ON CARPEL

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THE picture reproduced is intended to portray the three outstanding theories of the nature of the Angiospermous flower in general and its carpel in particular.

Nearly a hundred years ago, the great German poet-philosopher, J. W. von Goethe, conceived the Angiospermous flower as a modification of vegetative branch; according to him, a simple vegetative leaf with its three main vascular traces lost its colour and shape, acquired a different character and function and ultimately resulted in the sepals and petals. A similar leaf got its laminal surface reduced, the two lateral edges developed fertility, which offered a base for lodging the male fertilizing element; these structures have come to be known as stamens. Another leaf situated towards the tip of the branch upfolded; its margins got fused and after attaining fertility bore ovules which lodged the female sexual element; this transfiguration was accompanied by an elongation of the leaf-tip which has become differentiated as style and stigma, so much so this organ becomes a carpel. If we visualise a drastic reduction of the internodes between these metamorphosed leaves, we arrive at a "flower". This concept has been depicted in the picture as a climber which shows the several stages of the metamorphosis of the vegetative leaves.

There is also a much modified interpretation of the carpel, sponsored by Miss Edith R. Saunders in nineteen-twenties. The "classical", "monorphic" concept of Goethe holds that every carpel is a metamorphosed structure of a *single* leaf; but, she visualises such a carpel as a sort of compound structure consisting of a "valve" carpel and a "consolidated" carpel; this view has come to be known as "polymorphic". Miss Saunders believes that carpel polymorphism is a universal feature (even in those instances where she herself accepted monomorphism on previous occasions). Suffice it to record that this view has not met with acceptance; it has been severely criticised from several standpoints some of the significant ones being, (1) it rests on false assumptions and misinterpretations of important anatomical evidence; (2) Miss Saunders has generalised too hastily and has extended her theory to all flowering plants; (3) her contention that her polymorphic theory helps to clarify satisfactorily the various points of floral structure and organisation has, on the contrary, brought unnecessary complications into the arena; (4) some of the points "explained" by her have been invented in strange and roundabout methods so much that they have been described as "fantastic".

The most unusual example of carpel polymorphism of Miss Saunders is the instance of the common groundnut. That a single nut is a single carpel lodging a couple of seeds is generally accepted; but she contends that the nut is composed of 10 to 12 carpels as revealed by a corresponding number of longitudinally running vascular strands in the wall of the ovary! In spite of overwhelming criticism, however, she is clinging to her theory tenaceously. She has caged herself in the groundnut shell, reinforced by 10 to 12 main bars, a creation of her own imagination. Enveloped in the darkness of that self-erected cage, she shuns light and keeps repeating her untenable theory over and over again as though repetition could compensate for the lack of inherent soundness.

Until nineteen-thirties Goethe's "classical" view was not questioned on fundamental grounds. Evidence based on an accumulation of fossil data and a new interpretation in their light led Prof. Hamshaw H. Thomas to the view that mere metamorphosis does not explain satisfactorily the transition from the vegetative leaf to a fertile organ bearing sexual element. "The Angiospermic flower is *not* the homologue of a vegetative bud". So, he found the progenitor of the modern carpel in a lower Jurassic plant group, the Caytoniales, which, according to Prof. Thomas, show interrelationships between the lower Pteridosperms and the higher Angiosperms. The stamens and carpels exist in Caytoniales as "branch systems"; the modern stamen owes its origin to a form, *Antholithus Arberi*, and the nearest approach to this condition is what we see to-day in the flower of buttercup, poplar and walnut. Fossils like *Caytonia* and *Gristhorpia* are presented by Prof. Thomas to depict the ancestral condition of the modern carpel. These bodies lodging ovules (also called "ovaries" by him) are arranged in pairs on a main axis; during evolution, reduction and fusion have played a great role, a transitional stage in this process being represented in a hypothetical form, in which the pairs of "ovaries" are reduced to a single pair and the main axis becomes stunted; side by side with this process, lateral fusion of the two "ovaries" of the pair was accomplished so much so the ovule-bearing margins lie side by side. A complete fusion of the "ovaries" with one another and that of fused ovaries with the reduced main axis, result in the ultimate expression of the modern carpel. In short, "sterilisation of structures originally fertile is much more likely to have taken place than the metamorphosis of leaf-like structures into reproductive organs".

There are certain serious objections to this view. Apart from those legitimately raised against Prof. Thomas' terminology like "palmate sporophyll", "ovaries", etc., the most important criticisms are, that the evidence is one-sided being largely taken from fossils; that certain observations on the nature of living forms do not lend support to his argument; that the chain is broken at very crucial points; and that convincing intermediate stages are not in evidence at present, so essential for an understanding of the transitions.

An entirely new and striking idea as to the nature of the flower has been put forward by Prof. MacLean Thompson since the nineteen-

twenties. The evidence which has enabled him to put forward this theory has been collected by a study of what he calls "Developmental Morphology". The most significant feature of this view is the total rejection of the very existence of floral entities as carpels and stamens. "His theory directs attention to the flower as potentially sporogeneous axis-bearing floral parts which are not distinct entities but local extensions of the torus". The lower part of the primeval axis is sterile and gives rise to enations like bracts, bractioles and sepals. The upper part is potentially sporogenous. Into this mass sterility penetrates and advances to such an extent as to find the climatic expression in the modern flower, in which fertility becomes confined to the anthers and the surface of the hollow invagination of the receptacle; at whatever point on this fertile surface there is an accumulation of favourable nutrition, ovules emerge out as protuberances. The entire phenomenon of the "state of flowering known as Angiospermy" is thus explained purely on the basis of the principles of growth-physiology. Thus go rejected *in toto* all the current lines of speculation and the very notion of a carpel. According to Prof. Thompson, there is nothing like a carpel in the flower and the flower is "*Acarpous*". The "highlights" in this idea are depicted by the artist in "FUTURISTIC" manner and a human skeleton holds out a mirror in which carpel is seen only as an illusionary reflection.

This theory of "Acarpy" is, at first thought full of vigour, colour and attraction. But the most serious flaw is the gross rejection of the vascular structure indispensable to any morphological interpretation. In a limited sense the vascular structure may not be of much value. However, it does contribute towards an understanding of the "broader trends of race history". Prof. Thompson's views remain unacceptable because of its complete neglect of anatomical data, whose continued role in the verification of our morphological and phylogenetical interpretations are widely recognised.

Although most of the data on hand, developmental and anatomical, are in complete agreement with the "classical" theory, the theory is still imperfect. The Goethean view is regarded by some critics as nothing more than an instrument of description. They find it difficult to explain the derivation of a fertile organ from a sterile vegetative leaf, purely on the phenomenon of metamorphosis.* There is of course, a need for a much more cogent and comprehensive theory, which must be the outcome of a new approach. Saunders, Thomas and Thompson have certainly served us as pioneers in cutting fresh paths of enquiry and have undoubtedly given a new impetus to the study of a problem which was long neglected.

A critical appraisal of the different concepts leads us to the fact that the "classical" view of the flower in general and of its carpel in particular still remains unchallenged, and remains as firm and as solid as the statue of Gomateshwara. This statue at Sravanabelagola in the State of Mysore is a historical monolithic figure of colossal size, standing in the open, withstanding all environmental influences for the last 1,000 years. Even according to Jaina *puranas*, Gomateshwara is a symbol of dignified solemnity. It is said that having renounced the world and its cares, Gomateshwara, the Jain prince, sought peace in the contemplation of the Eternal Truth. He lost all sense of the external world and became so completely absorbed within himself that snakes crawled about his person; anthills enveloped his limbs; and climbing plants twined round his body. These are also chiselled in the great statue. The artist here has made the "classical climber" of Goethe twine round his body.

* Many botanists have, however, expressed the opinion that Goethe used the word "metamorphosis" in a figurative and not in a literal sense.

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