DOI: 10.2478/v10111-012-0034-0

Leśne Prace Badawcze (*Forest Research Papers*),
December 2012, Vol. 73 (4): 355–362.

SHORT COMMUNICATION

Insects found on black alder *Alnus glutinosa* (L.) Gaertn. when stands are dying back

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Abstract. The study gives information on insects living on the black alder *Alnus glutinosa* (L.) Gaertn. in those 57 alder stands which exhibited the most severe signs of dying back. The surveys revealed the presence of 28 species of insects belonging to various different orders. The most common species were *Agelastica alni*, *Xiphydria camelus*, *Xyleborinus attenuatus* (Bland.) (=*X. alni* Nissima) and *Saperda scalaris*. It seems that none of the species of insects identified would be expected to cause die back of alder over a large area. However, it was confirmed that insects do participate in the process of dying back of alder stands.

Key words: insects, black alder, *Alnus glutinosa*, stands die back

1. Introduction

In Poland, among the three native alder species, black alder *Alnus glutinosa* (L.) Gaertn. has the highest economic importance. This species grows in Europe, Siberia, Asia Minor and North Africa. In Poland, black alder is quite a popular tree, important from ecological and economic point of view. It is valued because of its landscape shaping properties (Białobok 1980; Jaworski 2011). In terms of humidity and trophic requirements it belongs to the category of species preferring wet, moderately rich (mesotrophic) and rich (eutrophic) soils. In young age, black alder grows fast, especially in conditions of good light exposure. Black alder, from our tree species, best tolerates high soil's humidity. However, for good growth, it requires flowing water, although it may also grow on areas with stagnation water (Pancer-Kotejowa, Zarzycki 1980; Jaworski 2011). Black alder does not tolerate however, long-term, summer flooding or significant groundwater level lowering (Sierota 2001).

In Poland, black alder is a typical lowland species, occurring especially in river valleys, at lakes and in depressions. In such places, in areas of boggy mixed broadleaved forest (BMBF), alder forest (AF), ash-alder swamp forest (AASF), flood plain forest (FPF) and moist broadleaved forest (MBF), black alder is one of main forest stand's species. In turn, on the habitats of coniferous forests and swamp and moist broadleaved forest (MBF), black alder is introduced as valuable admixture (Jaworski 2011). Black alder is the only forest-forming tree in Poland whose roots may create three types of symbiotic connection: autinorrhiza (with actinomyces, *Frankia* genus), ecto mycorrhizae (with macromycetes, for example *Paxillus* genus) and arbuscular mycorrhiza (with microscopic fungi from *Glomus* genus), thanks to which it is characterised with a wide ecological scale and high resistance level to environmental threats. Black alder's high adaptability skills allow for the use of this species for reclamation and afforestation of damaged or difficult to renew soils (Pancer-Kotejowa, Zarzycki 1980; Jaworski 2011).

Black alder belongs to the category of fast-growing trees, and so it is valuable for wood production. The use of alder's wood is very diverse: in furniture industry, in veneer production, in land and water construction,

Received 27 April 2012, accepted after revision 16 July 2012.

plywood production, as parts of musical instruments, as everyday-use objects and as firewood (Maciejowski 1953; Surmiński 1980; Godet 2006).

Alder's resources in Poland after II World War changed significantly. In 1945, alder's forest stands covered 181,000 hectares, which meant a 2.8% share in species composition of all forests jointly. In 2010, after 65 years, the area of alder's stands is 483,000 hectares, which caused the increase of the share of this species in our country's species composition to 5.3%. The share of alder's forest stands in State Forests management is 4.7%. Alder's large timber's share is around 4.4% and is smaller only than pine, spruce, beech, oak and birch (Łączyński et al. 2011).

Until the end of 20th century, black alder was considered in Poland as species that has a very low threat from damage-causing organisms (Maciejowski 1953; Siwecki 1980; Szmidt 1980). The situation changed from the end of the last century when the deterioration of alder's trees and forest stands health conditions started to be recorded. The deterioration was leading to local mass tree's secretion, mainly in forest stands over 20 years old. In following years, there was an intensification of this phenomenon. The largest number of such stands was noted in 2006 – over 58,000 hectares. The strongest decay was observed in the area of five Regional Directorates of State Forests (RDSF): Białystok, Lublin, Toruń, Wrocław and Olsztyn (IBL 2009). A little earlier, in the 1990s, this phenomenon was noted in some countries of western Europe, i.e. Great Britain (Brasier et al. 1995; Gregory et al. 1996; Gibbs et al. 1999) and France (Streito et al. 2002). During last few years, the disease covered almost the whole Europe (Oszako 2008). On decaying trees were many different organisms, including fungi (Kwaśna 1993; Gregory et al. 1996; Schumacher et al. 2001; Oszako, Orlikowski 2004), bacteria (Scortichini 1997), phytoplasma (Berges, Seemüller 2002) and insects (Gregory et al. 1996). The main cause of mass black alder's decay is however considered to be pathogens belonging to fungi-like organism from *Phytophthora* genus, *Phytophthora alni* (Brasier et al. 1995; Jung, Blaschke 2004; Orlikowski et al. 2003; Oszako, Orlikowski 2004; Orlikowski, Oszako 2005, 2009; Woodward et al. 2005; Trzewik, Orlikowska 2011).

Black alder is considered to be one of those forest trees with which only a relatively small number of insect species is connected (Szmidt 1980). To the phyllophagous species showing a tendency to mass occurrence belong *Agelastica alni* (L.) and *Melasoma alni* (L.) (Nowak 1966, Szujecki 1995). Only few insect species may on their own cause a decay of a single tree and alder's clusters. So far, there were no reports of alder's forest stands decay on larger areas as a result of insects feeding despite the fact that some of them may occur on alders in mass, and sometimes their control is being run. So, did the activity of insect species feeding on alder increase as a result of severe weakness of black alder's health state, and did the detrimental effect of feeding on this species deepen? To what extent may the insects be predisposing and/or participating factor in alder's decaying process?

The aim of this study was establishing which insect species occur on black alder in forest stands differing in age and showing symptoms of decay, inter alia through excessive tree secretion.

2. Research place and methodology

On the basis of data obtained from Forest Research Institute, Department of Forest Phytopathology (presently Department of Forest Protection) about surfaces of decaying alder's forest stands in individual forest inspectorates and RDSF and Poleski National

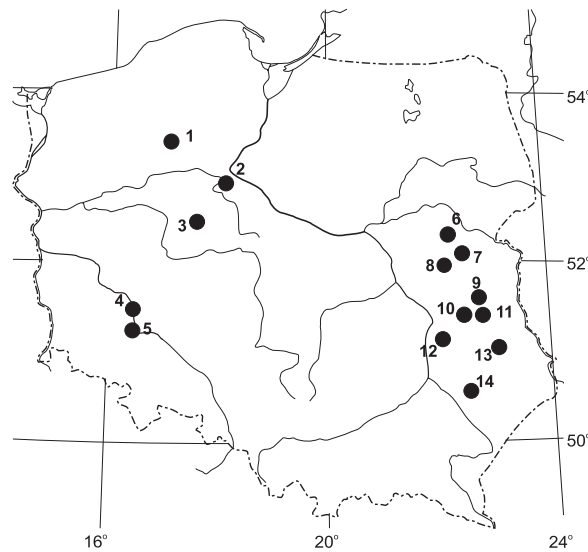

Figure 1. Location of research sites: 1 – N. Lutówko; 2 – N. Toruń; 3 – N. Miradz; 4 – N. Żmigród; 5 – N. Oborniki Śląskie; 6 – N. Sarnaki; 7 – N. Biała Podlaska; 8 – N. Radzyń Podlaski; 9 – N. Włodawa; 10 – Poleski PN; 11 – N. Sobibór; 12 – N. Świdnik; 13 – N. Strzelce; 14 – N. Zwierzyniec (N. – forest district, PN – national park)

Park from years 2004 to 2006 (Sierota et al. 2006, 2007), forests inspectorates with large surface of black alder's decaying process occurrence were selected. In 2007, in 13 Forest Inspectorates and in Poleski National Park (Fig. 1), 57 forest stands (research areas) were chosen for a detailed entomological analysis (Table 1). They represented diverse character and intensification of decaying symptoms; they were of different age, grew on terrain of varied irrigation degree and also represented different protection regime (economic forest stand, nature reserves and forest stands in national park). In the area of RDSF Lublin, inspection of 33 black alder's stands, 15 in RDSF Toruń and 18 in RDFS Wrocław, was conducted and in Poleski National Park in two forest stands. Four surfaces in Miradz Forest Inspectorate (compartments: 323j, 323s, 328l and 328b) belonged to nature's reserve 'Nadgoplański Millennium Park'. Alder up to 20 years old occurred on 14 surfaces; from 21 to 60 years old on 22; and over 60 years old on 21 surfaces. Three forest stands reached the age over 100 years, wherein the oldest analysed forest stand was 126 years old (Zwierzyniec Forest Inspectorate, comp. 234d).

The rated forest stands represented seven forests habitat types: AF (28 forest stands), AASF (14), FPF (2), MBF (9), Fresh broadleaved forest (FBF) (1), BMBF (2) and moist mixed broadleaved forest (1). The vast majority of forest stands (40 surfaces) are solid AFs of *Alnus glutinosa*, whereas on 14 surfaces the share of this species was at least 50%. Only in three cases the share of alder in forest stand was lower: in Toruń Forest Inspectorate in comp. 144 g, black alder constituted 30%, in comp. 148 g it occurred on 40% (wherein other 60% on this surface constituted grey alder), and in Biała Podlaska Forest Inspectorate comp. 280a, on habitat of FBF *A. glutinosa* constituted 20%. Second case, where except for black alder (80% of share) occurred grey alder (20%) was comp. 187b in Strzelce Forest Inspectorate.

During field inspection of individual surfaces, insect fauna material was collected with the use of the method 'for searched out'. Insect fauna material was located directly on damaged trees, and healthy trees

Table 1. Alder stands examined in 2007

Regional Directorate of State Forests	Forest District	Compartment	Forest site type*	Forest stand composition	Alder age (years)
Wrocław	Żmigród	80h	Ol	6Ol 2Brz 2Ol	21/15
		79c	Ol	10Ol	17
		64i	Ol	10Ol	102
		78a	Ol	10Ol	72
		50b	Ol	8Ol 1Brz 1Ol	30/52
	Oborniki Śląskie	461a	Lw	10Ol	70
		461b	Lw	8Ol 2Db	60/74
		359a	Ol	6Ol 3Brz 1Św	40
Toruń	Miradz	323j	OlJ	10Ol	81
		323s	OlJ	10Ol	71
		307f	OlJ	9Ol 1Js	15
		328l	OlJ	10Ol	24
		328b	OlJ	10Ol	24
	Lutówko	222f	Ol	10Ol	42
		224l	Ol	9Ol 1Brz	30
		224d	Lw	10Ol	60
		224a	OlJ	10Ol	28/55
		174j	Ol	10Ol	16
	Toruń	148g	Ł	6Olsz 4Ol	68
		144g	Ł	6Db 3Ol 1Js	13
		30a	Ol	7Ol 3Brz	73
		30g	Ol	10Ol	7
		22g	Ol	10Ol	38

Table 1. cd

Regional Directorate of State Forests	Forest District	Compartment	Forest site type*	Forest stand composition	Alder age (years)
Lublin	Radzyń Podlaski	345d	Lw	10Ol	55
		346c	Lw	7Ol 3Ol	18/13
		346b	Lw	10Ol	94
		347g	Lw	10Ol	11
		473h	Lw	10Ol	74
		473g	Ol	9Ol 1Ol	19/38
	Sarnaki	92c	OlJ	10Ol	68
		92h	OlJ	7Ol 3Ol	88/68
		92g	OlJ	10Ol	43
	Włodawa	204a	Ol	10Ol	88
		213a	Ol	10Ol	77
	Strzelce	186a	Ol	4Ol 3Brz 2Ol 1Ol	45/16/65
		187a	Ol	5Ol 1Brz 1Js3Brz	20
		187b	Lw	5Ol 2Olsz 3Ol	48/48/38
		136a	Ol	10Ol	9
	Zwierzyniec	264b	Ol	8Ol 2Ol	17/24
		234d	Ol	10Ol	126
		201g	Ol	10Ol	96
		203g	Ol	10Ol	48
		264a	LMb	8Ol 2So	41
	Sobibór	430a	OlJ	8Ol 2Js	110
		319d	Ol	10Ol	68
		273c	Ol	10Ol	69
		245g	Ol	10Ol	75
	Świdnik	28g	Ol	10Ol	15
		28f	OlJ	10Ol	71
		120c	OlJ	10Ol	28
		109g	OlJ	10Ol	20
		109d	OlJ	10Ol	42
		190j	LMb	10Ol	20
		190b	Ol	10Ol	42
	Biała Podlaska	280a	Lśw	3Db2Ol 2Lp2Js 1Kl	46
Poleski Park Narodowy		2i	LMw	8Ol 2So	74
		229a	Ol	8Ol 2Brz	49

* Ol – alder forest, OlJ – alder-ash forest, Lśw – fresh broadleaved forest, LMw – moist mixed broadleaved forest, LMb – boggy mixed broadleaved forest, Lw - moist broadleaved forest, Ł - riparian forest

** Ol – black alder, Olsz – grey alder, So – Scots pine, Brz – birch, Db – oak, Lp – lime, Js – ash, Kl – Norway maple, Św – Norway spruce

not showing disease symptoms, growing on the same surface. On surfaces mainly adult specimens were trapped. Control of insect occurrence was conducted on tree's crown (assimilation apparatus, sometimes with the use of binoculars), shafts, shoots and collar root. In the field initially, insect's taxonomic affiliation (on the base of imago) was defined, and species number was also estimated, which are able to occur in mass – all this with regard to *Agelastica alni*. In the last case, a three-stage occurrence scale was adopted, depending on degree of assimilation apparatus defoliation and number of adult specimen occurring:

1) Weak occurrence – lack of adult specimen or occurrence of single specimen on whole trees: leaves undamaged or with occasionally occurring single feedings;

2) Moderate occurrence – few adult specimen in various places on trees and singly beyond them; feedings on leaves easy to find, on each tree; however, defoliation did not exceed 50%;

3) Strong occurrence – numerous adult forms, appearing both on trees and shrub layer and soil cover; defoliation of leaves exceeding 50%.

Furthermore, on surfaces material was collected for laboratory breeding (shoots and fragments of shoots settled by xylophaga) and detailed taxonomic analysis, which were performed in Forest Protection and Ecology Cathedral of Agricultural University in Warsaw, and in Rogów near Koluszki.

3. Results

On inspected alder's forest stands, 28 insect taxons (Table 2) were stated, out of which most frequently folivore *Agelastica alni* occurred. This species was stated on 49 out of 57 examined surfaces. Most willingly, this species was feeding in lower crown parts, and on nine surfaces (for example, three out of five examined

Table 2. Insects found in alder stands at different age classes

L.p.	Taxon	Number of statements in stands at the age of			total
		<20 (stands)	21-60 (stands)	>60 (stands)	
I	**HOMOPTERA**				
1	*Psylla* sp.	1	2	1	4
2	Coccidae	1	1		2
II	**COLEOPTERA**				
3	*Sinodendron cylindricum* (L.)		1		1
4	*Dicerca alni* (Wald.)		3	2	5
5	*Hemicoelus canaliculatus*(Thoms.)		1	1	2
6	*Priobium carpini* (Herbst)			2	2
7	*Ptilinus pectinicornis* (L.)		3	6	9
8	*Xestobium rufovillosum* (De Geer)	1		1	2
9	*Elateroides dermestoides* (L.)		1	3	4
10	*Leiopus nebulosus* (L.)	4	5		9
11	*Leptura quadrifasciata* (L).		1	4	5
12	*Saperda scalaris* (L.)	2	13	12	27
13	*Rhagium mordax* (De Geer)		4	6	10
14	*Agelastica alni* (L.)	13	19	17	49
15	*Plagiosterna aenea* (L.)		1		1
16	*Platystomos albinus* (L.)			1	1
17	*Cryptorhynchus lapath i*(L.)	3	2		5
18	*Orchestestes tastaceus*(Miill.)	1	1	1	3
19	*Trypodendron signatum* (F.)	3	7	5	15
20	*Dryocoetes alni* (Georg)	3	3	1	7
21	*Xyleborinus attenuatus* (Bland.)	6	12	12	30
22	*Anisandrus dispar* (F.)	3	6	4	13
23	*Taphrorychus bicolor* (Herbst)		1		1
III	**HYMENOPTERA**				
24	*Xiphydria camelus* (L.)	11	15	8	34
IV	**LEPIDOPTERA**				
25	*Lymantria dispar* (L.)	1		2	3
26	*Synanthedon spheciformis* (Denis et Schiff.)			2	2
27	*Coleophora* sp.		1		1
V	**DIPTERA**				
28	*Phytobia* sp			1	1

surfaces in Miradz Forest Inspectorate) occurred in mass (strong occurrence) causing a strong tree defoliation. On many surfaces, in addition to frequently observed species belonged also some secondary pests. They were xylophagia – *Xyleborinus attenuatus* (=*X. alni*), *Xiphydria camelus* and cambiophagous *Saperda scalaris*. Other insect species occurred with smaller intensity. On surface in Radzyń Podlaski (comp. 346c), except insects, occasional occurrence of folivore saprophytes – Erophyoidea was observed.

4. Discussion

The majority of entomological reports of young alder's trunk were of damage caused by insect *Cryptorhynchus lapathi*. Larvae of this weevil burrow the paths deep in live tree wood, causing canceration in feeding places and wood's technical weakness, which often leads to breaking of leading shoots (Strojny 1954; Dominik, Starzyk 2004). However, cases of large-scale damages are extremely rare, and the major harm of this weevil is assigned to feedings on plantation willows and poplars. In research conducted in 2007, few feeding symptoms of *Cryptorhynchus lapathi* were stated in only five research areas.

In a monographic elaboration of *Alnus* genus, in the section concerning alder's pests, Szmidt (1980) lists around 70 species of certain economic importance, occurring more frequently on alder than on other tree's species. Nunberg (1964) offers some clues concerning insects feeding on trees from *Alnus* genus, and lists over 120 insect species. Schnaider (1991) lists 42 species of insects and arachnids that cause damage to alder from which the majority are species damaging leaves. However, Kolk and Starzyk (1996) present 38 species connected with alders, wherein for nine species alder is the only, or preferred, host plant. Browne (1968) lists 46 insect species occurring on *Alnus glutinosa*. Szujecki (1995) included *Agelastica alni* and *Melasoma alni* in folivore species showing a tendency for mass occurrence. They have relevance however in young alder's plantings or in nurseries, where planting material is being produced. It seems, that among demonstrated taxons, there are no species that would lead to alder's forest stands decay on a larger area, despite the fact that some of them sometimes occur on alders commonly.

Except insects preferring alders (including grey alder), more numerous and more common insect group feeding on alders are polyphagous species. On 28 taxons listed in Table 2, barely seven may be considered for species exclusive for alders (*Agelastica alni*, *Plagiosterna aenea*, *Orchestes testaceus*, *Coleophora* sp., *Phytobia* sp., *Psylla* sp., Coccidae) and another five for species preferring alders for further development (*Dicerca alni*, *Cryptorynchus lapathi*, *Dryocoetes alni*, *Xiphydria camelus*, *Synanthedon spheciformis*). Therefore, 16 demonstrated taxons are polyphagous species.

The folivore *Agelastica alni* occurred most often. This species was stated on 49 out of 57 examined surfaces, mainly in lower parts of crowns. On nine examined surfaces, *Agelastica alni* occurred in dry places, unfavourable for alder's development, whereas on positions which comply alder's ecological requirements, the population of this species is visibly lower. The author believes that on such surfaces *Agelastica alni* population is probably stronger controlled by predators feeding on larvae and eggs. The observed fluctuation of groundwater level, influencing *Agelastica alni* growth condition deterioration, may influence on the abundance and greater acreage of *Agelastica alni* appearance. Ambroży and Kosibowicz (2012) state that the main factor of gradual elimination of black alder recruitment in Karpaty and Sudety were snow damages. Damages caused by insects, mainly *Agelastica alni*, were far less important.

In similar research conducted in 2002–2004, Kodrík et al. (2006) stated alder 17 species of insects and saprophytes, of which four were on roots and trunks (*Agrilus viridis* L., *Trypodendron domesticum* L., *Xyleborinus saxesenii* Ratz., *Cossus cossus* L.), three species on branches (*Aphrophora alni* Fallén, *Cryptorynchus lapathi* L., *Cimbex connata* Schrank) and 10 on leaves (*Agelastica alni* L., *Plagiosterna aenea* L., *Chrysomela populi* L., *Phyllobius calcaratus* F., *Rhynchaenus alni* L., *Hemichroa australis* Lepel. =*H. alni* L., *Heterarthrus* (=*Phyllotoma* Fallén) *vagans* Fallén, *Agromyza alnibetulae* Hend., *Eriophyes laevis* Nal., *E. inaqulis* Nal.). The majority of stated taxons occurred occasionally, whereas in moderate intensification they occurred in four species (*Agelastica alni*, *Plagiosterna aenea*, *Cryptorynchus lapathi* and *Aphrophora alni*).

Gharadjedaghi (1995) states that in Germany, buds of young *A. glutinosa* trees were damaged by *Epinotia tenerana* (Tortricidae), whereas Gregory et al. (1996) observed thinned alder's crowns in Great Britain, except from volutes from *Epinotia* genus, and also folivore *Plagiosterna* (=*Chrysomela*) and Homoptera from *Psylla* genus.

On black alder's leaves, besides insects, may also feed saprophytes, creating papillary outgrowths, which redden and brown in time, causing at the same time deformation of leaves. The most common saprophytes belong to *Eriophyes* spp. and *Aceria* spp. genus. These saprophytes are of little importance, and their feeding does not cause significant alder weakness (Soika, Łabanowski 2003), though on the other hand it is known that they are vectors of virus, fungi and phytoplasma (Boczek 1988). Besides saprophytes, vectors transferring phytoplasma on alders may also be representatives of homopterans (Maixner, Reinert 1999). Those insects suck the cells of phloem, injecting at the same time pathogenic microorganisms, development of which without a doubt leads to sickness in plants, disrupting the most important physiological process. Oszako (2008) states that in our climate conditions, participation in *Phytophthora alni* spread also are insects and snails.

5. Results

On the basis of analysis of the published results of various studies concerning harmful insects feeding on alders so far, and on the basis of observations made in controlled forest stands, it can be concluded that none of insect species shown here is able to cause alder's forest stands decay on large areas alone. However, some of them cause physiological weakness of the trees, and sometimes, due to their increased activity, may accelerate single tree decay or rarely clusters, accompanying therefore alder's decaying process. Still, the process of healthy trees being infected with viruses, fungi and phytoplasma by pests runs is not fully understood, especially by those pests with suctorial apparatus, for example *Psylla* and *Aphrophora* genus, or representatives of Coccidae family. Future research should focus therefore on explaining the role of the above listed groups of insects and saprophytes in the decaying process, and not only in alders forest stands, but also in forest stands of other tree species.

Acknowledgements

The study was carried out as part of the research project commissioned by General Directorate of State Forests during 2005–2007, under the direction of Prof. Dr. Andrzej Grzywacz.

The authors would like to thank Prof. Dr Andrzej Grzywacz for comments on the first version of the work, the employees of State Forests and Poleski National Park for help during realisation of field work, and also would like to thank the reviewers for valuable remarks on the final version of work.

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Translated by: Anna Wyszyńska