On Relations between Ecologic and Taxonomic Aspects in the Pyrenomycetes.

By A. Munk (Kobenhavn, Danmark).

It is a common opinion among botanists that knowledge of ecological properties is of little importance and applicability in taxonomic considerations. This point of view is certainly reasonable when applied to the ecological features of green plants, because they all have the same basic type of nutrition, so that their ecological peculiarities are to be found in their relations to physical environmental factors. The fungi, however, display a great variety in their nutrition, and many ecological features appear, more or less evidently, to be determined by important biochemical factors in the fungi. Such properties are inheritable and constitute part of a fungus' genotype as well as the morphological properties. This does not mean, of course, that we can base a taxonomic consideration on any biochemical feature of any specimen of a fungus, this procedure is forbidden by the existence of adaptative enzymes and enzyme-mutants in fungi. But if we are prepared to view the biochemical characters in relation to the sum total of characters, as we ought to do also for any morphological character, we must expect, a priori, that some of them may appear to be useful for the understanding of taxa in the mycological system. The proper solution of such problems must be found by a combined work of taxonomists and biochemists. This paper presents some points of a taxonomist's experience in the ecology of Pyrenomycetes.

Ecology and the concept of "species" in the Pyrenomycetes.

It is hardly possible at present to give a good definition of the concept of species in the Pyrenomycetes, except in the species thoroughly studied in culture — but we cannot do without binomials, i. e. a certain concept of species, untill all the fungi have been studied in culture. In certain cases an ecological consideration may clarify the problems.

The species of the genus *Venturia* sensu auctt. are truly parasitic and apparently strictly host-specific. A *Venturia* on *Epilobium* is hardly to distinguish from a *Venturia* on *Rumex*. From a purely morphological point of view one would recognize one species only. But it is utterly unlikely that one species in a genus of numerous strictly

host-specific species would have two (and only two) so different hosts, so we may distinguish with certainty between *Venturia johnstonii* (Berk. & Br.) Sacc. on *Epilobium* and *Venturia rumicis* (Desm.) Wint.

Pleospora triglochinis Har. & Bres. is morphologically so much like the variable species *Pleospora media* Niessl that a morphologist will include it in *P. media*. But *P. media* is ubiquistic on dicotyledonous plants, and *Triglochin* would be its only monocotyledonous host if we included *P. triglochinis*. My conclusion is that *Pleospora triglochinis* ought to be regarded as an autonomous species, and that the slight differences from *P. media* are significant (slightly larger fruit-bodies combined with slightly smaller asci and spores).

In other cases, ecological considerations may leave the morphologist-taxonomist clearly convinced of his own incompetence. In the genus *Valsa* the delimitation of species is a difficult problem. Certain species — e. g. *V. salicina* (Pers.) Fr. — are host-specific, others — *V. ambiens* (Pers.) Fr. in particular — ubiquistic. On one hand, each species is certainly variable. On the other hand, the differential characters for the numerous species described in the literature do not seem to be consistent (not even the monostichous, resp. distichous arrangement of the perithecia) — and one newer knows whether a specimen belongs to a host-specific or an ubiquistic species, because both ecological types evidently exist within the genus. In such a case — fortunately almost unique in the Pyrenomycetes — the morphologist-taxonomist must give up, with a good conscience, and leave the problems to be solved by cultural experiments.

Ecologic aspects of higher taxa.

It is the experience of plant-pathologists that "parasitic" and "saprophytic" fungi often occur within one genus, and that even many species act as "facultative parasites". This fact alone may seem to forbid the application of ecologic considerations in taxonomy to taxa higher than species. But an analysis of the problem reveals something else.

The "facultative parasites", and the closely related "parasites" and "saprophytes", are mainly found among fungi growing on woody plants. Such fungi live upon the wood-tissue which is mainly composed of dead cells. It is natural that the fungi in question do not care for the possible presence of living cells among the dead ones they live upon, i. e. that they may grow on living host-individuals as well as on dead ones even if they are true saprophytes. Their noxiousness to a living host is also natural. The cells of the wood play an important rôle in the life of the tree, even if they are dead, if they disintegrate the tree will die because of lack of water.

In certain cases, fungi of — probably — this biological type may cause an obnormal development of living host-tissue (e. g. *Nectria galligena* Bres.). Such cases ought to be investigated physiologically. It seems likely, from our present knowledge, that the "galls" of *Nectria galligena* are merely a reaction of the host on certain substances from the metabolism of the fungus, but indifferent to its nutrition, — cp. the galls provocated by insects; such galls and their structure are of vital importance to the parasite.

The conclusion is that no difference exists between facultative parasites and saprophytes of first incidence on stems and branches of woody plants. The same conclusion is found independently by a taxonomic consideration, as facultative parasites and saprophytes able to open an attack on a recently dead branch occur miscellaneously in many families and even genera of Pyrenomycetes (e. g. *Hypoxylon, Diaporthe*). And a taxonomic consideration permits a further conclusion: that the saprophytes of second or higher incidence — the hypersaprophytes — constitute a special ecological type. I do not know any taxon of Pyrenomycetes in which hypersaprophytes occur mixed with saprophytes of first incidence, in other words: every taxonomic group of hypersaprophytes is characterized morphologically as well as ecologically. Exemples of taxa of hypersaprophytes are: *Herpotrichiellaceae*; the genus *Lasiosphaeria*; an outstanding group of the genus *Nectria* comprising *N. sanguinea* Fr., *N. magnusiana* Rehm, *N. modesta* v. Höhn., and *N. cosmariospora* Ces. & De Not.

Coprophilous Pyrenomycetes are hypersaprophytes inasmuch as they constitute the final element in the succession of the fungus-flora on dung. But truly coprophilous Pyrenomycetes generally constitute their own well defined taxa. It must be left to biochemical experiments to show whether the coprophilous type is a separate biochemical type or not. The peculiarities of the group may be morphological peculiarities of the spores instead of biochemical factors in their nutrition. The spores have slimy coverings or appendages which make them able to stick to grass etc., so that they have a good chance to get into the stomach of herbivorous animals. In the genus *Coniochaeta* (Sacc.) Massee the pattern of variation in the spores ranges — in the species with 8-spored asci — from small, light-coloured spores without a gelatinous wall to large, dark-coloured (= thick-walled) spores with a more or less developed gelatinous outer wall. The small-spored species do not seem to be fit to an endozoic dispersal — in fact they grow on wood as hypersaprophytes. The large-spored species do grow on dung; and the transitional type — *C. ligniaria* (Grev.) Massee — is found on dung as well as on wood. — *Xylaria pedunculata* Fr. might seem to be a coprophilous member in a genus of wood-inhabiting fungi. But its asci and spores are different from

those of other *Xylaria* spp. It probably ought to become the type of a new genus.

It remains to be investigated which are the biochemical peculiarities of hypersaprophytic fungi. The common method of cultivating fungi — empirically finding out some kind of substratum on which they will grow — leaves no good possibility for determining their biochemical activity. The most appreciated substrata favour the growth of a great number of fungi, such substrata may unite the important factores of several ecological types. It seems probable, thus, that the hypersaprophytes, in nature dependent on previous attack of other fungi, are not parasites on these fungi. This assumption is confirmed by the fact that the other fungi on the remnants of which we may find the hypersaprophytes are not abnormally developed, just old and dead.

Pyrenomycetes on living *Algae* seem to constitute a very clear-cut ecological type, as none of them seem to be distinctly related to any other Pyrenomycetes (I have not investigated such Pyrenomycetes). On the other hand, it is true for this type as well as for any other ecological type that it has come to manifestation several times during the evolution, as it is represented by ascolocular as well as by ascohymenial Pyrenomycetes (cp. lichenology). It is interesting that small Pyrenomycetes on large *Algae* — e. g. *Fucus* — described as *Mycosphaerella* spp. seem to be taxonomically related to lichenized Pyrenomycetes rather than to *Mycosphaerella* (Santesson, oral communication).

Spore-discharge and taxonomy.

Spore-dispersal is the determinative point in the life-cycle of all fungi. In the Pyrenomycetes a particular variety of methods for spore-discharge is observed. It remains to be investigated to how large extent the method of liberation of spores can serve as an aid in taxonomy. On one hand, one must be careful not to overemphasize the taxonomic significance of any peculiar type of spore-liberation. On the other hand, certain fundamental ascus-structures are evidently connected with the mechanism of spore-liberation, and in such cases the peculiar procedure of spore-discharge is more easy to observe than the almost submicroscopic ascus-top structure that determines it. This is the case for the famous "jack-in-the-box ejaculation" of the spores in *Ascoloculares*.

In *Ascohymeniales* it seems that primitive fungi — e. g. *Sordariaceae* — discharge their spores forcibly, the cylindric ascus serving as a gun-tube for the spore-projectiles; and that less efficient types of spore-discharge are found in phylogenetically more advanced forms. This may seem curious. Nevertheless, it is quite natural, as the spore-discharge in some higher Pyrenomycetes is carried out by

the perithecium as a whole and not by the single ascus. This tendency is particularly distinct in *Diaporthaceae,* the advanced types of which have the whole perithecial cavity filled with small asci at maturity. In such fungi the mechanism of the ascus has become biologically indifferent and is observed to be degenerated in various ways — the variations being of no great taxonomic importance.

The general necessity of ecological considerations in taxonomy.

This discussion cannot be finished without a few words about the general necessity for a taxonomist to keep his eyes open for ecological aspects.

It is well known, by hundreds of examples from the whole organic world, that similar way of living can be the cause of similarities in appearance, and that such similarities are not reliable as criteria for a taxonomic relationship. What the taxonomist has to do on this particular point is to speculate about the possible biological importance of the structures he observes. It is true that he had better investigate the presumed biological importance of a structure experimentally, but I am afraid it would take too much time for him, he would turn out to be a physiologist instead of a taxonomist. We need lots of physiologists, and it is no disaster when a taxonomist becomes a physiologist, but if all taxonomists did so we should have no one left — and we need lots of taxonomists too.

It is so important for a taxonomist to consider the possible biological importance of structures because it is the only way for him to estimate the taxonomic value of a character. The fathers of our knowledge of Pyrenomycetes in the 19th century did not realize the possibility for phenomenons of convergence, so they placed all Pyrenomycetes in one group and got a perfect mixture of *Ascohymeniales* and *Ascoloculares* in their system. If they had thought over the extraordinary efficiency of the life-form of Pyrenomycetes in nature, they might have got the justified suspicion that this type might have arisen several times independently. They further laid a great emphasis in taxonomy on the presence or absence of a stroma. If they had thought over the biological importance of 1. the demarcation against other fungi in the substratum by intramatrical stromata, and the 2. greatly improved exposure of spores to the air by prominent stromata, they might have got the idea that such structures are of little taxonomic importance.

The task of the present taxonomy of Pyrenomycetes is to establish a natural system. And the difficulty of this task is that the previous taxonomy is so far from being natural that it cannot even serve as the elementary basis for the new system. We have to take all possible means into consideration if we shall succeed in our work — also the ecological aspects.