PREFACE

This issue of Studies in Mycology deals with vegetative growth and development of *Aspergillus* in general and *A. niger* in particular. The first description of *Aspergillus* dates back to 1729. Pier Antonio Micheli (1679–1737) described *Aspergillus* as one of 1400 novel genera of plants in his *Nova plantarum genera* (Fig. 1). As a clerical, Micheli recognised the similarity between the sporulating structure of the fungus and the *aspergillum*, a liturgical device used in the Catholic Church to sprinkle holy water during a service.
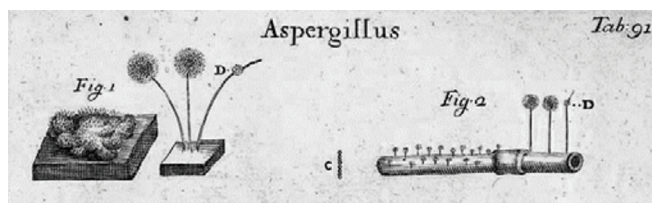

Fig 1. Early pictures of *Aspergillus* conidiophores as depicted by Pier Antonio Micheli in 1729.

Aspergillus niger was described in 1867 in a manuscript entitled *"Physiologie des mucédinées"* by the French botanist Philippe Edouard Léon van Tieghem. He isolated this fungus from molded galls with the main aim to study the production of gallic acid by a process of fungal fermentation. Gallic acid was important for a variety of applications including ink production. From the molded galls he isolated two fungi namely *Penicillium glaucum* and an *Aspergillus* species *"with ornamented spores, that was similar to Aspergillus glaucus, but that, by its blackish color that was conserved on different media, by the musky odor it produced and some other characteristics, I find and M. Dr. Leveille, from whom I am very happy that I could invoke his great authority, be a distinct and novel species to be named Aspergillus niger……"*.

Aspergillus niger is a cosmopolitan fungus. It can be isolated from all continents and is not very selective with respect to the environmental conditions. It grows between 6 and 47 °C, pH 1.5 and 9.8 and a water activity of ≥ 0.77 (Pitt and Hocking 2009). *Aspergillus niger* thrives in the soil and on decaying plant material but is also abundant in man-made environments. For instance, it can be found on the floor and in carpet and mattress dust (see Flannigan *et al.* 2011). Pitt and Hocking state that *A. niger* is by far the most common *Aspergillus* species responsible for postharvest decay of for instance guava's, litchis, mangoes, papaya's, pineapples, pomegranates, apples, pears, and grapes. Other food products such as onions, rice, coffee, nuts and sunflower seeds are also substrates for *A. niger*. During colonisation, *A. niger* may produce the mycotoxins ochratoxin A and fumonisins. Apart from being a saprotroph, *A. niger* is also an opportunistic pathogen of plants and animals. However, its impact as a pathogen is far less than its impact on postharvest decay.

Aspergillus niger is used as a cell factory for the production of enzymes. These enzymes are used in a wide variety of applications ranging from clarification of fruit juices, lipid hydrolysis during cheese production, and degradation of phytate in animal feeds (see for a review Wösten *et al.* 2007). It is also widely used for the production of the food additives citric acid and gluconic acid. In 1917 it was shown that *A. niger* produces large amounts of citric acid in a medium containing sugar (Currie 1917). This was very timely as at that time lemons were the main natural source and delivery of these fruits, mostly from Italy, was not guaranteed

during the First World War. In the original paper we find: *"In 1913 Zahorski was granted a patent in the United States on a method for producing citric acid by fermenting sugar solutions with Sterigmatocystis nigra. This is one of the many names that has been used to designate fungi of the black Aspergillus group. Zahorski, however, states that Sterigmatocystis differs distinctly from Aspergillus"*. It was the American company Chas. Pfizer & Co. Inc that started large scale production of citric acid in 1923 using surface cultures of the fungus.

This issue starts with a review on molecular mechanisms underlying differentiation processes in the vegetative mycelium and during asexual and sexual development of aspergilli (Krijgsheld *et al.* 2013). The other articles in this issue focus on germination of conidia (van Leeuwen *et al.* 2013a, b), formation of heterogeneous micro-colonies (van Veluw *et al.* 2013) and differentiation in sporulating colonies of *A. niger* (Bleichrodt *et al.* 2013).

The articles of van Leeuwen *et al.* show that the RNA composition of dormant conidia is highly different from that of germinating conidia (i.e. of conidia during isotropic and polarised growth). The transcriptome of conidia changes most dramatically during the first two hours of germination enabling initiation of protein synthesis and respiration. The antifungal natamycin does neither affect differential expression of genes nor germination of *A. niger* conidia during the first 2 h of the process. Notably, subsequent stages of germination were effectively blocked by the anti-fungal, but the transcriptome inside the cells had changed thoroughly.

The article of van Veluw *et al.* focusses on stages following germination namely the formation of micro-colonies. It is shown that micro-colonies of a control strain are smaller and more heterogeneous in size when compared to strains in which pigmentation genes are inactivated. These results are of interest from a biotechnological point of view since productivity is related to the morphology of micro-colonies. The results of Van Veluw *et al.* also indicate the existence of transcriptionally and translationally highly active and lowly active hyphae in 1 mm wide micro-colonies of *A. niger* as was previously shown in macro-colonies with a diameter of about 5–7 cm (Vinck *et al.* 2005, 2011, de Bekker *et al.* 2011). However, the existence of distinct populations of hyphae with high and low transcriptional and translational activity seems to be less robust when compared to macro-colonies. Why colonies have hyphae with different transcriptional and translational activity is still not clear but it may have a role in survival in an environment where conditions are dynamic.

The article of Bleichrodt *et al.* focusses on sporulating colonies. Evidence is presented that GFP but not mRNA streams from the vegetative mycelium to conidiophores. Apparently, flow of molecules to the reproductive structure is selective. Absence of RNA streaming would explain why distinct RNA profiles were found in the aerial mycelium when compared to the vegetative mycelium. Future studies should reveal why GFP flows but mRNA does not.

Aspergillus niger is a common fungus, but very beautiful. The white colonies on agar surfaces occasionally develop yellow tinges on which subsequently dark brown conidiophores are formed. With the binocular, it shows slender stalks bearing small white spherical vesicles that mature into dark-brown pigmented spore heads carrying numerous conidia on phialides and metulae. The round vesicles and the pronounced metulae can be regarded as a hallmark for *A. niger*, an important and versatile fungus.

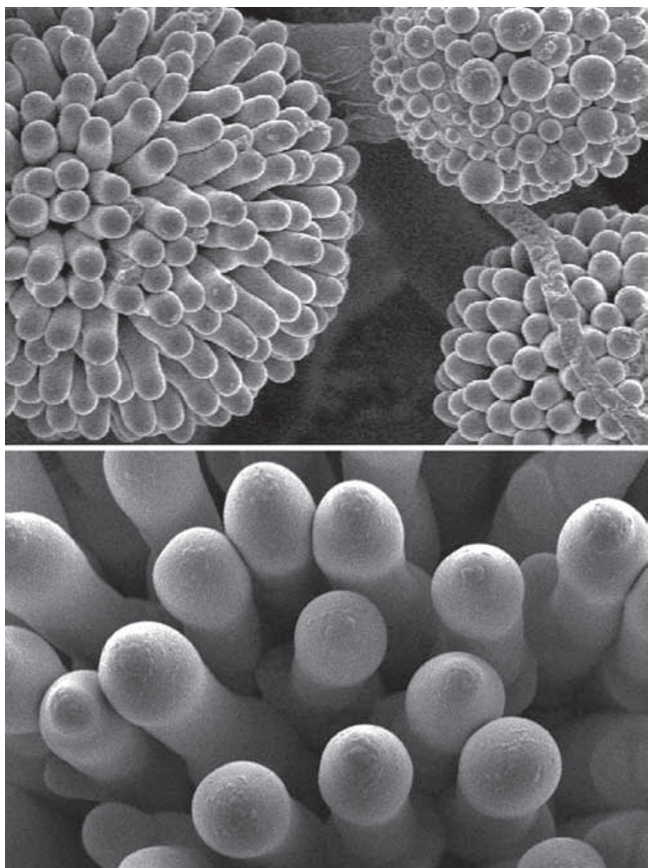The Editors, Jan Dijksterhuis and Han Wösten

Fig. 2. Three conidiophores during early formation (top) and details of phialides (bottom) of *A. niger.*

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