MARIA REYMANÓWNA

ON *DADOXYLON SCHROLLIANUM* WITH PITH AND OTHER *DADOXYLA* FROM THE UPPER CARBONIFEROUS IN SOUTH POLAND

Dadoxylon Schrollianum z rdzeniem i inne *Dadoxyla* z górnego karbonu Polski południowej

1. INTRODUCTION

South of Chrzanów, in the Cracow district, there is an area where petrified logs and smaller fragments of silicified wood occur frequently on the bottoms of little valleys, on the roads and even in the fields. They range to 1,17 m. in diameter and the biggest log found in 1946 was 4.60 m. in length.

The source of the fossils is the Kwaczała Arkose which forms there a stratum ranging up to 100 m. in thickness. The age of this stratum, known before as Permocarboniferous, has been later determined by S. Siedlecki (1954) as Stephanian. According to this author the Kwaczała Arkose corresponds to the Zaltmanian (Hexenstein) Arkose of the Bohemian coal basins which is considered to be the equivalent of the Middle Ottweil Beds (Middle Stephanian). The distribution of the silicified woods in the Arkose area is represented on a map by S. Zaręczny (1953).

The microscopic structure of the fossil wood was first investigated by H. R. Goeppert (1855, 1857) who described the fossils as *Araucarites Schrollianus*. According to J. Felix (1882) *Araucarioxylon Rollei* Ung. is present there too. M. Raciborski (1889) investigated several hundreds of specimens but found only *Araucarites Schrollianus*.

Recently M. Turnau-Morawska (1958) and M. Turnau-Morawska and M. Jahn (1954) have investigated the structure of mineral aggregates and the optic orientation in quartz grains in the fossil wood.

At the request of Professor Wł. Szafer the present author collected in 1955 over a hundred specimens in the localities Kwaczała, Lipowiec and Zagórze. Only certain specimens, in particular those with the central part of the stem preserved, are described in this paper.

According to Siedlecki (1954) the *Dadoxyla* producing forests grew on mountain slopes in a climate characterized by rapid changes of temperature and considerable humidity. The *Dadoxyla* stems were transported downwards by torrential rains, together with disintegrated rock material, and deposited in a presumably arid and warm piedmont area. According to S. Małkowski (1958) the silification of the stems from Kwaczała and Nowa Ruda (Lower Silesia) took place in hot mineral waters.

In autumn 1960 Dr K. Dziedzic from the Department of Geology of the University of Wrocław was kind enough to help the author in collecting samples of silicified wood in the locality Miłków near Ludwikowice Śląskie in the Infrasudetic Basin. The logs occur in coarse-grained sandstones in the upper part of the Zaclar beds (Westphalian) and were found (8 specimens) during excavations in ditches about 1/2 m. deep. Three more specimens were encountered in boreholes (Dziedzic 1958).

The diameter of the stems reaches up to 50 cm. and their whole length was probably several metres. Only one of the collected stems contained the pith and was therefore carefully investigated.

2. MATERIAL AND TECHNIQUES

The fossil stems from the Kwaczała Arkose are silicified, their colour being grey or brown with lighter stretches, sometimes showing red, yellow or black veins. The fossils of each of the three localities differ slightly in outer appearance. Those coming from Kwaczała are brown, often weathered over the surface and perfectly recalling recent wood. The stems from Zagórze are rather greyish and solid, being difficult to split. The Lipowiec stems are of a lighter colour showing many cracks, splitting easily and recalling in appearance rotten stems lying on the ground of old forests.

The microscopic structure of some of the stems is altogether indistinguishable. But even in the best ones such details as the pitting in the field are difficult to observe and in some samples are not to be seen at all. The observation of the pith and primary xylem is made difficult by the light colour of the cell walls and the presence of crystals. The structure of silicified fossils has been studied almost entirely on ground sections.

A tiny fragment of wood from Zagórze was preserved in an orange-coloured iron compound (comp. *Dadoxylon saxonicum* p. 9) and from it dry peels were prepared, using acetone and cellulose acetate film. They showed finely preserved structure (Pl. V, fig. 21—23).

Most stems from Miłków are black, showing perfectly preserved structure, only some of them are brown with badly preserved structure, very much like the woods from the Kwaczała Arkose. The black stems exhibit no traces of fungi, but there occur numerous insect burrows which will be described later.

The preparations investigated were ground sections.

DESCRIPTION OF THE FOSSILS

I. *DADOXYLA* FROM THE KWACZAŁA ARKOSE (STEPHANIAN, CRACOW DISTRICT)

1. *Dadoxylon Schrollianum* Goepp. *emend.* Frentzen with pith

Three fossils containing that type of wood associated with pith were found.

The specimen marked L 58 and found in Lipowiec is 13 cm. long, 7 cm. in diameter and represents a fragment of a branch that was split lengthwise. The zone of wood is 3.5 cm. wide and the diameter of the pith is 15 mm. (Pl. I, fig. 1). Neither bark nor lateral shoots are present.

Secondary xylem. No growth rings are visible, there being only zones of collapsed wood (Pl. I, fig. 3). The tracheids are square or short oblong in transverse section, ranging from 30 to 57 μ in radial diameter (Pl. I, fig. 4).

Near the primary xylem the pits on the radial walls of the tracheids are uniseriate, covering from 1/2 to 3/4 of the wall surface. In other parts they are often biseriate and alternating, covering almost the whole surface of the wall. The pits are in close contact and flattened where in touch with neighbouring pits. Separated pits were not observed. It is not possible to establish whether there are parts of tracheids without pits because of the poor preservation of the material. The height of the pits is about 14 μ.

Medullary rays occur after every 1—11th row of tracheids. They reach a depth of between 2 and 16 cells and are uniseriate, sometimes partially biseriate. In tangential section the cells are square or short rectangular, sometimes oval, and ranging from 17 to 46 μ in height (comp. Pl. I, fig. 6).

The pits in the crossing fields are difficult to observe. They are ellipses placed obliquely, 1—2 in each field. (Pl. I, fig. 5). Sometimes only their slits are visible. The features of the secondary wood of L 58 are those of a *Dadoxylon Schrollianum* according to Frentzen (1931).

Primary xylem. The inner wedge of the wood is often damaged but primary xylem groups are to be seen in many places. They form wed-

ges of irregularly arranged tracheids, easy to distinguish from the radially seriated elements of the secondary wood (Pl. II, fig. 7). The primary xylem consists of tracheids about 14 μ in diameter, with spiral or perhaps reticulate thickenings. They are followed by 1 or 2 rows of tracheids with radial walls completely covered by 2—3 rows of alternating, polygonal pits 10 μ in height (Pl. II, fig. 9). No pitted elements were ever observed between those with spiral thickenings and the pith, so the primary xylem is centrifugal.

The pith is continuous, without discoid cavities, its structure not being everywhere preserved. Near to the primary xylem especially it tends to decay (Pl. I, fig. 2).

The parenchymatous cells are isodiametric and slightly polygonal in transverse section (52—132 μ in diameter), and brickshaped in radial section (Pl. III, fig. 10—12). Near to the xylem they are narrower and elongated in a vertical direction.

Scattered through the parenchyma occur elongated elements running parallel to the axis of the branch. The structure seen on one of the slides shows their origin which suggests that they are of secretory character. The parenchyma cells are often arranged into vertical columns. Sometimes the vertical walls of such a column become straight and join together, and the transverse walls disappear, forming a canal with occasionally occurring transverse septa (Pl. III, fig. 12). In transverse section the canal is of the same shape and dimension as the surrounding parenchyma-cells, differing from them only in having thicker walls (Pl. III, fig. 10). Owing to this they are preserved even when the parenchyma is decayed; but then they may appear crescent-shaped. One of the canals was observed extend over a length of 6 mm.

Another specimen belonging to the same species and genus is No L 17 from Lipowiec. Like most stems from that locality it shows a dense network of cracks dividing the fossil into numerous small particles. It is a somewhat flattened fragment of a stem which was split through the centre, 30 cm. long and 12 cm. in diameter. It contains a part of the pith which is remarkably flattened, with diameters of 13 mm. and 3 mm. The secondary woods is of *D. Schrollianum* type.

It differs from L 58 in the slightly larger dimensions of some elements. E. g. the radial diameter of the tracheids is 40—68 μ (30—57 μ in L 58); the pits on the tracheids are 15—19 μ high (about 14 μ in L 58), but they still fit in the description characteristic for *D. Schrollianum* (K. F r e n t z e n 1931). The primary xylem is of the same type as in the former specimen.

Only fragments of pith show microscopic structure, but it is possible to establish that it consists of the same kind of parenchymatous cells and elongated ducts which occur in L 58.

2. *Dadoxylon Schrollianum* form *ramosissimum* n. f.

The specimen K 6 from Kwaczała is a slightly flattened fragment of a stem, 35 cm. long and 37 and 26 cm. in diameter, with the pith situated almost in its centre. This is the first investigated specimen to show lateral branching. A block 7×5×6 cm. was cut out around the pith, its sides revealing 13 small branches in transverse section, arranged in a rather irregular way (text-fig. 1). At a distance of a few cm. from the pith the branches disappear gradually and no knots are to be seen on the surface of the stem.

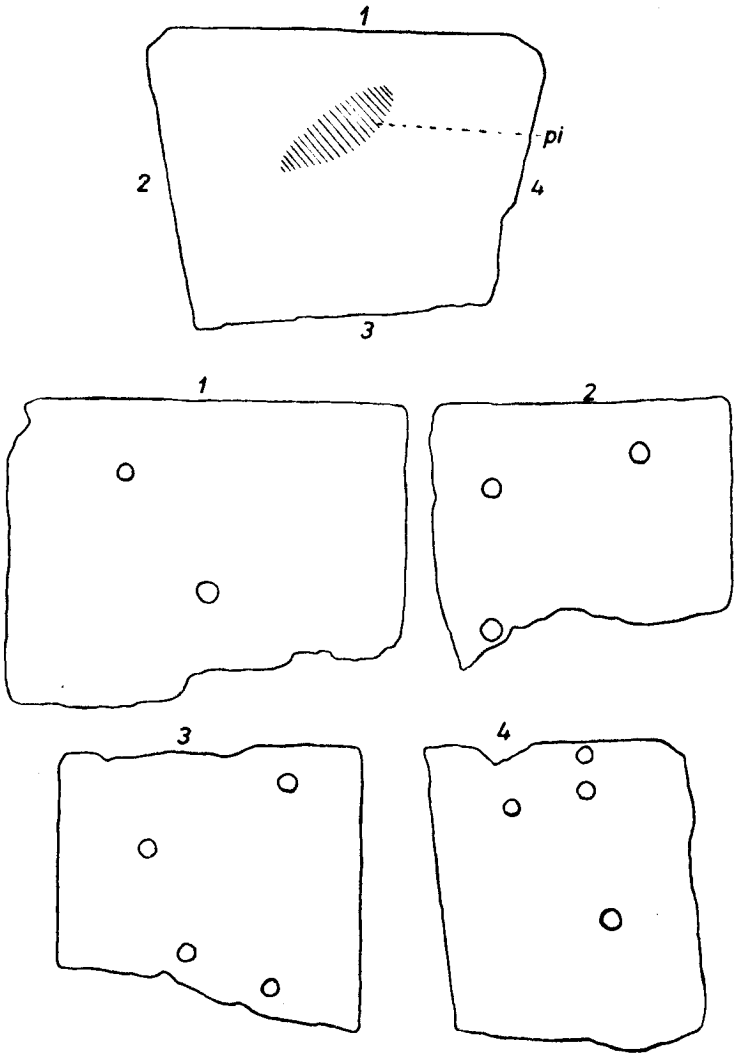
The secondary wood agrees both in structure and in size of tracheids with those of the specimen L 58 and is therefore of *D. Schrollianum* type. The primary xylem visible in the branches is of the same type as in L 58.

The pith of the stem, although only fragments of it are preserved, is seen to consist of parenchyma and elongated ducts, similar to those of L 58 and L 17 (Pl. III, fig. 14). In the branches, however, the pith-parenchyma consists of elongated and much narrower cells, although fragments of structure similar to that in the pith of the stem were also detected. But both in L 58 and in L 17 the parenchyma next to the xylem consists of narrower and vertically elongated cells, this being a feature in common with other *Dadoxyla*.

A particular feature are the small lateral branches. They are about 4 mm. in diameter and consist of pith surrounded by primary xylem and decayed secondary wood. (Pl. III, fig. 13). Similar branching is to be seen on Pl. LVI, fig. 2—4 (Goeppert 1864/65), representing *D. saxonicum ramosissimum*. Therefore the specimen is regarded as only a form of the former species: *Dadoxylon Schrollianum ramosissimum*.

3. *Dadoxylon Rollei* Ung.

This is represented by one specimen from Kwaczała, marked K 77, which is 10 cm. long and 8 cm. in diameter. Similarly to L 58 it is one half of a longitudinally split branch, tapering toward one end. The specimen is not semicircular in cross section, but shows two deep furrows and three eminent ribs (Pl. IV, fig. 17). At the thinner end it bears three circular scars of lateral branches, measuring about 5 mm. in diameter. At the wider end of the specimen there were preserved some fragments of pith, surrounded by wedges of primary xylem. The transverse section from the other end shows only a few pith-cells in the middle of primary wedges. The transverse section of a scar exhibits root structure: tracheids and no pith inside (Pl. V, fig. 19). The details could not however be made out. The specimen represents therefore the transitional region between stem and root.



Text-fig. 1. *Dadoxylon Schrollianum* f. *ramosissimum*. The arrangement of lateral branches shown on a block cut from the centre of the stem. At the top the transverse section of the block showing the position of pith (pi); below the four lateral sides of the block exhibiting the arrangement of lateral branches × 2/3

Ryc. 1. *Dadoxylon Schrollianum f. ramosissimum*. Układ odgałęzień bocznych, widoczny na bloku wyciętym z centrum pnia. Na górze poprzeczny przekrój bloku z widocznym rdzeniem (pi); poniżej cztery boki bloku, na których jest widoczny układ odgałęzień bocznych × 2/3

Secondary xylem. There are no growth rings, only zones of collapsed tracheids. The tracheids, nearly always square in transverse section, range from 29 to 46 μ in radial diameter. The pits occupy only the median part of their radial walls and they are uni-, sometimes biseriate, araucarioid, about 13 mm. high (Pl. IV, fig. 18).

Medullary rays occur between every 1—6th row of tracheids. They are from 1 to 14 cells high, here and there higher, 62% of them are uniseriate, 37% biseriate and about 1% partially triseriate. Their cells, ranging from 29 to 52 μ in height, are oval in tangential section (Pl. V, fig. 20).

In the crossing fields are to be seen only the long narrow slits of the pits. They are placed obliquely, 1—4, usually 2 or 3 in every field.

The primary xylem consists of wedges of centrifugal tracheids. The wedges are narrower, longer and more numerous than in *D. Schrollianum*. The pith could be observed only in transverse section. It consists of polygonal cells, much smaller than those of *D. Schrollianum*, (about 60 μ in diameter). The material was however too scanty to allow adequate investigation.

Taking as a basis the monograph of Frentzen (1931) the wood was determined as *Dadoxylon Rollei* Ung. It agrees with the diagnosis (l. c. p. 50) in the great majority of features, including the most conspicuous one, the high proportion of biseriate rays and the occurrence of triseriate ones. Only the height of the medullary rays is 1—26, mostly 1—14 cells, compared with 1—49, usually 1—10, mentioned by Frentzen, and the height of their cells is different: 29—52, average 43, compared with 19—36, usually 24—30 by Frentzen. Also the number of pits in the field is sometimes 4, compared with 1—3 in the diagnosis. Nevertheless the wood is no doubt a *D. Rollei*.

4. *Dadoxylon saxonicum* Goepp.

The biggest hitherto known specimen from the Kwaczała Arkose is the stem found in Zagórze by Siedlecki. It was found in a horizontal position with both ends hidden in the rock. The stem was excavated and transported to the Museum of the Polish Geological Institute in Warsaw.

The trunk is 4.60 m. in length, its diameters at one end are 110 and 32 cm., at the other one 90 and 54 cm. It is decorticated like the other specimens and shows no lateral branches, nor knots, only about the middle of the stem there are 3 large excrescences placed around it, recalling those to be seen on old trees today. The central part of the stem is decayed, about a half of it being apparently hollow inside and thus collapsed and considerably flattened under the pressure of the sediment.

The surface of the stem shows much damage recalling that of a recent stem transported by a river. On many places it is covered by silicified mud and sand. There are also precipitations of iron compounds, and

sometimes particles of wood are preserved in this way. Such a splinter sticking to the stem revealed the same wood structure and very probably did belong to it. The fragment measures about 4 mm. in length and 2 mm. across, and exhibits its structure preserved in radial section much better than in the silicified material (comp. Pl. V, fig. 21—23).

Secondary wood is the only tissue preserved. It shows no growth rings, only zones of collapsed tissue. The radial walls of the tracheids usually bear 2 rows of continuous, alternating pits with an obliquely placed slit. They cover the wall almost completely (Pl. V, fig. 21—22). The pits are flattened by the next lying ones, or sometimes circular. There occur also tracheids with one series of pits, covering only about 1/2 of their walls; in others 3 rows of pits are to be seen. The diameter of the tracheids ranges from 34 to 74 μ, the height of the pits being from 15 to 17 μ.

It was not possible to count accurately the number of cells in higher medullary rays because of their bad preservation. It was however established that about 16% of them are partially (in 1—4 cells) biseriate. Their cells are long elipses in tangential section, ranging from 34 to 49 μ in height. 1—8 (av. 3—7) pits are found in each field, tending rather to form groups in the centre of it (Pl. V, fig. 23). The pits appear to be circular or slightly oval, separated from each other and showing an obliquely placed slit; their height is about 10 μ.

All these features except the last one agree both with *D. Schrollianum* and *D. saxonicum*. However the number of the pits in the field which is greater than 4 shows that the big stem from Zagórze possesses the *D. saxonicum* type of wood, which has not yet been found among the fossils of the Kwaczała Arkose.

II. *DADOXYLON* FROM MIŁKÓW (WESTPHALIAN, INFRASUDETIC BASIN)

1. *Dadoxylon Schrollianum* Goepp. *emend.* Frentzen with pith

The wood fragment M9/2 from log No 6 in the paper by Dziedzic (1959, p. 431 and Fig. 1, p. 430) was collected in the ditch No 9, dug in a coarse-grained sandstone. It comes from a slightly flattened stem 2,80 m. long in its uncovered part, with diameters 0,52 and 0,30 m. A smaller fragment, belonging perhaps to a branch of it was found beneath, but no central part found in it.

The specimen M9/2 is 10 cm long with diameters 13 and 6 cm. and represents one half of the central part of the stem. It is silicified, black with white veins visible on sections and with rusty precipitations on its surface.

Secondary xylem. Growth rings are absent, even zones of collapsed tissues are not being present. The tracheids are squares or short oblongs in transverse section, their diameter ranging from 36 to 61 μ. They are arranged closely in radial rows which are separated every (1/2—7/11) row by medullary rays. The radial walls of the tracheids are usually not completely covered by the predominantly uniseriate, contiguous pits; if biseriate, the pits are alternating (Pl. VI, fig. 24). Very occasionally there occur also pairs of opposite pits, associated with a single row. The pits are flattened where they are in contact with the neighbouring ones, their horizontal diameter being often considerably larger than their height, which feature is mentioned in the diagnosis of *Dadoxylon Schrollianum* by Frentzen (Va, 1931, p. 51). The height of the pits (50 measurements) ranges from 10,1 to 17,7 μ average 14,1 μ. Their pores are either circular or elliptical and inclined, even crossed pores being observed. No pits were found on the tangential walls of the tracheids.

The medullary rays are mostly uniseriate (75%), and some of them partly, in one or more layers, biseriate (25%), reaching a depth of between 1 and 14 (33) cells (Pl. VI, fig. 25). Their cells are square or short oblong in tangential section, their height ranging from 14,9 to 31,1 μ. Some of the cells are filled with dark secretion.

The pits on the crossing fields are often not preserved, or only the pores are visible. But in some places it could be observed that they are narrow ellipses, inclined, from 1 to 4 in one field, showing a narrow margin (Pl. VI, fig. 26). Their length is about 13 μ.

The primary xylem protrudes into the pith by means of small, narrow wedges, consisting of 1—3 rows of tracheids, diminishing in diameter on passing inwards. The tracheids are clearly distinguished by their thicker walls from the thin-walled parenchyma cells (Pl. VI, fig. 27). The longitudinal section reveals the perfectly preserved structure of their walls (Pl. VII, fig. 28).

The primary xylem consists of a series of about 7 tracheids, their wall structure varying from spiral and probably even annular thickenings through reticulate and scalariform to tracheids with walls covered completely by 2—3 rows of alternating, continuous bordered pits. It was not possible to establish the arrangement of the leaf-traces, but it is clear that they do not possess centripetal elements (comp. Pl. VI, fig. 27, Pl. VII, fig. 29).

Secretion may occur also in the primary xylem tracheids; it is represented by solid black particles, similar to those seen in the secretory ducts and in some tracheids of the secondary xylem.

No traces of secondary xylem were established within inwards the primary xylem.

The pith about 15 mm. in diameter, is partly destroyed but what is left shows that it was continuous, without discoid cavities.

The part adjacent to the xylem consists of cells isodiametric and slightly polygonal in transverse section and square or oblong in longitudinal section. They tend to be arranged in vertical rows. Their diameter ranges from 54 to 135 μ. Nearer towards the centre the pith consists of irregularly arranged cells of varying shape and dimensions (Pl. VII, fig. 31). Their walls tend to dissolve and they often contain a brownish secretion. The cells in the neighbourhood of the xylem are smaller and they usually contain secretion in the form of black, obviously shrunken particles.

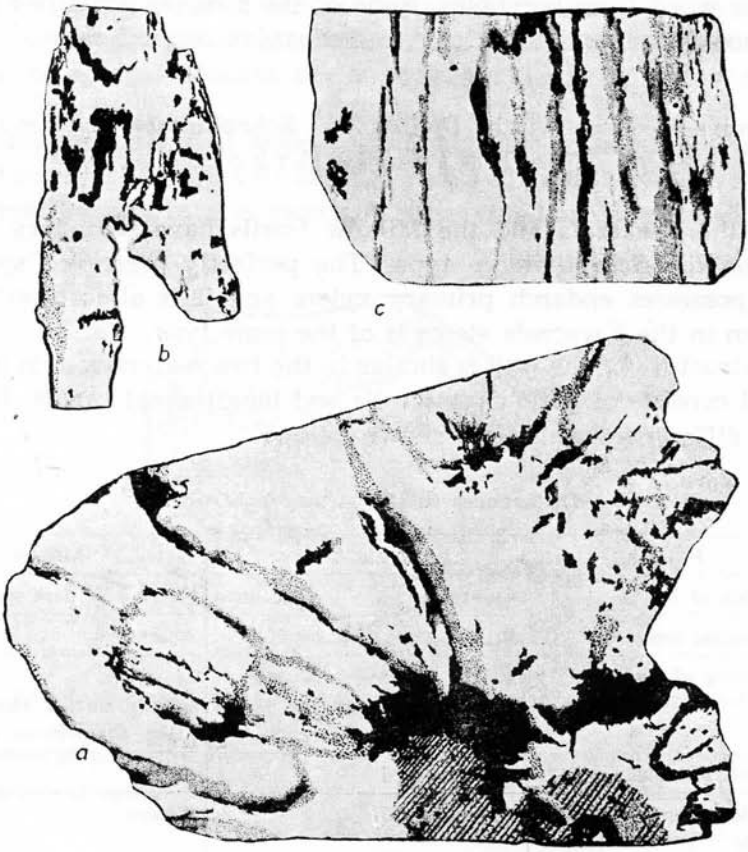
On many parenchyma cells pits occur which are irregular, changing from a circular to an oval shape (Pl. VIII, fig. 32). They appear to be simple pits and the cells ordinary parenchyma elements; similar pits are found also in the medullary rays of this specimen. Pitted cells occur also in the pith parenchyma of recent coniferous trees. Pitted cells were found by Kräusel and Dolianiti (1958) in the pith of *Taxopitys alves-pintoi* from South America and as there were found also bordered pits the pitted cells were regarded as tracheidal elements. For this reason the primary xylem of this genus was considered to be mesarch. It was not so in the specimen here described.

The pith contains very distinct vertically arranged secretory canals, usually filled with a black mass, which is divided by transversal cracks, due probably to shrinking (Pl. VII, fig. 30). Their walls are thicker than those of the parenchyma cells; their diameter is slightly smaller than that of the parenchyma cells. Sometimes the canals contain only fragments of a secretion. It was not possible to observe septa in the canals but there were spots showing clearly that the canals had developed from vertically arranged rows of cells, which had gradually lost their transverse walls. There occur also canals running in other directions, at right angles or obliquely to the vertical ones and connected with them (Pl. VIII, fig. 33). They are much narrower and less conspicuous than those.

2. Damage by insects

A characteristic feature of the described specimen is that it shows a considerable amount of damage by animals, most probably insects. The wood contains many burrows, and parts of the pith and primary xylem are destroyed, while the remaining parts are dislocated. It is possible to establish the prevalent shape of the burrows throughout the wood. In transverse section mainly radially running corridors are seen but sometimes also broader, irregular spaces. There occur also small injuries a few mm. in diameter. In radial section the burrows run horizontally, vertically and obliquely. In tangential section vertically running burrows of irregular shape are seen (Text-fig. 2).

Some of the corridors are empty but most of them are packed with debris of tissue and with small, ovoid bodies of black colour showing a light margin, 20—50 μ in diameter, which are apparently coprolites (Pl. VII, fig. 30).



Text-fig. 2. Shape of insect burrows in *Dadoxylon Schrollianum* from Miłków in transverse (a), radial (b), and tangential (c), section. Black — empty space (insect burrows and cracks); stippled — coprolites; hatched — pith; × 2,3

Ryc. 2. Kształt chodników owadzich u *Dadoxylon Schrollianum* z Miłkowa w przekroju poprzecznym (a), promienistym (b) i stycznym (c). Czarne — puste miejsca (pęknięcia i chodniki owadów); kropkowane — koprolity; kreskowane — rdzeń; × 2,3

Another feature characteristic for the specimen is that a black secretion occurs in different tissues. It fills not only the ducts in the pith but it appears also in medullary rays which in some parts of the wood are completely filled with it; it may also occur in the tracheids of the primary and

secondary xylem. However xylem parenchyma was not observed. This unusually rich occurrence of the secretion seems to be connected with the invasion of the insects.

Other specimens from Miłków. Sections were also examined from the other 7 stems found in this place, and from 3 samples of similar wood from boreholes. None of the samples contained pith and their wood was found to belong to *Dadoxylon Schrollianum*.

3. Comparison with *Dadoxylon Schrollianum* stems from the Kwaczała Arkose

Both the Kwaczała and the Miłków fossils have secondary wood of the *Dadoxylon Schrollianum* type. The perfectly preserved stem from Miłków possesses endarch primary xylem and it is almost certain that the xylem in the Kwaczała stems is of the same type.

The structure of the pith is similar in the two materials as it is continuous and consists of parenchyma cells and longitudinal canals. But there are also differences which are shown below:

Differences in the structure of pith

	Feature	Kwaczała Arkose	Miłków
1.	Lumina of canals	Empty except in one specimen	Filled with dark secretion
2.	Transverse septa	Present	Absent
3.	Diameter of the canals	20—94 μ, about the same as that of the parenchyma cells	24—64 μ, slightly smaller than that of the parenchyma cells
4.	Transverse canals	Not observed	Present
5.	Simple pits on parenchyma cells	Not observed	Present

In sizing up the importance of these differences the essential matter is that the two materials are preserved in a different way. Therefore such features as the absence of secretion and of the pitting on parenchyma cells in the Kwaczała stems may be due to their poor preservation.

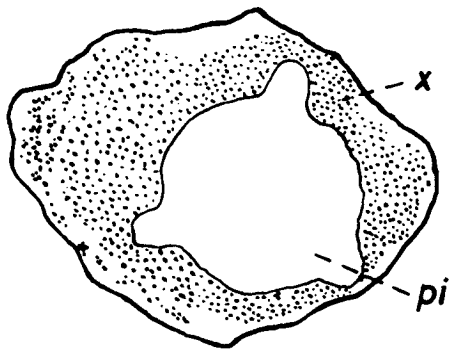
DISCUSSION

Some authors, e. g. Kräusel (1956) describe *Dadoxyla* associated with pith as new genera. Our fossils will also be discussed from this point of view.

There are only a few detailed descriptions of European *Dadoxyla* with pith. Frentzen (1931) mentions some but he does not pay much atten-

tion to the pith structure. Later R. F l o r i n (1940) established the genus *Walchiopremnon* (*W. valdajolense* = *Araucarites valdajolensis* M o u g e o t) from the Lower Permian of France. Its secondary wood with no pitting in the field preserved may belong to *Dadoxylon anulatum* F r e n t z e n, *D. saxonicum* G o e p p. or to *D. Schrollianum* G o e p p. *emend.* F r e n t z e n. Centripetal xylem is completely absent. The pith differs from that of the Kwaczała and Miłków specimens in being discoid and containing no elongated ducts, but it possesses lacunae filled with debris of tissue.

The numerous silicified wood from South Africa and South America (J. W a l t o n 1925, K r ä u s e l 1956, K r ä u s e l and D o l i a n i t i 1958) exhibit great variety in pith structure. The pith may be discoid or solid



Text-fig. 3. *Lobatoxylon Pedroi*. Transverse section showing the pith with three extensions; pi — pith, x — wood. (After Z e i l l e r)
Ryc. 3. *Lobatoxylon Pedroi*. Przekrój poprzeczny ukazujący rdzeń z trzema wystającymi listwami, pi — rdzeń, x — drewno. (Według Z e i l l e r a)

and may contain large canals or globular or elongated sclereids. There may also occur elongated ducts with transverse septa, developed from cells arranged into vertical columns, similar to those to be found in the Polish material.

Long secretory elements occur in *Dadoxylon Arberi* S e w a r d (W a l t o n 1925) from the Permian in South Africa, but they are narrower than the parenchymatous cells. The secondary wood differs distinctly from *D. Schrollianum* as it has growth rings, and in the tracheids occur also pits arranged loosely or in groups, and even placed oppositely. The same type of duct as in the Kwaczała and Miłków *Dadoxyla* is to be seen in the pith of the genus *Megaporoxylon* (*M. kaokense, M. scherzi, M. zellei,* K r ä u s e l 1956) from the Karroo Formation of South West Africa. But the wood showing one and sometimes two large pits in the field is different from *D. Schrollianum*. Similar elongated ducts are present in the

pith of *Lobatoxylon pedroi* (*Dadoxylon pedroi* Zeiller 1895) from the Permian of South America, and *L. kaokense* Kräusel (1956) from the Karroo Formation. But the pith of *L. pedroi* shows three and that of *L. kaokense* two radial extensions which persist along the whole length of the specimen. The pith of our specimens, however, although not completely preserved, must have been circular without any radial extensions.

Thus the comparison with the hitherto described Late Palaeozoic or early Mesozoic woods proves that none of them exhibit such a combination of features as the specimen M9/2 from Miłków and the Kwaczała woods, that is secondary wood of *D. Schrollianum* type, endarch primary xylem and pith containing characteristic elongated ducts. This would be sufficient for establishing a new genus. As the Kwaczała fossils show similar features except for minor differences in the pith structure, they would represent a different species. Mägdefrau (1958) describes a *D. Schrollianum* with pith showing no canals, which means that it would represent at least a new species, if not a new genus. The peculiar thing is that the three fossils which would have different names possess the same type of wood. Therefore it seems reasonable not to introduce new names until more material is investigated.

AFFINITIES

According to Florin and others, *Dadoxyla* with tracheid walls not completely covered with pits are found more often in Coniferous than in *Cordaites* remains, although the second possibility cannot be excluded. Kräusel (1956) points out that although most *Cordaites* stems possess discoid pith, it may well be solid in smaller branches. So neither the wood nor the pith structure give sufficient evidence concerning the affinity of our specimens.

Some authors consider *D. Schrollianum* as the wood of the Conifer *Walchia*. So far as the present author knows, the only hitherto described *Walchia*-wood is *Walchiopremnon valdajolense* (Mougeot) Florin 1940, which shows also leaf-bases. Taking as a basis their arrangement Florin was able to prove the affinity of this fossil with *Walchia (Lebachia?)*. But although *Walchiopremnon* possesses a wood structure similar to that of our fossils, its pith is different in showing no secretory canals, so none of our *Dadoxyla* is a *Walchiopremnon*.

Mägdefrau (1958) investigated large stems of Stephanian age from the Mannsfelder Schichten (= mittlere Ottweiler Schichten) in Germany. They have a *D. Schrollianum* wood, solid pith and irregularly arranged branches. The last mentioned feature, as well as the large size of the logs, indicate, according to Mägdefrau, that the stems belonged to *Cordaites*.

If so, the Kwaczała stems may well orginate from the *Cordaites*, because they show also such features as irregular branching and stems of large dimensions. But unless leaves or fructifications are found in connection with our fossil stems, there exists no convincing proof of their affinity.

Until now it appeared that at least the fossils from Miłków were certainly *Cordaites* stems because no Coniferous remains were known from the Westphalian. But recently R. Neves (1961) found in the English Namur C disaccate pollen grains of the *Pityosporites — Vesicaspora* type which presumably belonged to Coniferalean parent plants, so that also for this material the affinity with Conifers cannot be excluded.

CONCLUSION

1. The subject of the paper is the investigation of silicified stems of Westphalian and Stephanian age from Southern Poland.

2. From the Kwaczała Arkose (Stephanian, Cracow district) three specimens with *Dadoxylon Schrollianum* Goepp. wood showed continuous pith containing vertically running canals. A stem showing *D. Schrollianum structure*, with numerous lateral branches is described as *D. Schrollianum* f. *ramosissimum*. Only one specimen exhibiting *D. Rollei* Ung. structure was found. The biggest stem from this stratum, 4.60 m. long and 1,17 m. in diameter, possesses the structure of *D. saxonicum* Goepp. This was found for the first time among the Kwaczała woods.

3. A *Dadoxylon Schrollianum* with pith is described also from the Westphalian of the Infrasudetic Basin. Its pith possesses longitudinal canals which differ from those of the Kwaczała material in containing a dark secretion, in the absence of transverse septa and in the presence of small transverse canals. No adequate comparison can be made with the poorly preserved Kwaczała stems.

4. So far as the authors knows, no fossils containing wood and pith with similar structure have hitherto been described.

5. According to Kräusel (1956) *Dadoxyla* with known primary xylem and pith structure should be transferred to a different genus. But as it appears that more than one type of pith is connected with *D. Schrollianum* wood, the foundation of a new genus must be preceded by the investigation of more material.

6. It is not yet possible to establish whether the Kwaczała and Miłków stems belonged to *Cordaites* or Conifers; it is shown that they differ from the *Walchia* (*Lebachia*?) stem, *Walchiopremnon valdajolense* (Mougeot) Florin 1940.

ACKNOWLEDGEMENTS

I wish to express my thanks to Professor W. Szafer who entrusted me with the investigation of the Kwaczała material, to Professor A. Środoń for helpful assistance and to Professor J. Walton for examining the slides and discussing the paper. I am also grateful to Dr. K. Dziedzic and to Mgr. M. Mazaraki for their kind help in collecting the material, and to the authorities of the Museum of the Polish Geological Institute in Warsaw for samples from the greatest stem from Zagórze. Mgr. S. Łuczko was kind enough to take the photographs. The ground sections were made by W. Szczepański.

REFERENCES

1. Dziedzic K. (1958), O nowym stanowisku skrzemieniałych pni w karbonie górnym Niecki Śródsudeckiej (On a new occurrence of silicified trunks in the Upper Carboniferous of the Infrasudetic Basin). Ann. Soc. Geol. Pol., 28, (4) : 427—435.
2. Felix J. (1882), Studien über fossile Hölzer. Dissertation. Leipzig.
3. Florin R. (1940), Die Koniferen des Oberkarbons und des unteren Perms. Palaeontogr. 85B, Lfg. 5, 243—363.
4. Frentzen K. (1931), Studien über die fossilen Hölzer der Sammelgattung *Dadoxylon* Endl. I, II, Va Teil, Abh. Heidelb. Ak. Wiss. Math.-Naturwiss. Klasse, Berlin-Leipzig, Abh. 16, 19.
5. Goeppert H. R. (1855), Über die versteinerten Wälder Böhmens und Schlesiens. Jb. R. A. Wien.
6. Goeppert H. R. (1857), Über den versteinerten Wald von Radovenz bei Adersbach in Böhmen und über den Versteinerungsprozess überhaupt. Ibid. Wien.
7. Goeppert H. R. (1864/65), Die fossile Flora der permischen Formation. Palaeont. 12 : 1—316.
8. Kräusel R. (1956), Der Versteinerte Wald im Kaokoveld, Südwest-Africa. Hölzer aus dem südlichen Gebiet der Karru-Schichten Südwest-Africa. Senck. leth., 37 : 411—453.
9. Kräusel R., Dolianiti E. (1958), Gymnospermenhölzer aus dem Paläozoikum Brasiliens. Palaeontogr. 104B, Lfg. 4—6, 115—137.
10. Małkowski S. (1958), Struktura granoblastyczna kwarcytu ze szczątkami tkanki drzewnej. Prace Muzeum Ziemi, Warszawa, (1) : 157—161.
11. Mägdefrau K. (1958), Die Kieselhölzer im obersten Oberkarbon des Kyffhäusergebirges. Ber. Deutsch. Bot. Ges. 71 : 133—142.
12. Neves R. (1961), Namurian plant spores from the southern Pennines, England. Palaeontology, 4, (2) : 247—279.
13. Raciborski M. (1889), O niektórych skamieniałych drzewach okolic Krakowa. Spraw. Kom. Fizj. A. U. 29, Kraków.
14. Reymanówna M. (1958), Rezerwaty „araukariowe" w okolicach Kwaczały. (Araucaria reserves at Kwaczała). Chrońmy przyr. ojcz. 14 n. s., 14—20.

15. Siedlecki S. (1954), Utwory paleozoiczne okolic Krakowa. (Palaeozoic Formations of the Cracow Region). Inst. Geol. Biul., Warszawa 73.
16. Turnau-Morawska M. & Jahn M. (1954), Orientacja optyczna ziarn kwarcu w drzewie skamieniałym z okolic Chrzanowa. (Optic orientation of quartz grains in the fossil wood from the environs of Chrzanów). Roczn. Pol. Tow. Geol. 22 : 177—186.
17. Turnau-Morawska M. (1958), Zagadnienia mineralizacji drzew skamieniałych. (The problem of mineralization of fossil wood). Roczn. Pol. Tow. Geol. 28 : 409—426, wyd. 1959.
18. Walton J. (1925), On some South African Fossil Woods. Ann. South. Afr. Mus. 22 : 1—26.
19. Zaręczny S. (1953), Mapa geologiczna okolic Krakowa i Chrzanowa. Warszawa Wyd. Geol., pp. 290. (I edition 1891).
20. Zeiller M. (1895), Note sur la flore fossile des gisements houillers de Rio Grande do Sul. Bull. Soc. Géol. de France, III ser. 23 : 601—629.

STRESZCZENIE

DADOXYLON SCHROLLIANUM Z RDZENIEM I INNE *DADOXYLA* Z GÓRNEGO KARBONU POLSKI POŁUDNIOWEJ

Najpierw podano wyniki badań opartych na ponad 100 okazach drewien skrzemieniałych z arkozy kwaczalskiej (stefan). Ponieważ wiadome było z prac poprzedników (Raciborski 1899, Felix 1882), że ogromna większość drewien kwaczalskich należy do gatunku *Dadoxylon Schrollianum* Goepp., autorka skoncentrowała swą uwagę na okazach zawierających centralną partię pnia, aby móc uchwycić budowę ksylemu i rdzenia. W rezultacie znaleziono trzy okazy *D. Schrollianum*, zawierające rdzeń o charakterystycznych podłużnych kanałach. Jeden z tych okazów posiadał również nieregularnie ustawione rozgałęzienia boczne. Udało się również natrafić na rzadko w tym utworze występujące *D. Rollei* Ung. oraz stwierdzić, że największy dotąd znaleziony pień z arkozy kwaczalskiej, znajdujący się w Muzeum Instytutu Geologicznego w Warszawie, należy do nieznanego dotychczas z tego utworu gatunku *D. saxonicum* Goepp.

Następnie autorka opisała budowę skrzemieniałego drewna z górnych warstw żaclerskich (Westfal) z miejscowości Miłków koło Ludwikowic Śląskich. Podobnie jak u okazów z arkozy kwaczalskiej drewno wtórne posiada budowę *Dadoxylon Schrollianum*, ksylem pierwotny jest odśrodkowy, a rdzeń nie posiada przegród i składa się z komórek parenchymatycznych i podłużnie przebiegających kanałów.

Charakterystyczną cechą okazu jest obecność wygryzionych chodników, częstokroć wypełnionych koprolitami.

Budowa opisywanego okazu różni się od budowy drewien z Kwaczały pewnymi szczegółami struktury rdzenia. Dokładne jednak porównanie nie jest możliwe ze względu na znaczną różnicę w sposobie zachowania obydwu materiałów.

O ile autorce wiadomo, dotychczas nie zostało opisane drewno *D. Schrollianum* w połączeniu z ksylemem pierwotnym odśrodkowym i rdzeniem złożonym z parenchymy i podłużnie przebiegających kanałów. Istnieje pogląd, którego wyznawcą jest m. in. K r ä u s e l (1956), że pnie *Dadoxylon* występujące wraz z rdzeniem należy opisywać jako nowy rodzaj. W tym jednak przypadku byłoby to przedwczesne, ponieważ drewno typu *Dadoxylon Schrollianum* zdaje się występować w połączeniu z rdzeniem o rozmaitej budowie, co wymaga wyjaśnienia i dalszych badań.

Poznanie budowy anatomicznej okazów z Kwaczały i Miłkowa nie pozwala na razie na związanie ich z jakąś grupą roślin. Jak się wydaje, wchodzą tu w grę kordaity i rośliny szpilkowe. Jest jednak pewne, że okazów z Kwaczały i Miłkowa nie można zaliczyć do *Walchiopremnon valdajolense* (M o u g e o t) F l o r i n, które jest drewnem walchii.

CONTENTS — SPIS TREŚCI

PLATES

All figures are from untouched photographs

Wszystkie ryciny są nieretuszowanymi fotografiami

Plate I

Dadoxylon Schrollianum Goepp. *emend.* Frentzen.

1. L 58 in transverse section. Ground section; × about 2
2. L 58 in radial section, pi — pith, x — xylem. Ground section; × about 2
3. L 58 in transverse section, showing zones of collapsed wood. Ground section; × 23
4. L 58 in transverse section. Ground section; × 130
5. L 58. Pitting in the fields. Ground section; × 130
6. L 17. Tangential section. Ground section; × 45

Tablica I

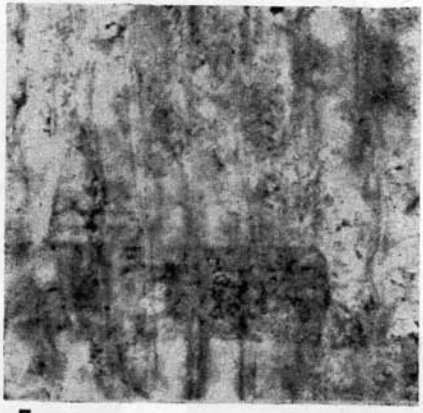
Dadoxylon Schrollianum Goepp. *emend.* Frentzen

1. L 58 w przekroju poprzecznym. Szlif; × około 2
2. L 58 w przekroju promienistym, pi — rdzeń, x — drewno. Szlif; × około 2
3. L 58 w przekroju poprzecznym, widoczne strefy zgniecionego drewna. Szlif; × 23
4. L 58 w przekroju poprzecznym. Szlif; × 130
5. L 58. Jamki na polach skrzyżowania. Szlif; × 130
6. L 17. Przekrój styczny. Szlif; × 45

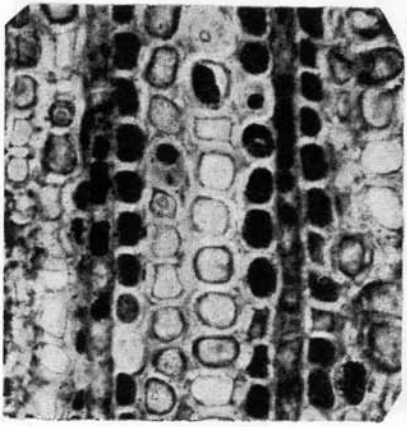
1

2

3



5



4

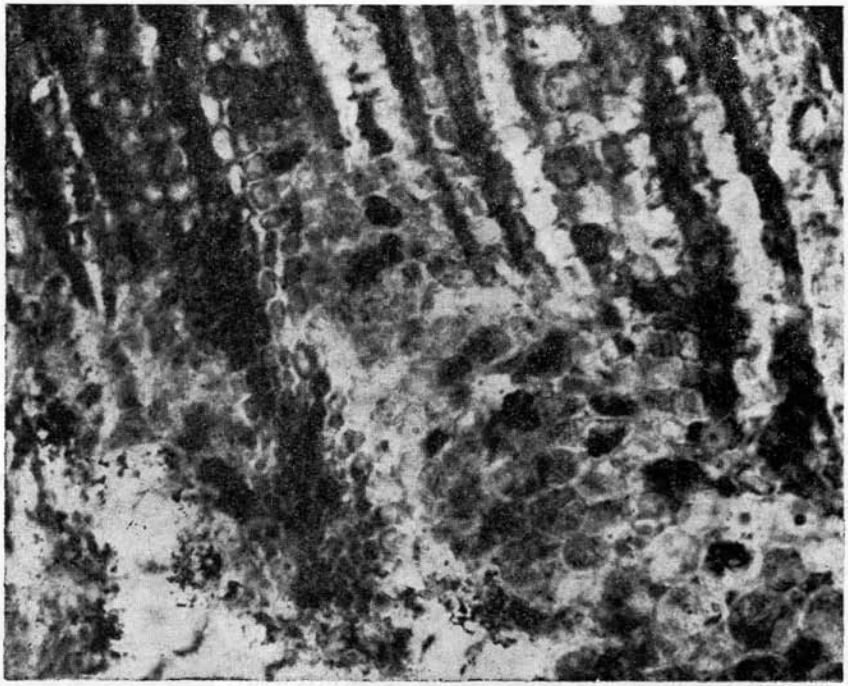
6

Plate II

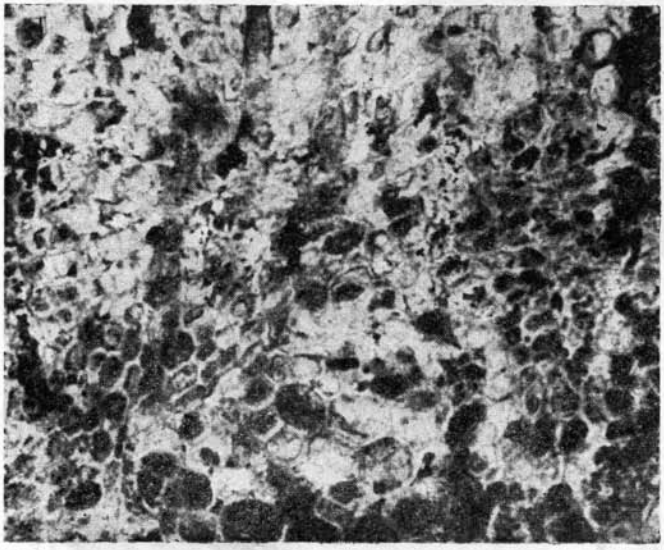
7. L 58. Primary xylem in transverse section. Ground section; × 130
8. L 58. Primary xylem in transverse section. Ground section; × 130
9. L 58. Elements of the primary xylem showing spiral thickenings and pitting. Ground section; × 260

Tablica II

7. L 58. Ksylem pierwotny w przekroju poprzecznym. Szlif; × 130
8. L 58. Ksylem pierwotny w przekroju poprzecznym. Szlif; × 130
9. L 58. Elementy ksylemu pierwotnego z widocznymi spiralnymi zgrubieniami i jamkami. Szlif; × 260



7



8

9

Plate III

10. L 58. Pith in transverse section, d — ducts, p — parenchyma. Ground section; × 65
11. L 58. Pith in longitudinal section. Ground section; × 65
12. L 58. Forming of canals in the pith. Ground section; × 45

Dadoxylon Schrollianum f. ramosissimum

13. K 6. Transverse section of a lateral branch, pi — pith, x — secondary xylem. Ground section; × 45
14. K 6. Pith in radial section. Ground section; × 90
15. K 6. Pitting on the tracheids. Dry peel; × 180

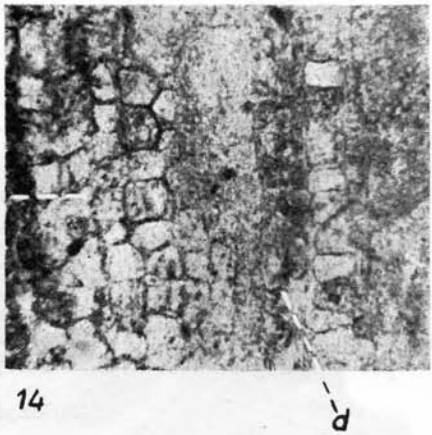
Tablica III

10. L 58. Rdzeń w przekroju poprzecznym, d — przewody, p — miękisz. Szlif; × 65
11. L 58. Rdzeń w przekroju podłużnym. Szlif; × 65
12. L 58. Tworzenie się przewodów w rdzeniu. Szlif; × 45

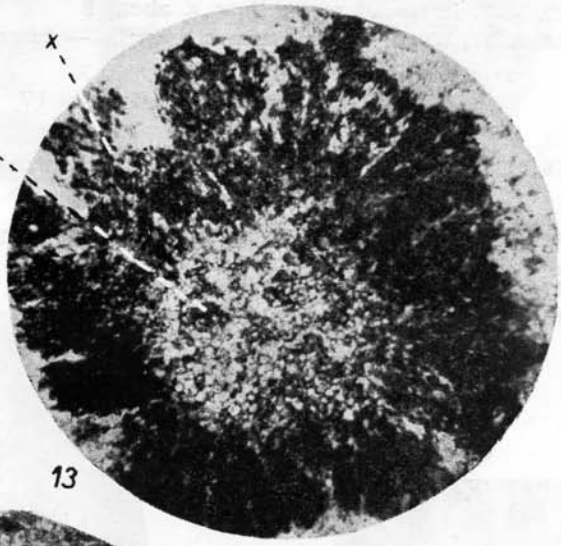
Dadoxylon Schrollianum f. *ramosissimum*

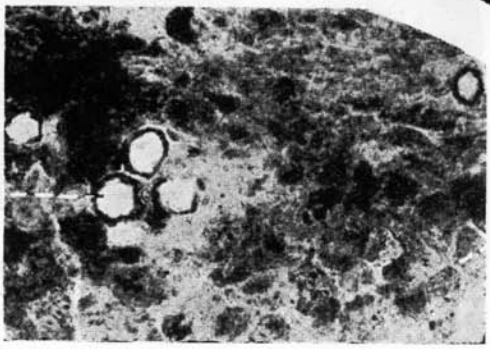
13. K 6. Przekrój poprzeczny odgałęzienia bocznego, pi — rdzeń, x — drewno wtórne. Szlif; × 45
14. K 6. Rdzeń w przekroju promienistym. Szlif; × 90
15. K 6. Jamki na cewkach. Błonka; × 180


11
d


P
14
d


P
d
12


x
pi
13


d
P
10


15

Plate IV

16. K 6. Pitting on the tracheids and medullary rays, pf — pitting in the field, pt — pitting on the tracheids. Dry peel; × 180

Dadoxylon Rollei Ung.

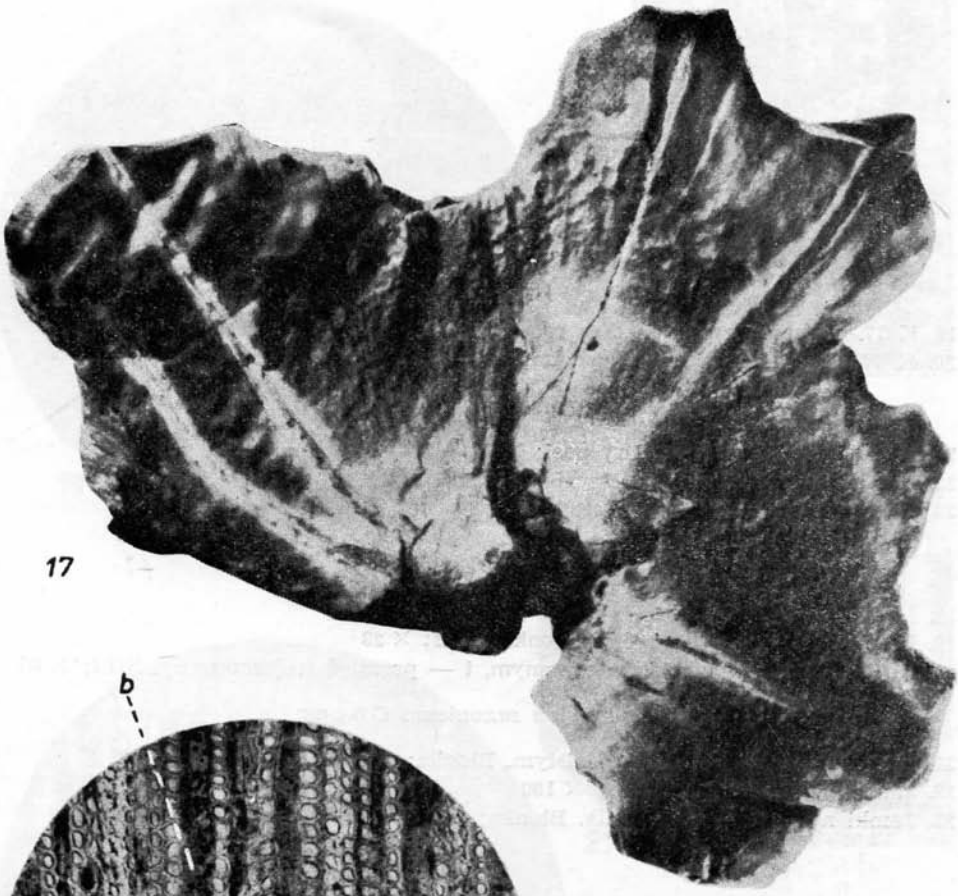
17. K 77 in transverse section; × about 2
18. K 77. Wood in transverse section; b — biseriate rays. Ground section; × 65

Tablica IV

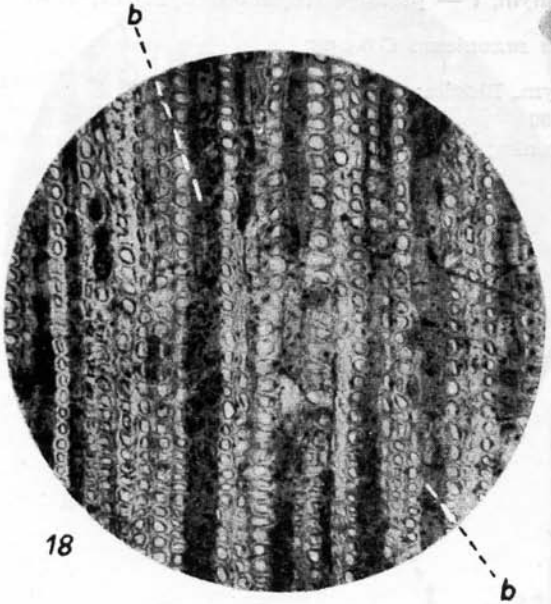
16. K 6. Jamki na cewkach i promieniach rdzeniowych, pf — jamki na polu skrzyżowania, pt — jamki na cewkach. Błonka; × 180

Dadoxylon Rollei Ung.

17. K 77. w przekroju poprzecznym; × około 2
18. K 77. Drewno w przekroju poprzecznym, b — promienie dwuszeregowe. Szlif; × 65



17



18

16

Plate V

19. K 77. Transverse section of a rootlet. Ground section; × 23
20. K 77. Wood in tangential section; t — triseriate ray. Ground section; × 65

Dadoxylon saxonicum Goepp.

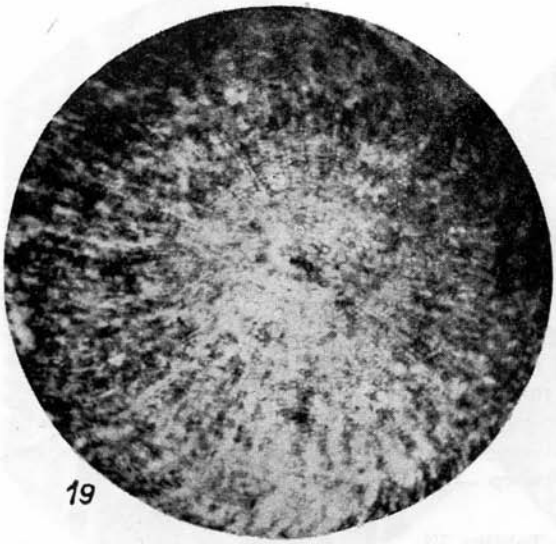
21. Wood in radial section. Dry peel; × 90
22. Pitting on the tracheids. Dry peel; × 180
23. Pitting in the field. Dry peel; × 180

Tablica V

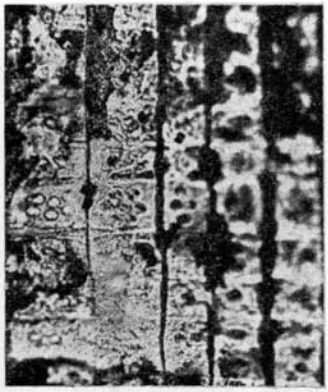
19. K 77. Poprzeczny przekrój korzonka. Szlif; × 23
20. K 77. Drewno w przekroju stycznym, t — promień trójszeregowy. Szlif; × 65

Dadoxylon saxonicum Goepp.

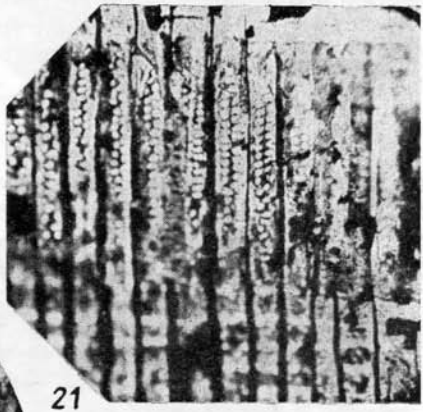
21. Drewno w przekroju promienistym. Błonka; × 90
22. Jamki na cewkach. Błonka; × 180
23. Jamki na polu skrzyżowania. Błonka; × 180



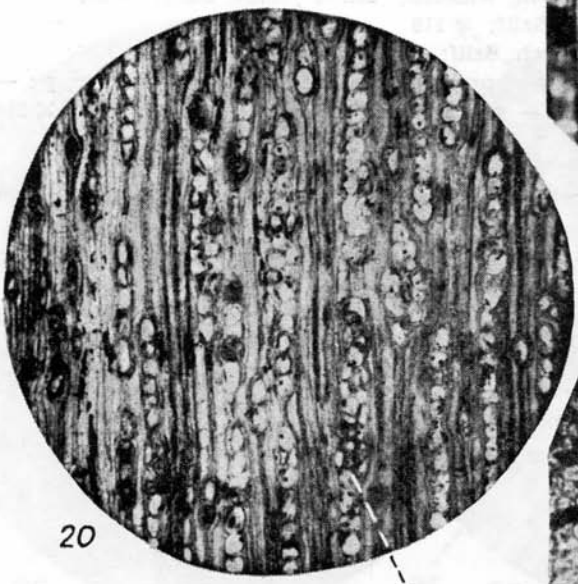
19



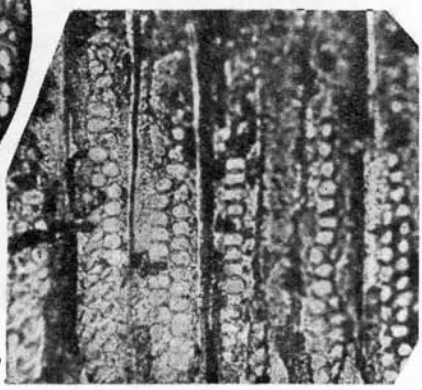
23



21



20



22

Plate VI

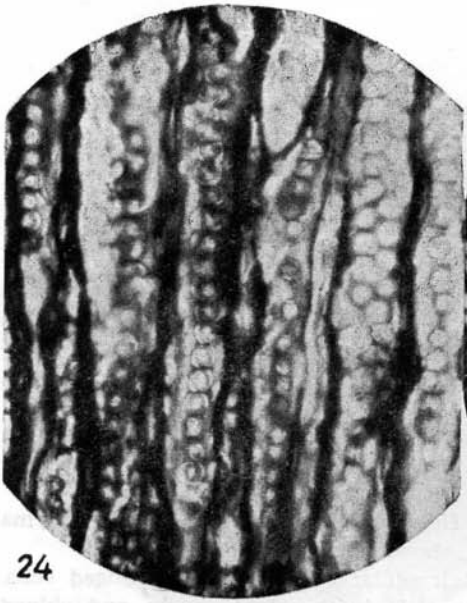
Dadoxylon Schrollianum with pith from Miłków (M 9/2)

24. Wood in radial section showing arrangement of pits; × 220
25. Wood in tangential section; × 110
26. Pitting of the medullary rays; × 450
27. Pith and adjacent xylem in transverse section; x — wood, px — primary xylem, pi — pith, lt — endarch leaf-trace, cp — coprolites; × 110

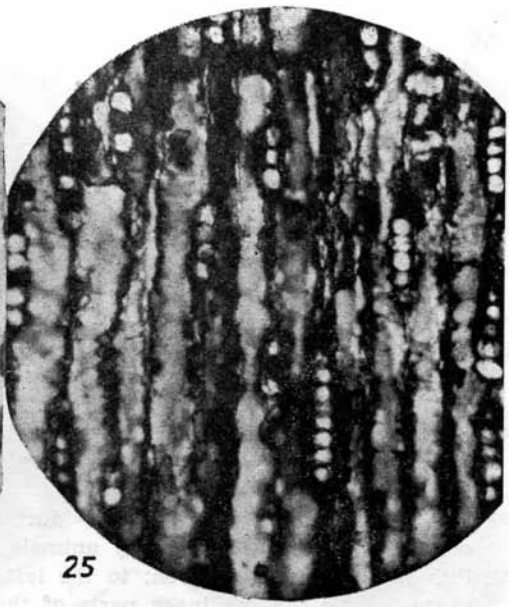
Tablica VI

Dadoxylon Schrollianum z rdzeniem z Miłkowa (M 9/2)

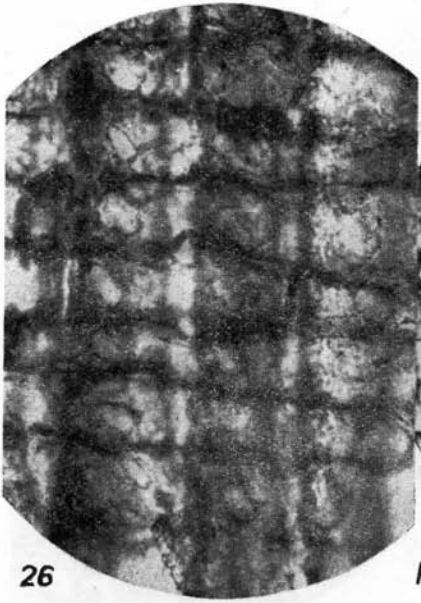
24. Drewno w przekroju promienistym, widoczny układ jamek. Szlif; × 220
25. Drewno w przekroju stycznym. Szlif; × 110
26. Jamki na promieniach rdzeniowych. Szlif; 450
27. Rdzeń i sąsiadujący z nim ksylem w przekroju poprzecznym, x — drewno, px — ksylem pierwotny, pi — rdzeń, lt — wiązka liściowa, cp — koprolity. Szlif; × 110



24



25



26

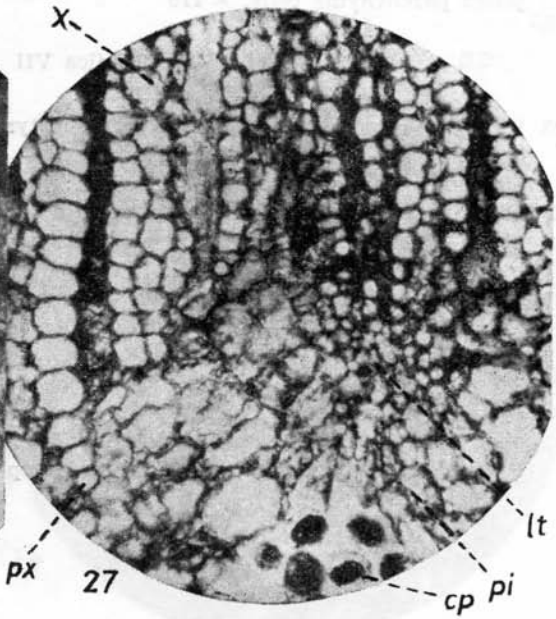
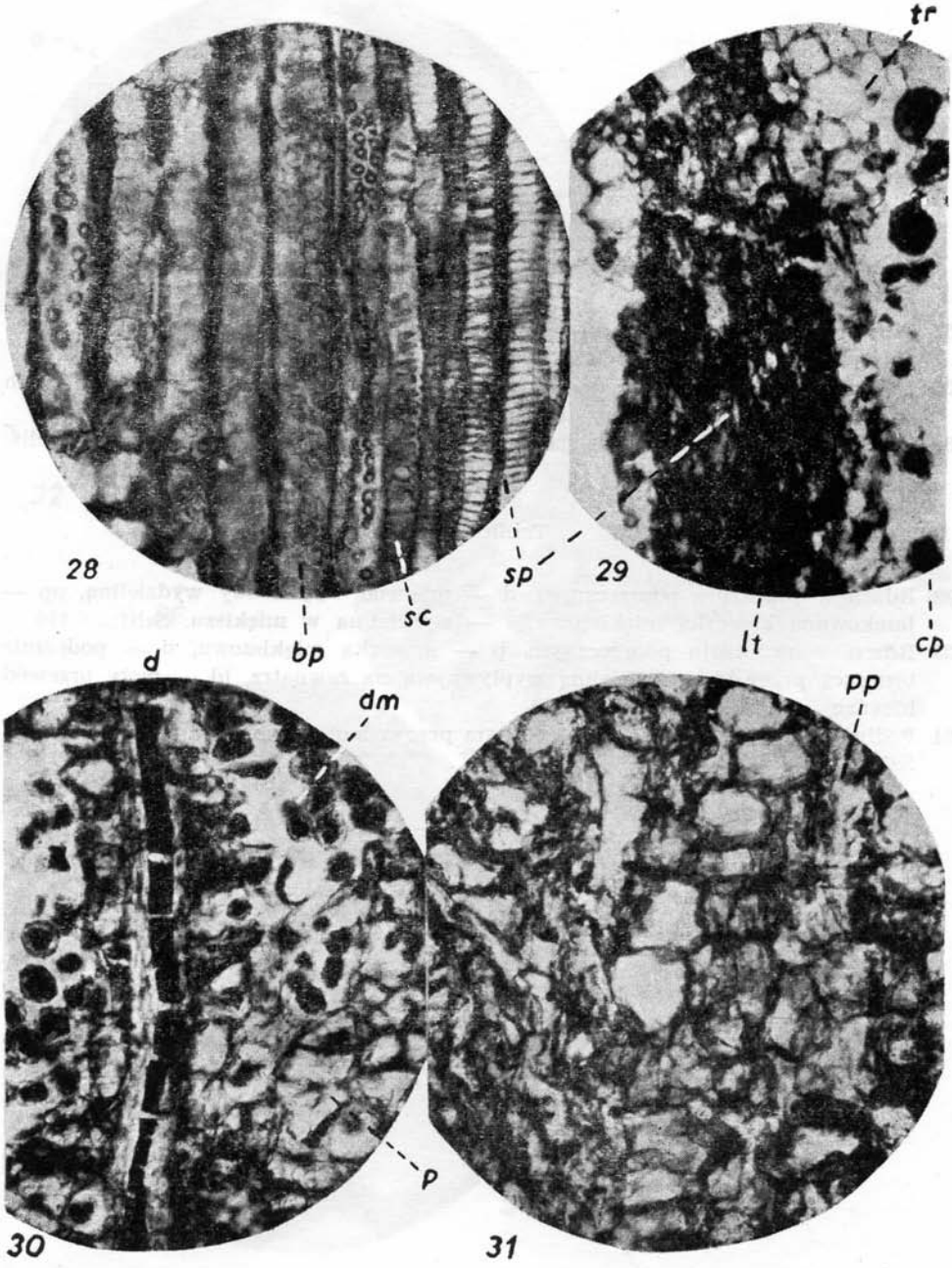


Plate VII

28. Primary xylem in radial section; sp — tracheids with spiral thickenings, sc — scalariform tracheids, bp — tracheids completely covered with bordered pits; × 220
29. Part of damaged wood in transverse section; tr — tracheids, lt — leaf-trace with tissues filled with secretion, sp — spiral tracheid of the leaf-trace, cp — coprolites; × 110
30. Pith in longitudinal section; d — duct filled with secretion, p — parenchyma cells, dm — parts damaged by animals, showing coprolites; × 110
31. Pith in longitudinal section; to the left irregularly shaped and arranged cells, characteristic for the inner parts of the pith, to the right square and oblong cells arranged in rows, characteristic for the peripheral parts of the pith; pp — pitted parenchyma cells; × 110

Tablica VII

28. Ksylem pierwotny w przekroju promienistym, sp — cewki ze spiralnymi zgrubieniami, sc — cewki drabinkowate, bp — cewki o ściankach kompletnie wypełnionych jamkami lejkowatymi. Szlif; × 220
29. Część uszkodzonego drewna w przekroju poprzecznym, tr — cewki, lt — wiązka liściowa o tkankach wypełnionych wydzieliną, sp — cewka ze spiralnymi zgrubieniami, cp — koprolity. Szlif; × 110
30. Rdzeń w przekroju podłużnym, d — przewód wypełniony wydzieliną, p — komórki miękiszu, dm — tkanki uszkodzone przez owady (?) i zawierające koprolity. Szlif; × 110
31. Rdzeń w przekroju podłużnym, po lewej stronie komórki o nieregularnym kształcie i układzie, charakterystyczne dla wewnętrznych partii rdzenia. Na prawo kwadratowe i prostokątne komórki ustawione w rzędach, charakterystyczne dla zewnętrznych partii rdzenia. pp — jamkowane komórki parenchymatyczne. Szlif; × 110


tr
28
sp
29
sc
bp
lt
cp
d
dm
pp
p
30
31

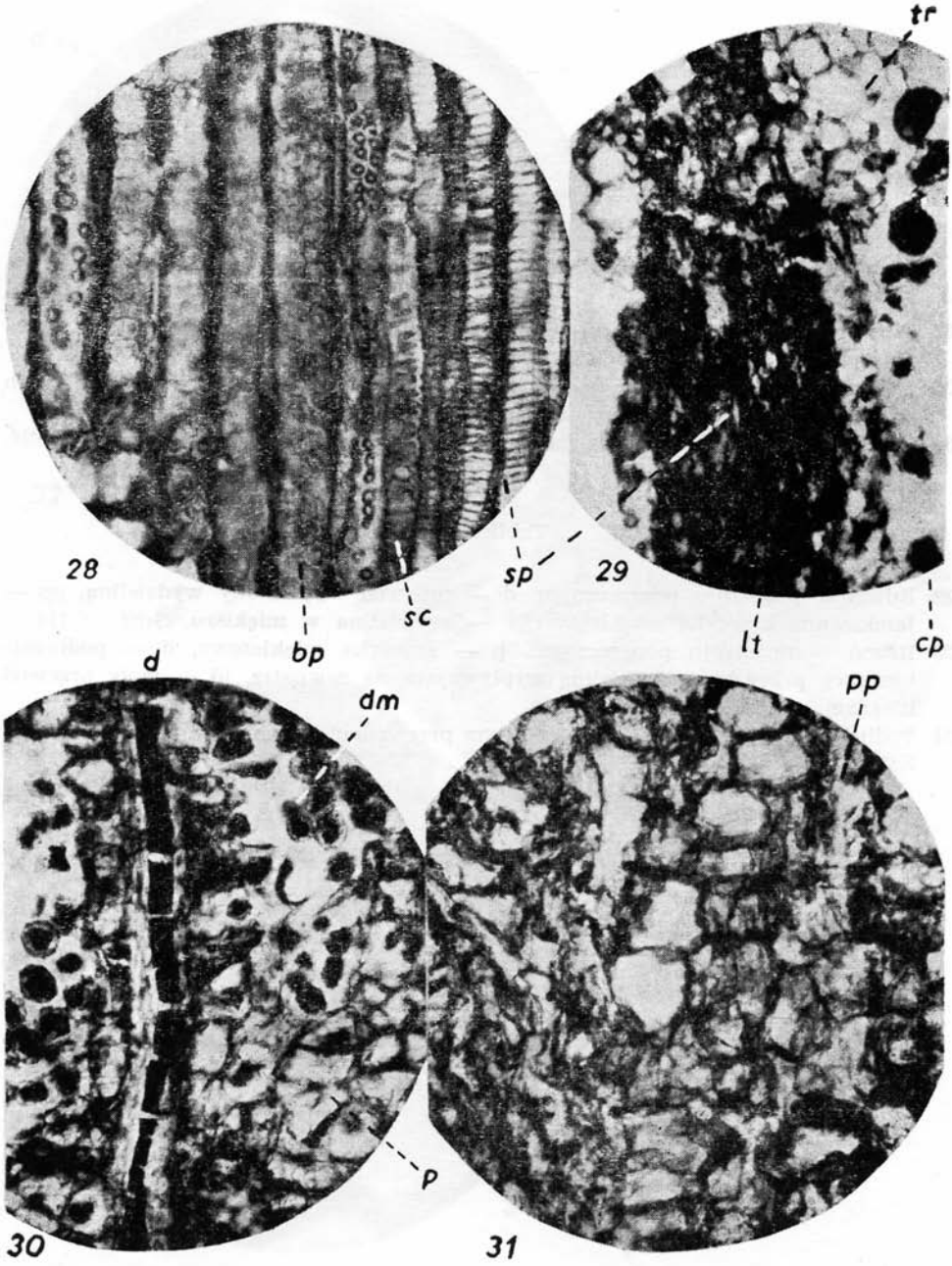
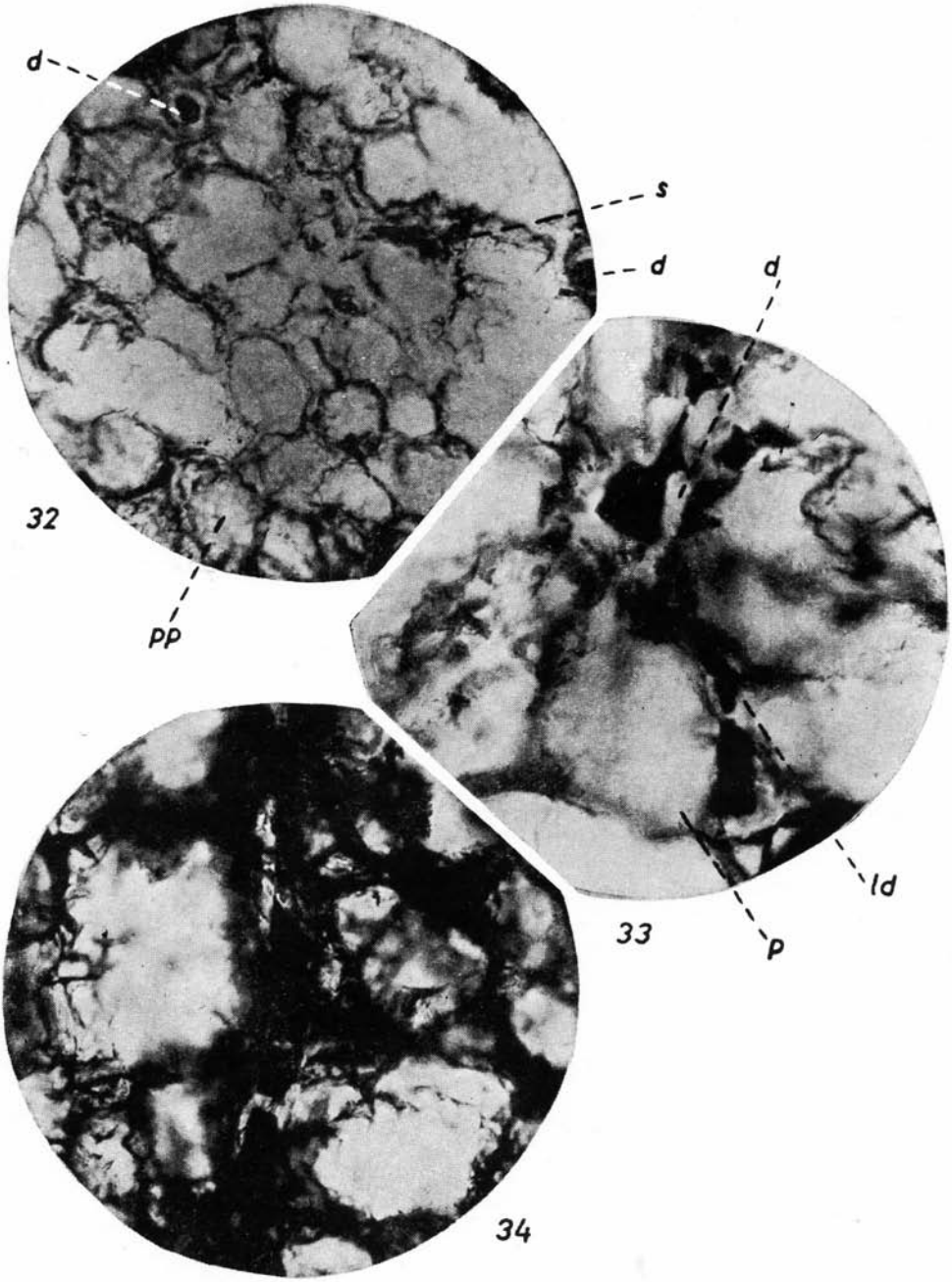

tr
28
sp
29
sc
bp
lt
cp
d
dm
pp
p
30
31

Plate VIII

32. Pith in transverse section; d — secretory duct filled with secretion, pp — pitted parenchyma cell, s — secretion in parenchyma; × 110
33. Pith in transverse section; p — parenchyma cell, d — longitudinal canal with secretion protruding outside, ld — small lateral duct; × 450
34. Longitudinal section of pith showing a secretory canal and parenchyma cells; × 220

Tablica VIII

32. Rdzeń w przekroju poprzecznym, d — przewód wypełniony wydzieliną, pp — jamkowana komórka miękiszowa, s — wydzielina w miękiszu. Szlif; × 110
33. Rdzeń w przekroju poprzecznym, p — komórka miękiszowa, d — podłużnie biegnący przewód z wydzieliną wypływającą na zewnątrz, ld — mały przewód biegnący poprzecznie. Szlif; × 450
34. Podłużny przekrój rdzenia z widocznym przewodem i komórkami miękiszowymi. Szlif; × 220


d
s
d
d
32
l
pp
ld
33
p
34