

Notes on *Biston betularia* industrial melanism in the Copşa Mică area

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Summary: The aim of our study is to evaluate the abundance of melanic forms of *Biston betularia* in the year 2012 from the Copşa Mică area. This locality is well known for the high pollution level caused by the synergic action of SO₂, soot black and heavy metals. The two industrial units, which were the pollution sources were closed and the now the pollution level decreased. We captured moths monthly from all eleven sampling points situated in woodland habitats. Results show that the proportion of black form carbonaria has drastically declined since 1987-1988. In the vicinity of the pollution source carbonaria form was 96 % in 1987-1988 and in 2012 the proportion is only 60 %. Overall the abundance of carbonaria also decreases with the increase of distance from the pollution source. In these sites carbonaria has only less than half it was recorded at the end of the 80's.

Key words: Industrial melanism, *Biston betularia*, atmospheric pollution, Copşa Mică, renaturation

Introduction

The Copşa Mică area was one of the most polluted sites in the world (Ianculescu *et al.* 2009), the non-ferrous metallurgy factory SC SOMETRA SA based here emitting extremely high concentrations of atmospheric emissions (Lăcătuşu and Lăcătuşu 2010). The negative effects of this unit were amplified by another industrial unit, the carbon black smoke factory SC CARBOSIM SA which emitted other types of pollutants. The most damaging to vegetation was the sulphur compounds emitted by the metallurgy factory, the black smoke from the second industrial unit only enhanced the effects of the sulphur compounds (Ianculescu *et al.* 2009). Soil, litter, vegetation and fauna were all affected by these pollutants. Based on the level of pollutants found in litter and vegetation, Barbu (2006) and Ianculescu *et al.* (2009) recognized three levels of degradation due to pollution, the forest stands closest to the pollution source being the most affected. On insect populations, one effect was the overall decrease of diversity and another was the occurrence of melanic forms (Sanda *et al.* 1976, Rákósy and Rákósy 1997). *Biston betularia* is world renowned for its three forms: carbonaria, insularia and typica. In Britain, the carbonaria form was strongly associated with high levels of atmospheric coal pollution (Kettlewell 1961, Clarke and Sheppard 1966, Less 1981). A similar association was recorded in the Copşa Mică area in the year 1987-1988; the proportions of carbonaria form in close proximity to

Copşa Mică reached 92.6 up to 100% revealing an extremely polluted site (Rákósy and Rákósy 1997). In the two other cities (Mediaş and Blaj) the percentages of this form decreased, and the proportion of the insularia form increased (Rákósy and Rákósy 1997). The SC CARBOSIM SA was closed the 1993 and in 2009 the main pollution source SC SOMETRA SA suspended its activity (Szanto *et al.* 2011). The aim of this research is to highlight the changes that have occurred in *B. betularia* melanic form frequencies, revealing the health of forest stands from Copşa Mică area in the year 2012.

Material and methods

Eleven sampling sites were selected closely matching the sampling localities used in the first study from 1987-1988. The collection points were set in forest habitats. Sampling was done during April and September 2012 using two 8 W black light traps powered by 12 V batteries for each site. In order to increase trap efficiency warm nights, with clear sky and without full moon were chosen. The sampling was done twice a month.

Results and Discussions

The results of our research recorded significant frequency differences in melanic forms between the two periods 1987 and 2012 (Table 1). In the intensely polluted area the carbonaria form was absolutely

Table 1. Number of individuals of *Biston betularia* forms in the year 1987 and 2012

Sampling sites	Year	No. of individuals		
		typica	carbonaria	insularia
Intensely polluted sites	1987	0	17	0
	2012	1	12	7
Medium polluted sites	1987	7	28	15
	2012	0	18	6
Unpolluted sites	1987	16	9	3
	2012	1	3	16

dominant in 1987, reaching 100%, whereas in 2012 the percentage of the black carbonaria form had declined drastically (60%), the intermediates insularia is 35% and we encounter even the black and white typica form (Fig. 1).

The decline of the carbonaria form is also found in the medium polluted forest stands, where the insularia form was the most common in 2012 (Fig. 2). Percentages of the melanic forms in medium and unpolluted sites are very similar, in the past and now. Comparing the overall situation between 1987 and 2012, the insularia form is dominating now; percentages of 75% and 80% were recorded in the medium and unpolluted sites. In the medium damaged stands only half the percentage of carbonaria can be found in 2012 and in the unpolluted sites the percentage of carbonaria decreased by 33% (Fig. 3). The typica form specimens are absent in 2012 in the medium polluted sites; this might be an effect of natural selection and also low trapping success. It should be mentioned that the insularia form specimens are morphologically diverse; we can encounter individuals that resemble with typica form and specimens with the carbonaria form. The decline of carbonaria was encountered in Britain and North America where measures to prevent the atmospheric pollution had been taken (Clarke and Sheppard 1966, Grant *et al.* 1998).

The pollution levels from Copșa Mică area had been gradually decreasing after 2009 when the non-ferrous plant SOMETRA was closed; this led to changes to the vegetation. The occurrence of melanic forms in the Copșa Mică area can be explained according to some authors to gene flow (Lees and Creed 1977); others linked rise and fall of melanic forms from Britain and America with the increase and decrease of atmospheric pollution (Grant 1999, Grant and Wiseman 2002). Predation has a substantial role in the decline of melanic forms in the post-industrial areas, the melanic moth being selectively eaten by birds given the fact that they are more visible on the trunks of the trees (Cook and Turner 2008, Cook *et al.* 2012, Cook and Saccheri 2013, van 't Hof *et al.* 2013, van 't Hof *et al.* 2016, Eacock *et al.* 2017).

Conclusions

Our data indicate a decline of the carbonaria form in the Copșa Mică area. Used as a bioindicator in the past, this decline suggests that the pollution level is lower now, and the health of the forest habitats has improved. The insularia form, which is independent of the pollution level (Rákossy and Rákossy 1997), is more frequent in 2012. Probably, the carbonaria form will continue to decline in the future and the typica form will become more abundant; additional research is needed to prove this hypothesis.

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Fig. 1. Frequency of the *Biston betularia* forms from the intensely polluted sites in the year 1987 and 2012

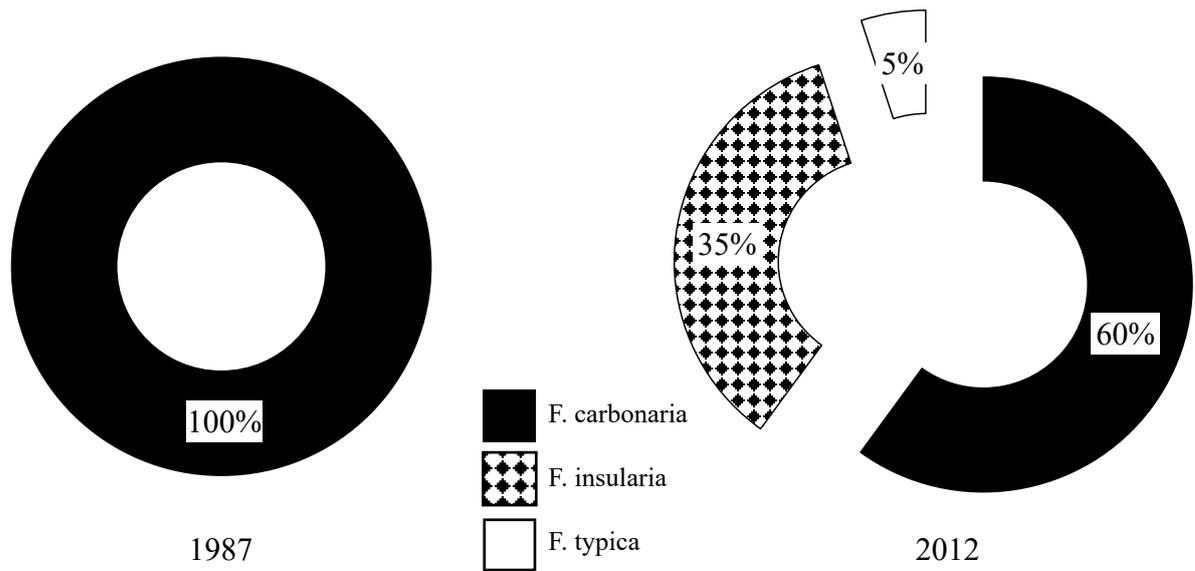


Fig. 2. Frequency of the *Biston betularia* forms from the medium polluted sites in the year 1987 and 2012

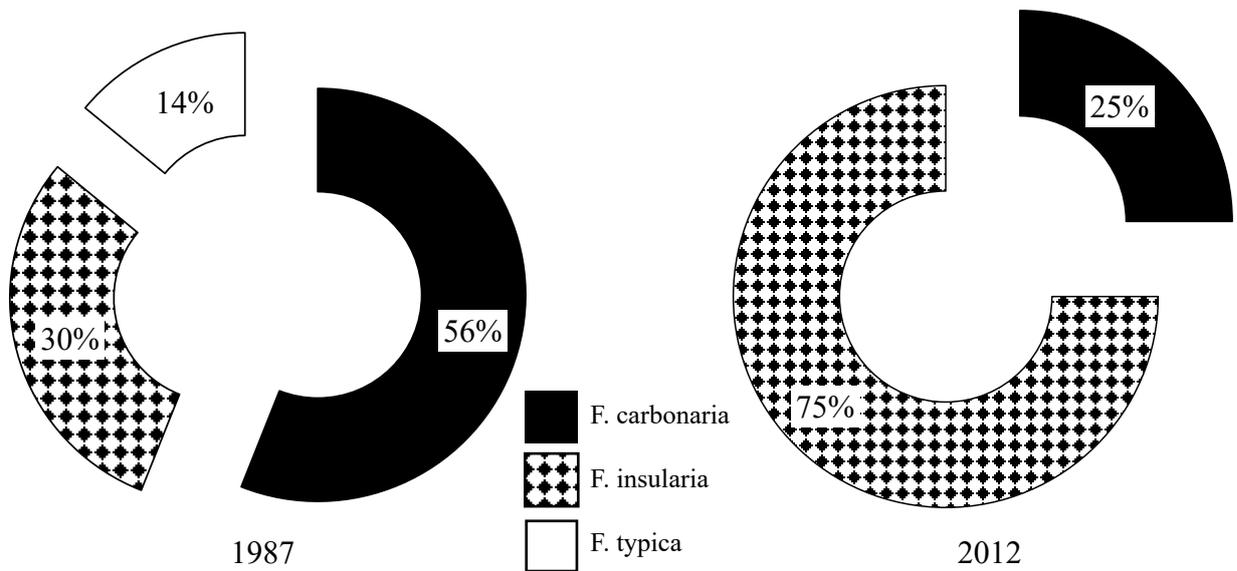
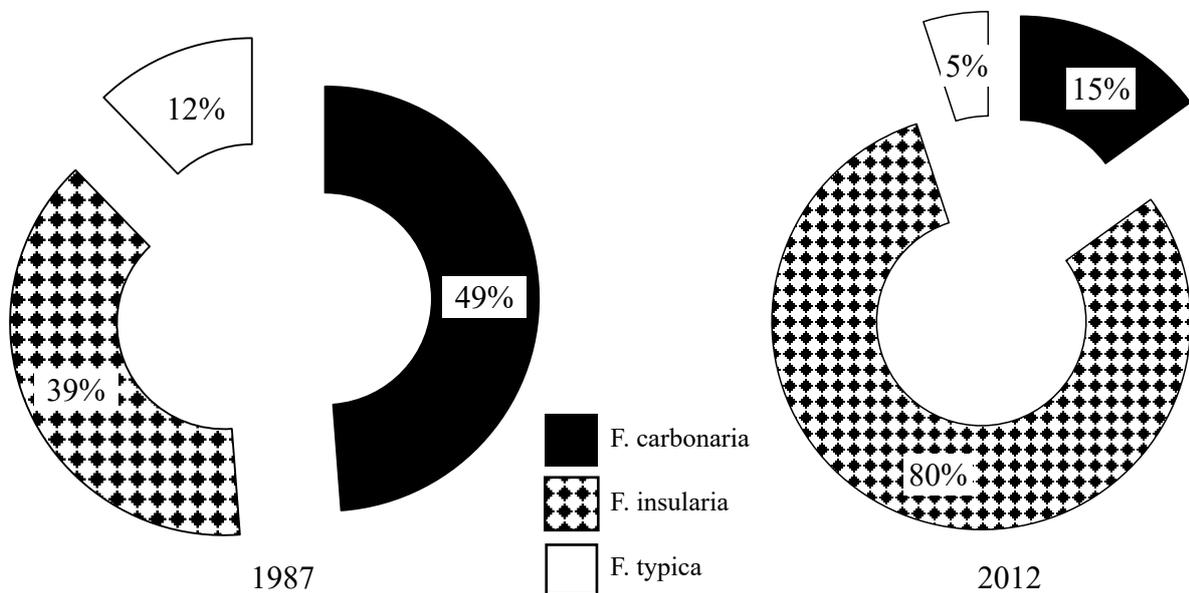


Fig. 3. Frequency of the *Biston betularia* forms from the unpolluted sites in the year 1987 and 2012



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