

First record of the winter moth *Operophtera brumata* (Linnaeus, 1758) (Lepidoptera: Geometridae) in northern Iran

Rajaei, H.^{a*}, Abaii, M.^b and Hausmann, A.^c

^a Zoologisches Forschungsmuseum Alexander Koenig, Adenauerallee 160, 53113 Bonn, Germany

^b Iranian Research Institute of Plant Protection, P. O. Box. 1454, Tebran, Iran

^c Zoologische Staatssammlung, Münchhausenstraße 21, 81247 Munich, Germany

Operophtera brumata (Linnaeus, 1758) is a winter moth with wingless females. It is a serious pest in forestry and fruit cultivation in Europe. We present the first report of its occurrence in Iran. Moths of both sexes and their genitalia are illustrated. The species is distinguishable from its sister species *O. fagata* (Scharfenberg, 1805) by a smaller male and the presence of two signa on the corpus bursae of female *O. brumata*. Potential host plants in Iran (mostly cultivated and forestry trees) are compared with those known in Europe. Natural enemies of *O. brumata* (mainly Hymenoptera, Coleoptera and Hemiptera) are listed.

Key words: *Operophtera brumata*, *O. fagata*, Iran, winter moth, host-plant

INTRODUCTION

Operophtera Hübner, 1825 belongs to the tribe Operophterini of the family Geometridae, subfamily Larentiinae consisting of 13 valid species (Scoble & Hausmann, 2007). *Operophtera brumata* (Linnaeus, 1758) is considered the most important leaf-feeding pest infesting fruit trees and deciduous forests in northern Europe (Edland, 1971) and elsewhere (Kudler, 1978; Zhang, 1994). Its distribution embraces most of the Holarctic region (Fauna Europaea, 2011; Nikusch, 2001), but there are no records of its occurrence in the Middle East. We review the salient diagnostic characteristics of the species in comparison with its Western Palearctic sister species, *O. fagata* (Scharfenberg, 1805). Food plants, potential food plants, and natural predators in Iran are reported.

MATERIAL AND METHODS

We compared European *O. brumata* and *O. fagata* with Iranian specimens. The European specimens examined were from collections in the Zoologisches Forschungsmuseum Alexander Koenig (ZFMK), Bonn, Germany and Zoologische Staatssammlung (ZSM), Munich, Germany. Collection data are given as they are written on the labels.

Material examined. *O. brumata*: 1 ♂, North Iran, Nowshahr, 22.08. [19] 96 [this date given on the data label is probably incorrect], Abaii, prep. 1008/2010 H. Rajaei; 1 ♀, North Iran [Nowshahr], 04.01. [20] 01, [leg.] Abaii, prep. 1009/2010 H. Rajaei, in ZSM; 1 ♂, Germania, Burg Liebenstein, 28.10.1972, leg. P. Kuhna, prep. ♂ 1441/2011 H. Rajaei; 4 ♂, 9 ♀, Germania, Bergisches Land, Wipperfürth, Neye/Umg. Nien, 11.11.1990. leg. Kuhna/Mertens, prep. ♀ 1442/2011 H. Rajaei; also for comparison >2,500 specimens of both sexes from the majority of European countries (ZFMK, ZSM).

Operophtera fagata: 3 ♂, Germania, M-Rhein, Burg Liebenstein, 16.11.[19]88, leg. P. Kuhna, preps ♂1439 and 1606/2011 H. Rajaei; 5 ♂, 2 ♀, Germania, Westerwald, Dierdorf, 28.10.[19]79, leg. P. Kuhna, prep. ♀ 1440/2011 H. Rajaei, all in ZFMK; also (for comparison) >800 specimens of both sexes from many European countries (ZFMK, ZSM).

RESULTS AND DISCUSSION

Operophtera brumata (Linnaeus, 1758)

Phalaena (Geometra) brumata Linnaeus, 1758: Syst. Nat. (Ed. 10) 1: 529

MORPHOLOGY

Sexually dimorphic (Figs. 1a, b, c). Female with strongly reduced wings, male with fully developed wings (wingspan 25-31 mm). Antennae filiform in both sexes. Male forewings pale sand-colored to yellowish grey with a distinct grey postmedial line. Other transverse lines often diffuse. Hindwings much paler, with sand-colored tinge, without pattern. Fringe with conspicuous black dots at the tips of veins. Female body with reduced wings, both dark brown. Length of wing remnants 2-5 mm (Fig. 1c).

DIFFERENTIAL DIAGNOSIS FROM *O. FAGATA*

The two species often occur sympatrically. Male *O. fagata*, (Figs. 1d, e) is larger, paler, especially the hindwing which is paler sand-colored, almost white, with a wingspan of 30-34 mm. Female *O. fagata* (Fig. 1f) with wings longer than the thorax. Female genitalia of *O. brumata* (Fig. 1g) with two signa on the cuticula of corpus bursae, *O. fagata* (Fig. 1h) with one signum. Male genitalia with minimal differential features; in *O. fagata* the uncus is often more pointed and the saccus broader (Figs. 1i, j).

BIONOMY

Adults are nocturnal, with a flight period from mid-October to late December in Central Europe, phenology shifting towards spring in southern Europe, e.g. in southern Italy it extends through late February.

As the females of *O. brumata* are wingless, this species should disperse very slowly; but Edland (1971) showed the effectiveness of larval distribution by wind, aided by silk threads produced by the newly hatched larva.

HOST PLANTS

Operophtera brumata is a polyphagous species. In Europe it is a serious pest with a broad diet, feeding on many cultivated plants. Nikusch (2001) listed 46 species of host plants for this species (Table 1). Since most of these plants also occur in Iran, naturally or as cultivated strains, *O. brumata* may have potential pest status in the north of Iran.

NATURAL ENEMIES

Predators play an important role in the mortality of *O. brumata* larvae, e.g. birds, mice, spiders (cf. Buckner, 1969), ground beetles (Carabidae), some Heteroptera (Nabidae, Anthocoridae), and larvae of green lacewings (Chrysopidae). Nikusch (2001) listed the following species as the most important larval parasitoids: *Cyzemis albicans* Fall. (Diptera: Tachinidae), *Eulophus larvarum* (L.) (Hymenoptera: Eulophidae), *Agrypon flaveolatum* Gravenhorst, 1807 (Ichneumonidae), and, as an important pupal parasitoid, *Cratichneumon culex* Müller, 1776 (Ichneumonidae). Balevski (1999) listed five braconid parasitoids (all of the subfamily Microgasterinae) of larva of *O. brumata*: *Apanteles immunis* (Haliday, 1834); *A. jucundus* Marshall, 1885; *A. praepotens* (Haliday, 1834); *A. sodalis* (Haliday, 1834); and *A. xanthostigma* (Haliday, 1834).

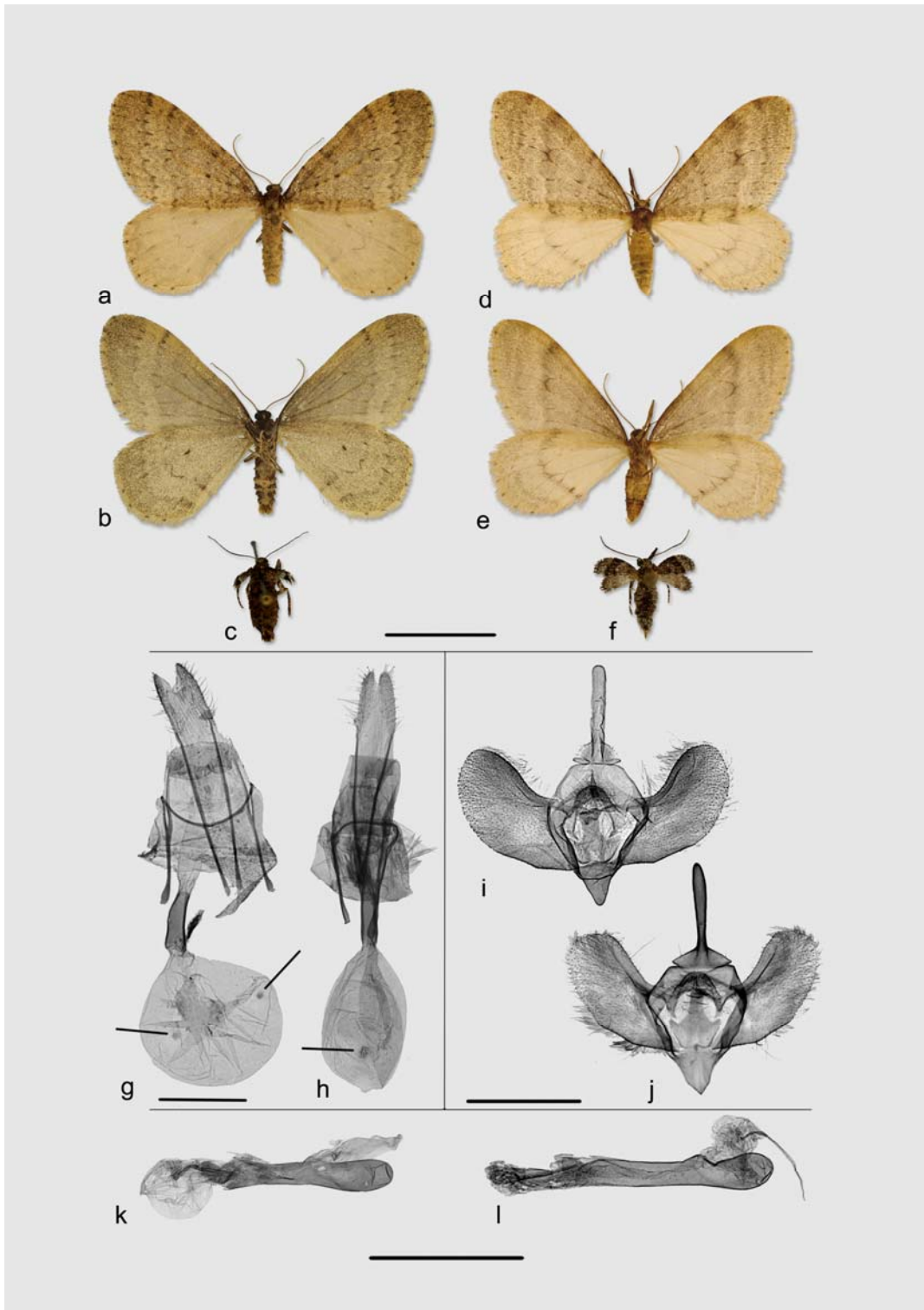


FIGURE 1. Morphological characters. *O. brumata*: a, male (dorsal view); b, male (ventral view); c, female (dorsal view); g, female genitalia (Iran, prep. 1009); i, male genitalia (prep. 1441); k, aedeagus (prep.1441); *Operophtera fagata*: d, male (dorsal view); e, male (ventral view); f, female (dorsal view); h, female genitalia (prep. 1440); j, male genitalia (prep. 1606); l, aedeagus (prep. 1439); Arrows on figs g and h show the number and position of signa on the cuticula of corpus bursae; scale bars: 1 mm.

TABLE 1. Reported food plant species of larvae in Europe and potential food plant species present in Iran

Host plant species	Europe (Nikusch 2001)	Potential foodplants in Iran
<i>Acer campestre</i>	+	+
<i>A. pseudoplatanus</i>	+	+
<i>Amelanchier Canadensis</i>	+	+
<i>A. integrifolia</i>	-	+
<i>Betula</i> spp.	+	+
<i>Carpinus betulus</i>	+	+
<i>Castanea sativa</i>	+	+
<i>Corylus avellana</i>	+	+
<i>Crataegus monogyna</i>	+	+
<i>Crataegus</i> sp.	-	+
<i>Cydonia oblonga</i>	+	+
<i>Fagus sylvatica</i>	+	-
<i>Fagus orientalis</i>	-	+
<i>Fraxinus excelsior</i>	+	+
<i>Juglas regia</i>	+	+
<i>Ligustrum vulgare</i>	+	+
<i>Lonicera xylosteum</i>	+	+
<i>Lonicera</i> spp.	-	+
<i>Malus domestica</i>	+	+
<i>Mespilus germanica</i>	+	+
<i>Picea abies</i>	+	+
<i>Populus tremula</i>	+	-
<i>P. Canadensis</i>	+	-
<i>P. euphratica</i>	-	+
<i>P. nigra</i>	-	+
<i>P. alba</i>	-	+
<i>Prunus armeniaca</i>	+	+
<i>P. avium</i>	+	+
<i>P. cerasus</i>	+	-
<i>P. communis</i>	+	+
<i>P. domestica</i>	+	+
<i>P. dulcis</i>	+	+
<i>P. mahaleb</i>	+	+
<i>P. padus</i>	+	+
<i>P. persica</i>	+	+
<i>P. spinosa</i>	+	+
<i>Quercus cerris</i>	+	-
<i>Q. petraea petraea</i>	+	-
<i>Quercus petraea iberica</i>	-	+
<i>Q. robur pedunculiflora</i>	-	+
<i>Q. robur robur</i>	+	-
<i>Rosa</i> spp.	+	+
<i>Tilia platyphyllos</i>	+	+
<i>Ulmus glabra</i>	+	+
<i>U. minor</i>	+	+
<i>Salix alba</i>	+	+
<i>S. caprea</i>	+	+
<i>Sorbus aucuparia</i>	+	-
<i>S. domestica</i>	+	-
<i>S. torminalis</i>	+	+
<i>Vaccinium arctostaphylos</i>	-	+
<i>V. corymbosum</i>	+	-
<i>V. myrtillus</i>	+	-
<i>V. uliginosum.</i>	+	-

DISTRIBUTION

Widespread over most of Europe from the northern cape of Norway, Iceland, the British Isles, and France to the Urals; in the east across Siberia to Amur and Japan (Fauna Europaea 2011; Leraut, 2009; Nikusch, 2001); in southern Europe, especially mountains and foothills, present also on Sicily and Sardinia; in the western Palaearctic, the southern border of distribution has been considered to be north-western Turkey (Mol, 1973; Kocak & Kemal, 2006), Caucasus, and Transcaucasia (Georgia, Armenia, Viidalepp, 1996). The species is also reported in western Canada and the northern United States as an introduced species (Embree, 1991; Nikusch, 2001). We record it for the first time in Iran, from Nowshahr (northern Iran), but its distribution may be wider.

ACKNOWLEDGMENTS

We thank Dr. Bernd Müller (Berlin) and Mohammad Jafari (Tehran) for their valuable comments about host plants. The senior author is grateful to Professor Dr. J. W. Wägele (ZFMK, Bonn) for supporting his PhD program and to the DAAD (Deutscher Akademischer Austauschdienst) for financial support. This paper forms part of the PhD of Hossein Rajaei at the University of Bonn, Germany.

LITERATURE CITED

- Balevski, N. A. 1999. Catalogue of the braconid parasitoids (Braconidae, Hymenoptera) isolated from various phytophagous insect hosts in Bulgaria. PENSOFT publication. 129 pp.
- Buckner, C. H. 1969. Some Aspects of the population ecology of the common Shrew, *Sorex araneus*, near Oxford, England. *Journal of Mammalogy*, 50 (2): 326-332.
- Edland, T. 1971. Wind dispersal of the Winter Moth larvae *Operophtera brumata* L. (Lep., Geometridae) and its relevance to control measures. *Norsk Entomologisk Tidsskrift [Norwegian Journal of Entomology]* 18 (2), 103-107.
- Embree, D. G. 1991. The winter moth *Operophtera brumata* in Eastern Canada, 1962-1988. *Forest Ecology and Management* 39, 47-54.
- Fauna Europaea. 2011. (accessed 17-4-2011). Hausmann *et al.*: Geometridae. In: Fauna Europaea version 2.4. Web Service available online at <http://www.faunaeur.org>.
- Koçak, A. Ö. and Kemal, M. 2006. Checklist of the Lepidoptera of Turkey. *Priamus, Centre for Entomological Studies Ankara, Suppl.* 1, 196.
- Kudler, J. 1978. Geometridae. In: Die Forstschädlinge Europas, Verlag Paul Parey, Hamburg, 3, 218-263.
- Leraut, P. 2009. Moths of Europe, Geometrid Moths. N. A. P. Editions, Paris, 2, 804.
- Mol, T. 1973. Marmara ve Ege Bölgeleri Ormanlarında Yaşayan Geometridae Türleri Üzerinde Araştırmalar. *İstanbul Üniversitesi Orman Fakültesi Dergisi (A)* 23 (1), 128-173.
- Nikusch, I. 2001. *in* Ebert, G., Die Schmetterlinge Baden-Württembergs, Band 8, Nachtfalter VI, Verlag Eugen Ulmer, 541 pp.

Nikolai, B. 1999. Catalogue of the Braconid parasitoids (Hymenoptera: Braconidae) isolated from various phytophagous insect hosts in Bulgaria. Pensoft Publisher, 66-67.

Scoble, M. J. and Hausmann, A. 2007. Online list of valid and available names of the Geometridae of the World, http://www.lepbarcoding.org/geometridae/species_checklists.php Page visited 15 March 2010.

Viidalepp, J. 1996. Checklist of the Geometridae (Lepidoptera) of the former U.S.S.R. Apollo Books, Stenstrup, 111 pp.

Zhang, B. C. 1994. Index of economically important Lepidoptera, CAB International, Wallingford, Oxford.