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## Origin of plant auxin biosynthesis in charophyte algae: a reply to Wang *et al.*<sup>☆</sup>

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The origin of plant auxin biosynthesis has long been controversial [1]. In our analyses of the TAA/YUC indole-3-acetic acid (IAA) biosynthetic pathway we suggested that this pathway evolved in land plants [2]. With the availability of *Klebsormidium* genome and other charophyte sequence data, Wang *et al.* performed additional phylogenetic analyses [3]. It was concluded by Wang *et al.* that clear evidence exists for the origin of the TAA/YUC pathway at least in charophytes. In our opinion, such a conclusion is contingent on two assumptions: (i) *Klebsormidium* or any other charophyte TAA and YUC homologs are functionally involved in IAA biosynthesis, and (ii) both of the two gene families (TAAs and YUCs) in charophytes and land plants share a common ancestry. At present, sufficient functional information for charophyte TAA and YUC homologs is still lacking. In the analyses of the TAA gene family by Wang *et al.* [3], land plant and charophyte sequences indeed form a clade, but they are also affiliated with homologs from miscellaneous eukaryotes. Although the green plant TAA clade (charophytes and land plants) was interpreted by Wang *et al.* as being horizontally transferred from a non-plant eukaryote [3], it can be easily explained by other scenarios (e.g., vertical inheritance followed by differential losses or gene transfer in the reverse direction). Given the affinity of plant TAAs to homologs from other eukaryotes that are not known to produce IAA, it is likely that TAAs also participate in activities other than IAA biosynthesis [2]. In this respect, the finding of TAA homologs should by no means be

considered as clear evidence for the existence of IAA production in charophytes. In the molecular phylogeny of the YUC family, relationships between charophyte and land plant sequences are unresolved, and it is uncertain whether land plant and charophyte YUCs derive from a common origin. Nevertheless, two of the three scenarios invoked by Wang *et al.* [scenarios (ii) and (iii)] suggest that charophyte and land plant YUCs likely do not form a monophyletic group. Furthermore, scenario (iii), which involves independent acquisitions by land plants and charophytes, is consistent with a land plant origin of the TAA/YUC pathway or, at best, points to independent origins of IAA production in land plants and charophytes. Therefore, the data presented by Wang *et al.* are ambiguous and neither support nor reject the available hypotheses (algal origin vs land plant origin of IAA biosynthesis).

It is likely that the origin of plant auxin biosynthesis will continue to be debated. Further functional investigations and phylogenetic analyses with additional samplings are necessary to better understand this important topic of plant biology.

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