The configuration of events and cell growth activity in the storeyed cambium of the linden (*Tilia cordata* Mill.)

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Abstract

A sample of wood from the trunk of the studied linden showed a periodic change in the orientation of the grain, occurring in an approximately two-year cycle. These changes in the grain were accompanied by cyclic changes in the configuration of events in the rays, that is, in the splitting and uniting of rays in the cambium. Intrusive growth on the lateral, radial edges near the ends of fusiform cells caused the translocation of cells on the storey borders, resulting in the splitting and uniting of rays. The growth activity of fusiform cells was determined on the basis of analysis of events in the rays through comparison of successive layers of the terminal parenchyma of the wood. Grouping of the ends of intrusively growing cells occurred here. The distribution of growth activity on the surface of the cambium was not uniform. It was possible to identify areas of cambium significantly differing from each other in respect to the duration of their growth activity. This period did not coincide with the duration of the cycle of changes in the configuration of events.

Key words: *Tilia cordata* Mill., cambium, configuration of events, growth activity

INTRODUCTION

It is possible to observe cyclic changes in the inclination of the grain of linden wood. This occurs both in the successive, tangent, layers causing the grain to interlock, as well as along the stem. Similar interlocked wavy grain has been described in *Aesculus* (Pyszyński 1977), *Entandrophragma* (Zagórska-Marek 1975, Zagórska-Marek and Hejnowicz 1980) and *Nyssa* (Krawczyszyn and Romberger 1980). Changes in the orientation of the grain in wood is usually a result of changes in the configuration of chiral cellular events in the cambium (Hejnowicz and Romberger 1979).

The mean length of the wave of grain and the mean duration of the cycle of changes in the orientation of grain can be determined on a radial split of the wood. The wave length is the distance between the intersection points of two successive peaks with the annual ring. Sometimes the duration of the cycle of grain orientation changes is the number of annual rings between two points of intersection of the ray with two peaks.

In those linden stems where interlocked grain is found, the cells on the tangential surface are so arranged that they form an irregular grain with a wave length of about 1 m. Various cycles of grain reorientation have been observed in various linden stems: 6 years (Włoch and Zagórska-Marek 1982), 2-4 years (Włoch 1987, Włoch and Bilczewska 1987) and from 2 to 15 years (Włoch 1985, 1988).

A record short period of grain wave reorientation was observed in the linden reported in this study, namely, about one year. One of the objectives of this study was to determine if the previously mentioned relationship between the reorientation of the wood grain and the changes in the configuration of chiral cellular events in the cambium occurs in cases of frequent changes in the orientation of the grain.

Earlier studies on the terminal parenchyma of the wood of *Entandrophragma* (Zagórska-Marek 1975) and linden cambium (Włoch and Bilczewska 1987) showed that the events occurring in successive annual growths are not uniformly distributed over large areas of the cambium. This is related to the group growth activity of the ends of fusiform cells on the storey borders. Groups of active and inactive cell ends occur. The active groups contain no more than 20 cell ends. The active ends of a given group are located on one storey border and come from one (upper or lower) storey of, or from both neighbouring storeys simultaneously. Usually, those cells whose ends are active on one storey border, have inactive opposite ends. In studies on linden cambium (Włoch and Bilczewska 1987, Włoch 1988), no regularities were found in the arrangement of active groups on the successive storey borders (along the stem axis). By observing the growth activity over longer periods of cambium activity, it was possible to conclude that the same group of initial cells is alternatively active and inactive. The active group undergoes development; this begins with individual active ends, goes through a phase of a peak number of active ends, after which it gradually dies out. It is possible to observe in the cambium, at any given moment, various active groups in various phases of their development. Because of this, groups with various numbers of active cells, from one to less than twenty, are found at the same time (Włoch and Bilczewska 1987, Włoch 1988). The mean duration of group activity does not last longer than one growth season. However, it has been observed that some ends of initial cells retain their activity for even several years, changing at least once their contacts with other cells. Activity in a given group of cells appears and disappears (fibrillates), which means that instead of shifting

activity to a group of neighbouring cells, a sudden change takes place which causes another group of ends to become active (Włoch 1987, 1988, Włoch and Bilczewska 1987).

The question can be posed whether frequent reorientations of the grain and frequent changes in the configuration of events which occur in the linden are accompanied by changes in the growth activity of cambial fusiform cells.

MATERIAL AND METHODS

The stem of the *Tilia cordata* Mill. tree under study had 25 annual rings. The bark was removed in order to enable a description of the surface grain to be made, after which a 6 cm disc was cut out. This disc was then split along the rays in several places (Fig. 1). Wavy split lines were obtained on the bottom side of the disc, which were indicative of cyclic grain orientation changes. Further parallel splits were made along one of the primary splits, at short (about 1 cm) distances from each other. The wavy edges of these splits were similar. The wavy edges of splits made in different places differed from one another, but when they derived from sites close to each other they were similar. A long, 2×0.5 cm, sample of wood was cut from the disc from the core to the surface of the wood (along the stem axis) (Fig. 1A — arrow). The sample was prepared for analysis of events according to the following procedure: The sample was boiled several times in water containing glycerin, after which, using a sleigh microtome, it was sectioned into a series of tangent sections about 30 μ m thick, and mounted on slides. The sections were dehydrated in alcohol and sealed in Canadian balsam. The slides with sections containing the terminal parenchyma from annual rings 7 through 25 (the last, the count starting from the core) were chosen. The chosen fragments were photographed using a DL-4 (Zeiss Jena) documator. The series of photographs from the borders of successive annual rings was the basis for the analysis of events in the rays. Some of the fragments of the terminal parenchyma were photographed using a microscope in order to analyse the cellular events which occurred during the formation of the given annual ring.

RESULTS

The mean wave length of the grain in the studied linden stem was 1 m. The orientation of the grain in successive annual rings changed, forming a characteristic interlocked grain. The cycle of the grain orientation changes was on average 2 years. In the place where the sample was taken to analyse the events in rays, the changes in grain orientation took place almost simultaneously with the formation of a new annual ring, which is especially well visible in rings 12 through 25. This situation has been diagrammed on Fig. 2.

Fig. 1. A disc of wood 6 cm thick cut transversely from the stem of a linden, then split along the rays in several places. A – A fragment of the upper surface of the disc – straight edges are visible (where the knife was applied). The arrow indicates the place where the sample of wood was taken for analysis of events in the rays. B – A fragment of the lower surface of the disc – the wavy edges of the splits are visible

Two types of rays were present in the cambium of the studied linden: multi- and uniserate rays. The uniserate rays visible on the tangent sections were in various stages of development – from only one cell to numerous cells. Their height usually did not exceed that of the fusiform cells in the given storey. They bent along with the fusiform cells and did not undergo divisions. They grew into short rays which initially were two-, then multiserate. When they reached the storey borders they frequently united. The multiserate rays were high mainly in the first annual rings (their height exceeded several-fold that of the storey of fusiform cells). After this they underwent divisions on the storey borders due to the changes in the contacts of the ends of the initials, but the

Fig. 2. A diagram of a radial split of a fragment of a linden stem. The domain borders and the borders of successive annual growths have been marked. The two-year cycle of domain changes has been marked. The checkered field denotes the place where the domain borders and annual ring borders are superimposed. The studied sample was taken from a site similar to this. 1-6-annual ring borders. S, Z — areas of domains in S or Z configuration. The areas of S domains are dotted

parts which arose due to such divisions united when they came into contact again.

Analysis of the configuration of uniting and splitting of rays makes it possible to determine the direction of the restructuring of the cellular pattern over relatively large areas. It was found that the change in the configuration of events in rays was in agreement with the change in the direction of the movement of the ends of fusiform cells on the storey borders in a given area. This is illustrated on Fig. 3. Let us trace what happened to the ray denoted on Fig. 3 as X. In the 9th annual ring this ray had a height of four storeys of fusiform cells. In ring 10 it split on one storey border in configuration Z. In 11, it divided twice again, giving a total of four parts. One of the two last divisions occurred in configuration Z. In ring 12 the two middle parts united (the configuration was not discovered). In ring 13 the middle part which was formed by reuniting, again underwent division in configuration S, and the two smaller parts so formed united in one place in ring 14, and then split in another in configuration Z. Similarly in ring 15 — the same two parts split in one part and then united in configuration S. In ring 16 the two middle parts (of the ray initially labelled X) united in configuration Z, and in number 17, the ray which was formed as the result of uniting, split in configuration Z. Please note that in rings 10, 11 and 12, the restructuring of the cell arrangement proceeded at low intensity, forming microareas in both configurations, whereas in ring 13 the ends of the cambium fusiform cells moved mainly in configuration S.

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10

11

12

13

14

Fig. 3 A fragment of cambium during a 9-year long period of development, as reconstructed on the basis of the successive annual rings. The manner of splitting and uniting of a high ray X is shown on the background of changes in the reconstruction of the ends of fusiform cells in the cambium. All of the parts deriving from ray X are marked on the following drawings also by X. The numbers in the upper corner of the figures indicate the successive number of the ring, counting from the core. The fusiform cells are marked by successive numbers in radial rows in the direction opposite to the direction in which the annual rings are formed, that is why some of the numbers are missing, especially in rings no. 9, 10, 11... — the cells with the missing numbers will be formed later. The thick lines denote anticlinal divisions. The shaded cells are those which will be eliminated the following year. The rays have been dotted. The black circles on the ends of fusiform cells denote the movement of the ends on configuration S, the open circles denote movement of the cell ends in configuration Z

Fig. 4. The configuration of the uniting and splitting of rays in 19 fragments of successive annual rings from 7 to 25 (counting from the core) in a 25-year-old linden stem. The numbers in the upper left-hand corner of each map indicate the number of the successive ring.

Su and Zu — uniting of rays in configurations S and Z, Ss and Zs — splitting of rays in configurations S and Z

In ring 14, a significant change in the position of the cell ends is visible only in configuration Z, while in ring 15, only in configuration S; in rings 16 and 17 — only in configuration Z.

The distribution of events in rays in the successive 19 rings on an area of $2\text{ cm} \times 0.5\text{ cm}$ is shown on Fig. 4. The subsequent maps show the pattern of type distribution (configuration) and kind of events. Let us go over them here in order: 1) Type (configuration) of events — changed in an approximately two-year cycle. This is especially well visible on rings 12 through 25. On following the configuration of events in the rays, we see on maps 7 and 8 the occurrence of both types of configurations, with a slight dominance of S events, on maps 9-12, mainly type Z events are found. Starting from map 13, we see a distinct annual alternation of event type. Maps 16 and 24 are exceptions where the same types of events as the preceding ones dominate. In map 16 they are S events, in 24, Z events. 2) Kind of events — alternation of events was not observed, that is, after rays united, they did not always split. In the two-year cycle of configuration changes, uniting and splitting occurred simultaneously in the same year. This behaviour of rays in successive annual rings is different from that which we have observed in other studied lindens (Włoch 1985, 1987), namely, when the cycle of configuration changes was longer, a similar cycle of kind of event changes was observed. The following sequence of events was observed: type Z uniting — type Z splitting — type S uniting — type S splitting and the cycle was repeated. When the duration of one configuration lasts one year, as in the case of the studied linden, no separation of event kinds is observed (Fig. 5). The successive maps show both uniting and splitting of rays along with very distinct changes in configuration type.

Fig. 5. A diagram of possible events in rays and an interpretation of them taking into account the two-year cycle of configuration changes. The reading of the events during a period of one year is the sum of the uniting and splitting of rays in a given configuration. The letter markings as in Fig. 4

The diagram on Fig. 6 shows the number of rays and the number of unitings and splittings of rays on the studied area over successive years. The number of rays undergoing events is very diverse and comes to from 52 to 166

in one year, which is about 3% to 11% of the total number of rays. The total number of rays depends on the number of splits and unitings. In the first examined rings, a large predominance of splits is noticeable. This is accompanied by an increase in the overall number of rays. This is associated with the rapid growth of the cambium surface in the first annual rings. In spite of the increase in the total number of rays in the entire period under study, it was possible to observe a slight alternation of kind events. Uniting of rays dominates in rings 11, 13, 15, 17, 19, 22, 23 and 25, that is, it nearly alternates with

Fig. 6. A comparison of the number of unitings and splittings of rays with the number of examined rays. The number of unitings and splittings of rays in successive rings is presented on a diagram (scale on left of drawing). The total number of studied rays in the successive annual rings is presented separately using points in the upper part of the figure (scale on right). Note that both scales are not the same

years in which splitting dominated. If events in rays had been studied in a continuous manner, this alternation of events would have been more clearly noticeable. The number of rays decreases in those rings where uniting dominates.

Figure 7 shows a comparison of the number of events in both configurations accompanied by a change in grain orientation, which is visible on

the lower edge of the split of the wood disc in the spot where the sample was taken. There is an almost strict dependence between the change in type of configuration of events and the change in the angle of inclination of the grain. In most of the rings, the change in the number of events in a specific configuration took place almost completely year by year. Either configuration S or configuration Z were found.

Fig. 7. A comparison of the number of events in rays of a specified configuration (A) with a wavy edge of the split seen from the bottom side in the spot where the sample was taken (B) in successive annual rings. A — A diagram illustrating the number of events in configurations S and Z in successive annual rings. B — A fragment of the split disc. The upper edges are marked with thin straight lines. The wavy lines denote the lower edges of the split. The spot from which the sample was taken is outlined with radial parallel lines and marked with an arrow. The dotted areas indicate that we are viewing a split fragment of the disc from the bottom side and that the radial plane of the split is visible. The numbers denote the successive annual rings, starting from the core

The more or less uniform separation of events in configuration S and in Z in successive years made it possible to study it there was a relationship between the changes in growth activity of cambium fusiform cells and the changes in the configuration of events in rays. It is, for all practical purposes, impossible to determine the activity pattern of fusiform cells over a large area of cambium. It is known, however, that the splitting and uniting of rays is the

Fig. 8. Maps showing the duration of growth activity of cambium cells (rHga) determined on the basis of studying the events in rays from 11 successive fragments of annual rings — from 11 to 21 — in the stem of the studied linden. Open circles — duration of activity not longer than 1 year. Black circles — duration of activity over one year

effect of the activity of the ends of fusiform cells, and therefore, if an event occurred in a ray, then the ends of the fusiform cells in the neighbourhood of the ray were active. Although this relationship cannot be reversed in such a way as to interpret the lack of events in rays as the lack of activity of fusiform cell ends, it is still highly probable that in the case of a ray not undergoing events during a certain period, the activity of fusiform cell ends in the neighbourhood of that ray had also been null or weak (at least weaker than in the vicinity of a ray that had undergone an event). The occurrence of an event

in a ray is taken by us as an indicator of the activity of neighbouring fusiform cell ends. In order, however, to avoid misunderstandings, we will call the occurrence of an event in a ray "relatively high growth activity of ends" (rHga), while the lack of events — "relatively low growth activity of ends" (rLga).

On 11 successive maps in Fig. 8, the duration and localisation of rHga in the vicinity of rays undergoing events have been depicted. On Fig. 9, the number of events whose rHga was shorter than one year was compared with the number of events with rHga's longer than one year. The graph shows that the number of rays undergoing events and active longer than one year is, in comparison with those lasting less than a year, very variable in successive years and equals from 6.7% to 51.9%. Rays active for longer than one year are usually active for two years. The number of rays active for three years is small

Fig. 9. A diagram showing the number of rays in which events (uniting and splitting) occurred during a period of 1 year but which were inactive during the following years (dotted columns) and the number of those which were active during both years (solid columns)

and does not exceed several percent of the total number of events. Rays active for four or five years occurred only sporadically. The maps of events in rings from 11 to 25, that is, where a regular two-year cycle of changes in the configuration of events occurred, are interesting in terms of the distribution

and duration of rHga. These maps show a change of configuration occurring year after year, that is, this change also occurred in rays in which rHga was longer than 1 year. For example, in ring 20, rHga lasting longer than one year occurred in the majority of rays undergoing events (over 50%) and at the same time, the configuration of events changed in almost all of the rays (in ring 19 these are Z type events, in ray 20, S type). It results from this that changes in the configuration of events in a given place in the cambium does not mean that the growth activity of a given group of ends has ceased – the same active group can change its configuration year by year. The duration of the growth activity is therefore independent of the period of the change in the type of configuration of events in rays.

A comparison of changes in the rHga and changes in the configuration of events in rays is shown for selected fragments of 8 successive maps on Fig. 10. Changes in the configuration of events for fragments of these maps were determined on the basis of changes of configuration of events for the whole area of the map from ring 10 to 17. All of the rays are marked on the map, not only those in which events occurred. It can be seen that rays can be inactive

Fig. 10. A comparison of changes in activity and configuration of events in a small fragment of the studied surface of eight successive annual rings. The numbers denote the successive annual rings. All of the multiserate rays are marked. Black circles denote events in rays in configuration S, open circles denote those in configuration Z. The vertical line denotes lack of events in a ray. The configuration of events observed on a much larger surface is marked by dotting the field in the case of configuration S and a blank field for configuration Z

for even as long as the 8 years under study. In the period represented by maps 12-14, some of the areas were active for three years. Changes in the rHga of individual rays do not coincide with the changes in the configuration of events in all of the rays in the studied area.

On examination of successive maps on which the duration of rHga has been noted (on the basis of rays undergoing events) (Fig. 8) it can be seen that the

distribution of events having a determined rHga duration, that is — up to one year or over one year, is not totally accidental. On those maps on which there are numerous rays with rHga's longer than one year, we can see that areas are becoming visible which group together rHga's exceeding one year and, at the same time, areas with rHga's under one year or those which have been completely inactive (or exhibit rLga's) for a period of at least one year. The reasons for this phenomenon will be the subject of further studies.

In order to obtain information on the occurrence of inactive areas and on rLga's longer than one year it is necessary to superimpose maps from at least two years. An example of such a procedure is given in Fig. 11. Areas which had been completely inactive during this period, as well as those areas which had been active once in one year and then once in another year or during two years at the same time when a complete change in the configuration of events took place over the entire studied areas can be discerned on a map which pictures the distribution of events over a period of two years (see maps 13 and 14, Figs. 4 and 8). The distribution of activity is seen not to be uniform, but mosaic. Areas of events whose rHga was longer than one year can be seen to group in those places where the active areas are largest. Over the two-year period, the size of the inactive areas was not smaller than that of the active ones and could remain inactive for longer lengths of time.

Fig. 11. The spatial distribution of events in rays over a period of two years, obtained by superimposing maps of annual rings 13 and 14. Map 13 shows that the events occurred almost exclusively in configuration S, map 14 — in configuration Z. Rays which were active for two years underwent events in configuration S in ring 13 and in configuration Z in ring 14. The sum of these two successive events with opposite configurations from both maps has been marked on the diagram with a half-opened circle. The events which occurred only in one year are marked using, respectively — an open circle for configuration Z and black circle for S. The circles actually mark the region of growth activity (rHga) for their respective configurations in neighbouring rays which underwent events

DISCUSSION

The cycle of changes in the configuration of events is related to the existence in the cambium of a pattern of transverse domains moving along the stem. It can be concluded on the basis of studies on non-storeyed cambium of such broadleaved trees as *Acer*, *Fraxinus* (Hejnowicz and Romberger 1973, Hejnowicz 1974), *Platanus* (Krawczyzsyn 1972), *Aesculus* (Pyszyński 1977), that this pattern, as seen on the border of annual rings, corresponds to the grain pattern of the wood when the intensity of events is high (Hejnowicz and Romberger 1979). The cycle of changes in the configuration of cellular events in these trees is long, usually over ten years, and the movement of domains and grain pattern in the wood can be observed simultaneously. The rate of movement of domain borders varies within very wide limits — from about 0.1 mm to 2000 mm per year (Hejnowicz 1976).

There is a dependence between the rate of movement of the grain pattern and the grain wave length, that is, between the rate of movement of the domain pattern and the domain height. The faster the movement of a given pattern, the higher are the domains (the longer the grain wave, the faster it moves). In the case of high rates of movement, the wave peaks on the radial splits are arranged almost vertically, almost parallel to the stem axis. The tree is then characterised by interlocked grain — in its successive layers the inclination of its grains periodically changes its direction.

In the studies on the non-storeyed cambium of trees described until this point, the relationship between the rate of movement of the domain pattern and the height of domains corresponded to small variability of the duration of the cycle of changes in grain orientation, that is, to period T . Period T is the quotient of the wave length and velocity ($T = \lambda/V$), and is the least variable wave parameter (Hejnowicz 1973, 1974, 1975).

The linden, which is characterised by the occurrence of storeyed cambium, does not fit the results of the studies described to this point. The wood of the linden described in this study has interlocked grain with a very short, two-year long cycle of changes in the orientation of its grain. The peaks of the grain waves form an acute angle with the stem axis, which indicates that a very quickly moving, long grain wave exists. The rate of movement at a wave length of about 1 m is 50 cm per year. A short cycle of changes in the orientation of grain results from a similar cycle of changes in the configuration of events in the cambium — a change in the configuration of cellular events occurs annually in a given place of the cambium. It is obvious that in this case of relatively small areas of studied terminal parenchyma, it is not moving story borders that are observed but rapidly changing configurations of events that once are Z type events, next S type, and that the cycle of configuration changes is 2 years. In this situation, the domain border will move through the studied area and the events in both opposite directions will be recorded on the ring

border in the terminal parenchyma. Only in places where the domain border intersects the annual ring border, that is, on a relatively small area of the terminal parenchyma, will we obtain maps with only one type of configuration. If the cycle of configuration changes is even shorter, e.g. 1 year, then no domain pattern at all will be observed on the borders of annual rings. In this case, the events in opposite configurations on the ring borders should be mixed with each other. It is interesting that we have not observed a mixing of cellular events in alternate configurations on small areas but, instead, spatially distinct separation of event types over small, irregular microareas (Włoch 1987). The existence of microareas can be explained by the non-simultaneous appearance of active groups on the surface of the cambium. In the cambium of *Tilia* and *Entandrophragma*, studied through the comparison of successive layers of terminal parenchyma, the activity of groups of fusiform cell ends lasts on average less than one year (Zagórska-Marek 1975, Włoch and Bilczewska 1987). When the cycle of configuration changes is relatively short, cellular events with opposite configurations should be expected in the same places of the cambium, but at different periods of time during the formation of the annual growth. This creates the effect of mutual "cancelling out" by the changes in the position of the cell ends on the ring borders. In such a situation, only "excess" events in the configuration that dominated are registered. This is the reason that we do not observe the random mixing of events in both configurations, but only "pure", spatially separated microareas, once in one, then in the opposite configuration. As the cycle of configuration changes lengthens (various cycle lengths occur in different lindens) a decrease in the area of microregions in favour of large regions should be expected. Large areas with set configurations will not, however, "fibrillate" but will change cyclically, once in configuration Z, then in S. They will also be separated by sets of microregions of so called transition areas (Włoch 1987). As the cycle continues to lengthen, we observe a reduction of the transition areas until they disappear completely. In the site where these transition areas disappear, a domain border appears and it will then be possible to observe it on the studied annual ring border (the domain pattern in cambium will be possible to decipher by examination of the terminal parenchyma in the wood). This domain pattern will coincide with the grain pattern of the wood just as it does in most of the previously described cases (Hejnowicz and Romberger 1973, 1979). This line of reasoning brings us to the conclusion that the pattern of the distribution of cellular events (studied by the comparison of terminal parenchyma layers of the wood of a linden with a short, two-year long cycle of configuration changes) does not correspond to the grain pattern in the wood on a larger surface of the stem.

In some lindens, the ends of the cambium initial cells retain their activity for periods of even several years (Włoch 1988). It is also possible, as in this study, that the average duration of growth activity of a group of cell ends is

longer than one year for about 40% of the rays undergoing events, and that during the growth activity, almost all of the events change their configuration annually.

The grouping of activity into areas greater than the active cambium regions seen on maps (Włoch 1987, Włoch and Bilczewska 1987) probably is due to the fact that the changes in the activity of groups of cell ends were not simultaneous. This is the reason why some active groups in the cambium terminate their activity and others initiate it during the formation of the annual ring. Because this activity cumulates, larger active areas appear on the ring borders than the group of active ends in the cambium.

When there is a short cycle of changes in the configuration of cellular events along with an extended duration of activity of groups of cell ends there is a greater probability of a temporary variability of the frequency of events, which may suggest the existence of significantly smaller domains than would result from the grain pattern (Włoch 1985).

An overall decrease in the number of events near domain borders is observed on the annual ring borders (Hejnowicz 1968, Zagórska-Marek 1984, Pyszyński 1977). In the light of the results presented in this report, this is probably due to the mutual cancelling out of the activities of groups which are in the process of forming the annual growth ring in opposite configurations.

The high variability of the duration of activity of active ends of fusiform cells in the cambium of lindens indicates that there are still unrecognised mechanisms regulating the growth activity of cambium. Their existence is suggested by the results of studies on *Entandrophragma* in which active groups are found to be separated by inactive groups of the same size, which gives in effect the characteristic checkerboard pattern for growth activity (Zagórska-Marek 1975).

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Konfiguracja zdarzeń a aktywność wzrostowa komórek w kambium piętrowym lipy (Tilia cordata Mill.)

Streszczenie

Na podstawie analiz zdarzeń w promieniach przedstawiono wyniki badań aktywności wzrostowej kambium w pniu 25 letniej lipy. Zdarzenia (łączenia i dzielenia się promieni) odczytywano porównując warstwy miękiszu terminalnego z 19 kolejnych granic przyrostów rocznych poczynając od 7 do 25, ostatniego przyrostu. Stwierdzono, że krótki dwuletni cykl zmiany orientacji włóknistości wynika z takiego samego cyklu zmiany konfiguracji zdarzeń. Zaobserwowano związek między kątem nachylenia włóknistości w drewnie a liczbą przewagi zdarzeń typu S lub Z. Wykazano, że aktywność wzrostowa występująca w grupach końców komórek wrzecionowatych na granicach pięter utrzymuje się około 1-2 lat, rzadziej 3 lata lub sporadycznie 4-5 lat. Niejednoczesna zmiana aktywności wzrostowej grup końców komórek wrzecionowatych kambium dokonuje się niezależnie od cyklicznej zmiany konfiguracji zdarzeń komórkowych i włóknistości w drewnie.