

### Credibility of the present molecular-systematics?

1. What is to do if a group, e.g. the family Nolidae s.l., is larvally unequivocally revealed as wrong defined by the imaginal-systematists but confirmed by the molecular workers?

2. The unjustified splitting of the Noctuidae s. HAMPSON into the Erebidae and Noctuidae s. str. (Lepidoptera, Noctuoidea)

by

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**Abstract:** The larval-imaginal-systematic comparison between the present Nolidae s. l., s. KITCHING & RAWLINS (1998) and the Nolidae s. HAMPSON unequivocally reveals that the present family Nolidae s. l. is not to be hold. The most reliable apomorphy, the boat-shaped cocoon is not at all reliable. The characters for the Nolidae s. str. - only three pairs of prolegs on A4-A6 and the construction of the scaphium - are not applicable for to enlarge the family Nolidae s. str. to the Nolidae s. l. To maintain the primary setation of the larvae of all the subfam. of the Nolidae s. l., except the Noliniae s. str., as reversal is absurd, because these patterns are completely congruent with the pattern of the primary-setosed Noctuidae-larvae s. HAMPSON. For a reversal-condition of these Nolidae s. l.-subfam. the pattern of the setae has to be the same as the pattern of the primary setosed first instar-larva of the Nolidae s. str. which is not applicable. The splitting of the Noctuidae s. HAMPSON into the Erebidae LEACH (for the quadrifine subfam. of the Noctuidae s. HAMPSON by inclusion of the also quadrifine former families Arctiidae, Lymantriidae and Nolidae) and into the Noctuidae s. FIBIGER & LAFONTAINE (for the trifine subfam. of the Noctuidae s. HAMPSON), LAFONTAINE & FIBIGER (2006), is not to be maintained.

The present philosophy of the phylogenetic systematics is idealistic and not realistic.

Key-words: Larval-systematics, imaginal-systematics, molecular-systematics, phylogenetic-systematics. Noctuoidea, Erebidae, Noctuidae, Nolidae s. str., Nolidae s. l.

#### Taxonomic changes

Family Noctuidae LATREILLE, 1809, s. HAMPSON, s. BECK **stat. rev.**

Erebidae LEACH, 1813 s. FIBIGER & LAFONTAINE **syn.nov.** (comprising the quadrifine subfam. of the Noctuidae s. HAMPSON, the Arctiidae s. HAMPSON, the Lymantriidae s. HAMPSON, the Nolidae s. HAMPSON).

Family Lymantriidae s. HAMPSON **stat. rev.**

Family Arctiidae s. HAMPSON **stat. rev.**

Family Nolidae s. HAMPSON = Nolidae s. str., **stat. rev.**

Family Nolidae s. l., s. KITCHING & RAWLINS: possibly all subfam. except the Noliniae s. str. (= family Nolidae s. HAMPSON) have to be combined with the Noctuidae s. HAMPSON: As yet the chaetograms of the larvae of the Chloephorinae, Nycteolinae, Eariadinae, Risobinae, Collomeninae, Afridinae, Diphtherinae and Balsinae could be controlled either by photos or by direct investigation of the larvae.

Noctuidae Chloephorinae **comb. rev.**

Noctuidae Nycteolinae (= Sarrothripinae) **comb. rev., stat. rev.**

Noctuidae Eariadinae **comb. rev., stat. rev.**

Noctuidae Diphtherinae **comb. nov.**

Noctuidae Risobinae **comb. nov.**

Noctuidae Collomeninae **comb. nov.**

Noctuidae Afridinae **comb. nov.**

Noctuidae Balsinae **comb. nov.**

Combination as yet not confirmed by larval material:

?Noctuidae Beaninae ?**comb. nov.**

?Noctuidae Eligminae ?**comb. nov.**

?Noctuidae Westermanniinae ?**comb. nov.**

**Material:** preserved Nolidae s. str.-larvae ex collection HASENFUSS. *Nola squalida* (STAUDINGER, 1870)- L1-larvae ex ovo (leg. P. ROSSET, S-Frankreich, 2008). Preserved larvae of Nycteolinae, Eariadinae and Chloephorinae ex coll. BECK. Images of living larvae and cocoons of the Nolidae s. l. by WAGNER (2011) and SILVONEN (*Nola cuculatella*).

**Introduction:** The Nolidae s. l. paradoxically is defined by the imaginal-systematist KITCHING (KITCHING & RAWLINS, 1998) by preimaginal characters: a specific cocoon and a seemingly specific larval setation. But contrary to the specific secondary-setosed larvae of the Nolidae s. str. KITCHING declares the primary setation of all the additional subfam. of the Nolidae s. l. as reversal without comparison of the specific setal maps of both. In the first instar the Nolidae s. str.-larvae (=Noliniae-larvae of the Nolidae s. l.) are primary-setosed; the concerning setal map (= chaetogram) is

completely different from the chaetogram of in all instars primary-setosed larvae of the Nolidae s. l. subfam. (except the Nolinae/Nolidae s.str.). The chaetogram of the Nolidae s. l. with primary-setosed larvae is completely identical with that of Noctuidae-larvae. That means: these Nolidae s. l.-subfamilies are in fact Noctuidae and not Nolidae.

If then the molecular-biology (ZAHIRI & al., 2012), in cooperation with the responsible imaginal-systematists (KITCHING, LAFONTAINE, HOLLOWAY & al.), confirms the wrong imaginal-systematical concept for the Nolidae s. l. as correct by molecular investigations, then the only conclusion remains that the present molecular working with the Noctuoidea is unable to confirm sure larval-morphological results.

The splitting of the Noctuidae s. HAMPSON into the Erebidae LEACH (for the quadrifine subfam. of the Noctuidae s. HAMPSON by inclusion of the also quadrifine former families Arctiidae, Lymantriidae and Nolidae) and the Noctuidae (for the trifine subfam. of the Noctuidae s. HAMPSON) s. LAFONTAINE & FIBIGER (2006) is not to maintain.

In both cases the present chaos in the Noctuoidea is caused by the wrong application of the methods of the phylogenetical systematics and the idealistic basis of this philosophy which is based on the irreversibility of evolution. But how to use then the phenomenon of reversals?

These disappointing results of the molecular-genetics (and of the imaginal-systematists too) and the possible causes were outlined in the talk of WÄGELE (still unpublished) on the 'Congress of the Society for Biological Systematics' at Dresden 2014.

After the appearance of BECK (1999, 2000), BECK engaged himself especially with the systematics of the Noctuidae, resp. Noctuoidea. BECK (2009) published his findings on the larval characterization of the Noctuidae s. HAMPSON and the Nolidae s. HAMPSON, including the view on the Nolidae s. KITCHING & RAWLINS (1998). On the SEL-congress 2013 BECK again had a talk to the problem of splitting the Noctuidae s. HAMPSON by LAFONTAINE & FIBIGER. In the personal discussion with LAFONTAINE, in which BECK brought the argument that it is impossible to find in such a speciose family one apomorphy as synapomorphy for to characterize all members of the family because there are always some reversals here and there, LAFONTAINE agreed. Therefore it is possible to characterize such a family only by combination of characteristic features. - LAFONTAINE still defended his opinion by referring to the molecular results, the so-called LAQ-clade. - Similar is it with the Nolidae s. l.: Already on the SEL-congress at Berlin 2007, BECK remarked to KITCHING that 'his' Nolidae s. l. have to be restricted to the Nolidae s. str., s. HAMPSON. - Again nothing happened and finally the opinion of KITCHING & RAWLINS (1998) was supported by the molecular workers (ZAHIRI, KITCHING, LAFONTAINE et al., 2012) who based their investigations on the most convincing apomorphy for the Nolidae s. str.: the boat-shaped cocoon. An impossible supposition as compared with the results of the larval investigation and the evidence by the pictures of cocoons of the Nolidae s. l. in the book of WAGNER (2011). There were, besides the larvae, enough cocoons of the different subfamilies of the Nolidae s. l. which were often quite different from the idealistic boat-shaped cocoon s. KITCHING (also within the genus *Nola!*). So at once it was clear that the systematics of the Nolidae s. l., based on the boat-shaped cocoon, was wrong. And this wrong systematics was affirmed by the molecular data (ZAHIRI et al., 2012).

- What could BECK do as the lonely larval-systematist? - Unexpected BECK got help: On the 'Congress of Biological Systematics' at Dresden, 2014, WÄGELE had a lecture on great mistakes in the molecular methods, especially with the algorithms for to evaluate the results of the ML-analysis on which are essentially based the molecular results of ZAHIRI et al. (2010, 2011, 2012). At once arose the question: 'What is, if a clear morphological result, the unequivocal larval characterization of the Nolidae s. str. is not recognized and acknowledged by neither the imaginal - nor by the molecular systematists?' - This was the heading of BECK's lecture at the SEL-congress 2015 at Dresden.

In the new edition of the 'Handbuch der Zoologie' - Lepidoptera the authors of the Noctuoidea, KITCHING & RAWLINS (1998), wrote: 'The family Noctuidae has been notoriously difficult to characterize'; KITCHING continues concerning the quadrid family-group of the Noctuoidea (the term 'quadrid' concerns the venation of the fore-wings): "One of the most intractable problems in Lepidoptera classification has been the phylogeny of the quadrid lineages of Noctuoidea. This is due to great homogeneity in adult morphology and widespread homoplasy in virtually every character system" ("and surprisingly", remark of BECK), "features of the immatures have been much more informative but resolution of phylogenetic problems has been hindered by the absence of vouchered immatures....".

As yet the importance of the chaetotaxy for systematic decisions within the imaginal-systematics of the Noctuoidea is nearly unknown. Haven taken this in consideration the great mistakes in the imaginal- and molecular-systematics of the Noctuoidea in the last 20 years would not have happened and also not the misleading by KITCHING to maintain the setal pattern of the primary-setosed Nolidae s. l. larvae - except the Nolinae - a reversal.

Instead: compare the respective situation at the Zygaenoidea (TARMANN, 1994) and also the basic studies of HASENFUSS (1963, 1973) on the larvae of the Lepidoptera, also in the handbook of Zoology.

#### **Nolidae s. str., s. HAMPSON or Nolidae s. l., s. KITCHING?**

Imaginally the characterisation of the Nolidae s. str. is as poor as with the Noctuidae s. HAMPSON. KITCHING (1998): „This subfamily Nolinae (= Nolidae s. str.) is most clearly diagnosed by two apomorphies: presence of lateral setosed lobes on the scaphium (lost at *Nola!*; scaphium = part of the anal tube) and - for the larvae - loss of prolegs on A3. - KITCHING's remark on the importance of the immatures is correct but should concern the complete investigation of the larvae, especially the distribution of the bristles (=setae, chaetae). The remark of missing of the prolegs on A3 and the full development of these on A4-A6 is too little for characterization. This is a comparable situation with most of the Plusiinae-larvae - Noctuidae s. BECK, s. HAMPSON - these with only two pairs of prolegs on A5 and A6, exception *Abrostola* OCHSENHEIMER, 1816.

FIBIGER (2009) studied the Nolidae s. str. (in FIBIGER, 2009 = Nolini!) in more detail and added concerning the scaphium: this character (the two setose patches with its differentiations) holds all Nolini phylogenetically together. FIBIGER also remarks, that such structures of the scaphium occur in Noctuidae Acontiinae as well. And because this character is present in Noctuidae Armadini (sedis incertae), too, this scaphium-character is homoplastic and not specific for the Nolidae s. str., resp. for the Nolini s. FIBIGER. All the other characters quoted by FIBIGER as 'aut.', are not specific for the Nolidae s. str., too. The additional larval characters (besides the proleg-formula), the specific and apomorphic secondary setation, FIBIGER rejects as not apomorphic.

The present characterization of the Nolidae s. l. is based only on 'the most characteristic apomorphy' (KITCHING & RAWLINS, 1998; ZAHIRI et al. 2012: 9) - the boat-shaped cocoon with a vertical exit-slit (images 1 b, 3 a).

All the characteristics of the Nolidae s. str.-larvae (BECK, 2009) are neglected, so also in FIBIGER et al. (2009) and in ZAHIRI et al. (2012).

KITCHING (1998) remarks the secondary setation of the Nolidae s. str. larvae as an autapomorphy for the Nolidae s. str., the Arctiidae, Lymantriidae and Pantheidae for to form a monophyletic group within the Noctuoidea without reflecting on the specificity in the secondary setation in these different families. He also did not take in consideration that there are in the Noctuidae s. HAMPSON the Acronictinae with many taxa the larvae of which are secondary-setosed and also in the Hadeninae s. KITCHING (1998) the larvae of *Dasycampa* GUENÉE, 1837 are secondary setosed.

### **How do we imagine a reversal to primary setation of the Nolidae s. l.?**

KITCHING combines (without comparison of the concerning setal patterns) the many if not all subfamilies of the Nolidae s. l. (with primary setosed larvae) with the Nolidae s. str. (with secondary setosed larvae from the second to the last instar) by the statement: the primary setation of the Nolidae s. l. subfam. is the result of a reversal. The concerning control (see figs. 1 a, 1 b and fig 4 - the primary setation of *Nola squalida*, first-instar larva) at once forbids any combination of the Nolidae s. str. with the subfam. of the Nolidae s. l. the larvae of which have primary setation in all instars and the typical setal-pattern of the Noctuidae-larvae s. HAMPSON. A reversal-condition in the Nolidae s. l.-subfam. would only exist, if the concerning pattern would be identical with the pattern of the primary-setosed L1-larva of the Nolidae s. str. That is not the case as the characterization of the Nolidae s. str. L1-larvae prove.

### **The specific secondary setation of the Nolidae as compared with the Arctiidae, Lymantriidae and Pantheidae**

The statement of KITCHING for a monophyletic group of the Noctuoidea (comprising the Nolidae, the Arctiidae, the Lymantriidae and the Pantheidae), characterized by secondary-setosed larvae, not at all is convincing.

In the secondary setosed Arctiidae either the verrucae D1 and D2 are separated and in trapezoidal position or, in Arctiidae Nytimerini, fused and the verrucae at the spiracula are in all (secondary-setosed) Arctiidae positioned as in the Nolidae s. str. (KITCHING & RAWLINS, 1998: 383, figs. 19.14). Separation there is only possible by the formula of the prolegs (in Arctiidae and Arctiidae Nytimerini prolegs on A3 to A6 present) and the heteroideous condition of the crochets. In the Lymantriidae the verrucae D1 and D2 on A1 to A6 are in trapezoidal order; the position of the verrucae around the spiracula is different, L1 either close to SD1 or combined with SD1; a further apomorphy of the Lymantriidae-larvae are the glands on A6, A7, dorsad median. 'Pantheidae': (on A1 to A6) D1 and D2 in trapezoidal position, L1 isolated, caudad of the spiraculum (character of Noctuidae).

The secondary-setosed Nolidae s. str.-larvae show, besides the typical formula of the prolegs (fully developed prolegs only on A4-A6), on A1 to A6 a large verruca above the spiracula (the SD1-wart, as compared with the primary-setosed L1-larva) and ventrocaudad of the spiracle a large verruca, consisting of the L1- and L2-position of the L1-instar-larva; the D1- and D2-position on A1 to A6 (to A8) show a large verruca in the D2-position and above this a/the single D1-seta, which often is covered or concealed by the large D2-verruca.

To proclaim a monophyletic group only by the phenomenon 'secondary setation' is not enough.

### **Characterization of the Nolidae s. HAMPSON, s. str. by characters of immatures**

In the Nolidae-larvae s. str. there are, beginning in the L2-instar, two chaetotactic apomorphies on A1-A8 (=S1-S8):

1. The large D2-verruca with many secondary setae and dorsad of this verruca and +/- concealed by the D2-verruca an isolated single D1-seta (fig. 3).
2. Around the spiracles, according to the condition in the first instar, there is only one densely setosed large verruca above the spiraculum (the SD1-verruca) and ventrocaudad to venter of the spiracle a large verruca (the combination of the L1- and L2-position as in the L1-larva, see figs. 3 and 4). The cause for the complete absence of the prolegs on A3 may be the conspicuous shortening of the body.

Whilst KITCHING (1998: 366) on one side recognizes a monophyletic group within the Noctuoidea by secondary setosed larvae (without consideration of the specific condition of the setation in the concerned families Nolidae, Arctiidae, Lymantriidae and 'Pantheidae'), he terms on the other side the primary (larval) setation in all the subfam. of the Nolidae s. l. (except the Nolini s. str.) a reversal-condition but without reference to the specific setation in both, the Nolidae s. str. (L1-instar; fig. 4) or the Noctuidae setal pattern (fig. 1). But because the setation in these Nolidae s. l.-subfam. with primary-setosed larvae is the same as in the Noctuidae s. HAMPSON (images 4 b, 5, 6) there is only one conclusion: all the additional subfam. of the Nolidae s. l. which have been put there because of the 'common possession of a boat-shaped cocoon', do not belong to the Nolidae but to the Noctuidae s. HAMPSON, s. BECK.

These characters, especially the setal map (the distribution of the primary setae on the body respectively the setosed verrucae in the position of these) are within the Lepidoptera so striking that any combination of the Nolidae s. str. with all the other 'subfamilies' of the Nolidae s. l. has to be rejected.

Additional the formula of the prolegs forbids this combination.

The molecular survey of ZAHIRI et al. (2012) does not refer to the chaetotactic characters and also not to the proleg-formula (BECK, 2009), solely the boat-shaped cocoon is the most convincing (syn)apomorphy (ZAHIRI et al., 2012: 9).

#### **About the most convincing apomorphy of the Nolidae s.l. – the boat-shaped cocoon with a vertical exit-slit:**

The present characterization of the Nolidae s. l. by a boat-shaped cocoon (KITCHING, 1998; ZAHIRI et al., 2012) with a vertical exit-slit (images 1 b, 3 a) is a very unfortunate and unsuitable character. When this character was proposed for the contribution of KITCHING & RAWLINS (1998) only of some species (mainly of the genera-type-species, FIBIGER, 2009) the cocoons were known.

Since the publication of WAGNER (2011) we know a lot more about the cocoons of the so-called Nolidae s. l. - Astonishingly within the Nolidae s. str. this character is not uniform because there exist species with a +/- spindlelike cocoon (see image 2, *Nola clethrae* DYAR, 1899). This concerns also other subfamilies of the Nolidae s. l.: image 7, *Baileya doubledayi* (GUENÉE, 1852), image 8, *Baileya levitans* (SMITH, 1906), both Risobinae.

The only subfamily of the Nolidae s. l. which in all species (of *Nycteola*) possesses the boat-shaped cocoon with the vertical exit-slit, is the Sarrothripinae (= Nycteolinae), image 3a *Nycteola metaspilella* (WALKER, 1866). But by chaetotactic features this subfamily clearly belongs to the Noctuidae s. BECK, s. HAMPSON. *Garella nilotica* (ROGENHOFER, 1881) which is included by FIBIGER (2009) in the Nycteolinae has not the specific boat-shaped cocoon (image 4 a); the ♂ genitalia of *Garella nilotica* (ROGENHOFER) are also very different from *Nycteola* HÜBNER, 1822. The position of *Garella* within the Nycteolinae is questionable, because the appearance of the larva (image 4 b) - body, pattern and setae - is very different in comparison with *Nycteola*-spec.-larvae, image 3 b; setal map as in Noctuidae s. HAMPSON.

#### **Images of Nolidae-s. l. subfamilies-larvae with the typical chaetogram of Noctuidae-larvae give the main evidence for combination of these with the Noctuidae s. HAMPSON**

The control of available larval material (images 3 b, 4 b, 5, 6) of extra-european subfamilies of the Nolidae s.l. from North-America (WAGNER et al., 2011) reveals that all larvae of these subfamilies, except the Nolidae s. str.-larvae (=Nolinae-larvae of the Nolidae s. l.) have the same and for Noctuidae-larvae typical setal map (images 5 and 6, compare also with fig. 1). In spite KITCHING (1998) maintains that the setation with primary setae in all additional subfamilies (combined with the Nolinae s. str. to the Nolidae s. l.) represents a reversal, this does not convince at all, because the setal map is completely identical with the pattern of the Noctuidae s. HAMPSON (fig. 1). If this primary setation would be a reversal, then the position of the setae had to be the same as in fig. 4 for the L1-larva of *Nola squalida* (STAUDINGER, 1870). Just this specific primary setation in the additional subfamilies to the Nolidae s. str. to the large family Nolidae s. l. is the strongest argument for the assumption that these subfamilies belong to the Noctuidae s. HAMPSON.

Image 5, *Concana mundissima* WALKER, 1857 (Collomeninae, Nolidae s. l.): the position of the setae are distinct by the black spots at their basis; on A1 and A2 the setae D1 and D2 above the white subdorsal line are distinct, below of this line the setae around the brownish rimmed spiracula are distinct, too and the positions of these setae are typical for Noctuidae. According to molecular investigations the Collomeninae (image 5) are true Noctuidae, close to the Bagisarininae (ZAHIRI & al., 2012: fig. 2). - Images 6 and 7 *Baileya doubledayi* (GUENÉE), subfam. Risobinae of the Nolidae s. l.: Image 6 shows the basis of some setae (each with a small white spot at the basis), distinct for D1 and D2 on A1 and A2 above the white subdorsal line: showing the trapezium-order as in Noctuidae. Image 7 shows the elongated spindle-shaped cocoon of the same species. Ergo: the Risobinae belong to the Noctuidae s. HAMPSON.

#### **Nolidae s. l. wrong defined by the imaginal-systematists but molecular-genetically stated to be correct (ZAHIRI et al., 2012)**

It is remarkable that the present teams (ZAHIRI et al. 2010-2013) for molecular-genetical investigations in the Noctuoidea are composed of imaginal-systematists (KITCHING et al.) and of one or some molecular workers (ZAHIRI et al.). The former offer with the Nolidae s. l. a completely wrong definition of the concerning group to investigate on which have to trust the molecular-systematists.

The result and conclusion for the Nolidae s. l. is clear: at present the molecular-genetics is not able to offer investigations with genes (gene-sections), which are compatible with morphological characters and so happens the dilemma with the Nolidae s. l.: This group got molecular-genetically confirmed as correct in spite of the wrong assumption by 'the most convincing apomorphy' for the characterization of the Nolidae s. l.: the boat-shaped cocoon with a vertical exit-slit. Because the imaginal-systematists were unable to find a synapomorphy at the adults, KITCHING went to the immatures, but there unfortunately to the wrong stage, the chrysalid and especially the embarkment of this, the cocoon.

#### **The dilemma with the Noctuidae s. HAMPSON – two families (Erebidae as by FIBIGER & LAFONTAINE and Noctuidae s. str. s. FIBIGER & LAFONTAINE) or the one family Noctuidae s. HAMPSON, s. Beck. The term 'pseudoquadrifine'**

Similar to the dilemma Nolidae s. str. or s. l. was the result with the Noctuidae s. HAMPSON: Because FIBIGER & LAFONTAINE (2005, 2006) could not find any apomorphy as a synapomorphy for the so speciose family Noctuidae, they split the Noctuidae s. HAMPSON into the series of trifine subfamilies of the Noctuidae s. HAMPSON, now the Noctuidae s. FIBIGER & LAFONTAINE and into the series of the quadrifine subfamilies of the Noctuidae s. HAMPSON, which are now named

Erebidae. But unfortunately the next dilemma happened, the force to include into these Erebidae the quadrifine families Lymantriidae, Arctiidae and Nolidae s. HAMPSON. Over all, a clear separation by this venation is not always possible; therefore the term pseudoquadrifine was created (ZAHIRI et al. 2013: 8). - Over all FIBIGER (2009: 149) puts the Bagisarinae to the trifine Noctuidae, whilst LAFONTAINE (pers. com. and in ZAHIRI et al., 2013) and WAGNER (2011) put this subfamily to the 'Erebidae'.

All these errors could have been avoided if the study of the setal maps of the larvae had been taken into consideration.

#### **Compatibility of the molecular-genetics. Reliability in the present molecular methods?**

So far the molecular-genetical investigations are based only on gene sections which match important physiological processes, e.g. the genes for intracellular respiration - the so-called 'chain of respiration' -, a congruence between convincingly morphologically defined systematic groups and the present molecular investigations is not to be expected.

In 2014 on a congress of Biological Systematics at Dresden, WÄGELE (Alexander-König-Forschungsinstitut & Museum, Bonn) demonstrated that the molecular investigations for finding the way of evolution as well as the correctness of the system of the animals have mistakes. He postulated: If a higher taxon is morphologically correctly defined, then the molecular-genetical results have to be in concordance with the morphological results. If this is not the case then the molecular methods have to be controlled and improved. - By this occasion WÄGELE (as yet unpublished) demonstrated that the methods, esp. the algorithms for evaluation of the analytic results of the molecular-systematics are incorrect too, especially in the maximum likelihood analyses on which the results of ZAHIRI'S molecular investigations are based (see below).

WÄGELE, concerning the relationship between crustaceans, insects and myriapods: "Some clades that appear consistently in molecular phylogenies are not compatible with evolutionary scenarios which integrate morphological and palaeontological data." There has been found a possible cause for these contradictions: "Recent computer simulations have shown that important systematic errors occurring in maximum likelihood (= ML) analysis can not be avoided with the currently available software. The hope that 'more data' will solve all problems must be replaced by the demand for better algorithms and for more evolutionary thinking."

#### **Importance of chaetotaxy for the systematics of Lepidoptera for decisions in the higher taxonomy of Lepidoptera.**

##### **Knowledge of chaetotaxy by the present imaginal-systematists?**

Within taxa with holometamorphosis, e.g. as with the Lepidoptera, which are imaginally so difficultly to study on a large scale of many species and specimens, we have the chance to control and to improve the results of one method (e.g. the imaginal investigations) by investigations of the larvae. This has not been done by the studies on the Noctuoidea, in spite of the prophetic words of KITCHING: "The immatures are more informative than.....!"

Contrary to the very superficial opinion "Why should the character 'bristle' be more worth than all the other (especially the imaginal) characters?" (unnamed redactor of the *Nota lepidopterologica*) - Beck demonstrated on the SEL-congress in Bulgaria 2013 the importance of chaetotaxy and the preconditions for this. There is little or no knowledge about chaetotaxy and its importance for taxonomy on higher levels (subfamily, family and higher taxa, e.g. Noctuoidea) at the imaginal-systematists (exception e.g. TARMANN, 1994: Zygaenoidea). In the zoological hand-book 1998 there is made very little use of chaetotactic characters in the key to the families (CARTER, 1998: 31-39). There is made no or only poor use of chaetotaxy within the chapter on the Noctuoidea (KITCHING & RAWLINS, 1998) in spite of the concerning drawings and knowledge of RAWLINS.

Chaetotaxy means the study of the very stable distribution of (primary) setae on the larval body (the setal map) and the comparison of the concerning setal maps between higher taxa as here is demonstrated with the differences in the setal maps of the Noctuidae-larvae s. HAMPSON (figs. 1 a, 1 b) and the L1-Nolidae s. str.-larva (see fig. 4). Here is given only a short introduction to the groundplan of the distribution of the primary setae on the abdominal segments A1-A8 (resp. S1-S8), see figs. 1 a, 1 b. For the all-round-contact with the environment there are the dorsad setae D1 and D2, the basis (=tubercles) of which form on A1 to A7 each a virtual trapezium with the other side of the bilateral larva (fig. 1 a, 1 b). Therefore these bristles were formerly named the 'trapezoidals'. The laterad macro-setae around the spiracula are: above the spiracle seta-SD1, behind the spiracle seta-L1 and below the spiracle seta-L2. The ventrad setae (V1) and the setae between the L-group and V1, the subventrad-setae (SV-setae) are here not considered. Between the dorsad setae (D-) and the L-setae there is only one subdorsad (macro)seta SD1 (above the spiracle). With this equipment of setae the larva can at once react as a whole when only one seta is contacted by a predator, because all setae are neurally connected (HASENFUSS, 1973). Thus the setal equipment is of greatest importance for survival of the species and therefore this successful system got an extraordinary stability during the evolution. As the setal ground-plan for the Noctuidae-larvae (fig. 1 a) demonstrates in comparison with the setal ground-plan of the Nolidae s. str. (fig. 4), the differences are relatively few: the number of setae in the concerning area is the same, but the position of the setae very different. E.g. in the L1-instar of *Nola squalida* STAUDINGER, 1870 (this instar is taken for comparison because the following instars of the Nolidae s. str., s. HAMPSON are set with secondary setae on verrucae) the setae D1 and D2 are nearly on one vertical axis and the L1- and L2-setae are closely together on one pinaculum, ventrocaudad of the spiracle.

These differences make it quite clear, that none of the combinations of the Nolidae s. str. with the other subfamilies in the Nolidae s. l., which are by the setal map true Noctuidae, can be hold.

By such chaetotactic studies HASENFUSS (1963) already proved the Psychidae to be the most ancient group within the Ditrysian Lepidoptera. This got now confirmed (MUTANEN et al., 2010; SOHNS et al., 2013) after about 50 years later,

by molecular studies, which in these basal groups of the Lepidoptera seem to be more in concordance with the larval-morphological results as compared with those at the Nolidae s. l. and the Noctuidae s. HAMPSON by MITCHEL et al. (2006) and ZAHIRI et al. (2010, 2011, 2012).

#### **The obligation of the phylogenetical systematics to search for characterization as monophylum by one or some autapomorphies and the problem of consistency in higher taxa**

As the problem of characterization of the Noctuidae s. HAMPSON proves and FIBIGER & LAFONTAINE attested: at the adults there could be found no apomorphic character as synapomorphy for all species for to characterize this Noctuidae as monophyletic - therefore these authors split the Noctuidae s. HAMPSON.

The phylogenetic systematics are idealistic and depend on the consistency of characters. But is that realistic? As we can see in the Noctuidae (and in other higher +/- speciose taxa): similar to the inconsistency of species there is an inconsistency of the characters chosen for characterizing higher taxa. This means that similar to the inconsistency of species there necessarily exists the inconsistency of higher taxa.

The efforts of systematists are directed to characterize clearcut taxa. This idealistic reasoning is also the basis of phylogenetical systematizing. But as we see, it is utopian to get a complete natural and phylogenetical system because of the phenomenon inconsistency by reversal(s). - There remains only the alternative of combination of apomorphies to get an optimal approach.

Therefore the characterization as monophylum has to be enlarged by the combination of suitable apomorphies: if one good apomorphy does not characterize all species (because of a reversal there), then it may be substituted by an other good apomorphy, etc.

The traditional praxis of the phylogenetical systematics to acknowledge high-level taxa as monophyla is not to hold in (very) species-rich higher taxa, e.g. in the family Noctuidae (one of the five most speciose families of the world-fauna).- This statement is in concordance with the remark of KITCHING concerning the characterization of the quadrifid families of the Noctuoidea, esp. of the Noctuidae s. HAMPSON: In the Noctuidae s. HAMPSON there is virtually no character to be found which is not homoplasic (KITCHING & RAWLINS, 1998), either by convergence or by reversal(s). - In very speciose taxa characterization as monophylum is possible only by combination of apomorphies: if one apomorphy can not be used for all species, because of reversals, then another 'exchange-apomorphy' must be used for support.

By doing this the heavy mistakes in the present (imaginal and molecular) systematics of the Noctuoidea could have been prevented.

#### **Final remark**

The above quoted moleculargenetical investigations were always done by teams of imaginal-systematists (KITCHING, LAFONTAINE, HOLLOWAY etc.) and molecular specialists (e.g. ZAHIRI et al., 20012); thus scientific independence is/was not warranted. In the Lepidoptera the investigation and participation of all stages, esp. the adults and the larvae and additional methods (e.g. the molecular investigation) are necessary to get a convincing result. The investigation by 'one hand', e.g. WÄGELE, is also idealistic. His demand is: An unequivocally morphologically characterized taxon has to be confirmed by moleculargenetical investigations. If there is no congruence then the moleculargenetical (and morphological) investigations have to be controlled and improved.

This is exactly the matter with the treating of the systematics of the Nolidae s. l. by the imaginal and molecular workers: the larval characterization of the Nolidae s. str. is so convincing that every other view of the nolid sysematics, as well imaginal as molecular, has to be rejected. So far as the molecular investigations do not confirm the larval results, these have to be treated as wrong.

WÄGELE demonstrated on 'The congress for Biological Systematics at the Senkenberg-Museum at Dresden, 2014' that the present algorithms for evaluating the moleculargenetical analytic results are incorrect.

This means for the present Nolidae s. l.: If this Nolidae (which were morphologically defined only by the boat-shaped cocoon, KITCHING & RAWLINS, 1998, and again by ZAHIRI et al., 2012, and what revealed to be a wrong supposition) are moleculargenetically confirmed (ZAHIRI et al., 2012), the concerning molecular methods are insufficient, faulty or even wrong.

It is also an illusion to try to confirm morphological characters which depend on cooperation of many morphogenetically working genes by investigation of some and not morphologically aimed genes.

Instead of discrediting, resp. neglecting the larval-systematics coworking of both, the imaginal-systematics with the larval-systematics is necessary and then the molecular-systematics can control with new methods and try to confirm.

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Nolidae s. l. and which were the basis as well for the talk at the SEL-congress at Dresden 2015, as now for this paper with his original photos/images. GERHARD TARMANN for discussion about larval-investigations at the Zygaenoidea and the value of these for elucidating the higher systematics there.

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#### Anschrift des Verfassers

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**In my own matter:** In the libraries of universities, natural history museums and institutions for biological research as well as in entomological/lepidopterists societies and in the large public libraries it is a 'must' to have books on Lepidoptera. But how is it with (scientific) books on larvae, which are very important for faunistics, ecology and especially for clearing of the systematics as is now demonstrated in BECK, H. (1999-2000) "Die Larven der europäischen Noctuidae - Revision der Systematik der Noctuidae". The concerning referents at the libraries often have not the experience about the importance of such/these books and need information. The paper above gives this information.- Of course these books also may be sent for to look at and to get the necessary impression for to make a respective decision.

Material for information you can find in the home-page ([www.dr-beck.net](http://www.dr-beck.net)) or ask, please, for informative material (flyers/prospects) at the author himself: Dr. HERBERT BECK, Max Planck Str. 17, D-55124 Mainz, E-mail: [noctuidae@dr-beck.net](mailto:noctuidae@dr-beck.net)

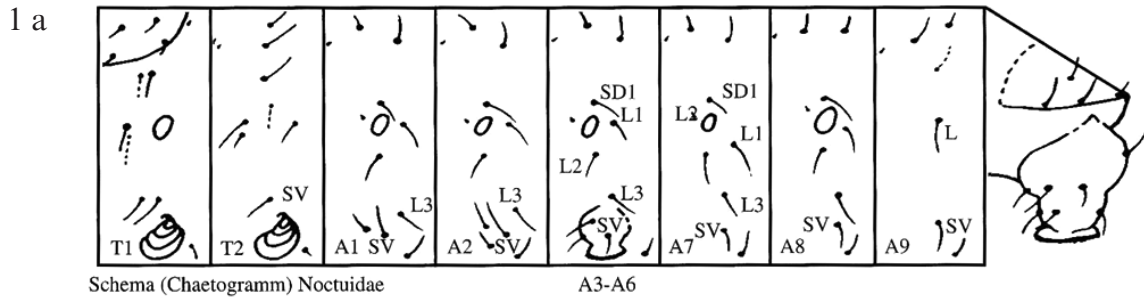


Fig. 1a: Scheme of the setal map of the Noctuidae (taken from BECK, 1999-2000).

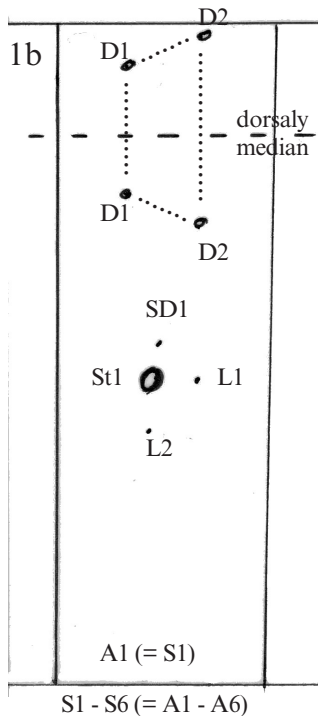


Fig. 1b: Detail of A1 = S1, demonstrating the 'trapezium' and the area around the spiracle.

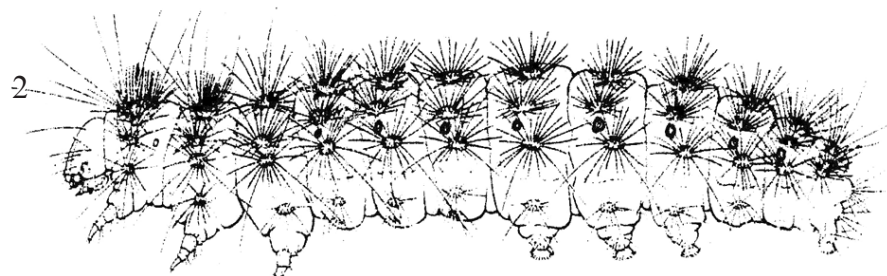


Fig. 2: Drawing of a Nolidae s. str.-larva in lateral view (taken from STEHR, 1987): take care for the prolegs on A4-A6 and the verrucae with secondary setae.

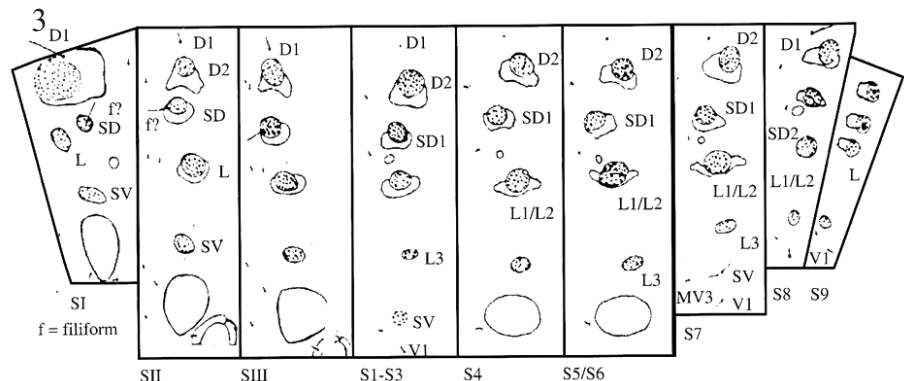


Fig. 3: Schematic setation of *Nola cuculatella* (LINNAEUS, 1758), last instar (drawing by HASENFUSS): (nearly) all setae on verrucae, but D1 as a single seta above verruca D2.

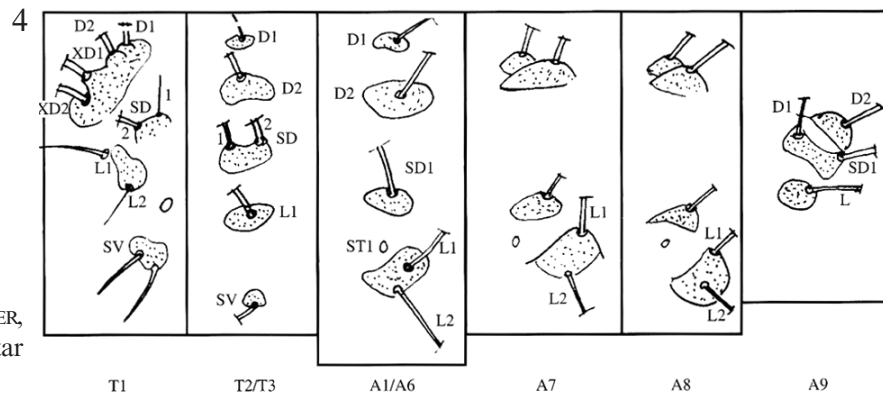


Fig. 4: *Nola squalida* (STAUDINGER, 1870): Setal map for the first instar (taken from BECK, 2009).





### Images 1 a-8:

**Image 1 a:** *Nola cuculatella* LINNAEUS, 1758: lateral view of the larva with distinct and evenly completely developed prolegs on A4-A6, prolegs on A3 missing; position of the verrucae around the spiracles (stigmae): verruca SD1 above the spiracle, verruca L1+L2 ventrocaudad of the spiracle (all secondary bristles on verruca). **Image 1 b:** *Nola triquetrana* (FITCH, 1856) (Nolidae s. str.), cocoon some boat-shaped - 100 KB. **Image 2:** *Nola clethrae* DYAR, 1899 (Nolidae s. str.), cocoon not boat-shaped but spindle-like - 107 (109) KB. **Image 3 a:** *Nycteola metaspilella* WALKER, 1866 (Sarothripinae, Nolidae s. l.): cocoon boat-shaped with the vertical exit-slit - 99 (100) KB. **Image 3 b:** *Nycteola cinereana* NEUMOEGEN & DYAR, 1893 (Sarothripinae, Nolidae s. l.) 112KB: appearance of the larva as compared with a true Nolidae-larva (fig. 5). **Image 4 a:** *Garella nilotica* (ROGENHOFER, 1881), 169 KB: appearance of the larva as compared with *Nycteola cinereana* NEUMOEGEN & DYAR, 1893. **Image 5:** *Concana mundissima* WALKER, 1857 (Collomeninae, Nolidae s. l.) 93,1 KB: larva in lateral view: no verrucae, the position of the primary setae as at Noctuidae-larvae s. HAMPSON, prolegs on A3 and A4 missing, primary setation distinct, especially around the spiracles: above the spiracle SD1, behind L1, ventrad of the spiracle L2. In the opinion of ZAHIRI now the Collomeninae also molecular fit better to the Noctuidae (s. FIBIGER & LAFONTAINE), close to the Bagisarinae. **Image 6:** *Baileya doubledayi* (GUENÉE, 1852), subfam. Risobinae of the Nolidae s. l. 140 KB The larva shows the basis of some setae (each with a small white spot at the basis), distinct for D1 and D2 on A1 and A2 above the white subdorsal line, showing the trapezium-order of D1 and D2 as in Noctuidae s. HAMPSON. **Image 7:** *Baileya doubledayi* (GUENÉE, 1852), subfam. Risobinae (KB 160), cocoon spindle-shaped. **Image 8:** *Baileya levitans* (SMITH, 1906), subfam. Risobinae (KB 117), cocoon some spindle-shaped. Except of fig. 5, phot. K. SILVONEN, all images (original photos) from D. WAGNER (WAGNER, D. & al. 2011).

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Autor(en)/Author(s): Beck Herbert

Artikel/Article: [Credibility of the present molecular-systematics? 1. What is to do if a group, e.g. the family Nolidae s.l., is larvally unequivocally revealed as wrong defined by the imaginal-systematists but confirmed by the molecular workers? 2. The unjustified splitting of the Noctuidae s. Hampson into the Erebidae and Noctuidae s. str. \(Lepidoptera, Noctuoidea\) 281-289](#)