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Monitoring studies of habitats of rare species and tree-dwelling insects in the Emerald Network sites

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Abstract. The pine stands of the Vyshcha Dubechnia State Forestry Enterprise in the Emerald Network sites Kyivske Reservoir UA0000094, Kyivske Podesennia UA0000233, Mizhrichynsky Regional Landscape Park UA0000047 are an important reserve that includes species and habitats of insects that are subject to protection. Most of the existing studies in this area were designed to identify and describe individual habitats, while xylophagous insects were not considered. The purpose of the research was to identify rare and endangered species of tree-dwelling insects in unique natural complexes. The research methods included reconnaissance surveys to determine the species composition of insects and their density. The surveys were conducted in 2020-2022, covering 33 plots with a total area of 50.5 hectares. The monitoring was performed through regular surveys of the territories, during which rare species listed in the Red Data Book of Ukraine and the Berne Convention resolution were identified. A desktop analysis of forestry materials was conducted. Rare species of insects subject to protection are encountered, but outside the areas where monitoring observations were conducted. These are mainly water, marsh, meadow lands, etc. Accounting for stem pests such as *Scolytinae* (small pine engraver *Tomicus minor* and pine shoot beetle *Tomicus piniperda*), *Buprestidae* (steelblue jewel beetle *Phaenops cyanea*) and *Cerambycidae* (pine sawyer *Monochamus galloprovincialis* and timberman beetle *Acanthocinus aedilis*). The identified populations of xylophagous insects are described as low to medium density, occurring only on very weakened trees, and species such as *Chrysobothris affinis, Cerambyx scopolii*, and *Scolytus ratzeburgi* are rare. The results of the study will serve as an informational base for the development of regional biodiversity conservation programs and the implementation of mechanisms for the sustainable use of forest resources

Keywords: protected categories, Bern Convention, Red Data Book of Ukraine, xylophagous insects, number of the young generation, degree of settlement

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INTRODUCTION

At the current stage of developing a global system of knowledge about the composition and structure of the Earth's biodiversity, local research is gaining importance as a component of international environmental science. In this context, monitoring studies of habitats of rare species and tree-dwelling insects allow the development of a regional source of scientific data on the state of natural populations of these organisms as part of the biodiversity of forest ecosystems around the world. In 2019, 377 objects in Ukraine officially have the status of Emerald Network sites, 15 of which are located within the Kyiv region, which is about 20% of the region's area (Updated list, 2019). The Emerald Network ensures the preservation of areas of conservation importance and ecological value, and its establishment is a dynamic process that requires regular updating of information (Emerald Network of Ukraine; International Union; Polyanska *et al.*, 2017). Monitoring studies with the collection of up-to-date data on the distribution of insect species and habitats in the territory plays a key role.

Tree-dwelling insects are an integral part of forest biocenosis. The most common species are those that bore larval or adult burrows under the bark and in the wood of living and felled trees (Ukrainian Biiodiversity Information, n.d.). Meshkova & Borysenko, (2018) demonstrate that there are insects that inhabit the so-called "dead" wood in the forest. Among these insects – "orderlies" that gradually destroy logging residues and dead shoots, annealed bark, stumps and parts of the trunk of storm and wind trees. Basile *et al.* (2020) note the importance of biodiversity conservation as the practice of storing trees with habitats for tree-related species, using assessment and monitoring of the available quantity and diversity of environmental resources for a wide range of animal taxa (and insects in particular) that live in forests. In the presence of "dead" wood, entomophagy and specific types of wood-destroying fungi develop intensively, which are potential competitors for pathogens dangerous to trees such as mushrooms and root sponges. Nordkvist *et al.* (2022) emphasise the potential for increasing species biodiversity in "dead" wood and note that this can result in a risk of increased frequency of insect phytophage outbreaks in pine forests. According to Vasylyshyn *et al.* (2022), the composition and structure of entomophagy and wood-destroying fungi at the local level significantly affect the volume and intensity of mortar accumulation. Soshenskyi *et al.* (2021) note that among the main catalysts for the development of "dead" wood in forest stands are natural and anthropogenic disturbances, among which forest fires play an important role.

Tree-dwelling insects belong to the trophic groups of xylophages and xylomycetophages. Meshkova *et al.* (2017) noted that xylophages are much more frequently monophagous than xylomycetophages, which is connected with the specific chemical composition of dead tree tissues, inside which their larvae develop. The proportion of wood-dwelling xylophagous insects in the habitat is determined by the composition of forest-forming woody plants, and by the availability of a suitable substrate for larval life during the larval stage, which varies from one to several years. Kuzemko *et al.* (2018) noted that xylomycetophages develop in wood affected by xylotrophic fungi, which has lost a significant part of the specificity of its chemical composition, and their species diversity is determined mainly by the humidity of the habitat. Puzrina *et al.* (2021) explored that xylobiont beetles are one of the most important groups, together with bark beetles and bark beetles, constituting the foundation of complexes of wood-dwelling xylophages of woody plants. Due to their wide species and ecological diversity, they have an essential role in the destruction of wood at all stages of its decomposition.

The purpose of the research was to determine the list of insect species and habitats to be protected in the Emerald Network sites on the territory of the Vyshcha Dubechnia State Forestry Enterprise and to conduct monitoring studies of tree-dwelling insects in the region.

MATERIALS AND METHODS

Monitoring for tree-dwelling insects was performed during the inspection of the territory where tree drying was observed due to the activity of entomological stem pests. To explore the distribution of tree-dwelling insects, the areas of the Vyshcha Dubechnia State Forestry Enterprise with the presence of xylophagous insects were examined, where model trees were selected. In 2020-2022, the monitoring surveys involved 33 plots with a total area of 50.5 hectares in the territory of Dovhobrodivka, Dachne, Central, Desnianske, Khutirske, and Prymorske forestries.

According to the geobotanical zoning, the territory of the Vyshcha Dubechnia State Forestry Enterprise is located in the left-bank part of Ukrainian Polissia (Eastern Polissia) in the Left-Bank Polissia district of oak-pine, oak, pine forests, floodplain meadows and eutrophic bogs of the Polissia subprovince of the Eastern European province of coniferous-broadleaf and broadleaf forests. According to the botanical zoning of Eastern Polissia, the territory of the enterprise is located in the Dnipro-Nizhnedesnyansky district (Gensiruk, 2002). The relief is described as flat, with elevations ranging from 100 to 120 meters above sea level, and the soil cover is dominated by soddy-weakly podzolic soils. The main forest-establishment species on the vast majority of the company's forestry land is Scots pine (*Pinus sylvestris* L.).

Identification of habitats of insects requiring protection within the Emerald Network sites (Kyivske Reservoir UA0000094, Kyivske Podesennia UA0000233, Mizhrichynskyi Regional Landscape Park UA0000047) and records of tree-dwelling insects was performed by analysing documents (Bern Convention..., 1979; Red Book of Ukraine.

Insects, 2009; Council of Europe, 1998), which describe emerald objects and their comparison with forestry materials, followed by a field reconnaissance survey of the territories. Therefore, the following research methods were used: analysis of forest inventory, planning and mapping materials, analysis of data on the Emerald Network sites and project materials of the territories of the Nature Reserve Fund of Ukraine, analysis of scientific publications, and field reconnaissance surveys of the territories.

These protected areas were designed to preserve rare and endangered species of plants and animals that have international protection status under Resolution 6 of the Bern Convention on the Conservation of Wild Flora and Fauna (Law of Ukraine, 1996), and to preserve natural habitats in Europe, as they contain natural habitats listed in Resolution 4 of the Bern Convention (Law of Ukraine, 1996). A general description of Emerald Network characteristics is presented in Table 1.

***Table 1**. Characteristics of the Emerald Network sites Kyivske Reservoir UA0000094, Kyivske Podesennia UA0000233, Mizhrichynskyi Regional Landscape Park UA0000047*

Network object code	Network object name	Area, ha	The number of protected objects (species, habitats), units.					
			Dwellings	Birds	Mammals	Invertebrates	Plants	All taxa
UA0000047	Mizhrichynskyi Regional Landscape Park	102 434		37	2		5	
UA0000233	Kyivske Podesennia	20 621		28				
UA0000094	Kyivske Reservoir	54 422		24	2		2	

***Source:** Emerald Network of Ukraine, (n.d.)*

Monitoring of rare species is conducted through regular surveys of the territories, during which rare species of animals and plants listed in the Red Data Book of Ukraine and the Annexes of the Bern Convention are identified (Council of Europe, 1998). The main period for identifying rare plant habitats is the period of active vegetation, which coincides with the period of the active life of rare invertebrate species. Valuable habitats of biotopic diversity (habitats of Emerald Network sites, virgin forests, quasi-virgin forests and old-growth forests) were identified through desk-based analysis of forest inventory materials, followed by a reconnaissance field survey and repeated refinement surveys during the growing season.

During the reconnaissance survey, a general overview of the study areas was performed using existing forest roads, clearings, sightings, etc. Detailed surveys consisted of determining the species composition of xylophagous insects and settlement density, i.e. the average number of families of different species of tree-dwelling insects per square decimeter of trunk surface (Meshkova, 2020; Puzrina *et al.*, 2021).

The average number of the main families of tree-dwelling insects per square decimeter of the trunk surface was determined after establishing the species composition on dry and drying trees. To determine the species composition of tree-dwelling insects, the model trees were cleared of knots by removing a 10 cm wide strip of bark on the trunk from the base to the top. In fixed areas of settlement for each species, counts were performed using pallets, calculating settlement density by the number of larvae per tree for mustelids and lacewings. The density of tree-dwelling insects was determined according to the indicators presented in Table 2.

***Table 2**. Criteria for assessing the density of tree-dwelling insects*

Type	Settlement density, units · dm^{-2}		
	Low	Average	High
Pine sawyer *Monochamus galloprovincialis*	0.2 and less	0.3-0.7	0.8 and more
Steelblue jewel beetle *Phaenops cyanea*	0.2 and less	0.3-0.5	0.6 and more
Capricorn beetle *Cerambyx scopolii*	0.1 and less	1.1-4.0	4.1 and more
Gold pit oak splendour beetle *Chrysobothris affinis*	0.7 and less	0.8-1.5	1.6 and more
Birch bark beetle *Scolytus ratzeburgi*	6.0 and less	6.1-8.0	8.1 and more

***Source:** Emerald Network of Ukraine, (n.d.)*

The distribution of pine beetle (strigonus) in the plots was determined by the presence of adults fallen from damage during their additional feeding on pine shoots (Table 3).

***Table 3**. Intensity of additional nutrition and number of young beetles*

Average number of shoots per 1 m²	Visual assessment of the number of shoots	Numbers of the young generation of beetles
up to 2	Singly	Mild
3-5	Everywhere	Increased
6-10	Plenty	High
Over 10	A great number	Excessive

***Source:** (Meshkova, 2020; Puzrina et al., 2021)*

The methodological approaches used allowed for obtaining objective information on habitats in demand of protection within the Emerald Network sites and tree-dwelling insects of the region.

RESULTS AND DISCUSSION

Potentially, the territory of the forest fund of the Vyshcha Dubechnia State Forestry Enterprise is suitable for the existence of habitats valuable from the environmental standpoint, and populations of several rare species of animals and plants, the necessity of conservation of which is determined by the national legislation of Ukraine and international environmental conventions (Bern Convention..., 1979; Law of Ukraine, 1996). Notably, due to the large size of the Emerald Network's facilities, a significant part of their territories are outside the forest fund of the Vyshcha Dubechnia State Forestry Enterprise and include the territories of other forest users. In particular, the territory of Mizhrichynskyi Regional Landscape Park (UA0000047) overlaps with the company's territory by 8% or 2,412 hectares (stands of Desnianske Forestry), Kyivske Reservoir UA0000094 by 0.3% or 91 hectares (stands of Dachne Forestry), Kyivskye Podesennia UA0000233 by -1.4% or 420 hectares (stands of Lebedivske, Ostrovske and Desnianske Forestry). The explored sites partially belong to the territory of the Emerald Network sites Kyivske Reservoir UA0000094, Kyivske Podesennia UA0000233, Mizhrichynskyi Regional Landscape Park UA0000047 (Fig. 1).

***Figure 1**. Surveyed areas on the territory of the Vyshcha Dubechnia State Forestry Enterprise*
***Source:** photo by the authors*

The analysed list of insect species protected in the region allowed establishing that the largest share of species is represented by insects of the order *Lepidoptera* (38 species), *Hymenoptera* (22 species) and *Coleoptera* (21 species) (Bern Convention on the conservation of European wildlife and natural habitats, 1979; Red Book of Ukraine. Insects, 2009). From this list, the most numerous are the Red Data Book species endangered, vulnerable and rare and the species with the status of endangered *Buprestis spendens* goldstreifiger.

The Red Data Book species of the first category (endangered species, species conservation is unlikely if adverse factors continue to act) among *Lepidoptera* include *Polyommatus eroides* eroides blue butterfly, *Zygaena laeta* bloodword burnet, *Eudia spini* sloe emperor moth and *Parnassius apollo*, among *Hymenoptera – Bombus fragrans* fragrant bumblebee, among *Orthoptera – Bryodemella tuberculata* speckled grasshopper, among *Odonata – Leucorrhinia albifrons* dark whiteface. The majority of the region's fauna belongs to category II (vulnerable species

that may be classified as endangered in the future if adverse factors continue to affect them) and category III (rare species, small populations that are not currently classified as endangered or vulnerable, although they are at risk). Among the *Lepidoptera*, these categories include *Acherontia atropos* dead head moth, *Aglia tau* tau emperor, *Apatura iris* purple emperor, *Catocala sponsa* dark crimson underwing, *Callimorpha dominula* scarlet tiger moth, *Coenonympha hero* scarce heath, *Coenonympha oedippus* false ringlet, *Cucullia argentea* green silver-spangled shark, *Eudia pavonia* small emperor moth, *Euphydrias aurinia* marsh fritillary, *Hemaris tityus* narrow-bordered bee hawk moth, *Hamearis lucina* duke of burgundy fritillary, *Hipparchia statilinus* tree grayling, *Hypodryas maturna* scarce fritillary, *Iphiclides podalirius* scarce swallowtail, *Lemonia taraxaci* autumn silkworm moth, *Limenitis populi* poplar admiral, *Lopinga achine* yellow-eyed satyr, *Lycaeides argyrognomon* reverdin's blue, *Lycaena dispar* large copper, *Maculinea arion* large blue, *Maculinea nausithous* dusky large blue, *Maculinea teleius* scarce large blue, *Marumba quercus* oak hawk moth, *Papilio machaon* old world swallowtail, *Pericallia matronula* large tiger moth, *Parnassius mnemosyne* clouded Apollo, *Proserpinus proserpina* willowherb hawkmoth, *Periphaenes delphinii* pease blossom, *Saturnia pyri* giant peacock moth, *Staurophora celsia* and *Zerunthia polyxena* southern festoon. The order *Hymenoptera* includes the following species of categories II and III: *Abia nitens* brilliant abia, A*noplius samariensis* solitary wasps, *Archirilleya inopinata* black archirilleya, *Arge beckeri* Becker's aggrey, B*lasticotoma filiceti* fern blasticotoma, *Bombus argillaceus* clay bumblebee, *Bombus muscorum* moss bumblebee, *Bombus paradoxus* unusual bumblebee, *Bombus pomorum* bright bumblebee, *Caenolyda reticulata* reticulated cenolyda, *Discoelius zonalis* zonal discoelia, *Dolichomitus cephalotes* headed dolichomitus, *Formica rufa* red wood ant, *Ibalia rufipes* giant nutcracker, *Janus femoratus* red-legged janus, *Megarhyssa superba* pearl megarhyssa, *Melitturga clavicornis* mace melitturga, *Orussus abietinus* parasitic orussus, *Polochrum repandum* sapiga polochrum, *Siobla sturmi* balsam siobla, *Xylocopa violaceae* violet carpenter bee and *Xylosora valg*a common xylocopa (carpenter bee).

Among the *Coleoptera* there are *Aromia moschata* musk beetle, *Bolbelasmus unicornis*, *Boros schneideri* smal skuggbagge, *Calosoma sycophanta* European calosoma beetle, *Carabus menetriesi* Menetrius' carabus, *Cerambux cergo* great capricorn beetle, *Cucujus cinnabarinus* red flat bark beetles, *Dorcadion equestre* black dorcadion, *Emus hirtus* rove beetle staphylin, *Eurythyrea aurata* golden eurythyrea, *Lucanus cervus* deer beetle, *Neopristilophus depressus*, *Onthophagus furcatus* horned dung beetle, *Oryctes nasicornis* European rhinoceros beetle, *Osmoderma barnabita* hermit beetle, *Rosalia alpina* alpine moustache and hooded beetles *Stephanopachys linearis* linearis and striped *Stephanopachys substriatus* powderpost beetles in the region. The categories II and III of the *Odonata* dragonflies include *Aeschna viridis* green hawker, *Anax imperator* emperor dragonfly, *Calopteryx virgo* beautiful demoiselle, *Cordulegaster boltoni* golden-ringed dragonfly, *Leucorrhinia pectoralis* large white-faced darter, *Stylurus flavipes* yellow-legged dragonfly, *Sympecma braueri* common winter damselfly, *Sympetrum pedemontanum* bandaged dragonfly, *Diptera: Asilus crabroniformis* robber fly and *Satanas gigas* giant robber fly, *Orthoptera*: one species of *Poecilimon ukrainicus* Ukrainian pollen-tail and two species of *Neuroptera: Mantispa styriaca* styrian mantis and *Myrmeleon formicarius* common ant lion.

Insects of Category IV (unspecified species that are classified as "endangered", "vulnerable" or "rare" in the absence of reliable information on their status) are the least numerous and include one species from the *Hymenoptera Scolia makulata* mammoth wasp and the *Homoptera Porphyropha polonica*, two species from *Coleoptera*, namely *Dytiscus latissimus* and *Graphoderus bilineatus* predaceous diving beetles.

Accordingly, not all species and habitats subject to protection at these sites are represented in the study area (Table 4). Some rare species of animals and plants and habitats from the list of those to be protected in the Emerald Network sites are found on the territory of the Vyshcha Dubechnia State Forestry Enterprise, however, outside the areas subject to monitoring observations of tree-dwelling insect species.

***Table 4**. List of insect species to be protected in the Emerald Network sites (Kyivske Reservoir UA0000094 (KR), Kyivske Podesennia UA0000233 (KP), Mizhrichynskyi Regional Landscape Park UA0000047 (MRLP)*

Species name	Availability on the territory			Characteristic habitat
	KR	KP	MRLP	
Class *Coleoptera*				
Boros schneideri	+		+	Woods
Dytiscus latissimus	+		+	Woods
Leucorrhinia pectoralis	+			Meadows, reservoirs
Graphoderus bilineatus			+	Reservoirs
Cerambyx cerdo			+	Old woods
Lucanus cervus			+	Old woods

Table 4, Continued

Species name	Availability on the territory			Characteristic habitat
	KR	KP	MRLP	
Stephanopachys linearis			+	Woods
Stephanopachys substriatus			+	Woods
		Class *Lepidoptera*		
Hypodryas maturna			+	Fields, meadows
Lycaena dispar		+		Fields, meadows

Source: *developed by the authors based on the Red Book of Ukraine, (n.d.); International Union..., (2022); Godlevskaya, (2010)*

The most numerous representatives of the protected categories in the study area are *Coleoptera*, in particular, in the forest stands of the Vyshcha Dubechnia State Forestry Enterprise there are populations of the *Cerambyx cerdo*, *Lucanus cervus*, *Osmoderma eremita*, *Boros schneideri* and hooded beetles: *Stephanopachys linearis* and *Stephanopachys substriatus*.

The species composition of wood-dwelling xylophagous insects in pine forests of different geographical regions is quite uniform. The least weakened trees are colonised by aggressive xylophagous species – *Tomicus piniperda* L. pine shoot beetle and *Tomicus minor* Hrtg. small pine engraver, *Ips acuminatus* Gill sharp-toothed bark beetle, *Phaenops cyanea* Fabr. steelblue jewel beetle and whisker moths of the genus *Monochamus*. As the trees become weaker, they are colonised by less aggressive species: *Ips sexdentatus* Boern. six-toothed bark beetle, *Acanthocinus aedilis* L. timberman beetle, *Trypodendron lineatum* L. two-striped timber beetle, and severely weakened and drying trees are colonised by the longhorn beetle *Asemum striatum* L., *Rhagium inquisitor* L., *Spondylis buprestoides* L. and *Criophalus* L. The physiological damage to living trees caused by xylophagous insects is the destruction of the plant's conductive system by their movements, damage to individual organs during additional nutrition, and the transfer of pathogens. Technical damage caused by stem pests to trees and harvested timber is the presence of wide and deep passages ("wormholes") and, accordingly, a decrease in wood quality (Fig. 2).

Figure 2*. Passages and exit holes of tree-dwelling insects on Scots pine*
Source: *photo by the authors*

The monitoring surveys of the habitats of tree-dwelling insects covered Dovhobrodivka, Dachne, Central, Desnianske, Khutirske and Prymorske forestries, and explored some areas of the territory of the Vyshcha Dubechnia State Forestry Enterprise for the presence of endangered and valuable insect species listed in the resolution of the Bern Convention and of international importance (Bern Convention, 1979). During the survey of areas dominated by Scots pine, tree-dwelling insects were identified on a small part of the trees (no more than 5-10%), most of which belong to category IV (weakened by stem pests), such as Scolytinae (Tomicus minor and Tomicus piniperda), Buprestidae (Phaenops cyanea) and Cerambycidae (Monochamus galloprovincialis and Acanthocinus aedilis) (Table 5).

***Table 5**. Degrees of colonisation by tree-dwelling xylophagous insects*

Type	Settlement density, pcs.·dm^{-2}/ average number of shoots per 1 m^2	Degree of infestation / number of young beetles
	2020	
Monochamus galloprovincialis	0.2 ± 0.1	Low
Acanthocinus aedilis	0.4 ± 0.2	Low
Phaenops cyanea	0.5 ± 0.3	Average
Scolytus ratzeburgi	4.5 ± 0.2	Low
Chrysobothris affinis	0.5 ± 0.2	Low
Cerambyx scopolii	0.9 ± 0.2	Low
	2021	
Monochamus galloprovincialis	0.6 ± 0.3	Average
Acanthocinus aedilis	0.4 ± 0.2	Average
Phaenops cyanea	0.5 ± 0.2	Average
Tomicus minor	2 (singly)	Normal (up to 5 thousand beetles per 1 ha)
Tomicus piniperda	2 (singly)	Normal (up to 5 thousand beetles per 1 ha)
Scolytus ratzeburgi	3.4 ± 1.4	Low
Chrysobothris affinis	0.5 ± 0.2	Low
	2022	
Monochamus galloprovincialis	0.5 ± 0.4	Average
Acanthocinus aedilis	0.3 ± 0.1	Low
Phaenops cyanea	0.5 ± 0.2	Average
Tomicus minor	3 (everywhere)	Increased (10-20 thousand beetles per 1 ha)
Tomicus piniperda	3 (everywhere)	Increased (10-20 thousand beetles per 1 ha)
Scolytus ratzeburgi	3.8 ± 0.6	Low
Cerambyx scopolii	1.0 ± 0.1	Low
Chrysobothris affinis	0.7 ± 0.3	Low

***Source:** developed by authors*

As can be seen from the above data, the population of *Monochamus galloprovincialis* in 2020 was characterised by a low degree of settlement at a density of 0.2 pcs.·dm^{-2}, in 2021 an average degree of settlement was recorded at a density of 0.6 and 0.5 pcs.·dm^{-2}, which indicates a potential increase in the number of the species. The population of *Phaenops cyanea* did not demonstrate a sharp increase in density during the study period. The detection of populations of T*omicus minor* and *Tomicus piniperda* was performed by the presence of signs of pest feeding (the so-called "crown cutting") and was first noted during the 2021 surveys, in 2022 an increased number of young beetles of the younger generation up to 10-20 thousand per 1 ha was detected, which can indicate a potential increase in numbers.

During the survey of plots with a share of deciduous trees (oak, birch, alder), the presence of *Buprestidae* (gold pit oak splendour beetle *Chrysobothris affinis*), *Cerambycidae* (capricorn beetle *Cerambyx scopolii*) and *Scolytinae* (birch bark beetle *Scolytus ratzeburgi*) was noted on trees weakened by xylophagous insects (Fig. 3).

Notably, in the development of centres of mass reproduction of xylophagous insects, phases are developed, each of which is characterised by a specific number (Seredyuk & Puzrina, 2019), thus in the surveyed plantations, tree-dwelling insects are in the phase of concentration or increase in numbers due to the development of populations with low density. Meshkova *et al*. (2017) consider that chronic foci are characterised by a long period of development, a slightly increased level of insect abundance and the size of current mortality compared to healthy stands. Episodic foci, or outbreaks, are characterised by a relatively short (3-5 years) developmental period, elevated abundance levels and the size of the current mortality rate. With the development of chronic and episodic foci, reversible and irreversible reactions of stands are possible, usually, with mass reproduction of tree-dwelling insects, their destruction is observed. To

find new habitats and expand the food base, migration centres are usually established near mass breeding areas with excessive population density. In these foci, the final dispersal of the population occurs within a few years and it returns to its original level of population size (Puzrina *et al.*, 2021).

Figure 3. *Passages, larvae, flight and larval holes of tree-dwelling insects on deciduous tree species*
Source: *photo by the authors*

According to research by Wyatt (2021), biodiversity loss is one of the main elements of damage caused by human activities. Wildlife protection and conservation policies such as the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) are attempts to halt the loss of wildlife.

At the stage of establishing and implementing the Emerald Network, which is currently underway in Ukraine, the description of the natural complex of each particular territory is becoming increasingly important. Therewith, notably, the studies frequently involve phytosociological characterisation of habitats of populations of vascular plant species with protected status in Europe (Tymochko *et al.*, 2022) and clarification of data on the occurrence of species with protected status (Vasyliuk *et al.*, 2022) with a set of data on the occurrence of species listed in Annex I of Resolution 6 of the Bern Convention (1996) and the Red Data Book of Ukraine. The study by Bezrodnova *et al.* (2021) covered the botanical and forestry features of the Mozh River Valley as an Emerald Network site and determined the state of populations of rare vascular plant species of different sozological status. Studies by Kuzemko & Borysenko (2019), Kuzemko *et al.* (2018) on the design and conservation of the Emerald Network and the catalogue of habitats in Ukraine allow estimating the habitats of species with protected status.

The investigation of insect species classified as protected and monitoring studies allowed for summarising the available information on the habitats of rare and tree-dwelling insect species in the study area.

CONCLUSIONS

During the research, the list of insect species to be protected was analysed and summarised, and monitoring of rare species and tree-dwelling insects in the Emerald Network sites (Kyivske Reservoir UA0000094, Kyivske Podesennia UA0000233, Mizhrichynskyi Regional Landscape Park UA0000047) in the Vyshcha Dubechnia State Forestry Enterprise was conducted. Insects subject to protection in forest stands include *Cerambyx cerdo, Lucanus cervus, Osmoderma eremita, Boros schneideri, Stephanopachys linearis* and *Stephanopachys substriatus*. Some rare species of insects and habitats from the list of those to be protected in the Emerald Network sites on the territory of the Vyshcha Dubechnia State Forestry Enterprise are located in areas that are indirectly related to the forest environment – water, marsh, meadow, etc.

During the survey of areas dominated by Scots pine, tree-dwelling insects with different settlement densities were identified, namely as small pine engraver *Tomicus minor* and pine shoot beetle *Tomicus piniperda*, steelblue jewel beetle *Phaenops cyanea*, timberman beetle *Acanthocinus aedilis* and pine sawyer *Monochamus*

galloprovincialis, and on deciduous woody species, gold pit oak splendour beetle *Chrysobothris affinis*, capricorn beetle *Cerambyx scopolii* and capricorn beetle *Scolytus ratzeburgi* were observed sporadically. In addition, recent climate change and the effects of military operations on the territory of Ukraine can cause significant changes in the structure of forests, potentially affecting habitat opportunities and trophic resources for many species. Therefore, the prospects for further research will be monitoring changes in the species composition of insects of protected categories and tree-dwelling insects of the region in the Emerald Network sites (Kyivske Reservoir UA0000094, Kyivske Podesennia UA0000233, Mizhrichynskyi Regional Landscape Park UA0000047).

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Моніторингові дослідження оселищ рідкісних видів та деревоживучих комах в об'єктах Смарагдової мережі

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Анотація. Соснові насадження Державного підприємства «Вищедубечанське лісове господарство» в об'єктах Смарагдової мережі Kyivske Reservoir UA0000094, Kyivske Podesennia UA0000233, Mizhrichynskyi Regional Landscape Park UA0000047 є важливим резерватом, що включає види та оселища комах, які підлягають охороні. Більшість існуючих досліджень даної території були спрямовані на виявлення та опис окремих біотопів, тоді як комахи-ксилофаги залишилися поза увагою. Метою досліджень було встановлення рідкісних видів деревоживучих комах і таких, що перебувають під загрозою зникнення в унікальних природних комплексах. Методи досліджень включали рекогносцирувальні обстеження з визначенням видового складу комах, щільності їх поселення. Дослідження проводились упродовж 2020–2022 років, під час яких було охоплено 33 ділянки загальною площею 50,5 га. Моніторинг проведено шляхом регулярного обстеження територій, під час яких ідентифікувалися рідкісні види, які занесені до Червоної книги України та до резолюції Бернської конвенції. Здійснений камеральний аналіз лісотаксаційних матеріалів. Рідкісні види комах, що підлягають охороні трапляються, проте поза межами ділянок, на яких проводилися моніторингові спостереження. Це переважно водні, болотяні, лучні угіддя тощо. Обліковано стовбурових шкідників, таких як короїди Scolytinae (малий *Tomicus minor* та великий T*omicus piniperda* соснові лубоїди), златки *Buprestidae* (синя соснова златка *Phaenops cyanea*) та вусачі *Cerambycida*e (чорний сосновий вусач *Monochamus galloprovincialis* та сірий довговусий вусач *Acanthocinus aedilis*). Виявлені популяції комах-ксилофагів характеризуються низьким і середнім ступенем заселення, вони відмічені лише на дуже ослаблених деревах, а такі види як *Chrysobothris affinis, Cerambyx scopolii* та *Scolytus ratzeburgi* зустрічаються поодиноко. Результати дослідження будуть слугувати інформаційною основою для формування регіональних програм збереження біорізноманіття та впровадження механізмів сталого використання лісових ресурсів

Ключові слова: охоронні категорії, Бернська конвенція, Червона книга України, комахи-ксилофаги, чисельність молодого покоління, ступінь заселення