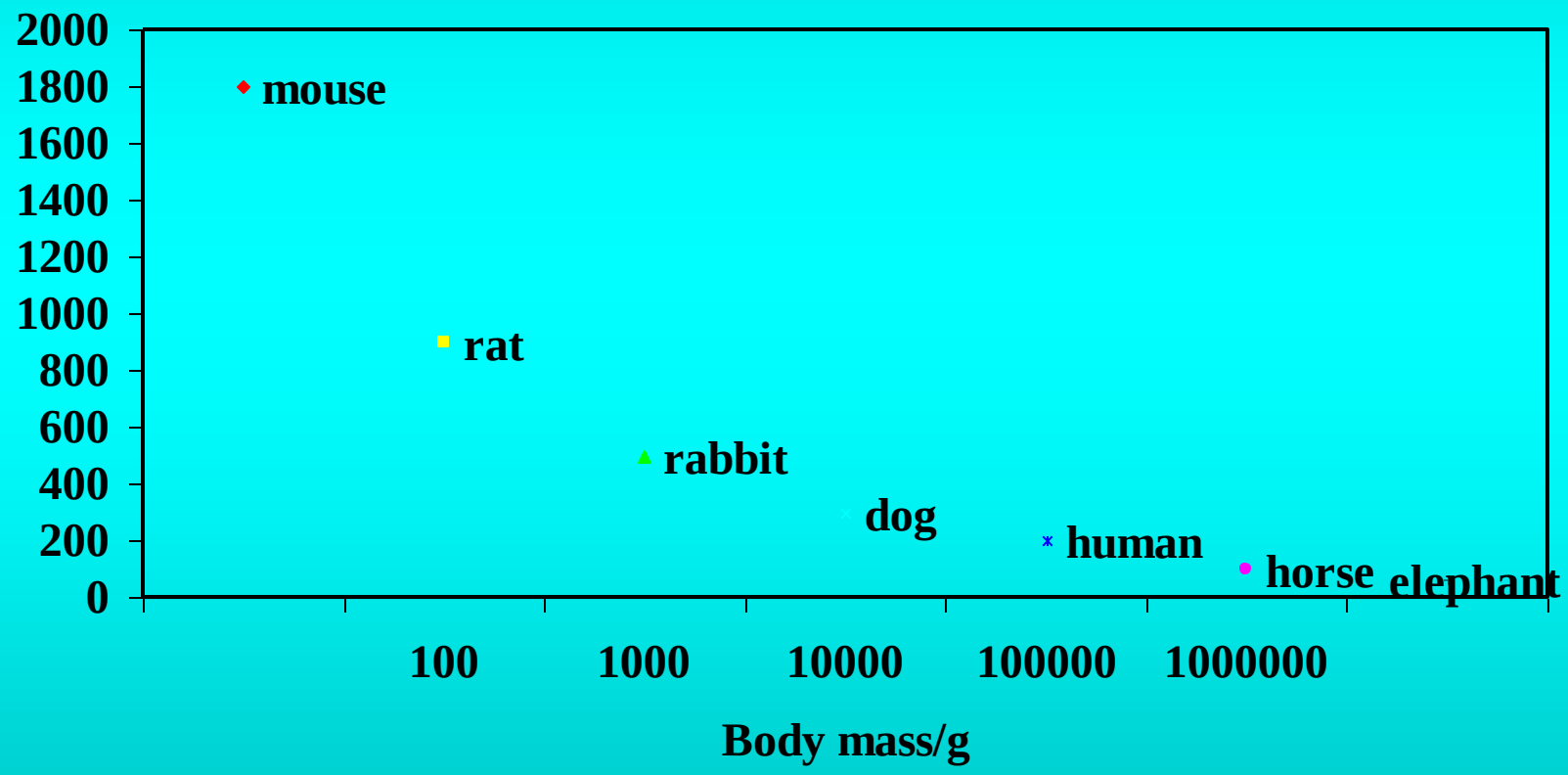
- **To maintain the BASAL METABOLIC RATE (BMR)**
  - **Minimum rate of energy conversion required just to stay alive during complete rest or sleep**

  (Generation of heat to maintain the body temperature (for warm blooded animals)
- **Physical Exercises (muscle contraction)**

Carbohydrates & Lipids : 80-85%

Proteins : 15-20%

Metabolic Rate of Animals Calculated per gram body mass



DAILY ENERGY REQUIREMENT

- **Small animals require more energy due to their greater ratio of surface area to volume permitting more escape of heat**
- **Daily energy requirement (kcal) = 140 x (body weight in kg) ¾**
  - **A shrew weighing 5 g. Needs 2.63 k cal/day : 527 kcal/kg**
  - **An active 68 kg. Human – 3315 k cal/day : 49 kcal/kg**
  - **A 544 kg brown bear - 15770 k cal/day : 29 kcal/kg**

	Body Weight (kg)	K Cal/day	K Cal/ kg
Shrew	0.005	2.63	527
H. sapien	68	3315.2	49
Brown Bear	544	15769.84	29

Bergman's rule

- Animals living in cold regions tend to be large
  - Tigers decrease in size with distance from poles
  - Polar and Grizzly Bears are much larger than Sloth and Sun Bear

Allen's rule

Species living in cold climates have smaller extremities than related species in warmer climates

PROTEINS

Made from amino acids c, h, o, n, (s)

20 amino acids

Most abundant organic molecules found in the cells (50% of their total dry mass)

Great diversity used for a range of structural and metabolic activities

Structural, Enzymes, Hormones, Respiratory pigments, Transport, Protective, Contractile, Storage, Toxins

Required for

- **Growth**
- **Reproduction**
- **Disease resistance**

Available in

- **Growing tips of stem**
- **Seed, grains, nuts & all legumes**
- **Raw meat**

Good general index to food quality

Other factors: palatability, digestibility, and toxicity, presence of special nutrients like vitamins/trace elements

CARBOHYDRATES

- **Includes cellulose, starches, glycogen & sugars; Comprised of Cx(H2O)y**
- **Starch: major fuel store in plants – can be converted to glucose**
- **Quick energy source - 4.2k. Cal/gr**
- **Cellulose (& chitin) have an structural role**
- **Cellulose also digested by certain animals (ruminants), bacteria & fungi**

LIPIDS (FATS)

- Formed out of condensation reactions between fatty acids & alcohols
- Water insoluble
- Fats (solid) & oils (liquid)
- Contains twice the energy as carbohydrates but takes longer time for body to extract energy
- Storage of energy for periods of high demands
- Insulator, blubber for buoyancy,
- Fats in animals and oils in plants
- Not much storage in most of the animals as it hinders mobility e.g. 5% in African antelopes while 20-26% in domestic sheep/cattle

VITAMINS

- **Function as enzymes in body**
- **Fat soluble - Vit A, D, E & K**
- **Water soluble - Vit B_1, B_2, B_{12}**
- **Mammals synthesize ascorbic acid (Vit C) and do not need a dietary source**
- **Ruminants: vitamins & fatty acids synthesized by symbiotic rumen bacteria**

MINERALS

MINERALS (major) **Na, Ca, Mg, K, Fe,P ,Cl**

Grewia **- rich in Ca, Mg. K**

Tecomella undulata **- rich in Fe**

WATER

PLANT

SOIL

Sometimes from faeces, urine and afterbirth

FOOD REQUIREMENT

QUANTITY AND QUALITY OF FOOD

May vary

- **Among species**
- **Between the sexes**
- **Among age classes**
- **Physiological functions and seasons of the year**
- **Weather**
- **Geographic location**

CARNIVORES

- **Opportunistic feeders**
- **No marked food preferences**
- **Raw meat: high quality diet**
- **Nutritional problems : quantity/availability**

HERBIVORES

- **Crude foods: carbohydrates with low conc. Of proteins & other nutrients**
- **Strong preferences**
- **Nutritional problems: lack of food of adequate quality**

- **PREFERRED FOOD: High Quality**
- **EMERGENCY FOOD: Moderate Quality**

  May sustain the animal thru' a critical period
- **STARVATION FOOD: Poor Quality**

  May not be able to sustain the population: Decline is certain

FOOD SUPPLIES

Food quality

- **Herbivores have a variety of plant material as food**

Food presence

- **Species list of all food items both plants and animals present in an area/habitat**

Food selection

- **What animal takes compared to what is available**

STUDYING FOOD PREFERENCES/ WILDLIFE NUTRITION

- **Feeding site observations**
- **Observation of the digestive tract**
- **Observation of faeces**
- **Observation of regurgitated pellets**
- **Observation of food remains & signs**
- **Measurement of forage use (quadrates)**
- **Preference trials**

FOOD QUANTITY

- **Biomass of plants produced by interaction of soil, moisture & solar energy (sun)**
- **Measurement of availability of food**
- **Take quadrate samples in the field**
  - **examine the frequency of species available**

- **To find out what parts of plants are eaten by animals, divide the plant material into leaf, stem and inflorescence and have a numerical count of the availability of different plant parts**

- **To know nutritional content conduct lab study**
- **Reduction of food quantity results in crop depredation**

- **Some plants tolerate the removal of browse up to 100% but few >20%**

AVAILABILITY

- **Prime foraging habitat**
- **Critical foraging habitat**
- **Forage unlimited but not available to animal**
  - **snow**
  - **human disturbance**

- **Fence - presence of human and cattle**
- **The temporary aspect of availability**
  - **migratory behaviour of animals**
  - **behavioural and physiological realities**

- **Utilization**

  - **utilization of food is classifies as:**

- **Preferred, staple, emergency, past time (mineral or tonic) and poisonous (Leopold, 1933)**

SUCCESSION

K. The orderly, largely predictable sequence of changes in vegetation & associated animals through which a site progresses over time

K. Influences food availability

WILDLIFE MANAGERS CONTROL SUCCESSION BY

- **Burning**
- **Forestry**
- **Flooding & irrigation**
- **Fertilizing**
- **Feeding (grazing)**

Fawning Periods

- **In India most favourable period of birth is mid June to mid Sept.**
- **Sambar-gives birth during the monsoon**
- **Barasingha - end of monsoon**

Exception

- **Chital and Gaur young are born during autumn when food resources diminish, they survive by suckling**

VERME EXPT. 1962, White Tailed Deer

- **RELATION OF WINTER & SPRING NUTRITIONAL LEVEL TO DEER REPRODUCTION PATTERNS**

Plane of Nutrition				
Diet	**Winter**	**Spring**	**Fawns Born Per Pregnant Doe**	**Fawn Mortality (percent)**
1.	High	High	1.6	7
2.	Moderate	High	1.6	6
3.	Low	High	1.4	35
4.	Low	Moderate	1.6	54
5.	Low	Low	1.3	93

- **Palatability is a function of taste, size, appearance, feel, work required per mouthful and ease of swallowing**
- **Deer prefer succulent bitter high protein plants**
- **Feeding behaviour in wild: feeding information is communicated from parent to offspring**

- **Browsing**

  - **Foraging on woody twigs and leaves**

  - **Reduces plant vigour or ability to produce biomass. Ritards growth**

- **Response of plants**

  - **desert plants can be browsed up to 30% in spring without loss in growth**
  - **utilization greater than 30% is over grazing**
  - **browsed shrubs produce more foliage and lateral branches; heavy browsing affects plant height**

- **Over grazing/utilization**
  - **Removal of more than 60% of current growth**
  - **Erosion, silt, sedimentation in streams**

    Trampling effect
  - **Formation of trails**
  - **Failure to set seeds**
  - **Increase in rodent and certain insect population**
  - **Unusual distribution of plants**

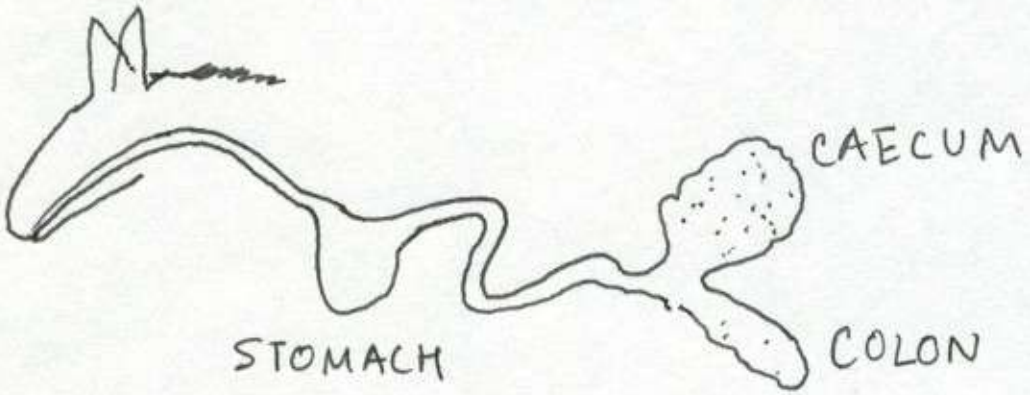
- **Animals forage requirement**

  - **Daily forage requirement in kg**
    = 0.045 x (deer wt in kg.) $^{0.75}$

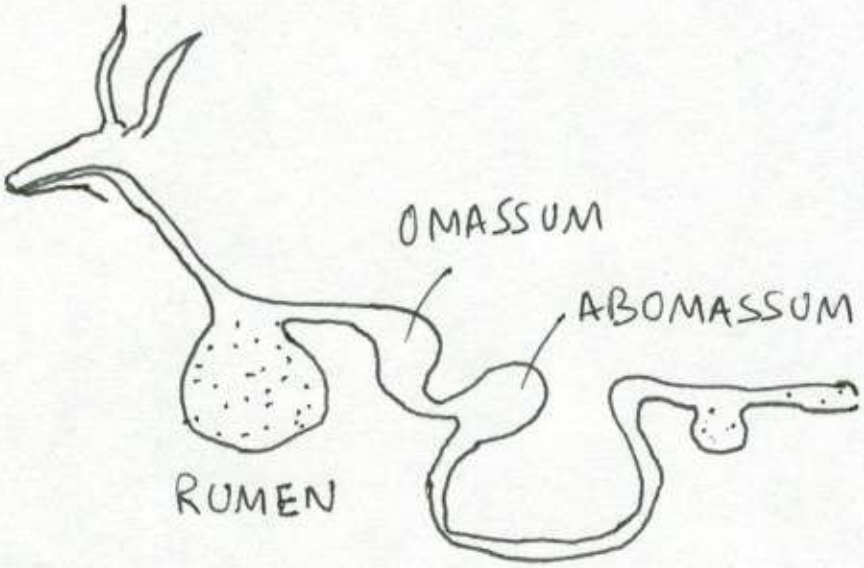
  - **For a pop the mean body wt. can be used for pop forage req.**

FEEDING ECOLOGY

- **Anatomy of digestive tract of herbivores**
  - **Order Perrisodactyla: odd toed ungulates and Proboscidae**
    - ***Hind gut fermentation***
    - **Elephants, horse, rhino**



HIND GUT FERMENTATION



FORE GUT FERMENTATION

ORDER ARTIODACTYLA: EVEN TOED UNGULATES

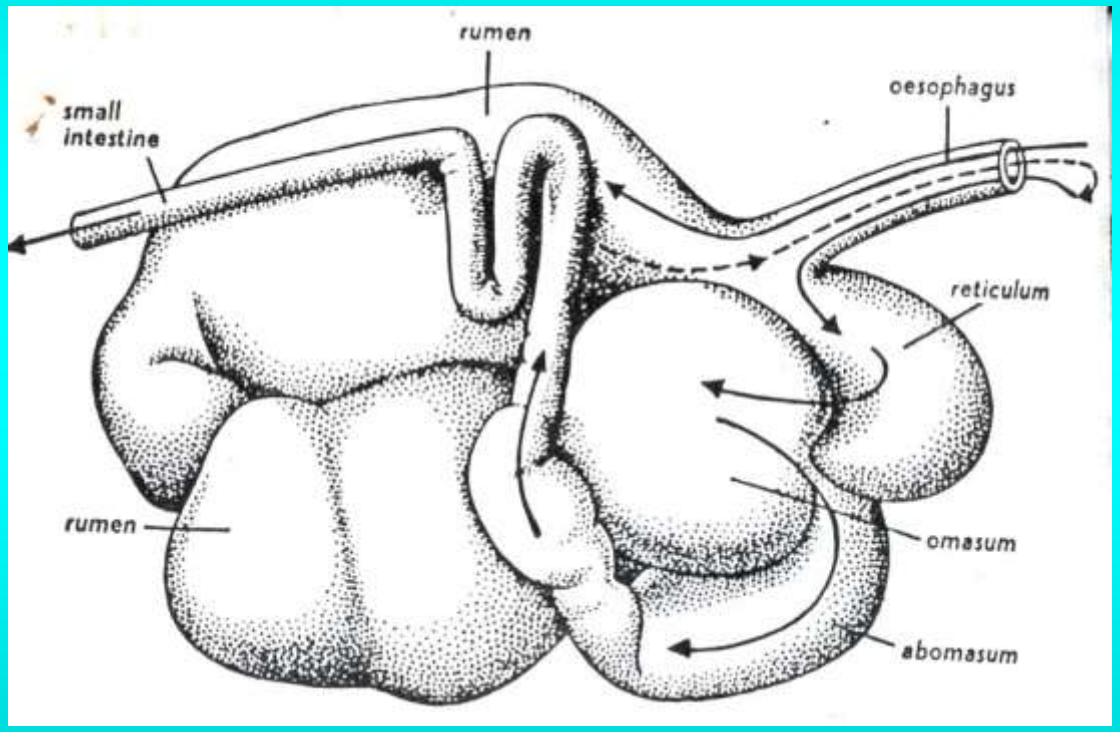
- ***Fore gut fermentation*** **(sub order Ruminantia)**
- **Primitive ruminants (Tylopoda)**
  - **Three chambered stomach**
  - **Camels and llamas**
- **Higher ruminants (Pecora)**
  - **Four chambered stomach**
  - **Bovidae (cattle, antelopes, goats, etc) and Cervidae**

RUMINANTS

- **Rumination: Regurgitate, or bring food back to their mouths after swallowing it, in order to chew the food further**
- **Ruminants can eat quickly, store masses of food in their stomachs, then retire to a place secure from predators to finish chewing in safety**

HIGHER RUMINANTS : STOMACH STRUCTURE

- **4 chambered stomach**
  - **Rumen**
  - **Reticulam**
  - **Psalterium**
  - **Abomassum**



Rumination Process

- **Mouth (Food + Saliva) →Rumen + Reticulum: Bacteria+ Protozoa (Rumen flora) breakdown enzyme resistant cellulose; Fermentation produces VFA (acetic, butyric and propionic acids) which are partly neutralised by the Sodium bicarbonate in the Saliva and also absorbed so that pH remains neutral; CO2 and CH_4 released thru' belching →Regurgitation (Contraction of Diaphragm & Abdominal muscles+reversed peristalsis of oesophageal muscles) → Chewing the cud (Mastication) → Psaltarium → Abomassum (Gastric juices)**

- **Mouth of grazers:- wide - non selection nature of feeding**

  Teeth: high cusps to chew monocots

- **Mouth of browsers:- narrow-selective feeder**

- **Internal anatomy**

- **Grazers**

Very large rumen as grasses are difficult to digest

rumen lining hard and characterized by very few blood vessels

- **Browsers**

rumen small with leaf like projection large no of blood vessels

quick absorption of volatile faty acids so the ph remains neutral.

Takes more protein less cellulose

Mineral balance

Browse (dicots) = 0.073% na

Monocots = 0.031% na

In elephants

Urine + fecal matter: 150g of na is released / day

From plants it gets 15-20 g / day

Rest from natural salt licks/ artificial salt licks.

For calcium: debarking.

FACILITATION

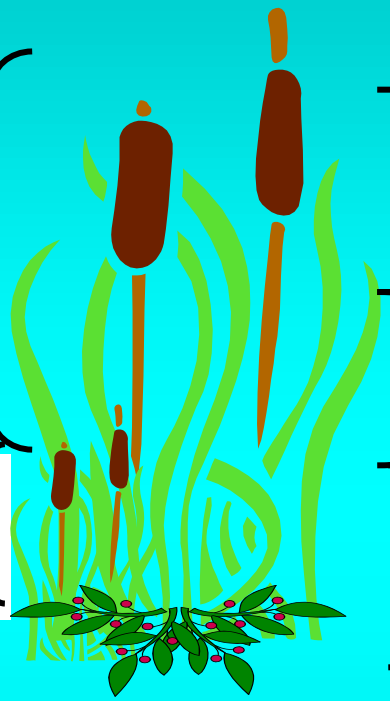
→ **Langur - chital association**

→ **Elephant - smaller herbivore**

Grazing succession = sequence in which diff. Animals graze

GRASS

FORBS+
HERBS



EATEN BY ZEBRA GRAZER

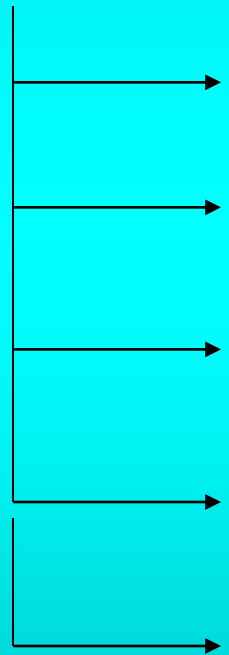
WILDE BEAST GRAZER

THOMSON'S GAZELL BROWSER

IN KAZIRANGA

RHINO → SWAMP DEER → HOG DEER

Chemical composition of plants



- **Crude proteins**
- **Crude fibre (cellulose + hemi cellulose + lignin)**
- **Ash (minerals)**
- **Silica**
- **Nfe (sol. Sugar & starches)**

CRUDE PROTEIN

* Species (browse >grass)
* Soil type
* Part of plant (leaf >sheath>stem)
* Season (wet >dry)
* Age (young > mature)

[More significant in grasses]

	PART	C.P.(WET SEASON)	C.P. (DRY SEASON)
GRASS	LEAF	6.2	3.4
	SHEATH	4.5	3.2
	STEM	2.9	2.1
BROWSE	LEAF	14.3	
	STEM	6.3	
	FRUIT	13.0	

SILICA CONTENT >4.5% $\Rightarrow$ NON- PALATABLE

>6.0% $=\!\!\rightarrow$ MAY LEAD TO MORTALITY

SECONDARY COMPOUNDS OR PLANT INHIBITORS

-Used to inhibit grazing pressures

* **Lignin**
* **Tannin**
* **Synergetic glycosides**
* **Alkaloids**
* **Mimosin, saponin ; ants mainly in browse**

In grasses silica is the only inhibitory compd.

- **Some animals can digest secondary compounds**
  - **Chinkara can feed on *Calotropis procera* which has high levels of alkaloids**
  - **Usually not more than 10-15% of diet**

WATER:

Uses

1. **Base for metabolic activities**
2. **Cooling the body**

AVAILABLE TO ANIMAL IN 3 WAYS

1. **Free water (drinking)**
2. **Metabolic water (oxidation)**
3. **Preformed water (food)**

LOSS OF WATER OCCURS

1. Maintenance of body temperature (sweat)
2. Removal of metabolic waste (urine)
3. Through faeces
4. Excreted air

Oxidation water meets 15-20% of water requirement

<u>Preformed water</u>

Oryx - peak, grazing period 2 am to 6 am as moisture content of food plant was 30% while in day time 6-7%

Minimum water requirement of Indian Gazelle 1.5 litres/day; preformed water available 2.6 litres/day

(Because food species have upto 50% moisture: browse)

Black buck - primarily grazer (<30%) preformed water so needs free water

Increasing body wt. - Less % loss of water thru evaporation

Dik dik: 40% ; Eland: 3-7%

Water requirement for desert animals in litres/day =

0.127 (W *raised to the power* 0.807)

W= weight in kg.

WATER STRESS

Animal vulnerable - Sambar, Chital, Nilgai

Animals with adaptation

- Black Buck, Chinkara,

Water unevenly distributed in wildlife habitat:

Seasonal migration - Wilde Beast, Zebra, Elephant, Gaur, Black Buck

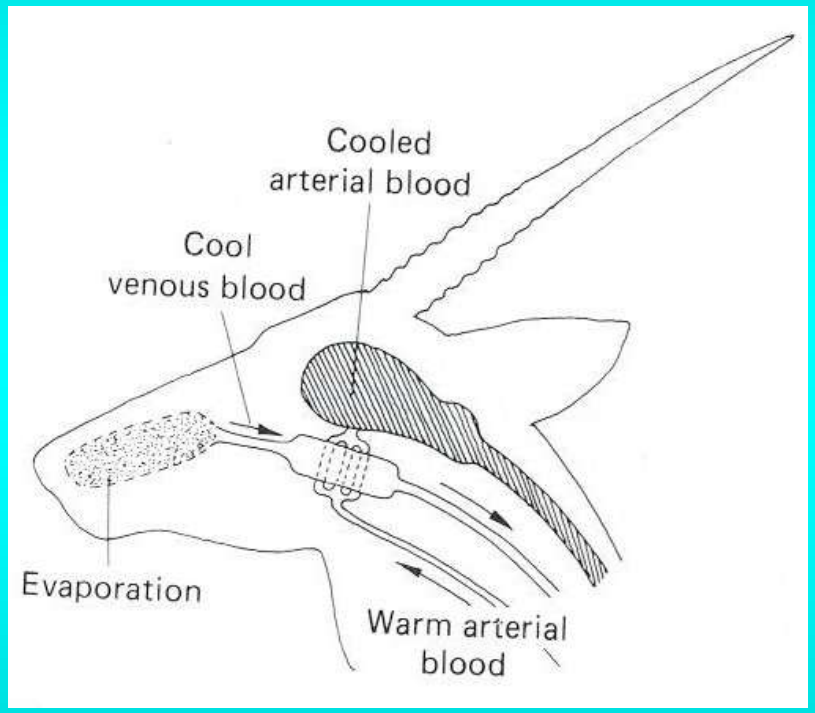
Successful breeding depends on water

ADAPTATION FOR WATER CONSERVATION

- **Nocturnal or Fossorial habits**
  - **Activities at lower temp. & High hum.**
- **Concentrating excreta**
  - **Dry faeces and concentrated urine**
- **Morphology (thermal inertia)**
  - **Large body size and abundant insulation**
  - **Greater insulation on the back**
  - **Scantily haired body**
  - **Large pinnae**

ADAPTATION FOR WATER CONSERVATION *contd.*

- **Labile body temp.**
- **Use of metabolic water**
- **Water storage**
  - **Rumen storage & quick rehydration**
- **Mobility**
- **Patterns of reproduction**



SPACE

Carrying capacity:

- **Maximum capacity of habitat to support animals, without damaging future capacities**
- **Carrying capacity is the user specified quality biomass of a particular species or a group of species, under the influence of social and behavioural constraints, for which a particular area having user specified objectives, will supply all energetic and physiological requirement over a long but specified period**

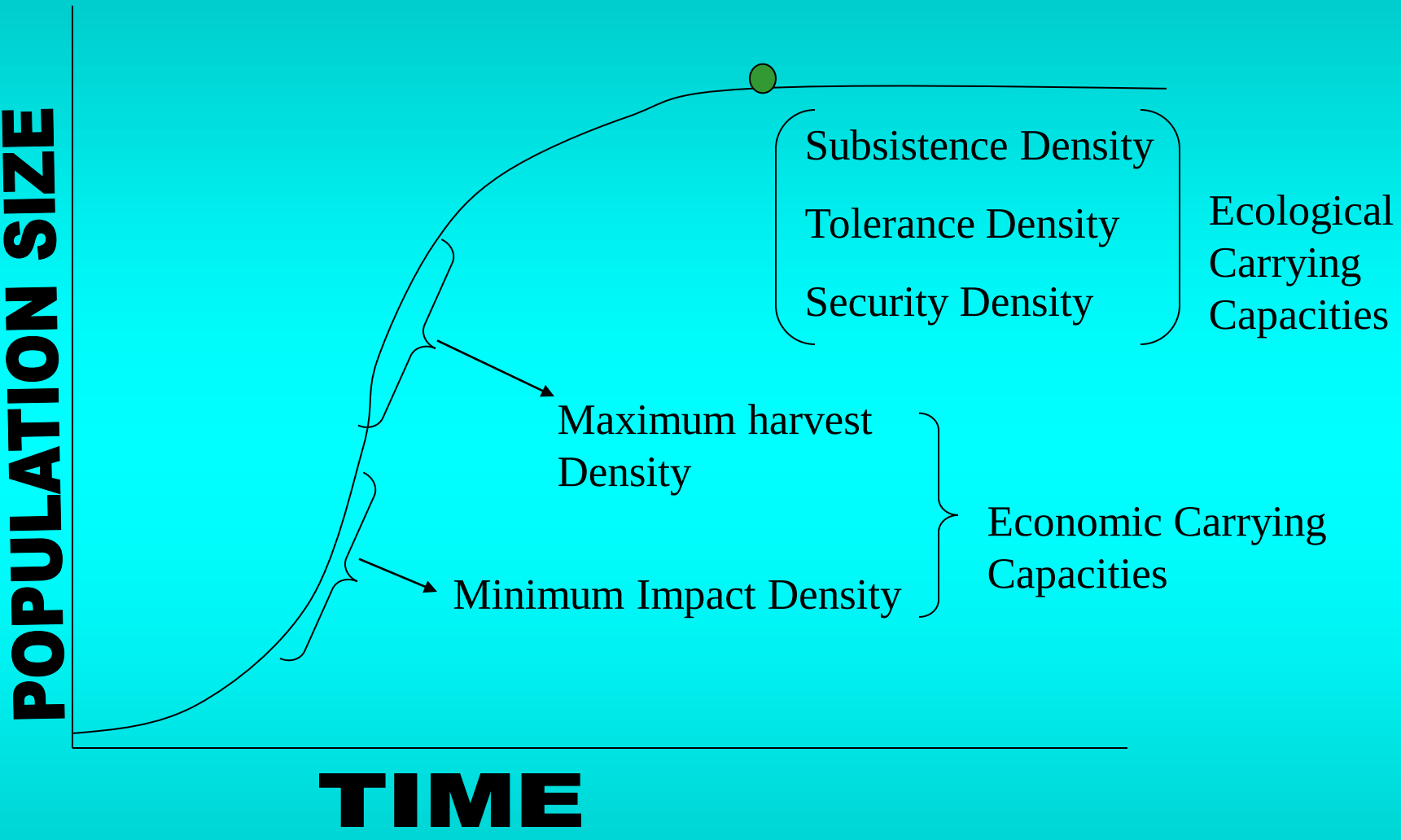
TWO TYPES

: Species specific

: Composite species

Actual C.C. - Current based on local or temporal factors

Potential C.C. - Theoretical maximum under a given set of natural conditions



Five types of population regulation in relation to the sigmoid population model.

Economic carrying capacity:

- **Maximum harvest density: max. No. Of animals a habitat will support while producing a max. Sustained harvestable surplus; good pop. Quality**

Minimum Impact Density: minimising the impact on other wildlife or vegetation without eliminating the population; for predators; good pop. Quality

Ecological carrying capacity- unharvested

Limiting habitat resources

3 types: subsistence, tolerance, security

Subsistance density

- **Usually applied to ungulates**
- **Pop. Limited primarily by forage**
- **Natural ecosystem**

Tolerance density

- **Intrinsic behaviour**
- **Territorial species**

Security density

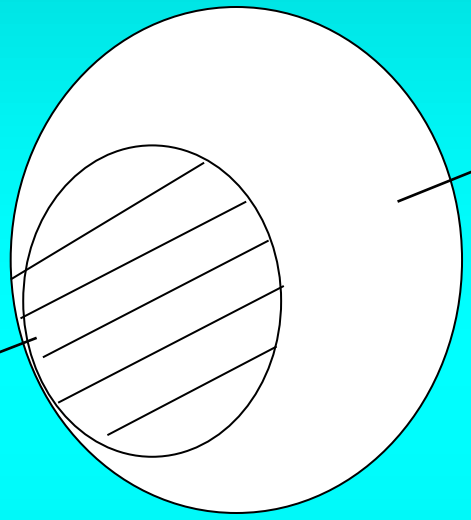
- **Predation is the limiting factor**

TERRITORY AND HOME RANGE

- **Territory relates to a space, which is vigorously defended by an animal**

- **Home range is the area where animal spends most of his time to secure its requirement for energy (food), shelter, water and breeding space**

HOME RANGE



TERRITORY

- **Territorial markings: to avoid intraspecific encounters as high intolerance and antagonism exists**
- **Territoriality is an innate species characteristic: mostly seen in mammals, birds and fishes**
- **Territories are flexible**
- **Territorial advertisement : visual, vocalizations, olfactory, defecation**

TIGER HOME RANGE (km^2)

MALE	FEMALE	LOCATION
60-72	16-20	Chitwan
90-105	26-39	Chitwan
30-35	10-20	Kanha
38-50	12-42	Palamau
800-1000	100-400	USSR

MONITORING OF HOME RANGE IS DONE BY

1. **Radio tele metry**
2. **Capture - mark recapture**
3. **Tracking and mapping routes followed by animal**

RADIO - TELEMETRY

- **Metering without wire connection**
- **Primarily the location of animals**

BIO - TELEMETRY

- **Biological Parameters are measured**

- **Temperature, heart beat, pulse rate, pH of rumen**

COMPONENTS

- **Transmitter**

  - **Weight (mainly due to battery weight)**
  - **Life (with respect to size of battery)**
  - **Smallest transmitter 100 mg, life 2 weeks**
  - **Transmitter weight (+ accessories) should not be more than 4% of body weight**

- **Frequency range allotted 142 - 168 M Hz. In India 150 - 152 M Hz. in use**
- **0.050 M Hz. separation between two transmitters**
- **Activity sensor: produces different signals in different activities e.g. resting, moving**
- **Recapture transmitters : collar with darts, triggered by receiver**

- **Receiver**
  - Range of reception

Tracking the Radio - Collared Tiger in different Habitats

(Chitwan N.P.); *Distances in km*

Method	Grassland	Riverine	Sal forest
Elephant	3.2	2.4	0.8
Vehicle	3.2	2.4	0.8
Air	16.0	16.0	13.0
Foot	1.6	1.0	0.4

- **Antennae**

- **Directional : H type, Yagi array**

- **Omni directional : e.g. wireless antennae, use for activity pattern**

•Collars

- **It should be long and smooth so that can be adjusted**
- **Expandable collars for sub adult animals**
- **Some degrade after fixed time**
- **Can be colour coded for easy recognition of animal**

- **Global positioning systems**
- **Satellite tracking- for animals (mainly Birds) showing large scale migration**
  - **Currently used for Olive Ridley Turtles**
  - **Siberian Cranes**

Habitat Use by Hog Deer in Chitwan NP

Dhungel and O'Gara

Comparison between Grassland, Riverine forest and Sal Forest; 20 Hog Deer's, 3186 transmitter locations

Sex	Grassland Locations	Riverine forest
Male (N=8)	99.4	0.6
Female (N=12)	99.7	0.3

Hog Deer used tall grasslands along rivers where food, water and dense cover are plentiful

INTERSPERSION :

The inter mixing of units of diff' veg' type/habitat types

JUXTAPOSITION:

- Contrast in habitat merging
- It is a measure of proximity of diff' habitats
- Dissimilar habitat units if juxtaposed properly produce increased animal richness

Example - food adjacent to cover

- nesting cover adjacent to feeding areas

EDGES

Edge is the place of contact between plant communities or successional stages or habitats

Ecotone: Where two or more communities not only meet but also intergrade

Junction zone; tension belt

ANIMALS SEEK EDGE:

A) To have simultaneous access to more than one habitat type

B) Greater access to desirable veg. Choice, cover etc.

'EDGE EFFECT': IS THE SUM OF INFLUENCES OF ALL CHARACTERISTICS OF EDGE

- **Composition and diversity of species**
- **Length and width**

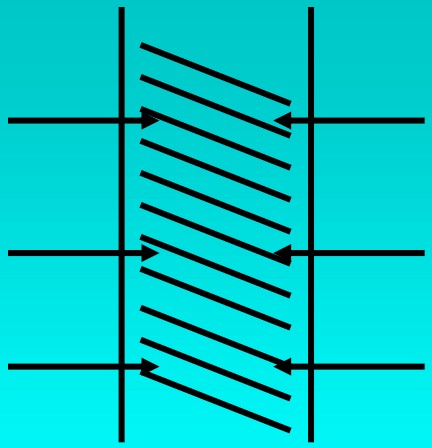
Abrupt edge - Lake and forest or sea shore

Inherent edge - Long term relatively stable features produced by natural factors - topography, aspects, type of soil

Induced edge - Management induced edge in forest

Mosaic edge -

VEG' A



VEG' B

SAMBAR

A

SPS' A USING OUTER AREAS BUT EDGE LIVING

CHITAL

B

SPS' B - ONLY EDGE

GAUR.
TIGER

C

SPS'C LIVING OUT BUT USING EDGE

MANAGEMENT IMPLICATIONS OF CREATING EDGES

- **Smallest edges are created by circular shape,**

- **Irregular forest edges look more natural**

Special habitats

Snags: standing dead trees

Down logs:

Slash: veg' material on forest floor

Cliffs: over hanging rock faces

Talus: accumulation of broken rocks at the base of cliff

Caves:

Point habitats/coverts: appear as points on maps

ECOLOGICAL ISOLATION

i) Diff. Habitat types

ii) Diff. Types of food

iii) Diff. Area in the same season or vice versa

iv) Diff. Levels in the veg

v) Diff. Dry season refuge

GIR CONSERVATION. AREA (BERWICK)

	FOR-EST	THORN SCRUB	SAV-ANNA	RIP.	RIV-ER	HILL SIDE	FL-AT
CHITAL	80	12	3	5	6	12	82
SAMBAR	69	5	10	16	14	51	35
NILGAI	41	29	27	3	5	35	60
HORNED	44	22	33	-	6	61	33
CHINKARA	-	12	88	-	-	71	29

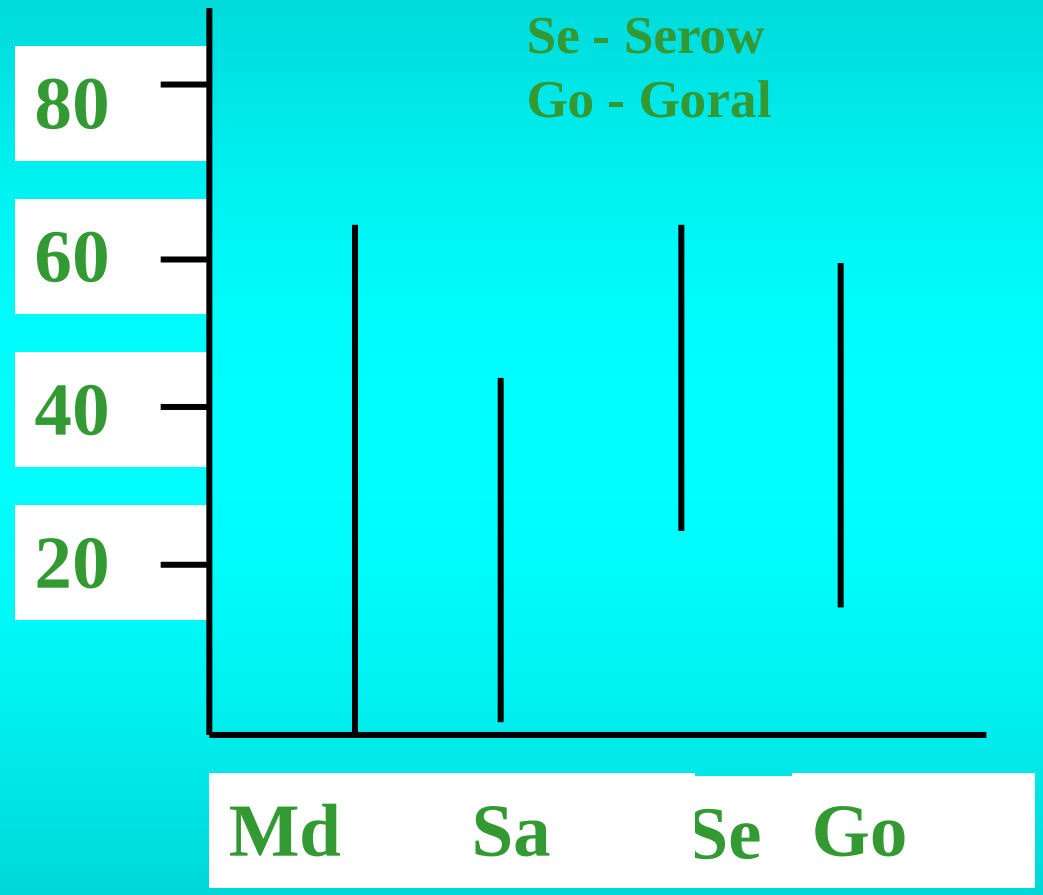
BASED ON SIGHTINGS.

HIMALAYAS - ALTITUDE HAS A LARGE INFLUENCE

Ecological separation of Ungulates in Kedarnath Sanctuary (MJB Green, 1985)

Md - Musk Deer.
Sa - Sambar
Se - Serow
Go - Goral

Angle of slope



Md - Musk Deer.
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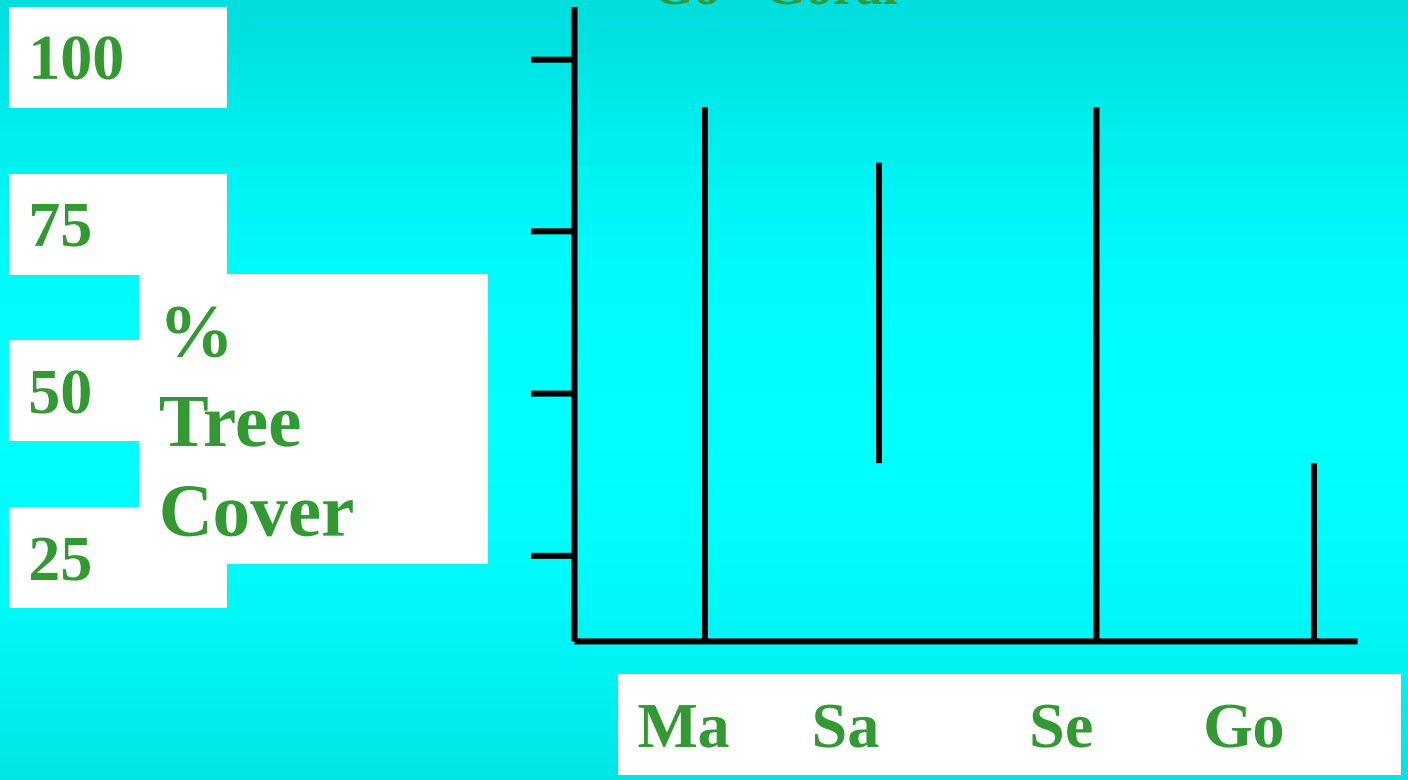
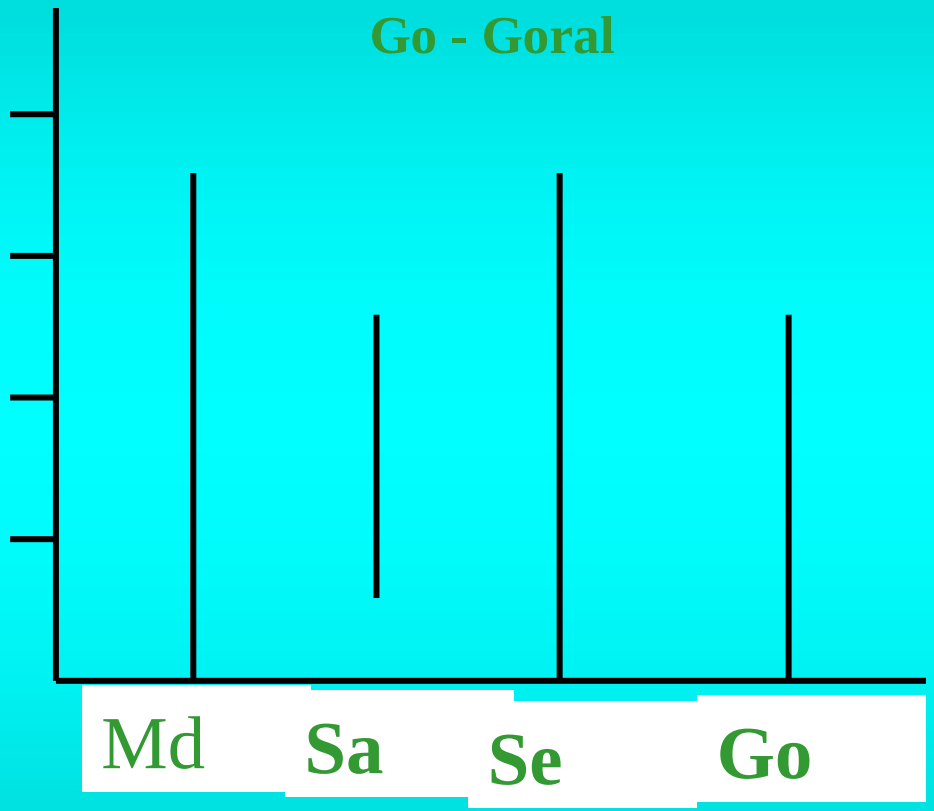
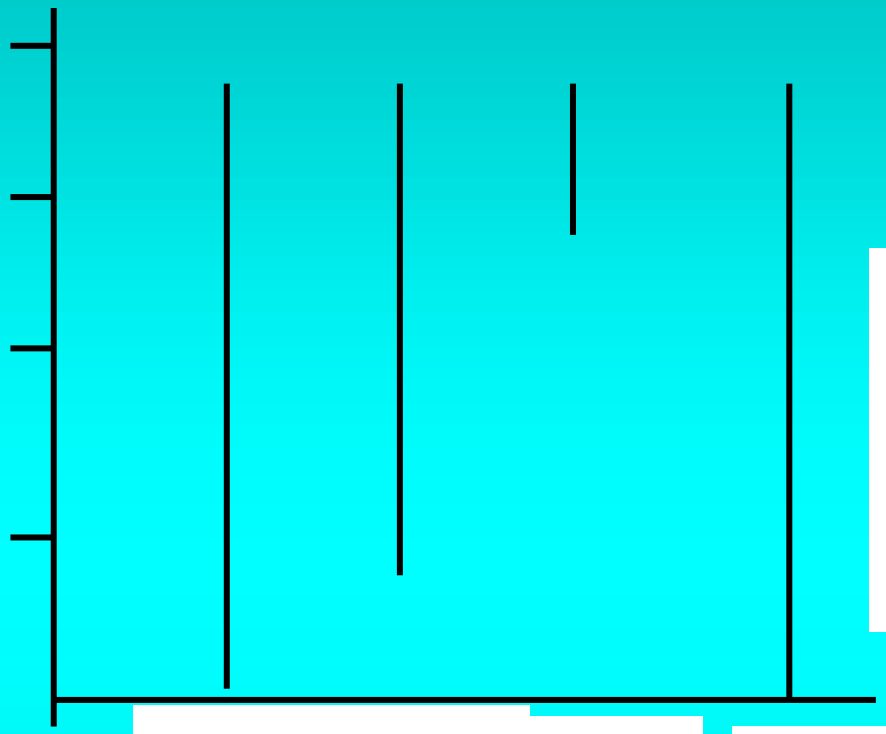


Md - Musk Deer.
Sa - Sambar
Se - Serow
Go - Goral

% Shrub Cover



% Herb Cover



Md - Musk Deer.
Sa - Sambar
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CARNIVORES:

1. **Habitat**
2. **Activity pattern**
3. **Prey size - species, age**

ECOLOGICAL SEPARATION OF PREDATORS

- **Differential use of habitat**
- **Prey density & utilization by predation**
- **Predation and set of prey**
- **Predation and age of prey**

Ecological Separation of Carnivores in Bandipur Tiger Reserve (AJT Johnsingh, 1980)

Ecological & behavioural parameters	Tiger	Leopard	Dhole
Nocturnal	+	+	-
Diurnal	-	-	+
Need for cover	+	+	-
Tolerance for sun	-	+	-

Need for water	**+**	**-**	**+**
Tolerance for human disturbance	**0**	**+**	**-**
Arboreal	**-**	**+**	**0**
Scavenging	**-**	**-**	**+**
Sociability	**0**	**0**	**+**
Inter pack tolerance	**-**	**-**	**+**

+ High
- Low
0 Absent

PREY- PREDATOR RELATIONSHIPS.

Prey predator ratio (biomass/number)

1: 124	**Bandipur**
1: 100	**Ngorongoro crater**
1: 250-300	**Serengeti**

Table. Prey biomass and Tiger densities.

Study site	Area km^2	Prey biomass kg/km^2	Tiger density No./100	% consumption of prey biomass
Kanha	318	4066	6.92	5.446%
Chitwan	1024	1946	8.78	8-10%
Ranthambore	400	2765	10.0	11.5%
Nagarahole	103	7658	11.65	4.868%

In Serengeti- Lions remove = 4.6 - 5.5 %

All predators = 9-10 %

NICHE

Functional address of the organism in a system w.r.t. to specific parameters.

Or the profession of an organism in the system (activity or parameter)

NICHE WIDTH

High N.W : species is generalist, can survive overlapping of species - with limited resources, the competition will set.

- **Broad Niches - less species but more numbers**
- **Narrow Niches - more species & less abundance if resources are constant**