KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,

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DEPARTMENT OF THEORETICAL AND APPLIED BIOLOGY

THE INFLUENCE OF TERMITES, OTHER FAUNA AND SOME CLIMATIC FACTORS ON THE DECOMPOSITION OF AN INDIGENOUS AND AN EXOTIC WOOD SPECIES IN A MOIST SEMI-DECIDUOUS FOREST ZONE OF GHANA

BY

Opoku-Kwarteng Christian BSc. (Hons.)

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By

Opoku-Kwarteng Christian

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DECLARATION

I thereby declare that this submission is my own work towards the MSc. and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University , except where due acknowledgement has been made in the text.

OPOKU-KWARTENG CHRISTIAN …………………… ……………….........

(Student) PG6509811 Signature Date

PROF. OBIRI-DANSO ………………………. …………...........

(Supervisor) Signature Date

REV. STEPHEN AKYEAMPONG ………………………. …………………

(Head of Department) Signature Date

DEDICATION

This work is dedicated to my father, Rev. Samuel Odom Kwarteng and my siblings.

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ABSTRACT

The role of termites, other fauna and environmental factors as a measure of decomposition rates of *Cola gigantea* and *Populus tremuloides Michx* (Aspen) were determined on twelve (12) plots in the Bobiri forest reserve, a near primary forest near Kumasi in the Ashanti region. Each plot measured 100 m x 6 m. Two wood samples, *C. gigantea* (indigenous wood species) and Aspen (*Populus tremuloides* Michx.) an exotic wood species were used for the study. Exclusion experiments with mesh bags of two different mesh sizes: 0.03 mm and 5 mm were used to exclude and include macro fauna and termites respectively. The single-exponential model was used to determine decomposition rates. The study identified termites within three genera; *Macrotermes*, *Microtermes* and *Ancistrotermes* all belonging to the sub-family Macrotermitinae which feed on wood and litter. Other fauna identified were earthworms, arthropods, spiders, wood louse, centipedes, millipedes and ants. Aspen wood in the large as well as small mesh bags decomposed about 3.4 and 3 times faster than *C. gigantea* wood in the large as well as small mesh bags respectively. Hence the 'the home field advantage' theory is not always true. In addition, the decomposition rate of Aspen and *C. gigantea* wood in the large mesh bags were about 4.6 and 4 times faster than the decomposition rate of Aspen and *C. gigantea* wood in the small mesh bags respectively. The decomposition rate of the *C. gigantea* and Aspen wood in the large as well as small diameter mesh bags decreased with increasing maximum temperature, with the optimum range being 31 to 33°C but it increased with increasing cumulative rainfall. Precipitation rates greatly affect decomposition than temperature. Macro and meso fauna, particularly termites, contributed significantly to nutrient cycling and CO_2 emission.

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CHAPTER ONE

1.0 INTRODUCTION

Nutrient cycling and carbon flux is essential to climate change, soil fertility maintenance and ecosystem productivity (Kricher, 2010). Decomposers' activities are necessary for nutrient cycling and carbon dioxide emissions. Organisms associated with wood degradation are principally fungi, insects, bacteria and marine borers. The marine borers include ship worms, pholads, *Limnoria* and *Sphaeroma*. Carpenter bees and carpenter ants have also been documented as being involved in wood degradation (Clausen and Yang, 2007). Decomposers in tropical forests are mainly fungi, termites, arthropods, beetles, wood louse, bacteria, algae, ants, earth worms *(Ascaris species)* and their activities are often affected by precipitation, relative humidity, soil moisture, soil temperature and atmospheric temperature (Clausen and Yang, 2007). Termites, social insects, are major decomposers in tropical forests and account for ninety-five percent (95%) of insect biomass in the tropical forest (Withgott and Brennan, 2011). The diversity of feeding and nesting groups among termites enables them to influence ecosystem processes at a number of levels; colony, the individual and the gut microbe level.

Each member of the termite colony performs specific roles as defined by their caste (worker, soldier, reproductive termites etc). Termite castes and job specialization make them very productive and/ or destructive (Hickin, 1975). The caste of a termite colony is made up of the reproductive caste, the queen (the supreme mother) who lays the eggs and the king (a male termite) that mates with the queen, the termite workers and termite soldiers. The soldiers' appearance is a distinguishing feature in separating one species from the other (Clausen and Yang, 2007). Termite species groups include dry wood termites, damp wood termites, formosan termites and subterranean termites. These are the most important termite species groups among over 5,000 known species of termites in terms of causing damage to wood by gnawing (Clausen and Yang, 2007; Synder, 1948). The social season (season for shedding wings by queen and king to start a colony) for termites often depend on the rainy season, time of year and size of colony.

1.1 Research questions

1. How do termites influence wood decomposition rate in the tropical moist semi- deciduous forest zone?

2. To what extent do termites influence wood decomposition rate in the tropical moist semi- deciduous forest zone?

3. What factors account for wood decomposition in the absence of termites (and other fauna above 0.03 mm in diameter)?

4. How and to what extent does other fauna and environmental factors (such as temperature and precipitation) influence wood decomposition rate in the tropical moist semi- deciduous forest zone?

1.2 Justification

Woody debris is a conspicuous feature of forest ecosystems. This material decomposes slowly (Harmon *et al.*, 1986) and influences a variety of ecosystem processes over long periods. Woody debris provides important habitat for a diversity of forest species and is a source of considerable amounts of carbon and other elements released into the soil or atmosphere through decomposition (Schowalter, 1998).

Ecologists and forest managers have recognized the potential long-term contributions of decomposing wood to carbon dynamics, nutrient cycling, soil development, ecosystem productivity and biotic diversity (Swift, 1977; Boddy 1983; Harmon *et al.,* 1986). The importance of wood as long-term carbon pool has gained significance with the prospects of global climate change (Harmon *et al.,* 1990), hence management of wood and factors influencing its turnover in forest ecosystems have become important component of forest management (Harmon *et al.*, 1986*;* Schowalter, 1992).

Ghana as a country has recently taken a proactive step towards implementing the Reduced Emissions from Deforestation and forest Degradation (REDD+) programme which is a strategy to better manage its forest resources and mitigate climate change. Data on wood decomposition will contribute to knowledge on ecosystem productivity, carbon flux and nutrient cycling that is needed in response to climate change and its mitigation measures such as the REDD+. Wood decomposition releases nutrient elements such as nitrogen, phosphorus, potassium, carbon in the form of carbon dioxide, calcium, magnesium, sulphur, sodium etc (Schowalter, 1998). In the context of the Reduced Emissions from Deforestation and forest Degradation (REDD+) programme, it is important to quantify both the carbon stocks and the carbon fluxes of African forests (Ciais *et al.,* 2011). In the light of this pressing research need, a study of this nature will help us to better understand ecosystem processes such as decomposition, nutrient cycling and fluxes of carbon in Ghana's forest, as well as the agents responsible for these processes. Data therefore obtained will serve as a reference point for estimating decomposition rates of wood in the moist semi-deciduous forest zone. It will also serve as a baseline for a more comprehensive assessment of the entire carbon budget of Ghana's forests. Results obtained and knowledge on carbon flux will help improve climate change education, mitigation and adaptation strategies.

Research on wood decomposition will also provide data on the relative importance of: termites, other fauna and environmental factors on ecosystem productivity, carbon flux (including carbon from wood decomposition) and nutrient cycling, as well as establish whether different species of wood decompose at different rates. It will also establish the contribution of other macro fauna to wood decomposition, affecting ecosystem dynamics.

Termites are one of the major macro fauna decomposers mostly associated with tropical regions. Lowland tropical primary forests are known to be places where termite diversity and abundance are highest (Eggleton *et al.,* 1994). Termites are very important for wood decomposition and using experimental bags with mesh diameter of 5 mm help to include termites while 0.03mm mesh bags exclude them. This is done in order to ascertain the importance of termites in terms of wood decomposition.

Decomposition is documented to contribute to carbon dioxide emission into the atmosphere (Schowalter, 1998) however data on termite activity resulting in decomposition in the moist semi-deciduous forest zone of Ghana is not adequate or lacking. There is therefore the urgent need to study the roles termites and other fauna play in decomposition in the forest in order to ascertain their contribution to carbon dioxide emission into the atmosphere.

1.4 General Objectives:

The study will examine the role of termites, other fauna and environmental factors in key ecosystem processes such as decomposition, carbon loss and also measure decomposition rates of *Cola gigantea* wood and *Populus tremuloides Michx* (Aspen) wood.

1.5 The specific objectives are:

1. To determine the termite species that significantly contributes to wood decomposition in a moist semi- deciduous forest zone.

2. To identify other fauna that significantly contributes to wood decomposition in a moist semi- deciduous forest zone.

3. To compare the decomposition rate of the wood of an exotic species (Aspen) and an indigenous species (*Cola gigantea*), with similar wood density.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1.1 Decomposition

Decomposition is the physical breakdown of organic matter into simpler forms. For decomposition to occur there must be adequate temperature, a water film, aeration, suitable pH, enzymes, diffusion conditions, and an accessible and susceptible substrate in the same place at the same time. It is primarily a biological process resulting from enzymatic activities of soil micro organisms and influenced in a variety of ways by activities of soil fauna (Visser, 1985). Melillo *et al.* (1989) presented a general model of the decomposition process from litter to humus in two phases. During the early stage, there is a rapid loss of water-soluble components followed by a rapid loss of cellulose from the litter. There is little loss of insoluble decomposition products (collectively referred to as lignin). During the early phase, carbon is relatively available and nutrients are limiting. There is immobilization of limiting nutrients (usually nitrogen). Once the litter reaches the late stage of decomposition, it is considered humus. It is distinguished by a stabilized content and slow decomposition of all components. The late stage of decomposition is characterized by a net loss of lignin and net mineralization of nitrogen. Most wood are converted to humus and that is to say the nutrients that have been stored within the wood for decades return to the soil after decomposition (Li *et al.*, 2006). Gonzalez *et al.* (2008) found that Aspen stakes decomposed fastest in the tropical sites and slowest in the temperate forest fragments. Also the percent of mass remaining was significantly greater in dry than in moist forests in boreal and temperate fragments, while the opposite was true for the tropical forest fragments. No effect of fragment size on the percent of mass remaining of Aspen stakes in the boreal sites, temperate dry and tropical moist forests were observed. Moisture condition is an important control over wood decomposition over broad climate gradients; and that such relationship can be non linear, and the presence of a particular group of organisms (termites) can significantly alter the decomposition rates of wood more than what might be predicted based on climatic factors alone (Gonzalez *et al.,* 2008). Biotic controls on wood decomposition might be more important predictors of wood decomposition in tropical regions, while abiotic constraints seems to be important determinants of decomposition in cold forested fragments (Gonzalez *et al.,* 2008). The decomposition rate is generally expressed through a constant (k) which indicates the relative mass over time, and can be determined by long-term monitoring, chronosequence approach and the ratio between initial and final mass of wood. Using mathematical models to simulate decomposition patterns and to estimate the decomposition rate has been widely applied to quantify the decomposition of wood (Harmon *et al.*, 1986; Li *et al.,* 2006). The single-exponential model is the most common multiple linear regression model form used to determine decomposition rates (Olson, 1963; Graham and Cromack, 1982; Barber and Vanlear, 1984; Edmonds and Eglitis, 1989; Harmon and Chen, 1991; Laiho and Prescott, 1999; Chen *et al.,* 2001; Janisch and Harmon, 2001; Zhang *et al.,* 2008). Typically, decomposition rates are expressed as *k* values or fractional loss rates. The unit of *k* is typically yr^{-1}. In the long-term, woody tissues are relevant to the global balance of atmospheric CO_2 through the sequestration of large amounts of carbon. It is therefore not surprising that many conservation and management strategies recommend minimum amounts and specific quality and distribution of wood in forests and recognize wood decomposition as a key ecological process (Gonzalez *et al.,* 2008).

Numerous studies support that many ecological processes in forested ecosystems depend on the mass of woody tissue, and that its decomposition is relevant to the global balance of atmospheric CO_2 (Schowalter, 1998; Gonzalez *et al.*, 2008).

Moisture has been observed to have non-linear effects on the decomposition of wood in laboratory experiments as low moisture levels decrease decomposition rates and saturated conditions can inhibit decomposer respiration (Powers *et al.*, 2009; Schuur, 2001). Field measurements also suggest that moisture is important in some ecosystems; but conflicting results for the relationship between wood decomposition and moisture are found in literature. For example, Harmon *et al*. (1987) found an inverse relationship between the decomposition rate of coarse woody debris in mixed conifer forests and annual precipitation (in a gradient ranging from 113–342 cm yr^{-1} in precipitation) in the western US; a result consistent with laboratory studies that indicate excess moisture can reduce aeration (Harmon and Chen, 1991) as represented by Yatskov *et al*. (2003). In contrast, Chambers *et al*. (2000) tested for controls of decomposition on coarse-litter from major forested ecosystems worldwide (including temperate coniferous, deciduous, mixed and tropical dry and evergreen forests), and found that precipitation was not correlated with decomposition rate constants but to mean annual temperature.

Consistent with Chambers *et al*. (2000); Marra and Edmonds (1996) found that saturated conditions did not control seasonal variations of decomposition of coarse woody debris on a clear-cut forest in Washington, USA. Gonzalez *et al.* (2008) found that both the percent of mass remaining and the decomposition rate constant were significantly and negatively correlated to the annual precipitation. The percent of mass remaining was significantly greater in dry than in moist forest fragments in the boreal and temperate forests. Yet, the results of other studies also showed a significant climate and moisture interaction on the decomposition rate constant; as the decomposition of aspen stakes was much higher in the moist than in the dry fragments in the tropical forests (Marra and Edmonds, 1996).

Soil organisms have been shown to be important determinants of decomposition. The fast decomposition rates of Aspen wood in the tropical forest fragments can be explained by the conditioning of fungi in the wood, the presence of wood burrowing insects such as termites in the tropical forest fragments (Gonzalez *et al.*, 2008). Whitford *et al.* (1981) and Schaefer *et al.* (1985) showed that termites are capable of improving the microclimate and fragmentation of litter in arid ecosystems, resulting in faster decomposition.

2.1.2 Decomposers of wood

The living organisms that can degrade wood are principally fungi, marine borers, bacteria and insects (Clausen, 2010).

2.1.2.1 Fungi

Molds, most sapwood stains, and decay are caused by fungi, which are microscopic, thread-like microorganisms that must have organic material to live on. For some of them, wood offers the required food supply (or substrate). The growth of fungi depends on suitably mild temperatures, moisture and air (oxygen) (Clausen, 2010).

2.1.2.2 Insects

Insects may damage wood and in many situations must be considered in protective measures. Termites are the major insect enemy of wood. Other insect degraders of wood are beetles, ants etc (Clausen, 2010). In the tropical countries, the damage insects cause to lumber and wood in service is of great economic importance. Although periodic estimates have been done for certain countries, the true worldwide losses in wood destroyed and labour expended in replacement cannot be evaluated to a satisfactory degree of accuracy, it is sufficient to state that the losses are extremely great and measures taken by wood users to reduce such damage are a sound investment (Kollman and Cote, 1984).

The class Insecta is divided into 30 orders of which five have species known to bore into wood. These are the orders Ephemeroptera (a species with wood-boring larvae), Lepidoptera (butterflies and moths) with relatively few members having adopted the wood-boring habit. For example, one primitive family, the Cossidae (goat and carpentry moths) consisting of large or very large species, has wood-boring larvae. The members of this family infest fruit trees, making large galleries. The Hymenoptera includes a primitive family, the Siricidae, known as Wood-Wasps or Horntail. The order Isoptera (Termites) is an extremely important wood-destroying group.

2.1.2.2.1 Termites

Termites are an ancient insect order. Termites belong to the group of insects called Isoptera. This term is Latin and refers to the fact that termites have 2 sets of wings that look very much alike. Features that help to differentiate termites from ants include termites having straight, flexible antennae and a broad waist while ants have elbowed antennae and a narrow waist (UNEP/FAO/Global IPM, 2000). Termites are small (4 to 15 mm long) and variable in color from white to tan and even black. They have three-body parts: head, thorax, abdomen, and six legs. They are also social insects and live in colonies. Termites have different looking individuals (called castes) living together in the colony. The largest individual is the queen. Her job is to lay eggs, sometimes thousands in a single day. A king is always by her side. Other individuals have a large head with powerful jaws, or a bulb-like head that squirts liquid. These individuals are called soldiers. But the majority of the termites in the colony are called workers. They toil long hours tending to the queen, building and maintaining the nest or gathering food and feeding the young, which are called larvae. Unique among social insects, termite workers can be male or female. Some individuals that develop wing buds become longer. Finally the nymphs develop into the fully winged adult (alates), the future kings and queens. Termites mostly feed on dead plant material, generally in the form of wood, leaf litter, soil or animal dung. Termites are major detritivores particularly in the tropical and subtropical regions. Their role in the nutrient cycle is of considerable ecological importance (Schowalter, 1998). In tropical habitats around the world, termites and the large earthen mounds they can build are very conspicuous. These mounds are air-conditioned and may contain millions of individuals (UNEP, 2000).

Creffield (1996) stated that termites are among the few insects capable of utilizing cellulose as a source of food. Since cellulose is a major component of wood tissues, majority of plant products are very susceptible to termite damage. Termites, sometimes called ‘white ants’, are found in virtually all parts of the world with the exception of the Arctic and Antarctic regions (Kollman and Côte, 1984; AWPA U1 – 08, 2008). Damage caused by termites is generally far more serious when they occur in the tropical and sub-tropical areas. It is estimated that there may be as many as 5,000 species of termites in five families of order Isoptera (Kollman and Côte, 1984). Termites are gregarious insects living in large colonies with a well-developed caste system (soldiers, workers and reproductives). Termites invade wood for the purpose of obtaining shelter and securing food. They are able to attack both seasoned and unseasoned timbers but are unable to utilize this material directly but rely on protozoa that swarm in the intestines of all the common species of termites for the digestion of cellulose (Kollman and Côte, 1984). According to FAO (1986), there are two main categories of termites, namely subterranean termites and dry - wood termites. There are four (4) main termite ecological groups. These are subterranean, drywood, harvester and mound builders (Supriadi and Ismanto, 2010).

2.1.2.2.1.1 Taxonomic Classification of Termites

Kingdom animalia

Class insecta

Order isoptera

2.1.2.2.1.2 Ecological groups of termites

Subterranean termites

Subterranean termites dwell underground and enter wood from the ground. They require constant supply of moisture for their survival and access their food by constructing soil-covered runways between their source of food and the ground (Kollman and Côte, 1984). They readily attack both sound and decaying timbers in contact with the ground and can also extend their attack to roofing timbers in high buildings. They are responsible for most of the severe termite damage to structural timbers and cause severest structural weakening at the ground lines of poles, bridge timbers, towers and in the foundation members of buildings (Kollman and Côte, 1984; Ofori, 2004). Subterranean termites avoid light and conceal themselves in wood thereby making it difficult to discover their presence. The occurrence of earthlike run ways on stones, bricks, wooden structure and concrete foundations are evidence of their presence (Essien *et al.,* 2012). The annual losses and control costs for subterranean termites in nine states of the southeastern United States were estimated at $435 million (Essien *et al.*, 2012)

Dry wood termites

Dry wood termites live their whole life in wood and require no contact with the ground as the subterranean termites do. They are attracted by light and enter sound wood directly from the air at the time of swarming through cracks, checks, crevice in buildings or small natural openings in wood. Dry wood termites are able to fly and attack very dry and well seasoned wood without external supply of moisture. They are insidious operators and the accumulation of characteristic pellets at the base of the attacking wood is evidence of their presence. The colonies of dry-wood termites are much smaller than those of subterranean termites; therefore their rate of structural destruction is slower (FAO, 1986; Ofori, 2004).

Damp wood termites

Dampwood termites are very restricted in their distribution. They derive their name from the fact that they live and feed in very moist wood, especially stumps and fallen trees on the forest floor (Essien *et al.,* 2012).

Harvester termites

The harvester termites belong to the sub-family *Hodotermitinae* of the family known as "damp wood termites". There is only one genus, the

Hodotermes. The pigmented harvester termite *Hodotermes mossambicus* Hagen belong to this group. The harvester termite lives in the rangeland in Southern Africa. The termite workers forage during the day and also at night. Unlike the workers of many other termites, harvester termite workers have compound eyes. They cannot see clearly, but they can recognize sources of light (UNEP, 2000).

The harvester termite workers make pheromone trails that they follow in order to make their way back to the nest opening. They follow the trails to bring food back to the nest. When these termites find a type of grass that they like, they often clear large patches. The termites create bare areas that many people call "Fairy Rings". The size of the rings can vary based on the size of the termite colony, the amount of grass present and the temperature. The foraging workers can remove as much as 60% of the grass. This can cause shortages for livestock and wild game that depend on the grass for food. By removing the grass, the termites can also cause serious soil erosion (Essien *et al.*, 2012).

Mound builders

Some mound builders are capable of building earthen towers 8 meters or more in height. Termite mounds which from their shear site or numbers often can dominate landscapes are common in Africa (Kollman and Côte, 1984).

2.1.2.2.1.3 Importance of termites

Positive Impacts of Termites

Termites contribute significantly to most of the world’s ecosystems. Termites are of greatest importance in recycling woody and other plant material. Their tunneling efforts help to aerate soils. Termite activity results in patchy changes/improvements to soil composition and fertility. Compacted and encrusted soils cannot absorb water and hence will no longer support plant life. Termite tunneling can help to reclaim such damaged soils as demonstrated in the African Sahel zone. Termites also contribute significantly to atmospheric gases (Edwards and Shipitalo, 1998; UNEP, 2000). Carton is organic material which has been processed by termites (see Plate 2-1). Sheeting is material which has been brought in from the surrounding area (sand or soil) and has the same colour as the substrate. Carton is usually darker and more structured than sheeting. The dry weight of sheeting provides information on how much material the termite species/ feeding group may bring in from the surrounding area while the dry weight of the carton provide information about how much of the wood has been processed. These are both important for the understanding of the ecology of termites.

Plate 2-1. Carton in wood

Negative Impacts of Termites

The negative impact of termites is often cited in economic terms as expenditures for damage, repair, and preventive treatment costs. In the United States alone estimates range between US$ 2-3 billion dollars annually (UNEP, 2000).

However, it can be argued that termites have little or no negative impact in environments unaffected by humans. There are over 5,000 described species of termites, but fewer than 185 are considered pests. Conflicts arise when termite societies compete for resources important to human societies. Termite species gain pest status because, as they fulfill their ecological role of recycling plant material they encounter and then endeavour to utilize the materials used in building, construction or agronomic and forestry commodities. In fact, significant environmental impact results when humans use persistent organic pesticides in an attempt to protect their investment from termite activity. There is little information that allows assessment of realistic economic thresholds to justify pesticide intervention for control of termites in either urban or agricultural habitats. Therefore, to assess their negative impact, a better understanding of termite ecology and the economics of termite damage are needed. Increasing urbanization that involves building in endemic termite habitats will likely continue to result in further conflicts between human and termite societies (UNEP, 2000). In addition, many termite problems in urban areas follow from the establishment of exotic species. Commercial traffic in wood products, infested solid wood packing materials and unsupervised disposal of ship ballast has been implicated in the spread of foreign termites to distant urban centers (UNEP, 2000). The potential for human-aided dispersion of termites needs to be addressed to reduce further introductions. The problems associated with native termites need to be systematically studied to provide a realistic assessment of their economic impact and the feasibility of using less pesticide for control.

Termite control in agriculture is often initiated on subjective information rather than on sound scientific inquiry into their true impact on certain crops. In agricultural situations, the use of exotic plants and planting in previously non-agricultural areas need to be studied to understand the ecological and economic impact termites have on cropping systems. The negative impact of termites is essentially a human perspective that is too often founded in apprehension rather than in fact (UNEP, 2000). Understanding the biology and ecology of termites in different areas of the world would be a first step in developing realistic economic thresholds and environmentally compatible control tactics.

2.1.2.2.1.4 Termite Biology and Ecology in Africa

The African continent is climatically and geographically very diverse and contains the world's largest desert and one of the greatest mountain peaks. Termite diversity also reflects this topological and climatological diversity. Termite diversity is tremendous, more than 1,000 of the above 5,000 recognized species occur on the African continent. Mound species of termites occur throughout most of the African landscape. Termite diversity for northern Africa is low, about 11 species, represented by subterranean and drywood termite groups (UNEP, 2000). The important genera are Anacanthotermes (Family Hodotermitidae), Psammotermes and Reticulitermes (Family Rhinotermitidae), Amitermes, and Microcerotermes (Family Termitidae), and several species of Kalotermitidae. The xeric conditions throughout most of northern Africa preclude dampwood termites. However, mound termites do occur (UNEP, 2000).

Termite diversity is great in eastern Africa, especially among the abundant Macrotermitidae. The important genera include Macrotermes (Family Termitidae), Hodotermes (Family Hodotermitidae), and Schedorhinotermes (Family Rhinotermitidae). Their biomass exceeds that of mammals in the same landscape and may exceed 50 kg dry weight per hectare. The distribution of mounds in the savannas appears highly dependent on resources more than competition from nearest neighbours. Grass-feeding and harvester species play an important role in decomposition of organic matter and turning over soil, as much as 2,000 kg of soil per hectare per year. Pheromones, cuticular hydrocarbons and genetics all play an important role in maintaining colony and species uniqueness. A number of chemicals are used by termites to communicate foraging information and illicit response across genera and families.

Termite diversity in western Africa is similar to eastern Africa; mound species dominate the landscape, although subterranean and drywood species also occur. Important genera include Ancistrotermes, Macrotermes, Odontotermes, Microtermes, and Cubitermes (Termitidae) (UNEP, 2000). Termites play a role in the rehabilitation of crusted soils in the Sahel. By using mulch, soils formerly barren and unusable for agriculture or grazing have been restored within months by termite activity. Termites in the genera Macrotermes, as a result of their tunneling and foraging, are primarily responsible for positively impacting soil structure, porosity, chemistry and organic residues. Important genera include Ancistrotermes and Odontotermes. Carbon dioxide production was approximately double for areas with termite mounds versus open areas. The recycling of carbon in grassy, shrubby, and woody savannas in Africa is greatly influenced by termites (UNEP, 2000).

2.1.2.3 Others

Other biodegraders of wood are arthropods, wood louse, bacteria, algae, earth worms etc.

2.2 *Cola gigantea* A. Chev.

Cola gigantea belongs to Malvaceae family and very common in both the Dry and Moist Semi- Deciduous forest types but not so common in the Evergreen forest type in Ghana (Hawthorne and Ntim-Gyakari, 2006). The tree can grow to about 50 m high and 5 m in girth with 90 cm as the prescribed minimum felling diameter (Oteng-Amoako, 2006). Uetimane *et al.* (2008) rated the wood as medium density with the basic density between 400-750 kgm^{-3}. It is an excellent wood for furniture, cabinet, artifacts, handicrafts and carvings as well as for bridge construction works.

2.2.1 Taxonomic classification of *Cola gigantea*

Kingdom Plantae

Subkingdom Tracheobionta

Superdivision Spermatophyta

Division Magnoliophyta

Class Magnoliopsida

Family Malvaceae

Subfamily Sterculioideae/ Sterculiaceae

Genus Cola

Species *Cola gigantea*

2.2.2 Plant Distribution and Ecology

Cola gigantea belongs to Malvaceae family and very common in the dry semi-deciduous ecological zone of Ghana. The tree can grow to about 50 m high and 5 m in girth with 90 cm as the prescribed minimum felling diameter. The *Cola gigantea* wood is classified as non-durable and medium density wood (Oteng-Amoako, 2006). The tree prefers full sun and grows on a wide range of soil types and can tolerate partial shade. It can be propagated by seeds and performs well under plantation establishment (Essien *et al.*, 2012).

2.23 BOTANICAL DESCRIPTION OF *COLA GIGANTEA*

They are evergreen trees, growing up to 50 m tall, with glossy ovoid leaves up to 30 cm long and star shaped fruit.

2.2.4 Economic Importance and Uses of *Cola gigantea*

The wood of *Cola gigantea* is suitable for pulp and paper production (Essien *et al.*, 2012). The wood is also used for fencing as well as for farm implements. Extracts from the bark is used to treat yaws, sores and other skin infections (Adenuga *et al.*, 2012).

2.3 Aspen

2.3.1 Distribution and ecology of Aspen

Aspen (*Populus tremuloides*) is the most widely distributed tree in North America. It is known by many names: trembling aspen, golden aspen, mountain aspen, popple, poplar and trembling poplar (Little, 1979). Aspen grows on a great variety of soils (mainly Alfisols, Spodosols and Inceptisols) ranging from shallow and rocky to deep loamy sands and heavy clays (USDA, 1975). It is quick to pioneer disturbed sites where there is bare soil. This fast-growing tree is short lived and pure stands are gradually replaced by slower-growing species. The light, soft wood has very little shrinkage and high grades of Aspen are used for lumber and wooden matches. Most aspen wood goes into pulp and flake-board, however. Many kinds of wildlife also benefit from this tree.

2.3.2 Taxonomic classification of Aspen (*Populus tremuloides* Michx.)

Kingdom Plantae – Plants

Subkingdom Tracheobionta – Vascular plants

Superdivision Spermatophyta – Seed plants

Division Magnoliophyta – Flowering plants

Class Magnoliopsida – Dicotyledons

Subclass Dilleniidae

Order Salicales

Family Salicaceae – Willow family

Genus *Populus* L.

Species *Populus tremuloides* Michx. – Aspen

2.3.3 Climate

Climatic conditions vary greatly over the range of the species, especially winter minimum temperatures and annual precipitation (Perala, 1977). The known widest range in temperatures aspen has endured in the United States is in Montana, where

January lows of -57°C and summer highs of 41°C have been recorded (Perala, 1977). Aspen occurs where annual precipitation exceeds evapotranspiration. It is abundant in interior Alaska where annual precipitation is about 180mm. In summary, the range of aspen is limited first to areas of water surplus and then to minimum or maximum growing season temperatures (Geraghty *et al.*, 1973; Zasada, 1989).

2.3.4 Damaging Agents

Numerous factors other than competition injure or kill young stands (Crouch, 1986; Hinds and Shepperd, 1987). Young trees are sometimes killed by bark-eating mammals, such as meadow mice and snowshoe hares. Also, larger animals, such as mule deer, white-tailed deer, elk, and moose, frequently seriously damage it. Such injuries often favor secondary attack by insects or pathogens. Cattle and sheep browsing is a serious problem in many areas of the Rockies. Excessive use and vandalism by recreationists has caused aspen to deteriorate in many camp sites (Hinds and Wengert, 1977; Shepperd and Engelby, 1983). Aspen is susceptible to a large number of diseases (DeByle and Winokur, 1985; Hinds and Laurent, 1978; Hinds and Wengert, 1977; U.S. Department of Agriculture, Forest Service, 1972; U.S. Department of Agriculture, Forest Service, 1976). These include shoot blight, angular black spots, leaf spot etc. Several leaf rust fungi of the genus *Melampsora* infect aspen. More fungi species cause butt and root rots than trunk rots-as much as one-third of the decay volume in Colorado (Stanosz and Patton, 1987).

Aspen hosts a wide variety of insects but only a few are known to severely damage trees (DeByle and Winokur, 1985; U.S. Department of Agriculture, Forest Service, 1972).

Aspen is highly susceptible to fire damage (Brinkman and Roe, 1975; Perala, 1974; Strothmann and Zasada, 1965). Aspen growth and vigor suffer from drought (Sucoff, 1982) and drought- stressed trees become predisposed to secondary agents such as insects and disease. Mechanical injuries inflicted on aspen bark by recreationists can lead to infection by canker disease and eventual death.

2.3.5 Special Uses

Aspen provides habitat for a wide variety of wildlife including hare, black bear, deer, elk, ruffed grouse, woodcock and a number of smaller birds and animals (Ohmann *et al.,* 1978; Patton and Jones, 1977; Scott and Crouch, 1987). Aspen forests allow more water or ground water recharge and stream flow (Gifford *et al.,* 1984). This aspen type is aesthetically appealing. In the West in particular, this type is used by recreationists during all seasons of the year. Aspen stands produce abundant forage and make excellent firebreaks (DeByle and Winokur, 1985). Whole-tree aspen chips can be processed into nutritious animal feed or biomass fuels (U.S. Department of Agriculture, Forest Service, 1976; Bella and DeFranceschi, 1980). Wood products from aspen include pulp, flake board, particle board, lumber, studs, veneer, plywood, novelty items, and wood flour. Aspen makes particularly good benches and playground structures because the wood surface does not splinter (Withgott and Brennan, 2011).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study site

The study was conducted within the Bobiri forest reserve (BFR) in the Ashanti region of Ghana under near- primary forest conditions. The forest reserve is located approximately 34 km south east of Kumasi and close to Kubease in the Juaso Forest district in the Ejisu-Juabeng Municipal Area (Abeberese and Kyere, 2005) (Fig. 3-2). Bobiri forest reserve is a tropical moist semi- deciduous forest, southeast sub-type (Hall and Swaine, 1981). The topography of the Bobiri forest reserve is gently undulating with an elevation between 180 m and 245 m above-sea-level. It lies between latitudes 6^o 39' and 6^o 44'N and longitudes 1^o 15' and 1^o 23'W. The reserve covers an area of 54.6 km^2 in southern Ghana (Hawthorne and Abu-Juam, 1995; Hall and Swaine, 1981). The forest experiences dry and wet seasons. The mean annual rainfall within the Bobiri forest reserve is between 1500 mm and 1750 mm. It experiences a minor and major rainy season each year. The major rainy season occurs between April and July, while the minor season is from September to October. The dry season is from December to mid-March. Ambient temperatures are usually high with 36.1^oC as the mean maximum and 21.7^oC as the mean minimum temperature. The maximum monthly average of 32.8^oC occurs in March while the minimum of 19.9^oC occurs in January. The relative humidity of the Bobiri forest reserve is about 85% (Hawthorne and Abu-Juam, 1995).

The soil texture vary from sandy loams to clay loams, passing into a grey leached sandy or silty soil on the periodically waterlogged river valleys, flats and swamps

(Foli and Pinard, 2009). The shallow valley is generally wet during the rainy season and becomes flooded for brief periods. The reserve is located on the rock type of the Cape Coast granite series.

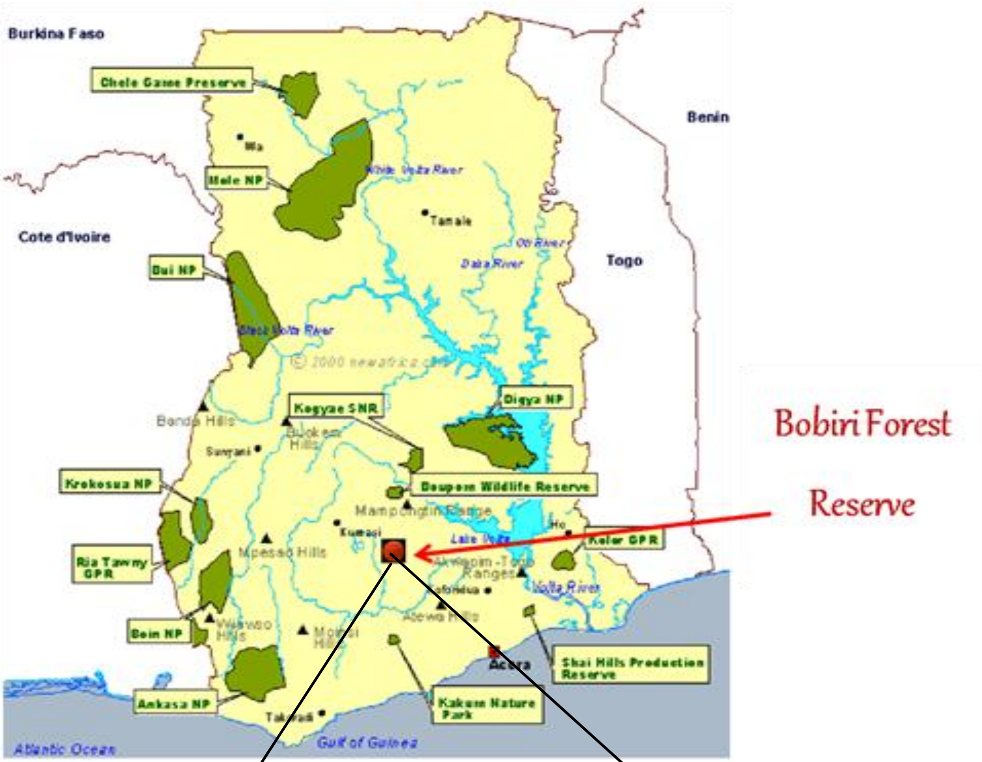
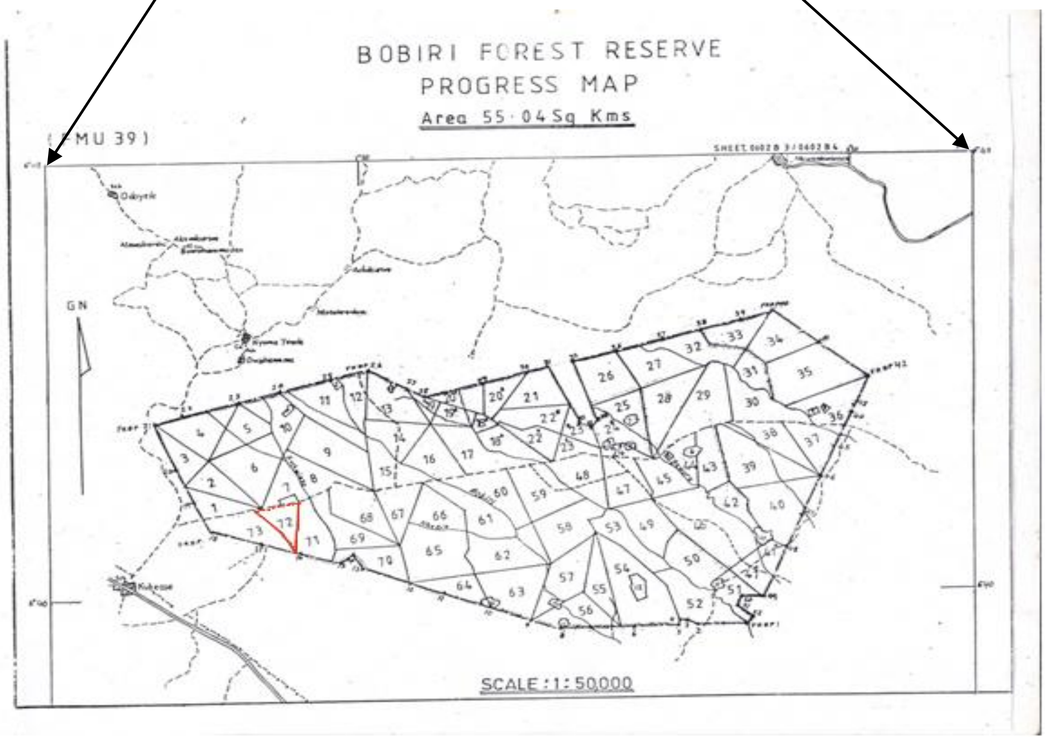


Fig. 3-1: Map of Ghana showing the Study Area



(Resource Management Support Centre of the Forestry Commission of Ghana, 2007).

Fig. 3-2: Map of Bobiri forest reserve

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3.2 Study plan

Twelve (12) plots were set out in the Bobiri forest reserve in the Ashanti region of Ghana under near- primary forest conditions. All the twelve (12) plots were laid out in compartment 72 of the Bobiri forest reserve which is highlighted with red boundaries on the Bobiri forest reserve map (Figure 3-2). Each plot size measured 100 m x 6 m. The wood samples were deposited 20 m between samples in a block and 5 m between blocks within a plot. Two wood samples, namely *Cola gigantea* (indigenous wood species) and Aspen (*Populus tremuloides* Michx.) an exotic wood species were used for the experiment. Aspen and *Cola gigantea* wood stakes of 20 cm x 9 cm x 2.8 cm were dried, weighed, put into mesh bags and deposited at the study site. Exclusion experiments with mesh bags of two different mesh sizes: 0.03 mm and 5 mm were used to exclude and include macro fauna and termites respectively. Two replicates were set out for each treatment. That is sixty (60) Aspen wood stakes were bagged in the 5 mm mesh bags for termite inclusion while sixty (60) Aspen wood stakes were also bagged in the 0.03 mm mesh bags for termite and macro fauna exclusion. In addition, sixty (60) *Cola gigantea* wood stakes were bagged in the 5mm mesh bags for termite inclusion while sixty (60) *Cola gigantea* wood stakes were also bagged in the 0.03 mm mesh bags for termite and macro fauna exclusion. Samples were collected according to an exponential time gradient on five occasions. At each collection point, two random samples from each treatment were collected according to a colour scheme representing the different sampling occasions (different times for picking Aspen and *Cola gigantea* wood stakes from the field after depositing them). At the point of collection, the wood was put into plastic bags to make sure that nothing is lost in case the wood is broken up. In the laboratory, sheeting and carton were removed and put into separate containers for drying. Termites and other macro fauna were removed and put into separate tubes filled with alcohol along with a label of the sampling number. The different layers of samples in the same tube were separated by cotton. These were identified and analyzed. Termite and fungal attack on the wood were recorded by allocating a number to the sample according to a list of characters on a scale of features. Finally the remaining wood was dried and weighed.

3.2.1 SAMPLING

3.2.1.1 Sampling points

The plots were labeled A to L. The Aspen stakes were deposited on plots A, B, C, D, E and F. While *Cola gigantea* stakes were deposited on plots G, H, I, J, K and L. Plots G, H, I, J, K and L were sited 10m west of plots A, B, C, D, E and F respectively. The GPS locations of the plots are as shown in Table 1.

Table 1. The GPS location of plots A to F.

Plot label	GPS location of plot
Plot A	N 06^{o}41.406' W 001^{o}20.310' and 270m above sea level (ASL)
Plot B	N 06^{o}41.473' W 001^{o}20.381' and 275m above sea level
Plot C	N 06^{o}41.506' W001^{o}20.403' and 280m above sea level
Plot D	N 06^{o}41.551' W001^{o}20.379' and 287m above sea level
Plot E	N 06^{o}41.565' W 001^{o}20.299' and 288m above sea level
Plot F	N 06^{o}41.536' W001^{o}20.234' and 276m above sea level

Four mesh bags, two of each mesh size, were collected from each plot (four with Aspen wood and four with *Cola gigantea* species) on each of the dedicated sampling occasions (Table 2). The samples were placed in plastic bags and transported to the laboratory to ensure that nothing of the sample was lost or mixed with other samples.

Table 2. Sampling occasions and colours for sampling

Sampling occasion	**Date**	**Colour**
1	1 week after deposit	White
2	2 weeks after deposit	Red
3	4 weeks after deposit	Yellow
4	8 weeks after deposit	Blue
5	16 weeks after deposit	Green

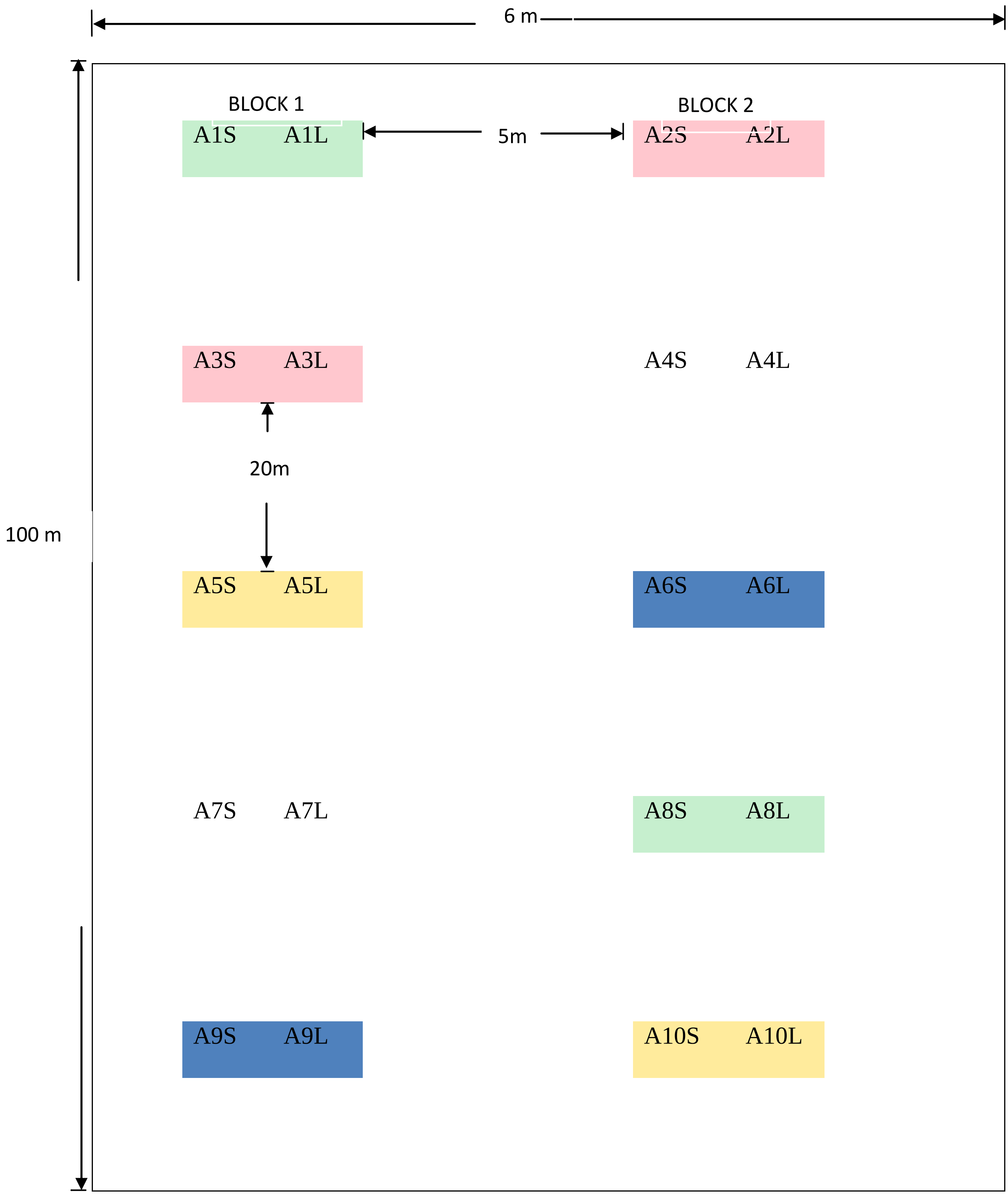

Fig.3-3: Plot Lay-out

In the laboratory, the carton and sheeting were removed from the wood and placed into separate containers. Termites and other macro fauna were carefully removed from the wood samples and placed in separate tubes with alcohol. Termite versus fungal attack on wood was then estimated using the standard descriptions in table 3. The wood, carton and sheeting in separate paper bags were then placed in an oven to dry at 103^{o}C until constant weight was recorded.

Table 3. Estimation of fungal and termite attack on wood following the method of Palin *et al.,* 2010

Attack score	**Termite attack**	**Fungal attack**
0. (sound wood)	No perceptible termite attack	No perceptible fungal attack or softening
1. (perceptible but very limited changes)	Very superficial deterioration to 1-2 mm in depth at some points or over several cm^2	Discoloration and very superficial degradation or softening up to 1 mm in depth
2. (clear changes to a moderate extent)	Damage from 2 to 5 mm in depth over several cm^2. Or with scattered points down to a depth exceeding 5 mm. Or by different combinations of the two types.	Softening to a depth of 2- 3 mm deep over all or part of the stake
3. (severe changes)	Extended and deep destruction from 5-10 mm in depth. Or tunnels reaching the centre of the wood.	Marked decay in wood to a depth of 3-5 mm over a wide surface area or by softening to a greater depth (10- 15 mm) over a small area
4. (breakage of the stake with moderate pressure applied)	Breakage due to extent of termite tunneling.	Breakage due to fungal attack and softening

3.2.2 Description of work

Carton is an organic material which has been processed by termites (Plate 2-1). Sheeting is a material which has been brought in from the surrounding area (sand or soil) and has the same colour as the substrate. Carton was usually darker and more structured than sheeting. This was removed and separated into different containers for drying. The dry weight of sheeting provided information on how much material the termite species/ feeding group may bring in from the surrounding area while the dry weight of the carton provided information about how much of the wood had been processed. These are both important for the understanding of the ecology of termites.

3.2.2.1 Assessment of Termites and other Macro fauna associated with wood

1. The fauna found in the samples were divided into termites and other macro fauna (including all macro fauna except termites). The two groups were collected in plastic tubes with 70% alcohol along with a label with the sample number. Each layer was separated with a piece of cotton. This is to better understand the diversity of macro fauna that may influence decomposition of wood.
2. Termite attack on wood can be easily recognised by the tunnels and marks they make in the wood when they colonise it. Fungal attacks on wood were easy to recognise by the discolouring of the wood. Additionally, wood which has been attacked by fungi were often softer and wetter than wood colonised by termites. The specified differences and levels of attack are shown in table 3.
3. The wood, sheeting and carton were kept separate. Also, all of the materials were dried in paper bags.
4. All dry weights were documented in the sampling document along with the scores for termite and fungal attacks.

3.3 Experimental Design

The experiment was a Factorial in Randomized Complete Block Design with two (2) replicates.

3.4 Statistical Analysis

The data was analyzed using the GraphPad Prism 5 Project software. Analysis of Variance (ANOVA) at 5% level of significance was done and the outcomes shown in the Appendix. Excel 2007 analysis tool pack was used to present additional results in graphs and tables. The decomposition rate was expressed as a constant k which indicates the relative mass over time. The k value was determined from the equation $X/X_o = e^{-kt}$, where X_o = initial dry mass and X = mass at time t (weeks) (Olson 1963). Mathematical models were used to simulate decomposition patterns and determine the decomposition rates of the wood (Harmon *et al.,* 1986; Li *et al.,* 2006). The single-exponential model which is a linear regression model form was used to determine decomposition rates (Olson, 1963; Graham and Cromack, 1982; Barber and Vanlear, 1984; Edmonds and Eglitis, 1989; Harmon and Chen, 1991; Laiho and Prescott, 1999; Chen *et al.,* 2001; Janisch and Harmon, 2001; Zhang *et al.,* 2008).

CHAPTER FOUR

4.0 RESULTS

4.1 Termite genera identified

The study identified termites within three main genera; *Macrotermes*, *Microtermes* and *Ancistrotermes.* The termites collected from the samples belong to the fungus growing sub-family Macrotermitinae which feed on wood and litter. These genera of termites were within the species groups; mound builders and subterranean termites. However, due to lack of identification keys, the termites collected could not be identified to the species level.

4.2 Other fauna identified

Fauna other than termites were also found associated with the decomposing wood. Most of the fauna isolated from the decomposing wood are documented as significant contributors to wood decomposition in the tropical moist semi-deciduous forest zone. The fauna isolated and identified were earthworms, spiders, arthropods, wood louse, millipedes, centipedes and ants.

4.3 Decomposition rate of *Cola gigantea* wood in the large diameter mesh bags compared to the *Cola gigantea* wood in the small diameter mesh bags

The decomposition rate of *Cola gigantea* wood in the large diameter mesh bags was $0.016gg^{-1}$ per week. There was a strong negative correlation for the decomposition rate of *Cola gigantea* wood in the large diameter mesh bags with time (weeks), with a coefficient of determination (R^2) of 0.9542. *Cola gigantea* wood in the large diameter mesh bags exhibited a high decomposition rate in week one (1).

This increased marginally in week two (2) and three (3), however after week eight (8) the decomposition increased exponentially to week sixteen (16) (Figures 4-1a). The average percentage decomposition (relative mass) in a week was 6.23%. This decomposition of *Cola gigantea* wood was statistically significant ($P < 0.05$) with time (Appendix I-1). Bonferroni post tests results indicated that the decomposition rate of *Cola gigantea* wood in the large diameter mesh bags for the sixteenth (16th) week differed significantly from weeks 1, 2, 4 and 8 at all the sampling points (Appendix I-2, I-3, I-4 and I-5).

Contrastingly, the decomposition rate of *Cola gigantea* wood in the small diameter mesh bags was only $0.004gg^{-1}$ per week. However, there was a strong negative correlation for decomposition in the small diameter mesh bags with time (weeks), with a coefficient of determination (R^2) of 0.9933 (Figure 4-1b). *Cola gigantea* wood in the small diameter mesh bags exhibited a relatively low decomposition rate ($0.004gg^{-1}$ per week) compared to the large diameter mesh bags ($0.016gg^{-1}$ per week) (Figures 4-1a and 4-1b). The average percentage decomposition in a week for the *Cola gigantea* wood in the small diameter mesh bags was 2.76%. The decomposition rate of *Cola gigantea* wood in the small diameter mesh bags was statistically significant ($P < 0.05$) with time (Appendix K-1). Bonferroni post tests results indicated that the decomposition rates of samples from plot I and plot K differed significantly from each other (Appendix K-2, K-3, K-4, K-5 and K-6). The decomposition rate of *Cola gigantea* wood in the small diameter mesh bags was significantly ($P < 0.05$) different from the decomposition rates of *Cola gigantea* wood in the large diameter mesh bags (Appendix N-1). Bonferroni post tests results indicated that there were significant differences in decomposition rates between *Cola gigantea* wood in the large diameter mesh bags and *Cola gigantea* wood in the small diameter mesh bags (Appendix N-2, N-3, N-4, N-5, N-6, N-7, N-8 and N-9).

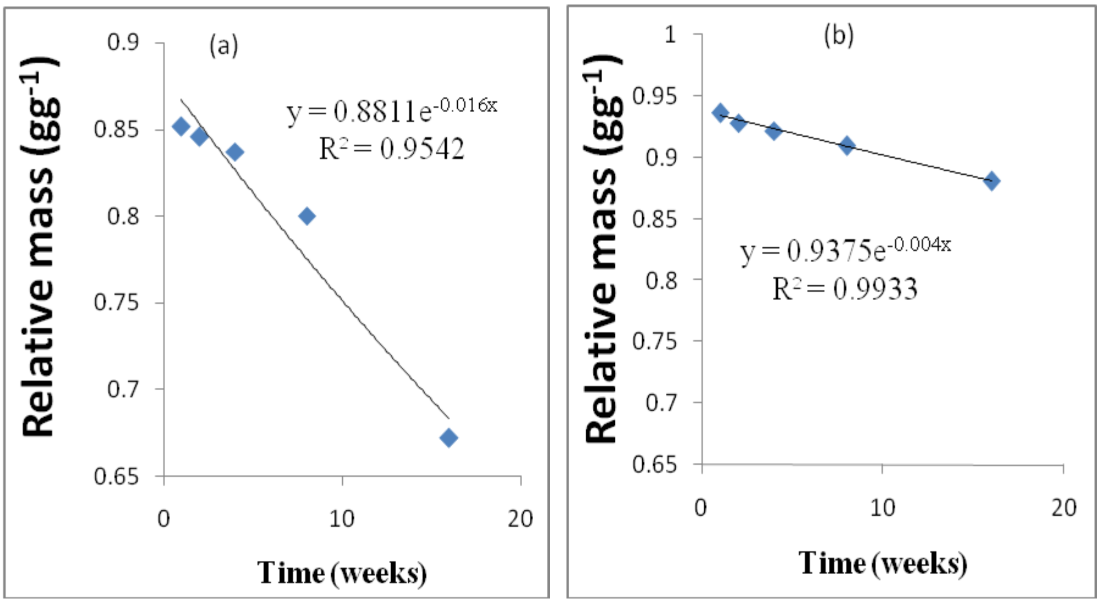

Fig. 4-1: Decomposition rate of *Cola gigantea* wood in (a) the large diameter mesh bags and (b) the small diameter mesh bags

4.4 Decomposition rate of Aspen wood in the large diameter mesh bags compared to the decomposition rate of Aspen wood in the small diameter mesh bags

The decomposition rate of Aspen wood in the large diameter mesh bags was 0.055gg^{-1} per week and showed a strong negative correlation with time (weeks), with a coefficient of determination (R^2) of 0.9535 (Figure 4-2a). The Aspen wood in the large diameter mesh bags exhibited a relatively low decomposition rate in weeks one (1) and two (2). This increased gradually to week four (4) and exponentially to about 42% of the initial mass remaining in week sixteen (Figure 4-2a). The average percentage decomposition in a week of the Aspen wood in the large diameter mesh bags was 3.16%. This decomposition of Aspen wood was statistically significant ($P < 0.05$) with time (Appendix J-1, J-2, J-3, J-4, J-5, J-6 and J-7).

Contrastingly, the decomposition rate of Aspen wood in the small diameter mesh bags was $0.012gg^{-1}$ per week. However, there was a strong negative correlation for decomposition in the small diameter mesh bags with time (weeks), with a coefficient of determination (R^2) of 0.993 (Figure 4-2b). Aspen wood in the small diameter mesh bags exhibited a relatively low decomposition rate of $0.012gg^{-1}$ per week compared to the Aspen wood in the large diameter mesh bags of $0.055gg^{-1}$ per week (Figure 4-2a). The average percentage decomposition in a week of the Aspen wood in the small diameter mesh bags was 1.18%. At 5% level of significance, time had a significant ($P < 0.05$) effect on the decomposition rate of Aspen wood in the small diameter mesh bags. Bonferroni post tests results revealed that there were no significant differences in the decomposition rates of the Aspen wood in the small diameter mesh bags over the study period (Appendix L-1).

Time had a significant ($P < 0.05$) effect on the decomposition rate of Aspen wood in the small diameter mesh bags and Aspen wood in the large diameter mesh bags (Appendix O-1) as their decomposition rates differed significantly from each other. Bonferroni post tests results revealed that there were significant differences in decomposition rates between Aspen wood in the large diameter mesh bags and Aspen wood in the small diameter mesh bags (Appendix O-2, O-3, O-4, O-5, O-6, O-7, O-8, O-9, O-10, O-11 and O-12).

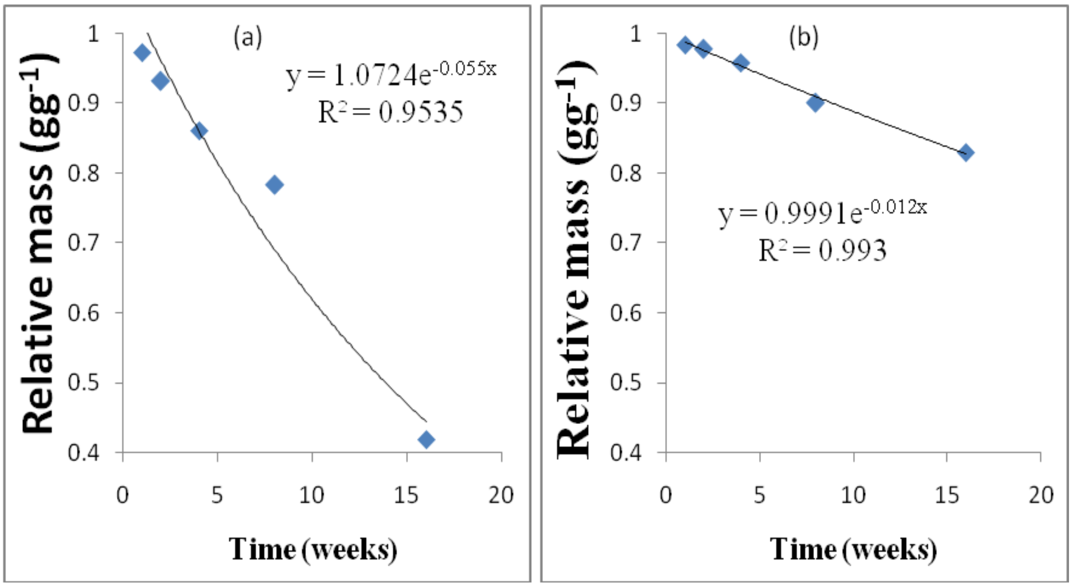

Fig. 4-2: Decomposition rate of Aspen wood in the (a) large diameter mesh bags and (b) small diameter mesh bags

4.5 Decomposition rate of Aspen wood in the large diameter mesh bags compared to *Cola gigantea* wood in the large diameter mesh bags

The decomposition rate of *Cola gigantea* wood in the large diameter mesh bags was steady between weeks one (1) and two (2) as it exhibited a relatively higher initial decomposition rate. After week eight (8) the decomposition rate of the *Cola gigantea* wood increased to about 67% of the initial mass remaining in week sixteen (Figures 4-1a and 4-3). But its decomposition rate of $0.016gg^{-1}$ per week, with coefficient of determination (R^2) of 0.9542 was relatively slow over time compared to the decomposition rate of Aspen wood of $0.055gg^{-1}$ per week, with coefficient of determination (R^2) of 0.9535. The decomposition rate of Aspen wood was less than 10% between weeks one (1) and two (2). After week eight (8), the Aspen wood decomposed at a faster rate than the *Cola gigantea* wood. This trend continued through to week sixteen (16) (Figures 4-2a and 4-3). Time had a significant ($P < 0.05$) effect on the decomposition rates (Appendix M-1). As their decomposition rates differed significantly from each other. Bonferroni post tests results revealed that the decomposition rates of *Cola gigantea* wood in the large diameter mesh bags differed significantly from the decomposition rate of Aspen wood in the large diameter mesh bags (Appendix M-1, M-2, M-3, M-4, M-5, M-6, M-7, M-8, M-9, M-10, M-11, M-12 and M-13).

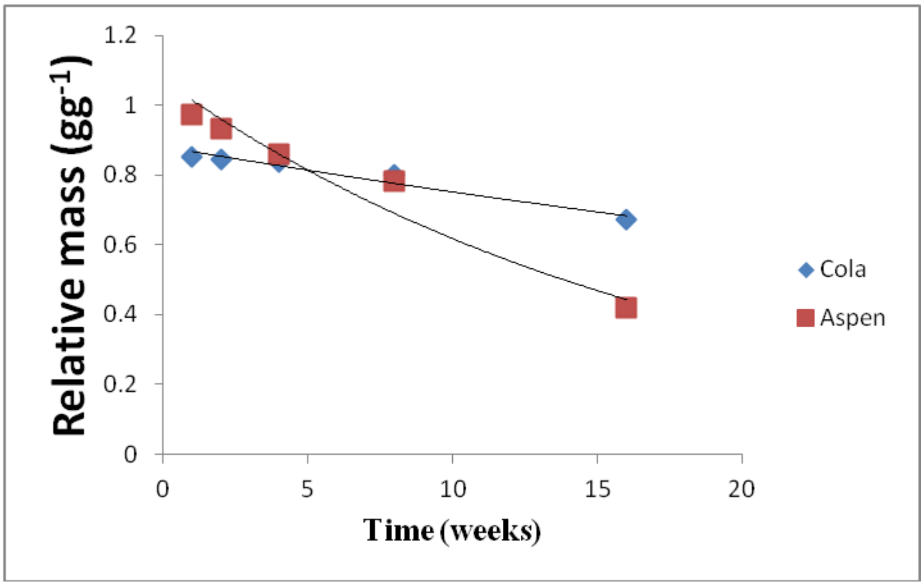

Fig. 4-3: Decomposition rate of Aspen wood compared to *Cola gigantea* wood in the large diameter mesh bags

4.6 Decomposition rate of *Cola gigantea* wood in the small diameter mesh bags compared to Aspen wood in the small diameter mesh bags

The *Cola gigantea* wood in the small diameter mesh bags exhibited a relatively faster initial decomposition rate. Its decomposition rate of 0.004gg^{-1} per week, with a coefficient of determination (R^2) of 0.9933 was relatively slower over time compared to the decomposition rate of Aspen wood in the small diameter mesh bags of 0.012 gg^{-1} per week, with a coefficient of determination (R^2) of 0.993 (Figures4-1b, 4-2b and 4-4). Time had a significant ($P < 0.05$) effect on the decomposition rates of Aspen wood and *Cola gigantea* wood in the small diameter mesh bags when analyzed together (Appendix P-1). Bonferroni post tests results revealed that the decomposition rate of *Cola gigantea* wood in the small diameter mesh bags differed significantly from the decomposition rate of Aspen wood in the small diameter mesh bags in plot C compared to plot I and in plot E compared to plot K (Appendix P-2, P-3, P-4, P-5, P-6, P-7, P-8 and P-9).

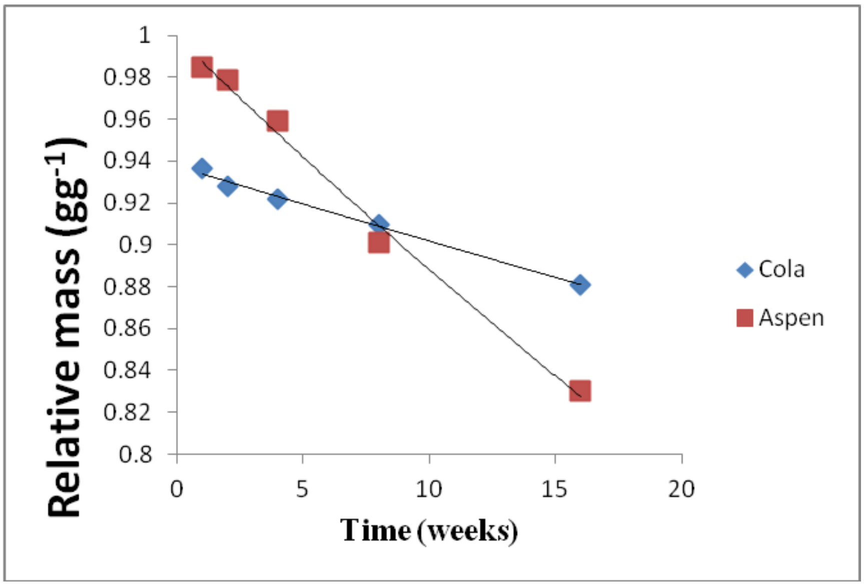

Fig. 4-4: Decomposition rate of *Cola gigantea* wood compared to Aspen wood in the small diameter mesh bags

4.7 Trend of extent of termite attack on *C. gigantea* wood and Aspen wood in the large diameter mesh bags

The *C. gigantea* wood in the large diameter mesh bags generally exhibited no perceptible decomposition due to termite attack in week one. From the second week to the fourth week after deposit, very superficial deterioration of up to 2 mm in depth over several areas of the wood was observed. The termite attack on the *Cola gigantea* wood increased with time. During week eight, the decomposition was observed to be from 2 mm to 5 mm in depth over several areas of the wood. In the sixteenth week after depositing the *Cola gigantea* wood samples in the field, there were extended and deep decomposition up to 10 mm in depth over several areas of the wood (Table 3, Figure 4-5a). However, the Aspen wood in the large diameter mesh bags generally exhibited decomposition up to 2 mm in depth at some points due to termite attack in the first week. From the second week to the sixteenth week after deposit, the decomposition extended to about 5 mm in depth over several areas of the Aspen wood stake. Although two Aspen wood stakes were completely decomposed by the sixteenth week, due to termite attack (Table 3, Figure 4-5b).

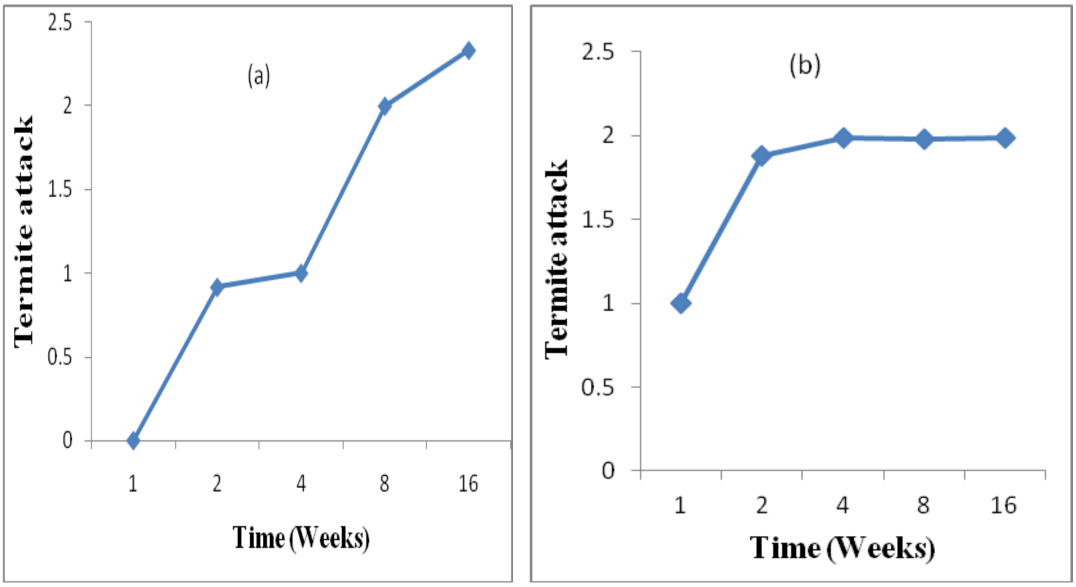

Fig. 4-5: Trend of extent of termite attack on (a) *Cola gigantea* wood and (b) Aspen wood in the large diameter mesh bags

4.8 Trend of extent of fungal attack on *Cola gigantea* wood and Aspen wood in the large diameter mesh bags

The *Cola gigantea* wood in the large diameter mesh bags generally exhibited discolouration and softening up to 1 mm in depth from the first week to the eighth week due to fungal attack. After the eighth week, the discolouration and softening spread to a depth of about 5 mm over a wide surface area of the wood and in some of the wood samples, the discolouration and softening spread to a depth of 15 mm over a small surface area (Table 3, Figure 4-6a). However, the Aspen wood in the large diameter mesh bags generally exhibited discolouration and softening up to 1mm in depth from the first week to the fourth week. After the fourth week, the discolouration and softening spread to a depth of 3 mm over part of the Aspen wood stake. During the eighth week, it spread to a depth of 5 mm over a wide surface area and in some of the wood samples, the discolouration and softening spread to a depth of 15 mm over a small surface area (Table 3, Figure 4-6b).

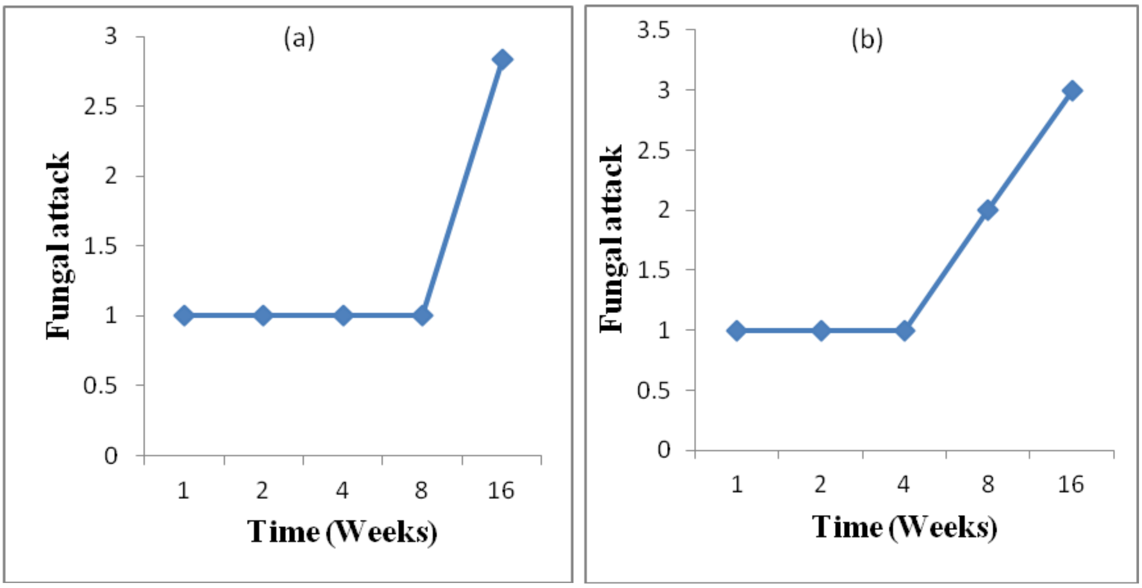

Fig. 4- 6: Trend of extent of fungal attack on (a) *Cola gigantea* wood and (b) Aspen wood in the large diameter mesh bags

4.9 Trend of carton accumulation on *Cola gigantea* wood and Aspen wood in the large diameter mesh bags

The carton accumulated on the *Cola gigantea* wood in the large diameter mesh bags in the first week was about 1 g generally. It increased to about 7 g in the second week. The carton accumulation increased to about 13 g in the fourth week after deposit. It increased steadily to about 47 g in week eight. In the sixteenth week, the accumulated carton had a mass of about 49 g (Figure 4-7a). However, the carton accumulated on the Aspen wood in the large diameter mesh bags in the first week was about 35.8 g generally. It increased to about 36.3 g in the second week. The carton accumulation increased to about 38.8 g in the fourth week after deposit. It increased steadily to about 39.5 g in week eight. In the sixteenth week, the accumulated carton had a mass of about 41.5 g (Figure 4-7b).

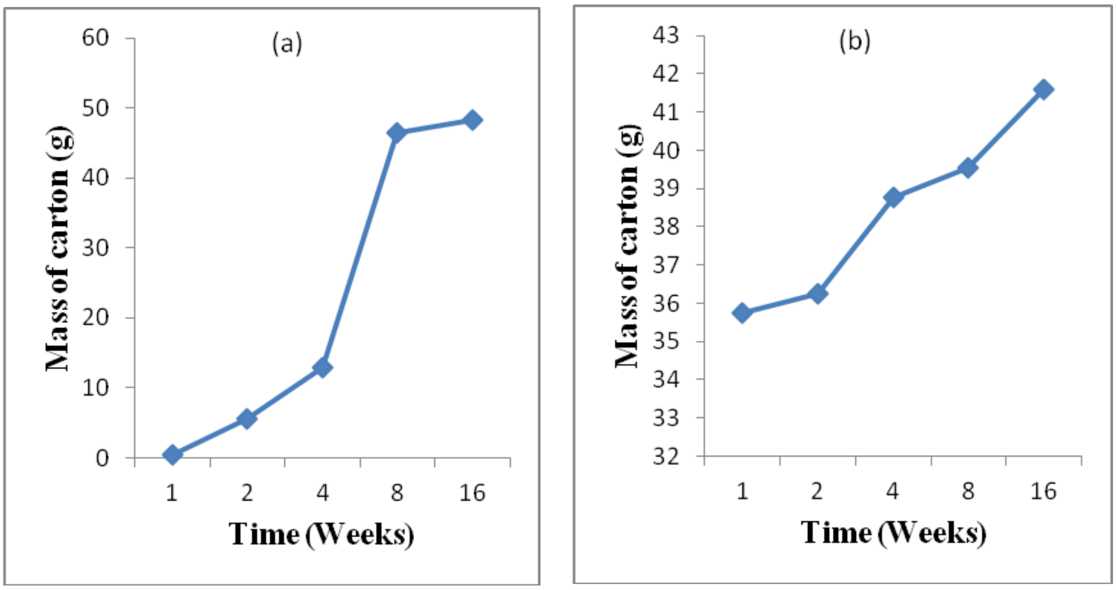

Fig. 4-7: Trend of carton accumulation on (a) *Cola gigantea* wood and (b) Aspen wood in the large diameter mesh bags

4.10 Trend of sheeting accumulation on *Cola gigantea* wood and Aspen wood in the large diameter mesh bags

The sheeting accumulated on the *Cola gigantea* wood in the first week was about 4g generally. It increased to about 8g in the second week. The carton accumulation increased to about 19g in the fourth week after deposit. It increased steadily to about 48g in the eighth week. In the sixteenth week, the accumulated sheeting had a mass of about 93g (Figure 4-8a). However, the sheeting accumulated on the Aspen wood in the first week was about 73g generally. It increased steadily to about 76g in the second week. The carton accumulation increased to about 78g in the fourth week after deposit. It increased steadily to about 80g in the eighth week. In the sixteenth week, the accumulated sheeting had a mass of about 81g (Figure 4-8b).

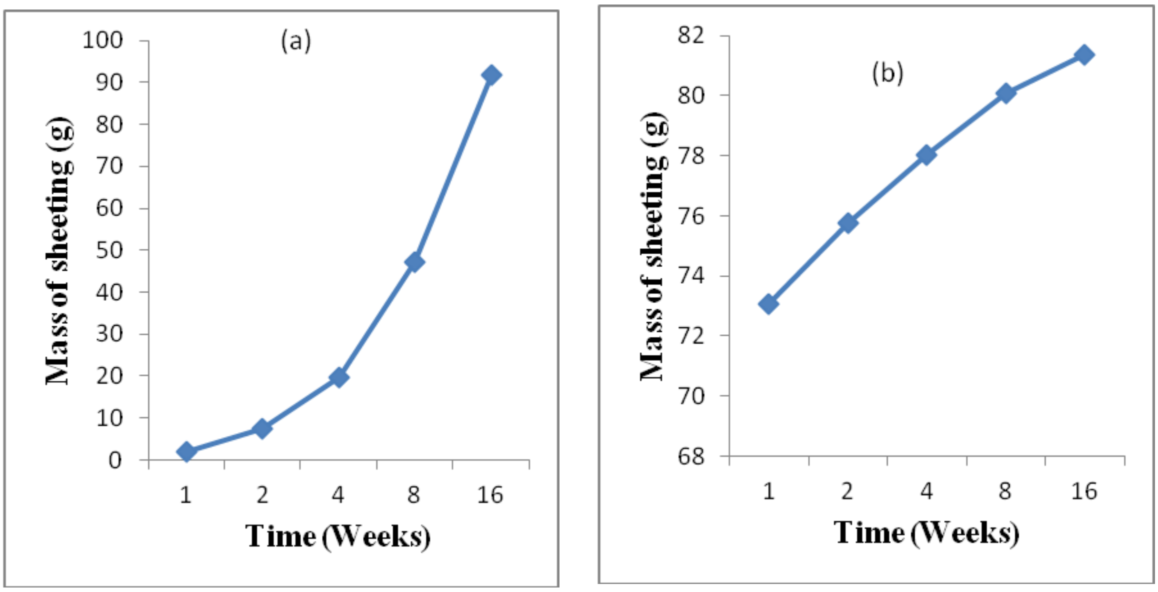

Fig. 4-8: Trend of sheeting accumulation on (a) *Cola gigantea* wood and (b) Aspen wood in the large diameter mesh bags

4.11 Trend of extent of fungal attack on *Cola gigantea* wood and Aspen wood in the small diameter mesh bags

The *Cola gigantea* wood in the small diameter mesh bags generally exhibited discolouration and softening up to 1 mm in depth from the first week to the fourth week. After the fourth week, it spread to a depth of 3 mm over part of the wood stake. After the eighth week, the discolouration and softening spread to a depth of 5mm over a wide surface area of the wood and in some of the wood samples, it spread to a depth of 15 mm over a small surface area (Table 3, Figure 4-9a). However, the Aspen wood generally exhibited discolouration and softening up to 1 mm in depth from the first week to the fourth week. Afterwards, it spread to a depth of about 3 mm over part of the Aspen wood stake. After the eighth week, it spread to a depth of about 5 mm over a wide surface area of the wood and in some of the wood samples, the discolouration and softening spread to a depth of about 15 mm over a small surface area (Table 3, Figure 4-9b).

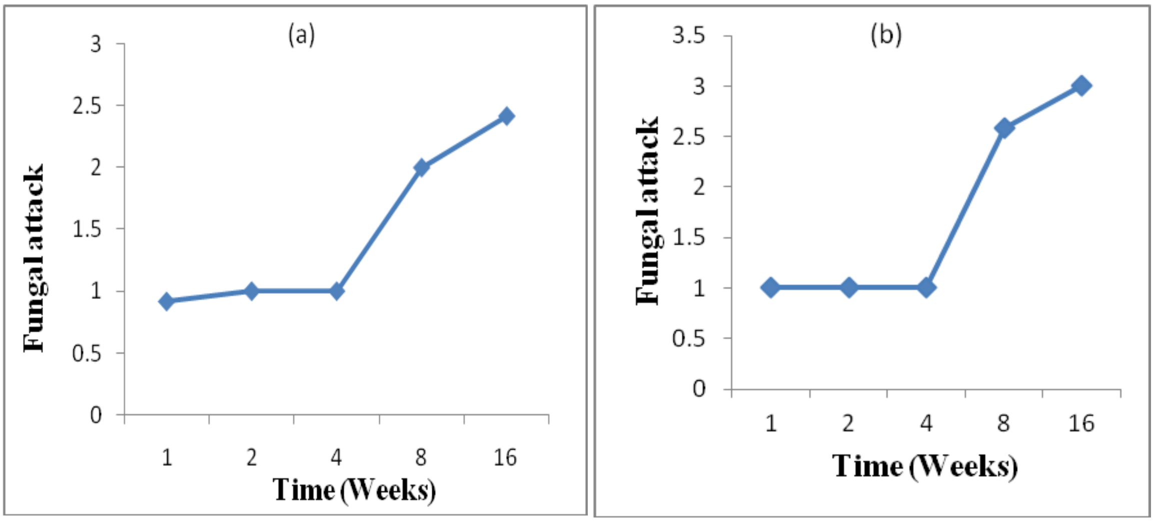

Fig. 4-9: Trend of extent of fungal attack on (a) *Cola gigantea* wood and (b) Aspen wood in the small diameter mesh bags

4.12 The relationship between decomposition rate of the *Cola gigantea* wood and environmental factors

Data on environmental factors were obtained from the weather station at CSIR-FORIG, Fumesua. This is because the data loggers placed on the soil surface to record soil temperature and moisture at the study site did not function to expectation. The study site and the CSIR-FORIG, Fumesua are both located in the moist semi-deciduous forest zone of Ghana. Hence weather parameters such as temperature and rainfall recorded for both sites are usually similar.

4.12.1 The relationship between maximum temperature and decomposition rate of the *Cola gigantea* wood in the large as well as the small diameter mesh bags

The decomposition rate of the *Cola gigantea* wood in the large diameter mesh bags decreased with increasing maximum temperature. There was a strong positive correlation between decomposition rate of the *Cola gigantea* wood in the large diameter mesh bags and maximum temperature, with a coefficient of determination (R^2) of 0.9313 (Figure 4-10a). Also, the decomposition rate of the *Cola gigantea* wood in the small diameter mesh bags decreased with increasing maximum temperature. There was a strong positive correlation between decomposition rate of the *Cola gigantea* wood in the small diameter mesh bags and maximum temperature, with a coefficient of determination (R^2) of 0.7802 (Figure 4-10b).

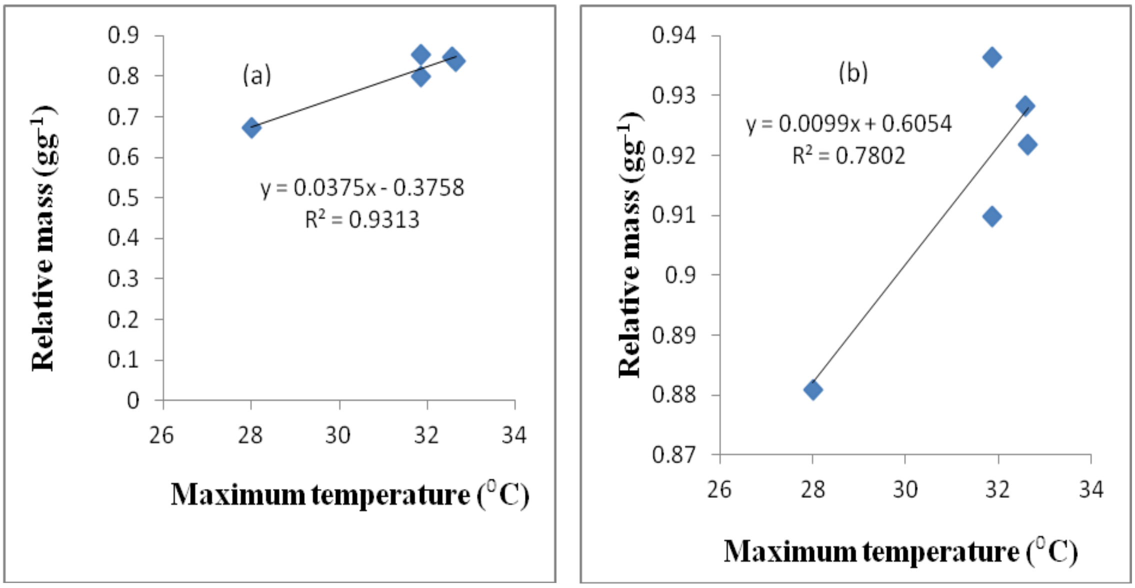

Fig. 4-10: The relationship between maximum temperature and decomposition rate of the *Cola gigantea* wood in (a) the large diameter mesh bags as well as (b) small diameter mesh bags

4.12.2 The relationship between minimum temperature and decomposition rate of the *Cola gigantea* wood in the large as well as the small diameter mesh bags

The decomposition rate of the *Cola gigantea* wood in the large diameter mesh bags increased with increasing minimum temperature. There was a weak negative correlation between decomposition rate of the *Cola gigantea* wood in the large diameter mesh bags and minimum temperature, with a coefficient of determination (R^2) of 0.0983 (Figure 4-11a). Also, the decomposition rate of the *Cola gigantea* wood in the small diameter mesh bags increased with increasing minimum temperature. There was a weak negative correlation between decomposition rate of the *Cola gigantea* wood in the small diameter mesh bags and minimum temperature, with a coefficient of determination (R^2) of 0.2412 (Figure 4-11b).

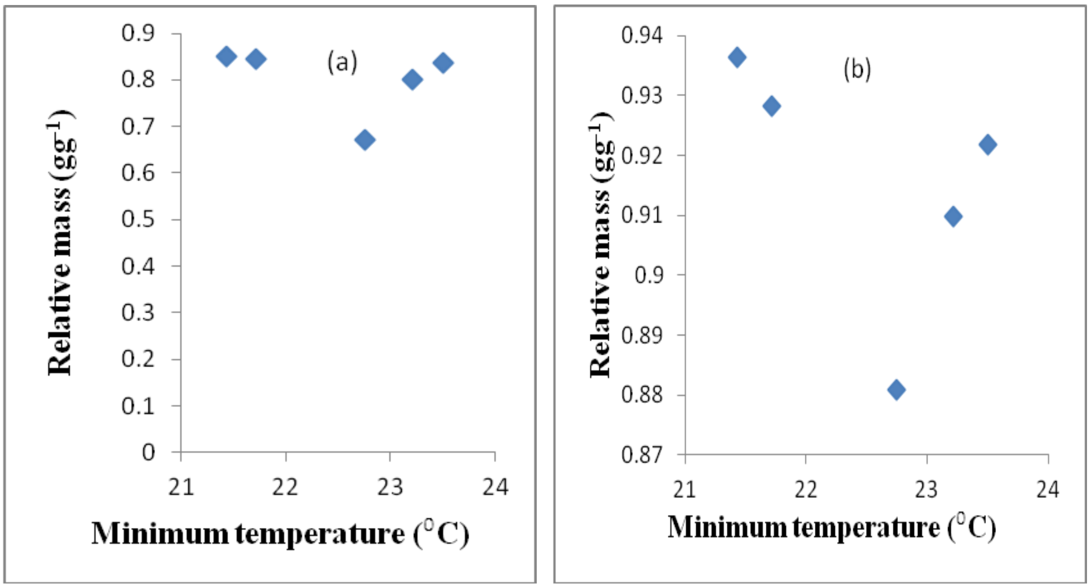

Fig. 4-11: The relationship between minimum temperature and decomposition rate of the *Cola gigantea* wood in (a) the large diameter mesh bags as well as (b) small diameter mesh bags

4.12.3 The relationship between cumulative rainfall and decomposition rate of the *Cola gigantea* wood in the large as well as small diameter mesh bags

The decomposition rate of the *Cola gigantea* wood in the large diameter mesh bags increased with increasing cumulative rainfall. There was a strong negative correlation between decomposition rate of the *Cola gigantea* wood in the large diameter mesh bags and cumulative rainfall, with a coefficient of determination (R^2) of 0.9896 (Figure 4-12a). Also, the decomposition rate of the *Cola gigantea* wood in the small diameter mesh bags increased with increasing cumulative rainfall. There was a strong negative correlation between decomposition rate of the *Cola gigantea* wood in the small diameter mesh bags and cumulative rainfall, with a coefficient of determination (R^2) of 0.9817 (Figure 4-12b).

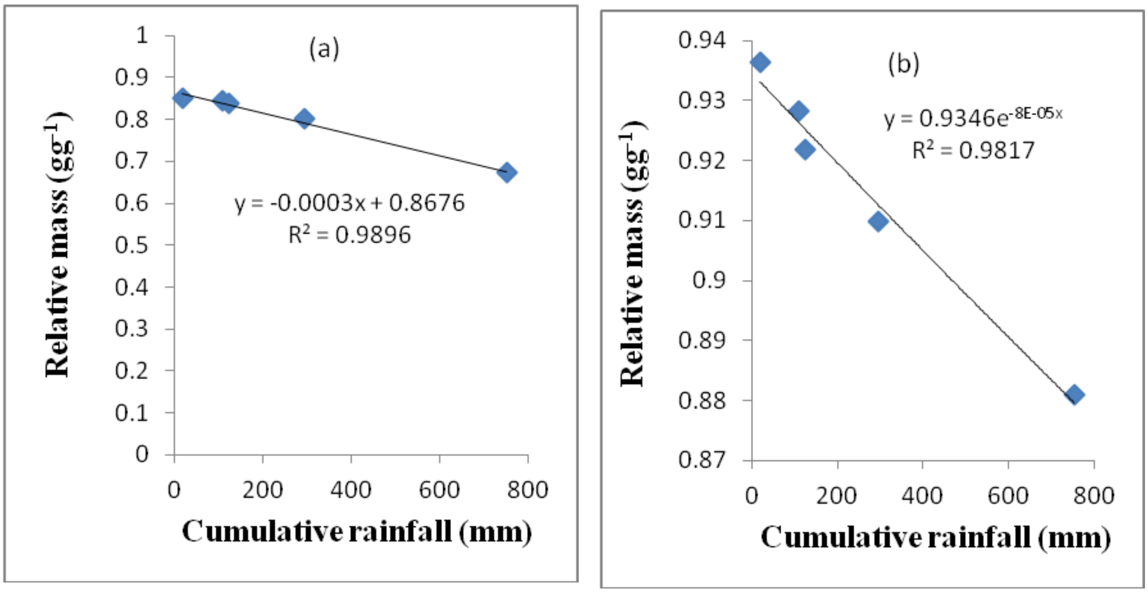

Fig. 4-12: The relationship between cumulative rainfall and decomposition rate of the *Cola gigantea* wood in (a) the large diameter mesh bags as well as (b) small diameter mesh bags

4.13 The relationship between soil temperature and ambient temperature

The soil temperature increased with increasing ambient temperature. There was a moderate positive correlation between soil temperature and ambient temperature, with a coefficient of determination (R^2) of 0.6905 (Figure 4-13).

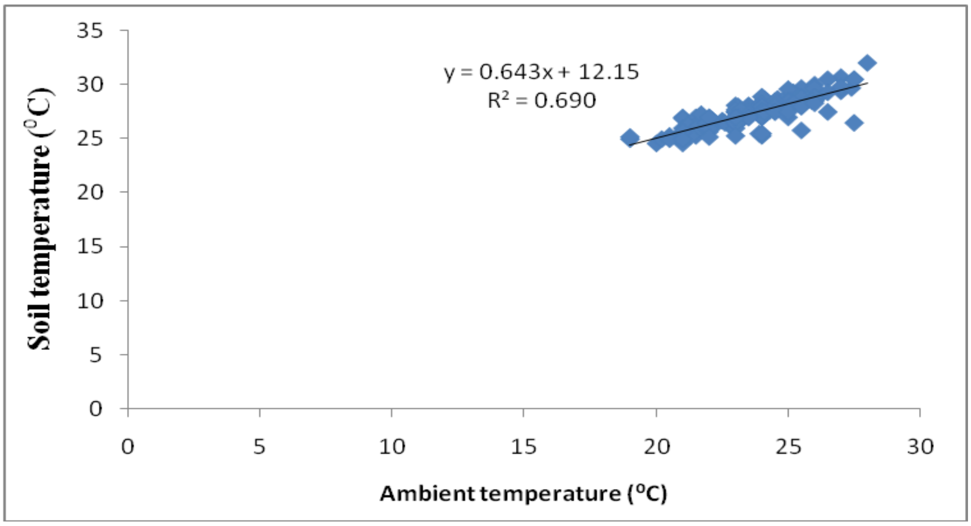

Fig. 4-13: The relationship between soil temperature and ambient temperature

4.14 The relationship between decomposition rate of the Aspen wood and environmental factors

4.14.1 The relationship between maximum temperature and decomposition rate of the Aspen wood in the large diameter mesh bags as well as small diameter mesh bags

The decomposition rate of the Aspen wood in the large diameter mesh bags decreased with increasing maximum temperature. There was a strong positive correlation between decomposition rate of the Aspen wood in the large diameter mesh bags and maximum temperature, with a coefficient of determination (R^2) of 0.9182 (Figure 4-14a). Also, the decomposition rate of the Aspen wood in the small diameter mesh bags decreased with increasing maximum temperature. There was a strong positive correlation between decomposition rate of the Aspen wood in the small diameter mesh bags and maximum temperature, with a coefficient of determination (R^2) of 0.7967 (Figure 4-14b).

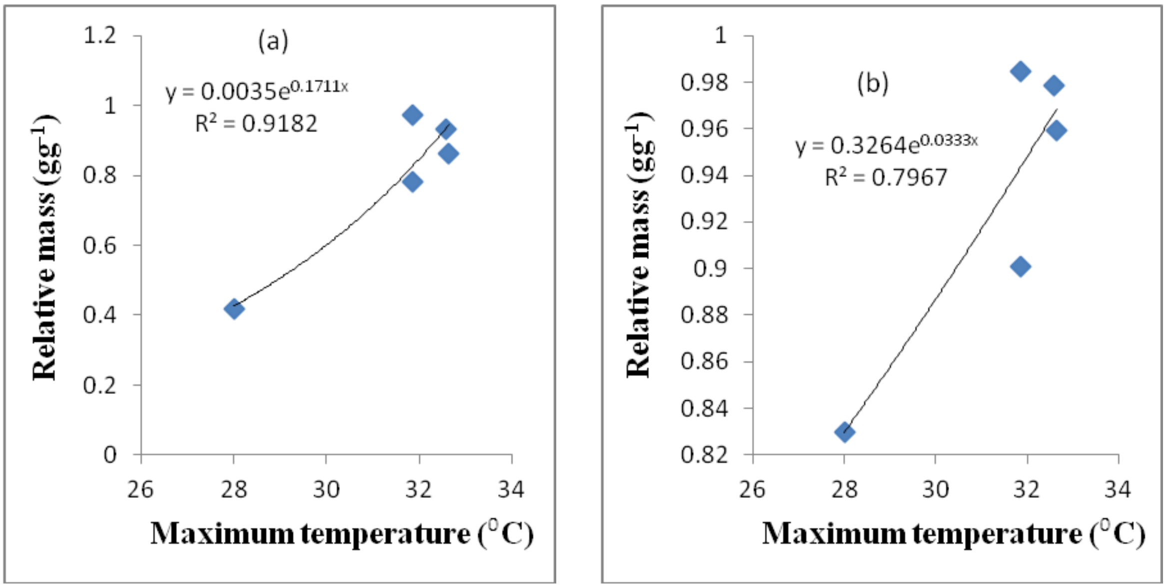

Fig. 4-14: The relationship between maximum temperature and decomposition rate of the Aspen wood in (a) the large diameter mesh bags as well as (b) the small diameter mesh bags

4.14.2 The relationship between minimum temperature and decomposition rate of the Aspen wood in the large *diameter* mesh bags as well as small *diameter* mesh bags

The decomposition rate of the Aspen wood in the large diameter mesh bags increased with increasing minimum temperature. There was a weak negative correlation between decomposition rate of the Aspen wood in the large diameter mesh bags and minimum temperature, with a coefficient of determination (R^2) of 0.1713 (Figure 4-15a). Also, the decomposition rate of the Aspen wood in the small diameter mesh bags increased with increasing minimum temperature. There was a weak negative correlation between decomposition rate of the Aspen wood in the small diameter mesh bags and minimum temperature, with a coefficient of determination (R^2) of 0.2269 (Figure 4-15b).

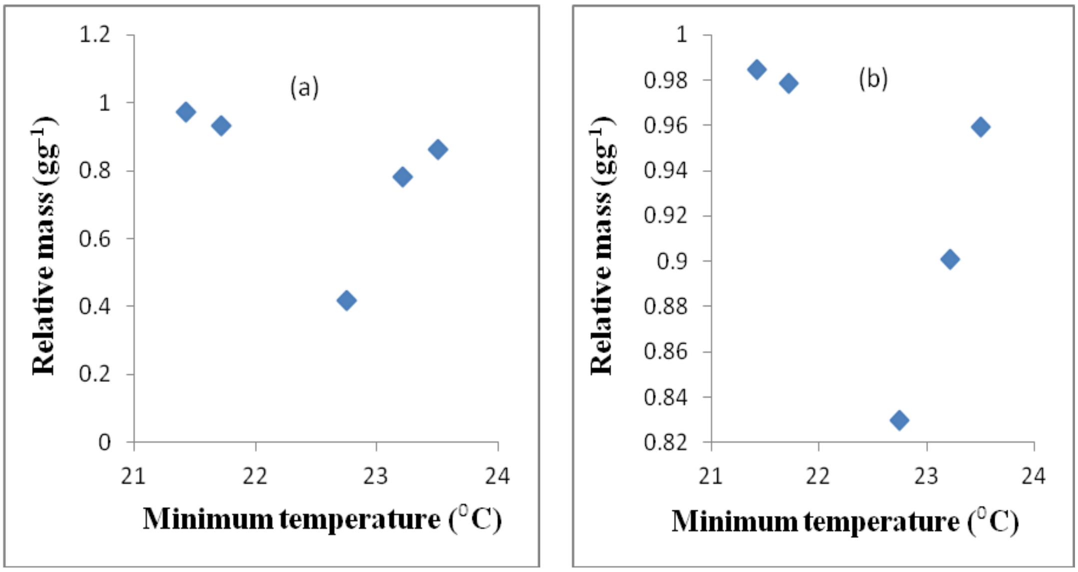

Fig. 4-15: The relationship between minimum temperature and decomposition rate of the Aspen wood in the (a) large diameter mesh bags as well as (b) small diameter mesh bags

4.14.3 The relationship between cumulative rainfall and decomposition rate of Aspen wood in the large diameter mesh bags as well as Aspen wood in the small diameter mesh bags

The decomposition rate of the Aspen wood in the large diameter mesh bags increased with increasing cumulative rainfall. There was a strong negative correlation between decomposition rate of the Aspen wood in the large diameter mesh bags and cumulative rainfall, with a coefficient of determination (R^2) of 0.9895 (Figure 4-16a). Also, the decomposition rate of the Aspen wood in the small diameter mesh bags increased with increasing cumulative rainfall. There was a strong negative correlation between decomposition rate of the Aspen wood in the small diameter mesh bags and cumulative rainfall, with a coefficient of determination (R^2) of 0.963 (Figure 4-16b).

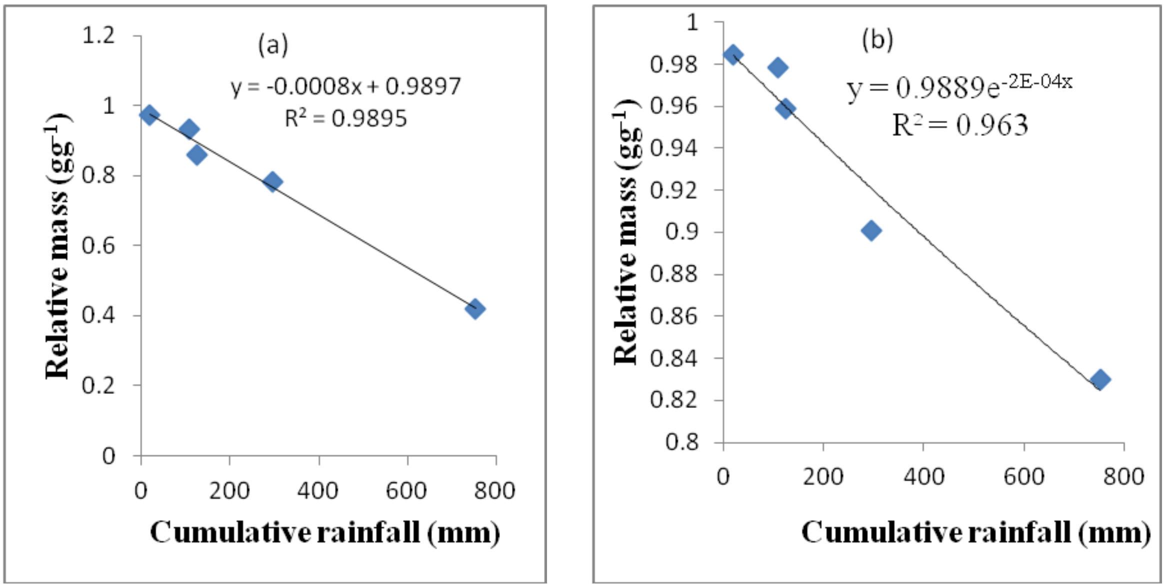

Fig. 4-16: The relationship between cumulative rainfall and decomposition rate of the Aspen wood in the (a) large diameter mesh bags as well as (b) small diameter mesh bags

4.15 The difference between the decomposition rate of *C. gigantea* as well as Aspen wood in the large compared to the small diameter mesh bags

The difference between the decomposition rate of wood in the large diameter mesh bags and wood in the small diameter mesh bags increased with time. There was a strong positive correlation between the difference in decomposition rate of the *C. gigantea* wood in the large and small diameter mesh bags as well as Aspen wood in the large and small diameter mesh bags with time, with a coefficient of determination (R^2) of 0.9539 and 0.7925 respectively (Figure 4-17a and 4-17b).

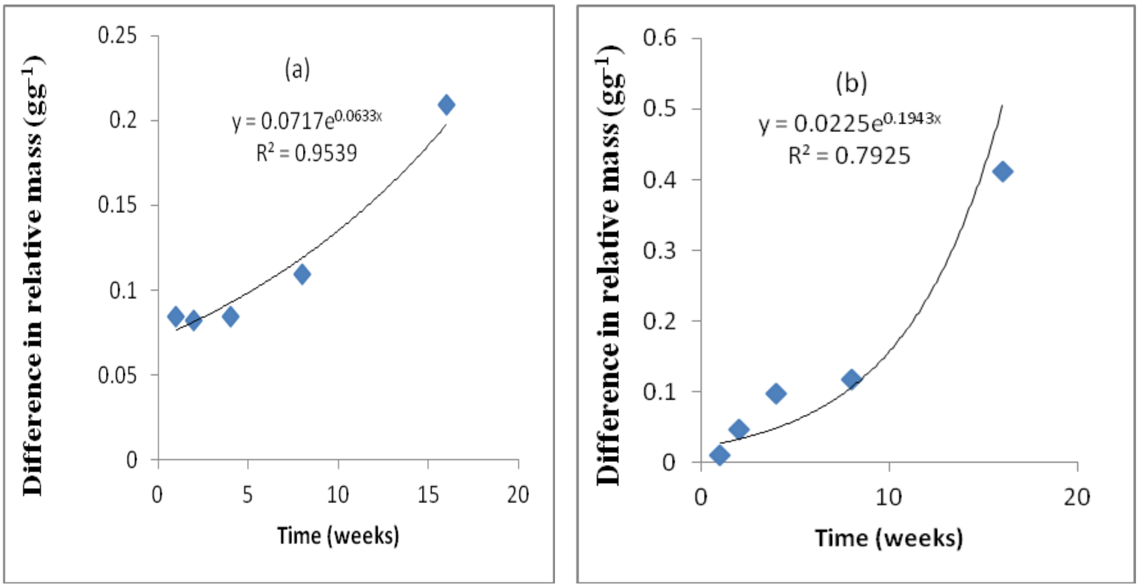

Fig. 4-17: The difference between the decomposition rate of the (a) *C. gigantea* wood in the large and small diameter mesh bags as well as (b) Aspen wood in the large and small diameter mesh bags

CHAPTER FIVE

5.0 DISCUSSIONS

5.1 Termite genera isolated and identified

This study identified three (3) termite genera; *Macrotermes*, *Microtermes and Ancistrotermes* which are also documented as the most dominant termite genera in the tropical moist semi-deciduous forest zone of Africa (UNEP, 2000; Attignon *et al.*, 2004).

5.2 Wood degraders

The wood degraders identified in this study; earthworms, spiders, arthropods, wood louse, millipedes, centipedes and ants are also known to facilitate wood decomposition (Richards 1987; Carpenter *et al.*, 1988; Edmonds and Eglitis, 1989; Clausen, 2010), and could have facilitated the decomposition of *Cola gigantea* and *Populus tremuloides Michx* (Aspen) wood in the large diameter mesh bags. Insects (Carpenter ants, bark beetles, wood borers and termites) play an important role in wood decomposition, particularly in the early phases of decomposition and are known to fragment woody substrates and introduce fungal spores and mycelia (Carpenter *et al.*, 1988; Edmonds and Eglitis, 1989; Edmonds, 2013). Additionally, non-fauna degraders of wood such as fungi were found associated with the decomposing wood (Gardiner 1957; Harmon *et al.*, 1986; Zhong and Schowalter, 1989; Edmonds, 2013).

5.3 Decomposition rate of wood in the large compared to wood in the small diameter mesh bags

The decomposition rates of wood in the small diameter mesh bags were relatively slow. Insects, fungi, myriapods, nematodes, acarina, collembola and oligochaeta are known to influence decomposition rates of wood (Harmon *et al.,* 1986). The inclusion of fauna in the large diameter mesh bags and its exclusion in the small diameter mesh bags could account for the differences in decomposition rates between the wood in the large versus small diameter mesh bags. This supports studies that faunal communities including termites are important in wood decomposition rates (Anderson and Swift, 1983; Harmon *et al.,* 1986). Powers *et al.* (2009) showed that when mesofauna such as insects are excluded, it had the largest impact on decomposition, reducing decomposition rates by half on average, but the magnitude of decrease was largely independent on climate. Respiration and leaching caused the loss of density or weight and the fragmentation caused the loss of volume (Lambert *et al.,* 1980; Sollins, 1982). A global-scale study conducted by Wall *et al.* (2008) confirmed the effect of soil fauna on wood decomposition. Studies by Powers *et al.* (2009) found that decomposition rates ranged from 0.47 $year^{-1}$ for raffia decomposing above ground without mesofauna in a dry forest in Thailand to 15.10 $year^{-1}$ for bay leaves decomposing above ground with mesofauna in a wet forest in Papua New Guinea. These results show that the rate of decomposition of litter that is not bagged at the soil surface could be up to 65 % faster, compared to litter that is enclosed in 1mm diameter litterbags (Bocock and Gilbert, 1957; Berhe, 2013). Litter bags that restrict access of meso- and macro-fauna could result in decreased rates of organic matter decomposition, as this prevents or reduces the potential for natural fragmentation of litter which is critical for initial breakdown of the organic substrates (Witkamp and Olson, 1963; Berhe, 2013). The decomposition rates of the *C. gigantea* wood in the small diameter mesh bags were not expected to be statistically different from each other. However, Bonferroni post tests results indicated that the decomposition rates of samples from plot I and plot K differed significantly from each other (Appendix K-2, K-3, K-4, K-5 and K-6). This may be due to the two small diameter mesh bags from plot I that mistakenly had some holes in them. These holes were large enough to permit entry by fauna such as termites, as the wood in these mesh bags exhibited termite damage. The close association between insects and decay fungi strongly influences the decomposition rate (Gardiner 1957; Zhong and Schowalter, 1989). The activities of these organisms are influenced by factors such as temperature, humidity, concentration of carbon dioxide (CO_2) and oxygen (O_2), and woody substrate quality including species, size, component and position (Harmon and Franklin, 1989). Soil organisms have been shown to be important determinants of decomposition (Gonzalez and Seastedt, 2001). Gonzalez *et al.* (2008) indicated that the fast decomposition rates of wood in the tropical forest fragments can be explained by the conditioning of fungi in the wood, the presence of wood burrowing insects and the presence of termites. Whitford *et al.* (1981) and Schaefer *et al.* (1985) showed that termites are capable of improving the microclimate and fragmentation of litter in ecosystems, resulting in faster decomposition rates. Fungi tend to begin the work of decaying the less nutritious heartwood, as their threadlike mycelia penetrate the tissue and allow entry for other organisms (Li *et al.*, 2006). Studies by Gonzalez *et al*. (2008) in a moist tropical forest in Puerto Rico revealed that Aspen wood had a decomposition rate of 1.52 per year compared to 0.055 per week in this study.

5.4 Decomposition rate of *Cola gigantea* wood compared to Aspen wood

The results showed that from week one (1) to four (4), the *Cola gigantea* wood exhibited a relatively higher initial decomposition rate than the Aspen wood in both the large and small diameter mesh bags. Currie *et al.* (1999) and Powers *et al.* (2009) have shown that litter identity effects on decomposition can depend on the incubation sites. These sites dependent responses have been interpreted as decomposers favouring local litter species over foreign litter due to long-term adaptation to a particular site-specific litter quality (Hunt *et al.,* 1988; Gholz *et al.,* 2000; Zhou *et al.,* 2008). Therefore, specialization of soil biota in degrading their litter matrix is partly responsible for home field advantages (Freschet *et al.,* 2011; Wang *et al.,* 2012). However, the decomposition rate of *Cola gigantea* wood in the large and small diameter mesh bags of $0.016gg^{-1}$ and $0.004gg^{-1}$ per week respectively were relatively slow over time compared to the decomposition rate of Aspen wood in the large and small diameter mesh bags of $0.055gg^{-1}$ and $0.012gg^{-1}$ per week respectively. It is documented that different tree species has different substrate chemistries in the wood; hence have different decomposition rates (Edmonds, 1980; Sollins *et al.,* 1987; Li *et al.,* 2006). Salinas *et al.* (2010) noted that the nature of the source material has a major influence on the decomposition rate. *Cola gigantea* wood is reported to have a higher lignin: nitrogen ratio compared to Aspen wood (Edmonds, 1980). The higher the lignin: nitrogen ratio of a wood species, the slower its decomposition rate (Trofymow *et al.,* 2002; Currie *et al.,* 2009; Wieder *et al.,* 2009). Wood decomposition rates vary according to the species and the site conditions (Herrmann and Prescott, 2008). During decomposition, the main factors include woody substrate quality (species, diameter and compound), site conditions (temperature, humidity, and O_2/CO_2 concentration), and organisms in the wood (Li *et* *al.*, 2006). Litter chemistry also has effect on decomposition rates in sites with more favourable climates (Meentemeyer, 1978). Site factors (such as moisture, by influencing abundance of ants and termites) can profoundly influence the rate and pattern of decomposition (Herrmann and Prescott, 2008). Decomposition rate also depends on the chemical composition (lignin, cellulose, hemicelluloses) of components. Lignin decomposes more slowly than celluloses, which results in an increase in the lignin/cellulose ratio with the decomposition process (Li *et al.*, 2006; Crawford, 1981). In terms of biological factors, plant species is important (Daubenmire and Prusso, 1963). Decomposition rates are regulated by climate in initial stages and by organic – chemical composition in later stages (Johansson, 1994). It has long been demonstrated that litter quality affects litter decomposition processes (Zhang *et al.*, 2008; Gholz *et al.*, 2000; Meentemeyer, 1978). Using the path analysis, Zhang *et al.* (2008) found that litter quality was the most important direct regulator of litter decomposition.

5.5 The extent of termite attack on *Cola gigantea* and Aspen wood

Termites suffer from high temperature especially when it reaches 52°C although sometimes this is moderated by increase in relative humidity (Harmon *et al.*, 1986). Wood is colonized by decomposer organisms such as termites that cause the initial mass loss (Grier, 1978; Fahey, 1983; Laiho and Prescott, 1999; Li *et al.*, 2006). Study sites are likely to differ in many ways besides climate. The results of this study underscores the findings of numerous studies that differences in diversity and abundance of micro organisms and fauna may explain some of the variation in decomposition within and among plots (Ostertag and Hobbie, 1999; Hobbie and Vitousek, 2000). According to Withgott and Brennan (2011) the optimum temperature for termite activity is 30°C at 90% relative humidity. Similarly, the average ambient temperature and relative humidity of the Bobiri forest reserve are 29°C and 85% respectively (Hall and Swaine, 1981), hence the observed high decomposition rates may, partly be due to termite attack.

5.6 Fungal attack on *Cola gigantea* and Aspen wood

The most important microbial decomposer agents are fungi in terrestrial ecosystems and bacteria in aquatic ecosystems among different microbes (Maser and Trappe, 1984; Harmon *et al.*, 1986). The trend and the extent of fungal attack on the two wood species used for the study were similar. Fungi are the dominant agents of decomposition in aerobic environments. They possess enzymes such as cellulase to efficiently break down complex substrates (Edmonds, 2013). The close association between insects and decay fungi strongly influences the decomposition rate (Gardiner 1957; Zhong and Schowalter, 1989). It is documented that many fungi species are mesophilous, the optimal scope for their growth in wood is between 25–30°C, their respiration will increase by 2-3 for every 10°C increase but they can't survive above 40°C (Käärik, 1974; Deverall, 1965). The ambient temperatures of the study site are hence favourable for fungal activity; with 36.1°C as the mean maximum and 21.7°C as the mean minimum temperature. Biological factors are extremely important in the decomposition process. Without the presence of microbes and their enzymes, organic matter decomposition would be very slow (Ugolini and Edmonds, 1983). Temperature can strongly influence the biological subsistence and at the same time the temperature is also influenced by many factors such as surrounding temperature, relative humidity and wood size (Rayner and Boddy, 1988).

5.7 Carton and sheeting accumulation on *C. gigantea* and Aspen wood

The carton and sheeting accumulated in/on the *C. gigantea* and Aspen wood in the large diameter mesh bags due to termite attack and activity increased with time (Figures 4-7a, 4-7b, 4-8a and 4-8b). This indicates that wood processing by termites increased with time.

5.8 The relationship between decomposition rate of the *Cola gigantea* wood, Aspen wood and environmental factors

Environmental factors (mainly temperature and moisture), soil fauna (activity and composition), soil microbes (activity and composition) and litter quality (lignin to nitrogen ratio, phenolics etc) are the main factors that influence decomposition rate of litter (Boddy, 1983; Prescott *et al.,* 2004; Makkonen *et al.,* 2012). The soil temperature increased with increasing current temperature (Figure 4-14). Laboratory experiments conducted by Bunnell *et al.* (1976) showed that adequate conditions of temperature must be present for decomposition to proceed. Temperature controls decomposition across large climatic zones in temperate and boreal forests (Berg *et al.,* 1993; Gholz *et al.,* 2000; Trofymow *et al.,* 2002). In contrast, precipitation is one of the most important drivers of decomposition in tropical sites (Powers *et al.,* 2009). Studies by Prescott *et al.* (2004) revealed that decomposition was more rapid in zones with greater moisture but similar temperatures. The community of soil organisms present and their activities are in turn related to environmental (largely climatic) conditions (Prescott *et al.,* 2004). Site conditions (temperature, humidity, and O_2/CO_2 concentration), woody substrate quality (diameter, species and compound) and the characteristics of organisms in wood also affect the decomposition (Foster and Lang, 1982; Graham and Cromack, 1982; Naesset, 1999;

Raija and Prescott, 2004). Lavelle *et al.* (1993) proposed that the hierarchy of factors regulating decomposition differs between humid tropical ecosystems and drier forests, for example biotic factors may be more important than abiotic factors in humid ecosystems such as the site used for this study. For example, González and Seastedt (2001) found that excluding fauna had little effect on decomposition rates in a tropical dry forest and significant effects in a tropical wet forest, suggesting that arthropod importance in tropical ecosystems may vary with rainfall. Empirical studies, conducted largely in the temperate zone, have identified three key drivers of decomposition, in order of decreasing importance: climate, litter quality (e.g. chemical composition) and the decomposer community (such as bacteria, fungi and soil fauna) (Meentemeyer, 1978, 1984; Coûteaux *et al.*, 1995). Zhang *et al.* (2008) showed that the decomposition rates (k values) increased with temperature, precipitation and nutrient concentrations at the large spatial scale. Factors such as mean annual temperature (MAT), mean annual precipitation (MAP), annual actual evapotranspiration (AET), litter quality (nitrogen content; carbon: nitrogen ratio, lignin content and lignin: nitrogen ratio); vegetation and litter types regulates decomposition rates (Aerts, 1997; Berg *et al.*, 2000; Dyer *et al.*, 1990; Edmonds, 1980; Gholz *et al.*, 1985, 2000; Meentemeyer, 1978; Meentemeyer and Berg, 1986; Moore, 1986; O'Neill *et al.*, 2003; Prescott *et al.*, 2004; Waring and Schlesinger, 1985; Yavitt and Fahey, 1986). Favorable temperature conditions also stimulate activities of the decomposer community such as fungi and soil fauna and there by accelerate the litter decomposition. Zhang *et al.* (2008) has also shown that MAT was more important than MAP in regulating litter decomposition. Nevertheless, water availability could become the dominant factor in influencing litter decomposition at local scales, particularly in desert or semi-arid regions where water was the primary limiting factor (Coûteaux *et al.,* 1995). Moore *et al*. (1999) found that MAT, MAP and lignin: nitrogen ratio explains 73% of the variation in mass remaining for 11 litter types across 18 forest sites. Similar results were also found by Silver and Miya (2001) who synthesized litter decomposition using buried litterbags. In contrast, Dyer *et al*. (1990) reported that climate clearly dominates the patterns of decomposition rates at large regional scales.

Results showed that the decomposition rate of the *C. gigantea* and Aspen wood decreased with increasing maximum temperature but increased with increasing minimum temperature. This trend supports the work of Zhang *et al.* (2008) which showed that the decomposition rates increased with temperature at the large spatial scale. However, low temperature is documented to limit the activity of soil fauna on decomposition (Wall *et al.* 2008). The optimum minimum and maximum temperature range for the decomposition of the *Cola gigantea* and Aspen wood in the large as well as small diameter mesh bags was between 21 - 24°C and 31 - 33^{0}C respectively. This observation suggests that the ambient temperature of the study site (with 21.7^{o}C as the mean minimum and 36.1^{o}C as the mean maximum temperature) as well as the minimum and maximum monthly average temperatures of the Bobiri forest reserve (19.9^{o}C and 32.8^{o}C respectively) (Hall and Swaine, 1981) were favourable for decomposition. Laboratory experiments conducted by Bunnell *et al.* (1976) showed that adequate conditions of temperature must be present for decomposition to proceed. Salinas *et al.* (2010) noted that temperature has a strong impact on tropical decomposition rates. According to Withgott and Brennan (2011) the optimum temperature for termite activity is 30^{0}C, similarly in this study, the optimum maximum temperature range was between 31 and 33^{0}C. At temperatures of

40^0C, all termite wood consumption ceases and at 20^0C, termite activity is at its lowest regardless of relative humidity values (Withgott and Brennan, 2011). Temperature plays an important role in the decomposition process. Decomposition is generally faster in cool, moist areas; slower in hot, dry areas but fastest in hot, moist areas (Edmonds, 2013).

Results showed that the decomposition rate of the *Cola gigantea* wood and Aspen wood in the large as well as small diameter mesh bags increased with increasing cumulative rainfall. This observation is consistent with findings by Chambers *et al.* (2000) as well as Marra and Edmonds (1996). In a study conducted by Buxton (1981), the foraging activity of termites was highest during the rainy season and declined to low levels during the long dry season. This study was conducted during the rainy season; hence, the relatively fast decomposition rate observed for the wood in the large diameter mesh bags is consistent with the findings of Buxton (1981). Similar to the findings in this study, Powers *et al.* (2009) as well as Austin and Vitousek (2000) reported positive linear relationship between mean annual precipitation and decomposition rates. According to Powers *et al.* (2009) precipitation controls decomposition in tropical forests with similar temperature regimes. Precipitation can have direct effects on decomposition through effects on faunal abundance, diversity and activity (Fragoso and Lavelle, 1992; Cornejo *et al.*, 1994; Austin and Vitousek, 2000). Hence the observed differences in decomposition rates between the wood in the large compared to the small diameter mesh bags. Laboratory experiments conducted by Bunnell *et al.* (1976) have shown that adequate conditions of moisture must be present for decomposition to proceed. Decomposition is generally faster in cool, moist areas; slower in hot, dry areas but fastest in hot moist areas such as the site used for this study (Edmonds, 2013). Adair *et al.* (2008) reported that water controls decomposition primarily through water stress. Decomposition is documented to increase with increasing humidity because it negatively correlates with wood density (Li *et al.,* 2006). According to Prescott *et al.* (2004) decomposition was more rapid in zones with greater moisture. Both high humidity and low humidity in particular can restrict the activity of wood inhabiting organisms. Fungi and other decomposing microorganisms can't live if the humidity is below 30%. Their activities are improved with the increase of humidity; however, these activities are limited by a very high humidity (Griffin, 1977). Some bacteria and fungi such as the soft rot fungi can survive in the high humidity of 240%. But only 30%–160% is the most optimal humidity for the growth of Basidiomycetes (Kaarik, 1974). In contrast to other studies, no evidence for inhibition of decomposition at high rainfall was found, which might occur due to anaerobic conditions (Powers *et al.,* 2009; Schuur, 2001). As observed in this study, in lowland tropical forests where temperatures are high all year round, decomposition rates of standard substrates were linearly related to annual precipitation, especially for litter decomposing above ground. Precipitation therefore, is one of the most important drivers of decomposition in tropical sites (Powers *et al.*, 2009). Moisture has been observed to have non-linear effects on the decomposition of wood in laboratory experiments (Chen *et al.*, 2001; Hicks, 2000), as low moisture levels decrease decomposition rates and saturated conditions can inhibit decomposer respiration (Yatskov *et al.*, 2003). On the contrary, consistent with Chambers *et al.* (2000), Marra and Edmonds (1996) found that saturated moisture conditions did not control seasonal variations of decomposition of coarse woody debris on a clear-cut forest in Washington, USA. In their study, they found that both the percent of mass remaining and the decomposition rate constant were significantly and negatively correlated to the annual precipitation. The percent of mass remaining was significantly greater in dry than in moist forest fragments in the boreal and temperate forests. Yet, the results of their study also showed a significant temperature and moisture interaction on the decomposition rate constant; as the decomposition of Aspen stakes was much higher in the moist than in the dry fragments in the tropical forests. The results support the contention that moisture condition is an important control over wood decomposition.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The following conclusions can be drawn from the results of this study:

The study identified termites within three genera; *Macrotermes, Microtermes* and *Ancistrotermes.* The termites belonged to the fungus growing sub-family Macrotermitinae which feed on wood and litter. Other wood degraders identified included earthworms, arthropods, spiders, wood louse, ants and fungi.

Aspen wood in the large as well as small diameter mesh bags decomposed about 3.4 and 3 times faster than *C. gigantea* wood in the large as well as small diameter mesh bags respectively. Hence the 'the home field advantage' theory is not always true. Decomposition rate of Aspen and *C. gigantea* wood in the large diameter mesh bags were about 4.6 and 4 times faster than the decomposition rate of Aspen and *C. gigantea* wood in the small diameter mesh bags.

The decomposition rate of the *C. gigantea* and Aspen wood in the large as well as small diameter mesh bags decreased with increasing maximum temperature, with the optimum range being 31 to 33°C. Also the decomposition rate of the *C. gigantea* and Aspen wood in the large as well as small diameter mesh bags increased with increasing cumulative rainfall. The difference between the decomposition rate of the Aspen as well as *C. gigantea* wood in the large compared to the small diameter mesh bags increased with time.

The entire mass of *C. gigantea* and Aspen wood in the large diameter mesh bags (15,023g and 12,417.69g) used for the study would decompose after seventy-three weeks (one year and five months) and eight months to release 27,542.167g and 22,765.765g of CO_2 into the atmosphere at 205.8g and 805.7g of CO_2 per week respectively. In addition, the entire mass of Aspen and *C. gigantea* wood in the small diameter mesh bags used for the study would decompose to release 22,755.59g and 27,069.735g of CO_2 into the atmosphere at 244.3g and 101.1g of CO_2 per week after two years and six years respectively.

6.2 RECOMMENDATIONS

Following the outcome of this research, the recommendations below are made:

The fungi species should be studied into detail.

Also further work should be done in order to identify the termite species that significantly contribute to wood decomposition in the moist semi-deciduous forest zone.

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APPENDICES

Appendix A-1: ANOVA at 5% level of significance for relative mass of Aspen and *Cola gigantea* in large diameter mesh bags.

Source of Variation	Df	Sum-of-squares	Mean square	F
Interaction	45	1423000	31630	0.8939
Time	9	743500	82610	2.335
Row Factor	5	133400	26680	0.7541
Residual (error)	60	2123000	35390	
Total	119	4423000		

	P value
Interaction	0.6502
Time	0.0250
Row Factor	0.5864

Appendix A-2: Tukey's multiple comparison test for relative mass of Aspen (Week 1) in large diameter mesh bags compared with relative mass of Aspen (Week 16) in large diameter mesh bags

AL1 vrs AL5

Row Factor	AL1	AL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	2.380	137.4	135.0	-614.6 to 884.7	0.7178	P > 0.05	ns
PLOT B	3.915	74.94	71.02	-678.6 to 820.7	0.3775	P > 0.05	ns
PLOT C	2.740	1066	1063	313.7 to 1813	5.653	P<0.001	***
PLOT D	4.755	103.2	98.44	-651.2 to 848.1	0.5233	P > 0.05	ns
PLOT E	16.04	195.8	179.7	-569.9 to 929.4	0.9555	P > 0.05	ns
PLOT F	2.000	137.0	135.0	-614.7 to 884.7	0.7176	P > 0.05	ns

Appendix A-3: Tukey's multiple comparison test for relative mass of *C. gigantea* (Week 1) in large diameter mesh bags compared with relative mass of Aspen (Week 16) in large diameter mesh bags

CL1 vrs AL5

Row Factor	CL1	AL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	20.45	137.4	117.0	-632.7 to 866.6	0.6217	P > 0.05	ns
PLOT B	47.05	74.94	27.89	-721.8 to 777.6	0.1482	P > 0.05	ns
PLOT C	51.75	1066	1014	264.7 to 1764	5.392	P<0.001	***
PLOT D	23.85	103.2	79.34	-670.3 to 829.0	0.4218	P > 0.05	ns
PLOT E	47.38	195.8	148.4	-601.3 to 898.1	0.7889	P > 0.05	ns
PLOT F	35.20	137.0	101.8	-647.9 to 851.5	0.5411	P > 0.05	ns

Appendix A-4: Tukey's multiple comparison test for relative mass of Aspen (Week 2) in large diameter mesh bags compared with relative mass of Aspen (Week 16) in large diameter mesh bags

AL2 vrs AL5

Row Factor	AL2	AL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	2.130	137.4	135.3	-614.4 to 884.9	0.7191	P > 0.05	ns
PLOT B	6.725	74.94	68.21	-681.5 to 817.9	0.3626	P > 0.05	ns
PLOT C	4.060	1066	1062	312.4 to 1812	5.646	P<0.001	***
PLOT D	7.790	103.2	95.40	-654.3 to 845.1	0.5072	P > 0.05	ns
PLOT E	7.115	195.8	188.7	-561.0 to 938.3	1.003	P > 0.05	ns
PLOT F	2.100	137.0	134.9	-614.8 to 884.6	0.7171	P > 0.05	ns

Appendix A-5: Tukey's multiple comparison test for relative mass of *C. gigantea* (Week 2) in large diameter mesh bags compared with relative mass of Aspen (Week 16) in large diameter mesh bags

CL2 vrs AL5

Row Factor	CL2	AL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	42.77	137.4	94.63	-655.0 to 844.3	0.5031	P > 0.05	ns
PLOT B	57.85	74.94	17.09	-732.6 to 766.8	0.09082	P > 0.05	ns
PLOT C	15.90	1066	1050	300.6 to 1800	5.583	P<0.001	***
PLOT D	47.20	103.2	55.99	-693.7 to 805.7	0.2976	P > 0.05	ns
PLOT E	24.07	195.8	171.7	-578.0 to 921.4	0.9128	P > 0.05	ns
PLOT F	46.60	137.0	90.40	-659.3 to 840.1	0.4805	P > 0.05	ns

Appendix A-6: Tukey's multiple comparison test for relative mass of Aspen (Week 4) in large diameter mesh bags compared with relative mass of Aspen (Week 16) in large diameter mesh bags

AL3 vrs AL5

Row Factor	AL3	AL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	8.735	137.4	128.7	-621.0 to 878.3	0.6840	P > 0.05	ns
PLOT B	11.86	74.94	63.08	-686.6 to 812.7	0.3353	P > 0.05	ns
PLOT C	32.37	1066	1034	284.1 to 1783	5.496	P<0.001	***
PLOT D	37.23	103.2	65.97	-683.7 to 815.6	0.3507	P > 0.05	ns
PLOT E	47.33	195.8	148.4	-601.2 to 898.1	0.7891	P > 0.05	ns
PLOT F	33.89	137.0	103.1	-646.6 to 852.8	0.5481	P > 0.05	ns

Appendix A-7: Tukey's multiple comparison test for relative mass of *C. gigantea* (Week 4) in large diameter mesh bags compared with relative mass of Aspen (Week 16) in large diameter mesh bags

CL3 vrs AL5

Row Factor	CL3	AL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	23.05	137.4	114.4	-635.3 to 864.0	0.6079	P > 0.05	ns
PLOT B	22.65	74.94	52.29	-697.4 to 802.0	0.2779	P > 0.05	ns
PLOT C	10.90	1066	1055	305.6 to 1805	5.610	P<0.001	***
PLOT D	14.35	103.2	88.84	-660.8 to 838.5	0.4723	P > 0.05	ns
PLOT E	6.600	195.8	189.2	-560.5 to 938.8	1.006	P > 0.05	ns
PLOT F	30.49	137.0	106.5	-643.2 to 856.2	0.5662	P > 0.05	ns

Appendix A-8: Tukey's multiple comparison test for relative mass of Aspen (Week 8) in large diameter mesh bags compared with relative mass of Aspen (Week 16) in large diameter mesh bags

AL4 vrs AL5

Row Factor	AL4	AL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	6.245	137.4	131.2	-618.5 to 880.8	0.6972	P > 0.05	ns
PLOT B	82.57	74.94	-7.630	-757.3 to 742.0	0.04056	P > 0.05	ns
PLOT C	53.70	1066	1012	262.8 to 1762	5.382	P<0.001	***
PLOT D	131.1	103.2	-27.95	-777.6 to 721.7	0.1486	P > 0.05	ns
PLOT E	45.10	195.8	150.7	-599.0 to 900.3	0.8010	P > 0.05	ns
PLOT F	104.1	137.0	32.88	-716.8 to 782.6	0.1748	P > 0.05	ns

Appendix A-9: Tukey's multiple comparison test for relative mass of *C. gigantea* (Week 8) in large diameter mesh bags compared with relative mass of Aspen (Week 16) in large diameter mesh bags

CL4 vrs AL5

Row Factor	CL4	AL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	37.45	137.4	99.95	-649.7 to 849.6	0.5313	P > 0.05	ns
PLOT B	48.21	74.94	26.73	-722.9 to 776.4	0.1421	P > 0.05	ns
PLOT C	38.21	1066	1028	278.3 to 1778	5.464	P<0.001	***
PLOT D	54.51	103.2	48.68	-701.0 to 798.3	0.2588	P > 0.05	ns
PLOT E	56.29	195.8	139.5	-610.2 to 889.2	0.7415	P > 0.05	ns
PLOT F	69.02	137.0	67.98	-681.7 to 817.6	0.3614	P > 0.05	ns

Appendix A-10: Tukey's multiple comparison test for relative mass of Aspen (Week 16) in large diameter mesh bags compared with relative mass of *C. gigantea* (Week 16) in large diameter mesh bags

AL5 vrs CL5

Row Factor	AL5	CL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	137.4	50.05	-87.35	-837.0 to 662.3	0.4644	P > 0.05	ns
PLOT B	74.94	50.91	-24.03	-773.7 to 725.6	0.1277	P > 0.05	ns
PLOT C	1066	64.91	-1001	-1751 to -251.6	5.323	P<0.001	***
PLOT D	103.2	114.8	11.59	-738.1 to 761.3	0.06164	P > 0.05	ns
PLOT E	195.8	230.1	34.29	-715.4 to 784.0	0.1823	P > 0.05	ns
PLOT F	137.0	58.48	-78.52	-828.2 to 671.1	0.4174	P > 0.05	ns

Appendix B-1: ANOVA at 5% level of significance for relative mass of Aspen wood and relative mass of *C. gigantea* wood in small diameter mesh bags.

Source of Variation	Df	Sum-of-squares	Mean square	F
Interaction	45	35820	796.0	1.622
Time	9	17240	1916	3.904
Row Factor	5	6600	1320	2.690
Residual (error)	60	29440	490.7	
Total	119	89100		

	P value
Interaction	0.0399
Time	0.0006
Row Factor	0.0293

Appendix B-2: Tukey's multiple comparison test for relative mass of Aspen wood (Week 1) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags

AS1 vrs CS2

Row Factor	AS1	CS2	Difference	95% CI of diff.	t	P value	Summary
PLOT A	51.75	14.49	-37.26	-125.5 to 51.02	1.682	P > 0.05	ns
PLOT B	46.25	20.85	-25.40	-113.7 to 62.88	1.147	P > 0.05	ns
PLOT C	45.85	26.50	-19.35	-107.6 to 68.93	0.8735	P > 0.05	ns
PLOT D	39.16	65.55	26.40	-61.88 to 114.7	1.192	P > 0.05	ns
PLOT E	34.86	125.0	90.14	1.861 to 178.4	4.069	P<0.001	***
PLOT F	44.00	50.85	6.850	-81.43 to 95.13	0.3092	P > 0.05	ns

Appendix B-3: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 1) in diameter small mesh bags compared with relative mass of Aspen wood (Week 2) in small diameter mesh bags

CS1 vrs AS2

Row Factor	CS1	AS2	Difference	95% CI of diff.	t	P value	Summary
PLOT A	9.775	22.63	12.86	-75.42 to 101.1	0.5803	P > 0.05	ns
PLOT B	43.41	38.34	-5.070	-93.35 to 83.21	0.2289	P > 0.05	ns
PLOT C	94.50	25.92	-68.59	-156.9 to 19.69	3.096	P < 0.05	*
PLOT D	24.25	20.26	-3.995	-92.27 to 84.28	0.1803	P > 0.05	ns
PLOT E	15.60	17.58	1.975	-86.30 to 90.25	0.08916	P > 0.05	ns
PLOT F	70.85	38.28	-32.58	-120.9 to 55.70	1.471	P > 0.05	ns

Appendix B-4: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 1) in small diameter mesh bags compared with for relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags

CS1 vrs CS2

Row Factor	CS1	CS2	Difference	95% CI of diff.	t	P value	Summary
PLOT G	9.775	14.49	4.715	-83.56 to 92.99	0.2129	P > 0.05	ns
PLOT H	43.41	20.85	-22.56	-110.8 to 65.72	1.018	P > 0.05	ns
PLOT I	94.50	26.50	-68.00	-156.3 to 20.28	3.070	P < 0.05	*
PLOT J	24.25	65.55	41.30	-46.98 to 129.6	1.864	P > 0.05	ns
PLOT K	15.60	125.0	109.4	21.12 to 197.7	4.939	P<0.001	***
PLOT L	70.85	50.85	-20.00	-108.3 to 68.28	0.9029	P > 0.05	ns

Appendix B-5: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 1) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 4) in small diameter mesh bags

CS1 vrs CS3

Row Factor	CS1	CS3	Difference	Row Factor	t	P value	Summary
PLOT G	9.775	7.250	-2.525	PLOT A	0.1140	P > 0.05	ns
PLOT H	43.41	8.760	-34.65	PLOT B	1.564	P > 0.05	ns
PLOT I	94.50	19.80	-74.70	PLOT C	3.372	P<0.01	**
PLOT J	24.25	44.40	20.15	PLOT D	0.9096	P > 0.05	ns
PLOT K	15.60	3.150	-12.45	PLOT E	0.5620	P > 0.05	ns
PLOT L	70.85	8.100	-62.75	PLOT F	2.833	P < 0.05	*

Appendix B-6: Tukey's multiple comparison test for relative mass of Aspen wood (Week 2) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags

AS2 vrs CS2

Row Factor	AS2	CS2	Difference	95% CI of diff.	t	P value	Summary
PLOT A	22.63	14.49	-8.140	-96.42 to 80.14	0.3675	P > 0.05	ns
PLOT B	38.34	20.85	-17.49	-105.8 to 70.79	0.7896	P > 0.05	ns
PLOT C	25.92	26.50	0.5850	-87.69 to 88.86	0.02641	P > 0.05	ns
PLOT D	20.26	65.55	45.30	-42.98 to 133.6	2.045	P > 0.05	ns
PLOT E	17.58	125.0	107.4	19.15 to 195.7	4.850	P<0.001	***
PLOT F	38.28	50.85	12.58	-75.70 to 100.9	0.5677	P > 0.05	ns

Appendix B-7: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags compared with relative mass of Aspen wood (Week 4) in small diameter mesh bags

CS2 vrs AS3

Row Factor	CS2	AS3	Difference	95% CI of diff.	t	P value	Summary
PLOT A	14.49	18.33	3.840	-84.44 to 92.12	0.1734	P > 0.05	ns
PLOT B	20.85	37.49	16.64	-71.64 to 104.9	0.7510	P > 0.05	ns
PLOT C	26.50	40.15	13.65	-74.63 to 101.9	0.6160	P > 0.05	ns
PLOT D	65.55	25.63	-39.93	-128.2 to 48.35	1.802	P > 0.05	ns
PLOT E	125.0	36.29	-88.72	-177.0 to -0.4357	4.005	P<0.01	**
PLOT F	50.85	39.67	-11.18	-99.46 to 77.10	0.5047	P > 0.05	ns

Appendix B-8: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 4) in small diameter mesh bags

CS2 vrs CS3

Row Factor	CS2	CS3	Difference	95% CI of diff.	t	P value	Summary
PLOT G	14.49	7.250	-7.240	-95.52 to 81.04	0.3268	P > 0.05	ns
PLOT H	20.85	8.760	-12.09	-100.4 to 76.19	0.5458	P > 0.05	ns
PLOT I	26.50	19.80	-6.700	-94.98 to 81.58	0.3025	P > 0.05	ns
PLOT J	65.55	44.40	-21.15	-109.4 to 67.13	0.9548	P > 0.05	ns
PLOT K	125.0	3.150	-121.9	-210.1 to -33.57	5.501	P<0.001	***
PLOT L	50.85	8.100	-42.75	-131.0 to 45.53	1.930	P > 0.05	ns

Appendix B-9: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags compared with relative mass of Aspen wood (Week 8) in small diameter mesh bags

CS2 vrs AS4

Row Factor	CS2	AS4	Difference	95% CI of diff.	t	P value	Summary
PLOT A	14.49	4.375	-10.12	-98.39 to 78.16	0.4566	P > 0.05	ns
PLOT B	20.85	24.07	3.220	-85.06 to 91.50	0.1454	P > 0.05	ns
PLOT C	26.50	43.42	16.92	-71.36 to 105.2	0.7636	P > 0.05	ns
PLOT D	65.55	17.12	-48.44	-136.7 to 39.84	2.187	P > 0.05	ns
PLOT E	125.0	18.95	-106.1	-194.3 to -17.78	4.788	P<0.001	***
PLOT F	50.85	25.00	-25.86	-114.1 to 62.42	1.167	P > 0.05	ns

Appendix B-10: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 8) in small diameter mesh bags

CS2 vrs CS4

Row Factor	CS2	CS4	Difference	95% CI of diff.	t	P value	Summary
PLOT G	14.49	25.27	10.78	-77.50 to 99.05	0.4864	P > 0.05	ns
PLOT H	20.85	19.47	-1.385	-89.66 to 86.89	0.06252	P > 0.05	ns
PLOT I	26.50	41.25	14.75	-73.53 to 103.0	0.6659	P > 0.05	ns
PLOT J	65.55	6.800	-58.75	-147.0 to 29.53	2.652	P > 0.05	ns
PLOT K	125.0	8.800	-116.2	-204.5 to -27.92	5.246	P<0.001	***
PLOT L	50.85	13.75	-37.10	-125.4 to 51.18	1.675	P > 0.05	ns

Appendix B-11: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags compared with relative mass of Aspen wood (Week 16) in small diameter mesh bags

CS2 vrs AS5

Row Factor	CS2	AS5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	14.49	43.21	28.72	-59.56 to 117.0	1.296	P > 0.05	ns
PLOT B	20.85	48.09	27.24	-61.04 to 115.5	1.230	P > 0.05	ns
PLOT C	26.50	70.74	44.24	-44.04 to 132.5	1.997	P > 0.05	ns
PLOT D	65.55	63.32	-2.235	-90.51 to 86.04	0.1009	P > 0.05	ns
PLOT E	125.0	34.36	-90.64	-178.9 to -2.361	4.092	P<0.001	***
PLOT F	50.85	31.70	-19.15	-107.4 to 69.13	0.8645	P > 0.05	ns

Appendix B-12: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 16) in small diameter mesh bags

CS2 vrs CS5

Row Factor	CS2	CS5	Difference	95% CI of diff.	t	P value	Summary
PLOT G	14.49	18.09	3.600	-84.68 to 91.88	0.1625	P > 0.05	ns
PLOT H	20.85	47.55	26.70	-61.58 to 115.0	1.205	P > 0.05	ns
PLOT I	26.50	59.75	33.25	-55.03 to 121.5	1.501	P > 0.05	ns
PLOT J	65.55	25.20	-40.35	-128.6 to 47.93	1.822	P > 0.05	ns
PLOT K	125.0	8.200	-116.8	-205.1 to -28.52	5.273	P<0.001	***
PLOT L	50.85	15.50	-35.35	-123.6 to 52.93	1.596	P > 0.05	ns

Appendix C-1: ANOVA at 5% level of significance for relative mass of Aspen wood in large diameter mesh bags

Source of Variation	Df	Sum-of-squares	Mean square	F
Interaction	20	1213000	60650	0.8637
Time	4	675200	168800	2.404
Row Factor	5	287700	57550	0.8196
Residual (error)	30	2106000	70210	
Total	59	4282000		

	P value
Interaction	0.6278
Time	0.0717
Row Factor	0.5454

Appendix C-2: Tukey's multiple comparison test for relative mass of Aspen wood (Week 1) in large diameter mesh bags compared with relative mass of Aspen wood (Week 16) in large diameter mesh bags

AL1 vrs AL5

Row Factor	AL1	AL5	Difference	95% CI of diff.	T	P value	Summary
PLOT A	2.380	137.4	135.0	-849.0 to 1119	0.5096	P > 0.05	ns
PLOT B	3.915	74.94	71.02	-913.0 to 1055	0.2680	P > 0.05	ns
PLOT C	2.740	1066	1063	79.35 to 2047	4.013	P<0.01	**
PLOT D	4.755	103.2	98.44	-885.6 to 1082	0.3715	P > 0.05	ns
PLOT E	16.04	195.8	179.7	-804.3 to 1164	0.6783	P > 0.05	ns
PLOT F	2.000	137.0	135.0	-849.0 to 1119	0.5095	P > 0.05	ns

Appendix C-3: Tukey's multiple comparison test for relative mass of Aspen wood (Week 2) in large diameter mesh bags compared with relative mass of Aspen wood (Week 16) in large diameter mesh bags

AL2 vrs AL5

Row Factor	AL2	AL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	2.130	137.4	135.3	-848.8 to 1119	0.5105	P > 0.05	ns
PLOT B	6.725	74.94	68.21	-915.8 to 1052	0.2574	P > 0.05	ns
PLOT C	4.060	1066	1062	78.03 to 2046	4.008	P<0.01	**
PLOT D	7.790	103.2	95.40	-888.6 to 1079	0.3600	P > 0.05	ns
PLOT E	7.115	195.8	188.7	-795.4 to 1173	0.7120	P > 0.05	ns
PLOT F	2.100	137.0	134.9	-849.1 to 1119	0.5091	P > 0.05	ns

Appendix C-4: Tukey's multiple comparison test for relative mass of Aspen wood (Week 8) in large diameter mesh bags compared with relative mass of Aspen wood (Week 16) in large diameter mesh bags

AL3 vrs AL5

Row Factor	AL3	AL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	8.735	137.4	128.7	-855.4 to 1113	0.4856	P > 0.05	ns
PLOT B	11.86	74.94	63.08	-921.0 to 1047	0.2381	P > 0.05	ns
PLOT C	32.37	1066	1034	49.73 to 2018	3.901	P<0.01	**
PLOT D	37.23	103.2	65.97	-918.1 to 1050	0.2489	P > 0.05	ns
PLOT E	47.33	195.8	148.4	-835.6 to 1132	0.5602	P > 0.05	ns
PLOT F	33.89	137.0	103.1	-880.9 to 1087	0.3891	P > 0.05	ns

Appendix C-5: Tukey's multiple comparison test for relative mass of Aspen wood (Week 8) in large diameter mesh bags compared with relative mass of Aspen wood (Week 16) in large diameter mesh bags

AL4 vrs AL5

Row Factor	AL4	AL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	6.245	137.4	131.2	-852.9 to 1115	0.4950	P > 0.05	ns
PLOT B	82.57	74.94	-7.630	-991.7 to 976.4	0.02879	P > 0.05	ns
PLOT C	53.70	1066	1012	28.39 to 1996	3.821	P<0.01	**
PLOT D	131.1	103.2	-27.95	-1012 to 956.1	0.1055	P > 0.05	ns
PLOT E	45.10	195.8	150.7	-833.4 to 1135	0.5686	P > 0.05	ns
PLOT F	104.1	137.0	32.88	-951.2 to 1017	0.1241	P > 0.05	ns

Appendix D-1: ANOVA at 5% level of significance for relative mass of Aspen wood in small diameter mesh bags

Source of Variation	Df	Sum-of-squares	Mean square	F
Interaction	20	3893	194.6	0.6970
Time	4	5874	1468	5.259
Row Factor	5	2149	429.8	1.539
Residual	30	8377	279.2	
Total	59	20290		

	P value
Interaction	0.7982
Time	0.0025
Row Factor	0.2076

Appendix D-2: Tukey's multiple comparison test for relative mass of Aspen wood (Week 1) in small diameter mesh bags compared with relative mass of Aspen wood (Week 8) in small diameter mesh bags

AS1 vrs AS4

Row Factor	AS1	AS4	Difference	95% CI of diff.	T	P value	Summary
PLOT A	51.75	4.375	-47.37	-109.4 to 14.69	2.835	P < 0.05	*
PLOT B	46.25	24.07	-22.18	-84.24 to 39.88	1.327	P > 0.05	ns
PLOT C	45.85	43.42	-2.435	-64.49 to 59.62	0.1457	P > 0.05	ns
PLOT D	39.16	17.12	-22.04	-84.10 to 40.02	1.319	P > 0.05	ns
PLOT E	34.86	18.95	-15.92	-77.97 to 46.14	0.9524	P > 0.05	ns
PLOT F	44.00	25.00	-19.01	-81.06 to 43.05	1.137	P > 0.05	ns

Appendix E-1: ANOVA at 5% level of significance for relative mass of *C. gigantea* wood in large diameter mesh bags

Source of Variation	Df	Sum-of-squares	Mean square	F
Interaction	20	46690	2335	4.188
Time	4	39490	9871	17.71
Row Factor	5	9463	1893	3.395
Residual	30	16720	557.4	
Total	59	112400		

	P value
Interaction	0.0002
Time	0.0001
Row Factor	0.0151

Appendix E-2: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 1) in large diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 16) in large diameter mesh bags

CL1 vrs CL5

Row Factor	CL1	CL5	Difference	95% CI of diff.	t	P value	Summary
PLOT G	20.45	50.05	29.60	-58.08 to 117.3	1.254	P > 0.05	ns
PLOT H	47.05	50.91	3.860	-83.82 to 91.54	0.1635	P > 0.05	ns
PLOT I	51.75	64.91	13.16	-74.53 to 100.8	0.5572	P > 0.05	ns
PLOT J	23.85	114.8	90.94	3.255 to 178.6	3.851	P<0.01	**
PLOT K	47.38	230.1	182.7	95.00 to 270.4	7.738	P<0.001	***
PLOT L	35.20	58.48	23.28	-64.41 to 111.0	0.9858	P > 0.05	ns

Appendix E-3: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 2) in large diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 16) in large diameter mesh bags

CL2 vrs CL5

Row Factor	CL2	CL5	Difference	95% CI of diff.	t	P value	Summary
PLOT G	42.77	50.05	7.280	-80.40 to 94.96	0.3083	P > 0.05	ns
PLOT H	57.85	50.91	-6.940	-94.62 to 80.74	0.2939	P > 0.05	ns
PLOT I	15.90	64.91	49.01	-38.68 to 136.7	2.076	P > 0.05	ns
PLOT J	47.20	114.8	67.58	-20.10 to 155.3	2.863	P < 0.05	*
PLOT K	24.07	230.1	206.0	118.3 to 293.7	8.725	P<0.001	***
PLOT L	46.60	58.48	11.88	-75.81 to 99.56	0.5030	P > 0.05	ns

Appendix E-4: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 4) in large diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 16) in large diameter mesh bags

CL3 vrs CL5

Row Factor	CL3	CL5	Difference	95% CI of diff.	t	P value	Summary
PLOT G	23.05	50.05	27.00	-60.68 to 114.7	1.144	P > 0.05	ns
PLOT H	22.65	50.91	28.26	-59.42 to 115.9	1.197	P > 0.05	ns
PLOT I	10.90	64.91	54.01	-33.68 to 141.7	2.287	P > 0.05	ns
PLOT J	14.35	114.8	100.4	12.75 to 188.1	4.254	P<0.01	**
PLOT K	6.600	230.1	223.5	135.8 to 311.1	9.465	P<0.001	***
PLOT L	30.49	58.48	27.99	-59.70 to 115.7	1.185	P > 0.05	ns

Appendix E-5: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 8) in large diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 16) in large diameter mesh bags

CL4 vrs CL5

Row Factor	CL4	CL5	Difference	95% CI of diff.	t	P value	Summary
PLOT G	37.45	50.05	12.60	-75.08 to 100.3	0.5337	P > 0.05	Ns
PLOT H	48.21	50.91	2.705	-84.98 to 90.39	0.1146	P > 0.05	Ns
PLOT I	38.21	64.91	26.70	-60.98 to 114.4	1.131	P > 0.05	Ns
PLOT J	54.51	114.8	60.27	-27.41 to 148.0	2.553	P > 0.05	Ns
PLOT K	56.29	230.1	173.8	86.09 to 261.5	7.360	P<0.001	***
PLOT L	69.02	58.48	-10.54	-98.22 to 77.14	0.4464	P > 0.05	Ns

Appendix F-1: ANOVA at 5% level of significance for relative mass of *C. gigantea* wood in small diameter mesh bags

Source of Variation	Df	Sum-of-squares	Mean square	F
Interaction	20	30650	1532	2.183
Time	4	11010	2752	3.919
Row Factor	5	5731	1146	1.632
Residual	30	21060	702.1	
Total	59	68450		

	P value
Interaction	0.0258
Time	0.0112
Row Factor	0.1818

Appendix F-2: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 1) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags

CS1 vrs CS2

Row Factor	CS1	CS2	Difference	95% CI of diff.	t	P value	Summary
PLOT G	9.775	14.49	4.715	-93.69 to 103.1	0.1779	P > 0.05	Ns
PLOT H	43.41	20.85	-22.56	-121.0 to 75.84	0.8514	P > 0.05	Ns
PLOT I	94.50	26.50	-68.00	-166.4 to 30.40	2.566	P > 0.05	Ns
PLOT J	24.25	65.55	41.30	-57.10 to 139.7	1.559	P > 0.05	Ns
PLOT K	15.60	125.0	109.4	11.00 to 207.8	4.129	P<0.01	**
PLOT L	70.85	50.85	-20.00	-118.4 to 78.40	0.7548	P > 0.05	Ns

Appendix F-3: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 4) in small diameter mesh bags

CS2 vrs CS3

Row Factor	CS2	CS3	Difference	95% CI of diff.	t	P value	Summary
PLOT G	14.49	7.250	-7.240	-105.6 to 91.16	0.2732	P > 0.05	ns
PLOT H	20.85	8.760	-12.09	-110.5 to 86.31	0.4563	P > 0.05	ns
PLOT I	26.50	19.80	-6.700	-105.1 to 91.70	0.2529	P > 0.05	ns
PLOT J	65.55	44.40	-21.15	-119.6 to 77.25	0.7982	P > 0.05	ns
PLOT K	125.0	3.150	-121.9	-220.3 to -23.45	4.598	P<0.001	***
PLOT L	50.85	8.100	-42.75	-141.2 to 55.65	1.613	P > 0.05	ns

Appendix F-4: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 8) in small diameter mesh bags

CS2 vrs CS4

Row Factor	CS2	CS4	Difference	95% CI of diff.	t	P value	Summary
PLOT G	14.49	25.27	10.78	-87.63 to 109.2	0.4066	P > 0.05	Ns
PLOT H	20.85	19.47	-1.385	-99.79 to 97.02	0.05227	P > 0.05	Ns
PLOT I	26.50	41.25	14.75	-83.65 to 113.2	0.5566	P > 0.05	Ns
PLOT J	65.55	6.800	-58.75	-157.2 to 39.65	2.217	P > 0.05	Ns
PLOT K	125.0	8.800	-116.2	-214.6 to -17.80	4.385	P<0.001	***
PLOT L	50.85	13.75	-37.10	-135.5 to 61.30	1.400	P > 0.05	Ns

Appendix F-5: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 16) in small diameter mesh bags

CS2 vrs CS5

Row Factor	CS2	CS5	Difference	95% CI of diff.	t	P value	Summary
PLOT G	14.49	18.09	3.600	-94.80 to 102.0	0.1359	P > 0.05	Ns
PLOT H	20.85	47.55	26.70	-71.70 to 125.1	1.008	P > 0.05	Ns
PLOT I	26.50	59.75	33.25	-65.15 to 131.7	1.255	P > 0.05	Ns
PLOT J	65.55	25.20	-40.35	-138.8 to 58.05	1.523	P > 0.05	Ns
PLOT K	125.0	8.200	-116.8	-215.2 to -18.40	4.408	P<0.001	***
PLOT L	50.85	15.50	-35.35	-133.8 to 63.05	1.334	P > 0.05	Ns

Appendix G-1: ANOVA at 5% for relative mass of Aspen wood in large diameter mesh bags compared to relative mass of Aspen wood in small diameter mesh bags

Source of Variation	Df	Sum-of-squares	Mean square	F
Interaction	45	1343000	29850	0.8468
Time	9	739500	82160	2.331
Row Factor	5	163600	32710	0.9281
Residual	60	2115000	35250	
Total	119.0	4361000		

	P value
Interaction	0.7181
Time	0.0252
Row Factor	0.4693

Appendix G-2: Tukey's multiple comparison test for relative mass of Aspen wood (Week 1) in small diameter mesh bags compared with relative mass of Aspen wood (Week 16) in large diameter mesh bags

AS1 vrs AL5

Row Factor	AS1	AL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	51.75	137.4	85.66	-662.5 to 833.8	0.4562	P > 0.05	Ns
PLOT B	46.25	74.94	28.69	-719.5 to 776.9	0.1528	P > 0.05	Ns
PLOT C	45.85	1066	1020	272.1 to 1768	5.435	P<0.001	***
PLOT D	39.16	103.2	64.04	-684.2 to 812.2	0.3411	P > 0.05	Ns
PLOT E	34.86	195.8	160.9	-587.3 to 909.1	0.8571	P > 0.05	Ns
PLOT F	44.00	137.0	93.00	-655.2 to 841.2	0.4953	P > 0.05	Ns

Appendix G-3: Tukey's multiple comparison test for relative mass of Aspen wood (Week 2) in small diameter mesh bags compared with relative mass of Aspen wood (Week 16) in large diameter mesh bags

AS2 vrs AL5

Row Factor	AS2	AL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	22.63	137.4	114.8	-633.4 to 863.0	0.6113	P > 0.05	Ns
PLOT B	38.34	74.94	36.60	-711.6 to 784.8	0.1949	P > 0.05	Ns
PLOT C	25.92	1066	1040	292.0 to 1788	5.541	P<0.001	***
PLOT D	20.26	103.2	82.94	-665.3 to 831.1	0.4418	P > 0.05	Ns
PLOT E	17.58	195.8	178.2	-570.0 to 926.4	0.9492	P > 0.05	Ns
PLOT F	38.28	137.0	98.72	-649.5 to 846.9	0.5258	P > 0.05	Ns

Appendix G-4: Tukey's multiple comparison test for relative mass of Aspen wood (Week 4) in small diameter mesh bags compared with relative mass of Aspen wood (Week 16) in large diameter mesh bags

AS3 vrs AL5

Row Factor	AS3	AL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	18.33	137.4	119.1	-629.1 to 867.3	0.6342	P > 0.05	Ns
PLOT B	37.49	74.94	37.45	-710.7 to 785.6	0.1995	P > 0.05	Ns
PLOT C	40.15	1066	1026	277.8 to 1774	5.465	P<0.001	***
PLOT D	25.63	103.2	77.57	-670.6 to 825.8	0.4132	P > 0.05	Ns
PLOT E	36.29	195.8	159.5	-588.7 to 907.7	0.8495	P > 0.05	Ns
PLOT F	39.67	137.0	97.33	-650.9 to 845.5	0.5184	P > 0.05	Ns

Appendix G-5: Tukey's multiple comparison test for relative mass of Aspen wood (Week 8) in small diameter mesh bags compared with relative mass of Aspen wood (Week 16) in large diameter mesh bags

AS4 vrs AL5

Row Factor	AS4	AL5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	4.375	137.4	133.0	-615.2 to 881.2	0.7086	P > 0.05	ns
PLOT B	24.07	74.94	50.87	-697.3 to 799.1	0.2709	P > 0.05	ns
PLOT C	43.42	1066	1023	274.5 to 1771	5.448	P<0.001	***
PLOT D	17.12	103.2	86.08	-662.1 to 834.3	0.4585	P > 0.05	ns
PLOT E	18.95	195.8	176.8	-571.4 to 925.0	0.9419	P > 0.05	ns
PLOT F	25.00	137.0	112.0	-636.2 to 860.2	0.5966	P > 0.05	ns

Appendix G-6: Tukey's multiple comparison test for relative mass of Aspen wood (Week 16) in small diameter mesh bags compared with relative mass of Aspen wood (Week 16) in large diameter mesh bags

AL5 vrs AS5

Row Factor	AL5	AS5	Difference	95% CI of diff.	t	P value	Summary
PLOT A	137.4	43.21	-94.19	-842.4 to 654.0	0.5017	P > 0.05	Ns
PLOT B	74.94	48.09	-26.85	-775.0 to 721.3	0.1430	P > 0.05	Ns
PLOT C	1066	70.74	-995.4	-1744 to -247.2	5.302	P<0.001	***
PLOT D	103.2	63.32	-39.88	-788.1 to 708.3	0.2124	P > 0.05	Ns
PLOT E	195.8	34.36	-161.4	-909.6 to 586.8	0.8598	P > 0.05	Ns
PLOT F	137.0	31.70	-105.3	-853.5 to 642.9	0.5609	P > 0.05	Ns

Appendix H-1: ANOVA at 5% for relative mass of *C. gigantea* wood in large mesh bags compared to relative mass of *C. gigantea* wood in small diameter mesh bags

Source of Variation	Df	Sum-of-squares	Mean square	F
Interaction	45	84410	1876	2.978
Time	9	58770	6530	10.37
Row Factor	5	8125	1625	2.580
Residual	60	37790	629.8	
Total	119.0	189100		

	P value
Interaction	0.0001
Time	0.0001
Row Factor	0.0352

Appendix H-2: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 1) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 2) in large diameter mesh bags

CS1 vrs CL2

Row Factor	CS1	CL2	Difference	95% CI of diff.	t	P value	Summary
PLOT G	9.775	42.77	33.00	-67.02 to 133.0	1.315	P > 0.05	Ns
PLOT H	43.41	57.85	14.44	-85.57 to 114.5	0.5754	P > 0.05	Ns
PLOT I	94.50	15.90	-78.60	-178.6 to 21.41	3.132	P < 0.05	*
PLOT J	24.25	47.20	22.95	-77.06 to 123.0	0.9145	P > 0.05	Ns
PLOT K	15.60	24.07	8.465	-91.55 to 108.5	0.3373	P > 0.05	Ns
PLOT L	70.85	46.60	-24.25	-124.3 to 75.76	0.9663	P > 0.05	Ns

Appendix H-3: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 1) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 4) in large diameter mesh bags

CS1 vrs CL3

Row Factor	CS1	CL3	Difference	95% CI of diff.	t	P value	Summary
PLOT G	9.775	23.05	13.28	-86.74 to 113.3	0.5290	P > 0.05	Ns
PLOT H	43.41	22.65	-20.76	-120.8 to 79.25	0.8272	P > 0.05	Ns
PLOT I	94.50	10.90	-83.60	-183.6 to 16.41	3.331	P<0.01	**
PLOT J	24.25	14.35	-9.900	-109.9 to 90.11	0.3945	P > 0.05	Ns
PLOT K	15.60	6.600	-9.000	-109.0 to 91.01	0.3586	P > 0.05	Ns
PLOT L	70.85	30.49	-40.36	-140.4 to 59.65	1.608	P > 0.05	Ns

Appendix H-4: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 1) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 16) in large diameter mesh bags

CS1 vrs CL5

Row Factor	CS1	CL5	Difference	95% CI of diff.	t	P value	Summary
PLOT G	9.775	50.05	40.28	-59.74 to 140.3	1.605	P > 0.05	Ns
PLOT H	43.41	50.91	7.500	-92.51 to 107.5	0.2989	P > 0.05	Ns
PLOT I	94.50	64.91	-29.60	-129.6 to 70.42	1.179	P > 0.05	Ns
PLOT J	24.25	114.8	90.54	-9.478 to 190.5	3.608	P<0.01	**
PLOT K	15.60	230.1	214.5	114.4 to 314.5	8.546	P<0.001	***
PLOT L	70.85	58.48	-12.38	-112.4 to 87.64	0.4931	P > 0.05	Ns

Appendix H-5: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 1) in large diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags

CL1 vrs CS2

Row Factor	CL1	CS2	Difference	95% CI of diff.	t	P value	Summary
PLOT G	20.45	14.49	-5.960	-106.0 to 94.05	0.2375	P > 0.05	Ns
PLOT H	47.05	20.85	-26.20	-126.2 to 73.81	1.044	P > 0.05	Ns
PLOT I	51.75	26.50	-25.25	-125.3 to 74.76	1.006	P > 0.05	Ns
PLOT J	23.85	65.55	41.70	-58.31 to 141.7	1.662	P > 0.05	Ns
PLOT K	47.38	125.0	77.63	-22.39 to 177.6	3.093	P < 0.05	*
PLOT L	35.20	50.85	15.65	-84.36 to 115.7	0.6236	P > 0.05	Ns

Appendix H-6: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 2) in large diameter mesh bags

CS2 vrs CL2

Row Factor	CS2	CL2	Difference	95% CI of diff.	t	P value	Summary
PLOT G	14.49	42.77	28.28	-71.73 to 128.3	1.127	P > 0.05	Ns
PLOT H	20.85	57.85	37.00	-63.01 to 137.0	1.474	P > 0.05	Ns
PLOT I	26.50	15.90	-10.60	-110.6 to 89.41	0.4224	P > 0.05	Ns
PLOT J	65.55	47.20	-18.35	-118.4 to 81.66	0.7312	P > 0.05	Ns
PLOT K	125.0	24.07	-100.9	-200.9 to -0.9224	4.022	P<0.001	***
PLOT L	50.85	46.60	-4.250	-104.3 to 95.76	0.1694	P > 0.05	Ns

Appendix H-7: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 4) in large diameter mesh bags

CS2 vrs CL3

Row Factor	CS2	CL3	Difference	95% CI of diff.	t	P value	Summary
PLOT G	14.49	23.05	8.560	-91.45 to 108.6	0.3411	P > 0.05	ns
PLOT H	20.85	22.65	1.800	-98.21 to 101.8	0.07173	P > 0.05	ns
PLOT I	26.50	10.90	-15.60	-115.6 to 84.41	0.6216	P > 0.05	ns
PLOT J	65.55	14.35	-51.20	-151.2 to 48.81	2.040	P > 0.05	ns
PLOT K	125.0	6.600	-118.4	-218.4 to -18.39	4.718	P<0.001	***
PLOT L	50.85	30.49	-20.36	-120.4 to 79.65	0.8113	P > 0.05	ns

Appendix H-8: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 8) in large diameter mesh bags

CS2 vrs CL4

Row Factor	CS2	CL4	Difference	95% CI of diff.	t	P value	Summary
PLOT G	14.49	37.45	22.96	-77.05 to 123.0	0.9149	P > 0.05	ns
PLOT H	20.85	48.21	27.36	-72.66 to 127.4	1.090	P > 0.05	ns
PLOT I	26.50	38.21	11.71	-88.31 to 111.7	0.4664	P > 0.05	ns
PLOT J	65.55	54.51	-11.04	-111.1 to 88.97	0.4399	P > 0.05	ns
PLOT K	125.0	56.29	-68.71	-168.7 to 31.30	2.738	P < 0.05	*
PLOT L	50.85	69.02	18.17	-81.85 to 118.2	0.7238	P > 0.05	ns

Appendix H-9: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 2) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 16) in large diameter mesh bags

CS2 vrs CL5

Row Factor	CS2	CL5	Difference	95% CI of diff.	t	P value	Summary
PLOT G	14.49	50.05	35.56	-64.45 to 135.6	1.417	P > 0.05	ns
PLOT H	20.85	50.91	30.06	-69.95 to 130.1	1.198	P > 0.05	ns
PLOT I	26.50	64.91	38.41	-61.61 to 138.4	1.530	P > 0.05	ns
PLOT J	65.55	114.8	49.23	-50.78 to 149.2	1.962	P > 0.05	ns
PLOT K	125.0	230.1	105.1	5.047 to 205.1	4.186	P<0.001	***
PLOT L	50.85	58.48	7.625	-92.39 to 107.6	0.3038	P > 0.05	ns

Appendix H-10: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 4) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 16) in large diameter mesh bags

CS3 vrs CL5

Row Factor	CS3	CL5	Difference	95% CI of diff.	t	P value	Summary
PLOT G	7.250	50.05	42.80	-57.21 to 142.8	1.705	P > 0.05	ns
PLOT H	8.760	50.91	42.15	-57.86 to 142.2	1.680	P > 0.05	ns
PLOT I	19.80	64.91	45.11	-54.91 to 145.1	1.797	P > 0.05	ns
PLOT J	44.40	114.8	70.38	-29.63 to 170.4	2.805	P < 0.05	*
PLOT K	3.150	230.1	226.9	126.9 to 326.9	9.042	P<0.001	***
PLOT L	8.100	58.48	50.38	-49.64 to 150.4	2.007	P > 0.05	ns

Appendix H-11: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 8) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 16) in large diameter mesh bags

CS4 vrs CL5

Row Factor	CS4	CL5	Difference	95% CI of diff.	t	P value	Summary
PLOT G	25.27	50.05	24.79	-75.23 to 124.8	0.9876	P > 0.05	ns
PLOT H	19.47	50.91	31.45	-68.57 to 131.5	1.253	P > 0.05	ns
PLOT I	41.25	64.91	23.66	-76.36 to 123.7	0.9426	P > 0.05	ns
PLOT J	6.800	114.8	108.0	7.972 to 208.0	4.303	P<0.001	***
PLOT K	8.800	230.1	221.3	121.2 to 321.3	8.817	P<0.001	***
PLOT L	13.75	58.48	44.73	-55.29 to 144.7	1.782	P > 0.05	ns

Appendix H-12: Tukey's multiple comparison test for relative mass of *C. gigantea* wood (Week 16) in small diameter mesh bags compared with relative mass of *C. gigantea* wood (Week 16) in large diameter mesh bags

CS5 vrs CL5

Row Factor	CS5	CL5	Difference	95% CI of diff.	t	P value	Summary
PLOT G	18.09	50.05	31.96	-68.05 to 132.0	1.274	P > 0.05	ns
PLOT H	47.55	50.91	3.360	-96.65 to 103.4	0.1339	P > 0.05	ns
PLOT I	59.75	64.91	5.155	-94.86 to 105.2	0.2054	P > 0.05	ns
PLOT J	25.20	114.8	89.58	-10.43 to 189.6	3.570	P<0.01	**
PLOT K	8.200	230.1	221.9	121.8 to 321.9	8.841	P<0.001	***
PLOT L	15.50	58.48	42.98	-57.04 to 143.0	1.712	P > 0.05	ns

Appendix I-1: ANOVA at 5% level of significance for the relative mass of *C. gigantea* wood in the large diameter mesh bags

Source of Variation	Df	Sum-of-squares	Mean square	F
Interaction	20	0.2056	0.01028	1.822
Sampling Occasion	4	0.2189	0.05473	9.703
Plot	5	0.05417	0.01083	1.921
Residual	30	0.1692	0.005641	
Total	59	0.6479		

	P value
Interaction	0.0667
Sampling Occasion	0.0001
Plot	0.1203

Appendix I-2: Bonferroni post tests results for relative mass of *C. gigantea* wood (Week 1) in the large diameter mesh bags compared with *C. gigantea* wood (Week 16) in large diameter mesh bags

CL 1 vrs CL 5

Plot	CL1	CL5	Difference	95% CI of diff.	t	P value	Summary
P G	0.9174	0.7911	-0.1262	-0.4052 to 0.1527	1.681	P > 0.05	ns
P H	0.8133	0.7935	-0.01983	-0.2987 to 0.2591	0.2640	P > 0.05	ns
P I	0.7859	0.7370	-0.04888	-0.3278 to 0.2300	0.6508	P > 0.05	ns
P J	0.9010	0.5245	-0.3765	-0.6554 to -0.09755	5.012	P<0.001	***
P K	0.8100	0.5146	-0.2955	-0.5744 to -0.01654	3.934	P<0.01	**
P L	0.8564	0.7577	-0.09875	-0.3777 to 0.1802	1.315	P > 0.05	ns

AppendixI-3: Bonferroni post tests results for relative mass of *C. gigantea* wood (Week 2) in the large diameter mesh bags compared with *C. gigantea* wood (Week 16) in large diameter mesh bags

CL 2 vrs CL 5

Plot	CL2	CL5	Difference	95% CI of diff.	t	P value	Summary
P G	0.8292	0.7911	-0.03812	-0.3170 to 0.2408	0.5076	P > 0.05	ns
P H	0.7885	0.7935	0.004957	-0.2740 to 0.2839	0.06601	P > 0.05	ns
P I	0.9353	0.7370	-0.1983	-0.4773 to 0.08058	2.641	P > 0.05	ns
P J	0.8008	0.5245	-0.2763	-0.5553 to 0.002576	3.679	P<0.01	**
P K	0.9035	0.5146	-0.3890	-0.6679 to -0.1101	5.179	P<0.001	***
P L	0.8077	0.7577	-0.05004	-0.3290 to 0.2289	0.6662	P > 0.05	ns

AppendixI-4: Bonferroni post tests results for relative mass of *C. gigantea* wood (Week 4) in the large diameter mesh bags compared with *C. gigantea* wood (Week 16) in large diameter mesh bags

CL 3 vrs CL 5

Plot	CL3	CL5	Difference	95% CI of diff.	t	P value	Summary
P G	0.8456	0.7911	-0.05452	-0.3334 to 0.2244	0.7258	P > 0.05	ns
P H	0.8290	0.7935	-0.03550	-0.3144 to 0.2434	0.4726	P > 0.05	ns
P I	0.8338	0.7370	-0.09684	-0.3758 to 0.1821	1.289	P > 0.05	ns
P J	0.8148	0.5245	-0.2903	-0.5692 to 0.01141	3.866	P<0.01	**
P K	0.8473	0.5146	-0.3328	-0.6117 to 0.05385	4.431	P<0.001	***
P L	0.8355	0.7577	-0.07778	-0.3567 to 0.2011	1.036	P > 0.05	ns

AppendixI-5: Bonferroni post tests results for relative mass of *C. gigantea* wood (Week 8) in the large diameter mesh bags compared with *C. gigantea* wood (Week 16) in large diameter mesh bags

CL 4 vrs CL 5

Plot	CL4	CL5	Difference	95% CI of diff.	t	P value	Summary
P G	0.8539	0.7911	-0.06276	-0.3417 to 0.2162	0.8356	P > 0.05	ns
P H	0.8103	0.7935	-0.01682	-0.2957 to 0.2621	0.2240	P > 0.05	ns
P I	0.8561	0.7370	-0.1191	-0.3980 to 0.1598	1.585	P > 0.05	ns
P J	0.7733	0.5245	-0.2488	-0.5277 to 0.03012	3.313	P < 0.05	*
P K	0.7737	0.5146	-0.2591	-0.5380 to 0.01979	3.450	P < 0.05	*
P L	0.7428	0.7577	0.01490	-0.2640 to 0.2938	0.1984	P > 0.05	ns

Appendix J-1: ANOVA at 5% level of significance for the relative mass of Aspen wood in the large diameter mesh bags

Source of Variation	Df	Sum-of-squares	Mean square	F	P value
Interaction	20	0.8689	0.04344	2.371	0.0158
Sampling Occasion	4	2.614	0.6536	35.66	0.0001
Plot	5	0.2646	0.05292	2.888	0.0303
Residual	30	0.5498	0.01833		
Total	59	4.298			

AppendixJ-2: Bonferroni post tests results for relative mass of Aspen wood (Week 1) in the large diameter mesh bags compared with Aspen wood (Week 8) in large diameter mesh bags

AL 1 vrs AL 4

Plot	AL1	AL4	Difference	95% CI of diff.	t	P value	Summary
P A	0.9884	0.9693	-0.01908	-0.5218 to 0.4837	0.1409	P > 0.05	ns
P B	0.9810	0.6238	-0.3571	-0.8599 to 0.1456	2.638	P > 0.05	ns
P C	0.9864	0.7479	-0.2385	-0.7412 to 0.2642	1.762	P > 0.05	ns
P D	0.9747	0.3400	-0.6347	-1.137 to -0.1320	4.688	P<0.001	***
P E	0.9093	0.7942	-0.1151	-0.6178 to 0.3876	0.8503	P > 0.05	ns
P F	0.9910	0.5535	-0.4375	-0.9403 to 0.06519	3.232	P < 0.05	*

AppendixJ-3: Bonferroni post tests results for relative mass of Aspen wood (Week 1) in the large diameter mesh bags compared with Aspen wood (Week 16) in large diameter mesh bags

AL 1 vrs AL 5

Plot	AL1	AL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.9884	0.3481	-0.6403	-1.077 to -0.2040	5.849	P<0.001	***
P B	0.9810	0.6455	-0.3354	-0.7717 to 0.1008	3.064	P < 0.05	*
P C	0.9864	0.6717	-0.3147	-0.7509 to 0.1216	2.874	P < 0.05	*
P D	0.9747	0.4839	-0.4909	-0.9271 to -0.05459	4.484	P<0.001	***
P E	0.9093	0.01170	-0.8976	-1.334 to -0.4614	8.200	P<0.001	***
P F	0.9910	0.3429	-0.6481	-1.084 to -0.2119	5.921	P<0.001	***

AppendixJ-4: Bonferroni post tests results for relative mass of Aspen wood (Week 2) in the large diameter mesh bags compared with Aspen wood (Week 8) in large diameter mesh bags

AL 2 vrs AL 4

Plot	AL2	AL4	Difference	95% CI of diff.	t	P value	Summary
P A	0.9664	0.9693	0.002891	-0.4998 to 0.5056	0.02136	P > 0.05	ns
P B	0.9459	0.6238	-0.3221	-0.8248 to 0.1806	2.379	P > 0.05	ns
P C	0.9649	0.7479	-0.2170	-0.7197 to 0.2858	1.603	P > 0.05	ns
P D	0.9470	0.3400	-0.6070	-1.110 to -0.1042	4.484	P<0.001	***
P E	0.9485	0.7942	-0.1542	-0.6570 to 0.3485	1.139	P > 0.05	ns
P F	0.9688	0.5535	-0.4153	-0.9180 to 0.08747	3.067	P < 0.05	*

AppendixJ-5: Bonferroni post tests results for relative mass of Aspen wood (Week 2) in the large diameter mesh bags compared with Aspen wood (Week 16) in large diameter mesh bags

AL 2 vrs AL 5

Plot	AL2	AL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.9664	0.3481	-0.6183	-1.121 to -0.1156	4.567	P<0.001	***
P B	0.9459	0.6455	-0.3004	-0.8031 to 0.2023	2.219	P > 0.05	ns
P C	0.9649	0.6717	-0.2931	-0.7959 to 0.2096	2.165	P > 0.05	ns
P D	0.9470	0.4839	-0.4631	-0.9659 to 0.03960	3.421	P < 0.05	*
P E	0.9485	0.01170	-0.9368	-1.439 to -0.4340	6.920	P<0.001	***
P F	0.9688	0.3429	-0.6259	-1.129 to -0.1231	4.623	P<0.001	***

AppendixJ-6: Bonferroni post tests results for relative mass of Aspen wood (Week 4) in the large diameter mesh bags compared with Aspen wood (Week 8) in large diameter mesh bags

AL 3 vrs AL 4

Plot	AL3	AL4	Difference	95% CI of diff.	t	P value	Summary
P A	0.9594	0.9693	0.009945	-0.4928 to 0.5127	0.07346	P > 0.05	ns
P B	0.9390	0.6238	-0.3152	-0.8179 to 0.1876	2.328	P > 0.05	ns
P C	0.8600	0.7479	-0.1121	-0.6148 to 0.3906	0.8280	P > 0.05	ns
P D	0.8118	0.3400	-0.4718	-0.9746 to 0.03090	3.485	P<0.01	**
P E	0.7568	0.7942	0.03745	-0.4653 to 0.5402	0.2767	P > 0.05	ns
P F	0.8381	0.5535	-0.2846	-0.7873 to 0.2181	2.102	P > 0.05	ns

AppendixJ-7: Bonferroni post tests results for relative mass of Aspen wood (Week 4) in the large diameter mesh bags compared with Aspen wood (Week 16) in large diameter mesh bags

AL 3 vrs AL 5

Plot	AL3	AL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.9594	0.3481	-0.6112	-1.114 to -0.1085	4.515	P<0.001	***
P B	0.9390	0.6455	-0.2934	-0.7962 to 0.2093	2.168	P > 0.05	ns
P C	0.8600	0.6717	-0.1883	-0.6910 to 0.3145	1.391	P > 0.05	ns
P D	0.8118	0.4839	-0.3280	-0.8307 to 0.1747	2.423	P > 0.05	ns
P E	0.7568	0.01170	-0.7451	-1.248 to -0.2423	5.504	P<0.001	***
P F	0.8381	0.3429	-0.4952	-0.9979 to 0.007526	3.658	P<0.01	**

AppendixJ-8: Bonferroni post tests results for relative mass of Aspen wood (Week 8) in the large diameter mesh bags compared with Aspen wood (Week 16) in large diameter mesh bags

AL 4 vrs AL 5

Plot	AL4	AL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.9693	0.3481	-0.6212	-1.124 to -0.1185	4.589	P<0.001	***
P B	0.6238	0.6455	0.02171	-0.4810 to 0.5244	0.1604	P > 0.05	ns
P C	0.7479	0.6717	-0.07617	-0.5789 to 0.4266	0.5627	P > 0.05	ns
P D	0.3400	0.4839	0.1438	-0.3589 to 0.6466	1.063	P > 0.05	ns
P E	0.7942	0.01170	-0.7825	-1.285 to -0.2798	5.781	P<0.001	***
P F	0.5535	0.3429	-0.2106	-0.7133 to 0.2921	1.556	P > 0.05	ns

Appendix K-1: ANOVA at 5% level of significance for the relative mass of *C. gigantea* wood in the small diameter mesh bags

Source of Variation	Df	Sum-of-squares	Mean square	F
Interaction	20	0.2843	0.01421	1.938
Sampling Occasion	4	0.1275	0.03187	4.347
Plot	5	0.07077	0.01415	1.931
Residual	30	0.2200	0.007332	
Total	59	0.7025		

	P value
Interaction	0.0491
Sampling Occasion	0.0068
Plot	0.1186

Appendix K-2: Bonferroni post tests results for relative mass of *C. gigantea* wood (Week 1) in the small diameter mesh bags compared with *C. gigantea* wood (Week 2) in the small diameter mesh bags

CS 1 vrs CS 2

Plot	CS1	CS2	Difference	95% CI of diff.	t	P value	Summary
P G	0.9519	0.9397	-0.01218	-0.3302 to 0.3058	0.1423	P > 0.05	ns
P H	0.8396	0.9182	0.07859	-0.2394 to 0.3966	0.9178	P > 0.05	ns
P I	0.6671	0.8931	0.2260	-0.09195 to 0.5440	2.640	P > 0.05	ns
P J	0.8924	0.7491	-0.1434	-0.4613 to 0.1746	1.674	P > 0.05	ns
P K	0.9267	0.6379	-0.2888	-0.6068 to 0.02920	3.373	P < 0.05	*
P L	0.7578	0.8288	0.07100	-0.2470 to 0.3890	0.8292	P > 0.05	ns

Appendix K-3: Bonferroni post tests results for relative mass of *C. gigantea* wood (Week 1) in the small diameter mesh bags compared with *C. gigantea* wood (Week 4) in the small diameter mesh bags

CS 1 vrs CS 3

Plot	CS1	CS3	Difference	95% CI of diff.	t	P value	Summary
P G	0.9519	0.9707	0.01889	-0.2991 to 0.3369	0.2206	P > 0.05	ns
P H	0.8396	0.9616	0.1220	-0.1960 to 0.4400	1.425	P > 0.05	ns
P I	0.6671	0.9204	0.2533	-0.06473 to 0.5712	2.958	P < 0.05	*
P J	0.8924	0.8602	-0.03218	-0.3502 to 0.2858	0.3759	P > 0.05	ns
P K	0.9267	0.9863	0.05965	-0.2583 to 0.3776	0.6966	P > 0.05	ns
P L	0.7578	0.9671	0.2093	-0.1087 to 0.5273	2.445	P > 0.05	ns

Appendix K-4: Bonferroni post tests results for relative mass of *C. gigantea* wood (Week 2) in the small diameter mesh bags compared with *C. gigantea* wood (Week 4) in the small diameter mesh bags

CS2vrs CS 3

Plot	CS2	CS3	Difference	95% CI of diff.	t	P value	Summary
P G	0.9397	0.9707	0.03108	-0.2869 to 0.3491	0.3629	P > 0.05	ns
P H	0.9182	0.9616	0.04345	-0.2745 to 0.3614	0.5074	P > 0.05	ns
P I	0.8931	0.9204	0.02722	-0.2908 to 0.3452	0.3179	P > 0.05	ns
P J	0.7491	0.8602	0.1112	-0.2068 to 0.4292	1.298	P > 0.05	ns
P K	0.6379	0.9863	0.3484	0.03044 to 0.6664	4.069	P<0.01	**
P L	0.8288	0.9671	0.1383	-0.1797 to 0.4563	1.615	P > 0.05	ns

Appendix K-5: Bonferroni post tests results for relative mass of *C. gigantea* wood (Week 2) in the small diameter mesh bags compared with *C. gigantea* wood (Week 8) in the small diameter mesh bags

CS2vrs CS 4

Plot	CS2	CS4	Difference	95% CI of diff.	t	P value	Summary
P G	0.9397	0.9005	-0.03920	-0.3572 to 0.2788	0.4578	P > 0.05	ns
P H	0.9182	0.9218	0.003577	-0.3144 to 0.3216	0.04177	P > 0.05	ns
P I	0.8931	0.8662	-0.02699	-0.3450 to 0.2910	0.3152	P > 0.05	ns
P J	0.7491	0.9712	0.2221	-0.09584 to 0.5401	2.594	P > 0.05	ns
P K	0.6379	0.9599	0.3220	0.004006 to 0.6400	3.760	P<0.01	**
P L	0.8288	0.9395	0.1107	-0.2073 to 0.4287	1.293	P > 0.05	ns

Appendix K-6: Bonferroni post tests results for relative mass of *C. gigantea* wood (Week 2) in the small diameter mesh bags compared with *C. gigantea* wood (Week 16) in the small diameter mesh bags

CS2vrs CS 5

Plot	CS2	CS5	Difference	95% CI of diff.	t	P value	Summary
P G	0.9397	0.9255	-0.01414	-0.3321 to 0.3039	0.1651	P > 0.05	ns
P H	0.9182	0.8077	-0.1105	-0.4285 to 0.2075	1.290	P > 0.05	ns
P I	0.8931	0.7599	-0.1333	-0.4513 to 0.1847	1.557	P > 0.05	ns
P J	0.7491	0.8952	0.1462	-0.1718 to 0.4642	1.707	P > 0.05	ns
P K	0.6379	0.9652	0.3273	0.009317 to 0.6453	3.822	P<0.01	**
P L	0.8288	0.9358	0.1070	-0.2110 to 0.4250	1.249	P > 0.05	ns

Appendix L-1: ANOVA at 5% level of significance for the relative mass of Aspen wood in the small diameter mesh bags

Source of Variation	Df	Sum-of-squares	Mean square	F
Interaction	20	0.04322	0.002161	0.2698
Sampling Occasion	4	0.2643	0.06608	8.249
Plot	5	0.007812	0.001562	0.1950
Residual	30	0.2403	0.008011	
Total	59	0.5557		

	P value
Interaction	0.9983
Sampling Occasion	0.0001
Plot	0.9620

Appendix M-1: ANOVA at 5% level of significance for the relative mass of *C. gigantea* wood in the large diameter mesh bags compared to the relative mass of Aspen wood in the large diameter mesh bags

Source of Variation	Df	Sum-of-squares	Mean square	F
Interaction	20	1.124	0.02499	2.085
Sampling Occasion	4	2.855	0.3173	26.47
Plot	5	0.2688	0.05376	4.486
Residual	30	0.7190	0.01198	
Total	119	4.968		

	P value
Interaction	0.0040
Sampling Occasion	0.0001
Plot	0.0015

Appendix M-2: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 1) in the large diameter mesh bags compared to the relative mass of Aspen wood (week 8) in the large diameter mesh bags

CL 1vrs AL 4

Plot	CL1	AL4	Difference	95% CI of diff.	t	P value	Summary
P A	0.9174	0.9693	0.05196	-0.3843 to 0.4882	0.4747	P > 0.05	ns
P B	0.8133	0.6238	-0.1895	-0.6258 to 0.2468	1.731	P > 0.05	ns
P C	0.7859	0.7479	-0.03800	-0.4743 to 0.3983	0.3471	P > 0.05	ns
P D	0.9010	0.3400	-0.5609	-0.9972 to -0.1247	5.124	P<0.001	***
P E	0.8100	0.7942	-0.01580	-0.4521 to 0.4205	0.1443	P > 0.05	ns
P F	0.8564	0.5535	-0.3029	-0.7392 to 0.1333	2.767	P < 0.05	*

Appendix M-3: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 1) in the large diameter mesh bags compared to the relative mass of Aspen wood (week 16) in the large diameter mesh bags

CL 1vrs AL 5

Plot	CL1	AL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.9174	0.3481	-0.5692	-1.005 to -0.1330	5.200	P<0.001	***
P B	0.8133	0.6455	-0.1678	-0.6041 to 0.2685	1.533	P > 0.05	ns
P C	0.7859	0.6717	-0.1142	-0.5504 to 0.3221	1.043	P > 0.05	ns
P D	0.9010	0.4839	-0.4171	-0.8534 to 0.01915	3.810	P<0.01	**
P E	0.8100	0.01170	-0.7983	-1.235 to -0.3621	7.293	P<0.001	***
P F	0.8564	0.3429	-0.5135	-0.9498 to -0.07728	4.691	P<0.001	***

Appendix M-4: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 1) in the large diameter mesh bags compared to the relative mass of Aspen wood (week 16) in the large diameter mesh bags

CL 2 vrs AL 5

Plot	CL2	CL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.8292	0.7911	-0.03812	-0.4744 to 0.3981	0.3483	P > 0.05	ns
P B	0.7885	0.7935	0.004957	-0.4313 to 0.4412	0.04529	P > 0.05	ns
P C	0.9353	0.7370	-0.1983	-0.6346 to 0.2379	1.812	P > 0.05	ns
P D	0.8008	0.5245	-0.2763	-0.7126 to 0.1599	2.524	P > 0.05	ns
P E	0.9035	0.5146	-0.3890	-0.8252 to 0.04728	3.553	P<0.01	**
P F	0.8077	0.7577	-0.05004	-0.4863 to 0.3862	0.4571	P > 0.05	ns

Appendix M-5: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 2) in the large diameter mesh bags compared to the relative mass of Aspen wood (week 8) in the large diameter mesh bags

CL 2 vrs AL 4

Plot	CL2	AL4	Difference	95% CI of diff.	t	P value	Summary
P A	0.8292	0.9693	0.1401	-0.2962 to 0.5764	1.280	P > 0.05	ns
P B	0.7885	0.6238	-0.1647	-0.6010 to 0.2715	1.505	P > 0.05	ns
P C	0.9353	0.7479	-0.1875	-0.6237 to 0.2488	1.712	P > 0.05	ns
P D	0.8008	0.3400	-0.4608	-0.8971 to 0.02456	4.210	P<0.001	***
P E	0.9035	0.7942	-0.1093	-0.5456 to 0.3269	0.9987	P > 0.05	ns
P F	0.8077	0.5535	-0.2542	-0.6905 to 0.1820	2.322	P > 0.05	ns

Appendix M-6: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 2) in the large diameter mesh bags compared to the relative mass of Aspen wood (week 16) in the large diameter mesh bags

CL 2 vrs AL 5

Plot	CL2	AL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.8292	0.3481	-0.4811	-0.9174 to -0.04484	4.395	P<0.001	***
P B	0.7885	0.6455	-0.1430	-0.5793 to 0.2932	1.306	P > 0.05	ns
P C	0.9353	0.6717	-0.2636	-0.6999 to 0.1726	2.408	P > 0.05	ns
P D	0.8008	0.4839	-0.3170	-0.7532 to 0.1193	2.896	P < 0.05	*
P E	0.9035	0.01170	-0.8919	-1.328 to -0.4556	8.147	P<0.001	***
P F	0.8077	0.3429	-0.4648	-0.9011 to -0.02858	4.246	P<0.001	***

Appendix M-7: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 4) in the large diameter mesh bags compared to the relative mass of Aspen wood (week 8) in the large diameter mesh bags

CL 3 vrs AL 4

Plot	CL3	AL4	Difference	95% CI of diff.	t	P value	Summary
P A	0.8456	0.9693	0.1237	-0.3126 to 0.5600	1.130	P > 0.05	ns
P B	0.8290	0.6238	-0.2052	-0.6414 to 0.2311	1.874	P > 0.05	ns
P C	0.8338	0.7479	-0.08596	-0.5222 to 0.3503	0.7853	P > 0.05	ns
P D	0.8148	0.3400	-0.4748	-0.9111 to -0.03855	4.337	P<0.001	***
P E	0.8473	0.7942	-0.05311	-0.4894 to 0.3832	0.4851	P > 0.05	ns
P F	0.8355	0.5535	-0.2820	-0.7182 to 0.1543	2.576	P > 0.05	ns

Appendix M-8: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 4) in the large diameter mesh bags compared to the relative mass of Aspen wood (week 8) in the large diameter mesh bags

CL 3 vrs AL 5

Plot	CL3	AL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.8456	0.3481	-0.4975	-0.9338 to -0.06123	4.545	P<0.001	***
P B	0.8290	0.6455	-0.1835	-0.6197 to 0.2528	1.676	P > 0.05	ns
P C	0.8338	0.6717	-0.1621	-0.5984 to 0.2741	1.481	P > 0.05	ns
P D	0.8148	0.4839	-0.3310	-0.7672 to 0.1053	3.023	P < 0.05	*
P E	0.8473	0.01170	-0.8356	-1.272 to -0.3994	7.634	P<0.001	***
P F	0.8355	0.3429	-0.4926	-0.9288 to -0.05632	4.500	P<0.001	***

Appendix M-9: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 8) in the large diameter mesh bags compared to the relative mass of Aspen wood (week 8) in the large diameter mesh bags

CL 4 vrs AL 4

Plot	CL4	AL4	Difference	95% CI of diff.	t	P value	Summary
P A	0.8539	0.9693	0.1155	-0.3208 to 0.5517	1.055	P > 0.05	ns
P B	0.8103	0.6238	-0.1865	-0.6228 to 0.2498	1.704	P > 0.05	ns
P C	0.8561	0.7479	-0.1082	-0.5445 to 0.3281	0.9883	P > 0.05	ns
P D	0.7733	0.3400	-0.4333	-0.8695 to 0.002983	3.958	P<0.01	**
P E	0.7737	0.7942	0.02053	-0.4157 to 0.4568	0.1876	P > 0.05	ns
P F	0.7428	0.5535	-0.1893	-0.6256 to 0.2470	1.729	P > 0.05	ns

Appendix M-10: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 8) in the large diameter mesh bags compared to the relative mass of Aspen wood (week 16) in the large diameter mesh bags

CL 4 vrs AL 5

Plot	CL4	AL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.8539	0.3481	-0.5057	-0.9420 to -0.06947	4.620	P<0.001	***
P B	0.8103	0.6455	-0.1648	-0.6011 to 0.2715	1.505	P > 0.05	ns
P C	0.8561	0.6717	-0.1844	-0.6206 to 0.2519	1.684	P > 0.05	ns
P D	0.7733	0.4839	-0.2894	-0.7257 to 0.1468	2.644	P > 0.05	ns
P E	0.7737	0.01170	-0.7620	-1.198 to -0.3257	6.961	P<0.001	***
P F	0.7428	0.3429	-0.3999	-0.8362 to 0.03636	3.653	P<0.01	**

Appendix M-11: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 16) in the large diameter mesh bags compared to the relative mass of Aspen wood (week 1) in the large diameter mesh bags

CL 5 vrs AL 1

Plot	CL5	AL1	Difference	95% CI of diff.	t	P value	Summary
P A	0.7911	0.9884	0.1973	-0.2390 to 0.6336	1.802	P > 0.05	ns
P B	0.7935	0.9810	0.1875	-0.2488 to 0.6237	1.712	P > 0.05	ns
P C	0.7370	0.9864	0.2494	-0.1869 to 0.6856	2.278	P > 0.05	ns
P D	0.5245	0.9747	0.4502	0.01395 to 0.8865	4.113	P<0.001	***
P E	0.5146	0.9093	0.3948	-0.04149 to 0.8310	3.606	P<0.01	**
P F	0.7577	0.9910	0.2333	-0.2029 to 0.6696	2.132	P > 0.05	ns

Appendix M-12: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 16) in the large diameter mesh bags compared to the relative mass of Aspen wood (week 2) in the large diameter mesh bags

CL 5 vrs AL 2

Plot	CL5	AL2	Difference	95% CI of diff.	t	P value	Summary
P A	0.7911	0.9664	0.1753	-0.2609 to 0.6116	1.602	P > 0.05	ns
P B	0.7935	0.9459	0.1524	-0.2838 to 0.5887	1.392	P > 0.05	ns
P C	0.7370	0.9649	0.2278	-0.2084 to 0.6641	2.081	P > 0.05	ns
P D	0.5245	0.9470	0.4225	-0.01377 to 0.8588	3.859	P<0.01	**
P E	0.5146	0.9485	0.4339	-0.002370 to 0.8702	3.964	P<0.01	**
P F	0.7577	0.9688	0.2111	-0.2252 to 0.6473	1.928	P > 0.05	ns

Appendix M-13: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 16) in the large diameter mesh bags compared to the relative mass of Aspen wood (week 16) in the large diameter mesh bags

CL 5 vrs AL 5

Plot	CL5	AL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.7911	0.3481	-0.4430	-0.8792 to -0.006713	4.047	P<0.001	***
P B	0.7935	0.6455	-0.1480	-0.5842 to 0.2883	1.352	P > 0.05	ns
P C	0.7370	0.6717	-0.06529	-0.5016 to 0.3710	0.5964	P > 0.05	ns
P D	0.5245	0.4839	-0.04065	-0.4769 to 0.3956	0.3713	P > 0.05	ns
P E	0.5146	0.01170	-0.5029	-0.9391 to -0.06661	4.594	P<0.001	***
P F	0.7577	0.3429	-0.4148	-0.8511 to 0.02146	3.789	P<0.01	**

Appendix N-1: ANOVA at 5% level of significance for the relative mass of *C. gigantea* wood in the large diameter mesh bags compared to the relative mass of *C. gigantea* wood in the small diameter mesh bags

Source of Variation	Df	Sum-of-squares	Mean square	F
Interaction	45	0.5445	0.01210	1.866
Sampling Occasion	9	0.5438	0.06042	9.315
Plot	5	0.07024	0.01405	2.166
Residual	60	0.3892	0.006486	
Total	119	1.548		

	P value
Interaction	0.0121
Sampling Occasion	0.0001
Plot	0.0698

Appendix N-2: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 2) in the large diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 1) in the small diameter mesh bags

CL 2 vrs CS 1

Plot	CL2	CS1	Difference	95% CI of diff.	t	P value	Summary
P A	0.8292	0.9519	0.1226	-0.1983 to 0.4436	1.523	P > 0.05	ns
P B	0.7885	0.8396	0.05106	-0.2699 to 0.3720	0.6340	P > 0.05	ns
P C	0.9353	0.6671	-0.2682	-0.5892 to 0.05273	3.331	P<0.01	**
P D	0.8008	0.8924	0.09157	-0.2294 to 0.4125	1.137	P > 0.05	ns
P E	0.9035	0.9267	0.02314	-0.2978 to 0.3441	0.2873	P > 0.05	ns
P F	0.8077	0.7578	-0.04994	-0.3709 to 0.2710	0.6200	P > 0.05	ns

Appendix N-3: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 2) in the large diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 2) in the small diameter mesh bags

CL 2 vrs CS 2

Plot	CL2	CS2	Difference	95% CI of diff.	t	P value	Summary
P A	0.8292	0.9397	0.1104	-0.2105 to 0.4314	1.371	P > 0.05	ns
P B	0.7885	0.9182	0.1296	-0.1913 to 0.4506	1.610	P > 0.05	ns
P C	0.9353	0.8931	-0.04220	-0.3632 to 0.2788	0.5240	P > 0.05	ns
P D	0.8008	0.7491	-0.05178	-0.3727 to 0.2692	0.6430	P > 0.05	ns
P E	0.9035	0.6379	-0.2656	-0.5866 to 0.05532	3.298	P<0.01	**
P F	0.8077	0.8288	0.02106	-0.2999 to 0.3420	0.2615	P > 0.05	ns

Appendix N-4: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 8) in the large diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 4) in the small diameter mesh bags

CL 4 vrs CS 3

Plot	CL4	CS3	Difference	95% CI of diff.	t	P value	Summary
P A	0.8539	0.9707	0.1169	-0.2041 to 0.4379	1.451	P > 0.05	ns
P B	0.8103	0.9616	0.1513	-0.1697 to 0.4723	1.879	P > 0.05	ns
P C	0.8561	0.9204	0.06429	-0.2567 to 0.3853	0.7982	P > 0.05	ns
P D	0.7733	0.8602	0.08693	-0.2340 to 0.4079	1.079	P > 0.05	ns
P E	0.7737	0.9863	0.2126	-0.1083 to 0.5336	2.640	P > 0.05	ns
P F	0.7428	0.9671	0.2243	-0.09665 to 0.5453	2.785	P < 0.05	*

Appendix N-5: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 16) in the large diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 1) in the small diameter mesh bags

CL 5vrs CS 1

Plot	CL5	CS1	Difference	95% CI of diff.	t	P value	Summary
P A	0.7911	0.9519	0.1608	-0.1602 to 0.4817	1.996	P > 0.05	ns
P B	0.7935	0.8396	0.04610	-0.2749 to 0.3671	0.5724	P > 0.05	ns
P C	0.7370	0.6671	-0.06990	-0.3909 to 0.2511	0.8680	P > 0.05	ns
P D	0.5245	0.8924	0.3679	0.04694 to 0.6889	4.568	P<0.001	***
P E	0.5146	0.9267	0.4121	0.09115 to 0.7331	5.117	P<0.001	***
P F	0.7577	0.7578	0.0001024	-0.3209 to 0.3211	0.001271	P > 0.05	ns

Appendix N-6: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 16) in the large diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 2) in the small diameter mesh bags

CL 5vrs CS 2

Plot	CL5	CS2	Difference	95% CI of diff.	t	P value	Summary
P A	0.7911	0.9397	0.1486	-0.1724 to 0.4695	1.845	P > 0.05	ns
P B	0.7935	0.9182	0.1247	-0.1963 to 0.4457	1.548	P > 0.05	ns
P C	0.7370	0.8931	0.1561	-0.1648 to 0.4771	1.939	P > 0.05	ns
P D	0.5245	0.7491	0.2246	-0.09641 to 0.5455	2.788	P < 0.05	*
P E	0.5146	0.6379	0.1233	-0.1976 to 0.4443	1.531	P > 0.05	ns
P F	0.7577	0.8288	0.07110	-0.2499 to 0.3921	0.8828	P > 0.05	ns

Appendix N-7: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 16) in the large diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 4) in the small diameter mesh bags

CL 5vrs CS 3

Plot	CL5	CS3	Difference	95% CI of diff.	t	P value	Summary
P A	0.7911	0.9707	0.1796	-0.1413 to 0.5006	2.231	P > 0.05	ns
P B	0.7935	0.9616	0.1681	-0.1528 to 0.4891	2.088	P > 0.05	ns
P C	0.7370	0.9204	0.1834	-0.1376 to 0.5043	2.277	P > 0.05	ns
P D	0.5245	0.8602	0.3357	0.01476 to 0.6567	4.169	P<0.001	***
P E	0.5146	0.9863	0.4718	0.1508 to 0.7927	5.858	P<0.001	***
P F	0.7577	0.9671	0.2094	-0.1115 to 0.5304	2.600	P > 0.05	ns

Appendix N-8: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 16) in the large diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 8) in the small diameter mesh bags

CL 5vrs CS 4

Plot	CL5	CS4	Difference	95% CI of diff.	t	P value	Summary
P A	0.7911	0.9005	0.1094	-0.2116 to 0.4303	1.358	P > 0.05	ns
P B	0.7935	0.9218	0.1283	-0.1927 to 0.4492	1.593	P > 0.05	ns
P C	0.7370	0.8662	0.1291	-0.1918 to 0.4501	1.604	P > 0.05	ns
P D	0.5245	0.9712	0.4467	0.1257 to 0.7677	5.546	P<0.001	***
P E	0.5146	0.9599	0.4453	0.1244 to 0.7663	5.529	P<0.001	***
P F	0.7577	0.9395	0.1818	-0.1392 to 0.5028	2.257	P > 0.05	ns

Appendix N-9: Bonferroni post tests results for the relative mass of *C. gigantea* wood (week 16) in the large diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 8) in the small diameter mesh bags

CL 5vrs CS 4

Plot	CL5	CS5	Difference	95% CI of diff.	t	P value	Summary
P A	0.7911	0.9255	0.1344	-0.1865 to 0.4554	1.669	P > 0.05	ns
P B	0.7935	0.8077	0.01422	-0.3067 to 0.3352	0.1765	P > 0.05	ns
P C	0.7370	0.7599	0.02286	-0.2981 to 0.3438	0.2838	P > 0.05	ns
P D	0.5245	0.8952	0.3707	0.04976 to 0.6917	4.603	P<0.001	***
P E	0.5146	0.9652	0.4506	0.1297 to 0.7716	5.595	P<0.001	***
P F	0.7577	0.9358	0.1781	-0.1429 to 0.4991	2.211	P > 0.05	ns

Appendix O-1: ANOVA at 5% level of significance for the relative mass of Aspen wood in the large diameter mesh bags compared to the relative mass of Aspen wood in the small diameter mesh bags

Source of Variation	Df	Sum-of-squares	Mean square	F
Interaction	45	1.078	0.02396	1.819
Sampling Occasion	9	3.563	0.3959	30.06
Plot	5	0.1064	0.02128	1.616
Residual	60	0.7901	0.01317	
Total	119	5.538		

	P value
Interaction	0.0152
Sampling Occasion	0.0001
Plot	0.1695

Appendix O-2: Bonferroni post tests results for the relative mass of Aspen wood (week 1) in the small diameter mesh bags compared to the relative mass of Aspen wood (week 8) in the large diameter mesh bags

AS 1vrs AL 4

Plot	AS1	AL4	Difference	95% CI of diff.	t	P value	Summary
P A	0.9820	0.9693	-0.01272	-0.4700 to 0.4446	0.1108	P > 0.05	ns
P B	0.9836	0.6238	-0.3598	-0.8172 to 0.09749	3.136	P < 0.05	*
P C	0.9858	0.7479	-0.2379	-0.6952 to 0.2194	2.073	P > 0.05	ns
P D	0.9846	0.3400	-0.6446	-1.102 to -0.1873	5.617	P<0.001	***
P E	0.9893	0.7942	-0.1950	-0.6524 to 0.2623	1.700	P > 0.05	ns
P F	0.9861	0.5535	-0.4326	-0.8899 to 0.02476	3.770	P<0.01	**

Appendix O-3: Bonferroni post tests results for the relative mass of Aspen wood (week 1) in the small diameter mesh bags compared to the relative mass of Aspen wood (week 16) in the large diameter mesh bags

AS 1vrs AL 5

Plot	AS1	AL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.9820	0.3481	-0.6339	-1.091 to -0.1766	5.524	P<0.001	***
P B	0.9836	0.6455	-0.3381	-0.7954 to 0.1192	2.946	P < 0.05	*
P C	0.9858	0.6717	-0.3141	-0.7714 to 0.1432	2.737	P < 0.05	*
P D	0.9846	0.4839	-0.5008	-0.9581 to -0.04344	4.364	P<0.001	***
P E	0.9893	0.01170	-0.9776	-1.435 to -0.5202	8.519	P<0.001	***
P F	0.9861	0.3429	-0.6432	-1.100 to -0.1858	5.605	P<0.001	***

Appendix O-4: Bonferroni post tests results for the relative mass of Aspen wood (week 2) in the small diameter mesh bags compared to the relative mass of Aspen wood (week 8) in the large diameter mesh bags

AS 2 vrs AL 4

Plot	AS2	AL4	Difference	95% CI of diff.	t	P value	Summary
P A	0.9557	0.9693	0.01361	-0.4437 to 0.4709	0.1186	P > 0.05	ns
P B	0.9584	0.6238	-0.3345	-0.7919 to 0.1228	2.915	P < 0.05	*
P C	0.9563	0.7479	-0.2084	-0.6657 to 0.2489	1.816	P > 0.05	ns
P D	0.9614	0.3400	-0.6214	-1.079 to -0.1641	5.415	P<0.001	***
P E	0.9631	0.7942	-0.1688	-0.6262 to 0.2885	1.471	P > 0.05	ns
P F	0.9582	0.5535	-0.4047	-0.8620 to 0.05263	3.527	P<0.01	**

Appendix O-5: Bonferroni post tests results for the relative mass of Aspen wood (week 2) in the small diameter mesh bags compared to the relative mass of Aspen wood (week 16) in the large diameter mesh bags

AS 2 vrs AL 5

Plot	AS2	AL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.9557	0.3481	-0.6076	-1.065 to -0.1503	5.295	P<0.001	***
P B	0.9584	0.6455	-0.3128	-0.7702 to 0.1445	2.726	P > 0.05	ns
P C	0.9563	0.6717	-0.2845	-0.7419 to 0.1728	2.480	P > 0.05	ns
P D	0.9614	0.4839	-0.4776	-0.9349 to -0.02026	4.162	P<0.001	***
P E	0.9631	0.01170	-0.9514	-1.409 to -0.4940	8.291	P<0.001	***
P F	0.9582	0.3429	-0.6153	-1.073 to -0.1580	5.362	P<0.001	***

Appendix O-6: Bonferroni post tests results for the relative mass of Aspen wood (week 4) in the small diameter mesh bags compared to the relative mass of Aspen wood (week 16) in the large diameter mesh bags

AS 3 vrs AL 5

Plot	AS3	AL4	Difference	95% CI of diff.	t	P value	Summary
P A	0.9828	0.9693	-0.01348	-0.4708 to 0.4438	0.1174	P > 0.05	ns
P B	0.9824	0.6238	-0.3586	-0.8159 to 0.09872	3.125	P < 0.05	*
P C	0.9877	0.7479	-0.2398	-0.6971 to 0.2175	2.090	P > 0.05	ns
P D	0.9822	0.3400	-0.6421	-1.099 to -0.1848	5.596	P<0.001	***
P E	0.9854	0.7942	-0.1912	-0.6485 to 0.2661	1.666	P > 0.05	ns
P F	0.9852	0.5535	-0.4317	-0.8890 to 0.02566	3.762	P<0.01	**

Appendix O-7: Bonferroni post tests results for the relative mass of Aspen wood (week 4) in the small diameter mesh bags compared to the relative mass of Aspen wood (week 16) in the large diameter mesh bags

AS 3vrs AL 5

Plot	AS3	AL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.9828	0.3481	-0.6347	-1.092 to -0.1773	5.531	P<0.001	***
P B	0.9824	0.6455	-0.3369	-0.7942 to 0.1204	2.936	P < 0.05	*
P C	0.9877	0.6717	-0.3160	-0.7733 to 0.1414	2.753	P < 0.05	*
P D	0.9822	0.4839	-0.4983	-0.9556 to 0.04098	4.342	P<0.001	***
P E	0.9854	0.01170	-0.9737	-1.431 to -0.5164	8.485	P<0.001	***
P F	0.9852	0.3429	-0.6423	-1.100 to -0.1849	5.597	P<0.001	***

Appendix O-8: Bonferroni post tests results for the relative mass of Aspen wood (week 8) in the small diameter mesh bags compared to the relative mass of Aspen wood (week 8) in the large diameter mesh bags

AS 4 vrs AL 4

Plot	AS4	AL4	Difference	95% CI of diff.	t	P value	Summary
P A	0.9803	0.9693	-0.01104	-0.4684 to 0.4463	0.09617	P > 0.05	ns
P B	0.8681	0.6238	-0.2443	-0.7016 to 0.2130	2.129	P > 0.05	ns
P C	0.7954	0.7479	-0.04749	-0.5048 to 0.4098	0.4138	P > 0.05	ns
P D	0.9211	0.3400	-0.5811	-1.038 to -0.1238	5.064	P<0.001	***
P E	0.9147	0.7942	-0.1205	-0.5778 to 0.3368	1.050	P > 0.05	ns
P F	0.8789	0.5535	-0.3254	-0.7827 to 0.1319	2.836	P < 0.05	*

Appendix O-9: Bonferroni post tests results for the relative mass of Aspen wood (week 8) in the small diameter mesh bags compared to the relative mass of Aspen wood (week 16) in the large diameter mesh bags

AS4 vrs AL5

Plot	AS4	AL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.9803	0.3481	-0.6322	-1.090 to -0.1749	5.509	P<0.001	***
P B	0.8681	0.6455	-0.2226	-0.6799 to 0.2347	1.940	P > 0.05	ns
P C	0.7954	0.6717	-0.1237	-0.5810 to 0.3337	1.078	P > 0.05	ns
P D	0.9211	0.4839	-0.4373	-0.8946 to 0.02007	3.810	P<0.01	**
P E	0.9147	0.01170	-0.9030	-1.360 to -0.4457	7.869	P<0.001	***
P F	0.8789	0.3429	-0.5360	-0.9933 to -0.07870	4.671	P<0.001	***

Appendix O-10: Bonferroni post tests results for the relative mass of Aspen wood (week 16) in the small diameter mesh bags compared to the relative mass of Aspen wood (week 8) in the large diameter mesh bags

AS5 vrs AL4

Plot	AS5	AL4	Difference	95% CI of diff.	t	P value	Summary
P A	0.7753	0.9693	0.1940	-0.2633 to 0.6513	1.691	P > 0.05	ns
P B	0.7635	0.6238	-0.1396	-0.5970 to 0.3177	1.217	P > 0.05	ns
P C	0.8254	0.7479	-0.07755	-0.5349 to 0.3798	0.6758	P > 0.05	ns
P D	0.8248	0.3400	-0.4848	-0.9421 to -0.02749	4.225	P<0.001	***
P E	0.8288	0.7942	-0.03456	-0.4919 to 0.4228	0.3012	P > 0.05	ns
P F	0.8550	0.5535	-0.3015	-0.7589 to 0.1558	2.628	P > 0.05	ns

Appendix O-11: Bonferroni post tests results for the relative mass of Aspen wood (week 16) in the small diameter mesh bags compared to the relative mass of Aspen wood (week 16) in the large diameter mesh bags

AS5 vrs AL5

Plot	AS5	AL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.7753	0.3481	-0.4272	-0.8845 to 0.03014	3.723	P<0.01	**
P B	0.7635	0.6455	-0.1179	-0.5753 to 0.3394	1.028	P > 0.05	ns
P C	0.8254	0.6717	-0.1537	-0.6110 to 0.3036	1.340	P > 0.05	ns
P D	0.8248	0.4839	-0.3410	-0.7983 to 0.1163	2.971	P < 0.05	*
P E	0.8288	0.01170	-0.8171	-1.274 to -0.3598	7.120	P<0.001	***
P F	0.8550	0.3429	-0.5121	-0.9695 to -0.05482	4.463	P<0.001	***

Appendix O-12: Bonferroni post tests results for the relative mass of Aspen wood (week 8) in the small diameter mesh bags compared to the relative mass of Aspen wood (week 16) in the large diameter mesh bags

AS5 vrs AL4

Plot	AS5	AL5	Difference	95% CI of diff.	t	P value	Summary
P A	0.7753	0.3481	-0.4272	-0.8845 to 0.03014	3.723	P<0.01	**
P B	0.7635	0.6455	-0.1179	-0.5753 to 0.3394	1.028	P > 0.05	ns
P C	0.8254	0.6717	-0.1537	-0.6110 to 0.3036	1.340	P > 0.05	ns
P D	0.8248	0.4839	-0.3410	-0.7983 to 0.1163	2.971	P < 0.05	*
P E	0.8288	0.01170	-0.8171	-1.274 to -0.3598	7.120	P<0.001	***
P F	0.8550	0.3429	-0.5121	-0.9695 to -0.05482	4.463	P<0.001	***

Appendix P-1: ANOVA at 5% level of significance for the relative mass of Aspen wood in the small diameter mesh bags compared to the relative mass of *C. gigantea* wood in the small diameter mesh bags

Source of Variation	Df	Sum-of-squares	Mean square	F	P value
Interaction	45	0.3523	0.007830	1.021	0.4656
Sampling Occasion	9	0.4468	0.04964	6.471	0.0001
Plot	5	0.05371	0.01074	1.400	0.2371
Residual	60	0.4603	0.007671		
Total	119	1.313			

AppendixP-2: Bonferroni post tests results for the relative mass of Aspen wood (week 1) in the small diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 1) in the small diameter mesh bags

AS1 vrs CS 1

Plot	AS1	CS1	Difference	95% CI of diff.	t	P value	Summary
P A	0.9820	0.9519	-0.03017	-0.3792 to 0.3189	0.3445	P > 0.05	ns
P B	0.9836	0.8396	-0.1440	-0.4931 to 0.2050	1.645	P > 0.05	ns
P C	0.9858	0.6671	-0.3187	-0.6677 to 0.03037	3.639	P<0.01	**
P D	0.9846	0.8924	-0.09220	-0.4413 to 0.2568	1.053	P > 0.05	ns
P E	0.9893	0.9267	-0.06257	-0.4116 to 0.2865	0.7144	P > 0.05	ns
P F	0.9861	0.7578	-0.2283	-0.5773 to 0.1208	2.606	P > 0.05	ns

AppendixP-3: Bonferroni post tests results for the relative mass of Aspen wood (week 1) in the small diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 2) in the small diameter mesh bags

AS 1 vrs CS 2

Plot	AS1	CS2	Difference	95% CI of diff.	t	P value	Summary
P A	0.9820	0.9397	-0.04236	-0.3914 to 0.3067	0.4836	P > 0.05	ns
P B	0.9836	0.9182	-0.06546	-0.4145 to 0.2836	0.7474	P > 0.05	ns
P C	0.9858	0.8931	-0.09264	-0.4417 to 0.2564	1.058	P > 0.05	ns
P D	0.9846	0.7491	-0.2356	-0.5846 to 0.1135	2.689	P > 0.05	ns
P E	0.9893	0.6379	-0.3514	-0.7004 to0.002304	4.012	P<0.01	**
P F	0.9861	0.8288	-0.1573	-0.5063 to 0.1918	1.796	P > 0.05	ns

AppendixP-4: Bonferroni post tests results for the relative mass of Aspen wood (week 2) in the small diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 1) in the small diameter mesh bags

AS 2 vrs CS 1

Plot	AS2	CS1	Difference	95% CI of diff.	t	P value	Summary
P A	0.9557	0.9519	-0.003845	-0.3529 to 0.3452	0.04390	P > 0.05	ns
P B	0.9584	0.8396	-0.1188	-0.4678 to 0.2303	1.356	P > 0.05	ns
P C	0.9563	0.6671	-0.2892	-0.6382 to 0.05989	3.301	P<0.01	**
P D	0.9614	0.8924	-0.06902	-0.4181 to 0.2800	0.7881	P > 0.05	ns
P E	0.9631	0.9267	-0.03637	-0.3854 to 0.3127	0.4153	P > 0.05	ns
P F	0.9582	0.7578	-0.2004	-0.5495 to 0.1487	2.288	P > 0.05	ns

AppendixP-5: Bonferroni post tests results for the relative mass of Aspen wood (week 2) in the small diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 2) in the small diameter mesh bags

AS 2 vrs CS 2

Plot	AS2	CS2	Difference	95% CI of diff.	t	P value	Summary
P A	0.9557	0.9397	-0.01603	-0.3651 to 0.3330	0.1830	P > 0.05	ns
P B	0.9584	0.9182	-0.04017	-0.3892 to 0.3089	0.4587	P > 0.05	ns
P C	0.9563	0.8931	-0.06312	-0.4122 to 0.2859	0.7206	P > 0.05	ns
P D	0.9614	0.7491	-0.2124	-0.5614 to 0.1367	2.425	P > 0.05	ns
P E	0.9631	0.6379	-0.3252	-0.6742 to 0.02389	3.712	P<0.01	**
P F	0.9582	0.8288	-0.1294	-0.4785 to 0.2197	1.477	P > 0.05	ns

AppendixP-6: Bonferroni post tests results for the relative mass of Aspen wood (week 4) in the small diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 1) in the small diameter mesh bags

AS 3 vrs CS 1

Plot	AS3	CS1	Difference	95% CI of diff.	t	P value	Summary
P A	0.9828	0.9519	-0.03093	-0.3800 to 0.3181	0.3532	P > 0.05	ns
P B	0.9824	0.8396	-0.1428	-0.4919 to 0.2062	1.631	P > 0.05	ns
P C	0.9877	0.6671	-0.3206	-0.6696 to 0.02848	3.660	P<0.01	**
P D	0.9822	0.8924	-0.08975	-0.4388 to 0.2593	1.025	P > 0.05	ns
P E	0.9854	0.9267	-0.05871	-0.4078 to 0.2903	0.6704	P > 0.05	ns
P F	0.9852	0.7578	-0.2274	-0.5764 to 0.1217	2.596	P > 0.05	ns

AppendixP-7: Bonferroni post tests results for the relative mass of Aspen wood (week 4) in the small diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 2) in the small diameter mesh bags

AS 3 vrs CS 2

Plot	AS3	CS2	Difference	95% CI of diff.	t	P value	Summary
P A	0.9828	0.9397	-0.04312	-0.3922 to 0.3059	0.4923	P > 0.05	ns
P B	0.9824	0.9182	-0.06423	-0.4133 to 0.2848	0.7334	P > 0.05	ns
P C	0.9877	0.8931	-0.09453	-0.4436 to 0.2545	1.079	P > 0.05	ns
P D	0.9822	0.7491	-0.2331	-0.5822 to 0.1160	2.661	P > 0.05	ns
P E	0.9854	0.6379	-0.3475	-0.6966 to 0.001553	3.968	P<0.01	**
P F	0.9852	0.8288	-0.1564	-0.5054 to 0.1927	1.785	P > 0.05	ns

Appendix P-8: Bonferroni post tests results for the relative mass of Aspen wood (week 8) in the small diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 2) in the small diameter mesh bags

AS 4 vrs CS 2

Plot	AS4	CS2	Difference	95% CI of diff.	t	P value	Summary
P A	0.9803	0.9397	-0.04068	-0.3897 to 0.3084	0.4644	P > 0.05	ns
P B	0.8681	0.9182	0.05005	-0.2990 to 0.3991	0.5714	P > 0.05	ns
P C	0.7954	0.8931	0.09777	-0.2513 to 0.4468	1.116	P > 0.05	ns
P D	0.9211	0.7491	-0.1720	-0.5211 to 0.1770	1.964	P > 0.05	ns
P E	0.9147	0.6379	-0.2768	-0.6259 to 0.07225	3.160	P < 0.05	*
P F	0.8789	0.8288	-0.05012	-0.3992 to 0.2989	0.5723	P > 0.05	ns

AppendixP-9: Bonferroni post tests results for the relative mass of Aspen wood (week 8) in the small diameter mesh bags compared to the relative mass of *C. gigantea* wood (week 2) in the small diameter mesh bags

AS 4 vrs CS 2

Plot	AS4	CS2	Difference	95% CI of diff.	t	P value	Summary
P A	0.9803	0.9397	-0.04068	-0.3897 to 0.3084	0.4644	P > 0.05	ns
P B	0.8681	0.9182	0.05005	-0.2990 to 0.3991	0.5714	P > 0.05	ns
P C	0.7954	0.8931	0.09777	-0.2513 to 0.4468	1.116	P > 0.05	ns
P D	0.9211	0.7491	-0.1720	-0.5211 to 0.1770	1.964	P > 0.05	ns
P E	0.9147	0.6379	-0.2768	-0.6259 to 0.07225	3.160	P < 0.05	*
P F	0.8789	0.8288	-0.05012	-0.3992 to 0.2989	0.5723	P > 0.05	ns