**TELOME THEORY (SPOROPHYTE EVOLUTION)**

The discovery of a group of earliest known land plants with simple organization of the sporophyte (rootless, dichotomously branched, single sporangium terminating a branch tip, protostele vascular cylinder) from the upper Silurian and lower and middle Devonian deposits has been of the greatest important to the understanding of the structure and phylogeny of vascular plants.

A theory which is based primarily upon the studies of the lower vascular plants, living as well as fossil and at the same time is capable of general application to all vascular plants has been suggested by Zimmermann, under the title of Telome theory (1930 and later elaborated on 1952).

The term telome has been given to the simple ultimate terminal portions of a dichotomously branched axis. These axes are undifferentiated and single nerved.

Zimmermann defines the telome as the single-nerved extreme portion (at base or apex) of the plant body from the tip to the next point of branching. The following two types of telomes have been recognized on the basis of their function:

(a) **Vegetative or sterile telomes: These telomes are without sporangia and they are called phylloids.**

(b) **Fertile telomes: Those telomes which bore terminal sporangia are called fertile telomes.**

Following evolutionary development telomes may be grouped together in various ways to form more complex bodies or Syntelome. Syntelome composed of either sterile (phylloid trusses) or of fertile (fertile telome trusses) or mixture of the two (mixed telome). The telome grow and divides dichotomously, the new segments becomes new telomes and older segment below are mesomes.

**The Origin of Telomes and the Ancestors of Primitive Land Plants**

According to the Telome theory the early land plants originated from the green algae which lived in tidal zone of the Cambrian and Silurian sea coasts. The plant body of those algal ancestors was undifferentiated branched thallus (primitive telome). According to Zimmermann these primitive telomes were formed from the unicellular stage by the following five elementary processes:

(i) Interconnection of cells

(ii) Differentiation of meristem

(iii) Rotation of cell axis

(iv) Shifting of chief phases in alternation of generation

(v) Differentiation of different permanent tissues

The dichotomously branched thallus had a central strand of mechanical tissue. These algal ancestors showed alteration of generation.

**The Primitive Land Plant**

The telome theory visualizes the Psilophytales of the upper Silurian and lower and middle Devonian deposits (Zosterophyllum, Rhynia, Horneophyton, Psilophyton etc) as representing the sporophyte of the ancient vascular plants. The sporophyte was relatively undifferentiated (no distinction between leaf and stem) and consisted of single-veined (protostele) telomes which may be sterile and fertile. The aerial portion developed stomata and the basal portion, hairs or rhizoids. The fertile telome produced terminal sporangia (Fig.1)



**Fig.1: Hypothetical diagramme of a primitive land plant**

**Evolution of the Higher Land Plants**

From the primitive syntelome of the early land plants the sporophytes of higher land plant evolved by certain organogenetic processes called ―**elementary processes**‖ each following its own trends. Zimmerman suggested that the following elementary processes were responsible for the development of higher vascular plants from the early vascular cryptogams.

**1. Overtopping:** Of the two usually equal dichotomies from the telome one become stronger and erect becoming the axis which grew further while the other remained overtopped as a short lateral branch (Fig. 2 A). Thus from an equal dichotomy to a sympodial and finally to a monopodial system the contrast in shoots between axis and its lateral members became evident and finally it led to the formation of an axis with lateral appendages, the leaves, e.g. open-veined pinnately compound type of fern leaf and between rachis and leaflet. Overtopping mesomes formed the rachis and the overtopped mesomes constituted the leaflets.

**2. Planation:** Branching in more than one plane (cruciate dichotomy) is replaced by a dichotomy in a single plane (fan shaped dichotomy). Thus plantation caused telomes and mesomes to arrange them in a plane (Fig. 2 B). By this process an organ of radial symmetry gives rise to one of bilateral symmetry. Plantation concerns mainly the evolution of the leaf.



1. Overtopping (b) Planation

**Fig.2 Digammatic representation of Overtopping and Planation**

**3. Syngenesis** (**fusion or webbing**): Fusion of the telome of telome trusses by the development of connecting tissue (as in the foot of swan) is called syngenesis or webbing. Telomes and mesomes connect by the formation of parenchymatous tissue between them (parenchymatous webbing) or by parenchymtous webbing accompanied by the fusion of their stele (Fig.3).

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**Fig. 3 Diagramme showing Webbing or syngenesis**

Syngenesis is a very important elementary process because it explains the origin and evolution of both the leaf and stele of the stem. It leads to the formation of:

(i) Foliar appendages with open dichotomous venation. In this case the sterile telomes (Phylloids) become united only by the development of (parenchymatous webbing)

(ii) Pinnately veined leaf: Parenchymatous webbing was accompanied by over-topping.

(iii) Leaf with reticulate venation: if fusion of steles or vascular bundles also occurred.

(iv) Parenchymatous webbing led to the polystelic condition (in an open form) as in many species of Selaginella.

**(4) Reduction**: It implies a simplification of the telome trusses. It involved transformation of a syntelome into a single needle-like leaf. According to Zimmermann the microphyllous leaves of Lycopods were evolved by the reduction of telome trusses (Fig. 4).



Fig 4. Steps in the Reduction process

**(5)** **Curvation**- This process resulted in unequal growth of the tissue on two opposite flanks

of the organ. Wilson (1953) recognized two separate sub-processes:

**Recurvation:** When telomes bent down inwards, it is called Recurvation. During this process, the fertile telomes (sporangiophores) were reflexed and sporangia became inverted (Fig.5)

**Incurvation:** This process accounts for the shifting of sporangia from terminal position to the

ventral surface of the leaf in ferns (Fig.6).



**Fig.5 Steps in the process of Recurvation**



**Fig. 6 Steps in the process of Incurvation**

**Merits of telome theory:**

1. It provides an excellent interpretation of origin and evolution of sporophyte of land plants.

2. The elementary process proposed by Zimmermann provides a basis of interpretation. which removes outstanding morphological difficulties in the lower vascular plant such as the nature of the aerial portion of the plant body of the family Ophioglossaceae and coenopterid ferns.

3. This theory emphasise on the fact that the plant body is an axis with a descending portion, the root, and an aerial portion, the shoot whose appendages are modified parts of the stem.

4. According to Eames, though the theory is built upon structure in the lowest known vascular plants, higher plant can also be safety interpreted in this way. It also tries to connect the fossil and living plants by their phylogenetical relations.

5. Bierhorst is of the view that the theory is too simple and easily applicable but unfortunately its excessive use has greatly diminished its value.

**Demerits of telome theory:**

1. According to Thomas (1950), the telome theory does not explain the whorled or spiral arrangement of sporangia, which is observed in some ancient and primitive plants.

2. Application of the telome theory to the origin of Lycopsida has been greatly criticised. Andrews (1960) supports this theory to some extent so far as Sphenopsida and Pteropsida are concerned, but for Lycopsida, he may well be quoted that: Zimmermann ‘concept for the Lycopsida is, so far as I am aware, purely hypothetical’.

3. According to Bower (1946), this theory does not explain how a telome-like characterized body has been developed. It has been taken for granted by Zimmermann (1930) that a telome type body is ‘ready-made’; whereas a fundamental problem is to know how such a unit has acquired its characteristic development so as to take place in Hofmeisterian cycle.

4. This theory does not provide a satisfactory derivation of all leafy structures from branches.

5. Stewart (1964) also criticised the telome theory because it does not explain the derivation of the dictyostelic condition.