

## Distribution of pathotypes of the potato cyst nematode (*Globodera* spp.) in Danish gardens

*Kortlægning af kartoffelcystenematodens (Globodera spp.) patotyper i danske haver*

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### Summary

The examinations were occasioned by the fact that only potato cyst nematodes of the pathotype Ro1 had previously been found in Denmark. Therefore, 3,000 gardens from all over the country were examined in 1982 in order to establish the presence, if any, of different pathotypes.

Potato cyst nematodes were found in 600 (20 per cent) of the gardens. Pathotype tests established that only nematode type Ro1 occurred, except at one locality found in the center of a town, where the samples contained nematodes of the Pa3 type. A subsequent collection of soil samples and pathotype tests in 1983 confirmed this result.

Generally, it may be said that in the majority of cases the potato cyst nematodes occurred in places where there was a minimal risk of spreading to field area. The occurrence of pathotypes other than Ro1 in Danish garden areas is very limited and of no practical importance.

**Key words:** Potato cyst nematode, *Globodera* sp. pathotypes, screening.

### Resumé

Med den baggrund at der tidligere kun er fundet kartoffelcystenematoder af arten *Globodera rostochiensis* (Woll.) og kun patotypen Ro1 i Danmark, blev der i 1982 foretaget en undersøgelse af 3000 haver fordelt over hele landet. Formålet var at få kortlagt en eventuel forekomst af forskellige patotyper.

I 600 (20%) af haverne blev der fundet kartoffelcystenematoder. En patotypetest viste, at der kun blev fundet nematoder af typen Ro1 med undtagelse af én lokalitet, som viste sig at indeholde nematoder af arten *Globodera pallida* (Stone) af typen Pa3. En efterfølgende indsamling af jordprøver og patotypetest i 1983 bekræftede dette resultat.

Generelt kan det konkluderes, at de fundne forekomster af kartoffelcystenematoder i langt de fleste tilfælde befandt sig på steder, hvor risikoen for en spredning til markarealer var yderst ringe. Specielt kan det nævnes, at lokaliteten med Pa3 blev fundet midt i en by og således med ringe risiko for at kunne spredes til markområder. Forekomsten af andre patotyper end Ro1 i danske havearealer er meget begrænset og uden praktisk betydning.

**Nøgleord:** Kartoffelcystenematode, *Globodera* sp. patotyper, kortlægning.

## Introduction

The potato cyst nematode (*Globodera rostochiensis* (Woll.)) was found in Denmark in 1928 for the first time (1). In the following years it was found in most parts of the country. The findings were mostly done in gardens or areas where potatoes had been grown year after year or at very short intervals. An examination in 1952 of a number of municipalities in mid-Jutland showed that the intensity of the attacks in gardens in the most strongly infested area was 8 per thousand (5). In 1953 all the gardens in the town of Ribe were examined. The degree of infestation found was 8 per cent (6). During the period 1959–1963, 15 per cent of the samples sent from garden areas to the Research Centre for Plant Protection for examination for potato cyst nematodes turned out to be infested (7).

When Stone (1973) had shown that there were 2 species of the potato cyst nematode, attention was focused on the new species, *Globodera pallida* (Stone). It has now been found in most European countries (3), including England where about 50 per cent of the nematodes found are *G. pallida* (2), and Norway, where less than 5 per cent of the potato cyst nematodes found belong to that species.

As *G. pallida* had not yet been found in Denmark, a survey of Danish garden areas was started in 1982 in order to establish the occurrence and distribution of this nematode. Garden areas were chosen on the assumption that if *G. pallida* was to be found in Denmark at all, the most likely place was there because of the insufficient crop rotation.

## Material and methods

### Collection of soil samples

Garden or allotment areas all over the country (fig. 1) were examined in the summer and autumn of 1982 for potato cyst nematodes.

In each garden or allotment, plants randomly chosen were dug out and the roots examined. If there were cysts on the roots, about 2 kg soil from the planting area were put into a plastic bag. If no cysts were found on a of minimum 3 different

plants, the garden was considered free from potato cyst nematodes.

The number of gardens examined in each area varied considerably. The purpose was to collect as many different populations of nematodes as possible. Therefore, the aim was to collect at least 10 samples with potato cyst nematodes from each geographical area, which meant that the number of gardens examined varied considerably from district to district.

### Pathotype examinations

The pathotype examination took place in a greenhouse at about 20°C. Each of the soil samples were put into 5 plastic pots. In order to examine the samples for pathotypes other than the Ro1 type found in Denmark, potato tubers of the 'Octavia' cultivar (Ro1 resistant) were put into 4 of the pots, and a tuber of the 'Bintje' cultivar (susceptible) was put into the last pot as a control.

When yellow or brown cysts were found on the roots of 'Bintje', the cysts on the surface of the root ball in the 'Octavia' pots were counted.

The samples which had cysts on the roots in all 4 'Octavia' replicates were then tested for other pathotypes. This was done by mixing the soil from the 5 pots after the cysts had ripened and fallen off the roots. The mixed soil was distributed to another 6 pots with tubers including cultivars from the international pathotyping scheme (4). The following cultivars were used – the resistance properties are given in parentheses: 'Frila' (Ro1, Ro4), '*Solanum kurtz.* 60.21.19' (Ro1, Ro2), '*S. vernei* 58.1642/4' (Ro1, Ro2, Ro3), '*S. vernei* 62.33.3' (Ro1, Ro2, Ro3, Ro4, Pa1, Pa2), '*S. vernei* 65.346/19' (Ro1, Ro2, Ro3, Ro4, Ro5) and '*S. multidissection* P 55/7' (Pa1). The number of cysts on the surface of the root ball was counted when there were many brown cysts on 'Frila'.

In the cases where pathotypes other than Ro1 were found, new soil samples were taken the next year – in 1983, to see if the results were reproducible. In most cases precise identification of the gardens was not possible, and a soil sample was taken from the most likely garden as well as the

surrounding gardens. The samples were tested with cultivars from the international scheme.

## Results

### Collection of soil samples

About 3,000 gardens in 46 localities (Table 1)

have been examined for the occurrence of potato cyst nematodes. Cysts were found on the potato roots from all the localities and in about 600 gardens in all. The occurrence varied considerably. Frequently if cysts were found, they were found in many gardens from the same locality.

**Table 1.** Localities examined (LOC) and number (N) of gardens infected by the potato cyst nematode.  
*Undersøgte lokaliteter (LOK) og antal (N) haver angrebet af kartoffelnematoden.*

LOC LOK	N N	LOC LOK	N N	LOC LOK	N N
Bredebro	4	Ikast	2	Rødbyhavn	8
Brønderslev	6	Kolding	8	Rørkær	4
Esbjerg	8	Korsør	16	Samsø	79
Fredericia	3	København	61	Skagen	11
Frederikshavn	12	Køge	6	Skanderborg	3
Gedser	10	Møgeltønder	2	Slagelse	10
Grenå	3	Nakskov	10	Sønderborg	12
Haderslev	10	Nr. Sundby	11	Thisted	36
Hanstholm	12	Nyborg	2	Tønder	2
Herning	64	Nykøbing F.	10	Varde	5
Hirtshals	3	Odense	1	Vejle	17
Hjørring	1	Randers	10	Vordingborg	10
Holbæk	12	Ribe	4	Åbenrå	12
Holsterbro	27	Ringsted	9	Ålborg	10
Horsens	12	Roskilde	19	Århus	21
Højer	1				

### Pathotype examinations

In 83 gardens spread over 18 localities cysts were found in at least one of the 'Octavia' pots. With the exception of 2, which did not sprout, cysts were found in all 'Bintje' pots. Table 2 shows the number of replicates with cysts in the 'Octavia' pots with soil from different gardens, and Table 3 shows the results of the detailed pathotype test.

**Table 2.** Samples with cysts from the Ro1 resistant cultivar 'Octavia'.

*Prøver med cyste på den Ro1 resistente sort 'Octavia'.*

Number of replicates with cysts <i>Antal gentagelser med cyste</i>	Number of samples <i>Antal prøver</i>
4	29
3	27
2	13
1	14

Table 4 shows the results in connection with soil samples from 1983.

## Discussion

As appears from Fig. 1, the majority (75 per cent) of the localities examined are situated in sea ports or close to the border. The reason is that pathotypes previously unknown in Denmark are most likely to occur there, if at all, because of the lively traffic over the sea and across the border.

In about 20 per cent of the gardens examined potato cyst nematodes were found on the roots of potato plants (Table 1). In the vast majority of cases there were many cysts (>100 per plant). At localities with few gardens, nematodes were often found in all of them, whereas at localities with many gardens nematodes were only found in some of the gardens. The gardens were usually situated close to each other, which might indicate

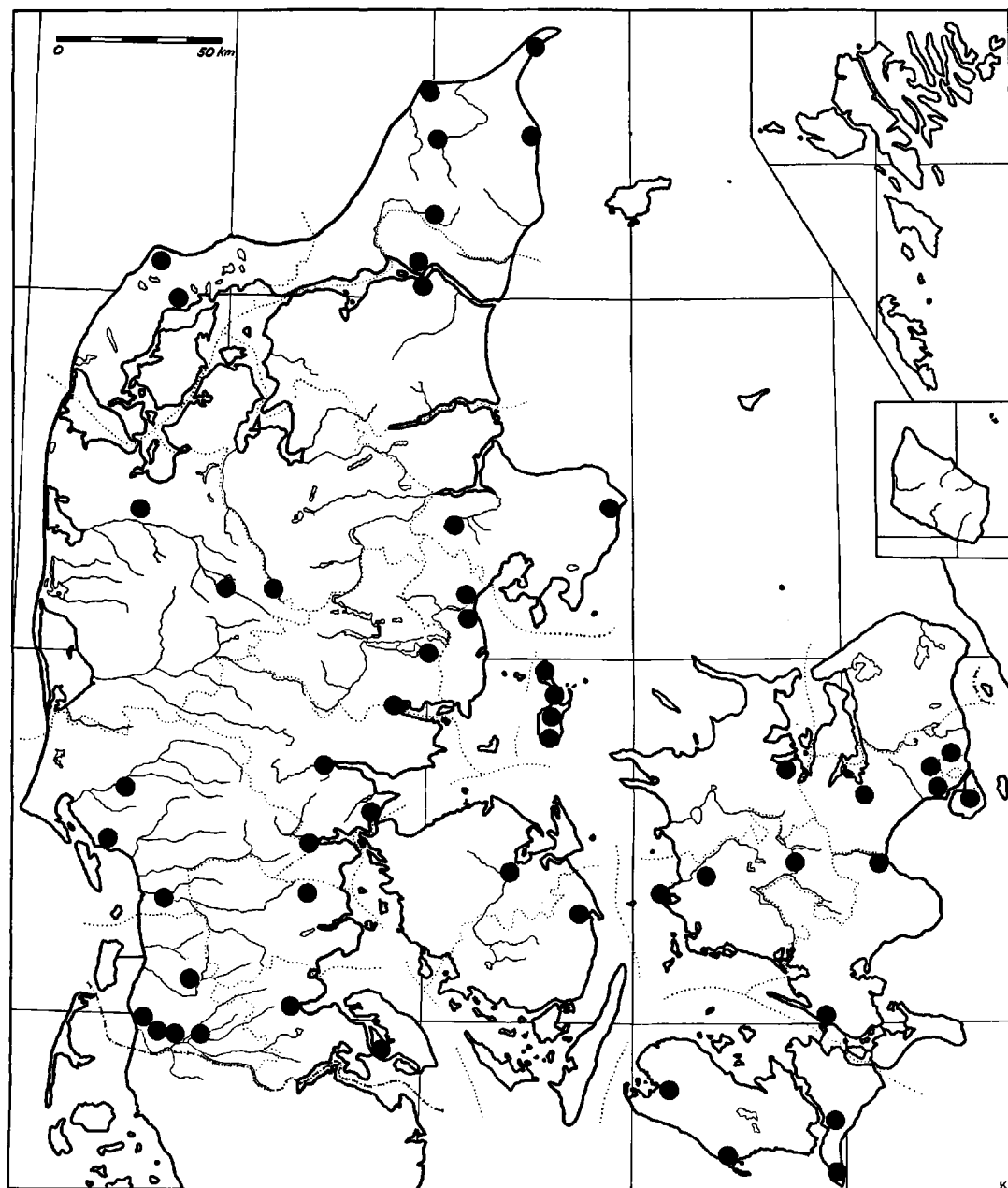


Fig. 1. Position of localities examined.  
*Beliggenhed af de undersøgte lokaliteter.*

that infestation mostly takes place from garden to garden through the exchange of garden tools, seed potatoes and other plant material. Almost all localities were isolated from agricultural areas, as they were situated in urban areas. Thus nothing seems to indicate that the frequent occurrence of potato cyst nematodes in garden areas will spread to agricultural areas.

The test for pathotypes other than Ro1 (Table 2) showed that in 29 gardens cysts were found on all 4 'Octavia' replicates. With the exception of 2 localities where 38 cysts were found per pot, the average occurrence was 4 cysts per pot. To save

labour, only these 29 soil samples were tested further for occurrence of different pathotypes. This was done because resistant cultivars may have a few cysts on the roots of pathotypes to which they are resistant (4). Thus the resistance is not 100 per cent, but propagation does not occur. To say that different pathotypes are present it is required that all replicates develop cysts. The pots with the 'Bintje' cultivar showed that there were many cysts in the samples.

The detailed pathotype test (Table 3) shows significantly different results at the 2 localities: Møgel 1 and Møgel 2, which showed considerably

**Table 3.** Number of cysts developed on tubers from cultivars with different resistant properties. Soil samples collected in 1982.

*Antal cyster udviklet på knolde af sorter med forskellige resistensegenskaber. Jordprøver indsamlet i 1982.*

Locality <i>Lokalitet</i>	FRILA	60.21.19	58.1642/4	622.33.3	65.346/19	P55/7
Esbjerg 1	2	0	0	1	2	0
Esbjerg 2	2	0	10	0	0	0
Gedser 1	1	0	0	0	0	0
Gedser 2	0	0	11	0	0	0
Grenå	0	0	2	0	0	—
Herning 1	21	0	3	0	0	7
Herning 2	15	0	9	6	0	—
Holbæk 1	0	0	0	0	0	—
Holbæk 2	8	0	3	4	5	2
Horsens	0	0	0	0	0	—
Korsør 1	0	0	0	0	0	—
Korsør 2	0	0	0	0	0	—
Korsør 3	0	0	0	0	0	—
Korsør 4	0	0	0	0	0	—
Korsør 5	0	0	0	0	0	—
Møgel 1	250	105	85	60	20	0
Møgel 2	200	145	130	10	13	25
Nakskov 1	0	0	0	0	0	0
Nakskov 2	2	4	0	2	0	0
Nykøbing	1	2	0	2	0	0
Roskilde	0	0	0	0	0	0
Rørkær 1	1	0	0	0	2	0
Rørkær 2	1	0	3	0	0	—
Slagelse 1	0	0	0	0	0	—
Slagelse 2	0	0	0	0	0	—
Vejle 1	3	0	0	0	0	0
Vejle 2	0	0	0	0	14	0
Åbenrå	0	0	0	0	0	—
Århus	0	0	0	0	0	—

(-): No sprouting

(-): Ikke spiret.

N=1.

**Table 4.** Number of cysts developed on tubers from cultivars with different resistant properties. Soil samples collected in 1983.

*Antal cyster udviklet på knolde af sorter med forskellige resistensegenskaber. Jordprøver indsamlet i 1983.*

Locality <i>Lokalitet</i>	BINTJE	FRILA	60.21.19	58.1642/4	62.33.3	65.346/19
Esbjerg A	>100	3	0	0	0	0
Esbjerg B	>100	1	0	0	0	0
Esbjerg C	10	0	0	-	0	-
Gedser A	20	0	0	-	0	-
Gedser B	30	0	0	-	0	-
Gedser C	>100	0	0	-	0	0
Gedser D	>100	0	0	0	0	0
Gedser E	25	0	0	-	-	-
Gedser F	>100	0	0	-	0	2
Herning A	>100	4	2	3	0	-
Herning B	50	3	2	-	2	-
Herning C	>100	4	2	-	3	-
Herning D	>100	1	0	3	2	-
Herning E	20	1	0	2	0	2
Herning F	-	1	0	-	0	-
Holbæk A	>100	8	0	0	0	0
Holbæk B	20	0	-	-	-	-
Holbæk C	>100	-	0	0	0	0
Holbæk D	>100	0	0	0	0	0
Holbæk E	>100	1	0	-	0	0
Holbæk F	>100	0	0	-	0	0
Holbæk G	>100	0	0	0	0	0
Holbæk H	>100	1	0	1	0	-
Holbæk I	>100	0	0	0	1	-
Holbæk J	>100	0	0	0	0	0
Møgel 1	>100	>100	>100	-	>100	-
Møgel 2	>100	>100	-	-	15	-
Nakskov A	10	4	0	-	-	-
Nakskov B	0	0	0	0	0	-
Nakskov C	20	-	0	0	0	30
Nakskov D	25	0	0	-	0	0
Nakskov E	-	0	0	0	0	0
Nakskov F	>100	0	-	0	0	0
Nakskov G	40	0	0	-	0	-
Nakskov H	>100	0	-	0	0	0
Nakskov I	>100	1	1	2	0	0
Rørkær A	-	3	0	2	0	0
Rørkær B	25	0	0	2	0	0
Vejle A	15	0	0	-	0	0
Vejle B	>100	3	0	0	-	-
Vejle C	-	2	0	-	2	-
Vejle D	40	1	9	1	1	2
Vejle E	>100	1	2	0	0	-
Vejle F	>100	3	0	-	0	-

(-): No sprouting

(-): Ikke spiret.

N=1.

greater quantities of cysts with the 'Octavia' test. Closer examination of the figures show the cysts to be pathotype Pa3, for although Møgel 1 does not have any cysts on 'P55/7', many cysts were found on '622.33.3'. The 2 samples with Pa3 may be considered as coming from one locality. The samples were taken 10 m from each other in the town of Møgeltønder in 2 gardens which were separated from each other only by a hedge. There is no risk that the population will spread as the gardens are situated in the middle of the town.

In comparison with Møgel 1 and Møgel 2, the occurrence of cysts on the roots of the other test plants is very limited. If only a few cysts are found, there is no reason to suppose that it is a question of new pathotypes, unless the results from all test plants are unambiguous, which is not at all the case. Soest *et al.* (1983) accept cysts on the root ball in quantities up to 25 per cent of the initial number. In this test the initial population has not been determined, but it may be assumed that there are many cysts in the pots, as the cysts growing on 'Bintje' in the previous test are part of the number.

In the few samples where a number of cysts >10 were found on a few test plants – for instance in the case of Herning 1 and Herning 2 with respectively 21 and 15 cysts on 'Frila' – the results from the other test plants show that it is nevertheless a case of the type Ro1.

Soil samples collected a year later (1983) show even clearer, results (Table 4). Soil samples were collected from areas where potatoes had been grown in 1983, which were usually the same areas or a few metres from the areas examined in 1982. Samples were collected from the garden, where they had presumably been collected the year before and from the neighbouring garden, and it is obvious that in most gardens many cysts of the type Ro1 were found. Other pathotypes (Pa3) were only found at the same locality (Møgel 1 and Møgel 2) as in 1982.

It may be concluded that the occurrence of pathotypes other than Ro1 in Danish garden areas is very limited and of no practical importance.

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