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Adam Dziurzyński

Miny motylowe w liściach *Cornus sanguinea* L. i *Vaccinium myrtillus* L. ze szczególnym uwzględnieniem min i rozwoju *Incurvaria oehlmanniella* Tr.

Мины бабочек в листьях *Cornus sanguinea* L. и *Vaccinium myrtillus* L., с особенным учетом мин и развития *Incurvaria oehlmanniella* Tr.

The mines of *Lepidoptera* in *Cornus sanguinea* L. and *Vaccinium myrtillus* L. leaves with the particular consideration of mines and development of *Incurvaria oehlmanniella* Tr.

While searching for mines of *Antispila petryi* Mart. in leaves of *Cornus sanguinea* L. at Czerna near Krzeszowice (2) I have found hitherto undetermined mines of a lepidoptera belonging to the genus *Incurvaria* Hw. (fig. 1 apex of leaf-blade and fig. 5).

I have found these mines in leaves of *Cornus sanguinea* L. growing along the road connecting the Czerna valley with Dębnik. I was finding them in a restricted area a little above and below an old monastery gate built across the road, in shady and moist places. On other dogwood trees growing on slopes of the same hill in less moist and shady places they were either wanting or appeared only very rarely.

The species of the food-plant, the size and situation of the mines and their particular shape, distinguishing them at the first glance from other known to me mines of the species belon-

ging to the genus *Incurvaria* Hw. have induced me to investigate them. First of all it was necessary to determine the insect. In order to do that I have undertaken the breeding of its larvae. I bred them during the years 1949—1952. To my astonishment it turned out that the mentioned mines were made by *Incurvaria oehlmanniella* Tr.

In the available literature I have found no reference whatsoever concerning the mining of the leaves of *Cornus sanguinea* L. by *Incurvaria oehlmanniella* Tr. A. Hartmann (3) and L. Sorhagen (10) mention *Alsine media* (?) and *Vaccinium myrtillus* L. as the food-plants of the larvae of this species. K. T. Schütze (8) on the other hand gives *Populus* L., *Tilia* L., *Pirus* L., *Malus* L., *Prunus spinosa* L. and *Vaccinium* L. whilst M. Hering (4) mentions various species of *Vaccinium* L. and, with some reservation, *Pirus* L. and *Prunus* L. No one of the above mentioned authors gives *Cornus sanguinea* L. as the food-plant of the species *Incurvaria oehlmanniella* Tr.

According to M. Hering (4) the larvae of only one species of the genus *Incurvaria* Hw., that is *Incurvaria pectinea* Hw., feed in the leaves of *Cornus* Tourn.

1. Mines of lepidoptera in leaves of *Cornus sanguinea* L.

The larvae of species belonging to the genus *Incurvaria* Hw. are leaf-mining ones. A part of them feed in the leaf and all do that when they are young. Afterwads they leave the leaf. Before leaving each of them cuts a double-walled case out of the walls of the mine in a way similar to that of the larvae of species belonging to the genus *Antispila* Hbn. (1,2) and then descends with it to the ground. Then its life is spent in the case on the ground. After cutting out of the case there remains in the leaf a hole characteristic for an abandoned mine of species belonging to the genus *Incurvaria* Hw.

In the leaves of *Cornus sanguinea* L., besides the larvae of *Incurvaria oehlmanniella* Tr., *Antispila pfeifferella* Hbn. and *Antispila petryi* Mart., there are mining those of *Incurvaria pectinea* Hw. and probably of *Incurvaria muscalella* Fb. (fig. 1). A common feature of all mines made by the said species

is the presence of the hole in place from which the hole was cut out. Thus to observe the hole is not sufficient for the determination what species had made the mine. It is necessary to find other distinguished features. These are furnished by

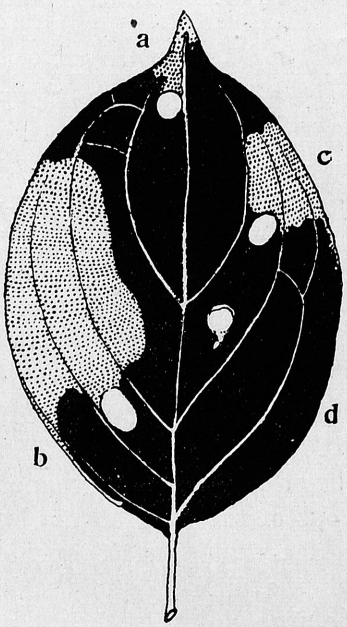

Fig. 1. The leaf of *Cornus sanguinea* L. with abandoned mines of: a — *Incurvaria oehlmanniella* Tr., b — *Antispila pfeifferella* Hbn., c — *Antispila petryi* Mart., d — *Incurvaria muscalella* Fb. (?), natural size.

the shape of the mine and by its situation in the blade of the leaf.

The larvae of the species belonging to the genus *Antispila* Hbn. abandon the leaf not when young, as do those belonging to the genus *Incurvaria* Hw., but in the 4th life-stage, i e. at the end of their development. Thus the size of the mine area made by the larva of *Antispila* Hbn. is much greater than the surface of the hole. The larvae of *Incurvaria* Hw., on the other hand, abandon the leaf already in the 2nd life-stage when they are still very small. Therefore in their mines the mine area, which remains always after cutting out of the case

is a little greater than the hole, often, however, smaller than it and sometimes so small that at the hole margins there remains only a scarcely visible fragment of the mine (figs. 1d, 2).

The shape of the hole is not the same either. The hole which is made in the leaf after cutting out of the case by the larvae of the genus *Incurvaria* Hw. is of rather variable shape. Sometimes it is almost circular or oval, sometimes distinctly rectangular or even triangular, whilst in the abandoned mines of species belonging to the genus *Antispila* Hbn. it is always regularly elliptical.

There is no pronounced difference in the size of holes remaining after cutting out of cases between leaf-mines of *Antispila petryi* Mart. and *Incurvaria oehlmanniella* Tr. For *Antispila petryi* Mart. characteristic is the length of both axes of the ellipse; the average values of these are 4,25 and 2,5 mm whilst for *Incurvaria oehlmanniella* Tr. these are 4 and 3 mm. In mines of *Antispila petryi* Mart. the difference of the length of both axes is averagely almost 2 mm. This difference is so considerable that the hole resembles an ellipse.

It has followed from measurements made in 50 holes remaining after cutting out of the cases in the leaf-mines of *Incurvaria oehlmanniella* Tr. that about 50 per cent of the mines have holes in which the difference of the length of the axes is 0—0,75 mm. The shape of these holes can be accepted as almost circular. The remaining 50 per cent had holes in which the difference between the length of the axes is 1—2,25 mm. In this case the shape of the holes was rather elliptical and thus the ellipse is somewhat wider than in the leaf-mines of *Antispila petryi* Mart. or the mine has a different shape, wither rectangular or triangular. The shape of the hole in mines of *Incurvaria* Hw. is considerably influenced by the nervature of the leaf-blade. That can be observed especially well in mines made in leaves of *Vaccinium myrtillus* L. (fig. 6).

The holes remaining after cutting out of the cases in the mines of *Antispila pfeifferella* Hbn. can be easily distinguished from those discussed above. Their longer axes are averagely 6 mm long and the inter-axial difference is so considerable that the outline of the margin is so regular that it is possible to define it as elliptical. Thus they differ from the holes remai-

ning after cutting out of the cases by *Antispila petryi* MART. by the dimensions and from those of *Incurvaria* HW. by the shape.

Therefore the leaf-mine of the genus *Antispila* HBN. may be distinguished from that of *Incurvaria* HW. by the shape and size of the hole remaining after cutting out of the case but it is not possible to state what species of *Incurvaria* did make a given mine. In such a case it is necessary to make the use of other distinguishing features. As it was mentioned earlier in the leaves of *Cornus sanguinea* L. there feed *Incurvaria oehlmanniella* TR., *Incurvaria pectinea* HW. and probably *Incurvaria muscalella* FB. M. HERING (4) writes about the mining of the leaves of that plant by *Incurvaria pectinea* HW. but I have found nothing about the feeding of *Incurvaria muscalella* FB. in the leaves of *Cornus sanguinea* L. I myself mention that with some reservation since the leaf-mines mentioned below were being found always abandoned. Thus the insect which made them is still, for a time being, undetected. In the central parts of the leaf-blade of *Cornus sanguinea* L. there appear in the spring, in the environs of Cracov, always very rarely and always singly, mines of a lepidoptera belonging undoubtedly to the genus *Incurvaria* HW. which cannot be regarded as the leaf-mines of *Incurvaria pectinea* HW. Within the area of my investigation I have seen neither insects belonging to that species nor their mines on other plants having ligneous shots, e.g. on birches where they are supposed to appear at that time en masse. I have been finding on the other hand usually and frequently *Incurvaria muscalella* FB. the larvae of which are polyphagous and make mines of similar shape and size. They, as I suppose, are responsible for single central mines being found in the leaves of *Cornus sanguinea* L. (fig. 2). On the other hand similarly small mines of the genus *Incurvaria* HW. but made near the apex of the leaf-blade of *Cornus sanguinea* L. or at its margin belong to *Incurvaria oehlmanniella* TR.

Not only the abandoned mines can be determined, so can be mines still unfinished, that is being still developed. By an inhabited mine is understood a mine containing a living larva inside. Different genera or even species of lepidoptera, the

larvae of which feed inside the leaves, have different larvae. These differences can be used for determination.

A healthy and for a time being resting larva of a species belonging to the genus *Incurvaria* Hw. has its body curved hook-like. That distinguishes it at the first glance from a stretched or slightly curved larva of a species belonging to the genus

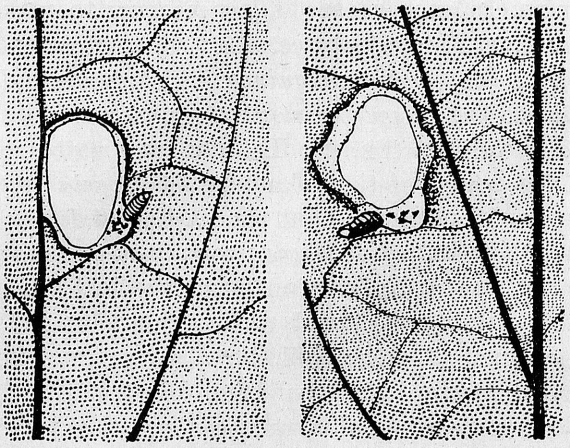

Fig. 2. Fragments of leaves of *Cornus sanguinea* L. with abandoned mines of *Incurvaria muscalella* Fb. (?) found on July 26th 1950 at Czerna near Krzeszowice. Enlarged 4×.

Antispila Hbn. What is more on its skin there can be distinguished no spots so characteristic for the larvae of *Antispila petryi* Mart.

Somewhat more difficult is the case of inquiline mines. By an inquiline mine I understand a mine without the hole remaining after cutting out of the case, inside which there is either a paralysed or partially destroyed larva; that is done by an inquiline *Hymenoptera*, in most cases by a *Chalcidid.* I regard as inquiline also such mines the inhabitants of which lost their lives due to unknown reasons. I have observed that for the larvae of lepidoptera belonging to genera *Antispila* Hbn. and *Incurvaria* Hw. the period of the first moulting is especially difficult to survive. A considerable number of larvae perish at that period. The causes of that are unknown to me.

Thus, despite that I cannot find the rason of the death of the larvae in that period of their life, I regard such mines as inquiline ones.

The inquiline mines of *Incurvaria* Hw. can be distinguished from those of *Antispila* Hbn. by a different situation of the so called incubatory vesicle in the leaf-blade and by the different size of that vesicle in both cases.

Therefore, despite the co-appearance in the leaves of the same food-plant, *Cornus sanguinea* L., it is possible to determine faultlessly the number of mines of each of the above mentioned species of lepidoptera. It is also possible to arrange the found mines in three categories, i. e. abandoned, inhabited and inquiline, so as it is shown below in tables I, II, and III.

2. Leaf-mines of *Incurvaria oehlmanniella* Tr. in the leaves of *Cornus sanguinea* L.

Incurvaria oehlmanniella Tr. is planting the mines in the leaves of *Cornus sanguinea* L. either at the apex of the leaf-blade or at its lateral margins. I call the first of these apical mines and the second lateral ones.

Both kinds of leaf-mines are made in the following way: the female cuts with the toothed end of the *ovipositor* the lower epidermis of the leaf and introduces the egg inside the blade. At the place in which the egg is laid there developes on the leaf a convexity, a kind of a vesicle which, on account of its destination, I call the incubatory vesicle (*vesicula incubatoria* (mihi), figs. 3, 4).

Incurvaria oehlmanniella Tr. belongs to bigger species in the superfamily *Tineoidea* and therefore its eggs as well as the incubatory vesicle are relatively big, bigger those of the genus *Antispila* Hbn., and easily perceptible. The dimensions of the incubatory vesicle are $1 \times 0{,}5$ mm., those of the egg resting in it 0,5—3,8 mm. The egg is oval, transparent, with a smooth surface.

Thus the female of *Incurvaria oehlmanniella* Tr. lays the egg inside the leaf similarly as do that for example *Incurvaria pectinea* Hw., *Incurvaria muscalella* Fb. and females of all lepidoptera belonging to the genus *Antispila* Hbn. The incu-

batory vesicle in the apical mine is situated at the apex of the leaf-blade at the distance of 3—3,6 mm. from the apex and always to the right or left of the central nerve whilst its aperture, ostium vesiculae, is always pointed to the petiole of the leaf.

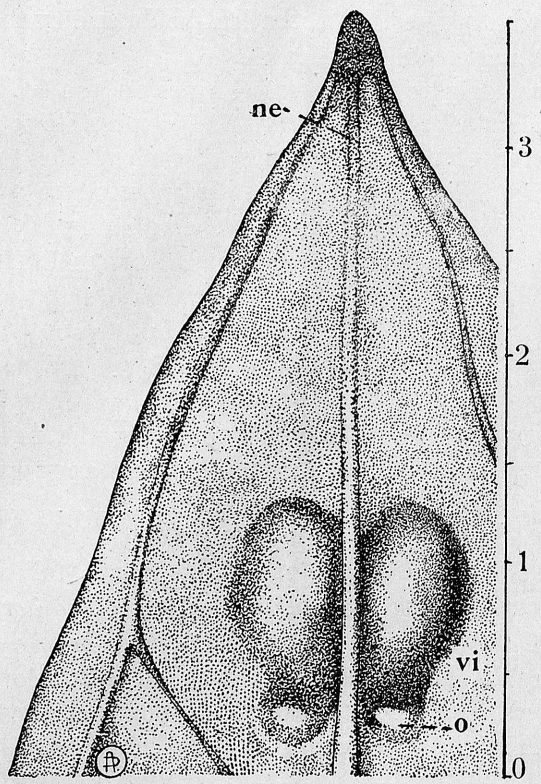

Fig. 3. The situation of incubatory vesicles of *Incurvaria oehlmanniella* Tr. at the apex of the leaf of *Cornus sanguinea* L., ne — central nerve, vi — vesicula incubatoria, o — ostium vesiculae, on the right there is a millimetre scale, the leaf is seen in light passing through.

It often happens, however, that the female lays one egg on one side of the central nerve and another on the other one planting thus in one leaf, at its apex two incubatory vesicles, situated one next to another. After a time two leaf-mines develop. Therefore, besides single mines (fig. 5a) I distinguish also double apical ones (fig. 5b).

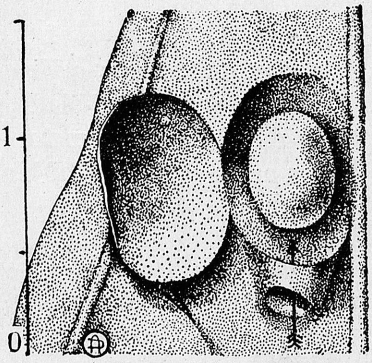

Fig. 4. An opened incubatory vesicle of *Incurvaria oehlmanniella* Tr. with an egg inside; the leaf is seen in reflected light, on the left there is a millimetre scale.

There is a greater number of single apical mines than the double apical ones. In the year 1949 I found from August 13th to September 25th at Czerna near Krzeszowice 295 single apical mines in 295 leaves and 178 double apical ones in 89 leaves. This expressed in percenteage amounts approximately to 62 per cent of single apical mines and 38 per cent of double apical ones (table I). At the same locality and at the same time I found in the year 1950, from July 26th to August 31st 218 single apical mines planted in 218 leaves and 114 double ones in 57 leaves, i. e. about 66 per cent of single mines and 34 per cent of double ones. During the year 1951 I was looking at Czerna for leaf-mines of *Incurvaria oehlmanniella* Tr. on other plants and only occasionally on *Cornus sanguinea* L. Thus the number of apical mines found in the leaves of that plant was much smaller, that is 75 single ones and 31 double ones (in table III there is the sum: 106). That is approximately 71 per cent of single mines and 29 per cent of double ones. During those three years the ratio of these two kinds of mines was rather similar.

In addition to that on August 10th and 12th 1951 I found in the same area 4 leaves of *Cornus sanguinea* L. with three apical mines each. Those were thus the triple apical mines. On the 1252 leaf-mines of *Incurvaria oehlmanniella* Tr. which I collected during three years at Czerna only 12 were thus planted, that is about one per cent of the total number.

Besides the apical mines in the leaves of *Cornus sanguinea* L. can be found the mines of *Incurvaria oehlmanniella* Tr. planted at the lateral margin of the leaf-blade, i. e. the lateral mines (fig. 5c). In this case also the female lays the egg some millimetres from the margin of the leaf-blade, but in such

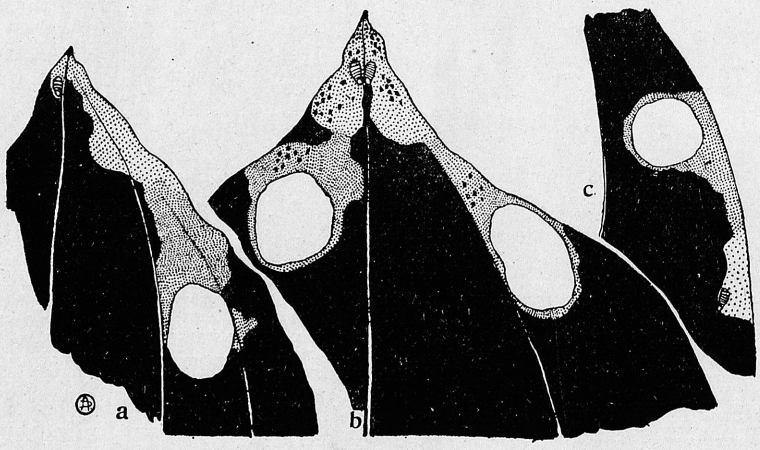

Fig. 5. Abandoned mines of *Incurvaria oehlmanniella* Tr. in fragments of leaves of *Cornus sanguinea* L., a — single apical mine, b — double apical one, c — single lateral one. Enlarged 5×.

a way that the aperture of the incubatory vesicle is pointed to the centre of the blade. That is a feature according to which it is possible to distinguish an iquiline leaf-mine of *Incurvaria oehlmanniella* Tr. from a small inquiline leaf-mine of *Antispila* Hbn. The lepidoptera belonging to the genus *Antispila* Hbn. plant their mines in a similar way as those belonging to the genus *Incurvaria* Hw. but their incubatory vesicles are situated at the very edge of the leaf-blade and not some millimetres from it. It should be added here that the female of *Antispila pfeifferella* Hbn. before laying the egg makes with the end of her ovipositor several „test" cuts in the leaf, which later can be found in the nearest proximity of the vesicula incubatoria. These cuts are situated always along a sickle-like curve. The female of *Antispila petryi* Mart. does not make such cuts. Thus it is possible to distinguish even very small inquiline

leaf-mines of both mentioned species by the presence of such cuts near the incubatory vesicle or by the lack of them. The leaf mines of the genus *Antispila* HBN. are always single.

The female of *Incurvaria oehlmanniella* TR. on the other hand plants at the edge of the leaf-blade of *Cornus sanguinea* L. single mines with one incubatory vesicle and double mines with two incubatory vesicles situated near to each other. On the ground of this I distinguish single lateral mines and double lateral ones.

In the year 1949 I found at Czerna 44 single lateral mines and 16 double ones (i. e. 8 pairs). This is approximately 73 per cent of the first ones and 27 per cent of the second ones. In the next year in the same area 45 single lateral mines and 8 double ones (i. e. 4 pairs) were found, that is approximately 85 per cent of the first ones and 15 per cent of the second ones.

Table I

Results of investigation on leaf-mines of *Incurvaria oehlmanniella* TR. on *Cornus sanguinea* L. at Czerna in the year 1949

Date	Duration of investigation	Leaf-mines				In the material were:			Sum
		apical		lateral		inhabited	abandoned	inquiline	
		single	double	single	double				
June 10th		0	0	0	0				
July 13th	ca. 3 hrs	1	0	0	0			1	1
July 28th	„	19	16	3	2	28	11	1	40
Aug. 4th	4 hrs.	72	48	10	0	69	19	42	130
Aug. 16th	„	47	46	3	2	39	27	32	98
Aug. 24th	„	93	42	22	6	64	50	49	163
Sep. 25th	„	63	26	6	6	80	3	18	101
Total		295	178 +	44	16 = 533	280	110	143	533
Approximately		90 per cent		10 per cent		53 per cent	20 per cent	27 per cent	

A characteristic feature of leaf-mines of *Incurvaria oehlmanniella* TR. occurring in leaves of *Cornus sanguinea* L. is also their twofold transparency. Thus the first part of the mine adjacent

to the incubatory vesicle is much lighter than the second part of it adjacent to the aperture. That second part in addition is greenish (figs. 5a, b, c). The causes of this phenomenon are discussed in Chapter IV.

The leaf-mines of *Incurvaria oehlmanniella* Tr. occur in the leaves of *Cornus sanguinea* L. not only at Czerna but also in the vicinity Cracow.

Table II

Results of investigation of leaf-mines of *Incurvaria oechlmanniella* Tr. on *Cornus sanguinea* L. at Czerna in the year 1950

Date	Duration of investigation	Leaf-mines				In the material were:			Sum
		apical		lateral		inhabited	abandoned	inquiline	
		single	double	single	double				
July 18th	unknown	6	0	0	0	3	2	1	6
July 26th	„	22	4	0	0	14	4	8	26
July 31st	„	6	6	3	0	2	6	7	15
Aug. 10th	3 hrs.	22	17	10	0	24	21	4	49
Aug. 12th	„	19	14	4	0	20	9	8	37
Aug. 16th	2 hrs.	47	37	4	0	35	22	31	88
Aug. 20th	1,5 hrs	35	12	3	4	15	18	21	54
Aug. 22nd	1 hr.	20	16	6	0	14	16	12	42
Aug. 31st	2,5 hrs	41	8	15	4	42	4	22	68
Total		218+114		45+8		169	102	114	385
		86 per cent		14 per cent		44 per cent	26 per cent	30 per cent	

In the year 1949 I found on *Cornus sanguinea* L. growing near Sowiniec 26 obandoned mines and 2 inquiline ones belonging to this species. On the slopes of the St. Bronisława Hill, at the so called Sikornik I found in the same year 5 abandoned mines. I did not find them, howewer, on the sunny Buczyna situated at Tenczynek near Krzeszowice, despite the fact that I did thoroughly search the dogwoods abundantly growing there. I was looking for the mines of the mentioned species in these regions in the years 1950 and 1951 but to no effect. It is evident therefore that the dogwood mines of *Incurvaria*

oehlmanniella Tr. are very rare besides these occurring at Czerna. This is probably the case why they have not been hitherto observed, or that despite observation have not been determined and described.

Table III

Results of investigation on leaf-mines of *Incurvaria oehlmanniella* Tr. on *Cornus sanguinea* L. and *Vaccinium myrtillus* L. at Czerna in the year 1951

abbreviations: ap. = apical, lat. = lateral, ab. = abandoned, inh. =inhabited, inq. = inquiline

Date	*Cornus sanguinea* L.					*Vaccinium myrtillus* L.				
	Leaf-mines		In the material were			Leaf-mines		In the material were		
	ap.	lat.	ab.	inh.	inq.	ap.	lat.	ab.	inh.	inq.
June 15th	0	0	0	0	0	0	0	0	0	0
June 28th	0	0	0	0	0	1	0	0	0	1
July 6th	2	0	1	1	0	1	0	0	0	1
July 12th	0	0	0	0	0	9	0	3	4	2
July 18th	19	0	4	13	2	92	4	38	38	20
July 23rd	26	2	16	8	4	44	5	18	21	10
Aug. 10th	39	5	24	12	8	69	13	63	2	17
Aug. 21st	20	5	19	2	4	0	0	0	0	0
Total	106	12	64	36	18	216	22	122	65	51

Approx:. 90,5 per cent; 9,5 per cent 91 per cent; 9 per cent

3. Leaf-mines of *Incurvaria oehlmanniella* Tr. in the leaves of *Vaccinium myrtillus* L.

According to M. Hering and other scientists the larvae of *Incurvaria oehlmanniella* Tr. feed in leaves of *Vaccinium* L. That note found in publications induced me in the years 1950 and 1951 to look for the leaf-mines of that insect in leaves of *Vaccinium myrtillus* L. and *Vaccinium vitis idaea* L.

I started the investigations in the year 1950 but then I did not know yet when the optimum of the development of the mines on *Vaccinium* L. occurs. Thus despite the considerable efforts of tiresome investigations on plants so low as *Vaccinium* L.

the results were not successful. But the investigations performed in the year 1951 in the forest Las Wolski and then at Czerna furnished a positive result.

First of all I must note that I did not find in the environs of Cracow any mines of species belonging to the genus *Incurvaria* Hw. on *Vaccinium vitis idaea* L. but on *Vaccinium myrtillus* L. I observed three types of leaf-mines of species belonging to that genus.

1. Leaf-mines of the first type are similar to central mines occurring in leaves of *Cornus sanguinea* L. They have considerably great incubatory vesicles and around the holes remaining after cutting out of the case a scarcely visible fragment of mine filled with faeces (fig. 6a).

2. Leaf-mines of the second type are presented in figs. 6 b, c. They differ from the former ones since the part of the mine remaining in the leaf after cutting out of the case is either much greater than that in the first type and only a little smaller than the surface of the hole (fig. 6 b) or it is of the size equa

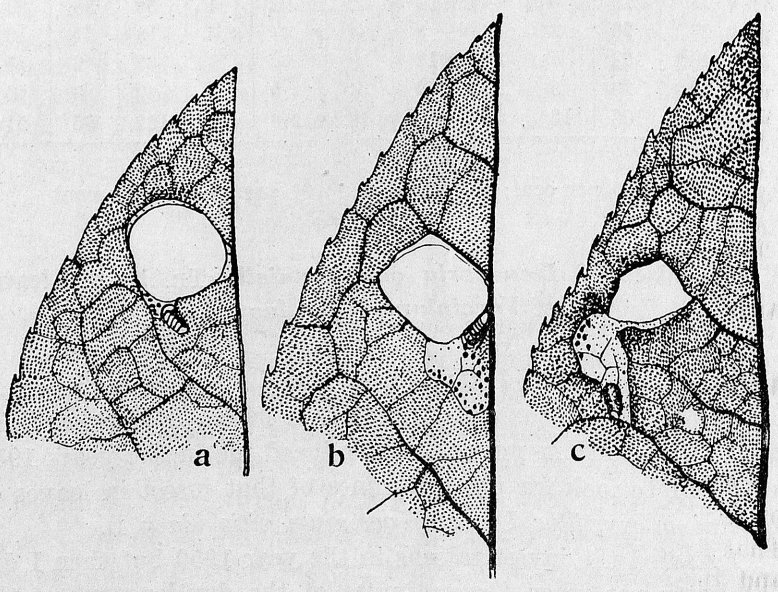

Fig. 6. Abandoned mines of *Incurvaria muscalella* Fb. in fragments of leaves of *Vaccinium myrtillus* L. found in the forest Las Wolski in June 1950.

to the hole. That preserved part of the mine is its first part and it retains as such the intact incubatory vesicle. Moreover it is sometimes more transparent than the part of the mine surrounding the hole. By this it resembles leaf-mines of *Incurvaria oehlmanniella* Tr. from leaves of *Cornus sanguinea* L. Despite the resemblance of the appearance these mines are not made by *Incurvaria oehlmanniella* Tr. They differ from those by a smaller surface of the devoured mine area and by the different position of the incubatory vesicle.

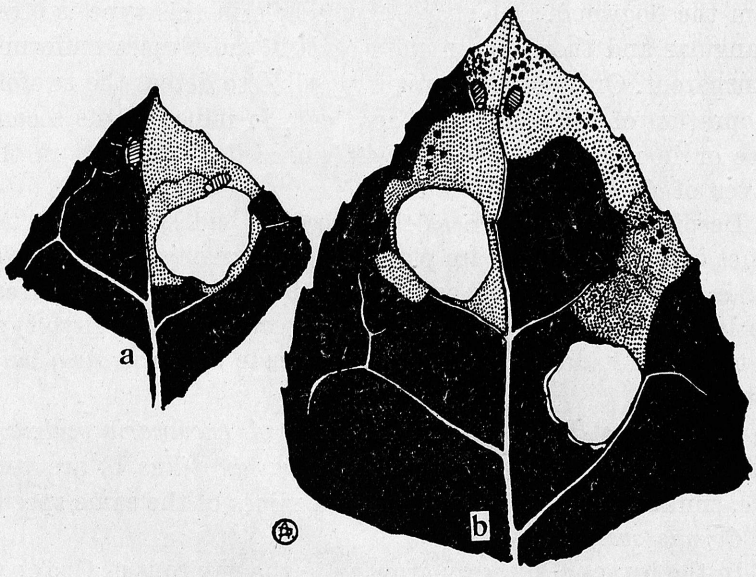

Fig. 7. Abandoned mines of *Incurvaria oehlmanniella* Tr. found in the forest Las Wolski in June 1950 in fragments of leaves of *Vaccinium myrtillus* L.

3. The third type of mines, presented in figs. 7a, b is corresponding almost exactly to mines found on *Cornus sanguinea* L. at Czerna. This is to be easily observed comparing fig 5 with fig. 7 drawn in both cases in the same scale. In the leaves of *Cornus sanguinea* L. and *Vaccinium myrtillus* L. the size of the area devoured, preserved beside the hole remaining after cutting out of the case is greater than the hole. In both plants the situation of the incubatory vesicle is the same, i. e. apical

or lateral. It turned out also that in the leaves of *Vaccinium myrtillus* L. the double apical mines occur, similarly as it is in the case of apical mines on *Cornus sanguinea* L.

Besides similarities slight differences can be found. So the lengths of the axes of the hole remaining after cutting out of the case in the mines of *Incurvaria oehlmanniella* Tr. on *Cornus sanguinea* L. are averagely 4,2 and 3,2 mm (50 mines measured), whilst those in mines from bilberry are averagely 3,3 and 2,5 mm (30 mines measured). Thus the holes in mines from bilberry are a little smaller and have more irregular shape than those from the dogwood. The shape of the hole in this type is often triangular and the whole mine area is in most cases uniformly transparent. Only sometimes it is possible to detect the twofold colouration of the mine, such as occurs in mines of the second type or in mines of *Incurvaria oehlmanniella* Tr. found in the leaves of *Cornus sanguinea* L.

Despite these differences the breeding had shown that the mines of the third type are planted by *Incurvaria oehlmanniella* Tr. in bilberry similarly as the apical and lateral mines from the leaves of *Cornus sanguinea* L. The mines of the first type on the other hand (figs. 6 a, b. c) are made by *Incurvaria muscalella* Fb.

In the forest Las Wolski the mines of *Incurvaria oehlmanniella* Tr. planted in leaves of *Vaccinium myrtillus* L. are very rare, similarly as rare are in that area mines of the same species on *Cornus sanguinea* L.

In the leaves of bilberry growing in the environs of Cracow, besides the mines of the lepidoptera mentioned above, the mines of still two species are found. The first of them are made by *Coleophora vacciniella* HS and the second by *Stigmella myrtilella* Stt. In fig. 8 there are presented the mines of all four lepidoptera species found in the Cracow area, drawn in the same scale. The female of *Coleophora vacciniella* HS lays the egg on the lower side of the leaf of *Vaccinium myrtillus* L., on the surface of the epidermis and not inside the tissue. The egg is black with a charasteristic shape of a truncated cone. Its surface is ribbed (fig. 9). After hatching the larva feeds in the leaf similarly as the larvae belonging to the genus *Incurvaria* Hw. but for a shorter period, viz. trough the 1st life-stage.

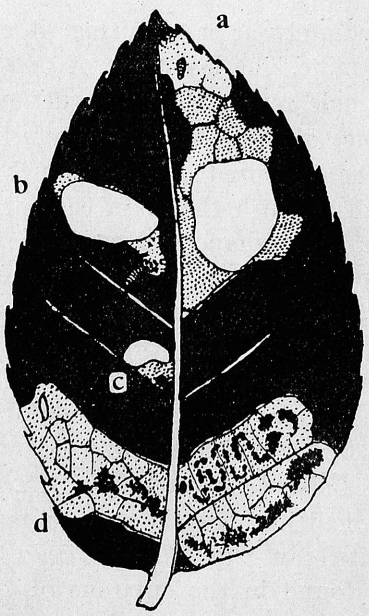

Fig. 8. A leaf of *Vaccinium myrtillus* L. with abandoned mines of: a — *Incurvaria oehlmanniella* Tr., b — *Incurvaria muscalella* Fb., c — *Coleophora vacciniella* HS, d — *Stigmella myrtilella* Stt. Enlarged about 5×.

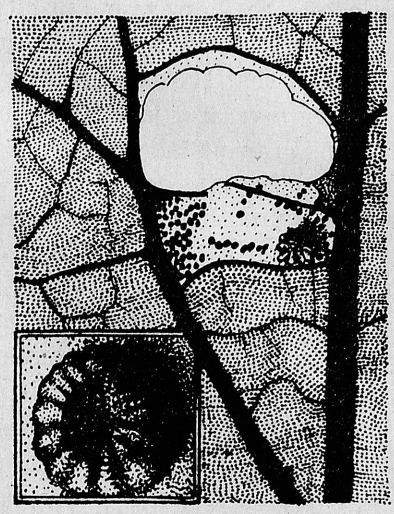

Fig. 9. A fragment of a leaf of *Vaccinium myrtillus* L. with the mine of *Coleophora vacciniella* HS found at Czerna on June 6th 1951. Enlarged about 20×. At the bottom left the egg of that insect. Enlarged about 60×.

Afterwards, immediately after moulting, it cuts out the case and abandons the mine. The leaf-mine of *Coleophora vacciniella* HS. has thus the hole remaining after cutting out of the case similar as the mines of the genus *Incurvaria* Hw., however, the hole as well as the devoured area are much smaller. Thus it is quite easy to distinguish them. In case of any doubts it is possible to compare the shape of eggs if they have not fallen away which happens often in dried up mines.

The mine of *Stigmella myrtilella* Stt. has the shape characteristic for the major part of the leaf-mines of that genus. It is a corridor-mine; the larva does not cut out the case and the egg is laid by the female on the lower side of the leaf. The egg is also black but its shape is oval and its walls smooth.

The larvae of *Coleophora vacciniella* HS. found at Czerna in the year 1951 had cut out the cases already on July 7th. The mines inhabited by *Stigmella myrtilella* Stt. on the other hand were being found in the environs of Cracow mainly in July and August, always in sunny places.

I can furnish more detailed data concerning leaf-mines planted by species belonging to the genus *Incurvaria* Hw. During the year 1950 I visited three times the ruins of the Tenczyńskis' castle on the Tenczyn hill at the village of Rudne near Krzeszowice. I was looking for the leaf-mines on bilberry and I learned that they occur there in a very small number. I looked also several times through the leaves of *Vaccinium myrtillus* L. growing along both sides of the road leading from Tenczynek to the ruins but always with a negative result. I had not found the mines on bilberry in the woods of the so called Zwierzyniec situated in a close vicinity of the village of Tenczynek, either. On the ground of the investigations hitherto performed I come to the conclusion that *Incurvaria oehlmanniella* Tr. lives in the environs of Cracow in hilly regions and that it avoids lowlands; it plants the mines in the leaves of *Vaccinium myrtillus* L. and *Cornus sanguinea* L. growing excusively in much shaded places, most preferably under leaf trees, e. g. beeches, more rarely oaks.

In the similarly shady places I was finding in the forest Las Wolski the mines of *Incurvaria muscalella* Fb. planted also in the bilberry leaves. Yet it should be noted that the

mines of *Incurvaria muscalella* FB. have hitherto not been found in the leaves of *Vaccinium myrtillus* L. According to SORHAGEN (10) the larvae of that insect make their mines in leaves of many trees, especially beeches. SCHÜTZE (8) names the species of these trees in detail, they are *Fagus* L., *Quercus* L., *Betula* L., *Carpinus* L. and *Rosa* L. bush. M. HERING on the other hand mentions only *Fagus* L., *Quercus* L. and *Carpinus* L. No one of the mentioned authors writes about *Vaccinium myrtillus* L. Neither do the Polish authors give that plant as the food-plant of that species. In the forest Las Wolski the larvae of *Incurvaria muscalella* FB. make their mines chiefly in the leaves of *Vaccinium myrtillus* L. and only sometimes in the leaves of *Fagus* L., *Tilia* L. and *Corylus* L. (table IV).

Table IV

Results of investigation on leaf-mines of *Incurvaria muscalella* FB. in the forest Las Wolski in the spring of 1951

abbreviations: ab. = abandoned, inh. = inhabited, inq. = inquiline

Date	*Vaccinium myrtillus* L.			*Fagus silvatica* L.			*Tilia* L.			*Corylus avellana* L.		
	ab.	inh.	inq.	ab.	inh.	inq.	ab.	inh.	inq.	ab.	inh.	inq.
May 20th	0	0	0	0	0	0	0	0	0	0	0	0
May 26th	0	51	0	0	2	0	0	0	0	0	0	0
May 28th	0	20	0	0	1	0	0	1	0	0	0	0
May 30th	3	23	4	0	2	0	0	0	0	0	1	0
June 5th	12	71	0	0	0	0	0	0	0	0	0	0
June 7th	27	16	2	0	0	0	0	0	0	0	0	0
June 11th	22	1	2	0	0	0	0	0	0	0	0	0
June 17th	4	0	0	0	0	0	1	0	0	0	0	0

4. The development of leaf-mines of *Incurvaria oehlmanniella* TR.

The determination of the duration of the embryonic development of lepidoptera the larvae of which are making mines in the leaves of plants is not easy. First of all in most cases we do not know the date of the egg-laying by the female of such a small insect. Yet it is possible to calculate the duration

of the embryonic development of *Incurvaria oehlmanniella* Tr. In the spring of 1951 I was obtaining from the material collected at Czerna almost exclusively the females of *Incurvaria oehlmanniella* Tr. Without their insemination one could not hope that the will lay eggs. It was necessary then to procure a male. In order to catch it I placed the newly hatched and virgin females in a small cage with tulle walls. These cages I hung on trees in the forest Las Wolski in various places. The first experiments had already shown that the idea was good.

On May 25th 1951 I collected in this way at noon of a sunny day 5 males and on May 31st 1951 10 males within an hour and I was able to collect still much greater a number. After returning home I placed the still virgin female in a spacious breeding-cage together with 5 males. Previously I placed in that cage freshly gathered branches of *Vaccinium myrtillus* L. and *Cornus sanguinea* L. with a water supply. The copulation must had taken place during the night since on June 1st I observed in morning hours that the eggs were laid. I counted 42 incubatory vesicles in the leaves of *Vaccinium myrtillus* L. and 25 in the leaves of *Cornus sanguinea* L. The male which had inseminated the female died on June 1st at 11 a. m., the female was still active on June 2nd. It is possible that under normal conditions it would still continue to lay eggs.

In that way I obtained eggs of *Incurvaria oehlmanniella* Tr. of known origin and with a definite date of laying. Then the question was how to keep fresh for a considerable time the cut branches of bilberry and dogwood. *Vaccinium myrtillus* L. can be cultivated for a longer time if already during the exursion the cut branches are placed in water and thus transported home. The branches of *Cornus sanguinea* L. on the other hand wither quickly. In order to keep them for a longer time without withering I kept them all that time under a glass bell (according to recommendation given to me by Prof. J. Ruszkowski). It should be noted here, too, that *Vaccinium myrtillus* L. cannot be cultivated under such a bell. In a closed moist space the leaves quickly get brown and the larvae hatched from eggs, not finding the green tissue stop to feed and perish. *Vaccinium myrtillus* L. proved to be so sensitive to enclosure in a small space that its leaves with inhabited mines could not be trans-

ported in closed boxes; already on the next day after gathering the leaves get brown and the larvae perished.

The breeding-cages were kept in the window of the room. The temperature and the relative humidity in the room were as in table V. The measurements were taken once a day in morning hours.

On June 12th 1951, i.e. on the 12th day since laying of the eggs I observed the first larvae which hatched from the eggs laid on the leaves of *Vaccinium myrtillus* L. In the whole material the hatchings occurred till June 15th 1951.

Already some days before hatching of the larvae of *Incurvaria oehlmanniella* Tr. is it possible to observe in the incubatory vesicle the outline of the egg and, inside it, the curved

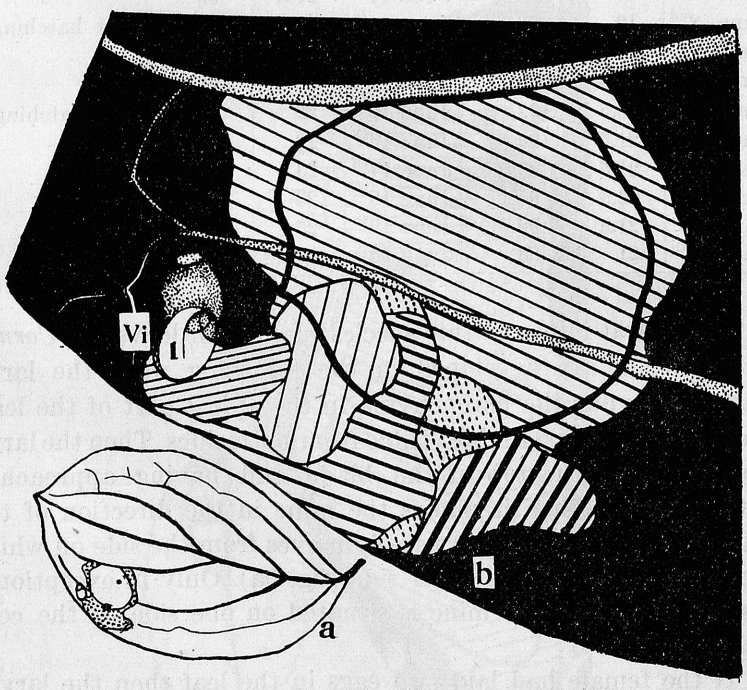

Fig. 10. a — single lateral mine of *Incurvaria oehlmanniella* Tr. in the leaf of *Cornus sanguinea* L. Englarged 3×. b — the history of the development of that mine. Explanations in the text. vi — vesicula incubatoria, l — the outline of the larva before hatching. In the fig. the respective daily stages of the enlarging of the mine are marked in a different manner. Enlarged 15×.

body of the larva, turned head to *ostium vesiculae* (figs. 10b and 11b). At that time it is possible to perceive the first, still very slight, motions of the embryo. When its head gets brown, which may be regarded as the mark of the finished sclerotization of the head and the end of the embryonic development, the larva hatches and starts the construction of the mine.

Table V

External conditions in the breeding of eggs and young larvae of *Incurvaria oehlmanniella* Tr.

Date	Temp. centigr.	Relative humidity	Date	Temp. centigr.	Relative humidity	Hatching
June 1st	19	87	June 11th	21,5	93	
June 2nd	19	89	June 12th	21	90	first hatchings
June 3rd	20	91	June 13th	21	87	
June 4th	20,5	92	June 14th	22	92	
June 5th	20,5	93	June 15th	22	92	last hatchings
June 6th	21,5	93	June 16th	22	91,5	
June 7th	21,5	93,5	June 17th	23,5	97	
June 8th	22,5	94	June 18th	23	95	
June 9th	21,5	90	June 19th	25	97	
June 10th	21	88	June 20th	23,5	85	

The apical mines of this species planted in leaves of *Cornus sanguinea* L. are developed in the following way: the larva starts to devour the parenchyma in the apical part of the leaf-blade forming thus a mine visible from both sides. Then the larva moves first to the top of the blade and having approached it turns back. Then it makes the mine in the direction of the petiole. In a single mine it usually moves from the side on which the egg was laid to the other side (fig. 5a). Only in exceptional cases the whole single mine is situated on one side of the central nerve.

If the female had laid two eggs in the leaf then the larvae usually keep to that side of the leaf on which the egg was laid. Rarely one of them goes to the other side of the blade. In the first case the holes remaining after cutting out of the case are situated on oposite sides of the central nerve (fig. 5b), in the second both are on one side of it.

In a similar way are developed the apical and lateral mines in the leaves of *Vaccinium myrtillus* L. but with such a difference that the passing of the larva in a single mine to the other side of the leaf-blade is not a rule at all. It happens only exceptionally (figs. 7a, b).

The larva of *Incurvaria oehlmanniella* Tr. lives in the leaf for only the first and a part of the second development stage. This is illustrated in figs. 10 and 11. In fig. 12 there is presented a development of a lateral mine in a leaf of *Cornus sanguinea* L. The female laid the egg on June 1st 1951. The embryonic development lasted in home-breeding conditions till June 12th 1951 and on June 13th the larva hatched and started to make mines

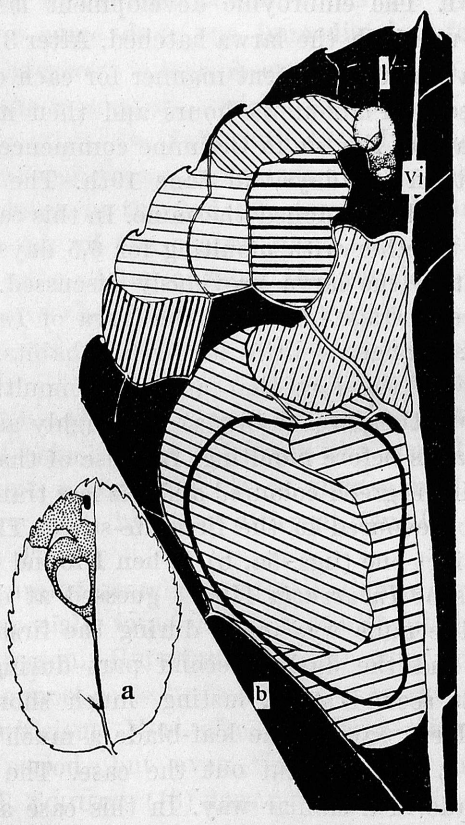

Fig. 11. a — single apical mine of *Incurvaria oehlmanniela* Tr. in the leaf of *Vaccinium myrtillus* L. b — the history of the development of that mine; other explanations as in fig. 10 and in the text.

in the leaf. After 3,5 days, marked in fig. 10 in a slightly different manner for each day, the larva stopped to feed and prepared for moulting. That period lasted 48 hours and was finished on June 18th. After moulting in the mine it still fed in the leaf till June 20th and then cut out the case and left the leaf in it. Thus it lived in the leaf trough the embroynic period lasted 12 days, then through the mine making period, which, together with moulting, it finished after 7,5 days. It left the leaf definitely in the 2nd life-stage.

The development of the mine of this species in the leaf of *Vaccinium myrtillus* L., presented in fig 13, is similar. In this case the female laid the egg at the apex of the leaf-blade on June 1st 1951. The embroynic development lasted till June 12th and on June 13th the larwa hatched. After 3 days, marked in fig. 13 in a slightly different manner for each day, the larva stopped to feed for about 35 hours and then moulted. Then the second stage of the life in the mine commenced; that lasted a little more than two days, till June 19th. The larwa cut out the case then and abandoned the mine. In this case the mining period lasted together with moulting for 6,5 days, i.e. one day less than that of the larva previously discussed.

In the second stage of its life the larva of *Incurvaria oehlmanniella* Tr. changes a little its feeding habits. That change is manifested by the fact that after the moulting the larva does not devour the parenchyma so thoroughly as it did in the first stage, that is before moulting. Because of that the second part of the mine is green coloured and has less transparent walls than the part devoured in the first life-stage. That difference is quite a distinct one (figs. 5a, b). When I found the first mine of this species of *Incurvaria* Hw. I guessed at once that the first part of the mine was made during the first stage of life of the larva and the darker second part during the second stage. In that second stage, lasting much shorter than the first one the larva eats in the leaf-blade a much greater mine area an then it starts to cut out the case. The lateral mine (fig. 5c) is made in a similar way. In this case also the difference of the transparency of mine walls from the first and second stages of the larva's life is quite distinct and caused by the same factors.

The larva gains a twofold advantage by the change of the feeding habits in the second life-stage. First of all it shortens the period of living inside the mine and then the case walls become less transparent because of the less thorough eating of the parenchyma and better conceal the presence of the larva in the case. In such conditions it cannot be observed from outside and when we hold the case against the light we see only its shade.

This difference of feeding habits of the larvae of *Incurvaria oehlmanniella* Tr. in the first and second life-stages cannot be generally observed in the mines occurring in leaves of *Vaccinium myrtillus* L. (figs. 7a, b).

The double apical and lateral mines are planted by the female on the same day, one immediately after the other. In one case, however, it was observed that in a double apical mine one of the incubatory vesicles was planted at a different time than the other. On July 29th 1949 I found at the apex of the leaf-blade of *Cornus sanguinea* L. an already developed mine with a larva in the 2nd life-stage inside and next to it, on the other side of the central nerve, an incubatory vesicle without the mine. After opening the vesicle I found an egg in it. Because of the opening of the vesicle the egg could not be left in the leaf. Therefore I transfered it to a moist microchamber. After 7 days, i.e. on August 5th a larva hatched from it. The difference in time between the laying of the egg on the left and right sides of the leaf-blade was according to my calculations about a fortnight. It is thus almost certain that the eggs were laid by two different females of *Incurvaria oehlmanniella* Tr.

For a naturalist searching for mines in order to breed the insects it is especially important to know about their occurrence in a given region. Unfortunately the data concerning this cannot for the most cases be found in the literature or, if found, they are insufficient. Most often only the season is given as the mining period, but even that is rarely mentioned. For example K. T. Schütze (13) does not mention it at all, L. Sorhagen generally neglects it and only M. Hering (7) gives it. The more detailed data concerning the phenology of mining insects must be looked for in more recent special papers. We

may for example find them in the papers of the Polish authors St. ADAMCZEWSKI (1, 2), M. BEYGER (3) and S. TOLL in all cases when they were successful in observing the details of the life of lepidoptera. But even in those papers I did not find data concerning the development of the larvae of lepidoptera mining in leaves of *Cornus sanguinea* L. and *Vaccinium myrtillus* L. On the ground of my systematic investigations in the forest Las Wolski and at Czerna near Krzeszowice I am able to give for those regions the time of the year in which the inhabited mines of the following lepidoptera can be found: *Incurvaria oehlmanniella* TR., *Incurvaria muscalella* FB., *Antispila pfeifferella* HBN. and *Antispila petryi* MART.

In the forest Las Woski the inhabited mines of *Incurvaria oehlmanniella* TR. can be found in the leaves of *Vaccinium myrtillus* L. during the first half of June. At Czerna, a locality situated 100 m higher above the sea level than Las Wolski — from mid July till the end of that month in the leaves of the same plant and from mid July till the end of August in the leaves of *Cornus sanguinea* L.

The inhabited mines of *Incurvaria muscalella* FB. occur in the forest Las Wolski mainly in the leaves of *Vaccinium myrthillus* L. from the last days of May till the first days of June, i. e. in the spring and not in the autumn as, probably erroneously, was given by L. SORHAGEN (10). The more detailed data are presented in table IV. At Czerna I did not find that insect at all.

Antispila pfeifferella HBN. lays eggs exclusively on the leaves of *Cornus sanguinea* L. Its inhabited mines can be found in the forest Las Wolski in June and at Czerna, a region somewhat more elevated and shady, in July till the first days of August.

Antispila petryi MART. lays its eggs also only on the leaves of *Cornus sanguinea* L. but it chooses sunny places. Its inhabited mines can be found from mid August till the end of September. That is the case in the forest Las Wolski as well as at Czerna.

5. The life of the larva of *Incurvaria oehlmanniella* Tr. in the case on the ground

Since the moment the larva leaves the leaf it starts a new stage of life outside the mine, on the ground. That period lasts long, since from the summer till the spring of next year. In order to follow it I had established a special breeding of the larvae in cases. I had chosen 12 cases. All of them were from Czerna and were cut out from the leaves of *Cornus sanguinea* L. between July 14th 1950 and August 5th 1950. I bred them in crystallizers placing one case in one crystallizer. Similar breedings which furnished similat results were performed in the year 1951 but then the cases were taken from the leaves of *Vaccinium myrtillus* L. The larvae were fed on fresh and mouldering leaves of *Cornus sanguinea* L. and *Vaccinium myrtillus* L. and, since the end of September, on reddening leaves of *Rubus fruticosus* L. yellow ones of *Carpinus betulus* L. and *Acer platanoides* L., i.e. the food which they were supposed to find under natural conditions beneath the plant in the leaves of which they were mining when they were young. The bottom of the crystallizer was covered with filter paper to absorb the excess of water which, in order to sustain the humidity of the breeding was dosed by drops in cases of necessity. Every 24 hours I made a control, doing more or less detailed observations and noted the results. I did that up till November 14th 1950. Since October 24th I kept the breeding between windows. The results of the observations are presented in several points:

a. The larva of *Incurvaria oehlmanniella* Tr.

The larva of *Incurvaria oehlmanniella* Tr. has a little dorsoventrally flattened body with anterior past broader than posterior ones in the first life-stage and vice versa in latter stages. It is whitish (especially in latter stages on account of the great number of fat body) with a pink tinge. There were no yellow larvae in the material investigated.

The head of the larva is black, in the latter stages there appear on it two narrow light stripes situated at the sides of the clypeus (fig 12). On the thorax, on its dorsal side there

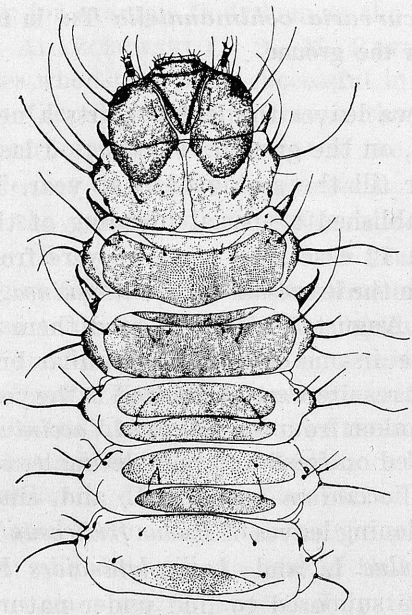

Fig. 12. The anterior part of the body of larva of *Incurvaria oehlmanniella* Tr. taken from the case in the ultimate life-stage on March 27th 1951. The mine was found in a leaf of *Cornus sanguinea* L. at Czerna near Krzeszowice. Dorsal view. Enlarged 50×.

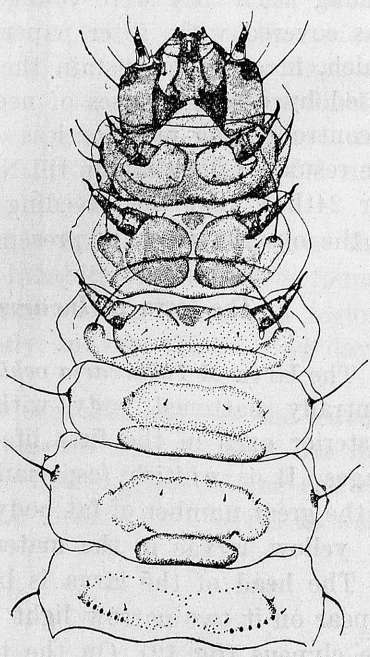

Fig. 13. The same as fig. 12. Ventral view.

occur protective plates. On the prothorax there is one black plate (scutum prothoracale dorsale) and on the mesothorax and metathorax each there are two lighter transverse plates situated one above the other. In the latter stages of life the plate on the prothorax is subject to a division into a left and a right part. The anterior plates on the mesothorax and metathorax are much narrower than the posterior ones adjacent to them.

Also the first abdominal segments of older larvae show on the dorsal side the presence of plates. These plates, however, are less developed than those on the thorax. So it can be said that the anterior part of the body, that one which the larva pushes outside the case when changing the place, feeding and, first of all, adding a new wall to the case, has on its dorsal side a protective skeleton strenghtening.

On the thorax of the larva there are three pairs of legs. The prolegs appear only from the beginning of the 2nd life-stage. On their surface there are claws which can be observed in the 3rd, 4th, 5th, and 6th abdominal segments. There are no prolegs on the 10th segment. The claws are situated in one row on each proleg (FRACKER'S transverse uniordinal band). The number of claws in a row is always small, variable, different on the left and right side of the body; the number of claws in the posterior prolegs is greater than that in the anterior ones.

Table VI

Number of claws on prolegs of the larva of *Incurvaria oehlmanniella* TR. in some different life-stages of it

abbreviations: d = number of claws on a proleg of the right side of the body, l = ditto on the left side of the body

Abdominal segment	Life-stage							
	1st		2nd		4th		ultimate	
	d	l	d	l	d	l	d	l
3rd	0	0	3	4	6	7	5	6
4th	0	0	5	6	11	13	11	10
5th	0	0	8	8	14	12	16	14
6th	0	0	10	8	20	21	30	22

In table VI there is given as an example their number in four different life-stages of investigated larvae. The claws are turned forwards by their curved part. Probably they hold the posterior part of the body in the case when the anterior one is pushed forwards.

b. The food of the larva of *Incurvaria oehlmanniella* Tr.

Since the moment of leaving the leaf of *Cornus sanguinea* L. or *Vaccinium myrtillus* L. the larva ceases to be monophagous and becomes polyphagous. In the home breeding conditions the larvae generally eat all leaves served them; the leaves of *Carpinus betulus* L. and *Acer platanoides* L. were most rarely and most unwillingly eaten whilst the leaves of *Vaccinium myrtillus* L. and *Cornus sanguinea* L. were the most preferable food. The number of days spent on feeding on *Vaccinium myrtillus* L. was averagely 75 per cent, on *Cornus sanguinea* L. 14 per cent, on *Vaccinium* and *Cornus* 5 per cent, on other plants 6 per cent. During this terrestrial stage of life the larvae feed on fresh leaves as well as on withered, browned, mouldering and moist or even dry ones. The detailed observations had shown that the number of days on which the larvae took only the fresch (green) food was averagely 45 per cent, the mouldering — 42 per cent and mixed, i.e. composed partly of fresh and partly of mouldering leaves — 13 per cent.

The results presented here seem to stand in an apparent opposition to that what about the larvae of *Incurvaria* Hw. was written by M. Hering (5). According to that author the larvae of *Incurvaria* Hw., when they abandon in their cases the birch leaves, do not want at first to eat the leaves of that tree. They eat them only when they cannot find other leaves. Bred on such unwillingly consumed food they produce a very small number of insects.

M. Hering writting about the above mentioned larvae did not give the specific name of that *Incurvaria* Hw. One can assume, however, that the details given by him apply to *Incurvaria pectinea* Hw. since of the genus *Incurvaria* Hw. only the larvae of that species are mining in the leaves of *Betula*

L. The data presented by M. HERING apply therefore to another species belonging to the genus *Incurvaria* HW. the larvae of which are mining in another plant when young. So I see in that the cause of different results. *Betula* L. belongs to heliophilous plants which do not form compact woods and thus the undergrowth of birches is rich in other higher plants. The larvae of *Incurvaria pectinea* HW. after getting in their cases to the undergrowth find there a great number of fresh and dried herbaceous plants. Their „menu" may be called rich. Living then under normal conditions they are able to adapt themselves to feeding of leaves of different species of plants.

It is not so when the case of the larvae of *Incurvaria oehlmanniella* TR. is concerned. They are mining in leaves of *Cornus sanguinea* L. or *Vaccinium myrtillus* L. Both plants serving the mentioned species as the food plant are growing at Czerna, i.e. in the region of the abundant occurrence of the mines of that insect, in a shady fir and beech wood. There in the undergrowth, besides *Vaccinium* L., mosses and other green plants can occur on the ground only the needles of *Picea excelsa* LK., the fallen and mouldering leaves of *Cornus sanguinea* L., *Vaccinium myrtillus* L. and *Fagus silvatica* L. This is then a poor „menu". By this I explain that in my breedings they did not reject neither the bilberry nor the dogwood leaves. The fallen last year oak leaves they used for the broadening of the case walls.

c. The duration of the fasting periods prior to moulting

As it is known the larva stops to feed before moulting. In the case of the larva of *Incurvaria oehlmanniella* TR. it is possible to observe a dependence of the duration of that fasting period in relation to the season. In August the fasting pre-moulting periods last generally shorter than in September and October. In the first half of August they last usually for 2 days, in the second half of that month and in September 3—4 days and in October 5—6 days.

d. The number of development stages and their duration

The life of the larva of *Incurvaria oehlmanniella* Tr. may be divided into 8 or 9 development stages. Each of them ends with moulting the larva throws away all the moults except the last one, i.e. that prior to pupation, in two parst; the last moult is thrown away in one part. The larva spends the first and a part of the second life-stage in the mine, the second, longer part of the 2nd life-stage and all further ones — in a case on the ground.

It may be seen from table VII that the duration of the development stages in the life of a larva is not equal. Later stages, those from the 5th onwards, last longer than the initial ones; that may be easily explained by the decrease of the rate of living due to the decrease of the temperature of the environment. This dependance of the rate of development upon the temperature shows in *Incurvaria oehlmanniella* Tr. more distinctly than in many other mining species. This is probably due to the fact that the development of larvae of *Incurvaria oehlmanniella* Tr. collected at Czerna, begins relatively late whilst this species, being a bigger one in the superfamily *Tineoidea* requires a long time to perform the full development.

Table VII

Duration of life-stages of the larvae of *Incurvaria oehlmanniella* Tr. given in days (examples for which that could be calculated chosen from the breeding)

2nd life-stage after abandoning the mine

Life-stage No. of breeding	II	III	IV	V	VI	VII VIII
2	8	10	18	16	30	hibernation
5	8	8	9	11	13	22 hibernation
7	8	9	9	14	21	hibernation
8	8	9	9	13	14	14 hibernation
10	8	8	10	15	17	18 63 (pupa) Dec. 15th imago
11	9	8	11	11	16	15 62 (pupa) Dec. 9th imago
12	7	8	10	14	19	hibernation

It is interesting that the number of moultings and thus also the number of life-stages of the larvae was variable up till winter. Almost a half, viz. Nos. 2, 6, 7, 9, 12 went through 6 stages from summer till winter, a second part, viz. Nos. 3, 4, 5, 8, 10, 11 went through 7 stages during that time. In the 7th stage hibernated Nos. 2, 6, 7, 9, 12, in the 8th Nos. 3, 5, 8, in the pupal stage only No. 4. Nos. 10 and 11 had ended their larval development already in their 7th life-stage, in the 8th they went through a pupal stage, which lasted for a relatively short time, viz. 62 and 63 days resp., i.e. from October 14th till December 15th and from October 9th till December 9th 1950 resp., and produced imagines still before winter.

e. The enlarging of the case

The stadial development of larvae necessitates the equally stadial enlarging of the case. The case in which the larva leaves the leaf and mine is of very small dimensions. They are suitable for the dimensions of the body of the larva in its 2nd life-stage. But the larva feeds and grows on and in a short time the case becomes too small for it. Then it begins to enlarge the case. That is made by adding a new larger wall to one of the original walls. The larva does that in the following way. Firstly it fastens the old case with the help of a few threads to a leaf from which it is about to cut out a new wall. Then it pushes its body outside the case and in a distance a little greater than the that to which the threads are fastened it eats out in the leaf narrow holes running more or less parallel to the old wall of the case. Initially there are several such holes and they do not merge with each other (fig. 14). The connection between them follows after a time. During the eating out of the mentioned holes the larva attaches the old case wall to the new one with the help of new threads so that the latter accomplishes finally a concave shape, suited to the convexity of the old case wall and to the shape of the larva's body.

During the time of attaching the leaf the larva does not leave the case but pushes out from it only the head, thorax and the first abdominal segments. The constructing of the new

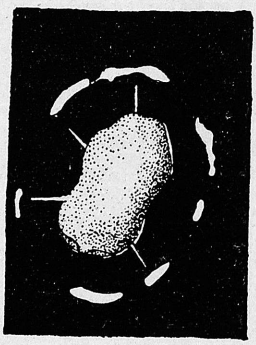

Fig. 14. The case of the larva of *Incurvaria oehlmanniella* Tr. Dimensions 1,5 × 1 mm. Found at Czerna on August 22th 1951. The larva was in the 4th life-stage, it was adding a wall to the case. The leaf providing the material for the wall is blackened, the holes in the leaf eaten out by the larva and threads fastening the case left white.

wall lasts a long time. It begins for example in the morning and ends in the afternoon.

Usually the addition of one new wall is sufficient until the next moulting. The detailed observation, however, had proved that after the 3rd and 4th moulting the investigated larvae were adding not one but generally, two, or sometimes even three walls shortly one after another. During the whole development the number of walls added was 4—7 six being the typical number (tables VIII and IX).

Originally I thought that with each addition of a new wall to the old case, the wall of the enlarged case becomes not only larger but that it also consists of more layers. It proved, however, that even the oldest cases in which the pupa rests have single mono-layer walls. Therefore it was necessary to see what the larva does with the old wall to which it adds a new wall while enlarging the case. In order to find that the cases had to be opened at least once in a day after a new wall was added to them. The case consists of two walls connected with each other with the help of threads. To open the case one of the connections has to be ripped with the help of a needle and the wall has to be slightly bent out. Such an operation carefully performed does not cause the death of the larva since it, if

Table VIII

Relation between moulting and enlarging the case by adding a new wall to it

abbreviations: w = date of cutting out of the case, l. = date of moulting from 2nd to 8th, d = date of adding the new wall to the case. Nos. 1—6 material from *Cornus sanguinea* L., 7—12 that from *Vaccinium myrtillus* L.

No.	w		2nd		3rd		4th		5th		6th		7th		8th	hatching
1	18/6	l	22/6		30/6		10/7		26/7		11/8		29/9		14/10	
		d		26/6		3/7 5/7		21/7		31/7				5/10		
2	18/6	l	23/6		30/6		12/7		17/7		16/8		16/9			
		d		24/6 25/6		2/7		16/7 19/7				25/8				
3	19/6	l	24/6		3/7		15/7		29/7		5/9		16/10			
		d		28/6		8/7		21/7								
4	20/6	l	24/6		4/7		18/7		2/8		23/8		30/9			
		d		30/6		11/7		19/7 28/7		9/8		25/8 25/8				
5	20/6	l	24/6		5/7		16/7		31/7		20/8		17/9		20/10	
		d		29/6 1/7 1/7				17/7 26/7		8/8		1/9 2/9				
6	21/6	l	26/6		3/7		16/7		27/7		13/8		8/9			
		d				4/7 11/7		18/7		6/8		16/8				

7	18/6	l	23/6		1/7		10/7		25/7		23/8		27/9		18/10	
		d		28/6				11/7		26/7 7/8		24/8		6/10		
8	19/6	l	22/6		30/6		13/7		26/7		9/8		?		3/10	
		d		25/6		1/7 5/7		14/7 15/7		31/7		19/8				
9	19/6	l	22/6		1/7		19/7		1/8		20/8		7/9			
		d		28/6		3/7 11/7		25/7		7/8 8/8		29/8				
10	19/6	l	23/6		1/7		12/7		31/7		20/8		13/9		16/10	
		d		26/6		5/7 6/7		14/7 22/7 27/7		11/8				19/9		
11	19/6	l	24/6		1/7		25/7		9/8		27/8					3/10
		d				2/7 5/7 19/7		30/7		14/8 19/8		9/9				
12	20/6	l	24/6		2/7		16/7		29/7		16/8		1/9			14/10
		d		26/6		5/7 11/7 13/7		23/7		2/8		21/8		21/9		

left in peace, already after a few minutes repairs the case again. Experiments of such kind made on the cases of *Incurvaria oehlmanniella* Tr. and *Incurvaria muscalella* Fb. had shown that the larvae of these species remove the old wall after adding a new one. The removal is done simply by eating the old wall. Eventually only the new wall remains; that is then covered with the threads from inside. The larvae of *Incurvaria oehlmanniella* Tr. do not do that immediately after adding a new wall but during a few subsequent days.

Table IX

The course of development of two larvae of *Incurvaria oehlmanniella* Tr. from mines situated next to each other on the apex of *Cornus sanguinea* L. leaf found at Czerna on August 29th 1950

Abbreviations: w = date of cutting out of the case, 2nd—6th dates of moulting, d = date of adding the new wall to the case, prz = date of threading the case to the ground prior to pupation, hatch. = date of hatching of imago in home breeding (two chosen examples)

No.	w	2nd	d	3rd	d	4th	d	5th	d	6th	d	prz.	hatch.
10	3/8	7/8	11/8	15/8	18/8 19/8	25/8	31/8	9/9	17/9	26/9	6/10	17/10	15/12
11	3/8	8/8	12/8	16/8	19/8	25/8	1/9	7/9	14/9	23/9	30/9	8/10	9/12

The adding of new walls serves only for the enlargement of the case and not for the nourishing of the larvae. The larvae use various leaves as the material for the enlargement of the case; they use most preferably the thin and brown ones. The larvae of *Incurvaria oehlmanniella* Tr. from the leaves of *Cornus sanguinea* L. used for the enlargement of the cases in August and September almost exclusively the leaves of *Vaccinium myrtillus* L., rarely of *Cornus sanguinea* L. During October besides *Vaccinium myrtillus* L. also the brown leaves of *Carpinus betulus* L., *Acer platanoides* L. and red leaves of *Rubus fruticosus* L. were also used. Those from the leaves of *Vaccinium myrtillus* L. on the other hand preferred walls cut out from the brown leaves of *Fagus silvatica* L. If they did not find in the

crystallizer in which they were bred the leaf material suitable for them, then they added a wall made from paper. In such a case they used labels with notes which were placed inside the crystallizers. It was shown then that their mouth apparatus, or rather their mandibles are able as need arises, to cut stiff paper and that the larvae are able to pass the paper through thier digestive system without any harm.

f. The plasticity of instinct

I was interested also in the problem whether a larva of *Incurvaria oehlmanniella* Tr. removed from the case and placed among leaves is able to cut out and make a new case. It turned out that each time I did such an experiment, no matter if it was in the 2nd or later life-stage, on the next day the larva was inside a newly made case.

The removal of the larva from the case creates for it a new situation with which it does not meet in normal life. In a similar but not identical situation it was already once in its life, viz. when it was still in the mine but was about to leave it. At that time above it as well as beneath it there were the thin walls of the mine which were to be cut out and connected in such a way as to enable it to leave the mine in a case thus made. When the larva is placed among the leaves, after being removed from the case it finds itself in a new situation although a little similar to that discussed above. Perphaps this is why it makes a new case.

It should be added yet that the larvae belonging to the genus *Antispila* Hbn. are not able to make a new case. When removed from the case immediately after its cutting out they stay among the leaves not even trying to make a new one. If they are transfered back into the mine which they made then, provided that not too many hours passed since the case was cut out, they can make a new one. The new case, however, is of not so regular a shape as the first one was and looks rather like a bungle.

g. The time of emerging of imagines

Incurvaria oehlmanniella Tr. occurs in only one generation. The larvae belonging to this species spend the winter in cases. In home breedings, kept between windows, they often interrupt the winter rest and on warmer days wander about the crystallizers looking probably for food. They do not reject then even the dried leaves which remained there since autumn. It is so until spring. In March they feed for a time being among mouldered leaves and then they pupate.

When a larva of *Incurvaria oehlmanniella* Tr. is about to pupate it attaches the lower side of the case to the ground with the help of several or two threads which it places in the anterior and posterior parts of the case. The case thus being fastened there follows the ultimate moulting and the change into the pupa occurs. Several days later the imago emerges.

In the 1949 a puzzling regularity was observed. On September 5th 1948 I found at Czerna five inhabited mines of *Incurvaria oehlmanniella* Tr. They furnished five cases with larvae which hibernated between windows. In the spring, in March and April they fastened the cases to the ground and the imagines emerged in April and May.

The details are given below:

No.	Date of attaching	Date of hatching	No. of days since attaching
1.	March 18th 1949	Apr. 6th 1949 ♂	19
2.	March 25th 1949	Apr. 13th 1949 ♂	19
3.	March 27th 1949	Apr. 15th 1949 ♂	19
4.	Apr. 14th 1949	May 2nd 1949 ♀	19
5.	Apr. 14th 1949	May 2nd 1949 ♂	19

On the 19th day since the attachement of the case to the ground all of them produced imagines, among these 4 males and 1 female. Similar observations were made in the year 1951. The result was approximately similar but not so regular. The details are:

No.	Date of attaching	Date of hatching	No. of days since attaching
1.	Apr. 18th 1951	May 9th 1951 ♂	21
2.	Apr. 19th 1951	May 7th 1951 ♀	18
3.	Apr. 21st 1951	May 8th 1951 ♀	17
4.	Apr. 21st 1951	May 12th 1951 ♂	21
5.	Apr. 28th 1951	May 17th 1951 ♀	19
6.	May 1st 1951	May 20th 1951 ♀	19
7.	May 5th 1951	May 25th 1951 ♀	20

On the ground of these results it can be said that from the moment of the attachment of the case in home breedings to the appearing of imagines there passes a period of about three weeks.

The pupa before opening pushes itself out of the case to the half of its length, sometimes still more and sometimes it even falls out. To push itself out it probably uses the pointed backwards thornlike processes situated on the dorsal side of the abdominal segments, from the 2nd one to the 8th one incl. On segments 7th and 8th they are bigger and on the ventral side there are no processes at all.

I had witnessed the hatching of the imago only once. On March 16th 1950 at 10 a. m. the cover of a pupa broke and three minutes later the imago was already in the crystallizer. At 10,17 the newly hatched female spread its wings and at 10,30 it put them down again. At 15,30 it was running restlessly in the crystallizer. The meconium of *Incurvaria oehlmanniella* Tr. is creamy white.

Finally I should like to draw attention to the occurrence in southern Poland of a lepidoptera from the genus *Incurvaria* Hw. which is externally very similar to *Incurvaria oehlmanniella* Tr. but which belongs undoubtedly to another species.

After having bred the imagines of *Incurvaria oehlmanniella* Tr. from the mines planted in the leaves of *Cornus sanguinea* L. I had undertaken the studies of their copulatory apparatuses. Then I compared these with the male and female copulatory apparatuses of *Incurvaria oehlmanniella* Tr. from the collection of the Museum Zool. of the Pol. Academy of Sciences in Cracow. The female was from F. Schille's collection and was caught

at Rytro near Nowy Sącz. Probably it was one of the specimens about which SCHILLE (11) wrote that he had beat them out from the bush at Życzanów and in the vicinity of Dominików in June and July. The male was from S. KLEMENSIEWICZ'S collection and had no name of the locality in which it was caught. It may be assumed that it was also collected in the environs of Nowy Sącz. In a paper by that author (9) there is a note saying that he had collected *Incurvaria oehlmanniella* TR. at Nowy Sącz and its environs in July 1883. Both specimens were determined by both above mentioned authors as *Incurvaria oehlmanniella* TR.

The comparison of the copulatory apparatuses of the male collected by S. KLEMENSIEWICZ with that of the male from Czerna bred from mine found on *Cornus sanguinea* L. did not furnish any considerable differences in structure. Only the number of big spines occurring on the posterior margin of the end of valva was different. The males from Czerna have 9—13 of these spines, the male from S. KLEMENSIEWICZ'S collection has only 6 of them. The lack of distinct differences is, however, not deciding in this case since, as S. TOLL (16) writes, in the family *Incurvariidae* the copulatory apparatuses, because of their considerable similarity are of little taxonomic value.

Distinct differences on the other hand can be seen in the structure of the female ovipositor. In the ovipositor of the female of *Incurvaria oehlmanniella* TR. from Czerna the apodemi bacilliformi interni form in the terminal part a cutting apparatus, destined to cut the epidermis of the food plant. In that apparatus three teeth can be distinguished; the middle one, the biggest of these, has finely serrated outer edges (fig 15b). In the cutting apparatus of the ovipositor of the female from SCHILLE'S collection the middle tooth has smooth edges without any traces of serrature (fig. 15a). Therefore I was justified in supposing that each of the two females belongs to a different species of the genus *Incurvaria* HW. It was necessary to decide which of them corresponds to the species described by TREITSCHKE. In order to solve this problem I asked Prof. E. M. HERING of Berlin to inform me what is the structure of the ovipositor of the females of *Incurvaria oehlmanniella* TR.

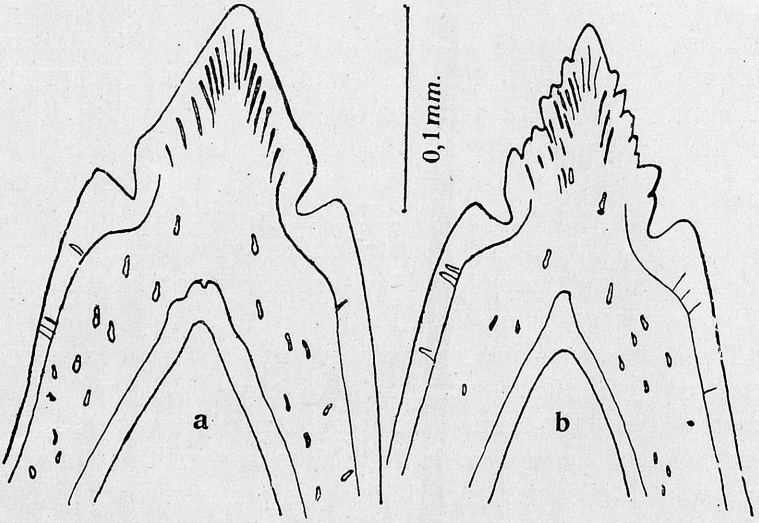

Fig. 15. The end of the ovipositor of the females of: a — *Incurvaria* Hw. (? sp.) from F. SCHILLE's collection, b — *Incurvaria oehlmanniella* Tr. from Czerna bred from leaf-mine planted on *Cornus sanguinea* L. Hatched on November 24th 1949.

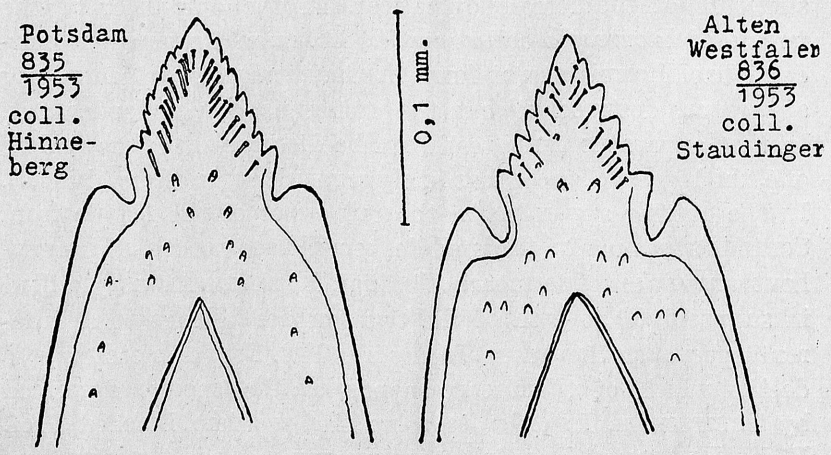

Fig. 16. The end of the ovipositor of the female of *Incurvaria oehlmanniella* Tr. Drawn by Prof. E. M. HERING.

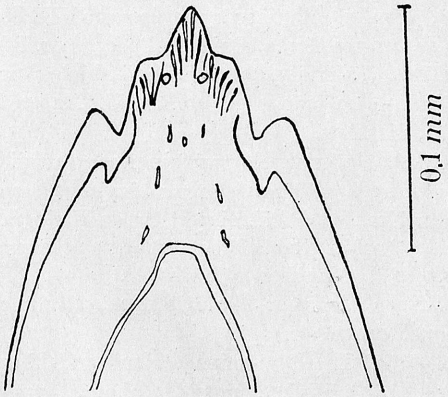

Fig. 17. The end of the ovipositor: a — of a female of *Incurvaria muscalella* Fb. bred from a leaf-mine planted in the leaf of *Vaccinium myrtillus* L. in the forest Las Wolski near Cracow. Hatched on April 14th 1952.

from the Museum of Berlin. Prof. E. M. Hering has sent me the drawings of cutting apparatus from the ovipositors of two females of *Incurvaria oehlmanniella* Tr. illustrated in fig. 16. One of the females is from Hinneberg's collection the other from Staudinger's. The shape of their ovipositors corresponds to a great degree to that of the female from Czerna. On account of this fact one can state with certainty that the mines described in this paper, planted at the apex or lateral margin of the leaf-blade of *Cornus sanguinea* L. are made by *Incurvaria oehlmanniella* Tr. It is still not known, however, to what species corresponds the structure of the ovipositor illustrated in fig. 15a.

In this place I take the opportunity to express my sincere thanks to Prof. E. M. Hering for the trouble taken in making the preparations of the ovipositors of the females of *Incurvaria oehlmanniella* Tr., making the drawings presented here (fig. 16) and furnishing me with detailed informations in reply to my problems and doubts.

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STRESZCZENIE

Autor w swej pracy zajmuje się głównie morfologią i rozwojem motyla *Incurvaria oehlmanniella* Tr., pobocznie zaś motylami, które występują w okolicach Krakowa, a które podobnie jak *Incurvaria oehlmanniella* Tr. zakładają miny w liściach tych samych roślin pokarmowych, tj. *Cornus sanguinea* L. i *Vaccinium myrtillus* L.

W liściach *Cornus sanguinea* L. pojawiają się miny *Antispila pfeifferella* Hbn. (ryc. 1b), *Antispila petryi* Mart. (ryc. 1c), a nadto niepodawane z tej rośliny, bo nierozpoznane, miny *Incurvaria oehlmanniella* Tr. (ryc. 1a, 5) i *Incurvaria muscalella* Fb. (ryc. 1d, 2a, b). W liściach zaś *Vaccinium myrtillus* L.

występują maleńkie miny *Coleoptera vacciniella* HS (ryc. 8c, 9), *Stigmella myrtilella* STT (ryc. 8d), *Incurvaria oehlmanniella* TR. i niepodawane dotychczas z borówki miny *Incurvaria musculella* FB. (ryc. 6a, b, c, 8b).

W rozdziale pierwszym podaje autor sposoby odróżniania min opuszczonych, zamieszkałych i pasożytniczych zakładanych w liściach *Cornus sanguinea*, a w rozdziale trzecim w liściach *Vaccinium myrtillus* L. W rozdziale drugim omawia miny *Incurvaria oehlmanniella* TR., które dzieli na szczytowe (ryc. 5a, b, 7a, b), około 90%, i boczne (ryc. 5c) około 10%; jedne i drugie dzieli jeszcze na pojedyncze (ryc. 5a, c, 7a) i podwójne (5b, 7b), pierwsze znacznie pospolitsze od drugich.

Następnie w rozdziale czwartym omawia sposób łowienia w dzień samców na przynętę, którą jest niezapłodniona samica, składanie jaj przez samicę w hodowli domowej, położenie jaj w liściu (ryc. 3, 4), zajmuje się długością trwania rozwoju zarodkowego (Tab. V), powstawaniem miny w liściu *Cornus sanguinea* L. (ryc. 12) i w liściu *Vaccinium myrtillus* L. (ryc. 13), śledzi rozwój gąsienicy żyjącej poza miną w worku, omawia jej budowę (ryc. 10, 11), rośliny pokarmowe i sposób odżywiania się nimi, podaje długość okresów bezżernych, poprzedzających linienie, ilość wylinek w życiu, ilość stadiów rozwojowych (Tab. VII), powiększania worka przez doszywanie nowych ścianek do niego, zwraca uwagę na związek zachodzący między linieniem a doszywaniem ścianek do worka (Tab. VIII i IX), zajmuje się plastycznością instynktu, która umożliwia gąsienicy wyjętej z worka wykonanie całkowicie nowego worka.

Omawia również porę lęgu motyla i długość trwania okresu poczwarkowego na wiosnę, który oblicza na niecałe 3 tygodnie.

Na koniec zwraca uwagę na istnienie w naszej faunie motyla, oznaczonego przez Fr. SCHILLEGO jako *Incurvaria oehlmanniella* TR., którego samice posiadają jednakże innego rodzaju pokładełko (ryc. 15) niż samice typowej *Incurvaria oehlmanniella* TR. (ryc. 15b i 16a, b).

РЕЗЮМЕ

Автор в своей работе занимается главным образом морфологией и развитием вида *Incurvaria oehlmanniella* Tr., а кроме того бабочками, встречающимися в окрестностях Кракова, которые подобно *Incurvaria oehlmanniella* Tr., минируют в листьях родственных растений: *Cornus sanguinea* L. и *Vaccinium myrtillus* L.

В листьях *Cornus sanguinea* L. встречаются мины *Antispila pfeifferella* Hbn. (рис. 1b) *Antispila petryi* Mart. (рис. 1c), а кроме того мины *Incurvaria oehlmanniella* Tr. и *Incurvaria muscalella* Fb., которые раньше не были находимы на этом растении, так как не были знакомы (рис. 1a и 5). В листьях *Vaccinium myrtillus* L. встречаюстя маленькие мины *Coleophora vacciniella* HS. (рис. 8e и 9), *Stigmella myrtillella* Stt. (рис. 8), *Incurvaria oehlmanniella* Tr. (7 и 8a) и не находимые раньше на этом растении мины *Incurvaria muscalella* Fb. (рис. 6a, b, c, 8b).

В первой главе автор описывает способы отличения покинутых, обитаемых и паразитических мин в листьях *Cornus sanguinea* L., а в главе третьей — в листьях *Vaccinium myrtillus* L. В главе второй оговорены мины *Incurvaria oehlamanniell* Tr., которые разделены автором на верхушечные (рис. 5a, b, 7a, b), около 90% и боковые (рис. 5c), около 10%; оба типа этих мин автор разделяет еще на одиночные (рис. 5a, c и 7a) и двойные (рис. 5b и 7b). Последние встречаются значительно реже.

В главе четвертой автор оговаривает способ ловли самицов днем при помощи неоплодотворенной самки, которая в этом случае играет роль приманки. Далее автор описывает кладку яиц в неволе и расположение яиц на листьях (рис. 3 и 4). Автор занимается вопросом продолжительности развития зародыша (таблица V), возникновением мин в листьях *Cornus sanguinea* L. (рис. 12) и *Vaccinium myrtillus* L. (рис. 13), следит за развитием гусеницы, живущей вне мины, в мешечке. Автор описывает: строение гусеницы (рис. 10 и 11), кормовые растения и способ питания ими гусеницы, продолжительность времени, в течении которого гусеница не принимает пищи, готовясь к линьке, количество линек в жизни и количество стадий развития гусеницы (таблица VII), увеличивание мешечка прн помощи пришивания к нему новых стенок. Автор обращает внимание на связь между линьками и дошиванием стенок мешечка (таблица VIII и IX). Далее автор занимается пластичностью ин-

стинкта гусеницы, которая позволяет гусенице, вынутой из мешечка, сооружить совершенно новый мешечек. Автор оговаривает также время появления бабочки и продолжительность стадии куколки, которая длится почти три недели.

Навонец автор обращает внимание на существование в польской фауне вида бабочки, причисленной Ф. Шилле к *Incurvaria oihlmanniella* Tr., у которого самка имеет иначе построенный яйцеклад (рис. 15a), чем у типичной *Incurvaria oehlmanniella* Tr. (рис. 15b и 16a и b).

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