KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,

KUMASI.

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

FACULTY OF RENEWABLE NATURAL RESOURCES

DEPARTMENT OF WILDLIFE AND RANGE MANAGEMENT

FEEDING HABITS OF THE ROAN ANTELOPE (*Hippotragus equinus* Desmarest, 1804) IN GBELE RESOURCE RESERVE.

BY

GEORGE DERY

B.Sc. (Hons) Agriculture Technology

JUNE, 2016.

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TOPIC:

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A THESIS SUBMITTED TO THE DEPARTMENT OF WILDLIFE AND RANGE MANAGEMENT IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER OF PHILOSOPHY DEGREE MPHIL. IN WILDLIFE AND RANGE MANAGEMENT.

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JUNE, 2016.

DECLARATION

I, George Dery hereby declare that this thesis is the results of my work and that no previous submission for an MPhil. Degree has been made elsewhere. All works that served as sources of information have been duly acknowledged by way of reference to the authors.

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ABSTRACT

Knowledge on the food habits of range animals is an essential tool for rangers and other range scientists for effective and sustainable management of rangeland and its resources. Such information provides a greater opportunity to assess the diet of animals and to evaluate any potential competition for forage among herbivores. However, there is no substantive data on the food habits of herbivores in Gbele Resource Reserve. The study was therefore conducted to identify forage species consumed by the roan antelope and to assess whether seasonal changes affect the diet and feeding habits of the roan antelope in the study area. It was also intended to create a database on the epidermal structures of the different plant species to aid the identification of forage species in the faecal matter of the roan antelope in the study area. Four nested quadrats of 50m by 50m and 3m by 3m were systematically laid at an interval of 200m to sample trees/browse, grasses and forbs respectively. The scraping method was used to study the foliar epidermal characteristics of plants. Thirty (30) faecal samples were collected monthly along transect lines and were identified by the shape of pellets and nearby hoof prints. Microhistological faecal analysis technique was used to analyse the faecal matter. The adaxial epidermis of grass and browse were generally characterised by little or no stomata except forbs species. Numerous stomata ranging from low-dome to high-dome subsidiary cell shape were however found on the abaxial epidermis of all plant species. Among the plant species identified in faecal matter, *Andropogon gayanus, Hyparrhenia spp, Hyperthelia dissoluta, Gardenia spp* and *Afzelia africana* were the most dominant forage species in the diet of the roan antelope. There were inter-seasonal and intra-species differences ($p > 0.05$) in the consumption of plant species in all the three forages (grass, browse and forbs). The proportions of the three forage types in the diet indicated that roans are mixed-feeders. The results also suggested that, seasonal changes and forage type influence the feeding habit and diet of the roan antelope. Further research should therefore be conducted over an extended period to determine the trend of the feeding habits of the roan antelope.

DEDICATION

This thesis is first and foremost dedicated to the Almighty God who gives and sustains life. It is further dedicated to my dear wife for her invaluable support and encouragement during the study.

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Glory and honour be yours Almighty God who gave me the strength and knowledge to share with others. I am most grateful to all those whose ideas and information I have borrowed towards the production of this work. I am equally indebted to my supervisor, Professor, S.K. Oppong who sacrificed his precious time and energy out of his busy schedules to diligently supervise me to come out with fruitful results. My profound gratitude goes to the management and staff of Gbele Resource Reserve for granting me permission to carry out this study in the reserve. Special mention is made of the assistant park manager, Mr. Polycarp and Mr. Richard and Mr. Baka for their invaluable support during my work at Gbele. My sincere thanks also go to all friends who in diverse ways have contributed immensely to the preparation of this work.

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CHAPTER ONE

1.0 Introduction

Herbivores use different techniques in the selection of their diet. The selection of diet is dependent upon food quality, abundance, the habitat and the morphology and physiology of the animal (Galende and Gricera, 1998, cited in Ioni *et al.*, 2010). Basic studies about the diet and food habits of wild herbivores might have been carried out through direct observation of the animals (Mcinnis *et al.*, 1983), stomach content sample analysis (Henley *et al.*, 2001) and microhistological analysis of faecal samples (Schuette *et al.*, 1998). The study of food habits of large herbivores is useful in assessing herbivores impact on rangelands (Eliana and Roberto, 2002). For a sustainable management strategy of rangelands, it is important to create a rapid and precise method of evaluating the type of plants consume by large herbivores in open ranges (Santos *et al.*, 2009). This knowledge can then be used practically by ranchers to recommend sound conservation and land management strategies (Holechek *et al.*, 1982).

The study of herbivore food habits using microhistological analysis of faeces was originally developed by (Baugartner and Martin, 1939) with squirrels. Since then, this method has been used by many different researchers to study the food habits of different species of herbivores including the roan antelope (Schuette *et al.*, 1998). According to Desbiez *et al.* (2009), microhistological faecal analysis means identifying plant fragments in faecal samples by comparing them to a reference collection of various plant species. Microhistological investigations from large mammals or herbivores provide the researcher with information over several periods of feeding rather than short time spans of hours or individual meals because of the time involved for residues to pass through the animal (Robbins *et al.*, 1995). Faecal analysis has been used extensively in recent years to evaluate diet botanical composition of wild herbivores (Holechek *et al.*, 1982). This procedure gives good precision but accuracy is a problem because of differential digestion between plant species (Holechek *et al.*, 1982).

Microhistological faecal analysis has become the most widely used method for quantifying botanical composition of masticated forage or faecal material. Recent studies have given an accurate representation of percent diet botanical composition by weight if observers use hand compounded diet to check their accuracy (Holechek *et al.*, 1982). Microhistological faecal analysis has become the most commonly used and successful method for determining microanimal diets (Maria and Stella, 2001). Chemical and botanical analysis of faeces provides information on diet quality and composition that is not easily collected directly from grazing animals. However, faecal excreta are readily available in pastures that animals graze (Ray and Kothmann, 1988).

The roan antelope is one of Africa's most attractive antelopes that has a particularly large distribution range and occupy all savanna areas and peripheral semi-arid areas south of the Sahara (Toms and Joubert, 2005). Their optimal habitat consists of open medium to tall grasslands fringed with an ecotone of woody vegetation that are particularly well represented by shallow, grass-covered drainage systems associated with miombo woodlands (Theodor, (1992). They are also partial to open savannah woodlands, the major features being medium to tall grasslands and fairly open woodland (Spinage, 1986).

1.1 Problem Statement and Justification

The roan antelope was formerly the widest-ranging antelope found nearly throughout the better-watered parts of northern and southern savannah (Theodor, 1992). The animal has a status of population decline within its native range (IUCN, 2004). In 1996, the roan antelope was classified as highly reproductive and a low risk; conservation dependent species by the International Union for the Conservation of Natural Resources. However, the new IUCN (2004) red data book on mammals of Africa classified it as vulnerable due to indiscriminate removal of habitat and poaching.

Gazetted purposely in 1975 to conserve the large population of the majestic roan antelope and the undisturbed guinea savanna ecosystem, Gbele resource reserve is no exception. In recent years, the reserve is bedeviled with a myriad of challenges ranging from rapid encroachment of human settlements and farm lands and indiscriminate poaching of animals and exploitation of wood products (Wildlife Division, 2009). Wildfires are among common occurrences in Gbele especially in the late dry season which contribute immensely to loss of biodiversity and vegetative cover thereby increasing the risk of environmental degradation and desertification (Wildlife Division, 2009). The rapid decline in the population of the roan antelope in Gbele resource reserve is the result of indiscriminate removal of the vegetative cover (Ghana National Parks, 2007).

Inspite of the above challenges, there has not been any study on the feeding habits and diet composition of animals in general and the roan antelope in particular in Gbele resource reserve (Wildlife Division, 2009). It is therefore hoped that this study will serve as a guide to reserve management for making important management decisions regarding the conservation of the roan antelope in particular and the reserve as a whole.

1.2 Research Questions

1. Apart from being predominantly grazers, what else do roan antelopes eat?
2. To what extent does seasonal change affect the feeding habits and diet of the roan antelope?
3. What differences and similarities exist among the epidermal structures of grass, browse and forbs species?

1.3 Objectives of the Study

The study has the following as its specific objectives.

1. To identify the different forage species consume by the roan antelope in Gbele resource reserve.

2. To determine the proportions of the different forage species consume by the roan antelope.
3. To create a database on the epidermal structures of forage species for the identification of the species in the faeces of the roan antelope in the study area.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Diet Composition of the Roan Antelope

Spinage (1986) reported that the roan antelope is a grazer and a mixed feeder. The roan antelope predominantly feed on medium height fresh grass up to 90% and foliage of bushes and trees (Theodor, 1992). The roan antelope drinks daily in the morning and evening and also at mid-day in the dry season but it can go without water for three days (Theodor, 1992). Like the sable antelope, the roan antelope is a selective grazer on perennial grasses that grow in leached soils of poor nutrient status which supports a low herbivore biomass, offering little nourishment in the dry season except on low ground that retains enough moisture to produce growth after the annual bushfires (Richard, 1992). The roan antelope browse to some extent up to 10 – 20% of rumen contents on forbs, leaves and pods. Like other water dependant wildlife, the roan concentrates near water points during the dry season and disperses during the rains (Richard, 1992).

According to Kingdon, (1997), roans graze on *Themeda sp*, *Hyparrhenia sp*, *panicum, paludosum Heteropogon*, *Digitaria horizontalis* and *Eragrostis tenella*. In addition to medium to short term grasses, they take various herbs and occasionally browse shrubs and trees, notably Grewia *barteri*, *Loncho carpus* and *Kigelia sp* (Kingdon, (1997). They are also fond of picking up Acacia pods in the dry season and they have been seen feeding on mushrooms (Kingdon, 1997). In the course of daily feeding, a herd move 2–4km from water point and the amount of ground covered varies with the season, the state of the grass and with the amount of disturbances they suffer from man, predators and perhaps other ungulates near the water hole (Kingdon, 1997). An area of cushion grass many hold roans for several days.

The animals often submerge their heads for as long as 48 seconds while gathering mouthful under water (Kingdon, 1997). They drink regularly and in great quantity, sometimes visiting water and mineral licks every day during the dry season. A lactating female has been noted eating soil with some avidity (Kingdon, 1997). Drying of water holes or severe scarcity of grazing occasionally brings roans together into aggregations of up to 150 individuals and the size of herd at any one time of the year might be influenced by the distribution of water and grazing and also by seasonal changes in the reproductive cycle, which might intensify male competition for females but the most commonly seen numbers are 4–18 females with young ones accompanied by a single male adult (Kingdon, 1997).

According to Schuette *et al.* (1998) roan antelopes are grazers that prefer leaves over stems. They will browse if grazing forage is poor (Schuette *et al.*, (1998). Roan antelopes feed grasses and other foliage in the morning and evening hours and retreat to more densely wooded areas during the middle of the day (Schutte *et.al*., 1998). Roans are grazers and by preference do not feed lower than approximately 15cm from the ground (Schutte *et.al*., 1998). They consequently avoid areas with high concentrations of short grazers such as impala, zebra and other wild beast (Toms and joubert, 2005). Roans are predominantly grazers, but also browse on leaves, seed pods and herbs, and they have been known to completely submerge their heads to feed on underwater plants where possible they drink daily or at least every other day and may also chew bones to obtain minerals, particularly calcium and phosphorus (Kingdon, 1997).

2.2 Seasonal Changes in the Feeding Habits of the Roan Antelope

According to Schuette *et al. (*1998), diet of the roan antelope varied from one season to another and the percentage of forage in the diet of the roan antelope varied a greater extent. During the rainy season roans eats more than 95% grass with peaks in the percentage of browse species in the diet of roans occurring at the end of the cool-dry season (OctoberJanuary) and the hot- dry season February-May (Schuette *et al.* 1998). As the hot-dry season progresses, the proportion of browse in the diet of roans increases pre-suggesting that most browse species did sprout after the wild fires in the cool-dry season (Schuette *et al.*, 1998). During the rainy season (June-September) the diet of roans is influenced by the abundance of different grass species with notable decrease of browse in the diet of roans in the rainy season suggesting that browse is not the preferred forage which further attested to the classification of roan as grass feeder (Spencer, 1995). In a typical hot-dry season where food presumably become less available; roans switch from being predominantly grazers (>95% grass) to mixed feeders (< 50% grass) and fires in November and December (cool-dry season) cause a decrease in the consumption of grass which is not entirely due to reduction in availability because grasses did regrow (Schuette *et al.*, 1998).

2.3 Seasonal Selection of Grazing Areas by the Roan Antelope

The end of the dry season is a critical period for herbivores, when they have to select areas to mitigate the limitations of decreasing forage quality (Scoones, 1995).

Low-lying areas have higher herbaceous green biomass and higher available browse species as compared with larger upland areas (Scoones, 1995). Many herbivores including buffalo (*Syncerus caffer*), zebra and roan all showed similar preferences for bottomland areas in the dry season (Perrin and Taolo, 1999; Heitkonig, 1993; Bell, 1984 and Duncan, 1975).

Bell (1984) linked the seasonal changes in the use of catena regions by herbivores to the different characteristics of grasses at the different catena levels. He observed that short grasses present on the upper level of the catena were used during the wet season and long grasses present in the lower part of the catena were selected in the dry season.

The preferential use of bottom lands during the dry season by roan antelope could be attributed to the availability of green grass in these areas than in upper level areas (Heitkonig, 1993; Duncan, 1975) and different species of herbivores show different preference for open or close vegetation types. An important factor/element influencing habitat use is fire although burning improves the nutritional quality of forage by stimulating the sprouting of new grasses (Owen, 2002; Hobbs and Spowart, 1984). The use of a burning regime is a possible management strategy to overcome the low nutrient availability during critical periods especially on poor soils (Magome, 1991).

2.4 Factors Influencing Forage Selection by Roan Antelope

2.4.1 Species Composition

During the year the leaf to stem ratio, greenness and growth stage of grasses may change with consequent seasonal variation in grass quality (Owen, 2002). As grass quality changes so does the plant species preference of grazing ungulates changes (Owen, 2002). Food quantity rather than quality appeared to attract herbivores to foraging sites in different seasons and food quality may appeared more important in the early wet and late dry seasons (Owen, 2002). The factors governing the selection of foraging sites by roan may not seem notably different from those influencing other species of grazing ruminants (Ignas and Norman, 2002).

2.4.2 Physical Characteristics of Plant Species

The physical properties and structure of the grass influences its acceptability. Nevertheless, grass species are less favoured when they become tall (Magome, 1991). Sheep and cattle show a clear preference for green material as compared with dry material. Stems have a lower digestibility compared to the green fraction of the plant since they have a higher content of fibre than green leaves (Murray and Illius, 1996). Selection of green leaves and avoidance of stems has been observed in sheep and cattle (Duncan, 1975). On the contrary, roan did take more stem-free bites on immature grasses than on brown grasses; 55% vs. 19% (Heitkonig, 1993).

2.4.3 Importance of Plant Epidermal Characters in Microhistology

The epidermis of grass leaves exhibits several characteristics which are useful in identifying members of the family Graminae (Dumham, 1988). Leaf epidermal characters have been used extensively in the identification of grass fragments found in faecal and stomach content of animals (Schuette *et al.,* 1998, Stewart, 1967). Epidermal micromorphology of leaves is used in emphasizing the interrelationships and segregations into major clades (Raole and Desai, 2009). Epidermal micro characters are quite important to delineate the different taxa in terms of taxonomic considerations (Raole and Desai, 2009). Indeed, foliar epidermal characters of the angiosperm depict a sufficient diversity of details due to its genetic and environmental make up (Kemka and Nwachukwu 2011). Micromorphological characters are valuable for systematic studies in the family poaceae and numerous reports on foliar anatomy are used for delimiting the different groups and specifically subfamilies or tribes in the family poaceae (Ellis, 1987). Besides the epidermal characters of leaves and stems other features; like microhairs, papillae and silica bodies have been considered of significance in segregating the taxa at various levels (Ogie–Odia *et al.,* 2010). Earlier, silica bodies' structure and composition have been used for the differentiation between the various grasses from the world. Leaf epidermal studies are important in segregating the different broad groups within the grasses particularly tribes and subfamilies and even up to the genera (Ellis, 1987). The techniques of plants epidermal cells analysis was used to identify the grass species in the diet of (impala) *Aepyceros melampus* (Dunham, 1988), and the roan antelope (Schuette *et al*., 1998).

2.4.4 Geographical Distribution and Habitat Requirement of the Roan Antelope

According to Spinage (1986), the distribution of the roan antelope encircles the Congo forest and it is one of the most common West African antelopes favouring the relatively high rainfall Sudano Guinean zone. Roan antelopes are commonly found in Africa south of the Sahara and are geographically distributed in the Sudan roughly between 15^{o}S–15^{o}N from Gambia to West Ethiopia, South through Central and East Africa to South Mozambique, Swaziland, North Botswana, Angola and South Africa. In many regions they are extinct or threatened (Theodor, 1992).

Richard (1992) reported that the roan antelope was formerly the widest-ranging antelope found nearly throughout the better-watered parts of northern and southern savannah, from sea level of 2400m and penetrating into adjacent arid zone, yet strictly absent from the eastern part of the southern savannah. Although now greatly reduced to both poaching and elimination of habitat, it was never an abundant species and a dominant herbivore in parts of southern range and it is a rare species in South Africa and Kenya where it is commonly found in Lambwe near Lake Victoria (Richard, 1992). Roan antelopes originally occurred over a very wide range of most wooded grasslands and they were once common all over the better watered areas of northern savannah between the tropical forest and the Sahara (Kingdon, 1997). In southern savannahs its distribution seem to have been more patchy and has apparently been absent from large areas on the eastern side of the African continent for as long as there are records (Kingdon, 1997).

Knowles (2000) reported that roan antelopes occurred from south Sahara to Botswana. Two species, *Hippotragus equinus kobe* and *Hippotragus equinus bokeri*, occupy the northern savannah of Africa from Chad to Ethiopia and the two other subspecies *Hippotragus equinus equinus* and *Hippotragus equinus cottoni* are located in southern savannah of Africa and in south and central Africa (Knowles 2000). The geographical range of the roan antelope extends across broad-leaved deciduous woodlands in the northern savannah and throughout most of the southern savannah and as a grazer and a browser whose preferred habitat includes lightly wooded savannah and its frequent flood plains and montane grasslands, it is mysteriously absent from Africa's eastern 'miobo' woodlands and has become scarce in its southernmost range, especially in South Africa (Encyclopaedia Britannica, 2011). Formerly very common in West Africa, it has been eliminated from many areas by settlement and poaching (Encyclopaedia Britannica, 2011).

Kingdon (1997) reported that roans are commonly found in lightly wooded country and grasslands throughout most of central Africa. Roans have a particularly large distribution range and occupy all savannah areas and peripheral semi-arid areas south of the Sahara. They avoid forests and deserts (Kingdon (1997).

According to the International Union for the Conservation of Natural Resources (IUCN, 2008) roan antelopes are found in woodland savannah mainly in the tropical and subtropical grasslands savannah and shrub lands biomes, which range in tree density from forest with a grassy under storey such as central Zambezian 'miombo' woodlands to grasslands dotted with few trees where they eat mid-length grass. Roan antelopes prefer open wooded land or dry bush savannahs, gallery forest, light woodland in plains and hills up to 2000m (Theodor, 1992). Like the sable antelope, the roan is associated with wooded savannah which is more of a grass and tree-savannah species, tolerating taller grass and high elevations including mountain grasslands (Richard, 1992). Roans are mostly characteristics of thinly tree grasslands, park-like savannahs that are often dominated by *commiphora* or to the south by *colophospermum* (Kingdon, 1997). Roan antelopes are found in lightly wooded savannah with medium to tall grass and must have access to water (wildlife Africa, 2001 cited in Roe, 2002). They are also partial to open savannah woodlands with the major feature being medium to tall grasslands with fairly open woodland (Toms and Joubert, 2005).

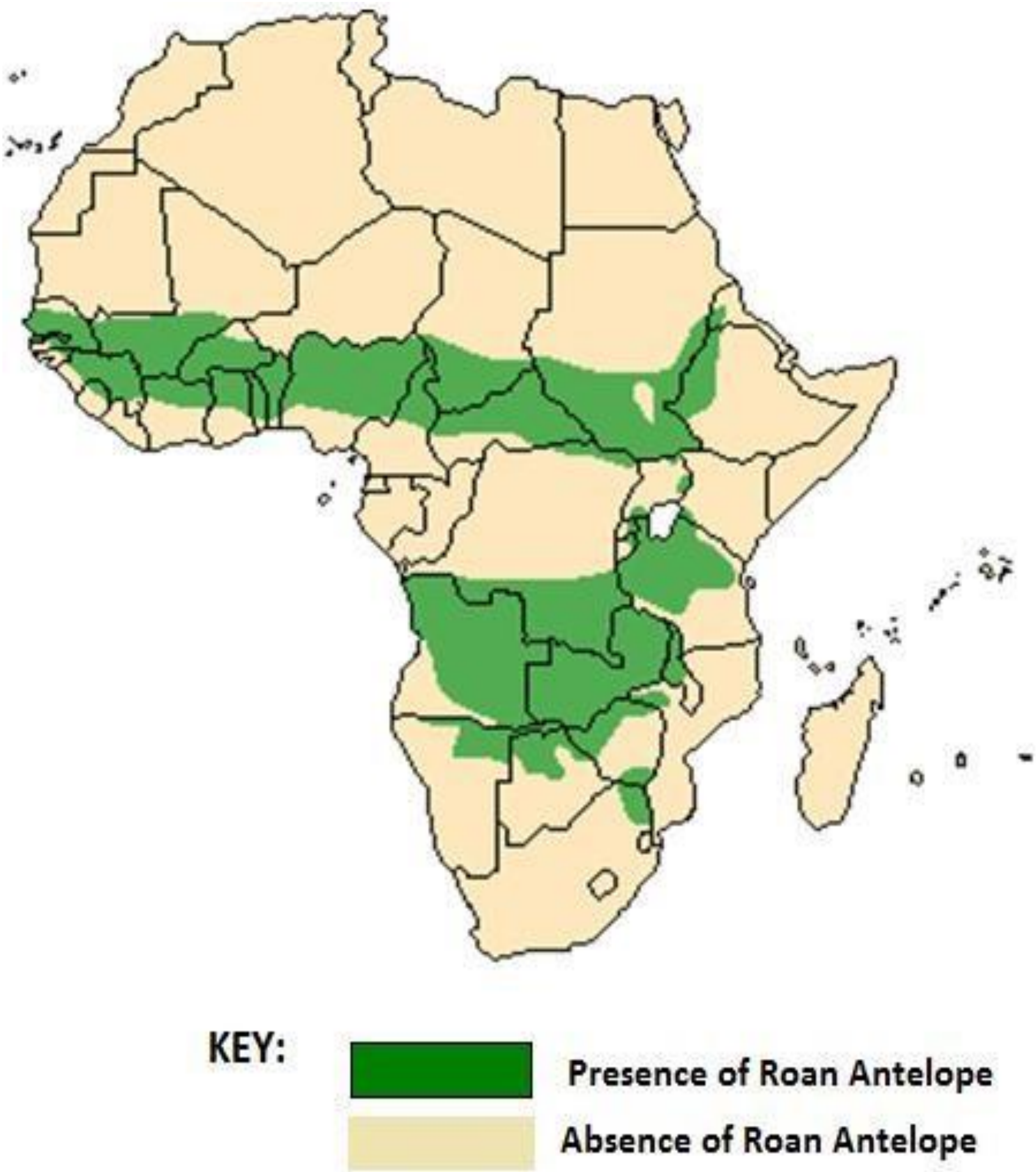

Figure 1: Range Map Showing the Distribution of the Roan Antelope

(Institute of Applied Ecology, 1998)

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 The Study Area

3.1.1 Location

Gbele Resource Reserve is the northern most wildlife protected area in Ghana closest to Burkina Faso. It is situated in the upper West Region of Ghana. The reserve serves as a transboundary migratory route for elephants and other mammals to and from the Nazinga Game Ranch in Burkina Faso (Wildlife Division, 2009; Ghana National Parks, 2007). The reserve was established (gazatted) in 1975 purposely to conserve the undisturbed Guinea savannah ecosystem and the large population of the majestic roan antelope in the area (Wildlife Division, 2009). Gbele resource reserve covers a total land area of 565 kilometers square with a perimeter of about 125km and lies partly in the Wa East, Nadowli, Sissala East and Sissala

West administrative districts (Ghana National Parks, 2007). The study area; that is the Gbele Camp is about 50km square within the 565km square of the Gbele resource reserve and it is situated between latitudes 10 degrees 22 minutes ($10^{o}22^{'}$) and 10 degrees 44 minutes ($10^{o}44^{'}$) North and longitudes 2 degrees 03 minutes (2^{o} $03^{'}$) and 2 degrees 17 minutes ($2^{o}17^{'}$) West (Wildlife Division, 2009 and Ghana National Parks, 2007).

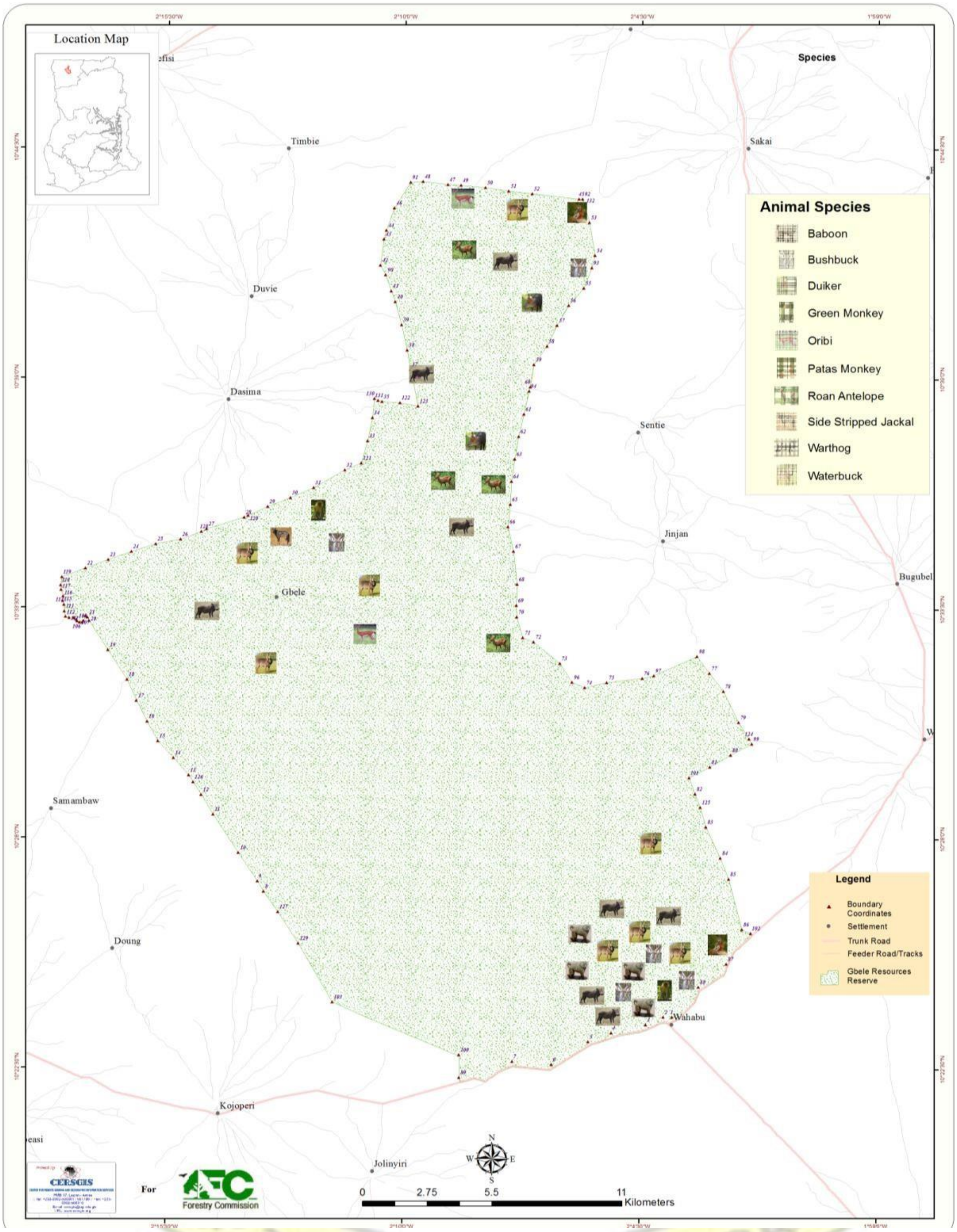

Figure 2: Map of Gbele Resource Reserve

(Forestry Commission, 2015)

3.1.2 Topography and Climate

The topography of Gbele is low lying and is between 259m to 288m above sea level with gentle slopes that drain the area into the Kulpawn river which flows from the west of the reserve southwards to the White Volta (Wildlife Division, 2009). There are two distinct seasons; rainy season which begins from May to October with peaks in August and

September and the dry season which last from November to April every year (Wildlife Division, 2009). The dry season is characterized by the north- easterly cold and hammattan winds (Ghana national parks, 2007). Annual rainfall is about 1000mm with annual temperature ranging between 21^0C to 32^0C with minimum and maximum reaching 18C^0 in

December/January and 40C^0 in March/April (Wildlife Division, 2009; Ghana national parks, 2007).

3.1.3 Vegetation

The dominant vegetation type in Gbele is open savannah woodland with a grass layer that can reach up to 3 meters in height during the rainy season which is burnt off almost every year (Wildlife Division, 2009). The trees and shrubs species are fire resistant and are well-adapted to the annual bush fires in the reserve with narrow banks of riverine forest approximately 20 meters wide grow along the Kulpawn river and its tributaries (Ghana National Parks, 2007). There are also swamps and flood plains vegetations characterized by marshy and inundated areas. The following trees and shrubs can be found in the reserve; *Adansonia digitata, Afzelia Africana, Anogeissus leiocarpus, Parkia biglobosa, Pterocarcapus erinaceus, Vitellaria paradoxa, Daniellia oliveri*, and *Ficus spp. Khaya senegalensis* are commonly found in riverine forests. The common grass species in the reserve are; *Andropogon gayanus,*

Pennisetum polystachion, *Eragrostis tenella* and *Hyparrhenia involucrate* (Wildlife Division, 2009).

3.1.4 Fauna

Gbele resource reserve is particularly noted for its large population of the majestic roan antelope, (*Hippotragus equinus)* and other ungulates such as elephants (*Loxondota africana*) hartebeest (*Alcelaphus buselaphus*), buffalo (*Syncerus caffer*), waterbuck (*Kobus ellipsiprymnus*) and bushbuck (*Tragelaphus scriptus*) (Wildlife Division, 2009). Gbele is also home to primate species such as baboons' patas monkeys and green monkeys with a very rich birdlife of about 194 species (Wildlife Division, 2009). There are also reports of a lot of invertebrates such as bees and some fishes and reptiles of different kinds (Wildlife Division, 2009).

3.2 Research Methodology

3.2.1 Data Collection Procedures

3.2.2 Sampling of Plant Species

Sampling of plant species was done in the rainy season during the first year of the study.

Before the commencement of data collection, a visit was made to the "Fadama" market in Wa where livestock are kept and sold to the public to collect samples of some of the native browse species which herdsmen use to feed their livestock. The intention was to acquaint myself with some of the local browse species that are likely to occur in the study area. The samples were taken to the veterinary unit of the Ministry of Food and Agriculture (MOFA) office in Wa for identification. The aim of sampling the plant species was to enable me identify them as grasses, browse and forbs to enable me prepare reference slides. Therefore, only the plant frequencies were recorded in the quadrats. The Gbele camp which is about 50km square was converted into meters to obtain 50000m square to facilitate easy gridding. The area was further divided into 50 transects of 1000m long at an interval of 800m with the aid of the Global Positioning System (GPS). Twenty (20) transects were systematically chosen from the 50 transects. After skipping every two transects the third transect was chosen until all the 20 transects were obtained.

Furthermore, the 20 transects of 1000m long were then gridded into 100m^2 as seen in (Figure 3). Four overlapping nested quadrats of 50m x 50m and 3m x 3m were systematically laid in the middle of each of the 20 transects at 200m interval to sample browse, grass and forbs that occur in the area (William, 2000). That is; the 3m x 3m quadrats were sited in the middle of the 50m x 50m quadrats, usually in the middle of the transects. This produced a total of 80 quadrats. That is; four (4) quadrats on each transect multiplied by twenty (20) transects. A total of 48 forage species made up of 12 browses, 21 grasses and 15 forbs were sampled from the 80 quadrats in the 20 transects in the study area. In each quadrat, the individual plant species were recorded and identified with the aid of field guides like; Handbook of West African Weeds (Okezie and Agyakwa, 1987), The Trees, Shrubs and Lianas of West African dry zones (Michel, 2004). Unidentified species were preserved and sent to the University for Development Studies herbarium for identification.

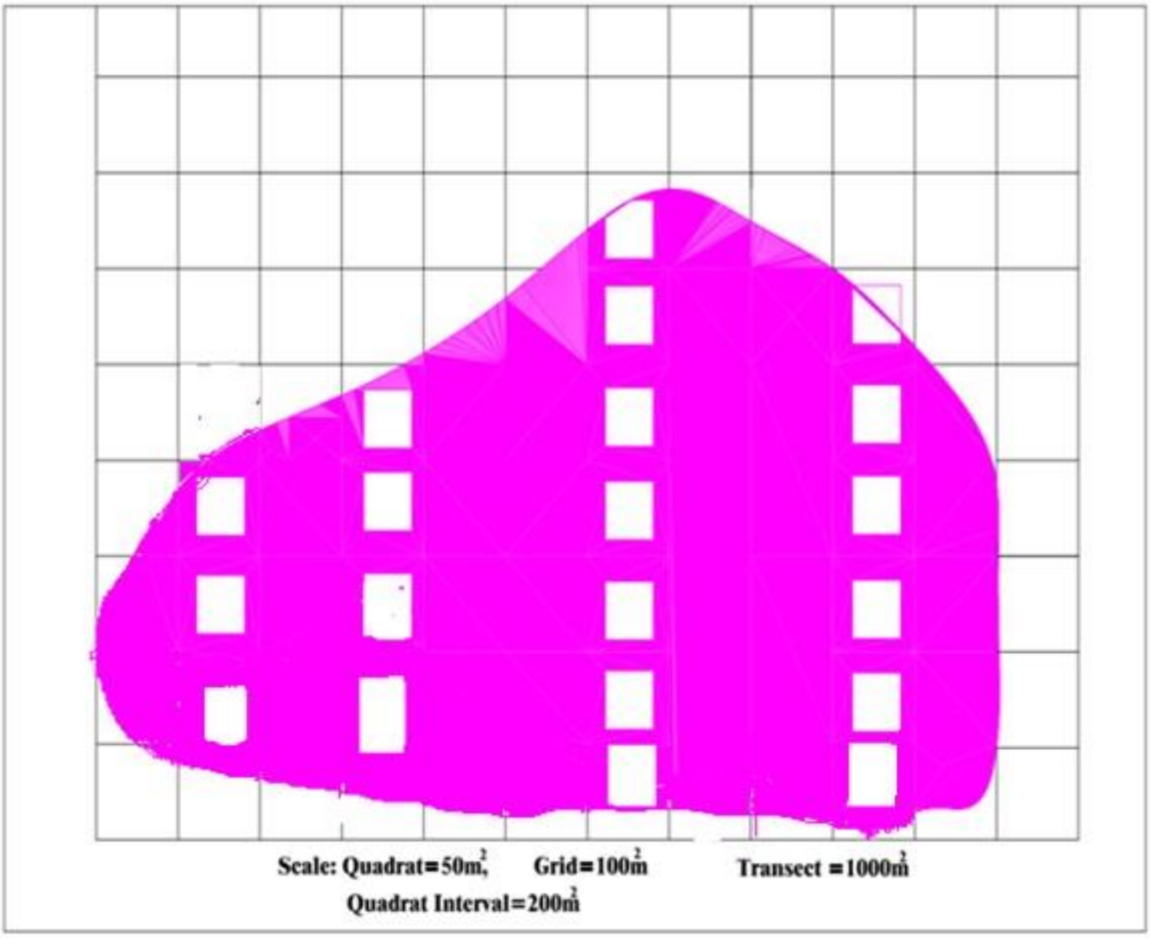

Figure 3: A Gridded Map of the study Area (Gbele Camp)

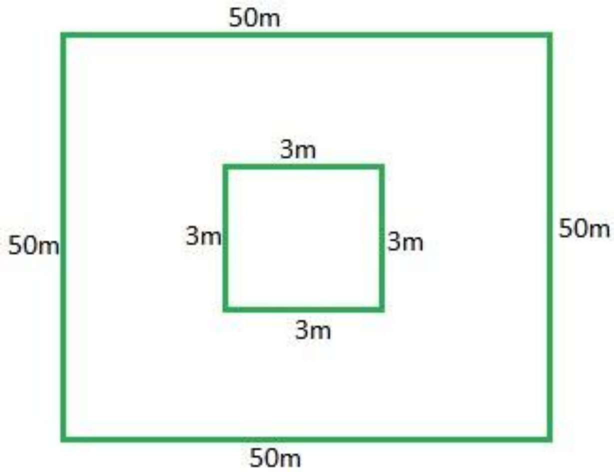

Figure 4: An example of a Nested Quadrat

3.2.3 Faecal Material Collection

Thirty (30) fresh faecal samples comprising of about 35-50 faecal pellets were collected per month. This gave me 120 samples in each of the 3 climatic periods of 4 months duration and 360 samples for the year (Schuette *et al.,* 1998). The seasons were; rainy season (JuneSeptember), cool-dry season (October-January) and Warm-dry season (February-May) (Schuette *et al.,* 1998). Faecal materials were collected by following fresh tracks of roans and their feeding activities within the 20 chosen transects. Identification of faecal pellets was made possible by the shape of the pellets and nearby hoof prints (Spinage, 1986), and also with the help of guards who have good knowledge in identifying faecal materials of the animals. Faecal materials were then air dried for 72 hours, collected and preserved until analysis (Schuette *et al.*, 1998). Five (5) individual faecal pellets were selected randomly from each of the 30 faecal samples per month. This yielded a total of 600 individual faecal pellets for each season and a total of 1800 pellets for the year. That is: 600 x 3 climatic periods of 4 months duration. The Samples were preserved and analyzed in the laboratory of the Savannah Agricultural Research Institute (SARI).

3.2.4 Determination of Leaf Epidermal Characters of Plants

Out of the 48 plant species sampled and identified, 32 of them comprising 12 grasses, 10 browses and 10 forbs were used for the preparation of reference slides. Reference slides of plants were prepared only in the rainy season. Slides were also prepared for a few fruits and nuts that occurred in the area during the time of sampling. Mature but fresh leaves of plants were cut into smaller pieces (1–2cm^2). They were first boiled in water for five minutes to restore to their normal shape (Ogie–Odia, *et al*., 2010). The side which is not needed was damaged by scraping with a safety razor blade to facilitate the penetration of bleaching solutions in order to obtain fast removal of chlorophyll (Ogie–Odia *et al.,* 2010: Raole and Desai, 2009: Dunham, 1988: Swanepoel and De La Harpe, 1983).

The epidermal peels were then soaked in household bleach (5% sodium hydrochlorite solution) for 30 minutes for grasses and forbs and 60 minutes for browse species till they become colourless (Ogie–Odia, *et al*., 2010). The peels were washed in water, stained with 1% safranine solution for 10 minutes and cleared in 50% ethanol. Each peel was then washed in water and mounted in a drop of distilled water in the center of 76mm x 26mm slide covered with a 22mmx22mm coverslip. Slides were then studied thoroughly using a Labomed CXL Digital Microscope under low and high power objective lenses of 40X and 100X magnifications as recommended by (Metcalfe, 1960). Photomicrographs of the epidermal features were taken from the slides with a Labomed Digital camera (3.0 mega pixels) fitted onto the microscope. Images and drawings from literature sources (Metcalfe, 1960 and Dunham, 1988) were used to aid the study of the specimens. Terminologies for the epidermal morphology such as stomata, nature of cells and cell wall structure, type of trichomes, prickle hairs, long cells, short cells and micro-hairs were that of (Ogie–Odia, *et al*., 2010) and Dunham, 1988).

3.2.5 Microhistological Analysis of Faecal Matter

Faecal analysis was done on seasonal basis. The year was divided into three climatic periods of four months duration. That is; rainy season (June-September), cool-dry season (OctoberJanuary), and warm-dry season (February- May), (Schuette *et al.,* 1998). A total of 5 pellets from a monthly 30 faecal samples comprising of 600 pellets for a season of a climatic period of 4 months. They were hand-ground using a laboratory pestle and mortar and sieved through a 1mm sieve (Schuette *et al.*, 1998). About 0.5g of the samples was placed in 30 ml test tubes that contained 10 ml of 10% nitric acid (HNO_2). The test tubes were placed in boiling water to allow the mesophyll to dissolve so that fragments can sink to the bottom. This was followed by cooling and decanting (Schuette *et al.*, 1998). Fragments were washed once with water and decanted before adding 5% sodium hydrochloride solution. Tubes were set aside for about 24 hours after which the bleach was decanted. Fragments were cleared in 50% ethanol for 10 minutes and stained with 1% safranine solution (Schuette *et al*., 1998).

To obtain plant fragments, a drop of each sample was then placed in the center of a microscope slide of 76 x 26mm covered with a 22 x 22mm coverslips. Five slides were prepared from each faecal sample. A total of 30 fields per slide were examined. The field-ofview was moved on each slide until fragments were identified as grass, browse, forbs, and fruits or unidentified (Chetri, 2006). Slides were examined following the systematic observation process described by Spark and Malechek (1968). Observation began from the lower-left corner of each slide, moving from bottom to top, left to right in a sweeping back and forth motion using a Labomed CXL Digital Microscope under low and high power objective lens of 40X and 100X magnifications. The identified fragments were compared to the already prepared reference plant material collected from the area which comprises of the grass and sedge families, browse species which included all woody plants and forbs which included all non-woody plants (Metcalfe, 1960). The fragments were identified as stomata, silica bodies, presence of papillae, nature of trichomes, nature of cells and cell wall structure, macro-hairs and micro-hairs, prickle hairs and presence of long cells and short cells (Schuette *et al.*, 1998 and Dunham, 1988).

3.2.6 Data Treatment and Analysis Procedures

The data obtained from microhistological analysis of faecal samples was arranged in a Randomized Complete Block Design (RCBD) taken the seasons as replicates and the forage species as the treatment applied. The treatments were; grass, browse and forbs. Each category of treatment was replicated four (4) times in each of the three climatic seasons.

The data was Log transformed and subsequently subjected to the analysis of variance (ANOVA) using the General Linear Model in (SAS). Fisher's least significance difference (LSD) test was used to separate means. The relative percentage frequency of fragments in the faecal sample was estimated using the formula; $Rf\% = \frac{n1+n2+n3}{N} x\ 100$ Where, Rf% = Relative percentage frequency, n_1 = total number of fragments identified as grass, n_2 = total number of fragments identified as browse and n_3 = total number of fragments identified as forbs in a sample. N=Grand total number of fragments made in a sample. (Chetri, 2006; Abbas, 1991).

CHAPTER FOUR

4.0 RESULTS

4.1 Plant Species Sampled in the Study Area

A total of 21 indigenous grass species, 12 browse species and 16 forbs species were sampled and identified in the area as in (Tables 1, 2 and 3) below respectively. In terms of frequency of occurrence, grasses occurred more frequently in quadrats followed by forbs species and browses respectively. Among the grass species sampled were; *Hyparrhenia rufa*, *Andropogon gayanus*, *Digitaria horizontalis*, *Hyparrhenia involucrata* and *Sporabolus pyramidalis*. The rest were; *Hyperthelia dissoluta*, *Eleucine indicca* and *Cyperus esculentus* (Table 1).

Anogeissus leiocarpus, *Acacia dudgeon, Pterocarpus erinaceus Faidherbia albida*, *Gardenia ternifolia* and *Gardenia aqualla* were some of the browse/tree species recorded in the area (Table 2). Some of the forbs species sampled were; *Phyllanthus amarus, Hibiscus asper, Desmodium scorpiurus, Evolvulus alsinoide, Impomea asarifolia*, *Cissus populnea, Jasminum obtusifolium* and *Crotalaria retusa* (Table 3).

Table 1: List of Grass Species Surveyed in the Study Area

SCIENTIFIC NAME	FAMILY NAME	COMMON NAME	LOCAL NAME (DAGAARE)
Acroceras zizaniodes (Kunth)	Poaceae	Oat grass	
Andropogon gayanus Kunth	Poaceae	Gamba grass	Mupilaa
Brachiaria lata (Schumach)	Poaceae	Signal grass	
Cyperus difformis (Linn)	Cyperaceae	Sedge	
Cyperus esculentus (Linn)	Cyperaceae	Yellow nut sedge	
Dactyloctenium aegyptium (Linn)	Poeceae	Crowfoot grass	
Digitaria horizontalis Willd	Poaceae	Crab grass	Lagara
Eleucine indica(Gaertn)	Poaceae	Bull grass	

Eragrotis tenella (Linn)	Poaceae	Love grass	
Frimbristylis ferruginea (Linn) Vahl	Cyperaceae	Rusty sedge	
Hyparrhenia involucrata (Stapf)	Poaceae	Roofing grass	Kari
Hyparrhenia rufa (Nees) Stapf	Poeceae	Roofing grass	Kari
Hyperthelia dissoluta (Clayton)	Poaceae	Yellow thatch grass	
Imperata cylindrica (Anderss)	Poaceae	Spear grass	Pulung
Paspalum orbiculare (Forst)	Poaceae	Ditch millet	
Pennisetum polystachion (Linn)	Poaceae	Feathery grass	Sanbala
Rottboelia cochinchinensis (Clayton)	Poaceae	Itch grass	Karinyaa
Setaria barbata (Lam.) Kunth	Poacaea	Foxtail grass	
Setaria pallid-fusca (Schum)	Poaceae	Cat tail grass	
Sporobolus pyramidalis (P.Beauv)	Poaceae	Giant rat tail	Mina
Vetiveria nigritana (Benth) Stapf	Poaceae	Adrenaline grass	

Table 2: List of Browse Species Surveyed in the Area

SCIENTIFIC NAME	FAMILY NAME	COMMON NAME	LOCAL NAME

			(DAGAARE)
Tamarindus indica (Linn)	Caesalpiniaceae	Tamarind	Puro

Acacia dudgeoni (Craib ex Hall)	Mimosaceae	Gum Arabic	Gozie
Acacia sieberiana (DC)	Mimosaceae	Paper bark thorn	Gopelaa
Accacia gourmaensis (A Chev)	Mimosaceae	Hook-thorn	Gosoglaa
Afzelia africana (Smith)	Caesalpiniaceae	Lingue tree	Kakalaa
Anogeissus leiocarpus (DC.)Guill.	Combretaceae	African birch	Siiraa
Balanites aegyptiaca (L) Del	Zygophyllaceae	Soapberry tree	Gongo
Daniellia oliveri (Rolfe)	Caesalpiniaceae	Balsam	Kankyeli
Faidherbia albida (Del) Chev	Mimosaceae	Acacia	Guoraa
Gardenia aqualla Stapf∞ Hutch	Rubiaceae	Gardenia	Dazugpoga
Gardenia ternifolia (Schumach)	Rubiaceae	Gardenia	Dazudaa
Pterocarpus erinaceus (Poir)	Fabaceae	African Kino	Bunegaa

Table 3: Lists of Forbs Species Surveyed in the Study Area

SCIENTIFIC NAME	FAMILY NAME	COMMON NAME	LOCAL NAME (DAGAARE)

Ageratum conyzoides (Linn)	Asteraceae	Billy-goat weed	
Cissus populnea (Guill∞ Perr)	Amplidaceae	Tree bine plant	
Commelina benghalensis (Linn)	Commelinaceae	Wandering jew	Fomofomo
Crotalaria retusa (Linn)	Fabaceae	Rattlebox	
Desmodium scorpiurus (Sw)	Fabaceae	Beggar weed	
Euphorbia hirta (Linn)	Euphorbia	Snakeweed	Ngmanbra
Evolvulus alsinoides (Linn)	Convolvulaceae	Dwarf morning glory	Zongaleri
Hibiscus asper (Hook f)	Malvaceae	Desert rose	Dakobire
Ipomoea asarifolia (Desr)	Convolvulaceae	Ginger leaf	
Jasminum obtusifolium (Baker)	Oleaceae	Jasmine	Waosaalong
Phyllanthus amarus (Schum))	Euphorbiaceae	Sleeping plant	
Physalis angulata (Linn)	Solanaceae	Wildcape goose	Nuoconmiron
Sesamum alatum (Linn)	Pedaliaceae	Gazelle sesamum	Saalonpelaa
Similax kraussiana (Meisn)	Smilacaceae	African Sarsaparilla	Ngmaawaari
Tephrosia bracteolata (Guill∞Perr)	Fabaceae	African mistletoe	
Tridax procumbens (Linn)	Asteraceae	Tridax	Alopelaabini

4.2 Leaf Epidermal Characteristics of Grass Species

Detailed descriptions of the leaf epidermal characters of the species were presented in (Table 4), while the morphological Keys and the epidermal slides were illustrated in Plates 1a-11b respectively. The leaf epidermis of grass species exhibited several characteristics which aided the identification of forage species in faecal matter. The adaxial epidermis of *Andropogon* *gayanus* was clearly distinguished into coastal and intercoastal zones. Long cells were numerous and rectangularly shaped and were elongated. A row of small round papillae were present on the long cells. Intercoastal hooked Prickle- hairs were found in the intercoastal zones. Infrequent bi-cellular micro-hairs with distal cell tapering towards the apex were present in the intercoastal zones. Subsidiary cells of the stomata were high-domed shaped. In the abaxial epidermis of *Andropogon gayanus*, Long cells were rectangularly shaped with straight anticlinal walls. Fewer solitary short cells were found in rows of two or more cells. Numerous bi-cellular micro-hairs with distal cell tapering towards the apex were spread over cell surfaces. Rows of small round papillae were present in short and long cells.

The adaxial epidermis of *Rottboelia cochinchinensis* was conspicuously distinguished into coastal and intercoastal zones. Long cells were rectangular and elongated with sinuous anticlinal walls. Prickle-hairs in row of dumb-bell-shaped silica bodies. Stomata were infrequent with low-domed shaped subsidiary cells. A row of coastal silica bodies ranging from dumb-bell-shaped to saddle-shaped occurred in the coastal zones. In the abaxial epidermis, long cells were rectangular and elongated with sinuous anticlinal walls. Numerous stomata were found across cell surface with triangular subsidiary cell shape. Fewer bi-cellular micro-hairs with hemispherical distal cell shape were present. Saddled-shaped silica-bodies were present in the coastal zones.

The adaxial epidermis of *Imperata cylindrica* was characterised by numerous stomata with high-domed subsidiary cells present. Long cells rectangular, numerous and elongated with near straight anticlinal cell walls. Few bicellular micro-hairs with distal cell tapering towards apex were seen. The abaxial epidermis was clearly distinguished into coastal and intercoastal zones. Long cells were rectangular and elongated with near straight anticlinal cell wall. Subsidiary cell of the stomata were high domed-shaped. Rows of saddled-shaped costal silica bodies occurred along the coastal zones

Adaxial epidermis of *Hyparrhenia rufa* was clearly separated into coastal and intercoastal zones. Long cells were rectangular in shape with straight anticlinal walls. A bundle of coastal silica bodies ranging from kidney-shaped to tall and narrow body shaped occurred in the coastal zones. Numerous prickles hairs ranging from angular to intercoastals hook were present in the intercoastal zone. Papillae not found on long cells. Stomata were conspicuously absent. In the abaxial epidermis, numerous stomata with high and low–dumb shaped subsidiary cells were present. Long cells were rectangular and elongated with sinuous anticlinal walls. Row of coastal silica bodies of different kinds ranging from dumb- bellshaped to cross-shaped occur within the coastal zone. Prickle-hairs in row of dumb–bellshaped silica bodies were found in the coastal zone.

In *Pennisetum polystachion*, the adaxial epidermis was distinguished clearly into coastal and intercoastal zones. Long cells are triangular and elongated in shape with sinuous anticlinal walls. Fewer numbers of stomata with triangular subsidiary cell shape were present. A row of angular prickle-hairs occurred in the coastal zone. In the abaxial epidermis, the subsidiary cells of the stomata were triangular in shape. Long cells were elongated and rectangular in shape with no papillae occurring on them. Anticlinal wall of the long cells were slightly sinuous. Few bi-cellular micro-hairs occurred in the intercoastal zone. Silica bodies of different types and shapes occurred within the coastal zones in all the grass species. Stomata were infrequent or absent in the adaxial epidermis of all the grass species but numerous in the abaxial epidermis of all species. Paracytic types of stomata were found across all the species.

The subsidiary cells of the stomata ranged from low-domed shape to triangular shape across the species. Stomata were infrequent or absent in the adaxial epidermis of all the grass species but numerous in the abaxial epidermis of all species. Paracytic types of stomata were found in all the species. The subsidiary cells of the stomata ranged from low-domed shape to triangular shape across all the grass species.

4.3 Leaf Epidermal Slides of some Grass species Studied in the Area

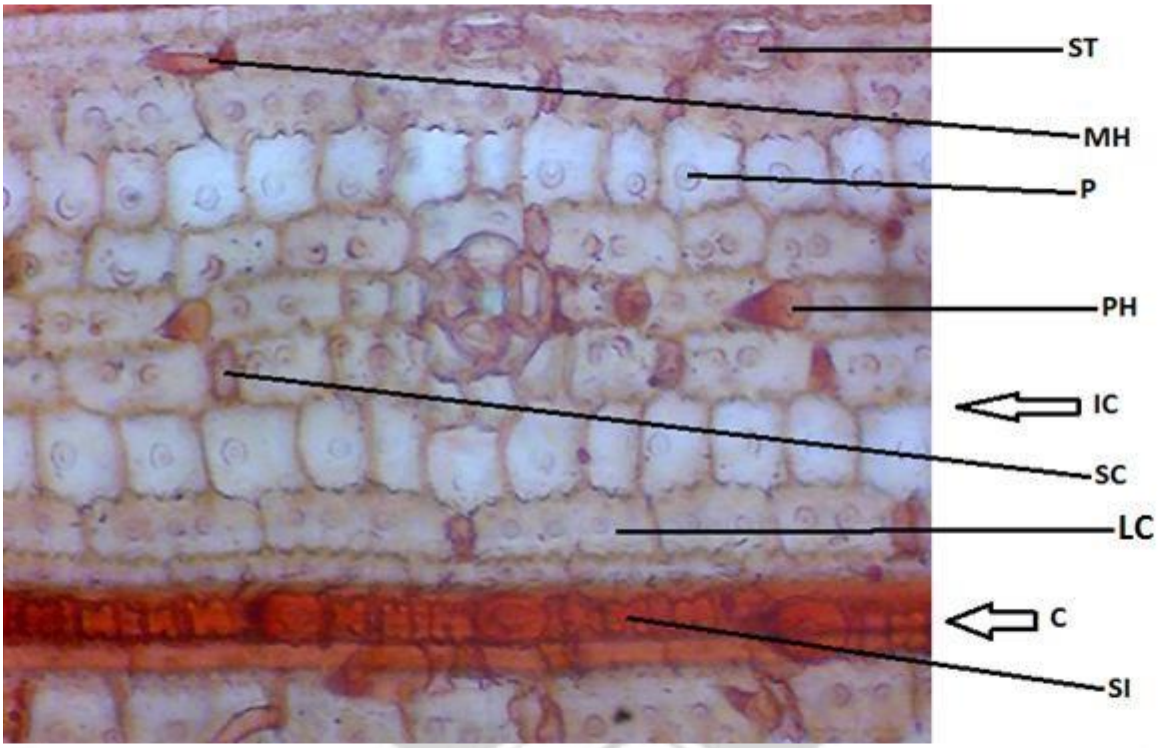

Plate1a:Adaxial epidermis of *Andropogon gayanus*

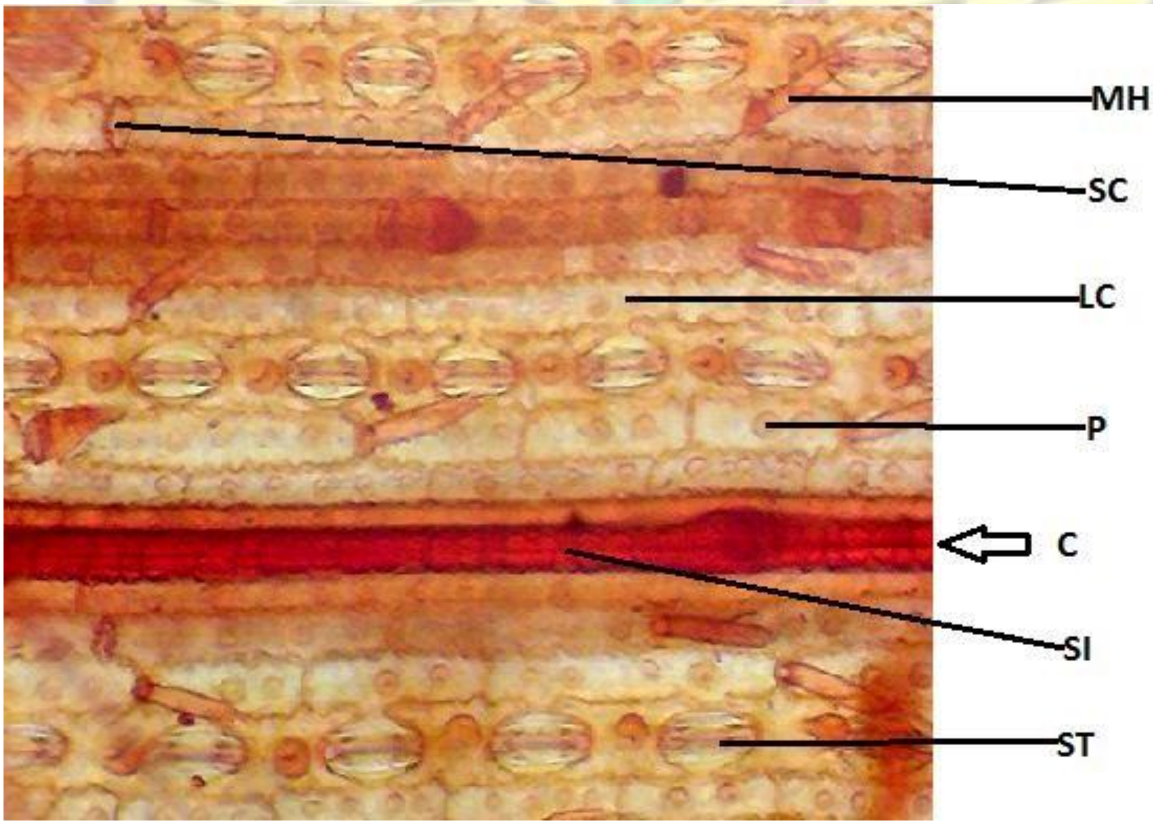

Plate 1b: Adaxial epidermis of *Andropogon gayanus*

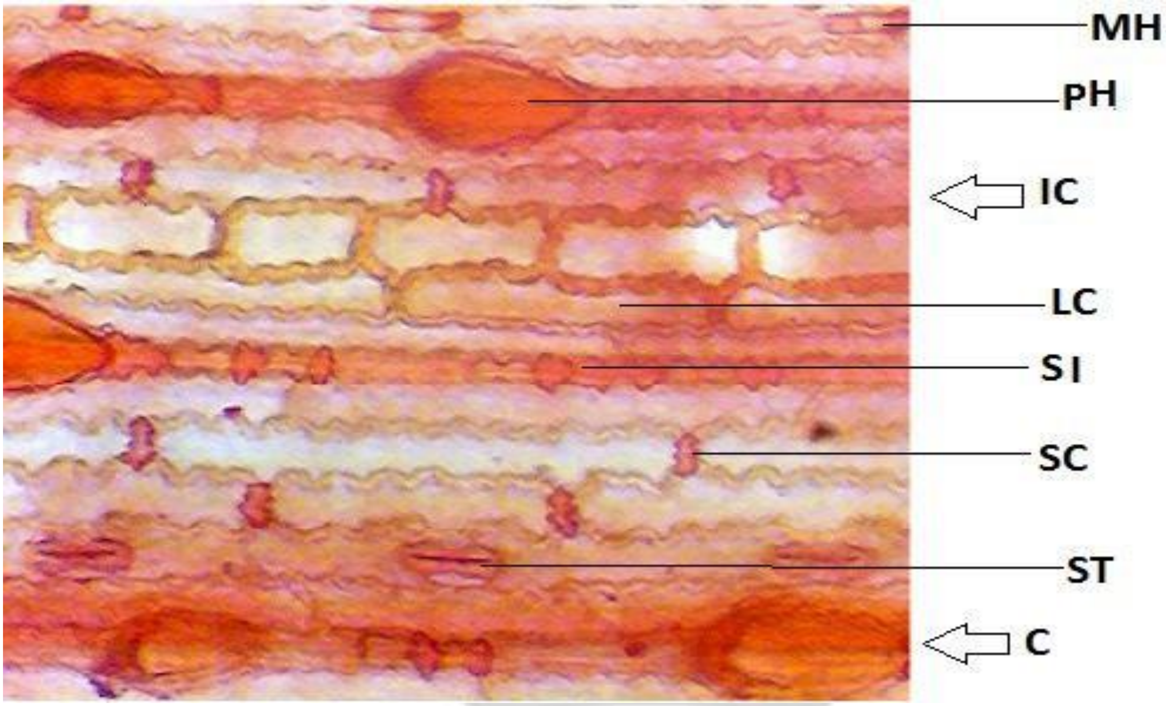

Plate 2a: Adaxial epidermis of *Rottboelia cochinchinensis*

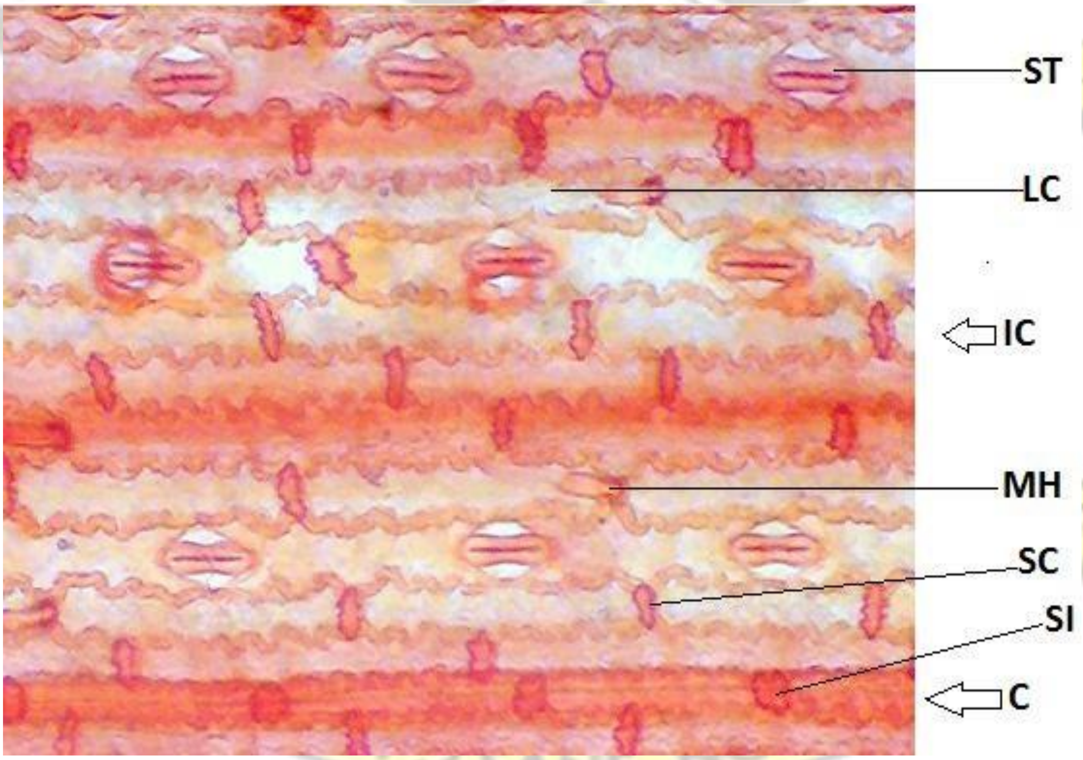

Plate 2b: Abaxial epidermis of *Rottboelia cochinchinensis*

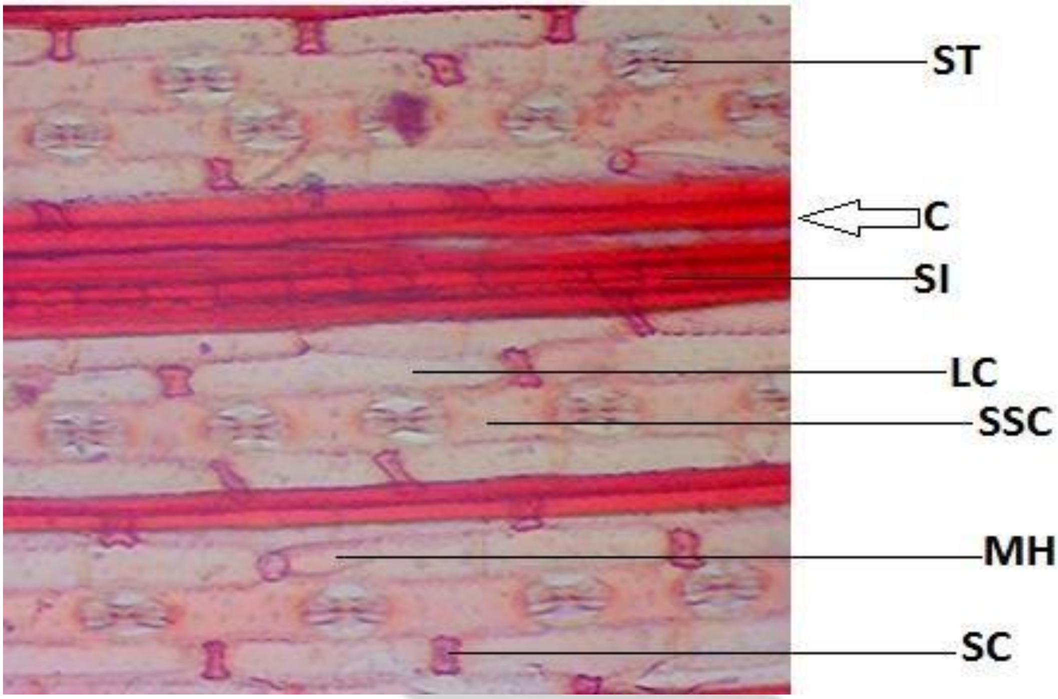

Plate 3a: Adaxial epidermis of *Imperata cylindrica*

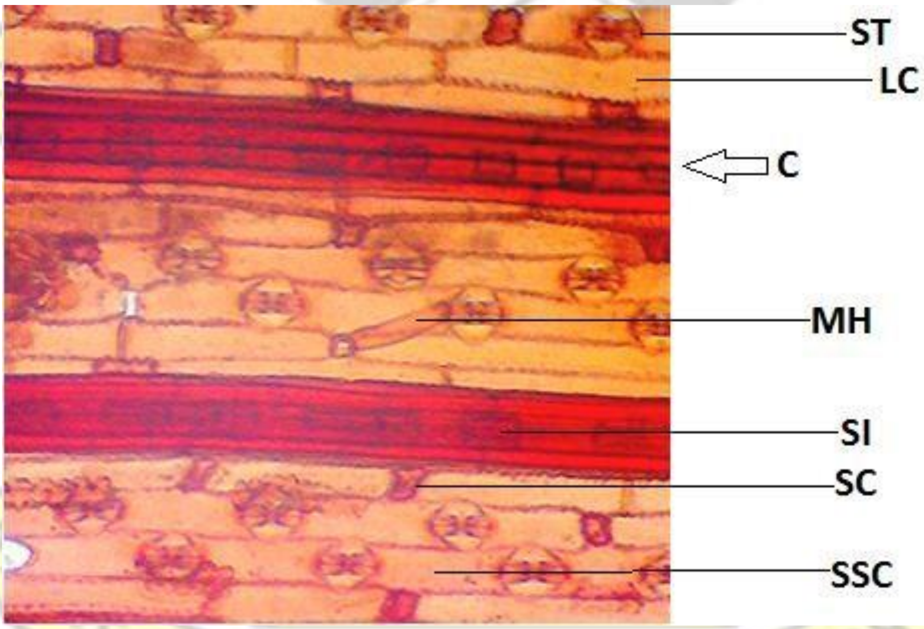

Plate: 3b: Abaxial epidermis of *Imperata cylindrica*

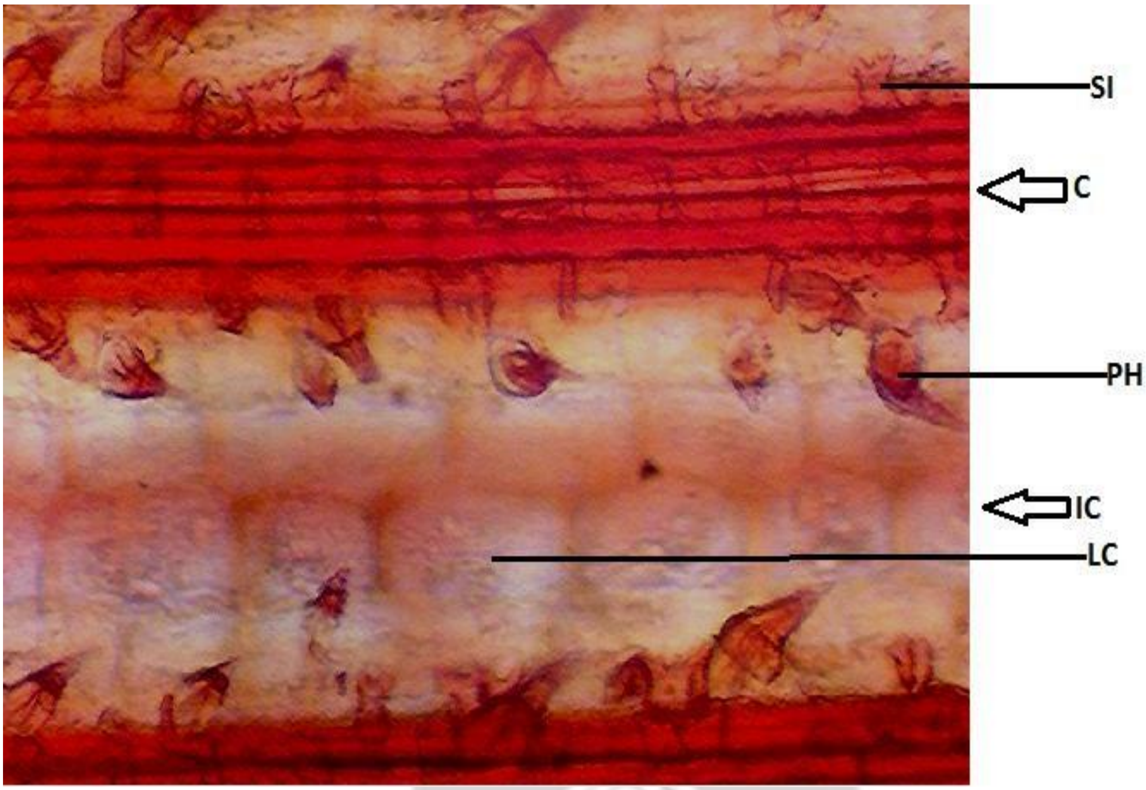

Plate 4a: Adaxial epidermis of *Hyparrhenia rufa*

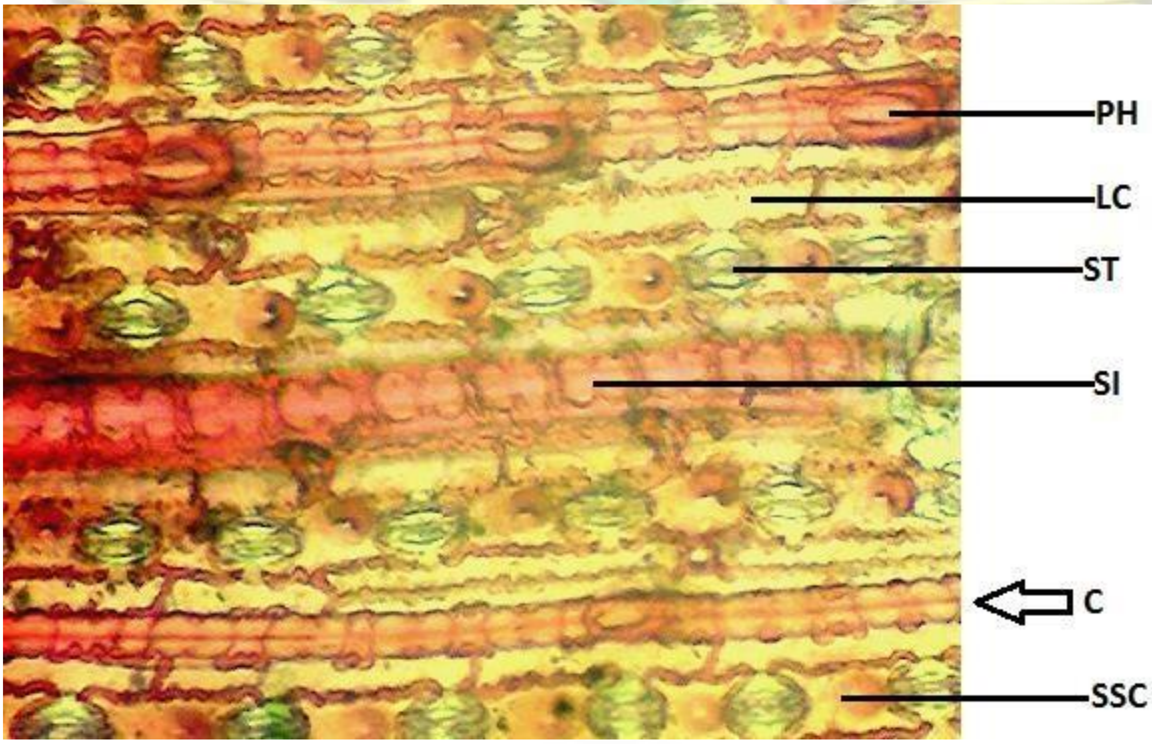

Plate 4b: Abaxial epidermis of *Hyparrhenia rufa*

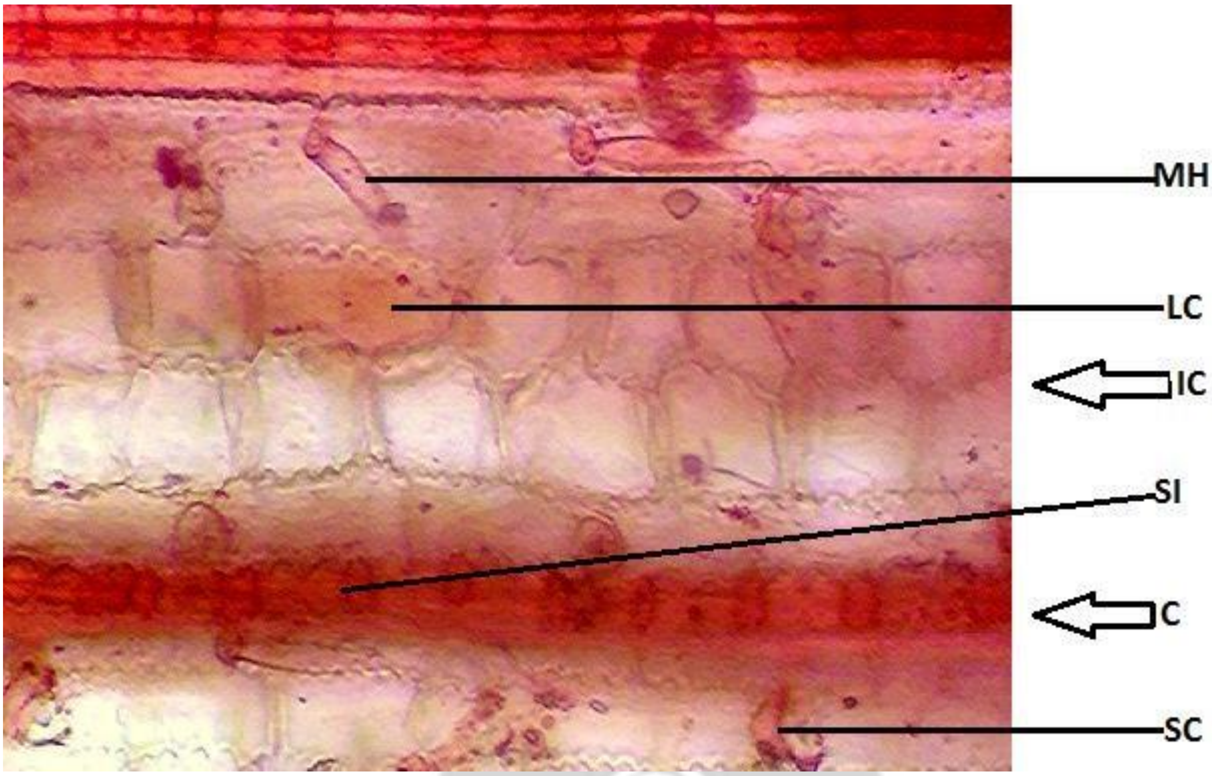

Plate 5a: Adaxial epidermis of *Hyperthelia dissoluta*

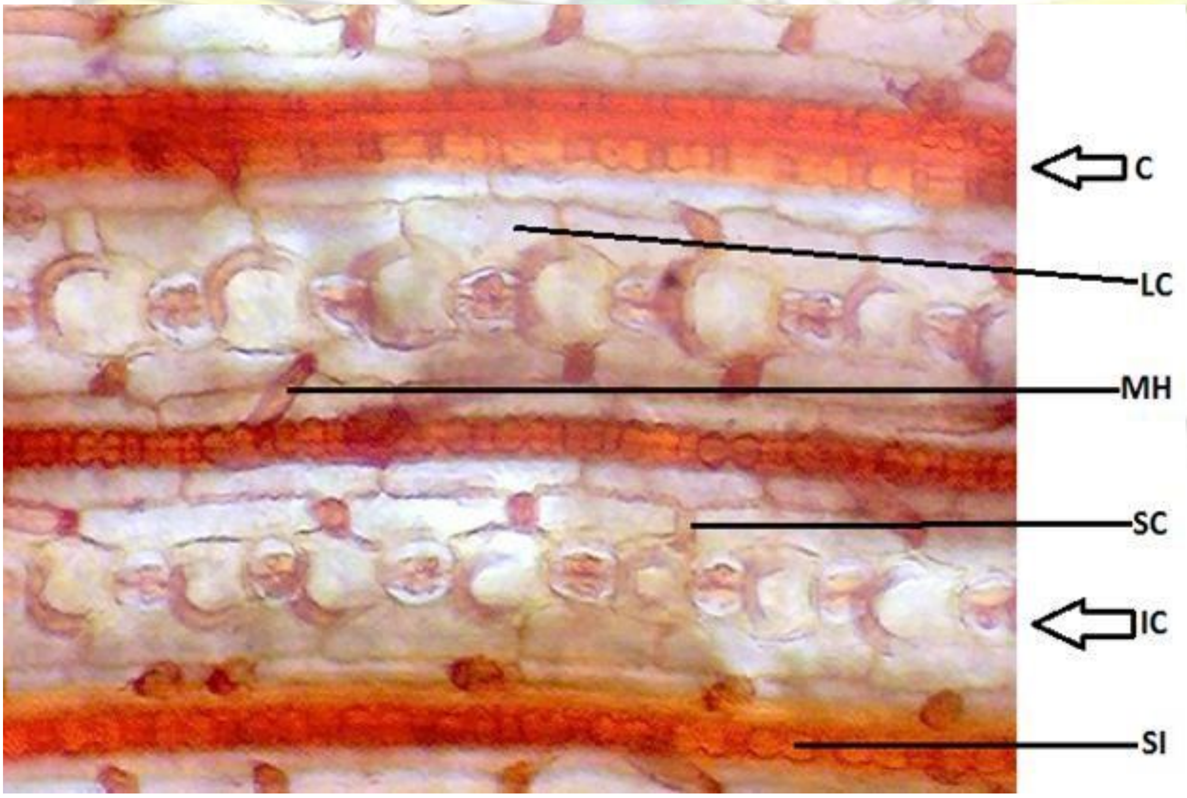

Plate 5b: Abaxial epidermis of *Hyperthelia dissoluta*

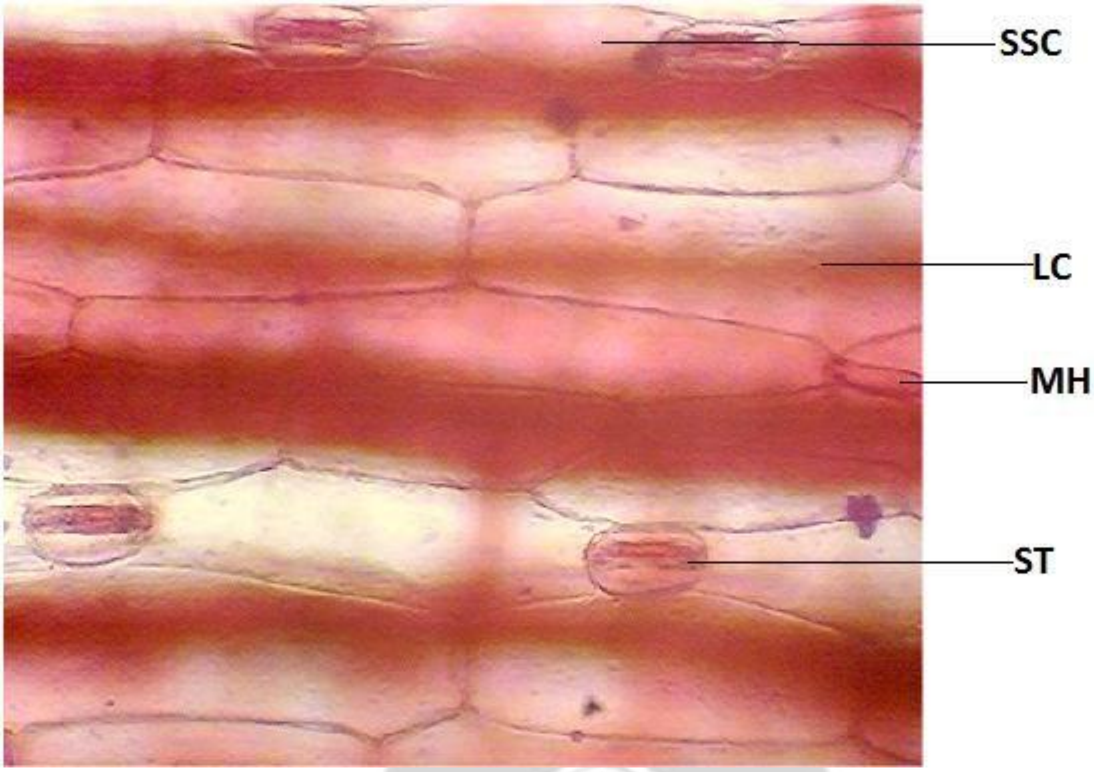

Plate 6a: Adaxial epidermis of *Setaria pallide- fusca*

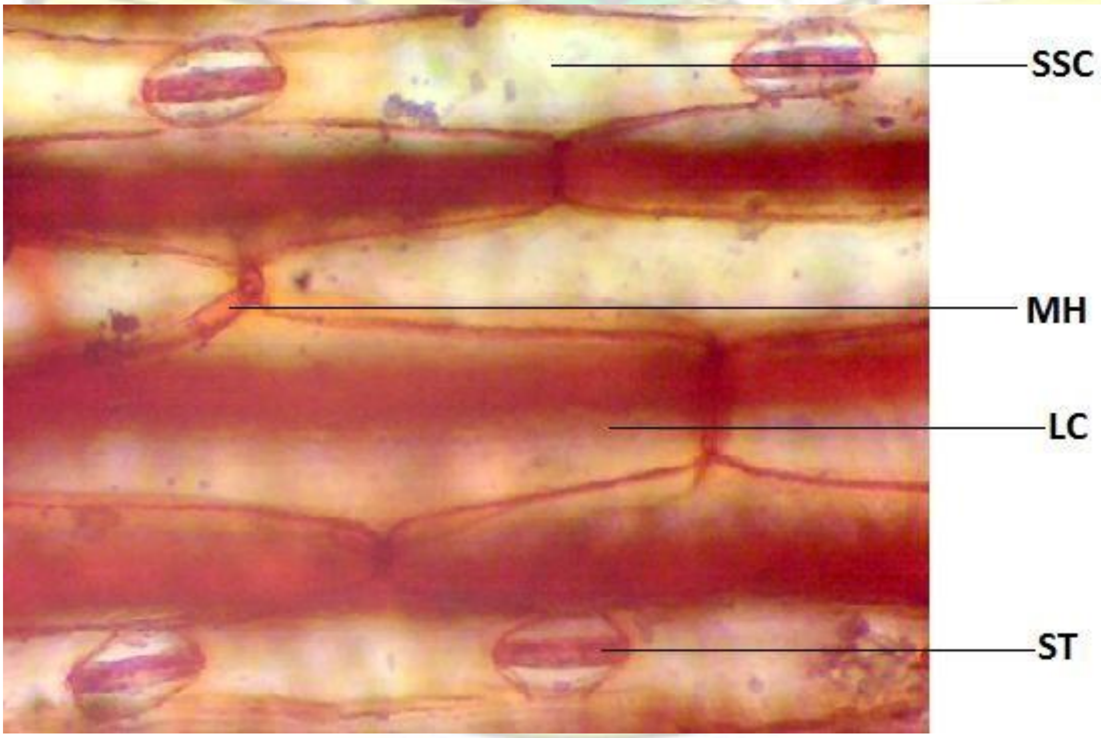

Plate 6b: Abaxial epidermis of *Setaria pallide- fusca*

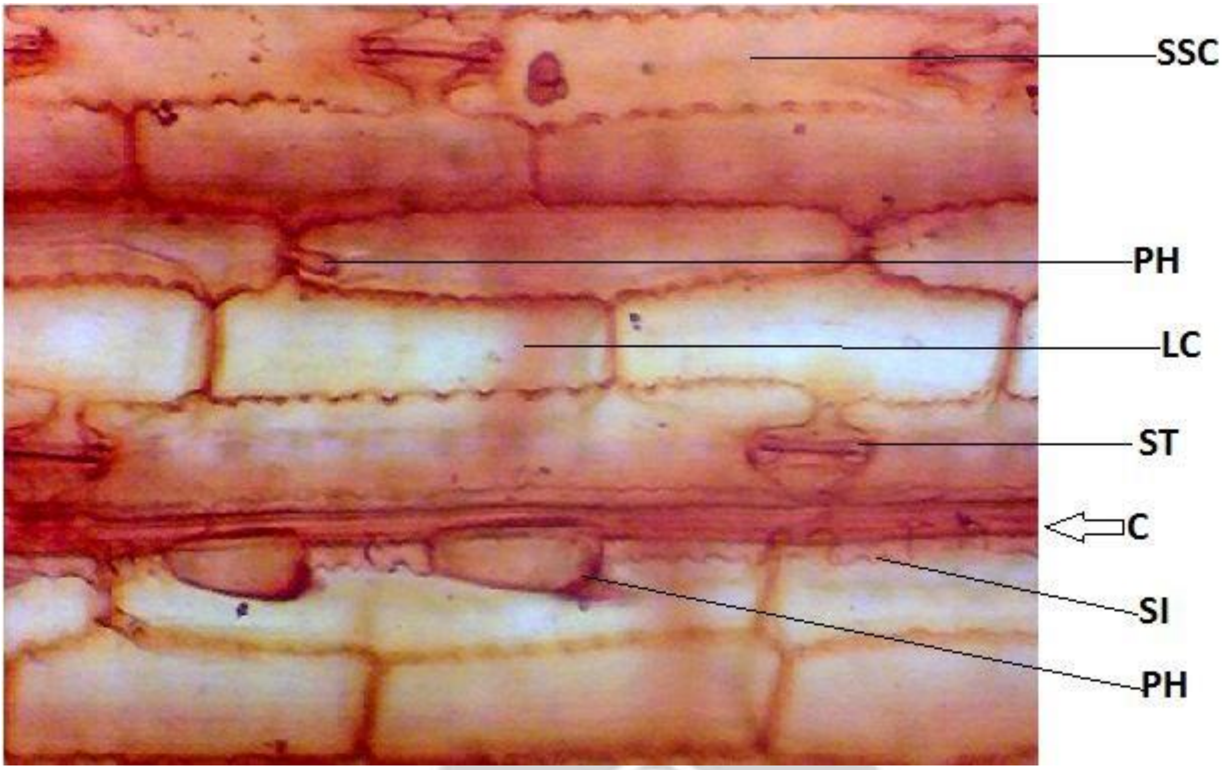

Plate 7a: Adaxial epidermis of *Pennisetum polystachion*

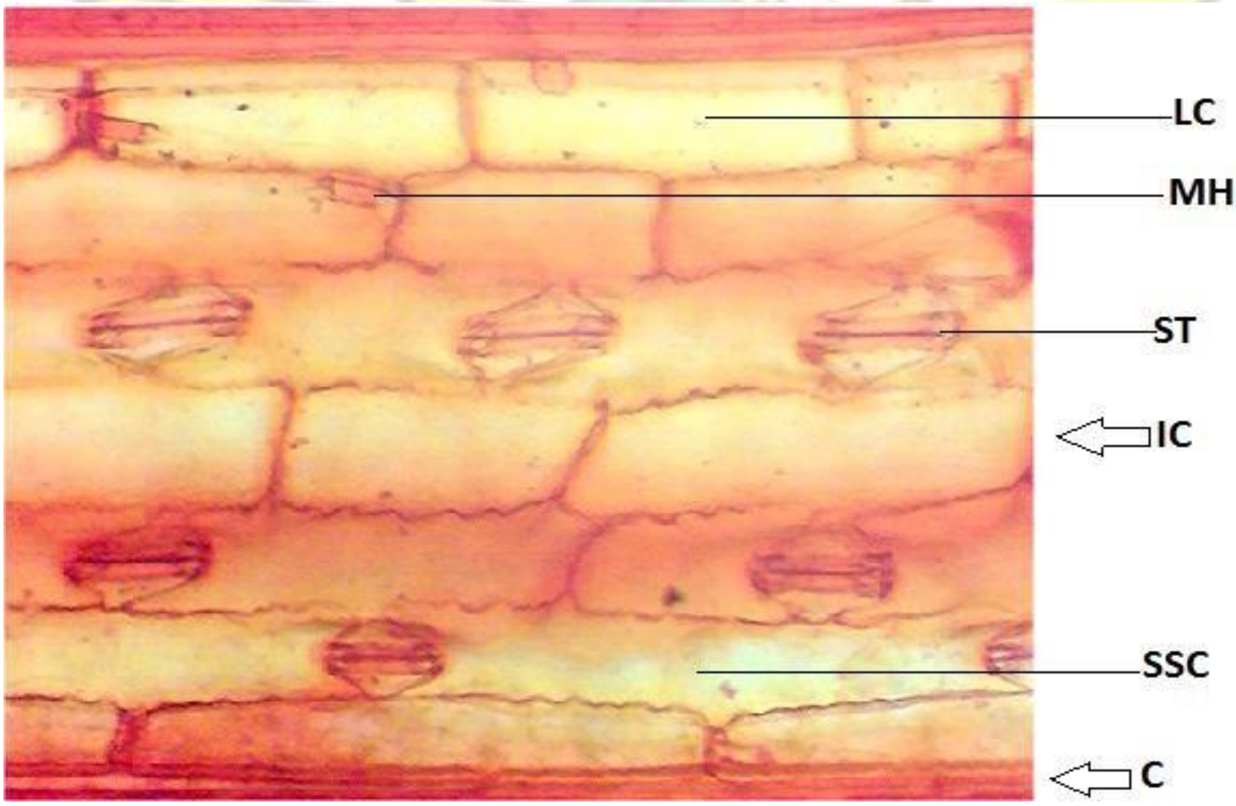

Plate:7b Abaxial epidermis of *Pennisetum polystachion*

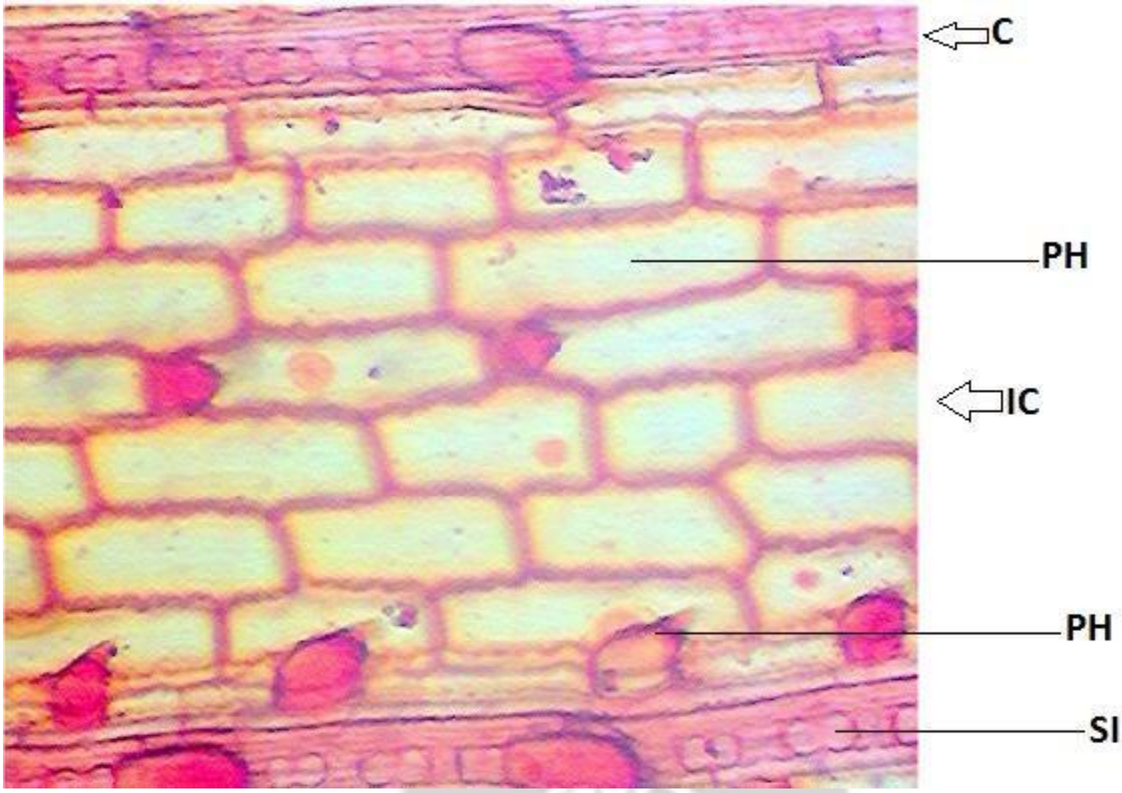

Plate 8a: Adaxial epidermis of *Digitaria horizontalis*

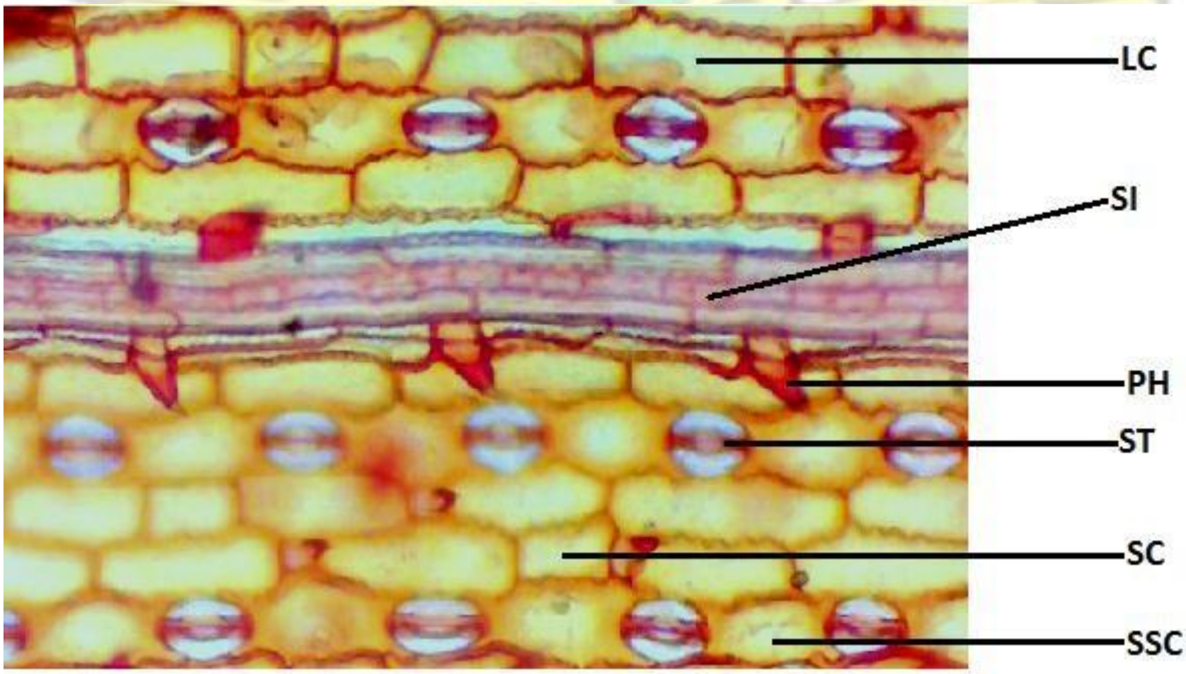

Plate 8b: Abaxial surface of *Digitaria horizontalis*

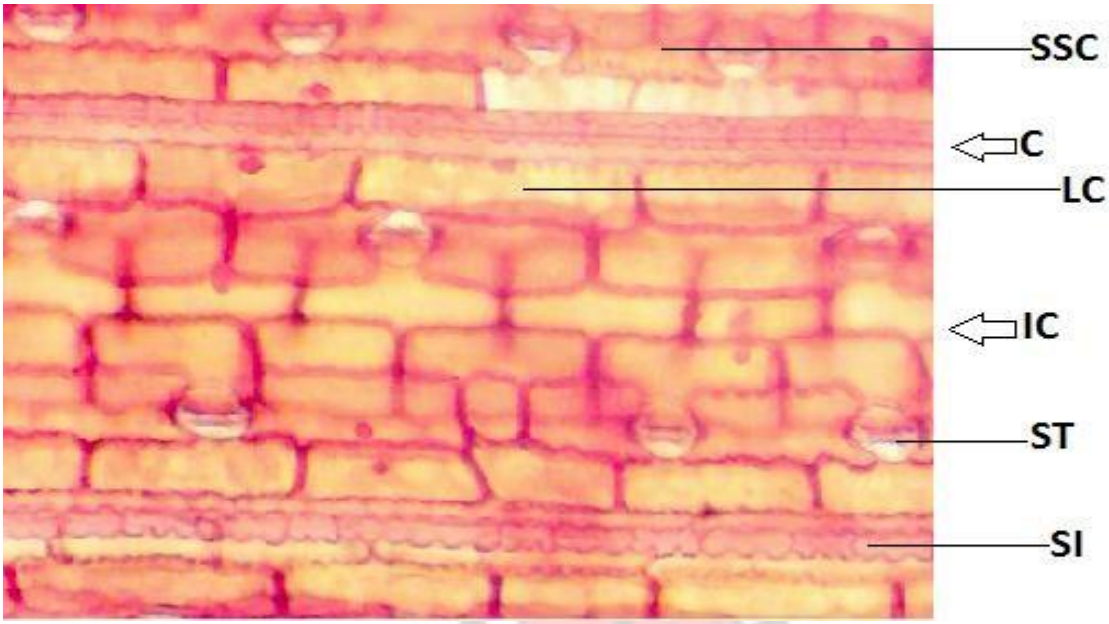

Plate 9a: Adaxial epidermis of *Brachiaria lata*

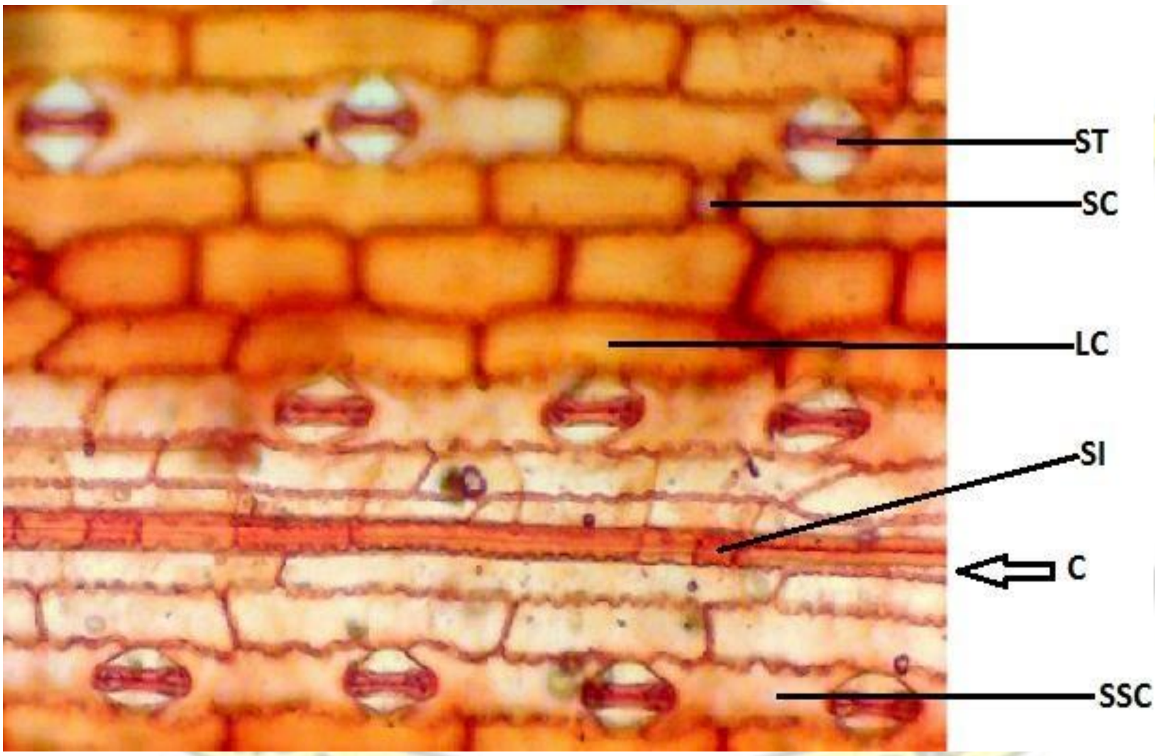

Plate 9b: Abaxial epidermis of *Brachiaria lata*

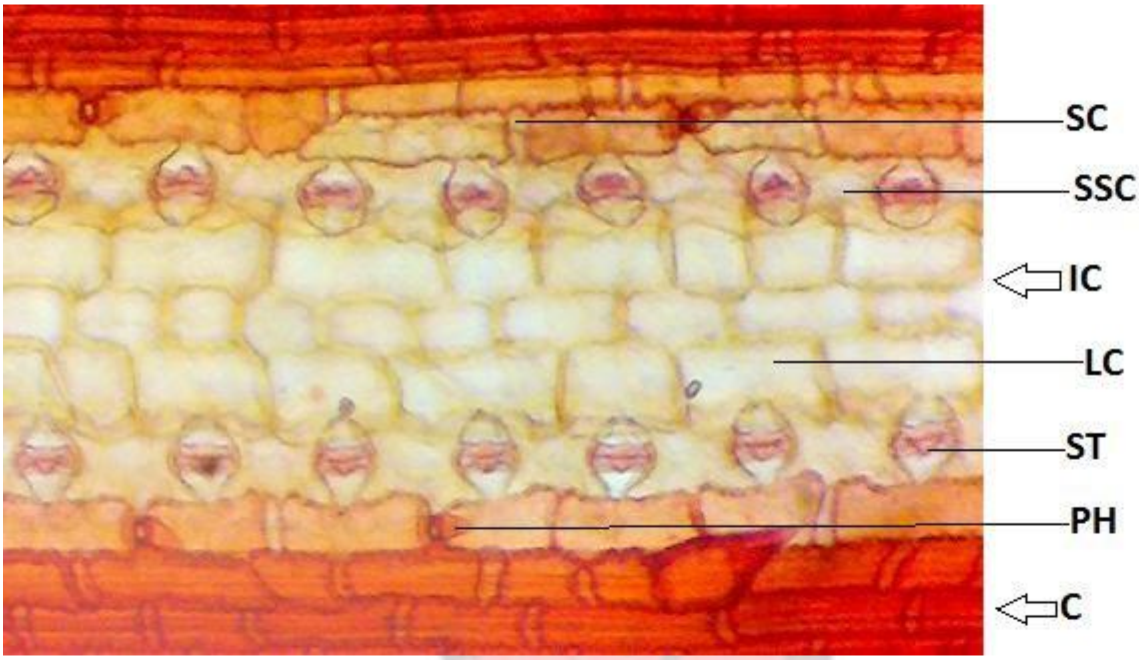

Plate 10a: Adaxial epidermis of *Elucine indica*

Plate 10b: Abaxial epidermis of *Elucine Indica*

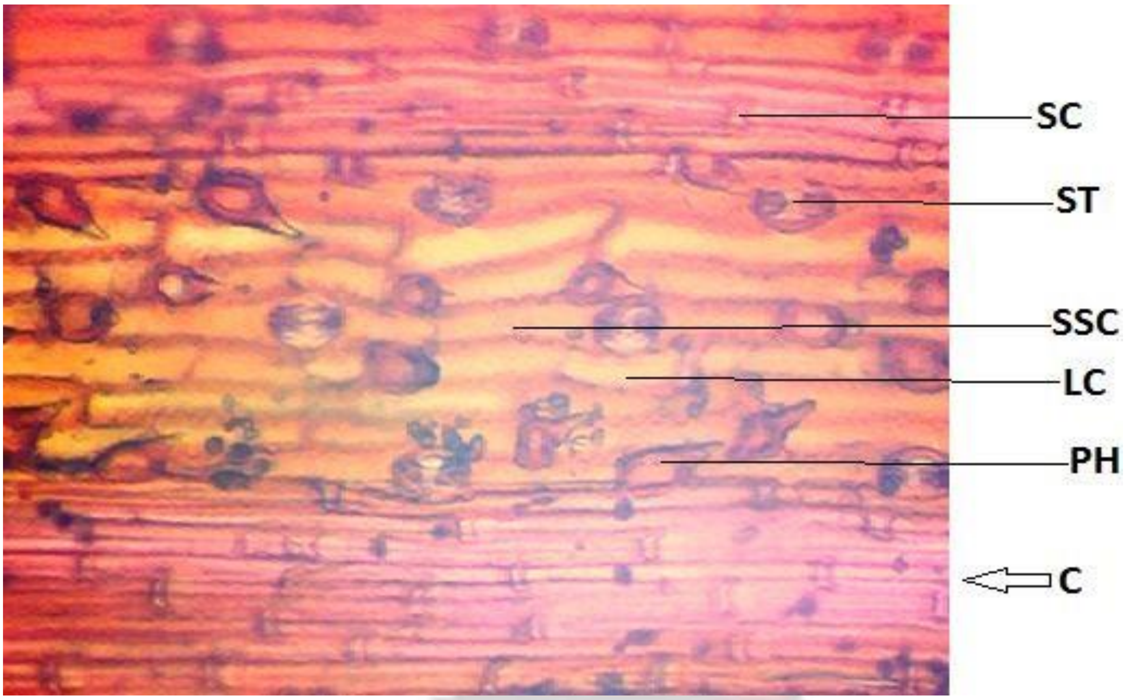

Plate 11a: Adaxial epidermis of *Sporobuolus pyramidalis*

Plate 11b: Abaxial surface of *Sporobolus pyramidalis*

Table 4: Leaf Epidermal and Stomatal Characters of Grass Species in Gbele Reserve

Species	Surface	C/IC	LC	SC	ST	MH	PH	SI	P	SSC
Andropogon gayanus	AD	_	+	+	+	+	+	_	+	LDS
	AB	IC	+	+	+	+	_	_	+	LDS
Rottboelia cochinchinensis	AD	IC	+	+	+	+	+	+	_	LDS
	AB	IC	+	+	+	+	_	+	_	TRS
Imperata cylindrica	AD	C	+	+	+	+	_	+	_	HDS
	AB	C	+	+	+	+	_	+	_	HDS
Hyparrhenia rufa	AD	IC	+	+	_	_	+	+	_	_
	AB	C	+	_	+	_	+	+	_	TRS
Hyperthelia dissoluta	AD	C	+	+	_	+	_	+	_	_
	AB	IC	+	+	+	+	+	+	_	HDS
Setaria pallide- fusca	AD	_	+	_	+	+	_	_	_	LDS
	AB	_	+	_	+	+	_	_	_	LDS
Pennisetum polystachion	AD	C	+	_	+	+	+	+	_	TRS
	AB	C	+	+	+	+	+	_	_	TRS
Digitaria horizontalis	AD	C	+	_	_	_	+	_	_	_
	AB	IC	+	_	+	+	_	+	_	HDS
Brachiaria lata	AD	IC	+	_	+	_	_	+	_	H/LDS
	AB	C	+	+	+	_	_	+	_	TR/HDS
Elucine indica	AD	IC	+	+	+	_	+	_	_	TR/HDS
	AB	IC	+	+	+	_	+	_	_	TR/HDS
Sporobuolus pyramidalis	AD	C	+	+	+	_	+	_	_	LDS
	AB	IC	+	+	+	_	_	_	_	LDS

4.4 Legends for Table 4 and plates 1a – 11b

AD = Adaxial surface | MH = Micro – hairs | LDS = Low dome-shaped

AB =Abaxial surface | PH = Prickle- hairs | HDS = High dome- shaped

LC = Long cells	SI = Silica-bodies	TRS =Triangular- shaped
SC = Short cells	P = Papillae	IC = Intercoastal zone
ST = Stomata	SSC = Subsidiary cells	C = Coastal zone
+ = Present	- = Absent	

4.5 Leaf Epidermal Characteristics of Browse and Forbs Species

The adaxial epidermis of browse and forbs were characterised by the presence of epidermal cells, trichomes and cell walls respectively, while the abaxial epidermis were mostly characterised by the abundance of stomata and guard cells. Irregular epidermal cell shape occurred in both adaxial and abaxial surfaces of all browse and forbs. Anticlinal cell walls were straight in the adaxial surfaces of *Gardenia ternifolia, Gardenia aqualla*, *Ficus capensis* and *Jasminum obtusifolium.* The abaxial epidermal walls of these species were however undulating and sinuous. Anticlinal walls in *Anogeissus leiocarpus, Desmodium scorpiurus* and *Sesamum alatum* were sinuous in both the adaxial and abaxial surfaces. Anticlinal walls were undulating in both adaxial and abaxial surfaces of *Pterocarpus erinaeceus, Evolvulus alsinoides* and *Daniellia oliveri*.

In terms of stomatal distribution, the adaxial epidermis of all browse species recorded no stomata. Paracytic and anomocytic types of stomata occurred in abaxial epidermis of all browse species. Anomocytic to paracytic types of stomata however occurred in both adaxial and abaxial surfaces of all forbs species. Non-glandular trichomes which were unicellular in shape occurred in the abaxial epidermis of *Pterocarpus erinaeceus (*plate 1b). Unicellular trichomes also occurred in both the adaxial and abaxial epidermis of *Gardenia ternifolia* and *Anogeissus leiocarpus* (plates 3a, 3b, 7a and 7b). Non-glandular unicellular trichomes occurred across the epidermis of forbs species except in the abaxial and adaxial epidermis of *Sesamum alatum* and *Euphorbia hirtha* (plate 4b and 5a). Detail descriptions of the leaf epidermal characters of browse and forbs were presented in (Table 5) while the morphological keys and epidermal slides were illustrated in plates 1a-7b and 1a- 5b.

4.6 Leaf Epidermal Slides of some Browse Species Studied in the Area

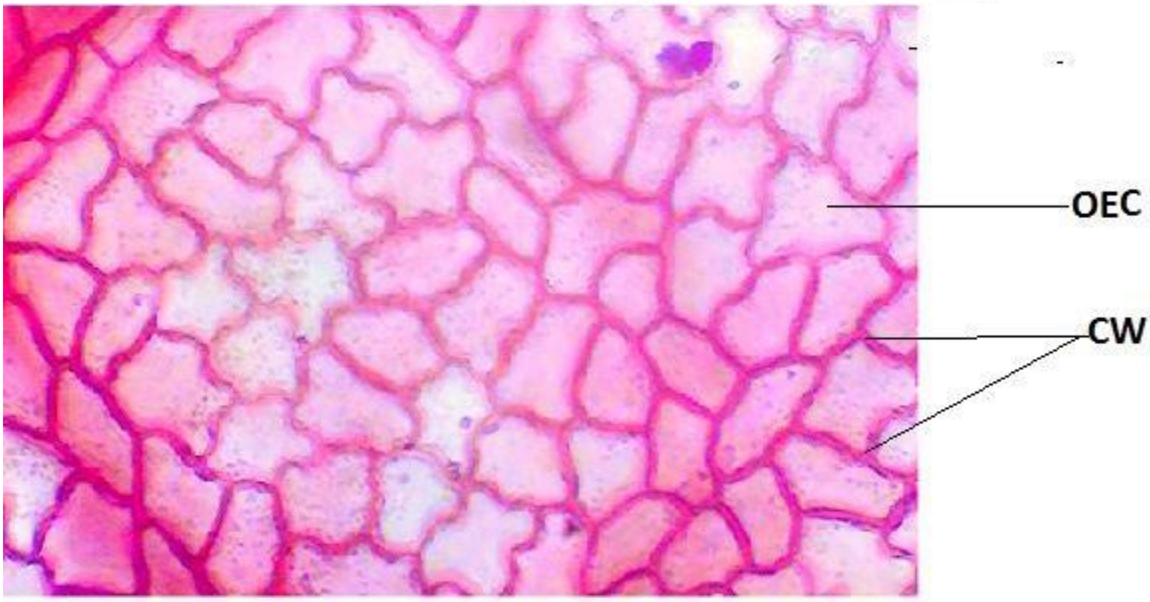

Plate 1a: Adaxial epidermis of *Pterocarpus erinaeceus*

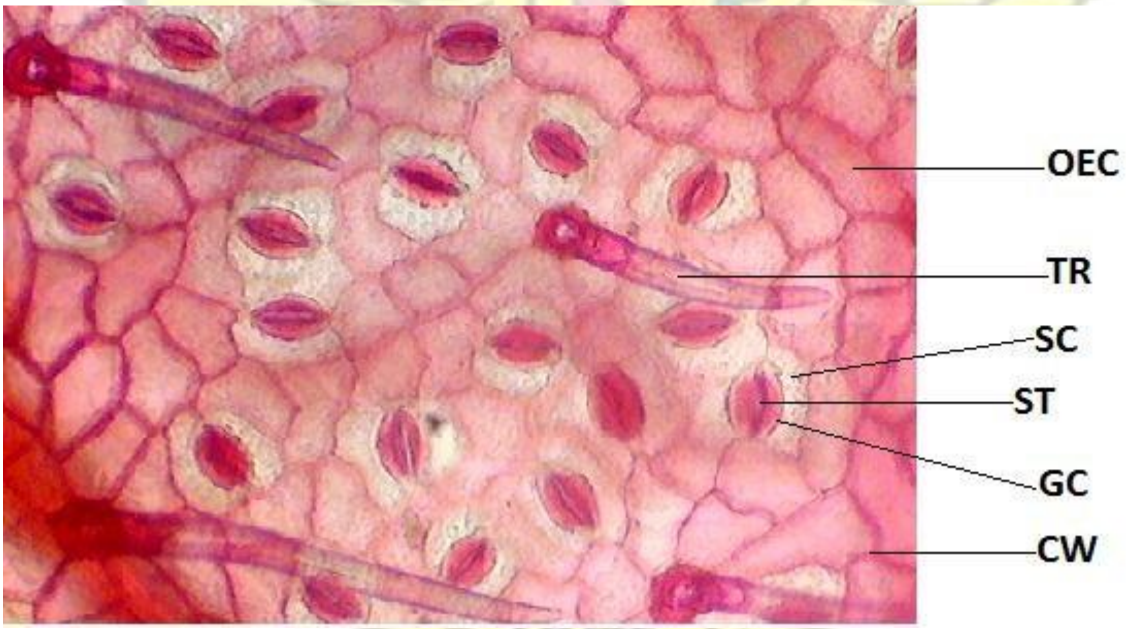

Plate 1b: Abaxial epidermis *Pterocarpus erinaceus*

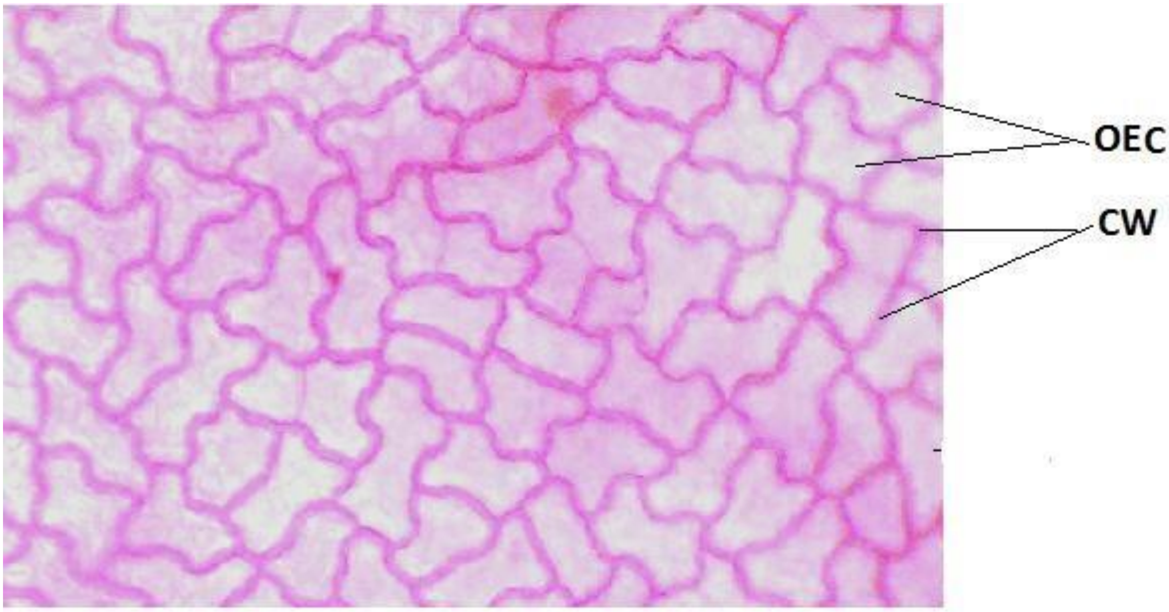

Plate 2a: Adaxial epidermis of *Afzelia africana*

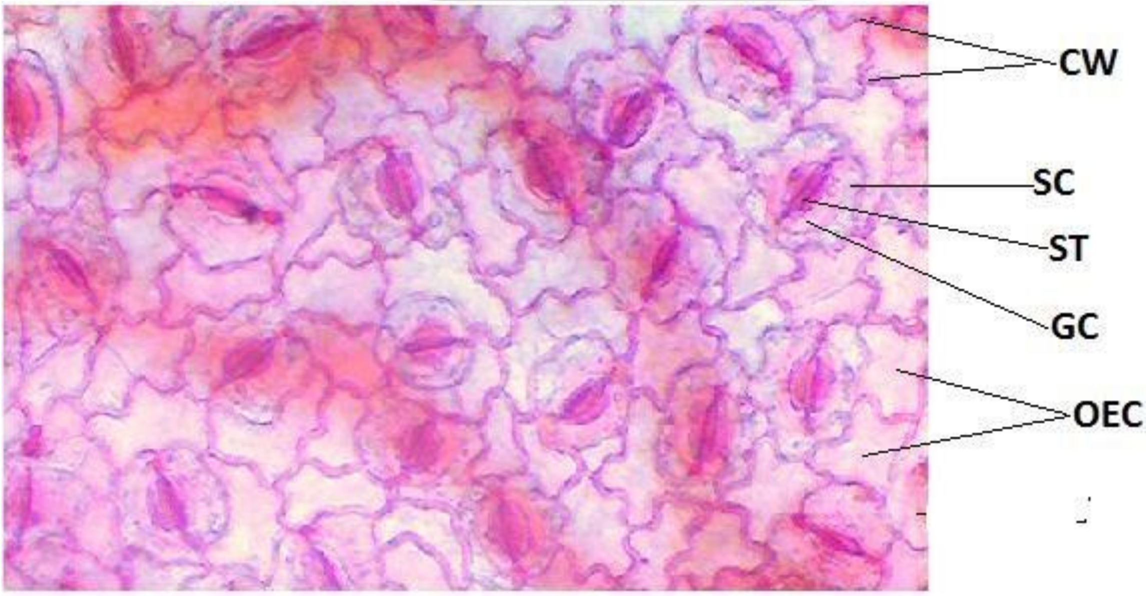

Plate 2b: Abaxial epidermis of *Afzelia africana*

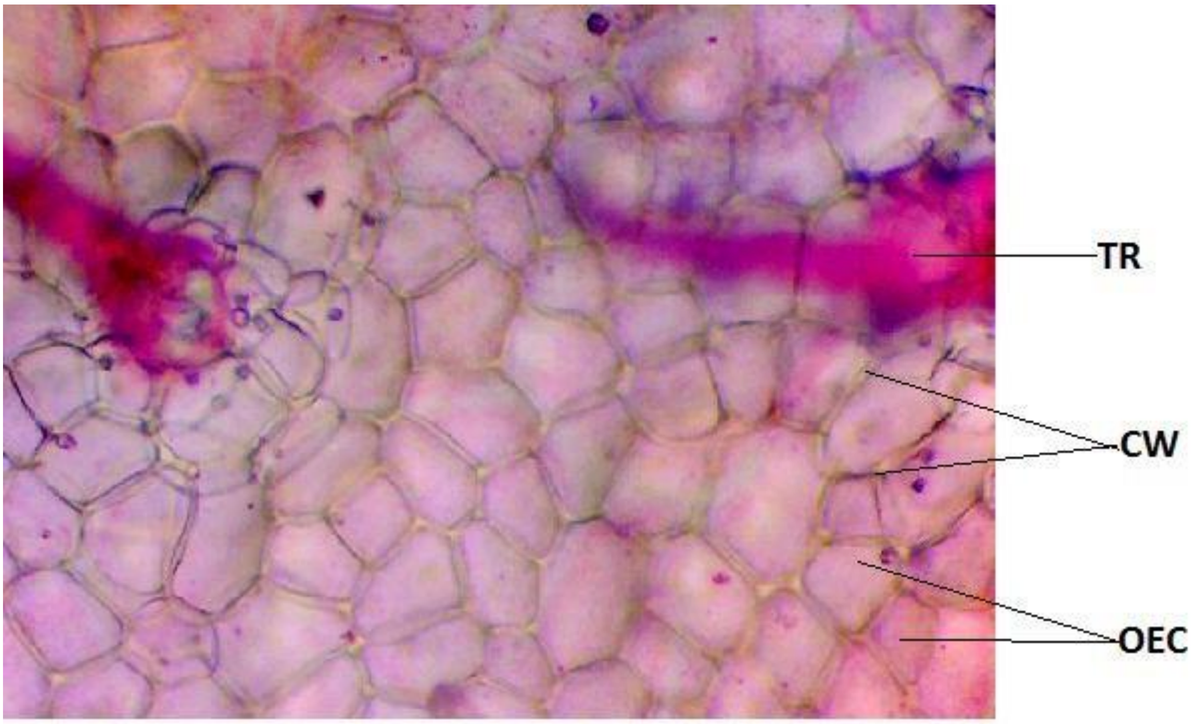

Plate: 3a Adaxial Epidermis of *Gardenia ternifolia*

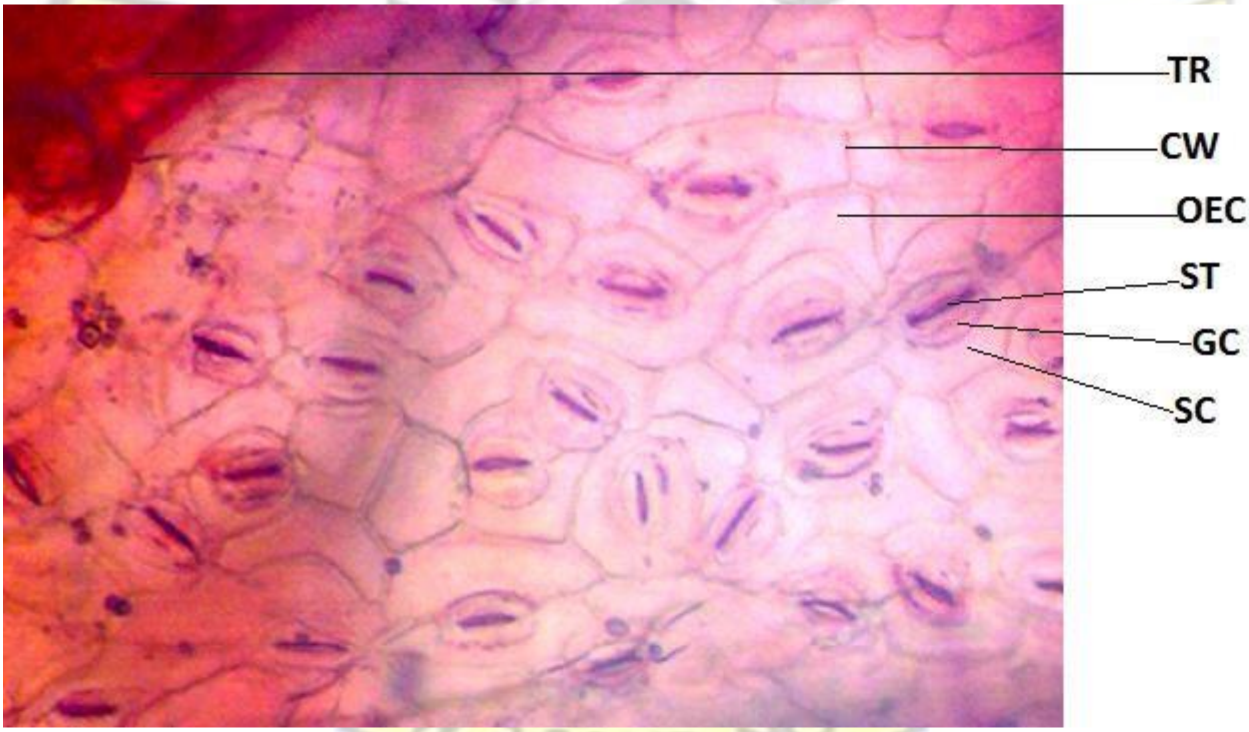

Plate 3b: Abaxial epidermis of *Gardenia ternifolia*

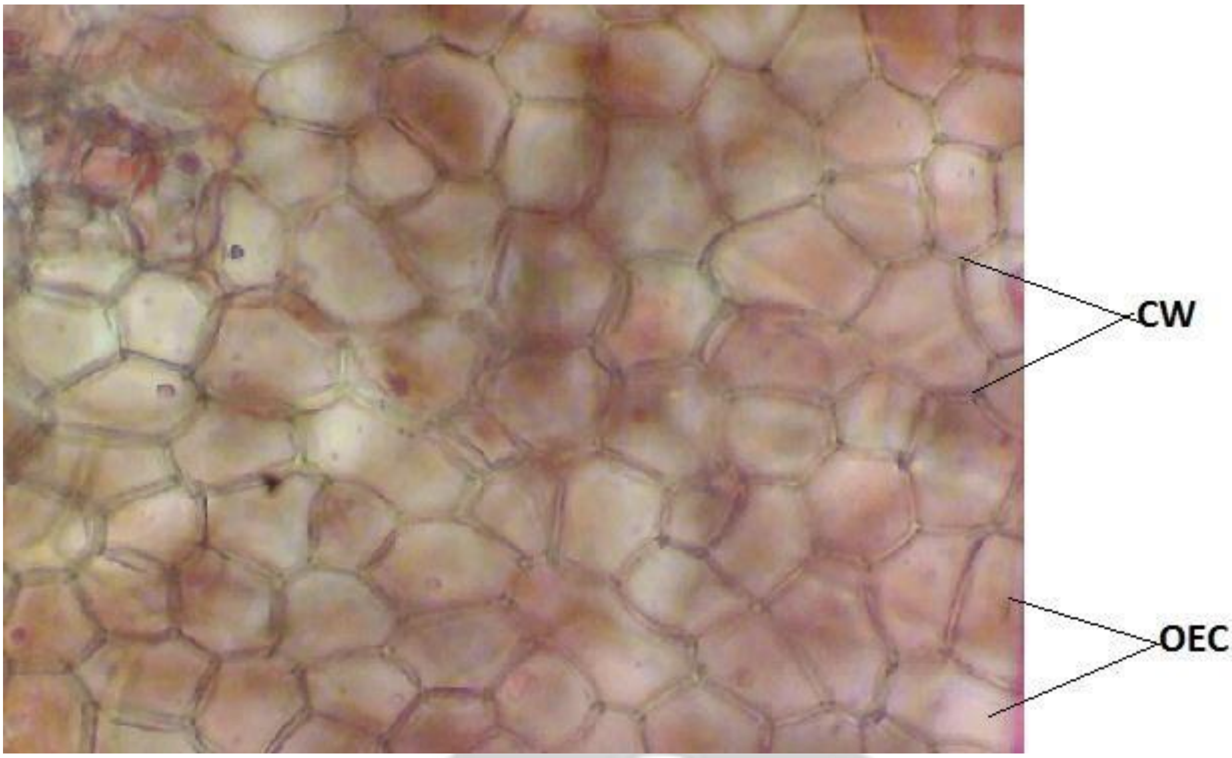

Plate 4a: Adaxial epidermis of *Gardenia aqualla*

Plate 4b: Adaxial epidermis of *Gardenia aqualla*

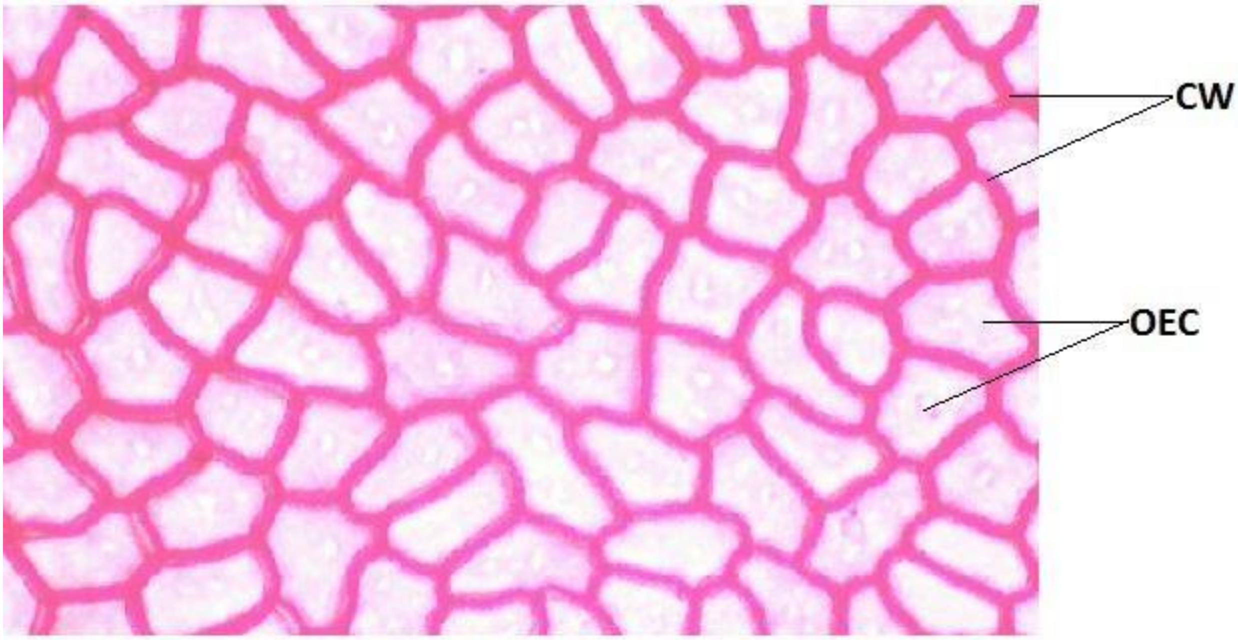

Plate 5a: Adaxial epidermis of *Daniellia oliveri*

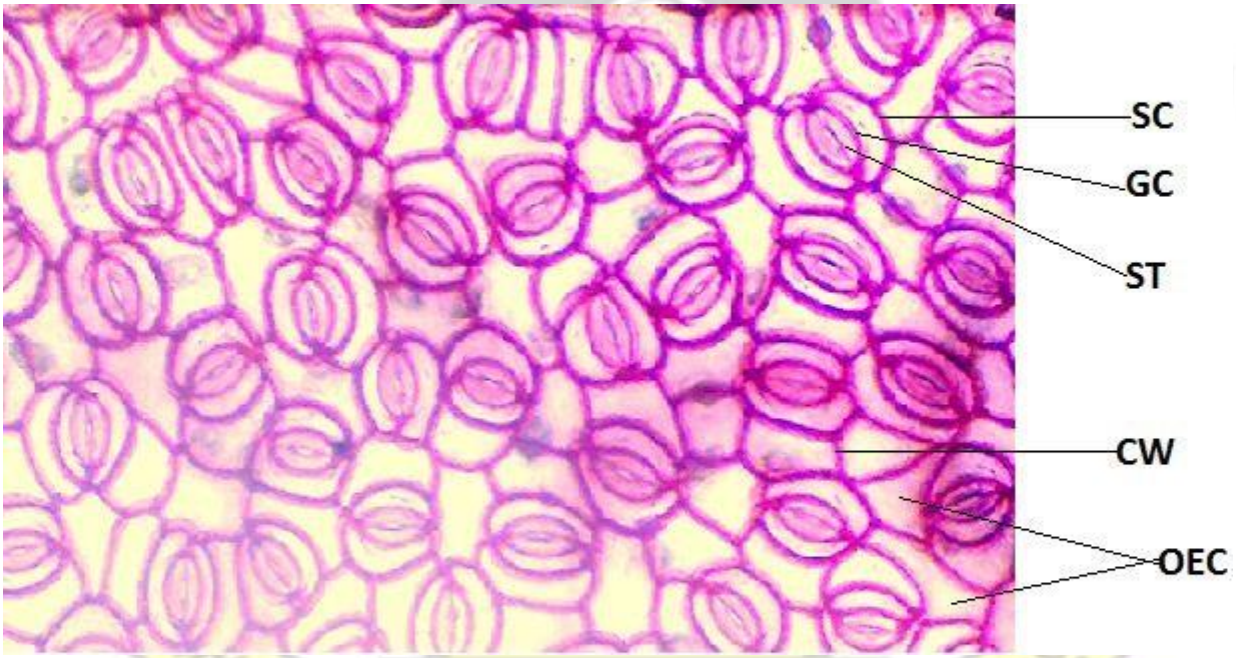

Plate 5b: Abaxial epidermis of *Daniellia oliveri*

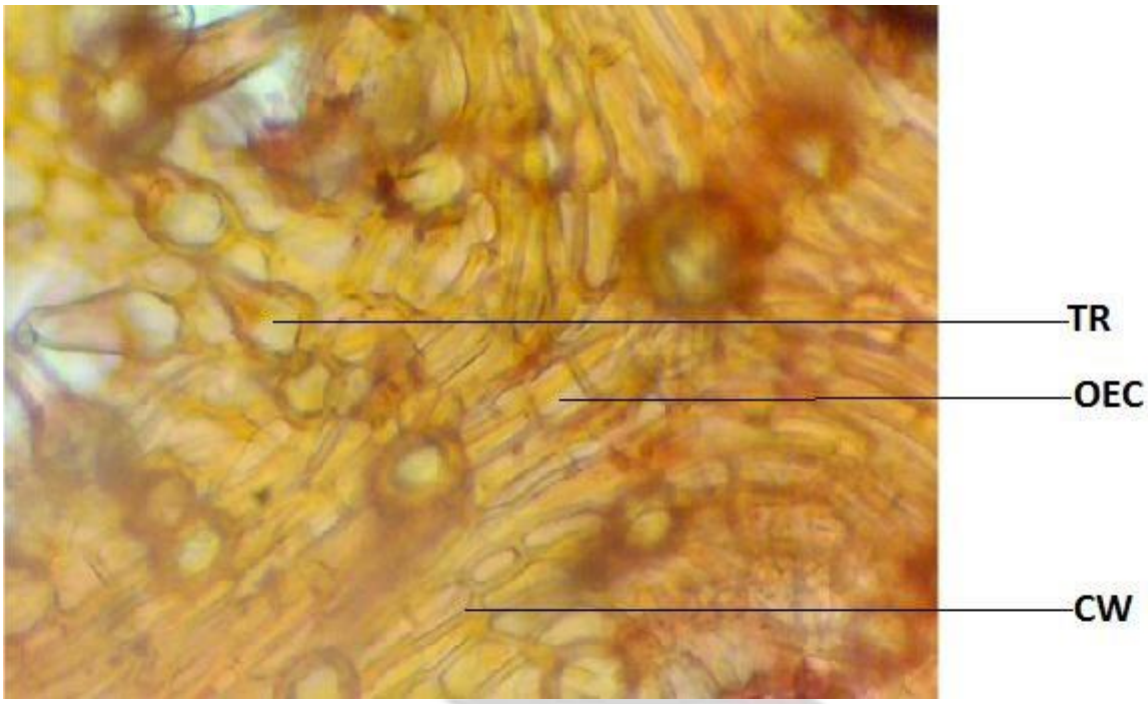

Plate 6a: Adaxial epidermis of *Ficus capensis*

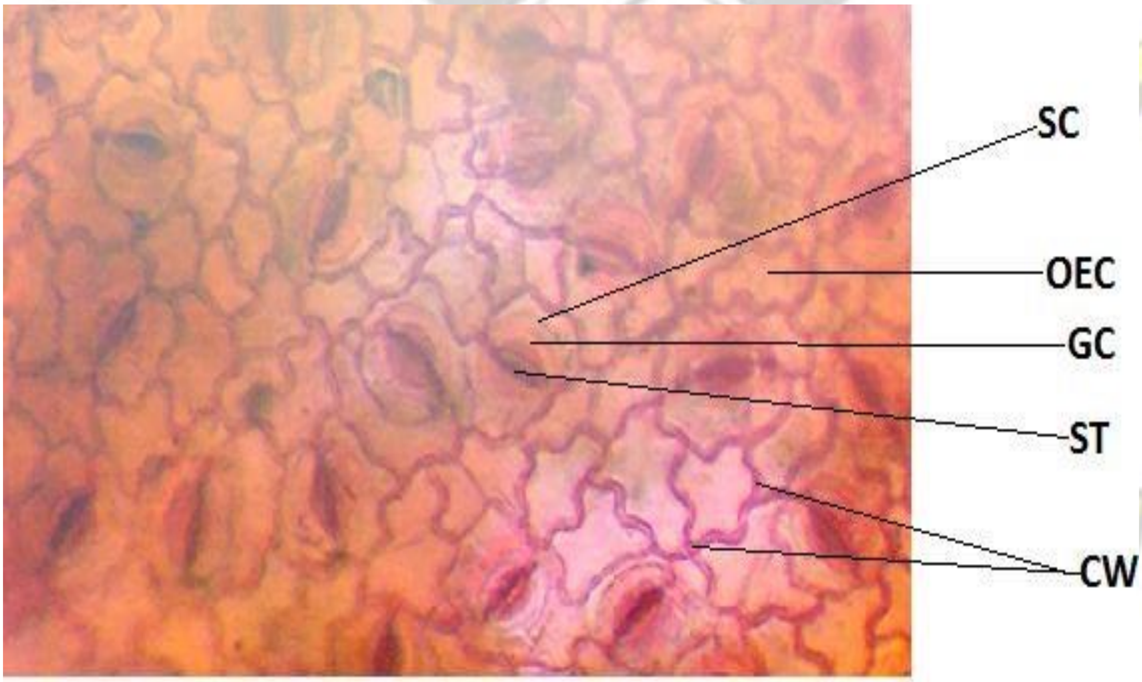

Plate 6b: Abaxial epidermis of *Ficus capensis*

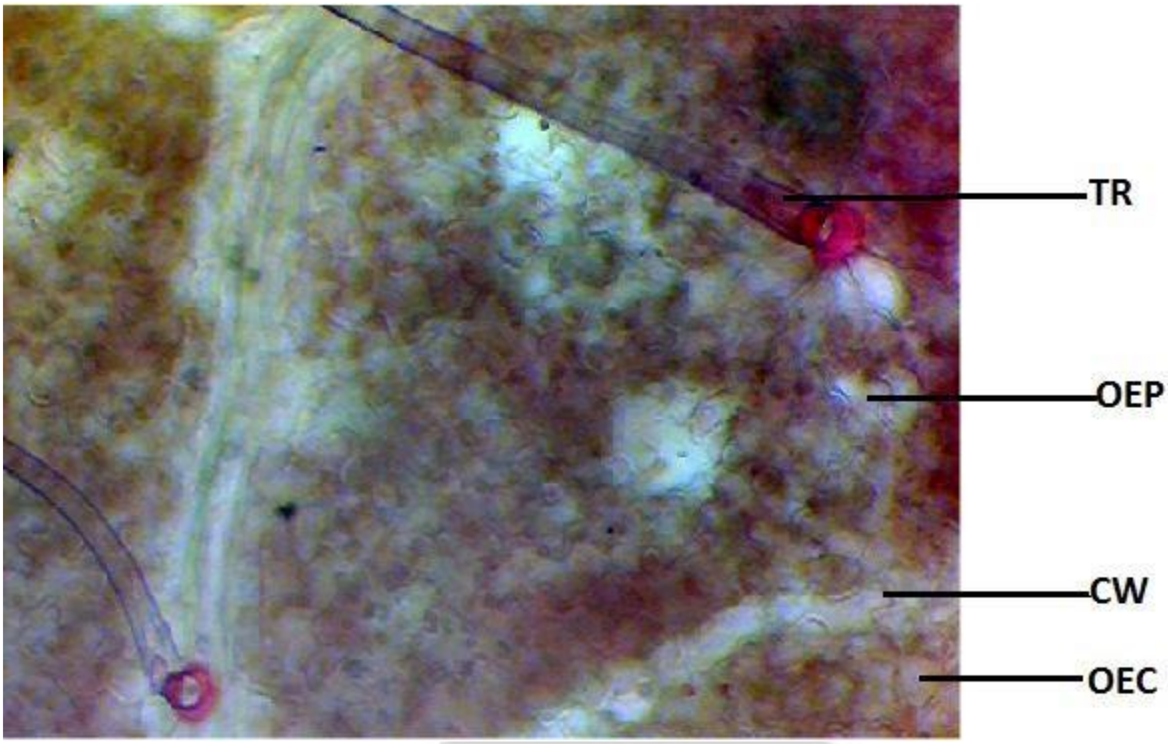

Plate 7a: Adaxial epidermis of *Anogeissus leiocarpus*

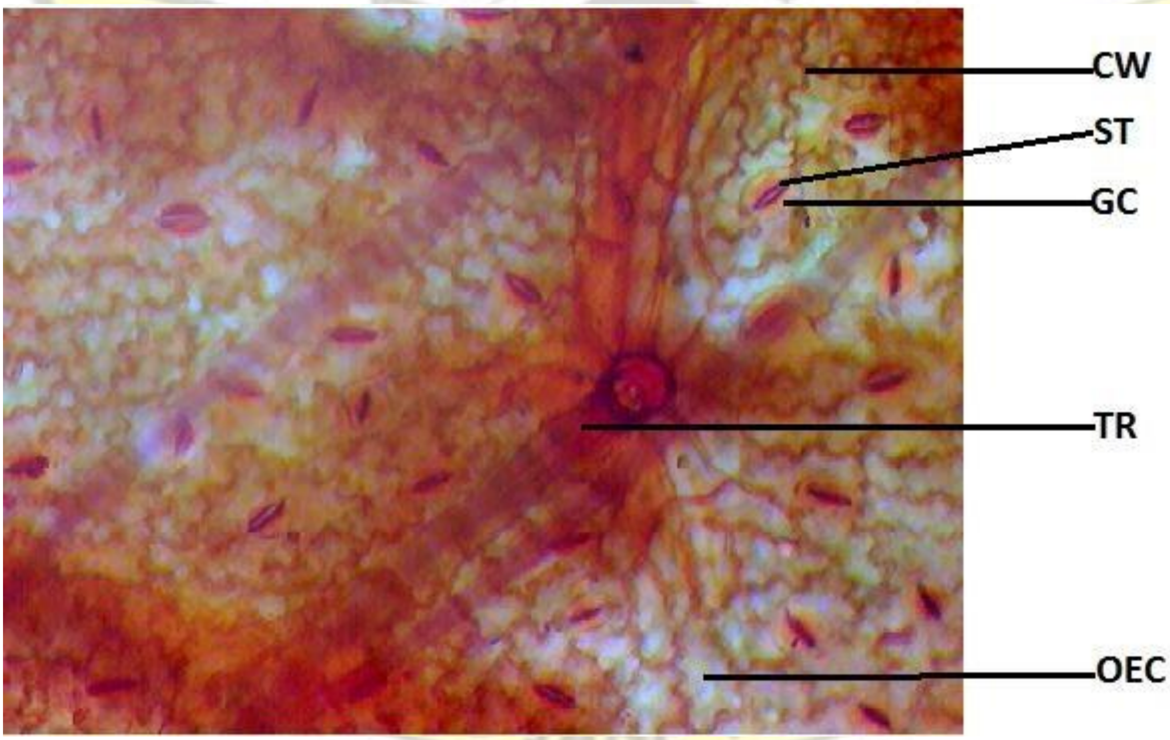

Plate 7b: Abaxial epidermis of *Anogeissus leiocarpus*

4.7 Leaf Epidermal Slides of some Forbs Species Studied in the Area

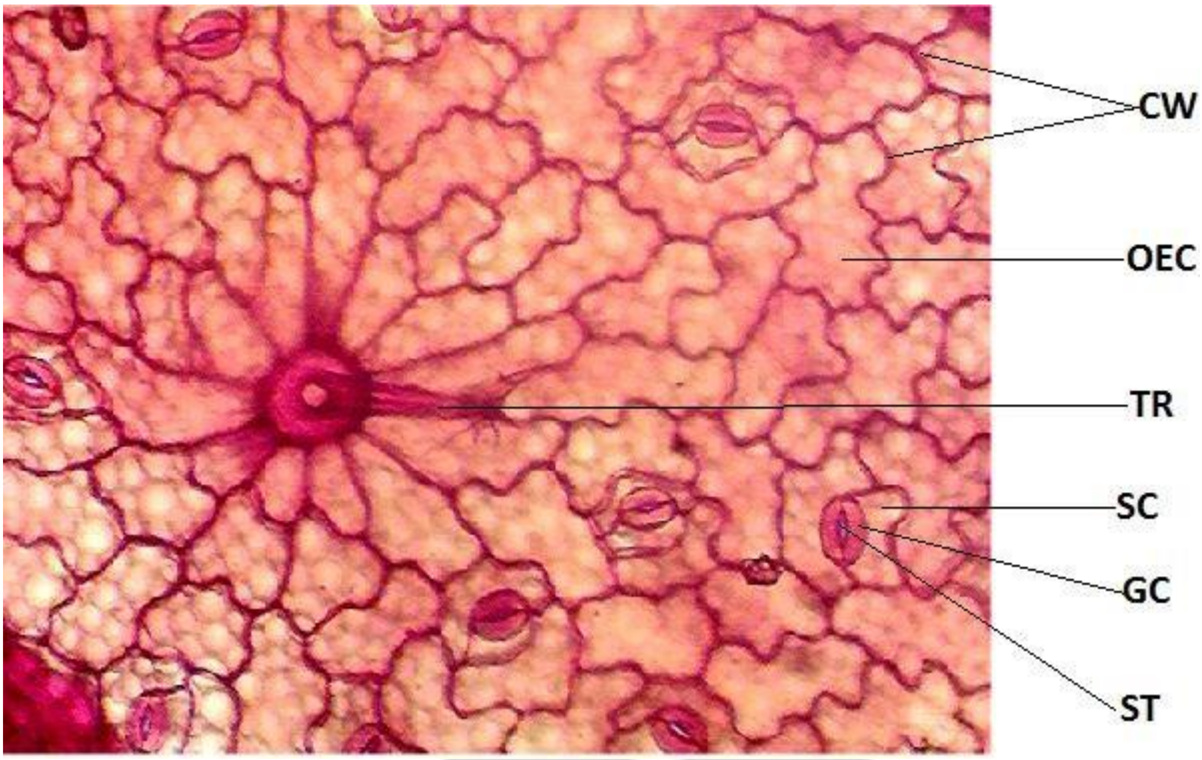

Plate 1a : Adaxial epidermis of *Desmodium scorpiurus*

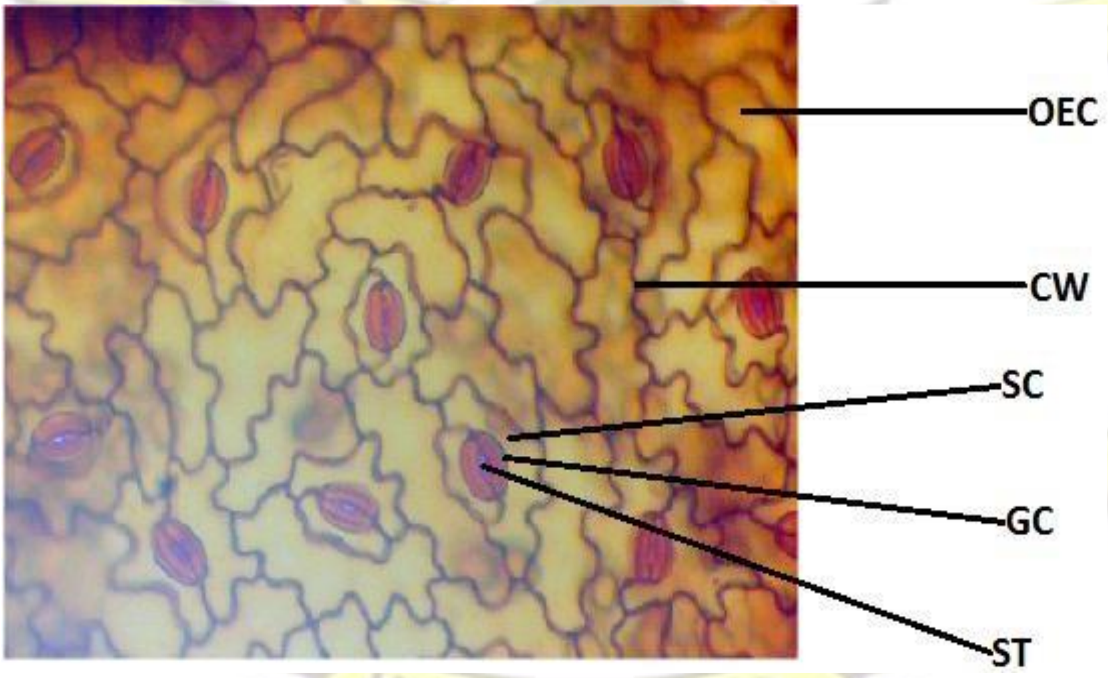

Plate 1b: Abaxial epidermis of *Desmodium scorpiurus*

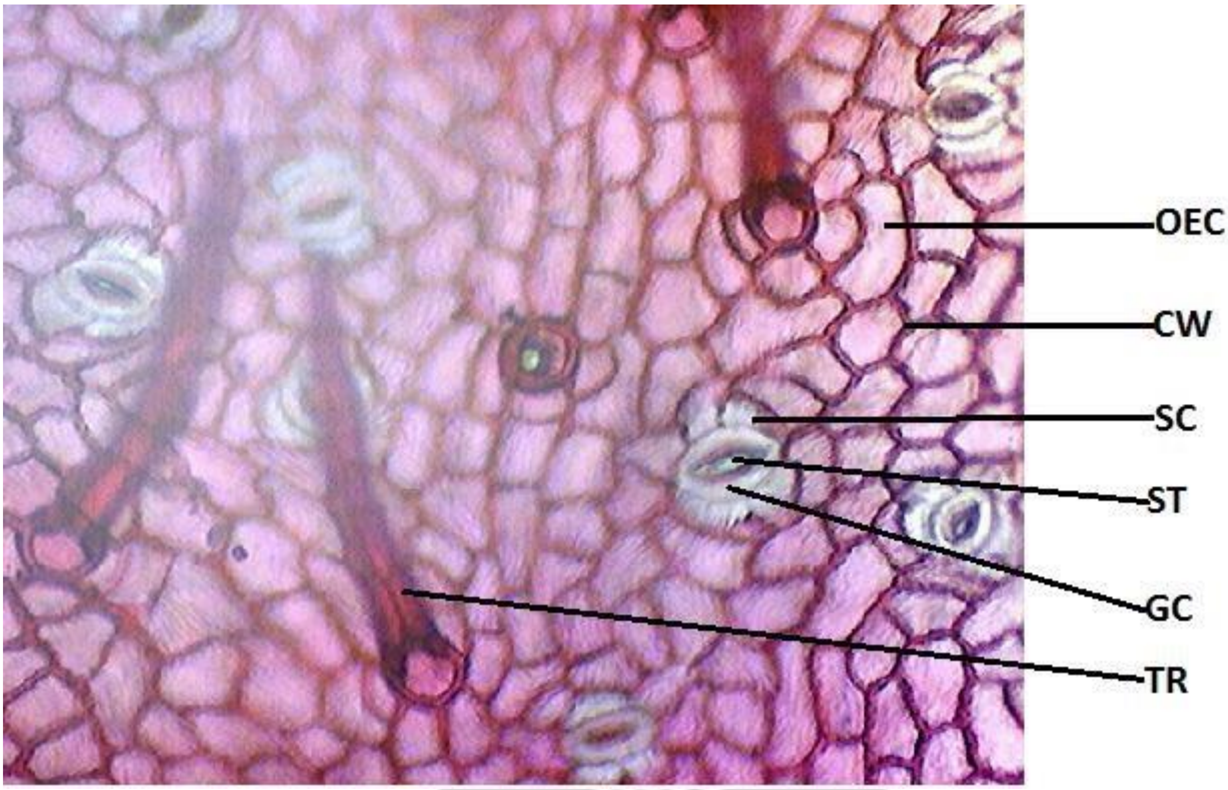

Plate2a: Adaxial epidermis of *Evolvulus alsinoides*

Plate 2b: Abaxial epidermis of *Evolvulus alsinoides*

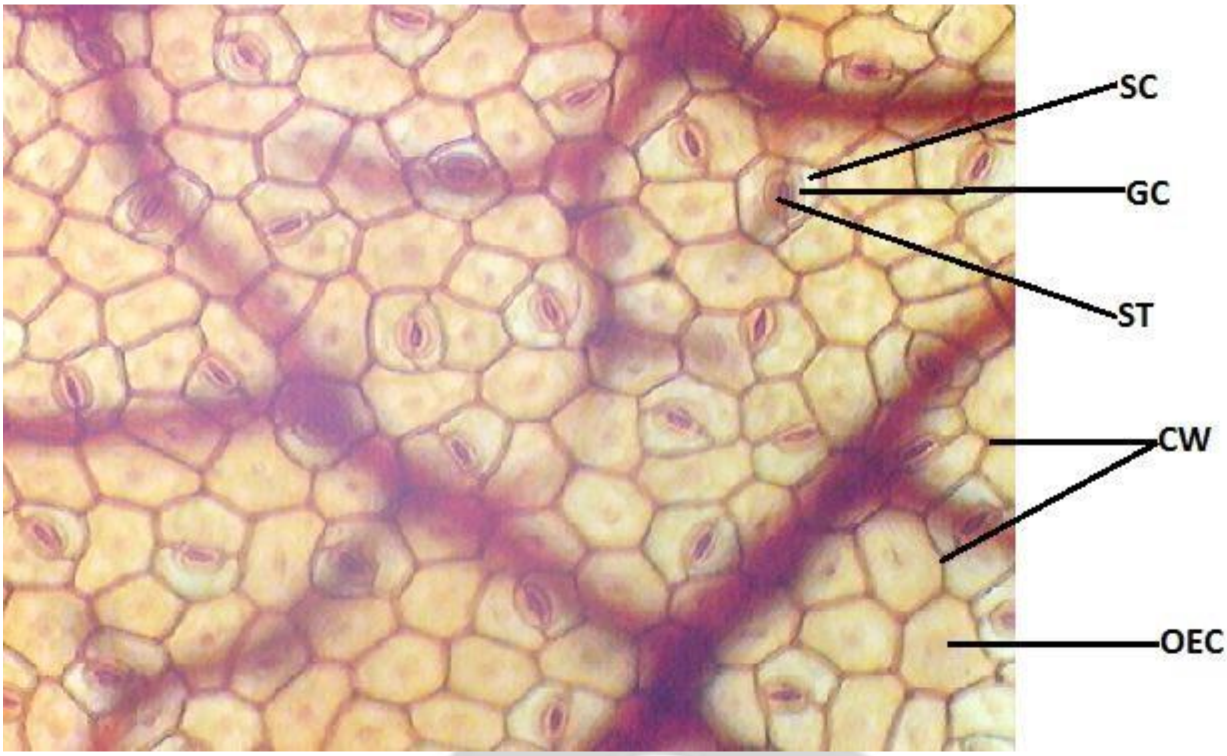

Plate 3a: Adaxial epidermis of *Jasminum obtusifolium*

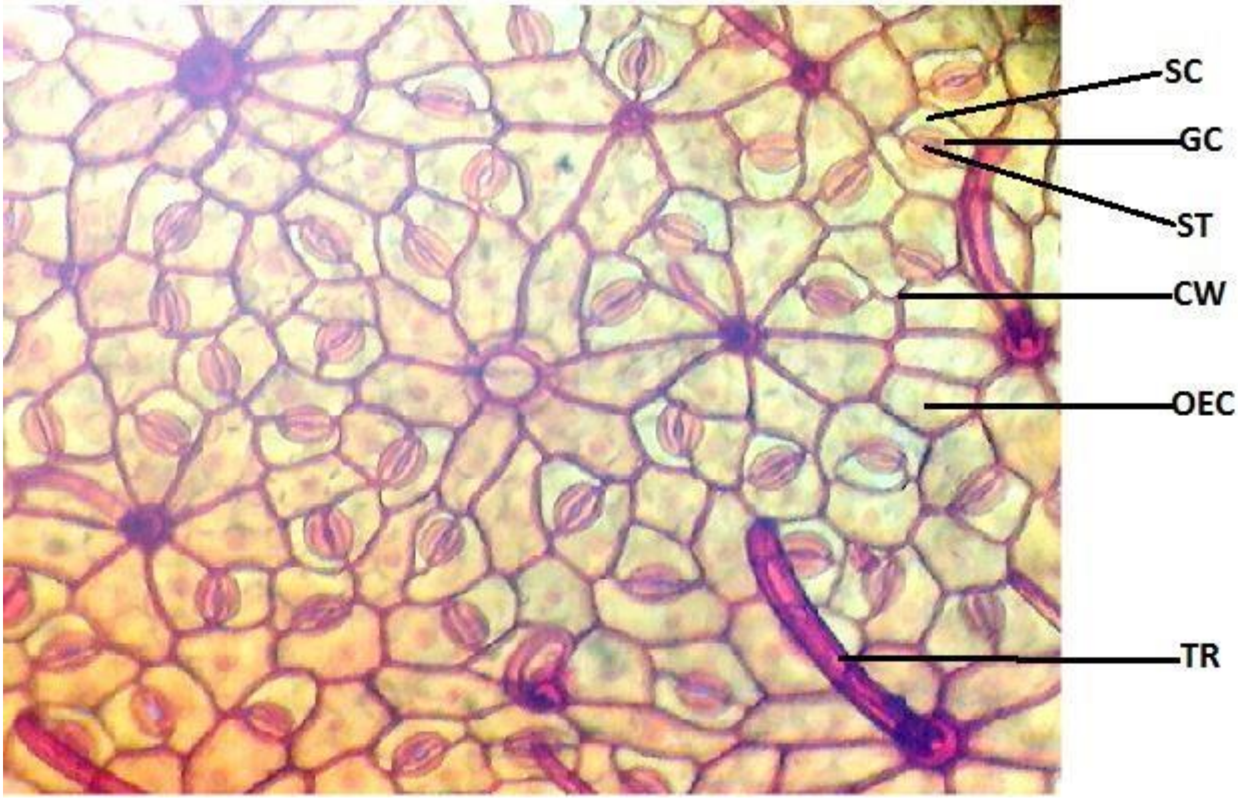

Plate 3b: Abaxial epidermis of *Jasminum obtusifolium*

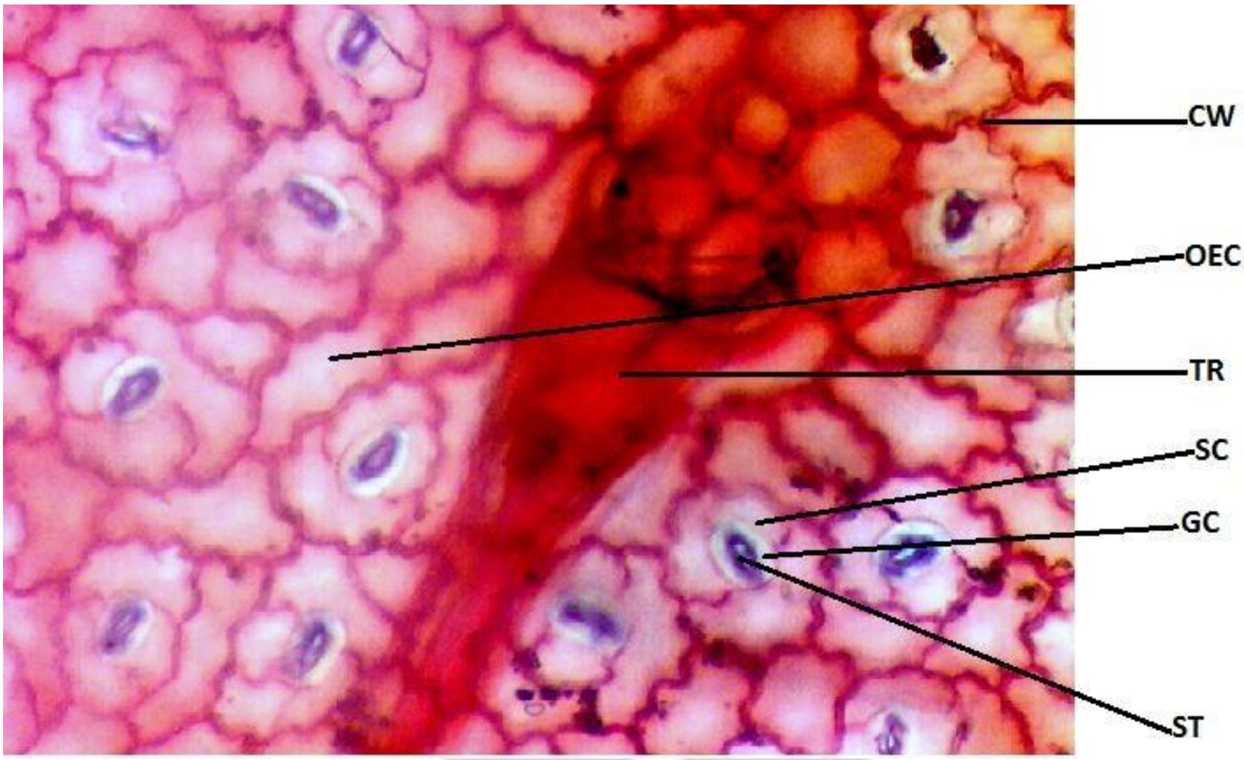

Plate 4a: Adaxial epidermis of *Sesamum alatum*

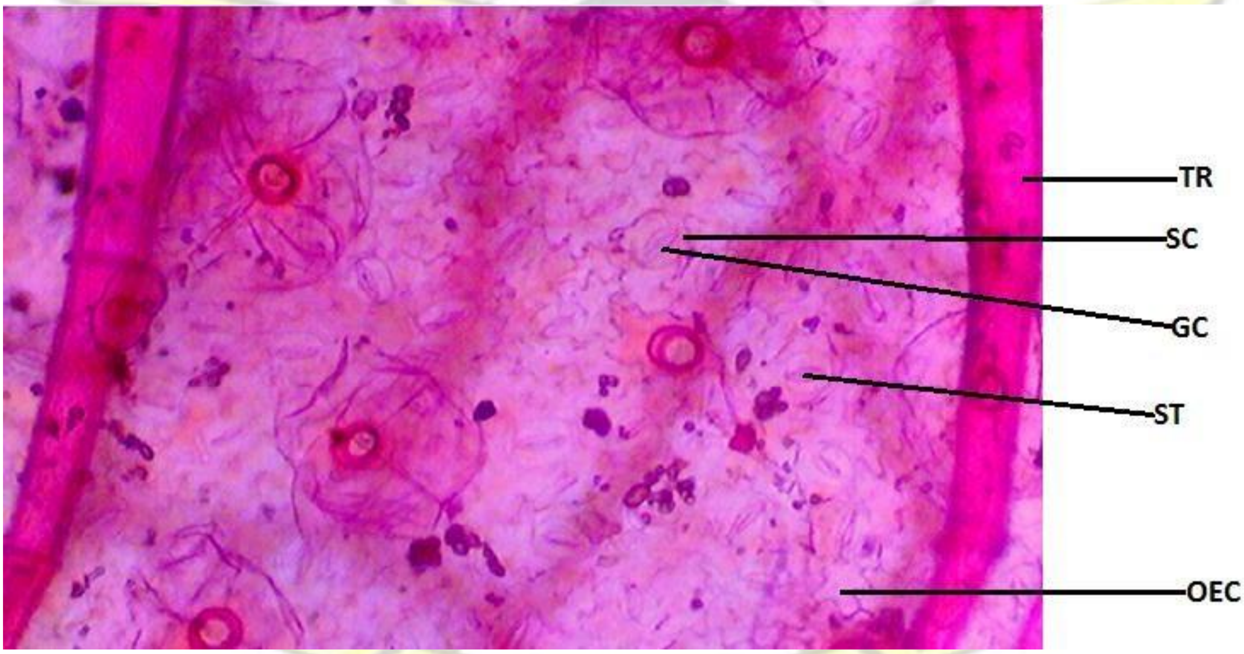

Plate 4b: Abaxial epidermis *Sesamum alatum*

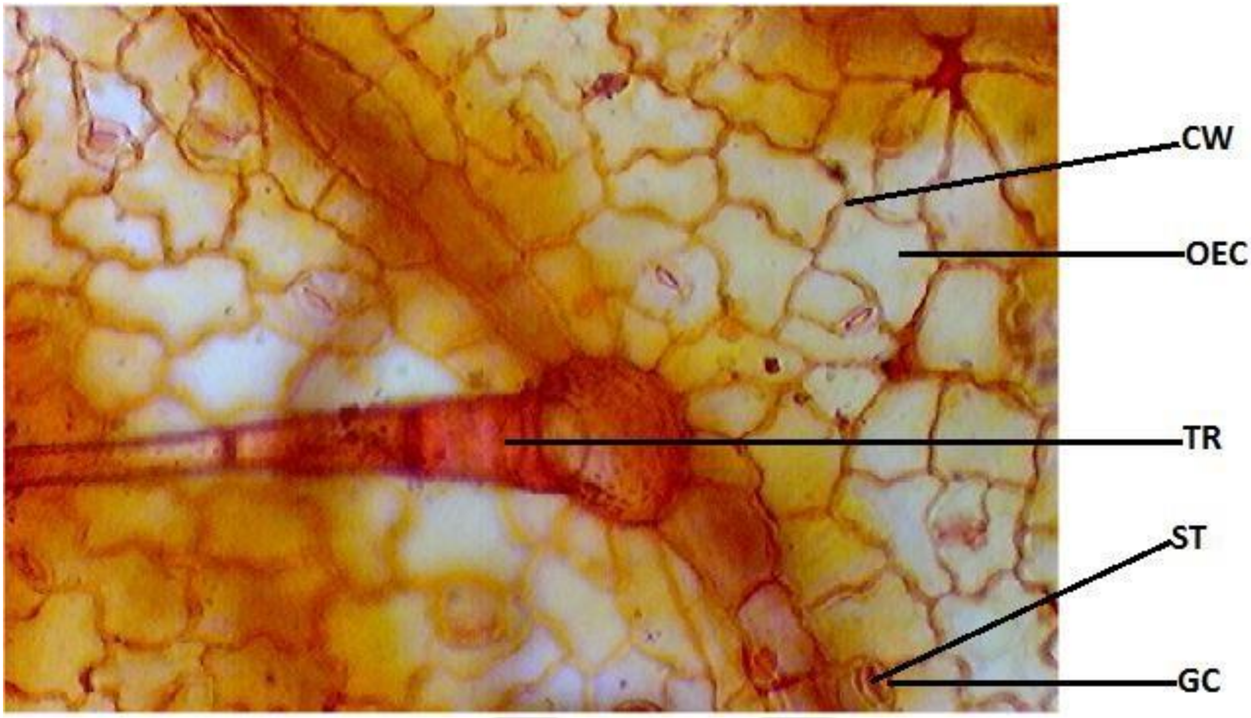

Plate 5a: Adaxial epidermis of *Euphorbia hirtha*

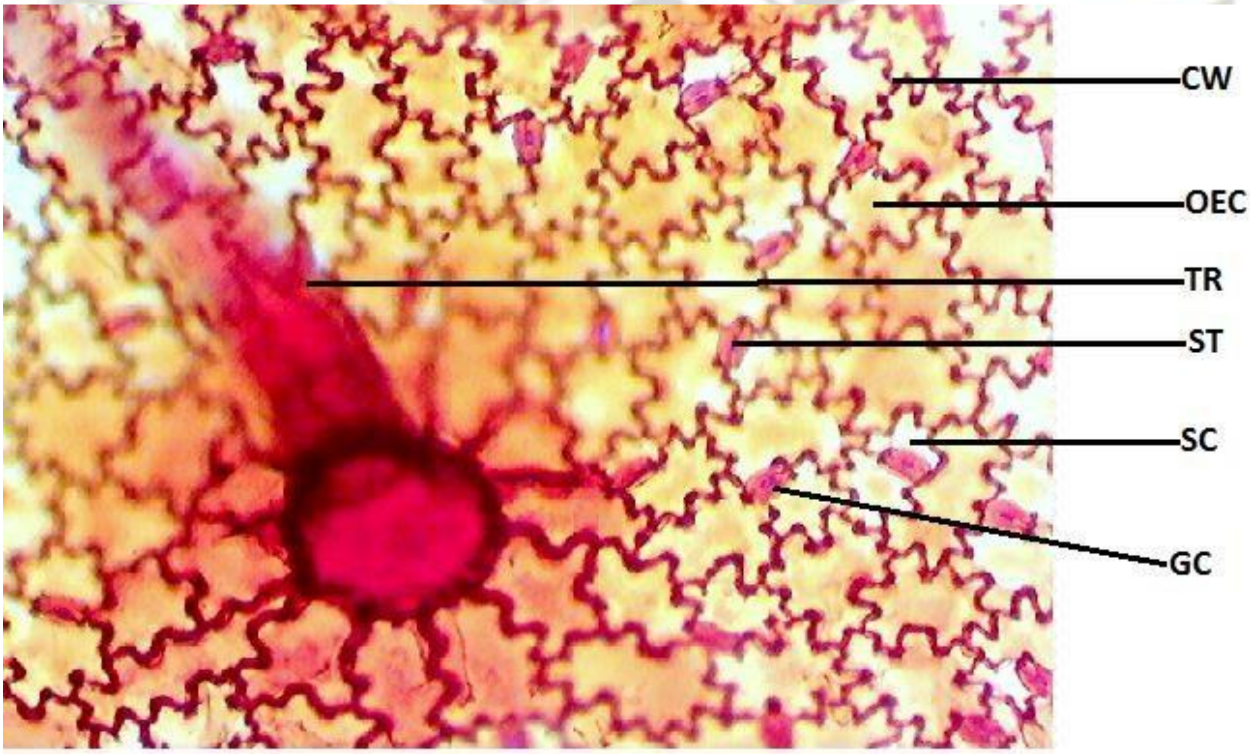

Plate 5b Abaxial epidermis of *Euphorbia hirtha*

Table 5: Leaf Epidermal and Stomatal Characteristics of some Browse and Forbs Species

	Surface	CS	CW	ST	TR
BROWSE					
Pterocarpus erinaeceus	AD	Irregular	Undulating	None	None
	AB	Irregular	Undulating	Anomocytic	Unicellular
Afzelia africana	AD	Irregular	Undulating	None	None
	AB	Irregular	Sinuous	Anomocytic	Unicelluar
Gardenia ternifolia	AD	Irregular	Straight	None	Unicellular
	AB	Irregular	Undulating	Paracytic	Unicellular
Gardenia aqualla	AD	Irregular	Straight	None	None
	AB	Irregular	Undulating	Paracytic	None
Daniellia oliveri	AD	Irregular	Undulating	None	None
	AB	Irregular	Undulating	Paracytic	None
Ficus capensis	AD	Irregular	Straight	None	Unicellular
	AB	Irregular	Sinuous	Anomocytic	None
Anogeissus leiocarpus	AD	Irregular	Sinuous	None	Unicelluar
	AB	Irregular	Sinuous	Anomocytic	Unicellular
FORBS					
Desmodium scorpiurus	AD	Irregular	Sinuous	Anomocytic	Unicellular
	AB	Irregular	Sinuous	Anomocytic	None
Evolvulus alsinoides	AD	Irregular	Undulating	Anomocytic	Unicellular
	AB	Irregular	Undulating	Anomocytic	Unicellular
Jasminum obtusifolium	AD	Irregular	Straight	Paracytic	None
	AB	irregular	Undulating	Paracytic	Unicellular
Sesamum alatum	AD	irregular	Sinuous	Anomocytic	Unicellular
	AB	Irregular	Sinuous	Paracytic	Multicellular
Euphorbia hirtha	AD	Irregular	Undulating	Anomocytic	Multicellular
	AB	Irregular	Sinuous	Anomocytic	Unicellular

4.8 Legends for Table 5 and Plates 1a-7b and Plates 1a-5b

AD = Adaxial
AB = Abaxial
ST = Stomata

TR = Trichomes
CW = Cell wall
GC= Guard cell

OEC= Ordinary epidermal cell
SC = Subsidiary cell

ST = Stomata

4.9 Forage Species Identified in the Diet of the Roan Antelope

Seventeen (17) forage species made up of seven (7) grasses, six (6) browses, and four (4) forbs were identified in the faecal matter of the roan antelope through microhistogical analysis of faecal samples. Plant species were identified based on the presence of at least two or three anatomical characteristics. Grass species were found to have possessed the following anatomical characteristics such as stomata, silica bodies, papillae, macro-hairs and microhairs, prickle hairs, long cells and short cells. Anticlinal cell walls of grass species varied from slightly sinuous to straight. The epidermal surfaces of all the grass species were clearly distinguished into coastal and intercoastal zones with the intercoastal zone broader than the coastal zone. Browse species were found to have unique anatomical structures such as trichomes and irregular cell shape. Numerous stomata were found on the abaxial surfaces of all browse and forbs species with few or none occurring on the adaxial epidermis. Anticlinal cell walls of browse species varied from straight to sinuous. These anatomical features were contained in the prepared reference slide.

Table 6: List of Forage Species Identified in Faecal Matter of Roan Antelope in all the three Seasons

SCIENTIFIC NAME	COMMON NAME	LOCAL NAME (DAGAARE)
Grass Species		
Andropogon gayanus	Northern Gamba grass	Mupilaa
Hyparrhenia spp	Thatching grass	Kari
Hyperthelia dissoluta	Yellow thatching grass	Boro
Imperata cylindrica	Spear grass	pulung
Pennisetum polystachion	Feathery grass	Sambala
Rottboellia cochinchinensis	Itch grass	Karinyaa
Setaria pallide-fusca	Cat tail grass	
Browse species:		
Acacia siebariana (pods)	Paperbark thorn	Gopelaa

Faidherbia albida (pods)	Acacia	Guoraa
Vitellaria paradoxa (fruits/nuts)	Shea nuts	Taangnaa
Afzelia africana	African oak tree	Kakalaa
Gardenia Spp	Gardenia	Dazugri
Pterocarpus erinaceus	African Kino	Bunegaa
Forbs:		
Desmodium. scorpiurus	Beggarweed	
Evolvulus alsinoides	Dwarfmorning glory	Zongaleri
Jasminium Obtusifolium	Jasmine	Wosaalong
Sesamum alatum	Gazelle's Sesanum	Saalonpela

4.10 Utilization of Grass Forage by Roan Antelope

There was significant difference ($p < 0.05$) among the grass species consumed by the roan antelope. *Andropogon gayanus, Hyparrhenia spp, Hyperthelia dissoluta* were the most consumed grass species. *Rottboellia cochinchinensis, Imperata cylindrica* were the least consumed grass species. *Andropogon gayanus, Hyparrhenia spp* and *Hyperthelia dissoluta* were however not significantly different ($p > 0.05$) from each other. *Pennisetum polystachion, Imperata cylindrica* and *Setaria pallid-fusca* were not also significantly different ($p > 0.05$; Table 7).

Table 7: Grass Forage Consumption by Roan Antelope in Gbele Resource Reserve

Plant Species	Mean Number of Epidermal Cells
Andropogon gayanus	3.41^{a}
Hyparrhenia spp	3.30^{a}
Hyperthelia dissoluta	3.16^{ab}
Setaria pallid-fusca	2.93^{bc}
Pennisetum polystachion	2.88^{bc}
Imperata cylindrica	2.71^{cd}

Unidentified grass	2.66[cd]
Rottboellia cochinchinensis	2.47[d]
SEM	0.11
L s d at 5% (0.29)	

Means with the same superscripts (a, b, c, d) are not significantly different at $p > 0.05$.

4.10.1 Utilization of Browse Forage by Roan Antelope

There was significant difference $p < 0.05$ in the utilization of browse species by roans. The roan antelope exploited the following browse species in a decreasing order in terms of frequency of occurrence in the faecal matter*; Gardenia spp*, *Accacia siebariana*, *Afzelia africana* and *Pterocarpus erinaceus* (Table 8). The results showed that these species were the most consumed browse species for roans. *Gardenia spp* was significantly different ($p < 0.05$) from all the other browse species. *Afzelia africana*, *Pterocarpus erinaceus and Faidherbia albida* were however not significantly different $p > 0.05$.

Table 8: Browse Forage Consumption by the Roan Antelope

Plant Species	Mean Number of Epidermal Cells
Gardenia spp	3.21[a]
Acacia siebariana	2.88[ba]
Afzelia africana	2.84[b]
Pterocarpus erinaceus	2.82[b]
Faidherbia albida	2.68[b]
Unidentified browse	2.62[b]
Vitellaria paradoxa	2.21[c]

SEM	0.13
L s d at 5% (0.36)	

Means with the same superscripts (a, b c) are not significantly different at $p > 0.05$.

4.10.2 Utilization of Forbs Forage by the Roan Antelope

There was significant difference $p < 0.05$ among the forbs species consumed by the roan antelope. The following forbs species were exploited in a decreasing order in terms of their frequency of occurrence in the faecal matter; *Desmodium scorpiurus, Jasminum obtusifolium, evolvulus alsiniodes* and *Sesanum alatum. Desmodium scorpiurus* was significantly different $p < 0.05$ from all other forbs species (Table 9). *Evolvulus alsiniodes* and *Jasminum obtusifolium* were however not significantly different at $p < 0.05$.

Table 9: Forbs Forage Consumption by Roan Antelope in Gbele Resource Reserve

Plant Species	Mean Number of Epidermal Cells
Desmodium scorpiurus	2.92^{a}
Evolvulus alsiniodes	2.74^{ab}
Jasminum obtusifolium	2.71^{ab}
Sesanum alatum	2.53^{b}
Unidentified forbs	2.52^{b}
SEM	0.12
L s d at 5% (0.31)	

Means with the same superscripts (a, b) are not significantly different at $p > 0.05$.

4.10.3 Seasonal Consumption of Grass Forage

There were inter-seasonal differences $p < 0.05$ in the consumption of grass forage by the roan antelope across the three seasons (Table 10). There were also intra-seasonal differences $p < 0.05$ in the consumption of the individual grass forage in each of the seasons (Table 10).

Table 1

0: Grass Forage Consumption within the Different Seasons in Gbele Resource Reserve

GRASS SPECIES	SEASONS			
	Rainy Season	Cool-dry Season	Warm-dry Season	SEM
Andropogon gayanus	3.70^{Aa}	3.38^{Ab}	$3.16^{A\ c}$	0.25
Hyparrhenia spp	3.52^{Ba}	3.23^{Ab}	3.15^{Ab}	0.20
Hyperthelia dissoluta	3.39^{Ba}	3.08^{BAb}	3.03^{Ab}	0.27
Setaria pallid-fusca	3.37^{Ba}	2.95^{Bb}	2.57^{Bc}	0.34
Pennisetum polystachion	3.36^{Ba}	2.83^{CBb}	2.52^{Bc}	0.41
Imperata cylindrica	3.11^{Ca}	2.77^{Cb}	2.37^{CBc}	0.24
Unidentified grass	2.85^{Da}	2.76^{Da}	2.08^{Db}	0.22
Rottboelia cochinchinensis	2.77^{Da}	2.54^{Db}	2.07^{Dc}	0.50

Means with the same uppercase letters (A, B, CB, DC and D) in the same column are not significantly different $p > 0.05$, and means with the same lowercase letters (a, b and c) in the same row are not significantly different at $p > 0.05$.

4.10.4 Seasonal Consumption of Browse Forage

There was inter-seasonal differences $p < 0.05$ in the consumption of browse species in all the three seasons. The consumption of *Gardenia spp, Pterocarpus erinaceus* and *Afzelia africana* in descending order was significantly different $p < 0.05$ in all the three seasons. There was also intra-seasonal differences $p < 0.05$ in the utilization of browse species in each season by the roan antelope (Table 11).

Table 1

1: Browse Forage Consumption within the Different Seasons in Gbele Resource Resource

BROWSE SPECIES	SEASONS			
	Rainy Season	Cool-dry Season	Warm-dry Season	SEM
Gardenia spp	2.62^{Aa}	3.22^{Ab}	3.80^{Ac}	0.63
Pterocarpus erinaceous	2.57^{Aa}	2.87^{Bb}	3.53^{Bc}	0.47
Acacia siebariana	2.41_{BAa}	2.86^{Bc}	3.40^{Bc}	0.61
Afzelia africana	2.34_{Ba}	2.82_{Bb}	3.29_{CBc}	0.29
Faidherbia albida	2.32_{Ba}	2.64_{CBb}	3.07^{CBc}	0.47
Vitellaria paradoxa	2.30_{Ba}	2.54^{Cb}	2.86^{Cc}	0.15
Unidentified browses	2.27^{Ba}	1.61^{Db}	2.46^{Da}	0.29

Means with the same uppercase letters (A, B, CB and D) in the same column are not significantly different at $p > 0.05$, and means with the same lowercase letters (a, b and c) in the same row are not significantly different at $p > 0.05$.

4.10.5 Seasonal Composition of Forbs Forage

There was no inter-seasonal interaction $p > 0.05$ in the utilization of all the forbs species identified in the diet of the roan antelope (Table 12). There was however intra-species differences $p < 0.05$ in the consumption of the various forbs species by the roan antelope in each season.

Table 1

2: Forbs Forage Consumption within the Different Seasons

FORBS SPECIES	SEASONS			
	Rainy Season	Cool-dry season	Warm-dry season	SEM
Desmodium. scorpiurus	2.86^{Aa}	3.02^{Aa}	2.89^{Aa}	0.41
Evolvulus alsinoides	2.66_{BAa}	2.87^{Aa}	2.71^{BAa}	0.52
Jasminium obtusifolium	2.64^{BAa}	2.85^{Aa}	2.62^{Ba}	0.55
Sesamum alatum	2.58_{Ba}	2.57^{Ba}	2.61^{Ba}	0.54
Unidentified forbs	2.42_{Ba}	2.42^{Ba}	2.57_{Ba}	0.56

Means with the same uppercase letters (A, B and BA) in the same column are not significantly different at $p > 0.05$, and means with the same lowercase letters (a) in the same row are not significantly different at $p > 0.05$.

4.10.6 Mean Total Number of Epidermal Fragments Identified

Among the three forage categories (grass, browse and forbs); grasses had the highest mean number of epidermal fragments (62.57) than browse (49.92), forbs (32.73) and unidentified (23.73) respectively as in (Table 13).

Table 13: Mean Total Number of Fragments Identified for each Forage Category

Seasons	Grass	Browse	Forbs	Unidentified	Total
Rainy season	23.22	14.56	10.58	7.99	56.35
Cool-dry season	20.77	16.02	11.31	7.73	55.83

Table 1

Warm-dry	18.58	19.34	10.84	8.01	56.77
TOTAL	**62.57**	**49.92**	**32.73**	**23.73**	**168.95**

4.10.7 Relative Proportions of the Three Forage Categories in Roan's Diet

The diet of the roan antelope consisted of a diverse species of food plants. Sixteen (16) plant species made up of seven grasses (7), five (5) browse and four (4) forbs were identified in the faecal matter of roan antelope. The forage species estimated in the diet of the roan antelope were in the following proportions; grass (37%), browse (30%), forbs (19%) and others (14%) (Figure 5).

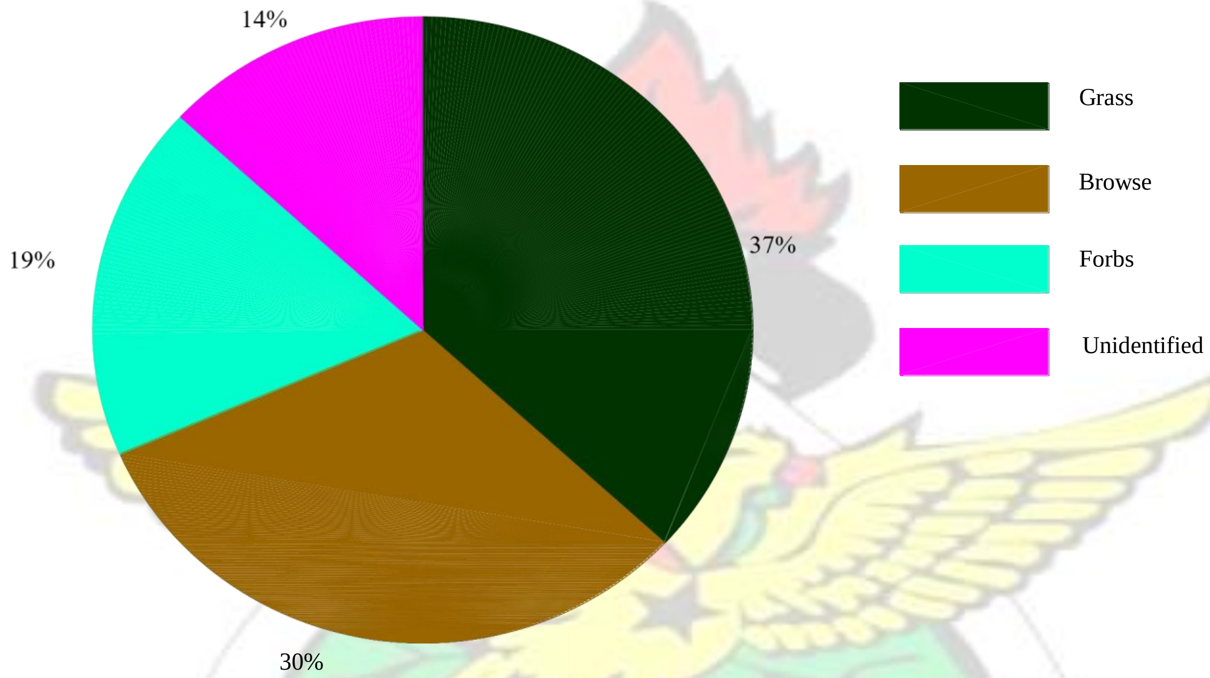

Figure 5: Diet Proportions of the Three Forage Category in the Diet of the Roan Antelope

4.10.8 Diet Proportions of the Roan antelope in the Three Seasons

In the rainy season the roan antelope's diet was estimated at 41% grass, 26% browse, 20% forbs and 13% other forage species (Figure 6). The results showed that grasses were the most consumed forage species for roans in the rainy season. Browse and forbs consumptions were low and lowest in the rainy season (Figure 6).

In the cool–dry season, there was a reduction in the consumption of grass species. Although grass consumption still remained high (37%) in this season compared to browse (29%) and forbs (20%), there was a sharp decline in grass diet compared to the rainy season (Figure 6). The warm-dry season witnessed a further reduction in grass consumption (33%) as compared to the previous climatic periods (41% and 37%) (Figure 6).

Browse consumption however appreciated remarkably in the warm-dry season (34%) compared to the cool-dry season (29%). Forbs consumption drop slightly (19%) in the warmdry season as against (20%) in the cool-dry season. The number of unidemtified forage species however appreciated slightly (14%) in this period compared to the rainy season (13%) (Figure 6).

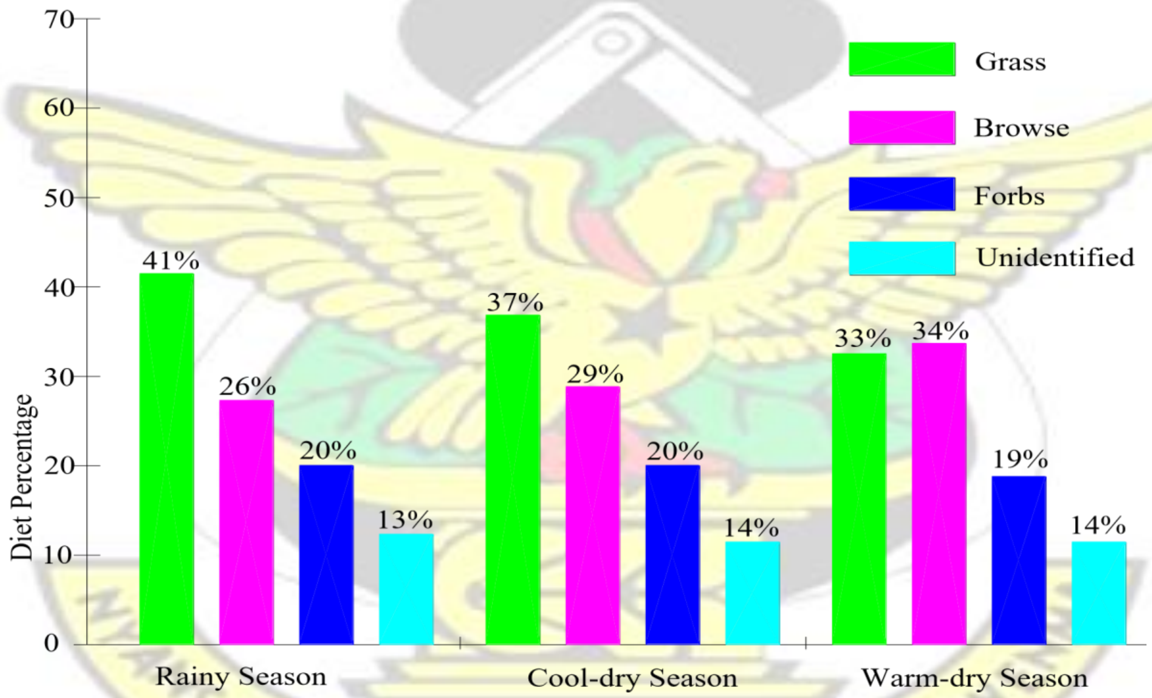

Figure 6: Percentage Compositions of Total Grass, Browse and Forbs in Three Seasons in Gbele Resource Reserve

4.10.9 Seasonal Variation of Six Most Consumed Grass and Browse Species

The consumption of individual forage species (grass, browse and forbs) varied dramatically from one season to another. Some forage species were consistently consumed by the roan antelope in all the three seasons, while others appear only in some seasons and virtually disappear during certain seasons of the year. *Andropogon gayanus, Hyparrhenia spp* and *Hyperthelia dissoluta* were the grass species consistently consumed by the roan antelope in large quantities (Figure 7). *Gardenia spp, Afzelia africana* and *Pterocarpus erinaceus* were also the browse species consistently consumed in large quantities. *Imperata cylindrica, Rottboelia cochinchinensis, Vitellaria paradoxa* were virtually absent in the diet of the roan antelope during the cold-dry and the warm-dry periods of the year.

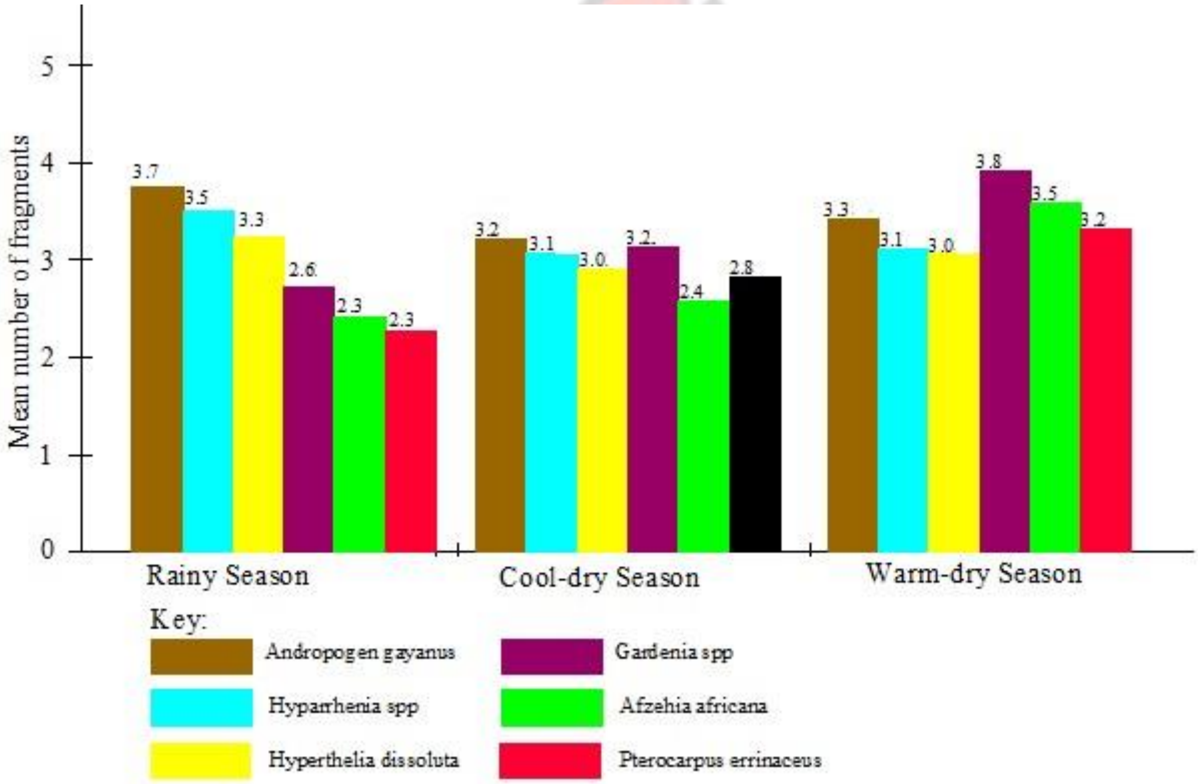

Figure 7: Seasonal Variations of Six most Consumed Grass and Browse Species

4.11 Browse to Grass Ratio in the Seasonal Diet of the Roan Antelope

The browse to grass ratio in the diet of the roan antelope varied from one season to another. The highest browse to grass ratio (1.04) was recorded in the warm-dry season, followed by the cool-dry season (0.77) and the lowest was recorded in the rainy season (0.62) (Figure 8).

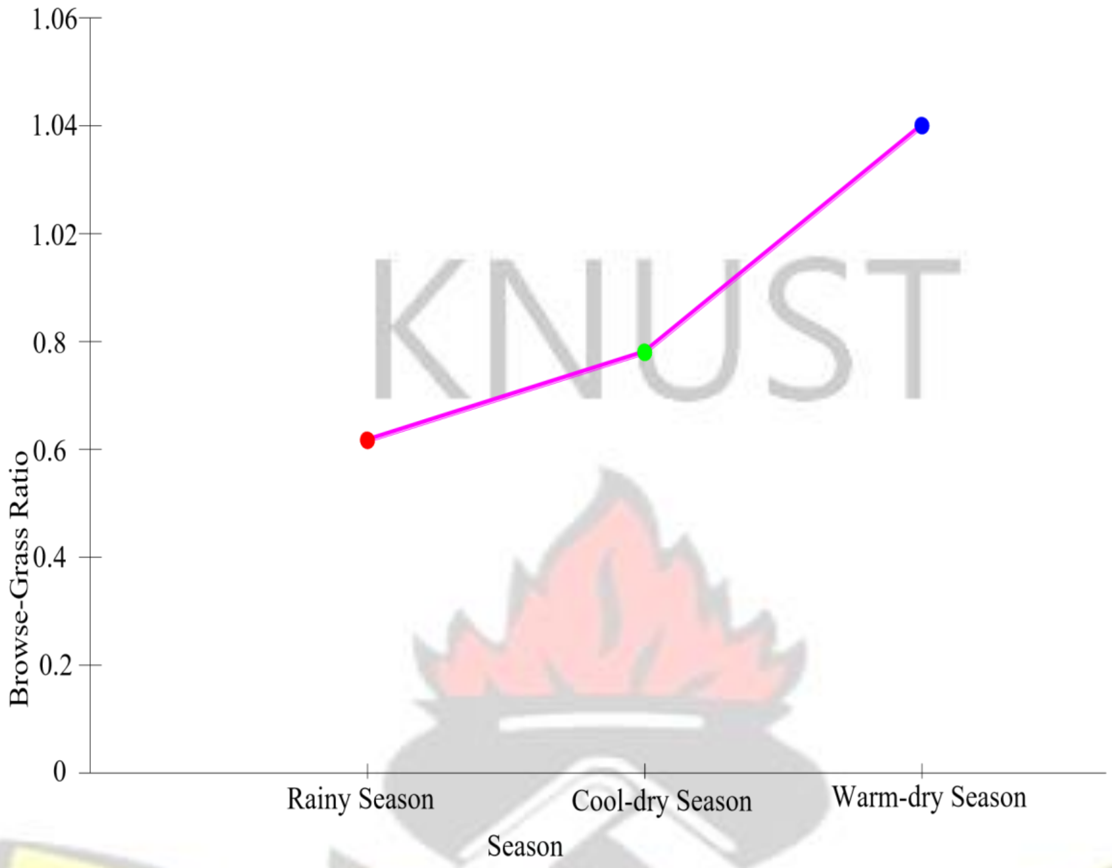

Figure 8: Browse to Grass Ratio in the Seasonal Diet of the Roan Antelope in Gbele Resource Reserve

CHAPTER FIVE

5.0 DISCUSSION

5.1 Diet Composition of the Roan Antelope across Seasons

The diet of the roan antelope consisted of a diverse species of food plants (Chetri, 2006; Schuette *et al.,* 1998). The mixed proportions of forage in the diet of the roan antelope in this study are in close agreement with the findings of (Schuette *et al.*, 1998; Spinage, 1986) that the roan antelope is a grazer and a mixed feeder. Kingdon, (1997) reported that the roan antelope grazes on medium to short term grass lengths and browses various shrubs and trees. In this study, the average grass consumption was (37%), browse (30%), forbs (19%) and other unidentified (14%).

In the warm-dry season, fruits of *Acacia siebariana* and *Faidherbia albida* were also recorded. The figures recorded for these fruits were however very minimal in the cool-dry season and the rainy season mainly due to the absence of these fruits during this period of the year. Also, fruits of *Vitellaria paradoxa* were recorded in the rainy season and the hot-dry season respectively. The presence of these fruits in the diet was probably due to their availability in both seasons as compared to *Acacia siebariana* and *Faidherbia albida* whose fruits were available only in the hot-dry season.

Kingdon (1997) also reported that, roans are fond of picking up acacia pods in the dry season, visiting mineral licks and chewing at old bones and soil. The proportion of unidentified forage species (14%) confirms that roans consume a wide variety of food species that could not easily be identified from a microscope slide. Generally, the consumption of forage species varied dramatically from one season to another mainly due to vegetation changes which resulted from changes in climatic conditions.

5.2 Seasonal Changes in the Diet of the Roan Antelope

In the typical rainy season (June-September) the diet of the roan antelope was dominated by grass forage. Schuette *et al.* (1998) reported that, roans consumed more than (95%) grass in the rainy season compared to other periods of the year. The results of this study further confirmed earlier reports presented by Spinage (1986) that the roan antelope predominantly feeds on medium height fresh grass up to (90%) in the rainy season. The higher preference for grass diet in the rainy season could be attributed to the abundant growth of new succulent grasses stimulated by the onset of the rains. The proportion of grass in the diet of the roan antelope was higher than all other forages. These findings confirmed earlier submissions made by

Schuette *et al.* (1998) and Spinage (1986) that roans are predominantly grazers. Browse consumption in the rainy season was on a relatively low side compared to the hot-dry season. This outcome is in close agreement with the findings of (Richard, 1992) that the roan antelope browses to some extent up to (10–20%) rumen content of forbs, leaves and pods during certain periods of the year.

In the cool-dry season (October–January), the proportion of grass forage in the diet of the roan antelope declined from (41%) to (37%). This reduction could be attributed to the relatively low supply of high quality grass. Chetri (2006) reported that most grasses senesce during this period of the year and grasses that had matured fully are avoided by animals. The proportion of grass diet was lowest in the warm-dry season (33%). The warm-dry season was the one in which the consumption of grass forage had drastically declined. This outcome is in close agreement with earlier reports made by Schuette *et al.* (1998) that roans usually switched from being predominantly grazers (>95% grass) in the rainy season to mixed feeders (<50% grass) in the hottest period of the dry season (February – May).

Again, the rainy season witnessed the least consumption of forbs and browse species. This could be due to the availability of high quality grass forage which attracted roans more than browse and forbs during this period of the year. The proportion of other unidentified forage species was high in the warm-dry season than in other seasons. These results are in consonance with early works done by (Kingdon, 1997) that roans consumed pods of various kinds, mushrooms, bones and soil during the dry period of the year. Also, during this time the animals were probably feeding on new shoots which have higher digestibility than mature plants or they might have eaten other forage species which were not covered in slide preparation. Holechek *et al.* (1982) also pointed out that fragments of forage species may differ between species during digestion, therefore the relative proportions of species appear different

5.3 Leaf Epidermal Characteristics of Grass Species

The leaf epidermis of the various grass species studied exhibited a wide variety of anatomical characteristics which may be useful in classifying plants into families and sub-families. Abayomi and Ojuolape (2009) pointed out that the leaf epidermal characteristics of grass species such as stomata, long cells, short cells, prickle-hairs, macro-hairs and micro- hairs varied considerably in size and shape according to species. In this study, the shape of the subsidiary cells of the stomata varied from low-domed to triangular-shape from one grass species to another.

Again, there was a marked difference in the distribution of stomata between the adaxial and abaxial epidermis of all the grass species studied. Numerous numbers of stomata were seen in the abaxial epidermis while solitary or none was recorded in the adaxial epidermis. Abayomi and Ojuolape (2009) reported similar distribution of stomata between the adaxial and abaxial epidermis in *Andropogon gayanus* and *Andropogon tectorum*. Moreso, the leave epidermis of *Hyparrhenia rufa, Hyperthelia dissoluta, Rottboelia cochinchinensis, Elucine indica* and *Imperata cylindrica* were clearly distinguished into coastal and intercoastal zones with the intercoastal zones broader than the coastal zones. These findings were in consonance with earlier studies conducted by Ogie-Odia *et al.* (2010) who made similar observations in other genera and tribes of the family Poaceae.

5.4 Leaf Epidermal Characters of Browse and Forbs Species

The leaf epidermal surfaces of both browse and forbs species showed a significant degree of variation in terms of anatomical characters found in them. The epidermal cells of both browse and forbs in this study varied considerably from irregular to slightly rectangular in shape in both adaxial and abaxial epidermis with the anticlinal cell walls undulating in adaxial epidermis and mostly sinuous in the abaxial epidermis. These observable features showed similarities with that of Kemka and Nwachukwu (2011) who reported a wide variation of leaf epidermal cell types and cell walls in the adaxial and abaxial epidermis of the genus *Grassocephalum*. Non-glandular types of trichomes which were generally unicellular in shape were observed in both the adaxial and abaxial epidermis of *Gardenia ternifolia* and *Anogeissus leiocarpus.* Adedeji and Jewoola (2008) have reported similar observations in the distribution of trichomes in the family Asteraceae.

Numerous stomata were recorded in the abaxial epidermis of all the species with infrequent or no stomata recorded in the adaxial epidermis. Stomatal types in all the species were anomocytic except in *Gardenia ternifolia, Gardenia aqualla* and *Daniellia oliveri* whose stomata were observed to be contiguous and paracytic. Abayomi and Ojuolape (2009) reported a marked difference in the frequency of stomata between the adaxial and abaxial epidermis of plant species. Similar stomatal distributions and types were reported earlier by Patil and Patil (2011) with the family Rubiaceae.

5.5 Forage Selectivity by the Roan Antelope

Among the six most important forage species, *Andropogon gayanus* was the most consumed species. These species dominated all other species in the rainy and cool-dry seasons except the warm-dry season. Its average proportions were highest (3.70 and 3.23) among all other species during the rainy season and the cool-dry season. These findings are in close relationship with earlier reports by Schuette *et al.* (1998) that roans continue to use *Andropogon* species throughout the year mainly due to its low ratio of reproductive or vegetative shoots to physically inhibit roan's use of their leaves than in the case of other grass species.

Among the browse species, *Gardenia spp* was most consumed as it dominated all other browse species in the diet of the roan antelope throughout the three climatic periods. Its proportion was highest in the hot-dry season (3.80) and lowest in the rainy season (2.62). This is in close agreement with that of Richard (1992) who reported that roans browse to some extent (10%–

20%) of rumen contents. Its continuous dominance among the browse species indicated that it was the most preferred browse species for roans.

5.6 Browse to Grass Ratio in the Diet of the Roan Antelope

The browse to grass ratio varied from one season to another. The highest browse to grass ratio (1.04) was recorded in the hot-dry season. The ratio however declined slowly and reached the lowest (0.62) in the rainy season. The main reason that could have accounted for the high browse to grass ratio in the hot-dry season is the low moisture content in the soil during this period which retards the growth of nutritious grass species until the returns of the rains in June (Schuette *et al.*, 1998). The lowest browse to grass ratio recorded in the rainy season could also be attributed to the availability of fresh and nutritious grass species which made roans to switch from high browse diet in the warm-dry season to a grass diet in the rainy season. These results are in closed consonance with earlier reports made by Schuette *et al.* (1998) that roans usually switched from being predominantly grazers (>95% grass) to mixed feeders (<50% grass) in the Warm-dry season when grasses presumably becomes less available. In this study, although the number of fragments of food plants recorded was quite high, leaves of delicate and succulent forage species could not appear on slide and therefore could not be identified, perhaps due to complete digestion.

Holechek *et al.* (1982) also pointed out that microhistological faecal analysis gives good precision but accuracy is a problem because of differential and incomplete digestion between plant species. In this study, only a smaller proportion (14%) was recorded as other unidentified forage in the three climatic periods of rainy season, cool-dry season and warmdry season. Vavra and Holechek (1980) also reported that faecal analysis does not incorporate all species in a herbivore’s diet because of the destruction of some plant species that may occur during slide preparation.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The results of the study suggested that diet of the roan antelope is composed of a variety of forage species which are consumed in different proportions in relation to different seasons of the year. Seasonal comparison of roan's diet indicated that its feeding habits varied from one season to another. The variation in feeding habits was influenced by changes in climatic conditions. In the rainy season where roans are faced with greater plant availability, they presented a more selective behaviour by consuming grasses than any other forage species. This behaviour was probably influenced by such factors as availability and freshness of grasses. In the dry season however, where food relatively became less available with reduced forage quality; the number of ingested plant species consumed by roans increased from being predominantly grasses to browse, forbs and others.

6.2 Recommendations

Based on the research findings, the following recommendations are made:

1. Further studies should be conducted in the area over an extended period to determine whether the feeding habit of the roan antelope is consistent or not.
2. Further research on the epidermal characteristics of plant species should be extended to cover other camps of the reserve in order to obtain a comprehensive and detail database of epidermal characteristics of plant species in the entire reserve for reference purposes.

REFERENCES

Abayomi, E.F and Ojuolape, F.O. (2009): Comparative foliar epidermal studies in

Abbas, A. (1991). Feeding strategy of Coypu (Myocastor coypus) in Central Western Accessed August 12, 2014.

Adedeji, O and Jewoola, O. A. (2008): Importance of leaf epidermal characters in the

African Bovids. *Journal of Mammalogy*. 76: 448-471.analysis of faeces. *Journal of Range management*. 36 (1): 132-133.

Andropogon gayanus and *Andropogon Tectorum*. *Thaizia Journal of Botany*. 19: 27-35.*Asteraceae* family. *Notulae Botanicae Horti Agrobotanici.* 36 (2): 7-16.

Baugartner, L. L., and Martin, A.C. (1939). Plant histology as an aid in squirrels food-

Bell, R. H.V. (1984). Soil–plant–herbivore interactions. In: Conservation and Wildlife Management in Africa. Eds. US Peace Corps: Washington D.C.Cambridge, U.K.

Chetri, M. (2006). Diet Analysis of Gaur, *Bos gaurus gaurus* (Smith, 1827) by Microhistological Analysis of Faecal Samples in Parsa Wildlife Reserve, Nepal. *Our Nature.* 4:20-28. Available online at www.lib.icinod.org/record/12231/files Accessed September 24, 2013.

Desbiez, A. L. J., Rocha, F. L. and keuroghlian, A. (2010). Interspecific association between an ungulate and a carnivore or a primate. *Acta Ethological press.* Available online at www.beheco.oxfordjournals.org/content. Accessed March 3, 2012.determining diet composition. Journal of Range Management. 54: 582-588).

Duncan, P. (1975). Tobi and their energy supply. PhD thesis, University of Nairobi.

Dunham, K.M. (1998). The Epidermal characters of some Grasses from North–West

Eliana, E. B. and Roberto, M. B. (2002). Sample Numbers for Microhistological

Ellis, R. P. (1987). A procedure for standardizing comparative leaf anatomy in the

Encyclopaedia Britannica, (2011). "Roan antelope", Encyclopaedia Britannica. Online at http:// www.britannica.com/EBchecked/topic/505211/roanantelopes. Accessed May 20, 2012.

Estimation of Vizcacha Diets. *Journal of Range Management*. 55 (5): 498-501. Available online at https://journals.uair.arizona.edu. Accessed September 6, 2012.

Foliar epidermal and phytochemical studies of grass *Cymbopogon citratus* (STAPF), *Axonopus compressus* (P. BEAUV) and *Eragrotis tremula* (S.W.BEAUV) in Ekpoma, Edo state, Nigeria. *Science World Journal*. 5 (1): 20-25. Available online at www.scienceworldjournal.org Aceessed May 20, 12. for light microscope studies of Vitis-leaves. *Journal of Ecology*. 4 (1): 19-53.France. *Journal of Zoology*. 224:385401. http://dx.doi.org/10.111/j.1469. Accessed June 3, 2013.

Ghana National Parks, (2007). Ghana Tourism Home Page. www.ghanatourism.info. Accessed May 10, 2012 habit studies. *Journal of wildlife Management*. 3 (3): 266268.Availlable online at https://www.sciencebase.gov/catalog/item. Accessed June 20, 2012.

hartebeest and roan antelope in Burkina-Faso, support of the long-faced hypothesis. *Journal of Mammalogy*. 79(2):426-436. Available online at http://ww.jstor.org/action

Heitkonig, I. M. A. (1993). Feeding Strategies of Roan Antelope (*Hippotragus equinus*) in a low Nutrient Savannah. PhD thesis. University of Witwatersrand, Johannesburg.

Henley, S.R., Smith, D.R. and Raats, J.G. (2001). Evaluation of 3 techniques for Hippotragus niger in Pilanesbergy National Park, Bophuthatswana. Msc thesis, Univeristy of Witwatersr and, Johannesburg.

Hobbs, N.T and Spowart, R. A. (1984). Effects of prescribed fire on nutrition of

Holechek, J. L., Vavra, M. and Piepe, R. D. (1982). Botanical composition determination of range herbivores diets. A review. *Journal of Range Management*. 35 (3): 309315.http://animaldiversity.org,accounts/Hippotragus-equinus/ Accessed (12 June, 2012).

IEA (Institute of Applied Ecology) (1998). *Hippotragus equinus*. African mammal's Data bank. A Databank for the Conservation and Management of the African Mammals, Vol.1 and 2. Bruxelles. www.gorialla.bio.uniromal.it/amd1726.html. Accessed 8th April, 2011.

Ignas, H. and Norman, S. (1998). Seasonal Selection of soil types and grass Swords by roan antelope in South African savanna. *African Journal of Ecology*. 36 (1): 57-70

International Union for the Conservation of Natural Resource (2008). Red List ofThreatened Species. (On-line), retrieved from http://iucnredlist.org. Accessed April 03, 2016.

International Union for the Conservation of Natural Resources, (2004). Red List. www.iucnredlist.org. Accessed June 24, 2012.

Ioni, G. C., Raquel, N.V., Oliveira, R. M. and Elton, P. C. (2010). Feeding habits of Coypu (Myocastor coypus Molina, 1978) in the Wetlands of the Southern region of Brazil. *Brazilian Academy of Science.* 82 (3): 671-678.

Kemka, C.I and Nwachukwu, C.U. (2011): Epidermal micromorphology of species in the genus Crassocephalum Moench. S. Moore (Compositae) in Nigeria. *Journal of Pharmacological Science*. (3): 29-41.

Kingdon, J. (1997). The kingdon Field Guide to African Mammals. Academic press, London and New York: Natural World.

Magome, D.T. (1991). Habitat selection and feeding ecology of the sable antelope,

Malechek, J.C. and Samuel, M. J. (1968). Disappearing forbs in microhistological Margraf

Publishers GMBH, MNHN, Wageningen. The Netherlands. 578Pp.

Maria, A. D. and Stella, M. G. (2001). Technical Note: A simple method for preparing reference slides of seed. *Journal of Range Management*. 54 (2): 191–193. Available online at https://journals.uair.arizona.edu. Accessed June 12, 2012.

Mcinnis, M. L., Vavra, M. and Krueger, W. C. (1983). A comparison of Four Methods used to determine the Diets of Large Herbivores. *Journal of Range Management*. 36 (3): 302-306. Available online at www.oregonstate.edu. Accessed May 12, 2013.

Metcalfe, C.R. (1960). Anatomy of the monocolydons. Gramineae. Oxford University. Clarendon Press, London.

Michel, A. (2004). Trees, Shrubs and Lianas of West African dry zones. 2nd edition mountain

Sheep and mule deer during winter and spring. *Journal of Wildlife Management*.

48: 551-560.

Murray, M.G. and Illius, A.W. (1996). Multispecies grazing in the Serengeti. Ecology and management of grazing systems. Eds. J.Hodgson and A.W. Illius, CAB International UK.

Ogie–Odia, E.A., Eseigbe. D., Llechie M.N., Erhabor, J. and Ogbebor, E. (2010).

Ogie–Odia, E.A., Mokwenye, A.I., Kekere, O. and Timothy, O (2010). Comparative vegetative and foliar epidermal features of three *Paspalum* L. species in Edo state, Nigeria. *Ozean Journal of Applied Sciences.* 3 (1): 20-38.

Okezie, I. A. and Agyakwa, C. W. (1987). A Handbook of West African Weeds. International Institute of Tropical Agriculture, Ibadan, Nigeria. 528 Pp.

Owen, S. N. (2002). Adaptive Herbivore Ecology.Cambridge University Press.

Patil, C.R. and Patil, D.A. (2011). Investigations on foliar epidermis in some Rubiaceae. *Journal of Phytology*. 3 (12): 35- 40.

Perrin, M.R. and Taolo. C. (1999). Habitat use by a herd of introduced roan antelope in Kwazulu-natal, South Africa. *Journal of Wildlife Restoration.* 29: 81–88.

poaceae; the past twenty five years. Proceedings of the International Symposium on Grass Systematics and Evolution. Washington D. July, 1986. 31Pp.

Raole, V.M. and Desai, R. J. (2009). Epidermal Studies in some Members of *Andropogoneae*. (Poaceae). *Not. Bot. Hort. Agrobot. Cluj*. 37 (1) 59-64. Available online at http://not-bot-horti-agrobo.blogspot.com/ Accessed November 4, 2012.

Ray, T.H. and Kottmann, M.M. (1999). Collecting, Drying and Preserving Faeces for Chemical and Microhistological Analysis. *Journal of Range Management.* 41 (2): 168-171.

Richard, D.E. (1992). The Behaviour Guide to African Mammals. The University of California press Ltd, Berkeley and Los-Angeles, California. 512Pp.

Robbins, C.T., Spalinger, D.E. and Wouter,V. H. (1995). Adaptation of ruminants to browse and grass diets. Are anatomical–based browsers–grazer interpretations valid? *Oecologia*. 103 (2): 208–213. Available online at www.springer.com. Accessed May 20, 2013.

Roe, B. (2002). "Hippotragus equines" Animal Diversity Web. Retrieved from

Santos, S.A., Desbiez, A., crispim, M. A., Comastri Filho, J.A., Abreu, U.G.P, and Rodela, L. (2009). Natural and cultivated pastures and their use by cattle. Pensoft press, sofia–Moscow.

Schuette, J.R., David. M., Robert. L. L. and Jonathan, A. J. (1998). Diet of

Scoones, I. (1995). Exploiting heterogeneity; habitat use by cattle in dry land Zimbabwe. *Journal of Arid Environment*. 29:221–237.

Sparks, D.R. and Malechek, J.C. (1968). Estimating percentage dry weight in diets

Spencer, L.M. (1995). Morphological correlations on dietary resource partitioning in

Spinage, C.A. (1986). The Natural History of Antelope. Facts on file publications, New York. 518 Pp.

Stewart, D.R.M. (1967). Analysis of plant epidermis in faeces; a technique for studying the food preferences of grazing herbivores. *Journal of Applied Ecology* 4: 83-111

Swanepoel, J.J. and De La Harpe, A.C. (1983). Preparation of epidermal tissues

Theodor, H. (1992). A Field Guide to Mammals of Africa including Madagascar.

Toms, R. and Joubert, S. (2005). Roans 200 years later. Africa's First on-line Science Magazine. Available online at http://www.scienceinafrica.com/biotechnolo.

University press, UK. Pp 115-117.

using a microscopic technique. *Journal of Range management*. 21: 264-265.

Vavra, M. and Holechek, J. L. (1980). Factors influencing Microhistological Analysis of Herbivores Diets. *Journal of Range Management*. 33(5): 371-374. Available at www. oregonstate.edu. Accessed August 20, 2013.

Wildlife Division, (2009). Wildlife and Nature Reserves in Ghana. Available online at www.wildlifeghana.com//gbele.html. Accessed June 4, 2012.William and sons co. Ltd, South China, Hong Kong.

William, J.S. (2000). Editor; Ecological Census Techniques, a Handbook. Cambridge Zimbabwe. *Kirkia*. 13(1):153-195. Available onine at www.africabib.org. Accessed February 12, 2012.

APPENDICES

APPENDIX I: Photographs of Sampled Grasses from the Area

Plate 1: Sporobolus pyramidalis

Plate 2: Andropogon gayanus

Plate 3: Hyparrhenia rufa

APPENDIX II: Photographs of some Browse Species in the Study Area

Plate 4: Daniellia oliveri

Plate 5: Gardenia ternifolia

Plate 6: Pterocarpus erinaceus

APPENDIX III: Photographs of Some Forbs Species in the Study Area

Plate 7: Tridax Procumbens

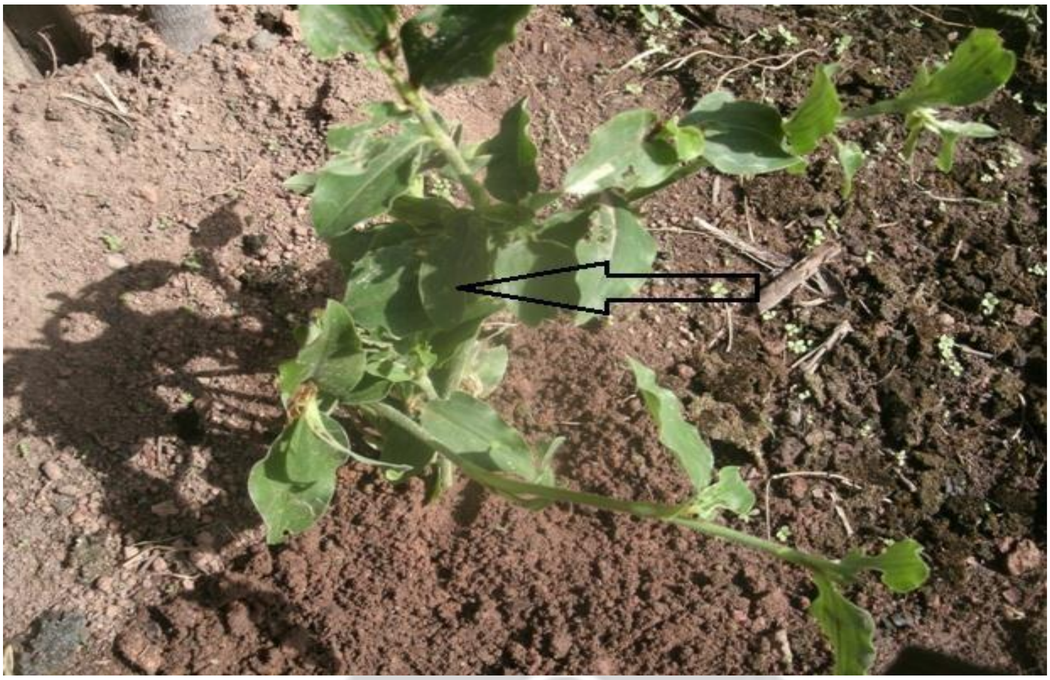

Plate 8: Commelina benghalensis