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Factors associated with the distribution of some phylloplane microbes

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Abstract

Using the spore-fall method, colonies of *Sporobolomyces* and *Tilletiopsis* were isolated, during autumn, from leaves of ferns, conifers, mono- and di-cotyledonous plants. Colonies on agar, which mirror-imaged leaf surface distributions, indicated that the above-mentioned fungi were, on some hosts, restricted to leaf margins while on others they occurred mainly along veins, were absent from veins or were randomly distributed. Colonies were commonly more numerous on parasitized than on undamaged leaves. Increased numbers of *Sporobolomyces* were associated with rust and powdery mildew attacks and damage by (a) the nematode *Aphelenchoides ritzema-bosi* and (b) the mite *Eriophyes macrorrhynchus*. Only powdery mildews increased significantly the incidence of *Tilletiopsis*.

Introduction

Observations were made, using a modication of the spore-fall method devised by Kluyver and van Niel (Last, 1955), of the populations of *Sporobolomyces* and *Tilletiopsis* colonizing leaves – these genera forming part of the Sporobolomycetaceae whose members produce, usually singly, ballistospores which are discharged by drop-excretion typical of many Basidiomycetes. Leaves from a range of outdoor ornamentals and vegetables were examined in the autumn.

Observations

Although exceptions have been reported e.g. *Sclerographium phyllanticola* on *Phyllanthus discoideus* (Last and Deighton, 1965), most phylloplane microbes (see Kerling, 1958) colonize a wide variety of plants. During the present study colonies of *Tilletiopsis* were cultured from hosts in the Polypodiaceae, Pinaceae, Aceraceae, Betulaceae, Caryophyllaceae, Compositae, Cruciferae, Cucurbitaceae, Fagaceae, Gramineae, Labiatae, Malvaceae, Onagraceae, Papilionaceae, Rosaceae and Scrophulariaceae. None of the isolates could, however, be matched exactly with the species described by Nyland (1950) and Tubaki (1952), conspicuously differing from *T. minor* and *T. washingtonensis* by their ability to develop submerged mycelium when growing on malt agar.

Numbers of *Tilletiopsis* colonies isolated from leaves of lettuce, *Armoracia rusticana* (horseradish) and *Cheiranthus cheiri* (wallflower) usually greatly exceeded those of *Sporobolomyces* but the latter fungus was usually the more abundant on the deciduous tree species *Aesculus hippocastanum* (horsechestnut), *Quercus robur* (oak) and *Ulmus procera* (elm). Most cultures of *Sporobolomyces* were identified as *S. roseus* but one of

the red colonies (FTL 223B), isolated from *Vicia faba*, formed symmetrical ballistospores typical of *Bullera*, species of *Sporobolomyces* having asymmetrical spores (Lodder and Kreger-van Rij, 1952).

As happened with cereals (Last, 1955) more *Sporobolomyces* colonies were usually cultured from old than from young leaves, numbers increasing from 0.4 to 6.3 per cm^2 on young and old chrysanthemum leaves, respectively. Although budding colonies of *S. roseus* were microscopically found to be arranged above the anticlinal walls of epidermal cells, as previously described by di Menna (1959), macroscopically they seemed to be (a) concentrated at the margins of horseradish, *Althaea rosea* and *Digitalis purpurea* leaves, (b) predominantly associated with veins on the lower surfaces of horsechestnut and elm, (c) absent from the environs of vascular tissues on *Cucurbita pepo* (vegetable marrow) and chrysanthemum, and (d) randomly arranged on oak and apple leaves – these distributions being judged by colony development on agar.

Sporobolomyces colonies were usually isolated in greater numbers from lower (L) than from upper (U) surfaces of many plants the surface effect being large on leaves of

Fig. 1. The distribution on potato dextrose agar of colonies of *Sporobolomyces* (dense) and *Tilletiopsis* (granular) isolated from leaves using the spore-fall method. A: *Ulmus procera* lower surface; B: *Quercus robur* lower surface; C and D: *Sorbus aucuparia*, lower and upper surfaces, respectively, their outlines being indicated.

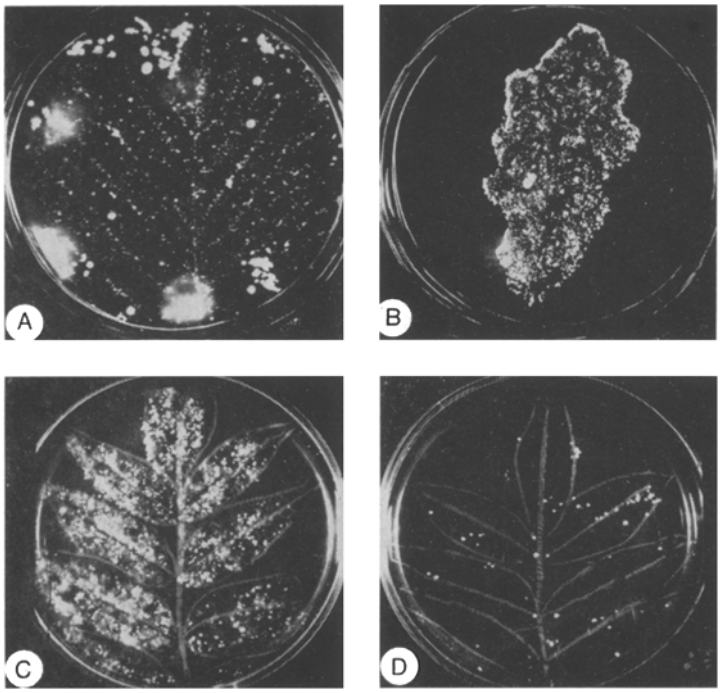

Fig. 1. De verspreiding van kolonies van Sporobolomyces (dicht) en Tilletiopsis (granulair) op aardappeldextrose-agar, van bladeren geïsoleerd door middel van de sporeval-methode. A: Ulmus procera, onderoppervlak; B: Quercus robur, onderoppervlak; C en D: Sorbus aucuparia, resp. onder- en bovenoppervlak, de omtrek der bladeren is aangegeven.

Athyrium filix-femina, elm and *Tussilago farfara* having 0.3 and 3.1, 2.3 and 7.7, and 1.0 and 65.0 per cm^2 of upper and lower surfaces, respectively. The incidence of *Tilletiopsis* was similarly differentiated on wallflower, *Phaseolus coccineus* and *Sorbus aucuparia* (Fig. 1).

The descriptions of the genera *Itersonilia* and *Sporidiobolus*, within the Sporobolomycetaceae, are based on type species isolated from rust pustules – *I. perplexans* being associated with *Puccinia malvacearum* attacking *Althaea rosea* (Derx, 1948) and *Sporidiobolus johnsonii* with *Phragmidium rubi-idaei* on *Rubus idaeus* (Nyland, 1949). When isolating from leaves of comparable age more *Sporobolomyces* colonies developed from leaves invaded by rust fungi than from uninfected leaves, increasing on *Antirrhinum* in the presence of *Puccinia antirrhini* from 7.5 to 97.0 per cm^2. Similar increases occurred on *Senecio vulgaris* infected by *Coleosporium senecionis* and on *Cirsium arvense* attacked by *P. obtegens*. On mint infected by *P. menthae* mean numbers of *Sporobolomyces* colonies isolated from upper surfaces increased from 0 to 44 per leaf and on lower surfaces from 10 to 275, the larger numbers on the lower surfaces being clustered around the erumpent rust pustules.

Rust fungi do not appear to influence the occurrence of *Tilletiopsis*, but numbers of both *Sporobolomyces* and *Tilletiopsis* were usually greater on agar plates beneath leaves infected with powdery mildews than when their uninfected counterparts were tested. From zero on uninfected leaves, numbers of both fungi from powdery mildewed Michaelmas daisy (*Aster novibelgii*) leaves were so large that the colonies developing on agar coalesced at an early stage so precluding counting. Infection with *Podosphaera leucotricha* increased mean numbers of *Sporobolomyces* from apple leaves from 0.5 to 21.0 per cm^2 while on vegetable marrow invaded by *Erysiphe cichoracearum* the few *Sporobolomyces* were restricted to marginal areas while the remainder of the leaf was colonized by *Tilletiopsis*. This type of distribution, possibly suggesting microbial competition between *Tilletiopsis* and *Sporobolomyces* also occurred on powdery mildew-infected cereal leaves (Last, 1955).

In addition to leaves parasitized by the mainly superficial powdery mildews, those infected by downy mildews seem to provide a suitable substrate for colonization by members of the *Sporobolomycetaceae*. Numbers of *Sporobolomyces* isolated from healthy tomato leaves increased from 38 to 550 when infected with *Phytophthora infestans*. *Bremia lactuca* attack on lettuce was associated with greatly increased numbers of *Sporobolomyces* and *Tilletiopsis;* similar associations occurring on apple and pear leaves infected with *Venturia inaequalis* and *V. pyrina*, respectively.

Whether injury was caused by fungal pathogens or insect pests, damaged leaves were often colonized by *Sporobolomyces*. When chrysanthemum leaves were held over agar, numerous colonies developed beneath angular sectors damaged by the parasitic nematode *Aphelenchoides ritzema-bosi*. Clusters of *Sporobolomyces* usually developed beneath *Acer campestre* leaf galls caused by the mite *Eriophyes macrorrhynchus* – the grouping of these colonies resembling that found around peripheral hydathodes when leaves of *Brassica oleracea* (cauliflower) were examined in spring.

Discussion

Airborne and rain-splashed propagules of a diverse range of microbes can be deposited/impacted on aerial structures of plants. Some, on germinating, initiate damaging

attacks while there are now sufficient data indicating that others are the forerunners of non-parasitic microfloras which develop systematically and include algae, bacteria and filamentous and yeast-like fungi (Ruinen, 1961).

Fokkema (1968) showed that the development of *Cladosporium herbarum* on rye leaves was stimulated by rye pollen. In the present study the development of members of the Sporobolomycetaceae, which are widespread in temperate regions, was stimulated directly or indirectly when the host was invaded by pathogens and pests. As yet little is known of the function of this group of non-parasitic fungi. They are sometimes considered to be scavengers but some isolates produce antifungal substances in vitro (Yamasakai et al., 1951). If this property were substantiated in vivo, it might be worth attempting to manipulate their incidence and that of other phylloplane microbes, hoping to minimize the damage done by parasites.

Samenvatting

Factoren die verband houden met de verspreiding van enige micro-organismen in de "phylloplane"

Gebruik makend van de sporeval-methode werden gedurende de herfst kolonies van *Sporobolomyces* en *Tilletiopsis* geïsoleerd van bladeren van varens, coniferen, en mono- en dicotyle planten. De verdeling van de kolonies op agar, die zich naar het spiegelbeeld van de verspreiding op het bladoppervlak ontwikkelde, gaf aan dat beide schimmels zich op sommige waardplanten beperkten tot de bladranden, terwijl zij zich op andere voornamelijk langs de nerven bevonden, niet bij de nerven voorkwamen, of willekeurig verspreid waren.

De kolonies waren gewoonlijk talrijker op aangetaste bladeren dan op onbeschadigde bladeren. De toename van *Sporobolomyces* ging samen met roest- en meeldauwaantastingen en schade door (a) de nematode *Aphelenchoides rtizema-bosi* en (b) de mijt *Eriophyes macrorrhynchus*. Een belangrijke toename van *Tilletiopsis* werd alleen door meeldauwen veroorzaakt.

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