REDIA, 102, 2019: 73-79 http://dx.doi.org/10.19263/REDIA-102.19.11

SILVIA GRECO [a] - ANNAMARIA IENCO [b] - STEFANO SCALERCIO [a]

ABUNDANCE AND DIVERSITY OF MACRO-MOTHS IN AN *ACER*-DOMINATED FOREST OF THE POLLINO NATIONAL PARK, SOUTHERN ITALY (LEPIDOPTERA MACROHETEROCERA)

[a] *Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria, Centro di ricerca Foreste e Legno (CREAFL), Rende, Italy.*
[b] *Via Castelvetere 40, 89041 Caulonia, Reggio Calabria, Italy.*
Corresponding Author: Sivia Greco; silvia.greco@crea.gov.it

Greco S., Ienco A., Scalercio S. – Abundance and diversity of macro-moths in an *Acer*-dominated forest of the Pollino National Park, southern Italy (Lepidoptera Macroheterocera).

Very few data are available on the biodiversity hosted by *Acer*-dominated forests in Europe, despite their importance for biodiversity conservation. In this paper we describe the moth assemblage of the *Acer*-dominated forest of the Special Area of Conservation (SAC) Monte Sparviere, southern Italy, where probably the highest diversity of maple species (6) is hosted at national level. We settled up ten monitoring sites, representative of the habitat complexity of the area, where moths were sampled monthly from March to November 2017. We found 371 species of Macroheterocera, among which tree-feeding species (in the larval stage) were particularly abundant and the presumably *Acer*-feeding *Nothocasis rosariae* was dominant. Despite a great homogeneity among individual species assemblages (the 26 most abundant species shared by all sites), the quantitative analysis of samples clearly separated pure *Acer* forests from mixed and *Alnus* forests, highlighting the importance of quantitative data for improving the use of nocturnal Lepidoptera as bioindicators. The richness of species at their boundary range and of conservation concern, make this area one of the most important for the conservation of Lepidoptera in southern Italy.

KEY WORDS: maple trees, Natura 2000 Network, Habitat Directive, species assemblage.

INTRODUCTION

Acer species are recognized to characterize two European forest types (EFTs): 5.4 Maple-oak forest and 5.6 Maple-lime forest, both Mesophytic deciduous forest (BARBATI *et al.*, 2014). In Italy they are largely distributed and present in several forest types as accessory species, composing characteristics forests on a surface of 177,504 ha only, of which 153,904 as maple-lime mountain forests and woods with ash tree and other species, and 23,600 ha as Apennine maple forests (GASPARINI and TABACCHI, 2011), for a total of the 1.7% of the Italian forested areas.

Despite the small surfaces occupied by these forests, they have a great importance from a conservation point of view as the Tilio-Acerion forests of slopes, screes and ravines (Code: 9180), the most widespread *Acer*-dominated forest, is of priority importance in the Habitat Directive 92/43/CEE. The importance of maple species for biodiversity increases in southern Italy where the endemic *Acer cappadocicum lobelia* (Ten.) A.E. Murray is present. One of the most important Italian *Acer*-dominated forest is on the north-eastern slope of the Sparviere Mount, in the Pollino National Park, Calabria, the southernmost region of the Italian peninsula. It is included within the Special Area of Conservation (SAC) Monte Sparviere (Natura2000 site code: IT9310019), where probably the highest diversity of maple species is hosted at national level. In detail, *Acer pseudoplatanus* L. is the dominant species, associated, according to local edaphic conditions, to *Acer opalus* Mill., *Acer monspessulanum* L., *Acer campestre* L., *Acer cappadocicum lobelia* (Ten.) A.E. Murray, and *Acer platanoides* L. (AVOLIO, 1993). In the next future, this forest can provide important genetic resources for the conservation of more than one *Acer* species as marginal and peripheral populations are present (DUCCI, 2015).

Studies concerning the insects living in maple forests are mainly addressed to their role as pests, such as the beetle *Glycobius speciosus* (Say) (HORSLEY *et al.*, 2002; DUKES *et al.*, 2009) and the moth *Paraclemensia acerifoliella* (Fitch) (PARKER *et al.*, 1983; DUKES *et al.*, 2009). The insect diversity of maple forests is studied and reported mostly for North America habitats (TERRIEN *et al.*, 1999; GERING and CRIST, 2000; BENTZ and TOWSEND, 2005; SUMMERVILLE and CRIST, 2005; MAJKA, 2010; MAGUIRE *et al.*, 2016; MLYNAREK *et al.*, 2018). In Europe few data are available (LESLIE, 2005; WOJTERSKA *et al.*, 2012), mostly for the forests belonging to the Rete Natura 2000 sites, and limited to the species included in the Annex II and IV of the Habitat Directive. Sporadic data can be gathered from faunistic papers, but these are usually hardly attributable to sites located within *Acer*-dominated forests.

Although several Lepidoptera species are trophically linked to *Acer* species, few data on the abundance of non-pest species with larvae feeding on *Acer* or living in maple-dominated forest ecosystems are available. This tree genus appears to be of particular importance in southern Italy as some moths of great biogeographic interest have larvae supposedly feeding on *Acer*, such as the notodontid *Ptilophora variabilis* Hartig, 1968 and *P. nebrodensis* Infusino & Scalercio, 2018, recently recognized as Italian endemic species (INFUSINO *et al.*, 2018a), and the geometrid *Nothocasis rosariae* Scalercio, Infusino & Hausmann, 2016, described few years ago, known for southern Italy and Greece only and likely by error related to *Fagus sylvatica* as hostplant (SCALERCIO *et al.*, 2016).

Recently, the most interesting faunistic findings obtained

– Received 7 January 2019 Accepted 28 May 2019

during a standardized survey of nocturnal Lepidoptera carried out in the Monte Sparviere *Acer* forest were published (Greco *et al.*, 2018a,b). Most of the species treated in this paper have there their southern range limit, elucidating the importance of this forest as a reservoir of a portion of biodiversity usually distributed at higher latitudes. In this paper we provide the complete dataset gathered during this survey describing for the first time a complete taxocoenosis for this forest type. Furthermore, we highlight the importance of abundance data as a measure of functional relationships between phytophagous Lepidoptera and their foodplants and for the use of this taxon as a bioindicator of forest ecosystems.

MATERIAL AND METHODS

Ten light traps were positioned in the Special Area of Conservation (SAC) Monte Sparviere (Natura2000 site code: IT9310019), in the eastern part of the Pollino National Park, southern Italy (Fig. I). All surveyed localities are included in the municipality of Alessandria del Carretto, at the northern administrative border of Calabria region (Fig. I).

Sampling sites were chosen in order to cover the habitat complexity of the *Acer* forest, from pure and mature stands with trees older than 100 years to stands mostly covered by young renewal of maple trees, from a clearing with *Pyrus* trees (*Pyrus pyraster* (L.) Burgsd.) to a pure stand of alder (*Alnus cordata* (Loisel.) Desf.) at the margin of the *Acer* forest, from stands in the dry facies of the forest to stands along water courses (Table 1).

Sampling was carried out from late March to mid-November 2017 (23rd March, 18th April, 19th May, 21st June, 19th July, 17th August, 18th September, 12th October, 12th November). *UV*-LED light traps (see Infusino et al., 2017a) were settled-up during nights favorable to the activity of moth and to the attractive power of traps, i.e. low wind speed, temperature not lower than the average of the period, no rain, no moonlighting. Traps were turned on at dusk and moths were collected the morning after. Specimens were counted and identified at species level using, in most difficult cases, the morphology of genitalia mounted on slides. Voucher specimens are deposited in the collection of the Council for Agricultural Research and Economics, Research Centre for Forestry and Wood (CREA-FL), Rende (Cosenza), Italy. Nomenclature follows the most updated version of Fauna Europaea (Karsholt and Nieukerken, 2013). Species are listed in alphabetical order within any family. In the faunistic list (Appendix 1) we report for any species the number of individuals collected in each stand, the total abundance, the number of sites where they were found, and the phenology indicated with the months of sampling in roman numbers.

The stand/species matrix with abundance data was submitted to Cluster Analysis (Past, version 2.17c) in order to group species assemblages according to their similarity. We used paired groups as algorithm and the abundance-based Morisita index as similarity measure.

RESULTS

We collected 12,007 specimens belonging to 371 species (see Appendix 1). Individual stands showed a richness

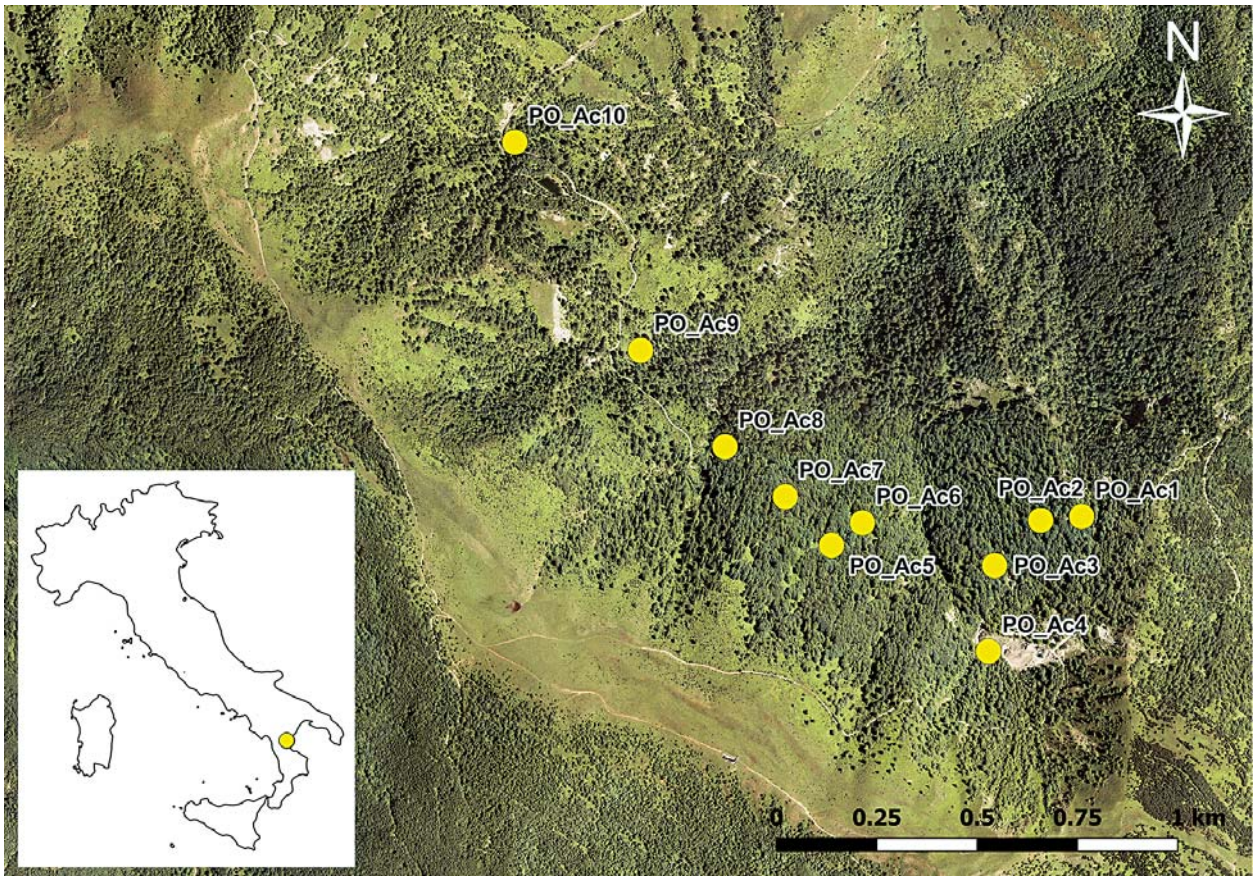

Fig. I – Location of study area (from Greco et al., 2018a, modified).

Table 1 – List of sampled sites and their description.

Site Code	Coordinate (lat-long)	Altitude (m a.s.l.)	Locality	Short description
PO_Ac1	39.9275; 16.3636	1371	Destra Balestrieri	Mature forest with maple trees older than 100 years
PO_Ac2	39.9275; 16.3624	1337	Destra Balestrieri	Forest with unevenly aged maple trees
PO_Ac3	39.9259; 16.3603	1305	Vallone Lupara	Mixed forest of broadleaves with unevenly aged trees
PO_Ac4	39.9245; 16.3609	1345	Vallone Lupara	Young mixed forest of alder and maple along a water course
PO_Ac5	39.9269; 16.3563	1314	Difesa di Privitera	Mature forest with maple trees older than 100 years
PO_Ac6	39.9274; 16.3572	1285	Difesa di Privitera	Small clearing with *Pyrus* trees in mature maple forest
PO_Ac7	39.9280; 16.3550	1291	Difesa di Privitera	Mature forest with maple trees older than 100 years
PO_Ac8	39.9291; 16.3532	1253	Sciortaglie	Sparse old maple trees in a *Pteridium aquilinum*-dominated area
PO_Ac9	39.9313; 16.3508	1246	Sciortaglie	Mixed stand of young alder and maple trees
PO_Ac10	39.9358; 16.3471	1253	Tappaiolo	Stand of unevenly aged alders

varying from 151 species found in the alder woodlot at the margin of the study area (PO_Ac10), to 209 found in the stand nearest to it (PO_Ac9) (Table 2). Many species (104) were collected at least in eight stands showing a relative homogeneity of species assemblages, as confirmed by the low number of exclusive species, ranging from two to 13, and their very low abundance (not more than 3 individuals) (Table 2). The 26 most abundant species are present in all sampled sites and cover 58.3% of the entire sample.

The most abundant species was *Nothocasis rosariae* (Geometridae) (n=1263), followed by *Alcis repandata* (n=574), and *Cabera pusaria* (n=456). Represented by more than 100 individuals were also the tree-feeding *Campaea margaritaria*, *Opisthograptis luteolata*, *Epirrita christyi*, *Allophyes corsica*, *Colotois pennaria*, *Ptilophora variabilis*, *Asteroscopus sphinx*, *Diloba caeruleocephala*, *Poecilocampa alpina*, *Cosmia trapezina*, and *Ptilodon cucullina*, and other 12 species feeding mainly on herbs and vegetal debris.

Among the three most abundant species within individual stands, *Nothocasis rosariae* was the most recurrent (eight out of ten stands), followed by *Alcis repandata* (5/10), *Xestia stigmatica* (3/10), *Cabera pusaria* and *Hypena proboscidalis* (2/10), and ten more species recurring only once (Table 2). Consistently with this observation, the first dichotomy on the tree obtained by Cluster Analysis (cophenetic correlation: 0.8868) separated the two stands without *N. rosariae* among dominant species from the others (Fig. II). This grouping is also consistent with the different composition of the tree cover, being the two separately grouped stands dominated by the alder *Alnus cordata* (Loisel.) Duby. The mixed composition of the tree cover in PO_Ac4 (see Table 2) determined the secondary separation of this species assemblage from the other maple woodlots. An important role in separating species assemblages was played by *Cabera pusaria* of which larvae feed primarily on alders.

At the beginning of spring, the species assemblage was characterized by species belonging to the genus *Orthosia*, mainly *O. gothica*, *O. incerta*, *O. cruda*, *O. cerasi*, and with few individuals *O. populeti* and *O. rorida* (Fig. III). Also the overwintering adults of *Conistra vaccinii* and *C. rubiginea* were abundant. Significant changes occurred only in May, when few individuals of *O. gothica* are still on flight and the assemblage was dominated by *Colocasia coryli* and *Peribatodes rhomboidaria*. From June to September four species, namely *Campaea margaritaria*, *Peribatodes rhomboidaria*, *Hoplodrina ambigua* and *Hypena proboscidalis*, were constantly among the most abundant, accompanied by different species as the season proceeded (Fig. III). The beginning of the summer is characterized by *Xanthorhoe montanata*, *Calliteara pudibunda* and *Charanyca apfelbecki*, whilst later the following species became more abundant: *Cabera pusaria* in July and August, *Alcis repandata*, *Xestia triangulum*, and *Eilema lurideola* in July only, *X. rhomboidea*, *Opistograptis luteolata*, and *E. complana* in August only. Late-summer assemblage was mainly characterized by *Eugnorisma depuncta*, accompanied by the first individuals of autumnal species. In September we observed the peak of abundance for *Nothocasis rosariae* that was the most abundant species until November. The first part of the autumn was characterized by *Trigonophora flammea*, *Mesotype parallelolineata* and *Tiliacea sulphurago*, later accompanied by *Allophyes corsica* and *Diloba caeruleocephala*. November was characterized by the abundance peak of *Epirrita christyi*, *Colotois pennaria*, *Ptilophora variabilis*, *Asteroscopus sphinx* and *Poecilocampa alpina*, found in October with only very few individuals.

DISCUSSION

The *Acer*-dominated forest of the Monte Sparviere is inhabited by a specialized moth species assemblage, dominated by *Nothocasis rosariae*, recently recognized as bona species. The larva of this species feeds on *Acer* trees,

Table 2 – Sampling results in the investigated maple stands. The number of species (S), the number of exclusive species (Sexcl), the number of individuals (N), the dominant species and the incidence of dominance species (%) are reported for each stand.

Stand	S	Sexcl	N	Dominant species	Incidence of dominant species (%)
PO_Ac1	166	11	805	*Nothocasis rosariae*	18.5
				Opistograptis luteolata	
				Eilema lurideola	
PO_Ac2	187	4	1248	*Xestia triangulum*	17.4
				Alcis repandata	
				Nothocasis rosariae	
PO_Ac3	199	13	1408	*Nothocasis rosariae*	28.1
				Alcis repandata	
				Epirrita christyi	
PO_Ac4	176	6	2127	*Nothocasis rosariae*	41.0
				Cabera pusaria	
				Alcis repandata	
PO_Ac5	160	2	829	*Nothocasis rosariae*	18.6
				Xestia stigmatica	
				Alcis repandata	
PO_Ac6	201	9	1399	*Nothocasis rosariae*	19.7
				Othosia gothica	
				Alcis repandata	
PO_Ac7	182	5	1102	*Nothocasis rosariae*	16.6
				Eugnorisma depuncta	
				Colocasia coryli	
PO_Ac8	161	9	1080	*Nothocasis rosariae*	19.2
				Hypena proboscidalis	
				Ptilophora variabilis	
PO_Ac9	209	13	1236	*Eilema complana*	12.4
				Allophyes corsica	
				Xestia stigmatica	
PO_Ac10	151	6	773	*Cabera pusaria*	23.8
				Hypena proboscidalis	
				Xestia stigmatica	

as known for the congeneric *N. sertata*. Scalercio *et al.* (2016) supposed this species feeding on *Fagus sylvatica* L., but its high abundance in this *Acer*-dominated forest, where no *Fagus* trees were observed, leave little doubt about its larval foodplant. Among other top-scoring species in abundance forest species the presence of *Ptilophora variabilis* is remarkable, another species supposed to have larvae feeding on *Acer*, an endemic of the Italian Peninsula (Infusino *et al.*, 2018a). Very interesting is also the presence of *Eupithecia inturbata* and *Cyclophora albiocellaria*, two species with monophagous larvae on *Acer* (Mironov, 2003; Hausmann, 2004). These species are here at their southern range border in the Italian Peninsula (Greco *et al.*, 2018b), whilst *N. rosariae* and *P. variabilis* were also found southwards in other forest types where *Acer* trees are accessory species only (Infusino *et al.*, 2017b, 2018b; Scalercio and Greco, 2018). Compared to the species assemblage sampled in the beech forest of the same Massif by Infusino and Scalercio (2018), the main difference of the *Acer*-dominated forest was the rarity of *Operophtera fagata*, very abundant in the beech forest and here represented with just two individuals, whilst most of the other species with larvae feeding on broadleaved trees are similarly abundant.

Quantitative similarity analysis showed a clear difference of species assemblages sampled within alder-dominated forests from those of maple-dominated forests. Although a great number of species is shared between these broad-leaved forests, moth assemblages are clearly separated by the mean of the relative abundance of *N. rosariae* and *Cabera pusaria*, the latter having larvae mainly feeding on *Alnus* (Flamigni *et al.*, 2016). This result underlined the

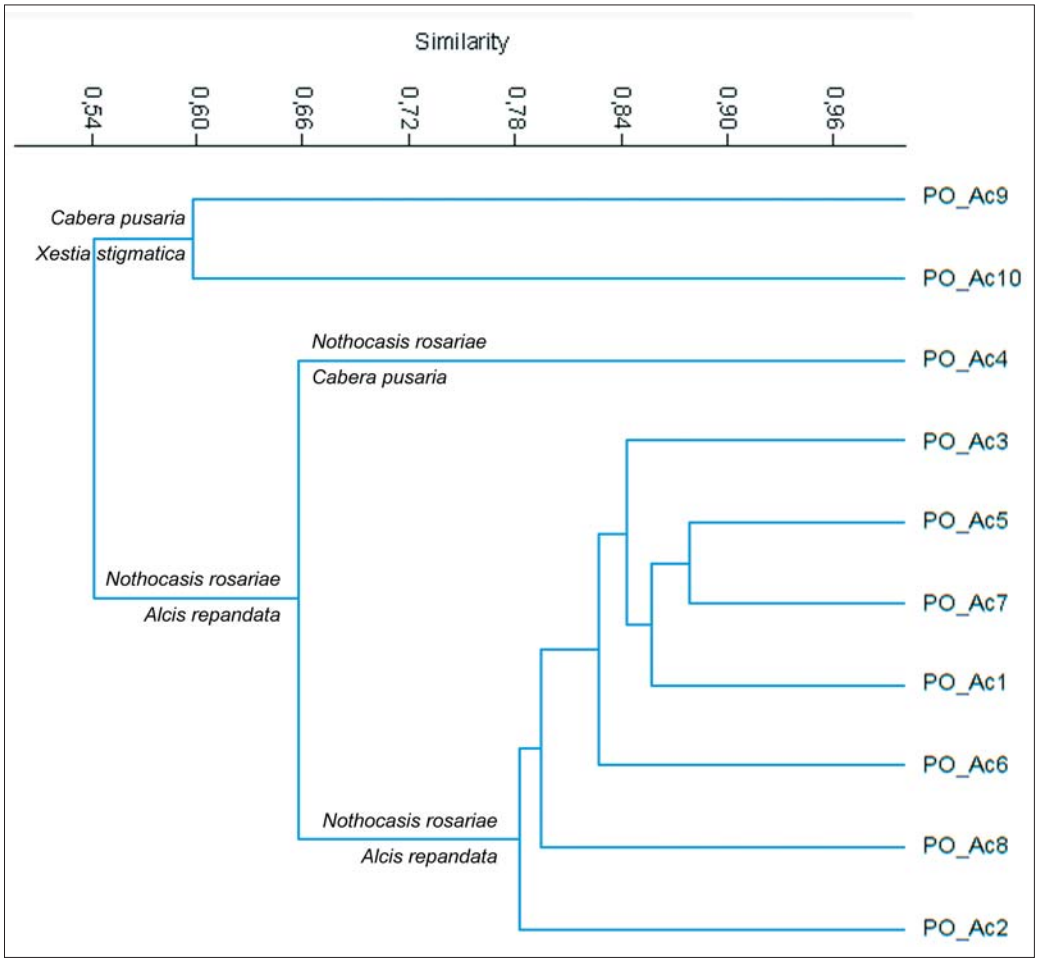

Fig. II – Ordination of stands obtained by Cluster analysis (Algorithm: paired groups; Similarity measure: Morisita).

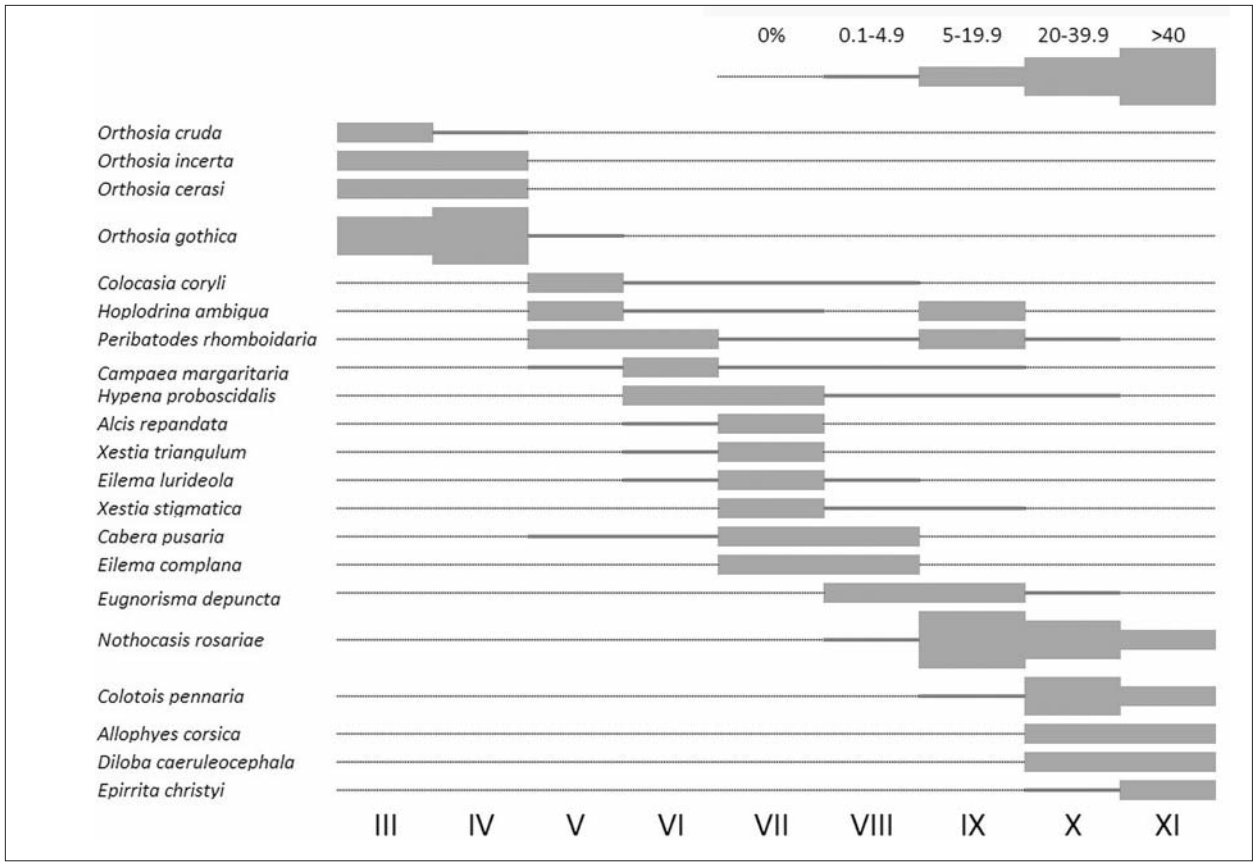

Fig. III – Phenological diagram of the three most abundant species during each sampling session.

habitat fidelity of moths which, although dispersing easily thanks to their high mobility, kept their highest abundance within the habitat of origin. As a consequence, the use of moths as bioindicators is greatly improved using quantitative data.

From a conservation point of view the Special Area of Conservation Monte Sparviere has a great importance for the presence of several species of biogeographic interest (Greco *et al.*, 2018a,b), and *Euplagia quadripunctaria*, the only moth of priority importance in the annexes of Habitat Directive 92/43/CEE. Furthermore, during our surveys we also occasionally observed the diurnal *Zerynthia cassandra* (Geyer, 1828), *Parnassius mnemosyne* (Linnaeus, 1758), *Phengaris arion* (Linnaeus, 1758), *Euphydryas aurinia* (Rottemburg, 1775), and *Melanargia arge* (Sulzer, 1776), also included in the Habitat Directive. In definitive, this site appears to be one of the most important for the conservation of Lepidoptera within the Natura2000 Network in southern Italy and further studies will likely increase its value.

ACKNOWLEDGEMENTS

We thank Marco Infusino for the help in field work and the Pollino National Park for the financial support of this study (Project: Studio pilota per il monitoraggio della biodiversità dei Lepidotteri in SIC forestali del Parco Nazionale del Pollino).

REFERENCES

Avolio S., 1993 – *Le acerete di Alessandria del Carretto*. In: Pollino - il mensile del Parco, anno II n. 6, settembre 1993, pp. 14-16.

Barbati A., Marchetti M., Chirici G., Corona P., 2014 – *European forest types and forest Europe SFM indicators: tools for monitoring progress of forest biodiversity conservation*. - Forest Ecol. Manag., 321: 145-157.

Bentz J.A., Townsend A.M., 2005 – *Diversity and abundance of leafhopper species (Homoptera: Cicadellidae) among red maple clones*. - Journal of Insect Conservation, 9 (1): 29-39.

Ducci F., 2015 – *Genetic resources and forestry in the Mediterranean region in relation to global change*. - Annals of Silvicultural Research, 39(2): 70-93.

Dukes J.S., Pontius J., Orwig D., Garnas J.R., Rodgers V.L., Brazee N., Cooke B., Theoharides K.A., Stange E.E., Harrington R., Ehrenfeld J., Gurevitch J., Lerdau M., Stinson K., Wick R., Ayres M., 2009 – *Responses of insect pests, pathogens, and invasive plant species to climate change in the forests of northeastern North America: what can we predict?* - Canadian journal of forest research, 39 (2): 231-248.

Gasparini P., Tabacchi G., 2011 – *L'Inventario Nazionale delle Foreste e dei serbatoi forestali di Carbonio INFC 2005. Secondo inventario forestale nazionale italiano. Metodi e risultati.* - Ministero delle Politiche Agricole, Alimentari e Forestali, Corpo Forestale dello Stato. Consiglio per la Ricerca e la Sperimentazione in Agricoltura, Unità di ricerca per il Monitoraggio e la Pianificazione Forestale. Edagricole, Milano.

Gering J.C., Crist T. O., 2000 – *Patterns of beetle (Coleoptera) diversity in crowns of representative tree species in an old-growth temperate deciduous forest*. - Selbyana, 38-47.

Greco S., Leonetti F. L., Scalercio S., 2018a – *A relict population of Cymbalophora rivularis on the Pollino Massif, southern Italy (Lepidoptera: Erebidae)*. - Fragmenta entomologica, 50 (1): 37-41.

Greco S., Ienco A., Infusino M., Leonetti F. L., Scalercio S., 2018b – *New records of moths elucidate the importance of forests as biodiversity hot-spots in Central Mediterranean landscapes (Lepidoptera)*. - Redia, 101:147-154.

Hausmann A., 2004 - *Sterrhinae*. - In: A. Hausmann (ed.): The Geometrid Moths of Europe. Apollo Books, Stenstrup, Vol. 2: 600 pp., 24 col. pl., 196+196 gen. figs., 237 Textfigs., maps.

Horsley S. B., Long R. P., Bailey S. W., Hallett R. A., Wargo P. M., 2002 – *Health of eastern North American sugar maple forests and factors affecting decline*. - Northern Journal of Applied Forestry, 19 (1): 34-44.

Infusino M., Brehm G., Di Marco C., Scalercio S., 2017a – *Assessing the efficiency of UV LEDs as light sources for sampling the diversity of macro-moth*. - European Journal of Entomology, 114: 25-33.

Infusino M., Luzzi G., Scalercio S., 2017b – *I macrolepidotteri notturni dell'Arboreto Sbanditi, Area MAB-UNESCO, Parco Nazionale della Sila (Calabria, Italia)*. - Memorie della Società Entomologica Italiana, 94 (1-2): 137-153.

Infusino M., Hausmann A., Scalercio S., 2018a – *Ptilophora variabilis Hartig, 1968, bona species, and description of* Ptilophora nebrodensis sp. n. *from Sicily (Lepidoptera, Notodontidae)*. - Zootaxa, 4369 (2): 237-252.

Infusino M., Greco S., Impieri A., Scalercio S., 2018b – *I Macrolepidotteri notturni dei castagneti della Catena Costiera Paolana (Calabria, Italia) (Lepidoptera)*. - Rivista del Museo civico di Scienze Naturali "E. Caffi" Bergamo, 31: 89-134.

Infusino M., Scalercio S., 2018 – *The importance of beech forests as reservoirs of moth diversity in Mediterranean Basin (Lepidoptera)*. - Fragmenta entomologica, 50 (2): 161-170.

Leslie A., 2005 – *The ecology and biodiversity value of Sycamore (*Acer pseudoplatanus L*) with particular reference to Great Britain*. - Scottish Forestry, 59 (3): 19-26.

Maguire D.Y., Bennett E. M., Buddle C. M., 2016 – *Sugar maple tree canopies as reservoirs for arthropod functional diversity in forest patches across a fragmented agricultural landscape in southern Quebec, Canada*. - Ecoscience, 23 (1-2): 1-12.

Majka C.G., 2010 – *Insects attracted to maple sap: observations from Prince Edward Island, Canada*. - ZooKeys, 51: 73.

Mironov L., 2003 – *Larentiinae II (Perizomini and Eupitheciini)*. - In: A. Hausmann (ed.). The Geometrid Moths of Europe, 4: 464 pp., 7 pls. Apollo Books, Stenstrup.

Mlynarek J.J., Taillefer A. G., Wheeler T.A., 2018 – *Saproxylic Diptera assemblages in a temperate deciduous forest: implications for community assembly*. - PeerJ 6: e6027 https://doi.org/10.7717/peerj.6027.

Parker B., Aleong J., Teillon H., Parker L., 1983 – *Population distribution of the maple leafcutter, Paraclemensia acerifoliella (Lepidoptera: Incurvariidae), in sugar maple trees*. - The Canadian Entomologist, 115 (3): 315-318.

Scalercio S., Infusino M., Hausmann A., 2016 – Nothocasis rosariae sp. n., *a new sylvicolous, montane species from southern Europe (Lepidoptera: Geometridae, Larentiinae)*. - Zootaxa, 4161(2): 177-192.

SCALERCIO S., GRECO S., 2018 – *Heterocera fauna of the Calabrian black pine forest, Sila Massif (Italy) (Insecta: Lepidoptera)*. - SHILAP Revta. lepid., 46 (183): 455-472.

SUMMERVILLE K. S., CRIST T. O., 2005 – *Temporal patterns of species accumulation in a survey of Lepidoptera in a beech-maple forest*. - Biodiversity & Conservation, 14 (14): 3393-3406.

THERRIEN F., CHAGNON M. & HÉBERT C., 1999 – *Biodiversity of Collembola in sugar maple (Aceraceae) forests*. - The Canadian Entomologist, 131(5): 613-628.

WOJTERSKA M., JAGODZIŃSKI A. M., SKORUPSKI M., KASPROWICZ M., DOBIES T., KAŁUCKA I., SŁAWSKA M., WIERZBICKA A., ŁABĘDZKI A., NOWIŃSKI M., MAŁEK S., BANASZCZAK P., KAROLEWSKI P., OLEKSYN J., 2012 – *Species diversity related to red maple (Acer rubrum L.) occurred on experimental stands in Rogów Arboretum (Poland)*. - In: Folia Forestalia Polonica, series A,, 54(4): 233-244.

80 - Blank Page