Norfolk observations of bracket fungi communities on Birch *Betula* spp.

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Introduction

Birch Polypore *Fomitopsis betulina* (formerly *Piptoporus betulinus*) and Hoof Fungus *Fomes fomentarius* (Figs. 1 & 2) are distinctive species of bracket fungi that are commonly found on birch trees (*Betula spp.*), exclusively so in the case of the former. In August 2022 CD mentioned that he had seen two birch trees at Mousehold Heath in Norwich with fruiting bodies of both Birch Polypore and Hoof Fungus (Fig. 3). This was in contrast to all of the other birch trees with bracket fungi present, which only displayed fruiting bodies of one species or the other. JE agreed that his experience in Norfolk was also that he typically only found a single species of bracket fungus per birch trunk, albeit with the caveat that he did not come across Hoof Fungus very frequently. Following this exchange, CD wrote a short note about the find for the Norfolk & Norwich Naturalists' Society quarterly newsletter The Norfolk Natterjack (Durdin 2023).

Figure 1 – Birch Polypore (James Emerson)

Figure 2 – Hoof Fungus (James Emerson)

In December 2025 CD was again at Mousehold Heath, and this time noticed five birch trees (a mixture of fallen and upright trunks) that held both Birch Polypore and Hoof Fungus. He also noted that it felt like the latter species was now more numerous at the site, including many small fruiting bodies (suggesting recent growth). This increase in the number of trees with both species suggested that perhaps their combined presence wasn't particularly unusual, however as these observations only involved small numbers from a single site, it was felt that a wider range of observations and further research would be useful to draw firmer conclusions.

Figure 3 – A birch trunk at Mousehold Heath showing Birch Polypore growing on the left and Hoof Fungus growing lower down and on the right (Chris Durdin).

Potential explanations why birch trunks would seem to host only a single species of bracket fungus

Four theories that could explain the observations that only one species of bracket fungus tended to occur per birch trunk were considered:

1) Direct inhibition by the first colonising species – whichever species establishes first within the trunk might inhibit the growth of other species of fungi by some mechanism (for example the secretion of anti-fungal chemicals)
2) Direct inhibition by a dominant species – one of the two species might be able to inhibit the other in a dominant manner whenever present, causing the second species to fail to produce fruiting bodies
3) Indirect inhibition – as both species can rot wood, the condition of the tree caused by the first colonising species might make it unsuitable for colonisation by a second species.
4) There is no significant inhibiting effect and the observations can be explained by the relatively recent colonisation and low abundance levels of Hoof Fungus in Norfolk.

The best way of investigating these interactions would be in a lab, by adding cultures of the two species to sterilised birch wood. This level of investigation is however beyond the time and expertise available here, so instead the focus was on the reading of existing literature combined with field observations.

Distribution and abundance in Norfolk

Birch Polypore is very common in Britain, and in Norfolk alone there were 1009 records from 248 sites by the end of 2024 (Fig. 4, NSFG 2026), all of which were on birch. In contrast, although Hoof Fungus was known to be present in Norfolk around 100,000 years ago as a result of a sub-fossil discovered at Shropham (Leech 2019), in recent times Hoof Fungus has only been recorded in Norfolk since 2007, when it was recorded from Roydon Common and Dersingham Bog in the west of the county. It has however spread widely in Norfolk since then, with 330 records from 88 sites (Fig. 5, NFSG 2026), although it is still probably commonest in the west around the area where it first established. Birch is the primary host of Hoof Fungus in Norfolk, although in Europe it readily utilises Beech *Fagus spp.*

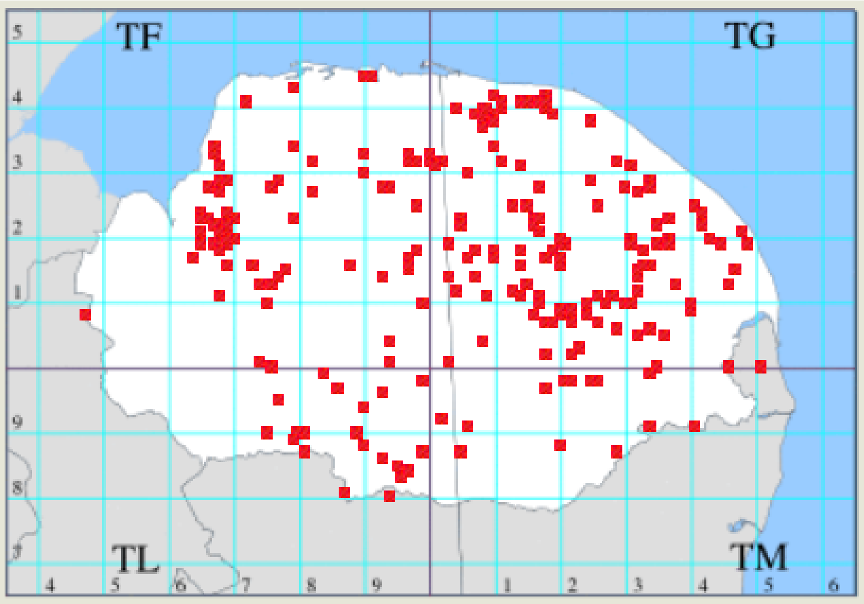

Figure 4 – Distribution map for Birch Polypore featuring records to the end of 2024, taken from the Norfolk Mycota (the online database of the Norfolk Fungus Study Group)

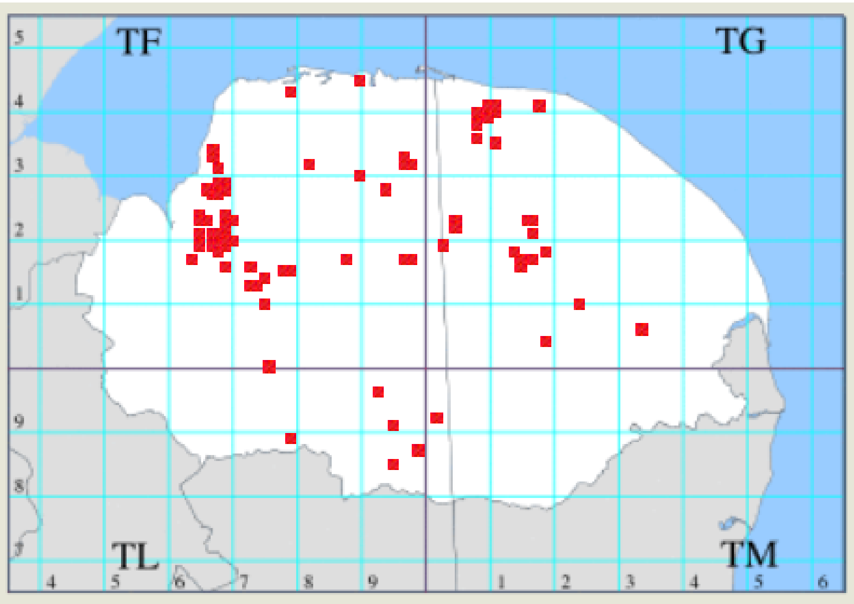

Figure 5 – Distribution map for Hoof Fungus featuring records to the end of 2024, taken from the Norfolk Mycota (the online database of the Norfolk Fungus Study Group)

Relevant research on interactions between bracket fungi

Wood-decaying fungi are typically grouped into three categories based on the type of rot that they cause. Brown rotting species use cellulolytic enzymes to degrade cellulose and hemicellulose, but do not contain enzymes that break down lignin. They also use a non-enzymatic degradation process known as the Fenton reaction to help break down polysaccharides within cell walls (Sugano 2022). White rotters contain both cellulolytic and lignin-degrading enzymes, and as a result can degrade cellulose, hemicellulose and lignin. The other category is soft rot, which tends to occur in wood with a lower lignin content and in damp conditions (Srivastava *et al*. 2013)

There appears to be little research covering any direct interactions between Birch Polypore and Hoof Fungus, however there are many papers detailing interactions of other species, along with related topics such as bacterial communities associated with wood-rotting fungi. Birch Polypore is known to cause ‘brown rot’, whilst in contrast Hoof Fungus causes ‘white rot’, degrading all three cell wall components (Haq *et al*. 2022). Hoof Fungus is known to occur as both a parasite on living trees as well as an early coloniser of dead wood (Bosch *et al*. 2024). In a report investigating and comparing the bacterial communities associated with types of rot in birch wood, Hoof Fungus was found to account for 66.84% of lignin decomposition but relatively little decomposition of hemicellulose, whilst Birch Polypore preferentially decomposed holocellulose. These differences in decomposition resulted in different pH values for the remaining wood, with wood decomposed predominantly by brown rotting Birch Polypore pH 2.9, significantly lower than white rotting Hoof Fungus at pH 4.0 ($P < 0.05$) (Haq *et al*. 2022). These differing pH values in turn influenced bacterial communities on wood hosting either species.

Studies looking at the interactions between wood-rotting fungi have found that some species are able to replace the mycelium of other species and others co-occur in a state referred to as ‘deadlock’ (Boddy 2000). Sometimes the order of colonisation reflects how dominant a fungus is, with initial colonising species (primary colonisers) usually only causing limited rot before being displaced by early secondary colonising species. The most combative/dominant fungal species then arrive and are referred to as late secondary colonisers or end-stage colonisers (Hiscox *et al.* 2016).

Investigations into the interactions between a range of brown and white rotting fungi species featuring Birch Polypore (but unfortunately not Hoof Fungus) suggested that Birch Polypore is likely to be one of the less dominant of the brown rotting species (Owens *et al*. 1994). When grown in paired culture with eight other brown-rotting fungi, Birch Polypore only replaced one, *Coniphora puteana*. It reached deadlock with *Fistulina hepatica*, *Gloeophyllum sepiarium, Lentinus lepidius* and *Laetiporus sulphureus*, but was replaced by *Gloeophyllum trabeum*, *Neolentinus lepideus* and *Poria placenta*. During further experiments pairing brown-rotting species with white-rotting species, Birch Polypore did not replace any of them, reaching deadlock with *Phanerochaete chrysosporium*, *Schizophyllum commune* and *Trametes versicolor* and being replaced by *Bjerkandera adusta, lrpex lacteus* and *Phlebia brevispora*. Similar outcomes were found by Fukasawa *et al*. (2020), who found that Birch Polypore replaced *Vuilleminia comedens* and *Coniophora puteana* regardless of the volumes present, but the result against Turkeytail *Trametes versicolor* varied depending on the volume of material of each. As a result, they classified Brich Polypore as an early secondary coloniser.

Research into wood-rotting fungi has demonstrated that antagonistic interactions can occur when the mycelium of different species come into contact with each other. In Evans et al. (2008) it is suggested that all basidiomycetes are capable of producing volatile organic chemicals (VOCs) which diffuse through their substrate and can produce effects on the mycelium of other fungal species present. In their particular research, they chose four wood-rotting species, three of them bracket fungi - Turkeytail *Trametes versicolor,* Bleeding Oak Crust *Stereum gausapatum*, Smoky Bracket *Bjerkandera adusta* plus the gilled species Sulphur Tuft *Hypholoma fasciculare,* and grew them on agar plates, monitoring the production of VOCs. They found that VOC production was both species and interaction specific, with Turkeytail replacing Bleeding Oak Crust, reaching ‘deadlock’ with Smoky Bracket but being replaced by Sulphur Tuft.

Interestingly, especially given the changing climate, abiotic factors such as temperature have also been shown to affect the interactions between fungal colonisers (Hiscox *et al*. 2016). A group of eight wood rotting fungi associated with Beech were paired and interactions studied at a range of temperatures, with nine out of 21 interactions showing different outcomes depending on the temperature. These outcome shifts included moving from deadlock to one species becoming dominant, but also a reversal in dominance.

Request for records

Norfolk has an active fungus study group, with members submitting thousands of fungus records each year for addition to the county database. Whilst the submission spreadsheet includes fields for additional information beyond the core biological record fields (what/where/when/who) such as substrate and associated organism, it is not designed to capture the sort of specific information such as what other fungi were growing on the same tree trunk (although if an observer considered it of interest then it can be included in the comments column). As a result, existing records of both Birch Polypore and Hoof Fungus could not supply information about the two species regularly occurred together. Instead, JE put out a request on the Norfolk Fungus Study Group Facebook group, asking group members to look out for birch trees with both species.

The most useful sightings were likely to come from West Norfolk, where Hoof Fungus was first (re)discovered in Norfolk and has therefore been present alongside Birch Polypore for the longest period of time. Fortunately one person to get in touch was Jenny Kelly, a fungus group member from West Norfolk. She said that anecdotally she regularly saw Birch Polypore and Hoof Fungus growing on the same tree trunk, however typically at either end of it. Jenny kindly followed this up by noting and photographing examples in the months that followed the request for sightings. Additional information was supplied by Irene Boston and Ian Senior, and is listed below by site:

<u>Beetley, New Plantation Wood</u>

Hoof Fungus *Fomes fomentarius* noted on a dead Silver Birch tree along with Birch Polypore *Fomitopsis betulina* and also Blushing Bracket *Daedaleopsis confragosa* – Norfolk Mycota, record from Ian Senior.

<u>Ingoldisthorpe Common</u>

"Most birches had either Hoof or Birch Polypore. Here are two birches arising from a common trunk. One side has Hoofs and the other Polypores. I also found a tree with Hoofs at the bottom and Polypores at the top"

Figure 6. Photo: Jenny Kelly

Ken Hill Woods

"Birch polypore and Hoof fungi growing on one tree at Ken Hill Estate today"

Figure 7. Photo: Jenny Kelly

East Winch Common

"Several birches had both Hoof and Birch Polypore yesterday at East Winch Common yesterday."

Figure 8. Photo: Jenny Kelly

Figure 9. Photo: Jenny Kelly

<u>Roydon Common</u>

"Quite a few birches (both standing and fallen) in the Extension woods at Roydon (from the eastern car park) with both hoof and polypores today."

Figure 10. Photo: Irene Boston

Conclusions

The number of observations of Birch Polypore and Hoof Fungus growing together at a range of sites strongly suggests that of the explanations proposed for the lack of sightings in East Norfolk, the fourth one is the most relevant, i.e. it can be explained predominantly by the relatively recent spread of Hoof Fungus and its presence at fairly low levels in most woodlands where it is present. Research suggests that dominant rotting species of fungus seldom colonise first and prevent future colonisation, and further that Birch Polypore is not a dominant rotting species, so the first and second proposed explanations seem unlikely. The third suggested explanation, that indirect suppression might occur as a result of changes in the wood caused by the initial rotting fungus has some merits, thanks to work demonstrating changed in wood pH and bacterial communities, and this might partly explain why in a woodland environment with large amounts of birch, single-species trees are found most frequently. However, given that this pair of species preferentially decompose different components of the wood, they are likely to occupy different decay columns within the tree and the mycelium of each is less likely to come into direct contact until both are established.

Possible further work

The sightings included here represent an indicator of presence, but not of how often interactions are occurring. A suggested improvement would be to visit an area of woodland where both fungal species occur, define a large area of it and count all the trees with one or other fruiting bodies, both or neither. From this data you could then calculate the percentage of trees infected by each fungus, then calculate the probability of a tree being infected by both species if the infection is random and not determined by any kind of interaction.

Acknowledgements

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