A study of poplar resistance to *Phyllodecta vitellinae* L. (Col., Chrysomelidae)

1. Greenhouse experiments

By Y. Finet[1] and J. C. Gregoire

Abstract

The sensibility of different *Populus* clones to a Chrysomelid defoliator, *Phyllodecta vitellinae*, has been analysed by choice experiments in a greenhouse. A first series concerned 3 clones: "Ghoy", "Beaupré" and "Columbia River". A second series concerned 6 clones: "Ghoy 1" (P. nigra), "Gaver", "Robusta vert", "Fritzy Pauley", "Columbia River" and "UNAL". In the two series of experiments, we recorded the number of beetles present on each plant, as well as the number of eggs. During the second series, we also made direct measures of leaf areas consumed. Moreover, in this series, marking of the insects also allowed us to study some particular aspects of their behaviour. The results are as follows:
1. Insects showed significant to very significant food preferences, which did not vary significantly from one experiment to another within the same series. The order of increasing "resistance" (negative choice by the insects) was: *P. trichocarpa X deltoïdes; P. deltoïdes X nigra; P. trichocarpa; P. nigra.*
2. There were no significant oviposition preferences, although correlation between number of eggs laid and adults' level of presence was on average good for most of the clones.
3. Correlation between consumed leaf areas and beetles' level of presence was always good.
4. "Long-range" (meters) orientation towards a plant was a linear function of its height.
5. There was a significant linear relation between clonal preference and time spent by individual beetles on plants of the different clones.
6. Feeding occurred especially on higher, younger leaves, and egg-laying on lower leaves.
7. Nocturnal activity did not differ significantly from diurnal activity. There was a peak at dusk.
8. Food-taking speed varies between 2 and 2,5 mm^2 of foliar surface per hour per beetle, and is independant of clonal preference (although this did not appear quite so clearly for the clone *P. nigra* "Ghoy 1").

1 Introduction

The study reported here is an attempt to detect different sensibility levels of some *Populus* clones to *Phyllodecta vitellinae*.

This beetle is very common in Poplar nurseries. It feeds on Poplar leaves at larval and adult stages. Eggs are laid in batches on the underside of a leaf, and the larvae remain gregarious almost until pupation, which occurs in the ground. In Belgium, there are generally two generations per year. Adults are the over-wintering forms. They may be harmful when they start feeding on opening buds, early in the season. In England, they have also been considered as a pest of willow plantations (Hutchinson and Kearns 1930).

Experimental analysis of Poplar clonal resistance to *P. vitellinae* has a place in the far more general context of the genetical improvement of plants. As

[1] Aspirant FNRS – Biologie animale.

stated by STEENACKERS (1970), the first aim of Poplar breeders is selection of disease – resistant varieties. Most of the current efforts concentrate on fungal and bacterial diseases.

However, insect damages on *Populus* are not negligible. Leaf-feeders on Poplars provided some classic examples of damage deriving from heavy defoliation of deciduous trees (ARRU, 1964–1965; DUNCAN and HODSON, 1958; NEF, 1969). Heavy defoliation was shown to cause growth reduction, twig dieback and delays in twig lignification (rev. in KULMAN 1971; FRANKLIN 1973; RAFES 1973; WILSON 1976).

Our study consisted in two series of experiments, each including:

1. Tests on experimental cuttings in a greenhouse;
2. Laboratory choice and rearing experiments;
3. Field experiments in a nursery.

This report concerns the results of the greenhouse experiments. The first series (1977) was a first approach, with three poplar clones. The second series (1978) was carried out on a larger scale, with slightly different material and methods. Six clones were compared, and marking of the insects allowed also some complementary behavioral observations.

2   Material and methods

2.1   Poplars

All the poplar clones used in our experiments were provided by the "Rijksstation voor Populierenteelt" – Geraardsbergen (Belgium). Most of these clones are recent selections of this Institute.

In the first series of experiments (1977), three clones were studied: "Ghoy", "Beaupré" and "Columbia River". In the second series of experiments (1978), six were tested: "Ghoy 1", "Gaver", "Robusta vert", "Fritzy Pauley", "Columbia River" and "Unal".

These clones belong to different species or hybrids:
– "Ghoy 1": *Populus nigra*;
– "Ghoy", "Gaver"; "Robusta vert": "*P. deltoïdes X nigra*";
– "Columbia River" and "Fritzy Pauley": *P. trichocarpa*;
– "Unal" and "Beaupré": *P. trichocarpa X deltoïdes.*

The cuttings were treated as described by VOGL and KEMMER (1961) (immersion in water at 30 °C for 24 h), in order to remove bud dormancy. Cultivation took place under artificial lighting in the laboratory. Light was provided by fluorescent tubes (5000 Lux; spectrum: 380 to 780 nm). In the first series of experiments we used sand as a substratum, adding a mineral nutrient solution (N – S – P : 60 – 20 – 20; K – Ca – Mg : 31 – 46 – 22). In the second series, we used a mixture of loam (65 %), sand (10 %) and peat (25 %).

2.2   Experimental design

Plants were disposed in rows. Each of the clones to be tested was represented once, in random order, in each row. Distance between rows and between plants within a row was about 50 cm.

In the experimental design of the first series of experiments there were four replicates (4 rows of 3 plants each). The same plants were used for all the experiments, their relative position being changed at random between experiments.

In the second series, there were also 4 replicates (4 rows of 6 plants each). Different plants were used in each experiment.

2.3   Experimental procedure

Adult *P. vitellinae*, starved for 24 h, were released from Petri dishes regularly distributed amongst the plants. In the first series of experiments, a 1 : 1 sex-ratio was carefully respected. Since this is

Table 1. First series of experiments

Release	Date of release	Date of counts made	Number of beetles released	Origin of beetles
1	21. 8. 1977	1st day (21. 8.) 2nd day (22. 8.) 3d day (23. 8.) 4th day (24. 8.)	120 pairs	Nursery at Grimminge. Caught on "Beaupré" and "Columbia River"
2	31. 8. 1977	1st day (31. 8.) 2nd day (1. 9.) 3d day (2. 9.) 4th day (3. 9.)	150 pairs	Caught in the nursery, on "Beaupré" and "Columbia River" and reared for 13 d on *P. nigra* var *italica* in the laboratory
3	23. 9. 1977	1st day (23. 9.) 2nd day (24. 9.) 3d day (25. 9.) 4th day (26. 9.)	150 pairs	From larvae collected in the nursery on "Columbia River", and reared in the laboratory on "Columbia River"

Table 2. Second series of experiments

Release	Date	Records	Number of beetles	Origin of beetles	Type of marking
1	24. 2. 78	1st day (24. 2.) (2 h after) 2d day (25. 2.) 4th day (27. 2.) 6th day (1. 3.)	150	75 adults reared on "Unal" 75 adults reared on "Columbia River"	by release point
2	7. 3. 78	1st day (7. 3.) (2 h after) 2d day (8. 3.) 3d day (9. 3.) 4th day (10. 3.) 7th day (13. 3.)	225	reared on "Columbia River"	by release point
3	14. 3. 78	1st day (14. 3.) (2 h after) 2d day (15. 3.) 3d day (16. 3.) 4th day (17. 3.) 5th day (18. 3.)	225	reared on "Unal"	individual
4	28. 3. 78	1st day (28. 3.) (2 h after) 2d day (29. 3.) 3d day (30. 3.) 4th day (31. 3.) 5th day (1. 4.)	300	reared on "Columbia River"	individual
5	4. 4. 78	1st day (4. 4.) (2 h after) 2d day (5. 4.) 3d day (6. 4.) 4th day (7. 4.) 5th day (8. 4.)	300	reared on "Unal"	by release point

24 h cycle: 28. 3. (17 h – 19 h – 23 h) – 29. 3. (03 h – 07 h – 11 h – 15 h)

the normal sex-ratio among natural populations, we decided, for the second series, to select the beetles at random.

After each release, we recorded daily the number of adults and eggs on each plant.

During the second series of experiments, we also measured the consumed leaf areas by superposing them with a piece of millimetric tracing paper.

2.4   Marking of the insects

During the second series of experiments, insects were marked with colour spots on the elytra, either individually or depending on their release point.

2.5   Temperature and humidity

During the second series of experiments, temperature varied between 13° and 33 °C, and relative air humidity between 30 % and 85 %. They were not recorded during the first series.

Tables 1 and 2 give detailed data about the experimental procedure.

3   Results

3.1   Insects' movements in the greenhouse

3.1.1   Greenhouse colonisation by the insects

An understanding of the movement patterns of the insects in the greenhouse was needed, among other reasons to ascertain if any plant in the experimental set-up had the same chances to be discovered by the beetles.

Marking of the insects in the second series of experiments allowed us to make the following observations: some of the beetles, very mobile, landed on the plant furthest from their release point. Some others walked on the ground and climbed on the first cutting they came to near their standing point.

With such systematic observations, we defined, for each experiment, an *average observed migration* of the beetles, given by: MOD = mean observed distance covered by all the beetles observed on each plant, in assuming that they moved along a straight line from their release point.

We considered also an *homogeneous theoretical migration* of the beetles, given by MTD.

Assuming that the beetles from each release point distribute themselves uniformly throughout the greenhouse, some reaching the cuttings next to their release point, others going to the furthest plants, with an homogeneous repartition of all intermediate situations, then MTD is the mean theoretical distance covered.

The ratio $K = \dfrac{MOD}{MTD} \times 100$ % gives us, for each experiment, a *relative mobility*:

Experiment	Relative mobility
1	76.4 %
2	81.8 %
3	62.9 %
4	59.8 %
5	65.1 %
	Mean: 69.2 %

Mean relative mobility has thus been nearly 70 %. We think that this value is high enough to consider that clonal differences observed in the infestation levels are not due to hazard nor to any physical heterogeneity in the greenhouse.

Moreover, we checked retrospectively that the random distribution of clones in our experimental designs did not systematically favor any of them.

3.1.2 Range of attraction of experimental plants

We calculated, for each plant, the mean distance from which it attracted marked insects. It appeared that this distance was not related to the nature of the clone, but grew slowly with the plants' height.

The parametric correlation coefficient was highly significant: r = 0,32** (throughout this report, * indicates a significant result: $p \leqslant 0,05$; ** a highly significant result: $p \leqslant 0,01$; *** a very highly significant result: $p \leqslant 0,001$, and N. S. a non significant result: $p > 0,05$).

The silhouette of a poplar tree could thus influence its range of attraction for *P. vitellinae*.

3.1.3 Nyctemeral cycle

Observations of a 24 h cycle was made possible, during the 4th experimental release, by the strictly individual marking of the beetles. Regular recording throughout one nyctemeral cycle showed peak-activity at dusk, immediately after the beginning of the experiment (Fig. 1). This could be a consequence of the 24 h starving period inflicted on the beetles just before their release. Apart from this peak, activity was more or less constant during the rest of the time.
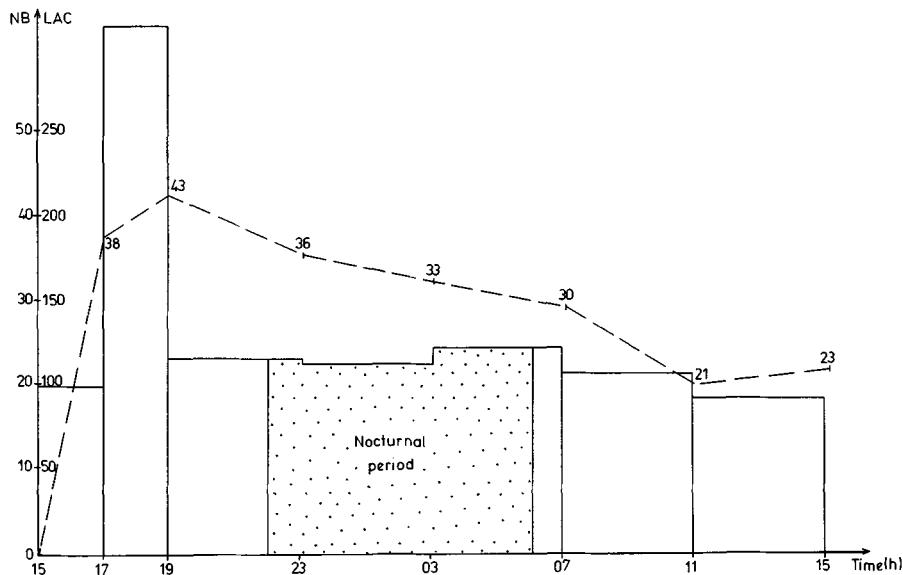

Fig. 1. 24 h – Cycle in the greenhouse. Consumed leaf areas and number of adults on the slips during a nyctemeral cycle

3.1.4   Migrations

These were recorded every four hours during our observations of the nyctemeral cycle; was counted as a migration every departure from or arrival to a plant. Changes of position on the same plant were not considered as migrations.

For each clone we calculated the ratio between the total number of migrations M and the total cumulated number A of beetles having infested plants of each clone during the experimental period of 24 h (the same individual, recorded n times on a particular plant, will add the value n to the computation of A).

The ratio M/A is the *migration frequency per individual per hour*. It allowed us to calculate the *average period Tm*, during which one individual migration occurs.

These Tm have been positively correlated with global infestation levels on each clone at the end of the experiments: r = 0.88* (fig. 2; table 4).

We may conclude from these observations that the poplar clones selected by the insects are also the clones where they spend in the average the longest time between two migrations.
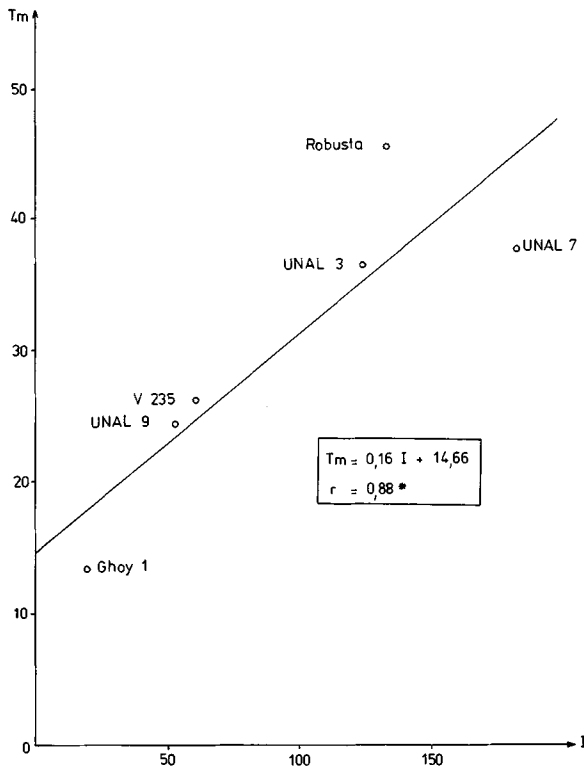

Fig. 2. Correlation between average periods of migration of the insects and the infestation levels of the clones. Tm = Average period during which one individual migration occurs, I = Global infestation level at the end of the experiments
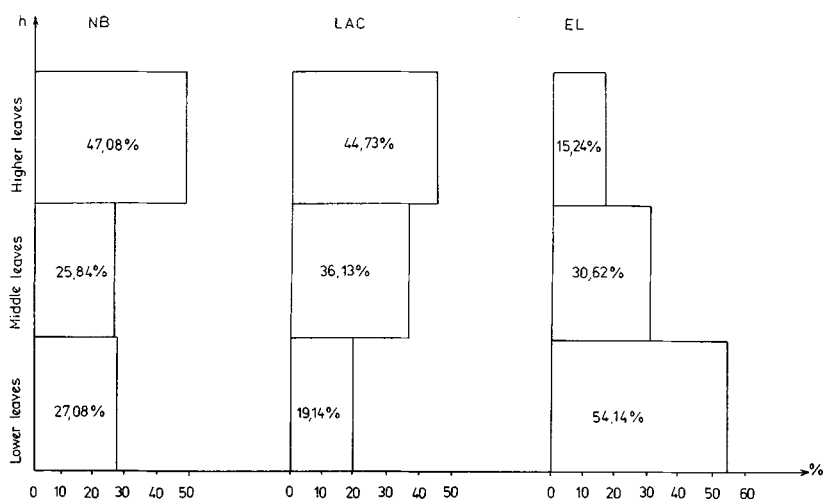
Fig. 3. Vertical distribution of the infestations on the plants. NB = Number of beetles, LAC = Leaf areas consumed, EL = Number of eggs laid

3.1.5   Vertical distribution on the plants

We tried to find a relation between leaf age and maximal density of *P. vitellinae* adults and eggs. Since our experimental cuttings were young, there were no lateral shoots, and leaf age could be directly related to height on the plant.

Each plant was divided into three equal vertical parts, each containing the same number of leaves, and for each part we counted the beetles and the eggs, and we measured the leaf area consumed (Fig. 3).

It seems fairly clear that feeding occurs mostly on the upper leaves and that the majority of eggs are laid on the lower ones. Adults are more numerous on the upper leaves, which corresponds very well with feeding activity. However, adults are not necessarily less numerous on the lower leaves than on the middle ones. This could be due to the egg-laying activity of females.

We observed many times that females are very mobile, and rapidly leave the lower areas when egg-laying is over. They join the upper region of the plant, where feeding and mating occur. This could prevent feeding competition between larvae and adults. Egg-laying periods are relatively short, whereas feeding is a slower and more continuous process. This difference is well reflected by the abundance of adult beetles on the upper leaves. Egg-laying has thus little influence upon the topology of an infestation by adult *Phyllodecta vitellinae*.

3.2   Food choice and oviposition site choice

3.2.1   Plant choice

This was estimated by recording the number of beetles on each plant. Tables 3 and 4 give the results of the two series of experiments. These data were submitted to a two-ways analysis of variance. It appears that there are significant choice differences between clones in the two series of experiments.

(Ser. I : F = 9.163[*]; Ser. II : F = 6,147[**]). On the other hand, the absence of significant interaction, in the two series, shows that choice of plant does not vary fundamentally from one release to another (Ser. I : F = 0.048[NS]; Ser. II : F = 1,194[NS]).

This is important, since in the two series we introduced possibilities of food choice conditionning : we varied (deliberately) the rearing plant of larvae (Series I : see table 1) and adults (Series I and II : see tables 1 and 2) prior to each release.

In our experimental conditions, we could not find any evidence of larval or adult choice conditionning.

Table 3. 1st series of experiments: plant and oviposition choice

Release	Clone			Total
	"Ghoy"	"Columbia River"	"Beaupré"	
1. Adults' level of presence ≡ plant choice				
1. 21. 8. → 24. 8. 77	126	29	72	227
2. 31. 8. → 3. 9. 77	135	53	155	343
3. 23. 9. → 26. 9. 77	100	55	121	276
Total	361	137	348	846
2. Number of eggs laid ≡ oviposition choice				
1. 21. 8. → 26. 8. 77	946	208	699	1853
2. 31. 8. → 3. 9. 77	539	252	1101	1892
Total	1485	460	1800	3745

Individual values are the sums of insects counted on each clone during one whole release.

Table 4. 2nd series of experiments: plant choice, food choice and oviposition choice

Release	Clones						Total
	P. nigra "Ghoy 1"	"Gaver"	"Robusta vert"	"Fritzy Pauley"	"Columbia River"	"Unal"	
1. Adults' level of presence ≡ plant choice							
1. 24. 2. 78	0 (4)	17 (900)	2 (444)	5 (391)	8 (626)	23 (1431)	55 (3796)
2. 7. 3. 78	5 (293)	30 (1238)	26 (1524)	11 (515)	16 (1091)	51 (2809)	139 (7470)
3. 14. 3. 78	7 (384)	7 (219)	8 (788)	6 (374)	10 (161)	19 (1086)	57 (3012)
4. 28. 3. 78	1 (113)	24 (1291)	32 (972)	16 (299)	13 (300)	25 (1215)	111 (4190)
5. 4. 4. 78	6 (183)	47 (2168)	67 (2825)	24 (773)	6 (352)	65 (4036)	215 (10337)
Total	19 (977)	125 (5816)	135 (6553)	62 (2352)	53 (2530)	183 (10577)	577 (28805)
2. Number of eggs laid ≡ oviposition choice							
a. 7. 3. 78	0	0	13	0	0	60	73
b. 14. 3. 78	32	10	62	0	2	13	109
c. 28. 3. 78	3	0	7	0	0	0	10
d. 4. 4. 78	30	108	143	95	0	193	569
Total	65	118	215	95	2	266	761

(In brackets: leaf areas consumed – mm^2 ≡ food choice)

3.2.2   Food choice

Food choice was estimated by recording the leaf area consumed for each clone at the end of each release period (table 4). These measures were made during the second series of experiments exclusively.

A two-way analysis of variance gave F = 7,836*** for the comparison between clones, and a F = 1,013^{NS} for the interaction between clones and releases. This last result suggests again that there has been no food choice pre-conditioning of the insects.

3.2.3   Oviposition site choice

This was ascertained by counting the number of eggs laid on each plant at the end of the release periods (tables 3 and 4). A two-way analysis of variance indicated no significant choice (Ser. I : F = 2.99; Ser. II = F = 1.94) nor any significant choice modification from one release to another (Ser. I : F = 2.19; Ser. II : F = 1.308).

3.2.4   Comparison of plant choice, food choice and oviposition choice

We wanted to compare the beetle's level of presence on the plants with the leaf areas consumed on the one hand, and with the numbers of eggs laid on the other hand. To this purpose, we used the SPEARMAN Rank Correlation Test, clone by clone, with the detailed experimental results (individual values of each replication).

3.2.4.1   Beetles' level of presence and leaf areas consumed

The results are given in table 5 (second series of experiments only). The correlation varies from very highly significant to highly significant. We saw earlier that feeding activity on a plant and level of presence of adult insects on this plant were linked together. Here we see that feeding choice between different poplar clones, and levels of infestation are also correlated.

3.2.4.2   Beetles' level of presence and number of eggs laid

Table 6 shows that, in the first series of experiments, the correlation varies from highly significant to non significant. In the second series, the correlation varies from significant to highly significant.

These significant correlations suggest that, even if analysis of variance failed to reveal an oviposition choice, there is a link between egg-laying and clone quality. The great variability observed in the measures of oviposition is certainly to a large extent responsible for the negative results of the analysis of variance in the first series.

Table 5. Correlations between the degree of presence of the adults and the leaf areas consumed.
Values of Spearman's coefficient

Clones	*P. nigra* "Ghoy 1"	"Gaver"	"Robusta vert"	"Fritzy Pauley"	"Columbia River"	"Unal"
	2nd series of experiments only (n = 20 observations)					
r_s	0.658**	0.903***	0.648**	0.520**	0.887***	0.813***

Table 6. Correlations between the level of presence of the adults and the number of eggs laid. Values of Spearman's coefficient

Clones	"Ghoy"	"Beaupré"	"Columbia River"
	1st series of experiments (n = 8 observations)		
r_s	0.881**	0.702*	0.607^{NS}

Clones	P. nigra "Ghoy 1"	"Gaver"	"Robusta vert"	"Fritzy Pauley"	"Columbia River"	"Unal"
	2nd series of experiments (n = 20 observations)					
r_s	0.597**	0.490*	0.542*	0.705***	0.478*	0.633**

3.2.5   Leaf consumption speed

These observations were made possible, during the second series of experiments, by individual marking and by regular observation of the beetles (fourth release).

3.2.5.1   Overall observations

We considered the total areas consumed appearing between two successive observations. We related them to total numbers Nt of beetles present on the plant during the same time intervals. Values of Nt were estimated by the arithmetic means of beetles' numbers at the beginning and at the end of each time interval.

The mean consumption speed computed this way is 2.12 mm² per beetle per hour.

During this 24 h cycle, the temperature fluctuated between a nocturnal minimum of 19 °C and a diurnal maximum of 25 °C. Mean RH was about 60 %.

3.2.5.2   Individual estimations

Individual marking allowed us to follow some individual insects from one time interval to another. Global estimation of consumption speed by this method gives a value of 2.4 mm² per beetle per h.

The discrepancy between overall and individual estimation could be due to the fact that some of the insects counted in the overall observations spent a part of their time walking or mating.

The ratio of the two calculated speeds gives us theoretically the percentage of time devoted by *P. vitellinae* to food-taking:

$$\frac{2.12}{2.40} = 88.3 \ \%.$$

For each experimental clone, this ratio is:

"Gaver":	89.77 %	
"Robusta vert":	75.8 %	
"Fritzy Pauley":	99.1 %	
"Columbia River":	92.9 %	
"Unal":	99.0 %	
"Ghoy 1":	?	(no individual case observed).

These percentages are very similar to each other, and obviously cannot be related to any feeding preference.

Leaf consumption speed has also been calculated for each experimental clone, and fluctuated between 2 and 2.5 mm^2 per h per beetle. It also seems independant of food preference.

This last point, together with the fact that the beetles spend almost 90 % of their time feeding, has as an evident consequence that the insects' distribution and the leaf consumption areas coïncide almost exactly. This appeared already earlier.

3.2.6   Synopsis: clonal sensibility to Phyllodecta vitellinae

Tables 3 and 4 allow a classification of our experimental poplar clones following their sensibility to adult *Phyllodecta vitellinae*. We present such a classification in table 7, for each of the two series of experiments, and concerning respectively *choice of the plant, food choice* and *oviposition choice*. The statistical method used here is the NEWMAN-KEULS test (DAGNELIE, 1970). Table 7 shows that:

1. In the second series of experiments, the choice of plant coïncides very well with feeding choice.
2. Oviposition choice differs somewhat from feeding choice but the same general tendencies remain for the two types of choice.

Table 7. Classification of the experimental Poplar clones

	Plant choice	Food choice	Oviposition choice
1st series of experiments	"Columbia River" (137)] "Beaupré" (348)] "Ghoy" (361)]	–	"Columbia River" (460)⌉ "Ghoy" (1485) ⎬ "Beaupré" (1800) ⌋
2nd series of experiments	*P. nigra* "Ghoy 1" (19) "Columbia River" (53)] "Fritzy Pauley" (62) ⌋ "Gaver" (125)] "Robusta vert" (135) ⎬ "Unal" (183) ⌋	*P. nigra* "Ghoy 1" (977) ⌉ "Fritzy Pauley" (2352) ⎬ "Columbia River" (2530) ⌋ "Gaver" (5816)] "Robusta vert" (6553) ⎬ "Unal" (10577) ⌋	"Columbia River" (2) ⌉ *P. nigra* "Ghoy 1" (65) ⎬ "Fritzy Pauley" (95) ⌋ "Gaver" (118)] "Robusta vert" (215) ⎬ "Unal" (266) ⌋

Numbers in brackets are total numbers of adults, or total leaf areas consumed, or total numbers of eggs recorded. A continuous line between two or more clones indicates that no significant difference has been found between them at the $\alpha = 0.05$ level.

3. There is a genetical homogeneity in Poplar clones' sensibility to adult *Phyllodecta vitellinae*:
   - "Ghoy 1", an indigenous *P. nigra*, is the most resistant;
   - "Columbia River" and "Fritzy Pauley" are rather resistant and suffer from the same level of attack. They both belong to the species *P. trichocarpa*;
   - "Ghoy", "Gaver" and "Robusta vert" are very susceptible clones. "Gaver" and "Robusta vert" are chosen almost equally by the insects. The three of them are hybrids *P. deltoïdes X nigra*;
   - "Beaupré" in the first series of experiments, and "Unal" in the second series are the most susceptible of our experimental clones.
     They are hybrids *P. trichocarpa X deltoïdes*.
   As far as a generalization is allowed, *P. nigra* could be considered as very

resistant, whereas hybrids *P. deltoïdes X nigra* could be considered as rather susceptible. *P. trichocarpa* could be considered as relatively resistant, but hybrids *P. trichocarpa X deltoïdes* may be seen as very susceptible.

4 Discussion

Our results lead us to suppose, first, that *P. nigra* has "resistance genes" against *P. vitellinae*, and second, that *P. deltoïdes* brings "susceptibility genes". We could not directly confirm this last hypothesis, since, for technical reasons, our experiments did not include *P. deltoïdes*.

However, ARRU (1973) reports that nursery observations indicated that *P. deltoïdes* cv. "Virginiana" was the poplar most attacked by *P. vitellinae*.

Such a coherence between the poplars' susceptibility to *P. vitellinae* and their genetical origin does not appear clearly from our observations concerning oviposition choice, in which we did not observe significant differences. It may be that technical reasons are at least partly responsible for these results: during the second series of experiments, where egg-laying occured only sporadically, the insects may have been in an improper physiological state caused by breaking of hibernation.

It may also be that oviposition stimuli differ from feeding stimuli, as in other insects, like the Colorado Potato Beetle (BONGERS 1970). Genetical origin has perhaps a different influence on these two categories of factors.

The fact that the beetles' level of presence on the plants coïncides very exactly with size of consumed leaf areas is a *a posteriori* verification of the validity of our experimental methods and results.

From a methodological point of view, it is thus correct to weight a feeding choice by *Phyllodecta vitellinae* adults among different plants by simply counting the number of insects on each of them.

Acknowledgements

Zusammenfassung

Untersuchungen über die Resistenz von Pappel-Klonen gegen Phyllodecta vitellinae L.
(Col., Chrysomelidae)

In der vorliegenden Arbeit wurde die Anfälligkeit verschiedener *Populus*-Klone gegenüber dem blattzerstörenden Chrysomeliden *Phyllodecta vitellinae* getestet.

Auswahlversuche wurden im Gewächshaus durchgeführt. In 2 Versuchsreihen wurden folgende Klone geprüft:

I. "Ghoy", "Beaupré" und "Columbia River"

II. "Ghoy 1", "Gaver", "Robusta vert", "Fritzy Pauley", "Columbia River" und "Unal".

In beiden Versuchsreihen wurden sowohl die Anzahl der Insekten pro Pflanze als auch die der Eier ermittelt. In der zweiten Versuchsreihe wurde zusätzlich die konsumierte Blattoberfläche

direkt gemessen. Auch konnte in dieser Reihe dank Markierungen das Verhalten der Insekten beobachtet werden.

Ergebnisse:

1. Die Insekten zeigten signifikante bis sehr signifikante Nahrungspräferenzen, die in wiederholten Versuchen nicht signifikant voneinander abwichen. Die zunehmende Resistenzreihe (negative Wahl durch die Insekten) ergab sich wie folgt: *P. trichocarpa X deltoïdes, P. deltoïdes X nigra, P. trichocarpa, P. nigra.*

2. Es wurde keine signifikante Ovipositionspräferenz beobachtet, wenn auch die Korrelation zwischen der Anzahl der gelegten Eier und der Anzahl der auf der Pflanze befindlichen Adulten im allgemeinen gut war.

3. Es existierte immer eine gute Korrelation zwischen der konsumierten Blattoberfläche und der Anwesenheit von *Ph. vitellinae.*

4. Die Fernorientierung in Richtung auf eine Pflanze hat sich als lineare Funktion der Höhe derselben ergeben.

5. Es existiert eine signifikante lineare Funktion zwischen der Klonpräferenz und der Zeit, die jedes Individuum auf den Pflanzen der verschiedenen Klone zugebracht hat.

6. Die Nahrungsaufnahme erfolgte vor allem auf den höchsten und jungen Blättern, die Eiablage erfolgte vor allem auf niedrigeren, älteren Blättern.

7. Die Nachtaktivität unterschied sich nicht signifikant von der Tagesaktivität. In der Morgendämmerung war sie am höchsten.

8. Die Geschwindigkeit der Nahrungsaufnahme liegt zwischen 2 und 2,5 mm^2 Blattoberfläche pro Individuum und pro Stunde. Sie ist unabhängig von der Klonpräferenz. (Bei "Ghoy 1" ist dies nicht ganz deutlich).

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Authors' addresses: Y. FINET and J. C. GREGOIRE, Université libre de Bruxelles, Faculté des Sciences, Laboratoire de Biologie, Av. F. D. Roosevelt, 50, B-1050 Bruxelles