

## MICROSCOPIC ANALYSIS OF DECAY IN RATTAN (*CALAMUS* SP.)

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The investigation aimed at the analysis of the characteristics of decay in rattan by the electron scanning microscope analysis. The black pitch spots as well as the occurrence of light brown and light blue spots signal the development of wood – destroying fungi.

### INTRODUCTION

Rattan has long played an important role in daily lives of the peoples of tropical countries, especially in Southeast Asia. Rattan, a product of tropical forests, has been used to produce furniture and wickerware since prehistoric times. The rattans were so invaluable to village-life that one can speak of the rattan civilization of Southeast Asia.

Rattan is a primary binding material, because it is long stems of great strength and flexible. In unsplit form it has been used like rope for tying up livestock, securing boats and constructing bridges etc. Rattan has highly varied uses in split form, mainly in the construction of houses.

Besides its use as a binding material, rattan in its split form is an essential ingredient of many necessary household including of furniture and agricultural items. The versatility of rattan in daily village life is tremendous.

In most developing countries rattan furniture is still produced at a craft level. In recent years, many technical developments have taken place in the production of rattan furniture. The rattan furniture is favorite all over the world, mostly as a garden and summer furniture.

### MATERIAL AND METHODS

The investigations aimed at the analysis of the characteristics of decay in rattan in the delivery of garden furniture from Indonesia. The decay was most markedly expressed by black grooves or blisters on the rattan surface and by

black to grey-blue spots on cross cuts (Fig. 1, 2). In furniture production the grooves were masked by plaster (Fig. 2). A less expressive characteristic of decay were the more frequently occurring light brown to light blue spots on the rattan surface.

For microscopic analysis there were prepared preparations for scanning. The preparations were cut in a cross position and cut and split in the radial plane. Coated by gold they were investigated by the Tesla Brno BS 300 electron scanning microscope.

#### DESCRIPTION OF THE RATTAN PLANT

Rattans are the most important group of forest species after timber. Rattans are woody whose natural habitat is tropical rain forest. Rattans belong to the family *Arecaceae* constituting the dominant portion of the subfamily *Lepidocaryoideae*. Rattans are climbing palms that grow at a wide range of altitudes and may be found from sea level up to about 2.900 m in the tropical virgin forests of Africa, Latin America and first of all in Southeast Asia and Pacific. The natural habitat of rattans is the dipterocarp forest, where the forest floor is always rich in humus and the moisture of the soil is always at an adequate level.

The reports indicate that there are 11 genera found in Southeast Asia, with approximatively 550 different species.

The largest genus *Calamus*, 370 species, occurs from West Africa to Fiji and from south China to Queensland. Rattans from other forest species one can easily differentiate, because they are climbing palms with numerous thorns or spines, hairs and bristles scattered all over the plant. Some rattans have leaves with an extended whip-like structure, the flagellum, which is an extension of the leaf (others have the cirrus, which is also whip-like, but is an extension of the leaf sheath). *Calamus* species have both the cirrus and the flagellum. Both cirri and flagella enable the palm to cling and to climb adjacent trees for support. Leaf-form is considerable.

The stem system of rattans is very variable. One of the most important stem variations, and one that has economic significance, is solitary versus clustered stems. Solitary stemmed rattans (*Calamus manan*, *Calamus laerigatus*). Clustering species are re-harvestable (*Calamus caesius*, *Calamus trachycoleus* and all species of genus *Korthalsia*).

Surface characteristics such as color, gloss and texture vary considerably among different species of rattan. This is the reason some rattans are more commercially acceptable than others.

Stem diameter varies considerably. The diameters are ranging from 3 mm to 250 mm and the lengths are extending from a few meters to 200 m. Internodal lengths tend to vary considerably within species, among stems from the same clump or even on the same stem.

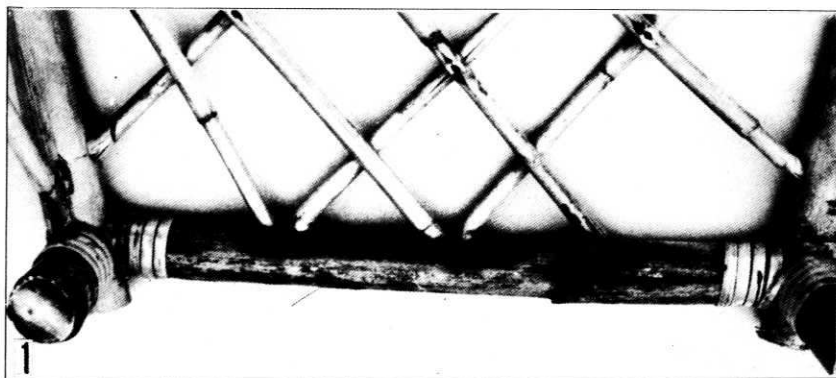


Fig. 1. The part of rattan garden furniture. The black grooves are the results of action of fungi and bacteria and they were masked by plaster during manufacturing  
Rys. 1. Część zestawu mebli ogrodowych z rotangu. Czarne rowki są wynikiem działania grzybów i bakterii. Rowki zostały zakryte kitem stolarskim w toku produkcji mebli

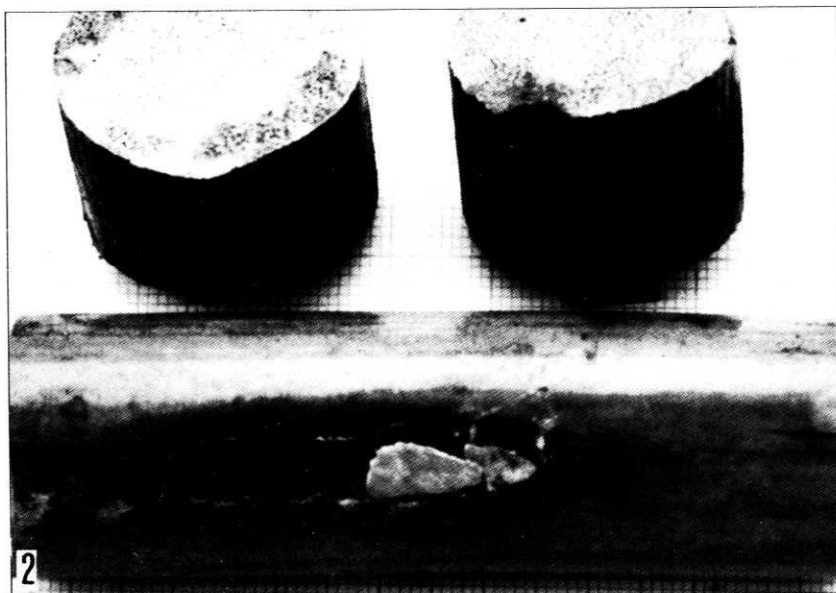


Fig. 2. Detail of the black grooves partly filled in by plaster. On the cross cuts are the grey-blue spots made by fungi

Rys. 2. Szczegół czarnych rowków częściowo wypełnionych kitem stolarskim. Na przekrojach poprzecznych widoczne są szaroniebieskie przebarwienia wywołane przez grzyby

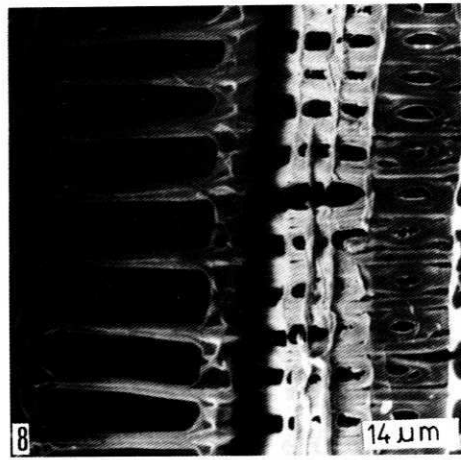
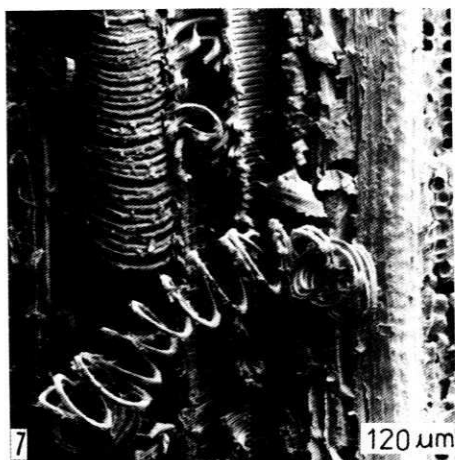
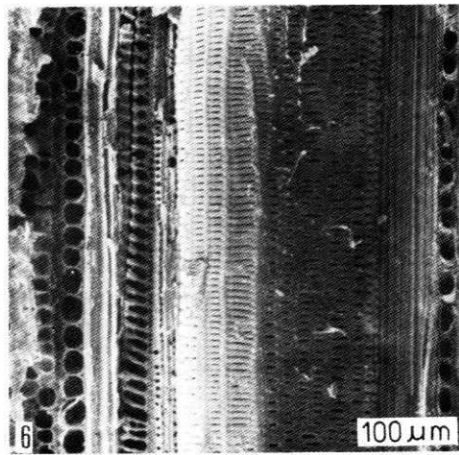
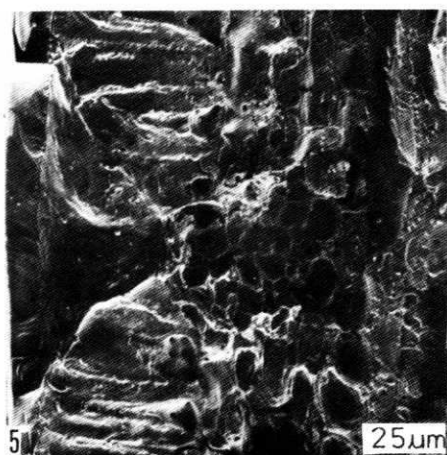
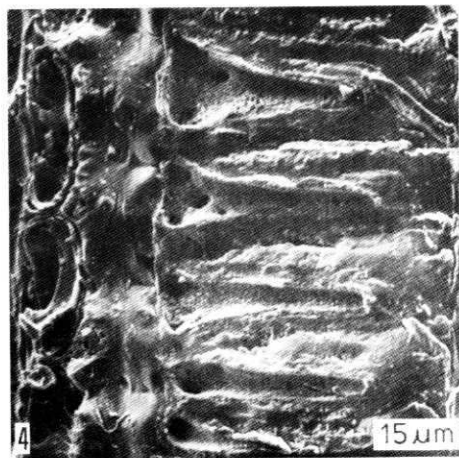
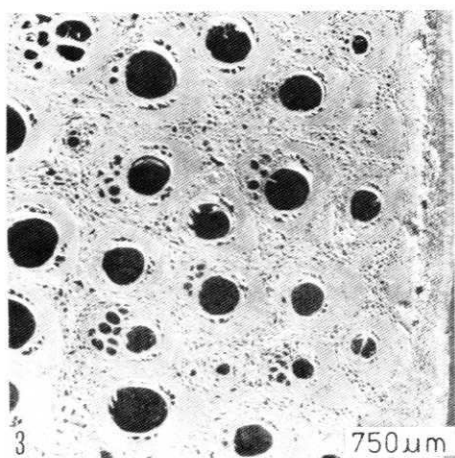


Fig. 3. The cross cut of rattan vessels. The vessels increase from the circumference to the centre. There is a number of parenchyma. On the right side is the narrow layer of of the epidermal coarse-wall ce  
 Rys. 3. Przekrój poprzeczny wiązki sitowo-naczyniowej rotangu. Naczynia mają większe wymiary liczb  
 brzegu do środka. Występuje stosunkowo mała ilość miększu. Z prawej strony wodoczna warstwa kon  
 naskórka

Fig. 4. The epidermal coarse-wall cells with a narrow lumen have the same shape in the radial and cross  
 Rys. 4. Grubościenne komórki naskórka mają taki sam kształt na przekrojach poprzecznym i promieni

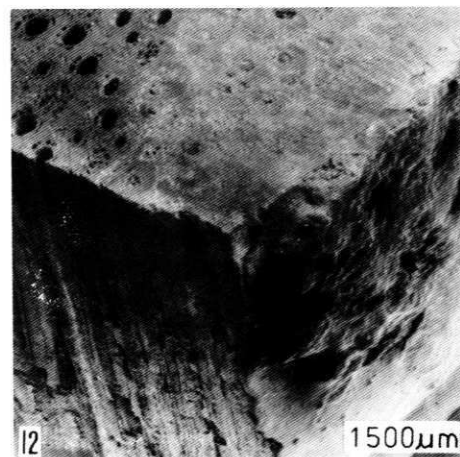
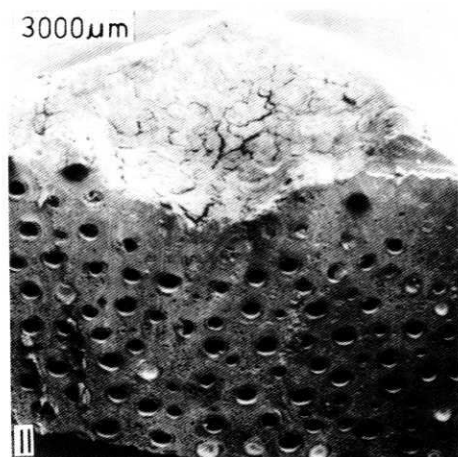
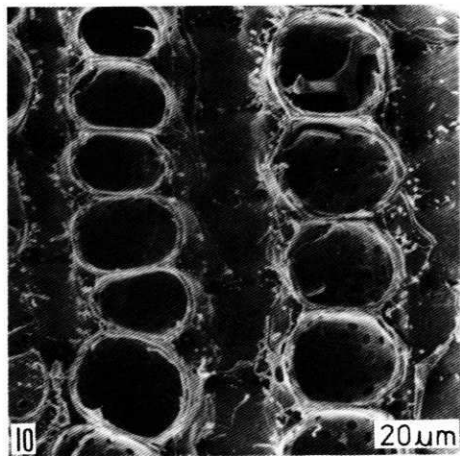
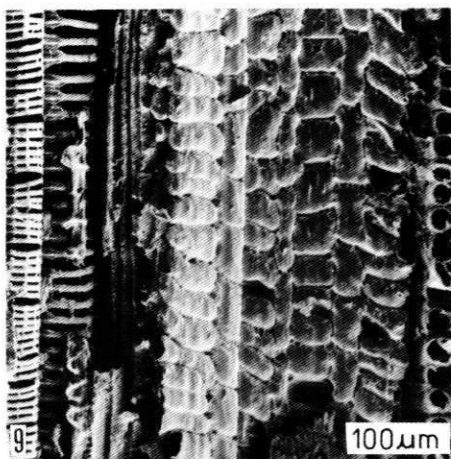


Fig. 5. The epidermis is locally interrupted by lenticels. These openings become a good entrance for parasitic organisms to penetrate to the live cells, to the left on the surface of rattan is a coat of lacquer

Rys. 5. Naskórek jest miejscami poprzerwany komórkami szparkowymi. Te otwory stają się dobrym miejscem wnikania mikroorganizmów do żywych komórek – z lewej strony na powierzchni rotangu znajduje się warstwa lakieru

Fig. 6. The radial middle cut of the large vessel, to the right are narrow grains, to the left is a ring vessel and parenchyma

Rys. 6. Promieniowy przekrój przez środek dużego członu naczynia. Z prawej strony widoczne wąskie włókna, z prawej pierścieniowe naczynie i miękisz

Fig. 7. More often occur the vessels with spiral reinforcement

Rys. 7. Bardzo często występują naczynia ze spiralnym wzmocnieniem

Fig. 8. Detail of the vessel with ring reinforcement

Rys. 8. Szczegół naczynia ze wzmocnieniem pierścieniowym

Fig. 9. After splitting off the large vessel on the radial surface we see the parenchyma which is surrounding it

Rys. 9. Po rozdzieleniu dużego naczynia na powierzchni promieniowej widoczny jest miękisz okołonaczyniowy

Fig. 10. Detail of the parenchyma with occurrence of hyphae

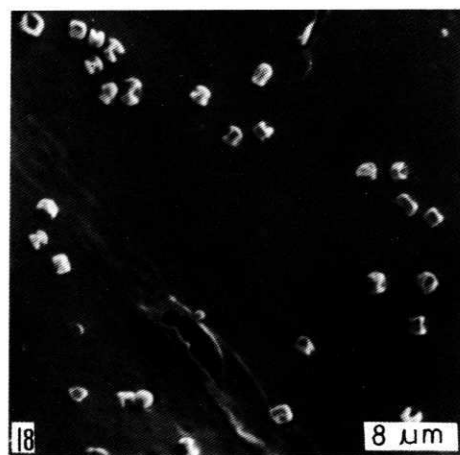
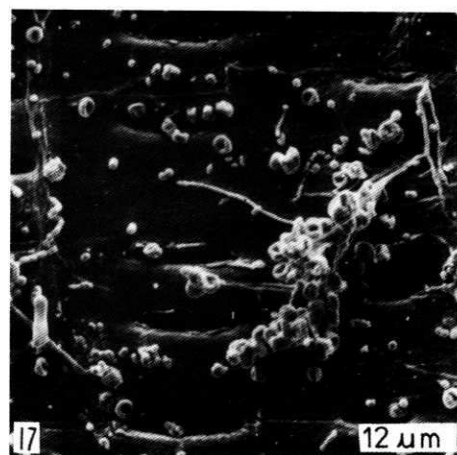
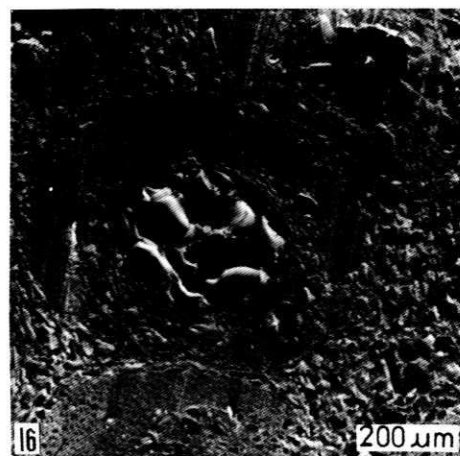
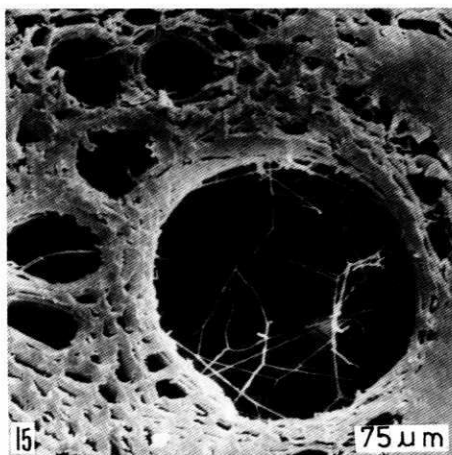
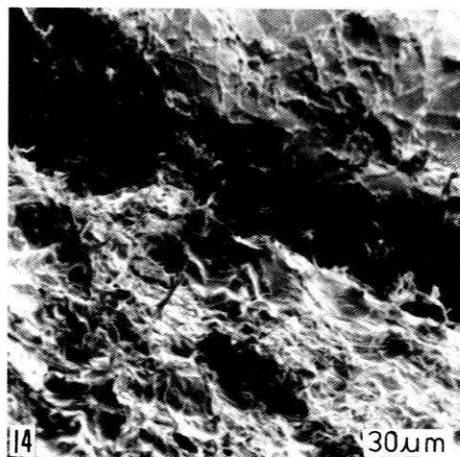
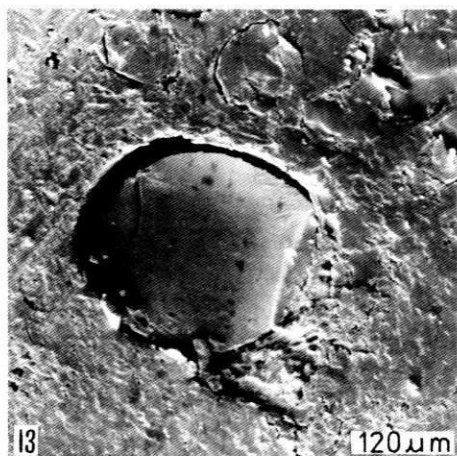
Rys. 10. Szczegóły miękiszu z występowaniem strzępek

Fig. 11. The cut of the black groove in which are also deeper placed lumina filled in by a black amorphous substance

Rys. 11. Przekrój czarnego rowka, w którym znajdują się również głębiej położone światła naczyń wypełnionych ciemną bezpostaciową substancją

Fig. 12. The black blister with amorphous substance positioned deeply under surface

Rys. 12. Czarny pęcherz z bezpostaciową substancją umiejscowiony głęboko pod powierzchnią



Rattans mature in about 10 to 15 years. They are prolific seeders.

Many rattans have local names. Trade names are developed by rattan merchants.

Most of the rattan found in the markets comes from plants growing in their natural habitat. Plantations are to be found in central Kalimantan in Indonesia.

The many inherent characteristics of rattan – it is light, durable, versatility, malleable, renewable, cheap and the finished product is attractive – set it apart as a material in its own right that does not need to fear competition from plastic, metal or wood. It is evident from the export of the various rattan-producing countries. Indonesia has been the dominant world supplier of raw rattans, approximately 80 percent of the world requirements.

#### RESULTS AND DISCUSSION

Rattan belongs to the single-germ plants which have no hollow axis such as e.g. bamboo. On the cross cut (Fig. 3) the vessel openings increase from the circumference to the centre. Basic parenchyma has low representation at the circumference. The protective surface layer is formed by coarse-wall palisade sclereides (Fig. 4) with a narrow lumen prolonged in radial direction. They have the same shape in the radial and cross cut. This coarse-wall skin layer is locally interrupted by a lenticel (Fig. 5). Large vessels (Fig. 6) have a regular occurrence of gap-like thinnings, these being attended by conductive elements with a ring (Fig. 7) or spiral lining (Fig. 8). The parenchyma surrounds a part of the vessel in the form of short thin-walled rollers (Fig. 8). The basic parenchyma has prevalingly the form of izodiametric cells (Fig. 10). The fibres on the circumference of the co-lateral vessel bundle (Fig. 3, 6) have an imperceptible lumen (Fig. 3, 16).

Fig. 13. Detail of the black substance filling the lumen of cell

Rys. 13. Szczegóły czarnej substancji wypełniającej światło komórki

Fig. 14. In the black substance on the surface of grooves and blisters occurs tangle of hyphae of fungi

Rys. 14. W czarnej substancji na powierzchni rowków i pęcherzy występuje splot strzępek grzybów

Fig. 15. The mycelium of fungi in the lumen of the vessel and in neighbourhood cells

Rys. 15. Grzybnia w świetle naczynia i we wnętrzu sąsiednich komórek

Fig. 16. Tyllae formation in the large vessel

Rys. 16. Powstawanie wcistek w dużym naczyniu

Fig. 17. Bacterium and hyphae in the lumen of the large vessel

Rys. 17. Bakterie i strzępki grzybnia w świetle dużego naczynia

Fig. 18. Bacterium and hyphae etched by bacterium

Rys. 18. Bakterie i strzępki grzybów wytrawione przez bakterie

A black amorphous substance similar to pitch occurs in the groves (Fig. 1, 2, 11) and in blisters (Fig. 12). It penetrates under the surface of the rattan axes and fills the cell lumens (Fig. 13). On the detail of the surface (Fig. 14) we can see that the pitch substance covers up the plait of hyphae. On the amorphous substance in the vessels bacteria are found together with the hyphae (Fig. 15). In some large vessels tyloses created on the inner edge of the black zone (Fig. 12). Based on the given facts it is obvious that it is the question of the activity of parasitic organisms during the growth of the plant. The black amorphous substance originated as a protective reaction of the plant in cooperation with the parasites. A proof that the black zones had originated during the growth is the occurrence of tyloses. Tyloses could have originated only in dying out of live cells of the parenchyma. It is possible to assume that rattan, originally attacked by the parasitic organism through the lenticel (Fig. 5) was further infected by other saproparasites after the dying away of the part of the stalk.

The frequent occurrence of dark spots on the cross cut (Fig. 2) is not only related directly with the deposits of black spots. A more frequent surface characteristic is the less expressive light brown and light blue colour. In the cell lumens of these coloured zones there occur fungal hyphae and bacteria (Fig. 17, 18).

The continuation of the decay process in the imported garden furniture may be due to different reasons. Rattan should be steamed before its processing. It is questionable whether all the raw material is steamed or only the parts to be bent. It is possible to assume that a part of the straight sections has not been steamed. Drying is not used and in air seasoning the moisture content does not drop below 17 per cent which is enough for the survival of the vitality of hyphae. At a slight increase of the moisture content the hyphae may act more intensively. But it is known [6] that after steaming rattan is often attacked by fungi also because it is not artificially dried. The import of rattan furniture by ship at a high air humidity also contributes to the further development of fungi.

#### CONCLUSION

The black pitch spots as well as the occurrence of light brown and light blue spots on the surface of rattan furniture signal the development of wood-destroying fungi which can completely and quickly devalue this furniture. Together with the intensive development of fungal hyphae the occurrence of bacteria has been found. A part of the activity of wood-destroying fungi is of parasitic origin from the period of the growth of rattan. The continuation of decay in furniture is related with its following infection by saprophytes.



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MIKROSKOPOWA ANALIZA ZGNILIZNY ROTANGU (*CALAMUS* SP.)

## Streszczenie

Rotangi tworzą największą grupę palm pnących rosnących głównie w niskiej i średniej wysokości, wilgotnych, zawsze zielonych albo częściowo tracących liście lasach tropikalnych, a także wtórnych lasach tropikalnych, przede wszystkim w południowo-wschodniej Azji i wyspach Oceanu Spokojnego. W słownictwie handlowym rotang reprezentowany jest przez ponad 550 botanicznych rodzajów rodziny *Arecaceae*. Najczęściej występującym rodzajem jest *Calamus* sp. Dzięki swoim właściwościom jest przeznaczony na wysokiej jakości wyboru, które w porównaniu z innymi technologiami i użyciu innych materiałów, są niepowtarzalne.

Wyroby z rotangu, przede wszystkim meble (np. ogrodowe), są często atakowane przez zgniliznę. Mikroskopowa analiza wykonana za pomocą elektronowego mikroskopu skaningowego wykazała, że czarne, smoliste plamy, a także występowanie tylko jasnobrązowych czy jasnoniebieskich plam na powierzchni rotangu oznacza rozwój atakujących drewno grzybów, które mogą dość szybko zniszczyć gotowe wyroby. Oprócz intensywnego rozwoju tych grzybów, zaobserwowano także obecność bakterii. Niektóre ze stwierdzonych na rotangu grzybów mają wyraźny charakter pasożytniczy i pochodzą z okresu jego wegetacji. Dalszy rozwój zgnilizny związany jest z infekcją przez grzyby saprofityczne.

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