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First report of the fungal entomopathogen *Paecilomyces* in Norway

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A search for natural enemies of the codling moth, *Cydia pomonella* L., was conducted in Norway in an attempt to find potential biological control agents. The fungal entomopathogen *Paecilomyces farinosus* was isolated from insects collected in nine locations. This is the first report for the genus *Paecilomyces* in Norway.

Key words: *Paecilomyces*, *Cydia*, biocontrol, entomopathogens, fungi.

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INTRODUCTION

One of the most important pests of apples and pears throughout the world is the codling moth, *Cydia pomonella* (L.) (Lepidoptera: Tortricidae) (Barnes 1991). Females lay eggs singly or in small clusters on leaves or directly on the fruit; once hatched, larvae bore holes into the fruit reducing its quality or rendering it unusable (Alford 1984). In an attempt to identify microbial agents with potential for use in biological control programs against the codling moth, cardboard band traps used to capture overwintering codling moth prepupae were installed in 9 locations in Norway (Table 1) in late July of 1999. Insect pathogens from Norway might be of special interest as potential microbial agents if they have a lower temperature optimum than isolates obtained from southern locations in Europe. Eight of the locations sampled were in the eastern part of Norway, while one location, Sogndal, was in the west. Based on the annual distribution of temperature and precipitation, the climate in Norway may be roughly divided into two climatic subzones (Aune 1993). The western subzone is characterized by cool summers and mild winters, and most of the precipitation occurs during autumn. The eastern subzone is characterized by warm summers and relatively cold winters, and most of the precipitation occurs in the summer. The eastern and western populations of *C. pomonella* are separated by geographical barriers that make migration between the two very unlikely (Sæthre & Hofsvang, unpublished), and might have different microbial agents attacking them, or the agents might show different responses to temperature and/or humidity. It was therefore decided to search for microbial agents in both climatic subzones and only at locations where *C. pomonella* was already known to be present (Sæthre & Edland 2001).

MATERIALS AND METHODS

The traps consisted of corrugated cardboard double wrapped around the trunk or branches of apple trees, and covered with a plastic screen. Codling moth infested apples tend to ripen and drop prematurely, and the fully grown larvae leave the fruit in search for overwintering sites beneath the bark or at the base of the tree (Alford 1984). The corrugated cardboard provides such a site. Traps were retrieved in early May of 2000 and larvae that were alive within the corrugated cardboard were individually placed in 55 x 15 mm Petri dishes with a screened lid; the bottom section of the dish was lined with filter paper moistened with sterile water. Dishes were placed on a plastic platform inside a sealed plastic container containing water, thus creating a 100 % relative humidity environment suitable for the proliferation of fungi on the insects' cuticle. The plastic container was kept in a growth chamber maintained at 28 EC. Larvae were examined daily for two weeks and when fungal growth was seen, an inoculating loop was used to subculture the fungus on to Sabouraud's dextrose agar (Becton Dickinson France S.A., Le Pont de Claix, France) for subsequent identification. Larvae that were dead when removed from the cardboard were individually placed in sealed 35 x 10 mm Petri dishes containing BactoJ agar (3 g/L; Becton Dickinson France S.A., Le Pont de Claix, France) with chloramphenicol (0.4 g/L; Fisher Scientific Labosi, Elancourt, France), kept at 28 EC, and examined daily for fungal growth.

RESULTS

The only insect pathogen isolated from all nine locations (Table 1) was the mitosporic fungal entomopathogen *Paecilomyces farinosus* (Holm ex S. F. Gray) Brown & Smith This is the first report of the genus *Paecilomyces* in Norway (Klingen et al. 2002a). However, very few surveys have been conducted in Norway on the occurrence of insect pathogenic fungi, and the most intensive study of soil dwelling insect pathogenic hyphomycetous fungi was conducted on arable land and adjacent field margins in northern Norway (Klingen et al. 2002b). *P. farinosus* is frequently isolated from forest soils (Samson 1974) and has also been reported to be very sensitive to the disturbing effects of cultivation (Vänninen 1995). *P. farinosus* has a wide range of hosts, mainly lepidopteran larvae (Tanada & Kaya 1992).

The isolation of *P. farinosus* in Norway is of significant interest in the field of applied entomology, since Norwegian regulations requires that commercial products containing fungal spores can only be used if the fungal species has already been found in the country. Future research will determine the virulence and the temperature range of the *P. farinosus* strains against the codling moth. It will be of special interest to investigate if there are any differences between the strain from Sogndal in western Norway and the strains from eastern Norway regarding temperature optimum. All strains have been deposited in the European Bio-

Table 1. Locations in Norway where traps used to capture overwintering *Cydia pomonella* were installed.

County	Municipality	Location	Altitude m a.s.l.
Akershus (1)	Ås	Skogvn. 39	90
Akershus (2)	Ås	Kajavn. 23	90
Buskerud (3)	Lier	Egge	100
Buskerud (4)	Lier	Foss Gård	60
Telemark (5)	Notodden	Nordre Sem	25
Telemark (6)	Sauherad	Jønsi	80
Telemark (7)	Sauherad	Rinde	80
Telemark (8)	Sauherad	Flåtin	40
Sogn og Fjordane (9)	Sogndal	Sogndalsfjøra	5

logical Control Laboratory (USDA, ARS) Fungal Entomopathogens Collection (Montpellier, France) and in the Plant Protection Centre Collection of Fungal Entomopathogens (Ås, Norway).

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