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Ecological Adaptation of the Wood-Rotting Polyporaceae*

ANJALI ROY

Department of Botany, Visva Bharati University, Santiniketan 731235

Polyporaceae are mostly wood-inhabiting fungi that utilize components of wood cells as their main source of energy for growth and reproduction. Wood consists mainly of three components : cellulose, hemicellulose and lignin. According to the type of the rot produced in wood after decay and degradation, wood rotting fungi are broadly classified into two groups-brown rot fungi and white rot fungi. Some fungi by means of the enzymes secreted by them breakdown the cellulose components of wood, the lignin part remaining as residue. Lignin is not degraded because these fungi lack the ability to secrete lignin breaking enzymes. As a result after breakdown of wood the lignin part remains as residue and the wood appears as brown cubical chunks. These are brown rot fungi. They give negetive oxidage reactions in the laboratory with phenol oxidase, gum guaic and syringaldazine. On the other hand, there is another group of fungi which degrade totally cellulose and lignin components of wood so that the wood at the advanced stages of decay becomes spongy or laminated and the wood appears somewhat bleached in outlook. These are white rot fungi and they are able to secrete both the cellulose and lignin breaking enzymes. In laboratories also they give positive reactions with phenol oxidases, gum guaic and syringaldazine.

From a survey of data it is apparent that in every country the brown rot fungi are relatively fewer in number than the white rot fungi. Moreover, world record of distribution of the wood-rotting fungi shows that with a few exceptions the brown rot fungi are associated with conifers while the white rot fungi are more common on deciduous hardwoods. The conifers generally occupy a boreal or high elevation habitat where the temperature is low, the growing season is short due to temperature restrictions, and climate is dry due to lower rainfall. Such an environment of the coniferous forests obviously

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will be adapted by those fungi which are cold loving, have the ability to grow and sporulate within a short growing season, and can withstand dry climate. Actually these are the properties of the brown rot fungi. In fact the brown rot fungi are found to be more efficient than the white rot fungi in obtaining energy from wood for their growth and reproduction in shorter periods of time, have low temperature optima, and are better suited to colder and drier climate with a shorter growing season. And that is why the brown rot fungi have found the coniferous forests as their best habitats and have developed so extensively in the coniferous forests of the world. In India also we find that the brown rot fungi thrive in the coniferous forests of the Himalayan region; or, in other words, they are better adapted in the conifers, while the white rot fungi are more common on hardwoods.

Side by side with this kind of adaptation some other basic relations are also noticed. These are the brown rot fungi which are associated mostly with the conifers, are heterothallic and bipolar and exhibit negative oxidase reactions, while the white rot fungi usually are more common on the hardwoods, heterothallic with tetrapolar sexuality and give positive oxidase reactions.

The wood rotting fungi are commonly regarded as harmful organisms that cause great damage to woods and timbers including valuavle ones, and thus cause great economic loss to a country. But these fungi economically are also very important organisms producing many beneficial effects. First of all, their basic role in natural ecosystem is the recycling of carbon removed from the atmosphere during photosynthesis. Green plants take up carbon in the form of CO_2 from the air during photosynthesis and fix it within their body. These wood rotting fungi after degrading the woods by means of enzymes release this carbon to nature. Thus carbon cycle is maintained on earth. Microbial degradation of cellulose has been estimated to return carbon to the atmosphere in the magnitude of 85 billion tons per year. In a forest the wood-rotting fungi weaken the older trees and make them vulnerable to windthrow and natural removal from the stand, thereby permitting the growth of ever changing nature of forests. These fungi have other great ecological importance too. Partially decayed wood residue, particularly those caused by brown rot fungi, are important components of soil, because these fungi remove only the cellulose part of wood while lignin remains in the soil as residue. This partially decayed wood residue increases the water holding capacity of the soil and also changes the physical and chemical properties of the soil which is essential for the growth of the native tree species. The increased water holding capacity of the soil also creates a favourable environment for seed germination and seedling establishment. Such soil in conifer forests also favours the development of mycorrhiza in conifer roots which are now regarded as essential for survival and growth of conifer trees. Recent studies have shown that brown rot residue in coniferous soils is also a site for N_2

fixation. In fact the brown rot fungi are regarded as one of the major factors in perpetuation of the coniferous forest biotype. So keeping in view the ecological functions of the brown rot fungi, wood residues should be left in coniferous forests to ensure stand generation and productivity.

Regarding the adaptive significance of the hyphal systems of wood-rotting fungi it may be said that the concept of hyphal system introduced by Prof. Corner in 1932 is an epoch making contribution in the field of fungal taxonomy. It is now established that basically three kinds of hyphae viz., generative hyphae, skeletal hyphae and binding hyphae are responsible for making up basidiocarps. Generative hyphae which develop skeletal and binding hyphae by differentiation. Moreover, the generative hyphae being the fundamental hyphae, are present in all basidiocarps. A basidiocarp composed of one kind of hyphae only, i.e., generative hyphae, is said to be monomitic in construction. A basidiocarp is dimitic when it is composed of two kinds of hyphae viz., generative and one of either skeletal or binding hyphae. A basidiocarp constituting generative, skeletal and binding hyphae is called trimitic basidiocarp. How the hyphal systems of basidiocarps aid in their adaptations is discussed below.

Monomitic fruitbodies-Monomitic species consist of generative hyphae only which may be simple septate or clamped. In fact from the generative hyphae all other kinds of hyphae viz., skeletal hyphae and binding hyphae are differentiated. So thin-walled generative hyphae are regarded as the most primitive ones. Fruitbodies monomitic consisting of thin-walled generative hyphae are soft in consistency and watery in fresh condition, becoming brittle on drying. Such fruitbodies occur in all groups of Aphyllophorales, but they are more abundant in the primitive groups. In Polyporaceae which is regarded as the most advanced group of the fungi include very few monomitic species with thin-walled generative hyphae and all of them belong to the genera *Ceriporia*, *Fibuloporia* and *Albatrellus*. The first two genera grow on greatly decayed and decomposed wood while *Albatrellus* grows on humus soil. Their growth does not necessitate a long life span and the short span of life excludes the necessity of the formation of biennial or perennial fruitbodies. So, fruitbodies with thin-walled generative hyphae only are always annual; never they are biennial or perennial.

Monomitic fruitbodies with thick-walled generative hyphae are more rigid than those monomitic species with thinwalled hyphae, and this rigidity is due to the thickness of the wall. Such fruitbodies may be soft when fresh and are hard on drying. Examples are species of the genera *Bjerkandara*, *Gloeoporus*, *Heteroporus*, *Inonotus*, *Oxyporus*, *Tyromyces* etc. The thickness of the wall of the generative hyphae has an adaptive importance. It aids the transition to the mesophytic and partly to the xerophytic way of life. This anatomical differentiation of generative hyphae also offers security and longivity to the fruitbodies. So, monomitic fruitbodies constituting thick-walled generative hyphae are usually annual, may be biennial, but never perennial.

Dimitic fruit-bodies-Dimitic friutbodies may be dimitic constituting generative hyphae and either of skeletal or binding hyphae. In dimitic fruitbodies containing skeletal hyphae, these hyphae are regarded as structural elements imparting mechanical strength to the fruitbody. The development of skeletal hyphae from generative hyphae also has an adaptive importance. In such dimitic fruitbodies the skeletal hyphae usually occur predominantly remaining mostly in parallel and compact condition. With such an anatomical structure the fruitbodies acquire a ligneous character and are able to withstand the destructive factors of the environment including seasonal changes. In other words, they acquire a long life and are thus able to grow as perennials. Good representative genera of this group are *Antrodia*, *Amyloporia*, *Flavodon*, *Phellinus*, *Rigidoporus*, *Skeletocutis* etc.

In fruitbodies dimitic with binding hyphae these hyphae are mainly mechanical in function imparting elasticity and strength to the basidiocarps. Within the fruitbodies the much branched binding hyphae remain irregularly arranged being interwoven by generative hyphae. This type of hyphal construction makes mature fruitbodies somewhat suberose or fibrous in consistency and they never become brittle ; on drying they become a little bit hard, but not as hard as dimitic fruitbodies with skeletal hyphae. *Polyporus anthelminticus*, *P. arcularius*, *P. brumalis* etc. have this kind of dimitic fruitbodies. Dimitic hyphal system of this kind is also inadaptive in the sense that it cannot ensure a prolonged life span for the species. As a result the fruitbodies are annual, and because of the relative looseness of their tissues easily become victims of of insects.

Of the two kinds of dimitic, species having skeletal hyphae have greater adaptive capabilities than those constituting binding hyphae, enabling the former to grow as perennials, the latter as annuals.

Trimitic fruitbodies—Such fruitbodies consist of generative, skeletal and binding hyphae where the skeletal hyphae form the framework of the fruitbody while the binding hyphae are responsible for its elasticity and cuticularisation of texture. Representatives of trimitic genera are *Coriolus*, *Coriolopsis*, *Daedalea*, *Fomes*, *Lenzites* etc. Trimitic fruitbodies are usually suberose or cuticularised or rather coriaceous in nature. They usually grow on tree stumps, little decayed logs and fallen branches under conditions which require preservation of the fruitbody for a period of time enough for sporulation and maturation. The fungi of this group are usually biennial, but never perennial.

However, it is to be remembered that the perennial habit of a fungal species is not always controlled by the hyphal system of its fruitbody. Every species has its definite nutritional requirements. Fungi growing saprophytically on dead substratum cannot obtain therefrom their specific nutrients for years together. Decomposition brought about by the growing fungi and other organisms bring about a change in the chemical composition of the substratum. As a result, a long perennial development is simply impossible for them.

Species of *Antrodia*, *Flavodon*, *Amyloporia*, *Rigidoporus* etc. show this kind of perennial habit. These fungi from the very beginning develop on dead or rotten wood and continue to grow for 2 to 3 years or so, till the decayed substratum can meet their special nutritional requirements.

On the other hand, the species of *Phellinus* and *Fomitopsis* which begin their development usually on living trees are true perennials and grow for several years on living plants where the condition remains unchanged for many years, particularly if the growing fungus is not too active.