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Response to MM46 protection of biodiversity value - why fungi must be considered!

As a professional ecologist with over 50 years of association with the ancient woodlands of Epping Forest, I am especially concerned that so little attention has been given to the invaluable role played by the exceptional range of fungi within Epping Forest as they provide essential support to the vegetation, especially the ancient pollards which are a unique feature and the main reason for the Forest's designation as a Special Area of Conservation. Their status within any assessment for biodiversity must not be ignored.

The association of certain fungi with specific trees has been known for a number of years, such as the Fly Agaric with Birch trees, but the breakthrough discovery was made by Suzanne Simard whose research work the late 1990's led to the discovery that trees within woodlands share and trade food via the fine thread like fungal networks within the soil that connect their roots. The term the wood wide web has now become widely accepted, (Simard, 2021) and consists of fine tubes called mycorrhiza along which food, water and chemicals are moved between individuals. Large vigorous trees can send food and water to struggling trees elsewhere in the woodland!

The host plant supplies synthesised food materials via its roots to its associated fungi in exchange for water and minerals. As 80% of plant species have this beneficial or symbiotic association with one or more fungal species this is the hidden value of fungi within all ecosystems. As some of the fungi involved do not produce a recognisable above ground fruiting body, they are difficult to detect other than by DNA profiling. This association is mutually beneficial and those species which are involved are termed ectomycorrhizal

Tree age and species diversity influences the range of species of these ectomycorrhizal (ECM) fungi. There are significant differences between ancient woodlands and more recent plantations. The long term stable conditions and well established undisturbed soil of ancient woodlands support a greater diverse range of fungi, with lists of 900 or more species for such sites being considered a good target (Evans, Marren and Harper 2014).
Some 1,600 species are listed for Epping Forest as its fungal assemblages have been studied since the mid 19th century and this list continues to increase with new species being added year on year (CoL Epping Forest Committee Reports). Some species are rare including a number which are on the UK Red Data list. Some of these are only found feeding on the decaying woods within its ancient trees. The list also includes an excellent range of the ECM fungi, the ones vital to the maintenance of healthy trees and other plants within the SAC.

It is difficult to assess the overall status of many species of fungi as those which produce visible fruiting bodies such as toadstools, only do so when the conditions are favourable e.g. after a warm summer and periods of rain! These fruiting bodies release spores so propagating the species.

However, those vital ECM species which grow within the woodland soil are under threat from increased visitor pressure as more trampling compacts the soil, damaging and fragmenting the wood wide web so it becomes less efficient at supporting the trees and other plants which rely on this fungal network for water, minerals and protection of pathogenic or

harmful fungal species. Illegal foraging is also an issue as this removes edible fruiting bodies which are a source of food for animals such as deer, slugs and certain insects.

The Impact of Pollutants on the SAC of Epping Forest causing distrubances to its biodiversity

Since the 1940s the increased use of nitrogenous fertilisers on agricultural land, fungicides and the combustion of fossil fuels have added chemicals to the air, to land surfaces and to water courses. The UK's National Ecosystem Assessment (2011) and the 2016 State of Nature Report flagged up that atmospheric nitrogen deposition was one of the top two drivers of change in plant diversity, which in turn impacts on fungal diversity. In 2014 90% of SACs including the Epping Forest SAC received excessive levels of nitrogen (RoTAP, 2012). More recent information can be found on APIS mapping interface Site Relevant Critical Loads. All the records show very high levels of nitrogen deposition the SW of the Forest. It is crucial to recognise that the prevailing winds blow from westerly directions so air borne pollutants from London will reach the Forest.

In the publication We Need to Talk about Nitrogen, produced by Plant Life, the authors discuss this problem, (Plantlife 2014). Sulphur and nitrogen deposition can change soil pH and alter the chemical balance of nitrogen and carbon within the soil. The fungal composition of woodlands which receive excessive input of nitrogen is altered with beneficial ECM species being outcompeted by those which are more tolerant of pollution, (EA, 2019). The changes in species composition may include a higher incidence of more aggressive pathogenic species as a good range of ECM species within soils tend to suppress the growth of some pathogens, (Quine, 2019).

As the total species richness below ground greatly exceeds the diversity of plants above, there now is more focussed research about the impact of pollutants on the soil microbiome too, (EA 2019). Natural England is working alongside the Forestry Commission, the National Trust and the farming community to make recommendations about limiting the impact of nitrogen deposition on sensitive sites such as the ancient woodlands of Epping Forest.

Whilst monitoring nitrogen deposition alongside roads is helpful, these toxic chemicals diffuse across the whole of the Forest and their impact can be monitored by bio-indicators such as lichens which are tolerant to high levels of this gas. The widespread presence the *Trentepohlia* sp,, a bright orange alga on the bark of many trees his visible on the bark of a number of trees located some distance from roads through the Forest.

Poor air quality from traffic fumes is exacerbated by the production of the toxic gas Ozone O_3 during hot sunny days. This gas drifts long distances through the atmosphere and it tends to be concentrated in the more rural areas especially around woodland canopies. In the UK, Lowland beech and yew woodlands are in areas where ozone concentrations were moderate to high. (SNIFFER., 2007).

This toxic gas interferes with the ability of foliage to photosynthesise with a reduction in carbohydrate synthesis (Ainsworth 2012). Since at least 20% of these carbohydrates are passed on to the tree's supporting mycorrhizal associates, the efficiency of these fungi may be reduced as they receive less food. There is much current research about this topic as there are so many variables to be considered. Using abundance of fruiting bodies can show some trends but changing weather patterns add another variable to be factored in, but there is

increasing amounts of evidence of a reduction in the quantity of fruiting bodies of certain ECM species.

Healthy trees produce chemicals which discourage attack by defoliating insects, those trees which are struggling as a result of damage by pollutants are more likely to be eaten as their ability to produce these chemicals is reduced. In recent years many of the Forest's ancient Beech trees have suffered serious defoliation by millions hungry Beech weevils *Orchestes fagi* which reduced the ability of these trees to photosynthesise as the leaves lost at least a third of their total area to damage by the hungry weevil larvae. This season has seen the majority of this summer's Lammas shoots on the Forest's mature Oaks being covered by Oak Mildew *Erysiphe alphitoildes* which reduces the ability of this new growth to photosynthesise. As these two major tree species are underperforming, their supporting network of fungal species will be less efficient too!

There is no monitoring by EFDC of PM2.5 locally. These fine particles have an impact on vegetation and the fungi associated with them.

Vehicle tyres and brakes release toxic heavy metals alongside roads which will be washed into the surrounding soils. Certain species of fungi accumulate these in their fruiting bodies so any creature eating these will ingest them too! More research on the impact of these toxic chemicals is required to ensure that the soil biome continues to flourish as this underpins the health of the Forest's vegetation.

In conclustion I feel that it is impossible to ignore the vital role that many fungi play in supporting the health of the trees and other vegetation in the Forest. It is highly unlikely that any mitigation measures proposed will be successful in reducing irreversible damage to these and other life forms which are found within the SAC of Epping Forest.

I do not consider this Main Modification to be sound.

Tricia Moxey

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