

New records and an updated checklist of the butterfly fauna (Lepidoptera: Papilionoidea) of Puglia, south-eastern Italy

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Abstract. An updated checklist of Rhopalocera occurring in Puglia region, in the south-eastern part of the Italian Peninsula, is presented, together with their occurrence status. Surveys were made from 2007 to 2020, and 110 butterfly species from 6 families, including several confirmations of historical published records, were encountered. Among these, threatened species such as *Zerynthia cassandra*, *Melanargia arge*, and *Euphydryas aurinia* should be mentioned. Including all the published records, the total number of butterfly species recorded in Puglia is 120, which amounts to 40% of the total Italian and approximately 24% of the total European butterfly fauna. A revised checklist represents a starting point for further research, provides a foundation for future butterfly conservation actions and implies that more research is needed, to increase the general knowledge of the butterfly fauna in South Italy.

Riassunto. Il presente lavoro riporta un elenco aggiornato delle farfalle diurne presenti in Puglia nella parte sud-orientale della penisola italiana, corredato dalle relative località di contatto. Le indagini sono state condotte dal 2007 al 2020. In questo periodo sono state censite 110 specie di farfalle appartenenti a 6 famiglie, tra cui diverse conferme di segnalazioni presenti in precedenti pubblicazioni. Tra queste, vanno menzionate alcune specie minacciate a livello europeo come *Zerynthia cassandra*, *Melanargia arge*, *Euphydryas aurinia*. Comprendendo tutte le segnalazioni già presenti in pubblicazioni pubblicate in passato, il numero totale di specie di farfalle registrate ad oggi in Puglia è di 120 specie, che equivale al 40% del totale italiano e circa il 24% della fauna europea totale delle farfalle. Una checklist rivista e aggiornata rappresenta un punto di partenza per future azioni di conservazione delle farfalle e implica la necessità di ulteriori ricerche, per aumentare le conoscenze generali sulla fauna delle farfalle nel Sud Italia.

Samenvatting. Een bijgewerkte checklist van Rhopalocera die voorkomen in de regio Apulië, in het zuidoostelijke deel van het Italiaanse schiereiland, wordt gepresenteerd, samen met de status van voorkomen. Van 2007 tot 2020 werden enquêtes gehouden en 110 vlindersoorten uit 6 families, waaronder verschillende bevestigingen van historische, gepubliceerde gegevens, werden aangetroffen. Onder deze moeten bedreigde soorten zoals *Zerynthia cassandra*, *Melanargia arge* en *Euphydryas aurinia* worden genoemd. Met inbegrip van alle gepubliceerde gegevens, is het totale aantal geregistreerde vlindersoorten in Apulië 120, wat neerkomt op 40% van de totale Italiaanse en ongeveer 24% van de totale Europese dagvlinderfauna. Een herziene checklist vormt een startpunt voor verder onderzoek, biedt een basis voor toekomstige vlinderbeschermingsacties en impliceert dat er meer onderzoek nodig is om de algemene kennis van de vlinderfauna in Zuid-Italië te vergroten.

Key words: Biodiversity – Distribution – Faunistics – Rhopalocera – Taxonomy.

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Introduction

The first in-depth studies of the butterfly fauna of Puglia commenced at the beginning of the 20th Century. Important research was undertaken by Cecconi (1908), who published a report on the butterfly species encountered on the Tremiti Islands. Numerous other entomological surveys were conducted by different researchers during the following years. Wimmers (1931) published an inventory of the butterflies of Gargano. Significant new additions were reported by De Togni (1948) for the same geographical area. A few surveys were conducted later in Gargano, Arco Jonico, Salento and Terra di Bari by Zangheri (1956, 1960). The first comprehensive overview of the butterfly fauna for Puglia was compiled by Parenzan (1975, 1980), who collected specimens in several locations, providing personal records for most of the species. Balletto & Toso (1982) provided new observations and ecological data from surveys on coastal dune biotopes of Southern Italy, including Puglia.

Almost thirty years passed until summaries of butterfly species in this region were compiled by Bruno (2002) and Russo (2004). A review of the data based on the available literature was later published by Parenzan & Porcelli

(2006). Recently, a systematic list for the Salento area was composed by Durante (2009). Since then, further efforts have been made to fill the gaps in the knowledge of the presence of butterflies in Puglia (Zilli 1998, Cicerale 2007, Cagnetta 2016).

A comprehensively updated checklist of the butterflies of Puglia is overdue and is presented in this paper, together with a historical overview of entomological records. A review of the published records is presented in Table 2.

Study area

Puglia is a region located in the south-eastern part of Italy. Its total area is 19,358 km² and it is one of the flattest regions in Italy: flat and plain areas cover over 50% of its surface, with only 1.5% covered by mountains. Puglia has more than 800 km of coastline, which is longer than that of any other Italian region. Puglia is dominated by a Mediterranean microclimate with warm, dry and sunny summers and mild, rainy winters with 15–16° C average annual temperature. The Adriatic side is affected by the continental climate caused by the mountainous complexes of the north-eastern sector and by the

extensive plains of eastern Europe, gradually attenuated towards the south by the influence of the eastern Mediterranean. The north-western part is influenced by the mountain climate of the nearby Apennines (Macchia *et al.* 2000).

Considering the different peculiarities at geomorphological and landscape level, the study took place in eight different sub-regions: Tavoliere delle Puglie, Gargano, Subappennino Dauno, Alta Murgia, Terra di Bari, Valle d'Itria, Arco jonico and Salento.

Tavoliere delle Puglie is the second largest Italian plain (approximately 4300 km²) and the largest alluvial plain in the Italian peninsula, overlaying Plio-Pleistocene marine sandy-gravelly deposits (Di Rita *et al.* 2011). Human activity through the ages has generated increasing pressure on the area, and cultivation, with massive cereal production, has progressively replaced the natural steppe vegetation since the 6th millennium B.C. (Baker *et al.* 1987).

The Gargano peninsula forms an elevated area of around 2,000 km² along the south-eastern Adriatic coastline. Deciduous mesophilous woods are spread on the promontory. "Foresta Umbra" may be considered one of the most important residual millenary forests of woods and pastures in Italy and is famous for an extraordinarily rich flora and beech stands, which are unique for SE-Italy. Karst phenomena reduce the hydrographic characteristics, but significant is the presence of two coastal lagoons, the Lesina and Varano Lakes.

Subappennino Dauno, in the northwest of the region, is characterized by hills and modest relief overall, where the highest peak is Mt. Cornacchia (1,151 m), degraded and engraved by a system of waterways that flow towards the Tavoliere delle Puglie plain. Lake Occhito, situated at the boundaries with the Molise region, is one the largest artificial reservoirs in Europe. The landscape is mainly cultivated with durum wheat and interspersed with small strips of oak woods.

Alta Murgia is a calcareous highland with a geological soil substrate mainly consisting of Cretaceous limestones. The typical Mediterranean vegetation of the area includes semi-natural dry grasslands, residual patches of downy oak forests, scrub, pastures and land harvested for seasonal crops. Serious alterations to the morphology of the area have been brought about through a combination of natural and anthropogenic processes over long periods by the practice of "rock-breaking" often applied to turn the original pasture to cropped land (Perrino *et al.* 2012), sheep grazing, cutting and deliberate light burning regimes (Labadessa 2014). The upper part of this area, spanning over 125,880 ha and ranging from about 300 to 700 m.a.s.l., is in part designated as a National Park.

The Terra di Bari extends between the last slopes of Murgia gradually dipping toward the Adriatic Sea and the coastline and represents relict landforms associated with ancient sea-level changes that occurred during the Middle and Late Pleistocene (Gioia *et al.* 2010). The more fertile lower flatter area is mainly used for irrigated fruit and vegetable crops, while the inner part, on the foothills of the first karst steps, is dominated by vineyards and intensive crops of olive, cherry and almond trees.

Valle d'Itria is characterized by the strong presence of karst morphologies, which articulate and fragment the landscape. The plateau is almost entirely made up of a dolomite limestone bank, locally covered by recent calcarenitic rocks or red clayey residual material (called "terra rossa") a product of the dissolution of limestone. The presence of a limestone soil is very important for the vineyards, one of the main crops in the area.

Arco Jonico is characterized by the particular orographic conformation of the karst environment, consisting in the succession of steps and terraces with peculiar features, besides an interspersed network of deep gorges locally called "gravine", with which the Murgia plateau slopes towards the sea, forming a kind of natural amphitheatre. The vegetation has a great biogeographic interest because of the eastern-Mediterranean floristic contingent, associated with a good western component (Biondi & Guerra 2008).

Salento is characterized by an alternation of flat areas, variously extended, with very low relief. The natural landscape in Salento is the consequence of thousands of years of human activity: agriculture, deforestation and forest fires have together deeply altered the natural vegetation, which is therefore extremely threatened and concentrated in small patches of maquis or its degradation forms, xeric grasslands and garrigue (Mele *et al.* 2006).

Although it is a small region, Puglia is notable for its rich landscape and biological diversity. Despite the fact that butterflies are one of the most studied insect groups in the World in southern Italy they are still understudied. Girardello *et al.* (2008) showed that the most important areas for butterflies in Italy are the Alps, the central Apennines, the island of Sardinia and the Puglia region.

Material and Methods

The checklist of the butterflies of Puglia presented in this work is based on records from all the available literature known to the authors and includes many records and new findings, mainly unpublished data from the authors and personal observations collected between 2007 and 2020. During the surveys, butterflies were observed, photographed and identified in the field, with only a few specimens collected for further examination. Identification was based on Tolman & Lewington (2008) and Lafranchis (2004). Taxonomy and nomenclature follow Wiemers *et al.* (2018) and van Nieuwerkerken *et al.* (2019). Subspecific taxa are not included in the checklist.

In total, 44 different localities were visited. The locations listed correspond approximately to the municipal limits of the sampled location (Table 1; Fig. 1).

Results and discussion

110 butterfly species from 6 families were encountered during surveys from 2007 to 2020, including several confirmations of historical published records. Including a systematic revision of the records from literature, the butterfly fauna of Puglia contains a total of 120 species.

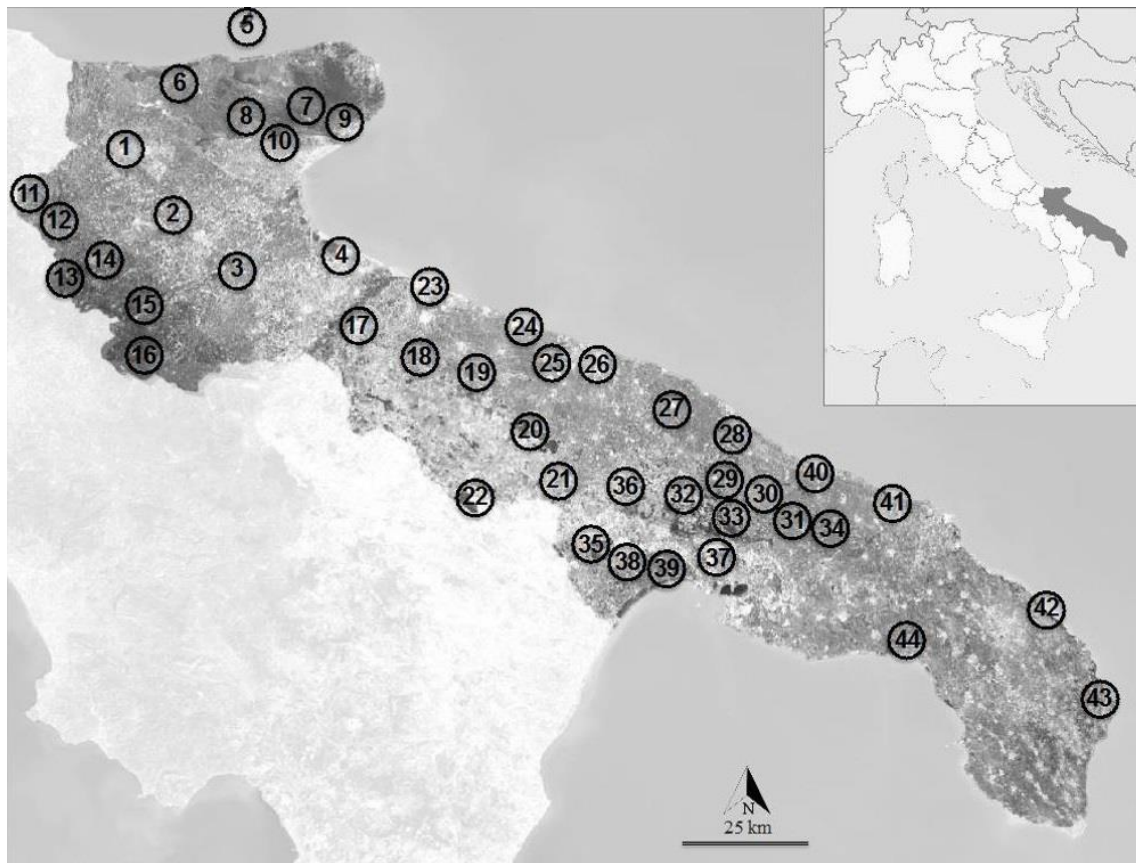


Fig. 1. Map of Puglia with the position of study locations. Study locations are listed in Table 1.

Checklist of butterfly species of Puglia

Family HesperIIDae

1. *Carcharodus alceae* (Esper, 1780)
2. *Carcharodus baeticus* (Rambur, 1839)
3. *Carcharodus floccifera* (Zeller, 1847)
4. *Erynnis tages* (Linnaeus, 1758)
5. *Gegenes nostradamus* (Fabricius, 1793)
6. *Gegenes pumilio* (Hoffmannsegg, 1804)
7. *Hesperia comma* (Linnaeus, 1758)
8. *Muschampia proto* (Ochsenheimer, 1808)
9. *Ochlodes sylvanus* (Esper, 1777)
10. *Pyrgus armoricanus* (Oberthür, 1910)
11. *Pyrgus carthami* (Hübner, 1813)
12. *Pyrgus malvoides* (Elwes & Edwards, 1897)
13. *Pyrgus onopordi* (Rambur, 1839)
14. *Pyrgus sidae* (Esper, 1784)
15. *Spialia sertorius* (Hoffmannsegg, 1804)
16. *Thymelicus acteon* (Rottemburg, 1775)
17. *Thymelicus lineola* (Ochsenheimer, 1808)
18. *Thymelicus sylvestris* (Poda, 1761)

Family Papilionidae

19. *Iphiclides podalirius* (Linnaeus, 1758)
20. *Papilio machaon* (Linnaeus, 1758)
21. *Zerynthia cassandra* (Geyer, 1828)

Family Pieridae

22. *Anthocharis cardamines* (Linnaeus, 1758)
23. *Aporia crataegi* (Linnaeus, 1758)
24. *Colias alfacariensis* (Ribbe, 1905)
25. *Colias croceus* (Geoffroy, 1785)
26. *Euchloe ausonia* (Hübner, 1804)
27. *Gonepteryx cleopatra* (Linnaeus, 1767)
28. *Gonepteryx rhamni* (Linnaeus, 1758)
29. *Leptidea sinapis* (Linnaeus, 1758)
30. *Pieris brassicae* (Linnaeus, 1758)
31. *Pieris ergane* (Geyer, 1828)
32. *Pieris mannii* (Mayer, 1851)
33. *Pieris napi* (Linnaeus, 1758)
34. *Pieris rapae* (Linnaeus, 1758)
35. *Pontia edusa* (Fabricius, 1777)

Family Riodinidae

36. *Hamearis lucina* (Linnaeus, 1758)

Family Lycaenidae

37. *Aricia agestis* (Denis & Schiffermüller, 1775)
38. *Cacyreus marshalli* (Butler, 1898)
39. *Callophrys rubi* (Linnaeus, 1758)
40. *Celastrina argiolus* (Linnaeus, 1758)
41. *Cupido alcetas* (Hoffmannsegg, 1804)
42. *Cupido argiades* (Pallas, 1771)
43. *Cupido minimus* (Fuessly, 1775)
44. *Cupido osiris* (Meigen, 1829)

45. *Cyaniris semiargus* (Rottemburg, 1775)
 46. *Eumedonia eumedon* (Esper, 1780)
 47. *Favonius quercus* (Linnaeus, 1758)
 48. *Glaucoopsyche alexis* (Poda, 1761)
 49. *Iolana iolas* (Ochsenheimer, 1816)
 50. *Lampides boeticus* (Linnaeus, 1767)
 51. *Leptotes pirithous* (Linnaeus, 1767)
 52. *Lycaena alciphron* (Rottemburg, 1775)
 53. *Lycaena phlaeas* (Linnaeus, 1761)
 54. *Lycaena thersamon* (Esper, 1784)
 55. *Lycaena tityrus* (Poda, 1761)
 56. *Phengaris arion* (Linnaeus, 1758)
 57. *Plebejus argus* (Linnaeus, 1758)
 58. *Plebejus argyrognomon* (Bergsträsser, 1779)
 59. *Plebejus idas* (Linnaeus, 1761)
 60. *Polyommatus amandus* (Schneider, 1792)
 61. *Lysandra bellargus* (Rottemburg, 1775)
 62. *Lysandra coridon* (Poda, 1761)
 63. *Polyommatus daphnis* (Denis & Schiffermüller, 1775)
 64. *Polyommatus dolus* (Hübner, 1823)
 65. *Polyommatus dorylas* (Denis & Schiffermüller, 1775)
 66. *Polyommatus escheri* (Hübner, 1823)
 67. *Polyommatus icarus* (Rottemburg, 1775)
 68. *Polyommatus thersites* (Cantener, 1835)
 69. *Pseudophilotes baton* (Bergsträsser, 1779)
 70. *Satyrium acaciae* (Fabricius, 1787)
 71. *Satyrium ilicis* (Esper, 1779)
 72. *Satyrium spini* (Denis & Schiffermüller, 1775)
 73. *Satyrium w-album* (Knoch, 1782)
 74. *Thecla betulae* (Linnaeus, 1758)
- Family Nymphalidae**
75. *Aglais io* (Linnaeus, 1758)
 76. *Aglais urticae* (Linnaeus, 1758)
 77. *Argynnis adippe* (Denis & Schiffermüller, 1775)
 78. *Speyeria aglaja* (Linnaeus, 1758)
 79. *Fabriciana niobe* (Linnaeus, 1758)
 80. *Argynnis pandora* (Denis & Schiffermüller, 1775)
81. *Argynnis paphia* (Linnaeus, 1758)
 82. *Boloria euphrosyne* (Linnaeus, 1758)
 83. *Brenthis daphne* (Bergsträsser, 1780)
 84. *Brenthis hecate* (Denis & Schiffermüller, 1775)
 85. *Charaxes jasius* (Linnaeus, 1767)
 86. *Chazara briseis* (Linnaeus, 1764)
 87. *Euphydryas aurinia* (Rottemburg, 1775)
 88. *Issoria lathonia* (Linnaeus, 1758)
 89. *Libythea celtis* (Laicharting, 1782)
 90. *Limenitis reducta* (Staudinger, 1901)
 91. *Melitaea celadussa* Fruhstorfer, 1910
 92. *Melitaea cinxia* (Linnaeus, 1758)
 93. *Melitaea didyma* (Esper, 1778)
 94. *Melitaea ornata* Christoph, 1893
 95. *Melitaea phoebe* (Denis & Schiffermüller, 1775)
 96. *Melitaea trivia* (Denis & Schiffermüller, 1775)
 97. *Nymphalis antiopa* (Linnaeus, 1758)
 98. *Nymphalis polychloros* (Linnaeus, 1758)
 99. *Polygonia c-album* (Linnaeus, 1758)
 100. *Polygonia egea* (Cramer, 1775)
 101. *Vanessa atalanta* (Linnaeus, 1758)
 102. *Vanessa cardui* (Linnaeus, 1758)
 103. *Brintesia circe* (Fabricius, 1775)
 104. *Coenonympha arcania* (Linnaeus, 1760)
 105. *Coenonympha pamphilus* (Linnaeus, 1758)
 106. *Danaus chrysippus* (Linnaeus, 1758)
 107. *Hipparchia fagi* (Scopoli, 1763)
 108. *Hipparchia semele* (Linnaeus, 1758)
 109. *Hipparchia statilinus* (Hufnagel, 1766)
 110. *Hyponephele lupinus* (Costa, 1836)
 111. *Hyponephele lycaon* (Kühn, 1774)
 112. *Lasiommata maera* (Linnaeus, 1758)
 113. *Lasiommata megera* (Linnaeus, 1767)
 114. *Maniola jurtina* (Linnaeus, 1758)
 115. *Melanargia arge* (Sulzer, 1776)
 116. *Melanargia galathea* (Linnaeus, 1758)
 117. *Melanargia russiae* (Esper, 1783)
 118. *Pararge aegeria* (Linnaeus, 1758)
 119. *Pyronia cecilia* (Vallantin, 1894)
 120. *Pyronia tithonus* (Linnaeus, 1771)

Table 1. List of surveyed localities.

Tavoliere delle Puglie	Subappennino Dauno	Terra di Bari	Arco Jonico
1. Torremaggiore	11. Occhito	23. Barletta	35. Laterza
2. Bosco Incoronata	12. San Marco la Catola	24. Giovinazzo	36. Gioia del Colle
3. Lucera	13. Faeto	25. Lama Balice	37. Crispiano
4. Zapponeta	14. Biccari	26. Bari	38. Castellaneta
Gargano	15. Bovino	27. Conversano	39. Pinete dell'Arco jonico
5. Tremiti islands	16. Accadia	28. Monopoli	Salento
6. Lesina	Alta Murgia	Valle d'Itria	40. Torre Canne
7. Foresta Umbra	17. Locone	29. Alberobello	41. Torre Guaceto
8. S. Marco in Lamis	18. Corato	30. Locorotondo	42. S. Cataldo
9. Mattinata	19. Ruvo di Puglia	31. Cisternino	43. Otranto
10. Monte S. Angelo	20. Cassano delle Murge	32. Noci	44. Pulsano
	21. Santeramo in colle	33. Pianelle	
	22. Gravina	34. Ostuni	

In Appendix 1, a table with localities where the specimens were sampled is presented.

In a recently published new finding, *Melitaea ornata* and *Melitaea trivialis* (Fig. 2), are reported for the first time in a list of Apulian butterflies (Cagnetta 2016). Concerning the congeneric species *M. celadussa*, it has long been known that *Melitaea athalia* and *M. celadussa* (often referred to as *M. nevadensis*) are separate taxa (Balletto *et al.* 2014) based on genitalia morphology. With the current knowledge on the distribution of these taxa, we refer all our past observations of *M. athalia* to

M. celadussa (see van Oorschot & Coutsis 2014). De Togni (1948) attributes specimens collected in Gargano to *M. athalia* var. *divergens*, but Zangheri (1956) regarded this assignment as questionable, as this variety was considered typical of the Po Valley, in northern Italy. Parenzan (1975) provided a reliable identification of specimen collected in Valle d'Itria (Pianelle) assigned to *Melitaea athalia celadussa*. Authors documented its presence also in Subappennino Dauno.



Fig. 2a. *Melitaea ornata*, Monti Dauni, June 2013. © Giuseppe Cagnetta.

Fig. 2b. *Melitaea trivialis*, Monti Dauni, June 2013. © Giuseppe Cagnetta.

With our recent field surveys, we confirm the presence of *Hamearis lucina*, *Lycaena alciphron*, *Cupido osiris*, *Iolana iolas* and *Polyommatus escheri* in Puglia. Apart from its inclusion by Wimmers (1931), who described it as "not rare" for Gargano, the presence of *H. lucina* (Fig. 3b) has not been reported in any other published record. During the surveys, this species was found in the surrounding of Biccari, Subappennino Dauno, in 2014. The scarcity of data can perhaps be attributed to a lack of surveys in this part of the region. *Lycaena alciphron* was first observed by Wimmers (1931) and De Togni (1948) in Gargano. This historical record was confirmed by the authors, who observed several specimens flying in June 2018 in the same location after 70 years. *Cupido osiris* was previously reported only by Russo (2004) in Accadia, but our recent observations in other localities suggest that it is likely to be more widespread in the Subappennino Dauno area. *Iolana iolas* (Fig. 4a) was reported by Chiavetta (2001) for Gargano, and it was also mentioned for the vicinity of Volturara Appula, in Subappennino Dauno, during June 1983 (Cicerale 2007). Specimens were mainly worn observed at the end of May 2020 in the vicinity of Accadia. Among these records, one of the most notable is the presence of *Polyommatus escheri* in Gargano and Subappennino Dauno. This is an apparently rare lycaenid butterfly that could be easily overlooked due to its similarity with other Polyommatinae butterflies.

The presence of some species included in the list requires confirmation. There is just a single report of the occurrence of *Hesperia comma* and *Thecla betulae* in Puglia (Cicerale 2007), near Monte Cornacchia.

The first documented record of *Eumedonia eumedon* is in Wimmers (1931) for Gargano. This species has only a recent record in Subappennino Dauno in 1986 (Cicerale 2007). *Polyommatus dorylas* was first reported from Gargano by Wimmers (1931) too. For the same location, Parenzan & Porcelli (2006) reported a personal communication by Bertaccini with a precise locality and date of sighting (Peschici, Baia di Manaccora, 28 June 1995). Later, *P. dorylas* was recorded in Subappennino Dauno (Cicerale 2007). There are no more recent sightings for any of these butterflies, and their presence also requires confirmation. Wimmers (1931) reported *Hyponephele lycaon* var. *lupina* for Gargano, but in all probability should be referred to *H. lupinus*. However, in 1983, Cicerale (2007) observed a single female of *H. lycaon* in the surrounding of a forest in Gargano. The presence needs to be confirmed as there is no photographic record or voucher specimen.

Based on records from data gathering from older literature, three species are mentioned but have never been re-found. De Togni (1948) and Zangheri (1956) collected many specimens of *Plebejus argyrognomon* from Gargano. Ideal habitats for this species are still

probably available in the same area and, despite the lack of recent records, *P. argyrognomon* is kept on the list on account of historical evidence. Only one report mentions the occurrence of *Pyrgus carthami* in Puglia (Parenzan *et al.* 2006), based on a personal communication by Capelli in 1969 for Bosco Incoronata. Only one published record exists for *Nymphalis antiopa* for Monti Dauni and Arco Jonico (Parenzan 1980). We consider *N. antiopa* as a potential species to be rediscovered in the future and forthcoming activities should be focused on the confirmation of this older historical record. Other questionable occurrences have been excluded from the list. For example, *Aphantopus hyperantus* and *Hipparchia*

alcyone were cited only by Wimmers (1931) for Gargano, but no specimens were collected or documented, and both are therefore excluded. Another species whose presence in Puglia is doubtful is *Carcharodus lavatherae* (Esper, 1780). As its presence is reported only in some field guides (Higgins & Riley 1983, Tolman 2008), it has been removed from the list.

The distribution of many species is still poorly documented because some parts of the region have not yet been surveyed adequately. However, new observations in different sub-regions have been provided for some species.



Fig. 3a. *Melanargia arge*, Cassano delle Murge, May 2012. © Giuseppe Cagnetta.

Fig. 3b. *Euphydryas aurinia*, Monti Dauni, June 2013. © Giuseppe Cagnetta.

Fig. 3c. *Hamearis lucina*, Monti Dauni, June 2014. © Giuseppe Cagnetta.

Fig. 3d. *Zerynthia cassandra*, Cassano delle Murge, April 2011. © Giuseppe Cagnetta.

Hyponephele lupina was mentioned by Parenzan (1975) for Arco Jonico, Cicerale (2007) for Subappennino Dauno, and by Durante (2009) for Salento. We collected specimens from localities where *H. lupina* was previously unrecorded, in Gargano (near S. Marco in Lamis and Monte S. Angelo), Alta Murgia (Ruvo di Puglia, Cassano delle Murge), and Terra di Bari (Conversano).

Parenzan (1980) included *Carcharodus baeticus* in the list for the first time, mentioning its presence in the northern part of the region. Specimens were recently observed in the central part of Puglia with new records in Alta Murgia, nearby Corato, Ruvo di Puglia and Cassano delle Murge.

Thymelicus acteon was reported only by Zangheri (1960) for Arco Jonico and Parenzan (1975) for some localities in Arco Jonico and Valle d'Itria. We confirm the presence in the same areas and provide new localities all over the region (see Table S1 for all localities).

During our surveys, *C. alcae* was found in every locality we sampled, while previously it had been reported by De Togni (1948) and Zangheri (1956) only from Gargano, Parenzan (1975) for some localities in Arco Jonico and Valle d'Itria, Balletto & Toso (1982) for Gargano.

As a result of our recent surveys, we provide also new findings for *Melanargia russiae* (fig. 4b). Wimmers (1931) and De Togni (1948) were the first to provide evidence for

M. russiae from Gargano. Later, Parenzan (1975) found it common and widespread in Valle d'Itria and Arco jonico.

We found this species in 14 localities in Gargano (Foresta Umbra, S. Marco in Lamis, Monte S. Angelo, Subappennino Dauno (S. Marco la Catola, Biccari) Alta Murgia (Locone, Corato, Ruvo di Puglia, Santeramo in colle, Gravina), Valle d'Itria (Pianelle), and Arco jonico (Gioia del Colle, Castellaneta).

Two of the newest faunistic elements in the last 20 years in Puglia are *Danaus chrysippus* and *Cacyreus marshalli*. *Danaus chrysippus* was first observed by Zilli (1988), but was probably already present in South Italy, as documented by Gagliardi (1811). However, during the last twenty years, records of this species have increased in southern Europe, along both sides of the Adriatic coast, for example in Italy in Emilia Romagna (Borgo *et al.* 1992) and also in Albania (Luquet & Misja 1989), Croatia (Perkovij 2006) and Montenegro (Franeta 2018). *D. chrysippus* has been documented in more than 8 localities in all coastal sub-regions, where *Cynancum acutum* is reported as the main host plant. *Cacyreus marshalli* is a South African native Lycaenid accidentally introduced in Europe at the end of the last Century. In Italy it was first observed in 1996 (Trematerra *et al.* 1997) and in recent years it has quickly colonized other Italian regions, including Puglia, with widespread colonies. First reported in Puglia by Russo (2003), we observed that today it occurs throughout Puglia.

Four of the surveyed species are considered threatened species by European and National Red Lists. They are also protected under European Law. *Phengaris arion* is listed as a near threatened (NT) species according to the International Union for the Conservation of Nature (IUCN) Red List Category of Europe. *P. arion* has only been reported for the northern part of Gargano in the past (Wimmers 1931). More recently, it was observed in Monte Cornacchia in 2004 (Cicerale 2007), though its occurrence has not been confirmed recently. Future work should try to verify all locations mentioned and clarify the presence and status of this species in the region.

Zerynthia cassandra (Fig. 3d) is an Italian endemic and Puglia represents the eastern edge of its distribution

range. Originally described as a subspecies of the Habitat Directive species (Annex IV) *Zerynthia polyxena*, *Z. cassandra* has recently been upgraded to species rank, due to genitalia and genetic differentiation from *Z. polyxena* (Dapporto 2010, Zinetti *et al.* 2014). Zangheri (1956) reported *Z. polyxena* var. *cassandra* for Gargano; also Parenzan mentioned the species for different localities in Gargano, Arco Jonico and Valle d'Itria. During our surveys, this butterfly was not recorded in any location in Arco jonico, lower part of Salento and Subappennino Dauno areas. The critical resource limiting the occurrence and the persistence of this sedentary and oligophagous species is the availability of a sufficient number of host plants (Vovlas *et al.* 2014). In our surveys, it was observed only on *Aristolochia clusii*, *A. lutea* and *A. rotunda*.

Euphydryas aurinia (Fig. 3b) has suffered a severe decline throughout its European distribution during the twentieth century and for this assessment it is listed in Annex II of the European Community Habitats and Species Directive (92/43/EEC). *E. aurinia* is also included in the Red List of Italian Butterflies (Balletto *et al.* 2015) as Vulnerable (VU). In Puglia this species was first recorded by Cicerale (2007) in Subappennino Dauno. From 2013 and in the following years, authors observed a fairly localized population, but possibly more widespread, in Subappennino Dauno. Researches should be extended to the Gargano area. Other information on the distribution, habitat selection and life cycle needs additional investigation.

Melanargia arge (Fig. 3a) is endemic in central and southern Italy. It is considered threatened in Europe and included in the Annexes II and IV of the Habitats Directive. In the Red List of Italian butterflies, *M. arge* is listed as Least Concern (LC). Simes (1920) mentioned the presence of *M. arge* "...near Brindisi". De Togni (1948) reported the species for the inner part, and Zangheri (1956) documented its presence along the coastal strip of Gargano. During our surveys we encountered this species in more than 20 sites in all sub-regions.



Fig. 4a. *Iolana iolas*, Accadia, May 2020. © Giuseppe Cagnetta.

Fig. 4b. *Melanargia russiae*, Santeramo in colle, June 2012. © Giuseppe Cagnetta.

Conclusion

In this paper we update the known butterfly fauna in Puglia to 120 species, and include a review of the information available in literature, together with recently recorded data. In the checklist, we report new localities and species previously unrecorded in the butterfly fauna of Puglia. The total number of butterfly species recorded amounts to 40% of the total Italian and approximately 24% of the total European butterfly fauna. We emphasise the presence and distribution of remarkable species for butterfly conservation and nature management point of view, such as *Zerynthia cassandra*, *Euphydryas aurinia* and *Melanargia arge*. Questionable occurrences have been excluded from the list, in the absence of voucher specimens or other evidence. For example, *Aphantopus hyperantus* and *Hipparchia alcyone* were cited only by Wimmers (1931) for Gargano. The number of species in Puglia compares favourably with that of neighbouring Italian regions (Sciarretta & Parenzan 2001), considering the geographical context and in spite of the two major threats in Puglia: extensive agricultural system and anthropogenic pressure caused by tourism.

This checklist is intended to be a starting point for new research, opening the way to further investigation. There

are many unpublished records, some areas remain unexplored, knowledge of the distribution of Apulian butterflies still remains incomplete. For example, ecological requirements of species present on both sides of the Adriatic Sea, such as *Melanargia russiae*, *Melitaea trivia* and *Charaxes jasius* require elucidation.

The updated checklist has increased the known number of species, but there is a strong possibility that new species will be added in the future. We hope that this contribution will encourage more people and public decision-makers to increase the efforts to better understand the distribution and the population status of butterflies in Puglia and South Italy.

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Appendix 1

Checklist of butterflies of Puglia with their updated presence in the localities surveyed. Available at http://www.phegea.org/Phegea/Appendices/Phegea48-4_S1.pdf

Appendix 2

Review of published records. Available at http://www.phegea.org/Phegea/Appendices/Phegea48-4_S2.pdf