

State of the art on Neuropterida of Sicily and Malta

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ABSTRACT

Sicily, the largest Mediterranean island, is surrounded by many small islands (Aeolian Islands, Ustica, Aegadian Islands, Pantelleria, Linosa, Lampedusa, Maltese Islands), some of which forming archipelagoes. The authors, after a historical sketch of the research on Neuropterida in Sicily (*sensu lato*), analyze the biodiversity of the area, highlighting the species richness and providing an up-to-date check-list. The lack of knowledge on some of the most paradigmatic communities of Neuropterida is discussed in relation to their various habitats. The distributional patterns of Sicilian Neuropterida are interpreted in order to obtain a biogeographical characterization of the area. It is confirmed that the location of Sicily and its surrounding islands forms a bridge between north and south and a door from the W Mediterranean region to the oriental Mediterranean basin.

KEY WORDS

Raphidioptera; Megaloptera; Neuroptera; faunistics; biogeography.

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INTRODUCTION

Sicily is the largest Mediterranean island. Its location represents a bridge from north to south, between the Italian Peninsula and the Tunisian Cape Bon, and a door to the W Mediterranean region, being in front of the Ionian Sea and the oriental Mediterranean basin. The main island is surrounded by many small islands, some of which forming archipelagoes (Fig. 1). From an orographical point of view, along the northern coast the Peloritani (1,300 m asl), Nebrodi (1,800 m asl), and Madonie (2,000 m asl) mountain ranges represent an extension of the mainland Apennines. Volcanism is widespread.

Mount Etna, which dominates over the eastern coast at a height of 3,320 m, is highly active as well as some other cones on the Aeolian Islands. Also the islands of Ustica, Linosa and Pantelleria are of volcanic origin. The Maltese Islands correspond to the high points of a shallow plateau between Sicily and North Africa and they are geologically linked with the Hyblaean Mountains (1,000 m asl) of SE Sicily. Consequently, despite the fact that Malta belongs to a different State, the Maltese Archipelago and Sicily (with its surrounding small islands) together form a single geographic system.

Due to their location in the Mediterranean Sea, Sicily and its surrounding islands have a particu-



Figure 1. Map showing the location of Sicily and the surrounding islands (modified from a map by Norman Einsten, Wikipedia).

larly rich flora and fauna and represent a crossroads between various biogeographical patterns. This is also confirmed by the data on Neuropterida that has been accumulating for some decades. Here we intend to review and summarize the current knowledge on Neuropterida, focusing on some still unresolved issues.

Notes. The upgrade includes data until April 2012. The main papers about Neuropterida from Sicily will be cited in the paragraph on historical data. In the text we use simply “Sicily” referring to the whole geographic system comprising mainland Sicily and its surrounding islands, including the Maltese archipelago. Otherwise we specify “mainland Sicily” referring only to Sicily *sensu stricto*. We follow Vigna Taglianti et al. (1992) in the names and definitions of geographical distribution patterns.

RESULTS AND DISCUSSION

History of the research on Neuropterida

The oldest mention of a neuropteran for Sicily is in “La topografia di Palermo e de' suoi dintorni” [The topography of Palermo and its surroundings] (Scinà, 1818). The abbot Domenico Scinà introduced occasional entomological observations in his book, listing some insects in a footnote in which he mentions an unidentifiable snakefly using the name *Raphidia ophiopsis*. The second, much more important record regards the description of a new, still valid, species of owlfly by the naturalist Bernardino Angelini (1827). Despite much damage, the type *Ascalaphus siculus* (today *Libelloides siculus*) is still preserved at the Natural History Museum of Verona (Fig. 2).

During the nineteenth century, the papers of three authors were the fundamental steps to our knowledge about Sicilian Neuropterida: two Ger-

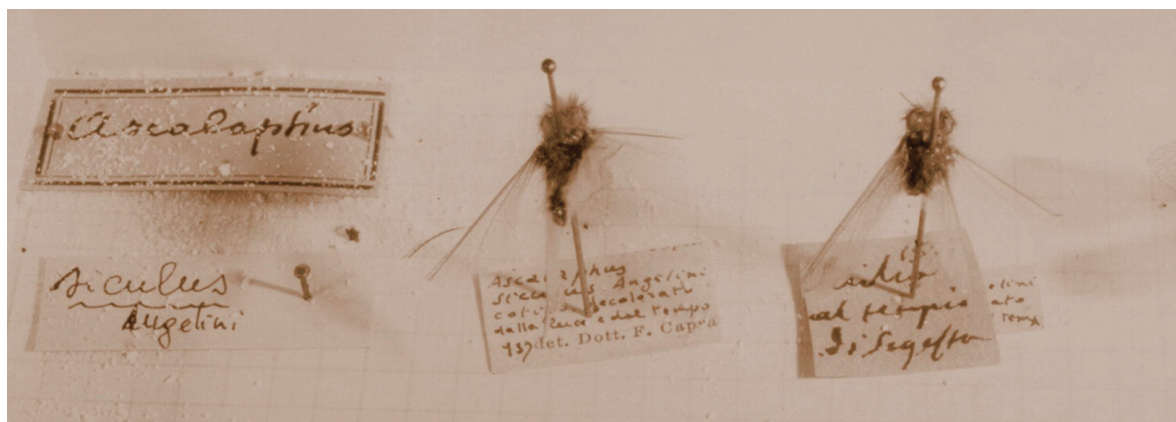


Figure 2. The two syntypes of *Ascalaphus siculus* Angelini, 1827, preserved at the Civic Natural History Museum of Verona. [Label under left specimen: *Ascalaphus siculus* Angelini \ cotipo decolorato \ dalla luce e dal tempo \ 937 det. Dott. F. Capra. Label under right specimen: Sicilia \ al tempio \ di Segesta. Photo by Daniele Zanini.

man-speaking scholars who studied the material collected by two traveling colleagues, and an eclectic indigenous naturalist.

Wilhelm Gottlieb Schneider, an entomologist and botanist from Silesia (Schröter, 1890), studied the material collected by Philipp Christoph Zeller (McLachlan, 1883), describing some new species (Schneider, 1845). Hermann August Hagen, a famous entomologist and bibliophile from Prussia who ended his career in the United States of America (Henshaw, 1894), published the list of Neuropterida collected by Jean-Baptiste Eugène Bellier de la Chavignerie (Hagen, 1860). From Castelbuono on the Madonie mountains, the physician Francesco Minà-Palumbo wrote on Sicilian Neuroptera (in the old sense, also comprising Odonata and other small orders) (Minà-Palumbo, 1858; 1871).

The first mentions of Neuropterida from a small island near Sicily, in this case Ustica, were due to the teacher Giuseppe Riggio (1885; 1889) from Palermo. In the twentieth century, both the main Italian specialists published a paper on Sicilian Neuropterida: Felice Capra published a list of antlions collec-

ted in NE Sicily (Capra, 1934) and Maria Matilde Principi published the results of the research on the fauna of the Apennines (comprising the northern Sicilian mountains) conducted by the Natural History Museum of Verona (Principi, 1966).

In the following decades, data accumulated mainly in the form of scattered occasional records. Nevertheless, some studies specifically dedicated to Sicilian (or South-Italian) Neuropterida (Aspöck et al., 1980; Nicoli Aldini, 1983; Insom et al., 1986; Pantaleoni, 1986; Duelli, 1994; Lo Valvo, 1994; Pantaleoni & Lo Valvo, 1995; [Bernardi] Iori et al., 1995; Plant & Schembri, 1996; Lo Verde & Monserrat, 1997; Nicoli Aldini & Baviera, 2001) appeared and the species known for Sicily rose from forty to one hundred (Fig. 3).

Biodiversity by taxa: species richness

Almost half of the Neuropterida species found in Italy, about a hundred (exactly 97 including the doubtful ones), are currently known in Sicily (Table 1; Figs. 4-19).

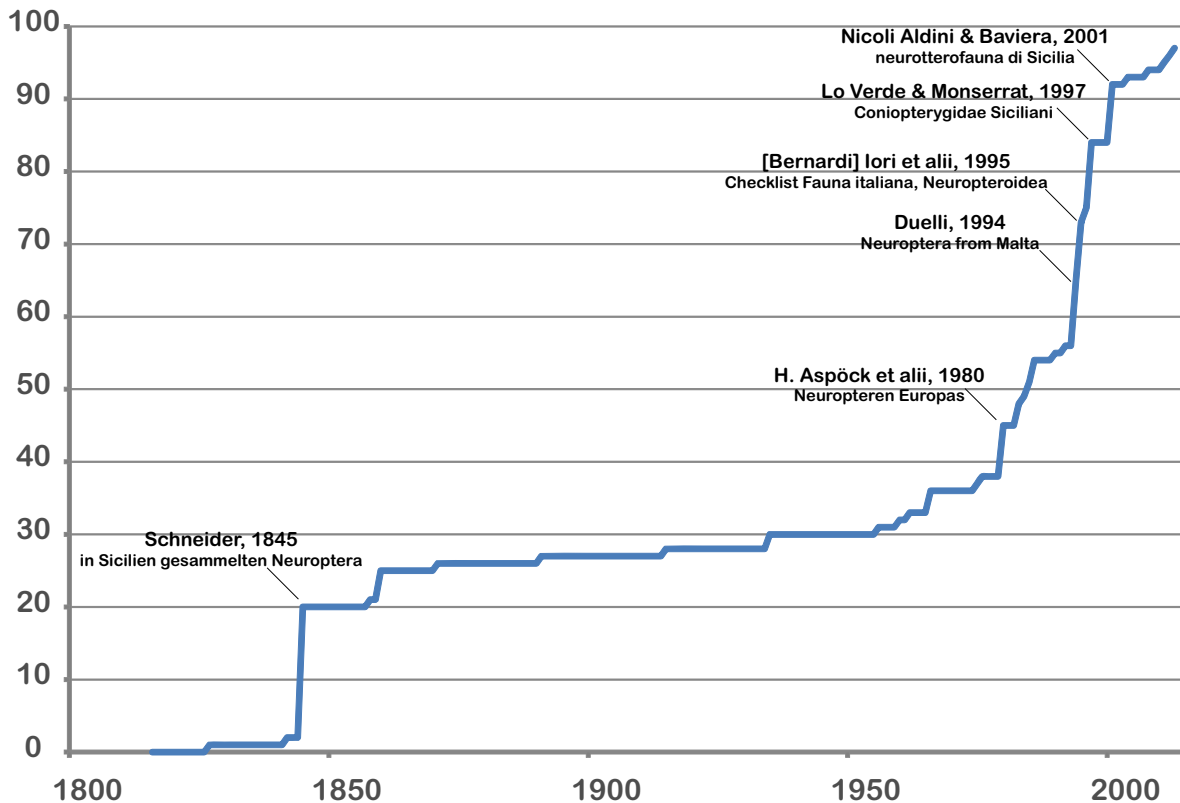


Figure 3. Cumulative progress of the number of Neuropterida species known for Sicily. Papers citing more than five new species for Sicily are highlighted.

As the order Megaloptera is absent, they belong to the orders Raphidioptera and Neuroptera.

Raphidioptera. Only two species of Raphidioptera are common in Sicily, each representing one of the two families of the order, Raphidiidae and Inocelliidae. The inocelliid *Fibla (Fibla) maclachlani* (Albarda, 1891) belongs to a typical Mediterranean genus. The W Mediterranean nominal subgenus *Fibla* has three species: *F. (F.) hesperica* Navás, 1915 from the Iberian Peninsula, *F. (F.) peyerimhoffi* Navás, 1919 from the Mediterranean areas of North Africa, and the Tyrrhenian *F. (F.) maclachlani* from Corsica, Sardinia and mainland Sicily. In the E Mediterranean area there is another subgenus with a species from Crete: *Fibla (Reisserella) pasiphae* (H. Aspöck et U. Aspöck, 1971).

The raphidiid *Xanthostigma corsicum* (Hagen, 1867) has a typical Tyrrhenian distribution being present in Corsica, Sardinia and mainland Sicily, even on small islands such as Capraia and Elba in the Tuscan Archipelago, and on the Italian Peninsula, moreover on the “Sierra” of Béjar, mountains of the Sistema Central, Spain (H. Aspöck et al., 1991). In every geographical area (e.g. Sicily, Corsica and Sardinia, Spain, etc) this species shows small but constant morphological differentiation.

A third species, the raphidiid *Subilla confinis* (Stephens, 1836), is known by a single unpublished record from the Madonie mountains (label: Sicilia (PA) Madonie / Piano Zucchi m 1300 / G. Sama leg. // Ex larva / Acer / 17.V.84. specimens: 1 male & 2 females. Location: Natural History Museum of Verona. Identification: H. & U. Aspöck, 2002). This species lives on tree canopies and has a wide distribution from Central Europe to Japan through Siberia. *S. confinis* reaches the Mediterranean range only through the Italian Peninsula, other similar *Subilla* inhabit the Iberian and Balkan peninsulas. However there is no report of this species along the Italian peninsula between the Alpine and southern populations.

Neuroptera. Seven families of Neuroptera are known for Sicily: Nevrothidae, Coniopterygidae, Mantispidae, Chrysopidae, Hemerobiidae, Myrmeleontidae, Ascalaphidae. The most speciose are the green lacewings (Chrysopidae) with 25 species, followed by antlions (Myrmeleontidae) with 23, dustywings (Coniopterygidae) with 20 and brown lacewings (Hemerobiidae) with 18. Nevrothidae, Mantispidae and Ascalaphidae have respectively one, three and four species.

The nevrorthid *Nevrothus iridipennis* A. Costa, 1863 is confined in the range of the Peloritani mountains (mainland Sicily) and in the facing Aspromonte massif (Italian peninsula). Another three species belong to the genus *Nevrothus*: *N. fallax* (Rambur, 1842) from Corsica and Sardinia, *N. hannibal* U. Aspöck et H. Aspöck, 1983 from Mediterranean areas of Algeria and Tunisia, *N. apatellios* H. Aspöck, U. Aspöck et Hölzel, 1977 from the Balkans reaching northwards to the foothills of the eastern Italian Alps (Letardi et al., 2006).

The species of Coniopterygidae recorded for Sicily are approximately three quarters of those found in Italy. This large number has been positively influenced by targeted, although occasional, research carried out recently by some specialists (Lo Verde & Monserrat, 1997). Actually, the small, delicate and inconspicuous dustywings are rarely collected by non neuropterists and they are very scarce in public entomological collections. Consequently the information about this family’s habitat, ecology, and species distribution is still poor. The list of Sicilian species, with many widespread, European or Mediterranean taxa, is not particularly informative (Table 1). Only *Helicoconis hispanica* Ohm, 1965 shows an interesting biogeographical pattern, being previously known only for the south of Spain and more recently for Sardinia (Loru et al., 2011).

All three species of Italian Mantispidae are recorded for Sicily. Insects with a complex biology, characterized by hypermetabolic development and larvae evolving in spider egg-sacs, the W Palearctic mantisflies show wide patterns of distribution. Relatively few species of Hemerobiidae are strictly correlated to the Mediterranean climate, so the number of species recorded for Sicily comes to only 40% of the whole Italian fauna. Among many species which are widespread, or common in agro-ecosystems, there are some with clearly defined biogeographical patterns. *Wesmaelius tjederi* (Kimmins, 1963), *W. ravus* (Withycombe, 1923), *Symphorobius elegans* (Stephens, 1836), and *Micromus paganus* (Linnaeus, 1767), all found rarely or once, have a northern distribution; *Wesmaelius navasi* (Andréu, 1911) and *Symphorobius fallax* Navás, 1908 a southern one. Moreover *W. navasi* is the only species recorded exclusively from Malta and not from Sicily or other surrounding islands.

The knowledge about Chrysopidae is strongly affected by unresolved taxonomical problems regard-

Species list	Record reliability and presence on the islands	Distributional pattern
RAPHIDIIDAE		
<i>Subilla confinis</i> (Stephens, 1836)	! S	Central-European
<i>Xanthostigma corsicum</i> (Hagen, 1867)	! S	W-Mediterranean
INOCELLIIDAE		
<i>Fibla (Fibla) machlachlani</i> (Albarda, 1891)	! S	Tyrrhenian
NEVRORTHIDAE		
<i>Nevrorthus iridipennis</i> Costa, 1863	! S	Sicilian-Calabrian
CONIOPTERYGIDAE		
<i>Aleuropteryx loewii</i> Klapálek, 1894	! S	S-European
<i>Aleuropteryx juniperi</i> Ohm, 1968	! S, M	S-European
<i>Helicoconis (Ohmopteryx) pseudolutea</i> Ohm, 1965	! S	Turanian-Euro-Mediterranean
<i>Helicoconis (Fontenellea) hispanica</i> Ohm, 1965	! S	W-Mediterranean
<i>Coniopteryx (Xeroconiopteryx) loipetsederi</i> Aspöck, 1963	! S, M	Mediterranean
<i>Coniopteryx (Coniopteryx) borealis</i> Tjeder, 1930	! S	European
<i>Coniopteryx (Coniopteryx) pygmaea</i> Enderlein, 1906	! S	Euro-Siberian
<i>Coniopteryx (Holoconiopteryx) haematica</i> McLachlan, 1868	! S	Euro-Mediterranean
<i>Coniopteryx (Holoconiopteryx) renate</i> Rausch et Aspöck, 1977	! S	E-Mediterranean
<i>Coniopteryx (Metaconiopteryx) arcuata</i> Kis, 1965	! S	Mediterranean
<i>Coniopteryx (Metaconiopteryx) esbenpeterseni</i> Tjeder, 1930	! S	S-European
<i>Coniopteryx (Metaconiopteryx) lentiae</i> Aspöck et Aspöck, 1964	! S	S-European
<i>Coniopteryx (Metaconiopteryx) tjederi</i> Kimmins, 1934	! S	S-European
<i>Parasemidalis fuscipennis</i> (Reuter, 1894)	! S	Holarctic
<i>Hemisemidalis pallida</i> (Withycombe, 1924)	! S	Central-Asian Mediterranean
<i>Conwentzia pineticola</i> Enderlein, 1905	! S	Holarctic
<i>Conwentzia psociformis</i> (Curtis, 1834)	! S, M	Holarctic
<i>Semidalis aleyrodiformis</i> (Stephens, 1836)	! S	Palaearctic
<i>Semidalis pseudouncinata</i> Meinander, 1963	! S	W-European
<i>Semidalis vicina</i> (Hagen, 1861)	! S, M	W-Mediterranean
MANTISPIDAE		
<i>Mantispa styriaca</i> (Poda, 1761)	! S	Central-Asian Euro-Mediterranean
<i>Mantispa perla</i> (Pallas, 1772) (sensu Erichson, 1839)	! S	Central-Asian Mediterranean
<i>Mantispa aphavexelte</i> Aspöck et Aspöck, 1994	! S	Central-Asian Mediterranean
HEMEROBIIDAE		
<i>Hemerobius humulinus</i> Linnaeus, 1758	? S	Holarctic
<i>Hemerobius stigma</i> Stephens, 1836	! S	Holarctic
<i>Hemerobius handschini</i> Tjeder, 1957	! S	S-European
<i>Hemerobius micans</i> Olivier, 1792	! S	European
<i>Hemerobius gilvus</i> Stein, 1863	! S	S-European
<i>Wesmaelius tjederi</i> (Kimmins, 1963)	! S	S-European
<i>Wesmaelius subnebulosus</i> (Stephens, 1836)	! S, L	Palaearctic
<i>Wesmaelius ravus</i> (Withycombe, 1923)	! S	Asian-European
<i>Wesmaelius navasi</i> (Andréu, 1911)	! M	Central-Asian Mediterranean
<i>Symphorobius pygmaeus</i> (Rambur, 1842)	! S, M	Turanian-Euro-Mediterranean
<i>Symphorobius luqueti</i> (Leraut, 1991)	! S, Æ	currently not definable

Species list	Record reliability and presence on the islands	Distributional pattern
<i>Symphorobius elegans</i> (Stephens, 1836)	! S	Turanian-European
<i>Symphorobius fallax</i> Navás, 1908	! S, M	Afrotropical-Mediterranean
<i>Megalomus tineoides</i> Rambur, 1842	! S	Mediterranean
<i>Megalomus pyraloides</i> Rambur, 1842	! S	W-Mediterranean
<i>Micromus variegatus</i> (Fabricius, 1793)	! S	Asian-European
<i>Micromus angulatus</i> (Stephens, 1836)	! S, M	Holarctic
<i>Micromus paganus</i> (Linnaeus, 1767)	? S	Asian-European
CHRYSOPIDAE		
<i>Hypochrysa elegans</i> (Burmeister, 1839)	! S	Central-European
<i>Italochrysa italica</i> (Rossi, 1790)	! S, M	Mediterranean
<i>Nineta flava</i> (Scopoli, 1763)	? S	European
<i>Nineta principiae</i> Monserrat, 1980	! S	S-European
<i>Chrysopa perla</i> (Linnaeus, 1758) sensu Schneider, 1851	? S, M	Asian-European
<i>Chrysopa dorsalis</i> Burmeister, 1839	! S	Turanian-European
<i>Chrysopa formosa</i> Brauer, 1850	! S, M, Æ	Asian-European
<i>Chrysopa viridana</i> Schneider, 1845	! S	Turanian-Euro-Mediterranean
<i>Chrysopa pallens</i> (Rambur, 1838)	! S, M, Æ	Palaearctic
<i>Pseudomallada flavifrons</i> (Brauer, 1850)	! S, M, Æ	Turanian-Euro-Mediterranean
<i>Pseudomallada marianus</i> (Navás, 1905)	! S	currently not definable
<i>Pseudomallada inornatus</i> (Navás, 1901)	! S	S-European
<i>Pseudomallada</i> sp. prope <i>picteti</i> (McLachlan, 1880)	! S, Æ	currently not definable
<i>Pseudomallada prasinus</i> (Burmeister, 1839)	! S	Palaearctic
<i>Pseudomallada zelleri</i> (Schneider, 1851)	! S	E-Mediterranean
<i>Pseudomallada genei</i> (Rambur, 1842)	! S, M, L, P, Æ	Mediterranean
<i>Pseudomallada venustus</i> (Hölzel, 1974)	! S, P	Mediterranean
<i>Pseudomallada clathratus</i> (Schneider, 1845)	! S, M	E-Mediterranean
<i>Cunctochrysa albolineata</i> (Killington, 1935)	! S	Asian-European
<i>Chrysoperla carnea</i> (Stephens, 1836) s. l.	? S, M, L, U	??
<i>Chrysoperla agilis</i> Henry, Brooks, Duelli et Johnson, 2003	! S	Mediterranean
<i>Chrysoperla lucasina</i> (Lacroix, 1912)	! S, M, L	Euro-Mediterranean
<i>Chrysoperla mediterranea</i> (Hölzel, 1972)	! S, M	S-European
<i>Chrysoperla pallida</i> Henry, Brooks, Duelli et Johnson, 2002	! S	Euro-Mediterranean
<i>Brinckochrysa chlorosoma</i> (Navás, 1914)	! S, M	Afrotropical-S-Mediterranean
MYRMELEONTIDAE		
<i>Palpares libelluloides</i> (Linnaeus, 1764)	! S	Turanian-Mediterranean
<i>Acanthaclisis occitanica</i> (Villers, 1789)	! S	Turanian-Euro-Mediterranean
<i>Synclisis baetica</i> (Rambur, 1842)	! S, M	Turanian-Euro-Mediterranean
<i>Myrmecaeurus trigrammus</i> (Pallas, 1781)	! S, U, Æ	Central-Asian Mediterranean
<i>Myrmeleon formicarius</i> Linnaeus, 1767	! S	Asian-European
<i>Myrmeleon inconspicuus</i> Rambur, 1842	! S	Turanian-Mediterranean
<i>Myrmeleon hyalinus</i> Olivier, 1811	! S, L, Æg, Æ	Afrotropical-Mediterranean
<i>Myrmeleon punicanus</i> Pantaleoni et Badano, 2012	! S, P	Sicilian
<i>Euroleon nostras</i> (Geoffroy in Fourcroy, 1785)	! S	European
<i>Dendroleon pantherinus</i> (Fabricius, 1787)	! S, M	Central-Asian European

Species list	Record reliability and presence on the islands	Distributional pattern
<i>Macronemurus appendiculatus</i> (Latreille, 1807)	! S, M, L, P, Æg	Mediterranean
<i>Neuroleon arenarius</i> (Navás, 1904)	! S, M	Mediterranean
<i>Neuroleon egenus</i> (Navás, 1915)	! S, M	Mediterranean
<i>Neuroleon nemausiensis</i> (Borkhausen, 1791)	! S, M, Æg	Mediterranean
<i>Neuroleon microstenus</i> (McLachlan, 1898)	! S, Æg	E-Mediterranean
<i>Neuroleon ocreatus</i> (Navás, 1904)	?! S	W-Mediterranean
<i>Distoleon tetragrammicus</i> (Fabricius, 1798)	! S	Turanian-European
<i>Distoleon annulatus</i> (Klug, 1834)	! M, L, P, Æ, Æg	Mediterranean
<i>Nemoleon poecilopterus</i> (Stein, 1863)	! S	Turanian-Mediterranean
<i>Creoleon griseus</i> (Klug, 1834)	! L	Afrotrop.-Indian S-Mediterranean
<i>Creoleon lugdunensis</i> (Villers, 1789)	! S, M, L, P, Æ	W-Mediterranean
<i>Creoleon aegyptiacus</i> (Rambur, 1842)	! M, L	Turanian-Mediterranean
<i>Gymnocnemia variegata</i> (Schneider, 1845)	! S, M	Turanian-Mediterranean
ASCALAPHIDAE		
<i>Bubopsis agrionoides</i> (Rambur, 1838)	! L	W-Mediterranean
<i>Deleproctophylla australis</i> (Fabricius, 1787)	! S, Æ	E-Mediterranean
<i>Libelloides coccajus</i> ([Denis et Schiffermüller], 1775)	! S	S-European
<i>Libelloides siculus</i> (Angelini, 1827)	! S, Æg	Sicilian

Table 1. Up-to-date Checklist of Sicilian Neuropterida. ! = reliable data, ?! = data to be confirmed, ? = uncertain data. S = mainland Sicily, M = Maltese Islands, L = Lampedusa and/or Linosa, P = Pantelleria, Æ = Æolian Islands, U = Ustica, Æg = Ægadian Islands.

ding mainly the genera *Chrysoperla* and *Pseudomallada*. The species of the former genus use acoustic signals (courting calls) as a reproductive barrier, and exhibit extremely uniform habitus and genitalia. In *Chrysoperla* the recent use of the call patterns as a discriminating characteristic was the starting point for detecting morphological distinguishing features (Henry et al., 2001). Instead, in *Pseudomallada* the “songs”, though present, are not specific but probably accompanied by the emission of pheromones. Therefore, without even bio-acoustic information as a guide, it is very difficult to discriminate between the different species. However patient work of correlation between subtle morphological characteristics, the bio-ecology and the first data on DNA-taxonomy allows us to begin to untangle this Gordian knot.

Chrysopidae is the most speciose Neuroptera family in Sicily, with half of the Italian species. Their distribution patterns gravitate mainly in the Mediterranean. In the unique, very interesting, case of *Brinckochrysa chlorosoma* (Navás, 1914) mainland Sicily represents the northern limit of distribution.

On the contrary, it is more frequently a southern limit of distribution, e.g.: *Hypochrysa elegans* (Burmeister, 1839), *Nineta flava* (Scopoli, 1763) and *N. principiae* Monserrat, 1980, *Chrysopa perla* (Linnaeus, 1758) sensu Schneider, 1851, *Pseudomallada marianus* (Navás, 1905), and *Cunctochrysa albolineata* (Killington, 1935).

Like the Coniopterygidae, the species of Myrmeleontidae recorded for Sicily are approximately three quarters of those found in Italy. However this large number is not due to specialized research but to occasional captures over a long period by many entomologists. Actually, antlions are attractive insects, frequently collected though always in low numbers. Specialized research has led us very recently to the discovery and description of a new species of *Myrmeleon* (*M. punicanus* Pantaleoni et Badano, 2012, known only on mainland Sicily and Pantelleria) whereas a species of *Creoleon* is still being studied. Despite the wide distribution of many antlion species, Sicily seems to be effectively a crossroads for distributional patterns in this family. There are two southern species reaching only

the island of Lampedusa near Africa, *Creoleon aegyptiacus* (Rambur, 1842) and *C. griseus* (Klug, 1834), one species for which Sicily represents the western limit of distribution, *Nemoleon poecilopterus* (Stein, 1863), three species for which Sicily represents the southern limit of distribution reaching Etna, *Myrmeleon formicarius* Linnaeus, 1767, *Euroleon nostras* (Geoffroy in Fourcroy, 1785) or the northern mountain range, *Dendroleon pantherinus* (Fabricius, 1787). Moreover the S Mediterranean antlion *Distoleon annulatus* (Klug, 1834) is recorded for many small islands.

Among the species of Ascalaphidae, *Bubopsis agrionoides* (Rambur, 1838) is known only for Lampedusa, having a W Mediterranean distribution with scarce and scattered records along the coasts of southern France, eastern Spain, Morocco and Tunisia. On the contrary the E Mediterranean *Deleproctophylla australis* (Fabricius, 1787) is widespread in Sicily. Owlflies are strong-flying insects and the narrow (3.1 km) Strait of Messina does not seem able to act as a barrier against them. However Sicily and Calabria, the two opposite regions of the strait, share only one species of *Libelluloides* whereas overall four species live in Calabria and two in Sicily. The shared species is *L. coccajus* ([Denis et Schiffermüller], 1775), the second Sicilian species is the endemic *L. siculus* (Angelini, 1827). The last belongs to a group of Mediterranean species (considered subspecies by some): *L. ictericus* (Charpentier, 1825) from W Mediterranean continental coasts, between south France and Tunisia; the Tyrrhenian *L. corsicus* (Rambur, 1842) from Corsica, Sardinia and Capraia, an island of the Tuscan Archipelago; *L. cyrenaicus* H. Aspöck, Hölzel et U. Aspöck, 1976 from Cyrenaica.

Biodiversity by habitat: the lack of knowledge

The following list of habitats does not derive from a rigorous classification of the Sicilian environment, but it is a simple frame of work including the most paradigmatic communities of Neuropterida.

Freshwater. The only amphibiotic species of Sicilian Neuropterida is the nevrorthid *Nevrorthus iridipennis*. Nevertheless if the absence of alderflies (Megaloptera Sialidae) and osmylids (Neuroptera Osmylidae) could be plausible, the lack of records regarding spongillaflies (Neuroptera Sisyridae) ap-

pears to be very questionable. In the W Mediterranean, the species *Sisyra iridipennis* A. Costa, 1884, is widespread including islands smaller than Sicily, such as the Balearics, and nearby Sardinia and Tunisia. Specialized research is required to resolve these doubts.

Soil. In the Euro-Mediterranean region many Neuropterida live in the soil, particularly the larvae of some Raphidioptera and almost all the larvae of Myrmeleontiformia. But the former live among litter, under stones, among mosses and the latter on the surface (Ascalaphidae) or immediately below the surface (other families), so they could both be considered epiedaphic. The only inhabitant of the soil mineral layer (euedaphic species) are the larvae of Dilaridae and, perhaps, of Berothidae. Both these families are not recorded from Sicily but the absence of Dilaridae does not seem plausible.

Wetlands and coasts. Neuropterida are scarce in wetlands excluding the amphibiotic ones, but the species living here are very interesting. The coastal environments are also the habitat of specialized Neuropterida, particularly the Myrmeleontidae species linked to loose sand. While no study was conducted in wetlands, some data on the coasts is available. Unfortunately wetlands and coasts are two extremely endangered environments in Sicily, facing destruction through urban development and recreational use.

Agro-ecosystems. Often the agro-ecosystems in the Mediterranean climate are environments rich in insect biodiversity. Previous studies in regions similar to Sicily, regarding both the Chrysopidae, family of agricultural interest (Pantaleoni & Lepera, 1985; Pantaleoni & Curto, 1990), and the Myrmeleontidae (Curto & Pantaleoni, 1987), noticed an unexpectedly high number of species. Unfortunately, in Sicily the communities of Neuropterida in agricultural cultivations were never studied, although many of these such as vineyards, citrus orchards, olive groves, and the very local and characteristic manna ash groves or pistachio orchards appear very promising.

Northern mountain ridge. The northern mountain ridge has the best preserved wildlife of Sicily and is perhaps the most frequented area by naturalists and entomologists. We have a lot of occasional and scattered data on Neuropterida of these mountains, but specialized research would produce some surprises.



Figures 4-7. Sicilian habitats of some interesting Neuropterida communities. Fig. 4: freshwater, wetlands and coasts: the mouth of the River Modione (Trapani), May 2008; Fig. 5: agro-ecosystems: Segesta (Trapani), April 2006; Fig. 6: Northern mountain ridge: beech wood on Monte Mufara, Madonie (Palermo), April 2003; Fig. 7: small islands: Isola dei Conigli, Lampedusa (Agrigento), September 2005. Photos by Marcello Romano.

Mediterranean forests, woodlands, and scrub. Mediterranean vegetation is the dominant vegetation in Sicily and probably its wide diffusion creates less interest in entomologists. Indeed this common environment would deserve more attention, as demonstrated by the recent discovery of a new arboreal species of the genus *Myrmeleon* (Pantaleoni & Badano, 2012).

Hyblaean Mountains. The lack of research on Neuropterida in the Hyblaean Mountains is one of the biggest grey areas in our knowledge of these insects in Sicily.

In fact, the Hyblaean Foreland belongs to the northern part of the African Plate and it is of huge biogeographical interest; the recent discovery of a new species of tree belonging to a relict genus in



Figures 8-13. Sicilian Neuropterida. Fig. 8: *Xanthostigma corsicum* female, Piano Battagliesia Madonie Palermo, 11.VI.2006. Fig. 9: *Fibla maclachlani* female, Paceco Trapani, 17.IV.2011. Fig. 10: *Fibla maclachlani* larva, L'Antennamare Peloritani Messina, summer 2001. Fig. 11: *Nevrothus iridipennis* adult, Valle dell'Alcantara Messina, 13.VI.2002. Fig. 12: adult of *Coniopteryx* sp., Catania, 30.IX.2007. Fig. 13: *Mantispa perla* adult, Piano Battaglia Madonie Palermo, 21.VII.2004. Photos by Marcello Romano (8, 13), Luigi Barraco (9), Rinaldo Nicoli Aldini (10, 11) and Alessandro Strano (12).

the Mediterranean range, *Zelkova sicula* Di Pasquale, Garfi et Quézel, 1992, is just one example which is also well known by the general public (Garfi, 1996).

Small islands. Specialized research was never carried out on the small surrounding islands except the Maltese Islands (Duelli, 1994; Plant & Schembri, 1996). In particular, current knowledge is

scarce about Chrysopidae, Hemerobiidae and Coniopterygidae, slightly better about Myrmeleontiidae and Ascalaphidae.

As far as we know, many studies appear very promising: the African species living in Lampedusa and Linosa, the Neuropterida of the woods in the Pantelleria mountains, the fauna of Aegadian Islands and Ustica.



Figures 14-19. Sicilian Neuropterida. Fig. 14: *Sympherobius luqueti* adult, Marausa Trapani, 30.VIII.2009. Fig. 15: *Chrysopa formosa* adult, Nubia Trapani, 14.VI.2009. Fig. 16: Chrysopidae eggs on flower, Paceco Trapani, 2.VI.2007. Fig. 17: larva of *Pseudomallada* sp. with its camouflage, Paceco Trapani, 20.VI.2009. Fig. 18: *Myrmeleon hyalinus* male, foce del Modione, Trapani, 1.VI.2007. Fig. 19: mating pair of *Libelloides siculus*, saline Trapani 16.V.2008. Photos by Luigi Barraco (14, 15, 16, 17) and Marcello Romano (18, 19).

Biodiversity by distributional pattern: biogeography

It is generally believed that many Neuropterida have wide distribution areas, however this is probably due primarily to the poor current knowledge on the taxonomy of some families, particularly the Chrysopidae. A paradigmatic example is that of *Pseudomallada prasinus* (Burmeister, 1839), a species which apparently has Palearctic distribution, but is probably composed of many more localized sibling species. Unfortunately this situation seriously affects the study of distributional patterns in Neuropterida.

Anyway, as far as we know, also the list of Sicilian Neuropterida is rich in species with a wide distribution area (Table 1), but the commonest distributional patterns are the Mediterranean, in a broad sense, and the S European ones. Obviously a Mediterranean fauna is the normal background for Sicily. The species with northern distributional patterns are more interesting. The majority of (Central-) European species, but sometimes also the Asian-European or Euro-Siberian ones, follow the beech woods (pure or mixed with conifers) along the Italian peninsula, reaching the northern Sicilian mountain ranges. The European beech woods are the main habitat of some species of Neuropterida such as, e.g., the green lacewing *Hypochochrysa elegans* (Burmeister, 1839) and the brown lacewings *Hemerobius micans* Olivier, 1792 and *Symphorobius elegans* (Stephens, 1836).

The species with southern distributional patterns are fewer. Among these there is the common *Symphorobius fallax* Navás, 1908, but also *Brinckochrysa chlorosoma* (Navás, 1914), a very interesting Chrysopidae, and two species of the African *Creoleon* recorded only for Lampedusa.

The position of Sicily in the W Mediterranean, but at the border of the east side, favors the presence of both western and eastern Neuropterida on the island. So we could find the E Mediterranean taxa that colonize the Italian peninsula, such as the lacewings *Pseudomallada clathratus* (Schneider, 1845) and *P. zelleri* (Schneider, 1851) or the owlfly *Deleproctophylla australis* (Fabricius, 1787). On the contrary we find also W Mediterranean species like the dustywing *Semidalis vicina* (Hagen, 1861) and the antlion *Creoleon lugdunensis* (Villers, 1789).

Finally, Sicily hosts some but few endemic or subendemic (i.e. with small distribution area) Neuropterida all belonging to W Mediterranean taxa.

CONCLUSIONS

The current state of knowledge on the Neuropterida of Sicily is satisfactory, especially if we compare it to many other Italian regions. However, the large number of records accumulated does not derive from specialized research but from occasional, sporadic sampling. Many environments have not been adequately studied and some of these appear to be particularly interesting. Certainly, much more work will be necessary to fill in the many gaps left in our knowledge. As far as Neuropterida are concerned, Sicilian biogeography is nevertheless well outlined and confirms that the island is a crossroads for Central European, Afrotropical, E and W Mediterranean species which can be added to the main Mediterranean and S European components.

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