

## Latent apple narrow leaf transmissible to *Malus × robusta* (Carr.) Rehd., cl. 5

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### Abstract

An agent, which was found by indexing to be latent in a sample of 'Cox's Orange Pippin', red, and in a sample of 'Jonathan', caused by transmission the development of small and narrow leaves in *Malus × robusta* (Carr.) Rehd., cl. 5.

The narrow leaf condition is described and it is shown by indexing results that the causative agent is not identical with any of the commonly known viruses or MLOs (mycoplasma like organisms) in apple.

Heat-therapy, 34°C for 14–17 weeks, eliminated this agent simultaneously with the other viruses or MLOs in 'Cox's Orange Pippin', red.

**Key word:** heat-therapy, virus, mycoplasma like organisms.

### Resumé

Latente smalle blade overført til *Malus × robusta* (Car.) Rehd., cl. 5.

Ved podningsforsøg (testninger) opdagedes det, at prøver af to æblesorter, 'Cox Orange', rød (Kortegård), og 'Jonathan' indeholder et smitstof, som ved podning til *M. × robusta* får denne til at udvikle små og smalle blade (fig. 1 og 2). En lang række andre prøver havde ingen virkning på *M. × robusta*. Ingen af sorterne havde symptomer, der lignede de i *M. × robusta* fremkaldte.

Baseret på testningsresultater kan konkluderes, at det smitstof, som fremkalder smalle blade i *M × robusta* ikke kan være identisk med nogle af de smitstoffer, som findes almindeligt i æble, og som fremkalder symptomer i de almindelige æbleindikatorer.

Ved varmebehandling, 34°C i 14–17 uger, blev skudspidser af 'Cox Orange', rød (Kortegård), frigjort for det omhandlede smitstof, ligesom for alle de andre smitstoffer, som fremkalder symptomer i en lang række indikatorer (tabel 1).

*M. × robusta* bruges mange steder i verden som grundstamme for æble på grund af dens store frostfasthed og den lethed, hvormed den kan formeres ved stiklinger.

**Nøgleord:** varmeterapi, virus, mykoplasmalignende organismer.

### Introduction

A genetic disorder called apple narrow leaf has been described by Posnette and Cropley (1963) in the cultivar 'Worcester Pearmain'. This disorder was not transmissible to healthy 'Worcester Pearmain' but was perpetuated when using graft wood from affected trees. In the present report a disorder in *Malus × robusta* (Carr.) Rehd., cl. 5 is

described, which develops when this clone is grafted with wood from two cultivars but not when grafted with wood from several other sources.

### Materials and methods

Buds of *M. × robusta* cl. 5 were budded into apple seedlings in August. The following spring

Table 1. Indexings of 18 samples of apple

Infectors clones	'Cox's Orange Pippin', red	'Cox's Orange Pippin'	'Cox's Orange Pippin'	'Cox's Orange Pippin'	'Cox's Orange Pippin'	'Crimson Cox'	'Cherry Cox'	'Ribston'	'Jonathan'	'Jonathan'	'Ingrid Marie', red
Indicators	H 0255	H 0213	H 537	H 585	H 4140	H 0316	H 0333	H 0321	H 4142	H 0349	H 520
M. x robusta no. 5											
SL .....	+	0	0	0	0	0	0	0	+	0	0
SP .....	0	-	-	-	-	-	-	-	-	0	0
'Lord Lambourne'											
RW .....	?	0	0	0	0	0	0	0	0	+	0
'Virginia Crab'											
SP .....	+	+	+	+	+	+	+	+	+	+	+
SGr .....	+	-	0	0	+	+	+	+	0	0	+
GUB .....	+	0	+	+	+	+	+	+	+	+	+
M. cl. R 12740-7A											
CLS .....	+	+	+	+	+	+	+	+	+	+	+
BN .....	+	+	+	+	+	+	+	+	+	+	+
SP .....	+	-	-	-	-	0	+	0	-	0	-
M. platycarpa cl. LA 17T2											
CLS or LP .....	+	+	+	+	+	+	+	+	+	+	+
ScB .....	+	?	+	0	+	+	+	?	?	+	+
'Spy' cl. 227											
CLS .....	+	+	+	+	+	+	+	+	+	+	+
E, BN .....	+	+	+	+	+	+	+	+	+	+	+
SP .....	-	-	+	-	0	0	0	0	0	+	0
M. sargentii											
E, BN .....	+	+	+	+	+	+	+	+	-	+	+
SP .....	+	+	?	+	0	+	+	0	-	0	-
SGr .....	0	+	+	?	+	+	0	0	-	?	+
X Pyronia veitchii											
E .....	+	-	-	-	+	-	-	-	-	-	+
VY .....	+	-	+	+	+	-	-	-	+	+	+
LP .....	0	-	-	-	-	-	-	-	-	-	0
SP .....	+	-	-	-	-	-	-	-	-	-	+
BS .....	0	-	+	-	+	-	-	-	0	-	?
Cydonia oblonga cl. C7/1											
VY .....	-	0	-	-	-	-	-	0	0	0	0
RS .....	-	0	-	-	-	-	-	+	+	+	?
'Early McIntosh'											
E .....	-	-	-	-	0	-	-	-	0	+	0
'Jonathan' .....	0	0	0	0	0	0	0	0	-	-	0
'Gravenstein' .....	0	0	-	0	-	0	0	0	-	0	0
'Guldborg' .....	0	0	0	0	-	0	0	0	-	0	0
'Boskoop' .....	0	0	0	-	-	0	0	0	-	0	0
'Spartan' .....	0	0	-	0	0	0	0	0	0	0	0
'Cox's Orange' .....	0	0	-	-	-	0	0	0	0	0	0
'Golden Delicious' .....	0	0	-	0	0	-	0	0	0	0	0

## cultivars on 17 pome fruit virus indicators

'Golden Delicious'	'Golden Delicious'	'McIntosh, Rogers'	'Gravenstein'	'Cox's Orange Pippin', red	'Cox's Orange Pippin', red	'Cox's Orange Pippin', red
H 4020	H 602	H 619	H 4129	H 421	H 422	H 425
0	0	0	0	0	0	0
-	0	-	-	-	-	-
0	?	0	0	0	0	0
0	+	+	+	0	0	0
0	?	+	0	0	0	0
0	+	+	0	0	0	0
+	+	+	+	0	0	0
+	+	+	+	0	0	0
+	0	+	-	-	-	0
+	+	?	+	0	0	0
0	-	+	0	0	0	0
+	+	+	+	0	0	0
0	+	+	+	0	0	0
0	0	+	0	-	0	0
0	+	+	+	0	0	0
0	+	+	+	0	0	0
0	+	0	+	0	0	0
0	-	-	-	0	0	0
0	-	-	-	0	0	0
+	-	-	-	0	0	0
-	-	-	-	-	-	-
0	-	-	-	0	0	0
0	0	+	-	0	0	0
0	0	0	-	0	0	0
-	0	-	0	-	-	-
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	-
0	0	0	0	-	-	-
0	-	0	0	0	0	-

## Abbreviations in table 1

## Indexing results:

- 0 = Successful indexing without symptoms  
 + = Indexing with symptoms  
 - = No results of indexing so far  
 ? = Inconclusive results of indexing

## Symptoms:

- BS: Bark split  
 BN: Bark necrosis  
 CLS: Chlorotic leaf spot  
 E: Epinasty  
 GUB: Graft union breakage  
 LP: Line pattern  
 RS: Ring spot  
 RW: Rubbery wood  
 ScB: Scaly bark  
 SGr: Stem grooving  
 SL: Small narrow leaves  
 SP: Stem pitting  
 VY: Vein yellows

samples of the cultivars were grafted into the stem underneath the *M. × robusta* by a side grafting technique. The same method was used for indexing with the other indicators.

Observations included assessment of woodpitting symptoms by lifting a bark flap across the union between *M. × robusta* and the understock in the third year after inoculation.

Plants of 'Cox's Orange Pippin', red, H 0255, were heat treated as described earlier (Larsen 1974). The treatments consisted of 32°C, 34°C, 36°C, and 38°C continuously. Two tips from a treatment at 34°C for 17 weeks survived to make the clones H 421 and H 422. From another similar experiment one tip from 34°C for 14 weeks made the clone H 425. All other treatments did not make any surviving plants.

## Results

The symptoms which developed in those *M. × robusta* cl. 5 grafted with 'Cox's Orange Pippin', red, cl. H 0255 and with 'Jonathan' cl. H 4142 were striking (plate 1 and 2). Most leaves were small and narrow, and some even strap like.

Some leaves on the affected plants were apparently still normal. These leaves were in some cases placed on branches where most other leaves were narrow, but generally whole branches were affected, while others on the same plant were normal. There was a tendency for the symptoms to be less distinctive with age with the strongest symptoms in the second year after infection.

The leaves of the two cultivars showed no narrow leaf-symptoms and appeared generally normal, except for 'Cox's Orange Pippin', red, cl. H 0255 where a few leaves could be found with yellow-green tissue along the midrib and the veins of first order (plate 3).

In table 1 is shown the indexing results of 'Cox's Orange Pippin', red, cl. H 0255, 'Jonathan' cl. H 4142 and 16 other samples selected out of 74 samples, which all did not cause any symptoms in *M. × robusta* cl. 5 by indexing in this host.

The indexing-results reveals no close correlation between narrow leaf in *M. × robusta* and any symptom in any other indicators.



Plate 1. Shoots of *M. × robusta* with small narrow leaves at right. Shoot with normal leaves at left.

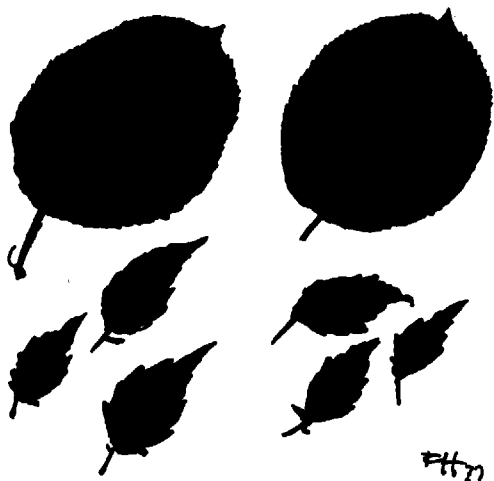


Plate 2. Small narrow leaves of *M. × robusta* below. Normal leaves above.

'Lord Lambourne' cl. M 139: Only 'Jonathan' H 0349 produced rubbery wood in 'Lord Lambourne'. None of the other samples, whether with or without narrow leaf produced any symptom in this indicator.

'Virginia Crab' cl. K 6: The two infectors with latent narrow leaf both shows stem pitting and graft union breakage, but several of the infectors have this same combination without narrow leaf. Stem grooving appears in 'Cox's Orange Pippin', red, H 0255 together with narrow leaf, but not in 'Jonathan' H 4142.

*M. R 12740-7A*: All untreated infectors, regard-



Plate 3. Leaves of 'Cox's Orange Pippin', cl. red, with yellow-green tissue along the main veins.

less whether they have narrow leaf or not, produce chlorotic leaf spot and bark necrosis in this indicator. 'Cox's Orange Pippin', red, H 0255 shows stem pitting, but so do three other infectors without narrow leaf in *M. × robusta*.

*M. platycarpa* cl. LA 17T2: Six infectors without narrow leaf showed the same symptoms in *M. platycarpa* as did 'Cox's Orange Pippin', red, H 0255, with narrow leaf.

*M. 'Spy'* cl. 227: All infectors except 'Golden Delicious' H 4020 incites chlorotic leaf spot, epinasty and bark necrosis in 'Spy' without correlation to narrow leaf in *M. × robusta*. Nine infectors were without stem pitting including one, 'Jonathan' H 4142, which has the narrow leaf agent.

*M. sargentii*: 'Cox's Orange Pippin', red, H 0255 has epinasty, bark necrosis and stem pitting but no stem grooving together with narrow leaf in *M. × robusta*. One other infector has the same combination of symptoms in *M. sargentii*, but not narrow leaf in *M. × robusta*. Four other infectors produce all three kinds of symptoms in *M. sargentii* but no symptoms in *M. × robusta*.

*X Pyronia veitchii*: 'Cox's Orange Pippin', red, H 0255 shows epinasty, vein yellows and stem pitting, but no bark split in *P. veitchii*. However, two other infectors show epinasty in *P. veitchii*, five infectors show vein yellows in *P. veitchii* and one infector shows stem pitting in *P. veitchii* without narrow leaf in *M. × robusta*.

*Cydonia oblonga* cl. C 7/1: 'Jonathan' H 4142 shows ring spot in C 7/1 together with narrow leaf in *M. × robusta*. One other infector shows ring spot in C 7/1 without narrow leaf in *M. × robusta*.

'Early McIntosh': One 'Jonathan' source, H 0349 shows epinasty in 'Early McIntosh' (Larsen, 1970), and no narrow leaf in *M. × robusta*, whereas 'Jonathan' H 4142 produces narrow leaf in *M. × robusta* and no symptoms in 'Early McIntosh'.

*Miscellaneous indicators*: In table 1 it can be seen that none of the infectors produced any symptoms in the indicators: 'Jonathan', 'Gravenstein', 'Guldborg', 'Belle de Boskoop', 'Spartan', 'Cox's Orange Pippin', and 'Golden Delicious', regardless of whether narrow leaf was present or not. This array of indicators will show

diagnostic symptoms for a number of pome fruit viruses, which apparently was absent in the infectors used here.

*Heat-therapy*: The indexings of the clones H 421, H 422 and H 425 (table 1), show that the agent (or agents) which inflicts narrow leaf in *M. × robusta* when transmitted to this host has been eliminated from the 'Cox's Orange Pippin', red, by the heat-treatment used, 34°C for 14 and 17 weeks. All other diseases which have been indexed for and which were in clone H 0255 were eliminated simultaneously.

## Discussion

The agent (or agents) which by transmission to *M. × robusta* cl. 5 make this host to produce small narrow leaves must be fairly seldom in apple cultivars. The present work showed it to be present in two samples out of 76 indexed, and the author is unaware of any other report of this condition, despite the fact that *M. × robusta* is used as a very hardy understock for apple cultivars in many parts of the world. (Nilsson, 1964, Wilding and Pellett 1969, Hutchinson 1969, Welsh and Spangelo 1971). The reason why the narrow leaf condition might have escaped attention could be that *M. × robusta* apparently produces normal leaves along with small narrow leaves after infection, and that there appears to be a tendency for the symptoms to be non-recurrent. To be certain of this, the indexings will have to be inspected for some more years.

The transmissible agent, which here was latent in the two cultivars where it appeared, is apparently not identical with any of the known diseases in apple. However, it still remains to be disclosed if there is any connection between the agent in question and the yellow vein symptom which appeared in 'Cox's Orange Pippin', red, cl. H 0255 (plate 3), but not in 'Jonathan' H 4142.

This symptom is supposed to be the same as that described by Mallach (1964) as »Hell – oder Gelbadrigkeit«.

Most of the infectors used have been indexed on 'Golden Delicious', 'Belle de Boskoop' and 'Gravenstein' without symptoms and as these cultivars are considered as indicators for apple

proliferation it should be fairly safe to assume that none of the samples have proliferation.

Welsh and Spangelo (1971) found after inoculation with one out of four isolates a decline condition in *M. × robusta*. Their picture of reduced foliage on declined trees may to a certain extent resemble the narrow leaf symptom observed here, but as none of the other symptoms of decline in *M. × robusta* was observed it is not likely that the narrow leaf condition described here is identical with Welsh and Spangelo's decline of *M. × robusta*.

The fact that the narrow leaf-agent has been eliminated by heat-therapy at 34°C for 14 and 17 weeks in the few plants produced gives no clue to the ease with which the agent can be eliminated, as this treatment will eliminate a number of viruses (Larsen 1974) as was also the case in the experiment reported here.

To the authors experience *M. × robusta* cl. 5 is very easy to root from soft-wood cuttings. This is in accordance with the experience of others (Nelson 1955, Fernqvist 1959).

#### Acknowledgment

The initial material of *M. × robusta* cl. 5 used in this work was received from Lantbrukshögskolan, Institutionen för Frukt- och Bärödling, Alnarp, Sweden. This donation is gratefully acknowledged. The drawings in plate 1 and 2 are made by Frank Hejndorf, Statens plantepatologiske Forsøg, Lyngby, Denmark, and is gratefully acknowledged.

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Manuscript received April 28, 1977