Nota Lepi. **37**(2) 2014: 123–133 | DOI 10.3897/nl.37.7940

Taxonomic comments on the treatment of the Zygaenidae (Lepidoptera) in volume 3 of *Moths of Europe*, Zygaenids, Pyralids 1 and Brachodids (2012)

Konstantin A. Efetov[1], Axel Hofmann[2], Gerhard M. Tarmann[3], Walter Gerald Tremewan[4]

1 *Crimean State Medical University, Department of Biological Chemistry and Laboratory of Biotechnology, 295006, Simferopol, Crimea; efetov.konst@gmail.com*

2 *Am Hochgestade 5, D–76351 Linkenheim-Hochstetten, Germany; hofmann@abl-freiburg.de*

3 *Tiroler Landesmuseen, Ferdinandeum, Naturwissenschaftliche Abteilung, Feldstrasse 11a, A–6020 Innsbruck, Austria; g.tarmann@tiroler-landesmuseen.at*

4 *Department of Life Sciences, Division of Insects, Natural History Museum, Cromwell Road, London SW7 5BD, U.K.; Correspondence address: Pentreath, 6 Carlyon Road, Playing Place, Truro, Cornwall TR3 6EU, U.K.; wgt.pentreath@btinternet.com*

http://zoobank.org/384F4C62-0E0E-4B66-B720-3177920ABA23

Received 4 February 2013; accepted 4 June 2014; published: 8 September 2014
Subject Editors: Lauri Kaila and Jadranka Rota.

Abstract. Critical taxonomic comments are provided on the section dealing with the Zygaenidae in volume 3 of *Moths of Europe* (Leraut 2012). A number of newly described nominal taxa in that work are here synonymised as are nominal subgenera and subspecies that were reinstated as valid. At the subgeneric level these are *Hesychia* Hübner, [1819] (**syn. rev.**), *Coelestis* Burgeff, 1926 (**syn. rev.**) and *Santolinophaga* Burgeff, 1926 (**syn. rev.**), all synonyms of the monophyletic subgenus *Mesembrynus* Hübner, [1819], and *Coelestina* Holik, 1953 (**syn. rev.**), *Epizygaena* Jordan, 1907 (**syn. rev.**) and *Lictoria* Burgeff, 1926 (**syn. rev.**), all synonyms of the paraphyletic subgenus *Agrumenia* Hübner, [1819]. At the subspecific level *Adscita geryon parisiensis* Leraut, 2012 (**syn. n.**) and *A. geryon aeris* (Verity, 1946) (**syn. rev.**) are synonyms of *A. geryon geryon* (Hübner, [1813]). *Zygaena exulans altaretensis* Le Charles, 1942 (**syn. rev.**) and *Z. exulans bourgognei* Le Charles, 1942 (**syn. rev.**) are synonyms of *Z. exulans exulans* (Hohenwarth, 1792). *Zygaena trifolii vindilisensis* Leraut, 2012 (**syn. n.**) is a synonym of *Z. trifolii subsyracusia* Verity, 1925. *Zygaena carniolica besseensis* Leraut, 2012 (**syn. n.**) and *Z. carniolica rogervillensis* Leraut, 2012 (**syn. n.**) are synonyms of *Z. carniolica modesta* Burgeff, 1914. *Zygaena hilaris nigriventris* Leraut, 2012 (**syn. n.**) is a synonym of *Z. hilaris chrysophaea* Le Charles, [1934]. *Zygaena rhadamanthus boixolsis* Aistleitner, 1990 (**syn. n.**) is a synonym of *Z. rhadamanthus rhadamanthus* Esper, [1789], *Z. rhadamanthus cleui* Dujardin, 1956 (**syn. rev.**) is a synonym of *Z. rhadamanthus grisea* Oberthür, 1909, and *Z. rhadamanthus aragonia* Tremewan, 1961 (**stat. rev.**), *Z. rhadamanthus azurea* Burgeff, 1914 (**stat. rev.**) and *Z. rhadamanthus aurargentea* Mazel, 1979 (**stat. rev.**) are reinstated as valid subspecies.

Résumé. Les auteurs font une analyse critique de la taxonomie employée pour le chapitre traitant des Zygaenidae, dans le volume 3 de la série «papillons de nuit d'Europe». Un certain nombre de taxons nominaux nouvellement décrits sont mis en synonymie, ainsi que des sous-genres et sous-espèces qui avaient été considérés comme valides. Au niveau subgénérique c'est le cas pour *Hesychia* Hübner, [1819] (**syn. rev.**), *Coelestis* Burgeff, 1926 (**syn. rev.**) et *Santolinophaga* Burgeff, 1926 (**syn. rev.**), qui doivent être replacés dans le sous-genre monophylétique *Mesembrynus* Hübner, [1819] et *Coelestina* Holik, 1953 (**syn. rev.**), *Epizygaena* Jordan, 1907 (**syn. rev.**) et *Lictoria* Burgeff, 1926 (**syn. rev.**), qui doivent eux être placés dans le sous-genre paraphylétique *Agrumenia* Hübner, [1819]. Pour ce qui concerne les sous-es-

pèces, il s'agit de *Adscita geryon parisiensis* Leraut, 2012 (**syn. n.**) et *A. geryon aeris* (Verity, 1946) (**syn. n.**), qui doivent être rattachés à *A. geryon geryon* (Hübner, [1813]); *Z. exulans altaretensis* Le Charles, 1942 (**syn. rev.**) et *Z. exulans bourgognei* Le Charles, 1942 (**syn. rev.**) synonymes de *Z. exulans exulans* (Hohenwarth, 1792); *Z. trifolii vindilisensis* Leraut, 2012 (**syn. n.**) synonyme de *Z. trifolii subsyracusia* Verity, 1925; *Z. carniolica besseensis* Leraut, 2012 (**syn. n.**) et *Z. carniolica rogervillensis* Leraut, 2012 (**syn. n.**) synonymes de *Z. carniolica modesta* Burgeff, 1914; *Z. hilaris nigriventris* Leraut, 2012 (**syn. n.**) synonyme de *Z. hilaris chrysophaea* Le Charles, [1934]; enfin *Z. rhadamanthus boixolsis* Aistleitner, 1990 (**syn. n.**) synonyme de *Z. rhadamanthus rhadamanthus* (Esper, [1789]), *Z. rhadamanthus cleui* Dujardin, 1956 (**syn. rev.**) synonyme de *Z. rhadamanthus grisea* Oberthür, 1909. *Zygaena rhadamanthus aragonia* Tremewan, 1961 (**stat. rev.**), *Z. rhadamanthus azurea* Burgeff, 1914 (**stat. rev.**) et *Z. rhadamanthus aurargentea* Mazel, 1979 (**stat. rev.**), sont réintégrées comme sous-espèces valides.

Introduction

In a recent review of the Zygaenidae of Europe (Leraut 2012), a number of questionable taxonomic changes were proposed, many of which lack convincing morphological and/or phylogenetic support (Efetov et al. 2013). For example, a number of subgenera within the genus *Zygaena* were unjustifiably reinstated as valid, as were a number of taxa at subspecific level. Moreover, five subspecies and several infrasubspecific forms were newly described, but only the former are dealt with in the present paper, as infrasubspecific forms have no status under the *International Code of Zoological Nomenclature* (ICZN 1999). In order to obtain a clear understanding of the problem, it is recommended that the review (Efetov et al. 2013) of the handbook and the present article are read together.

Phaudidae

Although treated as a subfamily of the Zygaenidae by Leraut (2012: 44), the Phaudidae were elevated to full family status within the Zygaenoidea by Niehuis et al. (2006: 822, fig. 3), a placement that is now widely accepted by lepidopterists (van Nieukerken et al. 2011) and fully supported by the present authors.

Procridinae

Genus. *Zygaenoprocris* Hampson, 1900, is considered to be a valid genus (Efetov 2001a). However, Leraut (2012: 67) referred to *Zygaenoprocris taftana* (Alberti, 1939) as *Adscita taftana* (Alberti, 1939).

Subspecies. Four subspecies of *Adscita geryon* are currently recognized as valid, viz. *A. geryon geryon* (Hübner, [1813]), *A. geryon chrysocephala* (Nickerl, 1845), *A. geryon acutafibra* Verity, 1946, and *A. geryon orientalis* (Alberti, 1938) (Efetov 2001b: 128, 2001c: 155, 2004: 23). However, it is intended to place *A. geryon chrysocephala* (Efetov and Tarmann in prep.), which Leraut (2012: 62) also recognized as valid, as a synonym of *A. geryon geryon*, while the status of *A. geryon acutafibra* is at present unclear.

Adscita (*Adscita*) *geryon geryon* (Hübner, [1813])

Sphinx geryon Hübner, [1813], Sammlung europäischer Schmetterlinge 2: pl. 28, figs 130, 131. Type-locality. Europe [Germany].

Adscita geryon razza *aeris* Verity, 1946, Redia 31: 154. Type-locality. France: [Alpes-Maritimes], Saint-Barnabé. **Syn. rev.**

Adscita geryon parisiensis Leraut, 2012, Moths of Europe 3: 62, pl. 6, figs 17, 18. Type-locality. France: Paris region. **Syn. n.**

Distribution and taxonomic notes. *Adscita geryon geryon* is distributed from the Iberian Peninsula and Britain to European Russia, the Crimea and Turkey. Leraut (2012: 61) reinstated the nominal taxon *A. geryon aeris* (Verity, 1946) as valid and on the following page newly described a subspecies from the Paris region. It is acknowledged that *A. geryon* is an extremely variable species, both in phenotype and genitalic morphology, but we see no justification for recalling a subspecies from synonymy, where it was placed by Efetov and Tarmann (1999: 28, 2012: 31), or in describing a new subspecies from France. Accordingly, both taxa are here formally placed as synonyms (**syn. rev.**; **syn. n.**) of the nominotypical subspecies *A. geryon geryon*.

Zygaeninae

Subgenera. In discussing the classification of the genus *Zygaena* Fabricius, 1775, at the subgeneric level, Leraut (2012: 67–68) refers to a paper by Niehuis et al. (2006) in which the subgenera are not mentioned. Presumably the intention was to refer to the evolutionary history of the genus, as based on nuclear and mitochondrial DNA-sequencing by Niehuis et al. (2007). The latter paper provides a phylogeny in which the *Zygaena* species are placed into species-groups within three subgenera, viz. *Mesembrynus* Hübner, [1819], *Agrumenia* Hübner, [1819], and *Zygaena* Fabricius, 1775, based on the classification of Alberti (1958, 1959) and, supported by their own research, followed by Naumann and Tremewan (1984) and Hofmann and Tremewan (1996, 2010). However, Leraut (2012: 67–68) resurrected various nominal subgenera from synonymy and applied them to some of the species groups, viz. *Hesychia* Hübner, [1819], *Coelestis* Burgeff, 1926, *Santolinophaga* Burgeff, 1926, all formerly placed as synonyms of the monophyletic subgenus *Mesembrynus* Hübner, [1819], and *Coelestina* Holik, 1935, *Epizygaena* Jordan, [1907], and *Lictoria* Burgeff, 1926, all formerly placed as synonyms of *Agrumenia* Hübner, [1819] (Hofmann and Tremewan 2010). It is accepted that the subgenera *Agrumenia* and *Zygaena* are paraphyletic, but *Mesembrynus* is monophyletic, based on morphology (Alberti 1958, 1959), larval host-plants (Hofmann and Tremewan 1996) and DNA analysis (Niehuis et al. 2007). Therefore, to split the last-mentioned subgenus into four subgenera is illogical and artificial, as two (*Mesembrynus* and *Santolinophaga*) will then become paraphyletic groupings. As a consequence, the nominal subgeneric taxa *Hesychia*, *Santolinophaga* and *Coelestis* are here formally reinstated as synonyms (**syn. rev.**) of *Mesembrynus*, and *Epizygaena*, *Coelestina* and *Lictoria* are reinstated as synonyms (**syn. rev.**) of *Agrumenia*. The full synonymy of the subgenera can be found in Hofmann and Tremewan (1996, 2010) and only those relevant to Leraut (2012) are discussed below.

Subgenus *MESEMBRYNUS* Hübner, [1819]

Mesembrynus Hübner, [1819], Verzeichniss bekannter Schmettlinge: 119. Type-species: *Zygaena pluto* Ochsenheimer, 1808, by subsequent designation, Tremewan, 1961, The Entomologist's Record and Journal of Variation 73: 202.

Hesychia Hübner, [1819], Verzeichniss bekannter Schmettlinge: 116. Type-species: *Sphinx laeta* Hübner, 1790, by subsequent designation, Holik & Sheljuzhko, 1953, Mitteilungen der Münchener Entomologischen Gesellschaft 43: 219. **Syn. rev.**

Santolinophaga Burgeff, 1926, in Strand, Lepidopterorum Catalogus 4 (33): 18. Type-species: *Zygaena corsica* Boisduval, [1828], by monotypy. **Syn. rev.**

Coelestis Burgeff, 1926, in Strand, Lepidopterorum Catalogus 4 (33): 29. Type-species: *Zygaena cuvieri* Boisduval, [1828], by subsequent designation, Tremewan, 1961, The Entomologist's Record and Journal of Variation 73: 201. **Syn. rev.**

Subgenus *AGRUMENIA* Hübner, [1819]

Agrumenia Hübner, [1819], Verzeichniss bekannter Schmettlinge: 116. Type-species: *Sphinx onobrychis* [Denis & Schiffermüller], 1775, by subsequent designation, Tremewan, 1961, The Entomologist's Record and Journal of Variation 73: 202.

Epizygaena Jordan, [1907], in Seitz, Die Gross-Schmetterlinge der Erde 2: 31. Type-species: *Zygaena afghana* Moore, [1860], by subsequent designation, Fletcher, 1925, Catalogue of Indian Insects part 9: 21. **Syn. rev.**

Coelestina Holik, 1953, Entomologische Zeitschrift 63: 15. Type-species: *Zygaena sedi* Fabricius, 1787, by original designation. **Syn. rev.**

Lictoria Burgeff, 1926, in Strand, Lepidopterorum Catalogus 4 (33): 20. Type-species: *Sphinx achilleae* Esper, 1780, by subsequent designation, Holik, 1938, Entomologische Rundschau 55: 352. **Syn. rev.**

Subspecies. In their systematic catalogue of the Zygaeninae, Hofmann and Tremewan (1996) attempted to provide a classification in which some rationale could be brought to the genus *Zygaena* Fabricius, 1777, with reference to subspecies; hence an enormous number of subspecific taxa were placed as synonyms. It would appear that the classification in that catalogue has largely been ignored, as Leraut reinstated two subspecific taxa as valid and newly described four within *Zygaena*. While this would have been acceptable during the first half of the 20th century, the description of new subspecies in the genus *Zygaena* from mainland Europe at the present time neither reflects current thinking nor the presently accepted concept of a subspecies and is reminiscent of the taxonomy practised in the 1920s and 1930s (e.g. Verity (1925, 1926) described and named three 'subspecies' of *Z. trifolii* from England, based on single colonies). Mayr (1969: 41) contended that a subspecies is 'an aggregate of phenotypically similar populations of a species, inhabiting a geographic subdivision of the range of a species, and differing taxonomically from other populations of the species' and that it may consist of many local populations all of which, though very similar, are slightly different from each other genetically and phenotypically. In contrast to the reinstatement of two subspecies, Leraut (2012) synonymised four without providing justification. All of these nominal subspecific taxa are discussed in detail below. As with the subgenera, the full synonymy of the subspecies can be found in Hofmann and Tremewan (1996) and only those relevant to the field guide (Leraut 2012) are listed below.

Zygaena (*Agrumenia*) *exulans exulans* (Hohenwarth, 1792)

Sphinx exulans Hohenwarth, 1792, in Reiner & Hohenwarth, Botanische Reisen nach einigen Oberkärntnerischen und benachbarten Alpen ... : 265, pl. 6, fig. 2. Type-locality. Austria: Kärnten, Gross-Glockner, Pasterzen Kees ('an den äussersten Alpengipfeln des Eisgebirges am Glockner, auf der sogenannten Pasterze').

Zygaena exulans altaretensis Le Charles, 1942, Bulletin de la Société Entomologique de France 47: 178, pl. 1, figs A–C (Zygaena). Type-locality. France: Hautes-Alpes, Col du Lautaret, 1,800–2,200 m. [Paratype 1 ♂ examined.] **Syn. rev.**

Zygaena exulans bourgognei Le Charles, 1942, Bulletin de la Société Entomologique de France 47: 180 (Zygaena). Type-locality. France: Alpes-Maritimes, Haute Vésubie, Vallon de la Madonna de Finestre (Madone de Fénestre). **Syn. rev.**

Distribution and taxonomic notes. The nominotypical *Zygaena exulans exulans* is widely distributed throughout the European Alps. While it is acknowledged that variation does occur among some of the populations occurring in this mountain system, we see no justification for recognising any as valid nominal subspecies. When compiling the systematic catalogue (Hofmann and Tremewan 1996) it was decided that the most rational approach to subspecies in *Z. exulans* was to recognise only one subspecies in each major mountain range. Leraut (2012: 120) reinstated *Zygaena exulans altaretensis* and *Zygaena exulans bourgognei* as valid subspecies without providing justification; both are here formally placed as synonyms (**syn. rev.**) of the nominotypical *Zygaena exulans exulans*.

Zygaena (*Agrumenia*) *hilaris chrysophaea* Le Charles, [1934]

Zygaena hilaris chrysophaea Le Charles, [1934], in Lhomme, Catalogue des Lépidoptères de France et de Belgique 1: 683 (Zygaena). Type-locality. France: Alpes-de-Haute-Provence (Basses-Alpes), Digne, Fontgaillard, 1,000 m.

Zygaena hilaris nigriventris Leraut, 2012, Moths of Europe 3: 115, pl. 32, figs 20, 21, pl. 33, fig. 1. Type-locality. France: Hautes-Alpes, La Bessée-sur-Durance. **Syn. n.**

Distribution and taxonomic notes. In the original description of *Zygaena hilaris nigriventris* it is stated, 'This subspecies can be distinguished from subsp. *apocrypha* Le Charles from the area around Nice essentially by the abdomen with its black ventral side and absence of whitish rings. Also wingspan is greater on average.' This taxon differs greatly from the nominal taxon *apocrypha*, as this was described as a subspecies of and is conspecific with *Z. fausta* from the Alpes-de-Haute-Provence; currently it is placed as a synonym of *Z. fausta fausta* (Linnaeus, 1767) (Hofmann and Tremewan 1996: 103). Leraut (2012) most likely confused the names *apocrypha* and *chrysophaea*, the latter taxon being a subspecies of *Z. hilaris*.

Zygaena hilaris chrysophaea has a wide distribution in France, ranging from Vaucluse, Alpes-de-Haute-Provence, Drôme and Hautes-Alpes to Isère. To describe a subspecific taxon from within that distributional range cannot be justified; therefore, *Zygaena hilaris nigriventris* is here formally placed as a synonym (**syn. n.**) of *Zygaena hilaris chrysophaea*.

Zygaena (*Agrumenia*) *carniolica modesta* Burgeff, 1914

Zygaena carniolica modesta Burgeff, 1914, Mitteilungen der Münchener Entomologischen Gesellschaft 5: 57, pl. 3, figs 99, 100, 106, 107. Type-locality. Germany: Rheinland-Pfalz, central and lower Rheintal from Mainz to Koblenz.

Zygaena carniolica rogervillensis Leraut, 2012, Moths of Europe 3: 108, pl. 28, figs 16, 17. Type-locality. France: Seine-Maritime, Rogerville. **Syn. n.**

Zygaena carniolica besseensis Leraut, 2012, Moths of Europe 3: 110, pl. 29, figs 1–3. Type-locality. France: Puy-de-Dôme, Besse-en-Chandesse. **Syn. n.**

Distribution and taxonomic notes. *Zygaena carniolica modesta* has a wide distribution that ranges from northern and central France, through Belgium, Luxembourg, central and southern Germany to northern Austria, Czech Republic and southern Poland. We see no justification for describing two new subspecies from single localities located within this distribution, as their phenotypes fall within the range of variation; therefore, *Zygaena carniolica rogervillensis* and *Zygaena carniolica besseensis* are here formally placed as synonyms (**syn. n.**) of *Zygaena carniolica modesta*.

Zygaena (*Zygaena*) *rhadamanthus* (Esper, [1789])

Sphinx rhadamanthus Esper, [1789], Die Schmetterlinge in Abbildungen nach der Natur mit Beschreibungen 2 (Supplement): pl. 40, figs 1, 2; 1794, ibidem 2: 13. Type-locality. France: Gard (Languedoc), Nîmes.

Remarks. In stark contrast to the splitting and naming of geographical populations of other *Zygaena* species, Leraut (2012: 98) lumps together a number of subspecific taxa of *Z. rhadamanthus* (Esper, [1789]), all but one of which were considered valid by Hofmann and Tremewan (1996: 130–131). The latter authors accept that less variation is exhibited in the populations occurring in France (east of the Pyrenees) compared to those in the Iberian Peninsula where they exhibit a mosaic of extreme geographical variation, with phenotypes ranging from 'normal' and melanistic to individuals with the forewing ground colour powdered with white scales (griseoid) and reminiscent of *Zygaena rhadamanthus grisea*. The subspecific nominal taxa relevant to their treatment by Leraut (2012: 98) are discussed in detail below.

Zygaena (*Zygaena*) *rhadamanthus grisea* Oberthür, 1909

Zygaena rhadamanthus grisea Oberthür, 1909, Etudes de Lépidoptérologie comparée 3: 414, pl. 29, fig. 187. Type-locality. France: Alpes-de-Haute-Provence (Basses-Alpes), Digne.

Zygaena rhadamanthus cleui Dujardin, 1956, Bulletin mensuel de la Société Linnéenne de Lyon 25: 261 (Zygaena). Type-locality. France: Ardèche, St-Privat. [Paratypes 1 ♂, 1 ♀ examined.] **Syn. rev.**

Distribution and taxonomic notes. *Zygaena rhadamanthus grisea* has a wide distribution in south-eastern and southern-central France, ranging from Alpes-de-Haute-Provence and Hautes-Alpes to Isère, Drôme, Ardèche, Vaucluse, Aveyron, Lot and Lozère. Based on phenotype (and geography – *Z. rhadamanthus cleui* cannot be recognised as valid because its location is within the distributional range of *Z. rhadamanthus grisea*), we see no justification for Leraut's (2012: 98) reinstatement of *Zygaena rhadamanthus cleui* as a valid subspecies under which he placed *Zygaena rhadamanthus aragonia* and *Zygaena rhadamanthus aurargentea* as synonyms (see also below). Even in the original description, Dujardin compared *Zygaena rhadamanthus cleui* with *Z. rhadamanthus grisea*, stating that the forewing ground colour was similar. Consequently, it is here reinstated as a synonym (**syn. rev.**) of *Zygaena rhadamanthus grisea*, as placed by Hofmann and Tremewan (1996: 131).

Zygaena (*Zygaena*) *rhadamanthus azurea* Burgeff, 1914, stat. rev.

Zygaena rhadamanthus azurea Burgeff, 1914, Mitteilungen der Münchener Entomologischen Gesellschaft 5: 60, pl. 2, fig. 158, pl. 6, figs 75, 76 (Zygaena). Type-locality. France: Alpes-Maritimes (excluding coastal regions).

Distribution and taxonomic notes. *Zygaena rhadamanthus azurea* is distributed in the départements of Var and Alpes-Maritimes (excluding coastal regions). Although Leraut (2012: 98) synonymised this taxon with the melanistic *Zygaena rhadamanthus stygia* Burgeff, 1914, the distribution of the latter ranges from east of the River Var (Alpes-Maritimes) in France to Imperia in Italy. Much has been written about littoral melanism (e.g. Burgeff 1951, 1956, 1965; Dujardin 1965: 586–587) and that exhibited by subsp. *stygia* is a good example for comparison with the 'normal' phenotype of subsp. *azurea* – to consider both taxa as one subspecies clearly disregards the concept of littoral melanism and the zoogeography of *Z. rhadamanthus* in south-eastern France. Consequently, *Zygaena rhadamanthus azurea* is here reinstated as a valid subspecies (**stat. rev.**).

Zygaena (*Zygaena*) *rhadamanthus rhadamanthus* (Esper, [1789])

Sphinx rhadamanthus Esper, [1789], Die Schmetterlinge in Abbildungen nach der Natur mit Beschreibungen 2 (Supplement): pl. 40, figs 1, 2; 1794, ibidem 2: 13. Type-locality. France: Gard (Languedoc), Nîmes.

Zygaena rhadamanthus pyrenaea Verity, 1920, The Entomologist's Record and Journal of Variation 32: 161 (Zygaena). Type-locality. France: Pyrénées-Orientales, between Prades and Mont Canigou, La Trancada d'Ambouilla.

Zygaena rhadamanthus boixolsis Aistleitner, 1990, Nachrichten des Entomologischen Vereins Apollo (N.F.) 11: 79. Type-locality. Spain: Lérida, Collado de Boixols, 1,300–1,400 m. [Paratypes 4 ♂, 4; Topotypes 4 ♂, 1 ♀ examined.] **Syn. n.**

Distribution and taxonomic notes. Based on a description by Oberthür (1910: 591), Verity provided the name *pyrenaea* for the population of *Zygaena rhadamanthus* occurring at La Trancada d'Ambouilla (Pyrénées-Orientales, between Prades and Mont Canigou). Leraut (2012: 98) considered this taxon to be a 'simple synonym' of the nominotypical *Zygaena rhadamanthus rhadamanthus*, a placement with which we agree even though Hofmann and Tremewan (1996: 131) had considered it to be a valid subspecies with which the taxon *Zygaena rhadamanthus boixolsis* Aistleitner, 1990, had been placed as a synonym. The latter is now automatically transferred as a synonym of the nominotypical subspecies. Specimens from La Trancada d'Ambouilla lack the white scaling (griseoid) on the ground colour of the forewings; moreover, a red abdominal cingulum is absent, as found in the nominotypical subspecies.

Zygaena (*Zygaena*) *rhadamanthus aurargentea* Mazel, 1979, stat. rev.

Zygaena rhadamanthus aurargentea Mazel, 1979, Entomops, Nice 6: 267, figs 1, 2 (Zygaena). Type-locality. France: Pyrénées-Orientales, Coustouges.

Distribution and taxonomic notes. Described from Coustouges (Pyrénées-Orientales, France), *Zygaena rhadamanthus aurargentea* is also found in Spain (Barcelona and Gerona, excluding coastal regions). It is distinguished from *Zygaena rhadamanthus rhadamanthus* by the extreme griseoid phenotype, i.e. with pronounced white scaling on the ground colour of the forewings, es-

pecially in the females, which is reminiscent of *Zygaena rhadamanthus grisea* from south-eastern and southern-central France (see above), and by the presence of a strong abdominal cingulum that is also present ventrally. Leraut (2012: 98) placed *Zygaena rhadamanthus aurargentea* as a synonym of *Zygaena rhadamanthus cleui*, which he reinstated as a valid subspecies, but we see no justification for this (see also above). The former is here reinstated (**stat. rev.**) as a valid subspecies, based on its extreme phenotype, which is so strongly different from that of the nominotypical taxon *Z. rhadamanthus rhadamanthus* (Hofmann and Tremewan 1996: 131).

Zygaena (*Zygaena*) *rhadamanthus aragonia* Tremewan, 1961, stat. rev.

Zygaena rhadamanthus aragonia Tremewan, 1961, The Entomologist's Record and Journal of Variation 73: 4. Type-locality. Spain: Teruel, Albarracín. [Holotype ♂, paratypes 16 ♂, 11 ♀ examined.]

Distribution and taxonomic notes. *Zygaena rhadamanthus aragonia* is distributed in the Spanish provinces of Cuenca and Teruel. While it is reminiscent of *Zygaena rhadamanthus grisea* from south-eastern and southern-central France, the placement of this taxon as a synonym of *Zygaena rhadamanthus cleui* by Leraut (2012: 98), which he reinstated as a valid subspecies, is inconsistent with the geographical distribution, its 'griseoid' phenotype and the presence of a strong abdominal cingulum. As a consequence, *Zygaena rhadamanthus aragonia* is here reinstated (**stat. rev.**) as a valid subspecies (Hofmann and Tremewan 1996: 130). It should be noted that *Zygaena rhadamanthus aurargentea* also has a griseoid phenotype and a strong abdominal cingulum, but the two taxa are geographically separated by a large lowland area that includes the River Ebro.

Zygaena (*Zygaena*) *trifolii subsyracusia* Verity, 1925

Zygaena trifolii subsyracusia Verity, 1925, The Entomologist's Record and Journal of Variation 37: 117, pl. 8, figs 31–33 (Zygaena); 1926, ibidem 38: 25 (Zygaena). Type-locality. France: Morbihan, Plouharnel; Channel Islands.

Zygaena trifolii vindilisensis Leraut, 2012, Moths of Europe 3: 87, pl. 14, figs 20, 21. Type-locality. France: Morbihan, Belle-Ile-en-Mer. **Syn. n.**

Distribution and taxonomic notes. *Zygaena trifolii* varies in phenotype from year to year, even within the same colony (A. Hofmann and W. G. Tremewan pers. obs.). Hence, specimens taken from the same island (Belle-Ile-en-Mer) in different years may not match the original description (E. Drouet pers. comm.). On this basis, *Zygaena trifolii vindilisensis* is synonymised (**syn. n.**) with *Zygaena trifolii subsyracusia*, a subspecies that is distributed along the coastal regions of north-western France, from Loire-Atlantique to Côtes-d'Armor and Ille-et-Villaine, and is also found in the Channel Islands (Hofmann and Tremewan 1996: 185).

General taxonomic comments

Leraut (2012: 67) stated that the phylogenetic sequence in the presentation of the species follows Niehuis et al. (2007), yet the sister species *Z. trifolii* and *Z. lonicerae* are divided

by *Z. filipendulae*; the first two species are more closely related to each other than either is to *Z. filipendulae* and together they form a sister group to the latter (Niehuis et al. 2007; Hofmann and Tremewan 2010: 123).

The position (Leraut 2012: 68) of *Z. persephone* in the 'subgenus' *Santolinophaga* (a synonym of *Mesembrynus*, as discussed above) is also incorrect. While we are aware that the systematic position of *Z. persephone* is at present enigmatic, we cannot see any justification for placing a species whose larva feeds on *Vicia glauca* C. Presl. (Fabaceae) (Barragué 1986: 316; Tremewan 1989) in a monophyletic subgenus consisting solely of Apiaceae-, Asteraceae- and Lamiaceae-feeders. No doubt Leraut had difficulty assigning it to a subgenus because it was not dealt with by Niehuis et al. (2007). However, until the taxon has been subjected to DNA analysis, it is better to keep the status quo, i.e. to leave it in the subgenus *Zygaena*, following Alberti (1958: 280, 313), Naumann and Tremewan (1984: 168) and Hofmann and Tremewan (1996: 142, 2010: 123).

While it is correctly stated (Leraut 2012: 100) that *Z. oxytropis* is closely similar to *Z. rhadamanthus*, there is little evidence that the former could only be a subspecies of the latter and that 'molecular biology' could be used to investigate further. In spite of the fact that a hybrid zone between the taxa occurs (or occurred) in north-western Italy (Burgeff 1951: 11), a phenomenon that is not unusual between the ranges of two closely related *Zygaena* species, the heterospecificity of *Z. oxytropis* and *Z. rhadamanthus* has been confirmed by DNA analysis (Niehuis et al. 2007).

With reference to the treatment of *Z. transalpina transalpina* and *Z. transalpina hippocrepidis* (Leraut 2012: 102–106), one has to acknowledge that the relationship between these two taxa has been controversial for many years. Leraut (2012) followed the intensive study by Mazel (2009a, 2009b, 2010) who contends that the genitalic morphology has 'confirmed' that both taxa are valid species and that a hybrid zone between the two taxa occurs in eastern France. However, while Mazel should be acknowledged for the enormous amount of research into the problem, his arguments based on genitalic morphology alone are unconvincing. It should be noted that there are also hybrid populations in Germany where they form a mosaic in their distribution rather than a hybrid zone or tension zone (Hofmann 1994: 285–288). Moreover, DNA analysis by Niehuis et al. (2007) supports their conspecificity, as does the work of Hille (2012) who has recently assessed populations by using genogeographic clustering, based on phenotype, genotype and haplotype variation. New molecular data provided by Hille, based on 200 specimens from Germany, Austria, Slovenia, Croatia, Czech Republic and Slovakia, augment the sequence data base available for this approach. Further support has been provided by a Bayesian phylogenetic analysis (von Reumont et al. 2012: 45, fig. 4).

Acknowledgements

We are most grateful to Professor Roger L. H. Dennis (Wilmslow), Mr Eric Drouet (Gap), Mr Marc Nicolle (Angers), Dr Klaus Sattler (London), Dr Adrian Spalding (Praze-an-Beeble) and Mr John Tennent (Ardley) for peer reviewing this paper and for their constructive comments which helped considerably to improve and clarify the text. Mr Drouet also very kindly provided a French translation of the abstract.

References

Alberti B (1958) Über den stammesgeschichtlichen Aufbau der Gattung *Zygaena* F. und ihrer Vorstufen (Insecta, Lepidoptera). Mitteilungen aus dem Zoologischen Museum in Berlin 34: 245–396.

Alberti B (1959) Über den stammesgeschichtlichen Aufbau der Gattung *Zygaena* F. und ihrer Vorstufen (Insecta, Lepidoptera). Mitteilungen aus dem Zoologischen Museum in Berlin 35: 203–242.

Barragué G (1986) Voyage entomologique dans le Maghreb. Première partie. 40.000 kilomètres à la recherche des Zygènes (Lepidoptera Zygaenidae). Linneana Belgica 10: 299–326.

Burgeff H (1951) Die Meeralpengrenze der Zygaenen (Lep.), eine mit Hilfe der Populationsanalyse der Arten der Gattung *Zygaena* (Lepidoptera) durchgeführte Untersuchung über die Lokalisation und die Bedeutung geographischer Rassen in ihrem Zusammenhang mit der Eiszeit. Biologisches Zentralblatt 70: 1–23.

Burgeff H (1956) Über die Modifizierbarkeit von Arten und geographischen Rassen der Gattung *Zygaena* (Lep.). Nova Acta Leopoldina (NF) 18(127): 1–59.

Burgeff H (1965) Über die Bestimmung systematischer Einheiten durch morphologische und physiologische Merkmale, dargestellt an der Gattung *Zygaena* (Lep.) Nachrichten der Akademie der Wissenschaften in Göttingen (II. Mathematisch-physikalische Klasse) 1965: 1–15.

Dujardin F (1965) Les voies de pénétration des Lépidoptères dans le département des Alpes-Maritimes. 90e Congrès des Sociétés Savantes 2: 585–596.

Efetov KA (2001a) On the systematic position of *Zygaenoprocris* Hampson, 1900 (Lepidoptera: Zygaenidae, Procridinae) and the erection of two new subgenera. Entomologist's Gazette 52: 41–48.

Efetov KA (2001b) On the systematic position of some taxa of Forester moths (Lepidoptera: Zygaenidae, Procridinae) described by Ruggero Verity. Entomologist's Gazette 52: 128.

Efetov KA (2001c) An annotated check-list of Forester moths (Lepidoptera: Zygaenidae, Procridinae). Entomologist's Gazette 52: 153–162.

Efetov KA (2004) Forester and Burnet moths (Lepidoptera: Zygaenidae). The genera *Theresimima* Strand, 1917, *Rhagades* Wallengren, 1863, *Zygaenoprocris* Hampson, 1900, *Adscita* Retzius, 1783, *Jordanita* Verity, 1946 (Procridinae), and *Zygaena* Fabricius, 1775 (Zygaeninae). Crimean State University Press, 272 pp.

Efetov KA, Tarmann GM (1999) Forester Moths: The genera *Theresimima* Strand, 1917, *Rhagades* Wallengren, 1863, *Jordanita* Verity, 1946, and *Adscita* Retzius, 1783 (Lepidoptera: Zygaenidae, Procridinae). Apollo Books, Stenstrup, 192 pp.

Efetov KA, Tarmann GM (2012) A Checklist of the Palaearctic Procridinae (Lepidoptera: Zygaenidae). Crimean State University Press, Simferopol, 108 pp.

Efetov KA, Hofmann A, Tarmann GM, Tremewan WG (2013) [Book review.] Nota lepidopterologica 36: 87–91.

Hille A (2012) Assessing Bayesian population and genogeographic clustering of the *Zygaena transalpina* superspecies complex – demonstrating a geographic visualization approach by applying Google Earth to the population structure and population history based on genetic variation (Lepidoptera: Zygaenidae, Zygaeninae). In: Tarmann GM, Tremewan WG, Young MR (Eds) Abstracts of the XIII International Symposium on Zygaenidae 16–23 September 2012, Innsbruck, 18.

Hofmann A (1994) Zygaenidae (Widderchen). In: Ebert G (Ed) Die Schmetterlinge Baden-Württembergs. Vol. 3. Eugen Ulmer GmbH & Co., Stuttgart, 153, 196–335.

Hofmann A, Tremewan WG (1996) A systematic Catalogue of the Zygaeninae (Lepidoptera: Zygaenidae). Harley Books, Colchester, 251 pp.

Hofmann A, Tremewan WG (2010) A revised check-list of the genus *Zygaena* Fabricius, 1775 (Lepidoptera: Zygaenidae, Zygaeninae), based on the biospecies concept. Entomologist's Gazette 61: 119–131.

ICZN (1999) International Code of Zoological Nomenclature. The International Trust for Zoological Nomenclature, London. Fourth Edition, xxix, 306 pp.

Leraut P (2012) Volume 3: Moths of Europe, Zygaenids, Pyralids 1 and Brachodids. NAP Editions, Verrières-le Buisson, 599 pp.

Mazel R (2009a) Le contact entre deux «bad species» *Zygaena transalpina* Esper, 1781 et *Z. hippocrepidis* Hübner, 1796 en France et dans quelques contrées limitrophes (Lepidoptera, Zygaenidae). Revue de l'Association Roussillonnaise d'Entomologie 18: 54–70.

Mazel R (2009b) Le contact entre deux «bad species» *Zygaena transalpina* Esper, 1781 et *Z. hippocrepidis* Hübner, 1796. Deuxième partie: dans le sud-est de la France, à l'est du Rhône (Lepidoptera, Zygaenidae). Revue de l'Association Roussillonnaise d'Entomologie 18: 127–147.

Mazel R (2010) Le contact entre deux «bad species» *Zygaena transalpina* Esper, 1781 et *Z. hippocrepidis* Hübner, 1796. Troisième partie: au sud-ouest du Rhône (suite et fin) (Lepidoptera, Zygaenidae). Revue de l'Association Roussillonnaise d'Entomologie 19: 89–106.

Naumann CM, Tremewan WG (1984) Das Biospecies-Konzept in seiner Anwendung auf die Gattung *Zygaena* Fabricius, 1775 (Insecta, Lepidoptera, Zygaenidae). Spixiana 7: 161–193.

van Nieukerken EJ, Kaila L, Kitching IJ, Kristensen NP, Lees DC, Minet J, Mitter C, Mutanen M, Regier JC, Simonsen TJ, Wahlberg N, Yen S-H, Zahiri R, Adamski D, Baixeras J, Bartsch D, Bengtsson BÅ, Brown JW, Bucheli SR, Davis DR, De Prins J, De Prins W, Epstein ME, Gentili-Poole P, Gielis C, Hättenschwiller P, Hausmann A, Holloway JD, Kallies A, Karsholt O, Kawahara AY, Koster SJC, Kozlov MV, Lafontaine JD, Lamas G, Landry J-F, Lee S, Nuss M, Park K-T, Penz C, Rota J, Schintlmeister A, Schmidt BC, Sohn J-C, Solis MA, Tarmann GM, Warren AD, Weller S, Yakovlev RV, Zolotuhin VV, Zwick A (2011) Order Lepidoptera Linnaeus, 1758. In: Zhang Z-Q (Ed) Animal Biodiversity: an outline of higher-level classification and survey of taxonomic richness. Zootaxa 3148: 212–221.

Niehuis O, Hofmann A, Naumann CM, Misof B (2007) Evolutionary history of the burnet moth genus *Zygaena* Fabricius, 1775 (Lepidoptera: Zygaenidae) inferred from nuclear and mitochondrial sequence data: phylogeny, host-plant association, wing pattern evolution and historical biogeography. Biological Journal of the Linnean Society 92: 501–520. doi: 10.1111/j.1095-8312.2007.00858.x

Niehuis O, Yen S-H, Naumann CM, Misof B (2006) Higher phylogeny of zygaenid moths (Insecta: Lepidoptera) inferred from nuclear and mitochondrial sequence data and the evolution of larval cuticular cavities for chemical defence. Molecular Phylogenetics and Evolution 39: 812–829. doi: 10.1016/j.ympev.2006.01.007

Oberthür C (1910) Études de Lépidoptérologie comparée 4, 692 pp.

von Reumont BM, Struwe J-F, Schwarzer J, Misof B (2012) Phylogeography of the Burnet Moth *Zygaena transalpina* complex: molecular and morphometric differentiation suggests glacial refugia in southern France, western France and micro-refugia within the Alps. Journal of zoological Systematics and Evolutionary Research 50: 38–50. doi: 10.1111/j.1439-0469.2011.00637.x

Tremewan WG (1989) Biological, ecological and synonymic notes on *Zygaena* (*Zygaena*) *persephone* Zerny, 1934 (Lepidoptera: Zygaenidae). Entomologist's Gazette 40: 15–20.

Verity R (1925) Remarks on the evolution of the Zygaeninae and an attempt to analyse and classify the variations of *Z. lonicerae* Scheven, and of *Z. trifolii* Esp., and other subspecies. The Entomologist's Record and Journal of Variation 37: 101–104, 117–121, 135–138, 154–158.

Verity R (1926) Remarks on the evolution of the Zygaeninae and an attempt to analyse and classify the variations of *Z. lonicerae* Scheven, and of *Z. trifolii* Esp., and other subspecies. The Entomologist's Record and Journal of Variation 38: 9–12, 22–26, 57–62, 69–74.