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FOREST DIE-BACK AT RAJAWAKA FOREST RESERVE AT BALANGODA: RESULTS OF PRELIMINARY OBSERVATIONS

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INTRODUCTION

Dieback of tropical Upper Montane Rain Forests (UMRF) has become a severe environmental problem in Sri Lanka. This phenomenon has been observed in UMRF of Horton Plains National Park (HPNP) (Perera, 1978; Werner, 1982; Hoffman, 1988), Pidurutalagala ridge, Kobonilgala near Cobet's gap in Knuckles range (Werner, 1988) and at summits of Hakgala Strict Nature Reserve (SNR) (Wijesundara, 1991). De Rosayro (1946) has also reported the unhealthy nature of UMRF in Sri Lanka. Adikaram and Mahaliyanage (1999) found that 38% of the trees in HPNP were either affected or dead. These authors observed that more than 90% of canopy trees on the Thotupolakanda ridge in the Horton Plains, about 75% of the Hakgala peak and a considerable number of trees in Riversturn area of the Knuckles range have already died. Most of the Sri Lankan experiences of forest die back has limited to the area of Montane forests which are above 1000 m from MSL. However, there is lack of information available on forest dieback in lowland forests, elevation especially below 1000 m from MSL. Field visits by the authors recently observed that many species of trees are dead or dying rapidly in the part of the Rajawaka forest reserve, which is located as lowland forest below 500 m from MSL near Balangoda region. The survey revealed that Rajawaka forest reserve was affected by dieback phenomenon, which was not given sufficient attention by the scientific community until this study.

The present study focused towards identifying the cause/s for forest dieback in Rajawaka forest while identifying the species specific subjected to die back. The main objectives were mainly;

(i) identify the vegetation susceptible to die-back in the Rajawaka Forest reserve
(ii) identification and documentation of symptoms and find out the possible cause/s for forest die back in Rajawaka forest reserve

METHODOLOGY

The standard sampling method was used to study the vegetation of the affected area of the Rajawaka forest. Dieback areas were identified using randomly selected 100 m long and 5 m wide belt transects. Measurements were done along the centre-line using a brightly-coloured nylon rope. Three complete transects were sampled during the last 12 months. Specimens of unidentified species were collected and numbered for subsequent identification at the National Herbarium, Peradeniya. The stratification, GBH and defoliation of trees, discoloration of foliage, the crown condition and living states at branches were recorded using the field template using the method adopted by Worboys (2006). The important quantitative analyses such as relative density, relative frequency of tree species and the value index were determined. Plant materials were collected from 20 m x 20 m blocks associated with main transects. Within a block, healthy and diseased trees were examined and recorded. The close-up examination of trees and plant parts was done considering the distribution of symptoms in individual trees. The soil around the selected trees was cleared away and the collar and roots

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were examined (both healthy and affected trees). Soil samples were collected around roots of selected healthy and diseased (dead or dying) trees to the depth of 10 cm and transported to laboratory in air tide bags. Samples of diseases roots, healthy roots, diseases stems, fruiting bodies of fungi, were collected and transported to laboratory in order to examine the relationship of dieback and the root depth. Laterally distributed and deep penetrated roots from at least two plant samples each from each GBH classes were selected in each block.

RESULTS AND DISCUSSION

Out of fifty two (52) tree species found in the area belonging to twenty eight (28) families, considerable dieback phenomenon in the Rajawaka forest was observed in six (06) families. Fifty eight percent (58%) of the *Mesua ferrea* (*Naa*) trees were affected and from which 72% were completely dead. This would be the first time in Sri Lanka that such a large number of *Mesua ferrea* trees were reported to be death in a natural forest. Eighty percent (80%) of the dead *"Naa"* trees were relatively large and included in 150 cm – 250 cm GBH in range (Fig.1). Other than *Mesua ferrea* trees, 19% of the *Palaquium hinmolpedda* trees were also affected from which 50% were completely dead. Few affected species for dieback was confined to the families of *Melastomatacea, Myrtacea* and *Clusiaceae.* It is important to note that higher percentage of dieback trees was observed in the upper GBH classes.

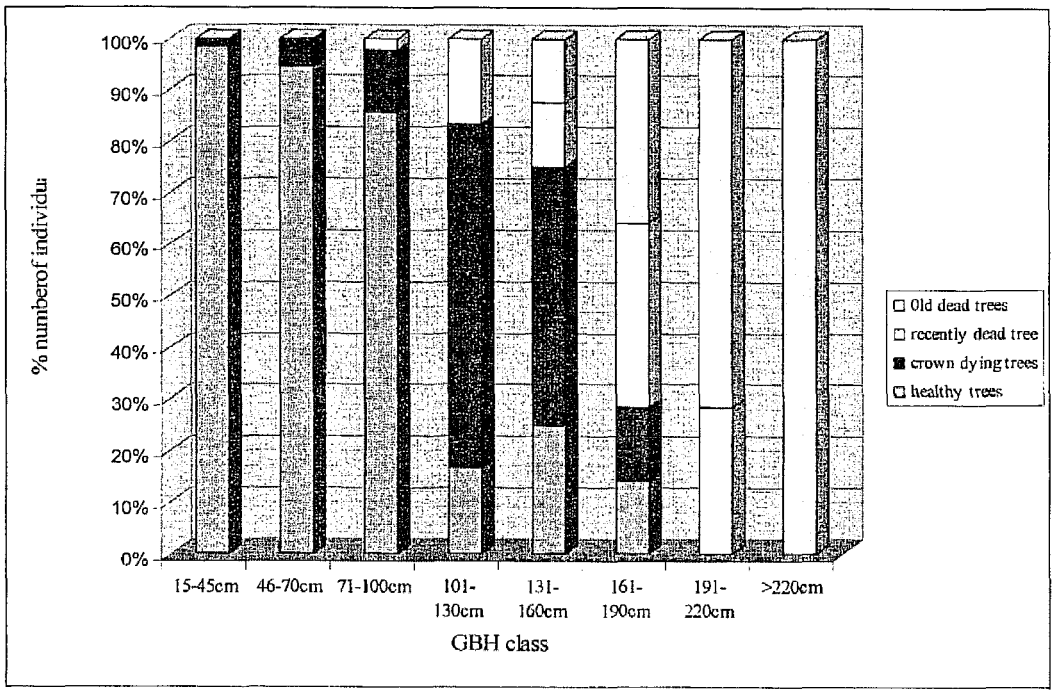

Fig. 1: Percentage Individuals Belonging to Different Dieback States in each GBH Class

The study shows that the proportion of recently dead trees and old dead *Mesua ferrea* trees *(Naa)* were recorded near similar numbers. Dieback occurred in mostly among old and canopy trees probably due to drastic opening up of the canopy. *Naa* is the most important species in forests of wet and intermediate zones as well as revering forests and is a National tree of Sri Lanka. The species seems to be under threat and large numbers of dead trees were seen in the Rajawaka forest reserve. It is the first time that the dieback of *"Naa"* trees was reported in Sri Lankan lowland forests. These trees are native to tropical Sri Lanka but also cultivated in Assam, southern Nepal, Indochina, and the Malay Peninsula (Hinrichsen, 1987). It is a tall tree reaching up to 30 m tall, often buttressed at the base with a trunk up to 2 m in diameter. It is common in wet zone at Sri Lanka up to 1500 m. It has simple, narrow, oblong, dark green leaves 7–15 cm long, with a whitish underside; the emerging young leaves are red to yellowish pink and drooping. The flowers are 4–7.5 cm diameter, with four white petals and a centre of numerous yellow stamens.

Two species of pathogenic fungi, namely *Rigidoporus lignosus* and *Gonorderma* spp. were found in diseased plants. *Rigidoporus lignosus* is well-known for destructive white root disease fungus that causes destructive damage to numerous living forest trees (Pichel, 1956; Nandris et al., 1985). Symptoms observed above the ground on diseased trees were wilting, yellowing of leaves, loss of leaf lustre, bark shrinkage, canopy gaps, defoliation and dieback. When it is observed below the ground, white rhizomorphs was observed on the root surface, adhering strongly to the surface of the root bark. The fruiting bodies of *Rigidoporus lignosus* and *Gonorderma* species were found in 80% of dead trees on stems and roots of the dead trees. Ninety percent (90%) of these were old *Mesua ferra* trees, which were observed as the most susceptible to white root disease compared to other species in this survey. The fresh *Rigidoporus lignosus* fruiting bodies were broad shaped, leathery, and without stalk. Edges of the fruiting bodies sometimes form a definite, bright yellow, or yellowish-white rim occurred in some times. When the fruiting bodies dry out, the colour becomes duller, the upper side turns pale yellowish-brown, the bottom side red-brown, the yellow colour of the rim fades away, and the edge turns downwards. According to root depth results, it was observed that lateral root system of affected trees was mostly confined to the upper 50 cm of the soil. The affected trees such as *Mesua ferrea, Palaquium hinmolpedda etc.* consists of lateral roots, which are close to the uppermost surface. Dieback of the Rajawaka forest has reportedly been aggravated in the last 15 years due to abnormal fungal growth of *Rigidoporus lignosus*, especially in trees of *Mesua ferra.* The root systems of *Mesua ferra* trees were found near the ground surface and lateral roots of diseased neighbouring trees were in close contact each one. It was frequently observed that, the trees were dying in shape of cercal patches and the infected trees spreader to adjacent trees through root contact. Similar phenomena have been reported by Nandris *et al.* (1987), who stated that the white root fungal mycelia strands or rhizomorphs grow rapidly and may extend several metres in the absence of any woody substrate and can infect the root of the healthy trees. Moreover, the root of the healthy trees are infected by rhizomorph growing from stumps, infected wood debris buried in the ground as well as by roots in contact with those of a diseased neighbouring tree. Kolek and Kozinka (1992) described the lateral roots are highly important in the purpose of water absorption of plants comprised of large number of hairs. Any damages to lateral roots may cause adverse effect to trees. It is clear that external factors may lead to the growth of fungus mentioned above abnormal soil moisture. Toussoun *et al.*, (1970) found that Fomes lignosus (*Rigidoporus lignosus*) is most severe in wet soils and producing more and larger mycelial strands as moisture levels increase. This study also reveals that the soil moisture content of the study area was higher and cause to rapid growth of fungus of *Rigidoporus lignosus*.

Rajawaka has been identified as one of the major catchment for the Samanalawewa reservoir. The water network of the area shows that after impounding the natural water flow due to construction of Samanalawewa reservoir the groundwater level may increase considerably from 400 m MSL into 430 m MSL in the Samanalawewa catchment (Laksiri, 2007). According to the monitoring results, behaviour of groundwater levels in the surrounding wells was observed to the similar behaviour irrespective of the location. The dieback problem was aggravated in the last 15 years after the construction of Samanalawewa reservoir, which facilitates higher soil moisture content of area and develop the fungal growth.
The relationship of fungal growth and water flow system in the area, as observed by many previous workers, could also be applied for Rajawaka forest.

CONCLUSIONS

This study revealed that eleven (11) plants species were susceptible to dieback in the Rajawaka reserve. Out of the 6 families were severely affected namely *Mesua ferrea, Palaquium hinmolpedda, Melastomatacea, Myrtacea* and *Clusiaceae and Melastomatacea.* This is the first time that such a large number of die back of *Mesua ferrea* was reported from a natural forest reserve.

Field and experimental evidence showed that two pathogenic fungi [*Rigidoporus lignosus* (Klotzsch) Imazeki and *Gonorderma* spp.] were the main cause for dying trees in Rajawaka forest, and which affected relatively larger trees than the smaller trees. The affected trees are mainly composed of lateral roots, which are located close to uppermost surface. These roots were believed to be attacked by fungi, which could easily grow in water saturated environments. Construction of Samanalawewa reservoir in 1990, could well increased the groundwater table at least by 30m. The soil moisture in the surroundings had facilitated the fungal growth. As a result of dieback phenomenon, rapid and drastic change of forest structure had occurred replacing many invasive species in the process. Further studies would continue to identify the cause/s behind the fungal growth to preserve existing plants in the Rajawaka forest reserve.

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