Short Communication

New Host Range for Parasitic Plants in Bonga and Yayu Natural Forests in Ethiopia

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Abstract

Parasitic plants are widely distributed across all continents except Antarctica. The competition for food nutrients and water by these plants has harmful effect on the physiological activities of the host plant. A survey on the occurrence of parasitic plants was conducted in 2011 in and around Bonga and Yayu natural forests of southwestern Ethiopia. This study was aimed at determining the distribution of parasitic plants on economically and ecologically important trees species in the two forests. Four species of parasitic plants were recorded associated with ten host plants. Higher rate infection was observed in the fragmented forests located around homesteads and margin of the forests than in dense forests. Further geographical variation and percent of infection were evident between the forests and host plants. For the first time, *Coffea arabica* was observed to be infected by *Viscum congolense*. This infection imparted negative effects on coffee bean production in Bonga forest. Similar infections were also recorded in several coffee shade trees. Therefore, future research works need to address forest situated in the lower administrative levels and analyze the impacts of parasitic plant in economically important tree species.

Key Words: Parasitic plant, Bonga forest, Yayu forest, south west forest, Ethiopia

Introduction

Mistletoes are polyphyletic and diverse group of flowering plants comprising of more than 1306 species from a broad range of habitats across all continents except Antarctica (Kartoolinejad et al. 2007). They partially or completely rely on host plants for carbon, nutrients and water (Watson 2009; Press & Phoenix 2005).

They usually attach themselves and penetrate host's xylem and/ or form close connections with phloem to host's roots or shoots using specialized structures known as *haustoria* (Press & Phoenix 2005). They have higher transpiration rates and conductance than their host plants (Orozco et al. 1990). Thus, they often have harmful effects to their hosts through reducing fruit (Way 2011), seed production (Mourao et al. 2009) and tree growth, and ultimately increase tree mortality (Way 2011) through competition for water (Orozco et al. 1990; Okubamichael et al. 2011) and diverting important resources or nutrients from the branches of host trees to themselves (Aukema 2003). In Africa, infection of parasitic plants can involve total crop failure, and average losses of 10 to 40 percent of production is almost certainly common (Parker 2012).
The dispersion of shoot mistletoe mainly depends on the movement of birds and their preferences for perching, foraging and nesting (Roxburgh & Nicolson 2005); whereas the germination, establishment and survival of mistletoe seeds depends on the physiological, biochemical and physical compatibility of host trees (Yan 1993; Lopez de Buen & Ornelas, 2002; Roxburgh & Nicolson 2005). On the other hand, the degree of host specialization may also be influenced by the length of time the parasite and the host plant have been associated (Norton & de Lange 1999). As a result all trees do not have likely chance to receive (Roxburgh & Nicolson 2005) and support mistletoe infection (Lopez de Buen & Ornelas 2002).

Polhill and Wiens (1998) described about 34 species of parasitic plants in tropical Africa and Arabia, among which 28 species that belong to 10 genera of Loranthaceae were recorded in Ethiopia.
It has been observed that the repot by Hedberg and Edwards (1980) has lacked both conclusive listing of host plants and the distribution of parasitic plants at districts or lower administrative division. Thus, significant knowledge gap has been observed among the scientific communities in the geographical distribution of the parasitic plants in the natural forests of Ethiopia. Therefore, the objective of this study was to determine the distribution of parasitic plants on economically and ecologically important trees species available in Bonga and Yayu natural forests.

Materials and Methods

Study site

The southwest forests of Ethiopia are rich in species diversity. It is also known as the center of origin for *Coffea arabica* (Tadesse et al 2014; Senbeta et al 2007). A survey on the presence of parasitic plants was carried out in Bonga and Yayu natural forests in December 2011. Bonga forest lies 07^{0}00'-07^{0}25'N and 35^0 55'-36^{0}37'E (Nune 2008) and 1520-1780 m a.s.l. It has a mean annual rainfall of 1794 mm with maximum and minimum temperature of 26.4^{0}C and 11.9^{0}C (Assefa 2010). Whereas, Yayu forest is located between 8° 21'–8° 26' N and 35° 45'–36° 3'E within an altitudinal range of 1200 to 2000 m a.s.l (Woldegeorgis & Wube 2012). It has a mean annual rainfall of 1900 mm and a maximum with minimum temperature of 34.7 and 7.6 °C (Woldemariam 2003 in Kufa & Burkhardt 2013).

Trees found in and around permanent plots established for phonological studies inside dense canopies, fragmented and margin of forests and trees grown near homesteads in the two forests were examined for the presence of parasitic plants. Samples of parasitic plants were collected from host trees that had infection. These specimens were properly labeled and pressed together along with leave sample of host plants and brought to Forestry Research Center, Addis Ababa for identification purpose. In addition to collecting of sample specimens an informal group discussion were conducted with ten coffee growers and local resident around Bonga natural forest. Finally, specimens were identified to species level and authenticated with type specimen preserved at the National Herbarium of Addis Ababa University, Addis Ababa, Ethiopia.

Results

Four different types of parasitic plants of two different families of mistletoes were found to be associated with ten plant species grown in Bonga and Yayu forests (Table 1). It was found that nearly all infected trees were grown in the road sides, homesteads and in parts of fragmented forests where there was full exposure to sunlight than inside or under dense forests. Some parasitic plants were observed to infect more than one host plant, and conversely a single host was infected by more than one parasitic plant.

In addition to the geographical variation of these plants, the size of infection of host trees varied from one species to the other. In both forest, branches of *Ficus vasta* and *M. ferruginea* that were grown in an open forests or edge of fragmented forest were found almost completely infected. Based on informal group discussions with the local coffee growers at Bonga Forest, it was understood that infected coffee trees bore a few to none coffee beans and lead to the death of coffee trees 4 to 5 years under the condition of heavy infection. Hence, some farmers were traditionally engaged in pruning infected branches to avoid further establishment and expansion of the parasitic plants in their farmlands. However, such management option was taken only to those parasitic plants found in the branch of coffee trees.

Table 1. Distribution of parasitic plants with respect to host plant and locality

Parasitic plant	Location	Host plant	Family
Phragmanthera regularis (Spragu) M. Gilbert	Yayu	*Ficus vasta*	Moraceae
(Steud.ex Sprague) M.G.Gilbert (synonym *Lorantuhus regularis*)	Yayu	*Cordia africana*	Boraginaceae
Phragmanthera macrosolen (A. Rich.)M. Gilbert	Yayu	*Albizia gummifera*	Mimosaceae
(synonym *L. macrosolen* Steudner ex A. Rich)	Yayu	*Acacia abyssinica*	Mimosaceae
Viscum congolense De Wild	Bonga	*Coffea arabica*	Rubiaceae
	Bonga	*Croton macrostachys*	Euphorbiaceae
	Bonga	*Millettia ferruginea*	Papilionaceae
Englerina woodfordioides (Schweinf.) M. Gilbert	Bonga	*Coffea arabica*	Rubiaceae
	Bonga	*Acacia abyssinica*	Mimosaceae
	Bonga	*Vernonia amygdalina*	Asteraceae
	Bonga	*Cordia africana*	Boraginaceae
	Bonga	*Ekebergia capensis*	Meliaceae
	Bonga	*Canthium oligocarpum*	Rubiaceae

Discussion

It was observed that four different species of parasitic plants were found to be associated with ten host trees in Bonga and Yayu forests. Both study locations have accommodated two different types of mistletoe species. It was also observed that different tree species within a single family can be infected by similar or different parasitic plants. The apparently none host preference of these mistletoes typically infer as they are generalist (Norton & Carpenter 1998; Lopez de Buen & Ornelas, 2002).

Based on socioeconomic studies on perception and benefits of coffee shade trees in Bonga and Yayu-Hurumu districts by Muleta et al (2011), *A. gummifera, A. abyssinica, M. ferruginea* and *C. africana* are highly favored tree species for their contribution in coffee yield increase, honey production, improvement of soil fertility and reduction of soil erosion. On the other hand, this study has found that *C. arabica, A. abyssinica, M. ferruginea,* and *C. africana* were infected by *V. congolense* and *E. woodfordioides*. The common list of parasitic plants of coffee and respective shade trees might show that the dupes dropped from the shade trees or avian dispensers are directly responsible for the underneath infection of coffee branches, so that the management option of the parasitic plants need to include the shade trees that used to be planted around coffee far too.

Although coffee bean production is expected to decrease as a result of mistletoe infection, significant impact has not been reported by respondent in the study area. This might be related to the relative availability of higher amount of annual rainfall in Bonga forest and early pruning of infected branches. If that were not the case, heavy economic damage could have been occurred.

In agreement with Hedber and Edwards (1980) and Lopez de Buen et al (2002), the parasitic plants distributed in Bonga and Yayu forests prefer to establish themselves in trees that are grown in forest margins and in secondary bush land or fragmented forests than inside dense and closed canopies. In addition to this, the relative difference in the number of parasitic plants infection of trees in these forests might be due to the aggregation of previous infections (Aukema & del Rio 2002), the architecture of the canopy that allows to receive more mistletoe seed than others (Aukema & del Rio 2002; Roxburgh & Nicolson 2005), height of the host plant, location of a tree with respect to other infected conspecific host tree, forest land such as fragmented edges (Lopez de Buen et al. 2002) and the length of time the parasite and the host have been associated together (Norton & de Lange 1999).

In terms of distribution and host trees of these parasitic plants, it has been reported that *E. woodfordioides* (Schweinf) Balle is found in Kenya, Uganda, Tanzania, Rwanda and Zaire (Hedberg and Edwards 1980). In Ethiopia, it grows on peach tree (Parker 1988) and *Maesa lanceolata* in several administrative regions (Hedberg & Edwards 1980). On the other hand, *P. regularis (Sprague) M. Gilbert* (1985) is widely found in different parts of Ethiopia and Kenya, and grows on *C. macrostachyus, Ficus* spp., *Rhus* , citrus, peach trees and less frequently on a variety of other hosts (Parker 1988; Hedberg & Edwards 1980); whereas, *P. regularis* was reported in Yemen and Southern Saudi Arabia (Mothana et al. 2012). Furthermore, Parker (1988) has observed the infection of coffee trees by *Tapinanthus globiferus* in Wellega end Kefa and *Cordia africana* by *T. heteromorpha* in Ethiopia.

Similarly, *P. macrosolen* (A. Rich.) M. Gilbert is reported in several administrative regions of Ethiopia (Hedberg & Edwards 1980). It almost always grows on *Acacia* or *Albizia* species, and rarely spreads onto other hosts in the vicinity (Hedberg & Edwards 1980). On the otherhand, *V. congolense* De Wild (synonym *V.grandifolium*) is distributed in Cote d'Ivoire, Ghana, Nigeria, Cameroun, Gabon, Zaire, Ruanda, Burundi (Hedberg & Edwards 1980), Tanzania, Central African Republic and Congo (Polhill & Wiens, 1999). *V. congolense* grows on *Albizia grandebracteata*, *C. macrostachyus* and *Mimusops kummel* in Ethiopia (Hedberg & Edwards 1980).

Conclusion

This study has clearly shown the existing gaps in the geographical distribution and host ranges of parasitic plants stated both in Flora of Ethiopia as well as other scientific literatures at the lower sub-district levels to a very limited extent. Therefore, future studies should exhaustively list the host-parasitic plants at lower administrative levels and also need to address the perspective economic impacts and phenology of the parasitic plants. Furthermore, the seed dispensers birds needs to be addressed in order to device management options.

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Reference

Assefa B. 2010. Land use and land cover analysis and modeling in South Western Ethiopia: the case of selected Resettlement Kebleles in Gimbo Woreda. A thesis submitted to the School of Graduate Studies of Addis Ababa University. In partial fulfillment of the requirement for the degree of Master of Science in Environmental Science.

Aukema JE, del Rio CM. 2002. Variation in mistletoe seed deposition: effects of intra-and interspecific host characterisitics. ECOGRAPHY 25:139-144

Aukema JE. 2003. Vector, Viscin, and Viscaceae: mistletoes as parasities, mutualists, and resources. Front Ecol Environ 1(3): 212-219

Hedber I, Edwards S. (eds). 1980. Flora of Ethiopia volume 3 Pittosporaceae to Araliaceae: editors Inga Hedberg and Sue Edwards. Addis Ababa and Asmara, Ethiopia Uppsala, 1989 Sweden University

Kartoolinejad D, Hosseini SM, Mirnia SK, Akbarinia M, Shayanmehr F. 2007. The Relationship among Infection Intensity of *Viscum album* with some Ecological Parameters of Host Trees. Int. J. Environ. Res. 1(2): 143-149

Kufa T, Burkhardt J. 2013. Studies on root growth of *Coffea arabica* populations and its implication for sustainable management of natural forests. Journal of Agricultural and Crop Research 1: 1-9

Lopez de Buen L, Ornelas JF. 2002. Host compatibility of the cloud forest mistletoe *Psittacanthus schiedeanus* (Loranthaceae) in Central Veracruz, Mexico. Am. J. Botany, 89 (1) 95-102.

Lopez de Buen L, Ornelas JF, Garcia-Franco JG. 2002. Mistletoe infection of trees located at fragmented forest edges in the cloud forests of Central Veracruz, Mexico. Forest Ecology and Management 164: 293-302

Mothana RAA, Al-Said MS, Al-Rehaily AJ, Thabet TM, Awad NA, Lalk M, Lindequist U. 2012. Anti-inflammatory, antinociceptive, antipyretic and antioxidant activities and phenolic constituents from *Loranthus regularis* Steud, ex Sprague. Food Chemistry 130: 344-349

Mourao FA, Jacobi CM, Figueira JEC, Batista EKL. 2009. Effects of the parasitism of *Struthanthus flexicaulis* (Mart.) Mart (Loranthaceae) on the fitness of *Mimosa calodendron* Mart.

(Fabaceae), and endemic shrub from rupestrian fields over ironstone outcrops, Minas Gerais State, Brazil. Acta Bot. Brass. 23(3): 820-825

Muleta D, Assefa F, Nemomissa S, Granhal U. 2011. Socioeconomic benefits of shade trees in coffee production systems in Bonga and Yayu-Hurumu districts, southwestern Ethiopia: Farmers' perceptions. Ethiopian Journal of Education and Sciences 7:39-56

Norton DA, Carpenter MA. 1998. Mistletoes as parasites; host specificity and speciation. Trends in Ecology and Evolution 13: 101–105

Norton DA, de Lange PJ. 1999. Host specificity in parasitic mistletoes (Loranthaceae) in New Zealand. Functional Ecology 13: 552-559

Nune S. 2008. Flora Biodiversity Assessment in Bonga, Boginda and Mankira Forest, Kafa, Ethiopia. http://www.kafa-biosphere.com/assets/content-documents/KafaFloral-Survey-Final-Report.pdf (Accessed September 17, 2014).

Okubamichael DY, Griffiths ME, Ward D. 2011. Host specificity, nutrient and water dynamics of the mistletoe *Viscum rotundifolium* and its potential host species in the Kalahari of South Africa. Journal of Arid Environment 75: 898-902.

Orozco A, Rada F, Azocar A, Goldstein G. 1990. How does a mistletoe affect the water, nitrogen and carbon balance of two mangrove ecosystem species? Plant, Cell and Environment. 13: 941-947

Parker C. 1988. Parasitic plants in Ethiopia. Walia 11: 21-27

Parker C. 2012. Parasitic weeds: A World Challenge. Weed Science 60: 269-276

Polhill, R.M. and Wiens, D. 1999. Flora of Tropical East Africa. Royal Botanic Gardens, Kew.

Polhill RM, Wiens D. 1998. Mistletoes of Africa. The Royal Botanic Gardens, Kew

Press MC, Phoenix GK. 2005. Impacts of parasitic plants on natural communities. New Phytologist 166 : 737-751.

Roxburgh L, Nicolson SW. 2005. Patterns of host use in two African mistletoes: the importance of mistletoe-host compatibility and avian disperser behavior. Functional Ecology 19:865-873

Senbeta F, Woldemariam T, Demissew S, Denich M. 2007. Floristic diversity and composition of Sheko Forest, Southwest Ethiopia. Ethiopian Journal of Biological Sciences 6:11-42

Tadesse G, Zavaleta E, Shennan C. 2014. Coffee landscapes as refugia for native woody biodiversity as forest loss continues in southwest Ethiopia. Biological Conservation 169: 384-391

Watson DM. 2009. Determinants of parasitic plant distribution: the role of host quality. Botany 87: 16-21

Way DA. 2011. Commentary: Parasitic plants and forests: a climate change perspective. Tree Physiology 31:1-2

Woldegeorgis G, Wube T. 2012. A survey on mammals of the Yayu Forest in Southwest Ethiopia. SINET: Ethiop. J. Sci. 35 (2): 135-138

Yan Z. 1993. Resistance to haustorial development of two mistletoes, *Amyema preissi* (Miq.) and *Lysiana exocarpi* (Behr) *Tieghem* spp. *exocarpi* (Loranthaceae) on host and non-host species. Int. J. Plant Sci. 154: 386–394.