FUNCTIONAL
PLANT ANATOMY

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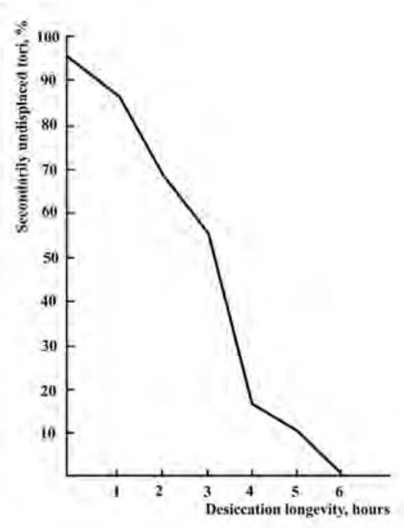

Fig. 2. **Torus re-displacements in variously desiccated and 10-min. rehydrated woods**

Experiment version 3. The wood sections were desiccated for 8 hrs 30 min. and then rehydrated for 30 min., 1 hr, 2 hrs, 3 hrs, 5 hrs, 24 hrs, 48 hrs and 72 hrs, respectively. A few undisplaced tori have only been revealed in 72-hrs rehydrated wood sections.

Experiment version 4. The wood sections were desiccated for 24 hrs and then rehydrated for 30 min., 1 hr, 2 hrs, 3 hrs, 5 hrs, 24 hrs, 48 hrs and 120 hrs, respectively. No one undisplaced torus has been revealed.

Gorn B. KEDROV †

FUNCTION OF THE TORUS IN CONIFERS' WOODS[4]

The conifer wood tori are usually considered to participate in regulation of the transpiratory water current through the wood and to prevent pit membrane from rupturing due to the hydrodynamic pressure in the wood. However, data have recently been obtained that the tori really prevent unsolved gas from penetrating bordered pits (Hart, Thomas, 1967). These data are only referred to sampled woods, though. Then, they need to be tested by experimenting on living trees.

[4] Interpolated author's abstract of the lecture given on December 12th 1973.

The proper experiments were performed on living trees of conifer plantations in Moscow Region and the Crimea. The trunks of trees of 20 conifer species of the families Pinaceae and Cupressaceae[5] were transversally incised with bevel-edge chisel to cut their sapwoods. Some trunks were injected with ethyl alcohol or acetone through their incisions just after incising. Incised trunk sapwoods without further treatment as well as incised trunk sapwoods treated with alcohol or acetone were sampled above the incisions over 15 minutes to 1 year. The woods of intact trees of the same species were also sampled for control items. Distances of air penetration into the woods were measured. Tangential sections of sampled woods were also prepared to test structure and chemical composition of the tori.

In intact-tree sapwoods, the tori were unlignified and occupied just middle positions in pit pairs (Fig. 1, p. 37). Mostly longitudinal, deep and rapid air penetration was detected in the sapwood samples of both alcoholized and acetonized trees. Their tori remained unlignified and undisplaced. In unalcoholized and unacetonized sapwoods, only cut tracheids were filled by the air at the outset. All tori in the cut-to-uncut tracheid pit pairs were tightly appressed to the orifices of uncut tracheid pits due to lower hydraulic pressure in the uncut tracheids. The tori were usually distinctively bulged into uncut tracheid lumens through the pit orifices (Fig. 2, p. 37). Such bulged displaced tori plugged the pit orifices up to form the primary bar to further gas penetration. The tori in the cut-to-cut tracheid pit pairs were thin (Fig. 3, p. 37) and appressed to either orifice of a pit pair (Fig. 2, p. 37). Close to the primary bar, the tori in the uncut-to-uncut tracheid pit pairs lignified. The tori usually were in the middle position of their pit pairs (Fig. 4, p. 39).

The uncut tracheids adjoining the primary bar became gas-filled in 1 to 4 to more days after incising trunk. More distant tracheids also became gas-filled later on. Thereof, a new gas-filled to water-filled tracheid boundary appeared. The tori of this boundary pit pairs were displaced and plugged orifices of the water-filled tracheid pits to form the secondary bar to gas penetration. Some additional experiments[6] showed that the gas in these uncut tracheids was not an air penetrated through the torus-plugged pits but a product of the wood living constituents. The gas-filled tracheid bulk gradually expanded in time and caused the third, the forth etc bars of plugged pits.

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[5] The list of species under experiment and experiment protocols have not been found.
[6] The experiment protocols have not been found.

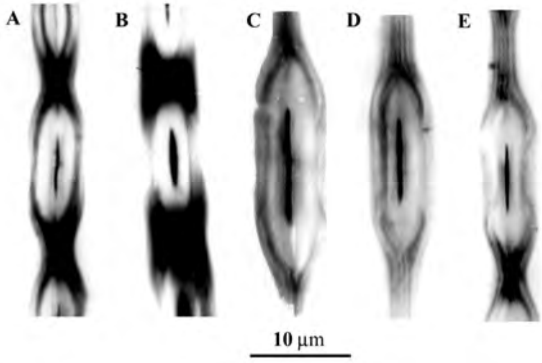

Fig. 1. **Unlignified undisplaced tori in the sapwoods of intact trunks**. A – *Abies balsamea* (L.) Mill., B – *Cedrus deodara* (Roxb. ex D. Don) G. Don, C – *Larix sibirica* Ledeb., D – *Picea abies* (L.) Karst., E – *Picea pungens* Engelm.

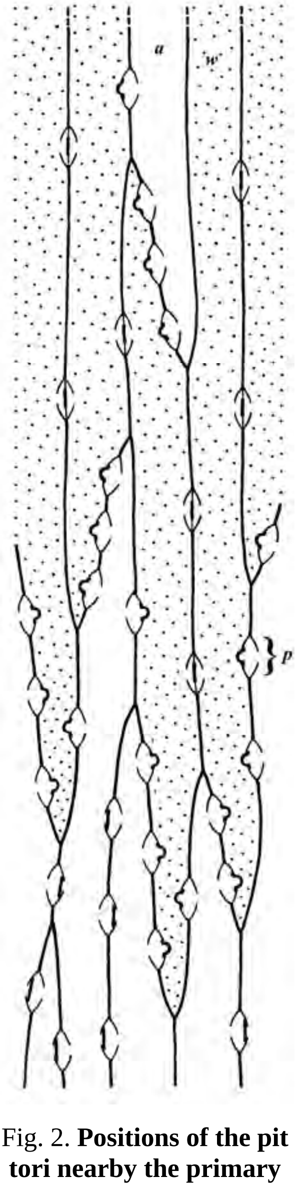

Fig. 2. **Positions of the pit tori nearby the primary bar:** *a* – air-filled tracheid; *p* – bordered pit; *w* – water-filled tracheid

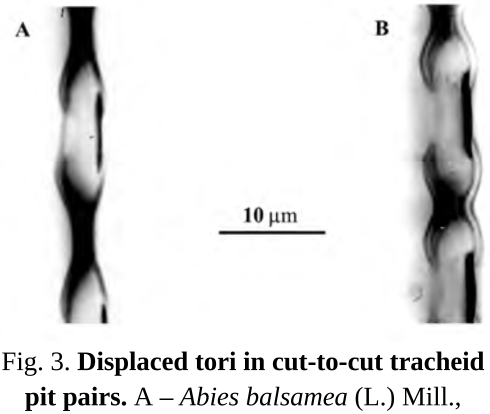

Fig. 3. **Displaced tori in cut-to-cut tracheid pit pairs.** A – *Abies balsamea* (L.) Mill., B – *Picea abies* (L.) Karst.

Wedge-shaped 3.5 to 8 cm long hardwood-like part of wood was formed above the incision in a year after processing the trunks. This part was bordered by the dried wood. The ray parenchyma cells of the latter were degenerated (Fig. 5, p. 39).

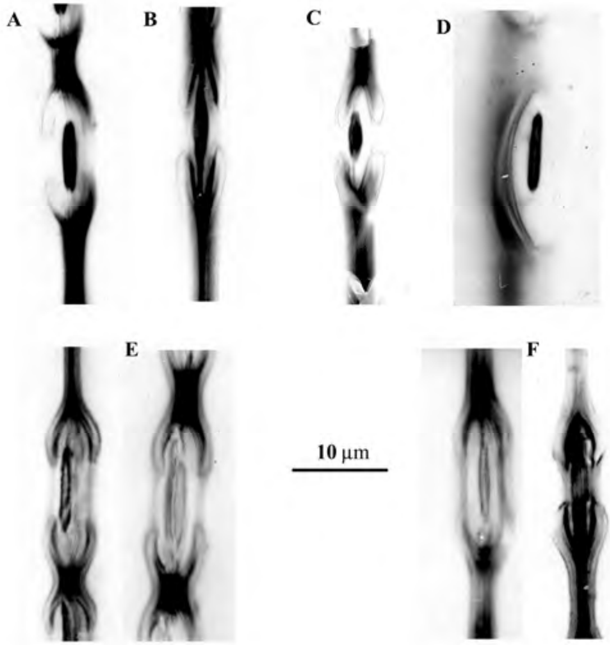

Fig. 4. **Lignified undisplaced tori in water-filled to water-filled tracheid pit pairs close to the primary bar.** A – *Abies balsamea* (L.) Mill., B – *Cedrus deodara* (Roxb. ex D. Don) G. Don, C – *Juniperus oxycedrus* L., D – *Larix sibirica* Ledeb., E – *Picea abies* (L.) Karst., F – *Picea pungens* Engelm.

The experiment results thus corroborate Hart & Thomas’ theory that there is prevention of gas-penetrating through bordered pits that is the main function of the wood pit tori.

Ancestors of the conifers and chlamydosperms seem to have had structurally and functionally homogeneous imperforate pit membranes. Such a membrane is likely to have evolutionary differentiated into a highly perforate marginal zone and an imperforate, impregnated by amorphous substances, mostly thickened central torus (Fig. 6) in most conifers and some chlamydosperms. This structure differentiation was accompanied by the function differentiation. The perforate marginal zone of pit membrane maintains efficient intercommunication of contiguous tracheids. The central torus prevents gas penetration through the pit and embolism expansion through the wood. Highly increased water permeability of the bordered pits combined with their highly increased gas resistance is the principal functional result of the pit membrane evolution as outlined above.

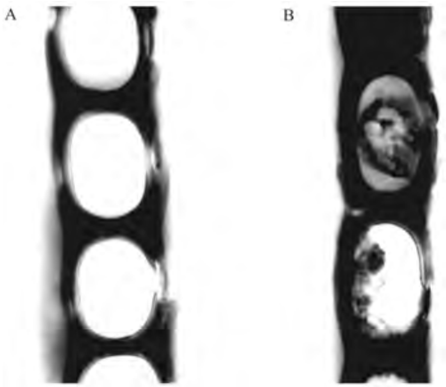

Fig. 5. **Tangentially sectioned rays in conducting (A) wood and dried wood in 7 days after incising trunk (B) in *Abies balsamea* (L.) Mill.**

Fig. 6. **Cut bordered pit in *Larix sibirica* Ledeb.:** *b* – bordering; *m.z* – perforate marginal zone of the pit membrane; *t* – imperforate torus. Magnification ×4500

References

Hart C.A., Thomas R.J. 1967. Mechanism of bordered pit aspiration as caused by capillarity // Forest Products J. V. 17. P. 61–68.