him for suggestions and criticisms in connection with this work.

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3 Dalgren, K. V. O., Botaniska Not., 1937, 487.

Vascular Anatomy of the Pistillate Flower of Enalus acroroides (L. fil.), Steud.

RECENTLY during the course of a detailed study of the embryology of Enalus acroroides (L. fil.), Steud., the writer1 noticed certain interesting features in the vascular structure of the pistillate flowers and a brief account of these is given now in the present paper. A transverse section of the scape of the flower shows the presence of two large vascular bundles in the centre and a large number of smaller bundles along the periphery. The two central bundles are slightly unequal in size and to this feature has been attributed the coiling of the scape by which the pistillate flower goes under water subsequent to pollination (cf. Svedelius2). At the base of the flower these two central bundles begin to move towards each other and finally fuse together giving off at the same time a number of branches which move outwards immediately. These branches are next seen arranging themselves in a ring within the original peripheral bundles of the scape. Thus two sets of outer bundles are now formed (Fig. 5) and these two sets enter the two imbricating spathes of the flower (Figs. 5–7). Soon after the departure of these bundles to the spathes the floral vascular tissue shrinks more or less to the centre and gives rise typically to six large bundles (Fig. 5, marked 1–6), which rapidly undergo a process of readjustment and become regularly arranged (Figs. 6–8). At the same time the six bundles also divide once tangentially and give rise to an outer set of as many, but slightly smaller, bundles (Figs. 5–7). Simultaneously with this three alternating bundles of this outer set divide once radially to form three clearly recognizable pairs (Figs. 5–8, marked a, a₁, a₂; b, b₁, b₂; and c, c₁, c₂). The other three bundles of this set do not divide, but merely move towards the periphery along with the paired bundles. Thus there are now seen at the base of the ovary altogether nine bundles in the periphery and six large bundles forming a circle in the centre (Fig. 8). Both these sets of bundles enter the gynoecium, the outer set of nine pursuing their course further in the wall of the gynoecium, while the inner six form the vascular supplies of the six carpels. Each bundle of the inner set divides at a slightly higher level to form five main bundles, of which the median becomes a large dorsal bundle of the carpel and the others form the two lateral bundles and the two ventral bundles (Figs. 10 and 13).

In the outer set the nine bundles traversing the wall of the gynoecium (Figs. 8, a f) represent the combined sepal-petal traces and the separation into the vascular supplies for the two sets of floral leaves takes place only above the ovary where each of the combined traces divides once tangentially. Thus two sets of nine bundles each are formed, of which the outer set constitutes the sepal bundles, each sepal receiving three bundles and the inner set forms the vascular connections to the petals, each petal also receiving three bundles (Figs. 11 and 12).

In the above description attention is confined only to what may be regarded as a typical vascular structure at the base of the gynoecium with a peripheral set of nine bundles (combined sepal-petal traces) and an inner set of six bundles (for the six carpels). But sometimes there is seen an extra bundle in the peripheral set and this is placed close to and slightly towards the inside of one of the main bundles from which it is evidently formed as a branch. This represents an early tangential splitting of one of the main bundles of the peripheral set.
Figs. 1 and 2. Transverse section of the scape of the pistillate flower. Figs. 3 and 4. The fusion of the two large central vascular bundles and the formation of branches from these. Figs. 5–7. The departure of the vascular bundles to the spathes and the formation of the six large central bundles (marked 1–6) and the outer set of nine bundles (marked a–f) which are the combined vascular traces to the sepals and petals; the six large central bundles are arranging themselves regularly as an inner ring and form the vascular supplies to the six carpels. Figs. 8–10. Sections at higher levels showing the arrangement of the bundles; in Fig. 10 the formation of the dorsal, lateral and ventral bundles is seen and an extra sterile carpel is also marked (St.C.). Figs. 11 and 12. Section higher up showing the separation of the two sets of floral leaves and the tangential splitting of the combined sepal-petal traces; the paired stigmatic lobes are also shown. Fig. 13. Diagrammatic longitudinal section of the pistillate flower to show the vascular connections to the different floral organs. Sb.—spathe; L.B.—lateral bundle; D.B.—dorsal bundle; V.B.—ventral bundle; Ov.—ovule; Sc.—mucilage-secreting scales; K.—calyx; C.—corolla.
even as low as at the base of the gynoecium, while the others divide only very much higher up where the actual separation of the two sets of floral leaves takes place. Similarly extra bundles are also met with in the inner set of bundles forming the vascular connections to the carpels. In such cases the gynoecium shows seven or eight carpels instead of the usual six and the extra bundles are related then to the additional carpels. These extra carpels appear to be invariably sterile and in Fig. 10 such a sterile extra carpel is shown (St. C.).

Above the ovary each carpel forms two stigmatic lobes which appear paired in a transverse section and the number of such pairs corresponds to the total number of carpels making up the gynoecium (Figs. 11 and 12). The pairs of stigmatic lobes are arranged in a circle forming a large cavity in the centre as a pollen collecting chamber. The carpellar vascular bundles reach only the lower portions of the stigmatic lobes, but disappear higher up.

Svedelius² regarded that the gynoecium in *Enalus acoroides* is "composed of six carpels which form a unilocular ovary divided into six cavities" and that the "parietal placentae project to the middle of the ovary and are, as in so many of the Hydrocharitaceae, split quite into two lamellae". Following this, Cunningham³ also described "a syncarpous unilocular inferior ovary with from 6 to 8 carpels". But Troll⁴ has recently shown that the gynoecium in this, as well as in the other Hydrocharitaceae, is really apocarpous and that it appears to be syncarpous only apparently. He designates such a gynoecium a pseudo-coenocarpous one. Further, he states that in the attainment of this condition the floral receptacle, which is said to become cup-like, is fused with the dorsal portions of the otherwise free carpels. On the other hand, the present anatomical study suggests that the outer wall of the gynoecium is made up of the fused basal portions of the two sets of floral leaves, for, the nine peripheral bundles which are recognizable at the base of the gynoecium are really combined sepal-petal traces, and the receptacular vascular tissue ends below the level at which these bundles and the main vascular supplies of the carpels are formed. The outer floral whorls are adnate to the carpels over a considerable distance and are free only above the gynoecium, which thereby has become not only pseudo-coenocarpous, but also inferior. Recently, Joshi and Pantulu⁵ have shown from a study of *Polianthes tuberosa* Linn. that the inferior ovary in the Amaryllidaceae is the result of fusion of the basal portions of the outer floral whorls with the carpels. Eames⁶ states: "The inferior ovary represents adnation in its extreme form. Comparative studies, made with the understanding that fusion of organs ultimately brings about fusion of the skeletal tissues also, demonstrate that the inferior ovary in nearly all—perhaps in all—families has resulted from the adnation of the outer floral whorls to the carpels."

Finally, it may be stated here that the central axis of the flower which Troll⁴ represents in his figures as a small projection at the base of the ovary in *Enalus* could not be made out in any of the preparations, though a careful examination was made through a complete series of transverse sections.

In conclusion, the writer wishes to record his sincere thanks to Prof. M. A. Sampathkumaran, Head of the Department of Botany, for his very critical reading of this paper.

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