On morphological thinking[1]

Morphological Polarity, an alternative to the concept of the essential organs (Grundorgane)

Peer Schilperoord-Jarke

The science of plant morphology was founded some 200 years ago by *Johann Wolfgang Goethe.* His scientific publication «Versuch, die Metamorphose der Pflanze zu erklären» reflects only one special methodological aspect of his way of thinking. The scientific estate left by Goethe contains interesting reflections on morphological thinking, and can give new impulses to plant morphology.[2] The way of comparing forms practised by *Goethe* in his publication on the metamorphosis of the plant can be described as a mental act of varying the proportions of an organ in a quantitative way, resulting in the form of another organ.

If one organ can be transformed by this act into another one, then both organs belong to the same type.[3] *Wilhelm Troll* has accepted only this special aspect of Goethean morphology. According to *Troll*, the main purpose of morphology is to understand the great variety of forms, groups, organisms or organs as quantitative variations of a type as the constituting principle.

The theory of the essential organs, an important part of the foundation of modern morphological thinking, is the result of reducing various ways of comparing forms to only one. The theory of the essential organs states – it is a statement, not a law – that no morphological relationships exist between root, shoot axis and leaf. They do not exist, because it is impossible to transform one of these organs by the way of varying proportions into one of the others. The essential organs cannot be compared to each other in a morphological sense.

Starting point of modern morphology is a description of the different organs of the seedling (or germ). In contrast, the starting point should be a reflection of the cyclic life of the plant. This reflection provides the base for a more adequate view on the organs of the seedling. Plant life is a cyclic process of germination, sprouting, flowering, fertilisation, embryogenesis, fructification, dissemination and again germination. Morphological thinking should reflect this cyclic process of the living plant. In

reality, morphological thinking is restricted to special parts of this cycle. I will try to show some limits of modern morphological thinking and how these limits can be overcome.

It can be clearly demonstrated that the enormous and fascinating variability of forms of the vegetative plant can be accurately described and the manifold parts and organs can be related to each other with the help of the principle of varying proportions, together with the concept of the essential organ. We need both concepts to establish homologies or analogies. In this respect, we have learned a lot from *Wilhelm Troll*.

These concepts have their limitations. The germ is one morphological stage in the life cycle of the plant. The preceding stage is the zygote. What is going on in a morphological sense during embryogenesis? Growth and differentiation of the developing embryo are well known processes. We have sufficient anatomical and histological knowledge to describe precisely the structure of the embryo in every moment of embryogenesis. In spite of this fact, we do not have a clear morphological concept of what is going on. Here we can learn from *Goethe*, not from *Troll*.

In the fourth chapter of his scientific estate, «Versuche zur Methode der Botanik»[4] (On methodology in botanical science), entitled «Organic disunion», *Goethe* introduces the concept of organic disunion: I quote:

«Before, (in the preceding chapter) we looked at the plant as a unity. We can see the empirical unity with our eyes. It arises by the association of many different parts of the greatest variety as an apparent individual. A one year old completed plant torn out. Ideal unity: when these different parts are thought to have arisen from an ideal body, and have developed sequentially. From the very beginning we have to consider this ideal body as simple as possible, and to look at it as disunited, for without the process of disuniting of an entity, a third one cannot develop.»[5]

The process of organic disunion becomes visible in the polarity of the root and the shoot. This polarity is at first a spatial one. Is it a structural one, as well? The second step after establishing the polarity of root and shoot is the differentiation of the shoot in shoot axis and leaf, and of the root in root axis and what I have called root organ.[6] So far, plant morphologists have considered the root to be one organ, not a complex of different organs. From a logical morphological point of view it is inconsistent to distinguish two shoot organs, stem and leaf, and to look at the root as not being differentiated into two organs. The meristem of the root tip gives rise to different kinds of tissues. Forwards, the meristem gives rise to the root cap, the rhizoderm with the root hairs and the hypoderm. The hypoderm is the next cellular layer adjacent to the rhizoderm; after the decay to the rhizoderm the hypoderm is in direct contact with the substrate. Backwards the meristem gives rise to the elements of the root axis: cortex and central cylinder. I have called the root cap the rhizoderm with root haires and the hypoderm root organ. The root organ must be compared to the leaf. The cortex and the central cylinder can be called root axis. The root axis must be compared to the stem.

The polarity of root and shoot are revealed in the following characteristics: 1) the central configuration of the vascular strands in the root axis, and their radial and pe-