Modern Phytomorphology **2**: 13–16, 2012

IS THERE A PLACE FOR PLANT MORPHOLOGY IN THE CONTEMPORARY RESEARCH?

Tetiana Pochynok

Abstract. The change of early plant morphologists' thoughts is shortly summarized in the paper. The establishment of this discipline was taking place under influence of scientists' views, thoughts and knowledge in combination with social life and beliefs. Some scientists tried to set margins all the time limiting morphology from other disciplines; others were widening its horizons due to interaction with different studies and application of new methods. Nowadays, it happens to hear that morphological data is less important than molecular. Though, morphology always served as a base for taxonomy in species determination and it still maintains its significance in the lineages reconstruction. Studying the morphological aspects of plant structure and function, one should keep in mind that he is dealing with a whole plant organism.

Key words: idealistic morphology, casual morphology, phylogeny, levels of organization, plant form, morphological characters, markers

Ivan Franko Lviv National University, Hrushevsky Str., 4, Lviv, 79005; tania.pochynok@gmail.com

Introduction

Being a valid scientific discipline plant morphology aims to study and explain the form, structure, and development of plants. This definition would not separate morphology from other departments of botany as it used to be one and a half century ago when morphology was recognized as being «a purely historical one», «perfectly distinct from any of the questions with which physiology has to do», with aim «to reconstruct the evolutionary tree» (Lang 1915).

In the history of morphology the idealistic, descriptive, and phyletic periods were the most inspired because of new approaches in philosophical study of nature. The German tradition of plant morphology took its origins from the study of the natural history of plants. However, in American society the attention was directed rather to the tools and techniques than philosophy as the microscopic conception of plant morphology became more detailed comparing to less precise study of form relationships based on external morphology (Kaplan 2001).

Brief historical overview

It is impressive, how plant morphology as a science has come through ages and what is its contribution to contemporary study of living organisms. Main figures in German plant morphology significantly contributed to its development were Johann Wolfgang von Goethe, Wilhelm Hofmeister, Karl von Goebel, and Wilhelm Troll.

By the appearance of Goethe's book «*Versuch die Metamorphose der Pflanzenzuerklären*» («*An Attempt to Explain the Metamorphosis of Plants*») in 1790 the origin of plant morphology as a discipline can be dated. Goethe was the first to propose the term «morphology», moreover its methodology – comparative morphology or typology. Because of theoretical nature of his views later his approach was called «idealistic morphology» by the phylogeneticists of the post-Darwinian period. Nevertheless, there were several idealistic morphologists following the tradition of Goethe till the latter part of the 19th century. However, no conflicts between these different points of view were seen because Darwinian evolution simply provided the explanation for the origin of many of the homologies determined by the idealistic morphologists (Kaplan 2001).

Whereas the idealistic morphologists studied the relationship between plant forms, Hofmeister (first person to set a basis for plant embryology and first biophysicist to apply the tools from physics and chemistry) raised the question why plants exhibit these form relationships, what is the causal basis for this morphological diversity. Besides presenting a fundamentally analytical view of the developmental basis underlying the diversity and dynamics of plant form, he also biophysically interpreted a range of phenomena including phyllotaxis and the effects of gravity and light on a plant's morphology (Kaplan 2001).

Change of attitude towards morphological problems in the beginning of the XXth century became more evident: the problems of development and construction from a causal point of view

(developmental physiology), together with genetics, indicate the need of recognizing general or causal morphology (Lang 1915). The most prominent at this time was von Goebel, a disciple of Hofmeister. With published English translation of the «*Organography of Plants*» in 1900 his influence became wider than Hofmeister, who preceded him, or Wilhelm Troll, who followed him (Kaplan 2001). Considering the further problem of modern morphology: the relation between form and function (Goebel 1905), he separated by the physiological explanations the adaptive characters from those that were a result of inner bases (perhaps genetic) showing weaker elements of his organography heritage(Kaplan 2001).

Hence, in von Goebel's era, phylogenetic interpretations of plant morphology came to displace those of idealistic morphology. But he skeptically thought of the phylogenetic speculation: «I do not wish to deny the value of phylogenetic investigation, but the results which it has brought forth resemble more the product of creative poetic imagination than that of exact study, i. e., study capable of proof» (Goebel 1905), influencing even a sharper reaction of his disciples and followers such as Wilhelm Troll, who became the most complicated and controversial figure in German plant morphology. His influenced by Catholicism beliefs in the postwar period developed a reaction against industrial materialism, mechanism in science, and the tendencies of contemporary science to focus on narrowly circumscribed, mathematically based problems (Nickel 1996; Kaplan 2001). This caused the desire to return to a more romantic era of Germany's past, to idealistic morphology of Goethe. Troll, however, was not sure that one could deal with morphology causally but with description and presentation only to analyze the diversity and to deduce the real types which stood behind the diversity (Kaplan 2001). Troll's typological philosophy was the reason to blame him in anti-evolutionary views. Yet, he for sure thought that evolution should have been the best explanation of forms diversity found (Nickel 1996). Nevertheless, he believed that persisted to different degree useless strain was caused by the bifurcation of idealistic and phylogenetically oriented morphology (Kaplan 2001). He skeptically considered fossil records too fragmentary to make phylogenetic deductions from it and argued with noted paleobotanist and phylogenist Walter Zimmermann, the author of telome theory. Zimmermann's theory is hypothetical as idealistic views and on the contrary he argued consistently against idealism. Though, it is based on the morphology of a particular fossil form, inclusion of latter and the incompleteness of these fossils resulted in a large number of unknown character states, reducing phylogenetic resolution (Schneider *et al.* 2009). Besides, Zimmermann's contribution in phylogeny and evolution is underestimated. He is known for pointing out the ideas of phylogenetic systematic («*Phylogenieder Pflanzen*» in 1930) later expressed in the core of Hennig's theory. As Mayr wrote: «with… leading botanists like Zimmermann… having achieved consensus with the geneticists, the ultimate triumph of neo-Darwinism had now simply become a matter of time» (Junker 2004). In his paper Zimmermann brings up the evidences that analyses of taxon phyletics and character phyletics are closely related, the basic logic of outgroup comparison, the elements of phylogenetic theory – however, he never developed his thoughts further and devoted his energy to interests in plant morphology (Donoghue & Kadereit 1992).

Present state

Concerning idealistic and descriptive morphology, which significantly influenced the development of botanical studies, demanded enormous exhausting work in solving problems might never be finished. As Goebel said: «Problems, however, which may not be solved appear to me less important than those which may» (Goebel 1905). There is no sense to spend a lifetime for never ending research if there are currently many problems to be resolved perhaps by means of other methods: «even in continuing to devote ourselves to pure botany we cannot afford to waste time and energy in purposeless work» (Lang 1915).

Plant morphology was always interacted with other disciplines. But there are still unresolved questions in it as this discipline studies the whole plant down to the organ level of organization in different environment conditions. Being mostly independent from morphological, the anatomical level of organization may be applied as histological characteristics (markers) that developmentally correlate with morphogenesis. Nevertheless, higher level of organismal organization and growth habit are also related to the plant's morphology (Kaplan 2001) which makes conclusions of structural relationship based on plant forms comparative study, on the module types of metameric organisms

(Maillette 1992; Savinykh 2008), as well as on the organogenesis study. Plant morphology, being a comparative discipline, is interested not in the isolated expression of the characteristics but between their connectivity, which might be the evidence of the plant forms diversity on the earth today. It happened that doctrine of form relations of plants, and the homologies lost its newness, the first experiments to explain the plant structure appeared to be too simple, so that was the time to raise new creative idea and new phylogenetic conception (Goebel 1905) of morphological problems to give morphology a new breath.

Nowadays morphology has less influence on the phylogenetic studies than in the past. But «close cooperation between the morphological analysis of the plant and the genetic analysis attained by the study of hybridization is most desirable… both should deal with structure as well as with form, and in the light of individual development» (Lang 1915). The need to be involved in other studies, especially applied, was well known for early botanists: «…it would be well if every botanist made himself really familiar with some limited portion of applied botany, so as to be able to give useful assistance and advice at need» (Lang 1915).

During last century there remained the facts requiring the causal explanation (Lang 1915) but today plant morphology focuses more on the causal aspects of plant form with the current emphasis on genetics in biology. Morphology, being German from the very beginning, never made greater impact on contemporary plant biology because of language barrier, philosophical style difficult to read, rapid development of tools and technologies in the USA. Moreover, with the advent of molecular techniques, this gulf has become even wider. The principles of plant morphology bring to the understanding the major features of plant evolution. «Such perspectives have the potential to complement the current emphasis on plant phylogeny and further illuminate our understanding of plant structural change» (Kaplan 2001). Besides, contemporary morphological, anatomical and other data are tried to be integrated along with molecular data to obtain the results either for cladistics or Linnaean taxonomy (Mitka 2004). It is common for morphological data to be considered less important than DNA sequence data in phylogenetic studies. However, many morphological characters show a much lower mutational rate than nucleotides. Several studies demonstrate that certain ultrastructure characters are informative for phylogenetic studies and are focused at deep nodes (but some of them appear to be highly conserved). Other morphological characters, such as the density of leaf indument, have been modified frequently during land plant evolution in response to various environmental factors, informative in studies focused on species-level relationships. As morphological data are the only set of characters that are observable in both fossil and living taxa, it is the only approach that will lead to the integration of fossil evidence into phylogenetic hypotheses dealing with whole organisms (Schneider *et al.* 2009). For compiled datasets numerical taxonomy is often helpful in establishing classification of organisms based on their similarities. It usually includes many equally weighted characters and employs clustering and similar algorithms to yield objective groupings. It can be extended to give phylogenetic or diagnostic system and can be applied to many other fields (Sneath & Sokal 1973).

It is demanded to reevaluate the contribution of scientists into the plant morphology and realize that shifting fashions of science force to work at the interfaces between plant morphology and other disciplines. This does not mean that there are no more unresolved problems in plant morphology but to realize its aspects nowadays it is necessary to go back and to try reviving it through with former scientists' thoughts; especially in morphology development it should be highlighted that various ideas, approaches, and new methods application widened its horizons. Gained morphological conceptions, facts and ideas became a priceless property. So, contemporary plant morphologists should possess a vast outlook to provide detailed investigations at the level of contemporary research and have a clear understanding that historical acquisition in accordance with events of that time appears to be a powerful noteworthy scientific background.

References

Donoghue M.J. & Kadereit J.W. 1992. Walter Zimmermann and the growth of phylogenetic theory. *Syst. Biol.* **41** (1): 74–85.

Junker T. 2004. Diezweite Darwinsche Revolution: Geschichte des Synthetischen Darwinismus in Deutschland 1924 bis 1950. Basilisken-Presse, Marburg.

Kaplan D.R. 2001. The science of plant morphology: definition, history, and role in modern biology. *Am. J. Bot.* **88** (10): 1711–1741.

Kaplan D.R. & Hagemann W. 1991. The relationship of cell and organism in vascular plants. *BioScience* **41**: 693–703.

Lang W.H. 1915. Plant morphology. *Science, New Series* **42** (1092): 780–791.

Maillette L. 1992. Seasonal model of modular growth in plants. *J. Ecol.* **80**: 123–130.

Mitka J. 2004. Linnaean taxonomy in the age of molecular biology. *Fragmenta Floristica et Geobotanica Polonica. Supplementum* **6**: 9–31.

Nickel G. 1996. Wilhelm Troll (1897–1978): Eine Biographie. *Acta Historica Leopoldina* **25**: 1–240.

Savinykh N.P. 2008. Application of modular organization conception in plant structure description. *Contemporary approaches for plant structure description*: 47–69. Kirov.

Schneider H., Smith A.R., Pryer K.M. 2009. Is morphology really at odds with molecules in estimating fern phylogeny? *Syst. Bot.* **34** (3): 455–475.

Sneath P.H. & Sokal R.R. 1973. Numerical taxonomy: the principles and practice of numerical classification. Freeman, San Francisco.

Goebel K. 1905. The fundamental problems of present-day plant morphology. *Science, New Series* **22** (550): 33–45.