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LEPIDOPTERA
Papilionoidea

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FAUNA D'ITALIA

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e dell'UNIONE ZOOLOGICA ITALIANA
con il patrocinio del MINISTERO DELL'AMBIENTE E DELLA TUTELA
DEL TERRITORIO E DEL MARE

BUTTERFLIES LEPIDOPTERA Papilionoidea

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CALDERINI

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FOREWORD

For people of many backgrounds and cultures, butterflies are signs of the incoming spring. Winter is over, finally. They contribute to the fascination afforded by grasslands, already studded with flowers, by offering their varied, vivid colours. For these people, walking about through such a marvel, on seaside or up in the mountains, accounts for a perhaps small, but sizable part of the pleasures of life. Some ecologists call this an 'ecosystem service'.

Field naturalist make no exception but are more inquisitive, they wish to know what and why, at various levels and in different combinations. 'Butterfly people' are just a small part of the latter, but come in many kinds, almost as varied as butterflies themselves.

Some are mainly attracted by species variety. One, ten, one thousand species, each with its own peculiar characters, each different from any other. Most hope to discover a 'new' butterfly and sometimes it happens, mainly in some exotic country, but occasionally even down here. If not really new to science, it can be at least new to my collection. This, however, marks a difference between amateurs and professionals, or at least it would be expected to.

While in the past morphological analysis used to be relatively easy, matters have steadily turned more and more complex. The study of wing colours and patterns had to make room to that of wing venation, exo- and endoskeletal features of the thorax and of genital organs, examination of androconial scales, geometrical morphology... The scope of butterfly (and insect) taxonomy has expanded to such a level that at one point in history it all but became abandoned by most University based students, only excluding those working on pest species, and irrespectively of personal inclinations. In mainland and northern Europe, like in America and elsewhere, it survived in Museums, but this was hardly possible in Italy, or marginal, at most, and increasingly so.

This was mainly because grasping the morphological intricacies of a single group, even of a single Family, takes at least ten years of unabated study. Publish or perish. In the meantime other colleagues were able to produce lots of papers, and got advancements in career.

Luckily enough, butterfly study was continued by non professional enthusiasts.

However, counting of chromosomes and gene-enzyme studies after sometime gave way to DNA sequencing, which brought about a mass of extremely important phylogenetic and biogeographic information. Now any undergraduate student can master DNA extraction in the turn of a fortnight. Sequencing may be contracted to privates. New 'impact-ranked' journals have mushroomed everywhere. DNA studies salvaged taxonomy, and might eventually come to kill

it. Symptoms are noticeable already. Even the mere existence of an International Code of zoological Nomenclature is very frequently ignored.

Others are less attracted by morphological differences or by phylogenetic relationships than they are by biological features. Jeremy Thomas, in his celebrated book on the butterflies of Britain, tells us how his well known illustrator cum co-author, Richard Lewington, became so fascinated by the subtle beauty of his first chrysalid of a Red admiral that he felt that he should illustrate every stage of the life history of each British butterfly. This was very much along the path set by T. A. Chapman and F. W. Frohawk in the beginning of the previous Century, and by E. B. Ford in later years, but was surely not the case, initially, for most Italian and S. European students.

However, interests are slowly changing, together with the increasing numbers of Italian field naturalist. That of butterfly biology is a huge research field. Papers dealing with subjects such as adult and larval ecology, differential foodplant use, regulation of population size, parasitoids and their intricate life histories, myrmecophily, mimicry, mating behaviour, visual and olfactorial acuity and physiology, or differential vagility and migratory behaviour, number already in the tens of thousands. Yet, in many cases they have just come to scratch the surface. Most of these subjects remain almost unexplored in the south of Europe, although with some notable exception, and just in some cases. There are so many butterfly species in the Mediterranean area!

Butterfly numbers are dwindling, mainly due to changes in land use and in global climate. If N. America may be taken as a mirror of how Europe will look like in twenty or thirty years, then we are in for trouble. In the U.S you can walk for half a day across farmland or along road verges and see just two or three Small whites, introduced from Europe together with as allochthonous cattle fodder grass.

As amply frequented as the field of butterfly conservation was in northern and central Europe for almost 50 years, it generally remained untackled, in Italy, until the European Habitats Directive came to foster much needed funding opportunities. Butterfly conservation, like animal conservation at large, generally follows a species by species approach. It starts by generating suitable habitats for adult ecological needs, including courtship sites and nectar sources, as well as abundant enough foodplant growth to attract ovipositing females. Monitoring results obtained by the management of specifically created natural reserves allows learning from errors.

Another approach has started to develop in more recent times, based on the identification of species groups characterised by sufficiently homogeneous morphological and physiological traits to be considered guild units, whose members can be dealt with all together for conservation purposes. This remains, for the moment, rather in the theoretical domain, but potentials appear promising.

So this is, in a nutshell, what butterfly field studies, from the simplest to the most complex, are about today, and here is where this work tries to fit in.

Introductions, apart from forewords, are generally the least read part of any book, and invariably the most difficult to write. Yet, gaining a grasp of morphological features will reveal important for a full understanding of the 'special

part' of this work. Besides, butterfly biology is full of marvellous details, not all of which are fully developed among European and Italian species, while general arguments are not repeated in the special part.

In our treatment of individual species we have endeavoured to deal with all the aspects we have just summarised, without privileging any of them. We detail nomenclatural and morphological issues, as well as what is currently known about the biology and ecology of each taxon, at all levels, but we do not normally deal with subspecies.

Common species are normally investigated only where they are uncommon, or at least where species are reasonably few, such as in Britain or in Scandinavia. Regretfully, this means that some of the ecological details that we provide for such butterflies may not fully correspond to those that would be observed in Italy.

Since, together with vertebrates, butterflies are among the biologically best known animal groups, in many cases we had to limit ourselves to the more general aspects, while providing citations of the most important papers dealing with special issues. We trust that readers interested in any individual species will find enough materials to orient themselves, also based on the literature lists provided in every cited paper.

Emilio Balletto

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CREDITS

The photographic pictures shown in the plates have been generously and freely provided by the following friends and colleagues:

	Male	Female	Larva	Pupa	
1	<i>Iphiclides podalirius</i>	x	x	PM	PM
2	<i>Papilio machaon</i>	x	x	MA	FM
3	<i>Papilio saharae</i>	x		LV	
4	<i>Papilio hospiton</i>	x	x	CaCa	CaCa
5	<i>Papilio alexanor</i>	x	x	CaCa	CaCa
6	<i>Zerynthia polyxena</i>	x	x	MZ	WW
7	<i>Zerynthia cassandra</i>	x	x	MZ	CaCa
8	<i>Parnassius apollo</i>	x	x	PM	PM
9	<i>Parnassius mnemosyne</i>	x	x	PM	PM
10	<i>Parnassius phoebus</i>	x	x	CC	WW
11	<i>Erynnis tages</i>	x	x	WW	WW
12	<i>Pyrgus malvae</i>	x	x	WW	WW
13	<i>Pyrgus malvoides</i>	x	x	GC	GC
14	<i>Pyrgus andromedae</i>	x	x	WW	WW
15	<i>Pyrgus cacaliae</i>	x	x	WW	WW
16	<i>Pyrgus carthami</i>	x	x	WW	WW
17	<i>Pyrgus sidae</i>	x	x	WW	WW
18	<i>Pyrgus serratulae</i>	x	x	WW	WW
19	<i>Pyrgus carlinae</i>	x	x	WW	WW
20	<i>Pyrgus cirsii</i>	x	x	WW	WW
21	<i>Pyrgus onopordi</i>	AB(EG)	AB(EG)	WW	WW
22	<i>Pyrgus armoricanus</i>	x	x	WW	WW
23	<i>Pyrgus foulquieri</i>	x	x	WW	WW
24	<i>Pyrgus picenus</i>	x	x		
25	<i>Pyrgus alveus</i>	x	x	WW	WW
26	<i>Pyrgus accretus</i>	x	x	WW	WW
27	<i>Pyrgus centralitaliae</i>	AB(EG)	AB(EG)		
28	<i>Pyrgus warrenensis</i>	x	x	WW	WW
29	<i>Spialia therapne</i>	AB(EG)	AB(EG)	WW	WW
30	<i>Spialia sertorius</i>	x	x	GC	GC
31	<i>Spialia orbifera</i>	AB(EG)	AB(EG)	WW	WW
32	<i>Carcharodus alceae</i>	x	x	GC	PM
33	<i>Carcharodus lavatherae</i>	x	x	WW	WW
34	<i>Carcharodus baeticus</i>	x	x	GC	GC
35	<i>Carcharodus floccifer</i>	x	x	GC	GC
36	<i>Muschampia proto</i>	x	x	GC	GC
37	<i>Heteropterus morpheus</i>	x	x	WW	WW
38	<i>Carterocephalus palaemon</i>	x	x	WW	WW

39	<i>Gegenes nostradamus</i>	x	x	WW	WW
40	<i>Gegenes pumilio</i>	x	x	WW	WW
41	<i>Thymelicus lineola</i>	x	x	PM	PM
42	<i>Thymelicus sylvestris</i>	x	x	GC	GC
43	<i>Thymelicus acteon</i>	x	x	GC	GC
44	<i>Ochlodes sylvanus</i>	x	x	GC	GC
45	<i>Hesperia comma</i>	x	x	WW	WW
46	<i>Leptidea juvernica</i>	AB(EG)	AB(EG)		
47	<i>Leptidea morsi</i>	PP PP			
48	<i>Leptidea sinapis</i>	x	x	PM	PM
49	<i>Leptidea reali</i>	AB(EG)	x		
50	<i>Colias hyale</i>	x	x	WW	WW
51	<i>Colias alfacariensis</i>	x	x	PM	PM
52	<i>Colias phicomone</i>	x	x	WW	WW
53	<i>Colias crocea</i>	x	x	PM	PM
54	<i>Colias palaeno</i>	x	x	CC	WW
55	<i>Gonepteryx rhamni</i>	x	x	CaCa	CaCa
56	<i>Gonepteryx cleopatra</i>	x	x	CaCa	CaCa
57	<i>Anthocharis euphenoides</i>	x	x	CaCa	CaCa
58	<i>Anthocharis damone</i>	x	x	PM	CaCa
59	<i>Anthocharis cardamines</i>	x	x	PM	PM
60	<i>Euchloe crameri</i>	x	x	WW	WW
61	<i>Euchloe insularis</i>	x	x	CaCa	
62	<i>Euchloe ausonia</i>	x	x	PM	PM
63	<i>Euchloe simplonia</i>	x	x	CaCa	CaCa
64	<i>Euchloe tagis</i>	x	x	WW	WW
65	<i>Aporia crataegi</i>	x	x	PM	PM
66	<i>Pontia callidice</i>	x	x	WW	WW
67	<i>Pontia daplidice</i>	x	x	WW	WW
68	<i>Pontia edusa</i>	x	x	PM	PM
69	<i>Pieris brassicae</i>	x	x	PM	PM
70	<i>Pieris manni</i>	x	x	WW	WW
71	<i>Pieris rapae</i>	x	x	PM	PM
72	<i>Pieris ergane</i>	x	x	PM	PM
73	<i>Pieris napi</i>	x	x	PM	GC
74	<i>Pieris bryoniae</i>	x	x	WW	WW

LEGEND

x	Directly obtained by the authors
AB(EG)	Alessandro Bisi (Enrico Gallo)
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CC	Cristiana Cerrato
FM	Francesca Martelli
GC	Giuseppe Cagnetta
LV	Laurent Voisin
MA	Michela Audisio
PM	Paolo Mazzei
PP	Paolo Palmi
WW	Wolfgang Wagner

AN OUTLINE OF ITALIAN BUTTERFLY STUDIES

THE PRE-LINNEAN AUTHORS

Since the early times of European studies in natural history, and well before the publication of Linné's seminal work, the very rich and diverse Italian butterfly fauna has raised considerable interest by amateurs and professional students alike.

This was not yet very much the case for Plinius Caius Secundus, better known as Pliny the Elder. In full agreement with Aristoteles' conception, Pliny paid little attention to butterflies, of which he only made some passing observation in the first part of Liber XI (Insecta) of his "*Naturalis Historia*" (AD 77), where butterfly development was briefly outlined [112 (37)], but dealt at length, in contrast, with the much more useful bees.

In 1544, Pier Andrea Mattioli published in Venice the first edition of his conspicuously annotated Italian translation of the 5 books of Pedanio Dioscorides' "*De Materia Medica*" (Περὶ ὕλης ἰατρικῆς; AD 50-70 ca.) where the "translator" ("*Nel secondo Lib. di Dioscoride, Cap. LIII: Dei Bruchi*") describes butterfly development from egg to early larva, caterpillar's growth, the pupa (which he calls 'Aurelia'), and finally the emergence of the adult butterfly ('Pauilione'). Mattioli was first to argue forcefully against Pliny's concept that butterfly eggs originate from honeydew condensing under the action of the sun rays, and declared that he himself had observed butterflies involved in egg-laying. Mattioli left, however, the door half-gaping; stating that he did not wish to contradict what Aristotle had written in "*History of Animals*" (Τῶν περὶ τὰ ζῶα ἱστοριῶν, ab. 350 BC, Lib. V. Chapt. LIII), and suggested that maybe caterpillars do, sometimes, originate spontaneously. None of Mattioli's many editions, not even the one published in 1565, which is the richest and the most lavishly adorned with hundreds of copper engravings, apparently depicted a single butterfly.

The gap was finally filled with the publication of the 3rd edition of Fabio Colonna's (1616) work. The chapter of this book titled "*Minus cognitarum stirpium pars altera*" (p. 86) includes a beautiful copper plate of what is probably the first representation of an Italian butterfly (*Papilio machaon*) and of its preimaginal instars (i.e. *Eruca rutacea*, *Chrysalis eiusdem* [in dorsal and lateral view], *Papilio eiusdem*). In the text accompanying the plate ("*Erucae Rutaceae, eiusque Chrysalidis, & Papilionis Obseruatio*": pp. 85-89) the author stresses that there is no doubt that butterflies lay eggs, a notion that was finally made generally acceptable by William Harvey (1651). F. Colonna also observed that caterpillars [of *P. machaon*] eat only *Ruta*, and that the larvae of various butterfly species eat only those plants on which they were born.

Ulisse Aldrovandi's seminal work, posthumously published in 1638, is arguably the first textbook of Entomology. Most of its 2nd "liber" (i.e. Chapt. I-VII, pp. 235-298) is dealing with Lepidoptera, featuring special parts on their biology, ecology and cultural significance (Praesagia, Proverbia, Mores et Ingenium, Nocumenta). The plates depict generally well recognisable adults of the species that are currently known as *Papilio machaon*, *Iphiclides podalirius*, *Pieris brassicae*, *Colias crocea*, *Argynnis paphia*, *Vanessa cardui*, *Nymphalis antiopa*, *Polygonia c-album*, *Satyrus ferula*, *Lasiommata megera*, *Coenonympha pamphilus* etc. together with a number of more or less recognisable moths. Thirty years there-

after, Francesco Redi (1668) described in detail the development of some butterfly species, which, although left unnamed, are perfectly identifiable as *Papilio machaon* (p. 170-171), or *Pieris rapae* (p. 172), while also describing some tachinid and ichneumonid parasitoids of the latter (p. 172-173).

Jan (Johannis) Swammerdam (1685) was first to propose a classification of Insects based on their development. Since then, many other “historical” books have accumulated over time, but we are not going to deal here with authors not involved in the study of the Italian fauna. The original descriptions of the butterfly species occurring in Italy are mainly due to C. European authors, which we will mention in the taxonomic part of this book.

THE POST LINNEAN AND MODERN AUTHORS

Among Italian publications mainly or exclusively dealing with butterfly taxonomy or geography, the most important, or more strictly scientific, published in the XVIII Century, are those by Scopoli (1763), Allioni (1766), Petagna (1786), Cyrillo (1787), Rossi (1790), Giorna (1791) and de Prunner (1798). Among authors working in the XIX Century, we can cite de Loche (1801), Bonelli (1826), O. Costa (1836), Gené (1839), Ghiliani (1852), Bertoloni (1844), Stefanelli (1869, 1900-01), Franceschini (1879), Sordelli (1885), Curò (1885, 1874-90), Gianelli (1890), Turati (1879-1933), Minà-Palumbo & Failla-Tedaldi (1889), or Mariani (1930-1957) and Verity (1905-1957) as concerns those of the beginning of the XX.

Roger (Ruggero) Verity's monumental work, vastly criticised for its taxonomic approach (but see below) and rarely praised for its many merits, was extremely influential in ‘educating’ at least two generations of Italian lepidopterists.

In 1988, Sergio Beer offered a loving, sometimes witty and always endearing memory of the past 60 (currently 90), and more, years of Italian butterfly studies, at the 6th Congress of European Lepidopterology (Sanremo 9-9/04/1988, see Beer 1991). On this occasion, this author gave a description of the work of such authors as Emilio Turati, Ruggero [Roger] Verity, Ubaldo Rocci, Attilio Fiori, Orazio Querci, Federico [Fred] Hartig, as well as of Leonardo de Prunner, Giuseppe Gené, Vittore Ghiliani, Pietro Rossi, Oronzio (Oronzo) Costa, Luigi Failla-Tedaldi, Antonio Curò, Fortunato Rostagno, Renato Perlini, Mario Mariani and many more. Conci & Poggi (1996) published the portraits of many Italian entomologists of the past, together with some essential information on their biographical data.

THE STATE OF THE ART

If the work of these, and other, old or ancient authors, represents the foundations of Italian butterfly studies, information, of course, has continued to accumulate throughout the past several years. The first edition of the Checklist of Italian butterflies featured 275 species (Balletto & Cassulo 1995), while in a more recent edition (Balletto *et al.* 2014) their number has raised to 290, and is probably still bound to increase, although perhaps slightly.

Around a dozen species, all listed in both editions, remain controversial. Among these, it is worth mentioning taxa included in the complexes of *Pyrgus alveus* and of *P. foulquieri*, those of the *Lycaena hippothoe* group, one *Lycæides*,

two or three *Polyommatus* (subgenus *Agrodiaetus*), as well as those of the *Euphydryas aurinia* complex.

To come to the newly discovered species, a peculiar case concerns the recent finding of some whose presence on Italian territory had been previously overlooked. *Euphydryas maturna* (or *E. italica* Back *et al.* 2015) a Habitats Directive species (!) was demonstrated to occur at a very small site in the Italian S.W. Alps. Its presence in the area had been reported as early as in the late 18th Century (de Prunner 1798), but only by Rocci (1911) in relatively more recent times. No one, however, really seemed to trust these records, until the species was rediscovered, and very unexpectedly so, by Gallo & Gianti (2003). Another, but totally “new” finding relates to *Callophrys avis*, a west Mediterranean species discovered by Bonifacino *et al.* (2009), again in N.W. Italy (W. Liguria), at a site not even very close to the French border. Even though Verity (1943) had hypothesised that this species might one day be found in Italy, no one had ever reported a single specimen from the Italian political territory. Finally, Nardelli & Huemer (2016) discovered a population of *Erebia claudina*, formerly considered the one and only butterfly species endemic to Austria, in N.E. Italy.

More recent developments were generated by proposals for the splitting of several ‘cryptic species’, either as a consequence of a combination of new and more detailed morpho-anatomical, or biological, more frequently molecular, investigations. This is the case for a series of taxa formerly considered conspecific, such as *Zerynthia polyxena*-*Z. cassandra*, *Leptidea sinapis*-*L. reali*-*L. juvernica*, *Polyommatus icarus*-*P. celinus*, *Melitaea phoebe*-*M. ornata*, *Melitaea athalia*-*M. nevadensis*, or *Coenonympha darwiniana*-[*C. macromma*]-*C. gardetta*-*C. arcania*. Doubts may still be raised as concerns the taxonomic status of some of these and other taxa, such as for instance in the case of *Coenonympha pamphilus*-*C. lyllus*, which are represented by allopatric mitochondrial lineages accompanied by slight morphological diversification, and of *Hipparchia hermione*-*H. genava*.

In relatively few additional cases, the increase in the number of our butterfly species has been a result of the natural range expansion of some tropical species, perhaps because of current climate changes. This is the case for *Danaus chrysippus*, historically reported only once, from Torre del Greco (Naples), in 1805 (Gagliardi 1811), but which became a stable Italian resident only in the years around 1980 (Gatto 1985, Leigheb & Cameron-Curry 1999). *Zizeeria karsandra* was first observed in Sicily around Marsala (Bigot & Stempffer 1954), wherefrom it almost immediately disappeared, but was found again on the Isle of Lampedusa some years later (Romano & Romano 1995). Finally, *Azanus ubaldus*, a generally Paleotropical species having presumably spread from N. Africa, was observed for the first time on the Isle of Lampedusa, in 2010 (Caporale & Guidi 2013).

Cacyreus marshalli represents a different case, since it is an alien species of S. African origin, accidentally introduced in S. Europe in the end of the last Century (first reported as established on Mallorca in 1989 by Eitschberger & Stamer 1990, see also Sarto i Monteys 1991). Therefrom it quickly managed to spread to the Iberian Peninsula and eastwards all across the N. Mediterranean, to reach Greece in 2010 (Martinou *et al.* 2011), W. Turkey in 2011 and Crete in 2016 (John *et al.* 2018). In Italy, *C. marshalli* was first observed in Rome (1996: Trematerra *et al.* 1997) and spread, either by repeated incidental introductions or by active flight from areas of original introduction, to most other regions. It

currently occurs all over the Country and is probably becoming naturalised on indigenous species of *Geranium*, from its native *Pelargonium* (Quacchia *et al.* 2008). Arrivals of alien insect immigrants are observed in increasing numbers all over Europe and, in the case of butterflies, some are more likely than others to reach the Italian shores in the near future. This may be the case for the N. American polyommataine *Brephidium exilis*, a highly polyphagous species which became established all over the Arabian Gulf already in 1995 (Pittaway *et al.* 2006). *Chilades pandava*, an Oriental species that develops on *Cycas*, ‘reached’ Taiwan and Madagascar in the beginning of this Century (Wu *et al.* 2010), and ‘spread’ to the United Arab Emirates (Feulner *et al.* 2014) and to Egypt (Fric *et al.* 2014) even more recently. Other strongly migratory species, such as *Danaus plexippus*, *Hypolimnas misippus* and *Vanessa virginiensis* have colonised the Macaronesian Islands, but the latter of these is known to occur also on the Portuguese mainland and even, although very rarely, on the S.W. coasts of Ireland and England (see Asher *et al.* 2001, Schmitt 2003).

If, generally speaking, the progress of the taxonomic and faunal studies carried out on Italian butterflies has paralleled that of the other European and North American countries, the same does not generally apply to biological and ecological investigations. Reasons for this asymmetry are generally unclear, but we can observe that, for a long time, the interests of Italian entomologists were generally aimed at the discovery of the “new” species still likely to be offered by the rich and diverse fauna of this country, while biological investigations were often neglected. Larval foodplants consumed by butterflies on the Italian territory, therefore, have remained almost completely unknown for quite a long time, as well as their relative larval developments, and authors tended to refer to information deriving from other parts of Europe, mainly from Germany, the UK or, sometimes, France. In more recent times, however, several valuable attempts to meet this lack of information have been made, such as those by Bolognesi (1999), and particularly by Villa *et al.* (2009) and by David Jutzeler and his co-workers (see to the special part of this volume).

MORPHOLOGY

The morphological features of the eggs, larvae and adults of Lepidoptera are described in a large number of books, both historical and recent, and either popular or of a more strictly scientific nature (see Herrich-Schäffer 1843, Spuler 1901, Ghidini 1949, Forster & Wohlfart 1954, Emmel 1975, Bourgogne 1979, Scott 1986, Weidemann, 1986-88, Eaton 1988, Ackery *et al.* 1999 and Scoble 2002). Our aim, therefore, is not to provide here an exhaustive account of all the many details of butterfly morphology, which can be easily found elsewhere. Rather, we will generally limit ourselves to describe those characteristics that are necessary for the general understanding and the correct identification of the butterfly species, as they will be observed in nature.

PREIMAGINAL INSTARS

Like in all other holometabolous insects, as soon as the egg hatches, butterflies start to develop along a series of larval stages, ending with the formation of

the chrysalis or pupa, from which the adult butterfly will finally emerge. As concerns the Italian fauna, Francesco Redi was first to describe the development of several, perfectly identifiable, butterfly species as early as in 1668 and may have been among the first, in this, throughout the European literature.

EGGS

The eggs of Lepidoptera come in a variety of shapes, from globular to depressed and limpet-shaped, or from erect and cylindrical to fusiform, and frequently differ, although slightly, even between species (see Döring 1955). Generally speaking, the Papilionidae lay dome-shaped, almost spherical eggs. The eggs of the Hesperidae are similar, in shape, to those of Papilionidae but, apart from being smaller, their chorion is seldom as smooth and frequently carries a series of ridges, tubercles or facets. Those of pierids are upright, ribbed, spindle- or bottle-shaped (fusiform); those of nymphalids are more or less thick, and barrel shaped, depending on subfamilies, while the eggs of lycaenids are similar to flattened disks (see Porter 1992 as concerns British butterflies).

The chorion is secreted by the ovarian follicles, and although it may be smooth in some cases, it more frequently carries a whole series of micro sculptures; their function is of regulating water evaporation rates and egg temperature. The egg's apex bears normally 4 (but up to 40 in some moths of the family Notodontidae), minute openings, or micropyles, through one of which the spermatozoon will penetrate. Aeropyles permit gas exchange by the embryo (see Mazzini 1974).

Eggs vary in shape, surface and colour, particularly among families (see Döring 1955, Porter 1992, and García-Barros 1994, 2000a). Egg size varies among butterfly species by a factor of about 20, but variation in size occurs also at intraspecific level. At least in the case of tropical butterflies (*Bicyclus anynana*), variation is temperature-mediated, as an adaptation to predictable seasonal change, the eggs being larger if females have been acclimated to lower ambient temperature (Steigenga *et al.* 2005). Butterfly females normally lay their eggs singly, sometimes in small groups, more rarely in batches (see below).

A key for the identification of eggs at family level is provided on p.p. 115-117. We will describe the eggs of individual Italian butterflies in the special part of this book.

LARVAE

Butterfly larvae, or caterpillars, are extremely variable in their shapes, but all are of the 'eruciform' type that is characteristic of Lepidoptera (Fig. 1).

The head capsule is strongly built. It carries two short 'antennae' (3 articles), which are not homologous to those of the adults, since the latter will be generated independently, during metamorphosis. Vision is guaranteed by 12 'ommatidia' (stemmata): 6 on each side, allowing to focus the image only from very short distances. The mouthparts, strictly of the mandibulate type, are principally represented by the well-sclerotised mandibles, always vertically oriented under the head capsule (orthognathous condition). The lower lip (labium) derives from the fusion of several more or less reduced parts, such as the

maxillae and the labium. The latter shows, in the middle, the external opening of the sericigenous glands (spinnerets), which represent the salivary glands of adults, while saliva is produced by separate glands (Lyonnet's glands). Silk is mainly formed of fibroin (75%), an elastic and highly resistant protein. Young L1 larvae will generally use silk to weave a resting pad and, in some species, also to mark trails to and from their resting place and the feeding areas. At pupation, caterpillars of some of the most basal Papilionoidea (Papilionidae: *Parnassius*, many Hesperidae, but not the Hedyliidae) use this silk to spin a more or less loose cocoon to protect the chrysalis; others produce a communal nest within which they will retire at night or under bad weather conditions (e.g. *Aporia*, *Euphydryas*, *Aglaia*). Caterpillars of other species use a silk thread to descend from the original (or initial) foodplant and start a new life elsewhere. Once secreted, the silk crystallises and shrinks considerably, thereby allowing species whose caterpillars live inside a refuge (Hesperidae etc.) to roll a cylinder made of one or more tightly curled leaves.

The thorax is composed of the 3 usual segments (pro-, meso- and metathorax). Each of these segments carries a pair of legs, while only the first of them bears also a pair of respiratory spiracles.

The larval abdomen is made of 10 segments, the first 8 of which have spiracles. Each of the segments 3-6 and 10 carry also a pair of fleshy pseudo-legs (or prolegs), distally ending in numerous minute hooks (crochets), circularly or longitudinally arranged. In first stage larvae, crochets are generally disposed in a ring, but in later stages, this condition will be maintained only in the Hesperidae, while in other families crochets will become roughly arranged semi-circularly or otherwise linearly. In lycaenids, the hooks on the false legs are set in 1-2 series, separated or accompanied by a fleshy sole allowing the larva to walk on smooth surfaces.

Male genital organs are already present in larvae and are represented by the testes, generally fused into a single, red coloured sphere (yellow in lycaenids). They are located dorsally, in most cases within the 5th abdominal segment.

Larval teguments may be smooth or, more often, carry sets of micro-spines, or spinules. In very early stages, each thoracic and abdominal segment bears one or more primary bristles (setae) whose exact number and position (chaetotaxis) may be characteristic, and change between even closely related species (Fracker 1915, Hinton 1946).

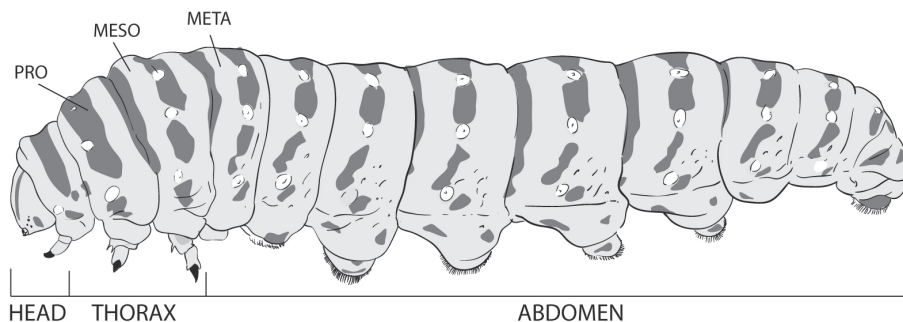


Fig. 1 - Generalised caterpillar of a Papilionid butterfly (*Papilio machaon*).

Butterfly caterpillars are generally of a roughly cylindrical shape, but their morphologies are very variable among families, which can be easily recognised even in the field. Those of the Papilionidae, for instance, are anteriorly 'humped', since their 2nd and 3rd thoracic segments, as well as their 1st abdominal segment, are more or less obviously inflated. Papilionid larvae are frequently large and brightly coloured. Crochets on their false legs are in a continuous semicircle, devoid of fleshy lobes. Pierid larvae are cylindrical and hooks on their false legs are arranged like in Papilionidae. Nymphalid larvae are peculiar, since their bodies are frequently covered with branched spines, or their head carries at least one pair of small lateral «horns». Lycaenid larvae are flattened and their head can be retracted into the thorax. They carry dorsal and/or lateral glands.

The caterpillars of some butterfly families (Hesperiidae, some Pieridae, etc.) can expel their frass to a considerable distance, apparently thereby avoiding that predators can easily detect their presence. This habit is made possible by the occurrence of an 'anal plate', a comb-like structure under the terminal parts of their abdomen, on the supra-anal lobe (Powell 1912, Frohawk 1913, see also Nel 1985, Huertas Dionisio 1987).

A key to the identification of larvae of the Italian butterflies at Family level is provided on p.p. 118-120. We will describe the larvae of each individual Italian butterfly species in the special part of this work.

PUPAE

Butterfly pupae are of the 'obtect' type (Fig. 2), which means that teguments of their head, thorax and abdomen are completely fused. Their eyes and their appendices (antennae, proboscis, wings and legs) are more or less visible but immobile; they are either weakly or strongly cemented, or otherwise fastened, to the body wall. This is the case also for the wings, which are contained in two cuticular cases (pterothecae). In some butterflies the 5th and 6th abdominal segments may show levels of mobility, or are otherwise completely fused with the others. Spiracles are in 9 pairs, one of which is in the thorax and the others in the abdomen. They are all functional. The cuticle is hard, strong and frequently shows some tubercles or ridges. The 9th abdominal segment bears the still imperforated genital furrow, which is single in the male and double in the female (8th and 9th).

At its posterior extremity (10th urite), the chrysalis may bear some hooks or other anchoring systems (cremaster); this structure is typical of the last instar. Depending on families, the chrysalis may just be hanging on the cremaster, or may be fastened to a vertical surface by a silky 'girdle' (succinct pupa), or both structures are present. Pupae can otherwise lay free on the ground among the grass or hidden under rocks, sometimes wrapped in silky threads or in a loose cocoon. Those not concealed in the substrate remain however difficult to observe, because of their mimetic colouration. Detailed descriptions of the pupae of Lepidoptera have been published by Hatchett-Jackson 1891, Poulton (1891), Chapman (1895), Talbot (1839), Mosher (1916), Scoble (2002) etc.

We provide a key to the identification of the pupae of Italian butterflies at family on level p.p. 120-122. We will describe the pupae of the individual Italian butterfly species in the special part of this book.

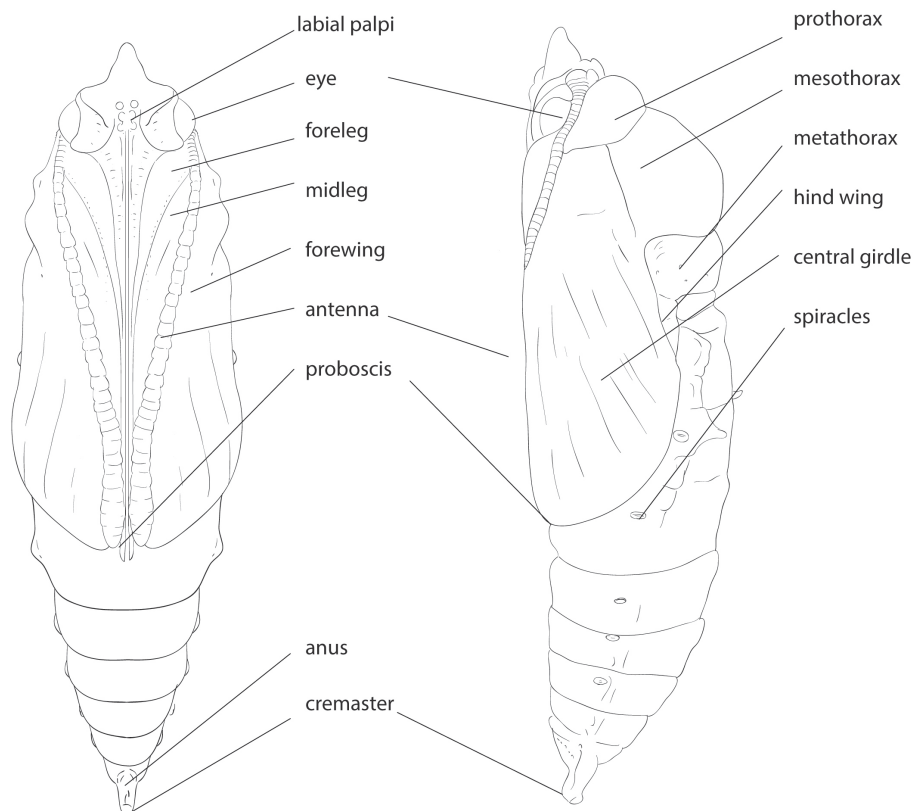


Fig. 2 - A generalised butterfly pupa.

ADULTS

After metamorphosis, butterflies have 4 membranous wings, each more or less completely covered in specialised scales. Wing scales are typical of this insect order and are considered homologous to the trichomes of Trichoptera (see Galant *et al.* 1998). The name « Lepidoptera » derives from their scale-covered wings, but scales occur also all over the body. Those clothing the head, the thorax and the abdomen are generally piliform scales.

HEAD. The head is almost globular and bears at least two pairs of sensory organs, i.e. the antennae and the compound eyes. Mouth parts are reduced to the labrum (upper lip), the maxillae, transformed to form the proboscis, and the labium (lower lip), which carries a pair of labial palpi (Fig. 3).

Eyes. The two compound eyes are set on the head sides. In contrast to moths, whose compound eyes generally look brown or black, butterfly eye colours may change with the angle of incidence of light, because of the reflecting tapetum of ommatidia. In other cases, they may be constantly opaque, or the eye colour may change with age or ecological conditions (Reuss 1951). Adult butterflies (Papilionoidea) do not have ocelli, which frequently occur in other Lepidoptera.

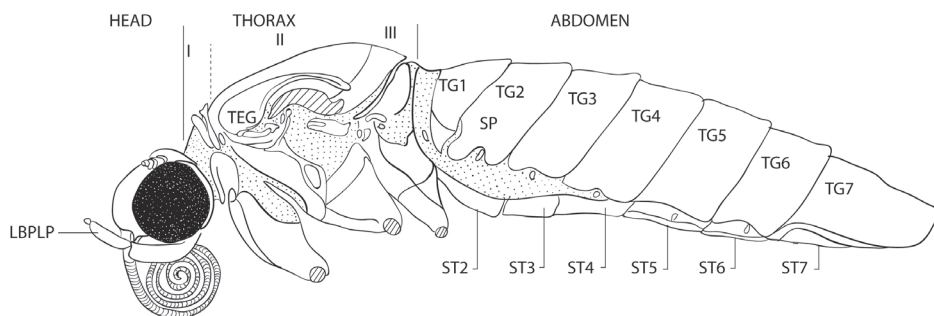


Fig. 3 - Generalised butterfly body (from Eaton 1988, redrawn).

Antennae. Dorsally, between the compound eyes, the head carries the two antennae, which in the case of butterflies may be either hooked at apex, as in most Hesperiidæ (or ‘skippers’), sometimes called ‘grypocera’, because of this characteristic, or more or less distinctly clubbed, in other families (‘rhopalocera’). The antennae carry a large number of sensilla, whose main function is to capture and identify the volatile molecules (smells).

Mouthparts. The mouth parts of some basal Lepidoptera, i.e. the Micropterigidae (all continents), the Heterobathmidæ (S. America) and the Agathiphagidi (2 species: S.W. Pacific), include more or less functional maxillae and mandibles, whose presence, at least in the former family, is connected with pollen manipulation (see Scoble 2002, Krenn 2010).

In contrast, the mouth parts of all other Lepidoptera (Fig. 3) are only represented by I) the labrum (upper lip), which dorsally closes the oral cavity; II) the very elongate maxillae, transformed into the proboscis; III) the transversally set labium (lower lip), which carries, on the two sides, the 3-segmented (labial) palpi used, sometimes, to clean the proboscis. At the distal extremity of each palp is present a cavity containing sensory setae (see Reuter 1896 for a very detailed study of the structure of the latter organs). All the sensilli occurring on the oral parts probably have both olfactory- and gustatory-like functions.

THE THORAX. The head is attached to the thorax by the “neck”, a short joint bearing no appendages and on which the head turns only to the two sides (not up and down). Like in all other insects (the Latin word “Insecta” means cut into pieces), the thorax is made of three segments (pro-, meso- and metathorax). Each of these segments bears a pair of legs. The prothorax is the smallest and carries no other appendages. The meso- and metathorax also bear a pair of wings each (Fig. 3).

The legs. Legs are more or less shaped as in the generalised type observed in the majority of other insects, with the coxa, trochanter, femur, tibia, and tarsus, which distally ends in a short joint carrying two nails (pretarsus). Butterflies legs often bear one or more tibial spines or spurs (Hesperiidæ: Lycaenidæ); in some groups they also have a tibial epiphysis, sometimes used for cleansing the antennae, or otherwise covered in scales and externally almost invisible (see Eaton 1988).

In butterflies of both sexes, the tarsi of the prothoracic legs have fully functional walking capability only in the three most basal families, i.e. in the Papilionidæ,

Hesperiidae and Pieridae. In the Hedyliidae, the male forelegs are fused. In male lycaenids, articles of the fore tarsi are fused too, whereas in females the prothoracic legs can be generally used for walking. Tarsal segments can otherwise be vestigial also in the females of some species. In nymphalids (s. l.), the fore tarsi are strongly modified and, in males, all tarsal segments are either completely absent or, more commonly, strongly reduced (see Fox 1966, and Shirozu & Shima 1979 for the case of the satyrines of the genus *Ypthima*; see also Wolfe *et al.* 2011 for a more in-depth analysis). Tarsal claws are generally simple, or double, in pierids only.

The wings. Lepidoptera are typically four-winged insects, having a pair of fore- (mesothoracic) and another of hind- (metathoracic) wings. Both wing pairs are membranous, never sclerotised, and the relative stiffness that is necessary to insure flight is provided by a series of wing veins. Shape, size and venation differ between the two pairs and while both may be strongly reduced or even absent in the females of some moths (see Heppner 1991), this is not normally the case for butterflies, with the only known exception of *Redonda bordoni*, a satyrine nymphalid from Venezuela (Viloria *et al.* 2003).

In contrast to many other Lepidoptera, butterflies can move their forewings rather independently from the hindwings, since the two pairs are not respectively connected by any co-optation structure. Both the retinaculum and frenulum are normally absent, with the only exception of male *Euschemon rafflesia* (Hesperiidae: Pyrginae). Some perhaps reminiscent structures are observed in *Gegenes* (Hesperiidae: Hesperinae). In all other butterflies, wing pairing occurs because the hind wing's humeral area is cranially expanded and never passes above the anal area of the forewing, during flight. However, as we have seen, this is not a real coupling mechanism.

Wing venation is very variable among Lepidoptera and insects in general (Woodwarth 1906). Butterflies are, in this respect, classified as Heteroneura, since the number and position of the veins observed in the forewings are different from those in the hind ones. Wing venation offers a number of taxonomically relevant characters, both directly, since different families and subfamilies have different vein combinations, and indirectly, since the position of spots, bands and other wing markings are identified in relation to veins (Fig. 4).

In the middle of each wing, we find the discal cell, presumably derived by the fusion of the radial, median and cubital veins. In the lepidopterological literature, we have at least 5 principal systems for identifying wing veins. The most widespread are the one introduced by Herrich-Schäffer (1843-1856) and followed by many British students, and another independently developed by Comstock & Needham (1899) by transforming the previous arrangement by Redtenbacher (1886, already slightly modified by Staudinger & Schatz 1892) (see Comstock 1918 for a review and on p. 345 of that same paper for a comparison of the various systems).

Following the Comstock-Needham method, veins are named, and we will therefore speak of costal, subcostal, radial (R_1 to R_5), median ($M_{1,3}$), cubital (Cu: 1 or 2) and anal (An: 1 to 3) veins. Areas between veins (or 'spaces'), in this case, are indicated by the veins between which they occur (e.g. M_1 - M_2).

In contrast, following the method that was for a long time widespread in the British literature, veins are numbered starting from the abdominal wing corner. Since the 'anal' veins, originating directly from the wing base below the cell, may

vary from 1 to 3, they are always counted as 1 (1a, 1b, 1c). Proceeding in this way, the 'costal' vein will always correspond to vein 12. More or less complete fusions between veins will be indicated, for instance, as 7+8. The same procedure is followed to indicate spaces between veins and s2 refers to the area between v2 and v3, since those between two anal veins are indicated as s1a, s1b, or s1c.

The two methods are equivalent, but one should keep in mind that the numeral order (1-12) proceeds in the opposite direction with respect to the systems based on the names of veins. Both the latter and the numeral system are shown for comparison in Fig. 4.

In the forewings of most butterflies, veins of the radial and sometimes the median system are partially fused at basis, and several may derive from a single stem. The only exception is represented by the Hesperiiidae, where all forewing veins arise separately, either from the wing's base or from the cell (radial, median and cubital veins).

In many Satyrinae butterflies, such as *Maniola jurtina*, the forewing veins 1, 2 and 11 are swollen to contain an auditory, or tympanic, organ (see Vogel 1912, Swihart 1967).

Scales. With a few notable exceptions, such as for instance in the S. American Ithomiinae having fully or partially transparent wings, the wings of Lepidoptera are covered in rows of overlapping scales, each typically 75-200 μm long. The wings' scales come in very variable shapes, depending on their function and on the part of the wing where they occur. The most widespread are the cover scales, which imbricate on each other like the tiles on a roof. On the distal margin, scales form the wing's cilia. Here scales are set in 6 rows, separately on the dorsal and ventral surface, including a proximal series of scales, often short and dark coloured, followed by a second and a third series, of longer and often white scales.

For the practical purpose of describing wing patterns in the special part of this book, we have followed the nomenclature of wing areas shown in Fig. 4.

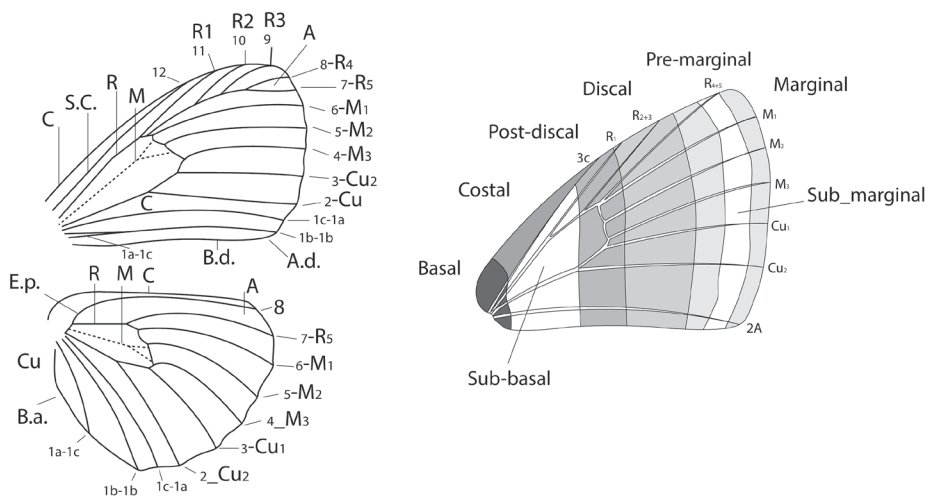


Fig. 4 - Wing veins and areas (modified from Le Cerf 1953, Balletto *et al.* 2014).

ABDOMEN. The abdomen of adult Lepidoptera is composed of 10 segments, 8 of which are free in the case of males, and 7 in females (Fig. 3). The tergite of the first segment is attached to the metathorax. Its sternite is reduced and fused with that of the second segment. Segments 2-8 (in males) or 2-7 (in females) are virtually all identical. Each abdominal segment includes a sclerotised tergite and a sternite, as well as two lateral membranous pleurae. Each of the pleurae from 1 to 7 bears on either side a single opening (stigma) of the tracheal respiratory system, while the pleurae of the 8th segment lack these openings, in all butterflies.

Male genital organs are already present in larvae and are represented by the testes, generally fused into a single red coloured sphere (yellowish in lycaenids), located dorsally, in most cases within the 5th abdominal segment. A pair of accessory glands produce most of the other materials that are transmitted to the female during mating.

The last 2 abdominal segments of male butterflies, or the 3 terminal ones of females, are transformed to form external copulatory organs, generally known as genitalia. In contrast to many Coleoptera, in the case of butterflies the male and female genitalia generally provide important information at family, subfamily, tribe and genus levels, but seldom enough, although with many exceptions, at species level.

MALE GENITALIA. Although the study of butterfly genitalia was initiated by Rambur as early as in 1839 (Faune ent. Andalousie, pl. 8), this author's work remained neglected for at least 70 years (de Jong 2016b) and the study was started again, perhaps independently or however without any mention of Rambur's work, by Scudder (1874) in the case of some N. American hesperiids and by Buchanan White (1879) for European butterflies. Since those times, the male genitalia of European butterflies have been depicted by many authors, which we will cite where appropriate in the main text, but only by a few on a regional basis, such as by Verity (1940-53), and Higgins (1975).

Even though they are extremely variable (Fig. 5), male genitalia always include a tegumen (9th tergite), which may expand into a simple or double dorsal prong called uncus (10th tergite) having the function of limiting the vertical movements of the female's abdomen during mating. The uncus fits into a pocket below the female's papillae genitales (her 9th segment). The 9th sternite forms the vinculum, a ring-shaped sclerite providing some rigidity to the system, on which are inserted, on the two sides, the valvae. These three structures, i.e. the uncus (sometimes accompanied by the gnathos, also originating from the 10th segment) and the valvae, clasp the tip of the female's abdomen and keep it in place during copula. In some Theclini (Lycaenidae), the valvae fit into the female's ductus bursae. The aedeagus is not a real penis, since it simply represents a sheath having the function of penetrating the female's genital opening and of protecting the membranous saccus internus. During mating, the saccus evaginates inside the female's bursa copulatrix, where it reaches the end. After evagination, the outer opening of the male's 'ductus ejaculator' (ejaculatory duct) will open on the sac's inner surface (see Kusnetsov 1929, Lorković 1953a, Sibatani *et al.* 1954, Okagaki *et al.* 1955, Ogata *et al.* 1957, and Niculescu 1973, 1988).

Homologies among all these structures across the extremely variegated insect world have been studied by a number of authors (summarised by Scudder 1971).

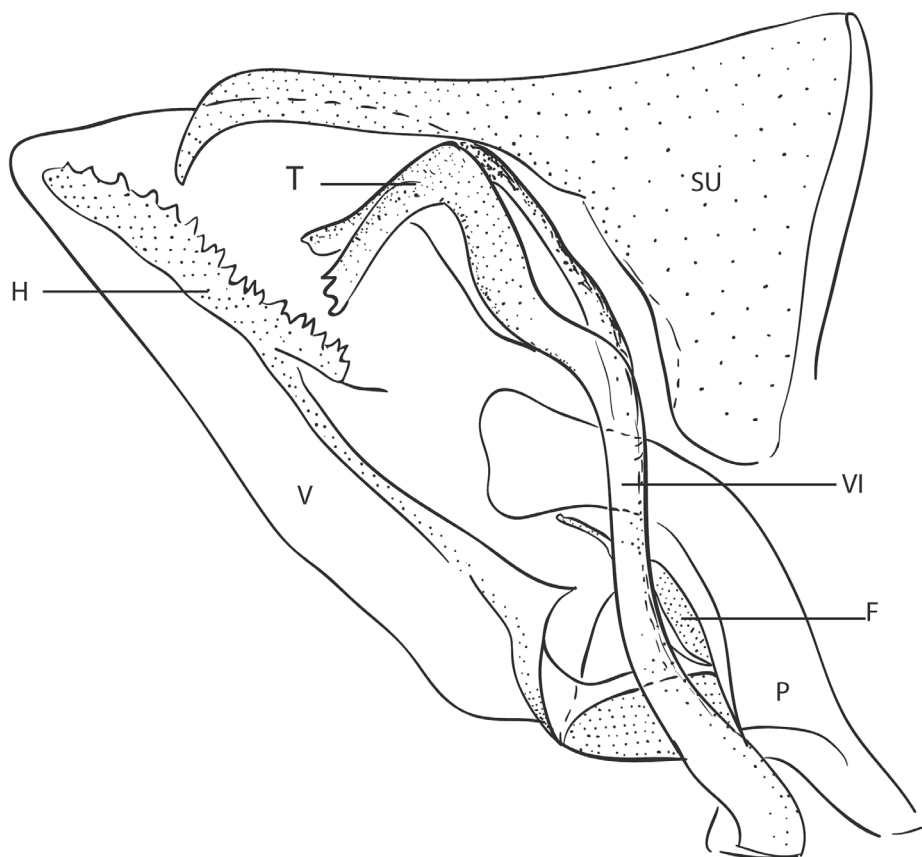


Fig. 5 - Side view of the genitalia of *Papilio machaon* (simplified from Higgins 1975). SU: Superuncus, T: Tegumen, V: [right] Valva, H: harp, VI: vinculum, F: fultura inferior (furca), P: aedeagus.

FEMALE GENITALIA. Female butterflies have one fewer abdominal segment than males, since they seem to have only 9 in total, probably because of the fusion of the 9th and 10th segments. Together with approximately 95% of all Lepidoptera, butterflies (Papilionoidea) are part of the Dytrisia, which are characterised by having females with two distinct genital openings, one of which is used for pairing and the other one for egg-laying (Fig. 6a). The digestive system terminates in a third, the most dorsal, abdominal opening. The most ventral opening is the copulatory one. This opening is located either in front of, or behind, or even between, two genital plaques probably having different origins depending on families; in butterflies it normally occurs between the 7th and 8th sternites. To come to tergites, the 8th forms two ‘anterior apophyses’ for the insertion of the abdominal muscles. The 9th tergite similarly forms the ‘posterior apophyses’, which have the same function as the anterior ones while, more posteriorly, is represented by two plaques positioned on the anus’ sides and called the ‘papillae anales’, which are used by the female to “manipulate” eggs during oviposition.

The copulatory opening represents the ostium bursae, a more or less complex structure which may be variously protected by a sterigma, and which is followed cephalad by a sclerotised or unsclerotised ductus bursae, depending on families; the distal part of ductus bursae is sometimes called antrum, if sclerotised. The bursa copulatrix represents the reservoir where the male's spermathecae are stored. The inner surface of the bursa frequently bears one or more sclerites ('signum', pl. 'signa', also known as 'lamina dentata' in the case of Papilionidae and Pieridae), or several smaller sclerotised processes, or may be otherwise completely smooth. As concerns the Italian fauna, species devoid of signa are found among the Papilionidae (*Parnassius*), Hesperiiidae, Pieridae (e.g. *Leptidea*, *Anthocharis*) and Lycaenidae (e.g. *Celastrina*). In some subgroups of the latter family (e.g. in the *Polyommata*) one can also observe situations in which strictly related species may differ in this character (e.g. *Polyommatus damon* is the only species of the Subgenus *Agrodiaetus* not showing signa).

GENITAL PLUGS. In some butterflies, a genital plug, called 'sphragis' when particularly large (e.g. in *Parnassius*), is transferred from male to female during copulation and will generally prevent her from mating again, thereby avoiding or at least limiting sperm competition.

The very conspicuous sphragis of *Parnassius apollo* was already described by Linné in the first edition of *Fauna Svecica* (1746: 246, no. 802: "*sub ano membrana crassa, conava, carinata*"), well before binomial nomenclature ever became established. Early hypotheses on the function and origin of this organ are reviewed in Eltringham (1925).

The sphragis is generated by the coagulation of a white fluid secreted by two very developed accessory glands located in the male genitalia, on the 8th abdominal segment, at the base of the (pseudo) valvae. This fluid is gradually extruded before hardening, thereby causing the sphragis to become much larger than any other abdominal structure present in males (see Carvalho *et al.* 2017 and literature cited therein), and will generally remain fixed under the female's abdomen for the rest of her life. It is made of mucous substances, and may contain scales from the male's abdomen, sperm, but also many nutrients, so that it seems to improve the female's reproductive success.

The production of a sphragis is not devoid of costs, since the energetic investment for secreting a sphragis amounts to 3-20% of the male's body weight. In some cases (ex. *Heteronympha penelope*: Australian Satyrinae) males cannot produce more than 3-4 during all their life, so that, once one has been secreted, another cannot be produced for 7-10 days (Orr 2002).

At taxonomic level, the shape of sphragis was initially investigated by Elwes (1886) and by Austaut (1889), who demonstrated that, at least in the case of *Parnassius*, the shape is species-specific and can offer interesting phylogenetic information. This species-specificity may depend on the fact that the sphragis is moulded on a specialised area of the inter-segmental membrane.

Among the Papilionidae, a sphragis occurs also in most Troidini, such as in *Troides* (Parsons 1983), *Euryades*, *Cressida*, *Atrophaneura* and *Parides* (see also Orr 1988, 1995), and in *Luehdorfia* (Luehdorfini: Matsumoto 1997), while in *Zerynthia* s. l. it is represented by a small plug. A sphragis is also present in some Nymphalidae (Acraeini: *Acraea* see Epstein 1967, Paluch *et al.* 2003; Satyrini: *Heteronympha penelope*, see Orr 2002; *Hipparchia* see García-Barros 1989). To

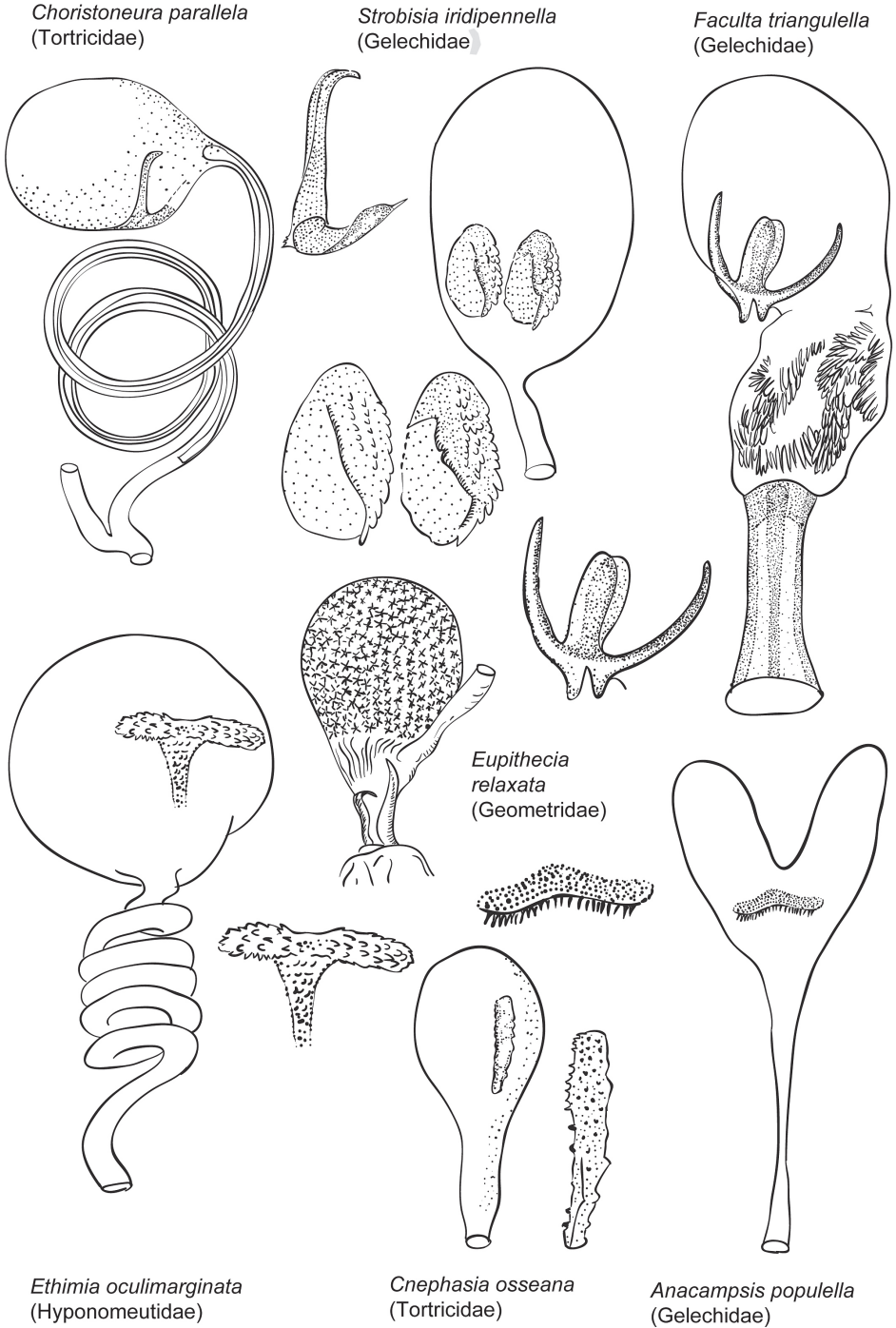
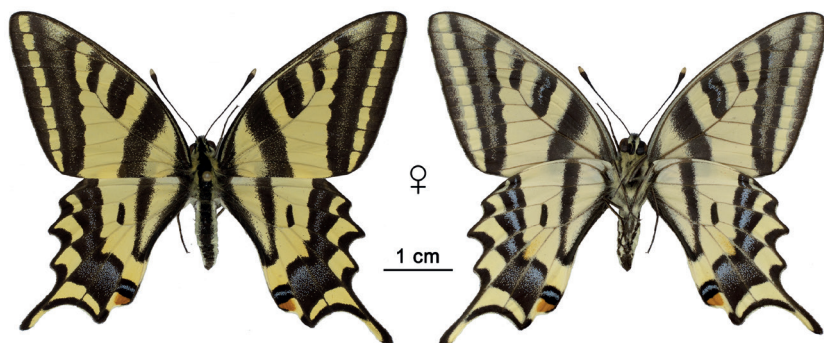
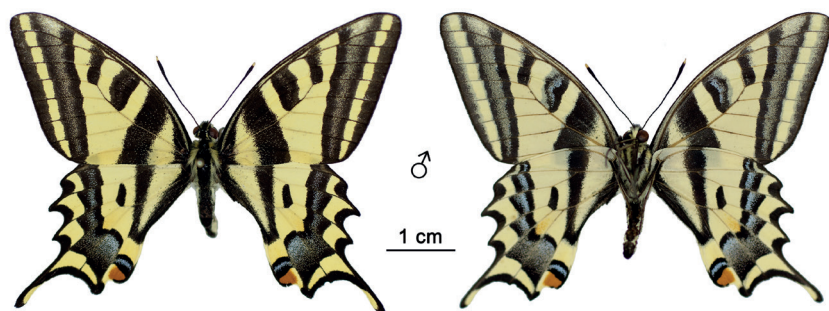
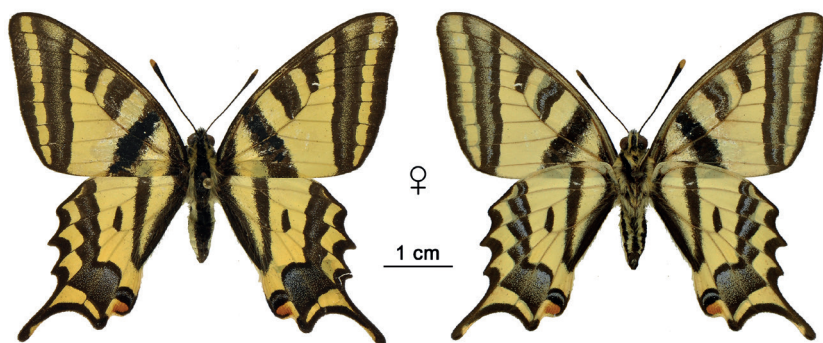


Fig. 6 - Genital organs of some female Lepidoptera (only ductus bursae and bursa copulatrix are shown. From Bourgoigne 1979, slightly modified).

Papilio alexanor



Papilio alexanor - Sicily



Papilio alexanor

♀ - Valdieri, Val Gesso, Cuneo, 14.07.1990, legit Cameron-Curry

♂ - Piemonte, Cuneo, Valdieri, m 750, legit Cameron-Curry

Papilio alexanor, Sicilia

♀ - Etna, 21.05.80, legit H.J. Henriksen (Foto di Maurizio Bollino)

Erynnis tages



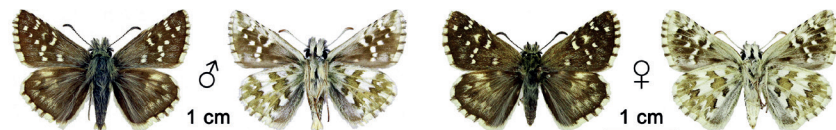
Pyrgus malvae



Pyrgus malvoides



Pyrgus onopordi



Erynnis tages

♂ - Liguria, Savona, Andora, Rollo, 08.05.1994, legit Cameron-Curry

♀ - Cortina, 18.05.1968

Pyrgus malvae

♂ - Prealpi Carniche, M.te Festa, m 400-800, 01.07.1980, legit I. Pecile

♀ - Prealpi Carniche, Foresta Prescudin, Barcis, Pordenone, m 1000, 05.06.1973, legit Morandini

Pyrgus malvoides

♂ - 19.05.74, Pigna

♀ - Dolomiti, Cortina, 17.06.1971. legit Beer

Pyrgus onopordi

♂ - Liguria, Val Leron - 31.05.1962 - leg. et coll. E. Gallo (foto di Alessandro Bisi)

♀ - Abruzzo, Aquila, Gole di Celano, m 850, 9.08.1976 - leg. et coll. E. Gallo (foto di Alessandro Bisi)

Colias alfacariensis



♂
1 cm



♀
1 cm



Colias hyale



♂
1 cm



♀
1 cm



Colias alfacariensis

♂ - Arquatese, Alessandria, Val Borbera, Ponte Brotte, m 340, 13.07.1979, legit Cassulo
♀ - Savignone, (Genova), Tavola Rotonda, 08.10.1963

Colias hyale

♂ - Miasino, Orta, Novara, 26.08.1961, legit G. Floriani
♀ - Quinzano, Varese, 15.09.1973, legit G. Floriani



Pyrgus accretus



Pyrgus alveus



Pyrgus andromedae



Pyrgus armoricanus



Pyrgus cacaliae



Pyrgus carlinae



Pyrgus carthami



Pyrgus cirsii



Pyrgus foulquieri



Pyrgus malvae



Pyrgus malvoides



Pyrgus onopordi



Pyrgus serratulae



Pyrgus sidae



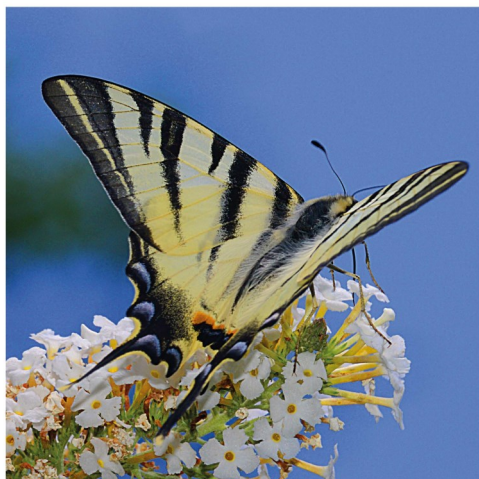
Pyrgus warrenensis

**FAUNA D'ITALIA VOL. LIV
LEPIDOPTERA - PAPILIONOIDEA**

FAUNA D'ITALIA
LEPIDOPTERA
PAPILIONOIDEA

Butterflies

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