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On the vertical distribution of *Ips duplicatus*, *I. cembrae* and some bark- and longhorn beetles (Col.: Curculionidae, Scolytinae; Col.: Cerambycidae) in the Tatra National Park in Poland

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Abstract

In 2013–2014, a set of 30 pheromone traps baited with synthetic lures attracting *I. duplicatus* (Duplodor – 15 traps) and *I. cembrae* (Cembrodor – 15 traps) was installed in 6 altitudinal transects (1000–1400 m a.s.l., every 100 m of elevation) in the eastern, central and western part of the Tatra National Park (TPN) in Poland and operated during the entire growing season. The main aim of the survey was to check if and to what vertical extent these two species of bark beetles, not yet recorded, are presently distributed in TPN. Collected insects, including non-target Scolytinae and Cerambycidae, were determined. Overall 1896 Scolytid bark beetles belonging to 13 species, all occurring in the whole elevation range, were collected. *I. duplicatus* (28 specimens in total) was collected in the whole elevation profile, similarly as *I. cembrae* (718 specimens in total). Among Cerambycidae (282 individuals) belonging to 19 species, *Rhagium inquisitor* and *Pidonia lurida*, found on all elevations, were the most abundant; 8 species were collected on the highest locality. *Pogonocherus decoratus* was found for the first time in the Tatra. Results indicate the upward spreading of the studied insects as a possible effect of climate change and the resulting environmental conditions favourable for those organisms.

Key words

Ips duplicatus, *Ips cembrae*, Scolytinae, Cerambycidae, vertical distribution, Tatra Mountains

Introduction

Tatra is the mountain region of special natural value, located along the border between Slovakia (75% of mountain land area) and Poland (25% of area), remaining from several decades under nature protection regime and certified in 1993 as UNESCO MAB Biosphere Reserves (Mirek, 1996). About 71% of the area of the Tatra National Park (TPN) in Poland, that is, about 15 thousand ha, is covered by forests. Dominating tree species is Norway spruce *Picea abies* (L.) H. Karst., both in natural stands in the higher mountain zone, and artificially planted in the lower mountain zone (Fabijanowski and Dziewolski 1996), recently affected by massive decline due to the bark beetle *Ips typographus* (L.) outbreaks (Grodzki and Guzik 2009;

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Grodzki and Gąsienica-Fronek 2019). Contrarily, European larch *Larix decidua* Mill. is one of the most scarce species, although in Poland its sole indigenous population (179 trees) is located in the Tatra Mts. (Madeyski 1974), where also some stands with artificially planted larch exist.

The entomofauna in the Tatra Mts. in Poland is not recognized enough (Szymczakowski 1996), only some taxonomic groups were more deeply studied. The number of available sources of information about Coleoptera decreased during the last decades (Tykarski and Knutelski 2010). This concerns scolytid and longhorn beetles – the data contained in Catalogus Faunae Poloniae (Burakowski et al. 1990, 1992) are incomplete and (often) out of date. In the monographic publication concerning Curculionoidea in Tatra Mts., (Knutelski 2005) subfamily Scolytinae is excluded. More complete information about the coleopterofauna of the Slovak part of the Tatra Mts. is published by Majzlan (2015), who also provided the information about the localities, including elevation. One should however take into consideration that data from Slovakia concern the southern part of the Tatra Mts., and may not be fully applicable to the northern, Polish part, where the thermal conditions, that are crucial in the context of environmental requirements of insects, may be different. On the other hand, due to climatic changes, the recently observed shift in the distribution of insect species results in their expansion to new territories (Turčáni et al. 2001), that correspond with their requirements. This concerns especially mountain areas, where environmental conditions are strictly related to the orographic features, especially elevation.

As the model organisms two bark beetle species, not recorded yet in the Tatra Mts. in Poland, were selected: the double spined bark beetle *Ips duplicatus* (Sahlb.) feeding on Norway spruce and the larch bark beetle *I. cembrae* (Heer) breeding on larches *Larix* spp. Both species are known as recently producing local outbreaks in some other parts of Poland (Grodzki 1997, 2009). The main goal of the study was to recognize if, and to what vertical extent, these two species of bark beetles are presently distributed in the Polish part of the Tatra Mts. Although, due to the collection method applied, it was also possible to collect the data about the distribution of some other, non-target species of bark- and longhorn beetles.

Material and methods

The research was done in the area of the Tatra National Park (TPN) in Poland. Six sets of collection points were located in the western (2), central (2) and eastern (2) part of the Park. Each set consisted of 5 points in form on an altitudinal transect, every 100 m of elevation between 1000 and 1400 m a.s.l. – in total, 30 traps were operated each year (Tab. 1). On every collection point, a single pheromone slit trap with a container for captured insects, filled by conservation liquid, was installed at the beginning of the vegetation season (early April) in 2013 and 2014. On three transects, located in Norway spruce stands, the traps were baited with pheromone dispensers Duplodor (ZD Chemipan, Poland) containing synthetic lure to attract *I. duplicatus*, on the three others, located in the stands with larch – with pheromone dispensers Cembrodor (ZD Chemipan, Poland) containing synthetic lure to attract *I. cembrae*. One set of the dispensers was exposed during the whole vegetation season and all captured insects were collected in the autumn (early October), then determined in the laboratory. As the pheromone traps used in the study is not very selective tool (Majzlan and Ferenčik 1988; Grodzki 2007), the non-target insects collected from the traps were also determined.

Results

1. Target insects – *I. duplicatus*, *I. cembrae*

During 2 vegetation seasons, 718 *I. cembrae* beetles were collected in the pheromone traps baited with Cembrodor lure (IC). The beetles were caught in the entire range of altitudes, with the highest captures at 1400 and 1300 m a.s.l. (202 and 173 beetles, respectively) (Tab. 2); most of them were captured in the central transect (526 beetles in total). No *I. duplicatus* beetles were found in the traps baited with Cembrodor (Tab. 3).

At the same time, 28 *I. duplicatus* individuals were collected in the pheromone traps baited with Duplodor lure (ID). The beetles were caught in the entire range of altitudes, with the highest captures at 1000 and 1200 m a.s.l. (9 and 14 beetles, respectively) (Tab. 2) and in the eastern transect (13 beetles in total). No *I. cembrae* beetles were found in the traps baited with Duplodor (Tab. 3).

2. Other insects – Scolytinae and Cerambycidae

Besides the two target species, the bark beetles (Scolytinae) belonging to 11 species were collected. The most abundant were: *I. typographus* (38.9% of the total excl. target species) and *Dryocoetes autographus* (Ratz.) (34.3%), while two species were collected in a number of less than 10 specimens (Tab. 2). All species were collected in the whole elevation range, although some were missing at certain altitudes. The highest number of other scolytids was collected at 1200 and 1000 m a.s.l., but the number of species was the lowest at 1000 (8) and 1300 (9) m a.s.l. All species were captured in the traps baited with the two types of pheromones, regardless the tree species dominating in the stands, however most of them (89,8%) – in the traps with *I. duplicatus* lure. Out of 447 *I. typographus*

Table 1. Location of elevational transects with pheromone traps for *Ips duplicatus* and *I. cembrae* in the western, central and eastern part of the Tatra National Park

Tree species Pheromone	Transect (part)	Location	Forest comp.	Elevation. m a.s.l.	Coordinates (X, Y)	
Larch Cembrodor (IC)	Krowi Żleb (western)	MZ1	241 a	1000	418446	5457042
		MZ2	241 a	1100	418618	5456973
		MZ3	241 b	1200	418771	5456668
		MZ4	241 b	1300	418795	5456461
		MZ5	249 j	1400	418929	5456057
	Jaworzynka (central)	MS1	192 yx	1000	425965	5458152
		MS2	178 b	1100	426300	5456879
		MS3	176 f	1200	426896	5456553
		MS4	176 f	1300	427173	5456459
		MS5	176 f	1400	427334	5456287
	Sywarne (eastern)	MW1	43 f	1000	434209	5454213
		MW2	71 d	1100	433683	5454016
		MW3	71 b	1200	433458	5454164
		MW4	71 h	1300	433354	5454221
		MW5	71 j	1400	433276	5454375
Norway spruce Duplodor (ID)	Adamica (western)	SZ1	247 b	1000	417930	5457087
		SZ2	246 d	1100	418142	5456861
		SZ3	246 d	1200	418442	5456526
		SZ4	249 f	1300	418539	5456043
		SZ5	249 j	1400	418822	5455964
	Sucha Woda (central)	SS1	36 f	1000	429857	5459897
		SS2	147 b	1100	429866	5459442
		SS3	151 b	1200	429870	5457804
		SS4	151 b	1300	429253	5457501
		SS5	153 h	1400	428621	5456920
	Rybi Potok (eastern)	SW1	42 g	1000	434281	5455347
		SW2	44 g	1100	433709	5453882
		SW3	45 c	1200	434196	5452436
		SW4	47 a	1300	433065	5451575
		SW5	55 a	1400	432625	5451368

beetles only 1 was found in the trap baited with Cembrodor (Tab. 3).

A total of 278 individuals of longhorn beetles (Cerambycidae) belonging to 19 species were collected. The most abundant were *Rhagium inquisitor* (L.) (61.2%) and *Pidonia lurida* (Fabr.) (10.8%); these two species dominated at all (*R. inquisitor*) or almost all (*P. lurida*) elevations, while 10 species were represented by up

Table 2. Bark beetles (Col.: Curculionidae, Scolytinae) collected from pheromone traps installed on altitudinal transects in the Tatra National Park in Poland in 2013–2014

Species	Elevation a.s.l. (m)					
	1000	1100	1200	1300	1400	total
Cryphalus asperatus (Gyll.)		1	1		4	6
Dryocoetes autographus (Ratz.)	106	96	102	36	55	395
Hylurgops glabratus (Zett.)		1	3	4	10	18
Hylurgops palliatus (Gyll.)	1		3	15	11	30
Ips cembrae (Heer)	166	73	104	173	202	718
Ips duplicatus (Sahlb.)	9	2	14	1	2	28
Ips typographus (L.)	177	12	234	16	8	447
Orthotomicus laricis (Fabr.)	6	2	5	2	4	19
Pityogenes chalcographus (L.)	28	13	29	15	3	88
Pityophthorus pityographus (Ratz.)	5	2	17		2	26
Polygraphus poligraphus (L.)	1	2	3	5	4	16
Trypodendron lineatum (Oliv.)	9	5	63	16	5	98
Xylechinus pilosus (Ratz.)		2	2	1	2	7
Scolytinae	508	211	580	284	312	1896
excl. *I. duplicatus* and *I. cembrae*	333	136	462	110	108	1150

Table 3. Bark beetles (Col.: Curculionidae, Scolytinae) collected from pheromone traps with Cembrodor (IC) and Duplodor (ID) on altitudinal transects in the Tatra National Park in Poland in 2013–2014, with location of captures

Species	IC	ID	Locations (abbreviations – see Table 1)
Cryphalus asperatus (Gyll.)	4	2	MW2, MW5, MZ3, SS5
Dryocoetes autographus (Ratz.)	80	315	All except MS1-3, MS5, SZ4
Hylurgops glabratus (Zett.)	2	16	MW3, MS2, SW3, SS4-5, SZ3, SZ5
Hylurgops palliatus (Gyll.)	3	27	MW3, MS3, SS1, SS4-5
Ips cembrae (Heer)	718		MW1-5, MS1-5, MZ1-5
Ips duplicatus (Sahlb.)		28	SW1-4, SS1, SS5, SZ1, SZ2, SZ5
Ips typographus (L.)	1	446	MW5, SW1-5, SS1-4, SZ1, SZ2, SZ5
Orthotomicus laricis (Fabr.)	2	17	MW1, MS2, SW3-5, SS2, SZ1
Pityogenes chalcographus (L.)	8	80	MW1, SW1-4, SS1-SS5, SZ1, SZ3
Pityophthorus pityographus (Ratz.)	3	23	MW3, MZ2, MZ5, SW1-3, SS5, SZ1, SZ3
Polygraphus poligraphus (L.)	1	15	MZ2, SW3-4, SS1-2, SS4-5, SZ4-5
Trypodendron lineatum (Oliv.)	12	86	MW1, MW3, MW5, MZ4,
Xylechinus pilosus (Ratz.)	1	6	MZ2, SW2, SS3-5
Scolytinae	835	1061	1896
excl. *I. duplicatus* and *I. cembrae*	117	1033	1150

Table 4. Longhorn beetles (Col.: Cerambycidae) collected from pheromone traps installed on altitudinal transects in the Tatra National Park in Poland in 2013–2014

Species	Elevation a.s.l. (m)					
	1000	1100	1200	1300	1400	total
Acanthocinus griseus (Fabr.)	1	1	7			9
Alosterna tabacicolor (DeGeer)	1		3			4
Anastrangalia dubia (Scop.)		1				1
Anastrangalia sanguinolenta (L.)		1		1		2
Clytus lama Muls.	2	2	3			7
Evodinus clathratus (Fabr.)	1		2	1	10	14
Gaurotes virginea (L.)	1	1	1			3
Judolia sexmaculata (L.)			1	1		2
Lepturobosca virens (L.)	1		1			2
Molorchus minor (L.)	2	3	4	2	1	12
Oxymirus cursor (L.)		4	2		1	7
Pachyta quadrimaculata (L.)		1				1
Pachytodes cerambyciformis (Schrank)		2	1			3
Paracorymbia maculicornis (De Geer)	1	1	1			3
Pidonia lurida (Fabr.)	1	4	10	12	3	30
Pogonocherus decoratus Fairmaire				1		1
Rhagium inquisitor (L.)	13	41	33	59	24	170
Rhagium mordax (De Geer)	1			2		3
Tetropium castaneum (L.)		1	2		1	4
Cerambycidae	25	63	71	79	40	278

to 3 specimens (Tab. 4). The highest total number of specimens was collected on 1400 m a.s.l., the lowest – at 1000 m a.s.l., and the number of species was the highest at 1200 m a.s.l. (14), slightly lower (11–13) at lower altitudes and markedly decreasing at higher elevations, reaching only 6 species at 1400 m a.s.l. From the total spectrum of collected insects, 3 species: *Anastrangalia dubia* (Scop.), *Pogonocherus decoratus* (Fairmaire) and *Rh. mordax* (De Geer) were collected exclusively in the traps with *I. cembrae* lure (IC) located in larch-dominated stands, from which 68% of the collected beetles came, while another 5 species: *Acanthocinus griseus* (Fabr.), *Gaurotes virginea* (L.), *Judolia sexmaculata* (L.), *Pachyta quadrimaculata* (L.) and *Pachytodes cerambyciformis* (Schrank) – only in those with *I. duplicatus* lure (ID) installed in spruce-dominated stands (Tab. 5).

Discussion and conclusions

Until the end of XX century, *I. duplicatus*, considered as a native species in the Polish fauna, was known as widespread in the north-eastern part of the country, and never found in the mountains, including Tatra Mts. (Burakowski et al. 1992). In spite of its spreading southward and local outbreak in the Silesian Upland in late 90's (Grodzki 1997), the species was not recorded in the Tatra in 2001–2002 using traps baited with specific pheromone, when some individuals were collected in the Western Carpathians in Beskid Śląski (Skrzyczne Massif) and Beskid Żywiecki (Police Massif) at the altitudes of 1000–1050 m a.s.l. (Grodzki 2003). *I. duplicatus*, responding to *I. typographus* lures (Grodzki 1998), was also not found in the pheromone traps installed in the TPN to monitor *I. typographus* populations (Grodzki 2007), nor recorded by Tykarski (2006), due to the applied methodology based on the dissection

Table 5. Longhorn beetles (Col.: Cerambycidae) collected from pheromone traps with Cembrodor (IC) and Duplodor (ID) on altitudinal transects in the Tatra National Park in Poland in 2013–2014, with location of captures

Species	IC	ID	Locations (abbreviations – see Table 1)
Acanthocinus griseus (Fabr.)		9	SW2-3, SS3, SZ2
Alosterna tabacicolor (DeGeer)	1	3	MZ3, SZ1, SZ3
Anastrangalia dubia (Scop.)	1		MZ2
Anastrangalia sanguinolenta (L.)	1	1	MZ4, SW2
Clytus lama Muls.	4	3	MS3, MZ2, SS2, SZ1
Evodinus clathratus (Fabr.)	8	6	MW5, MS5, MZ3, SW5, SS4-5, SZ1, SZ3
Gaurotes virginea (L.)		3	SW1, SW3, SZ2
Judolia sexmaculata (L.)		2	SW3-4
Lepturobosca virens (L.)	1	1	MW3, SW1
Molorchus minor (L.)	2	10	MS2, SW1-5, SS3-4, SZ3
Oxymirus cursor (L.)	4	3	MZ2-3, SS5, SZ2
Pachyta quadrimaculata (L.)		1	SS2
Pachytodes cerambyciformis (Schrank)		3	SW3, SS2
Paracorymbia maculicornis (De Geer)	2	1	MS1, MS3, SS2
Pidonia lurida (Fabr.)	21	9	MW2, MW4-5, MS4, MZ2-4, SW1, SS2-3, SZ4
Pogonocherus decoratus Fairmaire	1		MW4
Rhagium inquisitor (L.)	142	28	All except SW4, SS2, SS4-5, SZ4
Rhagium mordax (De Geer)	3		MW1, MW4
Tetropium castaneum (L.)	1	3	MW3, SW3, SW5, SS2
Cerambycidae	192	86	278

of lying trees, that usually are not colonized by *I. duplicatus* (Grodzki 1997). This species, mainly infesting upper parts of the stem in the crown, could also be overlooked during the investigations in strictly protected areas, where the felling of infested trees is not allowed. Also, Majzlan (2015) do not mention this species among the beetles found in Tatra. According to our data, in the Polish part of Tatra, the species occurs in wide range of altitudes, up to 1400 m a.s.l., which seems to be against the existing knowledge about its environmental requirements. This indicate the spreading of the species towards higher altitudes, similarly as it is observed in Slovakia, where *I. duplicatus* was recorded for the first time in the area of the Tatra national park (TANAP) in 2016 (Vakula et al. 2017), and then – but in higher number of specimens – in 2017, in the western part of Tatra, although no information about the altitude is available (Vakula et al. 2018). Low captures of beetles in TPN, in comparison to those from TANAP, could probably result from the pheromone dispenser used, as ID Ecolure (used in *I. duplicatus* monitoring in Slovakia) is much more efficient than Duplodor (Holuša et al. 2010); however, the amount of collected beetles is of secondary importance, as the main aim of the presented survey was the detection of species occurrence. On the other hand, *I. duplicatus* is known as an important species of cambiophagous insect (Grodzki 1997), thus its contribution in spruce mortality due to beetle infestation could increase in the next future.

Ips cembrae was not registered from the Polish part of the Tatra (Burakowski et al. 1992; BioMap 2020), and in the Slovak part, only one specimen was captured into Malaise trap in 2007, at the altitude of 1080 m a.s.l. (Majzlan 2015). The species is known as feeding on larch (Grodzki and Kosibowicz 2009); the existing in published knowledge information about the occurrence on Swiss stone pine *Pinus cembra* L. is considered as doubtful (Jamnický 1988; Grodzki et al. 2019). Our findings demonstrating its presence in Tatra, collected using pheromone traps, were also confirmed by the breeding galleries found on larch in Jaworzynka Valley in 2013 (Grodzki unpubl.). The total captures, generally much lower than those recorded in the Izerskie Mts. in 2008 during the local outbreak (Grodzki and Kosibowicz 2009), indicate quite high abundance of the species, distributed in a large range of altitudes up to 1400 m a.s.l.; however, no increased larch mortality due to the infestation was yet recorded in TPN.

Out of 38 species of Scolytinae recorded in the Tatra Mts. in Poland (Burakowski et al. 1992; BioMap 2020), the specimens belonging to 13 species were collected from our pheromone traps. All species (except the two target ones, already discussed) are known as occurring in the Tatra Mts. both in Polish (Burakowski et al. 1992; Tykarski 2006; BioMap 2020) and in Slovak (Ferenčik et al. 1992; Majzlan 2015) part. The most abundant species (i.e., captured in the highest number of individuals): *I. typographus* and *D. autographus* were also found by Tykarski (2006) as the most frequent and occurring in the whole range of studied elevations (850–1550 m a.s.l. vs. 1000–1400 m a.s.l in this study). Their high abundance results from the favourable breeding conditions offered by high amount of dying and dead trees in the stands affected by bark beetle outbreak (Grodzki and Guzik 2009; Grodzki and Gąsienica-Fronek 2019). Lower captures of the other species, such as *Pityogenes chalcographus* (L.), *Polygraphus poligraphus* (L.), *Trypodendron lineatum* (Oliv.), found as frequent by Tykarski (2006), most probably result from different methods of data collection in the field, especially the response of some bark beetle species to the compounds of synthetic pheromone. The effect of method is also reflected by the case of *I. amitinus* (Eichh.) – the species abundant in Tatra forests but never found in pheromone traps (Grodzki 2007; Grodzki et al. 2008). The numbers of beetles collected in the higher part of elevation range were lower, although without any visible trend, which in general corresponds with the findings obtained using different methods of investigations (Tykarski 2006). All collected bark beetles are trophically related with Norway spruce – this can explain very high share of bark beetles collected from the traps installed in spruce stands.

From 56 species of Cerambycidae known from the Tatra in Poland (Tykarski and Knutelski 2010), 19 were captured in our traps. Among those species, 8 were earlier found in pheromone traps for bark beetles, installed in the Slovak part of the Tatra Mts. (Majzlan and Ferenčik 1988; Ferenčik et al. 1992); although in later survey made by Majzlan (2015) with the use of various, mostly passive, traps, the presence of 15 out of those 19 species was documented in the areas affected by wind disaster from 2004.

Six species: *Evodinus clathratus* (Fabr.)*, Molorchus minor* (L.)*, Oxymirus cursor* (L.), *Pidonia lurida, Rhagium inquisitor* and *Tetropium castaneum* (L.), collected in all (or almost all) elevations up to 1400 m a.s.l., are common in the mountain regions including Tatra and widespread in forests (Starzyk 1970b; Burakowski et al. 1990; Sláma 1998; Majzlan 2015; BioMap 2020). The captures in large range of altitudes indicate their high plasticity regarding the environmental conditions, including host tree. The same can concern the other species, collected at various altitudes in low number of specimens.

The most abundant species *Rh. inquisitor* is known as widespread in the European forests from the north till Mediterranean region (Burakowski et al. 1990; BioMap 2020) and very often found in the pheromone traps set for bark beetles (Sláma 1998). The high captures in our traps can result from low environmental requirements of the species and good breeding conditions offered by dying and dead trees. The same concerns other species collected in relatively high (> 10) number of specimens. At least some of beetles could be captured in a passive way, as the pheromone trap used in the survey can act as a barrier that interrupts the insect flight.

Acanthocinus griseus, a species considered as common and widespread (Sláma 1998), was not earlier found in the pheromone traps in Slovak and Polish part of the Tatra (Majzlan and Ferenčik 1988; Ferenčik et al. 1992; Grodzki 2007), and quite recently considered as absent (Burakowski et al. 1990), collected in 2006 in the Eastern part of the Polish Tatra at the altitude of 1020 m a.s.l. (Starzyk et al. 2008) and in 2009 at similar altitude in the eastern part of TANAP (Majzlan 2015). Our finding is the second one in Polish Tatra, and the first record from such elevation (up to 1200 m a.s.l.),

Gaurotes virginea is a species widespread in the Tatra in large range of altitudes up to 1200–1250 m a.s.l. (Starzyk 1970a; Majzlan 2015), thus our captures remain in known vertical distribution range.

Oxymirus cursor is known to be commonly captured in pheromone traps set for spruce bark beetles

(Sláma 1998), but it was not found in the traps in the Slovak part of the Tatra (TANAP) (Majzlan and Ferenčik 1988; Ferenčik et al. 1992), then recorded on the altitude of 1030 m a.s.l. (Majzlan 2015), and only single individual was caught on the Polish (TPN) side on 1000 m a.s.l. (Grodzki 2007). Our data indicate that the species, widespread in many regions of Poland, can be distributed in large range of elevations, up to 1400 m a.s.l.

Pogonocherus decoratus, known as widely distributed in Poland but 'except higher parts of the mountains', was not earlier recorded from the Tatra Mts. in Poland (Burakowski et al. 1990; BioMap 2020), but also in Slovakia (Majzlan 2015). Our finding is the first one in the Polish Tatra, and the first record from such altitude (1300 m a.s.l.), although the species is distributed in the Alps up to 1700 m a.s.l. (Sláma 1998).

The presented results indicate the ongoing change in the distribution of insect species that spread into new territories following changing environmental conditions (Jönsson et al. 2007; Bentz and Jönsson 2015). This is distinct in mountainous conditions, where orographic diversity can easily simulate and/or reflect changes in climatic, especially thermal, features. The discovered presence of two bark- and one longhorn beetle species, that were absent in Tatra in the past, but also the occurrence of the other ones in the entire elevation profile, can be considered as a sign that confirms such changes. On the other hand, it is not clear if this is fully true in the case of longhorn beetles, as – taking into account the gaps in the knowledge about local coleopterofauna – the new findings can result from incomplete recognition, and not directly from the upward spreading of those species.

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