

HOLISTIC MYCOLOGY – BACK TO BIOLOGY!

The fungal world is enchanting for its biodiversity, complexity, and beauty! A long career has taught me that Mycology breaks easily into segments of specialization. But it makes sense and adds overall value to keep it connected and to keep a stable eye on biology as a whole.

My mycological career started early. I was inspired by my father, Morten Lange (1919–2003), to hunt for edible or rare fungi from kindergarten age. I was treading in the steps of my grandfather (Jakob E. Lange, 1864–1941), looking for plants and “sporeplants”. Even before school age, I told my parents that the first thing I would rescue from our house if it caught fire was the cabinet with the original *Flora Agaricina Danica* drawings. *Mycological teaching and the training of youngsters to see, distinguish, and name are the basis of cognitive learning, and art is one of its powerful instruments.*

During my doctoral studies, I had the privilege of working with some of the grand personalities of mycology: I was an assistant to Frederick K. Sparrow (1903–1977), who taught me the wonders of chytrids and other zoosporic fungi in the inspiring surroundings of Ann Arbor and Douglas Lake in Michigan State. Observations not only of static morphological characters, but also dynamic ones such as motility patterns, are needed to determine the genus and species; even major groupings can be distinguished just by looking at the zoospores. This way of thinking, merged with Ralf Emerson’s heritage, brought to me through my wise colleague and close friend Lee Olson, provided *the conceptual precursor to bioimaging, experimental physiology, and new fungal genetics.*

In Thomas A. Shalla’s (1933–1983) laboratory at the University of California in Davis¹. I learned immunological and ultrastructural techniques, helping to visualize and understand interactions between plant viruses and fungi. *Mycology can be developed by transferring technologies from other scientific areas and most importantly by studying the interactions between fungi and other parts of the biological world (viruses, archaea and bacteria, plants, and animals).*

My first boss was Paul de Neergaard (1907–1987), a specialist on *Alternaria* and

head of the Seed Pathology Institute of the Danish Ministry of Foreign Affairs in Copenhagen. He dedicated his life to collaborations with the developing world, meticulously and strategically working to spread knowledge globally – thereby empowering all to control the spread of seed-borne plant pathogens through knowledge of their life-cycles and biology: “you must understand the strategy of the enemy to fight it”! Paul entitled one of his books on seed pathology *Seed: A Horse of Hunger or a Source of Hope* (1986), with the message that: *we by solid research efforts carefully disseminated, can avoid detrimental attacks of fungal pathogens.* But for this, global collaboration is a requisite!

Working in the Institute for eight years with scientists from Asia, Africa and South America, in the aftermath of the green revolution, I realized that we had the knowledge but not the products to use it at the field scale. K.M. Saseeula of Mysore University, India, was my main role model in how to combine laboratory and field studies. I saw a need to develop biocontrol measures, as all could not be achieved by agrochemicals alone. I also saw the need for state-of-the-art equipment for quality mycological research. Novo industries made that possible. They were already a world leader in the biological production of enzymes from fungi and bacteria. Further, they had large solution-focused and interdisciplinary R&D groups. I was part of a team being established to initiate work on biocontrol agents to control plant pathogens and insect pests. *Biological processes and products are complex, but when mastered, evidence-based, and with suitable equipment, can lead to more sustainable biological solutions worldwide – unlocking the magic of Nature!*

My 20 years with Novo, Novo Nordisk, and Novozymes A/S, provided a platform for productive international collaborations. Japanese mycologists and natural product chemists provided a new dimension to the study of antifungal compounds from fungi, later strengthened by inspiring collaboration with Danish, Dutch, and not least, Australian mycologists. The development of new biological production methods using filamentous fungi brought me into contact with talented research groups in South America, China,



the USA, and Europe. *Mycology united! And respect mycological expertise wherever you meet it, as it transcends geographical and cultural borders, and seamless collaboration is possible between academic and industrial researchers.*

Fashion and technological trends are also a factor in science. I have lived through periods in which different techniques have been seen as overarching. Electron microscopy and ultrastructure gave their names to entire institutes and funding schemes. Likewise for protein engineering; all proteins could be developed in the laboratory. Genome sequencing subsequently took the scene and the funding, threatening to submerge biology in data. Now synthetic biology is starting to attract funding and fame. *Let us help each other to see technologies as tools and new and inspiring ways of gaining even more and deeper insight. But do not forget that the main discipline is biology, and the main questions to answer are biological.*

Genomics is not just a tool for evolution, phylogenetic systematics, and identification. It is not just what fungi are, how they are related, and where they came from. Genomics can also be used to elucidate what fungi do and how they interact in nature. But here the focus must be not just genomics, but transcriptomics and secretomics, focusing on interactions both within populations and with other kinds of organisms. Now back in academia, the fungal secretome

¹Undertaking a part of my PhD studies in Davis brought another fortunate inspiration to my onward mycological life, having John W. Taylor as a PhD colleague.

is a focus in my new research group – the filamentous fungi’s way of interacting with the rest of the world. *Contributing to new insights which may in turn contribute to new and more sustainable solutions to important global problems.*

Today, we are in the most fantastic era of biology. We have an entire new tool box filled with marvelous, powerful techniques, many of which can be used remotely through international collaboration, virtual thinking, and decentralized sharing – all leading to empowerment. *Let us use this fantastic time to develop mycology in an integrated, biological, social and environmental context.*

STOP PRESS!

Registries of names and the new Code

The *International Code of Nomenclature for algae, fungi, and plants*, ratified by the 18th International Botanical Congress in Melbourne last July, dictated that, as of 1 January 2013, each new fungal name must be registered in a recognized registry prior to publication. The Code leaves to the permanent Nomenclature Committee for Fungi (NCF), established by the Congress, the task of which registries to approve.

With the year during which we must decide how to implement efficient nomenclatural registration almost half over, NCF deliberations are deceptively muted. ‘Muted,’ because formal committee discussion over the mechanics of name registration and registries is only beginning, but ‘deceptive,’ because behind the scenes it appears we are on the cusp of an impressive international accord.

The International Mycological Association (IMA) Executive Committee members who met in Utrecht after the IF = ?N symposium in April agreed that registration of new fungal names must be handled as efficiently and accurately as possible. The majority agreed that MycoBank (MB), the fungal name registry initiated in 2004–2005 at the Centraalbureau voor Schimmelcultures (CBS) and transferred to IMA jurisdiction in 2010, was the logical choice to serve as either sole or central nomenclatural registry for fungi. Many felt that multiple registries would be less reliable, less synchronous, and possibly proliferate illegitimate homonyms. That MycoBank (MB) was the first registry to assign identifiers for fungal names with MB registration already

Mycologists all over the world have important work to do. One of the most important tasks is to contribute, with a true sense of urgency, to the feeding of the world, and to develop new biological processes, products, and also to facilitate the shift from being a fossil based world to a sustainable, biobased and globalized society. Fungi have a major role to play, and some aspects are unfolded in the article on pp. 87–92 in this issue. However, to realize this vision, we need to work together. Across all parts of the mycological specializations, and on a globally embracing scale of collaboration (see pp. (6)–(7) in this issue). Much of the new talent and investment in mycology

required by most major mycological journals was also persuasive. Some, particularly those whose first language and alphabet is not English, spoke passionately for multiple registries. Recognizing that multi-language portals to a central registry that would track all identifiers simultaneously are also desirable, the Executive asked IMA President John W. Taylor to recommend that the NCF approve MycoBank as either a sole or central registry. After polling all IMA executive members, President Taylor sent the approved letter to the NCF Secretary on 20 May 2012.

Before the Amsterdam and Utrecht meetings, most were unaware that other fungal registries were already in operation. While virtually every mycological author has consulted the formidable resource that is Index Fungorum (IF), relatively few know that it has issued fungal name identifiers since 2009. Index Fungorum and MycoBank have coordinated their identifiers so that there is no numerical overlap and each number remains unique, even without the MB or IF prefix. Fewer are aware that a third fungal name registry — Fungal Name (FN) — has been established in China and has issued identifiers since mid-2011 that are also coordinated by IF to prevent numerical overlap with IF and MB. As noted in Taylor’s letter: “At the time of IF = ?N, neither of these new registries [IF, FN] was effectively synchronized with MycoBank, such that all three sites had to be searched to learn about novel taxa, thereby increasing the likelihood of simultaneous publication of different fungi with the same name.”

The recognition of the existence of three independent registries in Amsterdam prompted a desire to see whether they could

is right now in South America, Asia, and southern Africa; a movement already making a very positive and encouraging impact on the development of world mycology – adding expertise and new thinking to that available in North America and Europe. I believe we can do even more to collaborate across continents, cultures and traditions. And also that we still have much to learn from what former generations used fungi for.

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work together. Communication channels have been opened while their developers collaborate on how best to facilitate synchronization among the registries and present the best user-friendly multi-language interface(s). After two months, we now believe that coordination among the three main registries is not only possible, but probable if logistical hurdles between software can be overcome. At this time, it appears that MycoBank could serve as the central repository recognizing that it is more commonly used by mycologists worldwide, and that it, Index Fungorum, and Fungal Name will collaborate to launch mandatory registration on January 1 with relatively few problems. A vote on the registries by the NCF will take place by the end of August following meetings in the USA and China.

We ask all mycologists, including lichenologists, to log onto the three sites to see what each offers and urge all of you who are not already doing so to register all new names now, whether or not a journal editor requires it. The more who learn how to register their names now, the easier it will be for everyone when name registration is required in 2013.

MycoBank — www.mycobank.org

[now available in English, Chinese, German, Arabic, French]

Index Fungorum — <http://www.indexfungorum.org/names/IndexFungorumRegister.htm>

Fungal Name — <http://www.fungalinfo.net/fungalname/fungalname.html>

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