INSTITUTE OF ECOLOGY-POLISH ACADEMY OF SCIENCES

EKOLOGIA POLSKA

Vol. XX Warszawa 1972 No. 41

Institute of Biological Basis of Animal Breeding, Agricultural College, Szczecin

Jarosław PRABUCKI

THE HONEYDEW-SECRETING APHID *PHYLLAPHIS FAGI* L. (*HOMOPTERA*) AND ITS LIVING CONDITIONS IN THE „BEECH FOREST" NEAR SZCZECIN FROM THE ASPECT OF BEE-KEEPING REQUIREMENTS

(Ekol. Pol. 20: 561–591). The purpose of this study was to examine variations in numbers and vertical distribution of a population of *Phyllaphis fagi* L. in the undergrowth and crowns of the beech (*Fagus silvatica* L.). In addition an attempt was made at ascertaining the ecological factors affecting uneven development of different generations of aphids. Observations show that aphids develop best in the top layers of tree-crowns in spring, but in the lower layers in autumn, and in summer in the upper layers of the undergrowth. The numbers of aphids depended on the combined action of food, temperature and humidity conditions.

The increasing interest taken in honeydew for both theoretical and practical reasons, and the insufficient information on this problem available in Poland induced me to undertake studies on the possibilities of obtaining honeydew from deciduous trees and shrubs. The present study forms a partial result of these investigations.

Honeydew produced on deciduous trees can, according to: Zöbellein (1956a, 1956b), Schmutterer 1952, 1953, 1954, 1956, 1958), Schels (1958, 1962, 1964), Fossel (1962, 1963), Haragsim (1966), Prabucki (1967, 1968), is one of pastures used by bees, and therefore from the economic point of view it is important to ascertain what factors limit the development of honeydew producers.

The beech is the dominating species of deciduous tree in the Szczecin area, and on this account it was decided to examine possibilities of obtaining honeydew in relation to the beech aphid – *Phyllaphis fagi* L. This aphid is the chief producer of beech honeydew collected by bees (Zöbellein 1956a, 1956b, Haragsim 1966). Studies by Burschel and Vite (1951), Schmutterer (1952) and the sporadic mention in beekeeping literature of this aphid supplies a certain amount of information on its biology and usefulness in beekeeping. The problem of its food and climatic requirements, and the causes of its uneven development during the growing season have, however, been overlooked up to the present, neither has any mention been found of the spatial distribution of *Phyllaphis fagi* L. in beech tree crowns. The chief food mass of this aphid is located in the crowns of trees, which suggests that it is necessary to concentrate studies on this part of trees.

The aim of this study was to examine vertical distribution and variations in numbers of a population of *Phyllaphis fagi* in tree-crowns and seedling beeches (*Fagus silvatica* L.), and also to ascertain what factors inhibit the development of its various generations. A further task was to examine its usefulness for beekeeping purposes in areas with extensive beech stands.

DESCRIPTION OF STUDY AREA

"The Beech Forest" is situated to the south of Szczecin and extends in an elongated belt in a NW-SE direction, is bordered in its north-west part by the south-west parts of the city of Szczecin (Klęskowo, Zdroje, Podjuchy). The south-west fringe of the Forest is situated in the Gryfino administrative district. The eastern limits of the Forest run along the river Płonia, and the western along the River Oder (Fig. 1). The belt is approx. 15 km long and 4–6 km broad and it covers a total area of approx. 7800 ha.

Two trees in age class VI, situated in the southern and southeast part of the „Źródliskowa Buczyna" reserve, in sector 222 and 224 of the Glinna Forest Administration district, were chosen for the studies (Fig. 1). Beech tree I grew at the base of a gentle slope with a western exposure. It is located in the subassociation *Melico-Fagetum festucetosum silvaticae*, bordered on the west side by a small area of very boggy *Carici elongatae Alnetum* association, with almost constantly standing water. Beech tree I grew on the edge

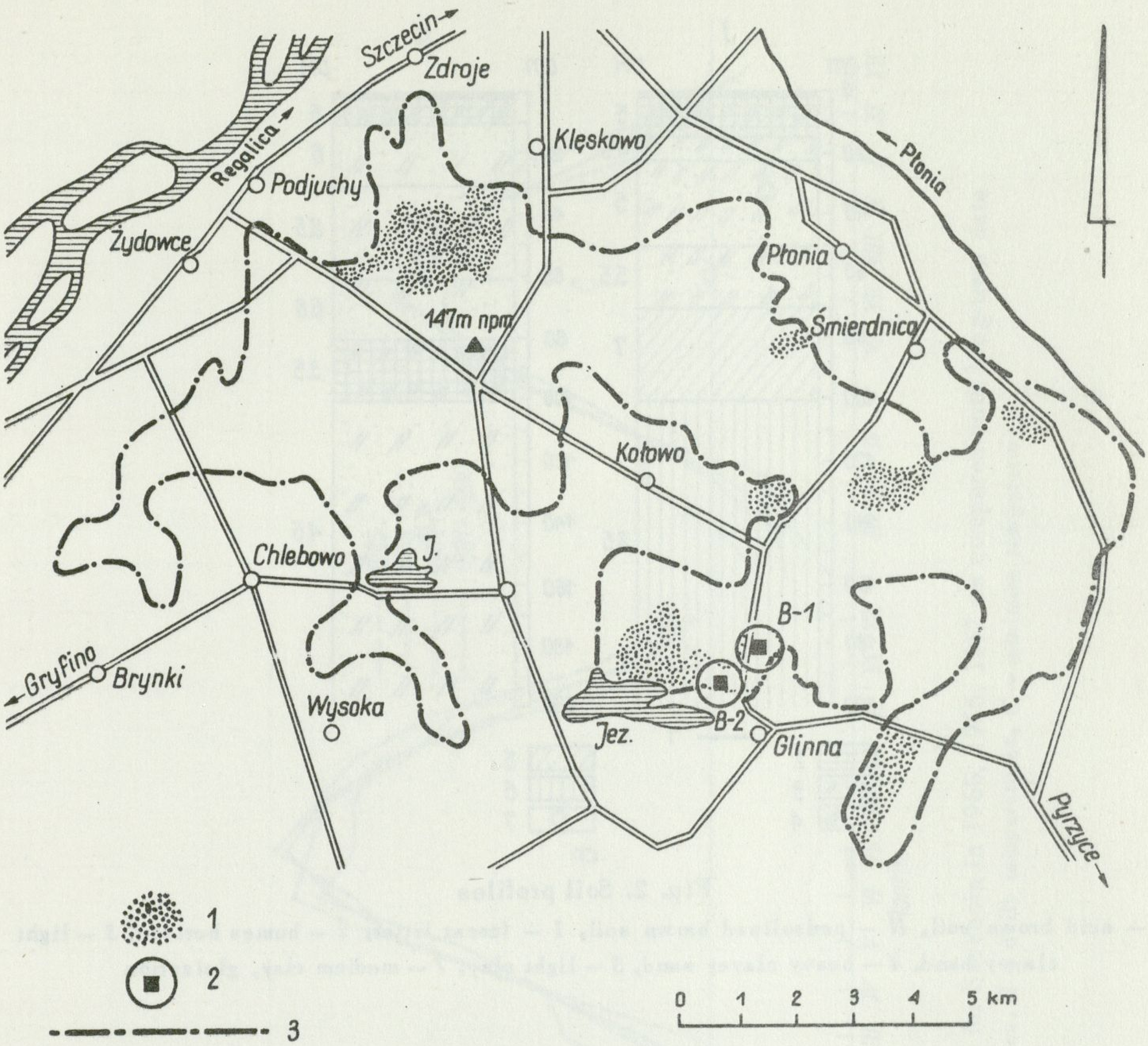

Fig. 1. Plan of Beech Forest near Szczecin

1 – reserves, *2* – Study areas, *3* – boundary of the forest

of the forest, on a gentle slope with a north-west exposure, and is completely open on the south side, while on the west, east and, through a road, north sides, is in contact with the crowns of neighbouring trees. It is located in the sub-association *Melico-Fagetum typicum*, which on the north and west sides is bordered by a small area of the *Fago-Quercetum* association and with the wet depression, with constant standing water, covered by the *Carici – remotae-Fraxinetum* association. The tree stand of these associations belongs to age classes V and VI and its density is from 75 – 80% (Celiński 1962). Seedling beech trees from 3–20 years old are encountered near the stations described, which are characterized by the occurrence of brown soils (Fig. 2).

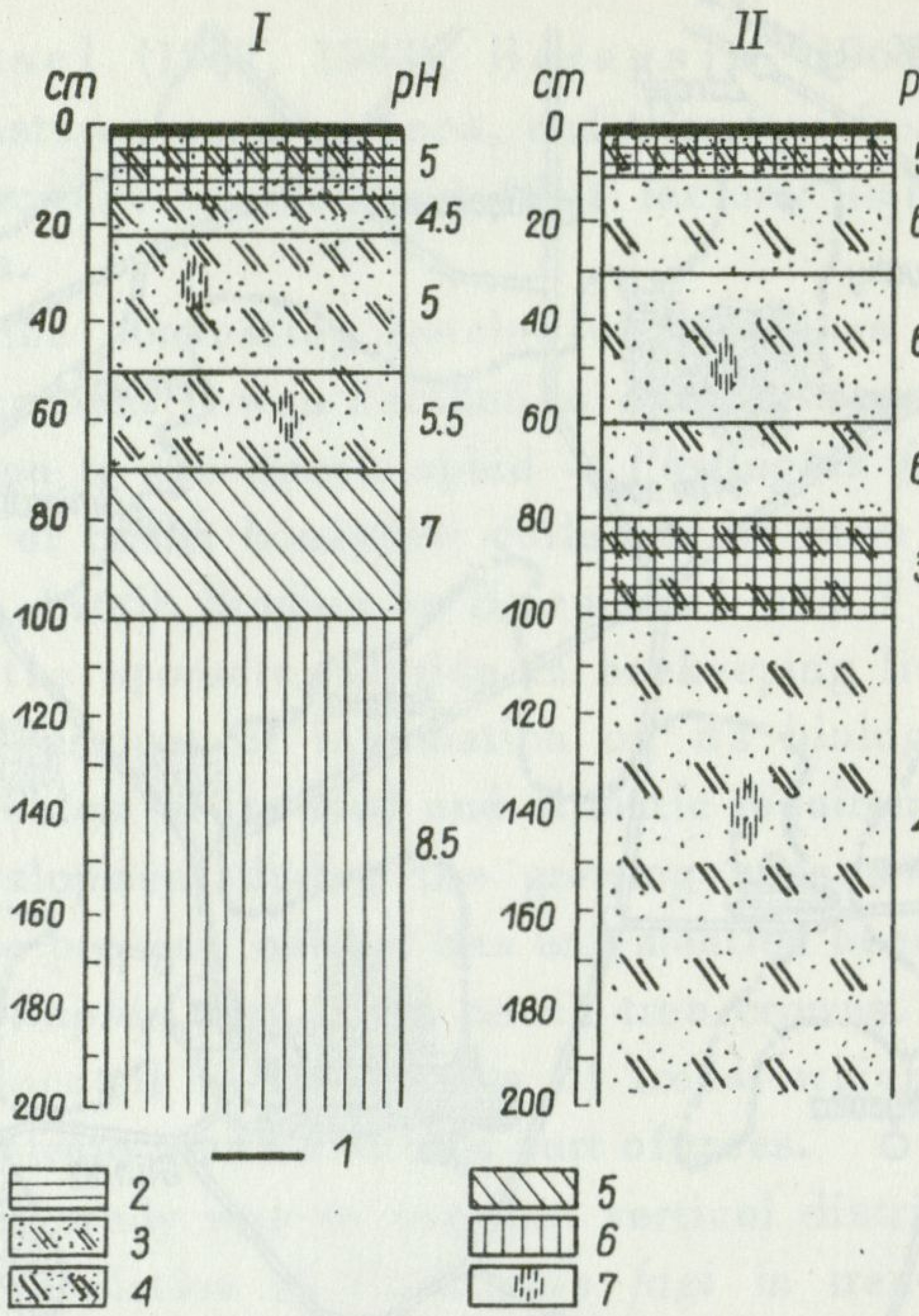

Fig. 2. Soil profiles

I – acid brown soil, *II* – podsolised brown soil, *1* – forest litter, *2* – humes horizon, *3* – light clayey sand, *4* – heavy clayey sand, *5* – light clay, *7* – medium clay, gleization

CLIMATE

The climate of the upland belt of beech forests is characterized by annual precipitation of over 600 mm, with about 180 mm for the months of May-July. Average annual temperature varied from 7–7.6°C, average temperature for May-July from 14–15°C, and average daily amplitude from 9.5–11.0°C. (Prawdzic 1961). Average temperatures for the spring and summer months for the period 1965–1967 did not exhibit any great deviation from long-term normal values (Wiszniewski, Gumiński, Bartnicki 1949), but May was colder during the study period (Fig. 3). Maximum rainfall in Szczecin and Glinna for 1965–1967 occurred during the spring and summer months, culminating in July (Fig. 4). The distribution of monthly rainfall averages was similar to that for long-term periods (Wiszniewski 1953). Atmospheric humidity during the study period was always higher in the interior of the forest (Beech I) than on its fringe (Beech II). From the climatic aspect the period 1965–1967 was typical of this region.

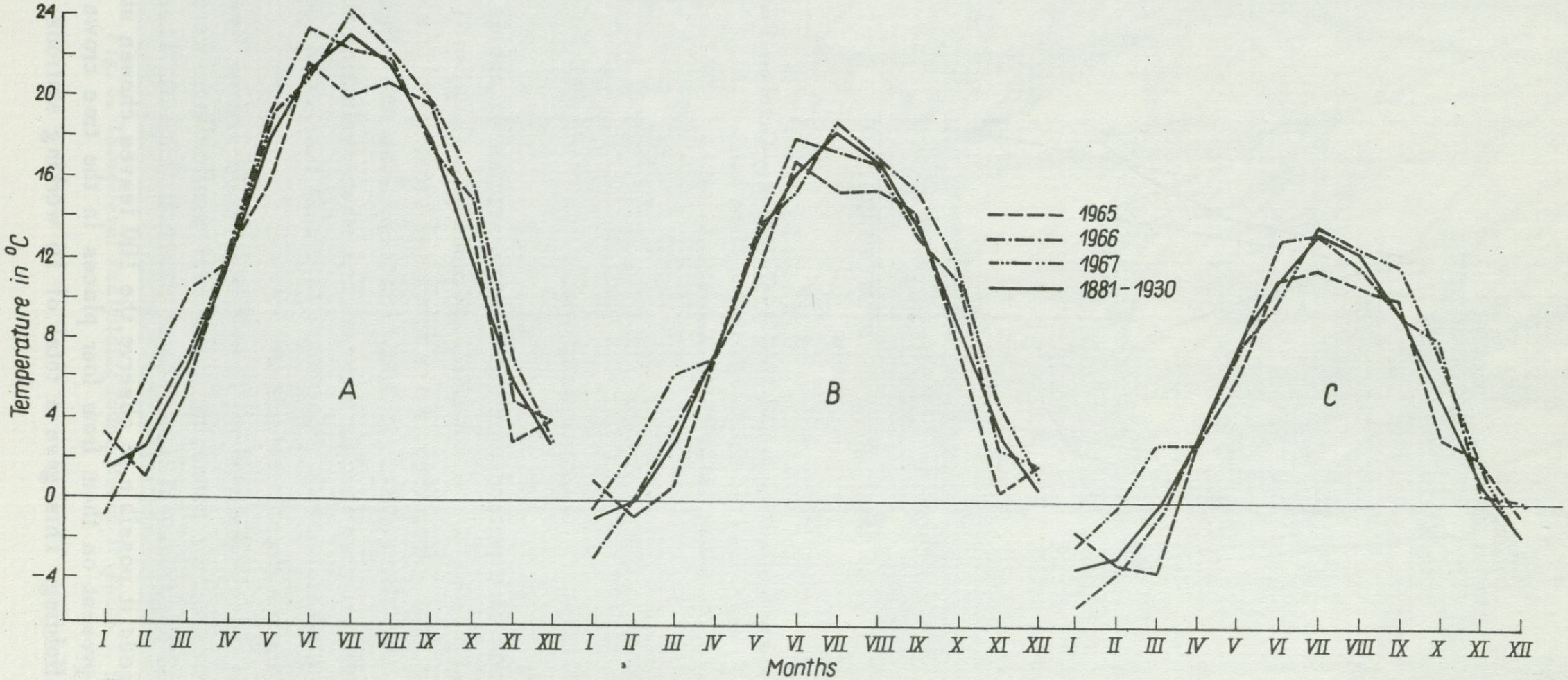

Fig. 3 – Average monthly temperatures for Szczecin in 1965, 1966, 1967 as compared with long-term data
A – maximum temperatures, *B* – daily temperatures, *C* – minimum temperatures

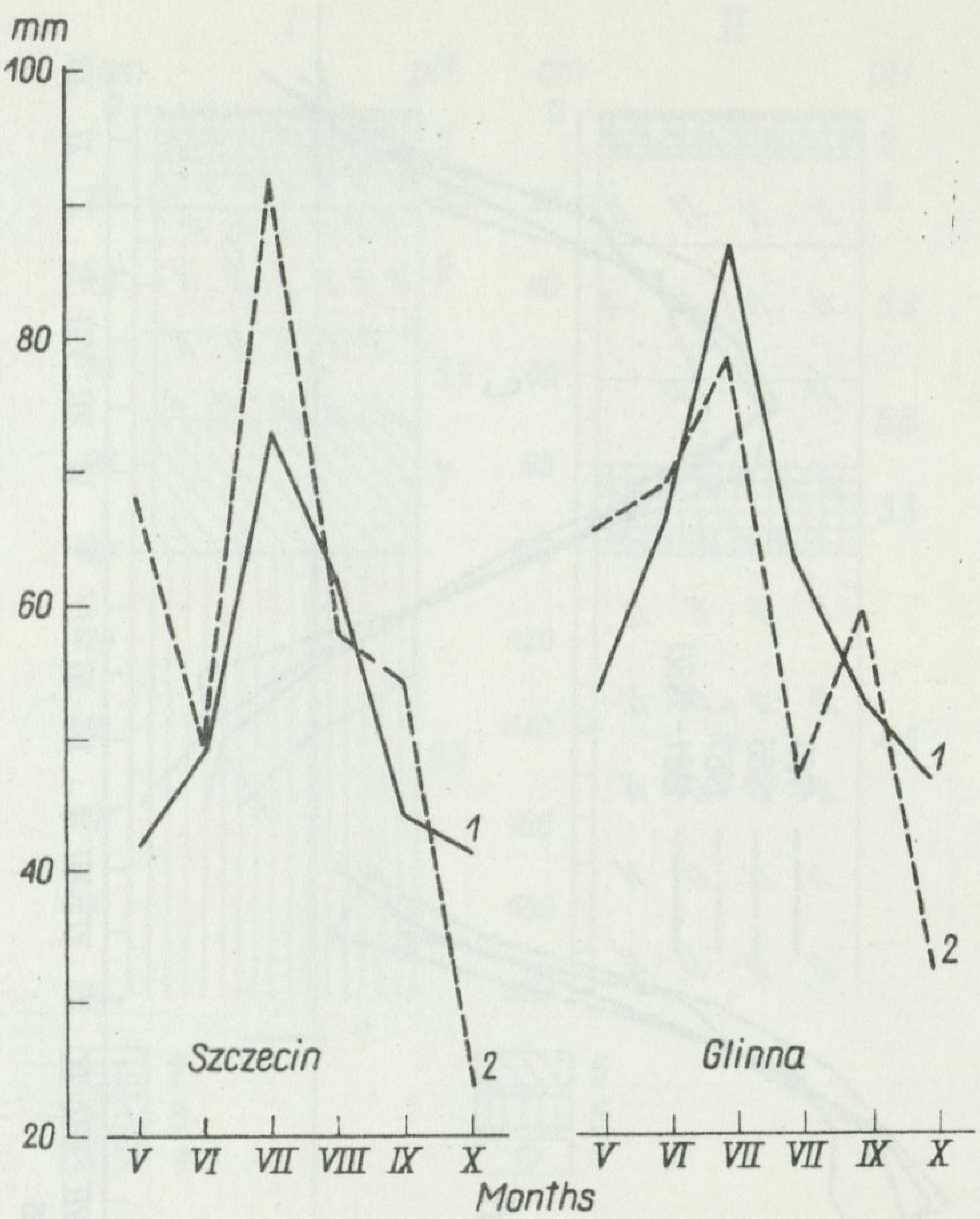

Fig. 4. Average monthly rainfall for period 1965–1967 form May-October. For Szczecin and Glinna, as compared with long-term data
1 – period 1891–1930, *2* – period 1965–1967

STUDY METHODS

The most appropriate methods for quantitative studies on aphids of trees and shrubs would appear to be numerical methods (Łęski, Smolarzowa 1959, Achremowicz 1966, 1968, Karczewska 1964, Berliński 1956, 1958). Mathys and Baggiolini (1965), in comparing the effectiveness of different methods, showed that the best method when evaluating the actual numerical state of aphids in tree plantations is visual inspection, consisting in counting individuals and aphid colonies.

The method of calculating numbers of aphids from 100 leaves was adopted in the present study. Two permanent three-level scaffoldings were erected in July 1965 round the trunks of Beech I and Beech II (Fig. 5). These tower-like structures made it possible to observe the 100 leaves chosen at random, with the aphids present on them from four places in the tree crown on each level of the scaffolding. This gave a total of 16 working stations with 100

Fig. 5. Three-level scaffolding round Beech II (photo J. Prabucki)

leaves each, that is, 1600 leaves on each tree. The various levels were numbered as follows: level I at a height of about 200 cm from ground level (within hand reach from the ground), level II – in the case of Beech I – 670 cm and Beech II – 570 cm, level III – for Beech I – 1030 cm and Beech II – 960 cm, level IV for Beech I – 1350 cm and Beech II – 1310 cm. The first working stations at each level faced south, the second west, the third north and the fourth east.

Observations were also made in the undergrowth, examining the numbers of aphids on 3–20 year old beech seedlings in the immediate vicinity of Beech I and II. As the shortest seedlings had very scanty foliage aphids were counted there from the surface of 20–50 leaves. The numbers of individuals observed were next calculated per 100 leaves, so as to obtain comparable results. Four working stations were chosen: level I – seedlings up to 20 cm high, level II – seedlings up to 50 cm, level III seedlings up to 100 cm and level IV – seedlings over 100 cm high.

Observations were carried out once weekly, starting with the development phase of beech leaves (May) up to the period of golden tree crowns (October).

When investigating factors reducing population development the following conditions were considered: food, temperature, rainfall, humidity, exposure and position of the tree in the habitat and occurrence of enemies or allies.

The basic component of aphids' food is plant protein, and consequently endeavour was made to ascertain what percentage of raw and true protein is present in beech leaves. As a result chemical analyses were made for nitrogen compounds content in leaves. Leaves for analysis were taken during the period of maximum development of the population in June, and again during the second 10-day period of July, when there was an abrupt drop in the numbers of aphids. Total nitrogen (raw protein) was identified by Kjeldahl's method, and true protein by Bernstein's method.

Automatic recording instruments were used for tracing microclimatic conditions. Weekly thermohygrographs were installed on each tree, in typical meteorological houses situated in the tree crowns, at a height of 1080 cm from the ground in Beech I and 960 cm for Beech II. Tapes in the instruments were changed during the weekly observations made. Readings of rainfall were made daily at 7 a.m. A Helmann pluviometer was installed at a height of 1 m above ground level in the gamkeeper's cottage at Glinna.

Average values and calculated correlation coefficients were used when analysing results. These relations were established on the basis of results for 1966 and 1967 treated jointly. For each pair of relations separate correlation tables were drawn up in accordance with the recommendations of Oktab (1966) and Ruszczyc (1970). The information obtained make it possible to present a picture of correlations and calculate correlation coefficients.

In order to find whether the correlation coefficient was significant the results were compared with extreme values with $P_{0.05}$ and $P_{0.01}$. All the(r) values calculated equal to, or greater than, the extreme value(r_{theor}) were significant.

VARIATIONS IN POPULATION NUMBERS

Vertical distribution of aphids in tree crowns

Differences in numbers of aphids in different layers of treecrowns are illustrated in figures 6 and 8. The data they contain are averages for two study years.

Tree crown of Beech I. The development of aphids on Beech I began on May 10th on level I, II and IV, but on level III after May 17th from this time an systematic and rapid increase was observed in the number of aphids, particularly on levels III and IV, and less rapid on levels I and II (Fig. 6). Sum-

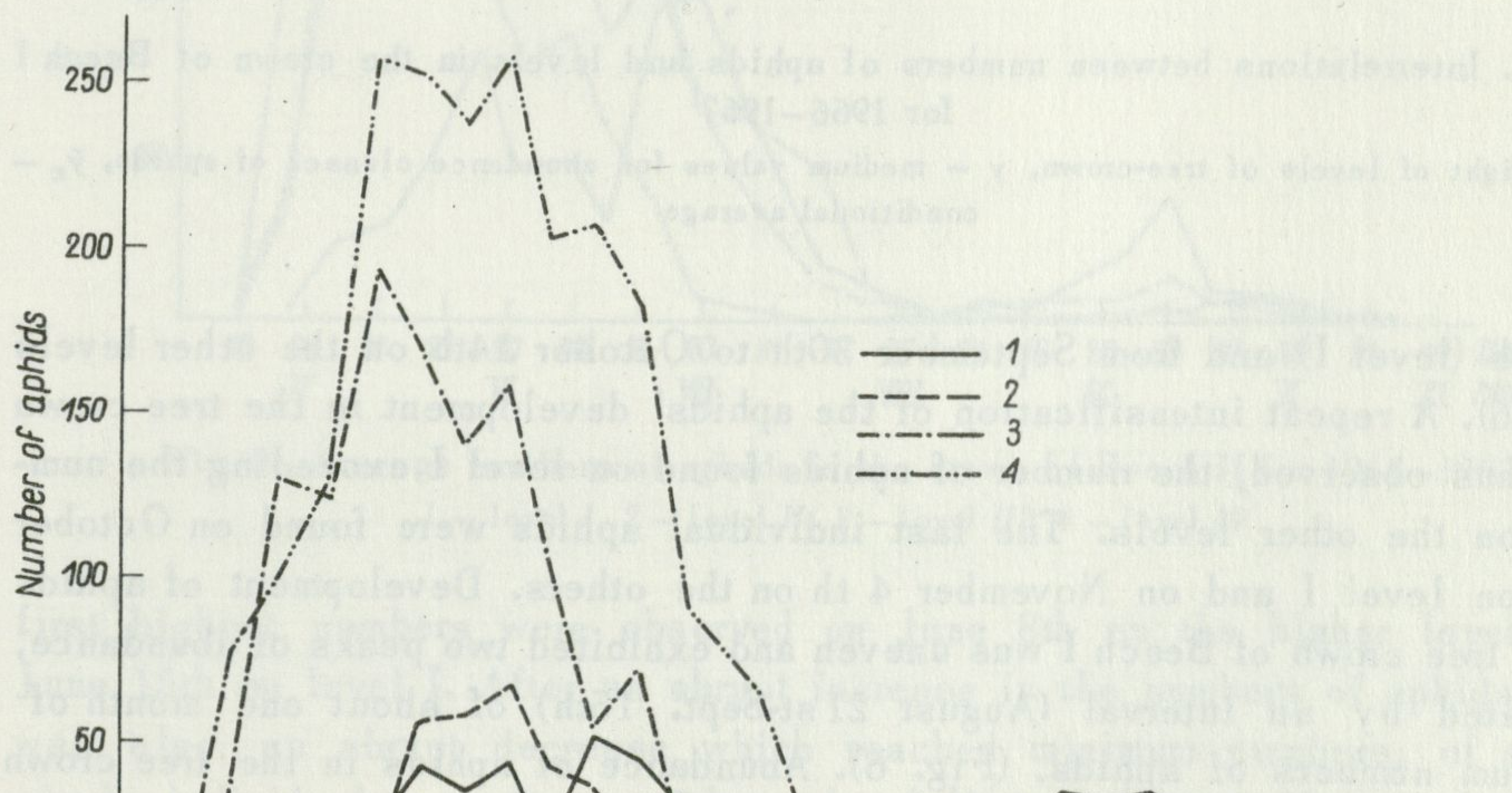

Fig. 6. Average numbers of aphids in the crown of Beech I for 1966–1967
1 – level *I*, *2* – level *II*, *3* – level *III*, *4* – level *IV*

mer peak numbers of aphids were observed during the period from June 8th to 29th on level III and IV and from June 15 th to 29th on level I and II. As from June 29th the number of aphids continually decreased, and underwent almost complete reduction during the second 10-day period of August (Fig. 6). The aphids found optimum living conditions on level IV, where they fed on leaves from May 10th to August 21st, then in turn on level III (17th May--August 14th) and level II (May 10th to August 7th) and level I (May 10th to August 21st). From the beginning of September the number of aphids again increased, reaching their culmination during the period from September 23rd

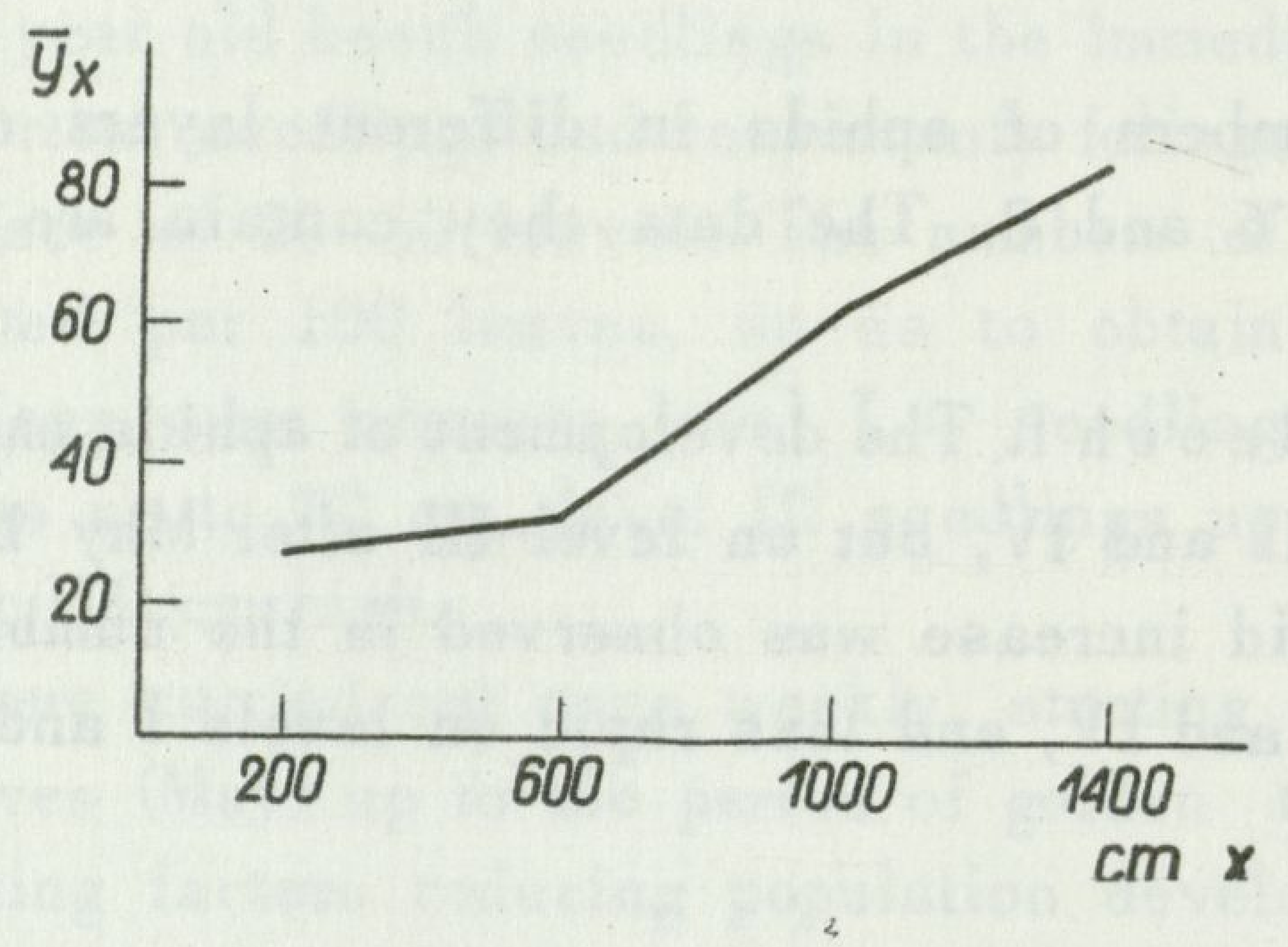

Fig. 7. Interrelations between numbers of aphids and levels in the crown of Beech I for 1966–1967

x – height of levels of tree-crown, y – medium values for abundance classes of aphids, $\bar{y}_x$ – conditional average

to 30th (level I) and from September 30th to October 14th on the other levels (Fig. 6). A repeat intensification of the aphids' development in the tree crown was thus observed, the number of aphids found on level I exceeding the numbers on the other levels. The last individual aphids were found on October 21st on level I and on November 4 th on the others. Development of aphids in the tree crown of Beech I was uneven and exhibited two peaks of abundance, seperated by an interval (August 21 st-Sept. 15th) of about one month of minimum numbers of aphids. (Fig. 6). Abundance of aphids in the tree crown of Beech I depended on the height at which the insects fed. Aphids occurred in the greatest numbers and for longest at level IV, then III, II and I, whereas in autumn they occurred on the first most numerously, and in small numbers only on the remaining levels. The correlation curve (Fig. 7) confirms the phenomenon observed, since it shows that abundance of aphids increases with increase in the height of the level. The correlation is thus positive and coefficient $r = 0.416$, with $r_{theor} = 0.195$ ($P_{0.05}$) and 0.254 ($P_{0.01}$), points to the highly significant correlation between abundance of aphids and layers of the tree crown.

Tree crown of Beech II. The development of aphids on Beech II began on May 10th on levels II, III and IV, and on May 17th on level I (Fig. 8). The

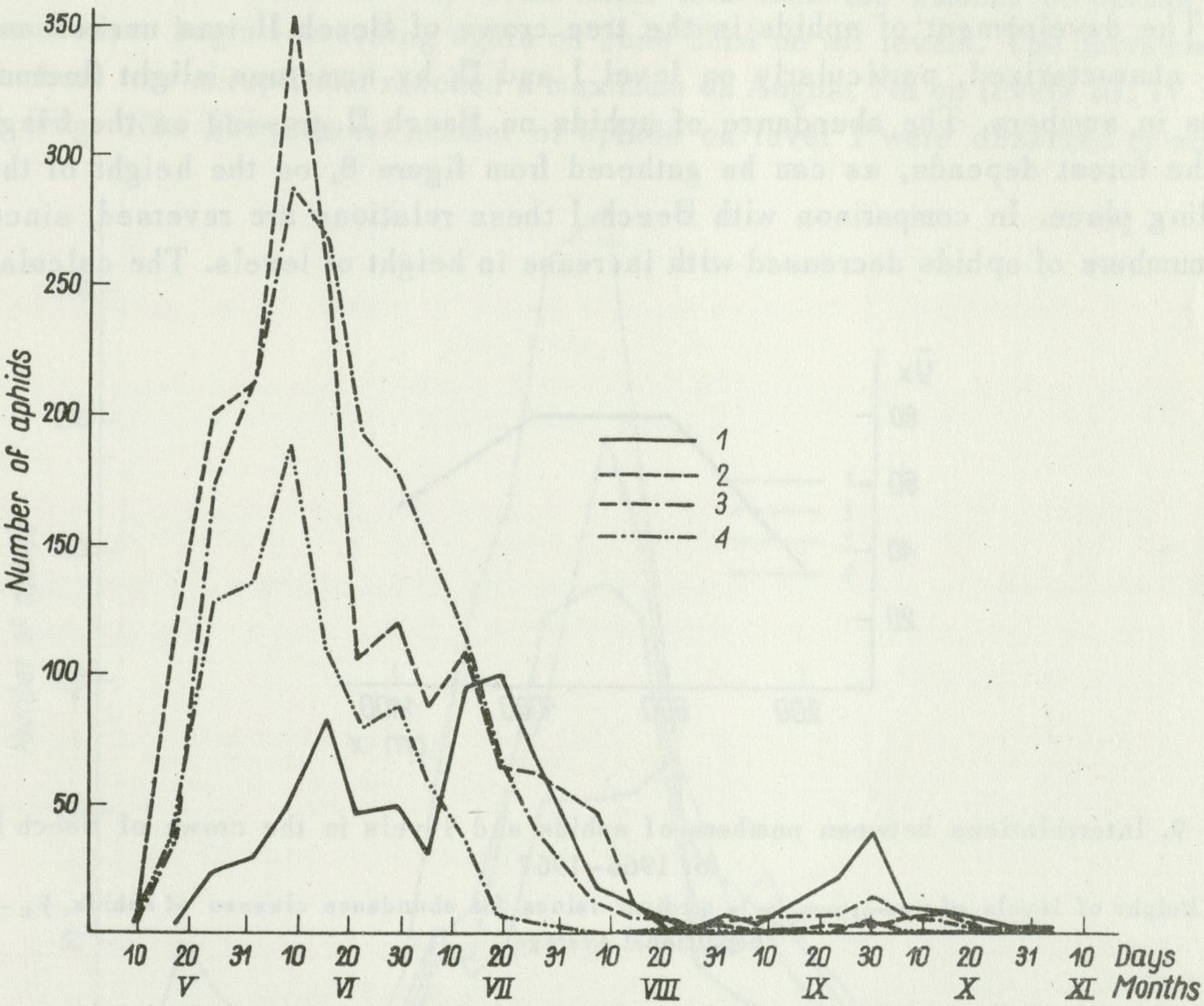

Fig. 8. Average numbers of aphids in the crown of Beech II for 1966–1967
1 – level *I*, *2* – level *II*, *3* – level *III*, *4* – level *IV*

first highest numbers were observed on June 8th on the higher levels and June 15th on level I. After an abrupt increase in the numbers of aphids there was also an abrupt decrease which reached minimum numbers, of almost single individuals, on August 7th on level IV and August 21st on levels. II and III. Abundance of aphids exhibited two summer maxima on level I – the first on June 15th and second during the period from July 12–19th. These peaks were separated by the reduced numbers of aphids during the period from June 22nd to July 15th. A second period of reduced numbers was observed from August 21st to September 8th (Fig. 8).

The autumn maximum numbers occurred on level I only. Although the other levels exhibited a slight autumn increase in numbers of aphids these did not exceed 10 individuals, except on level III. The last aphids were found on November 4th (Fig. 8). The insects occurred most numerously on level II, feeding on leaves from May 10th to August 21st, then on level III (May 10th--Aug. 21st), IV (May 10th-August 7th) and finally on level I (May 17th-Aug. 21st and Sept. 8th-Nov. 4th) (Fig. 8).

The development of aphids in the tree crown of Beech II was uneven and was characterized, particularly on level I and II, by numerous slight fluctuations in numbers. The abundance of aphids on Beech II growing on the fringe of the forest depends, as can be gathered from figure 8, on the height of the feeding place. In comparison with Beech I these relations are reversed, since the numbers of aphids decreased with increase in height of levels. The calcula-

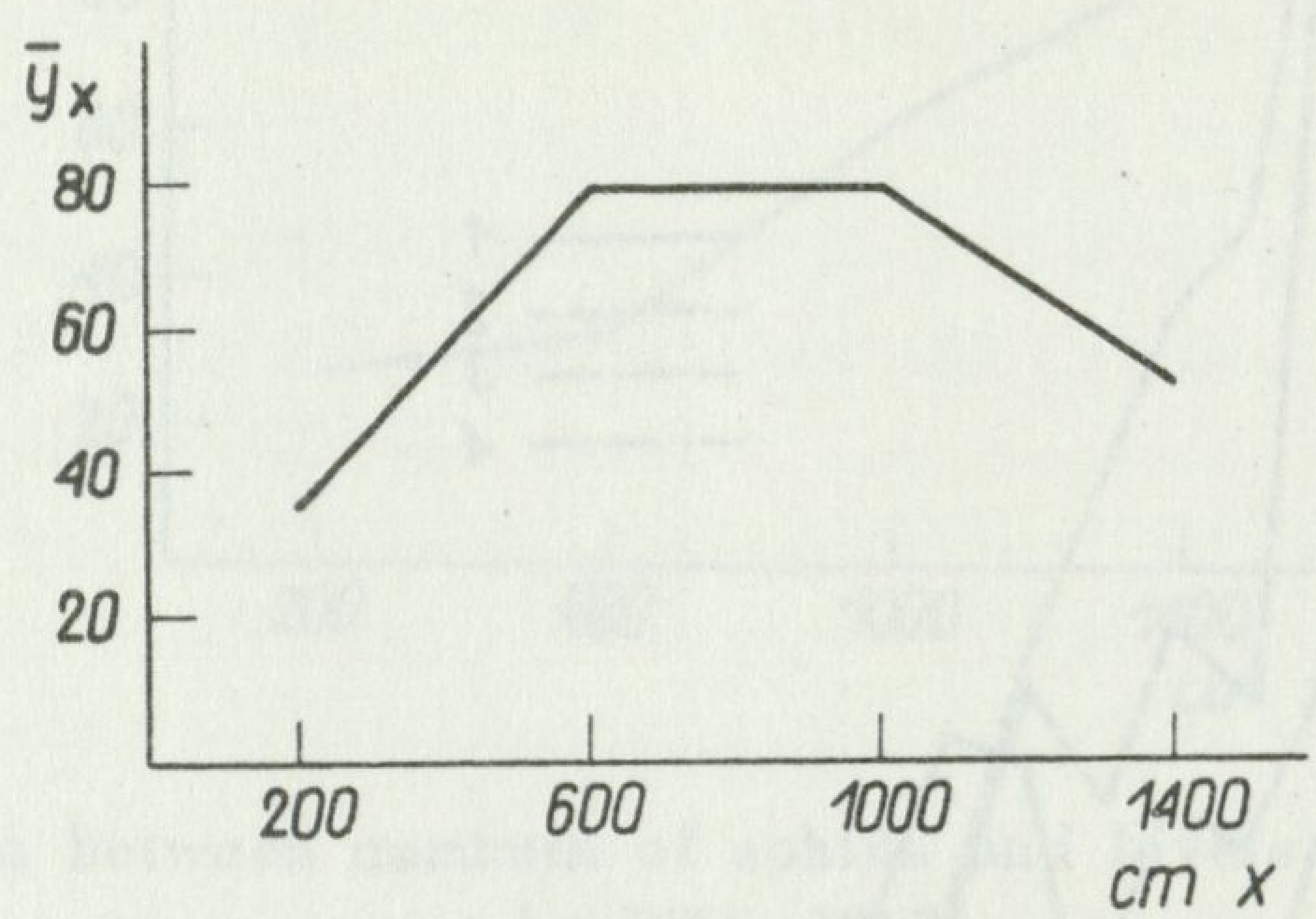

Fig. 9. Interrelations between numbers of aphids and l vels in the crown of Beech II for 1966–1967

x – height of levels of tree-crown, y – medium values for abundance classes of aphids, $\bar{y}_x$ – conditional average

ted coefficient $r = 0.096$ with $r_{theor} = 0.195$ ($P_{0.05}$) and 0.354 ($P_{0.01}$), however, points to absence of significant correlation between the levels of the tree crown of Beech II and abundance of aphids. The correlation curve (Fig. 9) exhibits a positive correlation in the first phase, then its complete disappearance and finally a negative correlation in relation to the top layer of the tree crown. It must be assumed that the different location of the tree in the habitat was responsible for the lack of correlation.

To sum up it can be said that the conditions most favourable to development of aphids are those on the highest levels of the tree crown in spring and summer (Beech I – level III and IV, Beech II – level II and III), but in autumn on levels I (within handreach).

Vertical distribution of aphids in the undergrowth

The vertical distribution of aphids on seedling beeches in the vicinity of Beech I and II from 1966–1967 is illustrated in figures 10 and 12. The data given are the average numbers of aphids for the two study years.

Undergrowth of Beech I. The development of aphids in the undergrowth of Beech I began on May 10th on levels I and III, reaching the first maximum in numbers on May 17th. After this time the number of aphids decreased, to begin increasing again on June 22nd on all levels. The increase in numbers was abrupt, and reached a maximum on August 7th on levels III, IV and II (Fig. 10). The greatest number of aphids on level I were observed to occur

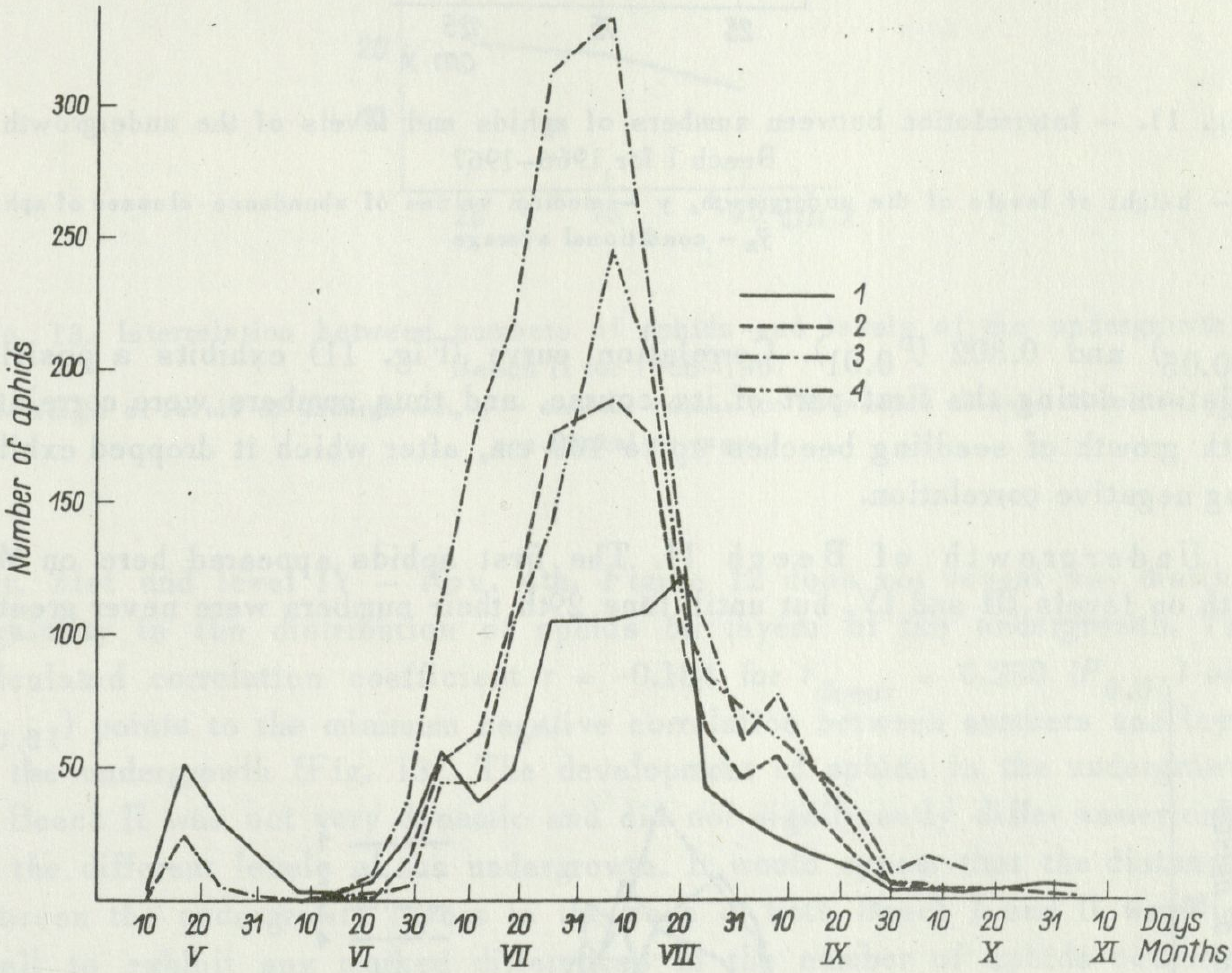

Fig. 10. Average numbers of aphids in the undergrowth of Beech I for 1966–1967
1 – level *I*, *2* – level *II*, *3* – level *III*, *4* – level *IV*

two weeks later i.e. August 21st (Fig. 10). After these dates numbers systematically decreased, reaching a minimum at the beginning of October on levels I, II and III and on 21st October on level IV. The most dynamic development was exhibited by aphids on level III, that is, on seedlings up to 100 cm high, then on levels IV, II and I (Fig. 10). Abundance of aphids increased with increase in the height of beech seedlings up to 100 cm, but undergrowth higher than 100 cm reduced the number of aphids feeding there (Fig. 10). An attempt at finding the significance of these relations reveals a minimum and non-significant correlation. Coefficient $r = 0.181$ was lower than $r_{theor} = 0.232$

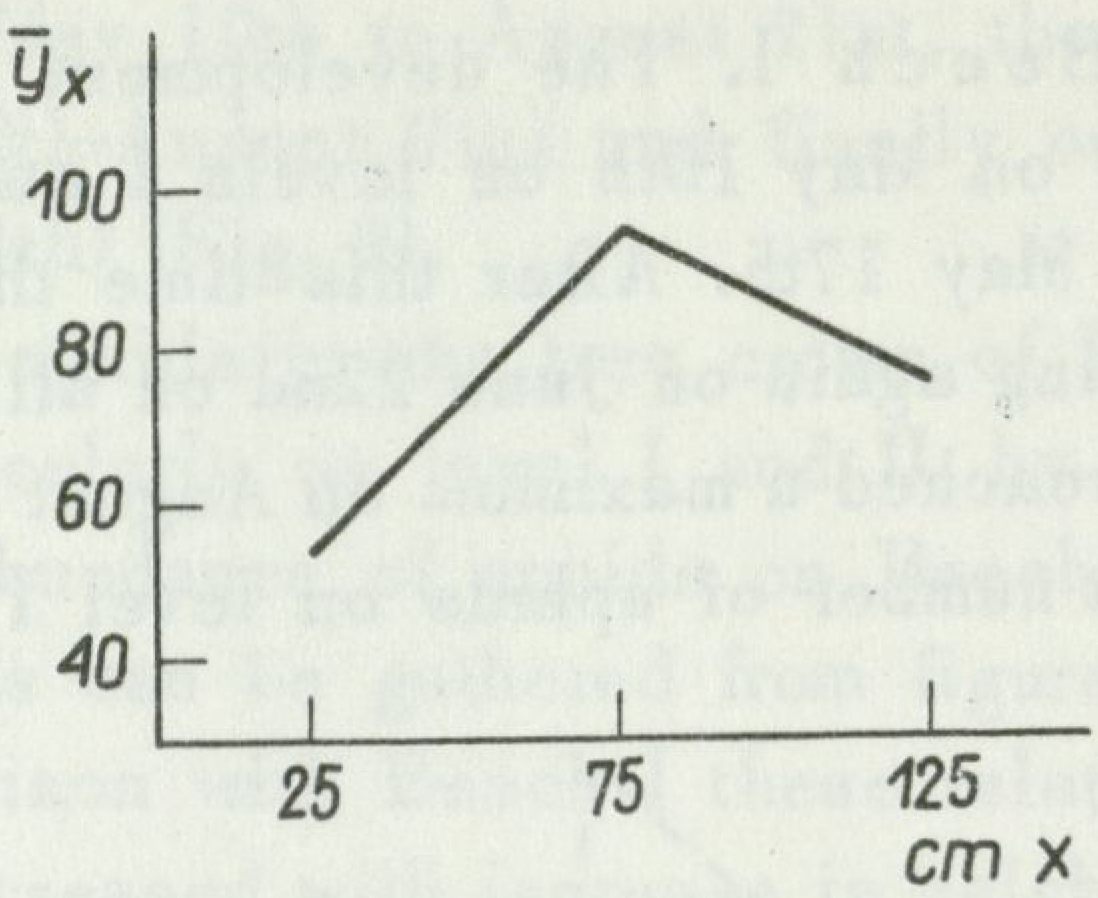

Fig. 11. – Interrelation between numbers of aphids and levels of the undergrowth of Beech I for 1966–1967

x – height of levels of the undergrowth, y – medium values of abundance classes of aphids, $\bar{y}_x$ – conditional average

($P_{0.05}$) and 0.302 ($P_{0.01}$). Correlation curve (Fig. 11) exhibits a positive relation during the first part of its course, and thus numbers were correlated with growth of seedling beeches up to 100 cm, after which it dropped exhibiting negative correlation.

Undergrowth of Beech II. The first aphids appeared here on May 17th on levels III and IV, but until June 29th their numbers were never greater

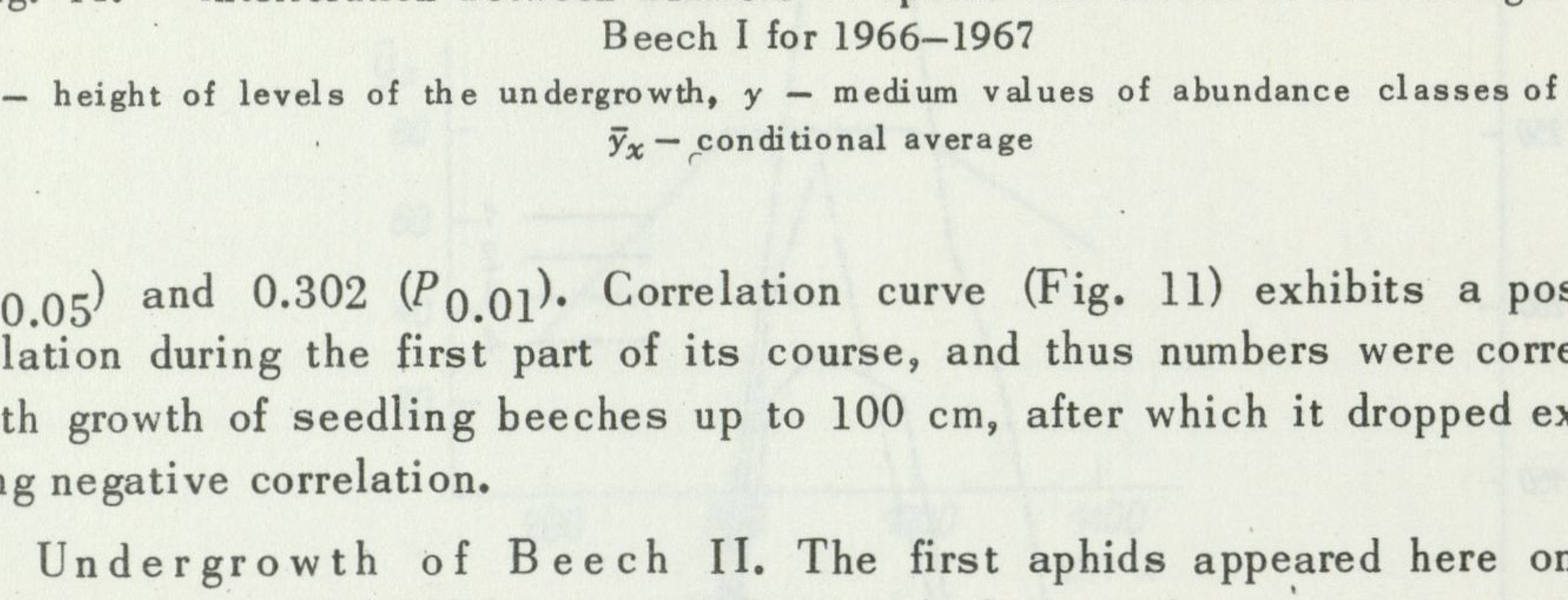

Fig. 12. Average numbers of aphids in the undergrowth of Beech II for 1966–1967
1 – level *I*, *2* – level *II*, *3* – level *III*, *4* – level *IV*

than a few individuals. The first aphids were found on the other levels on this day, and from that time onwards a very slow increase in the number of aphids was observed (Fig. 12). Maximum numbers of aphids were found on different levels at different times, on level II on July 26th, on level III –

August 7th, level I – Aug. 14th and level IV on Aug. 21st (Fig. 12). Aphids fed most successfully and in greatest numbers on beech seedlings up to 50 cm in height, then on levels I, III and IV (Fig. 12). The last individual aphids were encountered on level III on Sept. 30th, level I – Oct. 7th, level II –

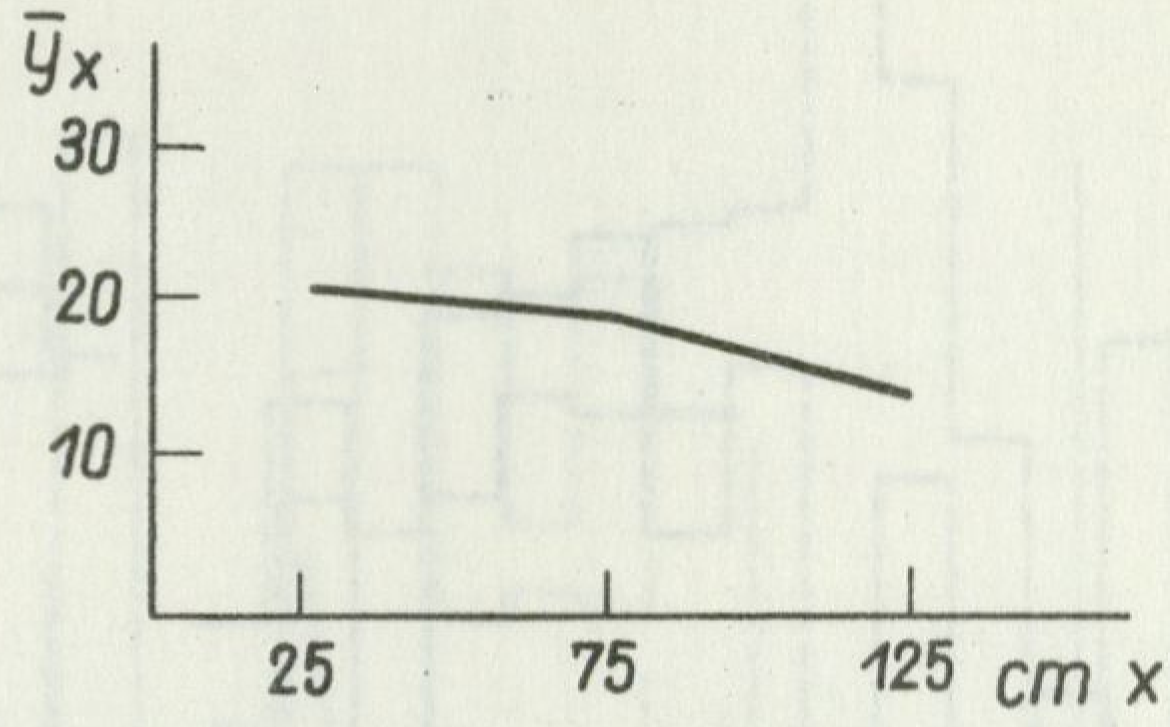

Fig. 13. Interrelation between numbers of aphids and levels of the undergrowth of Beech II for 1966–1967

x – height of levels of undergrowth, y – medium values for abundance classes of aphids, $\bar{y}_x$ – conditional average

Oct. 21st and level IV – Nov. 4th. Figure 12 does not reveal any distinct regularity in the distribution of aphids on layers of the undergrowth. The calculated correlation coefficient r = -0.184 for r_{theor} = 0.250 ($P_{0.05}$) and ($P_{0.01}$) points to the minimum negative correlation between numbers and layer of the undergrowth (Fig. 13). The development of aphids in the undergrowth of Beech II was not very dynamic and did not significantly differ numerically on the different levels of the undergrowth. It would appear that the distances between the undergrowth layers in the case of both Beech I and II were too small to exhibit any marked differences in the number of aphids occurring there.

SPATIAL DISTRIBUTION OF THE POPULATION DURING THE GROWING SEASON

In order to illustrate the spatial distribution of the population joint diagrams were used, illustrating the development of aphids in 1966 and 1967 in the undergrowth and crown of both trees. The data given in figures 14–17 show that development of aphids in the crowns of these trees began on May 10th in both study years and continued on them with different degrees of intensity. During this period all the beech leaves had unfurled but were still thin and pale, and it was not until the end of May that they had acquired their true size and colour.

In 1966 the curve of population growth reached its maximum numbers on

June 8th. The fall in the curve was abrupt and as from June 8th a decrease could be observed in the numbers of aphids, resulting in definite decrease

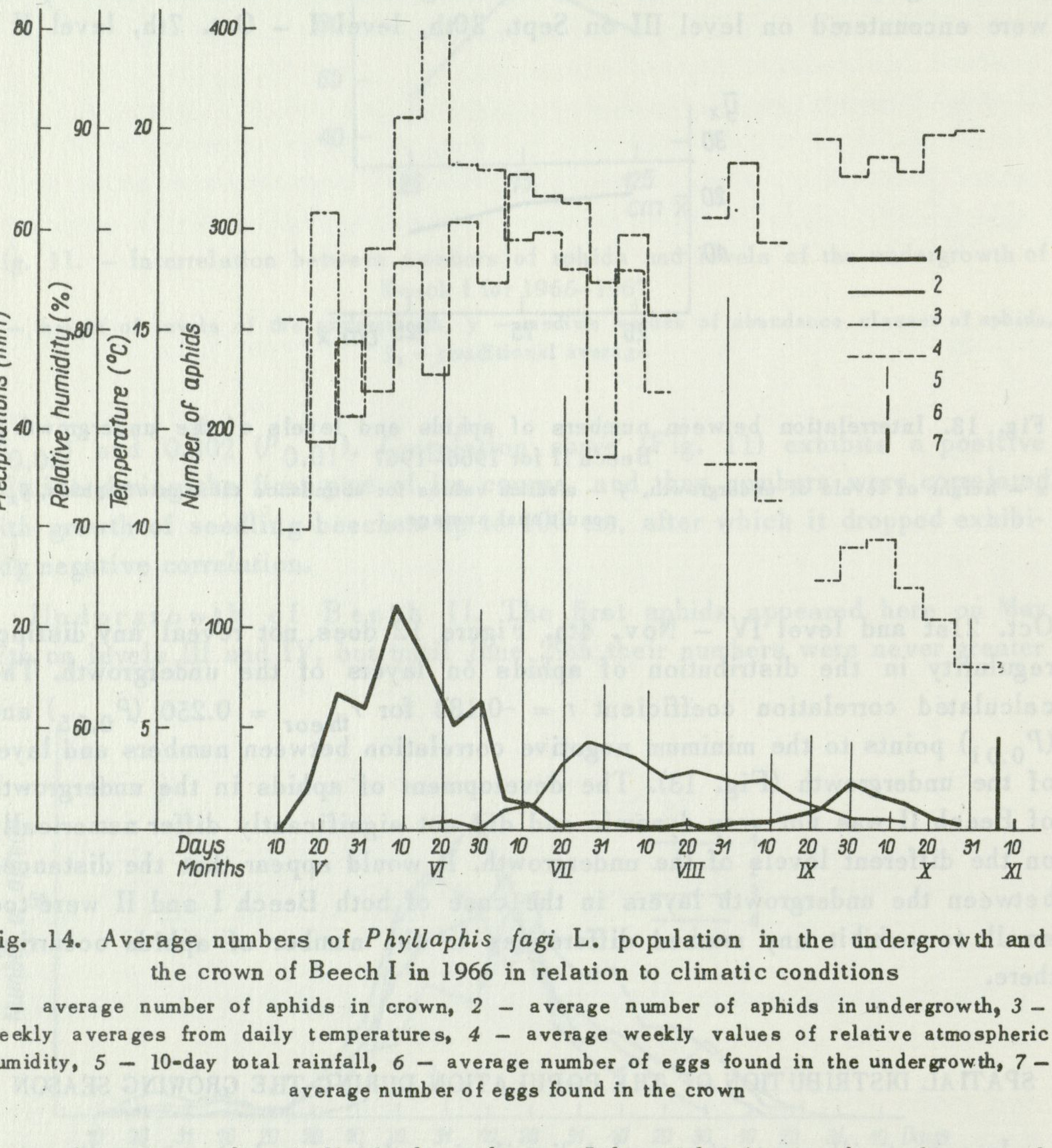

Fig. 14. Average numbers of *Phyllaphis fagi* L. population in the undergrowth and the crown of Beech I in 1966 in relation to climatic conditions

1 — average number of aphids in crown, *2* — average number of aphids in undergrowth, *3* — weekly averages from daily temperatures, *4* — average weekly values of relative atmospheric humidity, *5* — 10-day total rainfall, *6* — average number of eggs found in the undergrowth, *7* — average number of eggs found in the crown

in numbers to a few individuals only on July 19th. As numbers decreased in the crown, there was a gradual rise in the curve for the undergrowth, reaching peak numbers on July 26th, that is, during the period of the greatly reduced numbers of aphids in the tree crown. The undergrowth curve gradually dropped, with simultaneous increase in numbers of aphids in the tree crown (Fig. 14). Quantitative relations and courses of curves are similar for Beech I and II, only the peaks of aphid numbers in the undergrowth being slightly shifted in time. In the undergrowth of Beech II the greatest numbers of aphids were not observed until August 25th, that is a month later than in the case of Beech I.

The autumn increase in numbers of aphids in the crowns, however, occurred at the same time (Sept. 30th), only the number of aphids being slightly different (Fig. 14, 15).

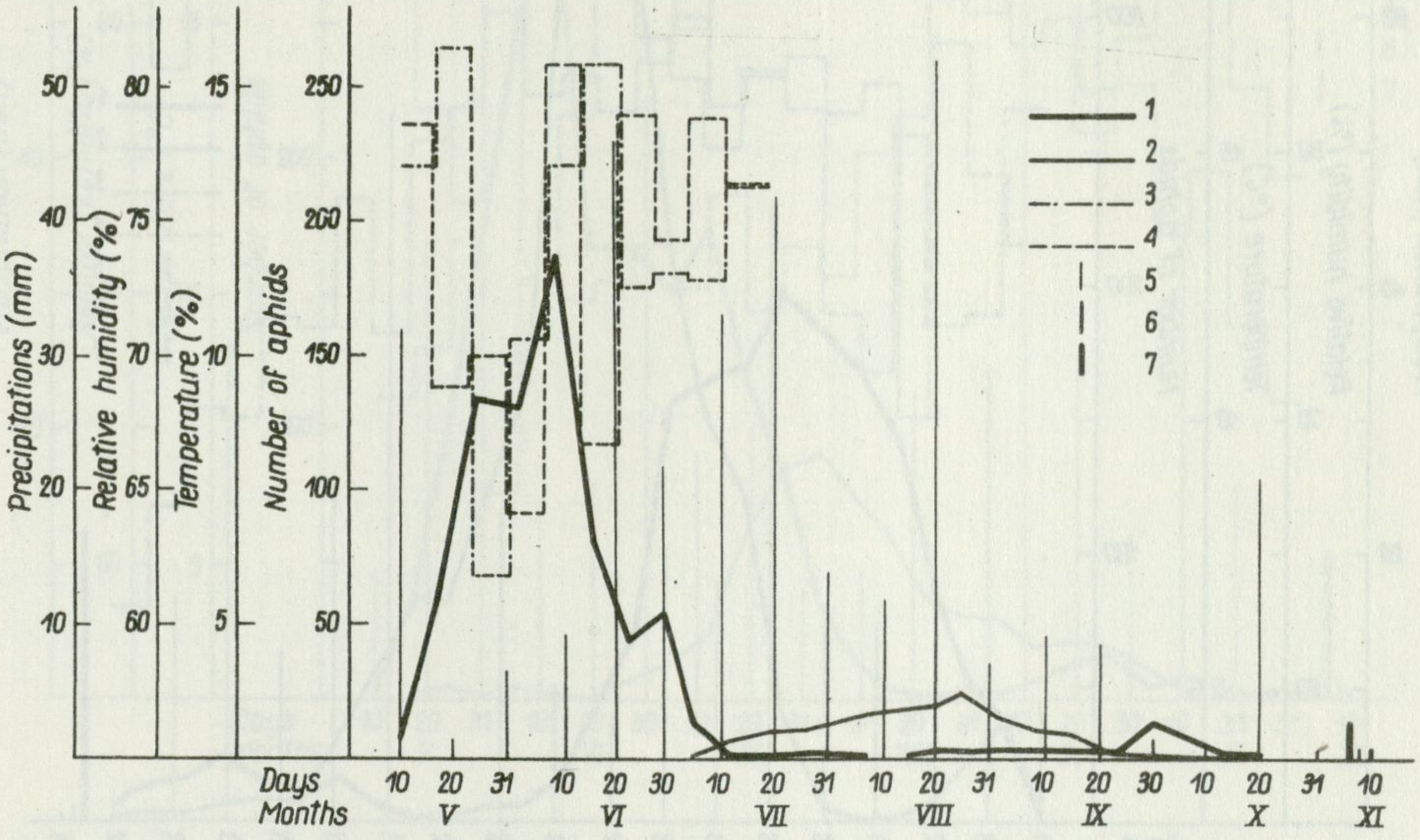

Fig. 15. Average numbers of *Phyllaphis fagi* L. population in the undergrowth and the crown of Beech II in 1966 in relation to climatic conditions

1 — average number of aphids in crown, *2* — average number of aphids in the undergrowth, *3* — weekly averages from daily temperatures, *4* — average weekly values of relative atmospheric humidity, *5* — 10-day total rainfall, *6* — average number of eggs found in undergrowth, *7* — average number of eggs found in the crown

In 1967 also the aphids' development began on May 10th, but the curve of numbers reached its maximum on Beech I on June 28th (Fig. 16) and on Beech II on June 13th (Fig. 17). The full development of the population was thus shifted in time by 5—20 days. Decrease in abundance in the tree crowns was also slower, since minima were not observed until the beginning of August, that is, in comparison with 1966, by about one month later. Slightly different quantitative relations were observed in the undergrowth, the first peak numbers occurring in May and after a short period of low numbers, again in July and August (Fig. 16, 17). Numbers in aphids in 1967 exceeded those of the previous year, particularly in the undergrowth of Beech I (Fig. 16) and Beech II (Fig. 17). After the culmination in numbers observed there was a fairly

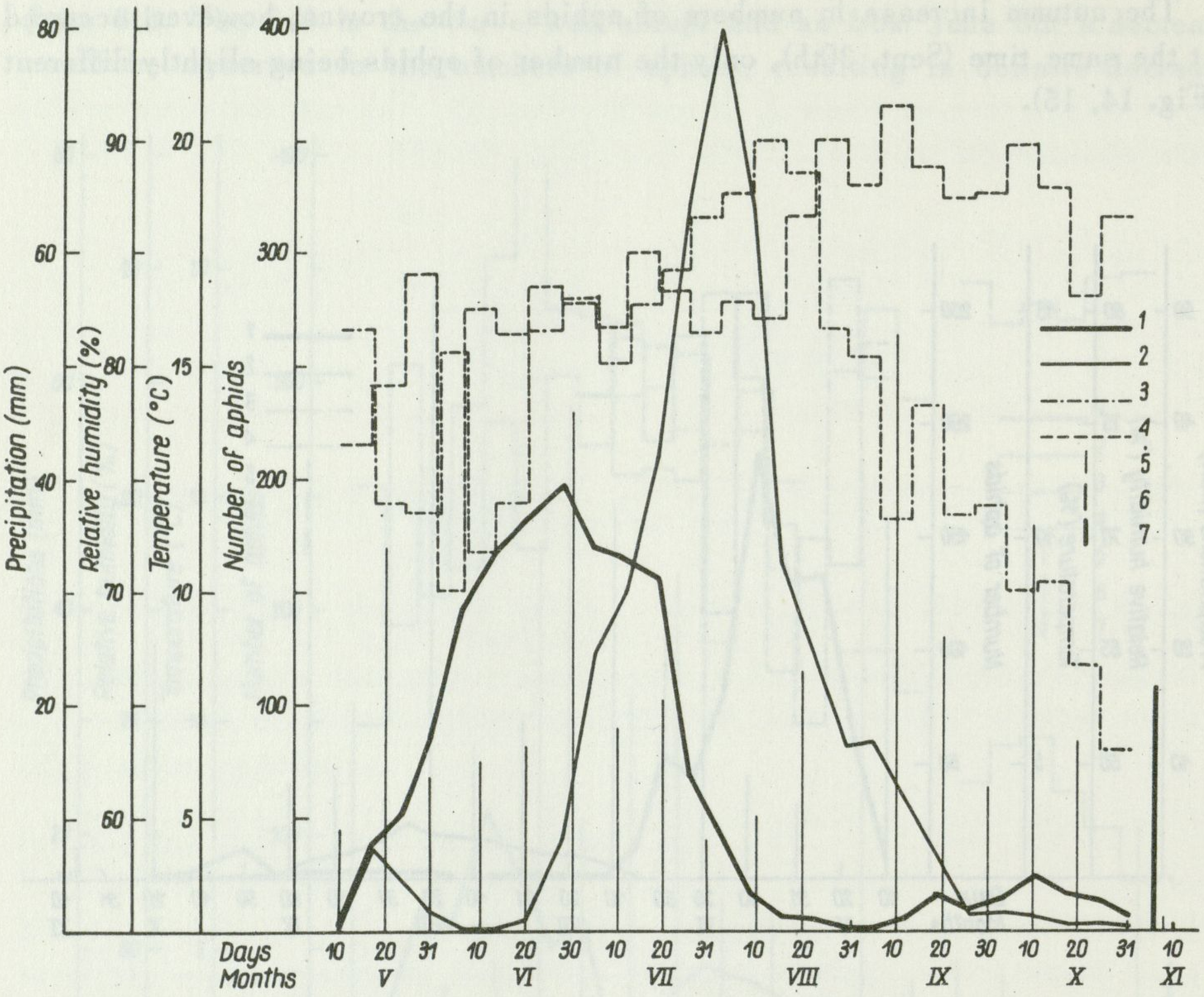

Fig. 16. Average numbers of *Phyllaphis fagi* L. population in the undergrowth and the crown of Beech I in 1967 in relation to climatic conditions

1 — average number of aphids in the crown, *2* — average number of aphids in the undergrowth, *3* — weekly averages from daily temperatures, *4* — average weekly values of relative atmospheric humidity, *5* — 10-day total rainfall, *6* — average number of eggs found in the undergrowth, *7* — average number of eggs found in the crown

abrupt decrease, resulting in single individuals only occurring in the undergrowth of Beech I at the end of September (Fig. 16) and Beech II at the beginning of October (Fig. 17). The number of aphids in the tree crowns increased parallel to the decrease in numbers in the undergrowth, to reach an autumn peak on Beech I on Oct. 11th and on Beech II — on Sept. 26th.

As from Oct. 28th the first single eggs were found on the bark of branches. The last inspection of working stations on Nov. 4th 1966 showed that different numbers of eggs were found. It proved impossible to find any in the undergrowth of Beech I, while there were only 2 eggs in the undergrowth of Beech II. In the tree crowns these numbers were higher, as 45 were found in Beech I, but only 12 on Beech II. The situation differed slightly in 1967, as about 5 eggs were found in the undergrowth of Beech I, and 6 in the under-

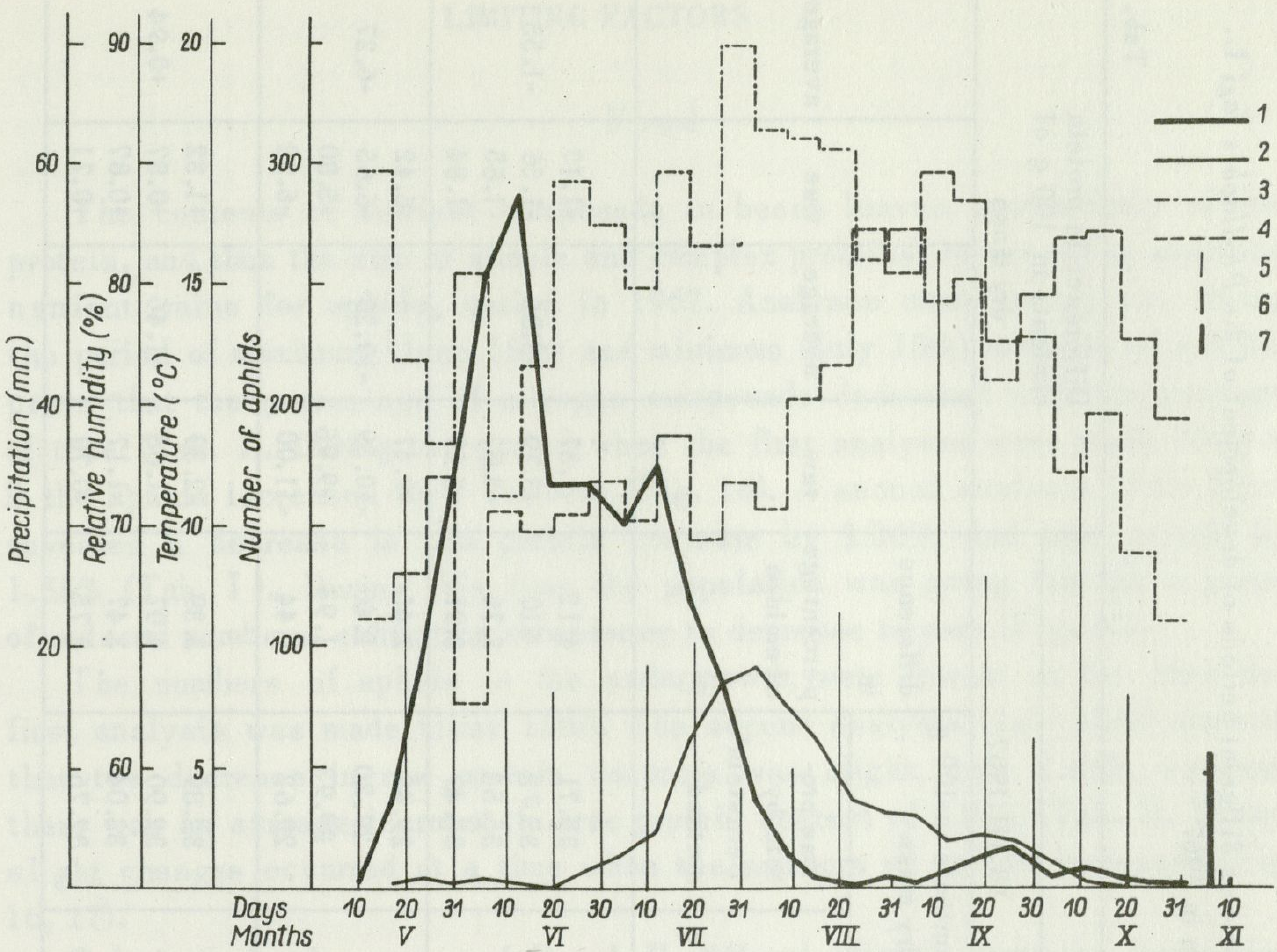

Fig. 17. Average numbers of *Phyllaphis fagi* L. population in the undergrowth and the crown of Beech II in 1967 in relation to climatic conditions

1 – average numbers of aphids in the crown, *2* – average number of aphids in the undergrowth, *3* – weekly averages from daily temperatures, *4* – average weekly values of relative atmospheric humidity, *5* – 10-day total rainfall, *6* – average number of eggs found in the undergrowth, *7* – average number of eggs found in the crown

growth of Beech II. The number of eggs found in the crowns of these trees was greater, i.e. 107 on Beech I and 57 on Beech II (Fig. 14–17).

The above discussion shows that the development of the population of *Phyllaphis fagi* begins in tree crowns in May and lasts until mid-July. Further development takes place in the undergrowth and lasts from July to mid-September. Numbers rise again in tree crowns at the end of September and beginning of October. This leads to the conclusion that it is a question here of migration of given generations of aphids from crown to undergrowth and vice versa. This finding does not agree with the observations made by Popowa (1967), who states that *Phyllaphis fagi* has a period of summer diapause during its development.

Contents of nitrogen bodies and true protein in beech leaves during different periods of development of the *Phyllaphis fagi* L. population in 1967

Tab. I

Number of sample	Sampling site	Sampling date						Difference in protein contents in 100 g of dry mass			
		15 VI 1967			18 VII 1967						
		protein contents in 100 g dry mass		difference in	protein contents in 100 g dry mass		difference in				
		raw protein by Kjeldal's method	true protein by Bernstein's method	percentage of amides	raw protein by Kjeldahl's method	true protein by Bernstein's method	percentage of amides	raw	average	true	average
1	Beech (tree) I	41.40	36.88	4.52	39.83	35.71	4.12	-1.57		-1.17	
2	Beech I	43.53	37.29	6.24	39.83	35.73	4.10	-3.70	-3.06	-1.56	-1.55
3	,,	42.96	37.18	5.78	39.29	35.53	3.76	-3.67		-1.65	
4	,,	42.69	37.33	5.36	39.40	35.49	3.91	-3.29		-1.84	
1	Beech II	41.34	35.84	5.50	31.87	29.42	2.45	-9.47		-6.42	
2	,,	42.06	35.86	6.20	31.67	29.20	2.46	-10.39	-10.20	-6.65	-6.27
3	,,	41.82	35.73	6.09	31.87	29.93	1.94	-9.95		-5.80	
4	,,	42.06	35.84	6.22	31.06	29.62	1.44	-11.00		-6.22	
1	Undergrowth	38.58	31.57	7.01	36.28	32.89	3.39	-2.30		+1.32	
2	,,	38.65	32.03	6.62	36.97	32.90	4.07	-1.68	-1.46	+0.87	+0.94
3	,,	37.68	32.17	5.51	36.51	33.04	3.47	-1.17		+0.87	
4	,,	37.21	32.05	5.16	36.51	32.76	3.75	-0.70		+0.71	

LIMITING FACTORS

Food

The contents of nutrient compounds in beech leaves, particularly of true protein, and thus the sum of simple and complex proteins, representing maximum nutrient value for aphids, varied in 1967. Analyses made twice, i.e. during the period of maximum (June 15th) and minimum (July 15th) numbers of aphids, prove that the percentage of nitrogen compounds decreased with the passage of time (Tab. I). During the period when the first analyses were made (Beech I) the aphids increased their numbers (Fig. 16). A second analysis (July 15th) revealed a decrease in raw protein contents by 3.06%, and true protein by 1.55% (Tab. I). During this time the population was going through a period of reduced numbers, exhibiting a tendency to decrease to zero (Fig. 16).

The numbers of aphids in the undergrowth were lowest at the time the first analysis was made (June 15th). The second analysis (July 15th) showed that the decrease in raw protein contents was slight, only 1.46%, whereas there was an average increase in true protein content of 0.94% (Tab. I). These slight changes occurred at a time when the numbers of aphids increased (Fig. 16, 17).

Relations in the crown of Beech II differed slightly from the foregoing. Differences in nitrogen compounds contents were surprisingly great in comparison with Beech I, being 10.20% (in −) for raw protein and 6.27% (in −) for true protein (Tab. I). In this case also abrupt reduction in numbers of aphids was observed on June 15th (Fig. 17).

The relations presented form evidence that the numbers of aphids decreased with decrease in the percentage of true protein in the beech leaves. The slight rise in the amount of true protein observed in the undergrowth coincided with increase in the number of aphids, which shows that there is a distinct correlation and could account for migration of aphids from the crown to the undergrowth.

Temperature and relative atmospheric humidity

The effect of temperature and relative atmospheric humidity on the development of the *Phyllaphis fagi* population was similar in both trees in both study years. The effect of these factors is most clearly shown during the spring and summer period (Fig. 14–17). Beech I, growing in a dense tree stand, exhibited higher temperatures and greater atmospheric humidity in both study years than in the crown of Beech II, which grew on the edge of the forest.

Aphids in tree-crowns in 1966 reacted similarly to fluctuations in temperature and humidity (Fig. 14, 15). As from May 10th relative atmospheric humidity was observed to fall to 70% with increase in temperature to 17°C, while aphids increased in number during this time (Fig. 14). Development of the aphids was temporarily inhibited when temperature fell below 17°C and humidity increased to 79%. Renewed fluctuations in temperature (in +) and humidity (in −) hastened further development of aphids (Fig. 14, 15). Variations in temperature and humidity occurring in July exerted no significant effect on the numbers of aphids in the tree crowns, although it was observed that reduction in air temperature below 17°C, with simultaneous increase in humidity over 85%, coincided with intensive development of aphids in the undergrowth (Fig. 14). The later period, covering the months of August, September and October, was characterized by systematic decrease in temperature and increase in humidity, which did not markedly affect population numbers.

The spring period of 1967 was characterized by slightly lower temperatures and higher atmospheric humidity, particularly in relation to Beech I. Maximum temperatures occurred at the end of July and beginning of August, that is, nearly a month later than in 1966. During the first period of the population's development (May 17–24) temperature fell to about 12°C, while humidity rose to 85% (Beech I) and about 73% (Beech II), and development of the aphids was slightly reduced at this time. Further variations in temperature (in +) to about 15°C and humidity (in −), for Beech I up to 70% and Beech II to 63%, contributed to very dynamic increase in the abundance of aphids. A later drop in temperature to 11°C and increase in humidity to about 82% (Beech I) and 70% (Beech II) caused some limitation of increase in the numbers of these insects. During the period from June 13th to the beginning of August relative atmospheric humidity increased with increase in temperature, and this coincided with sharp reduction in the numbers of aphids in the tree crown and with distinct increase in their numbers in the undergrowth. As from August 10th there was systematic decrease in temperature, while the numbers of aphids in the undergrowth decreased (Fig. 16, 17). No distinct relation was found between the above phenomena during the period of the autumn peaks in numbers of aphids.

In an attempt at finding confirmation of the observed relations calculation was made of the correlation coefficient separately for temperature and numbers, and humidity and numbers of aphids. These coefficients indicate that there is a significant positive correlation between air temperature and numbers of aphids, since $r = 0.27$ for $r_{theor} = 0.159$ ($P_{0.05}$) and 0.208 ($P_{0.01}$), and a significant negative correlation between relative atmospheric humidity and numbers of aphids, since $r = 0.26$ for $r_{theor} = 0.0159$ ($P_{0.05}$) and 0.205

($P_{0.01}$). These relations are given separately for each pair in figures 18 and 19.

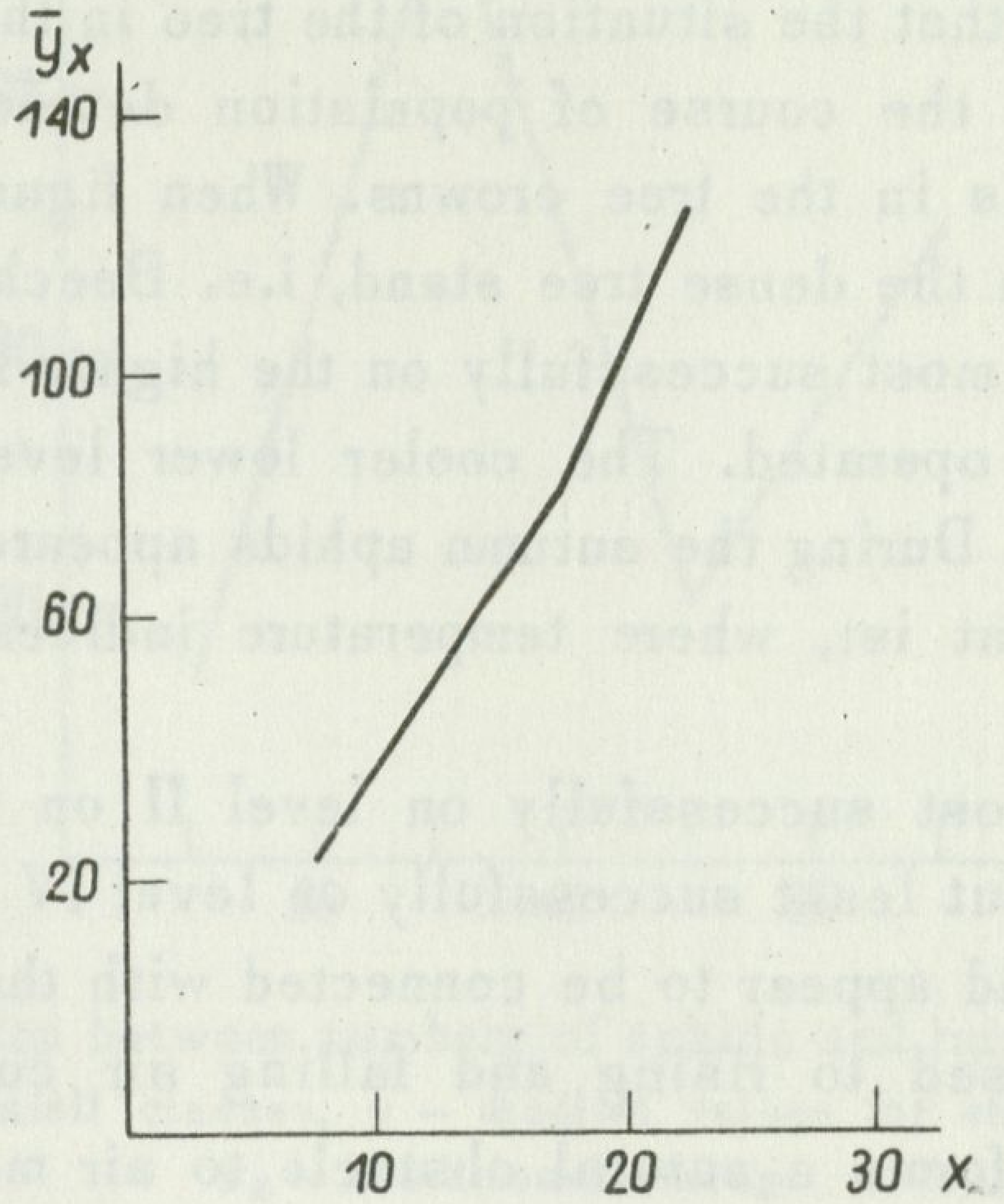

Fig. 18. Interrelation between numbers of aphids and tempetature for 1966–1967
x – medium values for temperature classes, *y* – medium avlues for abundance classes of aphids, $\bar{y}_x$ – conditional average

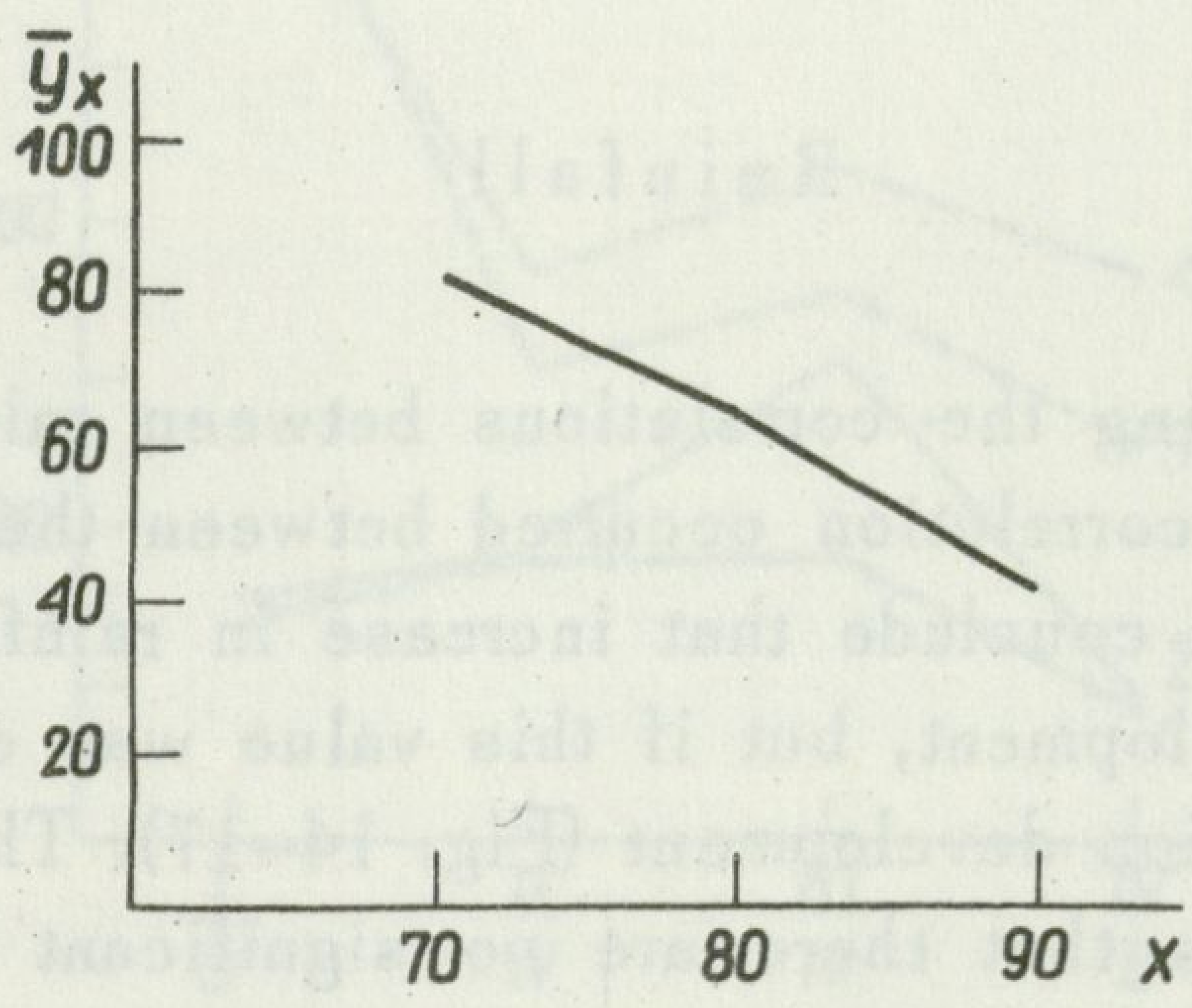

Fig. 19. Interrelation between abundance of aphids and relative atmospheric humidity for 1966–1967
x – medium values for humidity classes, *y* – medium values for abundance classes of aphids, $\bar{y}_x$ – conditional average

To sum up it must be said that the increase in temperature with simultaneous decrease in relative air humidity brought about increase in numbers of aphids and conversely – increase in relative atmospheric humidity with a drop in temperature reduced population numbers. The population developed particularly successfully with low relative atmospheric humidity of about 70% and relatively high average temperatures of about 14°C.

It would also appear that the situation of the tree in the habitat had a fairly significant influence on the course of population development and formation of temperature conditions in the tree crowns. When figure 6 is considered it may be concluded that in the dense tree stand, i.e. Beech I, during the spring period aphids developed most successfully on the higher levels, that is, where the warmth of the sun operated. The cooler lower levels always exhibited lower numbers of aphids. During the autumn aphids appeared in greater numbers on the lower levels, that ist, where temperature indices were higher at that time (Fig. 6, 8).

Aphids developed most successfully on level II on the tree on the edge of the forest, Beech II, but least successfully on level IV (Fig. 8). The causes of this phenomenon would appear to be connected with the fact that the higher levels were more exposed to rising and falling air currents. The compact wall of the forest edge forms a natural obstacle to air movement. The tree in question was exposed on the southern side, where insolation was far more intensive than in the interior of the forest, and consequently the differences in temperature created in this way had an additional influence on intensive air movement which rendered the population's development difficult on level III and IV.

Rainfall

An attempt at defining the correlations between rainfall and numbers of aphids showed that no correlation occurred between these factors (Fig. 20). It was only possible to conclude that increase in rainfall to 30 mm did not inhibit the aphids' development, but if this value was exceeded it had a retarding effect on population development (Fig. 14–17). The calculated correlation coefficient confirms that there are no significant connections between these factors, since $r = 0.08$ for $r_{theor} = 0.237$ $(P_{0.05})$ and 0.354 $(P_{0.01})$.

Exposure

In order to examine the relations between the number of aphids and exposure of the two working stations in relation to all the quarters of the compass the numbers of aphids were totalled for stations with the same exposure, for each tree separately, and the figures obtained were divided by the number of

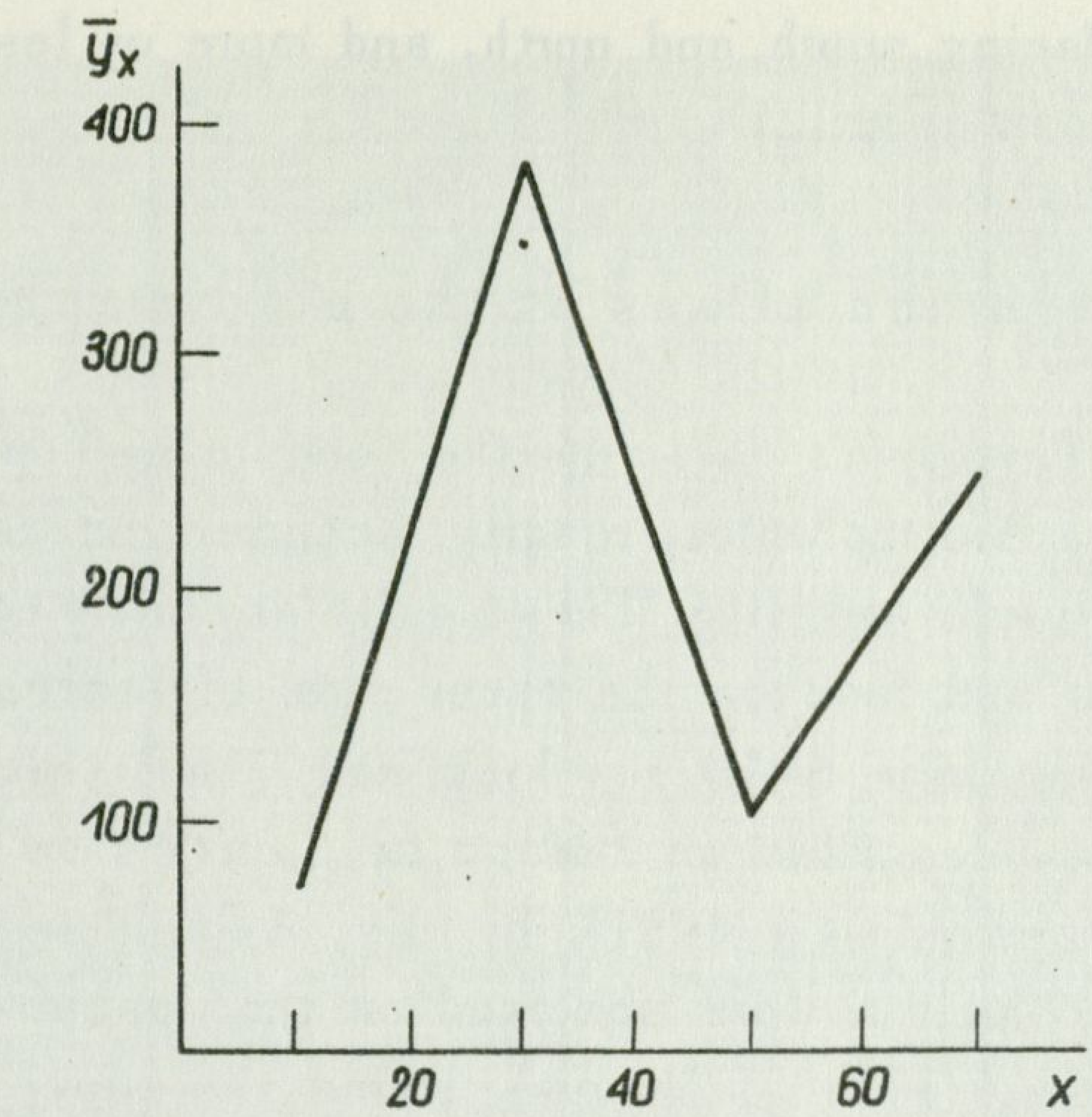

Fig. 20. Interrelation between numbers of aphids and rainfall for 1966–1967
x – medium values for rainfall classes, y – medium values for abundance classes of aphids, $\bar{y}_x$ – conditional average

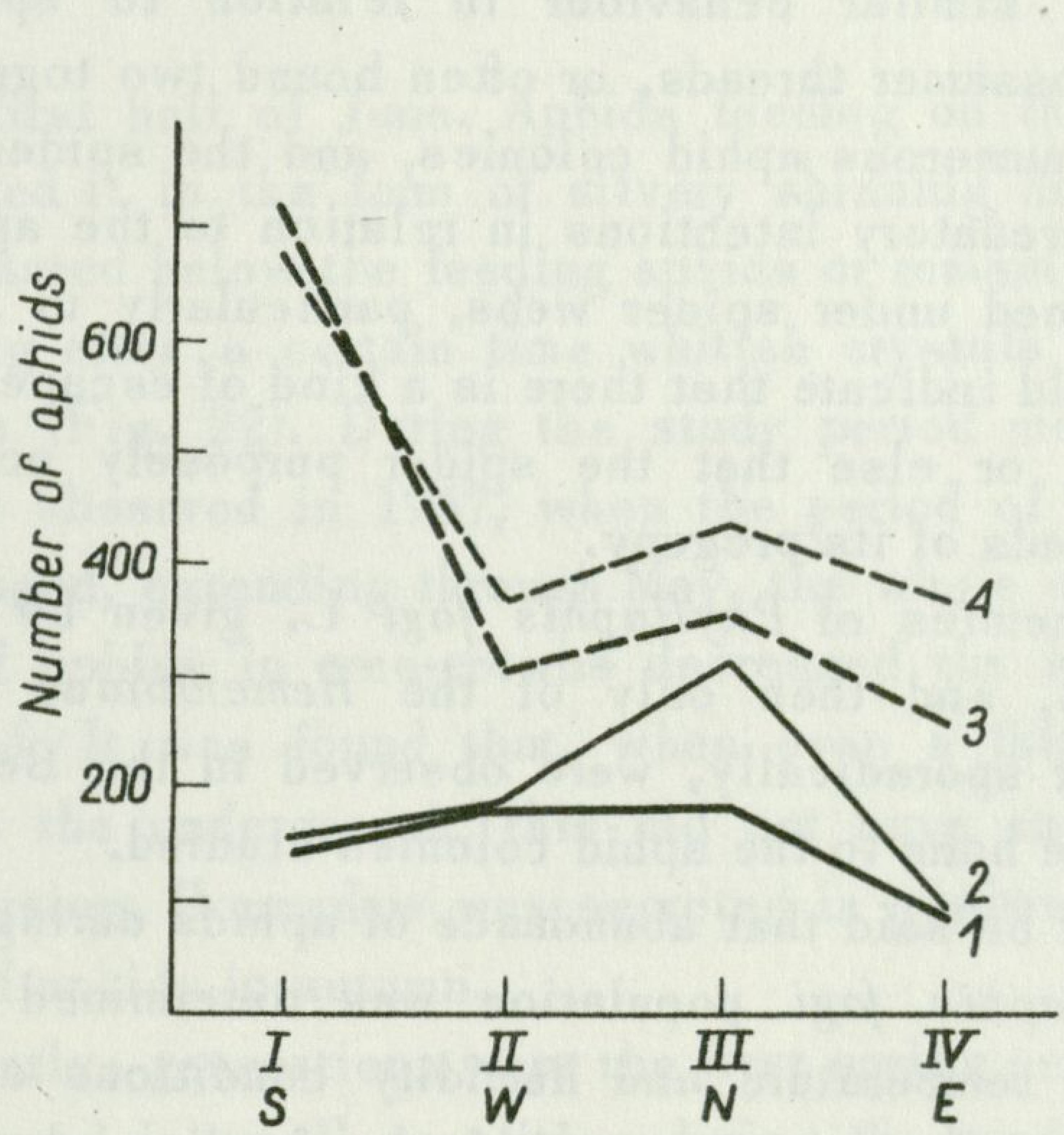

Fig. 21. Average numbers of aphids in vertical line of working stations in tree crowns
1 – Beech I in 1966, *2* – Beech II in 1966, *3* – Beech I in 1967, *4* – Beech II in 1967, S – south, *W* – west, *N* – north, *E* – east

levels. In this way the average number of aphids for a vertical line of stations with the same exposure were obtained and these data are given in figure 21. Aphids developed best on both trees in 1966 on stations facing north and west, and worst on stations facing east. In 1967 development was most successfull on stations facing south and north, and more or less uniform on stations facing west and east (Fig. 21).

Enemies and allies of the beech aphid

The population of *Phyllaphis fagi* was the dominating population on *Fagus silvatica*. Numerous aphid colonies readily occurred on leaves with galls caused by larvae of *Miciola fagi* Htg. These galls are fairly commonly encountered in beech forests and form on the upper side of laeves in the shape of brown sharp formations from 6–10 mm long and 7 mm thick (Dziurzyński 1961). These have been described in Poland by Szulczewski (1931, 1936, 1953, 1954) and Moszczyńska (1931). In July, August and September rings of aphids attached by suction were observed on the opposite side of the protruding zoocecidia (lower side of leaves), round the place where the larva had penetrated into the leaf lamina. It can therefore be concluded that aphids found better feeding conditions in the places where the injuries to the leaf had scarred over, but this problem requires separate treatment.

Aphids exhibited similar behaviour in relation to spider (*Araneidae*). Leaves covered by gossamer threads, or often bound two together by the web, formed a shelter for numerous aphid colonies, and the spider was in no case observed to exhibit predatory intentions in relation to the aphid aggregation. Aphids readily remained under spider webs, particularly in July, August and September, which would indicate that there is a kind of escape from unfavourable living conditions, or else that the spider purposely accumulated stores of live food for the needs of its progeny.

Of the natural enemies of *Phyllaphis fagi* L. given by Sorauer (1957) very few individuals, and then only of the *Hemerobidae* and *Chrysopidae* families, which occur sporadically, were observed in the Beech Forest area, and they did very little harm to the aphid colonies studied.

To sum up it must be said that abundance of aphids during the development period of the *Phyllaphis fagi* population was determined primarily by the joint action of food, temperature and humidity conditions and to a far more limited extent by rainfall, the exposure of the feeding place and the action of natural enemies.

PERIODS OF OCCURRENCE OF HONEYDEW AND ITS UTILIZATION BY BEES

The intensivity of secretion of honeydew during the development cycle of *Phyllaphis fagi* was subject to fluctuation and depended on population numbers. The greatest amount of honeydew was observed during the second

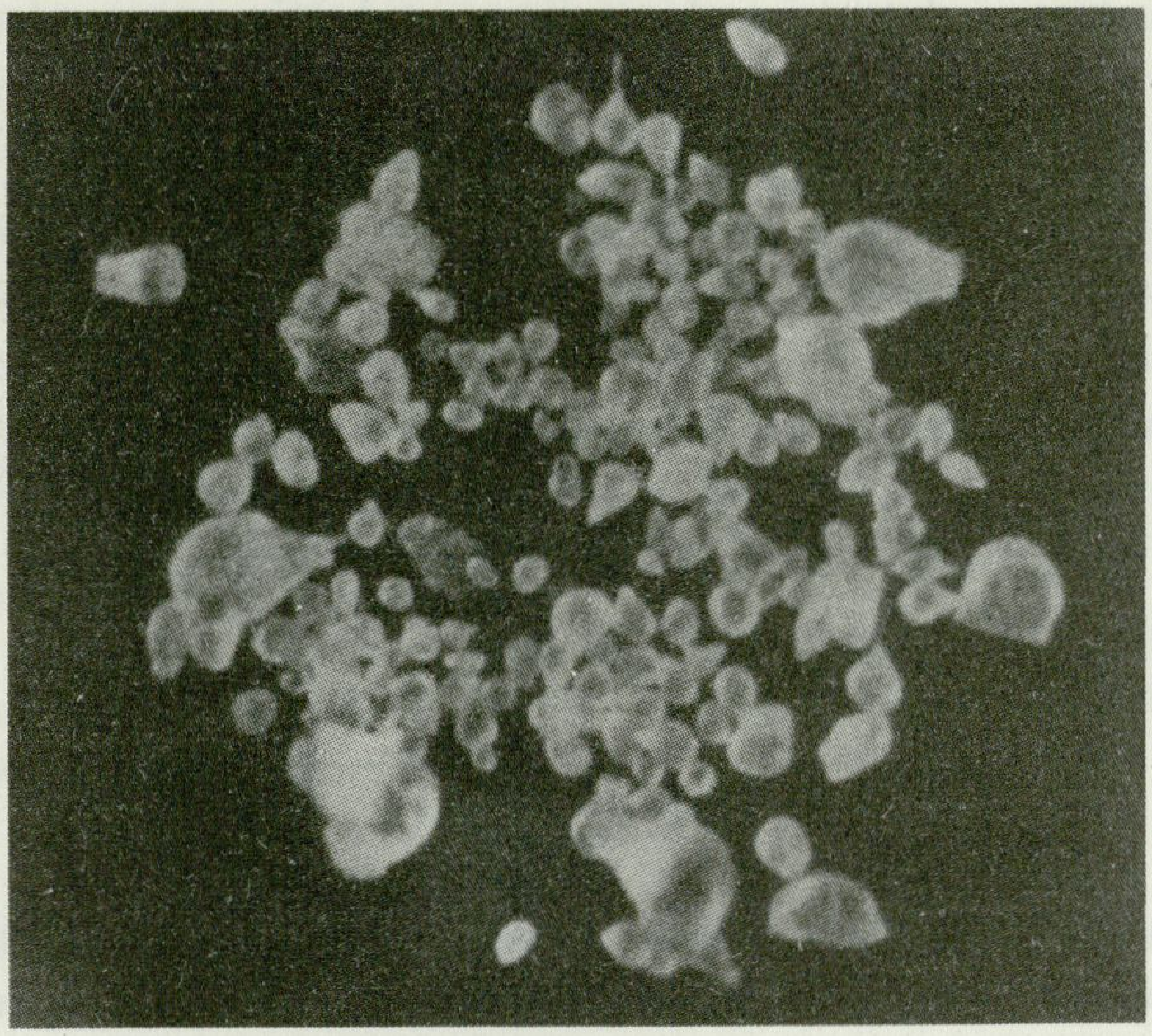

Fig. 22 – Crystallized honeydew of *Phyllaphis fagi* L(magn. 6^x, photo J. Prabucki)

half of May and first half of June. Aphids feeding on the lower side of the leaf lamina secreted it in the form of silvery shinning droplets, which either fell on the leaf situated below the feeding aphids or remained on the underside of the leaf, forming after a certain time whitish crystals similar in shape to grains of semolina (Fig. 22). During the study period most intensive honey dew secretion was observed in 1967, when the period of intensive secretion was slightly prolonged, extending through May, the whole of June to mid-July. As the numbers of aphids in tree-crowns decreased the amount of honeydew produced decreased. It was found that, when even a fairly large number of aphids occurred in the undergrowth, this did not have any significant effect on honeydew production. Honeydew was secreted in minimum quantities during the peak numbers of aphids in autumn.

The most productive generations were the first spring generations.

Honeydew occurred in small quantities during the study years and rapidly underwent crystallization, particularly in 1967, and was thus of no great significance as honeydew pasture for bees.

No large numbers of collector bees were encountered. In 1966 a single bee was twice observed to visit a leaf with honeydew on it and in 1967 five bees in June, which had presumably flown there accidentally (the nearest hives were 1.5 km away). During the period of honeydew secretion on the beech large areas of rape flowered in the vicinity, and also plants in the forest herb layer, which constituted a strong stimulus attracting the bees to this source of nectar. Intensive honeydew production was also observed on sycamores and maples. In 1967 particularly bees were observed to make numerous flights to the maple honeydew secreted by *Periphyllus testudinaceus* Fernie, and *Drepanosiphum platanoidis* Schrank. The honeydew of these species, contrary to that of *Phyllaphis fagi*, was more watery and consequently easier for the bees to collect. Honeydew honey from maples was centrifuged in the apiary at Glinna Forest Administration area in that year. The honey was brown with a greeny tinge and a bitter-sweet taste, with sickly aftertaste.

There was no honeydew harvest from the beech tree in the Beech Forest during the study period. No significant production of honeydew of any importance to bees should be expected from the beech in this area.

CONCLUSIONS

1. The reduced numbers of aphids in beech crowns occurred during a period of increase in their numbers in the undergrowth, which points to the fact that aphids migrate from tree crowns to the undergrowth in July and from the undergrowth to tree-crowns during the second half of August and first half of September. These migrations were conditioned by the combined action of habitat conditions, particularly food, temperature and humidity factors.

2. The climatic conditions (long-term data) characteristic for the West Pomerania were typical of the study period. This habitat did not create optimum conditions for the development of aphids and limited honeydew production to a considerable degree. This shows that improvement in the living conditions of *Phyllaphis fagi* in the Beech Forest area is not to be expected. From the economic point of view no good perpose would be served by basing migrating bee keeping on honeydew collection from the beech.

3. Observations made in 1967 indicate that bee-keepers should take a greater interest in collection of honeydew produced by *Periphyllus testudinaceus* Fernie and *Drepanosiphum platanoidis* Schrank on maples.

I wish to express my thanks to Doc. Dr. hab. Aleksander Rajski for help and critical remarks during preparation of this paper.

REFERENCES

1. Achremowicz, J. 1966 – Metody ilościowych połowów mszyc na polach uprawnych – Ekol. Pol. B, 12: 351–355.
2. Achremowicz, J. 1968 – Metody pobierania ilościowych prób mszyc do badań populacyjnych – Kurs Afid. Ogol., Wrocław–Warszawa–Kraków, 197–219.

3. Berliński, K. 1956 – Metody badań ilościowych mszyc – Ekol. Pol. B. 2: 339–342.

4. Berliński, K. 1958 – O metodach połowu mszyc – Ekol. Pol. B, 2: 133–136.

5. Burschel, P., Vitte, P. 1951 – Neue Beobachtungen über die Buchenblattbaumlaus *Phyllaphis fagi* L. (*Hem. Aphididae*). Forst. Centralblatt., 70: 180–186.

6. Celiński, F. 1962 – Zespoły leśne Puszczy Bukowej pod Szczecinem – Monographiae Bot., XII, Warszawa.

7. Dziurzyński, A. 1961 – The inhabitants of the galls of *Mikiola fagi* Htg. Part I. – Acta Zool. Crac., VI, 2: 9–49.

8. Fossel, A. 1962 – Die Grosse Pflaumenblattlaus Biologie, Beflug, Bekämpfung – Dtsch. Bienenwirt., 13, 8: 232–235.

9. Fossel, A. 1963 – Aus dem leben der Europäischen shomblattlaus *Peryphyllus villosus* Htg. – Zeit. Bienenforsch., 6, 7: 199–207.

10. Haragsim, O. 1966 – Medovice a vcely – Prahy, 4–260.

11. Karczewska, M. 1964 – Z badań nad mszycami *Aphididae* występującymi na jabłoniach – Biul. IOR, Poznań, 26: 74–88.

12. Łęski, R., Smolarzowa, S. 1959 – Porównanie skuteczności preparatów kontaktowych i układowych w zwalczaniu mszyc na drzewach owocowych – Pr. Inst. Sadow. 4: 259–277.

13. Mathys, G., Baggiolini, M. 1965 – Me'thodes de recensement d'insectes ravageurs dans des vergers soumis ades essais de integreé – Mit. d. Schweiz. Entom. Gessells., 38, 1: 120–141.

14. Moszczyńska, M. 1931 – Galasy (zoocecidia) drzew i krzewów półwyspu Helskiego – Kosmos, A. 55: 273–292.

15. Oktab, W. 1966 – Elementy statystyki matematycznej i metodyka doświadczalnictwa – Warszawa, 308 pp.

16. Popova, A. 1967 – Tipy prisposoblenii tlei k pitaniju na kamovych rastieniach – Leningrad, 350 pp.

17. Prabucki, J. 1967 – Population of dew secreted aphids *Phyllaphis fagi* L. in the Beech Woods near Szczecin – Pszczel. Zesz. Nauk., 1–3: 61–68.

18. Parabucki, J. 1968 – Honey-Dew of Leafed Trees and its Givers – Przegl. Zool. – 1: 35–39.

19. Prawdzic, K. 1961 – Klimat województwa szczecińskiego w świetle potrzeb rolnictwa – Szczecin, 63 pp.

20. Ruszczyc, Z. 1970 – Metodyka doświadczeń zootechnicznych – Warszawa 408 pp.

21. Schels, J. 1958 – Über Honigtau erzeugende Pflanzen Sauger – Dtsch. Bienenwirt. 2: 21–27.

22. Schels, J. 1962 – Wie beobachte ich Honigtauerzeuger im Laufte des Jehres – 3 Mitt. Dtsch. Bienenwirtsch., 13: 107–110.

23. Schels, J. 1964 – Was der praktische Imker von den Honigtauerzeugem und Waldhong wissen mus – Dtsch. Bienenwirt., 15: 251–258.

24. Schmutterer, H. 1952 – Zur Kenntnis der Buchenblattlaus *Phyllaphis fagi* L. (*Homoptera, Aphidoidea*) einer wichtigen Honigtauerzeuge rainauf – Anz. Schadlingsh., 25: 1–4.

25. Schmutterer, H. 1953 – Aphiden und Cocciden als Honigtauerzeuger auf Laubhorzern – Zeit. ang. Ent. 34: 607–612.

26. Schmutterer, H. 1954 – Zur Lachnidenfauna Beyerns Nachrichtenbl. – D. Bayer Entom. 3: 1–6.

27. Schmutterer, H. 1956 – Saugschaden an Eichen und Buchen durch Lachniden in Abhengigkeit von Ameisen – Trophobiose – Zeit. ang. Ent. 39: 178–185.
28. Schmutterer, H. 1958 – Die Honigtauerzeuger Mitteleuropas – Zeit. ang. Ent. 39: 409–419.
29. Sorauer, P. 1957 – Handbuch der Pflanzenkrankheiten. Band V, Tierische schädlinge an Nutzpflanzen 2 Tell. – Berlin.
30. Szulczewski, J., 1931 – Wyrośle (zoocecidia) Gdyni i okolic – Kosmos A, 55: 149–272.
31. Szulczewski, J. 1936 – Wykaz wyrośli (zoocecidia) zebranych w okolicach Myszyńca na Kurpiach – Spraw. Kom. Fizjogr., 70: 11–128, Kraków.
32. Szulczewski, J. 1953/1954 – Wyrośle (zoocecidia) Gorzowa w Ziemi Lubuskiej – Prace Kom. Biol., 14; 1: 1–38, Poznań.
33. Wiszniewski, W. 1953 – Atlas opadów atmosferycznych w Polsce 1891–1930, Warszawa.
34. Wiszniewski, W., Gumiński, R., Bartnicki, L. 1949 – Przyczynki do klimatologii Polski – temperatura – Wiad. Służby Hydr. Meteo., I, 5, Warszawa.
35. Zöbellein, G. 1956a – Der Honigtau als Nahrung der Insekten – Zeit. ang. Ent. 38: 369–416.
36. Zöbellein, G. 1956b – Der Honigtau als Nahrung der Insecten – Zeit. ang. Ent. 39: 126–167.

SPADZIODAJNA MSZYCA BUKOWA *PHYLLAPHIS FAGI* L. (*HOMOPTERA*) NA TLE WARUNKÓW BYTOWYCH PUSZCZY BUKOWEJ POD SZCZECINEM, W ASPEKCIE POTRZEB PSZCZELARSKICH

Streszczenie

Zamiarem autora było prześledzenie pionowego rozmieszczenia oraz dynamiki liczebności populacji *Phyllaphis fagi* L. w koronie i podszyciu buka zwyczajnego – *Fagus silvatica* L., jak również zbadanie czynników ograniczających rozwój poszczególnych jej generacji. Dalszym zadaniem było stwierdzenie jej przydatności dla gospodarki pszczelarskiej w rejonach o dużym zalesieniu drzewostanami bukowymi. Badania prowadzono w latach 1966 i 1967 na terenie Puszczy Bukowej pod Szczecinem (fig. 1). Do badań wybrano dwa drzewa w VI klasie wieku, wokół których wybudowano trzypoziomowe rusztowania (fig. 5). W trakcie opracowywania dynamiki liczebności oraz rozmieszczenia pionowego populacji, posłużono się metodą liczenia mszyc na 100 liściach. W tym celu na każdym poziomie rusztowania wyznaczono cztery stałe stanowiska, każde po 100 liści, w rezultacie pod obserwacją znalazło się 16 stanowisk. Poszczególne poziomy rozlokowane były w koronie na następujących wysokościach: poziom I – w zasięgu ręki (ok. 200cm), poziom II – ok. 630 cm, poziom III – ok. 1000 cm, poziom IV – ok. 1330 cm. Numeracja stanowisk była zgodna z kierunkami stron świata, i tak: stanowiska pierwsze były wystawione w kierunku południowym, drugie – zachodnim, trzecie – północnym i czwarte – wschodnim. Obserwacje prowadzono również w podszyciu, wyznaczając cztery stanowiska w sąsiedztwie każdego badanego drzewa, i tak: poziom I wyznaczono na siewkach do 20 cm wysokich poziom II na siewkach do 50 cm wysokich, poziom III na siewkach do 100 cm oraz poziom IV na siewkach powyżej 100 cm wysokości. Doszukując się przyczyn

wpływających na rozwój populacji *Phyllaphis fagi* L. śledzono warunki pokarmowe, termiczne, opadowe, wilgotnościowe oraz wpływ wystawy i pozycji drzewa w środowisku. Warunki pokarmowe zbadano wykonując analizę chemiczną liści buka na zawartość związków azotowych w różnych okresach rozwojowych populacji. Całkowity azot oznaczono przy pomocy metody Kjeldahla, natomiast białko właściwe przy zastosowaniu metody Bernsteina. Warunki mikroklimatyczne badano przy pomocy zainstalowanych wewnątrz koron drzew tygodniowych termohygrografów oraz ustawionego przy gajówce Glinna deszczomierza. Obserwacje prowadzono od fazy rozwoju liści buka (maj) do okresu złotych koron (październik), z tygodniową częstotliwością.

Na podstawie przeprowadzonych obserwacji autor dochodzi do następujących głównych wyników. 1. Cykl rozwojowy populacji na terenie Puszczy Bukowej zaczął się w maju i trwał do połowy lipca w koronach (fig. 6, 8). Dalszy rozwój kontynuowany był w podszyciu i trwał od lipca do września (fig. 10,12), aby ponownie w ostatnich dniach września i pierwszych października uaktywnić się w koronach drzew (fig. 6, 8). 2. Na szczególnie pomyślne warunki rozwojowe pierwsze generacje *Phyllaphis fagi* L. natrafiły na poziomach wyższych (II–IV), natomiast ostatnie generacje na poziomach pierwszych (fig. 6, 8). Stwierdzono współzależność dodatnią i istotną – Buk I (fig. 7) oraz nieistotną – Buk II (fig. 9). 3. W podszyciu najliczniej mszyce występowały na piętrach wyższych, czyli na siewkach do 100 cm wysokich (fig. 10, 12), wyliczony jednak współczynnik korelacji był niewielki i nieistotny (fig. 11, 13). 4. Stan ilościowy mszyc w poszczególnych okresach rozwojowych populacji uzależniony był od zespołowego działania czynników pokarmowych, termicznych i wilgotnościowych (fig. 14–17). 5. Spadek zawartości związków azotowych oraz białka właściwego w liściach koron (czerwiec, lipiec), ściśle wpływał na redukcję stanu ilościowego mszyc. Niewielki wzrost zawartości białka właściwego (lipiec) w podszyciu, powodował intensywniejszy rozwój mszyc na siewkach (Fig. 14–17, tab. I). 6. Wzrost temperatury przy jednoczesnym spadku wilgotności względnej powietrza, pociągał za sobą zwiększenie stanu ilościowego mszyc i odwrotnie. Rozwój populacji szczególnie pomyślnie przebiegał przy niskiej wilgotności względnej powietrza (70%) i stosunkowo wysokich średnich temperaturach rzędu 14°C (fig. 14–17). Korelacja między tymi zjawiskami była istotna (fig. 18, 19). 7. Wpływu opadów na rozwój populacji *Phyllaphis fagi* nie udało się stwierdzić (fig. 20). 8. Usytuowanie drzew oraz stanowisk w stosunku do stron świata nie wpływa wyraźnie na stan ilościowy afidofauny na buku (fig. 21). Drzewa bardziej narażone na działanie wiatrów, stwarzały szczególnie na poziomach wyższych, mniej pomyślne warunki rozwojowe populacji (fig. 6, 8). 9. Spadź produkowana była przez cały okres rozwoju populacji, jedynie intensywność wydalania jej przez mszyce była różna (fig. 22). Proces wydalania przez mszyce spadzi był ściśle uzależniony od warunków rozwojowych populacji. 10. Spadź na terenie Puszczy Bukowej występowała, lecz nie miała znaczenia jako pożytek spadziowy dla pszczół. Z gospodarskiego punktu widzenia nastawienie wędrownej gospodarki pszczelarskiej na wziątek spadziowy z buka jest niecelowe. Większe zainteresowanie pasiek produkcyjnych winno iść w kierunku pozyskiwania spadzi wytwarzanej przez *Periphyllus testudinaceus* Fernie i *Drepanosiphum platanoidis* Schrank na klonach.

AUTHOR'S ADDRESS:
Dr Jarosław Prabucki,
Instytut Biologicznych Podstaw
Hodowli Zwierząt WSR,
Szczecin, ul. Janosika 8,
Poland.