SINET: Ethiop. J. Sci., 36(1):41–44, 2013
 ISSN: 0379–2897

Short communication

EPIPHYTIC RECRUITMENT OF *SCHEFFLERA ABYSSINICA* (A. RICH) HARMS. AND THE ROLE OF MICROSITES IN AFFECTING TREE COMMUNITY STRUCTURE IN REMNANT FORESTS IN NORTHWEST ETHIOPIA

Abrham Abiyu [1] , Georg Gratzer [2], Demel Teketay [3], Gerhard Glatzel [4] and Raf Aerts [5]

[1] Gondar Agricultural Research Centre, PO Box 1337, Gondar, Ethiopia. E-mail: abrhamabiyu@yahoo.com
[2] University of Natural Resources and Life Sciences, Peter-Jordan Strasse 82, A-1190, Vienna, Austria. E-mail: georg.gratzer@boku.ac.at
[3] GIZ Nairobi Office, African Ecolabelling Mechanism, PO Box 41607, 00100, Nairobi, Kenya. E-mail: demel.teketay@giz.de or dteketay@yahoo.com
[4] Commission for Interdisciplinary Ecological Studies, Austrian Academy of Sciences, Dr. Ignaz Seipel-Platz 2, A-1010 Vienna, Austria. E-mail: Gerhard.Glatzel@oeaw.ac.at
[5] Forest Ecology and Management-Division Forest, Nature and Landscape-University of Leuven (KU Leuven), Celestijnenlaan 200E-2411, BE-3001 Leuven, Belgium. E-mail: Raf.Aerts@ees.kuleuven.be

ABSTRACT: Epiphytic recruitment of trees on trees is a form of facilitation allowing trees to escape herbivory and abiotic stress. In terms of survival and reaching the upper canopy sooner, this form of recruitment may be more successful than recruitment from the ground. Hence epiphytic recruitment may play a major role in affecting plant community structure and vegetation dynamics. To this effect, we studied epiphytic *Schefflera abyssinica* (A. Rich) Harms. density and characteristics in a church forest and the surrounding degraded matrix in northwest Ethiopia using different sampling techniques. The role of suitable microsites was evaluated as a secondary objective. The result showed that no seedling of *Schefflera abyssinica* was found on the ground. The average density of epiphytic *Schefflera abyssinica* was much higher than already standing mature trees. *Schefflera abyssinica* rejuvenates majorly by forming canopy seedling bank on six different kinds of tree species. Rot holes, branch forks and moss layer on the host tree were important microsites for successful establishment. Our result substantiates earlier reports that *Schefflera abyssinica* does not form persistent soil seed bank. The result also suggests that the spatial configuration of trees in the forest and in the landscape will remain largely the same; however, the dominant species will change as the epiphyte will gradually outcompete the host. Dominance of only one tree species might have a negative effect on the tree community structure of the forest and the surrounding agro ecosystem.

Key words/phrases: Epiphyte, facilitation, host, microsite, Tara Gedam

INTRODUCTION

Facilitation or positive interaction among plants as a factor shaping plant communities is getting importance (Kitzberger *et al.*, 2000; Bruno *et al.*, 2003). Plants may facilitate other plants directly or indirectly (Bertness and Callaway, 1994). Direct facilitation may be by improving substrate resource conditions, dormancy breakage or protection from harsh environmental conditions (Bruno *et al*. 2003; Maestre *et al*., 2009). Indirect facilitation can occur by attraction of seed dispersers and accumulation of seed, or protection from herbivores (Bruno *et al*. 2003; Maestre *et al*., 2009).

Epiphyte-host relationship can be seen as a facilitative ecological process (Callaway *et al.*, 2002), at least initially, as the epiphyte benefits from the presence of the host. Epiphytic recruitment of trees on trees is a specific form of facilitation, most frequently described from figs (Harrison *et al.*, 2003). In forests and outside forest condition, figs take advantage of a host to escape herbivory and reach the upper canopy much sooner than seedlings established on the ground (Werner and Gradstein, 2008).

Schefflera abyssinica (Araliaceae) is dominant tree species in the Afromontane forests of Ethiopia (Bamps, 1989) and sometimes found growing as an epiphyte (*e.g*., Fichtl and Admasu Adi, 1994). To the knowledge of the authors, there are no reports from Ethiopia on the regeneration strategy of the species and the relative contribution of epiphytic recruitment to

recruitment from the ground. To assess the role of this epiphytic strategy of *Schefflera abyssinica* and to pave the way for future studies of vegetation dynamics, we studied the density inside and outside a church forest. The effect of microsite was evaluated as secondary objective.

MATERIALS AND METHODS

The study was carried out at Tara Gedam church forest (N 12° 08′ 35′′ and E 37° 44′ 29′′) and adjoining agro-ecosystem in south Gonder, north-western Ethiopia. The average altitude is 2290 m. The mean minimum and maximum temperatures are 13 and 27°C, respectively, and the mean annual rainfall is 1085 mm. The rainfall occurs from June to September. The most common tree/shrub species include: *Olea europaea* L. subsp. *cuspidata* (Wall. ex G. Don) Cif. , *Albizia schimperiana* Oliv., *Teclea nobilis* Del., *Schefflera abyssinica* (A. Rich) Harms., *Croton macrostachyus* Hochst. ex Del., *Apodytes dimidiata* E. Mey. ex Arn., *Nuxia congesta* R. Br. ex Fresen., *Scherebera alata* (Hochst.) Welw., *Grewia ferruginea* Hochst. ex A. Rich., *Calpurnia aurea* (Ait.) Benth., *Carrisa spinarum* L., *Bersama abyssinica* Fresen., *Rhus glutinosa* A. Rich., *Clausena anisata* (Willd.) Benth., *Osyris quadripartita* Decn., *Maesa lanceolata* Forssk. and *Myrsine africana* L.

Schefflera abyssinica individuals were considered as epiphytic recruits, when they perennate a rainy season and the following dry season by forming ligno-tuber structures. There may be more than one epiphytic recruit on a single host tree; however, they were considered as a single individual as they finally coalesce into a single mature tree. To assess the differential contribution of epiphytic recruitment, the density of recruits of *Schefflera abyssinica* were evaluated from the ground and on the host trees, as well as inside and outside the forest. Recruitment from the ground inside the forest patch was assessed by using 15 circular sampling plots of radius 5.64 m distributed on six transect lines, which run perpendicular to the contour line. Recruitment from the ground outside the forest was assessed by doing exhaustive search in every direction from the parent tree and up to 25 m distance. Recruitment on the host tree, inside the forest patch, was assessed on 15 sampling points (plotless methods). The sampling points were distributed along five transect lines which run perpendicular to the contour. The spacing between sampling points on the transect was 50 m and between transects was 100 m. In the farm-grazing land, each and every tree species was visited for the presence or absence of *Schefflera abyssinica* as an epiphyte. Density estimates of epiphytic *Schefflera abyssinica* recruits (inside the forest) were calculated using closest individual plotless density estimator (Engeman *et al.*, 1994) for 100 random subsets of 10 sampling points obtained through Monte Carlo permutations.

$$BDCI = \frac{1}{4\left[\sum_{i=1}^{N} R_{1(i)} \Big/ N\right]^2},$$

where,

BDCI is the closest individual basic distance density estimator (individuals m^{-2}),

$R_{1(i)}$ the distance from transect point *i* to the closest tree which hosted epiphytic *Schefflera abyssinica*,

N the number of sampling points.

Square brackets denote the greatest integer function.

Monte Carlo permutations were performed using the Poptools extension for Microsoft Excel (Hood, 2011).

Microsites, where seedlings of *Schefflera abyssinica* grow as an epiphyte on a given host tree in the field, were stratified into rot holes, branch forks and moss layer. A microsite was defined as: (i) a rot hole when the seedlings are established on cavities of different size, (ii) branch forks when the seedlings are established on the junction between two branches and (iii) moss layer when the seedlings are established on the trunk or branch of the host tree covered with mosses. All study activities were undertaken between 2009 and 2011.

RESULTS

No *Schefflera abyssinica* seedling/sapling was observed on the ground inside and outside the church forest. The mean density of recruits of epiphytic *Schefflera abyssinica* inside the church forest (29 ± 5 recruits ha^{-1}) was higher than the number of mature already standing (upper canopy) individuals (7 trees ha^{-1}). Exhaustive search, for the presence and absence of epiphytic recruits of *Schefflera abyssinica* on scattered trees on the farm-grazing-degraded matrix showed the presence of 29 trees, which equates to approximately two trees ha^{-1}.

The major host tree species in the farm-grazing degraded matrix were *Olea europaea* ssp. cuspidata (50%), *Schrebera alata* (23%), *Teclea nobilis* (14%), *Olea capensis* L. (10%) and *Schefflera abyssinica* (3%) inside the forest, and *Olea europaea* (69%), *Apodytes dimidiata* (10%), *Combretum molle* R.Br. ex G. Don (7%) (Table 1). Olea was important host tree for epiphytic recruitment of *Schefflera abyssinica* both inside and outside the church forest. Despite being abundant, *Apodytes dimidiata* was more important host tree in the farm-grazing land than inside the forest patch.

The percentage of seedlings established on rot holes, created either by fungi or by man-made wounds, outside the forest was 51, and on branch forks was 49. Moss layer was observed to have little contribution as suitable microsite outside the forest for epiphytic recruitment of *Schefflera abyssinica.* On the other hand, 58% of the seedlings encountered in the forest were found on moss layers (Table 1). About 70% of all suitable microsites were located at the lower one third of the tree height.

DISCUSSION

Our result showed that recruits of *Schefflera abyssinica* were mainly concentrated on other trees. This suggests that epiphytic recruitment was more important than recruitment from the ground for this tree species. This tree species can establish itself as a hemiepiphyte on different host tree species. Although, the different host tree species occupy different position on the canopy, the epiphytic recruitment of *Schefflera abyssinica* on the specific host tree was restricted to the lower one third of the tree total height.

Although rot holes, moss layers and branch forks are rare microsites compared to the ground, they contribute to the majority of rejuvenation of *Schefflera abyssinica.* A similar study on the importance of rot holes as key microhabitat for epiphytic lichen on beech (*Fagus sylvatica*) has been reported (Fritz and Heilmann-Clausen, 2010). This may be the result of directed dispersal where dispersal agents take seeds to nonrandom places that are well-suited for establishment and growth (Wenny, 2001).

Our result provides a possible explanation to why *Schefflera abyssinica* was represented by neither seedlings nor seeds in the soils in Gara Ades and Menagesha dry Afromontane forests in south-eastern and central Ethiopia, respectively, although mature trees were present (Demel Teketay, 1997). Our result also suggests that the major regeneration route of *Schefflera abyssinica* may be by forming canopy seedling bank instead of persistent soil seed bank or ground seedling bank.

Table 1. List of identified host tree species, percentage abundance of microsites on the host tree and their percentage contribution as a host (inside and outside the church forest) for epiphytic recruitment of *Schefflera abyssinica.*

Tree species	*Microsite*						Total for species	
	Rot hole		*Branch fork*		*Moss layer*			
	Forest	Farm	Forest	Farm	Forest	Farm	Forest	Farm
Combretum molle	0.0	3.5	0.0	3.5	0.0	0.0	0.0	7.0
Nuxia congesta	0.0	0.0	0.0	3.0	0.0	0.0	0.0	3.0
Apodytes dimidiata	0.0	7.5	0.0	2.5	0.0	0.0	0.0	10.0
Ekebergia capensis	0.0	0.0	0.0	4.0	0.0	0.0	0.0	4.0
Olea europaea subsp. *cuspidata*	12.5	40.0	19.0	29.0	18.5	0.0	50.0	69.0
Schrebera alata	0.0	0.0	3.0	7.0	20.0	0.0	23.0	7.0
Schefflera abyssinica	0.0	0.0	0.0	0.0	3.0	0.0	3.0	0.0
Olea capensis	0.0	0.0	5.0	0.0	5.0	0.0	10.0	0.0
Teclea nobilis	0.0	0.0	3.0	0.0	11.0	0.0	14.0	0.0
Total	12.5	51.0	30.0	49.0	57.5	0.0	100.0	100.0

1 ha = 10,000 m^2.

CONCLUSION

Epiphytic recruitment of *Schefflera abyssinica* is a facilitative ecological process, because it benefits from the presence of the host trees. The facilitation mechanism may be direct, where the microsites on the host tree increase availability of key resources and ameliorating harsh environmental conditions, or indirect by attracting seed disperser organisms and protection from herbivores (Bertness and Callaway, 1994; Hietz-Seifert *et al.*, 1996; Zanne and Chapman, 2001; Flores-Palacios and García-Franco, 2008; Fritz and Heilmann-Clausen, 2010).

From succession theory (Connell and Slatyer, 1977), a facilitative pathway leads to the establishment of other plant species. Similarly, although the spatial configuration of trees in the landscape will remain largely the same, the dominant species will change as the epiphyte will gradually outcompete the host. Dominance of only one tree species as an epiphyte might have a negative effect on the community structure of the church forest and also the livelihood of the farmers. Therefore, we recommend an in depth study on the dispersal, seed and seedling ecology as well as the ecophysiology of the species.

AKNOWLEDGEMENTS

We thank the Commission for Development Studies (KEF) in the ÖAD, and the International Foundation for Science (IFS) for financial support.

REFERENCES

1. Bamps, P. (1989). Araliaceae. **In**: *Flora of Ethiopia, Vol. 3,* pp. 537-542, (Hedberg, I. and Edwards, S., eds). The National Herbarium, Addis Ababa, Ethiopia, and Department of Systematic Botany, Uppsala, Sweden,
2. Bertness, M.D. and Callaway, R. (1994). Positive interactions in communities. *Trends in Ecology & Evolution* **9**:191–193.
3. Bruno, J.F., Stachowicz, J.J. and Bertness, M.D. (2003). Inclusion of facilitation into ecological theory. *Trends in Ecology & Evolution* **18:**119–125.
4. Callaway, R., Reinhart, K., Moore, G., Moore, D., Pennings, S. (2002). Epiphyte host preferences and host traits: mechanisms for species-specific interactions. *Oecologia* **132**:221–230.
5. Connell, J.H. and Slatyer, R.O. (1977). Mechanisms of Succession in Natural Communities and Their Role in Community Stability and Organization. *The American Naturalist* Vol. **111**:1119–1144.
6. Demel Teketay (1997). Seedling populations and regeneration of woody species in dry Afromontane forests of Ethiopia. *Forest Ecology and Management* **98**:149–165.
7. Engeman, R.M., Sugihara, R.T., Pank, L.F., Dusenberry, W.E. (1994). A comparison of plotless density estimators using Monte-Carlo simulation. *Ecology* **75**:1769–1779.
8. Flores-Palacios, A. and García-Franco, J. (2008). Habitat isolation changes the beta diversity of the vascular epiphyte community in lower montane forest, Veracruz, Mexico. *Biodiversity and Conservation* **17**:191–207.
9. Fichtl, R., and Admasu Adi (1994). *Honey Bee Flora of Ethiopia*. The National Herbarium, Addis Ababa University and Deutscher Entwicklungsdienst (DED), Margraf Verlag, Germany, 510 pp.
10. Fritz, Ö. and Heilmann-Clausen, J. (2010). Rot holes create key microhabitats for epiphytic lichens and bryophytes on beech (*Fagus sylvatica*). *Biological Conservation* **143**:1008–1016.
11. Harrison, R.D., Hamid, A.A., Kenta, T., Lafrankie, J., Lee, H.-S., Nagamasu, H., Nakashizuka, T., Palmiotto, P. (2003). The diversity of hemi-epiphytic figs (*Ficus*; Moraceae) in a Bornean lowland rain forest. *Biological Journal of the Linnean Society* **78**:439–455.
12. Hietz-Seifert, U., Hietz, P., Guevara, S. (1996). Epiphyte vegetation and diversity on remnant trees after forest clearance in Southern Veracruz, Mexico. *Biological Conservation* **75**:103–111.
13. Hood, G. M. (2011). PopTools version 3.2.5. Available on the internet. URL http://www.poptools.org Accessed on 22 Sep 2011
14. Kitzberger, T., Steinaker, D.F. and Veblen, T.T. (2000). Effects of climatic variability on facilitation of tree establishment in Northern Patagonia. *Ecology* **81**:1914–1924.
15. Maestre, F.T., Callaway, R.M., Valladares, F., Lortie, C.J. (2009). Refining the stress-gradient hypothesis for competition and facilitation in plant communities. *Journal of Ecology* **97**:199–205.
16. Wenny, D.G. (2001). Advantages of seed dispersal: a re-evaluation of directed dispersal. *Evolutionary Ecology Research* **3**:51–74.
17. Werner, F. and Gradstein, S. (2008). Seedling establishment of vascular epiphytes on isolated and enclosed forest trees in an Andean landscape, Ecuador. *Biodiversity and Conservation* **17**:3195–3207.
18. Zanne, A.E. and Chapman, C.A. (2001). Expediting reforestation in tropical grasslands: distance and isolation from seed sources in plantations. *Ecological Applications* **11**:1610–1621.