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HEART ROT OF PTÆROXYLON UTILE(SNEEZEWOOD) CAUSED BY FOMES RIMOSUS (BERK).

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HEART ROT OF *PTÆROXYLON UTILE* (SNEEZEWOOD)
CAUSED BY *FOMES RIMOSUS* (BERK).

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(With Plates XXXIX–XLIV.)

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INTRODUCTION.

Ptaeroxylon utile (Eng., Sneezeewood; Dutch, Nieshout; Kafir, Um-tati) is a tree which appears to have but few enemies. Sim* writes: "It is strange that a timber so durable when dead and dry should be, while alive, subject to attack by a Polyporus, which not only acts on the sapwood, but is even more partial to the heartwood, and in many cases trees are found to consist of only a cylindrical shell, the centre being completely gone; but even in such cases the timber, when once dead, is everlasting and proof against fungus and white ants. Two borers occasionally affect the tree, the smaller acting only in the sapwood and forming numerous small channels, while the larger bores through the heart wood, leaving one tunnel $\frac{1}{4}$ in. diameter." The Polyporus, mentioned by Sim, is evidently *Fomes rimosus*, Berk., the fungus treated in this article.

On the timber of this tree Sim† remarks: "The timber is one of the hardest and heaviest in the Colony; it is dense and close-grained, strong and tough, and heavily charged with oily resin. It is of a yellowish colour, often

* Sim, T. R., The Forests and Forest Flora of Cape Colony, p. 168.

† Sim, T. R., *op. cit.*, p. 167.

dark brown towards the centre, while the sapwood, which is distinct and sometimes an inch deep on a large tree, is nearly white. Rings irregular, close, often distinctly marked, wavy in outline, 10–30 per inch in accordance with habitat, some distinct and closer than others, all fairly straight or wavy, and parallel in the longitudinal section, darker than the greyish-yellow interspaces. Medullary rays almost imperceptible, very fine and close, giving a minute satiny lustre. Pores very small, either separate or 3–6 in line together.” The Sneezewood is undoubtedly our most resistant timber, and Hutchins* classes it with Jarrah and Greenheart as imperishable wood. Fourcade† gives the properties of Sneezewood as : “Weight, 68 lb. per cubic ft. ; relative hardness, 8 ; coefficient of elasticity, 965 tons ; modulus of rupture, 9·71 ; crushing load, 7·17 tons per sq. in.”

Prof. Unwin,‡ who describes it as the strongest but also the heaviest of Cape timbers submitted to him, found its properties : “Weight, per cubic ft. 67·44 lbs. ; shearing stress, 0·490 tons ; crushing strength, 5·365 tons ; coefficient of elasticity, 983·7 tons per sq. in.”

It is as fencing-poles, gate-posts, and in the construction of harbour works that this timber is most largely used. Hutchins states that used in the marine works it has only once allowed the entrance of *Teredo navalis*, and that under exceptional circumstances. This case is treated in a paper by Hemmersley-Heenen.§

It is unfortunate that such a valuable timber should in the past have been used as firewood or for purposes which could have been as well served by a cheaper. Hutchins (*op. cit.*) mentions that in 1883 it was still sold for firewood on the King Williamston market, and states that the burning of it was like the burning of bank-notes. Even to-day there is a great deal of injudicious cutting-out and destruction of this tree.

The natives, in particular, fancy this tree for firewood, perhaps owing to its being very inflammable and burning even when green, and they are directly responsible for no small share of the destruction of this tree in the past, and even at present, when opportunity offers, do not hesitate to illicitly fell and use these trees for firewood.

The wood is extremely handsome and takes a fine polish, though its one serious drawback is the fact that the dust from it produces sneezing (hence the vernacular name) and running of the eyes. Another drawback, if such it be, is its extreme hardness.

Further references and remarks on the timber will be found in Sim's work referred to and in reports of the Forestry Department.

* Hutchins, Official Handbook of the Cape, 1893, p. 133.

† Fourcade, H. G., Report on Natal Forests, 1889, p. 133.

‡ Unwin, Cape Agricultural Journal, 1900, p. 605.

§ Hemmersley-Heenen, R. H., “A Short Account of the Attacks of the *Teredo navalis* and *Chelura terebrans* upon Greenheart (*Nectandra Rodioei*) and Sneezewood (*Ptaeroxylon utile*) Timbers,” Trans. S.A. Phil. Soc., vol. v, p. 313.

Well is it that such a valuable timber tree is at present protected and endeavours made to get back, by self-seeding or otherwise, some of the forests of the past; nor is it a bit too soon to call attention to the havoc worked by *Fomes rimosus*, Berk., which, as we shall see, causes a heart-rot not only in *Pteroxylon utile*, but also attacks a large number of our other forest trees.

DISTRIBUTION OF *FOMES RIMOSUS*.

Von Schrenk, who described the heart-rot of *Robinia pseudacacia* (locust tree), caused by this fungus, gives its distribution in the eastern United States, from New York southward along the Alleghanies to Alabama and westward to south-east Missouri, and during the year 1900 in great numbers on the southern shore of Long Island, N.Y., where it destroyed many of the fine old trees.

Overholts* mentions it from Ohio as growing only on living trunks of *Robinia*. Lloyd† mentions it as being most abundant in the United States (Middle West) on the locust tree (*Robinia*), and further states that although *Robinia* is very common as an ornamental tree in Europe, this *Fomes* is only known in Europe from a single specimen. He has had the fungus from Jamaica, Mauritius, South Africa, India, Samoa, and Ceylon.

In South Africa the fungus appears most commonly on living trees of *Pteroxylon utile* (Sneezewood), but it has thus far also been reported on: *Curtisia faginea* (Assegai tree); *Rhus laevigata* (Red currant); *Olea verrucosa* (Wild Olive); *Olea laurifolia* (Black Ironwood); *Schotia latifolia* (Boer bean); *Elaeodendron croceum* (Saffraanhout, Saffron-wood); *Pleurostyli. Capensis* (Coffee Pear); *Kiggelaria africana* (Wild Peach); *Acacia*, sp.; *Scolopia Mundtii* (Red Pear); *Xymalos monospora* (Wild Lemon).

What is evidently the same fungus is described by Murrill‡ under the name *Pyropolyporus Robiniae*, Murr. Virginia is given as the type locality and the distribution Connecticut to Florida and west to Missouri and Texas. The habitat is given as living trunks of *Robinia pseudacacia*.

GENERAL ACCOUNT OF THE DISEASE.

It is very common, especially in the Gxulu forest of the Eastern Conservancy, Cape Province, to find a large percentage of Sneezewood trees with hollow stems. The fruiting bodies (Figs. 1 and 2) of *Fomes rimosus*, Berk., usually appear at wounds and the scars of former branches, and there is no doubt that it is especially through wounds that the fungus gains entrance.

* Overholts, L. O., "The Polyporaceae of Ohio," Ann. Missouri Bot. Gdn., vol. i, no. 1, p. 133.

† Lloyd, C. G., Synopsis of the genus *Fomes*, p. 248.

‡ Murrill, Wm. A., North Am. Flora, vol. ix, pt. 2, p. 105, Bull. Torrey Bot. Club, vol. xxx, p. 114, 1903.

The Sneezewood trees are particularly favourable to this method of infection; the branches are brittle and easily broken off, and the tree is slow-growing and relatively poor in sapwood, conditions favourable to the entrance of the fungus.

Mr. J. D. Keet, District Forest Officer, who has had this fungus under observation for some time, in reply to a question *re* the distribution of this fungus, states: "It is worse in forests more heavily stocked with Sneezewood and such forests—in the Eastern Conservancy—belong entirely to the 'Low Type Forests.' In the 'High Forests,' Sneezewood occurs mostly on the stony, drier ridges, but while the individual trees are much bigger they are few and far between. In such forests Sneezewood is very seldom attacked by *Fomes rimosus*, although, strange to say, Black Ironwood (*Olea laurifolia*) may here be attacked." I have examined the fungus from Black Ironwood and verified Mr. Keet's statement that it is *Fomes rimosus*.

The elevation of the Gxulu forest where this fungus is particularly abundant on Sneezewood varies from 3300–3600 ft. The fungus, as mentioned above, causes the heartwood of the tree to rot, and as a result the tree, though it remains standing and growing, is hollowed in the centre. This hollowing is easily evident by tapping the tree. The rotten wood usually crumbles into a dark brown powder, and natives make holes in diseased trees to get at this mixture of rotten wood and fungus, which they use for tinder and know as "viti." The fruiting bodies or *sporophores* of the fungus are often found high up on the branches, and as noted always in association with a wound or scars of former branches. The natives know the sporophores under the name "Sbeni" (liver). The sporophores are hoof-shaped, with a black cracked surface (hence the second name of the fungus).

A transverse cut (Fig. 3) through a diseased trunk in its earlier stages shows a number of yellowish-brown pockets usually surrounded by a Vandyke brown margin. These pockets are arranged more or less concentrically and extend outwards in radial lines.

In a tangential section these pockets stand out as lens-shaped masses. The yellowish-brown mass, which represents nothing less than a felt-like mass of fungus threads, can be readily lifted out of the pocket. Fig. 4 shows some empty pockets from which the fungus has dropped.

By the spread of the fungus, both longitudinally through the wood elements and transversely through the medullary rays and pits, the rotten wood is gradually added to until ultimately only the sapwood and the bast exterior to it remain. It is seldom that the fungus attacks the sapwood, and if it does the death of the tree is certain.

Not always is the stem merely hollowed out as above described, but the fungus also forms masses of felted tissue in the decayed area. Fig. 5 represents a mass of felt-like fungous threads matted together and taken from a hollow Sneezewood tree. This particular mass was almost white,

Fig. 6 shows practically in the centre of the diseased stem a dark brownish mass composed of fungous threads closely matted together and also enclosing some wood. If this mass was to be removed, the hollowness of the trunk would be complete.

ACTION OF THE FUNGUS ON THE WOOD.

The diseased wood is bounded from the healthy by a dark Vandyke brown ring, darker in colour than the normal wood.

In the decayed wood the mycelium of the fungus is abundant in the vessels (Figs. 7 and 8), wood prosenchyma, and medullary rays (Fig. 9). In transverse section the vessels frequently appear completely blocked, and in addition to the mycelium they may contain a dark colouring matter, evidently composed of decomposition products of the fungus.

The fungus secretes an enzyme which converts the lignin of the wood cells into cellulose; the middle lamellae of the cells are destroyed, and as a result the cells easily separate.

The destruction of the lignin results in the attacked wood frequently showing as white areas or patches (Fig. 6), where the elements consist of practically pure cellulose and are readily crumbled between the fingers. The enzyme would appear to diffuse from the region where the mycelium is abundant, and wood elements of which the walls consisted of cellulose were observed where there was little trace of fungoid hyphae.

The following reactions were tried to show that the lignin of the wood is destroyed, and that these elements, therefore, give reactions for cellulose.

(1) *Schulze's Soln. (Chlorozinc Iodide)*.—The rotten wood takes the blue colour characteristic of cellulose.

(2) *Phloroglucin and Hydrochloric Acid*.—The healthy xylem stains red-violet, characteristic of lignin, whereas the decayed xylem, since the lignin has been destroyed, does not give this reaction, but those for cellulose.

(3) *Iodine and Sulphuric Acid*.—The healthy wood stains yellowish and the decayed gives the blue cellulose reaction as would be expected.

(4) *Aniline Sulphate and Sulphuric Acid*.—The normal wood takes a bright yellowish colour characteristic of lignin, whereas, again, the decayed does not, but would give reactions with reagents for cellulose.

The action of the fungus on the wood may therefore be briefly summarized as follows:

(1) The fungus secretes an enzyme which reacts on the lignin of the wood elements and converts it into cellulose.

(2) The middle lamellae of contiguous cells are destroyed and the cells therefore easily separate.

(3) Ultimately the remaining, now cellulose, walls of the xylem are destroyed, and the fungus forms yellowish masses of matted fungoid threads

in the cavities it has produced by the destruction of the wood. Fig. 10 shows a collection of hyphae evidently intertwining and becoming matted together.

MYCELIUM OF THE FUNGUS IN ITS HOST.

In young stages the mycelium consists of delicate, thin-walled, colourless hyphae, which are branched and septate. Frequently the septa are quite close together. From being colourless the hyphae change through a yellow ochre to a dark Vandyke-brown and become thicker walled. More frequently they measure $1.1-2\mu$ across, though thicker and also thinner hyphae have been met with. The hyphae fill the vessels, wood prosenchyma elements, and medullary rays, and, as already mentioned, form a thick felted mass in the cavities and in the place of the wood elements which have been destroyed.

The hyphae show the characteristic clamp connections, and usually they become peculiarly intertwined and twisted, as is evident from some of the illustrations.

The manner in which a fungus penetrates and spreads through wood is to some extent determined by the structure of the particular wood. It may be taken that generally the course of the hyphae is through the medullary rays and vessels in the first instance, and that from these points individual hyphae penetrate the adjoining wood cells.

Briefly considering the wood of *Ptaeroxylon utile* we note :

(1) The medullary rays, though not easily evident to the naked eye, are abundant, 1 cell broad and between 5-12 cells deep, and are composed of comparatively thin-walled parenchymatous cells.

(2) The vessels have a diameter of medium size (lumen $39.16-52.8\mu$ diam. and walls 6.6μ thick), and their walls are pierced by numerous bordered pits.

(3) The groundwork of the xylem is composed of wood prosenchyma cells, with walls 3.68μ (on the average) thick and lumina 7.36μ diam. The prosenchyma cells have simple pits.

It is the absence of wide wood elements that makes the wood of *Ptaeroxylon utile* so hard and firm.

Through wounds the fungus finds entrance into the medullary rays and from them penetrates vertically and laterally into the wood elements. The hyphae pass directly through the walls of the medullary ray cells (Fig. 11), and the pits formed in the process are slightly enlarged. The hyphae are also capable of directly boring their way through the walls of the wood prosenchyma cells (Figs. 12 (a) and 13). Where the hyphae thus bore their way directly through the walls a tuberos swelling was frequently noticed at their ends and in proximity to or touching the wall to be bored through.

In the vessels I have not observed the fungus to bore directly through the walls, and here they appear to follow the pits (Fig. 12 (b)), which are abundant. From what has been said above it will be evident that the growth of the fungus longitudinally through the continuous vessels and the wood prosenchyma will be more rapid than laterally, in which latter case the hyphae have to bore their way through the walls of the wood cells or are else dependent on pits.

Von Schrenk * has pointed out that the formation of sheets is largely dependent on the resistance of the wood cells, and whether they are closely packed or not, and as pointed out by him for *Robinia Pseudacacia*, so I hold the same to be a very plausible theory also for the sheets formed in *Ptaeroxylon utile*.

Von Schrenk † has reported that the common form of destruction in *Robinia* is for the wood cells to break up into small pieces owing to their walls being perforated by hyphae. The smallest pieces were shown to be wood, thus indicating that the destruction does not pass through the cellulose stage.

In the material of *Ptaeroxylon utile* examined I have never come across any small pieces of unaltered wood. The destruction here appears invariably to pass through the cellulose stage. In between delignified wood cells I have at times come across elements, especially vessels, which still gave lignin reactions, but these were never isolated into small pieces. The walls of the vessels are particularly resistant.

DESCRIPTION OF THE FUNGUS.

The fructifications or sporophores of *Fomes rimosus* are among the most conspicuous of the so-called "shelf" fungi which grow on living trees. They vary in shape, size, etc., and especially does this appear to be the case with sporophores obtained from different hosts.

On *Ptaeroxylon utile* they are usually hoof-shaped (Fig 1) or applanate, and the sizes most frequently met with vary between 2·4–14 × 3·5–7·5 × 1·5–5 cms. In young specimens the upper surface is smooth and fulvous, but with age it becomes concentrically sulcate and very much cracked or jagged. The cracks do not penetrate far into the mass of the sporophore, and are usually limited to the outer hard surface which in this fungus is not encrusted. With age the surface colouring varies between dark brown and purplish-black, and older specimens are frequently covered with moss, etc. The most recent layers, which form the front of the sporophore, are charac-

* Schrenk, H. von, "A Disease of the Black Locust (*Robinia Pseudacacia*)," Miss. Bot. Gdn., Twelfth Ann. Rep., 1901, p. 21.

† *Op. cit.*, p. 26.

terised by their smooth, fulvous, almost velvety surface, which extends over the edge on to the lower surface.

The substance of the pileus is hard and woody and of a raw sienna colour; a section shows the outer rind to be inclined towards Vandyke brown. The whole sporophore is exceedingly hard and woody.

The lower surface of the sporophore is a dull reddish-brown and smooth and velvety to the touch. The pores are minute, on the average $112-132\ \mu$ across, hardly discernible to the naked eye, $3-5$ to the mm.; dissepiments rather thick, on the average $78-125\ \mu$, and poremouths entire and circular.

The tubes are arranged in strata, not always very distinct, $2-6$ mm. long, and are a light brown (raw sienna). They extend practically to the surface, there being only a thin, hard, woody context tissue $3-1$ cm. thick and zoned. The tubes of the older strata later become plugged by mycelial hyphae, and this plugging appears to start irregularly in any particular layer. As has also been pointed out by other writers, a large number of spores are frequently imprisoned in these plugged-up tubes.

The spores (Fig. 14) are abundant, yellowish-brown, smooth, globose, or slightly oval, $4.35-5\ \mu$ diameter. Setae are absent.

The fructifications do not form after the trees are dead, nor does the diseased wood when used for poles, etc., continue to rot. This was also reported by von Schrenk* for the locust tree, and would suggest, as pointed out by him, that conditions in the living tree must be essentially different from those existing after the tree is dead.

The description of the fructification is from specimens taken from Sneezewood, and the size that most frequently met with on the above tree. The largest specimen (frontispiece) seen by the author was from *Elaeodendron croceum* (saffron wood) and measured $73 \times 36 \times 28$ cms. Its weight was $24\frac{1}{2}$ lb. It was collected at Knysna by Mr. C. E. Legat, Chief Conservator of Forests for the Union.

CONTROL OF THE HEART ROT CAUSED BY *FOMES RIMOSUS*.

We have seen that *Fomes rimosus* is a wound parasite, and the two methods of control which suggest themselves are:

- (1) The prevention of wounds.
- (2) The removal of the primary sources of infection.

Whereas on large areas it would be practically impossible, from an economic point of view, to treat trees individually, yet nevertheless much can be done in a general way to lessen the chances of natural wound infection.

The most practical method for combating heart rot is undoubtedly the

* Schrenk, Herman von, *op. cit.*, p. 29.

removal of the possible sources of infection. Wherever it is intended to conserve forest areas, a careful search should be made for all trees infected with this fungus, and they should be promptly removed. This is the more important since, as already stated, in South Africa *Fomes rimosus* does not limit itself to *Ptaeroxylon utile*, but attacks a large number of trees belonging to different orders.

The presence of the sporophores of the fungus on a tree is evidence of the presence of heart rot and of the necessity of removing the tree. Sporophores on trees should be removed wherever found.

The practice of leaving uncut, trees affected with heart rot is wrong from the standpoint of proper forest sanitation, for it merely enables the causal fungus to develop its fructifications and exposes the coming generation to a continuous danger of becoming infected as soon as they have developed heart wood and the opportunity offers itself. *Fomes rimosus* is not known to form new fructifications after the attacked tree is dead, and a proper look-out for and the destruction of living diseased trees as well as the sporophores of the fungus should go a long way towards lessening infection in the forests.

The foregoing would appear to be the most practical methods for controlling this disease in large forests. On a small scale it may perhaps be necessary to give attention to individual trees; assist the natural pruning tendency of the tree and trim all wounds prior to painting them over with some disinfectant. The disinfectant should have sufficient penetrating power to infiltrate into the wood for some considerable distance. Coal-tar creosote heated up until thoroughly liquid will be found as good as any. The disinfecting is especially advisable where the wounds are large.

Humphrey and Fleming* have recently published an interesting paper on the toxicity to fungi of oils and salts, and particularly those used in wood preservation. In their research they included two wood-destroying fungi—*Fomes annosus*, Fr., and *Fomes pinicola* (Sw.) Fr. They find the preservatives used act in a considerably different manner on these two fungi and the former to be as a rule more resistant.

Mention should here also be made of a recent paper by Howe† on the effects of various dressings on pruning wounds of fruit trees. The author found untreated wounds to heal more rapidly, and on peach trees the substances experimented with caused so much injury that the author holds wounds on peach trees should never be treated with any of them. The author's conclusions are that there is nothing to show that it is worth while

* Humphrey, C. J., & Fleming, R. M., "The Toxicity to Fungi of Various Oils and Salts, particularly those used in Wood Preservation." U.S.A. Dept. of Agriculture, Bureau of Plant Industry, Bull. 227, 1915.

† Howe, G. H., "Effect of Various Dressings on Pruning Wounds of Fruit Trees," New York Agric. Exp. Station (General), Bull. No. 396, 1915.

treating wounds, large or small, of fruit trees with any of the substances in common use. At the same time he points out that had the experiments extended over a longer period it might have turned out that the treatment saved the wood from decay which often sets in on exposed wood of fruit trees. Here, however, it is pointed out that the injury caused by the dressings might overbalance the protection afforded against decay.

The whole question of dressing wounds with disinfectants would appear to be well worth serious attention, and especially with reference to particular fungi. Further work along the lines followed by Humphrey and Fleming would give interesting and valuable results.

SUMMARY.

The paper deals with a heart-rot disease in *Ptaeroxylon utile* (Sneeze-wood) caused by *Fomes rimosus*, Berk.

The distribution of the fungus and the effect it has on the wood of *Ptaeroxylon utile* are fully recorded.

It appears to have been generally held that this fungus limits itself to *Robinia Pseudacacia*, or members of the Leguminosae, and it is therefore all the more interesting to know that in the Union of South Africa it has thus far been reported on 11 genera belonging to 8 different natural orders.

Ptaeroxylon utile is one of our hardest and most valuable trees, and with endeavours that are being made to get back some of our forests of the past, particular attention should be given to the presence of this fungus in areas demarcated, and every means taken to prevent its spread.

This is all the more important since we now know the fungus attacks a large number of trees belonging to different orders.

The fact that fruiting bodies are not developed after the tree is dead somewhat simplifies the control of the disease along the lines suggested.

ACKNOWLEDGMENT.

I have to express my indebtedness to various officers of the Forestry Department for much useful assistance and information. Through the kind assistance of Mr. C. Ross, Conservator of Forests of the Eastern Cape Conservancy, and the District Forest Officers of his conservancy, a large number of *Polyporaceae* have been collected, and we are well on the way towards learning more of the fungi responsible for the destruction of our indigenous trees and also of those living on dead stumps. My thanks are especially due to Mr. J. D. Keet for the great interest he has shown in this important phase of forestry and for the large number of specimens. A good general idea of the destruction caused by *Polyporaceae* was obtained by the

author during a visit to Mr. J. D. Keet, when several of the forests under his charge were visited and a large number of *Polyporaceae* collected.

I have also to acknowledge the services rendered by Mr. C. G. Lloyd and Mr. L. O. Overholts in the verification of certain material of *Fomes rimosus* and for assistance with the *Polyporaceae* generally.

NATAL HERBARIUM,
BEREA, DURBAN,
April 5th, 1916.

EXPLANATION OF PLATES XXXIX—XLIV.

PLATE XXXIX.

FIG.

Frontispiece. Largest specimen of *Fomes rimosus*, Berk., seen by the author. It is from *Elaeodendron croceum* (Saffron wood), and measured 73 × 36 × 28 cms. and weighed 24½ lb.

PLATE XL.

1. Sporophore of the fungus on *Ptaeroxylon utile* (Sneczewood).
2. Same as 1. Note the cracks where the sporophore originates.
3. Diseased stem of *Ptaeroxylon utile* cut through and showing the destruction caused by the fungus.
4. Stem cut through longitudinally. Note the brown fungous mass and also some empty pockets.

PLATE XLI.

5. Felted mass of mycelium from hollow trunk of *Ptaeroxylon utile*.
6. Brown fungous mass, practically in centre of stem, and white wood elements which have become delignified and now consist of practically pure cellulose.
7. (× 300).—T.S. through diseased stem. Mycelium in large vessels.

PLATE XLII.

8. (× 400).—Diseased stem in longitudinal section. Mycelium of the fungus in wood elements.
9. (× 400).—Radial longitudinal section. Mycelium in medullary rays.
10. (× 300).—Mass of mycelial threads of the fungus in the wood.

PLATE XLIII.

11. (× 1000).—Mycelium boring its way through the cells of the medullary rays.
12. (× 1000).—Mycelium passing through pits of large vessels (*a*); boring its way through wood cells (*b*) and also some mycelial threads (*c*). The mycelium frequently runs in close contact to the walls of the cells of the host, and where a wall is to be bored through is usually swollen.

PLATE XLIV.

13. (× 1000).—Mycelium boring through wood cells.
14. (× 1000).—Spores of the fungus. They are yellowish-brown, smooth, and vary from circular to oval.



Fig. 1.



Fig. 2.



Fig. 3.

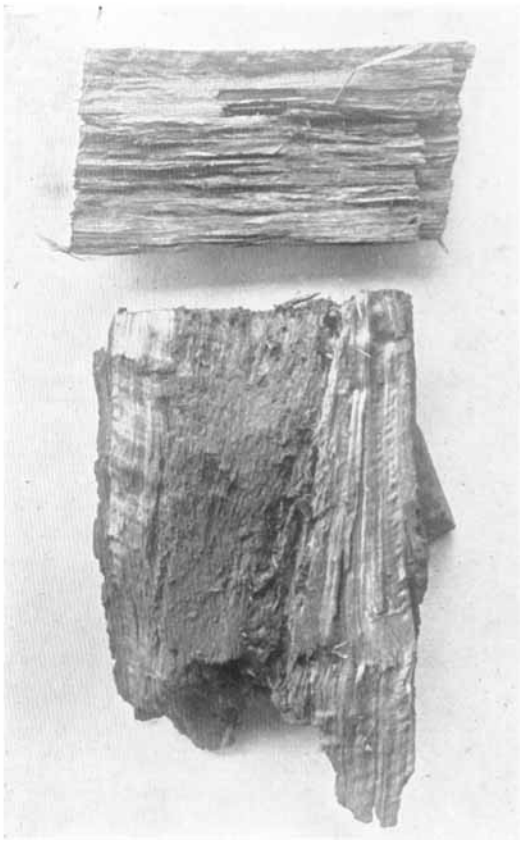


Fig. 4.

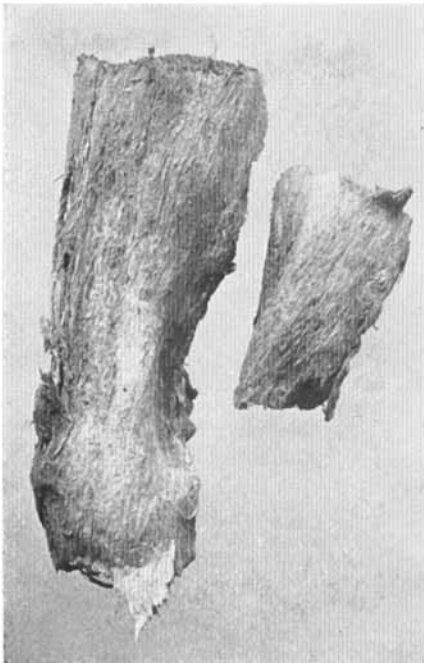


Fig. 5.



Fig. 6.

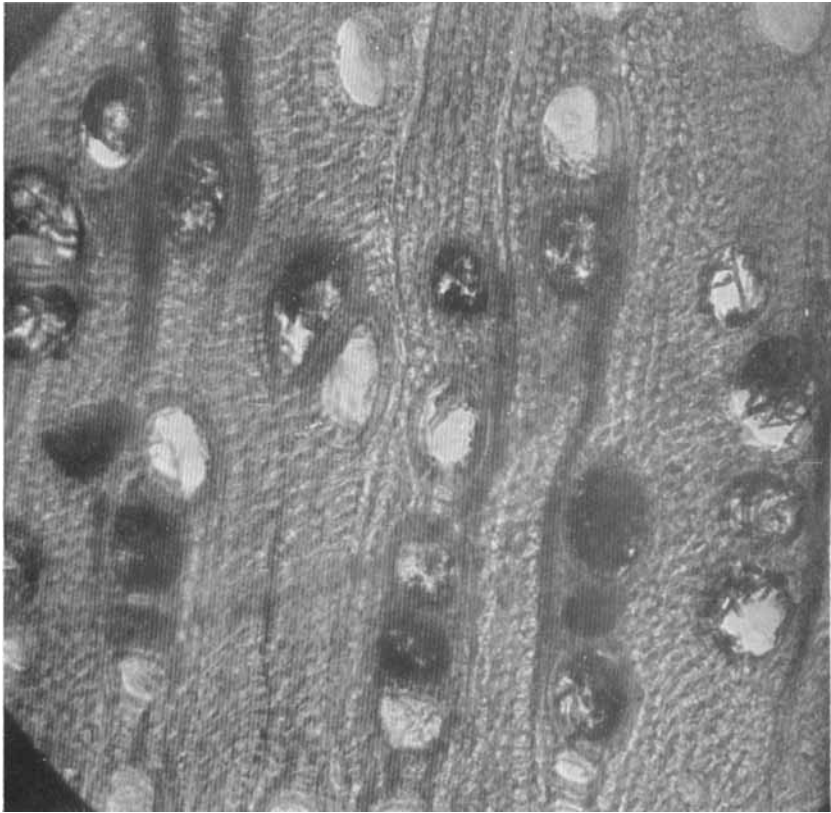


Fig. 7.



Fig. 8.



Fig. 9.



Fig. 10.

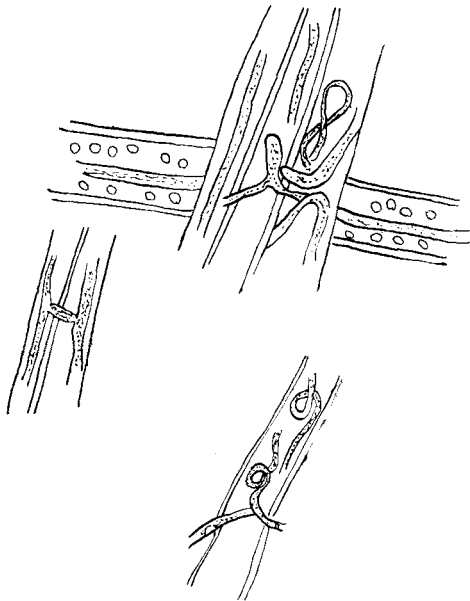


Fig. 11.

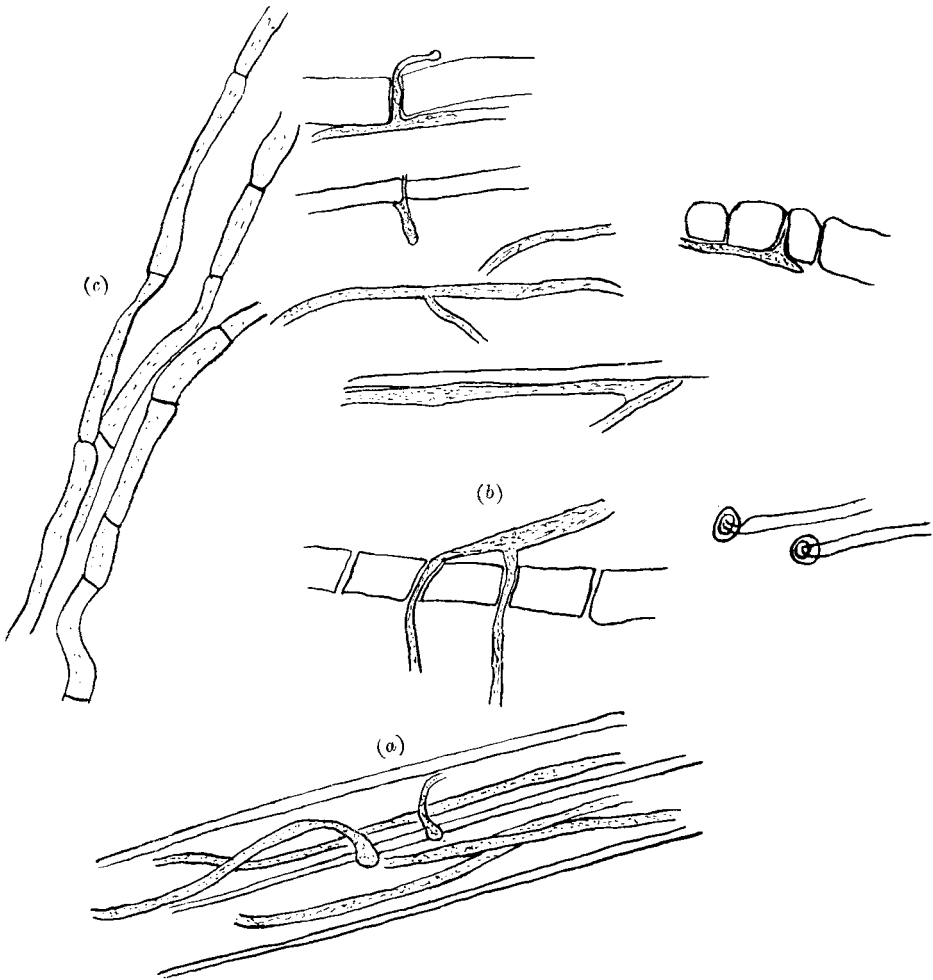


Fig. 12.

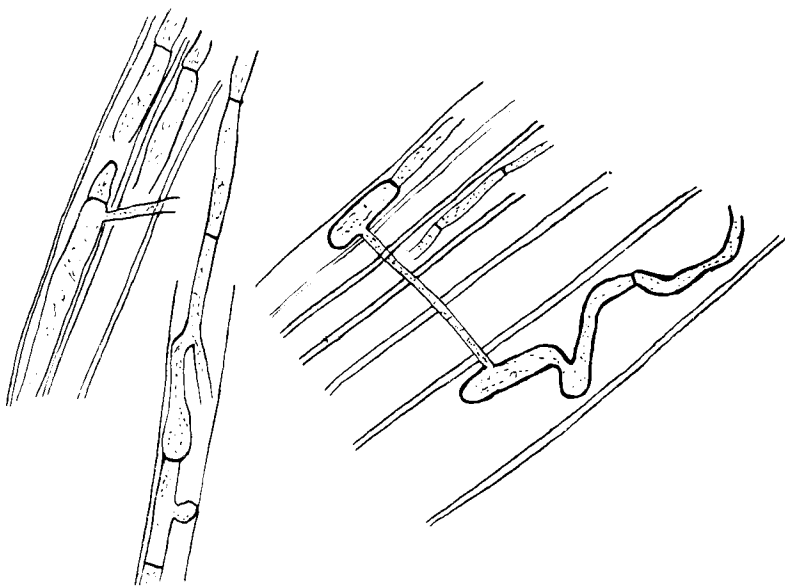


Fig. 13.

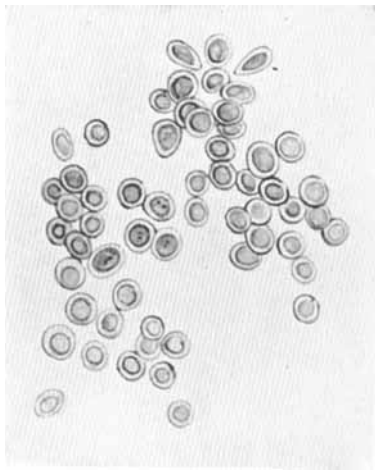


Fig. 14.