

VARIATION IN *POLYSTICTUS XANTHOPUS* FR.

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(With Plates I to IV and 4 Text-figures)

THE present study has been undertaken to determine the degree of variation and the differences that exist between the variants in *Polystictus xanthopus* Fr. So far, three forms of the fructifications of the fungus have been recognised based only on the nature of the hymenial surface and they have been reported mainly from the hills of Assam. They usually grow on logs of *Shorea robusta* under identical environmental conditions.

It has been found that all the three forms of the fungus differ not only in the characters of the hymenial surface but also in the external morphology and microscopic anatomy of the sporophores, in growth characteristics on artificial and natural media, in oxidase reactions, in the rate of decaying sapwood of *Shorea robusta* and in the reaction to a toxic substance. Some of these characteristics have been found to be overlapping. The differences between the three forms in growth characteristics are both morphological, such as colour, topography and texture of the superficial mats, and physiological, as exemplified by the existence of antagonism between the uniting pairs of mycelia on artificial media, effects of variation in pH of a medium on growth, reactions to zinc chloride and the rate of growth. No hyphal fusions between the polysporous mycelia of the three forms have been observed.

INTRODUCTION

There are records (Stakman, 1929) of many species of fungi which exhibit physiologic forms. These forms differ greatly in their parasitic activity, growth characteristics under cultural conditions and also to some extent in morphological characters. Among Hymenomycetes, wide variation of this type within the same species has been noted only in a few species by Schmitz (1925) and Verrall (1934). In any comparative work it is, therefore, essential to find out the range of variation existing within the same species in the characters being studied. Considerable cultural work has already been done with wood-rotting fungi from India by Bose (1929, 1929a, 1930), Banerjee and Bakshi (1945), Bagchee and Bakshi (1950) and Bakshi and Bagchee (1950), but no work has been done on form-variation on any species in India so far. It is, therefore, desirable to study on a comparative basis the range of variation exhibited by a given species.

The present study has been undertaken to determine the degree of variation existing in *Polystictus xanthopus* Fr. This fungus has been selected, because Bose (1936) has reported form-variation within this species mainly on the characters of the hymenial surface. According to him "the hymenial surface of specimens of *Polystictus xanthopus* Fr.

at high altitude shows three different kinds of porous area, viz., some with typical very small pores, some with much bigger pores and some with hydroid pores". He also concludes that they are variations of one and the same species. Such variations, however, are hardly found in the specimens collected from the plains. Bose's report has been based on materials from different localities of Cherrapunji (8000 ft.) and Lokra hills (8000-10,000 ft.) Assam, collected in 1929 and 1934 respectively.

So far as the authors are aware, very little work has been done on this fungus up to the present time. Although first named and described by Fries (Saccardo, 1888), it was subsequently re-described by various workers like Lloyd (1910), Bose (1918, 1919, 1936), Corner (1932) and others based on collections from different localities. Their descriptions were mainly based on external morphology of the fruit-bodies. In 1932, Corner not only described the characteristic form of *Polystictus xanthopus*, but also extended his researches on the hyphal anatomy of the fruit-body of the fungus. Further, its sexuality has been recently studied by Banerjee and Samadder (1957). Nothing more in particular, is known about the fungus on other aspects.

The scope of the present investigation is to determine how much this species varies with regard to external form and anatomy of the fruit-bodies together with general cultural characteristics on artificial media including the rate of growth, habit of growth, colour-variation and hyphal characteristics of the mycelium. Attempts have also been made to find out the nature of antagonism and compatibility that exist between the mycelia of different forms, their rate of decaying wood and also their response to a toxic substance of different concentrations.

GEOGRAPHICAL DISTRIBUTION

Polystictus xanthopus Fr., a common saprophyte, has been known for more than a century in the tropics of the old world. In India, it is known to occur on logs and fallen branches of *Shorea robusta* Gaertn.f. and on *Cedrela toona* Roxb. (Banerjee 1947; *List of common names of Indian Plant Diseases*, I. C. A. R., 1950) causing white spongy rot. Lloyd (1910) reports that the home of this plant is Africa and probably it was first published by Ehrenberg as *Polyporous katui* which was subsequently re-named as *Polystictus xanthopus* by Fries. The African collections run to the mesopodial types mainly. In tropical America they are very rare. There are records of this species from America in Saccardo (1888), but according to Lloyd (1921), they are erroneous, as in his wide experience he did not receive a single specimen from this country. More recently, however, Killermann (1928) has again stated it to be pantropical. Petch (1916), mentions that it generally occurs in low countries. According to Corner (1932), besides these, there are collections in Singapore herbarium from many of the low lying parts of Malaya and specimens from high altitudes, such as from Camerons highlands in Pahang (6000 ft.), have also been found. In Fraser's hill, Pahang, (4000 ft.) luxuriant growth of this fungus has been reported. It has also been reported from Negri Sembilan

on Gumong Angsi (2700 ft.). Therefore, it can be stated that *Polystictus xanthopus* seems to be generally distributed throughout the Peninsula and is independent of altitudinal variations. Saccardo (1888) reports it to be commonly found in the tropics, Sierra Lione (Africa), India, Java, Guyana, Brazil, Peru, Pegu, Sumatra, Coccinea (S. America), Australia, North America and Islands of the Pacific Ocean. It has also been reported from various places in India by Bose (1919, 1936) and others (Butler and Bisby, 1931).

MATERIALS

The fructifications used for the study were collected from Cherrapunji, Assam, in 1953, in the month of September. The situation was rather cool, very damp, somewhat shady and provided a favourable condition for the growth of the fungus. They were found to grow luxuriantly on posts and logs of *Shorea robusta*. Several collections of the fungus from this locality were made from which three morphologically different types were carefully selected. The materials when brought into the laboratory, were revived by placing the fructifications with their upper surface downwards on moist cotton wool in several Petri-dishes and from these spores were collected in sterile agar plates. From these spores initial polysporous cultures were made by transferring loopfulls of spores aseptically to 2.5% malt-agar slants. These were then incubated at 30°C. Within a week good mycelial growth was obtained in all the tubes and these were finally kept as stock-cultures for subsequent study and comparison. Microscopic examination of all the cultures showed the presence of much branched, hyaline, septate hyphae with abundant clamp-connections.

MORPHOLOGY OF THE SPOROPOHORES

A. External features

It has been previously stated that there exists considerable variation in external morphology of the fruit-bodies of *Polystictus xanthopus* which first attracted the attention of Bose in the year 1936. He recognises three different types of fructifications based mainly on the character of the hymenial surface. After careful study of the external features of all the materials three distinct types of fruit-bodies have been segregated as follows:

Type-I. Fructifications with long and narrow excentric stipe, very thin, more or less obliquely infundibuliform and with very minute, regular pore-mouths;

Type-II. Fructifications small, with somewhat stout and thick excentric stipe, more or less obliquely saucer-shaped, with a central depression and with minute, regular and slightly larger pore-mouths;

Type-III. Fructifications thin, always sessile, bracket-shaped and with angular to 'Irpecoid' or 'Hydnoid' pore-mouths.

Forms with intergrading characters have also been noticed in many specimens, but these cannot be strictly placed in either of the above-mentioned three distinct categories. The external features of the types recognized by the writers have been fully described below. In all cases the colour of the fruit-bodies has been expressed according to Ridgway (1912).

Type-I (Plate I, figs. 1 and 2)

Fructifications: Stipitate. *Stipe*: Usually excentric, sometimes central but never lateral, more or less cylindrical, arising from a small disc-like concolorous base, gradually expanding upwards into the pileus but sharply delimited from it, smooth, Ochraceous-Buff to Ochraceous-Orange in colour, often with Ferruginous spots, somewhat stiff on drying, dimension about $10-25 \times 1-3$ mm. *Pileus*: Infundibuliform, usually obliquely so; coriaceous, becoming stiff on drying; sometimes laterally confluent; usually about 7-9 cm. or more in diameter; margin very thin, entire, even, becoming lobed in larger specimens, involute on drying; white but becoming Cinnamon-Buff in dry specimens. *Upper surface*: Glabrous, shining; concentrically zoned; somewhat stiff; rugulose due to longitudinal wrinkles; colour showing various shades of Cinnamon-Buff, Orange-Cinnamon, Vinaceous Tawny; Garnet Brown and Maroon in regular concentric bands of variable thickness, Cinnamon-Buff colour being predominant in some specimens. *Context*: Very thin, less than 0.5 mm. in thickness; white; coriaceous. *Hymenial surface*: Smooth, somewhat longitudinally wrinkled in dry specimens; dull white in colour but becoming Pinkish-Buff when old; pore-mouths minute, regular, more or less circular, ending abruptly near the margin forming a sterile zone, about 1 mm. wide; pore-tubes very short, forming a distinct layer, not separable from the substance of the context.

Type-II (Plate I, figs. 3 and 4)

Fructifications: Stipitate. *Stipe*: Always excentric, never central or lateral; usually short cylindrical, sometimes elongated, dilating upwards into the pileus but sharply delimited from it, arising from a more or less concolorous discoid base; Ochraceous-Orange or Antimony Yellow in colour, sometimes with Ferruginous spots; smooth and glabrous, sometimes rugulose; somewhat stiff and corky on drying; dimension about $5-7 (12) \times 5-8$ mm. *Pileus*: Always shallow, saucer-shaped but oblique; coriaceous, becoming stiff on drying; sometimes laterally confluent; about 3.5-7 cm. wide and 2.5-4 cm. deep. Margin thin, usually entire, even, sometimes slightly wavy but never lobed, not involute on drying, at first white, but turning Pinkish-Buff with age. *Upper surface*: Glabrous; shining with numerous narrow to broad concentric zones; somewhat rugulose due to longitudinal wrinkles; colour showing various shades of Garnet Brown, Maroon and Claret Brown throughout, a broad band of Maroon colour invariably present just behind a narrow Pinkish-Buff margin; a prominent ridge around the central depression almost invariably present. *Context*: Somewhat thick, less than 1 mm. in thickness; white; coriaceous. *Hymenial surface*: Usually smooth, sometimes with wide longitudinal

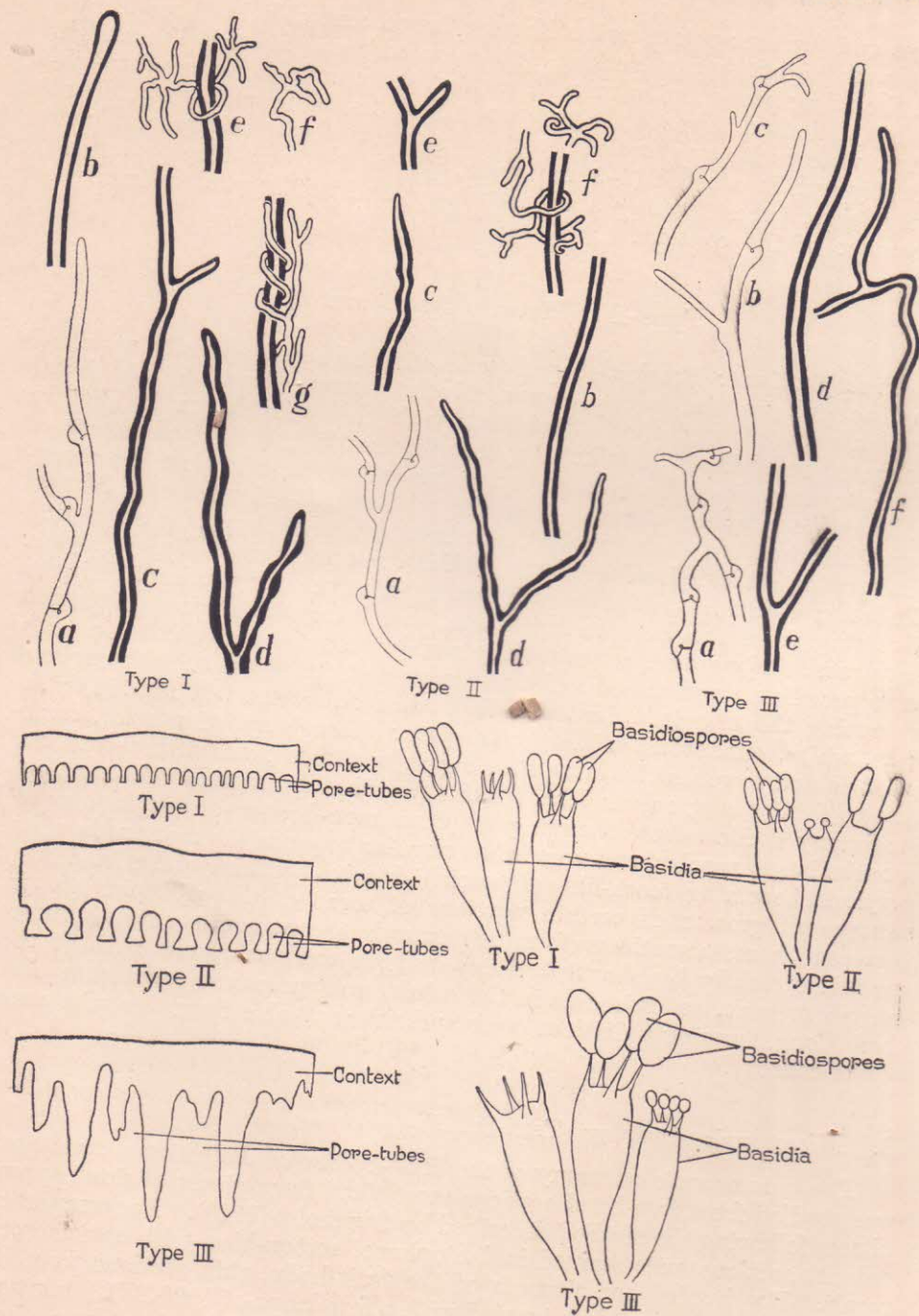
ridges and furrows; colour not uniform, a broad central light Wood Brown zone with Light Buff to Pinkish-Buff coloured areas towards the margin and the stipe; pore-mouths minute, regular, more or less circular throughout but delimited towards the periphery by a distinct narrow zone, about 1 mm. wide and consisting of somewhat angular pores; this narrow zone abruptly ends in a broad (2-3 mm. wide) sterile edge; pore-tubes comparatively large; tubes forming a distinct layer and not separable from the substance of the context.

Type-III (Plate I, figs. 5 and 6)

Fructifications: Bracket-shaped (reflexed), and sessile; usually attached to the substratum by a comparatively narrow base or the basal portion near the point of attachment with the substratum is slightly elongated resembling a stalk; thin; flabelliform, in the form of an arc of a circle; sometimes imbricate; coriaceous when fresh, becoming somewhat stiff on drying; about 3-7 cm. across and 2.5-4 cm. deep. Margin very thin, uneven, slightly lobed, not involute on drying; whitish at first but turning Pinkish-Buff to Warm Buff in dry specimens. *Upper surface*: Glabrous; somewhat shining; stiff; with numerous longitudinal wrinkles diverging from the base outwards and rendering the surface somewhat rugulose; faintly zoned, zones usually narrow but one or two zones usually very prominent and raised; colour Maroon and Garnet Brown throughout excepting the margin. *Context*: Very thin, less than 0.4 mm. in thickness, white, coriaceous. *Hymenial surface*: Rough and 'Irpecoid', somewhat folded towards the margin in bigger specimens, sometimes with one or two faint zones; colour Warm Buff towards the margin, other portions Antimony Yellow but changing to Cinnamon-Brown on drying; pore-mouths large, regular, and somewhat angular towards the margin, in older portions becoming teeth-like (Irpecoid) due to breaking down and also subsequent growth of certain portions of some of the dissepiments in between them, sometimes forming somewhat continuous cavities interrupted internally by short partition walls; a uniform sterile zone at the margin present, not raised as in the other two types; pore-tubes comparatively long, forming a distinct layer and not separable from the substance of the context.

B. *Microscopic Anatomy* (Text-fig. 1)

The microscopic anatomy of the fruit-bodies of *Polystictus xanthopus* was studied from free-hand sections mostly cut from pieces of dried sporophores following the method described by Overholts (1929). For temporary mounts sections were stained in lactophenol-cotton-blue with satisfactory result. For hyphal constituents of the fruit-body, thin sections from its different parts were at first treated with a few drops of 10% KOH solution on a slide and washed with water. Small groups of hyphae were then teased from these sections in warm lactophenol and examined without staining. Staining of the hyphae was considered unnecessary, because when the substage diaphragm and the condenser of the microscope were



Text-fig. 1. Anatomical features of the three types of fructifications of *Polystictus xanthopus*.
(Hyphal systems and basidia & basidiospores. $\times 700$)
(For explanation, vide text)

slightly regulated, visibility of the hyphae was decidedly increased. These teased materials were also mounted in Erythrosine-glycerine-agar jelly for making permanent preparations. Measurements regarding the width of the hyphae and other elements or structures of any given specimen were based entirely, according to the suggestion given by Bisby (1945). Ten to twenty routine examinations and measurements of carefully selected elements to include the range of sizes were found to be sufficient for this purpose. The nomenclature adopted by Corner (1932) in describing different types of hyphae of the fruit-bodies have been followed.

(i) *Thickness of the context.* The thickness of the context varies greatly in the three types, maximum being in Type-II and minimum in Type-III. The thickness of the context in Type-I is intermediate between the two and varies from $300-420\mu$, that of Type-II and Type-III ranging from $600-870\mu$ and $120-330\mu$ respectively.

(ii) *Length of the pore-tubes.* The pore-tubes, with regard to length, vary greatly and do not form a well distributed series. The pore-tubes in Type-II are almost double in length than those in Type-I, but between Type-II and Type-III there is a wide gap. The length of the pore-tubes in Type-I varies from $80-140\mu$ and that in Type-II $170-230\mu$. Maximum length of the pore-tubes has been attained in Type-III which varies from $660-1950\mu$.

(iii) *Thickness of the dissepiments.* As regards the thickness of the dissepiments it is also different in the three types. In Type-I it is narrow, more or less uniformly thick from base to apex of the pore-tubes and about $4-8\mu$ in thickness. In Type-II the dissepiments appear as biconcave columns in longitudinal section, dilating towards the pore-mouths and the bases of the pore-tubes, and finally merging into the context. Its thickness varies between $8-12\mu$ in the middle and about $16-20\mu$ at either ends. In Type-III, the dissepiments appear as more or less conical structures in longitudinal section being widened towards the context and more or less tapering towards the pore-mouths. Its thickness varies from $12-14\mu$ towards the apex and $44-48\mu$ near the base.

(iv) *Diameter of the pore-tubes.* The diameter about the middle of the pore-tubes does not vary much in Type-I and Type II, being $60-110\mu$ in the former and $60-120\mu$ in the latter, but in Type-III it is very much widened and ranges from $150-300\mu$.

(v) *Length and width of basidia and basidiospores.* The shape and size of the basidia and basidiospores in Types I and II agree more or less closely with each other. The basidia in Type-III appear to be larger although the basidiospores do not vary much with those in other two types so far as their measurements are concerned. Table 1 will furnish the relevant data.

Table 1. *Basidia and basidiospores of Polystictus xanthopus*

	Type I	Type II	Type III
Basidia	Broadly clavate, tetra-sterigmatic and quadri-sporous; dimension about $12.2-13.5 \times 3\mu$.	Broadly clavate, mostly di-sterigmatic and bi-sporous; some tetra-sterigmatic and quadri-sporous; dimension about $12-13 \times 3-3.5\mu$.	Clavate, elongated, tetra-sterigmatic with long sterigmata and quadri-sporous; dimension about $18-19 \times 5.5-6\mu$.
Basidiospores	Oval to cylindrical, sometimes slightly curved; hyaline, thin-walled, smooth; dimension about $5-5.5 \times 2-2.2\mu$.	Shape and structure like those in Type-I; dimension about $5.4 \times 1.5-2\mu$.	Mostly oval to sub-cylindric; hyaline, thin-walled, smooth; dimension about $6.4-7.5 \times 3\mu$.

(vi) *Hyphal characteristics.* In hyphal composition of the fruit-bodies, there appear to exist two distinct groups. Fructifications of Types I and II together form one group in which all the four types of hyphae, viz., *generative*, *skeletal*, *mediate* and *binding*, as defined by Corner (1932), are present. Fructification of Type-III alone forms the other group in which there is a tendency towards the elimination of binding hyphae. The hyphal composition of the three types of fruit-bodies has been summarized in Table 2.

Table 2. *Hyphal system in the three types of fruit-bodies of Polystictus xanthopus*

Generative hyphae	Frequent; usually thin-walled, sometimes the walls become slightly thick but with uniform linear lumen; branched extensively or sparingly; longitudinal or interwoven; hyaline; about $1.5-3$ (4) μ wide; usually nodose septate and having a simple clamp-connection at each septum; with abundant protoplasmic contents, in the older portions contents becoming scanty. (Text-fig. 1, a)	Frequent; characters same as those in Type-I; about $2-6\mu$ in diameter. (Text-fig. 1, a)	Very abundant; profusely branched and interwoven; width varying from $2-3$ (4) μ ; full of granular contents; nodose septate; branches often becoming narrow, coralloid, nodulose or spiculiferous; general characteristics like those in Type-I. (Text-fig. 1, a-c)
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	Type I	Type II	Type III
Skeletal hyphae	Most abundant; thick-walled; straight or slightly flexuous; unbranched; more or less longitudinal; without clamp-connexions; hyaline to pale yellow in colour; about $2-6\mu$ wide; wall thickness very variable, in some cases lumen almost obliterated in mature parts, sometimes uniformly thick throughout; apices mostly thin-walled, usually aseptate, but in a few occasional septa may be present. (Text-fig. 1, b)	Most abundant; characteristics more or less similar to those in Type-I; width of the hyphae $4-6\mu$. (Text-fig. 1, b-c)	Very abundant; mostly flexuous but sometimes straight; usually interwoven due to flexuous nature; hyaline to yellowish brown in mass; about $5-6\mu$ wide; other characters similar to those in Type-I. (Text-fig. 1, d)
Mediate hyphae	Frequent, more or less uniformly thick-walled, with lumen linear; usually aseptate, a few occasional septa may be present; pale yellow in colour about $1.5-3.5\mu$ wide; straight or slightly flexuous; somewhat interwoven; scanty granular contents may be present; apices thin-walled with granular contents. (Text-fig. 1, c-d)	Present but less frequent; characters similar to those in Type-I; about $2-4.5\mu$ wide. (Text-fig. 1, d-e)	Present but comparatively very few; about $2-4\mu$ wide; characters similar to those in Type-I. (Text-fig. 1, e-f)
Binding hyphae	Frequent; thick-walled; much branched; often intertwining or twisted, usually coiling around skeletal and mediate hyphae, sometimes coralloid, nodulose or spiciferous; without clamp-connexions; mostly hyaline to pale yellow coloured; about $1-2.5(3)\mu$ wide; wall thickness variable with lumen linear or obliterated in older parts; apices thin-walled with few granular contents. (Text-fig. 1, e-g)	Frequent; characters more or less similar to those in Type-I; width varies between $1.5-2.5(3)\mu$. (Text-fig. 1, f)	Not in evidence; structures appearing as binding hyphae are in reality much branched generative hyphae.

FUNGUS IN CULTURE

A. Cultural Characteristics

(i) On agar medium

So far as the authors are aware, nothing is known about the cultural characteristics of *Polystictus xanthopus*. For studying the cultural characteristics of the three forms recognized by the writers, polysporous mycelia of all the types were grown separately on *potato-dextrose-agar* in Petri-dishes (90 mm. in diameter). The medium was prepared, according to the recipe of Fritz (1923). The cultures were grown in complete darkness under ordinary conditions of temperature (28°–30°C.) of the laboratory. In order to maintain the size of the inocula as constant as possible, small discs (5 mm. in diameter) of agar with the polysporous mycelium of each type were cut out from the periphery of the advancing mycelium by means of a sterile cork-borer from 7-days-old culture. Each disc was then placed with upside downwards upon the medium at the centre of the Petri-dish containing approximately about 30 c.cm. of the medium. The pH value of the medium after sterilization was found to be 5.2. Observations were based on an average of four Petri-dish cultures of each type. The terms used to describe the texture of the mat are those proposed by Nobles (1948) and the colour exhibited by the mycelium has been expressed, according to Ridgway (1912). The cultural characteristics of the three types have been described below separately.

Type-I (Plate II, fig. 7)

(i) *Habit of growth.* In all cases, growth started with much rapidity and within 24 hours after inoculation, formed a thin, cottony mycelium over the surface of the inoculum. Within the next 24 to 36 hours, growth appeared over the agar medium forming an appressed mycelium which later tended to become somewhat raised and cottony towards the periphery, while the mycelium over the inoculum turned somewhat felty. As the growth advanced, the superficial mat gradually condensed and in about six days after inoculation it was differentiated into an outer raised felty zone surrounding a central appressed area. On the tenth day the central zone was somewhat lacunose and the peripheral zone became slightly raised and felty to farinaceous. No further change in the habit of growth was, however, noticed even in cultures 15 to 20-days-old, excepting the mycelium appeared to be more compact. No change in colour of the medium was noticed in any case.

(ii) *Colour.* The colour of the mycelium was white throughout during the early period of growth, but from the eighth day pigmentation of the mycelium started. At first patches of Light Vinaceous appeared only in the central lacunose zone. A gradual change of colour was, however, noted from the ninth day onwards with the age of the culture and the range of colour included Vinaceous to Drab towards the centre and

Pinkish-Buff with Apricot Buff spots here and there towards the periphery.

(iii) *Rate of growth.* The rate of growth was more or less uniform from the very beginning and increased about 5 mm. daily in radial direction.

Type-II (Plate II, fig. 8)

(i) *Habit of growth.* Growth started with moderate rapidity forming thin mycelium over the inoculum within 24 hours after inoculation. On the following day it turned somewhat patchy felty and became surrounded by a thin, narrow zone of appressed mycelium over the agar medium. On the fourth day the major portion of the superficial mat became uniformly smooth but tended to become somewhat raised and felty towards the margin and with a narrow appressed zone of advance. Within a couple of days a somewhat rugulose area appeared in the central region of the mat which soon became separated from the inoculum by a slightly raised circular felty area. Towards the periphery of the mat, the texture remained uniform. Between the periphery and the rugulose region, the mat became slightly depressed and assumed Chamoise texture in culture, about 10-days-old. No change in colour of the agar medium was, however, noticed.

(ii) *Colour.* At the onset, the mycelium was pure white throughout but tinting of the mat started on the sixth day after inoculation. The central area of the mat at first became coloured and the range included Pinkish Cinnamon and Pinkish-Buff. Further change in colour was, however, not noticed excepting in that certain portions of the coloured area became more intense.

(iii) *Rate of growth.* To start with the growth was rather slow but within three to four days after inoculation it became more rapid and remained more or less uniform throughout in all cases. The average daily increment of growth was 5.5 mm. in radial direction.

Type-III (Plate II, fig. 9)

(i) *Habit of growth.* At first the growth was rather slow to start with and within 24 hours after inoculation practically no growth was observed over the inoculum. After 32 to 34 hours, thin, white sub-felty growth could be recognized only over the inoculum which within the next 12 to 16 hours descended over the medium forming a narrow circular zone of appressed and sodden mycelium. As the growth advanced, the superficial mycelium gradually became raised, smooth and felty forming a zone towards the periphery. On the tenth day the superficial mat became smooth and felty throughout, but with two to three raised concentric zones about the middle portion of the mat. No further change in texture was, however, noticed during later stages of development of the mycelium excepting in that it became more or less tightly interwoven. There was no discolouration of the medium during this period.

(ii) *Colour.* At the beginning the colour of the superficial mat was white throughout. On the sixth day of inoculation slight tinting of the

mycelium started at the periphery in the form of a circular zone of Pinkish-Buff while other portion of the mat remained white. With age, pigmentation gradually extended towards the centre showing lighter shades on the tenth day. Finally, the colouration of the mat deepened and showed gradual shades of Saccardo's Umber, Twany-Olive and Pinkish-Buff from the periphery to the centre.

(iii) *Rate of growth.* Although the growth started slowly, the mycelium soon became active and subsequently grew more or less at uniform rate. The daily increment of growth was found to be 4.5 mm. in radial direction.

In Table 3 a comparative account of the cultural characteristics of the mycelia of the three types of *Polystictus xanthopus* on the tenth day on *potato-dextrose-agar* has been summarized.

Table 3. *Comparative cultural characteristics of the mycelia of the three types of Polystictus xanthopus on the tenth day of inoculation on potato-dextrose-agar.*

	Type-I	Type-II	Type-III
Habit of Growth	Growth slightly raised, felty to farinaceous towards the periphery, surrounding a central lacunose zone.	Peripheral region somewhat raised and uniformly felty; behind it a slightly depressed Chamoise zone surrounding a central somewhat rugulose area.	Smooth and felty throughout but with two to three raised concentric zones about the middle portion of the mat.
Colour	Light Vinaceous towards the centre and a few Pinkish-Buff spots here and there towards the white peripheral mat.	Central portion of the mat showing shades of Pinkish Cinnamon and Pale Pinkish-Buff; other portions white.	Pinkish-Buff peripheral zone with lighter shades extending from the periphery towards the white central region.
Daily increment of growth	Uniform; 5 mm. in radial direction.	Uniform; 5.5 mm. in radial direction.	Uniform; 4.5 mm. in radial direction.

(ii) On wood-blocks (Plate II, figs. 10-12)

Growth characteristics of the superficial mycelia on sapwood blocks of *Sāl* were also studied (Plate II, figs. 10-12). For this purpose, several Kolle flasks, each containing sterile 2.5% *malt-agar* slants, were inoculated with polysporous mycelia of the three types of *Polystictus xanthopus* separately and after 10-days-growth, several water-soaked sapwood blocks were exposed to them. These flasks were then kept in complete darkness and room temperature (25°-30°C) of the laboratory.

After three to four days, almost all the blocks were attacked and partly covered by the mycelia, but the rate of growth in case of Type-III appeared to be rather slow. The mycelium in each case was white throughout at the beginning. On the seventh day after exposure of the wood-blocks, very luxuriant growth of the mycelium of Type-II was observed and the texture was Chamoise like in appearance. In case of Type-I, the free faces of the wood-blocks were covered with densely felty to cottony mycelium, which later became more active and uniformly compact. The growth of the mycelium in case of Type-III was somewhat thin and cottony which later became compact to form patchy felty areas while the other portions remained as before. Gradually, shades of colour appeared in all cases. In Type-I, the mycelium at first turned Vinaceous which later deepened to Drab colour in about a month. In Type-II, the mycelium became Pale Pinkish-Cinnamon and remained in that condition during subsequent stages of development. In Type-III, the mycelium turned Pinkish-Buff at places and no further change of colour was observed in this case even in cultures 1-month-old.

B. *Oxidase Tests* (Plate II, figs. 13-18)

Oxidase tests, as originally recommended by Bavendamm (1928) to distinguish a "white rot" fungus from the "brown rot" type, were also performed. These tests were made in the laboratory by growing polysporous mycelia of the three types of *Polystictus xanthopus* on 2.5% malt-agar containing 0.5% gallic or tannic acid in Petri-dishes. Dark brown rings due to the presence of oxidase appeared in all cases within 36-48 hours indicating that all the three types of mycelia are capable of decomposing lignin constituents of the wood and can be considered positive reactors. Therefore, they are all of "white rot" type. In general, the intensity of reaction was greater on gallic acid medium than that on the medium containing tannic acid due to both types I and II while the reverse condition prevailed in case of Type-III. The variation in the intensity of reaction and diameters of the diffusing zones after 48 hours have been shown in a comparative way in Table 4. The terms used in describing the intensity of reaction are those of Nobles (1948).

Table 4. *Comparative account of the oxidase activities of the polysporous mycelia of the three types of Polystictus xanthopus.*

		Type-I	Type-II	Type-III
Tannic acid	Diameter	20 mm.	17 mm.	22 mm.
	Intensity	Strong	Moderately Strong	Very Strong
Gallic acid	Diameter	17 mm.	20 mm.	18 mm.
	Intensity	Strong	Strong	Strong

C. *Effects of acidity and alkalinity* (Plate IV, figs. 31-42)

In order to find out whether there was any variation in the rate of growth of the polysporous mycelia of the three types of *Polystictus xanthopus* in a medium having different pH, an experiment was set up. The medium taken was 2.5% malt-agar and N./10 HCl and N./50 NaOH solutions were used as acid and alkali to prepare four different pH grades, viz., 4, 6, 8, and 10, two on the acid side and two on the alkali. A small disc of inoculum was put at the centre of each plate with the mycelial side downwards. The inoculated plates were then kept in diffused light and at room-temperature (28°-32°C.) of the laboratory.

In all cases, except in Type-III, growth started after 24 hours while in Type-III it was evident in about 36 hours. On the fifth day of inoculation the variation in the rate of growth of the three types of mycelia were noted as shown in Table 5.

Table 5. *Comparative data showing the rate of growth in diameter of the three types of mycelia of Polystictus xanthopus on the fifth day after inoculation on malt-agar having different pH.*

pH (range)	Type-I	Type-II	Type-III
4	5.5 cm.	6.6 cm.	5 cm.
6	6 cm.	5.5 cm.	5.7 cm.
8	4.2 cm.	3.5 cm.	3.5 cm.
10	2 cm.	1.5 cm.	1.7 cm.

From the table it is evident that there is no marked variation in the rate of growth of the three types of mycelia on a medium having different pH. There is, however, a decline in the rate of growth in Types I and III on both sides of pH 6. In Type-II, on the other hand, this decline in the rate of growth becomes evident even from pH 6. That is to say, the growth in diameter of the colonies is maximum in pH 6 in Types I and III, while in Type-II it is maximum in pH 4. In pH 10, the growth of mycelia of all the types is considerably checked.

D. *Hyphal Characteristics*

In all cases preparations for microscopic examination were made of mycelium mounted directly in water and examined with the aid of a Phase-contrast microscope. For making permanent preparations, hyphae from different regions of the mat were mounted in Erythrosine-glycerine-agar jelly. In order to note size, form and gradual differentiation of the actively growing hyphae, observations were made from different regions of 7, 10 and 14-days-old cultures beginning from the periphery to the centre of the mat before it attained tough consistency.

In describing the different types of hyphae, the descriptive terms as proposed by Corner (1932) have been used throughout. In order to avoid unnecessary repetition a full description of the hyphal types and their

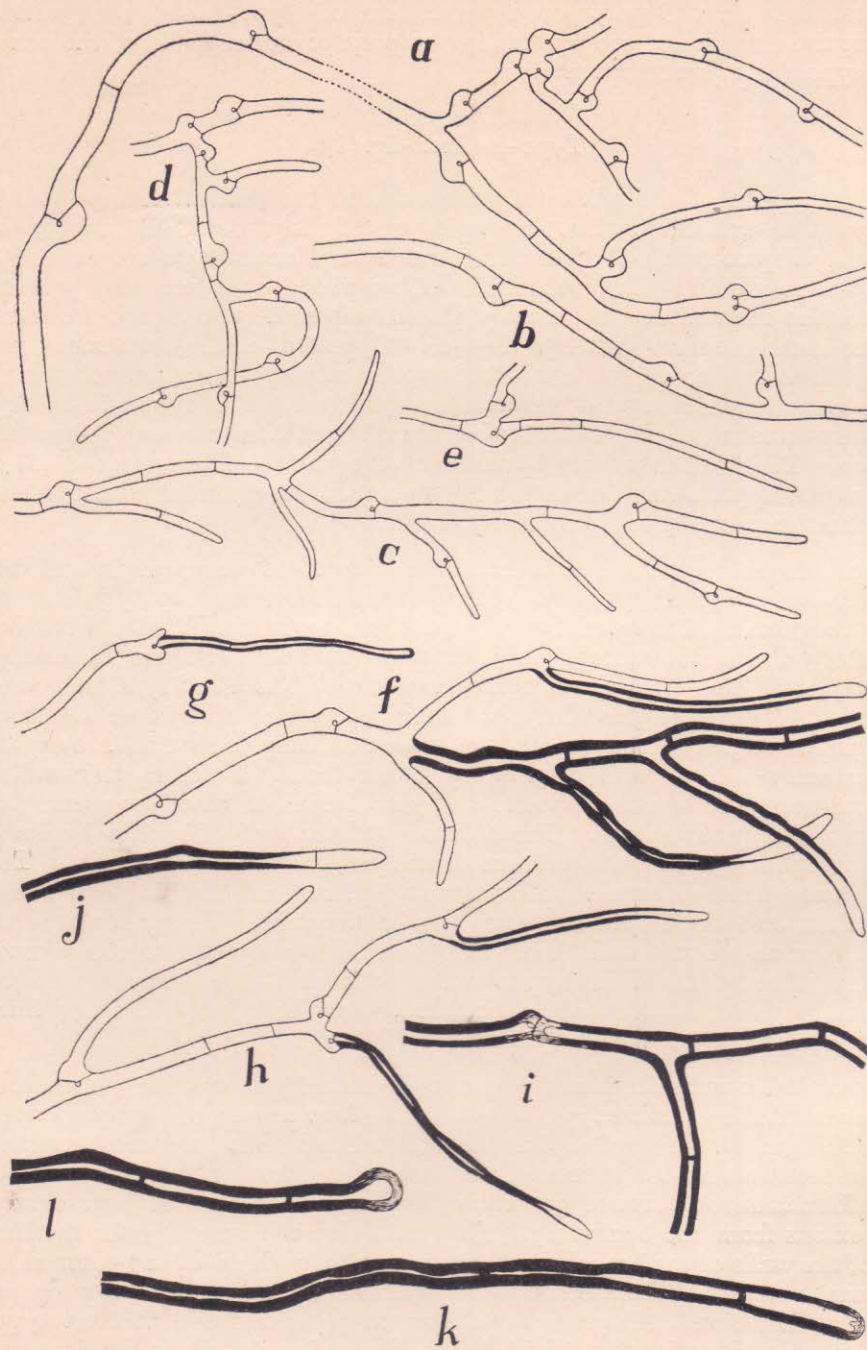
interrelations in the polysporous mycelium of Type-I and the salient descriptive features of the hyphae in the polysporous mycelia of the other two types are given separately.

Type-I (Text-fig. 2)

The hyphae of the advancing zone are of the *generative type* being always thin-walled, hyaline, straight or slightly flexuous, closely or distantly septate, full of granular contents and usually bearing a single clamp-connexion at each septum. Many plain septa are also present. The clamp-connexions are usually found alternately on opposite sides of the same hypha (Text-fig. 2, a-e). Opposite clamp-connexions are rarely found (Text-fig. 2, a). The hyphae are sparingly branched and each branch either originates from the opposite side of a hypha just below a clamp-connexion or the clamp-connexion proliferates and forms the branch. The width of the hyphae is very variable, being 1.5-4 (5) μ . The wider hyphae have been found to contain less granular contents and as such they appear to be more hyaline.

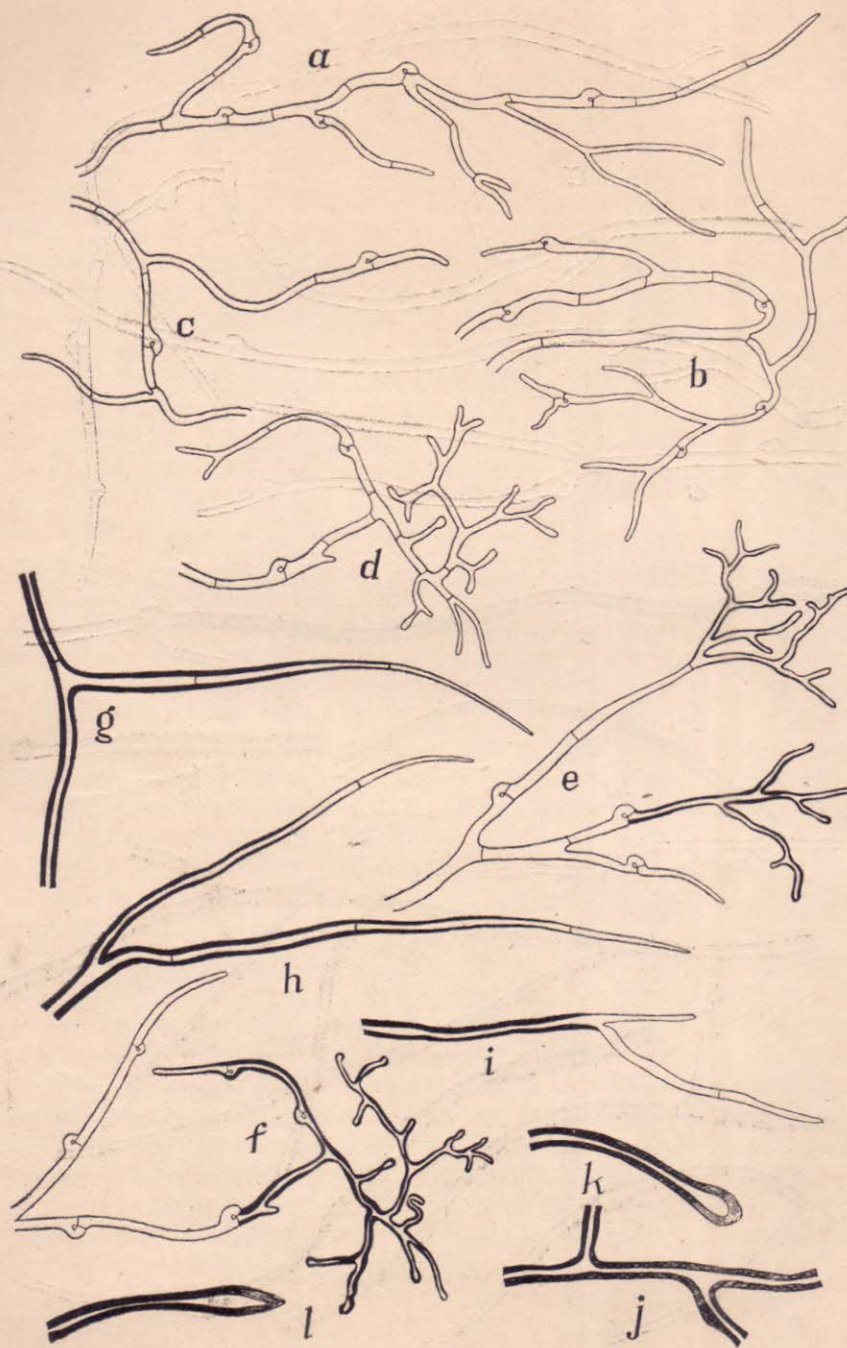
Just in the region a little behind the zone of advance, origin and differentiation of other types of hyphae from the generative type can be well-recognized. The latter type becomes less conspicuous, often branches profusely forming a complicated network and with infrequent clamp-connections. Thick-walled hyphae, mostly of the *skeletal type*, are very abundant at this stage. They are mostly hyaline, always unbranched, straight or slightly flexuous, always without clamp-connexions, aseptate to distantly septate and originating either from the main thin-walled generative hypha on the opposite and just below a clamp-connexion or by its direct proliferation. The thickness of the wall of such a hypha is very variable. It may be uniform or unequal in the same hypha. The lumen sometimes becomes obliterated at places so that its continuity is broken and the hypha appears to be aseptate. The granular contents become fewer and fewer and sometimes appear to be almost absent. The width of the hypha varies between 2-6 μ . The tip of the skeletal hypha is attenuated or rounded, may be thick-walled or thin-walled and sometimes slightly inflated (Text-fig. 2, g-h, i-l).

Some thick-walled hyphae appear to be distantly or sparingly branched, and constitute the *mediate type* (2.5-3.5 μ). They are undoubtedly derived from the generative hyphae like the skeletal type but they are branched and without clamp-connexions. Sometimes they are formed due to direct transformation of parts of generative hyphae which do not bear clamp-connexions from the beginning. They may also be formed by the thickening of the walls of the branched generative hyphae whose clamp-connexions become totally obliterated due to thickening and stretching or by their proliferation. All gradations between generative and mediate types of hyphae are noticeable (Text-fig. 2, f, i). In the older portions and towards the centre of the mat, all the three types of hyphae, namely, generative, skeletal and mediate, can be recognized but of these, the generative type predominates. Some of the generative hyphae are distinctly



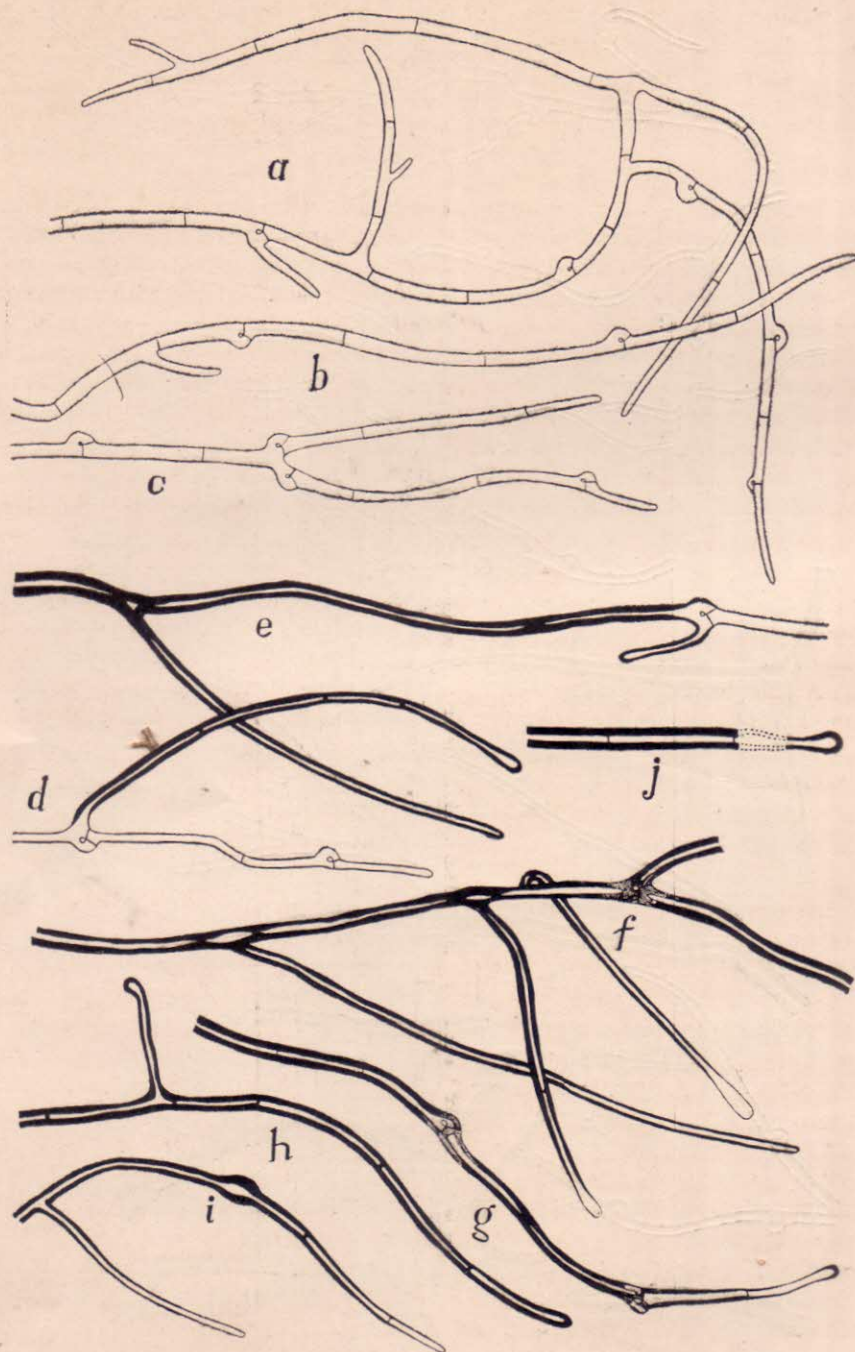
Text-fig. 2. Hyphal system in the polysporous mycelium of *Polystictus xanthopus* (Type-I).
× 1400.

(For explanation, vide text)



Text-fig. 3. Hyphal system in the polysporous mycelium of *Polystictus xanthopus* (Type-II).
× 1400.

(For explanation, vide text)



Text-fig. 4. Hyphal system in the polysporous mycelium of *Polystictus xanthopus* (Type-III).
× 1400.

(For explanation, vide text)

thick-walled and show plenty of proliferating clamp-connexions. The *binding hyphae*, so characteristic of the fructifications of this type, are not in evidence even in old cultures.

Type-II (Text-fig. 3)

As in Type-I, the advancing zone is full of *generative hyphae* ($1-3.5\ \mu$) with abundant simple clamp-connexions and also with plain septa (Text fig. 3 a-d). Partial or entire transformation of some of the generative hyphae into thick-walled branched hyphae with or without clamp-connexions can be clearly seen. This may be designated as much branched *mediate hyphae* and their width varies between $1-2\ (4)\ \mu$ (Text-fig. 3, e, f). Some of the generative hyphae appear to be entirely empty, closely septate and without clamp-connexions. No skeletal hyphae have been differentiated in this region.

In the regions behind the advancing zone and towards the centre, three types of hyphae, viz., generative, mediate and skeletal, become gradually differentiated. The *skeletal hyphae* [$1.7-2.8\ (4)\ \mu$] in the older region of the mat become most abundant. The *generative hyphae* are fewer and there are transitional stages between these and the *mediate type* (Text-fig. 3, e, f). The hyphal characteristics are more or less similar to those in Type-I, but the apices of the skeletal and those of the branches of mediate hyphae ($1-2.5\ \mu$) upto a considerable distance from the tip, remain thin-walled and become gradually attenuated showing nuclei and sparse granular contents within (Text-fig. 3, g, i). The skeletal and mediate hyphae (Text-fig. 3, i-l) are usually uniformly thickened showing more or less linear lumina. Partially twisted or coiled binding hyphae which are present in the fructification of this type cannot be observed.

Type-III (Text-fig. 4)

The same three types of hyphae, viz., *generative*, *skeletal* and *mediate*, enter into the composition of the mycelium of this type. The advancing zone is similar in having only the characteristic generative hyphae (Text-fig. 4, a-c). The width of the generative hyphae vary between $1.5-3.5\ \mu$. The clamp-connexions are comparatively few and the plain septa are frequent. Just behind the zone of advance, only the skeletal hyphae become differentiated from the generative type and they become more and more abundant towards the centre (Text-fig. 4, d, g, i, j). Their characteristics are similar to those found in Type-I. In the central portion of the mat, all the three types of hyphae, viz., generative, skeletal and mediate, are present of which the skeletal type ($2-5\ \mu$) predominates. The mediate hyphae ($2-5\ \mu$) are springly branched (Text-fig. 4, e-f, h) and agree closely with those in the other two types.

ANTAGONISM AND COMPATIBILITY

The nature of antagonism between the polysporous mycelia of the three types of *Polystictus xanthopus* have been ascertained. They were tested on 2.5% *malt-agar* slants in special culture-tubes ($10'' \times 1\frac{1}{2}''$). The

three types of mycelia were paired in all possible combinations. All pairings were run in triplicate and each set repeated at least once. For observing the uniting hyphae *in situ* pairings were made on cleared malt-agar (1%) in Petri-dishes. When the colonies approached each other, the lids of the Petri-dishes were removed and they were directly observed under the microscope.

The mycelia of the three Types show diversity in their reaction in culture which ranges from complete intermingling to apparent antagonism at the point of meeting. The three principal types of reaction observed are: (a) the two colonies either intermingle completely without any apparent antagonism and any line of demarcation between them, (b) the two colonies do not intermingle freely and are apparently separated from each other by a narrow space between them, and (c) two such colonies although intermingle freely yet show a faint line of separation in between them. Close examination of these zones of separation reveals that these are not entirely free from the hyphae of the two interacting aerial mycelia and this is always constant for any pair of cultures.

The advancing hyphae of the two colonies when directly observed under the microscope, it has been found that the hyphae of the interacting mycelia simply cross one another, grow in opposite directions and in no case hyphal fusions have been observed in the early stages. Further observations could not be made during subsequent stages of development due to free intermingling of the hyphae in all directions and the place of contact between the two colonies became somewhat dense.

DECAY-RESISTANCE

In order to determine the rate of decay of sapwood samples of Sāl (*Shorea robusta*) caused by the mycelia of three different forms of *Polystictus xanthopus* decay tests were done in the laboratory. The process in general involved in exposing small sterilized samples of sound sapwood of Sāl to the attack of the mycelia of three different forms of the fungus growing in pure cultures under a set of controlled conditions and the resulting weights of decay were measured by estimating the loss in dry weight. The results also give an indication of the degree of decay-resistance of sapwood of Sāl to the attack of each of the three types of mycelia under consideration. Although various methods on durability tests of different timber were suggested by various workers the writers have followed mainly the method proposed by Banerjee (1956) with some modifications as detailed below.

Small rectangular wood blocks ($1" \times \frac{1}{2}" \times \frac{1}{2}"$) from sound sapwood of *Shorea robusta* were cut uniformly with their long axis parallel to the grain of the wood. These were planed, numbered serially and then dried in an oven at 60°C. to a constant weight. Before sterilization the test-blocks were soaked in distilled water till the moisture-content of each test-piece was 65-70%. This was done in order to ensure proper water supply to the mycelium of the fungus for its activity during the test-period

and it was much above the fibre-saturation-point, (Cartwright and Findlay 1946). Sets of four such test-pieces were introduced into several test-tubes ($10'' \times 1\frac{1}{2}''$) each having a little distilled water at the bottom, plugged and sterilized for ten minutes at 15 lbs. pressure (Banerjee, 1956).

About twelve days before exposing the sterilized test-samples to the mycelia, small bits of actively growing polysporous mycelium of each type were transferred separately to sterile 2% *malt-agar* slants in Kolle flasks. Each flask contained about 80 c.cm. of the medium which was slanted after sterilization. Within a week the mycelium of each flask almost covered the surface of the slant and in about twelve days was ready to receive the test-pieces. At this stage the sterilized wood-blocks were introduced into the Kolle flasks, four in each, and placed over the actively growing mycelium of the fungus. Twelve such test-pieces were exposed to the mycelium of each type. Adequate controls were also prepared in a similar way but without the fungus. These inoculated flasks with controls were kept in darkness and room temperature (28° – 32° C.) of the laboratory during the experimental period.

In order to obtain a significant loss in weight, the period of exposure to fungal attack, in this case, was four months following Cartwright and Findlay's (1946) recommendations. According to them this period is sufficient in order to obtain a fair indication of the rate of decay of wood-samples. At the end of the test-period, the wood-blocks were taken out of the flasks and the superficial mycelia were carefully removed without causing injury to the blocks. Immediately, the initial weights of these blocks were first noted and these were then again dried to a constant weight as before at 60° C. The resulting dry weights were subtracted from the original and the percentage losses based on dry weights of the sound blocks were calculated. Average moisture-content of the test-pieces before and after they were exposed to fungal action were also determined in the same way. The results of the experiment are given in Tables 6-8.

Table 6. *Decay-resistance of sapwood of Shorea robusta after 4-months-test when exposed to the polysporous mycelium of Polystictus xanthopus (Type-I)*

Serial number of blocks	Initial oven-dry weight (gm.) before test	Final oven-dry weight (gm.) after test	Loss	Loss %
1	3.160	2.415	0.745	23.2
2	3.730	3.390	0.340	9.1
3	3.505	3.025	0.480	13.6
4	3.210	2.285	0.925	28.8
5	3.177	2.750	0.427	13.4
6	3.777	2.852	0.925	24.3
7	3.237	2.170	1.067	32.3
8	3.750	2.985	0.765	20.4
9	3.470	2.915	0.555	15.9
10	3.485	3.175	0.310	8.9
11	3.142	2.440	0.702	22.3
12	3.527	2.910	0.617	17.5

Average loss in dry weight (%) = 19.1

Table 7. *Decay-resistance of sapwood of Shorea robusta after 4-months-test when exposed to the polysporous mycelium of Polystictus xanthospus (Type-II)*

Serial number of blocks	Initial oven-dry weight (gm.) before test	Final oven-dry weight (gm.) after test	Loss	Loss %
1	3.077	2.670	0.407	13.2
2	3.435	3.220	0.115	3.3
3	3.155	2.760	0.395	12.5
4	3.532	3.200	0.332	9.4
5	3.755	3.625	0.130	3.5
6	3.462	3.305	0.157	4.4
7	3.665	3.415	0.250	7.3
8	3.930	3.285	0.645	16.4
9	3.857	3.740	0.117	3.1
10	3.115	2.640	0.475	15.2
11	3.655	3.205	0.450	12.6
12	3.300	2.920	0.380	11.5

Average loss in dry weight (%) = 9.36

Table 8. *Decay-resistance of sapwood of Shorea robusta after 4-months-test when exposed to the polysporous mycelium of Polystictus xanthopus (Type-III)*

Serial number of blocks	Initial oven-dry weight (gm.) before test	Final oven-dry weight (gm.) after test	Loss	Loss %
1	3.467	3.025	0.442	2.7
2	3.350	3.285	0.065	1.9
3	3.980	3.645	0.245	5.2
4	3.535	3.180	0.355	10.0
5	3.637	3.492	0.145	3.9
6	3.552	3.420	0.132	3.8
7	3.542	3.320	0.222	6.2
8	3.357	3.175	0.182	5.4
9	3.285	3.150	0.135	4.1
10	3.690	3.460	0.230	6.2
11	3.722	3.605	0.117	3.1
12	3.885	3.550	0.335	8.5

Average loss in dry weight (%) = 5.0

From the Tables, it is clear that the average loss in dry weight of sapwood blocks is maximum in Type-I where it is 19.1% and those in Type-II and Type-III are 9.3% and 5.0% respectively, after 4-months-test. Thus, the losses in the sapwood blocks due to mycelial infection of Types II and III are very little in comparison to that in the sapwood blocks caused by the polysporous mycelium of Type-I. Findlay (1938) has classified the timbers into five groups according to their natural resistance to fungal decay on the basis of a four-months-test. Here, the decay of sapwood caused by Type-I comes under Findlay's 'non-resistant' group as the average loss in dry weight in the sapwood due to this type is within 10-30%. On the contrary, the sapwood can be termed 'moderately resistant' and

'resistant' to the attacks by the Types II and III as the former causes average loss in weight within 5-10% and the latter within 5% during 4-months-test. Thus, it is evident that the sapwood of *Shorea robusta* greatly differ in their degrees of natural resistance to decay caused by the polysporous mycelia of the three types of *Polystictus xanthopus*. In this connection, it has been noted that in all cases the controls show very little or no loss of weight after the experimental period.

After the test-period, the average moisture-content of the sapwood blocks was again determined. It was found that it came down from 65-75% to 40%. No attempt was, however, made to control the exact moisture-content of the wood-blocks during the test-period. Nevertheless, it clearly indicates that the moisture-content in general remained above the fibre-saturation-point and consequently it was sufficient for the normal activity of the mycelia of the three types of *Polystictus xanthopus* in bringing about the losses.

REACTIONS TO ZINC CHLORIDE

In order to determine whether the polysporous mycelia of the three types of *Polystictus xanthopus* react differently to a toxic substance or not, toxicity tests were made by using zinc chloride as the toxic substance. This inorganic salt, a common wood preservative, was selected because of the ease of handling and it could be easily used with an agar medium in Petri-dishes. It is well known that the toxicity of a wood-preservative is one of the important factors influencing its effectiveness on wood and this property can be readily evaluated by making laboratory tests. There are two outstanding methods for carrying out toxicity tests. The American workers prefer the use of an agar medium in which to test the wood-preservative while the European and other methods favour the use of wood as the medium with which the wood-preservative is tested. Since the present investigation is not for evaluating the effectiveness of various preservatives and their toxicity to fungi, the writers have preferred to follow the former method by using a malt agar medium to which zinc chloride as an antiseptic was added.

For this purpose by adding requisite quantities of sterile zinc chloride solution in distilled water (1%) to sterilised *malt-agar* medium (2.5%) in Petri-dishes the following concentrations (%) of zinc chloride were obtained: 0, 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09 and 0.1. The Petri-dishes were inoculated with the mycelia of all the three types and were allowed to grow for a week in ordinary conditions of diffused light and temperature (28-30°C.) of the laboratory. After the test-period, it was found that only the growth of the mycelium of Type-III was completely checked (Plate III, figs. 27-30) in the medium containing 0.1% zinc chloride while others remained almost unaffected excepting in that the rate of growth in Type-I became slightly slower.

Consequently, subsequent trials were given with a higher concentration of zinc chloride using 2% sterile stock solution and the grades were

0.1, 0.12, 0.13, 0.14, 0.15, 0.16, 0.17, 0.18, 0.19 and 0.2 per cent. Similarly, the plates were inoculated with mycelia of Types I and II. After 7-days-test, the growth of the mycelium of Type-I was only inhibited completely in 0.16% (Plate III, figs. 19-22) concentration of zinc chloride while the mycelium of Type-II although not inhibited completely in these concentrations yet showed a gradual decline in the rate of growth from concentration 0.16 to 0.2 per cent (Plate III, figs. 23-24).

Finally, in order to determine the point of inhibition of the mycelium of Type-III similar tests were performed with still higher concentrations of zinc chloride (0.22, 0.24, 0.26 and 0.28 per cent) using 3% sterile stock solution. After a week's test, it was found that the growth of the mycelium was completely checked in 0.24% concentration of zinc chloride (Plate III, figs. 25-26).

Thus, the reactions and the power of tolerance of the mycelia of the three types to a toxic substance are different for each type which appear to be maximum in Type-II, minimum in Type-III while the mycelium of Type-I may be placed in the intermediate category.

DISCUSSION

A comparative study of the different forms of *Polystictus xanthopus* recognized by the writers as Types I, II and III, makes it possible to discuss in a general way some of the salient points regarding the relationship that exists between them. From the previous literature, it appears that there exists two varieties of *Polystictus xanthopus* (here recognized as Types II and III) which not only differ from each other but also from the typical form (Type-I) in the character of the hymenial surface. Closer examination of the three types of fructification of the fungus and their subsequent study, however, reveal that this separation is somewhat justified. This separation into three types by macroscopic characters alone cannot, however, be substantiated in all cases by microscopic characters and in other details. From the thickness of the context, the length of the pore-tubes and the width of the dissepiments, it can be stated that all the three types vary greatly from one another but in the diameter of the pore-tubes, Type-I resembles closely Type-II while Type-III forms a separate group possessing much wider pores. The dimensions of the basidia and basidiospores in Types I and II are also more or less the same but they are much bigger in Type-III.

The hyphal composition of the fructifications of Types I and II appear to be similar in having all the four types of hyphae, viz., *generative*, *skeletal*, *mediate* and *binding*. In Type-II, on the other hand, the binding hyphae are totally absent. There are, however, some much branched generative hyphae which look somewhat like the binding hyphae and these seem to be the transitional stages between the generative and the binding types. Further, the widths of the different types of hyphae of the fruit-bodies of Types I and III vary within limits while those of Type-II exhibit a wider range.

As regards the growth characteristics on agar medium, there exists slight variation in texture, colour and rate of growth between the mycelia of all the three types. The mycelia of Types I and II are fast growers at the onset while that in Type-III, the initiation of growth is much delayed. During the later stages, however, the daily increment of growth in all the three types, is more or less the same. This is also seen in wood-block cultures of all the three types in which the growth characteristics in Types I and II have been found to resemble more or less closely with each other while that in Type-III is less pronounced and the mycelium exhibits poor growth. There is also a difference in reaction to oixdase tests, although all the types are positive reactors. The Types I and II, differing only in their intensity of reaction, behave more or less similarly on both gallic and tannic acid media. In each case, however, the reaction appears to be more pronounced in gallic acid medium than that in the other. In Type-III, on the other hand, the reaction is much more vigorous in tannic acid medium.

From a comparative study of the effects of the variation of pH on growth of the three types of mycelia, it can be said that the difference in pH of the medium has but very little effect on the rate of growth of the colonies. As alkalinity of the medium increases to pH 10, growth in all cases is considerably checked. On the acid side (pH 4) the growth of the colonies is also slowed down excepting that in Type-II. The maximum growth in the diameter of the colony has been observed in pH 6 in both Types I and III whereas, in Type-II, there is a gradual decline in growth of the colony from pH 6-10.

The mycelia of all the three types are composed of *generative*, *skeletal* and *mediate* hyphae only. The *binding* hyphae which are characteristic of the fructifications of Types I and II, are not differentiated at this stage. Further, the modes of development of the skeletal and mediate types from the generative hyphae are identical in all cases. In other minor details, slight differences between them do occur but these appear to be of not much significance.

From the decay-resistance tests it has been found that the three types differ markedly in their ability to decay the sapwood of Säl. Of these, Type-I appears to be most active in its ability to decay sapwood and as such the wood falls under the 'non-resistant' group. In other cases the sapwood of Säl is 'moderately resistant' and 'resistant' to the attacks by Types II and III respectively.

In the power of tolerance of toxic substance like zinc chloride, the three types also differ from one another. The growth of the mycelium in Type-III is totally checked in 0.1% of zinc chloride and has been found to be the weakest of all the three types in so far as their power of tolerance is concerned. On the other hand, the power of tolerance is maximum in Type-II where the inhibition point is 0.22%. Type-I falls under the intermediate category, the point of inhibition being 0.14%.

Pairing experiments with the polysporous mycelia of all the three types reveal that their interaction varies from complete intermingling to

apparent inhibition of growth at the place of contact between the two reacting mycelia. The Types I and II have been found to be apparently antagonistic to each other while it is homogeneous without any antagonism between mycelia of Types I and III. The reaction between the mycelia of Types II and III is intermediate with slight tendency towards antagonism and showing a faint line of aversion between them. In all cases, however, free intermingling of hyphae takes place but in no case hyphal fusion between the uniting pairs can be observed. Such intersterility between strains, varieties or forms of the same species is, in no way, uncommon as reported by Verrall (1934) in *Fomes igniarius*, Arnold (1935) in *Collybia cirrhata* and Biggs (1937) in *Corticium coronilla*. These are regarded as collective species in which distinct intersterile forms occur and these are further characterised morphologically. This condition also possibly holds good for *Polystictus xanthopus*.

It is often suggested that these differences are due to altitudinal variations which seems to be so untenable, as fructifications of all the three types have been collected from the same locality and growing under identical conditions. Thus, variations within this particular species may possibly be attributed to genetical or other factors rather than ecological ones.

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EXPLANATION OF PLATES I-IV.

PLATE I

Figs. 1-6. The fructifications of *Polystictus xanthopus* showing upper and hymenial surfaces : Type-I (figs. 1 and 2), Type-II (figs. 3 and 4) and Type-III (figs. 5 and 6). Half Nat. size.

PLATE II

Figs. 7-9. Habit of growth of polysporous mycelia of *P. xanthopus* 10-days-old, on malt-agar at 28°-30°C. in darkness : Type-I (fig. 7), Type -II (fig. 8) and Type-III (fig. 9).

Figs. 10-12. Cultures of polysporous mycelia of three types of *P. xanthopus*, about 1-month-old, on sapwood-blocks of *Shorea robusta* at 25°-30°C. in darkness: Type-I (fig. 10), Type-II (fig. 11) and Type-III (fig. 12).

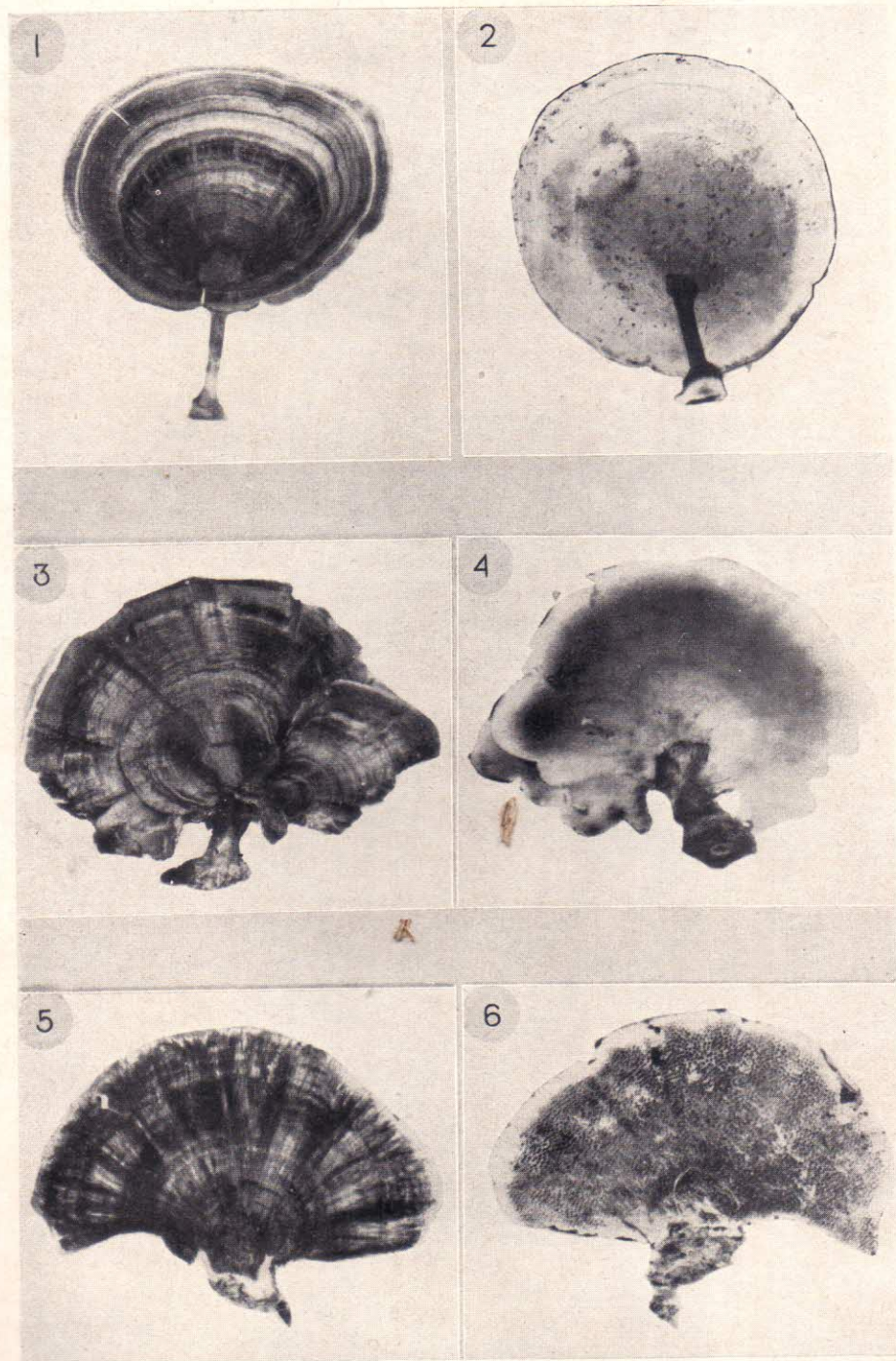
Figs. 13-18. Oxadase tests with the polysporous mycelia of Type-I (figs. 13, 16), Type-II (figs. 14, 17) and Type-III (figs. 15, 18) of *P. xanthopus* on malt-agar containing 0.5% tannic acid (figs. 13-15) and 0.5% gallic acid (figs. 16-18), after 48 hours of inoculation.

PLATE III

Figs. 19-30. The toxic effect of zinc chloride in malt-agar on polysporous mycelia of Type-I (figs. 19-22), Type-II (figs. 23-26) and Type-III (figs. 27-30) of *P. xanthopus* at 28°-30°C. and in the diffused light of the laboratory.

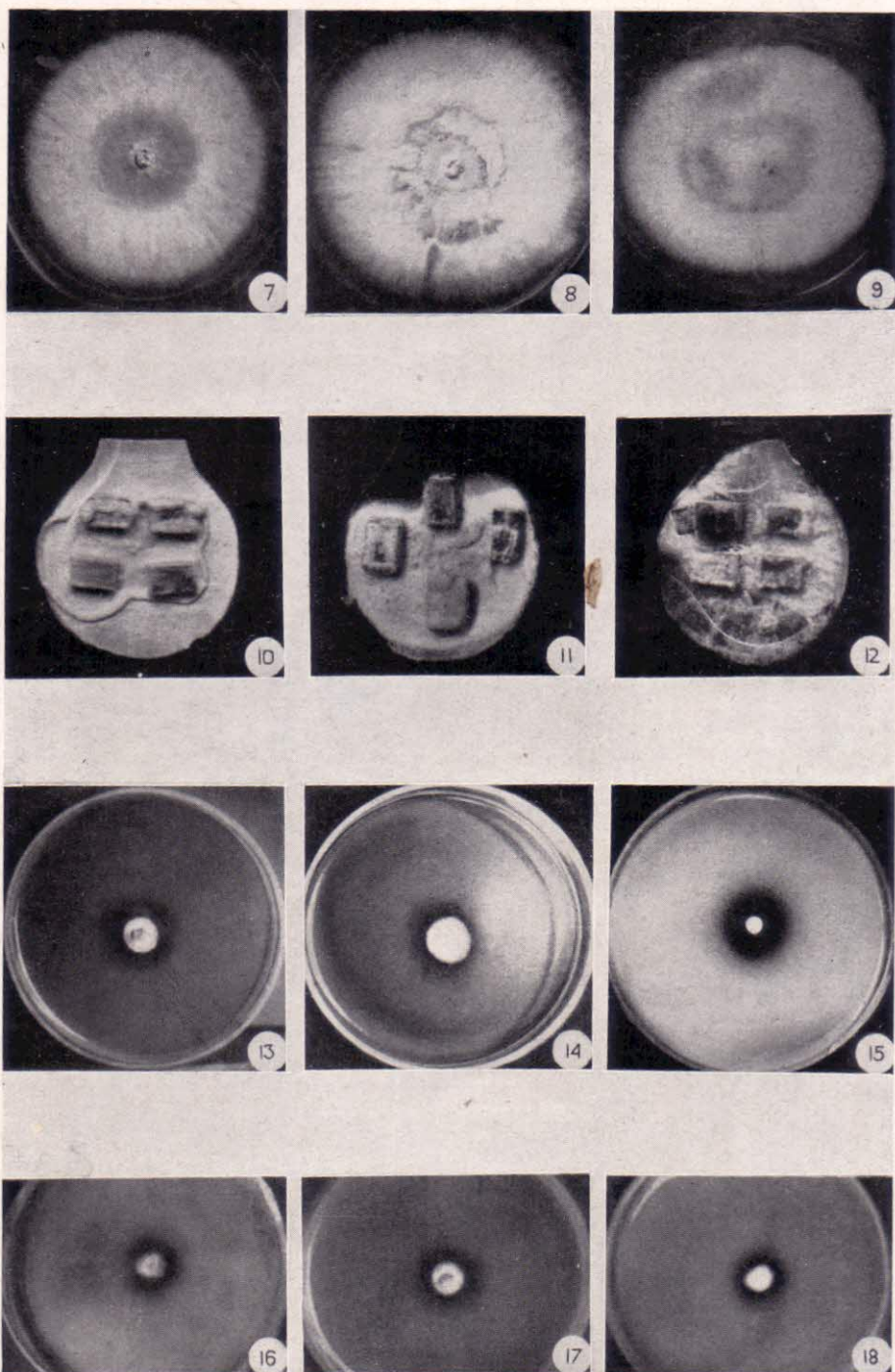
PLATE IV

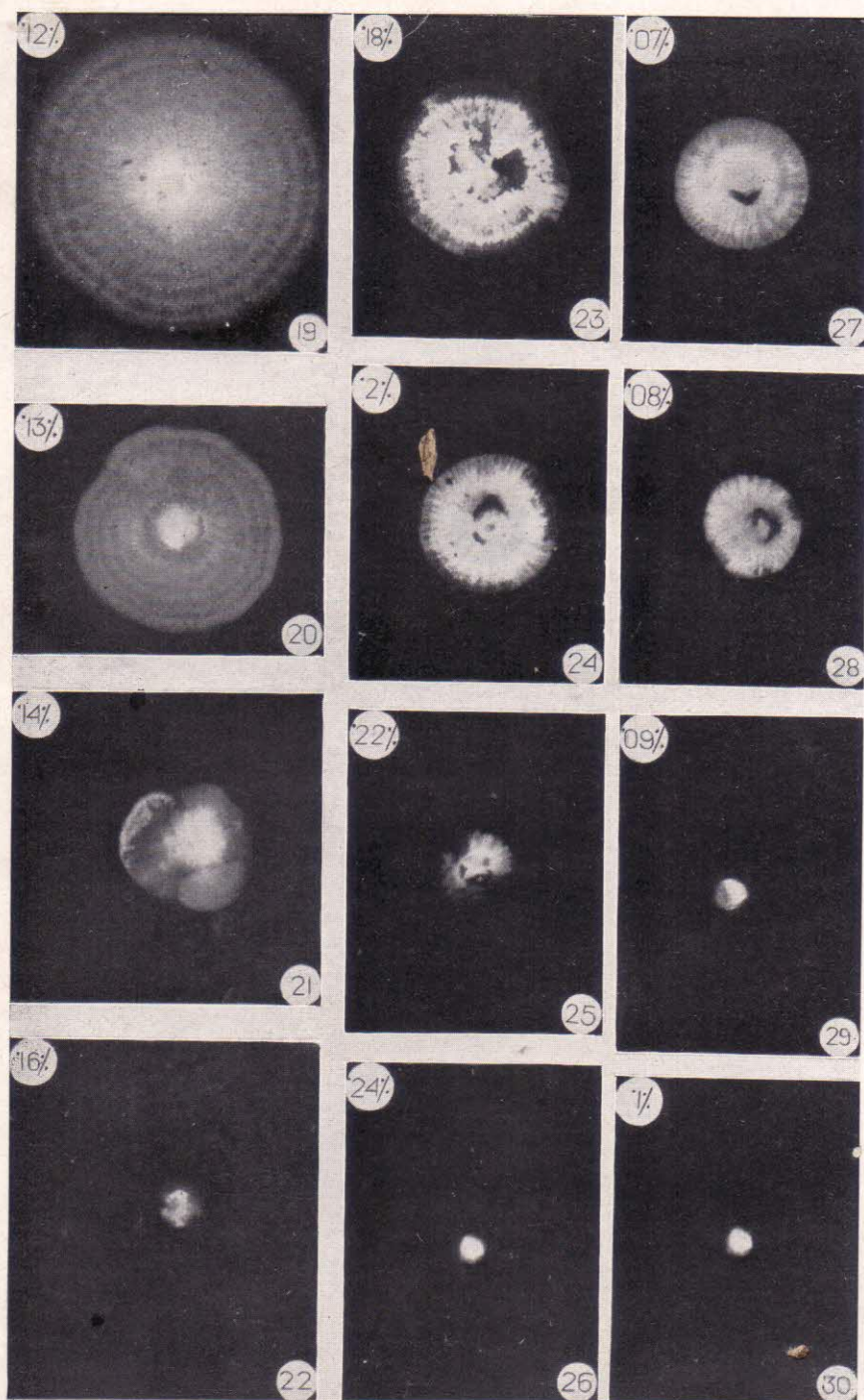
Figs. 31-42. Effects of acidity and alkalinity of malt-agar medium on habit of growth of polysporous mycelia of Type-I (figs. 31-34), Type-II (figs. 35-38) and Type-III (figs. 39-42) of *P. xanthopus* at 28°-32°C. and in the diffused light of the laboratory after five days of inoculation.



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