THE INFLUENCE OF ARTEMISIA ABSINTHIUM ON NEIGHBOURING PLANTS

(An essay of Experimental Plant Sociology No. III)

by

G. L. FUNKE

(The Hague).

1. Introduction.

In 1939 Bode (2) published a paper on the influence of foliate excretions of *Artemisia Absinthium* on neighbouring plants. He stated that seedlings of *Foeniculum vulgare* and other species were hindered in their development when grown in the proximity, that is within 1 m of absinth plants; at a distance of 130 cm and further the development was normal. The leaves of *Artemisia Absinthium* bear glandular hairs which excrete ethereal oils and the alcaloid absinthiin; the latter substance is probably the main cause of the scanty growth of neighbouring plants. It is specially formed during dry, hot weather and appears in numerous droplets on the surface of the hairs, easily perceptible under the microscope. When a shower occurs a considerable part of it is washed away and spread on the vegetation nearby with the consequence above mentioned. The production is specially intense in the small leaves which are formed at the top of the plants towards the time of flowering and their inhibiting influence, therefore, is most marked at this stage. I may refer to Bode for a detailed description of the anatomy of the hairs and their excretion, and for many particulars about the chemistry and other characteristics of the substances produced.

Fröschel and the present author having taken some steps in the new field of experimental sociology (7, 8a-b), Bode's observations were of special interest to us; it was our intention to make experiments based thereupon, but as circumstances temporarily prevented us from collaborating I have continued our work alone in the way which will be described here.

2. Experiments at Leiden, 1941.

A hedge, 4 m long, of *Artemisia Absinthium* was planted in the Botanical Garden at Leiden; the material was taken from plants a few years old in the "Clusius Garden". The hedge was placed in an approxi-

mately West—East direction in order that the test species could be sown at the northern and at the southern side of it. In doing so any influence of factors such as sunshine, shade, etc. could be distinguished from that exerted by the absinth plants. The experiment was made on a plot of limy, rather poor garden soil, but as *Artemisia* itself as well as the chosen test species are not used to rich nutrition, this means no great impediment if at all; it appeared indeed that the development of the test plants, as far as they were outside the range of influence of the absinth, and that of the latter itself was perfectly normal, notwithstanding the fact that no manure was given. Competition for food may also be considered as negligible because none of the species used possesses an extensive root system. The experiments made at Lisse in 1942 have, amongst others, fully confirmed this assumption. The plot which was available for the experiment offered one disadvantage, viz. that it is surrounded by trees, so that the plants received full sunshine only during a restricted number of hours per day. The climate in 1941 was not very favourable; we had a spell of hot, dry weather from the middle of June till July 29th; during this time the peculiar smell of the absinth leaves was strong, an indication of their high content of alcaloid. Before and afterwards low temperatures and heavy rains prevailed; the leaves smelled faintly. Bode measured the excretion throughout the season and has indeed demonstrated that during a rainy period it sinks to a very low level. In spite of these factors, moderately contributory or even distinctly unfavourable, results were satisfactorily convincing.

The hedge was planted in the end of March. Owing to the cold spring its growth was slow, but on May 27th it had reached a height of 40 cm and on that day a number of test species were sown beside it, each in one or two rows of 1½ m long, perpendicular to the hedge, and this on both N. and S. sides. Thinning, spraying, etc. took place whenever it was necessary. The absinth plants lengthened rapidly during June to a height of ± 115 cm and started flowering towards the end of that month; consequently they formed most of their alcaloid exactly during the time when conditions for its production were favourable. The seedlings of May 27th, therefore, underwent the proximity of the absinth plants to the full during the first weeks of their growth and the results became soon visible. Other species were sown later in the season, when the weather was much less fine, and therefore they showed the influence of the absinthiin to a lesser degree and at a later stage of their development.

I will now briefly summarize the results obtained with the different test species.

Artemisia Absinthium. Sown in April; seedlings of 2 cm high were planted beside the hedge on May 20th; on July 25th they had reached a height of 35 cm and were cut near the soil; they started growth anew till the end of the season. No influence from the older plants in the hedge could be detected; the rows were equal in height over their whole length.

Salvia sclarea. Bode mentions that this species is sensitive to the absinthiin. It was sown on May 27th; the seedlings appeared on June 6th. On June 26th samples close by the hedge were distinctly smaller than

those which were further away from it; the differences accentuated gradually, especially on the S. side. On July 28th the diameter of the rosettes on this side was as follows: at a distance between 150 and 75 cm

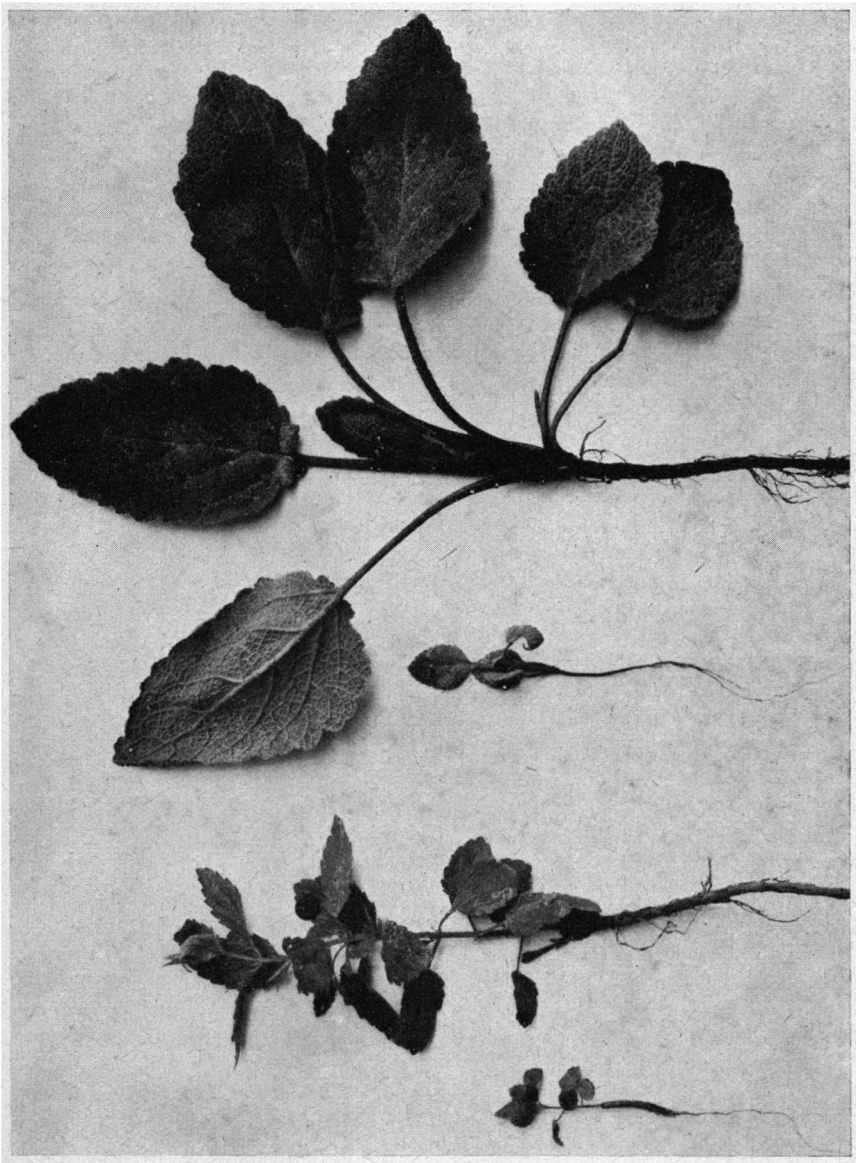

Fig. 1 — *Nepeta nuda* (l.) and *Salvia sclarea* (r.); resp. at distances of 40 cm (l.) and 120 cm (r.) from *Artemisia Absinthium*; 8 Aug. 1941.

from the hedge: 30 cm; within this distance it diminished to resp. 15, 12, 7, 3½, 2½ cm; those not farther away from the absinth plants than ± 40 cm, therefore, showed regular dwarf forms. The same held true

for the specimens on the N. side, but here the inhibitory effect of the absinth plants was only felt within a distance of 50 cm. Two specimens on the S. side, grown resp. at 120 and 40 cm from the hedge, were photographed on August 8th; see *fig. 1.* Table I gives an impression of the dimensions of the rosettes and the leaves on different data.

Levisticum officinale, Nepeta nuda, Carum bulbocastanum and *Lepidium sativum* were also sown on May 27th; their development and the influence of the absinth plants on it were much the same as in the case of *Salvia*; a detailed description, therefore, is superfluous; see the data in Table I and *fig. 1* (*Nepeta*) (Bode examined *Levisticum officinale, Carum Carvi* and *Nepeta cataria*). It is noteworthy that *Levisticum* was injured by the absinth to such a degree that on the S. side of the hedge the plants died up to 75 cm from it; the measurements are therefore given of specimens on the N. side.

Tagetes erecta nana, Zinnia Haagaana and *Calendula officinalis* were sown on July 17th; the fair weather ceased soon after that and consequently the production of absinthiin was scarce. These species, therefore, developed normally in the beginning; their specimens close by the hedge were equal in size to those at the greatest distance. This proves that the competition for food between the absinth and the test plants may be considered as of no importance. It was only in the course of September that the influence of the absinth became clearly visible; the specimens nearest the hedge remained small, their flowers were scanty and hardly opened, their stems were not ramificated; further particulars will be found in Table I.

We see that every species of test plant, with the exception of *Artemisia Absinthium* itself, underwent the influence of the alcaloid to more or less the same degree; this action made itself felt after a longer or shorter period according to the weather, but the final result was principally the same in every case.

In the end of July a number of specimens of *Salvia, Nepeta, Carum* and *Levisticum,* which had grown close by the hedge, were replanted to a place far outside the sphere of the absinth plants. During the ensuing months they recovered partially from the injurious influence of the alcaloid, but at the end of the season they still stayed far behind those specimens which had grown in normal conditions from the beginning. Not until 1942 they reached their full development. The same can be said about the specimens which were kept during the winter in the rows beside the hedge; in the autumn of 1941 they were cut at their base, as well as the absinth plants themselves; they all survived the severe winter 1941—42 and in the following spring they resumed growth, *Artemisia* last of all. The four test species very soon outgrew the plants in the hedge and started flowering without showing the least trace of impediment exerted by the absinth. They were then removed because I needed their space for other experiments. We see therefore that seedlings can be injured very considerably by the proximity of absinth plants, that they can be even killed by it (*Levisticum*), but that once they have survived its influence they can keep their ground.

TABLE I.

Development of the test species beside the hedge of *Artemisia Absinthium*.

Species	Date	Development at distances of 120 and 40 cm from the hedge; (dimensions in mm)	120 cm	40 cm
Salvia sclarea	28/7 –'41	diameter rosettes	300	70
	20/9 –'41	— —	600	120
	4/10–'41	length of petiole	210	20
		length of leafblade	155	30
Carum bulbocastanum	4/10–'41	height of plants	370	125
		length of leaf	270	90
Levisticum officinale	4/10–'41	length of main petiole	150	72
		length of top leaflet	40	25
Nepeta nuda	4/10–'41	height of plants	290	70
		length of leafblade	40	14
Lepidium sativum	14/7 –'41	dry weight per spec.	650 mg	190 mg
Tagetes erecta nana	4/10–'41	height of plants	455	240
		flowers per spec.	5—6	1
Zinnia Haagaana	16/9 –'41	ramification	normal	none
		flowers per spec.	4—5	1
Calendula officinalis	23/8 –'41	flowers per spec.	3—4	1
Perilla nankinensis	10/8 –'42	height of plants	320	60
		length of leaf	135	25
Dianthus barbatus	10/8 –'42	height of seedlings	70	22
Pisum sativum	31/8 –'42	height of plants	225	130
Hyssopus officinalis	14/8 –'42	height of plants	280	110
		ramification	normal	none
Linum usitatissimum	14/8 –'42	height of plants	460	240
Lavatera cretica	10/9 –'42	height of seedlings	150	75
		breadth of leafblade	44	19
Cheiranthus Allionii	10/9 –'42	height of seedlings	50	19
Dahlia variabilis	10/9 –'42	height of seedlings	150	70
		length of petiole	80	35
		length of leafblade	50	22
Iberis coronaria	10/9 –'42	height of plants	100	60
		length of petiole	36	14
Lysimachia punctata	10/9 –'42	height of seedlings	160	80
		length of leafblade	52	21

3. Experiments at Leiden, 1942.

The climate in 1942 was still much worse than in 1941. We had fine weather on July 3rd and 5th, but apart from these exceptional days low temperature and much rain prevailed throughout the first months of the summer season. The production of absinthiin, therefore, was without doubt very scanty (comp. Bode) and we need not wonder that the results in the beginning of the summer were on the whole negative. This was a. o. the case with *Foeniculum vulgare, Iberis coronaria, Pisum sativum, Phaseolus multiflorus, Phacelia tanacetifolia, Lathyrus Clymenum, Linum austriacum*; their development was equal, no matter whether they grew close by the hedge or at a distance from it. We shall see later on that this does not mean that they are insensitive to the absinthiin, but that it is really the lack of production of the alcaloid which is responsible for their undisturbed growth. That *Carum, Levisticum, Nepeta* and *Salvia* overcame the influence of the absinth plants in their second year is perhaps a fact which would have occurred anyhow, but on this occasion they were certainly helped in doing so by the weather conditions which, though unfavourable in themselves, overbalanced the otherwise still greater impediment of the alcaloid.

The results of 1941 were practically accomplished in the end of July; at the same time in 1942 hardly anything of this kind was to be seen yet. Therefore I sowed a number of species on August 3rd, some of them for the second time: *Pisum sativum* (2nd time), *Iberis coronaria* (2nd time), *Dahlia variabilis, Cheiranthus Allionii, Lavatera cretica. Hyssopus officinalis* (May 27th), *Lysimachia punctata* (May 27th) and *Linum usitatissimum* (June 17th), sown on the data mentioned after their names, were kept throughout the summer. The weather in August and September was a little better than during the foregoing months; notwithstanding this the species sown on August 3rd and *Lysimachia* did not develop beyond the seedling stage; but nevertheless the action of *Artemisia* became appreciable and gradually differences comparable to those observed in 1941 were visible in all species mentioned. Particulars about each of them will be found in Table I; these are sufficient to demonstrate that even in highly unfavourable conditions the action of the absinthiin can make itself felt and very distinctly so.

4. Experiments at Lisse, 1942.

I wanted to make perfectly sure that the influence of absinth plants on others is not illusory and therefore I repeated my experiments in different surroundings, viz. on the ground of the Laboratory for Bulb Research, Lisse near Leiden, where we find the soil characteristic for the bulb district along the foot of the dunes. The plot of ground put at my disposal was open to all winds and without any shade. Therefore the circumstances were widely different in many respects from those in the rather enclosed area at Leiden. In these conditions, moreover, the bad weather of 1942 made its influence doubly felt as was seen by the extremely slow development of all plants.

Besides this I extended the experiments to other species whose action on neighbouring plants was to be investigated, viz. *Artemisia vulgaris* and *Atriplex hortensis*. The former excretes ethereal oils, though not so much as *Artemisia Absinthium* and of different composition, and no absinthiin (3, 10, 14); the latter may be considered as perfectly "neutral", but is about the same height as the *Artemisia*'s and gives the same density of shade; it is, moreover, a nitrate plant, the food competition of which must be considerable. For the rest the experiment was carried out in the same way as those in Leiden, hedges of 4 m long in a E—W direction and on both sides rows of test plants, 2 m long and perpendicular to them. It goes without saying that the same test species were sown beside every-one of the hedges. I chose as such in the first place some of the species which in 1941 had proved to be very sensitive to the absinthiin, viz. *Salvia, Nepeta, Carum* and *Levisticum*, further *Linum usitatissimum* (which was also investigated in Leiden), *Dianthus barbatus* and *Perilla nankinensis*.

The hedges of both species of *Artemisia* were planted in the end of March; *Atriplex* was sown on April 16th. On June 2nd the *Artemisia*'s were only ± 30 cm high, of *Atriplex* a small number of seedlings were visible; therefore I sowed it a second time. Later on in the summer these plants as well as the *Artemisia*'s grew better and formed hedges of a height of ± 1 m (*Art. Abs.*) to ± 2 m (*Art. vulg.* and *Atriplex*).

The test species were sown on June 2nd and 18th. Except *Nepeta* which germinated irregularly, they grew well but very slowly and until the end of July they did not develop beyond the seedling stage. It was only in the beginning of August, when the hedges had reached a considerable height, that dwarf forms became visible in the specimens growing next to the absinth plants; these deviations became accentuated and in September they were as considerable as those which were observed in the experiments at Leiden; I refer to Table I for particulars. The results with *Salvia, Carum, Nepeta* and *Levisticum* are especially valuable because they confirm fully those of 1941. *Linum usitatissimum* presented identical phenomena at Leiden and at Lisse.

The test species sown besides *Atriplex* showed no deviation at all; the specimens close by the hedge, even those at the northern side of it, were exactly of the same height and general habitus as those at the greatest distance. Notwithstanding food competition, shade, etc., *Atriplex* appeared to exert no influence on the neighbouring flora. The same can be said about *Artemisia vulgaris*, but for a complication of secondary importance. Towards the end of July these plants had developed so abundantly and their side branches were so spreading and laid by the wind, that part of them had to be cut away and the others were tied up. It then appeared that they had oppressed the specimens of the test species growing under them, so that up to a distance of 60 cm from the hedge the test plants were very small, but those farther away from it were all full sized and there was no transition between these two groups. This fact demonstrates clearly that there is no question of any chemical action of *Artemisia vulgaris*. Beside the absinth plants, on the contrary, the aspect was quite different: there was a gradual decrease in height

as the plants stood nearer the hedge; between the tallest and the smallest there was at least a distance of 50—60 cm, whereas in the case of *Artemisia vulgaris* it was hardly 10 cm. The flax showed this best of all; I measured the height of the slender, unbranched stems in every decimeter of the rows and obtained data which could be plotted without any further arrangement. The 3 graphs, combined in *fig. 2,* show very clearly the chemical oppression exerted by *Artemisia Absinthium,* the

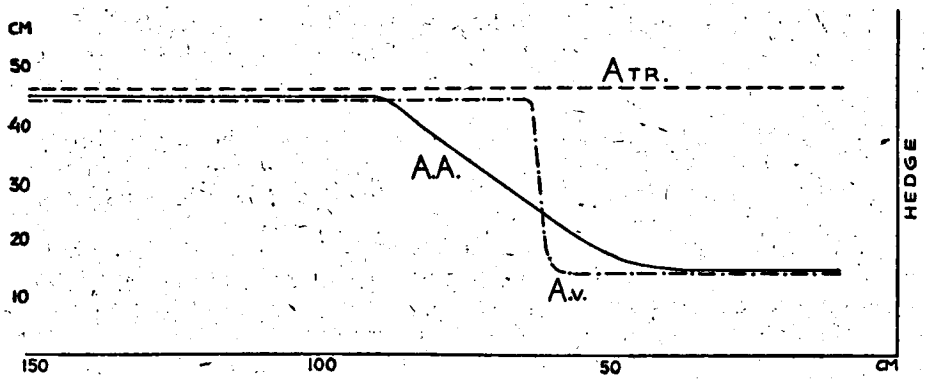

Fig. 2 — Height of *Linum usitatissimum*; 26 Aug. 1942.
———— beside the hedge of *Artemisia Absinthium* (chemical oppression).
—·—·—·— „ „ „ „ *A. vulgaris* (physical oppression).
— — — — — „ „ „ „ *Atriplex hortensis* (no oppression).

physical oppression of *Artemisia vulgaris* and in the case of *Atriplex hortensis* no oppression at all.

The results obtained at Lisse and Leiden justify the conclusion that the injurious action of *Artemisia Absinthium* on neighbouring plants is due to its secretion and most probably to that of absinthiin.

5. The influence of absinth leaves in the soil on germination and development of seedlings.

Bode stated that fresh or pulverized leaves of *Artemisia Absinthium,* dug in the soil where *Foeniculum* has been sown, reduce and retard the germination and inhibit the development of this plant. I extended this experiment to several other species. *Pisum sativum* and *Phaseolus multiflorus* were sown in open soil mixed with fresh absinth leaves, which were cut into small pieces; the results are recorded in Table II.

The retardation in the germination of *Pisum,* though considerable, lasted only a few days. The seedlings were smaller than those in the control, but these arrears too disappeared gradually until on August 11th they were no longer visible. *Phaseolus* appears to be much more sensitive to the absinth leaves; not only the percentage of germination never reached that of the control, but the development too was less vigorous and many of the plants kept an abnormal habitus, rolled up or undulated leaf blades, and did not recover, so that even in the middle of October the differences were still as distinct as in August. It is worth while

TABLE II.

Germination % with and without foliage of *Artemisia Absinthium* in the earth.

Date	*Pisum sativum*		*Phaseolus multiflorus*	
	Control	with fol. of *A. A.*	Control	with fol. of *A. A.*
25/7–'41	sown		sown	
31/7	89	3½	0	0
1/8	95	52	0	0
2/8	100	86	32	0
4/8	100	100	93	14
5/8			100	36
6/8			100	46
7/8			100	54
11/8			100	61
21/8			100	75
15/10			100	75

to recall the fact that in 1942 the absinth plants did not exert any influence on the beans, most probably because their production of absinthiin was checked by the bad weather; this sowing experiment shows that *Phaseolus* is by no means insensitive to the alcaloid.

In 1942 I continued these experiments with the species mentioned in Table III. Equal quantities of their seeds were sown in shallow square

TABLE III.

Germination with and without foliage of *Artemisia Absinthium* and *A. vulgaris* in the earth.

Species	Days	Control	*A. vulg.*	*A. Abs.*	Development
Cheiranthus Allionii	7	253	86	85	with *A. A.* small
	14	289	87	113	equal
Dianthus barbatus	7	241	152	60	with *A. A.* small
	14	282	191	135	equal
Lathyrus Clymenum	9	88		35	equal
Lathyrus magellanicus	4	22	20	12	
	23	26	29	23	with *A. A.* small
Levisticum officinale	13	28	30	16	
	15	35	38	30	with *A. A.* small
Linum austriacum	11	62		28	
	14	114		39	equal
Linum usitatissimum	9	152	153	110	equal
Perilla nankinensis	9	30	22	9	
	15	75	63	50	equal

bowls, in plain earth and in earth mixed with fresh leaves of resp. *Artemisia Absinthium* and *A. vulgaris*; the former ones had but a faint smell. The seedlings were counted every day; only the essential data are recorded in the table. These results, as well as those of 1941, tally well with what Bode observed in his experiments with *Foeniculum*. We see that in every case the germination is most rapid in plain earth, although it can catch up to some extent in the other bowls. The rate of development is not nearly so much influenced as the percentage of germination, but whenever this happens to be the case, the strongest inhibition is seen in the earth with absinth foliage. Bode observed a tendence to succulency amongst other phenomena in the plantlets of *Foeniculum*; I never detected anything similar.

When we compare the germination in the bowls with the foliage of *Artemisia Absinthium* and *A. vulgaris*, we see that, except in the case of *Cheiranthus*, the absinth leaves are the most injurious. *A. vulgaris* is by no means without influence, though; its retarding action is perhaps due to the ethereal oils, but this seems not very probable, witness the fact that in the field experiments no chemical influence of this plant on other species could be detected. It is therefore more probable that the inhibition of the germination must be ascribed to causes which will make themselves felt whenever there is a great quantity of organic manure in the soil; a high concentration of CO_2 will be one of the first among them. The same may hold true for *Artemisia Absinthium*; that absinth foliage does have an unfavourable effect on the germination of other species appears to be a fact, but as long as we do not know what exactly the action of absinthiin or other substances excreted by *Artemisia* is, added in pure condition to the soil, it is too risky to draw any conclusions from my experiments. It was my intention to spray the seedlings with infusions of absinth leaves; I awaited a sequel of fine summerdays for this purpose, but in vain.

Attention may be drawn to the fact that of all species investigated *Lathyrus Clymenum* and *Linum austriacum* are most strongly inhibited in their germination by the absinth foliage. In the early summer of 1942 they were also planted beside the absinth hedge and not injured at all because the amount of alcaloid produced during that spell of bad weather was not sufficient to assert itself; this case, therefore, is parallel to that of *Phaseolus*.

The foliage which remained on the plants of *Artemisia Absinthium* and *A. vulgaris* in the end of the autumn 1942 has been collected and dug under in reserved plots; next spring we will sow species on them which have appeared to be very sensitive to the fresh foliage in the soil; possible positive results may be of some ecological value.

Apple air has a strong influence on various life phenomena of plants, owing to its content of ethylene. Defoliation and chemonastic movements of the leaves are among the most conspicuous and rapid responses (9, 12). Species which in former experiments have proved to be extremely, sensitive in this respect, e. g. *Mimosa pudica*, were put under glass bells together with strongly smelling branches of *Artemisia Absinthium*; the alcaloid appeared to exert no influence whatever under these circumstances.

6. DISCUSSION.

Bode made the following experiment: 5 g of dry leaves, taken from the top of the absinth plants, were put in water; the cut surface of the petioles remained in the air, so that only substances excreted by the intact hairs on the leafblades could dissolve in the water; the surface of the lamina itself remains dry. After 10 minutes the leaves were removed, the water showed a yellowish tint and after evaporation there remained a dark brown residue weighing 130 mg. I repeated this experiment on hot, dry days in the summer of 1941, when the weather had been fine for a number of days in succession, in other words when conditions for the formation of absinthiin were at their best. I never obtained more than 48 mg of residue; the secretion is apparently much stronger in the continental climate of Geisenheim a. Rh. where Bode made his observations, than in the sea climate of Leiden. This is what one might expect according to the evidence yielded by the researches of de Saussure (13), Arens (1) and Lausberg (11). When, moreover, we bear in mind that on the whole the circumstances during the two last summers were extremely unfavourable for the production of the alcaloid, we can only wonder that the results have been as they were. Arens, Bode a. o. emphasize the empirical fact that drug plants should be harvested during dry, hot weather and never immediately after rain; they give several examples of species which are known to lose their active substances as soon as they are wetted by dew or otherwise (*Datura, Hyosciamus, Chelidonium*).

Artemisia Absinthium is a plant characteristic for a continental climate and in its habitat it cannot but exert a considerable influence on the neighbouring flora. Since I have never had occasion to observe it in its natural surroundings, I will be pleased to receive any information on this point. There was something which I could see myself, though, viz. in the nursery of medicinal plants of mr. A. C. Caspers at Noordwijk-Binnen. A field of two years old *Thymus vulgaris* bordered on the S.E. side of one of *Artemisia Absinthium*. The thyme was planted in rows, the three outward ones of which were at distances of resp. 40, 80 and 120 cm from the absinth. In the end of August 1942 I could observe that the first row had developed extremely poorly; especially where the soil was clayish most specimens had altogether disappeared; those which had survived where very small and many showed a sickly yellowish colour; from this row no appreciable harvest was obtained. The second row looked considerably better, yet was far from being normal; only the third row had remained free from the action of the absinthiin and was similar to the following ones. The distances at which the absinth plants made themselves felt here tally well with those in Bode's and my experiments. Another plot of thyme, sown in 1942, bordered on the N.W. side of a field of *Artemisia Absinthium*; although the distance between the species was 40 cm in this case too, no action of the latter on the thyme could be observed; this seemed the more remarkable because in my experiments it were precisely the seedlings which felt the influence of the alcaloid most strongly. Mr. Caspers ascribed this apparent inconsistency to the

prevailing wind which in this particular place comes from a northwestern direction.

A three year old crop of *Levisticum*, S.E. from an absinth field, was not injured by it; this tallies with my experience.

The weed vegetation in the absinth crop reacted very differently to it: *Stellaria media, Atriplex hortensis* and *Datura Stramonium* (migrated from a neighbouring field) grew as well as anywhere, but *Senecio vulgaris* was distinctly oppressed.

It goes without saying that what I saw in this nursery is communicated here by way of suggestion only; but I venture to add that these suggestions may prove to be valuable for further research.

Inventory of square meters in a region where *Artemisia Absinthium* occurs, must needs strongly vary according to whether it is present in the examined area or not.

Up till now Bode is one of the very few who have investigated the chemical action of a phanerogamic plant on others in its natural surroundings; the influence of emanations of plants on other species has often been studied under bell jars (4, 5, 9, 12), but this sort of research can hardly give an impression of their ecological significance. That these emanations occur in endless variety has long been known; that they are of higher ecological importance than many botanists up till now were inclined to acknowledge (6), was made clear by the work of Arens and Lausberg. Plant ecology and sociology should certainly reckon with this fact; for further discussion on this point I may refer to the literature cited elsewhere (8 c-d).

7. Summary.

Eighteen species of plants, most of which were chosen at random, were sown beside a hedge of *Artemisia Absinthium*; they were severely injured and in one case (*Levisticum officinale*) even killed by the chemical excretions of the latter within a distance of ± 100 cm; seedlings of *Artemisia Absinthium*, on the contrary, were not harmed by the plants in the hedge. The experiments were made during two successive summers and in different surroundings; the results were consistent and confirmed those of Bode, notwithstanding the fact that climatic conditions were extremely unfavourable for the excretion of absinthiin and that even during fine weather it appeared to be feeble owing to the sea climate of Leiden. Spells of cold and of heavy rains sometimes kept the excretion so low that temporarily the absinth plants seemed to exert no action at all.

Seedlings which had survived the proximity of the absinth in their first year developed normally during the next season.

It was demonstrated that the proximity of *Atriplex hortensis* had no influence on the same test plants which were injured by *Artemisia Absinthium* and that they were only physically oppressed by *Artemisia vulgaris*, viz. by its spreading branches. This makes it probable that it is indeed the absinthiin, excreted by *Artemisia Absinthium*, which causes this species to be harmful to the surrounding plants.

Fresh leaves of *Artemisia Absinthium*, dug in the soil, reduced the percentage of germination and sometimes also hindered the development of the seedlings of a number of species. Foliage of *Artemisia vulgaris* had sometimes a similar action, but seldom to the same degree. In the case of *A. Absinthium* two harmful effects are apparently combined: a too great amount of organic manure and the formation of absinthiin.

It will be worth while to examine the ecological importance of *Artemisia Absinthium* in its natural habitat.

I want to express my heartfelt thanks to everyone in the Botanical Institute and in the National Herbarium at Leiden who helped me to carry out these researches.

I feel greatly indebted to the Director and the staff of the Laboratory for Bulb Research at Lisse who very kindly enabled me to extend my experiments.

Leiden, Botanical Institute. November 1942.

Literature

1. ARENS, K., Die kutikuläre Exkretion des Laubblattes. — Jahrb. wiss. Bot., 80, 1934, 248.
2. BODE, H. R., Ueber die Blattausscheidung des Wermuts und ihre Wirkung auf andere Pflanzen. — Planta, 30, 1939, 566.
3. CZAPEK, F., Biochemie der Pflanzen. — 3e Aufl. 1922.
4. DETTO, C., Ueber die Bedeutung der aetherischen Oele bei Xerophyten. — Flora, 92, 1903, 147.
5. DIXON, H. H., On the effect of stimulative and anaesthetic gases on transpiration. — Proc. Roy. Irish Soc., ser. III, 4, 1898, 618.
6. FREY-WYSSLING, A., a) Die Stoffausscheidung der höheren Pflanzen. — 1935;
   b) Het geheim van het natregenen der tabak. — De Trop. Nat., 24, 1935, 206;
   c) Ueber die kutikuläre Sekretion. — Verh. Schweiz. Nat. forsch. Ges., 1937, 146.
7. FRÖSCHEL, P., en FUNKE, G. L., a) Een poging tot experimenteele plantensociologie (An essay of experimental plant sociology). — Nat.wet. Tijdschr., 21, 1939, 348;
   b) Ein Versuch zur experimentellen Pflanzensoziologie II (An essay of experimental plant sociology II). — Biol. Jaarb., 7, 1940, 267.
8. FUNKE, G. L., a) Essai de phytosociologie expérimentale. — Bull. Soc. d'Hist. Nat. Toulouse, 73, 1940;
   b) Een poging tot experimenteele plantensociologie. — Hand. Ned. Nat. en Geneesk. Congres, 28, 1941, 135;
   c) Bouwstoffen voor eene experimenteele plantensociologie. — Vakbl. v. Biol., 23, 1942, 50 en 61;
   d) Experimenteele plantensociologie. — J. Noorduijn & Zn. N. V., Gorinchem, 1943 (in press).
9. FUNKE, G. L., F. DE COEYER, A. DE DECKER and J. MATON, The influence of the emanation of apples on several life phenomena of plants. — Biol. Jaarb., 5, 1938, 335.
10. HEGI, G., Illustrierte Flora von Mitteleuropa, Vol. VI, 2.
11. LAUSBERG, T., Quantitative Untersuchungen über die kutikuläre Exkretion des Laubblattes. — Jahrb. wiss. Bot., 81, 1935, 769.
12. MOLISCH, H., Der Einfluss einer Pflanze auf die andere; Allelopathie. — 1937.
13. SAUSSURE, TH. DE, Recherches chimiques sur la végétation. — 1804.
14. WEHMER, C., Die Pflanzenstoffe. — 2e Aufl., I 1929, II 1931, III 1937.