Mycopathologia (2016) 181:161–163
DOI 10.1007/s11046-016-9993-7

GUEST EDITORIAL

Challenges in *Fusarium*, a Trans-Kingdom Pathogen

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Received: 16 February 2016 / Accepted: 16 February 2016 / Published online: 11 March 2016

Abstract *Fusarium* species are emerging human pathogens, next to being plant pathogens. Problems with *Fusarium* are in their diagnostics and in their difficult treatment, but also in what are actual *Fusarium* species or rather Fusarium-like species. In this issue Guevara-Suarez et al. (Mycopathologia. doi:10.1007/s11046-016-9983-9, 2016) characterized 89 isolates of Fusarium from Colombia showing especially lineages within the *Fusarium solani* and *oxysporum* species complexes to be responsible for onychomycosis.

Keywords *Fusariosis* · Refraction to treatment · Fusarium *taxonomy* · Human pathogen · Plant pathogen

Fusarium head blight, *Fusarium* ear rot, vascular wilting… Please note that no human diseases are even mentioned here, but plant infections because *Fusarium* mostly causes diseases in a wide diversity of cereals and other economically important plant species, like the devastating epidemics currently swiping across the world decimating our banana trees and crops. These diseases not only diminish yields, but also may spoil the crops by the production of persistent mycotoxins affecting consumer's health [1, 2]. *Fusarium* infections cause billions of dollars of losses and need huge investments in pesticides and other measures to keep them under control and out of the food chain. Every host plant seems to have at least one *Fusarium* pathogen and together they form a very large genus within the fungal kingdom with many plant pathogens (and related species with a saprobic life style).

Even more worrying is that quite a number of fusaria prove capable not only of plant infections but also of trans-kingdom infections in human and animal. Numbers of human infections by *Fusarium* spp. are rising worldwide due to a better detection, but also due to an increase in the number of susceptible and immunocompromised people [3]. For example, onychomycosis is not a rare condition in healthy humans, but some studies show that up to 10 % of them are caused by *Fusarium* spp. when etiological agents are typed to species level [4]. Eye infections after trauma with soil or plant material commonly occur in warmer drier climates, while in temperate areas (lack of) lens hygiene appears a common source of keratomycosis [5]. Life-threatening, deep and disseminated infections occur in severely immunocompromised patients, where especially leukemic patients are at risk; a relatively innocent dermatological fusariosis may

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prove to be the portal of entry [6]. A major problem to all these infections is the fact that *Fusarium* species are relatively insensitive to most available antifungal compounds [7].

Within the large genus *Fusarium*, it has become customary to cluster closely related sibling species or lineages with little to no morphological differences in so-called species complexes. The opportunists on humans group into seven species complexes: the *Fusarium solani*, *F. oxysporum*, *F. incarnatum-equiseti*, *F. fujikuroi*, *F. clamydosporum*, *F. dimerum* and *F. sporotrichioides* species complexes [4]. In particular members of the *Fusarium solani* and *F. oxysporum* species complexes have been implicated in human infections worldwide [8–10], but local, endemic plant pathogens prove to have virulence to humans as well (e.g., [4]). Many molecular siblings have no binomial designations yet. As it proves that different lineages within one species complex may vary in the antifungal susceptibility [10, 11], it seems advisable to determine etiological agents to species/lineage level.

In this issue Guevara-Suarez et al. [12] characterized 89 isolates of *Fusarium* from Colombia, the majority having been isolated from onychomycoses. They used multi-locus sequence analysis—the gold standard—to identify known lineages in the *F. solani* and *F. oxysporum* species complexes and also identified two new lineages with members capable of human infection. Based on these outcomes, it seems that in the Americas as well as in Europe [12–15] members of these two complexes predominate in onychomycosis, while for instance in Thailand species of the *F. incarnatum-equiseti* complex are also frequently observed [4]. Interestingly the authors [12] show that pedicure treatment is not a predisposing factor, but rather seems to limit these infections. Most importantly, Guevara-Suarez et al. [12] show that the different lineages vary in susceptibility to antifungal drugs and that the only approved antifungal agent for treating nail infections in Colombia, fluconazole, is exactly the one for which all isolates have minimum inhibitory concentrations higher than 64 μg/ml. This explains the limited success in onychomycosis treatment.

Another problem in addition to the increasing frequency of infections and the problems of treatment, is in diagnostics. A consensus was reached that *Fusarium* was to be the preferred name [16], while a minority of researchers advocated a subdivision of *Fusarium* into smaller genera [17]. Diseases are commonly named after the etiologic agent, in this case *Fusarium* spp. cause 'fusariosis'. When generic names are changed, as a consequence also the disease name is affected. A major problem now lies in the question how large the genus *Fusarium* actually is and which species are to be regarded as fusarium-like. Clinically relevant are especially the suggested renaming of the *Fusarium dimerum* species complex as *Bisifusarium*, and the resurrection of the genus *Neocosmospora* for the *Fusarium solani* species complex [17], while the other complexes are currently not in danger of renaming. Clinically, however, all these species give the same type of opportunistic infections ranging from onychomycosis, keratitis, to disseminated infections with necrotic lesions so there it is easiest to describe them all as *Fusarium* and fusarioses.

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