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Complex wavy grain in the stem of *Aesculus*

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Abstract

Two types of wavy grain were found in the xylem from *Aesculus* stems: with long (500 mm) and short (6 mm) waviness superposed on spiral grain. On radial splits the ridges of long waviness ran obliquely up the stem from the pith to the cambium on the average at a 5° angle with the stem axis. On the other hand, the short waviness ran down the stem from the pith to the cambium at an average angle of 86° with the stem axis. Investigation of the orientation of cambial events on the basis of splitting and uniting rays in the successive terminal xylem layers demonstrated that domain patterns in the cambium are responsible for the wavy grain.

INTRODUCTION

The general orientation of cells of the axial system in relation to the stem axis is known as the grain (see Panshin et al., 1970). The grain of wood may be:

1. uniform on the whole surface of the given annual ring and in the successive annual rings;
2. undergo changes in relation to the stem axis on the surface of the annual ring and in successive annual rings.

In the former case the long axes of the cells may run:

(a) parallelly to the stem axis,

(b) along a helical line.

In case (1a) the wood is straight-grained, in case (1b) it is spiral-grained and may be right (Z) or left (S) oriented.

In case (2) the inclination of the cells in relation to the stem axis in the tangential plane may change regularly or irregularly. When the changes are regular we speak of wavy grain. Two varieties of wavy grain may be distinguished: curly — when the wavelength is short, and a variety with long wave. Long waves occur in wood with interlocked grain in which the inclination of the grain in successive groups of annual rings changes cyclically. Such grain on a quarter section gives a ribbon figure. Typical interlocked grain consists in that in the successive annual rings the grain is oriented alternately to the right and to the left in relation to the stem axis. In the present paper the term "interlocked grain" is used in a wider sense, when the orientation of the cells changes from right to left and vice versa in respect to the mean direction of the grain which is not necessarily parallel to the stem axis.

Cyclic changes in grain inclination along the radius are termed transverse cycles, whereas cyclic changes of grain inclination along the general course (trunk axis) are called longitudinal cycles (H e j n o w i c z, 1973a). The distances between extreme points of the transverse cycles we called periods of the transversal cycle. The distance between the extreme points of the longitudinal cycles is called wavy length of grain. Maximal deflections from the mean direction of grain measured in degrees is proportional to the amplitude of the wave (see Fig. 1).

The orientation of xylem cells reflects the orientation of cambial cells. The latter depends in turn on the direction of events occurring in the cambium such as oblique anticlinal division, the direction of intrusive growth, or splitting and unting of rays.

The above named events occur in the alternative Z (to the right) and S (to the left) configurations. It results from the investigations of B a n-

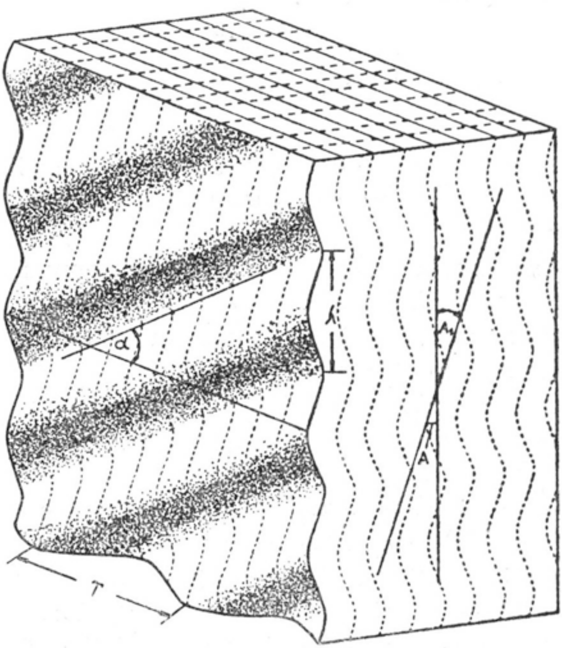

Fig. 1. Spatial model of wood sample with wavy grain
A — amplitude. A_1 — angle between direction of general course and maximal deflection of grain wave. λ — wavelength of waviness. α — angle of ridge inclination in respect to ray. T — period

n a n (1966), H e j n o w i c z (1964, 1968, 1971, 1972, 1973a, b, c, 1974a, b) K r a w c z y s z y n (1971, 1972, 1973), P y s z y ń s k i (1972), H e j n o-w i c z and R o m b e r g e r (1973) that at a given site in the cambium only one of the configurations — Z or S occurs. The cambial region where only one type of events takes place is called a domain (H e j n o w i c z, 1964; B a n n a n, 1966). In the Z domain partitions from anticlinal division are Z-oriented and the ends of initials growing intrusively overlap Z-wise, whereas the oblique S-oriented bands of fusiform initials separating rays disappear.

The type of domain at the given cambial site is not stable but changes in time. This change is due to migration of the domains along the trunk axis in respect to the cambial cells during formation of wood (H e j n o-w i c z, 1971, 1972, 1973a, b, c, 1974a, b; K r a w c z y s z y n 1971, 1972, 1973; P y s z y ń s k i, 1972; H e j n o w i c z and R o m b e r g e r 1973). The borders between the domains on the cambium surface run transversely or obliquely. The time of occurrence of a given domain in the given region of cambium depends on the domain length (vertical dimension) and the velocity of its migration. The rate of this migration is the quicker the higher the domain length. The domain pattern of the cambium finds its reflection in the grain pattern, when the frequency of the events in the cambium is high enough so that, in the period when the domain is at a given site, the orientation of the cells changes in the direction corresponding to the given type of events. Then the areas on the annual ring surface in which the cells change their orientation in Z and S direction correspond to the domains of Z and S type, respectively.

Since domains migrate, the areas of waviness with a given orientation are shifted in respect to one another in the successive annual rings, this being manifested in an oblique course of the ridges on the surface of the radial splits (see Fig. 1).

In the majority of the so far known cases of broadleaved trees the domains migrated up the stem, thus, the ridges of waviness on the radial split ran obliquely upwards from the core to the cambium (*Fraxinus excelsior, Acer pseudoplatanus, Betula verrucosa* — H e j n o w i c z, 1972, 1973b, 1974a, b; H e j n o w i c z and R o m b e r g e r, 1973; and *Platanus occidentalis* and *P. acerifolia* — K r a w c z y s z y n, 1971, 1972, 1973). An exception is *Aesculus hippocastanum* in which short domains migrate down the stem, therefore the short waviness ridges run obliquely down the trunk (see P y s z y ń s k i, 1972). Migration of domains down the stem has also been noted in *Betula verrucosa* (H e j n o w i c z, 1974a).

In wood with curly grain domains are short and the velocity of their migration is low, whereas in wood with interlocked grain the domains are long and their migration velocity is high.

The movement of domains in cambium characterized by a high frequency of events prevents excessive inclination of the cells. Owing to this the type of domain at the given site in the cambium changes: each domain compensates the influence of the preceding domain on cell inclination and as the result of this the cells oscillate to the right and left (Hejnowicz and Krawczyszyn, 1969; Krawczyszyn, 1972).

The wood within the same species may be of interlocked or straight type (Panshin, 1933; Limaye, 1954). The differences in type results from the differences in the frequency of cambial events within the domain (Hejnowicz and Romberger, 1973). In straight-grained wood the frequency of events is much lower than in wavy wood.

In the same stem several types of waviness and several overlapping domain patterns may occur. For instance in *Fraxinus excelsior* or *Betula verrucosa* wavy grain occurred with long and short wave (Hejnowicz, 1974a).

It was found in the course of investigations on *Aesculus*, concerning mainly the mechanism of spiral grain formation in wood, that, beside spiral grain, wavy grain also occurs in the same stem in two variants — with short and long wave. The object of the present study is wavy grain.

MATERIAL

The wood for examination was taken from two *Aesculus* stems cut down in the Botanical Garden of the Wrocław University.

From one 150-year-old *Aesculus hippocastanum* L. tree denoted as stem no. 1 a wood disk 7 cm thick was cut at a distance of 1 m from the base.

Another 80-cm fragment of stem (no. 2) was cut from a 75-year-old *Aesculus carnea* Hayne, at a distance of 1 m from the base.

Material for studying the events in the cambium was derived from the disk of *Aesculus hippocastanum* L. (stem no. 1. The sample included 26 annual rings from the 54th to the 80th year of life of the tree and its surface area was 5 $\times$ 7 mm.

METHODS AND RESULTS

1. Characteristic of waviness

The blade of a knife was applied to the upper surface of the transversely cut disk, along its radius and hit with a hammer to split the disk. At all points of the disk splitting occurs along the grain.

In straight-grained wood the lower edge and the projection of the upper edge of the split disk are superposed, whereas in wood with spiral grain the lower edge is shifted in respect to the projection of the upper edge and it is wavy in the case of wood with interlocked grain. The height of the disk and the distance between the projection of the upper edge (Fig. 2) and the lower edge being known, the inclination angle C of the waviness was determined at various distances from the core.

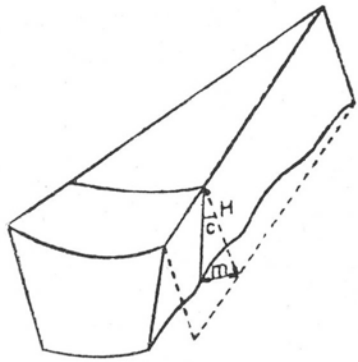

Fig. 2. Determination of angle of inclination of wood waviness
Radially split wood block H — length of block, m — distance between lower edge of split and projection of upper edge. C — grain angle

For checking the accuracy of this method additional measurements were performed on tangential sections prepared from the sample in which one radial surface was the split one and the three others — two transversal and one radial — were carefully sanded so that they formed right angles with one another. Images of the section were projected on a screen by means of a Zeiss "Documentor" and the course of the split edge was compared with that of the vessels and tracheids. Both courses in the sample from the 7-cm disk (stem no. 1) proved parallel. It should be added, however, that this method is less precise when high blocks are split, since in that case, owing to thigh stresses the splits are not parallel to the waviness.

Fig. 3 shows a diagram of angle values for wood waviness in stem no. 1. As seen the angle of grain inclination in the successive segments gradually increased in the period of the first 50 years with only slight oscillations. In the course of the next 10 years the angle value distinctly diminished, and from the 60th to the 80th year of life a new increase of the angle appeared. During further years the angle diminished several times and increased again. In the latest annual rings (from 145 years to thee nd) the angle value decreased. In splite of these oscillations in the successive segments of the radius the angle was continuously positive and the grain Z-oriented. The wave outline of the lower, edge of the split (Fig. 3) is evidence that we are dealing here with wood of interlocked grain type.

The radial split is easy to obtain in a high block as far as straight--grain wood is concerned. In the case of interlocked grain it is difficult to get a split running along the grain. It is more convenient then to cut the stem into disks and then split them so that the upper edges of the splits from the sucessively superposed disks would lie in one plane (Martley, 1920, Lamaye, 1954; Hejnowicz, 1972). When the disks are assembled to fit exactly, they give the surface of the radial split. Such a method was applied for stem no. 2. The stem fragment 80 cm high was sawed into 26 disks. Each of them was then split along the radius so that the corresponding upper edges of the split would lie in one plane.

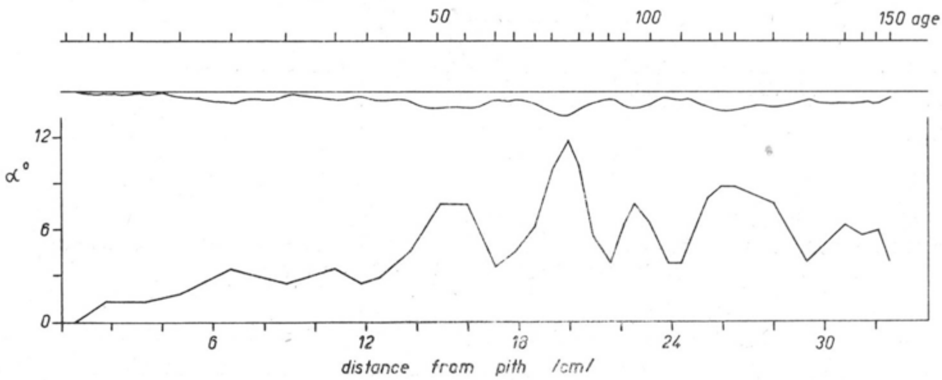

Fig. 3. Waviness angle along radius in 150-year-old *Aesculus hippocastanum* tree (stem no. 1)

Upper part of figure shows the outline of the lower edge of the radially split disk 7 cm high

In Fig. 4 the ridges and valleys of the wavy surface of the radial split are visible in the form of alternating lighter and darker stripes. The lighter stripes correspond to wavines with an increasing inclination angle to the stem axis, whereas the dark stripes correspond to waviness with a diminishing angle. The waviness indicates that we pass through successive areas of ridges and valleys along the radius from the pith to the combium surface. If we refer these changes of the angle to the mean direction of spiral grain, it is seen that in the sucessive segments the radius passes through areas in which the grain orientation changes cyclically Z- and S-wise.

For comparing the course of waviness ridges with the borders of annual rings the latter are marked in the figures with dark longitudinal lines (at 10-year intervals). It results from Fig. 4 that the ridges run obliquely in respect to the borders, from below upwards, towards the stem surface. The ridges form an angle of 5° with the borders of annual rings. The oblique position of the ridges proves that areas differing in the angle of cell inclination migrate up the stem in the successive annual rings. Owing to this, in the given area of the cambium the cells cyclically change their orientation (transversal cycles). The inclination of the ridges is, moreover,

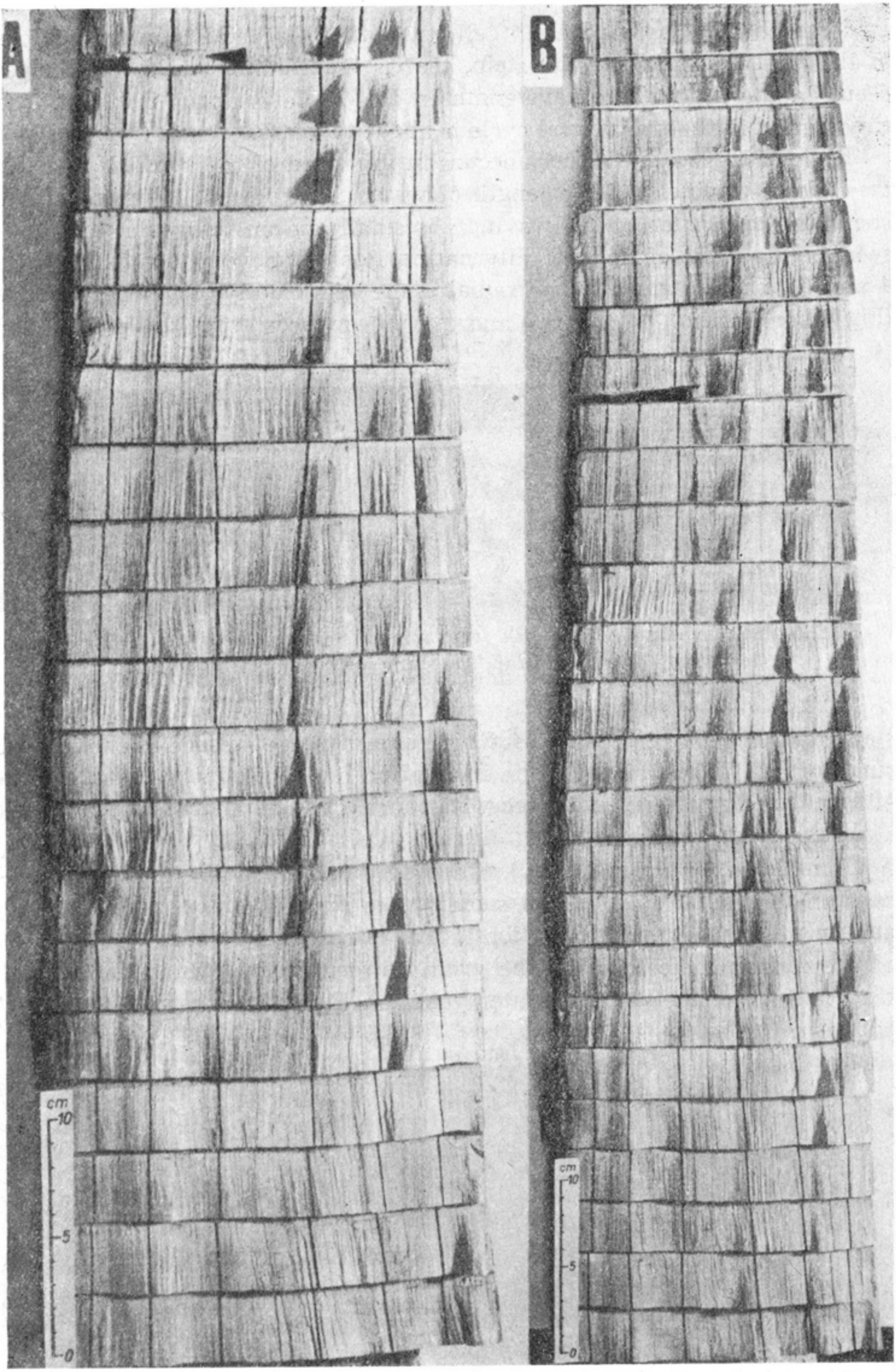

Fig. 4. Radial split surface (right) from *Aesculus carnea* stem obtained by assembling split disks. Stem surface is to the right

A — surface obtained from disks between nos 8 and 26 along radius "a". B — surface obtained from disks between 1 and 26 along radius "b". Longitudinal lines mark the border of annual rings at 10-year intervals evidence that cyclic changes in cell orientation occur also on the surface of the annual ring along the stem, that is longitudinal cycles of changes occur in the grain. The wavelength in this cycle is about 500 mm. The time period in the transversal cycle is about 15 years.

Beside long waviness there occurs in the wood of the studied *Aesculus* trees short waviness with a length of wavy grain of about 6 mm. In both stems the amplitude of the waviness is small and on the radial split it is seen in the form of delicate alternating lighter and darker stripes (Figs 4 and 5). These stripes in the radial plane are usually somewhat oblique (Fig. 5) in relation to the ray and run downwards from the pith to the

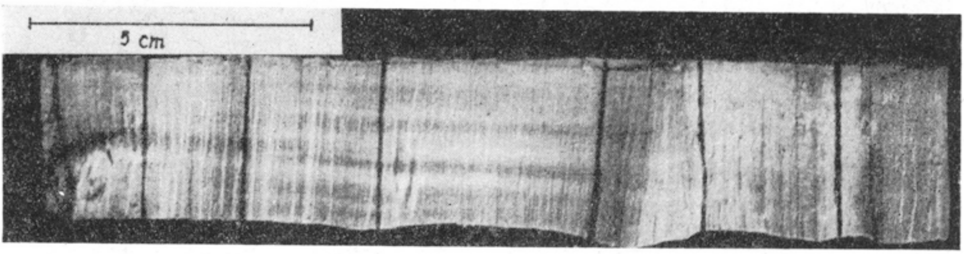

Fig. 5. Fragment of fig. 5A (5th disk from above) showing short waviness. Orientation of the disk is natural. The stem surface on the right side

stem surface at an angle of 4° (86° in respect to the surface of the annual ring border). It results from the inclination of these stripes that the longitudinal cycle pattern associated with short waviness migrates downwards along the stem.

Sometimes, however (Fig. 6), the stripes corresponding to short waviness on the radial split run in some places almost parallelly to the rays and only in some their inclination is noticeable. The parallel arrangement of the stripes indicates that the grain pattern formed in earlier annual rings is further continued in later years on the given cambial surface so

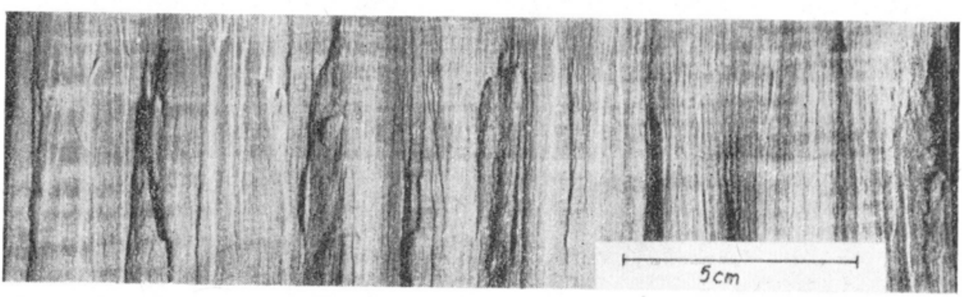

Fig. 6. Radial split surface (left) from *Aesculus hippocastanum* stem (no. 1) Fragment comprises annual rings from 51 to the end, i.e. the 150th one. Stem surface on the left side. Orientation of the block is natural. Narrow transversal stripes corresponding to short waviness are visible

that the longitudinal cycle pattern does not migrate but remains always in the same position.

It would seem that short waviness is common in *Aesculus* although its amplitude is often very small.

It should be noted that the direction of inclination of short waviness stripes within the same stem on the radial split (from above downwards from the core to the stem surface) is opposite to the inclination of stripes of long waviness (up the stem).

2. Domain pattern

The change of cell orientation in the wood on the radial split in the successive groups of annual rings on the same spot in relation to the radius expresses changes in the domain pattern in the cambium. The domain pattern in the cambium was examined in stem no. 1. For the study of the events in the cambium a fragment of the wood block was chosen in which the changes of the angle in connection with long waviness along the radius were widest in ontogenesis. Short waviness on the radial split surface was hardly noticeable, and the stripes corresponding to it were almost parallel to the radii.

Reconstruction of the cambial events on the basis of changes is simple in the case of wood of conifers. In the wood of these trees the arrangement and length of the tracheids are identical with those of the fusiform cells in the cambium at the moment of their formation. The tangential section of such wood shows the cambium pattern prevailing during formation of the xylem layer in this section. In the case of broadleaved trees the pattern in the wood is deformed as compared with that existing previously in the cambium, owing to the transversal growth of the vessel members and intrusive growth of fibers during their differentiation. But in broadleaved trees the developmental events in the cambium can be reconstructed on the basis of the wood, since in these trees the cell pattern in the cambium is preserved, at least once in the year in the annual ring during formation of terminal parenchyma. In the layer of this wood intrusive growth does not occur nor do vessels form, only transversal divisions take place which do not disturb the original arrangement of the fusiform cells in the cambium (Hejnowicz and Krawczyszyn, 1969). For distinguishing the domain pattern in the cambium of *Aesculus* tangential sections from successive layers of terminal parenchyma were compared. On the basis of the changes found in this comparison, the direction of the cambial events could be reconstructed.

The type of orientation of the cambial events can be studied on the basis of the inclination of the partitions formed in anticlinal divisions or of changes occurring in the rays as for instance the direction of their splitting and uniting.

A series of tangential sections 30 μm thick were prepared from the wood sample comprising 26 annual rings (27 borders). The sections from the terminal parenchyma layers were stuck to the slides with Haupt's adhesive and dried, then immersed in hot alcohol in order to remove air from the cell lumen, transferred to xylene and embedded in balsam. Photographs were taken of the preparations by projection of the picture onto photographic paper and the use of a Zeiss "Documator" reading apparatus. The pictures were enlarged 49.5 times. Analysis of the types of events (domain patterns) was done by comparing the rays on the photographs of the successive terminal parenchyma layers. The photographs were compared in pairs and the points where the rays split or united were marked by the respective sign Z or S. In this way maps of events were obtained shown in Fig. 7.

On the maps of the examined surface changing events of one or another type prevailed. The frequency of events varied. The maps corresponding to annual rings 55—57 showed predominantly Z events and on those of the 58—68 rings S events prevailed (with the exception of rings 62 and 64 where numerous Z's were noted), while on the maps of rings 69—76 Z's were most numerous and on the following ones from 77—80 S's prevailed again. Maps in which events of Z-type dominated corresponded to the wood block fragments in which a transition from a valley to a ridge occurred on the surface of the radial split, while those in which S-events were more numerous corresponded to the fragments where a transition from ridges to valleys took place. It would seem that domains passed over the examined area, responsible for the formation of long waviness. Diagrams were plotted (Fig. 8) showing the number of splittings in the successive annual rings. Positive values represent Z splitting leading to a Z orientation, and the negative ordinates indicate splits leading to an S orientation. A total of 356 splittings were noted on the examined area; of these 179 led to a Z orientation and 277 to an S orientation. It is noteworthy that in splite of the prevalence of S splitting, the general course of the grain was always to the right (Z) on the examined area.

Fig. 9 shows the difference in the number of splittings during the formation of successive annual rings (absolute value of the algebraic sum). In this figure the outline of the lower edge is shown and the values of the waviness angle in the particular annual rings. If we compare in Fig. 9 the course of the curves representing the different events (prevalence of events of a given type) with the outline of the lower edge (or the curve of angle changes) of the split, it is distinctly seen that the type of events is closely associated with the change in orientation of the waviness. In the annual rings 54—57, namely, in which splitting of Z type dominated, there occurs on the examined area the first peak of angle size. When in the annual ring 58 a drastic change appeared in the type of splitting to the S type, the angle size began to diminish rapidly up to the annual ring 61.

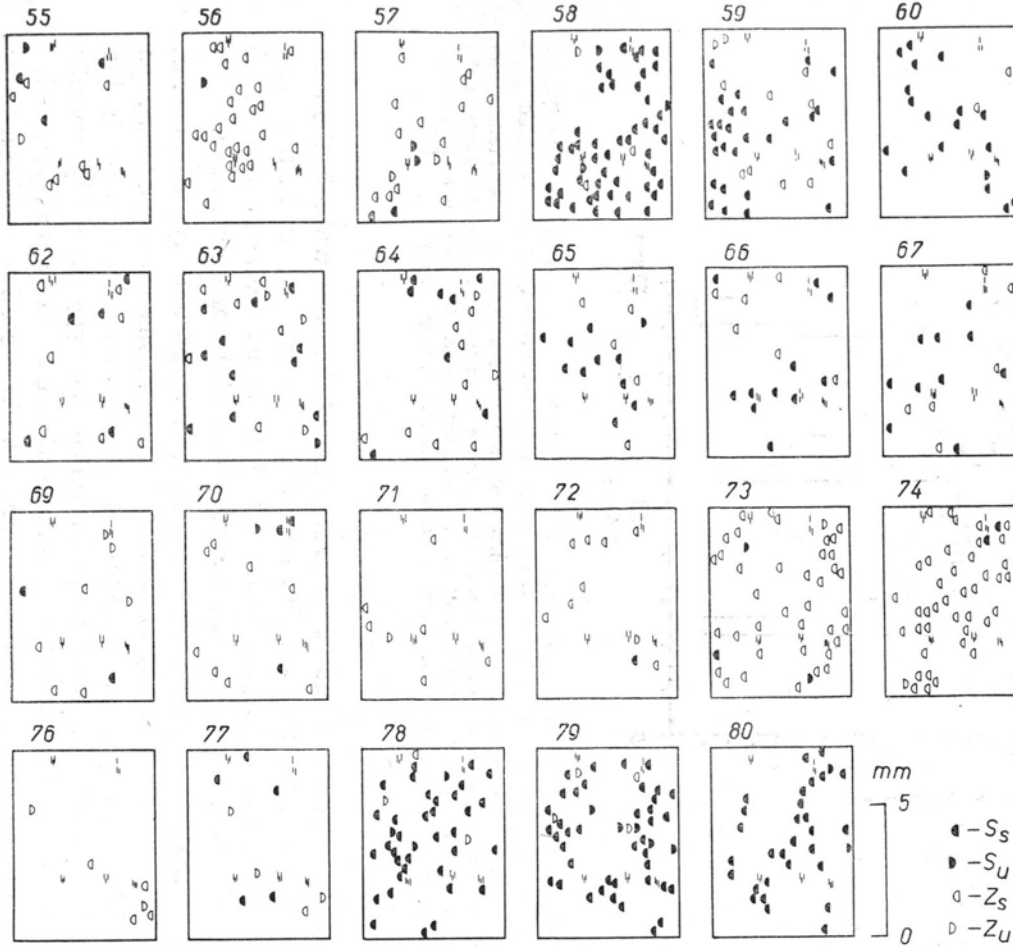

Fig. 7. Maps showing splitting and uniting of rays on a 5 × 7 mm surface area in successive 26 annual rings from the 54th to the 80th yer of life of the tree (stem no. 1). Black semicircles correspond to type S events, clear ones to type Z events

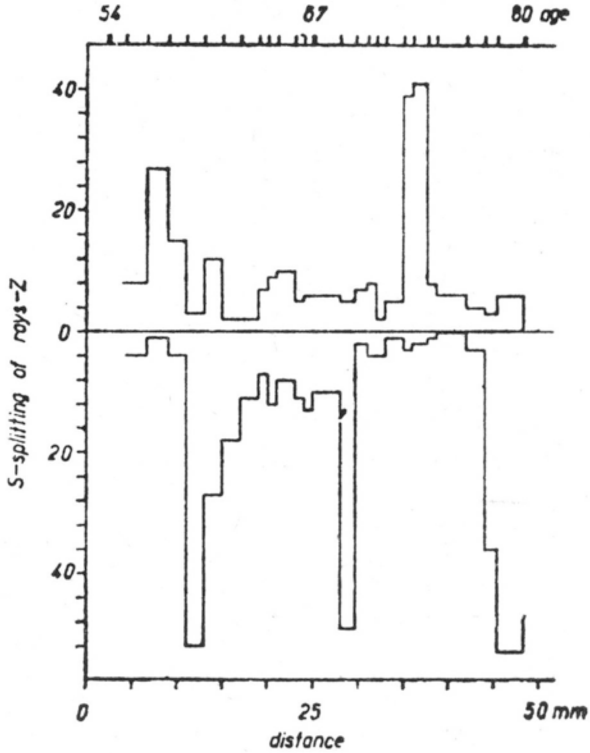

Fig. 8. Number and direction of ray splittings on a 5 × 7 mm surface during 26 years of cambium activity from the 54th to the 80th year of life of the tree

The bars above the abscissa denote the number of splittings leading to a Z orientation. The bars under the abscissa denote S splittings. The ordinate gives the number of splittings in the particular annual rings. The position of the annual rings in relation to core and their age are given underneath and above the figure, respectively

Between the years 62 and 68 its size remained the same while in the 69th year, that is at the moment when the Z type began to prevail, the angle started growing. In the year 77 it reached its second peak and then, as the dominance of S events set in, a new decrease of the angle occurred.

On some maps in the series examined, in which both types of events, Z and S, occur, a grouping of events of one type may be seen. Thus, on maps of rings 60, 65, and 67 most of the S events are localized in the central part. Also on some maps in which one type markedly prevails (S), a greater accumulation of S events is visible in the central part of the area as for instance in maps of 59 and 60. On the other hand, on other maps with predominant Z events their grouping occurs in the upper and lower parts of the maps and the central parts are empty. It seems that this grouping is connected with the short domain pattern migrating slowly and associated with formation of short waviness.

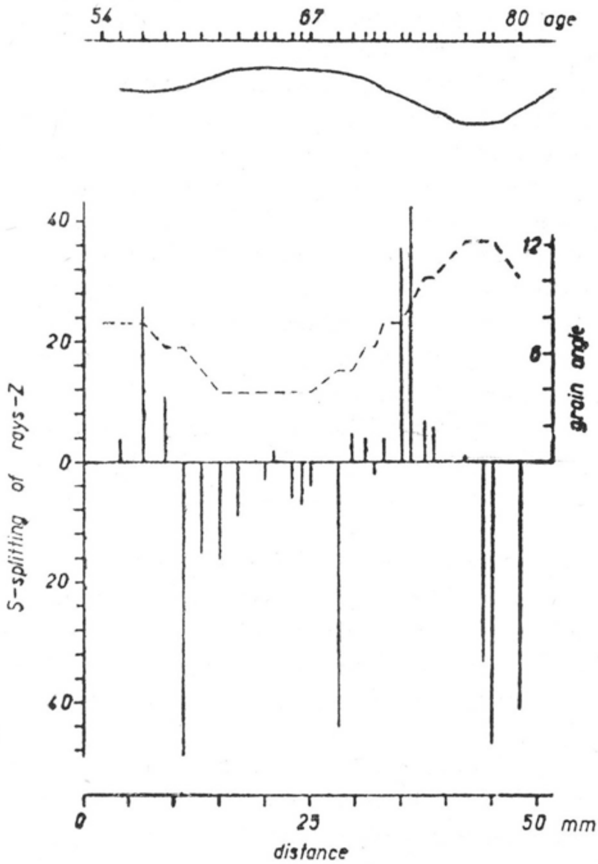

Fig. 9. Vertical segments show differences in the number of splittings of type Z and S (prevalence of splittings of given type) in successive annual rings during 26 years of cambium activity on the 5 × 7 mm surface

The dashed line outlines the waviness angle. Above — outline of projection of lower edge of radial split along the segment examined for cambial events

DISCUSSION

It is known from the literature that: (1) cambium has a domain structure, (2) domains migrate in respect to the cells along the stem, (3) the domain pattern lies at the base of the mechanism producing a grain pattern.

The here presented investigations on the wood of *Aesculus* point to the fact that the inclination of grain at the given site of the cambium changes cyclically in the succesive annual rings and that on the surface of the given annual ring (which at the moment of formation was adjacent to the cambium) there exist two kinds of areas differing in size and orientation in which changes in the inclination of the waviness occurred.

The only rational explanation of these observations is the migration of the domain pattern in the cambium.

Study of the type of events in the cambium of the stem no. 1 characterized by a distinct outline of ridges corresponding to long waviness on the surface of the radial split, shows that the prevalence of alternating events of both types is responsible for the formation of long waviness.

For determining in *Aesculus* the length of the domain responsible for the pattern of wavy grain with a long wave on the basis of maps of the cambial events, the investigations would have to be performed on a wide area. This would be extremely difficult when using the method of comparison of the terminal parenchyma on microtome sections.

In his investigations of the domain pattern in interlocked wood of *Platanus* Krawczyszyn (1973) used veneer owing to which it was possible to analyse large surfaces. This method could not, however, be applied to the studies on *Aesculus* on account of the small dimensions of the rays.

The size of large domains in *Aesculus* may, however, be ascertained in an indirect way on the basis of wood waviness parametres namely on the basis of the length of the longitudinal cycle.

It results from up to date investigations on the domain pattern in trees with curly or interlocked grain that the length of two domains (Z and S) is approximately equal to the wavelength of the waviness (one longitudinal cycle). In the examined wood from stem no. 2 the wavelength of the long waviness is equal to about 500 mm. It may hence be concluded that one large domain in *Aesculus* has a length of about 250 mm.

It is possible, when knowing the wavelength of long waviness (500 mm) and the period (10 years), to determine the velocity of domain migration up the stem. This velocity amounts to 50 mm per year.

Slight stripes corresponding to short waviness with small amplitude are also visible on the surface of the radial split of the block examined for cambial events.

It was found in earlier investigations on *Aesculus* (Pyszyński 1972) that, in wood of short waviness but with a large amplitude (12°), the ridges were inclined obliquely in respect to the rays and ran down the stem from the pith to the cambium at an angle of 4°. The wavelength was on the average 6 mm. Examination of the type of events in the cambium demonstrated the existence of a distinct domain pattern. The domains migrated down the stem at mean velocity of 0.2 mm per year, that is 1 mm per 10 mm of wood produced. The domain length was about 3 mm. As seen all the parametres except the amplitude were the same as in the wood of the trees examined in the present study.

When comparing the maps of events from the preceding paper (Fig. 10) with the present ones, traces of narrow domains may be detected, superposed on a background of much longer ones.

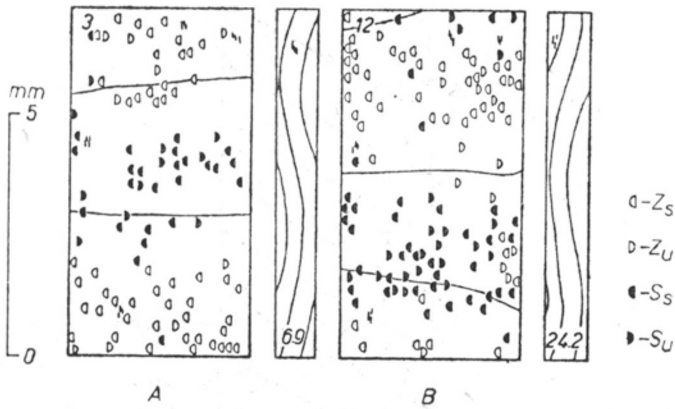

Fig. 10. Maps showing splitting and uniting of rays in the cambium of *Aesculus hippocastanum* producing wavy grain with a distinct amplitude on the surface of. 3.7 × 7.5 mm. Clear semicircles correspond to events of type Z, black semicircles correspond to type S events

Map B corresponds to cambium from the last annual ring of the stem (about 85 years old) and map A corresponds to the same cambium surface 10 years earlier. Borders between areas with different orientation of short waviness are indicated. Beside maps of the domain pattern, in narrow rectangles maps of waviness in the examined area are shown. The distance between layers A and B is 20 mm (after Pyszyński, 1972).

One of the reasons why the pattern of short domains is not distinct in the wood examined in the present study is the low density of events. The short waviness is also but little pronounced.

Hejnowicz (1973a, b, c, 1974a, b, 1975) advanced the hypothesis that there occur in the cambium waves of orientational tendencies. In this aspect the domain pattern would be a spatial manifestation of the wave and the change of domain type at a given site of the cambium would be its manifestation in time (Fig. 11).

Interference of waves is a known phenomenon. Interfering waves are either amplified or attenuated in dependence on the phase in which they meet. Thus, if there is more than one wave of orientational tendencies in the cambium, then in the case of interference of these waves an extension of the domains of one type may occur and narrowing of those of the other type as well as changes in amplitude (Fig. 12). Hejnowicz (1974a, b) established that in *Fraxinus excelsior* in which two kinds of waviness occurred with long and short wave, there occurred pulsations of the domain lengths which can be explained on the basis of interference of the waves of orientational tendencies of different velocity and wavelength.

Domain pulsation was also observed by Krawczyszyn (1973) in *Platanus*. It is also probable as regards the examined *Aesculus* that, as the result of superposition of short domains on long ones, the short ones of opposite type become narrower or disappear. This would be an additional factor causing the obliteration of the short domain type.

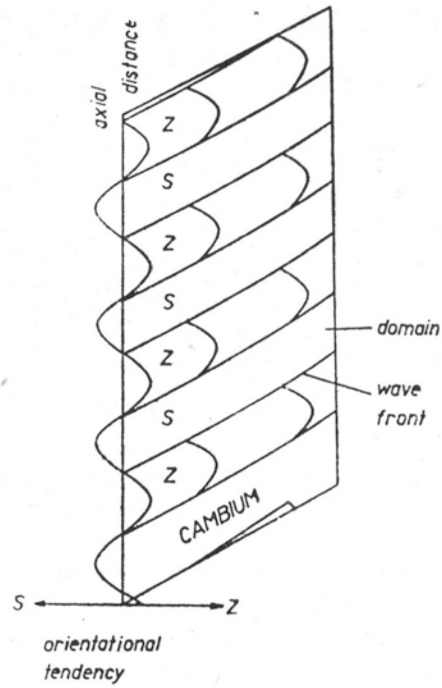

Fig. 11. Diagram illustrates the waves of orientational tendencies in the cambium and the domain pattern corresponding to it (after H e j n o w i c z, 1972)

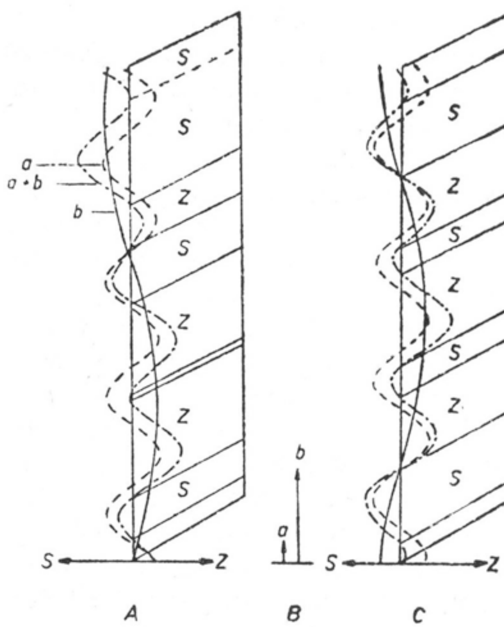

Fig. 12. A — diagram illustrating the occurrence of two waves of orientational tendencies in the cambium and the corresponding domain pattern. B — a and b wave velocity vectors. C — like A but after shift of waves by their velocity vectors (after H e j n o w i c z, 1972)

It should be noted that the stripes associated with short waviness in the wood from stem no. 1 run in general almost parallelly to the rays and only in some places inclination is noticeable.

A horizontal stripe pattern may be evidence that the previously formed waviness pattern is continued without change if the intensity of the events is low. Even if the domain pattern corresponding to this waviness would migrate continuously, the cambium would not be able to change the cell orientation on account of the low frequency of the events. In fact the frequency of events corresponding to the short domain pattern was very low in the studied wood fragment.

The velocity of migration of the short domain pattern and the duration of the transverse cycle will be the subject of further research.

In the examined fragment of the *Aesculus hippocastanum* stem (no. 1) there occurred along the radius a general distinct prevalence of S events (see Fig. 8); in a total of 356 splittings 277 of type S and 179 of type Z. Nevertheless the general orientation of the grain at all points was of Z type. Hejnowicz and Krawczyszyn (1969) found in stems of *Aesculus hippocastanum* that there was a distinct predominance of type S anticlinal divisions. If we take into account their findings, it may be concluded that the Z orientation is the result of some other factor so far not taken into account. The results of the search for this factor will be reported in a future publication.

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Złożona włóknistość falista w pniach Aesculus

Streszczenie

W badaniach nad mechanizmem tworzenia typów włóknistości drewna w pniach kasztanowca (*Aesculus hippocastanum* L. i *A. carnea* Hayne) stwierdzono, że w drewnie występują dwa typy falistości: o dużej (500 mm) i krótkiej (6 mm) fali włóknistości, nałożonej na włóknistość skrętną. Analizę typu włóknistości drewna prowadzono na podstawie przebiegu zarysu dolnej krawędzi oraz powierzchni krążków drewna przełupywanych promieniowo. W badanym materiale zarysy dolnych krawędzi były faliste a na powierzchni promieniowej zaznaczały się szerokie pasma dużych grzbietów i dolin w sposób charakterystyczny dla drewna o włóknistości przeplatanej. Grzbiety dużej falistości biegły stromo w górę pnia od rdzenia do kambium tworząc z granicami przyrostów średnio kąt 5°. Falistość drobna zaznaczała się w postaci de-

likatnych smug (ze względu na małą amplitudę) zbiegających w dół pnia od rdzenia do kambium tworząc średnio kąt 86° z granicami przyrostów rocznych.

Badania wzoru domenowego prowadzono na podstawie analizy rozszczepienia i łączenia promieni w kolejnych warstwach miękiszu terminalnego. Wykazały one, że za tworzenie wzorów falistych drewna odpowiedzialne są wzory domenowe w kambium.

W pniu badanym pod względem zdarzeń w kambium ogólnie wystąpiła przewaga zdarzeń S-owych (typu lewego) a pomimo to skrętna włóknistość w każdym miejscu przełupu była Z-owa (prawoskrętna). Dane te wskazują na to, że za ogólny skręt w pniu kasztanowca odpowiedzialny jest jakiś inny czynnik niż kierunek zdarzeń w kambium, nie brany dotychczas pod uwagę.