submitted to *Acta crystallogr.* A). We obtained our derivation from Shore and Johnson's papers, in which the notion of independent dimensions is refined to a requirement of system independence, and the whole treatment is given a proper axiomatic foundation. Shore and Johnson give four axioms — uniqueness, invariance, system independence and subset independence — which must be satisfied by any consistent selection algorithm. In careful and formal work that is remarkably similar to an axiomatic derivation of Shannon information, Shore and Johnson derive the entropy formula, generalized to $S = -\Sigma_i p_i \log(p_i/m_i)$ to allow for a possible prior model $m$. Although they describe $p$ as a probability distribution, this is unnecessary; their work applies equally well to any distribution of proportions, and the technical words 'probability' and 'information' need never appear.

These ideas justify the fundamental claims made for maximum entropy in data analysis, and it is clear that we need not quantify our preference for the maximum entropy selection by anything other than the numerical value of $S$. It is sufficient to know that we must use maximum entropy — or lay ourselves open to the charge of inconsistency. Let's get on with it. □

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**Palaeobotany**

# Early evolution of leaves

*from J.B. Richardson*

THE origin and evolution of leaves was a major event in land plant evolution and must have affected all other life on land. Much remains to be learnt, however, of when they first appeared and how they evolved. Fossils described on page 785 of this issue by Gensel[1] confirm what had already been suspected from compression fossils from the Gaspé Peninsula: by the end of the Lower Devonian, vascular plant evolution was quite advanced with complex forms present. The presence of divided non-laminate leaves at the end of the Lower Devonian is already documented[2] but Gensel[1] describes changes in anatomy in a lateral branch system suggestive of the early evolution of a megaphyll — a laminated leaf with a complex pattern of venation.

Did leaves arise as Zimmermann suggests in his telome theory[3], through evolutionary overtopping, planation and webbing? A telome is the most distal dichotomy of a plant. Overtopping describes what occurs if one branch of the dichotomy develops more than the other. The overtopped branches would diminish in size, eventually tranforming the equal dichotomies into a main stem with lateral branches. Planation describes the change from a three-dimensional arrangement into a single plane of neighbouring telomes. Webbing, the joining of tissues between the lateral branches of the planar telomes, would result in the familiar lamina (leaf-like structure) with dichotomous venation.

This is what Zimmerman proposed but how is the theory testable? One of the restraints on evolutionary hypothesis is the geological record. Do these morphological features appear in the geological succession in the order demanded by the theory? The answer is both yes and no. Simple dichotomously-branched axes have been recorded in the mid-Silurian (Wenlock)[4], while by the late Silurian, rhyniopsids, with a similar appearance, were common but not diverse. Overtopping was present in the early Devonian (Lower Gedinnian)[5]. At that time there was considerable diversity of the rhyniopsids, and zosterophylls, distinguishable from the rhyniopsids on the basis of lateral sporangia, were present[6]. Later, during the Siegenian, the zosterophylls diversified[7] and the trimerophytes, such as *Dawsonites*, appeared. Later still, in the Lower Emsian of Belgium, a similar flora along with several *Psilophyton* spp. was present[8] and work by Andrews indicates a high diversity of plants at that time (see *inter alia* ref.9). Trimerophytes in the Emsian exemplify overtopping and reduction of laterals; as Stewart[10] states "Trimerophytopsida exhibits almost every branching pattern to be found in megaphyllous vascular plants". Thus, as re-emphasized by Gensel's paper, Zimmermann's leaf-forming processes, apart from planation and possibly webbing, had happened by the late Lower Devonian and much of the geological record supports the telome theory on the origin of megaphylls.

Zimmermann derived a great variety of leaves and leaf-like structures, including microphyllous 'leaves' of the lycopsida, from a rhyniopsid-like ancestor. Bower's enation theory[11] is an alternative proposal for deriving microphylls — small leaves with a single central vein. In the telome theory, the microphylls arise by reduction of bunches (trusses) of telomes. Bower's theory is that bumps (enations) emerged from the surface of the stems. As these enations extended (in the evolutionary sense) they developed vascular tissue, first at the base of the enation (as in *Asteroxylon*) and then throughout the enation, as in *Baragwanathia*, which thus became a true microphyll. According to the telome theory this series would be reversed: reduced vascularized microphylls would precede unvascularized outgrowths. Which

## 100 years ago

SOME forty years ago Dr. Joule raised the question whether a body that is magnetised undergoes any changes in its temperature; but the question has not yet received a definite solution, the rise of temperature which accompanies magnetisation being ascribed by some to induction currents, and not directly to magnetism. While recognising the influence of the former, Mr. Borgman has tried to show that there is also a change of temperature due to the magnetism and demagnetisation, and that the amount of heat thus disengaged is proportionate to the squares of the temporary magnetism. M. Bachmetieff, having made, at the University of Zurich, an extensive series of experiments, the first part of which is now published in the *Journal of the Russian Chemical Society* (vol. xvi. fasc. 3), arrives at the conclusion that magnetism, *by itself*, produces variations of temperature in magnetised bodies, and that this "magnetic heat" is equal to the product of the magnetic moment by the magnetising force multiplied by a constant; it increases also, within a certain limit, with the frequency of the interruptions of the magnetising current, and increases still more when the direction of the current is alternately changed. Its amount is not equal throughout the length of an iron cylinder, reaching its maximum about its middle and decreasing towards its ends. Its cause must be searched for in purely mechanical forces.

RATHER a strange occurence came recently before my notice, and thinking perhaps you might care to insert it in your columns, I send you the facts of the circumstance. A few days since, towards evening, I killed a snake just close behind my house; it measured about a yard and a half in length, was one of the most deadly of the numerous kinds of snakes found in Java, and bears the name of "Oelar belang." On examining it later I found what I thought to be the tail of another small snake protruding from its mouth, but on pulling it out I was greatly surprised to discover that it was really a snake of the same species, and of almost the same length. There was certainly not more than three inches' difference in the length of the two snakes, and at the time I killed the outside snake only about an inch and a half or two inches of the tail of the one he had swallowed protruded from his mouth. The natives here say that the two snakes must have been fighting, the victor afterwards swallowing his opponent. I should be pleased to know whether such an instance has ever before been brought before your notice, or whether it is really an uncommon case.
Soemedang, Java.

M. MONTGIGNY has recently published a pamphlet on the influence of the atmosphere in the apparition of colours seen in the scintillation of stars. He has previously noticed that there is a great predominance of blue in the scintillating colour when rain is approaching, and he is now so convinced of the accuracy of this forecast that it is included among others in the *Bulletin Météorologique* published by the Observatory of Brussels.

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