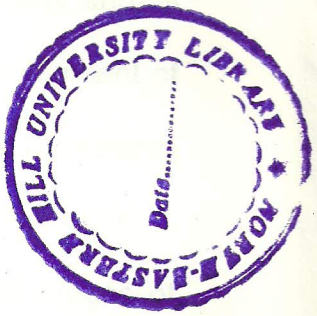
STUDIES ON THE VASCULAR CAMBIUM AND ITS DERIVATIVES IN SOME PRIMITIVE ANGIOSPERMS OF SUBTROPICAL MOIST FOREST OF MEGHALAYA



ABSTRACT

By

M.G. LIANGKUWANG

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SHILLONG –793 022, INDIA

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ABSTRACT

Angiosperms are the most dominant and successful land plants; they are distinguished by the presence of a flower (Maddison 2001). The primitive angiosperms were believed to be small trees or woody shrubs with large complex flowers (Taylor and Hickey 1996). The development of the first terrestrial plants coincided with the evolution of a vascular system that could transport water and solutes and also provide structural support.

Procambium and cambium represent two developmental stages of the meristem in plants; in the primary plant body the vascular system arises from the procambium while the secondary growth takes places due to the activity of the vascular cambium and give rises to secondary vascular tissues outside the primary ones. The development and evolution of vascular system in the land plants is the concomitant transition from the aquatic to the terrestrial habitat during the course of the evolution.

Unlike the apical meristems, which consist of a population of similar cells, the cambium has typically two morphologically distinct cell types, or initials; the axillary elongated fusiform initials leading to the axial system (including tracheids, vessel elements, fibres, axial parenchyma cells, sieve elements and companion cells) and the smaller isodiametrical ray initials giving rise to the radially orientated parenchymatous rays (Iqbal and Ghouse 1990).

The vascular cambium has been the subject of intense study ever since its importance in building up the plant body was felt. These works

described the seasonal changes in the vacuolation pattern in the fusiform initial and also elucidated the mechanism of additive and multiplicative cell division in the cambium. Bailey (1920a,b,c; 1923) made an accurate observations on the structure and dimensional changes in the vascular cambium in both the dicotyledons and gymnosperms, which were latter confirmed by using sophisticated instrument.

North-Eastern India is one of the megabiodiversity centres of the world (Swaminathan 1991; Mohan Ram and Seghal 2001). According to Takhtajan (1981), Indo-Malaysian tract is the cradle of the origin of Angiosperm. This region contains most of the arborescent and primitive angiospermous plants. However, the tree growth, particularly primitive angiosperms of sub-tropical moist forest of Meghalaya has not been studied in detail.

Therefore, in this thesis, three Brevi-deciduous species viz. *Dillenia indica* Linn. (Dilleniaceae), *Michelia champaca* Linn. and *M. oblonga* Wall. Ex Hk. f. (Magnoliaceae) and two Evergreen species viz. *Exbucklandia populnea* (R. Br. Ex Griff.) R. W. Br. (Hamamelidaceae) and *Magnolia grandiflora* Linn. (Magnoliaceae) were studied with reference to the following aspects.

- To find out the cambial activity in relation to phenology and climatic factors
- To study the seasonal variation in the structure, cytology and ergastic substance of the vascular cambium
- Duration of wood production

- Dimensional changes in the vascular cambium and its derivatives during different seasons

The interrelationship between different phenological events such as emergence of new leaves and buds, flowering, fruiting, seed dispersal and leaf fall, with environmental factors such as temperature, rainfall, relative humidity and periodicity of cambial activity was examined for all the five plants. It was observed that there was a clear cut correspondence between timing of vegetative bud break and cambial reactivation in all the five plants. Since the timing of flowering overlapped with the formation of new leaves, it could not be categorically proved that reproductive phase was really responsible for enhance activity of the cambium in these five primitive angiospermous trees.

It was observed that both cambial reactivation and peak activity were generally favoured by mean minimum temperature in *D. indica* and by mean temperature in rest of the four plants viz. *E. populnea, M. grandiflora, M. champaca* and *M. oblonga*; a positive correlation also existed between the least cambial activity/dormancy and lower mean temperature. Relative humidity had no effect on cambial periodicity. The selected plants did not have any water stress because they are growing in the sub-tropical wet forests of North east India, where water was not at all a limiting factor. Moreover, this study site is located 60 km from Cherrapunji, which is the region of highest rainfall.

The vascular cambium of all the five plants is of non-storied type. The length of fusiform initials was highest in *Exbucklandia populnea* and lowest in *Michelia champaca*. The radial and the tangential wall of fusiform

initials were primary in nature; however, the radial wall was not only thicker than the tangential wall but also always beaded in nature. The beading was more prominent and closer to one another during dormancy than the active period of vascular cambium. The fusiform initials of all plants showed multinucleate condition 2-3 in *D. indica, E. populnea* and *M. grandiflora,* 3-4 in *M. champaca* and *M. oblonga,* of varied shapes and sizes. Cambial reactivation was marked by radial swelling of cambial cells, resulting in increase of width of cambial zone. This was followed by periclinal division and as a result of which the number of layers in the cambial zone increased. There was also an increase in length of fusiform initials which consequently brought about the thinning of cell walls so that the beads in the radial walls were not distinct. The frequency of periclinal divisions was more during the active state of the vascular cambium, while towards dormancy the cambial zone exhibited predominantly anticlinal divisions in the plants.

In all these primitive angiospermous trees, the secondary xylem were diffuse porous wood. The end walls of the vessel elements in all the plants had a scalariform perforation plate. Growth ring was distinct and demarcated by initial parenchyma in *M. champaca* and *M. oblonga,* by terminal parenchyma in *M. grandiflora.* But the growth ring is indistinct, occasionally indicated by layer of radially compressed fibres in *E. populnea,* delimited by smaller vessel and denser fibrous tissue in *D. indica.* Fibres tracheid and nucleated xylem fibres was present in *E. populnea.*

The duration of xylem production was about eight and half months in *E. populnea* and *M. champaca*, about eight months in *D. indica,* about seven and half months in *M. grandiflora* and *M. oblonga.* The length of fusiform initials and their derivatives like xylem fibres and vessel elements was maximum during the peak activity of the vascular cambium and was minimum during cambial dormancy. The trend in variation in the length of different vascular elements followed closely the trend in variation in length of fusiform initials from which they were derived.

Conspicuous changes could be found on the content of secondary metabolites (ergastic substances) during the approach of dormancy as well as during cambial reactivation and peak cambial activity. In *D. indica,* starch grain, polyphenol and tannin content were the major reserve products. But irrespective of the active and dormant cambium phenolic contents were present in *D. indica*. In *E. populnea,* the amount of starch grain, phenolic contents and crystal of calcium oxalate (cystolith) appeared in large quantity with the approach of dormancy but disappear slowly with the onset of cambial reactivation and disappear in the active period. The starch was the major food reserve in all the investigated plants viz. in *D. indica, E. populnea, M. grandiflora, M. champaca* and *M. oblonga*. Probably starch and crystal of calcium formed the source material for the new cell wall synthesis (e.g. Carbohydrates and calcium pectate) when the cambial derivatives are rapidly produced.

It was observed that the phenological events especially sprouting of new leaves and buds had a close relationship with cambial reactivations. The relationships of different climatic factors (monthly mean, mean

minimum, mean maximum temperature, precipitation and relative humidity) with that of cambial parameter (the average width of cambial zone, the average width of differentiating xylem zone, the average length of fusiform initials, xylem fibres and vessel elements) were high explaining more than 40% of the variability between two variables. Therefore, multiple (partial) regression analysis was employed to see how much every climatic parameter contributes to the variability of the activity of the vascular cambium. Multiple (partial) regression analysis have shown that monthly mean minimum temperature in *D. indica* and mean temperature in *E. populnea, M. champaca, M. oblonga* and *M. grandiflora* is an important factor for cambial reactivation and xylem production. Further activity of vascular cambium and differentiation of xylem occurred due to the synergistic effect of both temperature and precipitation. Relative humidity had little/no effect on cambial activity and xylem formation. Cambial dormancy was imposed by the fall in mean temperature.