



VALUABLE ROADSIDE TREE AVENUES IN THE NORTH-EASTERN PART OF THE DRAWSKI LANDSCAPE PARK

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ABSTRACT. The paper describes species composition and state of preservation of five roadside tree avenues situated in the north-eastern part of the Drawski Landscape Park and its buffer zone. The inventory was based on tree species identification, measurements of their diameter at breast height, and estimation of health status of stems, crowns and foliage. In total, 1488 trees from the following taxa were found: *Acer platanoides*, *Acer pseudoplatanus*, *Acer pseudoplatanus* 'Purpureum', *Betula pendula*, *Fagus sylvatica*, *Fraxinus excelsior*, *Fraxinus pennsylvanica*, *Quercus robur* and *Tilia cordata*. The most frequently occurring species were: *Acer platanoides*, *Acer pseudoplatanus* and *Fraxinus excelsior*. In roadside tree avenues high numbers of trees with monumental diameters (275 trees, 18.5%) were found. Estimation of health status shows that most trees are in good condition (up to 10% of damages). In all roadside avenues discontinuities and the presence of branch deadwood have been recorded resulting from a lack of supplementary planting and inappropriate treatment. All studied avenues have high landscape and environmental values, therefore should be protected as nature monuments.

KEY WORDS: epiphytes, state of health, roadside green, cultural heritage, nature monuments

INTRODUCTION

Roadside tree avenues are buffer strips which occur adjacent to roads. Most frequently they occur as one or a couple of tree rows. Their role in landscape is broad: avenues highlight landscape's linearity, facilitate orientation in the field, compose views and compositional axes, and increase landscape aesthetics which may promote tourism. Avenues are also considered historical and cultural heritage in local scale (WITKOŚ-GNACH & TYSZKO-CHMIELOWIEC 2014). From an ecological viewpoint, avenues increase localised water retention, prevent water and wind erosion and form ecological corridors for many species (RUCIŃSKI 1998, OLEKSA et al. 2006, KUBUS 2008, 2010, LIŻEWSKA & ZWIEROWICZ 2009, PODOLSKA 2013).

Avenues are also habitats for several groups of species (WITKOŚ-GNACH & TYSZKO-CHMIELOWIEC 2014).

For example, in old trees with hollows, many species of protected insects may be found. The most precious of them are Natura 2000 priority species – *Osmoderma eremita* and *Cerambyx cerdo* (OLEKSA et al. 2012). ORŁOWSKA (2012) found that roadside avenues can provide habitats for 43 species of birds, including woodpeckers (*Picidae*) and owls (*Strigiformes*). Trees in old avenues are often colonised by lichens (*Lichenes*) as their wide diameters and fissured bark provide suitable habitats for them; additionally the amount of sunlight in avenues is higher than in forests (LIPNICKI 2003, OLEKSA 2012). On such trees rare and/or protected species of fungi (e.g. *Fistulina hepatica*, *Grifola frondosa* or *Geastrum striatum*) have been observed (KUJAWA 2012).

Avenues are threatened by increasing communication pressure and route modernisations. Roadside tree removal occurs primarily to facilitate road

widening, increasing driver visibility, traffic flow and overall road safety (PODOLSKA 2013). Some trees also suffer from increasing air pollution and mechanical damage (GAMRAT et al. 2011). Utility line construction and maintenance often results in asymmetrical crown removal which negatively affects avenue habitats and tree stability. Other factors which threaten avenues include natural dieback of trees, removal of old and unhealthy trees and lack of supplemental plantings (PODOLSKA 2013). One conservation method to ensure the longevity of the most precious objects as nature monuments is legal protection. In 2013, 735 avenues were listed as nature monuments in Poland (OCHRONA ŚRODOWISKA 2014).

The aim of the study was to provide an inventory of tree species composition and state of preservation of five roadside tree avenues in the north-eastern part of the Drawski Landscape Park and in its buffer zone.

MATERIAL AND METHODS

The study was conducted in the Drawski Landscape Park (DLP), located in NW Poland, between four towns: Połczyn Zdrój, Łubowo, Czaplunek and

Złocieniec. DLP covers an area of 38 360.17 ha and the buffer zone around DLP covers an area of 23 560.41 ha (OCHRONA ŚRODOWISKA 2014, UCHWAŁA... 2014). The history of planting avenue trees dates back to the 18th century, when Prussian kings Frederick William I and Frederick II the Great ordered the introduction of roadside tree plantings and introduced penalty for their destruction (KUBUS 2008). In the DLP three roadside tree avenues are protected by law as nature monuments, and 11 are planned to be protected. For this study five avenues were chosen: Prosino-Stare Gonne, Kocury-Brusno, Brusno-Popielewo, Kocury-Brusno planned nature monument and 'Brusno' nature monument tree avenue (Fig. 1, Table 1).

Field work was conducted in 2013. The length of each avenue, distances between trees as well as between roadside and trees were measured. Each tree's diameter was measured at breast height (DBH) and state of health was assessed based on percentage of damage to individual tree components: foliage (foliage area), crown branches and stems (circumference) in six class scale: 0 – no damages, 1 – damages up to 10%, 2 – damages on 11–25%, 3 – damages on

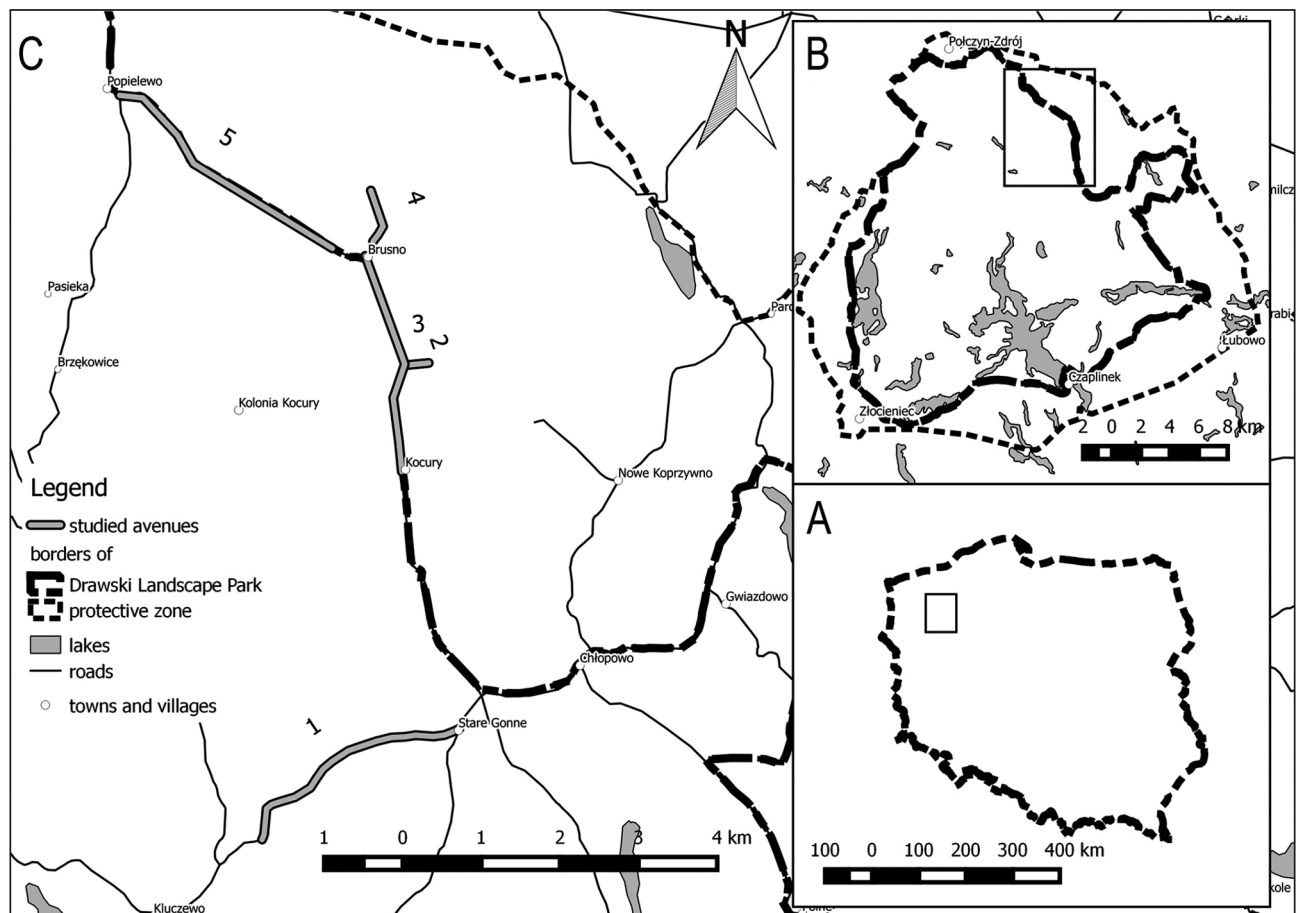


Fig. 1. Locality of tree avenues studied: A – location of the Drawski Landscape Park in Poland, B – borders of the Drawski Landscape Park, C – localities of avenues studied in the north-eastern part of the Drawski Landscape Park. Numbers of avenues: 1 – Prosino-Stare Gonne, 2 – Kocury-Brusno, 3 – planned nature monument Kocury-Brusno, 4 – nature monument 'Brusno', 5 – Brusno-Popielewo

26–50%, 4 – damages on 51–75%, 5 – damages over 75% (KOSMALA et al. 2009). The health assessment was performed visually during the inventory. Due to differences in the length of tree avenues between left

and right side of the road, these sides were analysed separately. Minimal DBH for precious trees (nature monuments) were taken from RUCIŃSKI'S (1998) list for semi-natural sites.

Table 1. Geographical coordinates of studied tree avenues in north-eastern part of the Drawski Landscape Park

Avenue	Side	Beginning of the avenue	End of the avenue
Brusno-Popielewo	left	53°43'36.7"N, 16°13'04.2"E	53°44'35.8"N, 16°10'32.0"E
	right	53°43'37.0"N, 16°13'03.0"E	53°44'35.8"N, 16°10'32.9"E
Prosino-Stare Gonne	left	53°39'35.3"N, 16°12'26.9"E	53°40'20.2"N, 16°14'35.2"E
	right	53°39'33.0"N, 16°12'25.6"E	53°40'20.7"N, 16°14'38.0"E
Nature monument 'Brusno'	left	53°44'01.6"N, 16°13'25.0"E	53°43'42.0"N, 16°13'29.7"E
	right	53°44'01.5"N, 16°13'25.0"E	53°43'41.2"N, 16°13'29.3"E
Planned nature monument Kocury-Brusno	left	53°42'49.2"N, 16°13'54.9"E	53°42'50.6"N, 16°14'07.3"E
	right	53°42'49.2"N, 16°13'54.9"E	53°42'50.6"N, 16°14'07.3"E
Kocury-Brusno	left	53°42'02.3"N, 16°13'55.2"E	53°43'31.4"N, 16°13'24.0"E
	right	53°42'01.9"N, 16°13'55.4"E	53°43'27.4"N, 16°13'26.7"E

Table 2. Characteristics of studied tree avenues in north-eastern part of the Drawski Landscape Park

Parameter	Brusno-Popielewo		Prosino-Stare Gonne		Nature monument 'Brusno'		Planned nature monument Kocury-Brusno		Kocury-Brusno	
	L	R	L	R	L	R	L	R	L	R
Length (m)	3 500	3 400	2 950	3 150	600	650	221	221	2 790	2 899
Range of distances between trees (m)	5–138	4–174	3.5–83	4–76	1–110	3–33	5–31	2–34	1–49	0.9–51
Range of distances between trees and roadside (m)	1–3	0.5–1	1–3	1.5–4	4–8	4–12	1.5–5	0.5–5	1–11	0.5–3
Range of DBH (cm)	9–112	19–124	7–110	20–95	41–140	35–165	21–132	13–104	4–100	10–100
Number of trees	237	225	175	223	43	53	21	21	252	238

Explanations: L – left side of avenue, R – right side of avenue.

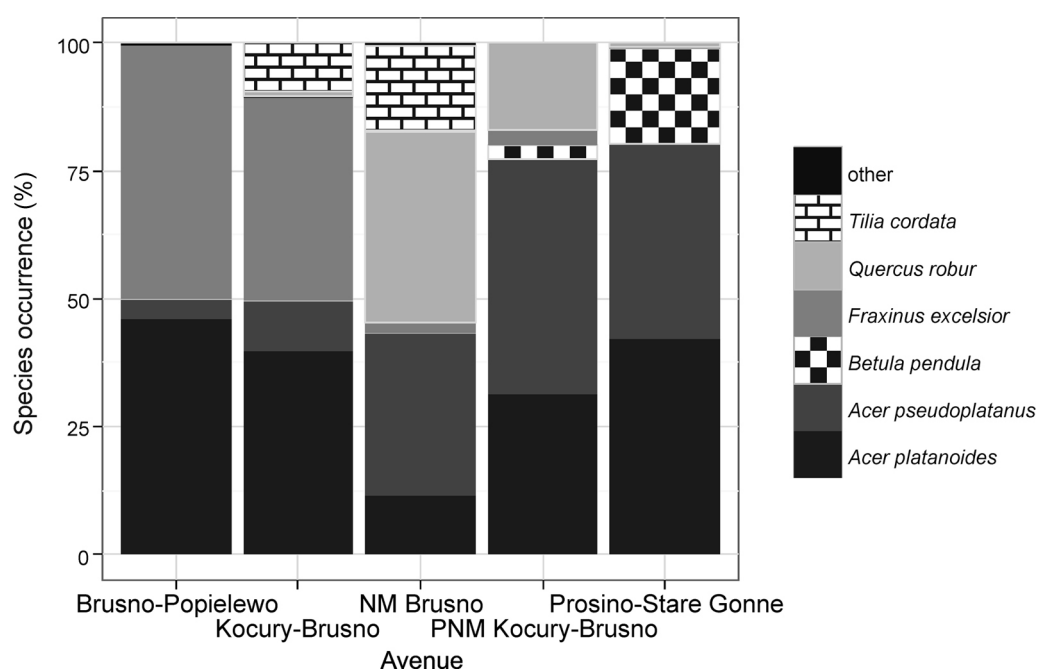


Fig. 2. Tree species occurrence in studied avenues in north-eastern part of the Drawski Landscape Park

Explanations: *Acer pseudoplatanus* 'Purpureum' was grouped with *A. pseudoplatanus*; other species are *Fraxinus pennsylvanica* and *Fagus sylvatica*, PNM – planned nature monument, NM – nature monument.

Table 3. Number of trees from each species in studied tree avenues in north-eastern part of the Drawski Landscape Park

Tree species	Brusno-Popielewo		Prosino-Stare Gonne		Nature monument 'Brusno'		Planned nature monument Kocury-Brusno		Kocury-Brusno	
	L	R	L	R	L	R	L	R	L	R
<i>A. platanoides</i>	100	113	76	92	3	8	7	4	86	109
<i>A. pseudoplatanus</i>	5	13	71	80	15	16	6	10	13	12
<i>A. pseudoplatanus</i> 'Purpureum'									15	8
<i>B. pendula</i>			25	50				1		
<i>F. sylvatica</i>					1					
<i>F. excelsior</i>	130	99	1			1	1		102	92
<i>F. pennsylvanica</i>	2								2	
<i>Q. robur</i>			2	1	15	21	7	6	4	
<i>T. cordata</i>					9	7			30	17

Explanations: L – left side of avenue, R – right side of avenue.

RESULTS

Distances between trees and roadside were very diverse – ranging from 0.5 to 12 m (Table 2). These distances were variable not only between different avenues, but also inside one side of the avenue (e.g. left side of Kocury-Brusno avenue: 1–11 m). Distance between trees along the avenue was also very variable – ranging from 1 to 174 m, due to natural gaps, cuttings and private roads. The highest range of distances between trees was found in Brusno-Popielewo tree avenue (4–174 m), and lowest – in planned nature monument Kocury-Brusno avenue (2–34 m).

All studied tree avenues (excluding fragment of Kocury-Brusno avenue) were single row, two-sid-

ed and formed from different tree species: *Acer platanoides*, *A. pseudoplatanus* (including cultivar *A. pseudoplatanus* 'Purpureum'), *Betula pendula*, *Fagus sylvatica*, *Fraxinus excelsior*, *F. pennsylvanica*, *Quercus robur* and *Tilia cordata*. In total, 1488 trees were identified and measured. Only two species – *Acer platanoides* and *A. pseudoplatanus* occurred in all studied avenues. *Fraxinus excelsior* and *Quercus robur* were recorded in four avenues, *Tilia cordata*, *Betula pendula*, *Acer pseudoplatanus* 'Purpureum' and *Fraxinus pennsylvanica* occurred in two avenues and *Fagus sylvatica* occurred in only one avenue. The species composition in the studied avenues was different (Fig. 2, Table 3). In Brusno-Popielewo, as well as in Kocury-Brusno the two main tree species were *Acer platanoides* and *Fra-*

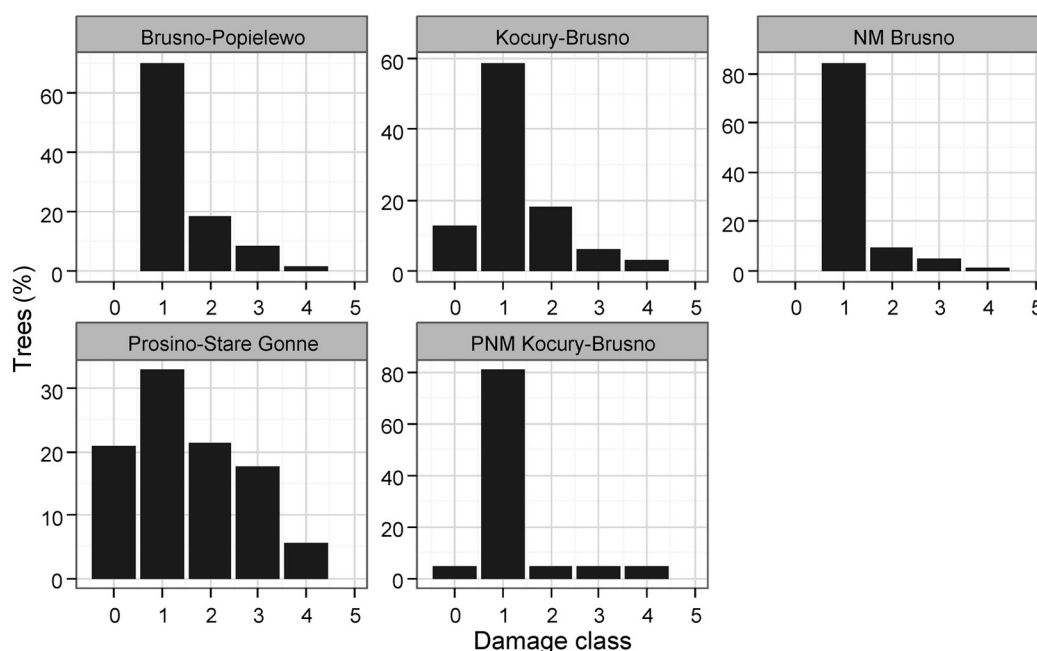


Fig. 3. Percentage of trees in each particular stem damage class in studied avenues of north-eastern part of the Drawski Landscape Park

Explanations: PNM – planned nature monument, NM – nature monument, 0 – no damages on tree stem, 1 – damages up to 10% of circumference, 2 – damages on 11–25%, 3 – damages on 26–50%, 4 – damages on 51–75%, 5 – damages over 75% of circumference.

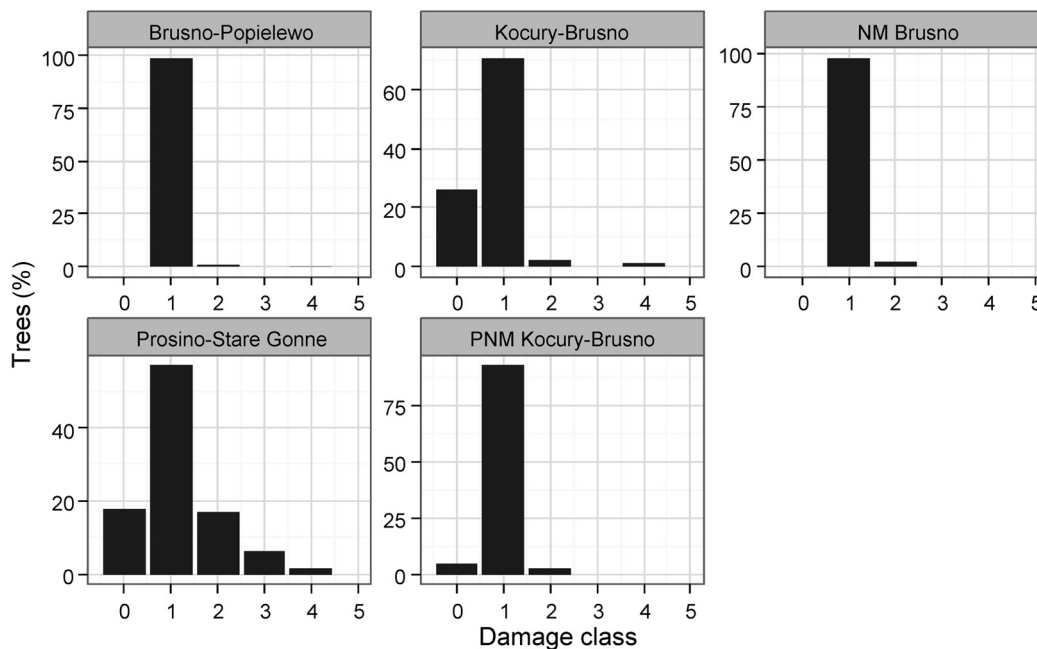


Fig. 4. Percentage of trees in each particular foliage damage class in the studied avenues of north-eastern part of the Drawski Landscape Park

Explanations: PNM – planned nature monument, NM – nature monument, 0 – no damages, 1 – damages up to 10% of leaf area, 2 – damages on 11–25%, 3 – damages on 26–50%, 4 – damages on 51–75%, 5 – damages over 75% of leaf area.

xinus excelsior. In ‘Brusno’ tree avenue the most frequent species were *Acer pseudoplatanus* and *Quercus rubra*, with an admixture of *Tilia cordata*. In planned nature monument Kocury-Brusno tree avenue and in Prosino-Stare Gonne avenue most trees were *Acer platanoides* and *A. pseudoplatanus*, whereas in Prosino-Stare Gonne there was an admixture of *Betula pen-*

Overall health condition of studied trees was good. In all the studied avenues the most frequent class of stem damage was 1 (up to 10% of damaged circumference); in four of five avenues this class consisted of more than 50% of observations, with the exception of Prosino-Stare Gonne, where it was 32.9%, but 0 class (no damages) in this avenue was 20.8%. Higher classes (3–5) never exceeded 20% of

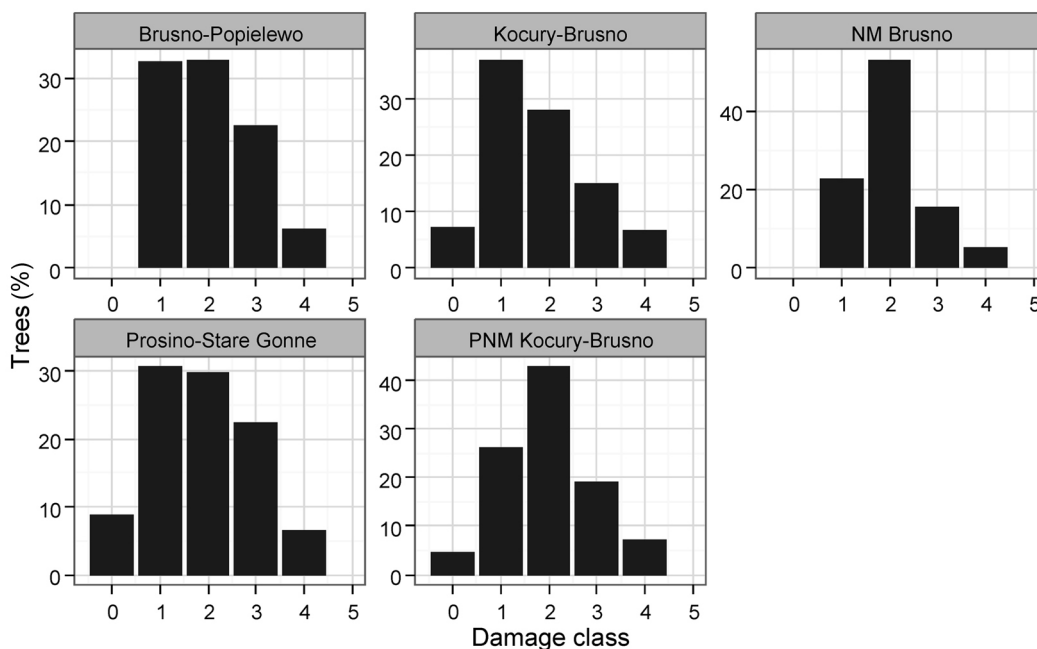


Fig. 5. Percentage of trees in each particular crown branches damage class in studied avenues of north-eastern part of the Drawski Landscape Park

Explanations: PNM – planned nature monument, NM – nature monument, 0 – no damages, 1 – damages up to 10% of branches, 2 – damages on 11–25%, 3 – damages on 26–50%, 4 – damages on 51–75%, 5 – damages over 75% of branches.

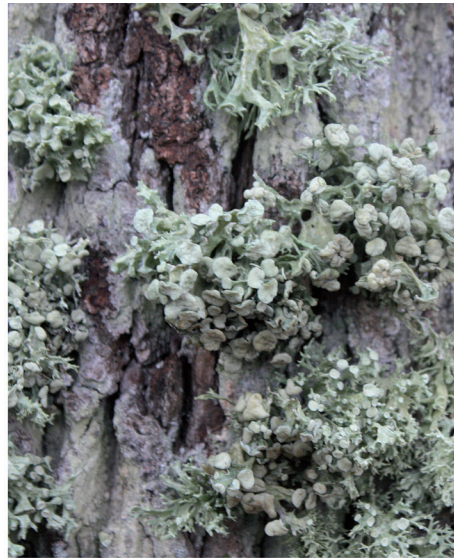
**Ramalina fraxinea***Ramalina fastigiata****Ramalina farinacea****Pleurosticta acetabulum*****Evermia prunastri*****Pseudevernia furfuracea*

Fig. 6. Species of epiphytic lichens rare and/or protected by Polish law found on trees in the studied tree avenues: * – strictly protected, ** – partially protected, *** – rare species, legally protected in 2014 (phot. R. Grzegorzczuk)

trees (Fig. 3). The most frequent class of foliage damage in all studied avenues was 1 (57–98.9% of trees). Higher classes (3–5) were rarely recorded, e.g. in Prosino-Stare Gonne (8.5%) and in Kocury-Brusno (1%) (Fig. 4). Branches health differed among the studied avenues, however most trees had low class of damage (1 and 2). The largest occurrence of trees with visible branch damage (3–5) were recorded in Brusno-Popielewo and Prosino-Stare Gonne avenues (Fig. 5).

DBH range for studied trees was very variable, in studied avenues both young and old trees grew. From 1488 examined trees, DBH of 275 (18.5%) trees was higher than minimal qualifying diameter to be classed as a nature monument according to RUCIŃSKI's (1998). The majority of these trees were *Acer platanoides* (130 trees, DBH from 71 to 136 cm) and *A. pseudoplatanus* (86 trees, DBH from 71 to 156 cm). Kocury-Brusno and Brusno-Popielewo avenues contained 32 trees of *Fraxinus excelsior* with monumental diameters (DBH from 81 to 124 cm). Several monumental sized *Quercus robur* trees were recorded in Brusno and Kocury-Brusno avenues (12 trees, DBH range from 96 to 155 cm). In Prosino-Stare Gonne and Kocury-Brusno avenues nine trees of *Betula pendula* with diameters exceeding monumental dimensions were recorded (DBH from 66 to 79 cm). In 'Brusno' and Kocury-Brusno avenues there were 12 *Tilia cordata* trees with DBH higher than minimal qualification size as a monument of nature (DBH from 98 to 165 cm).

Epiphytic lichens were present growing on a number of trees in the studied avenues. During the field investigation, six valuable species of epiphytic lichens were found: *Ramalina fastigiata* (Pers.) Ach. and *Ramalina fraxinea* (L.) Ach. – these are strictly protected by Polish law, *Pleurosticta acetabulum* (Neck.) Elix & Lumbsch and *Ramalina farinacea* (L.) Ach. – with partial protection according to Polish law and *Evernia prunastri* (L.) Ach. and *Pseudevernia furfuracea* (L.) Zopf. – considered relatively rare species in Poland and legally protected in 2014 (Fig. 6).

DISCUSSION

The studied avenues are two-sided, one-row arrays of trees, composed of more than one tree species. KUBUS (2008) claims that this type of roadside avenue is the most frequent in West Pomerania region. Studies conducted recently in northern Poland have shown that the most frequent tree species forming roadside avenues are *Acer platanoides*, *Fraxinus excelsior*, *Quercus robur* and *Tilia cordata* (KUBUS 2008, KOŁODZIEJ et al. 2009, LIŻEWSKA & ZWIROWICZ 2009, JUŻWIĄK 2012, SZMIGIEL-FRANZ & TYSZKO-CHMIELOWIEC 2012). Although KUBUS (2008) claimed that in West Pomerania *Fraxinus excelsior* is rare in roadside avenues, in our study this species

occurred in four of five studied avenues and in two of them – Brusno-Popielewo and Kocury-Brusno – 49.6% and 39.6% of trees present were this species, respectively.

From the assessed parts of trees, crowns had the worst health condition. The most damaged tree species and component were *Fraxinus excelsior* crowns, damages were caused by fungal diseases, mainly by ash dieback resulting from *Chalara fraxinea* infection (KOWALSKI 2001, KOWALSKI & CZEKAJ 2010, KUBUS 2010, WICZYŃSKA et al. 2013). Although LIŻEWSKA & ZWIROWICZ (2009) found that improper cutting of branches caused most crown damage, in studied areas only some trees were treated in this way and cuttings were conducted properly. Foliage damage was mainly caused by *Rhytisma acerinum*, which also occurred in West Pomerania avenues studied by KUBUS (2008, 2010). However, condition of foliage was good and no more than 10% of leaf area was damaged. Trunk damages were highest in trees growing closest to the roadside, and were mostly caused by agriculture vehicles. GAMRAT et al. (2011) also highlighted this factor as an important threat for trees in roadside avenues in Suchań and Dobrzany communities.

Two hundred and seventy-five trees with monumental diameters, as well as six species of rare and/or protected lichens occurred in studied avenues showing the important conservation value of such avenues. Polish roadside avenues face a myriad of threats, resulting from ineffective legislation and unjustified maintenance and road and utilities construction (SZMIGIEL-FRANC & TYSZKO-CHMIELOWIEC 2012, PODOLSKA 2013). The avenues studied in this paper indicate that such avenues require conservation. Gaps should be complemented by trees typical for each avenue, to maintain continuity of avenues, as ecological corridors. All studied avenues also should be protected by law as nature monuments.

SUMMARY

In north-eastern part of the Drawski Landscape Park there are roadside avenues which contain old, large and precious trees. The most frequent trees in studied avenues were *Acer platanoides*, *Acer pseudoplatanus* and *Fraxinus excelsior*. A high number of trees with monumental diameters occurred in studied avenues; 18.5% of trees which occurred in avenues were classified as monumental. Estimation of health status showed that most trees are in a good state of health (up to 10% damage). In all roadside avenues discontinuities were noticed, which are a result of lack of supplementary planting and improper treatments (unjustified cutting of trees). All the studied avenues have high landscape and environmental values, therefore should be protected as nature monuments.

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