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The effect of chronic foliage damage by *Tomostethus nigritus* (Fabricius, 1804) larvae on the radial growth of *Fraxinus excelsior*

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The research aimed to evaluate the response of the European ash Fraxinus excelsior L. radial increment to the foliage damage by Tomostethus nigritus (Fabricius, 1804). In Kharkiv's Molodezhny Park, defoliation of European ash by black ash sawfly increased from 2013, reached a maximum (94.1±3.4%) in 2015, and then decreased. The mean defoliation of individual trees in individual years ranged from 31.7±18.1% to 73.3±13.5%. Only three trees were completely defoliated over two consecutive years. No dependence of tree defoliation on their diameter was found. The mean health condition index HCl started to increase in 2017 and reached 2.4 in 2018. Its dependence on the defoliation level was high and significant (r=0.83; p<0.001). The radial growth of trees decreased in years of increasing foliage damage. In 2013–2018 compared to 2007–2012, the average annual, early, and late wood in the total sample decreased by 12.4%, 7.2%, and 14.9%, respectively. However, the changes were statistically significant only for the late wood. The late growth changed almost synchronously with the annual growth. The proportion of the late

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wood in the annual growth was only 56.1 % in the year of maximum defoliation and exceeded 70 % the following year.

In the group of trees with low defoliation (on average < 25%), the annual wood width in 2013-2018 (the years of black ash sawfly outbreak) was higher than in 2007-2012 by 0.2 mm (8.5%). In the group of trees with moderate defoliation (26-50%), the annual wood width decreased by 0.2 mm (8.5%), and in the group with severe defoliation (> 50%) by 0.7 mm (20.9%). However, the change in the annual wood growth was significant only for the group of trees with severe defoliation.

In the group of healthy trees (HCI=1), late wood width in 2013-2018 was higher than in 2007-2012 by 0.04 mm (3.7%), in the group of weakened trees (HCI=2) was lower than in 2007-2012 by 0.2 mm (16.6%), and in a group of severely weakened trees (HCI=3) was lower by 0.15 mm (12.4%). However, these differences were not statistically significant.

Most Spearman's rank correlations between ash wood growth and weather parameters are low and insignificant. Negative correlations between ash wood growth and air temperature of the growing season, May and September, are the most significant. An increase in the Hydrothermal Index in 2016, compared to the previous year by 0.2 units (by 25%), could have a positive impact on growth recovery.

The research indicates that European ash foliage damage by the black ash sawfly does not pose a noticeable threat to the plantings. At the same time, weakened trees became susceptible to infestation by the emerald ash (Agrilus planipennis Fairmaire, 1888 (Coleoptera: Buprestidae) in subsequent years.

Key words: *European ash; black ash sawfly; defoliation; health condition index; early wood; late wood.*

Introduction.

In the last few decades, the health condition of *Fraxinus* L. has deteriorated in many regions (Pyvovar et al., 2022; Ciornei et al., 2024; Schertler et al., 2025). This has happened largely due to climate change and increased anthropogenic pressure, which were favorable for the spread of alien pests, such as *Hymenoscyphus fraxineus* (T. Kowalski) Baral, Queloz & Hosoya) (Schertler et al., 2025) and Emerald ash borer *Agrilus planipennis* Fairmaire, 1888 (Coleoptera: Buprestidae) (Mathieu & McCullough, 2025). Along with alien ash pests, the range and harmfulness of native species have increased in recent years. One of them is the black ash sawfly *Tomostethus nigritus* (Fabricius, 1804) (Hymenoptera: Tenthredinidae), whose larvae feed on ash foliage. Outbreaks of the black ash sawfly have been recorded in many European countries, from Italy to Northern Ireland (Mitali, 2012; Soldi et al., 2022) and even in China (Zeng et al., 2024).

Within its range, the black ash sawfly develops in a single generation (Зінченко & Кукіна, 2015; Jess et al., 2017; Ciornei et al., 2024). The beginning of adult swarming coincides with the start of European ash foliage development. In eastern Ukraine, mass swarming begins in the third decade of April (Зінченко & Кукіна, 2015). Females lay eggs in leaves that are beginning to grow. The eggs hatch in early May, the larvae feed on growing foliage, complete feeding in the third decade of May, and descend into the soil, where they form cocoons and undergo eonymph and pronymph stages. They pupate in the first half of April, and adults emerge in late April (Зінченко & Кукіна, 2015).

In Kharkiv's Molodezhny Park, an abundant swarming of black ash sawfly and severe ash crown damage by its larvae were first observed in 2002 (Meshkova et al., 2017). Since 2012, defoliation monitoring has been conducted annually on over 90 labeled trees. Each year, defoliation of some trees exceeded 75%, while other trees showed only minor damage. No ash tree mortality was observed during these years until the Emerald ash borer invaded the stand in 2022 (Meshkova et al., 2024).

Foliage damage by insects can lead to deterioration in tree health and reduced growth (Kulman, 1971; Lyytikäinen-Saarenmaa & Tomppo, 2002; Simmons et al., 2014; Tabaković & Milosavljević, 2018). However, the extent of tree growth reduction depends on the timing and extent of defoliation, tree species, its health before pest attacks, weather, etc. Most research focused on the growth-climate relationships of *Fraxinus* sp. In the eastern USA, the total ring width of white ash (*F. americana* L.) was positively correlated with precipitation and negatively correlated with temperature during May to July, when most radial growth occurs. So white ash growth was most strongly influenced by drought stress in the first half of the growing season (Lockwood & LeBlanc, 2017). In Poland, the tree-ring width of European ash was related to climatic factors in July, August, and September of the previous year, and May, June, and July of the current year (Okoński, 2017). A negative impact of moisture deficit on the radial growth of European ash was also observed in Lithuania (Karpavičius & Vitas, 2006) and Ukraine (Koval & Maksimenko, 2020). Despite the presence of the ash black sawfly in different regions, the effect of defoliation on radial wood growth has not been sufficiently studied.

The object of research was the radial growth of European ash. *The subject of research* was the radial growth of European ash under foliage damage by black ash sawfly. The study *aimed* to evaluate the response of the European ash radial increment to the foliage damage by *Tomostethus nigritus*.

Material and methods.

The research was conducted in the Molodezhny Park (50°0'28.39"N 36°15'5.38"E) of Kharkiv (Ukraine, Left-bank Forest-steppe), where *Fraxinus excelsior* L. had been regularly damaged by the ash black sawfly *Tomostethus nigritus* (Meshkova et al., 2017, 2024). Since 2007, more than 90 European ash trees in this park have been labeled and surveyed annually. The trees ranged in age from 50 to 70 years, with diameters ranging from 36.7 to 62.6 cm (average diameter 51±1.9 cm).

Defoliation and the health condition of individual trees were assessed in July-August. The accuracy of visual assessment of defoliation was 5%. Health condition index (HCI) was assessed by referring each tree to one of the classes: 1– healthy; 2 – slightly weakened; 3 – weakened; 4 – drying up; 5 – recently dead; 6 – died more than one year ago (Санітарні правила в лісах України, 2016).

In March, 2019, the cores were extracted by standard dendrochronological techniques with the Pressler borer at a height of 1.3 m (Cook & Kairiukstis, 1992). After air drying, the core surfaces were prepared with razor blades, and the surface contrast was enhanced with chalk. When preparing the cores for measurement, it was found that many trees had signs of stem rot, and only 17 cores were suitable for further analysis.

The widths of early, late, and annual increments were measured using a digital equipment HENSON at an accuracy of 0.01 mm. All cores were dated using visual and graphical techniques to determine the exact date of each tree-ring formation (Cook & Kairiukstis, 1992). The proportion of late wood was calculated.

Climatic parameters (monthly air temperature and precipitation) were taken from Kharkiv weather station (49°58′50″ N, 36°15′09″ E, 113 m a.s.l.).

Selyaninov's Hydrothermal Index – HTI was calculated by the formula (2):

$$HTI = 10\frac{\Sigma P}{\Sigma t}, \qquad (2)$$

where ΣP is the amount of precipitation for the period with mean monthly air temperature over 10°C, mm; Σt is the sum of daily air temperatures for the same period, °C.

All data were organized using the software Excel 2019. PAST: Paleontological Statistics Software Package for Education and Data Analysis (Hammer et al., 2001) was used for data analysis (descriptive statistics, correlation analysis, etc.) and visualization.

Results.

Defoliation of individual ash trees by ash sawfly larvae in individual years of the period 2013-2018 varied from 0 to 100% (Fig. 1). The mean defoliation of individual trees in individual years ranged from 31.7±18.1% to 73.3±13.5%, and the average for 2013-2018 was 52.5±3.3%. The coefficient of variation of defoliation of individual trees over this period ranged from 26 to 241.4%.

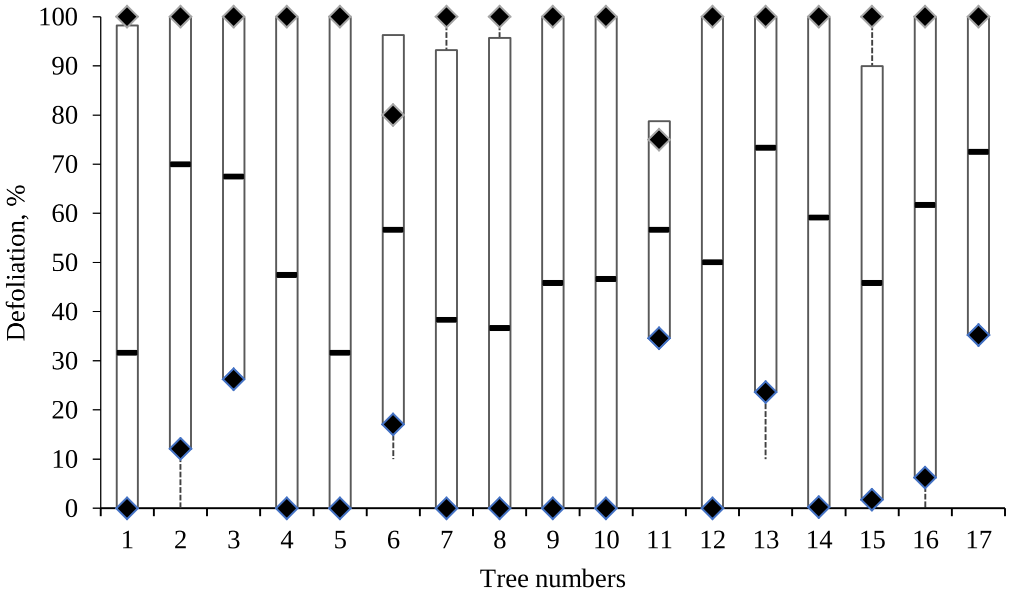

Fig. 1. **Defoliation of individual ash trees by ash sawfly larvae in 2013-2018 (box length is one sigma; whiskers are max-min)**

Correlation coefficients between the defoliation dynamics of individual trees ranged from 0 to 0.96, with both negative and positive values (Fig. 2). Defoliation of 100 % over two consecutive years was observed only for tree No3, while defoliation rates of 95-100-90% were observed for tree No2, and 90-100% were observed for trees No 4 and No 14. Defoliation of most trees in the year following reaching 100% did not exceed 50-70%.

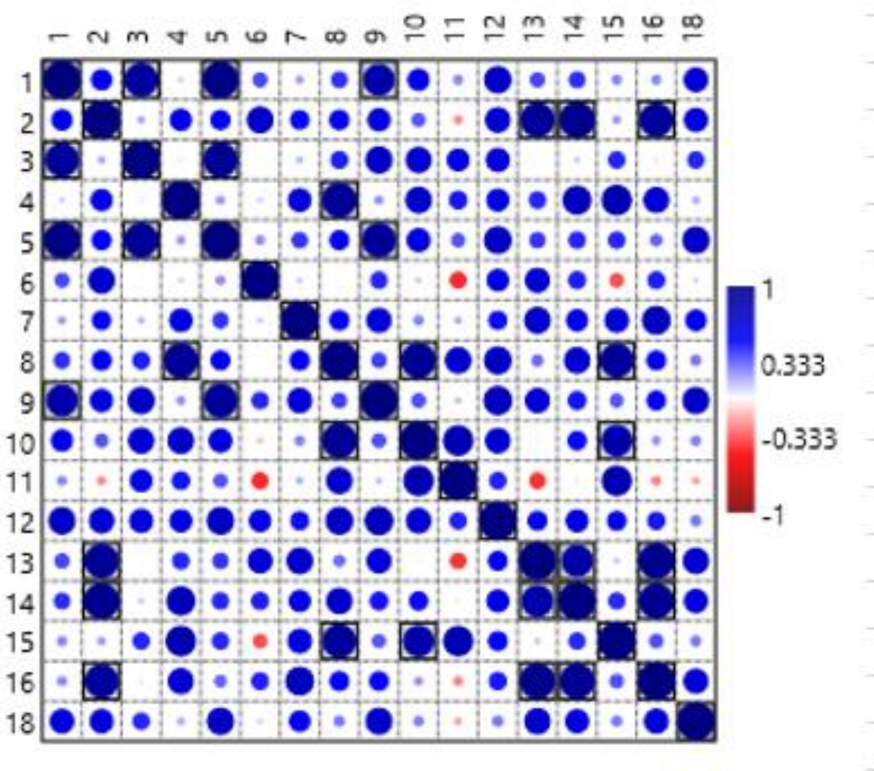

Fig. 2. **Correlation plot of individual trees' defoliation in 2013-2018 (p < 0,05 boxed)**

Mean defoliation increased from 2013, reached a maximum (94.1±3.4%) in 2015, and then decreased (Fig. 3). In all years of the outbreak except 2015, defoliation of some trees was close to 0%. The coefficient of variation in individual tree defoliation before the outbreak was about 70%, decreased to 15% in the years of maximum foliage damage, and increased to 125% in the following two years.

No dependence of tree defoliation on their diameter was found (R^2=0.0045; r=0.07) (Fig. 4).

The dependence of the health condition index on the defoliation level was high and significant (R^{2-} = 0.6994; r= 0.83; p < 0.001) (Fig. 5).

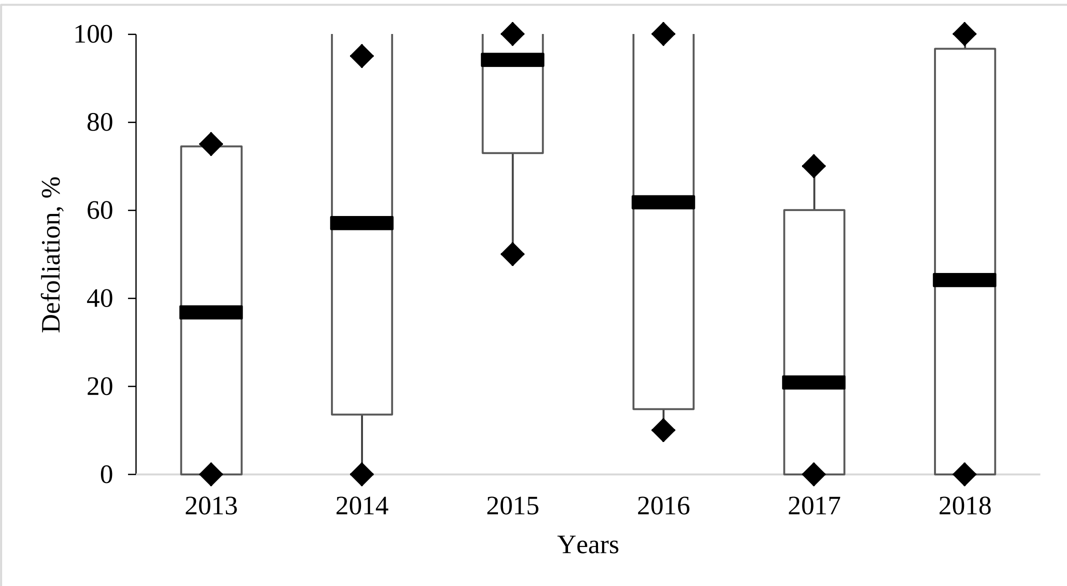

Fig. 3. **Defoliation of ash trees by ash sawfly larvae in individual years of 2013-2018 (box length is one sigma; whiskers are max-min)**

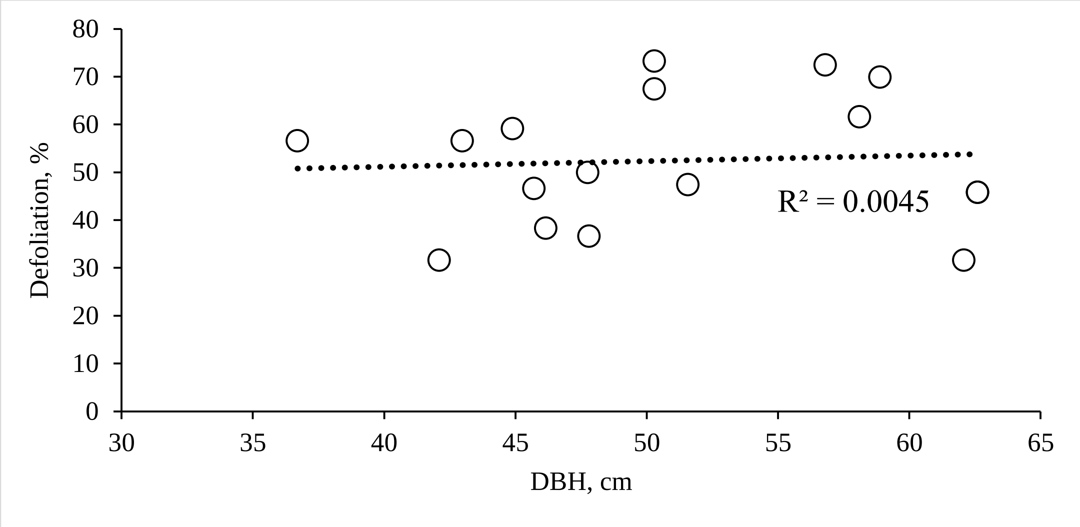

Fig. 4. **Mean defoliation of ash trees by ash sawfly larvae in 2013-2018, depending on stem diameter (DBH)**

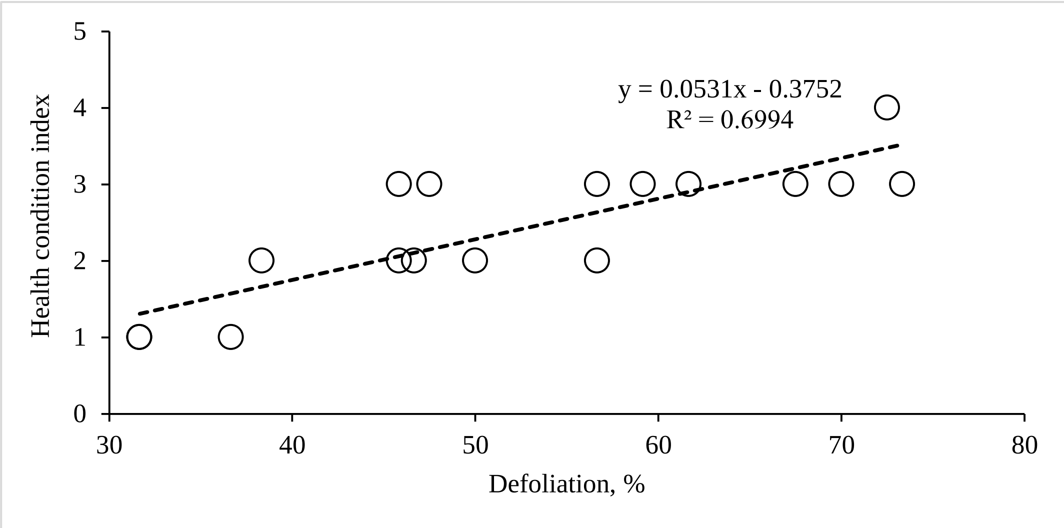

Fig. 5. **Health condition index of ash trees in 2018 depending on mean defoliation in 2013-2018**

In years of increasing foliage damage, the radial growth of trees decreased; after the maximum of the outbreak, it increased sharply but then decreased again (Fig. 6).

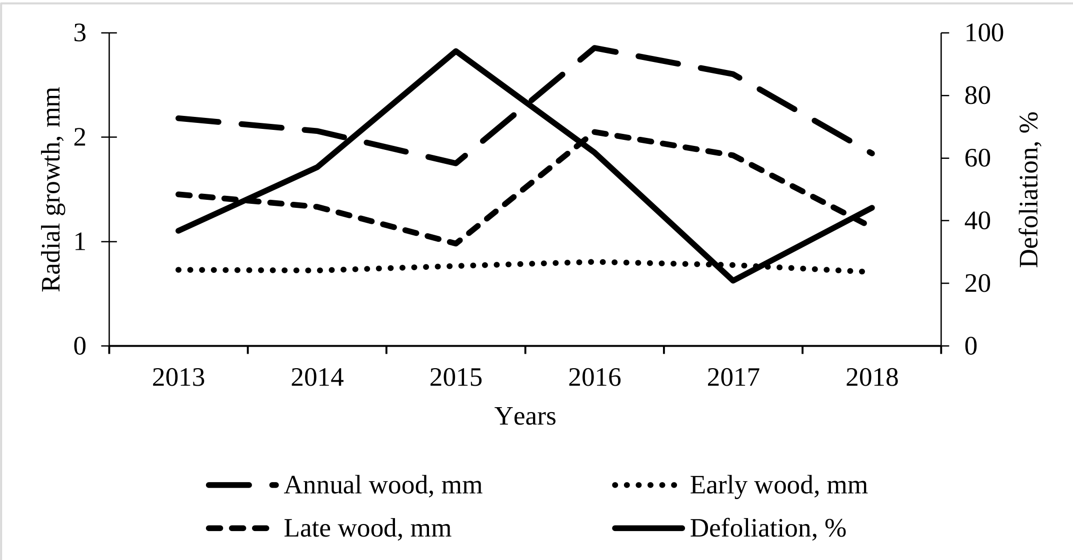

Fig. 6. **Defoliation of ash trees by ash sawfly larvae and radial wood increment in 2013-2018**

The late growth changed almost synchronously with the annual growth, but its share in the annual growth in the year of maximum defoliation was only 56.1%, and in the following year it exceeded 70% (Fig. 7).

The mean health condition index did not exceed 2, and only in 2017 did it start to increase, reaching 2.4 in 2018 (see Fig. 7).

The average annual, early, and late increments for all ash trees in 2013-2018 compared to 2007-2012 decreased by 0.31, 0.06, and 0.26 mm, respectively, and the relative changes were 12.4%, 7.2%, and 14.9%, respectively. However, statistically significant changes were found only for late increment ($F_{fact} = 4.06$; $F_{0.05} = 3.89$; $p = 0.05$).

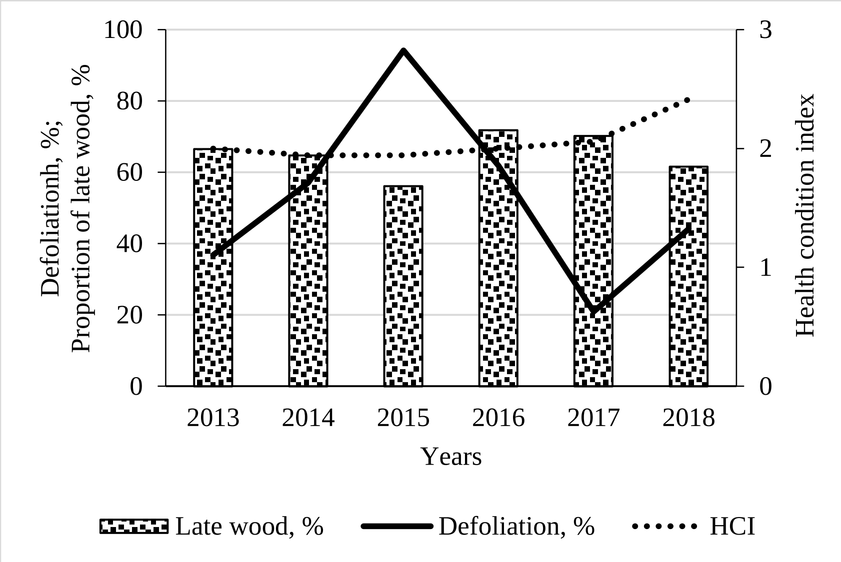

Fig. 7. **Defoliation of ash trees by ash sawfly larvae, the health condition index and proportion of late wood in the radial wood increment in 2013-2018**

The comparison showed that in the group of trees with low defoliation (on average < 25%), the annual wood growth in 2013-2018 (the years of black ash sawfly outbreak) was higher than in 2007-2012 by 0.2 mm (8.5%). In the group of trees with moderate defoliation (26-50%) it decreased by 0.2 mm (8.5%), and in the group with severe defoliationn (> 50%) it decreased by 0.7 mm (20.9%) (Fig. 8). However, the change in the annual wood growth was significant only for the group of trees with severe defoliation ($F_{fact.} = 5.42$; $F_{0.05} = 3.98$; $p = 0.02$).

Late wood width in the groups of trees, which were healthy, weakened, and severely weakened (HCI – 1, 2, and 3, respectively) in 2018, was not significantly different in 2007-2012 ($F_{fact}. = 0.38$; $F_{0.05} = 3.04$; $p = 0.7$) and in 2013-2018 ($F_{fact\ .} = 1.01$; $F_{0.05} = 3.04$; $p = 0.4$).

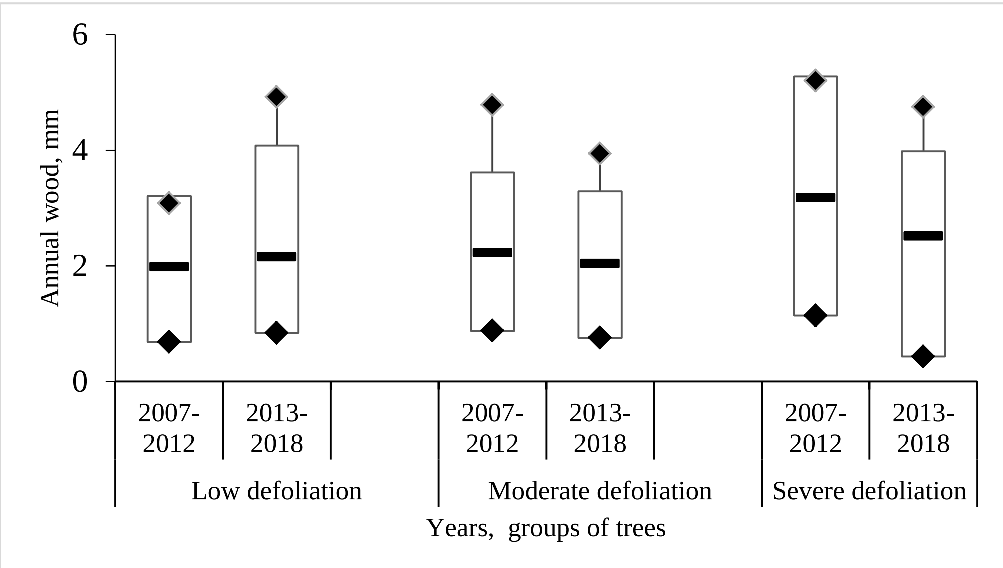

Fig. 8. **Annual wood growth of ash trees in 2007-2012 and after defoliation by ash sawfly larvae in 2013-2018 (low defoliation – < 25%; moderate defoliation – 26-50%; severe defoliation – > 50%; box length is one sigma; whiskers are max-min)**

In the group of healthy trees (HCI = 1), late wood width in 2013-2018 was higher than in 2007–2012 by 0.04 mm (3.7%), in the group of weakened trees (HCI = 2) it was lower than in 2007-2012 by 0.2 mm (16.6%), and in a group of severely weakened trees (HCI = 3) it was lower by 0.15 mm (12.4%) (Fig. 9). However, these differences were not statistically significant ($F_{fact.} < F_{0.05}$).

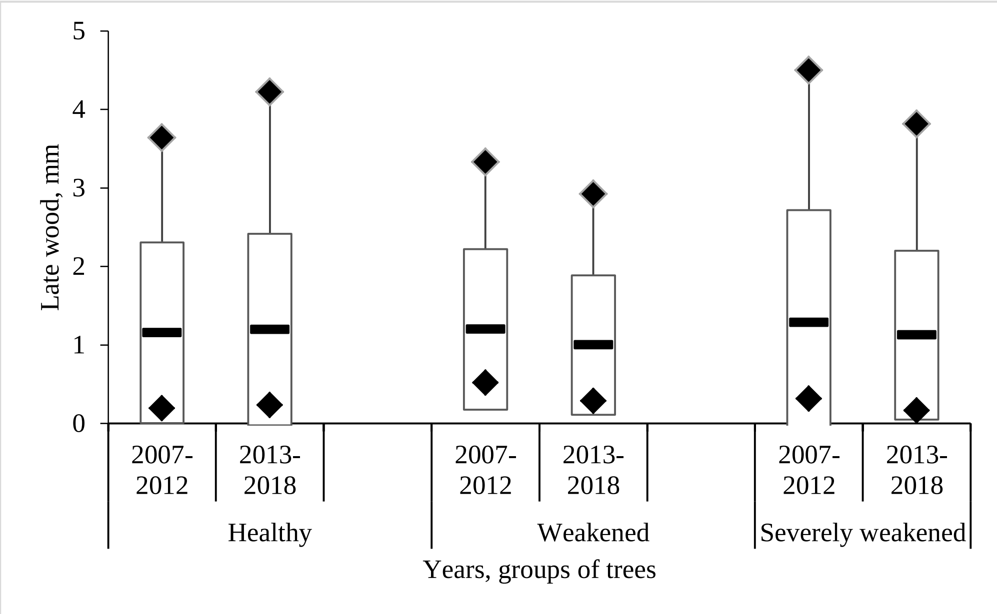

Fig. 9. **Late wood width of ash trees in 2007–2012 and after defoliation by ash sawfly larvae in 2013-2018 (healthy trees – Health condition class 1; weakened trees – Health condition class 2; severely weakened – Health condition class 3; box length is one sigma; whiskers are max-min)**

Most Spearman's rank correlations between ash wood growth and weather parameters were low and insignificant (Table 1). Negative correlations between ash wood growth and the temperature of the growing season, May, and September were significant at $p < 0.05$.

Table 1. **Spearman's rank correlation between ash wood growth and weather parameters**

Para-meters	rs			Sr			t		
	Annual growth	Early wood	Late wood	Annual growth	Early wood	Late wood	Annual growth	Early wood	Late wood
P4	-0.01	0.26	0.04	0.30	0.28	0.30	-0.05	0.92	0.14
P5	-0.04	-0.06	0.01	0.30	0.30	0.30	-0.14	-0.19	0.05
P6	-0.27	-0.13	-0.30	0.28	0.30	0.27	-0.98	-0.42	-1.10
P7	-0.10	-0.16	-0.06	0.30	0.29	0.30	-0.35	-0.55	-0.21
P8	0.29	0.25	0.30	0.28	0.28	0.27	1.04	0.89	1.10
P9	0.08	-0.29	0.02	0.30	0.28	0.30	0.28	-1.04	0.07
Pveg	0.03	-0.10	0.06	0.30	0.30	0.30	0.12	-0.33	0.19
Tveg	**-0.49**	**-0.52**	**-0.50**	**0.23**	0.22	0.23	**-2.14**	**-2.38**	**-2.19**
HTI	0.13	0.03	0.14	0.30	0.30	0.30	0.42	0.09	0.47
T4	-0.06	-0.27	0.01	0.30	0.28	0.30	-0.21	-0.98	0.02
T5	-0.46	**-0.65**	**-0.49**	0.24	0.17	0.23	-1.95	**-3.74**	**-2.14**
T6	-0.20	-0.25	-0.22	0.29	0.28	0.29	-0.70	-0.89	-0.76
T7	-0.13	-0.27	-0.11	0.30	0.28	0.30	-0.44	-0.98	-0.38
T8	-0.06	-0.07	-0.08	0.30	0.30	0.30	-0.20	-0.23	-0.26
T9	**-0.52**	-0.23	**-0.53**	0.22	0.29	0.22	**-2.35**	-0.81	**-2.46**

Notes: P4 – P9 – precipitations for April – September; T4 –T9 – air temperature for April – September; Pveg – precipitation for growing season; Tveg –mean air temperature for growing season; rs – Spearman's rank correlation; Sr – standard error of rs; t – Student's t; significant values are bold

An increase in the Hydrothermal Index in 2016, compared to the previous year (by 0.2 units, or by 25%), could have a positive impact on growth recovery (Fig. 10).

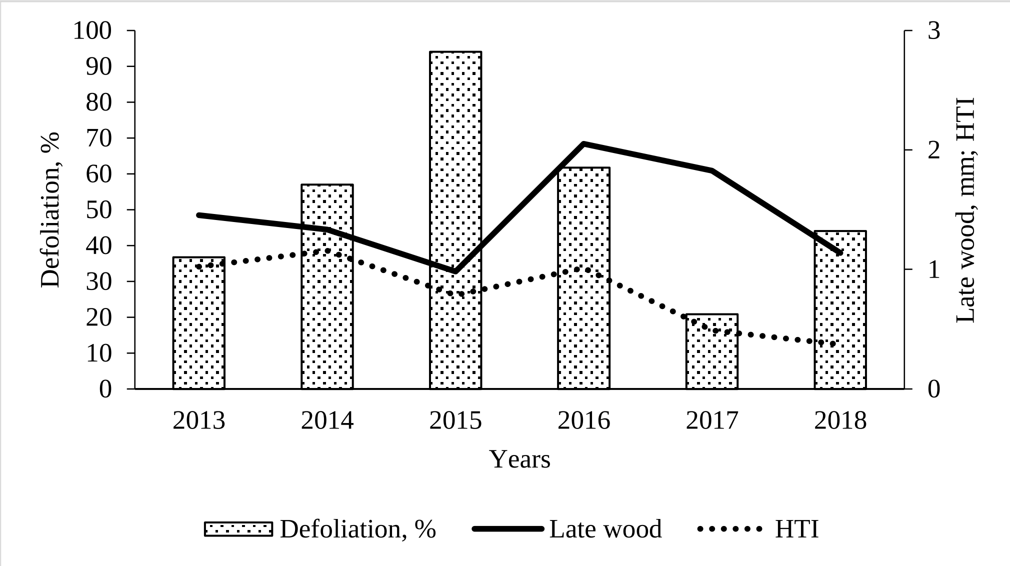

Fig. 10. **Defoliation of ash trees by ash sawfly larvae, the health condition index and late wood width of ash trees in 2013-2018**

Discussion.

Across regions, plantings, and tree species, estimates of radial growth response to insect damage vary widely (20-84%) (Kulman, 1971). This depends on the methodological approaches, the timing of foliar damage, weather conditions, and other factors. Since pest outbreaks last 5-7 years, when assessing the impact of foliar damage on wood growth, these indicators are compared for 5-10 years before the pest outbreak and the same period after the outbreak (Kulman, 1971).

In our study area, the black ash sawfly outbreak developed in 2013-2018, peaking in 2015. In each year, no more than 2-3 trees were damaged to almost 100% (see Figs. 1 and 2). This may be related to the fact that trees typically delay budburst in the following year after severe defoliation. Due to stress and the costs of crown restoration, the tree requires more time and warmth to start vegetation the following spring (Wesołowski & Rowiński, 2006). This phenological shift disrupts the synchrony between the tree's leaf emergence and the peak feeding times of emerging larvae.

The observed decrease in the coefficient of variation in individual tree defoliation in the year of maximum foliage damage is similar to patterns in the dynamics of foliage-gnawing insect population density (Meshkova, 2021).

In years with increasing foliage damage, the radial growth decreased; after the year of maximum foliage damage, the radial growth increased sharply, but then decreased again (see Fig. 6).

Ash is a ring-porous species with large vessels arranged in rings in the early wood. Earlywood width varies little under any factor, while latewood responds more noticeably (Koval & Borisova, 2019; Lockwood & LeBlanc, 2017). The previous radial growth can be restored after the weakening factor ceases. The rate of its recovery depends on defoliation level, weather, forest site conditions, and tree health (Коваль, 2023). Our data confirm it (see Fig. 6).

The late growth changed almost synchronously with the annual growth, but its share in the annual growth in the year of maximum defoliation was only 56.1%, and in the following year it exceeded 70 % (see Fig. 7).

Earlywood development begins with bud break by utilizing the previous year's carbohydrate reserves. Summer growth occurs due to products of photosynthesis accumulated during the current year (Tulik et al., 2010). Since black ash sawfly damages foliage during larval development (in May), it does not affect earlywood. However, the proportion of late growth responds to defoliation.

Deciduous tree species begin to regrow foliage immediately if insect damage occurs before completion of shoot growth and wood ring formation (Kulman, 1971). Therefore, deciduous species can tolerate repeated defoliation for several years.

A significant decrease in wood growth in the trees with severe defoliation (> 50%) in 35.3% of analyzed trees and an insignificant decrease in late wood width among severely weakened trees (HCI = 3), which constituted 47% of analyzed trees and 17.5% of monitored trees, as well as relative growth change was less than 25% (Schuler & Fajvan, 1999) indicate that foliar damage by the black ash sawfly does not pose a noticeable threat to the plantings.

The lack of statistically significant correlations between ash wood growth and weather parameters (see Table 1) may be due to the short period of exposure to severe defoliation.

Thus, research in the Kharkiv region showed that in 1975-1995, the radial growth of European ash was affected by the growing-season temperature, and in 1995-2016, by the air temperature in March, April, and the winter months. Precipitation in September and December of the previous year had a positive effect on the radial growth in 1975-1995 (Коваль & Борисова, 2019).

The results of the research show that foliage damage by black ash sawfly larvae did not cause significant direct damage to the planting. However, the weakened trees became susceptible to the emerald ash borer in the coming years (Meshkova et al., 2024).

Conclusions.

1. In Kharkiv's Molodezhny Park, defoliation of European ash by black ash sawfly increased from 2013, reached a maximum (94.1±3.4%) in 2015, and then decreased. The mean defoliation of individual trees in individual years ranged from 31.7±18.1% to 73.3±13.5%. Only three trees were completely defoliated over two consecutive years. No dependence of tree defoliation on their diameter was found. The mean health condition index started to increase in 2017 and reached 2.4 in 2018. Its dependence on the defoliation level was high and significant ($r = 0.83$; $p < 0.001$).

2. The radial growth of trees decreased in years of increasing foliage damage. In 2013-2018 compared to 2007-2012, the average annual, early wood and late wood in the total sample decreased by 12.4%, 7.2%, and 14.9%, respectively. However, the changes were statistically significant only for the late wood.

3. The late growth changed almost synchronously with the annual growth. The proportion of the late wood in the annual growth was only 56.1% in the year of maximum defoliation and exceeded 70% the following year.

4. In the group of trees with low defoliation (on average < 25%), the annual wood width in 2013-2018 (the years of black ash sawfly outbreak) was higher than in 2007-2012 by 0.2 mm (8.5%). In the group of trees with moderate defoliation (26-5%), the annual wood width decreased by 0.2 mm (8.5%), and in the group with severe defoliation (> 50%) by 0.7 mm (20.9%). However, the change in the annual wood growth was significant only for the group of trees with severe defoliation.

5. In the group of healthy trees (HCI = 1), late wood width in 2013-2018 was higher than in 2007-2012 by 0.04 mm (3.7%), in the group of weakened trees (HCI = 2) was lower than in 2007-2012 by 0.2 mm (16.6%), and in a group of severely weakened trees (HCI = 3) was lower by 0.15 mm (12.4%). However, these differences were not statistically significant.

6. Most Spearman's rank correlations between ash wood growth and weather parameters are low and insignificant. Negative correlations between ash wood growth and air temperature of the growing season, May and September, are the most significant. An increase in the Hydrothermal Index in 2016, compared to the previous year by 0.2 units (by 25%), could have a positive impact on growth recovery.

7. The research indicates that European ash foliage damage by the black ash sawfly does not pose a noticeable threat to the plantings. However, the weakened trees became susceptible to the emerald ash borer in the coming years.

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Conflicts of Interest.

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Вплив хронічного пошкодження листя личинками *Tomostethus nigritus* на радіальний приріст *Fraxinus excelsior*

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У Молодіжному парку м. Харкова чорний ясеновий пильщик *Tomostethus nigritus* (Fabricius, 1804) (Hymenoptera: Tenthredinidae) пошкоджує ясени понад 20 років. З 2012 р. науковці щорічно оцінюють дефоліацію та санітарний стан 90 пронумерованих дерев. Мета цього дослідження полягала в оцінюванні реакції радіального приросту ясена звичайного на пошкодження листя чорним ясеновим пильщиком (*T. nigritus*). Чисельність цього шкідника у Молодіжному парку з 2013 р. збільшувалася, а у 2015 р. середня дефоліація сягала 94,1±3,4%. Середня дефоліація окремих дерев змінювалась за роками від 31,7 до 73,3%, причому сусідні дерева в той самий рік могли мати дефоліацію від 0 до майже 100%. Лише три дерева два роки поспіль були дефолійовані на 100%. Залежності середнього рівня дефоліації від діаметра дерев не визначено. Залежність індексу санітарного стану дерев від рівня дефоліації була високою та значущою ($r = 0.83$; $p < 0.001$).

У роки збільшення пошкодження листя ли-

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чинками радіальний приріст дерев зменшувався. У 2013-2018 рр. порівняно з 2007-2012 рр. значення річного, раннього та пізнього приросту зменшилися на 12,4; 7,2 та 14,9% відповідно. Водночас статистично значущим є лише зменшення пізнього приросту. Приріст пізньої деревини змінювався під час спалаху чорного ясенового пильщика майже синхронно з річним приростом. Водночас частка пізньої деревини у річному прирості становила лише 56,1% у рік максимальної дефоліації, а наступного року сягала 70%. У групі дерев із низькою середньою дефоліацією (< 25%) річний приріст деревини у 2013-2018 рр. був більшим, ніж у 2007-2012 рр., на 0,2 мм (на 8,5%). У групі дерев р помірною середньою дефоліацією (26-50%) річний приріст деревини за ці роки зменшився на 0,2 мм (на 8,5%), а у групі дерев із високою дефоліацією (> 50%) – на 0,7 мм (на 20,9%). Водночас ці зміни є значущими лише стосовно дерев із високою дефоліацією.

У групі здорових дерев (категорія санітарного стану «1») ширина шару пізньої деревини в 2013-2018 рр. була вища, ніж у 2007-2012 рр., на 0,04 мм (на 3,7%). У групі ослаблених дерев (категорія санітарного стану «2») ширина шару пізньої деревини в 2013-2018 рр. була менша, ніж у 2007-2012 рр., на 0,2 мм (на 16,6%), а у групі сильно ослаблених дерев (категорія санітарного стану «3») ширина шару пізньої деревини в 2013-2018 рр. була менша, ніж у 2007-2012 рр., на 0,15 мм (на 12,4%). Водночас ці зміни не є статистично значущими.

Більшість значень коефіцієнтів кореляції Спірмена між річним приростом деревини та погодними показниками є низькими та незначущими. Від'ємні коефіцієнти кореляції між річним приростом деревини і температурами травня, вересня та вегетаційного періоду загалом є значущими при р < 0,05. Збільшення гідротермічного індексу у 2016 р., порівняно з попереднім роком, на 0,2 одиниці (на 25%) могло позитивно вплинути на відновлення крон дерев після пошкодження личинками чорного ясенового пильщика

Результати дослідження свідчать, що пошкодження листя личинками чорного ясенового пильщика не спричинило помітної прямої шкоди насадженню. Водночас ослаблені дерева стали сприйнятливими до заселення в наступні роки ясеновою смарагдовою вузькотілою златкою.

Ключові слова: ясен звичайний; чорний ясеновий пильщик; дефоліація; індекс санітарного стану; рання деревина; пізня деревина.