Unusual Relevance Of Root Rot Fungi In Dead Wood Ecology Of Rubber Forestry Plantation In Nigeria

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Abstract: Aside the destructive effects of root rot fungi of rubber trees, they potent salient potentials in the functioning of the plantation ecological systems. Dead and living trees are habitat for varying wood decaying fungal organisms. They hasten the development of decomposing wood habitat with concomitant advantages such as nutrient flow, carbon sequestration, soil formation and aggregation for stable forest ecosystems. The functions of the wood decaying organisms depend largely on the coarse woody debris morticultural practices are little known. The implication of this ignorance often leaves out threatened habit at where coordinated practices such as management, and management and conservation practices are enforced the realization of a stable ecological systems in the rubber forest is achieved. This study therefore elucidate potential implications of root rot fungi based on reviewed articles for a sustainable eco-system and much research in this regard is expected as
Challenges to pathologists, management and conservation scientists.
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1. Introduction

The monoclonal *Hevea* tree is subject to a plethora of numerous diseases including leaf, stem and branch, and root diseases as well as those of wind damage and erosion. Impact of these maladies implicated in wind throw, stand, and dead wood of affected trees either standing or fallen is quite enormous. The effect of root decaying pathogen in particular results in losses in productions to the resource poor rubber farmers. The root diseases are mainly the white root rot, red root rot, brown root rot diseases. Others are the Armillaria root rot, as well as root galls.

Of the root diseases, the white root rot is most notorious and aggressive and accounts for 94% of incidences of root diseases, and up to five trees per hectare are destroyed annually (Otoide, 1978). Over a period of time 50% of rubber trees in a plantation may be lost to white root rot. The casual pathogens for the root rot diseases are *Rigidoporus lignosus* (Klotzsch) Imazeki, *Phellinus noxius* (Corner) G. H. Cunn; *Gonoderma phillipi* (Bres And P. Henn) Bres for white, Brown and red root rot diseases, respectively, while *Armillaria mellea* (Vahl. Ex Fr.) P. Karst, incite Armillaria root rot, and *Thonningia sanguinea* is known to cause root galls. Sting root rot by *Sphaerostilbe repens* (Berk. And Br.); Poria root rot caused by *Poria Vincta* (Berk.) Cooke, are lesser consequence in Nigeria.The *Hevea brasiliensis* (Willd. Ex. Adr. De Juss) (Muell. Arg.) is of the family Euphobiacea of laticiferous plants. The tree is highly valued for its raw material – the latex from which natural rubber is obtained. This single product has contributed immensely to the industrial development of the whole world. Furthermore, the effects of the root pathogensis usually accumulation of deadwood in the plantation.

In a forest plantation, these parasitic root fungi are more or less considered efficient ecosystem engineers in a dead woodlogy (Grove, 2002). In a rubber ecosystem in Nigeria, the wood decaying fungal pathogens are significant component of the functioning of such ecological system. More often than not such wood decaying fungi serve as biomes (habitats) for some other organisms and play roles in forest regeneration. According to Lonsdale *et al.* (2008), wood decomposers are actively involved in processes such as nutrient recycling, soil formation, and carbon budget of forest ecosystems. Impacts of decaying logs are common observation in rubber plantation often provide differences in substrates, micro sites that allow several species with different niche requirements to co - exists that support future tree decomposition.

Fungi organisms inhabiting wood are subsequently part of the biodiversity of a forest ecosystem. There are some conditions that influence these organisms species – riches which result in increase in the amounts of substrate available (Allen *et al.* 2000., Berglund and Jonsson 2005; Simila *et al.* 2006).

The role of root pathogens rubber has been that of their incidence and destructive effects leading to serious economic loss. However, the contrary role of wood decaying pathogens as component of the functioning of the ecosystem had probably been at the hind sight of researchers. According to Deleney *et al*. (1998); Groove (2001), the roles and status of wood decaying fungi have been largely unreported from the tropical region, or rather, the idea is not in existence. This rather unnoticed deadwoodlogy of rubber poses as a challenge to pathologists, or evolve conservationists and forest managers to focus on this rather new trend of study. The relevance of this challenge will be more beneficial if dead wood are well managed for greater productivity, regeneration and preservation of the rubber ecological system. This study attempts to point out a new research focus in the rubber industry for sustainable agriculture.

2. Rubber Wood Decay Ecological Functioning

Wood decaying fungi are involved in complex ecological systems interactions in tropical forests. The basis for ecological functions of wood decaying fungi is the starting materials such as standing deadwood and snags, fallen logs, standing living trees with heart rot and dying branches (Lonsdale *et al*. 2008). The fungal pathogens are known to have the capacity to immediately colonize any organic material (Piepenbring and Ruiz-Boyer 2008). This ability is heterotrophic, and since they lack the ability to use solar energy for their nutrition, they incorporate organic compounds such as sugars and carbohydrates by absorption are essential substrates for carbohydrates by absorption are essential substrates for saprophytic fungi. In tropical ecosystem with enormous species-richness of a population of wood decaying organisms would require a certain amount of coarse woody debris (CWD) at certain level of decay.

Wood decaying fungal infection could be aggressive and takes place in three stages namely penetration of hyphae into root system, colonization of the tissues, and degradation of the structures of the host cells (Nandris *et al.* 1987). Infection process involves penetration of the roots either actively by enzymatic digestion of the tissues, or by mechanically, through natural openings or wounds. The authors further stated that tissue penetration is either by perforation and digestion of cell walls or by penetration through pores and pits of the phloem and xylem cells. In the rubber trees (Nandris *et al*. 1987), infection by *P. noxius* creates a very large increase in hydrolytic enzymes activities of glycosidases and polysaccharidaes, compared to *R. Lignosus* effects only in the development of high laccase activity.

In dead wood ecology pathogenic fungal species are often complex of previously undifferentiated taxonomic units that specialize in different ecological conditions (Londale *el al*. 2008), as prevailing in rubber plantations. Dead and decaying wood in rubber plantation serves as a functional requirement for regeneration of a forest plantation occurring when fallen logs decay in-situ. Coarse woody debris is said to be protective seeds of *Picea engelmanli,* and *Abies lasiocarpa* (Zhong and Vander Kamp 1991) as in seedling e.g. *Tsuga Canadensis* (O'Hanion – Manners and Kotonen 2004). This assertion may be applicable to rubber seedlings since the mechanisms, generally have to do with dead wood which is expected to facilitate seedling survival by some provision including moisture retention, mineral recycling, mycorrhizal fungal, biological control of soil – borne pathogens among others. These benefits of the ecology of the deadwood could provide sustainability in the survival and development of rubber seedlings.

Observations in rubber plantations ecosystems in Nigeria, show a positive relationship may exist between CWD size and the number of fruiting species incidence on rubber. The observations may indicate that the number of wood-inhabiliting organisms may increase with CWD size, and Lonsdale *et al*. (2008) stated, the occurrence of relatively few fungal species in large CWD units depicts a combined effects of many factors, such as, the small the size of CWD, the larger the surface are a (per volume) allowing more space for fungal sporocarps. The authors also noted that, on the contrary, the larger the CWD size, the more space for large (macro) fungal species. In certain basidiomycetes such as white, brown, and red root rots of rubber may inhabit wood of certain size before fruitification. The age of plants important role in the determination of the relationship between CWD and the number of fungal species, and also partly related to size of plant. Odor *et al.* (2006) state that the larger the log the longer time it takes to decay hence would allow more time for colonization of different fungal species. Several authors, Niemela *et al.* (1995); Kruys and Jonson (1999), have a wide range of CWD to represent different sizes and stages of decay in order to support species of varying requirement. In the rubber tree, a problem may arise where some fungal species are present endophytocally, such as *R. lignosus* to cause decay only after the tree's death. Seasonal variation in temperature and moisture content are concurrent to influences of more complex wood-colonizing community on decomposition (Progar *et al*. 2000).

3. Management of Deadwood Ecology

The ecology impact in forest ecosystems are basically on management of dead wood retention. Deadwood ecology provides habitat for species-richness wood decaying fungal species. Biodegradation of dead wood by wood decaying fungi is beneficial to the ecological systems as they often provide soil nutrients and regeneration of the forest trees, among others. In rubber plantations in

Nigeria, dead wood (often caused by pathogenic fungi species) management is quite low since sanitation practices are usually never the rule. As a result, dead wood logs left in the plantation serve as sources of inoculums for further infection of healthy trees. This tends to negate the relevance of deadwood decaying fungi in the management of deadwood ecology. However, in the management of forest landscapes, deadwood retention factors are usually considered, where sanitation approaches are the rules, thus the average deadwood volumes in managed forests are low that many species dependent on deadwood are restricted to protected areas. According to Virolainnen *et al.* (2006); Mayer *et al.* (2006). suggested the need to select a network of projected forests with abundance of naturally occurring deadwood required for meeting conservation targets within a given country or supranational region. The authors further stated that ignoring such measures invariably could result in serious decimation even total elimination of the forests. Consequently, the quality of landscaping matrix should be considered in achieving successes in the implementation conservation measures for fungi dependent on decaying wood, a phenomenon common with root rot fungi of the robber wood. Management of deadwood relates conservation significance, certain macrofungal species including those of mainly mycorrhizal fungi and some wood decaying fungal species in some forests are imperatives for the conservation process in a plantation. Kouki *et al*. (2001), have pointed out that negative effects of absence of deadwood result not only due to loss of habitat but also through fragmentation.

4. Maintaining Coarse Woody Debris And Wood Decaying Fungi

The population of wood decaying fungi is maintained when dispersed within old plantation or old growth stand (Komonen 2005), which might be disrupted by forest fragmentation. Conservation measures in this regards may not be achieved if the amount of CWD in managed forests is increased without necessary connecting the forest patches. The level of standing and fallen CWD in the tropical forests and that of the temperate and boreal old-growth forests can be compared in terms of high productivity in the tropics with a positive relationship between productivity and deadwood volumes as in the temperate and boreal forest (Harris 1999; Feller 2003). In the tropical condition, rate of decomposition is higher with higher mean temperatures of tropical forests which often is increased by the activities of termites, and Lonsdale *et al*. (2008)'s study claimed that no evidence to indicate that CWD is more abundant in the tropics.

5. Management of Deadwood

Event arising from devastating effects of pests and diseases of plantation trees leaving loss of tree stands and consequent replacement by continuous supply of deadwood in forests (Harmon *et al.* (1986); Mc Gee 2000. Mcpherson *et al*. 2005) claimed could lead to deadwood management. This continuous supply of deadwood flow is part of ecological status of forests (Peterson 2002). The incidence of damaged trees as in rubber plantation aggravated by human activities is one factor predisposing chronological changes in the incidence and severity of plant diseases much evidenced in many managed forest as in the occurrence of *H. annosum* due to unnatural abundance of cut stump which serves as a selective substrate for this pathogen and similar root rot fungi (Redferm and Stenlid 1998), as well as favouring the growth of Armillaria spp. (Prospero *et al*. 2003).

Wind throw stand gaps as in rubber plantations, in their natural state of development form potentially deadwood island in a CWD deprived matrix (Bouget and Duelli 2004). Ranius and Kindvall (2004) stated that they provide an opportunity to increase deadwood abundance in managed forests faster than can be achieved applying biodiversity oriented silvicultural practices.

6. Possible Effects of Deadwood

The importance of deadwood in a forest plantation has been shown that a forest plantation in their natural state is assessed from the amount of available deadwood (Rouvinen *et al*. 2005); The levels of CWD have also been indicated that it is lower in managed forests than those of unmanaged forest (Guby and Dobbertin 1996; Jenkins *et al.* 2004; Gibb *et al*. 2005), however, without statistical differences. Also, impact of deadwood is significant in forest certification, given the best practice guidelines which encourage the retention of a higher volume of deadwood in managed forests as in rubber plantations. For a viable retention of CWD as well as maintenance of wood decaying fungal population, the classes of CWD from various decay are more evenly represented in plots harvested by best management practices than the usual conventionally harvested plots, in which CWD consists mainly of slash left behind after harvest (McClure *et al*. 2004), a common practice in rubber plantation.

7. Conclusion

What is obvious is that there is imperative necessity for CWD management practices that can achieve a sustainable protection of deadwood biodiversity, while minimizing economic drawbacks to the plantation sector. In a study by Omorusi *et al.* (2008) at the Rubber Research Institute of Nigeria, Iyanomo, rubber trees afflicted by wind storm damage, numerous fallen trees as a result, were subjected to a variety of root rot pathogens infection and bark burrow beetles. The effects of pests in such with throw plantation can have a far reaching consequence for policy of retaining deadwood especially in an unmanaged plantation where population of deadwood decaying fungi is usually not taken cognizance of.

A monoculture like rubber or similar crop, creative catabolic transformation of CWD intso biodiversity, energy CO_2 and nutrients according to Swift (1977) should be enhanced by forest management in equally creative ways. Lonsdale *et al.* (2008) stated that the provision of CWD at an adequate spatiotemporal scale needs to be balanced against log productions, and fire risk in dry climate as in the marginal rubber growing lands in Nigeria for instance. A new trend of a paradigm shift, the morticulture an operation connecting dead and live trees (Harmon 2001) should translate a dead tree per hectre of logged or felled trees to a traditional planting of trees for every new born child (Harris 2001).

The need for active creation of dead trees by cutting tops and girdling (Aulen 1991; Lilja *et al.* 2005) compliments the understanding of interconnections between saproxylic organisms (Torgersen and Bull 1995; Bull and Wales 2001) as noted by Lonsdale (2008). In rubber plantations in Nigeria, morticulture has never been in practice, however, pruning exercises to some extent are carried out (see Omorusi *et al*. 2008) where pruned and fallen trees are logged away with very little logs or deadwood left for a less significant amount of CWD. Forest management in rubber plantation is advocated to enhance moriticulture practice. Standing living trees and fallen trees should be inoculated with wood decaying fungi as has been successfully shown to hasten the development of decay based habitat (Baker et al. 1996; Lewis 1998; Jack *et al*. 2003).

The impact of deadwood would help stabilize the ecology of the forest plantation with much available nutrient flow from wood decaying fungal organisms even in threatened habitat, management and morticulture provide a shift in the restoration and improvement of a forest ecology.

References

1. Allen RB, Buchanan PK, Clinton PW. Composition and diversity of fungi on decaying logs in a New Zealand temperate beech forest. *Canadian Forest Research* 2000; 30:1025-1033.
2. Allen G. Increasing insect abundance by killing deciduous tree - a method of improving the food situation for endangered wood peckers. *Holarctic Ecol* 1991; 14: 68-80.
3. Baker FA, Daniels SE, Park CA. Inoculating trees with wood decay fungi with rifle and shortgun. *West J. Appl. For* 1996; 11:13-15.
4. Berglund H, Jonsson B G. Verifying an extinction debt among lichens and fungi in Northern Swedish Boreal Forest. *Conservation Biology* 2005; 14: 338-348.
5. Bouget C, Duelli P. The effects of wind throw on forest insect communities: a literature review. *Biology Conservation* 2004; 118: 281- 299.
6. Bull EL, Wales BC. Effects of disturbances on Birds of conservation concern in eastern Oregon and Washington. Northwest Sci 2001; 75: 166-173.
7. Delaney M, Brown S, Lugo AE, Torres - Lezema A, Quintero NB. The quantity and turnover of deadwood in permanent forest plots in six life zones of Venezuela. *Biotropica* 1998; 30: 2- 11.
8. Feller MC. Coarse woody debris in the old-growth forest of British Columbia. *Environ Rev* 2003; 11: 5135-5157.
9. Gibb H, Ball JP, Johansson T, Atlegrim O, Hjalten J, Daniell K. Effects of management on coarse woody debris volume and composition in Boreal forest in northern Sweden. *Scan J. For. Res* 2005;20: 213-222.
10. Grove SJ. 2001. Extent and composition of dead wood in Australian Lowland tropical rainforest with different management histories. *For. Ecol. Manage* 2001; 154: 35-53.
11. Grove SJ. 2002. Saproxylic insect ecology and the sustainable management of forest. *Ann. Rev. Ecol. Syst* 2002; 33: 1-23.
12. Guby NAB, Dobbertiri M. Quantitative estimates of coarse wooded debris and standing trees in selected Swiss forest. *Glob. Ecol. Biogeogr. Let* 1996;5: 327-341.
13. Harmon ME, Franklin JF, Swanson FJ, Sollins P, Gregory SV, Lattin JD, Anderson NH, Cline SP, Aumen NG, Sedell JR, Lienkaemper GW, Cromack K, Cummins KW. Ecology of coarse woody debris in temperature ecosystems. *Adv. Ecol. Res* 1986; 15: 133-302.
14. Harris RB. Abundance and characteristics of snags in Western Motana forests. *USDA. Forest Services RMRS GTR* 1999; 31: 1-19.
15. Harris RB. Observations on the use of stubs by wild birds: a 10-year update. *J. Ecosyt. Manage* 2001; 1: 19-23.
16. Jack SB, Park CG, Stober JM, Engstorm RT. Inoculating.Red heart fungus (*Phellinus pint*) to create nesting habitat for the red- cockaded Woodpecker. In: *Proceedings of the Red cock added Woodpecker Symp* 2003; 1-18.
17. Jenkins MA, Webster CR, Parker GR, Speitch MA. 2004. Coarse woody debris in managed central Hardwood Forests of Indiana, USA. *For. Sci*. 50:781-792.

18. Komonen A. Local spatial pattern in the occurrence of two congeneric wood-decaying fungi in an old growth boreal forest. *Scand J. For. Re* 2005; 20: 393-399.
19. Kouki J, Lofman S, Martikainen P, Rouvien S, Uotila A. Forest fragmentation in Fennoscandia: Linking habitat requirements of wood associated threatened species to land Scape and habitat changes. *Scand. J. For. Res* 2001; 16:27-37.
20. Kruys N, Jonsson BG. Fine woody debris is important for species-richness on logs in managed boreal spruce forests of northern Sweden. *Ca. J. For. Res.* 1999; 29: 1295-1299.
21. Lewis C. 1998. creating snags and wildlite trees in commercial forest landscapes. *West J. Appl. For.* 13(3):97-101.
22. Lilja S, De Chantal M, Kuuluvainen T, Vanha-Majamaa I, Puttonen P. 2005. Restoring natural characteristics in managed Norway spruce (Picea abies (L.) Karst.) stands with Partial cutting, dead wood creation and fire: immediate treatment effects. *Scand J. For. Res* 2005; 20(6): 68-78.
23. Lonsdale D, Pautasso M, Holdwnrieder O. Wood-decaying Fungi in the forest: conservation needs management options. *Eur J. Forest Res* 2008; 127-22.
24. Mayer AL, Kauppi PE, Tikka PM, AngelismPK.Conservation implications of exporting domestic wood harvest to neighbouring countries *Environ. Sci. Polut* 2006; 9: 228-236.
25. Mc Clure JM, Kolka RK, White A. Effect of forest harvesting best management practices on coarse woody debris distribution in stream distribution in stream and riparian zones in three Appalachian watersheds. *Water Air Soil Pollut* 2004; 4: 4: 245-261.
26. McGee GG. 2000. Stand-level effects on the role of decaying logs as vascular plant habitat in Adirondack northern hardwood forests. *J. Torrey Bot. Soc* 2000; 128: 370-380.
27. Mcpherson BA, Mopri SR, Wood DL, Storer AJ, Svihra P, Kelly NM, Standford RB. Sudden oak death in Califonia, disease progression in oaks and tanoaks. *For. Ecol Manage* 2005; 213: 71-89.
28. Nandris D, Nicole M, Geiger JP. Root rot diseases of rubber trees. *Plant Disease* 1987; 71(4): 298-306.
29. Niemela T, Renvall P, Penttila R. Interactions of fungi at Late stages of wood decomposition. *Ann. Bot. Fenn* 1995; 32: 141-152.
30. O'Hanlon-Manners DL, Kotanen P.M. Logs as refugas from fungal pathogens for seds of eastern hemlock (Tsuga Canadensis). *Ecology* 2004; 85: 284-289.
31. Omorusi VI, Ogbebor NO, Evueh GA. 2010. Evaluation of Hevea brasiliensis clonal resistance to wind damage in Nigeria. *J., Ani. And Plt. Sci.* 2010; 6(3): 724-728.
32. Otoide VO. Further observations on the pre-treatment of forest trees for root disease control. In Hevea plantings. Paper presented at RRIN Seminar, 1978; 7pp.
33. Peterson GD. Contagious disturbance, ecological memory, and the emergence of landscape pattern. *Ecosystems* 2002; 5:329-338.
34. Piepenbring M, Ruiz-Boyer A. Diversity and ecology of fungal in the Golfo Dulce region. *Eur. J. Forest Res* 2008; 127: 1-22.
35. Progar RA, Schowalter TD, Freitag CM, Morrel JJ. Respiration from coarse woody debris as affected by moisture and saproptroph functional diversity in Western Oregon. *Oecologia* 2000; 124: 426-431.
36. Prospero S, Holdenrieder O, Rigling D. Primary resource capture in two sympatric. Armillaria species in managed Norway. Spruce forests. *Mycol. Res* 2003; 107: 329-338.
37. Ranius T, Kindvall O. Modeling the amount of coarse woody debris produced by the new biodiversity-oriented silvicultural practices in Sweden. *Bio.Conserve* 2004; 119:51-59.
38. Redfern DB, Stenlid J. Spore dispersal and infection. In: Wood-woard. (S.Stenlid, J. Karjalainen, K. Huttermann. eds) *Heterobasidion nosum:* biology, ecology, impact and control. CABI, Wallingford 1998; 105-142.
39. Rouvinen S, Rautiainen A, Kouki J. A relation between historical forest use and current dead wood material in a boreal protected old-growth forest in firiland. *Silva Fenn* 2005; 39: 21-36.
40. Simila M, Kouki J, Monkkonen M, Sippola AL, Huhta E. Covariation and indicators of species diversity: can richness of forest dwelling species be predicted in northern boreal forest? *Ecol. Indic* 2006; 6: 686-700.
41. Swift MJ. The ecology of wood decomposition. *Sci. Prog* 1977; 175-199.
42. Torgersen TR, Bull EL. Down logs as habitat for forest dwelling ants-the primary prey of pileated woodpeckers in North Eastern Oregon. *Northwest Sci*. 1995; 69: 294-303.
43. Virolainen KM, Ahiroth P, Hyvarien E, Korkeamaki E, Mattila J, Paivien J, Rintala T, Suomi T, Suhonen J. 2000. Hot Spots, indicator taxa, complementarity and optimal networks of taiga. *Proc. R. Soc.Lond* 2000; 13. 267:1143-1147.

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