Abyss. J. Sci. Technol. Vol. 4, No. 1, 2019, 26-33
ISSN 2616 – 4728 (Online); 2616 – 471X (Print)

Abyssinia Journal of Science and Technology

Insects Incidence and Woody species composition of Yegof Forest, South Wollo, Ethiopia

Asmare Dejen[a], Tsegaye Gobezie[b] and Seid Hassen[a]

[a] Department of Plant Science, College of Agriculture, Wollo University, Dessie, Ethiopia
[b] Department of Forestry, College of Agriculture, Wollo University, Dessie, Ethiopia

ABSTRACT

Yegof is a neglected state forest with limited attention has challenged with biotic and abiotic stresses. Insect pests are among the biotic stresses in reducing the economic value of the forest. This study aimed to assess the incidence and severity of insects on woody species. The systematic sampling technique was deployed to take a total of 40 sample plots (20 m × 20 m) from four directions along the transect lines that radiated from the peak of Yegof mountain to bottom of the forest. In each plot's diameter at breast height, height, density of woody species, damage incidence and severity of different insect species were collected and specimens were taken to laboratory for identification. A total of thirty-nine wood species were identified. The result revealed that cypress aphid caused damage of 90% and 45% on *Cupressus lucitanica* and *Juniperus procera*, respectively.. In this study, the insect *Ophelimus eucalypti* caused high *Eucalyptus camaldulensis* leaf damage (80%) with severity of 75% (8 scales). Olea europaea subsp cuspidata was highly damaged (63%) with high significant severity (51-75%) by olive lace bug, *Plerochila australis*. It was observed that olive lace bug secreted a honeydew and sooty mold developed on the lower part of the leaf. This could cause the photosynthesis process halted due to stomata closing and leaf area reduction. The researchers and users should give attention on reducing the damage of pests. Further study on climate change, insect pest and woody species interactions are vital.

Keywords: Forest insects, incidence, mortality, severity, woody species.

INTRODUCTION

Ethiopia possesses a large and diverse plant and wildlife resources due to the extreme variation in climate and terrain. The climatic and landscape diversity have contributed to the formation of diverse ecosystems in Ethiopia. The ecosystems host a great diversity of flora and fauna resources. The flora of Ethiopia is estimated to comprise about 6,500 - 7,000 plant species; 12 percent of these plant species considered as endemic (GGWSSI, 2012). Biodiversity plays key roles in economic, ecological and social fabrics in Ethiopia (EBI, 2014).

Insects have vital positions in food webs, dynamics of populations and communities. They act as herbivores, predators, decomposers, parasitoids and pollination. It has an essential in the forest ecosystem. Such as nutrient recycling leaf-litter and wood degradation, dispersal of fungi, dispersal of carrion and dung (Vinod & Sabu, 2007) and soil turn over; plant propagation, including pollination and seed dispersal; maintenance of plant community composition and structure, including seed feeding (Lowman, 2006). Many insects as important secondary dispersal agents for seeds of several tree species defecated by fungivorous vertebrates. Thus, insects are participating in the natural process of forest regeneration (Vinod & Sabu, 2007). Moreover, the regeneration of some trees is facilitated by the activity of termites (Chacko, 1998). On the other hand, insect seed predators may adversely affect regeneration of some tree species (Curran & Leighton, 2000).

Insects feeding on living trees have a negative impact on the growth and survival of individual trees. The major groups of forest pests are defoliators, shoot borers and wood borers. They can retard the growth of trees, cause deformation of the stem or even kill seedlings, saplings and trees (Nair, 2007). Wood boring insects reduce structural integrity of trees they infest, thus increasing their susceptibility to wind throw. Insects that feed in wood in use can cause structural damage to poles, fences and wooden buildings (Ciesla, 2011). Gall making insects can kill branches, reduce seed production. Shoot and stem infesting insects kill growing portions of trees

*Corresponding author: asmaredejen@gmail.com

and cause growth reduction and tree deformity. Some groups of insects, such as foliage feeders and bark beetles, are considered major forest pests. It suffers some type of insect damage each year. This is more than twice the area burned by wildfires (FAO, 2005).

Termites cause over 90% loss of newly transplanted Eucalyptus seedling in Ethiopia (Abdulahi, 1992). It is also an important pest on a number of other exotic and native tree species. Eucalyptus attacked by blue gum psyllid is the most common in several localities (Worku, 1991). It also attacks young seedlings in nurseries, plantations and young shoots of coppices causing reduction in shoot growth or even dieback of terminal shoots.

In Ethiopia, it occurred in 2003/2004 together with an unidentified scale insect on cypress planted for a hedge in cities and towns, and in plantations (Tefera, 2005). The pest affected the aesthetic value of cypress hedges and above all caused death of many trees in several Cupressus lusitanica plantations. According to (Watson et al., 1999), the pest has a wide host range including Juniperus procera, which is native to Ethiopia. It also the cypress aphid showed significantly higher levels of infestation on C. lusitanica (35–90%) than on J. procera (1-16%).The results revealed that the cypress aphid causes enormous losses of C. lusitanica (Demeke, 2018). Wood-boring beetles and termites insects damage trees in the forest, felled logs, stored timber, and wood-based products in use (Abegaz & Tsehaye, 1987). Therefore it is critically important to protect these valuable resources from disturbances such as fire, pollution, invasive species, insects and diseases (FAO, 2009). Insect pests can adversely affect tree growth, vigor and survival, the yield and quality of wood and non-wood products, wildlife habitat, recreation, aesthetics and cultural values. However, research on focused on insect pests damage/infestation level and regeneration status in forest plants is at infant stage in South Wollo Ethiopia. Therefore this study has the following objectives: (i) to determine tree mortality; (ii) to assess insect pests' incidence; (iii) to determine the level of insect pests' severity of Yegof forest.

MATERIALS AND METHODS

Collection of Samples:

This study was carried out in Yegof, South Wollo. It is located in the Amhara people's regional state, Ethiopia. The site is located between 11º01' to 11º 03' North latitude and 39º4' to 39º44 East longitude with an elevation between 2000 and 3014 masl. The map of the study area is shown in fig.1.

The rainfall in the study area is bimodal. The average annual rainfall is about 1001 mm. The long rainy season extends from June to September, which supports major crop production. The short rainy season comes in March and April and allows minor crop production. The annual minimum and maximum temperatures of the area are 12.7ºC and 27.1ºC, respectively.

The topography of the study area is comprised of plain (3%), mountainous (23.5%), rugged and undulating (73.5%). The largest water body around Kombolcha is Borkena River flowing to the Awash River. The major soil type in the study area is loam and sandy loam (Tekle et al., 1997). The soil pH ranges from 6.0 to 7.26 and the texture varies from loam to clay loam with textural compositions of 19–28% (clay), 32–41% (silt) and 27–46% (sand) (Eshetu, 2002).

Yegof forest was designated as a national forest priority area in 1985/86 by the then state forest development and conservation department of the ministry of agriculture. Unclear demarcation of the forest resulted in an open access situation. In which, the forest faced severe disturbance from grazing animals, illegal cuttings of trees for construction, timber, and fuelwood collection (Pankhurst, 2001). Consequently, the most valuable indigenous tree species, as well as wild animals, are becoming severely affected in the area.

Forest sampling:

For this study, a systematic sampling technique was deployed to take samples from four directions along the transect lines that radiated from the peak to the bottom of the forest. The method covered variations in aspect and slope (Gurmessa et al., 2012). The sample plot size of 20 m × 20 m (400 m2) was established at distance 100 m along transect line. A total of 40 sampled plots were used as main plots to sample woody species. In each main plot, the subplot was placed at each corner and sizes of subplots were 5m ×5m and 1 m ×1 m for sapling and seedling regeneration, respectively.

Plants were categorized as mature plants (height > 3 m) saplings (height between 1.5 m and 3 m), and seedlings (height < 1.5 m) and counted following (Awoke, 2018). Seedlings (<2.5 cm dbh) were counted in each subplot for regeneration assessment. The circumference of woody plants at breast height (1.3 m) was measured and recorded. The height of each woody species > 2.5 cm dbh was measured by using calibrated stick and visual estimation. In each plot the number of dead woody species was recorded. All woody specimens were collected, pressed, dried and brought to the National Herbarium, Addis Ababa University for identification.

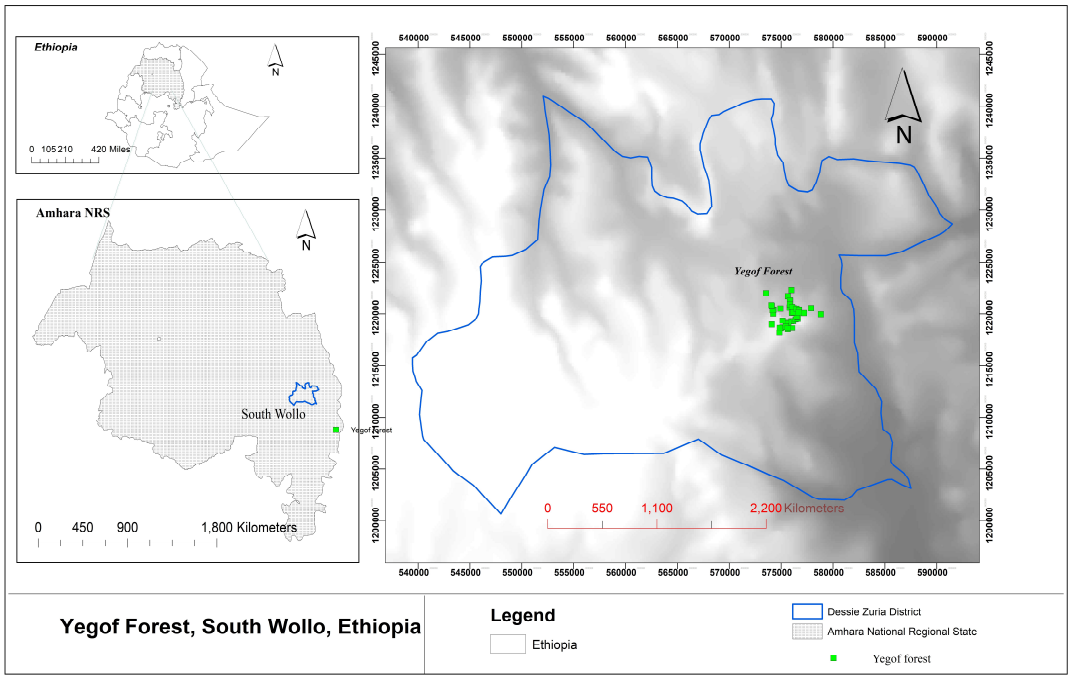

Figure 1 Map of the study area, Yegof forest, South Wollo, Ethiopia

Forest insects sampling:

A survey on the damage incidence and severity of different insects of Yegof mixed forest was conducted. The presence and absence of different insect species on different tree species were employed. Data on different insect species damage incidence and severity were collected from 40 main plots with a plot size of 400 m2. Each main plot was subdivided into subplot. Thus, five subplots with a size of 5 m x 5 m were used in each main plot. Data on insects were collected from five corners of each plot in 'X' fashion. In each subplot, the total number of tree species was recorded. Data on the tree body parts (leaf, bark, branch, stem, and root), which each insect species, were recorded.

Different sampling methods were used to collect insect pests from different wood species; such as hand-picking, beating net and debarking techniques were employed on the main plots and subplots of different ages and their parts of forest species. The beating net technique was done to collect insect pests to shaking tree and dropping on cotton cloth (Stork, 1988). All collected samples were labeled. Then collected insect pests specimens were identified in the field and unidentified insect pests were preserved in vile 95% Ethanol and identification was done at Wollo University Plant Science laboratory.

Data analysis

Vegetation data analysis:

The density of each naturally regenerated woody plant species per hectare was derived from the total number of individuals recorded on the sample plots in the study areas. Basal area of tree species with 2.5 cm DBH were calculated as basal area =$\sum \pi D2/4$, relative density, relative frequency, and relative dominance were computed using the following. The regeneration potential of the forest seedling, sapling and trees were counted from the sample quadrats to know the regeneration potential of the forest. The regeneration status of the forest was determined by comparing seedlings ($\leq$ 2.5 cm) and saplings (2.5-10cm) with the matured trees (> 10cm) following. Accordingly, the status is in good regeneration, if seedlings > saplings > adults; the status was fair regeneration, if seedlings > or $\leq$ saplings $\leq$ adults; the status become in poor regeneration, if the species found only in sapling stage (saplings may be $\leq$ or $\geq$ adults); and if a species is present only in adult form it is considered as not regenerating.

The data concerning tree mortality was transformed into tree mortality indices (TMI) and expressed as the mean volume of infested trees per one hectare (m3/ha). The data were ranked following (Jakuš et al., 2002), with ranges of mortality in m3/ha: 0.01-0.4 – normal, 0.41-1.2 – premonitory, 1.21- 2.4 – intensive, 2.41-10.0 – very intensive, >10.0 – catastrophic.

Insect data analysis:

Insect pests' incidence: the numbers of damaged and undamaged tree species were counted to determine percentage of incidence. The damage severities of each insect species were calculated using 0-8 scales. The rating scales were described

Table 1: Stand structure of live and infested stems of *J. procera, H. abssinica and O. europaea subsp. Cuspidate in* Yegof forest Ethiopia.

Attribute	Live	Infested	TMI
Density (stems /ha)			
Cupressus lucitanica	214.1	32.5	0.15
Juniperus procera	199.4	15.9	0.08
Olea europaea subsp cuspidata	26.8	10.6	0.40
Hagenia abyssinica	1.3	0.7	0.50
Other species	539.5		
Basal area (m^2 /ha)			
Cupressus lucitanica	3.5	1.0	0.3
Juniperus procera	1.9	0.2	0.1
Olea europaea subsp cuspidata	0.3	0.1	0.4
Hagenia abyssinica	0.0	0.0	0.5
Other species	18.5		
Volume m^3/ha			
Cupressus lucitanica	87.0	13.5	0.15
Juniperus procera	37.9	2.9	0.08
Olea europaea subsp cuspidata	6.1	3.0	0.49
Hagenia abyssinica	0.5	0.3	0.59

as 0-8 scale), where, 0= nil, 2= light (up to 25%), 4= moderate (26-50%), 6 = heavy (51-75%), 8 = sever (≥75%) (Ciesla, 2011).

RESULTS

The proportion of live and infested woody species:

In total, 39 woody species were recorded in this study. Among this *Cupressus lucitanica* ,*Juniperus procera, Olea europaea* subsp *cuspidata*, and *Hagenia abyssinica* species were encountered insect pest infestation.

As indicated in Table-1, *Cupressus lucitanica* was found to be intensive categories. *Hagenia abyssinica, Olea europaea subsp cuspidata*, were categorized under the premonitory stage. *Juniperus procera* was found to be at normal stages.

The regeneration status of the woody plants in Yegof forest was analyzed by comparing sapling and seedling with matured trees (Table 2).

Insects incidence and severity infestation in Yegof forest:

The result revealed that cypress aphid caused damage of 90% and 45% on *Cupressus lucitanica* and *Juniperus procera*, respectively (Fig. 2). Similarly, cypress aphid caused higher *C. lucitanica* damage severity than *J. procera* (Fig. 3). In this study, the insect *Ophelimus eucalypti* caused high leaf damage (80%) and high severity (8 scales) on the exotic *Eucalyptus camaldulensis* (Fig. 2 & 3). The indigenous leaf of *Olea europaea*

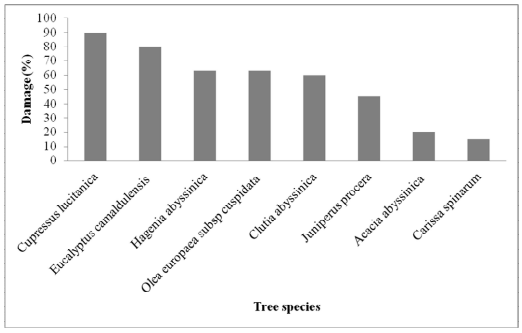

Fig. 2: Status and insects damage (%) on different tree species at Yegof forest in South Wollo, Ethiopia.

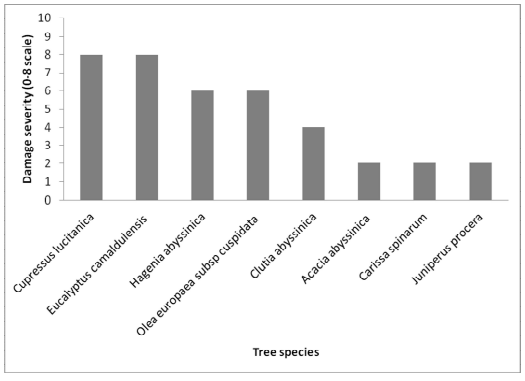

Fig. 3: Damage severity (0-8 scale) of different tree species by major insects in Yegof forest in South Wollo Ethiopia, where 0= none, 2= light up to 25%, 4= moderate 26-50%, 6 = heavy 51-75%, 8 = sever ≥75%

Table 2: Regeneration status of some woody plants in Yegof forest

	Plant type	Seedling	Sapling	Tree	Reg. Status
1	*Euclea racemosa subsp schimperi*	281.3	225.0	0.0	GRS
2	*Calpurnia aurea*	275.0	325.0	0.0	GRS
3	*Maytenus arbutifolia*	81.3	62.5	1.0	GRS
4	*Euphorbia candelabrum*	56.3	25.0	15.0	GRS
5	*Cupressus lusitanica*	175.0	150.0	434.0	FRS
6	*Carissa edulis*	131.0	50.0	0.0	GRS
7	*Olea europaea subsp cuspidata*	225.0	300.0	659.3	FRS
8	*Hygenia abyssinica*	0.0	0.0	5.0	NRS
9	*Maesa lanecleata*	182.0	47.0	33.0	GRS
10	*Myrsine africana*	850.0	775.0	15.0	GRS
11	*Osyris quadripartite*	206.3	150.0	0.0	GRS
12	*Pittosporum viridiflorum*	0.0	0.0	16.0	NRS
13	*Ekebergia capensis*	0.0	0.0	3.0	NRS
14	*Olinia rochetiana*	63.8	50.0	90.6	FRS
15	*Bersama abyssinica*	25.0	50.0	0.0	FRS
16	*Dodonaea angustifolia*	175.0	150.0	0.0	GRS
17	*Juniperus procera*	131.3	275.0	268.8	FRS

subsp *cuspidata* was highly damaged (63%) with significant-high severity (6 scales) by olive lace bug (*Plerochila australis*).

It was observed that olive lace bug secreted a honeydew and sooty mold developed on the lower part of the leaf. In the meantime, it was observed that the leaves were scrolled or shrunk and lead leaf area reduction. This sooty mold and honeydew could be caused the photosynthesis process halted due to stomata closing and leaf area reduction. This study result showed that damage of 63%, 60%, 20%, and 15% was recorded on *Hagenia abyssinica, Clutia abyssinica, Acacia abyssinica,* and *Carissa spinarum,* respectively (Fig. 2).

DISCUSSION

The proportion of live and infested woody species:

In total, 39 woody species were recorded in this study. According to the previous study made on Yegof Forest, the forest embraces a total of 123 species of vascular plants representing 63 families, out of this, 33 species were trees, 26 species were shrubs, 24 species were trees/shrubs, 18 species were herbs, 12 species were climbers, 7 species were grasses and 3 species were epiphytes (Mohammed & Abraha, 2013), Among this *Cupressus lucitanica* ,*Juniperus procera, Olea europaea* subsp *cuspidata,* and *Hagenia abyssinica* species were encountered insect pest infestation.

As indicated in Table -2, *Cupressus lucitanica* was found to be intensive categories. *Hagenia abyssinica,* and *Olea europaea* subsp *cuspidata,* were categorized under premonitory stage. *Juniperus procera* was found to be at normal stages.

Insects incidence and severity infestation in Yegof forest:

In study forest, six types of insect pests were recorded in major woody species, cypress aphid, bark beetle, termites, blue gum, chalcid, eucalyptus, gall wasp, and olive lace bug.

Insects cause severe damage on tree seeds, seedlings in nurseries, standing trees, and tree products. The commonly observed insects include termites, bark beetles, boring insects, chewing insects, defoliating insects, sucking insects and gall makers in western, southern and eastern parts of Ethiopia (Habtewold, 2009).

C. lucitanica about 90% damage and severe infestation (8 scales) Cypress Aphid infestation were recorded. The results similar to finding Harego protected forest, the insect caused significantly higher infestation (35–89%) on twigs and barks of *C. lustinica* than on *J. procera* (9–15%) (Demeke, 2018).

Juniperus procera

The result revealed that cypress aphid caused damage of 90% and 45% on *Cupressus lucitanica* and *J. procera*, respectively. Similarly, cypress aphid caused higher *C. lucitanica* damage severity than *J. procera*. The cypress aphid caused a

significantly higher infestation (56–90%) on twigs and barks of *C. lustinica* than on *J. procera* (1–15%) (Demeke, 2018).

Blue gum chalcid, and Eucalyptus Gall Wasp insect pest were recorded. It also high leaf damage (80%) and high severity (8 scales) on the *Eucalyptus camaldulensis.* Worku (1991) reported that *Eucalyptus psyllid* attacks young seedlings in nurseries, plantations and young shoots of coppices causing reduction in shoot growth or even dieback of terminal shoots.

In this study, the indigenous leaf of *Olea europaea* subsp *cuspidata* was highly damaged (63%) with significant-high severity (6 scales) by olive lace bug *(Plerochila australis).* Similar study in Tigray Region reported that this native olive tree encountered 24-109 death per hectare (Yirgu et al., 2012). The dieback of the two dominant tree species has significantly reduced the living stand density and basal area (Aynekulu et al., 2011).

The nymph of *Plerochila australis* resemble that of aphids and feed gregariously on underside of olive tree leaves or shoots, where accumulated honeydew may promote sooty molds (Yirgu et al., 2012).

Acacia abyssinica

About 20 % damage and low infestation of bark beetle were recorded, *Acacia abyssinica.* Similar to in Sudan locusts, termites and beetle pest that cause damage to the bark, seeds, leaves, and roots of *Acacia spp*. (Tahir et al., 2010).

This study Bark beetle and Termites were recorded in the bark part of *Hagenia abyssinica.* About 63% damage and heavy infestation were recorded. This result similar to wood boring beetles and termite damage trees in the forest, felled logs, stored timber, and wood-based products in use (Abegaz & Tsehaye, 1987). Termites caused an important pest on a number of other exotic and native tree species (Abdulahi, 1992).

H. abyssinica population has drastically decreased due to the growing pressures from various anthropogenic factors (Assefa et al., 2010). The current population of *Hagenia abyssinica* in Yegof forest is very rare (1.3 tree /ha). Besides, there was no sapling and seedling of this species in the forest during this survey. Our result is consistent with (Ayalew et al., 2006; Tadele et al., 2013). Moreover different study has recorded that the wood is susceptible to attack by borers. The insect can adversely affect tree growth, vigor, and survival, yield, and quality of wood and non-wood products (FAO, 2009).

In conclusion, total, 39 woody species were considered**.** *Cupressus lucitanica , Juniperus procera ,Olea europaea subsp cuspidata, Hagenia abyssinica, Eucalyptus camaldulensis, Acacia abyssinica, Clutia abyssinica* and *Carissa spinarum* species were encountered insect pests infestation. The tree mortality index showed that *Cupressus lucitanica, Hagenia abyssinica, Olea europaea subsp cuspidata,* and *Juniperus procera* were categorized under the intensive, premonitory and normal stages, respectively.

Cypress aphid, Bark beetle, Termites, Blue Gum Chalcid, Eucalyptus Gall Wasp, and Olive lace bug were observed on woody species in this study, high *Olea europaea* subsp *cuspidate* was highly damaged with significant-high severity (6 scales) by olive lace bug.

In conclusion the high occurrence of insect pest severity and incidence were recorded on *Cupressus lucitanica , Juniperus procera ,Olea europaea subsp cuspidata, Hagenia abyssinica,* and *Eucalyptus camaldulensis.* The researchers and forest users should give attention on reducing the damage extent of these economical tree species. Therefore, further study on climate change, insect pest and woody species interactions should be studied.

ACKNOWLEDGEMENTS

The research budget and facilities was funded by Wollo University.

REFERENCES

Abdulahi, A. (1992). Research need in forest entomology. *Proceedings of the National Workshop on Setting Forestry Research Priorities in Ethiopia.* Addis Ababa, Ethiopia. Forestry Research Center, pp. 113–121.

Abegaz, M., & Tsehaye, A. (1987). Wood preservation in Ethiopia. Addis Ababa, Ethiopia: Ministry of Agriculture, Natural Resource Conservation and Development Main Department-Wood utilization and research Center.

Assefa, B., Glatzel, G., & Buchmann, C. (2010). Ethnomedicinal uses of *Hagenia abyssinica* (Bruce) J.F. Gmel. among rural communities of Ethiopia. *Journal of Ethnobiology and Ethnomedicine, 6,* 20.

Awoke, T.G. (2018). Floristic Composition and Structural Analysis of Susgen-Bosena Forest, Ambasel District, North Wollo, Amhara Region, Ethiopia. *Abyssinia Journal of Science and Technology*, *3*(2), 24–35.

Ayalew, A., Bekele, T., & Demissew, S. (2006). The undifferentiated afromontane Forest of Denkoro in the central Highland of Ethiopia: a Floristic and structural analysis. *Ethiopian Journal of Science and Technology, 29(1),* 45–56.

Aynekulu, E., Tsegaye, D., Aerts, R., Neuwirth, B., & Boehmer, H.J. (2011). Dieback affects forest structure in a dry Afromontane forest in northern Ethiopia. *Journal of Arid Environments*, *75*, 499–503.

Ciesla, W.M. (2011). Insects of Wood in Use. Forest Entomology Perspective, Wiley Blackwell, A Johan Wiley sons, Ltd publication, UK. P-398.

Chacko, K. C. (1998). Termite-aided mesocarp removal of teak (Tectona grandis L. F.) fruits for enhanced germination and cost-effective seed handling. *Indian Forestery*, *124*, 134–140.

Curran, L.M., & Leighton, M. 2000. Vertebrate responses to spatiotemporal variation in seed production of mast-fruiting Dipterocarpaceae. Ecological Monographs, *70(1)*, 101-128.

Demeke, A. D. (2018). Status of cypress aphid on Cupressus lusitanica and Juniperus procera in protected and cultivated forests of South Wollo, Ethiopia. *Journal of Forestry Research.*

EBI. (2014). Ethiopia's Fifth National Report to the Convention on Biological Diversity (National Report). Addis Ababa ,Ethiopia: Ethiopian Biodiversity Institute.

Eshetu, Z. (2002). Historical C3-C4 vegetation pattern on forested mountain slopes: its implication for ecological rehabilitation of degraded highlands of Ethiopia by afforestation. *Journal of Tropical Ecology*, *18*(5), 743–758.

FAO. (2005*). Global forest resources assessment* – 2005: Progress towards sustainable forest management (Forestry paper No. 147). Rome, Italy: Food and Agriculture Organization of the United Nations.

FAO. (2009). *Global review of forest pests and diseases* (Forestry paper No. 156). Rome, Italy: Food and Agriculture organization of the united Nations.

GGWSSI. (2012). National Strategy and Action Plan for the Implementation of the Great Green Wall Initiative in Ethiopia. GGWSSI.

Gurmessa, F., Soromessa, T., & Kelbessa, E. (2012). Structure and regeneration status of Komto Afromontane moist forest, East Wollega Zone, west Ethiopia. *Journal of Forestry Research*, *23*(*2*), 205−216.

Habtewold, T. (2009). Terminal report on forest entomology research activity. Increasing Crop Production Through Improved Plant Protection (Vol. II, p. 542). Addis Ababa, Ethiopia: Forestry Research Center, Ethiopian Agricultural Research organization.

Jakuš, R., Grodzki, W., Jachym, M., & Ježík, M. (2002). Definition of Spatial Patterns of Bark Beetle Ips typographus (L.) Outbreak Spreading in Tatra Mountains (Central Europe), Using GIS. In A. M. Liebhold & M. L. McManus (Eds.), *Proceedings Ecology, Survey and Management of Forest Insects* (Vol. General Technical Report NE-311). Kraków, Poland: USDA Forest Service.

Lowman, M. (2006). Seasonal variation in insect abundance among three Australian rain forests, with particular reference to phytophagous types. *Australian Journal of Ecology, 20(1),* 353-361.

Mohammed, S., & Abraha, B. (2013). Floristic Composition, and Structure of Yegof Mountain Forest, South Wollo, Ethiopia. *Ethiopian Journal of Science and Technology*, *5(1),* 33–45.

Nair, K.S. (2007). Tropical Forest Insect Pests Ecology, Impact, and Management. New York: Cambridge University Press.

Pankhurst, A. (2001). Resource management institutions in post-conflict situations: lessons from Yegof State Forest. *Natural Resource Management in Ethiopia* (pp. 85–104). Addis Ababa, Ethiopia: Forum for Social Studies.

Stork, N.E. (1988). Insect diversity: facts, fiction and speculation. *Biological Journal of the Linnean Society, 35,* 321-337.

Tadele, D., Lulekal, E., Damtie, D. & Assefa, A. (2013). Floristic diversity and regeneration status of woody plants in Zengena Forest, a remnant montane forest patch in northwestern Ethiopia. *Journal of Forestry Research.*

Tahir, B. A., Fadl, K.E.M., & Fadlalmula, A.G.D. (2010). Forest biodiversity in Kordofan Region, Sudan: Effects of climate change, pests, disease and human activities. *Biodiversity*, *11*(*4)*, 34–43.

Tefera, A. (2005). Cypress aphid (*Cinara cupressivora*): a trait to the cypress (*Cupressus lusitanica*) plantations and hedges in Ethiopia. *Forestry Research Center, Ethiopian Agricultural Research Organization, Addis Ababa, Ethiopia*, *2*(*1*), 4–7.

Tekle, K., Backeus, I., Skoglund, J., & Woldu, Z. (1997). Vegetation on hill slopes in southern Wello, Ethiopia: Degradation and regeneration. *Nordic Journal of Botany*, *17*, 483–493.

Vinod , K.V, & Sabu, T. K. (2007). Species composition and community structure of dung Beetles attracted to dung of gaur and elephant in the moist forests of South Western Ghats. *Journal Insect Science*, 7, 56-69.

Watson, G. W., Voegtlin, D. J., Murphy, S. T., & Foottit, R. G. (1999). Biogeography of the Cinaracupressi complex (Homoptera: Aphididae)

on Cupressaceae, with description of a pest species introduced into Africa. *Bulletin of Entomological Research*, *89*(3), 271–283.

Worku, D. (1991). Are we ready to protect Eucalyptus globulus from a new pest. *FRC Newsletter, 2(1)*, 2–3.

Yirgu, A., Getachew, B., & Belay, T. (2012). Report of an Olive Lace Bug Infestation on Olea europaea ssp. cuspidata (Wall. ex G. Don) P. S. Green in Desa'a Natural Forest, Northern Ethiopia. *Pest Management Journal of Ethiopia*, *16*, 70–75.