**Rule-based simulation of dendritic Structures from Cupric Chloride Di-hydrate.**

**Goal:** Simulation of the form of existing two dimensional dendritic structures from Cupric Chloride Di-hydrate (See Fig 1,2 and 3) with a rule based system.
**Material**: The used dendritic structures are crystallization patterns from mixtures of Cupric Chloride Di-hydrate with extracts from Barley samples and have a size of 10 cm in diameter. The crystallization method has been applied also for a range of defined samples and processes like Wheat (growth systems) [Szulc et al. 2010] , Milk (processing) [Kahl et al. 2009] [Kahl et al. 2014], Carrot (varieties) [Andersen et al. 2001] [Busscher et al. 2010a] and Carrot baby-food (Processing) [Seidel K 2013] . The basic physical backgrounds of the method are described in [Gallinet & Gauthier-Manuel 1992] [Busscher et al. 2010b] [Busscher, Kahl & Ploeger 2014].
**Scope of work**: The existing scanned structures (600 dpi tif files [in RGB or grey]) are evaluated visually by marking special points. The marked points, e.g. for branching, sharp bending and end of line, are transferred into a data structure (attributed graph representation). Based on this graph representation parameters for a rule-based simulation are chosen. The goodness of fit of the simulation is checked by a comparison with the graph representation of the existing structures. The metric of this comparison can be stepwise refined and narrowed.

**Rule-based Simulation:**
Basis of the work will be the software platform GroIMP [Kniemeyer 2008]. With the help of the platform, so-called L-systems (Lindenmayer systems; see [Prusinkiewicz & Lindenmayer 1990]) with 2-dimensional geometric interpretation will be designed, which produce patterns which are visually similar to the observed structures. The same pattern analysis methods as for the scanned structures will be applied to the artificial patterns from the L-systems, using queries in GroIMP. Visual comparison of patterns will thus be extended and replaced by the calculation of a distance metric between natural and artificial patterns. This will guide the further improvements of the L-system based simulations.

**Internal Metric:**
In a first step the histograms of e.g. the lengths between branching points and the histograms of the branching angles are compared (each separately). In a second step the comparisons of the histograms are limited to so called **R**egions **o**f **I**nterest (ROI) which are circles around the geometric center, with a radius starting in the geometric center and expressed in % of the picture radius. (first is the whole picture = radius from 0 till 100 %). So-called slices will be used, which are the area between two radiii (e.g. 30 % till 50 %). In a third step the comparison is made of the combined (two dimensional) histogram of length and angle.

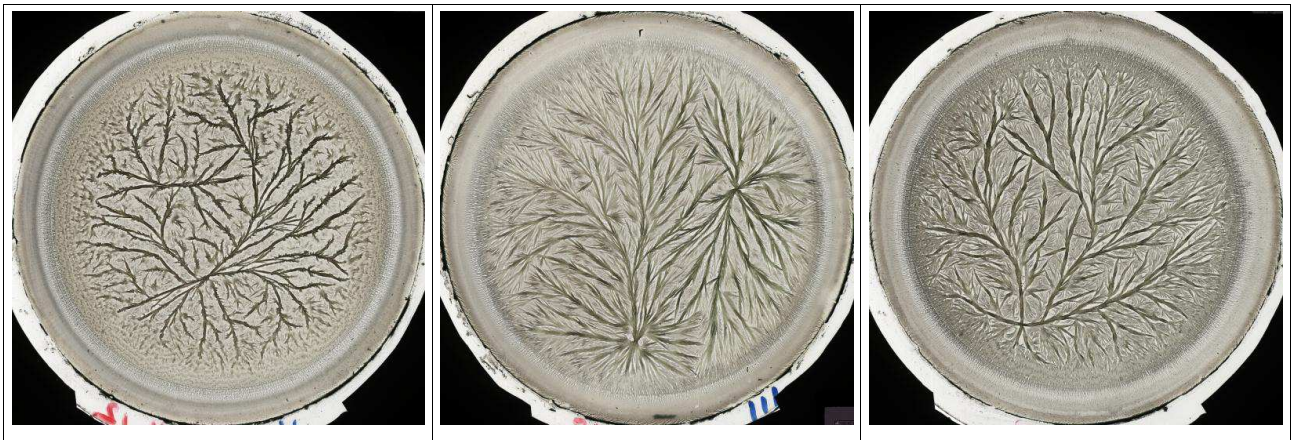

Fig.: Dendritic structures from Cupric Chloride Dihydrate. Left: Series HH-12, middle: Series HH-13, right: Series HH-1.

**External Metric:**
The pictures have an agricultural background. They are from mixtures of Cupric Chloride Di-hydrate with extracts from (a) different Barley Varieties (n=2 Varieties) which have been growing under different (b) Sun Light (n=3 shadow values) and (c) Nitrate fertilization levels (n=4 levels) in (d) field repetition (n=2 fields). For each of the samples defined by the factors (a,b,c,d) from this experiment, several (n=6) pictures were made in repetition. These can be used for a metric threshold for comparison of the goodness of fit. The variation inside the groups should be smaller then the difference (variation) between the groups (Anova).

**Supervision:**
By Prof. Dr. W. Kurth, University of Göttingen, Department Ecoinformatics, Biometrics and Forest Growth, Göttingen, and Dr. N. Busscher, University of Kassel, Faculty of Ecological Agriculture, Department of Organic Food Quality and Food Culture (Prof Dr. A. Ploeger), Witzenhausen

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