

Notes on the Naming Game

“A rose is a rose is a rose”, according to Gertrude Stein. However poetic the line, Stein’s approach thwarts speaking about *varieties* of roses. It’s the same for butterflies: if you want to talk about different butterflies, you have to give them different names.

Most people accept the need for names, but are *scientific* names necessary? And why are these the way they are? You may also wonder why scientific names keep changing, and why species appear or disappear with new editions of butterfly field guides. Finally, you may wonder why some identically looking butterflies are given different names. This note aims to answer these questions.

The first issue is easy to explain. Although possibly 30 million species of animals exists, relatively few receive a vernacular name. Moreover, vernacular names are in the particular language that happens to be used where the animal is found. Since to date roughly 7000 different languages are spoken, a particular species may have many vernacular names. Having no name at all, or having many names in different languages stifles communication, so biologists have invented *scientific names*. Every species described in the literature receives a unique scientific name, enabling biologists to communicate about them.

Scientific names are subject to strict rules, application of which hinges on biological theory. Rules and theory together make up the Naming Game, which is in the province of both *Taxonomy* and *Systematics*. Taxonomy deals with describing and naming organisms, and Systematics deals with the relationships between *taxa* (groupings of organisms). Since you first have to describe and name something before you can consider its relationship to other things, Systematics depends on Taxonomy.

The Naming Game

The naming game is hierarchical

Items can be classified in any number of ways. For instance, at your local garden center, plants may be divided into herbs, shrubs and trees, with herbs subdivided into wild species and cultivars. Such an ordering is very practical for a garden center but is not acceptable for biologists. For a biologist, superficial similarity, or similarity in growth form, is not the key to a valuable classification. It is *evolutionary relatedness* that biologists want to express in their classification.

The vast majority of biologists accepts that species are not fixed but change in time – that is, species *evolve*. We rarely observe such changes because the processes involved are usually rather slow. Quite often it takes more than 100 generations for substantial changes to materialize. For most butterflies this means a long time indeed, 50 to 100 years – in other words, your entire lifetime.¹

¹ For a gentle introduction to the topic of evolutionary theory, I recommend Carl Zimmer’s *Evolution: The Triumph of an Idea*.

Before the idea of evolution was widely accepted, species were thought to be fixed. Species, in this view, are collections of individuals that are morphologically very similar. So a single specimen represents the entire species.

But if species are changeable, then what constitutes a species? This is not an easy question to answer, and biologists have invented many species concepts. For butterflies the so-called *biological species concept* normally works well. According to this concept, “A species generally consists of all the individual organisms of a natural population which are able to interbreed, generally sharing similar appearance, characteristics and genetics due to having relatively recent common ancestors” (Wikipedia). In addition, most biological species are morphologically different from each other, but they need not be! Sometimes species are indistinguishable from outward appearance; these are called cryptic species.

Species may thus change in time, and if the changes are substantial enough, it is legitimate to say a new species has arisen. A species may also give rise to *several* descendant species. For instance, the range of a species may become subdivided by mountains (e.g., the Pyrenean Mountains). The populations on both sides of the mountains may then evolve in different ways. If isolated for long enough, populations on both sides of the mountains will no longer recognize each other as being the same species. If so, the original species has ceased to exist, but two daughter species have come into existence.

Let us now change our perspective from looking forward in time to looking backward. Several related species must have had a common ancestor a long time ago. For instance, the Small White and the Green-veined White share a common ancestor. Looking further backwards in time, the ancestor of these whites together with the ancestor of all Orange tips also share a common ancestor. Looking even further backwards in time, *all whites* share a common ancestor. Still further backwards in time, *all butterflies* share a common ancestor. Thus all butterflies are related to each other, and biologists look for a classification scheme that reflects the essentials of these interrelationships. Given the nature of the process described, this scheme will be hierarchically ordered. The highest rank collects all species that share a common ancestor. Lower ranks contain subsets that share a more recent common ancestor; the subsets exclude each other necessarily.

Looking up from below, the basic level of the classification scheme is formed by the *species*. Similar species are grouped into *genera* (singular: genus), which in turn are grouped into *families*. Ranks above the family level are *order*, *class* and *phylum*. If one wants to express a more fine-grained pattern, one may prefix the basic ranks with *sub-* or *super-* to indicate a level just below or above the prefixed level. So *subfamily* is a level just below family rank, but above genus. I will now focus on the levels most relevant for the names you normally come across.

The reference to a species is binomial

Since there are so many species, we need strict rules to name them. A *scientific name* consists of two parts (hence it is *binomial*), treated as Latin. The first part is the *genus*, the second part the *species* name. For instance, the Swallowtail is officially known as *Papilio machaon*. Scientific names are always italicized, and the genus but not the species name starts with a capital letter. The genus name is often abbreviated after first mentioning, so the second time you read *P. machaon* if there is no risk of confusion.



The Swallowtail, also known as Papilio machaon

In addition to the genus and species name, the author who first described the species may also be mentioned. For the Swallowtail this author was Linnaeus, who described it in 1758. So you might read this: *Papilio machaon* Linnaeus 1758. If you read about the Scarce Swallowtail, however, you find the author's name in parentheses: *Iphiclides podalirius* (Linnaeus). Why is that?

Linnaeus put all butterflies in the genus *Papilio*, including *podalirius*. Given the state of knowledge in his days, or lack thereof, that was a reasonable thing to do. But when more and more species were described, a single genus for all butterflies became quite inconvenient. Later authors thus started to create new genera, like *Iphiclides* for the Scarce Swallowtail. But happily enough Linnaeus' species name *podalirius* did not change, or else we certainly would have lost track. To indicate that the genus name was not originally chosen by Linnaeus, his name is put in parentheses.

Linnaeus's basic idea, a double name to designate a species, has not changed since. The *binomial nomenclature* is quite an efficient way to deal with the large number of species that exist. Nowadays, the validity of a name is formally regulated by strict rules, put down in the International Code of Zoological Nomenclature (see <http://www.iczn.org/iczn/>).

Extensions of the naming game

Sometimes you come across a more complex scientific name, like *Papilio machaon* ssp. *britannicus*. The third name refers to a particular *subspecies*. This is a geographically isolated and recognizably different form of a species. The British Swallowtails around Norfolk differ somewhat from continental populations. They are also geographically isolated from them, so they can be called a subspecies. They form a locally adapted group, but were France and England ever to unite, one may expect that the continental and the Norfolk specimens would freely interbreed. Therefore, Norfolk and continental Swallowtails are considered to be a single species.

Further subdivisions: form, variety and aberration

Below the subspecies level there are the semi-formal *form*, *variety* and *aberration*. They always refer to individual specimens, not to populations – in this way they differ from the concepts of *species* and *subspecies*. They are semi-formal in that the above mentioned code does not regulate their use. *Form* is often used to designate seasonal variation in butterflies but is also used for different colour forms that fly at the same time. *Variety* is used for all kinds of individual variations. *Aberrations* are rare colour forms that differ greatly from the normal pattern.



*Silver-studded Blue, Plebejus argus; unnamed aberration.
The spots that gave this species its vernacular name lack, while the spots present
are drawn out. The spots near the wing base normally lack.*

Why names keep changing

As explained above, biologists try to express their insights into how species are related in the classifications they use. When these insights change, the classification may have to be adjusted to fit the new insights. As long as the new insights only concern the levels above that of the genus, nothing much happens to everyday practice, since species are referred to by genus plus species name. And most of the evolving insights indeed concern the levels above generic level, so this will not affect species names.

For various reasons, however, the names of species may change too. First, new insights may develop that a particular species is placed in the wrong genus. This might happen if the current position of a species is uncertain and new techniques (for instance, DNA sequence data) shed new light on the position of that species. For European butterflies such uncertainty seems to be rather rare; I don't remember a single example over the past 30 years or so.

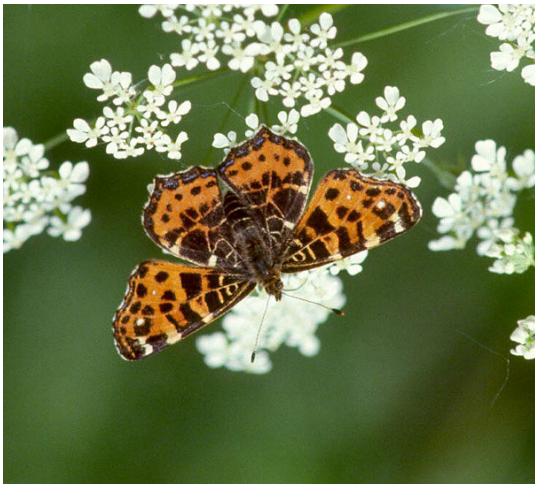
Second, a new species may be 'discovered' in the sense that some already known variety is later recognized to be a different species. For example, in 1945 the Pale Clouded Yellow, *Colias hyale*, was recognized to comprise two different species. Of course, the newly recognized species, Berger's Clouded Yellow, needed a separate scientific name, but there is still no agreement about that. You may encounter *alfacariensis*, *australis* as well as *calida*. Although there are strict rules for naming a species, it takes a specialist to interpret these, and different specialists rarely agree. There is no doubt, however, that *hyale* and its sibling species are indeed different species.



Pale or Berger's Clouded Yellow? We'll never know...

Another possible example concerns the Wood White, *Leptidea sinapis*. Here, like in the *Colias* example, two very similar looking species shared the same name. The name for the recently ‘discovered’ species is *Leptidea reali*; it acquired species rank only in 1989. However, it was already recognized to be a different form in 1932, although it was then named *L. duponcheli lorkovicii* Pfeiffer. *Leptidea sinapis* and *L. reali* are so similar looking that they can only be distinguished by looking at the male genitalia (i.e., sex organs). Whether they are indeed two species should, in my view, be established by failure of the two forms to interbreed, and by consistent genetic differences. As far as I’m aware of, this information is still lacking, so I still find the distinction between *sinapis* and *reali* suspicious.

The opposite may also happen: two forms that were initially recognized as separate species turn out to be forms of a single species. The only example I’m aware of is the historic case of the Map Butterfly *Araschnia levana*. This species exhibits such extreme seasonal dimorphism that in the 1758 edition of *Systema Naturae*, Linnaeus described the two seasonal morphs as different species. He named the spring form *Papilio levana* and the summer form *Papilio prorsa*. Since the offspring of *levana* turned out to be *prorsa*, both must necessarily be forms of the same species.



The Map Butterfly fooled Linnaeus, who mistook its seasonal morphs for different species.

Left: spring form, (A. levana f. levana)

Right: summer form (A. levana f. prorsa)

The two reasons for name change just described both have to do with *factual information*. Two other reasons are due to *theoretical* considerations only. As already mentioned for the sibling species of *Colias hyale*, the formal rules for names are open to interpretation by specialists. If an author challenges the currently accepted interpretation, the name of the species concerned may change. This is the reason for the name change of another Clouded Yellow. *Colias libanotica* in Higgens & Riley 1984 is referred to as *Colias aurorina* by Tolman & Lewington 1997. The third reason for nominal volatility is thus uncertainty about the application of the code for nomenclature.

The fourth reason for the instability of butterfly names is responsible for the vast majority of name changes. Various authors give different answers to the question what degree of evolutionary relatedness should be expressed by the labels 'genus' and 'species'? A different choice results in a different name, so the issue is not innocuous. Since such choices in the end are arbitrary, they will never cease to affect names.

An example of this type of nominal instability is the phenomenon of *rank inflation*. This phenomenon is so important that it merits its own section.

Rank inflation

Rank inflation means that authors in time give gradually more and more weight to some degree of evolutionary differentiation. This degree then gets expressed at gradually higher levels in the classification scheme. So a subspecies gets species-rank, species tend to get genus-rank, and a genus may eventually get family rank. A clear example of the latter is Linnaeus' original genus *Papilio*, which nowadays has the rank of a superfamily, the Papilionoidea.

With rank inflation in action, subspecies become upgraded to species. This is an important reason why a new edition of a field guide might contain 'new species', and therefore new names. No spectacular new find occurred; much more mundanely, some author has upgraded a subspecies to species rank.

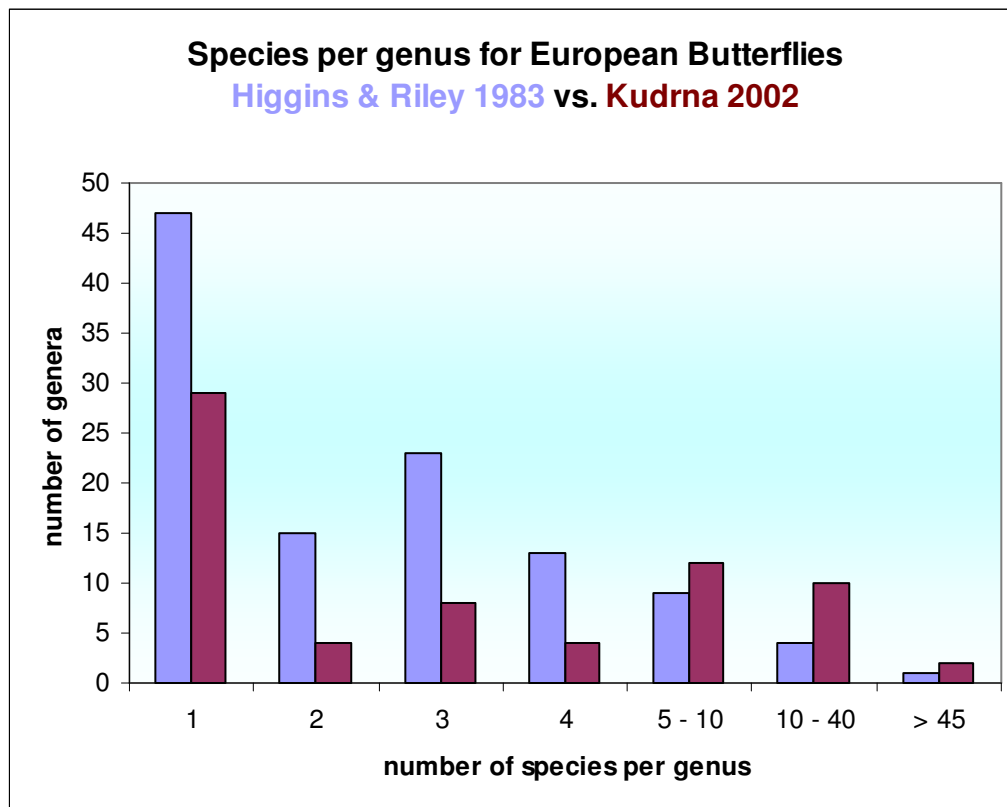
To show how important rank inflation is in creating 'new species' and thus new names, I'll compare two species lists popular field guides for a single family, the Pieridae (Whites). (In the following, HR refers to the field guide by Higgins & Riley 5 ed. 1983, while TL refers to the field guide by Tolman & Lewington 1997.)

- *Pieris brassicae cheiranthi* HR is treated as species *P. cheiranthi* TL
- *Artogeia napi bryoniae* HR is treated as *A. bryoniae* TL
- *Artogeia napi canidiaformis* HR is treated as *A. balcana* TL
- *Pontia daplidice* HR has been split into *Pontia edusa* and *Pontia daplidice* TL
- *Euchloe simplonia* HR has been split into *E. crameri* and *E. ausonia* TL, while *E. ausonia* HR is renamed *E. simplonia* TL
- *Euchloe pechi* HR has uncertain rank in TL *E. tagis pechi* (TL mention *pechi* as the extreme end of continuous geographical variation)
- *Elphinstonia charltonia penia* HR has been raised to species rank by TL: *E. penia*
- *Colias balcanica* HR is referred to as *C. caucasica ssp. balcanica* by TL
- *Leptidea sinapis* HR is split into *L. sinapis* and *L. reali* by TL

Most of these examples pertain to what I interpret as bona fide subspecies; the new 'species' has a distribution that does not overlap with the original species, while morphological differentiation may be marginal or clear. But the real issue is whether or not the forms from different localities would cross. More often than not, this is not substantiated. Hence much of this upgrading should be treated with great care, if not outright suspicion.

Although the species rank is rarely directly upgraded to genus level, rank inflation can still be observed at this interface. For instance, a genus may be split into two or more smaller genera, or a single species slightly discordant with the others may be put into a different genus of its own. If this process continues for long enough, genera will become species poor. This process

must have contributed significantly to the taxonomy of butterflies. With few exceptions, European butterfly genera are very poor in species, as shown in the following graph.



The graph shows the number of species per genus according to two lists of species, that in the *Field Guide to the Butterflies of Britain and Europe* by Higgins & Riley 1983, and that in the *Distribution Atlas of European Butterflies* by Kudrna 2002. Many genera have only a single species, while very few have many species. For butterflies, rank inflation is rife.

There are two reasons for this. First, butterflies are a group that has received an enormous amount of attention, by amateur as well as professional entomologists. It is easy to understand why; their beauty is beyond denial, they fly if the weather is fine, and, unlike moths, they fly at a convenient time of the day. These reasons explain why many people study butterflies for their own sake. Butterflies often make suitable model species for more general biological questions too. They can be easily captured and marked, have a short life span, and can be reared in the laboratory. For all these reasons butterflies are well studied indeed. But with increasing knowledge of the group, people will become sharply aware of the broad variation in the group. There will be a natural tendency to express this awareness by upgrading the ranks in the biological classification. In short, butterflies, as well as other well studied taxa, are prone to rank inflation.

The second reason I see is that a researcher can gain authority, and thus status, by reworking an existing classification. This reworking often involves upgrading subspecies to species rank, splitting a genus into smaller genera, etc. The new genera need names too, so creating new genera means that you can establish your own name in the literature. Maybe you think I'm a diehard cynic, but it is hard to deny the human psyche in this; people crave to be important, or at least, to be relevant. Inserting your name into the literature is making clear you're important in this field.

People with a habitual inkling for rank inflation are called *splitters*; those who tend to deflate ranks are *lumpers*. This is a highly individual matter, but still there is also an element of fashion involved. In butterflies, splitters have predominated for a long time, with the result that butterfly genera nowadays tend to be very species poor. However, in the past decade or so the splitting tide has turned, and the trend has become to reunite closely related genera into more encompassing genera; i.e., to deflate ranks at the generic level. The result is that the number of genera is going down, and the number of species per genus is going up. For example, Higgens & Riley used four genera to represent the various Coppers, while Tolman & Lewington only use a single genus.

A nice example of the waxing and waning of splitting and lumping is seen in the naming of the Painted Lady and the Red Admiral. The Lady and the Admiral were both placed in the genus *Vanessa* for a long time, but then sometime around 1980 the genus *Vanessa* was split into *Vanessa* and *Cynthia*. Both new genera contained a smaller number of species that showed a strong resemblance, and both genera are beyond doubt natural groupings. However, the two genera are so closely related that giving them the status of a separate genus is questionable. Nowadays the Lady and the Admiral again form a handsome couple sharing the generic name *Vanessa*.



Handsome couple: the Admiral and the Lady

One advantage of more encompassing genera is that there are fewer names to remember. But more importantly, more encompassing genera better show which species are closely related. And because of that knowledge, you tend to give more weight to the similarities between species. Although this is a purely psychological phenomenon, for me as user of butterfly taxonomy, it is a rewarding one!

By now you will understand to some degree why names change so frequently (i.e., the third issue mentioned in the introduction of this paper). But if you understand what's going on you will probably not be bothered too much by the instability of genus names. To paraphrase Shakespeare: what's in a generic name?

Why some species are look-a-likes

Above I have explained why we use scientific names, what their basic appearance is, and why names change much too often. There thus remains only one issue: why are some species so similar that it is hard to distinguish them at all, while others are so variable that it seems hard to recognize them as belonging to the same species? In trying to answer such questions, one encounters the ramifications of the biological species concept. This is certainly worthwhile, so let us see where we get.

The biological species concept hinges on interfertility. Any two populations whose members can hybridize without a reduction in fertility belong to the same species. Any two populations that do not freely interbreed belong to separate species. Normally if two species do not interbreed, they are immediately recognizable from their outward appearance as different species.

But not always! And nothing in the definitions makes clear that this should be the case. If males and females recognize each other on the basis of UV reflectance, or pheromones, we humans would be practically blind to differences that are very obvious to the butterflies involved. So we may expect to encounter species that to us are real look-a-likes, but nevertheless behave as perfectly bona fide species. Such species are called cryptic species. An example in butterflies would be the Wood Whites, *Leptidea sinapis* and *reali*, mentioned earlier.

An obvious reason for the existence of sibling species is that they share a recent common ancestor, i.e. they are young species. A recent ancestry for some species groups is likely to be correlated with the onset of the current interglacial. Some 10,000 years ago, the last Ice Age ended and Europe gradually became warmer. As a result, suitable vegetation developed and became inhabitable for butterflies. During the Ice Age, species survived the cold in isolated *refugia*. Many species dispersed into the newly available habitat, while at the same time the habitat of the Ice Age refugia disappeared. For some species the distribution became fragmented into a number of smaller areas. But as soon as populations are fully isolated, each population starts to adapt to the local conditions, and if this adaptation continues for long enough, the populations gradually diverge. If they become recognizably different they have become subspecies. If they become reproductively isolated they have become species.

There are several examples for which this seems a plausible scenario. For instance, there are many forms of *Agrodiaetus ripartii*, many of which fly in small isolated geographical areas. Tolman & Lewington have accorded species rank to many of these forms, despite the fact that differentiation in wing markings is minimal. They could equally well have been accorded subspecies rank, since I doubt whether crossing experiments have been performed to check for the possibility of interbreeding.



Agrodiaetus ripartii (left) and *Erebia tyndarus* (right) both have many look-a-likes. But are these different species?

Another example is formed by the *Erebia tyndarus* group. Here six very similar species occupy different geographical areas; where these overlap they appear to be separated by altitude. *Erebia*'s are typical mountainous butterflies, and any mountainous area in Europe may have its own subspecies of species of *Erebia*. The argument according the various *tyndarus*-like forms species-rank has to do with distinctive characters in male genitalia.

The male genitalia are a recurrent theme in butterfly systematics, so it is well worth paying attention to this subject. The genitalia are made from chitinous material. This means that the genitalia have a fixed morphology, and if prepared properly a specimen can be stored indefinitely. Moreover, they are morphologically extremely variable. For a long time, it was thought that male and female genitalia in effect are lock and key, to prevent hybridization. However, this idea has serious problems. To explain why, I quote (in blue) at length from a relevant article on the topic (Schilthuizen 2003):

As early as 1844, Dufour advanced this hypothesis, saying that '*l'armure copulatrice [...] est la garantie de la conservation des types, la sauvegarde de la légitimité de l'espèce*'. More explicitly, the lock-and-key hypothesis states that, to avoid the production of maladapted hybrids, females have evolved specialised 'locks' to which only the 'keys' of the males of the same species will fit (Shapiro & Porter, 1989). Gosse (1883: 280) echoed Dufour more poetically when he wrote: 'if I see a number of keys, of very minute and elaborate workmanship, all different, I cannot doubt that every one is intended to fit some special lock'

It is not surprising that this hypothesis has been very popular, because intuitively it makes good sense. However, on close inspection, serious empirical and theoretical

problems appear. First of all, copulations between different species and even different genera have been documented in abundance. However, it is usually not clear if such couplings result in fertilization, and if they do, whether fertilization rates are similar to intraspecific copulations. More compelling empirical evidence against the hypothesis is that genitalic divergence is just as strong in allopatric as in sympatric species. Insect species that are endemic to islands, such as *Oliarus* bugs on the Galápagos islands (Fennah, 1967), to separate cave systems (bathysciine beetles; Dupré, 1992) or specific to certain hosts, like parasitic lice (Emerson & Price, 1981) have quite divergent genitalia, even though they never come in contact with each other, so allospecific copulation will not occur. In addition, a stronger theoretical reason to be suspicious of the lock-and-key hypothesis is that, as remarked by Alexander (1964), one would expect natural selection to favour mechanisms that allow a female to ascertain the species identity of her mate at an earlier courtship stage than copulation.

A rigorous test of the lock-and-key hypothesis was carried out by Arnqvist (1998), who compared monandrous insect groups with polyandrous sister groups, and found that in the polyandrous groups the male genitalia were more divergent among species. This is strong evidence against the lock-and-key hypothesis, since one would expect that mistakes are selected against more strongly in groups where females mate only once. In fact, Arnqvist's test supports a group of hypotheses that have become fashionable in recent years, and that rely on sexual selection.

Although the lock-and-key idea of insect genitalia is thus losing ground, it has left an indelible mark on butterfly systematics. If consistent differences in male genitalia can be found in populations from different geographical areas, this is taken as a **very** strong argument for according species rank to the geographically isolated populations.

As a result, a recurrent theme in field guides is the reference to characteristics of male genitalia. Here's a choice selection from HR and TL:

- *Papilio saharae*: 'genitalia differ but are too variable for reliable separation.' TL
- *Leptidea reali*: 'Wing-characters variable, inadequate for reliable determination, but, in either sex, readily separable from *L. sinapis* by substantial morphological and reproductively significant differences in genitalia.' TL
- *Zizeeria knysna karsandra*: 'indistinguishable from *Z. knysna knysna* except by a small character in the male genitalia.' HR
- *Hipparchia delattini*: 'probably indistinguishable by external characters but male genitalia are distinctive.' HR
- *Hipparchia cretica*: 'Male genitalia are distinctive.' HR

Similar remarks can be found by many more subspecies or species.

Morphological differentiation may be a key factor in speciation, but a consistent difference is certainly no guarantee that hybridization is impossible. Therefore, in my opinion species rank should not be accorded to any geographically isolated form with some distinguishing character in male genitalia. No doubt, many geographically isolated populations may well be on the road of speciation. But giving any recognizable form a species rank is overstressing the species concept considerably. The subspecies rank suffices here, recognizing their distinctiveness as well as their potential for speciation.

References

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