

**RARE AND THREATENED GEOMETRID MOTH *Erannis ankeraria* IN CROATIA:
HISTORICAL REVIEW, DATA ANALYSIS & PERSPECTIVES**RIJETKA I UGROŽENA GRBICA HRVATSKE *Erannis ankeraria* –
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SUMMARY: A “winter moth” *Erannis ankeraria* is one of the most threatened geometrid moths in Europe, listed on both Annex II and Annex IV of the EU Habitats Directive and assigned as strictly protected taxa in Croatia. There is a great lack regarding distribution, population trend parameters and conservation status of this moth in Croatia. According to historical data, an Angoran Umber occurred in Pula (Istria) and Kaštel Stari (Dalmatia), and current field research in potentially suitable habitats resulted without records. Therefore, future research should focus on an active involvement of lepidopterists and foresters in long-term monitoring of the species, where beside light trapping, more successful attracting methods as pheromone traps should be used. Obtained results could lead to management guidelines proposal on sites where the Angoran Umber occurs. Management guidelines or future species action plan should focus of maintaining structure and function of Angoran Umber habitat - light Pubescent Oak and Sessile Oak forests and forest edges, in order to fulfill ecological requirements and subsistence of the species.

Key words: winter moth, monitoring, occurrence, Natura 2000

INTRODUCTION – Uvod

Since 2009 and according to Official gazette No. 99/09 (Ministry of Culture of Republic of Croatia, 2009), 49 Lepidoptera taxa are legally protected in Croatia. In category of protected taxa there are 14 butterflies, and in the category of strictly protected taxa 30 butterflies and 5 moths. Following systematic by Karsholt & Razowski (1996) these are: *Eriogaster (Eriogaster) catax* (Linnaeus 1758) (Lasiocampidae), *Erannis ankeraria* (Staudinger 1861) (Geometridae), *Gortyna borelii lunata* (Freyer 1839) (Noctuidae), *Orthosia (Dioszeghyana) schmidti* (Dioszeghy 1935) (Noctuidae) and *Euplagia quadripunctaria* (Poda 1761) (Arctiidae). The first four are listed in both Annex II and Annex IV of EU Habitats Directive (European Commission, 1992) and they are all considered to be of EU im-

portance and a part of NATURA 2000 Network (www.natura2000.hr).

An Angoran Umber is a member of the family Geometridae (subfamily Ennominae) – one of the two most numerous lepidopteran families (Hausmann, 2001). The European fauna of Geometridae comprises 957 species in total (Okyar & Mironov 2008), while the number of species occurring in Croatia is nearly 440, representing about 45% of the overall European geometrid fauna on approximately 0.55% of the total European territory (Mihoci 2010). Besides geometrids, the best studied of all moth families in Croatia are noctuid moths with approx. 590 species in total (e.g. Kranjčev 1985, Kučinić 1992, 1997, Kučinić et al. 1994, Kučinić & Bregović 1996, Kučinić & Perović 1996, Kučinić & Hrašovec 1999).

The Angoran Umber is a rare moth with localized occurrence in south and south-eastern Europe, spread from Italy, Slovenia, Croatia, Austria, and Hungary to

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Bulgaria and Romania (Čelik et al. 2004, Flamigni et al. 2007, Leraut 2009). It is single brooded with adults emerging at the end of February and being active into beginning of April, when the air temperatures are favorable (Čelik et al. 2004, Flamigni et al. 2007, Leraut 2009, Beshkov & Zlatkov 2011). They belong to so-called ecological group of “winter” moths. The “winter moth syndrome” is a set of ecological traits which refers to the adult flight season either very early or very late in the season; winter moths prefer forest habitats, spring-feeding and/or larval polyphagy and have limited or no adult feeding at all (Wahlberg et al. 2010).

Males of the Angoran Umber have a wingspan of 32 to 40 mm with forewings light beige in color and transverse light brown lines often weakly visible (Leraut 2009). Males are strongly attracted to lights and can often be found flying around lamps or light UV-traps. An adult male is morphologically close to the most significant oak defoliators (Glavendekić 2010) *Agriopsis marginaria* (Fabricius, 1776), *Agriopsis aurantiaria* (Hübner, 1799) and *Erannis defoliaria* (Clerck, 1759) (Table 1, Fig. 2). According to Beshkov & Zlatkov (2011) the structure of antennae in males is the most reliable morphological feature of separation between mentioned taxa. They are slightly bipectinate with short lamellae forming tufts of hair, not a pecten in *E. ankeraria* and in other three species male antennae form two-times longer pecten. Although, *Erannis* and *Agriopsis* are not closely related, the highly similar appearance of these moths (formerly considered congeneric based on similar structure of male antennae) indicates convergent evolution (thus,

wing morphology enabling active flight at low temperatures, and mimicking yellow autumn leaves) (Wahlberg et al. 2010). By the structure of male genitalia Leraut (2009) and Beshkov & Zlatkov (2011) place *E. ankeraria* into the genus *Desertobia* Viidalep, 1979 and *A. marginaria* and *A. aurantiaria* into the genus *Phigaliohybernia* Inoue, 1942.

The female is brownish, from 9 up to 15 mm in length (Čelik et al. 2004, Leraut 2009) and suffers from a wing reduction (is it brachypterous) so therefore flightless. She emits sex pheromones that often attract males. Females are usually found at the base of trees or crawling up the tree trunks.

Caterpillars feed on leaves on both Pubescent Oak (*Quercus pubescens* (von Willdenow, 1796) and the Sessile Oak (*Quercus petraea* ((Mattuschka) Liebl., 1784) and inhabit sub-Mediterranean xerothermophilous oak shrub forests, light open oak forests and oak groves in sub-Mediterranean environments from plain up to 600 m a.s.l (Leraut 2009). The Angoran Umber hibernates in the pupal stage (Čelik et al. 2004).

Although, the Angoran Umber is strictly protected in Croatia, the conservation status assessment - regarding current range, population size and trend, detailed habitat features and future prospects is inadequate and insufficient, precisely unknown.

Purpose of this paper is to pronounce a lack in knowledge in distribution and population dynamics of this endangered moth, to initiate systematic research for gathering data needed to assess species conservation status; and to accent the need in active involvement of foresters in future long-term monitoring.

MATERIAL AND METHODS – Materijal i metode

In order to assess species occurrence and distribution in Croatia we analyzed records from published papers, data from collections of Croatian and Slovenian museums and faculties and unpublished recent field data. Re-examined material is deposited in the Central moth collection of Croatian Natural History Museum – sub collection of the Geometridae family (G CNHM), in the Igalffys’ entomological collection of CNHM (I CNHM), Kučinićs’ collection (K CNHM) and Vajdićs’ collection (V CNHM) of Lepidoptera of CNHM, in the moth collection of the Natural History Museum in Rijeka (NHMR), collection of butterflies and moths of Radovan Kranjčev from the Koprivnica city museum (RKM), Koščecs’ entomological collection from the Varaždin city museum (KVCM), Hafners’ collection of Lepidoptera of the Slovenian Museum of Natural History (H SMNH) and Badovinac (BFF) and Hench entomological collection (HFF) at the Faculty of Forestry, University of Zagreb, Croatia. Abbreviations are used further in the text when referring to col-

lections. Specimens were identified by the wing morphology according to Flamigni et al. (2007) and Leraut (2009).

Field data was gathered during the field trips in Istria, on the Čičarija Mt., Učka Mt. and coastal side of the Velebit Mt. in one night per week fieldtrips during February and March 2009, with insufficient catch per unit effort, referring to the limited number of only four light traps per site. Adult male moths were accessible to standardized sampling method by attractable light UV-traps Osram Blacklight L 18 W/73 – 600 mm with a white reflectable fabric on the pyramidal metal construction. A construction has a base length of two meters and operates at a ground level. Light trap was on from dusk till early morning, not less than 5 hours. Given that females of the species are brachypterous and therefore do not fly, we visually inspected oak trees during daytime.

RESULTS AND DISCUSSION – Rezultati i rasprava

Presented results are compiled from records published in papers, data from collections of Croatian and Slovenian museums and unpublished field data. The oldest published papers on occurrence of the Angoran Umber in Croatia date back to the beginning of the XX century. Herman Stauder published the first find of the Angoran Umber in *Castelli near Spalato* (Split, Dalmatia) (male specimen deposited in the collection H SMNH) (Naufock, 1915, Stauder, 1924, Hafner, 1994) and Albert Naufock recorded a male specimens in *Pola* (Pula, southern Istria) (Naufock, 1915). There is an additional published record of species occurrence in forest Repaš in Podravina (Kovačević & Franjević-Oštrec, 1978) but the identification of that/those specimen/s could not be confirmed because of no voucher specimen/s.

Reviewing entomological collections we found that specimens identified as *E. ankeraria* are not deposited in the collections (*) or have been misidentified (**) (RKM*; BFF and HFF*; I CNHM** (redet. *E. defoliaria*); G CNHM** (redet. *E. defoliaria*). In collections K CNHM, V CNHM, NHMR and KVCM specimens of *E. ankeraria* are not present. Reviewing H SMNH in Ljubljana valid identification of specimen collected by Stauder on March 15th 1908 in Kaštel Stari (Castelli) (Hafner, 1994) was confirmed (Fig. 1).

As for almost 100 years there were no new or confirmed records of this moth in Croatia, there is a great lack in knowledge on species presence and distribution. As light trapping yielded no results, in future research pheromone trapping should be considered. Chemical, pheromone communication among insect sexes is



Figure 1 Male specimen of *Erannis ankeraria* from Kaštel Stari, Croatia deposited in the Hafner's collection Ljubljana, Slovenia

Slika 1. Mužjak *Erannis ankeraria* s lokaliteta Kaštel Stari, Hrvatska pohranjen u Hafnerovoj zbirci leptira u Ljubljani, Slovenija

(Photo – Foto: dr. sc. Nikola Tvrković)

prominent, and stereochemicals of genus *Erannis* are known (not exclusively for *E. ankeraria* although mixture of identified stereochemical components for the genus can be used) (Hansson et al. 1990, Szöcs et al. 1993, Goller et al. 2007). Therefore, pheromone traps should be used in attracting males in their habitats.

Potential sites on which an Angoran Umber could be found correspond with xerothermophilic sun-Mediterranean oak forest (degraded) habitats (Čelik et al. 2004, Flamigni et al. 2007, Leraut 2009, Barčić et al. 2011, Baričević & Šapić 2011). In xerothermophilic environments these are represented with six vegetation communities (Vukelić et al. 2008):

- (1) mixed forest of Sessile Oak and Sweet Chestnut (As. *Quercus-Castanetum sativae* Horvat 1938) that occurs in the Kvarner region above Kastav and Učka.
- (2) forest of Sessile Oak with Autumn Moore grass (As. *Sesleria autumnalis-Quercetum petraeae* Polidini/1964/1982) which is present on a single locality in Croatia, in Dragonja (Istria).
- (3) thermophilic forest of Pubescent Oak with Tall Moor grass (As. *Molinio-Quercetum pubescentis* Šugar 1981) which grows in the flysch part of Istria near Motovunski Novaki and represents part of a larger complex of Pubescent Oak stands in which Sessile Oak and Turkey Oak dominate.
- (4) thermophilic and weakly acidophilic forest of Pubescent Oak with White Cinquefoil (As. *Potentillo albae-Quercetum pubescentis* A.O. Horvat 1973) which has only been identified in the locality Bregi in the flysch part of Istria (Vukelić et al., 2008). The tree layer is dominated by Pubescent Oak, Turkey Oak and Hop Hornbeam.
- (5) forest and scrub of Pubescent Oak and Oriental Hornbeam (As. *Quercus-Carpinetum orientalis* Horvatić 1939) in the sub-Mediterranean zone of the littoral belt from Istria to Dubrovnik.
- (6) mixed forest and scrubs of Pubescent Oak and Hop Hornbeam (As. *Ostryo-Quercetum pubescentis* /Horvat 1950/Trinajstić 1979) in the northern Adriatic (northern Istria, the littoral slopes of Velebit, and the northern slopes of Bukovica).

After surveying potential habitats and defining current distribution of species, obtained results could help in proposing several forest management guidelines. Proposal should focus on maintaining structure and function of the Angoran Umber habitat – light Pubescent Oak and Sessile Oak forests and forest edges, in order to fulfill ecological requirements and survival of the species. As Lepidoptera are in general habitat-dependent, forest management should consider providing good stability and condition of forests and best protection and conservation of specific microhabitats for this threatened moth.



Figure 2 *Erannis ankeraria* and morphologically similar winter moths *Agriopsis marginaria* (Fabricius, 1776)(a), *A. aurantiaria* (Hübner, 1799)(b) and *A. defoliaria* (Clerck, 1759)(c)

Slika 2. *Erannis ankeraria* i morfološki slični mrazovci *Agriopsis marginaria* (Fabricius, 1776)(a), *A. aurantiaria* (Hübner, 1799)(b) i *A. defoliaria* (Clerck, 1759)(c)

(Photo – Foto: David Mihoci according to Leraut (2009))

Table 1 Basic morphological and ecological characteristic for separation of *E. ankeraria* from the most similar (winter) moths, see Figure 2. Modified according to Flamigni et al. (2007), and Leraut (2009) and Beshkov & Zlatkov (2011). Abb. FW-forewing, HW-hindwing.

Tablica 1. Osnovne morfološke i ekološke značajke koje omogućuju razlikovanje vrste *E. ankeraria* od sličnih vrsta (mrzovaca), vidi slika 2. Modificirano prema Flamigni i sur. (2007), i Leraut (2009) i Beshkov i Zlatkov (2011). Kratice: FW-prednja krila, HW-stražnja krila.

Species vrsta	Male mužjak	Female ženka	Larval host plants biljke hraniteljice gusjenice	Flight time vrijeme rojenja
<i>Erannis ankeraria</i>	FW light beige with weak transverse lines, HW dirty-white, antennae bipectinate without a real pecten <i>prednja krila svjetlobež boje s poprečnim linijama; stražnja prljavo bijela; ticala s nježnim dlačicama bez "pravog češlja"</i>	Brachypterous <i>vrlo zakržljalih krila</i>	<i>Quercus pubescens</i> & <i>Q. petraea</i>	Single-brooded, February till April <i>jedna generacija, veljača-travanj</i>
<i>Agriopis marginaria</i>	FW brownish beige, distal area darker with transverse lines poorly distinct, HW variable in color, both wings with black marginal dots; antennae with 2-times longer pecten <i>prednja krila smeđe-bež boje, vrhovi tamniji, poprečne linije slabo vidljive; stražnja krila varijabilne boje; oba krila s rubnim crnim točkama; dvostruko češljasta ticala</i>	Wings with stumps, but inadequate for flight <i>zakržljalih krila, nesposobna za let</i>	<i>Quercus, Betula, Fagus, Populus, Alnus, Prunus, Crataegus</i>	Single-brooded, January till April (rarely from December) <i>jedna generacija, siječanj-travanj (vrlo rijetko od prosinca)</i>
<i>Erannis defoliaria</i>	FW whitish with light brown basal area and postmedial line and black discal spot, HW whitish; antennae with 2-times longer pecten <i>prednja krila bjelkaste boje sa smeđom bazom i crnom diskalnom točkom; stražnja bjelkaste boje; dvostruko češljasta ticala</i>	Apterous <i>beskrilna</i>	<i>Quercus, Betula, Crataegus, Salix, Carpinus</i>	Single-brooded, October till December <i>jedna generacija, listopad-prosinac</i>
<i>Agriopis aurantiaria</i>	FW orangey yellow with yellowish brown transverse lines, HW white; antennae with 2-times longer pecten <i>prednja krila narančasto žuta s žutosmeđim poprečnim linijama; stražnja bijela; dvostruko češljasta ticala</i>	Dark brown, wings with stumps <i>tamno smeđa, zakržljala krila</i>	<i>Quercus, Carpinus, Betula, Prunus, Crataegus</i>	Single-brooded, October till December <i>jedna generacija, listopad-prosinac</i>

CONCLUSIONS – Zaključci

1. An Angoran Umber is strictly protected taxa in Croatia, endangered and rare, of EU importance, and therefore listed in the Annexes (II & IV) of the EU Habitats Directive.
2. It belongs in the group of so called “winter moths”, preferring xerothermophilous Mediterranean oak forest habitats and depending on leaf feeding on Pubescent Oak and Sessile Oak larval host plants.
3. Current distribution of the species is based on reviewing published papers, re-examination of material from museums and University collections and recent field data. Without current records, distribution is based on two “historical” records – sites in Istria and middle Dalmatia.
4. As potential habitats of this threatened species are Pubescent Oak and Sessile Oak forests and forest edges and degradation patches, foresters should be the first involved in field data collecting and long-term monitoring.
5. Future activities should focus on encouraging systematic research (involving pheromone traps in field methodology) of distribution and population parameters of this species in Croatia. Efforts in improving scarce knowledge and raising awareness for detecting geometrid moth diversity in Croatia, their ecological requirements and conservation in general are also necessary.

ACKNOWLEDGEMENTS – Zahvala

The research was supported by the grant of NATURA 2000 project in Croatia and by Croatian Ministry of Science, Education and Sports as a part of the Project No. 183-1193080-0831 grant to Dr. Sc. Nikola Tvrković (Croatian Natural History Museum,

Zagreb). We are grateful to Prof. Dr. Mladen Kučinić (Faculty of Science, University of Zagreb), Prof. Dr. Boris Hrašovec (Faculty of Forestry, University of Zagreb) and anonymous reviewers on their useful suggestions in preparing the manuscript.

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SAŽETAK: *Mrazovac* *Erannis ankeraria* jedna je od najugroženijih vrsta noćnih leptira iz porodice grbica, navedena u Dodatku II i IV Direktive o staništima Europske Unije i zakonom zaštićena u Republici Hrvatskoj u kategoriji strogo zaštićene zavičajne divlje svojte. Iako, taksonomski blizak i morfološki vrlo sličan nekim našim vrlo čestim vrstama, među kojima se nalaze i značajni štetni defolijatori poput velikog mrazovca (*E. defoliaria*), ovaj se mrazovac nalazi iznimno rijetko i sporadično. Podaci o rasprostranjenju vrste, njenim populacijskim parametrima, kao i stvarna razina ugroženosti, i shodno tome, nužne mjere zaštite ove vrste u Hrvatskoj nisu do sada bili posebno istraživani. Prema publiciranim podacima, vrsta je početkom prošlog

stoljeća zabilježena u Puli i Kaštel Starom. Provedeno istraživanje obuhvatilo je detaljan pregled svih dostupnih relevantnih lepidopteroloških zbirki u Hrvatskoj i Sloveniji, uz ponovnu re-evaluaciju primjeraka označenih kao *E. ankeraria*. Ispostavilo se da u je u zbirkama u više navrata došlo do zamjene s vrstom *E. defoliaria* ili da jednostavno vrste nema u većini relevantnih zbirki. Jedini valjano determiniran primjerak vrste *E. ankeraria* potvrđen je u zbirci Prirodoslovnog muzeja Slovenije, a odnosi se na nalaz Staudera 1908. godine kod Kaštel Starog. Tijekom ciljanih dvomjesečnih terenskih istraživanja 2009. godine, vrsta nije potvrđena na lokalitetima dokumentiranih prethodnih nalaza, kao i očekivanim lokacijama pridolaska s obzirom na šumski vegetacijski tip, iz kojega potječu njeni rijetki nalazi.

Cilj pokrenutih istraživanja je da se nastave i prošire sustavna istraživanja rasprostranjenja svojte, a kako se radi o pravom šumskom kukcu, da se u njih uključi šumare-specijaliste zaštite šuma. U okviru postojećih programa monitoringa šumskih kukaca-štetočinja, na kserotermofilnim submediteranskim staništima hrasta medunca i hrasta kitnjaka, uz primamljivanje mužjaka svjetlosnim klopka, mogle bi se koristiti i feromonske klopke kao potencijalno učinkovitiji način prikupljanja podataka o njenom rasprostranjenju. Prikupljeni podaci poslužili bi u donošenju smjernica upravljanja ili akcijskog plana svojte, kojim bi se utvrdio način upravljanja staništima u cilju očuvanja njihove strukture i funkcije, a u svrhu zadovoljavanja ekoloških potreba i očuvanja ove rijetke i prilično tajnovite vrste grbice u Hrvatskoj.