The hidden wing pattern in European species of the genus *Colias* (Lepidoptera: Pieridae)

Otakar Kudrna

Abstract. Wing pattern is known to play an important role in the life of butterflies. Insect eyes perceive a different light spectrum than human eyes. Butterfly eyes perceive short wavelengths invisible to the human eye, particularly the ultra violet rays in the range of 365 nm. The hidden wing pattern is characteristic of pale coloured butterflies, particularly in the family Pieridae, especially in the genera *Colias* Fabricius, 1807 and *Gonepteryx* Leach, 1815. This short paper shows the visible and hidden wind patterns of the European species of the genus *Colias* and give an impulse to reviewing the hidden wing pattern at least in European species of Pieridae.

Samenvatting. Het is bekend dat het vleugelpatroon een belangrijke rol speelt in het leven van vlinders. Insectenogen nemen een ander lichtspectrum waar dan menselijke ogen. Vlinderogen nemen korte golflengten waar die onzichtbaar zijn voor menselijke ogen, met name de ultraviolette stralen in het bereik van 365 nm. Het verborgen vleugelpatroon is kenmerkend voor bleekgekleurde vlinders, vooral in de familie Pieridae, meer bepaald in de geslachten: *Colias* Fabricius, 1807 en *Gonepteryx* Leach, 1815. Dit korte document is om in ware kleur het verborgen vleugelpatroon van de Europese soorten van het geslacht *Colias* te tonen en een impuls te geven om het verborgen vleugelpatroon te herbestuderen, in ieder geval voor de Europese soorten van Pieridae.

Résumé. Le motif des ailes est connu pour jouer un rôle important dans la vie des papillons. L'œil des insectes perçoit un spectre lumineux différent de celui de l'œil humain. L'oeil des papillons perçoit de courtes longueurs d'onde invisibles à l'oeil humain, en particulier les rayons ultraviolets de l'ordre de 365 nm. Le motif caché des ailes est caractéristique des papillons de couleur pâle, en particulier dans la famille des Pieridae, et spécialement dans les genres *Colias* Fabricius, 1807 et *Gonepteryx* Leach, 1815. Le but de ce court article est d'illustrer, en couleurs visibles, le motif caché des ailes des espèces européennes du genre *Colias* et de donner une impulsion à la révision de ce motif, au moins chez les espèces de Pieridae d'Europe.

Key words: *Colias* – Hidden wing pattern – Europe.

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Wing pattern is known to play an important role in the life of butterflies and its pretty diversifications are illustrated in "butterfly books". Wing pattern makes butterflies the most beautiful objects created by nature admired even by laymen. Wing pattern has been extensively studied by B. N. Schwanwitsch (1889–1957) who published 13 fundamental papers on the subject in the years 1924–1956 (see References). The purpose of this short paper is to compare the visible and hidden wing pattern of European species of the genus *Colias* Fabricius, 1807.

Insect eyes perceive a different light spectrum than human eyes. Butterfly eyes perceive short wave lengths invisible to human eyes, particularly the ultra violet rays in the range of 365 nm. Butterflies can thus distinguish objects perceived as of the same colour by human eyes, for instance white, different according to their absorption or reflection short wave UV light. This applies both to other butterflies and to flowers. Mazokhin-Porshnyakov (1969) discovered that certain butterfly species differ by the way their wings reflect or absorb UV light although their colour appears identical to human eye. He described this phenomenon and named it the hidden wing pattern.

The hidden wing pattern is characteristic of pale coloured butterflies, particularly in the family Pieridae, especially in the genera: *Colias* Fabricius, 1807 and *Gonepteryx* Leach, 1815. The hidden wing patter is found also in the genus *Pieris*, but its specific presence and variation are not adequately known. Shreve *et al.* (2009) confused the hidden wing patter with the light reflected by silver and pearl coloured components of the wing pattern such as is found e.g. in the genus *Argynnis* Fabricius, 1807 (Kudrna 2013).

Settele *at al.* (2009) were right to invite a group of authors to compile a chapter on wing pattern in their study of ecology of butterflies in Europe (Shreeve *at al.* 2009). Surprisingly both the editors of the book and the authors of the chapter were not aware of the fundamental work of their predecessor B.N. Schwanwitsch and mistook the hidden wing pattern produced by UV light (Mazokhin-Porshnyakov 1969) with a simple reflection of light produced by elements of metallic colours on butterfly wings; none of their photos shows hidden wing pattern. Regrettably they made no reference to the methods utilized.

The authors of the two recently published standard reference works on the genus *Colias* Fabricius, 1807, (Grieshuber *et al*. 2012, Grieshuber 2014) overlooked the external anatomy of genitalia and failed to describe perhaps the most interesting feature of the genus: the hidden wing pattern. They were unaware of the existence of the hidden wing pattern and of any papers on the subject (e.g. Ferris 1972, Kudrna 1992). The purpose of this short paper is to illustrate in true colour the hidden wing pattern of the European species of the genus *Colias* and give an impulse to reviewing the hidden wing pattern at least in European species of Pieridae.

Using the hidden wing pattern as a criterion the species of the genus *Colias* can be split into two groups:

(1) The first group contains species the dorsal wing pattern of which absorbs UV rays. The following European species belong to this group:

Colias alfacariensis RIBBE, 1905 (Figs 1, 2)
Colias erate (ESPER, [1803]) (Figs 11, 12)
Colias hyale (LINNAEUS, 1758) (Figs 15, 16)
Colias palaeno (LINNAEUS, 1760) (Figs 19, 20)

Colias phicomone (ESPER, [1780]) (Figs 21, 22)
Colias tyche BOEBER, 1812 (Figs 23, 24)

The upper wing surface of these species is yellow, white or greenish, never orange.

(2) The second group contains species in which the dorsal pattern of wings reflects (to various extent and intensity) UV rays:

Colias aurorina (HERRICH-SCHÄFFER, [1850]) (Figs 3, 4)
Colias balcanica REBEL, 1903 (Figs 5, 6)
Colias chrysotheme (ESPER, [1781]) (Figs 7, 8)
Colias crocea (GEOFFROY, 1785) (Figs 9, 10)
Colias hecla LEFEBVRE, 1836 (Figs 13, 14)
Colias myrmidone (ESPER, [1781]) (Figs 17, 18)

In these species the upper wing surface is orange or orange-yellow except the case of rare yellow males of *C. crocea* which appear similar to *C. erate* but reflect UV rays.

UV photographs can be produced using various techniques (e.g. Bowden & Kay 1979, Ferris 1972, Kudrna 1992). The present photos were taken by SLR Contax 139 with Planar 50 mm, f. 1.7 standard lens on Agfacolor 200 ASA colour slide film using a Paffrath & Kemper ring flash as UV light source and a Hoya U360 filter (= Schott U1 glass) to eliminate visible light.

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Fig. 1. *Colias alfacariensis* RIBBE, 1905 – Germany: N.W. Bavaria (conventional lighting).

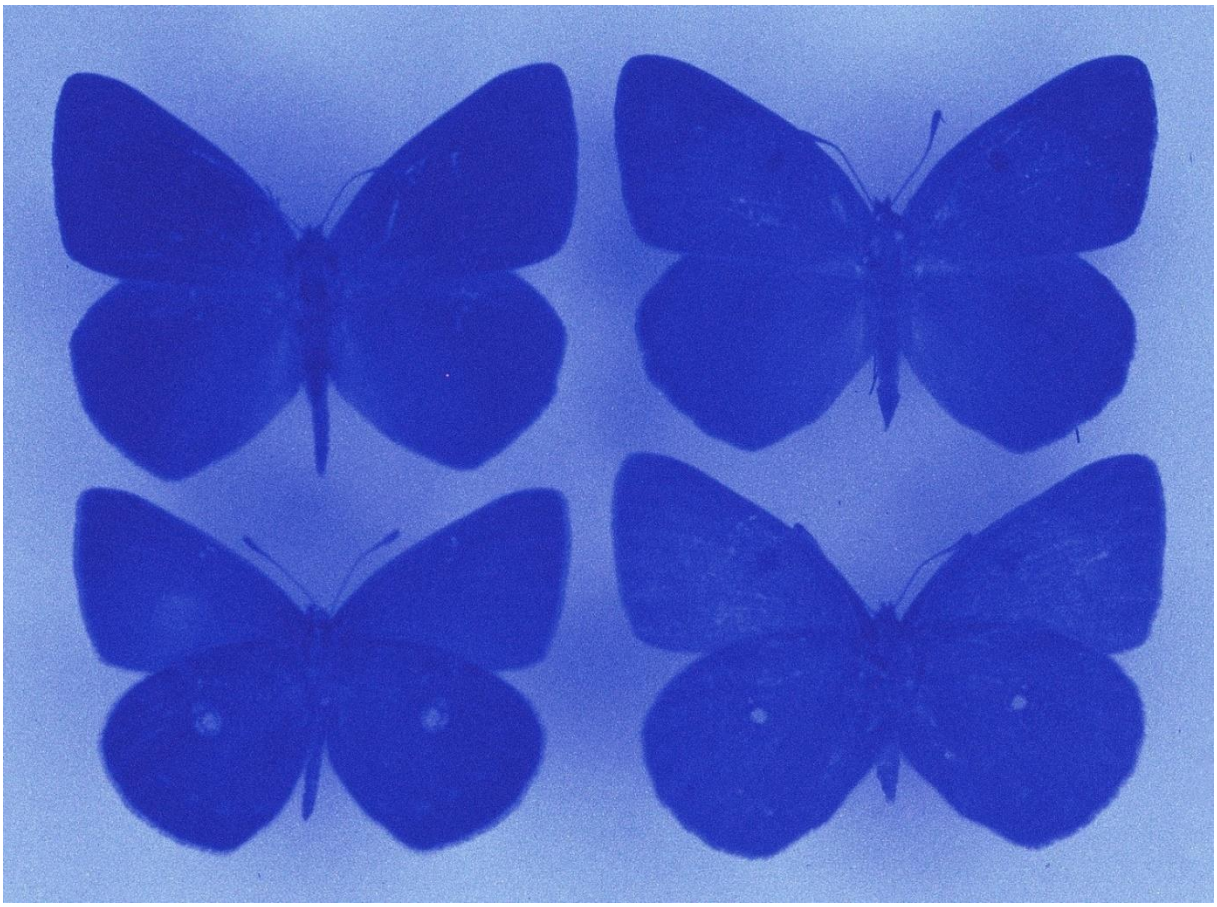

Fig. 2. *Colias alfacariensis* RIBBE, 1905 – Germany: N.W. Bavaria (UV lighting).

Fig. 3. *Colias aurorina* (HERRICH-SCHÄFFER, [1850]) – Greece (conventional lighting).

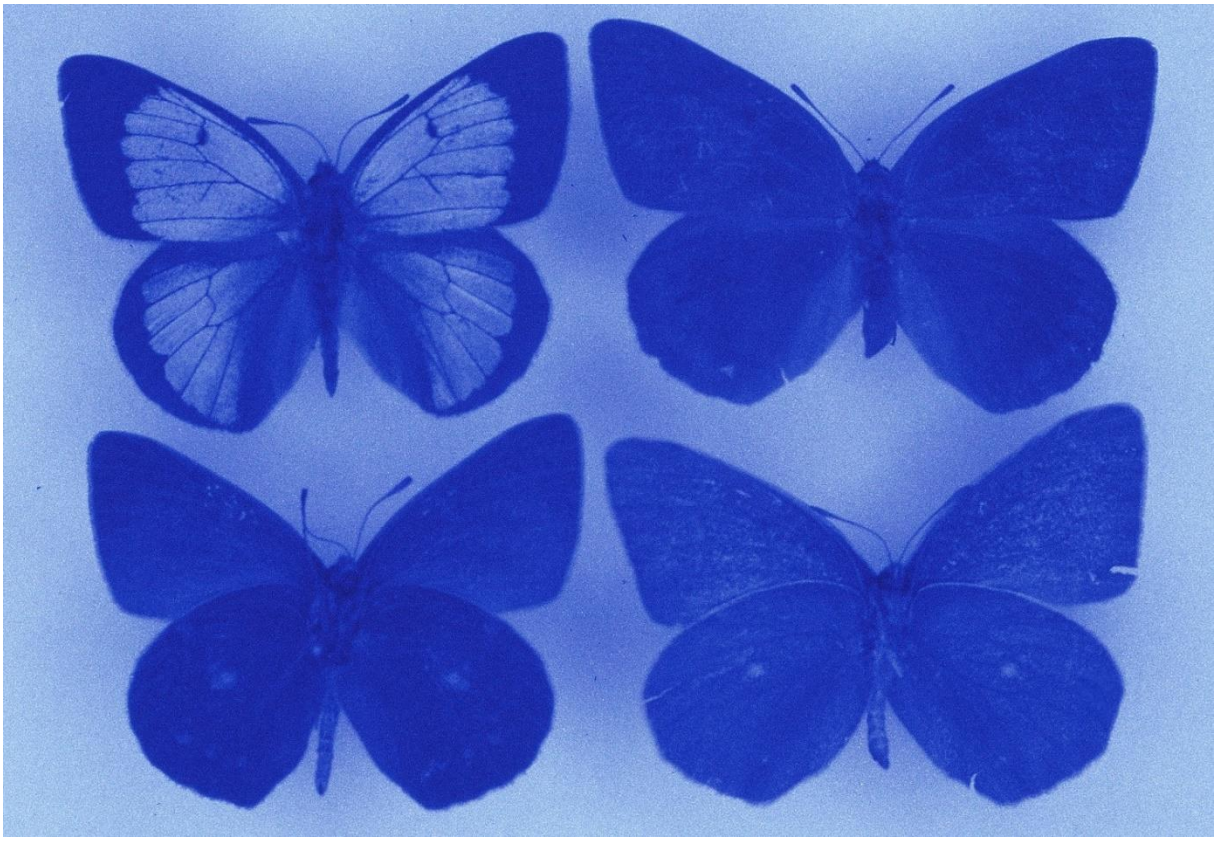

Fig. 4. *Colias aurorina* (HERRICH-SCHÄFFER, [1850]) – Greece (UV lighting).

Fig. 5. *Colias balcanica* REBEL, 1903 – Macedonia (conventional lighting).

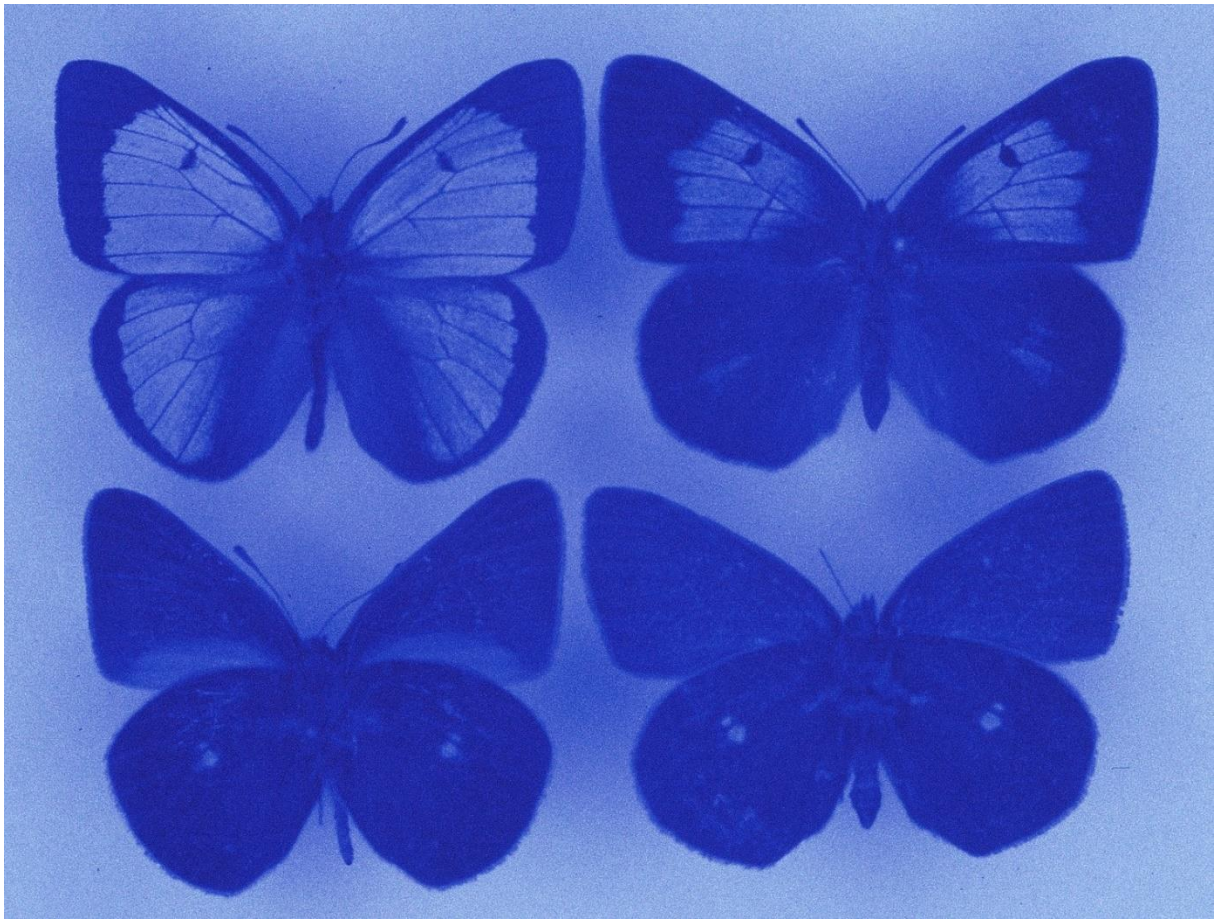

Fig. 6. *Colias balcanica* REBEL, 1903 – Macedonia (UV lighting).

Fig. 7. *Colias chrysotheme* (ESPER, [1781]) – Hungary (conventional lighting).

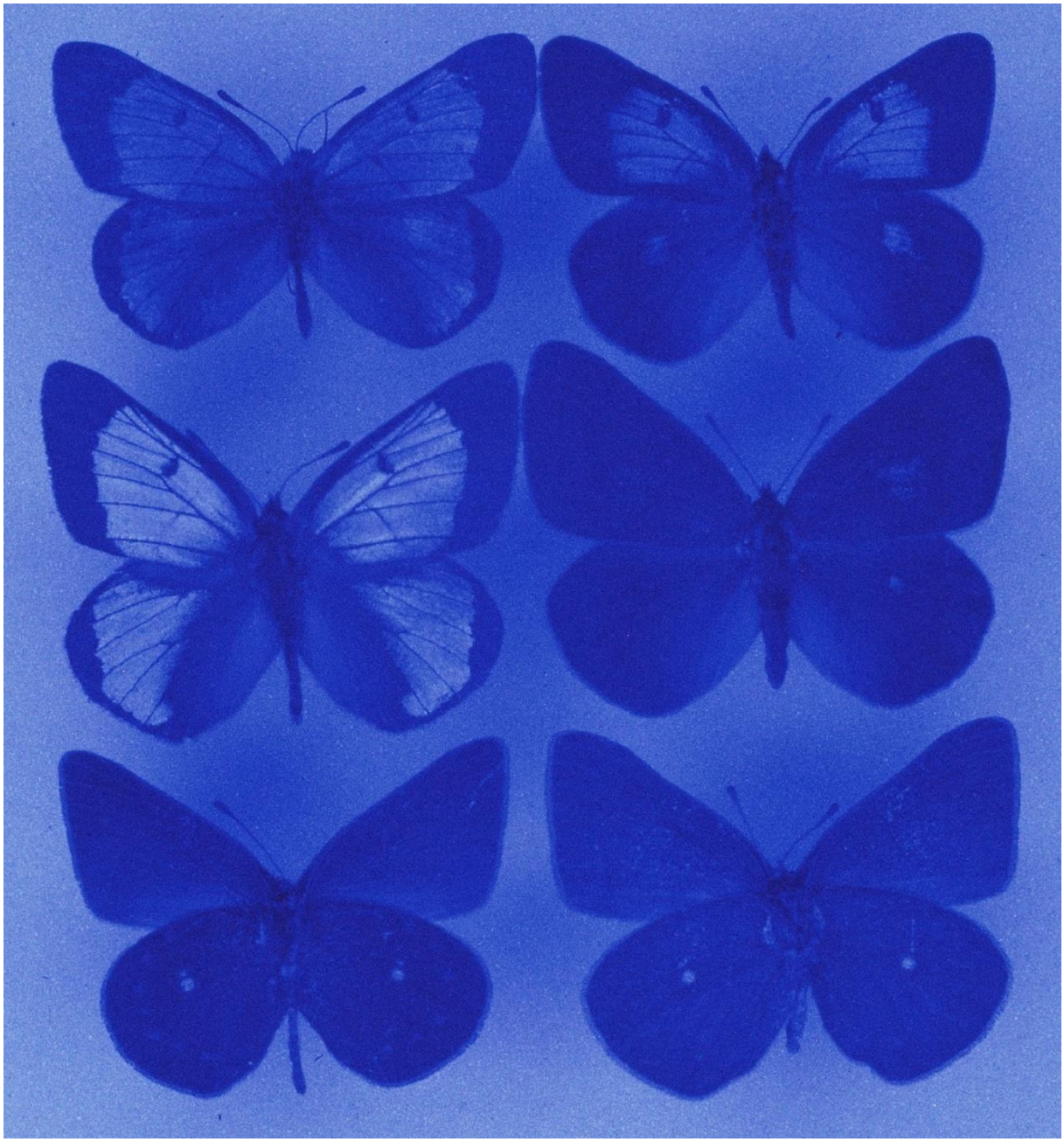

Fig. 8. *Colias chrysotheme* (ESPER, [1781]) – Hungary (UV lighting).

Fig. 9. *Colias crocea* (GEOFFROY, 1785) – N. Italy (conventional lighting).

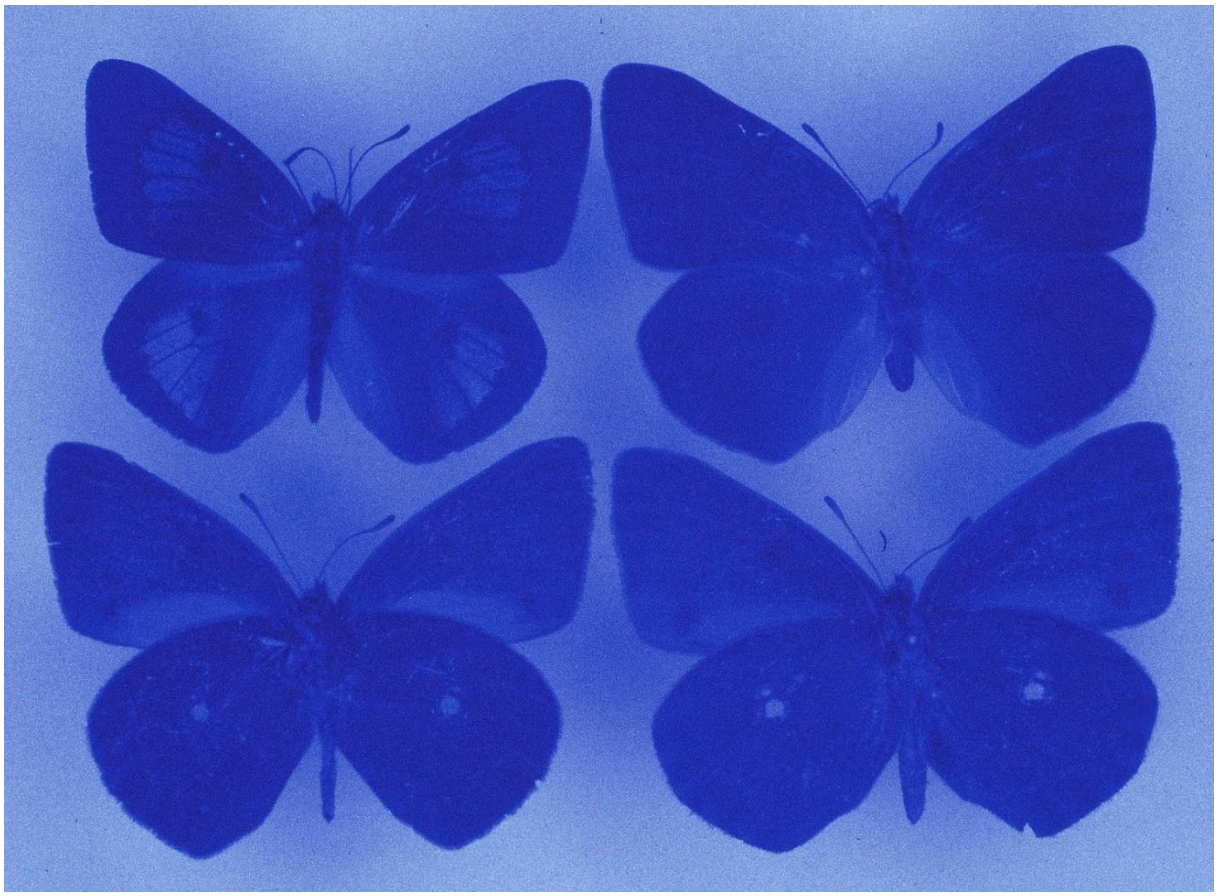

Fig. 10. *Colias crocea* (GEOFFROY, 1785) – N. Italy (UV lighting).

Fig. 11. *Colias erate* (ESPER, [1803]) – Ukraine (conventional lighting).

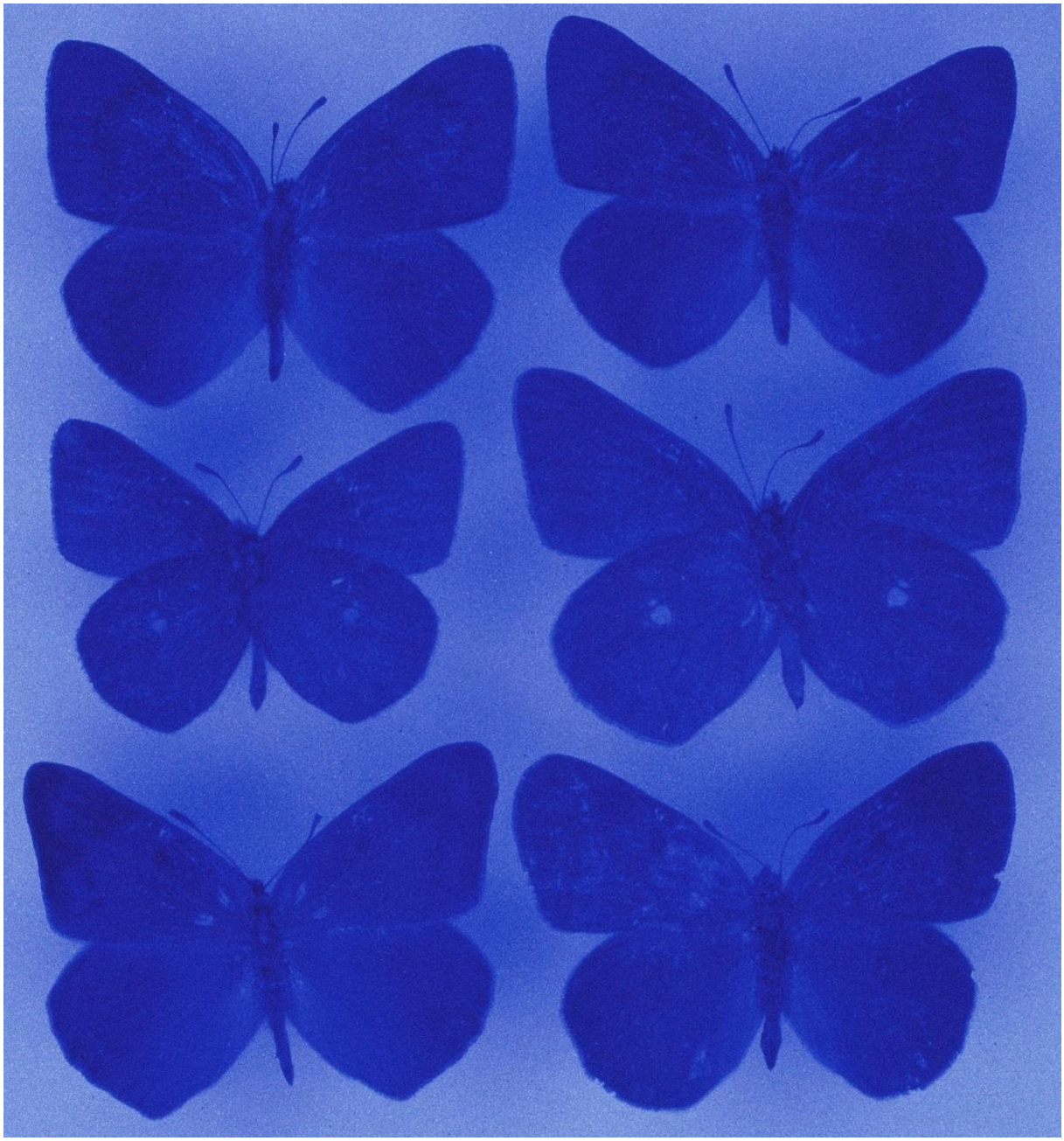

Fig. 12. *Colias erate* (Esper, [1803]) – Ukraine (UV lighting).

Fig. 13. *Colias hecla* LEFEBVRE, 1836 – N. Sweden: Lapland (conventional lighting).

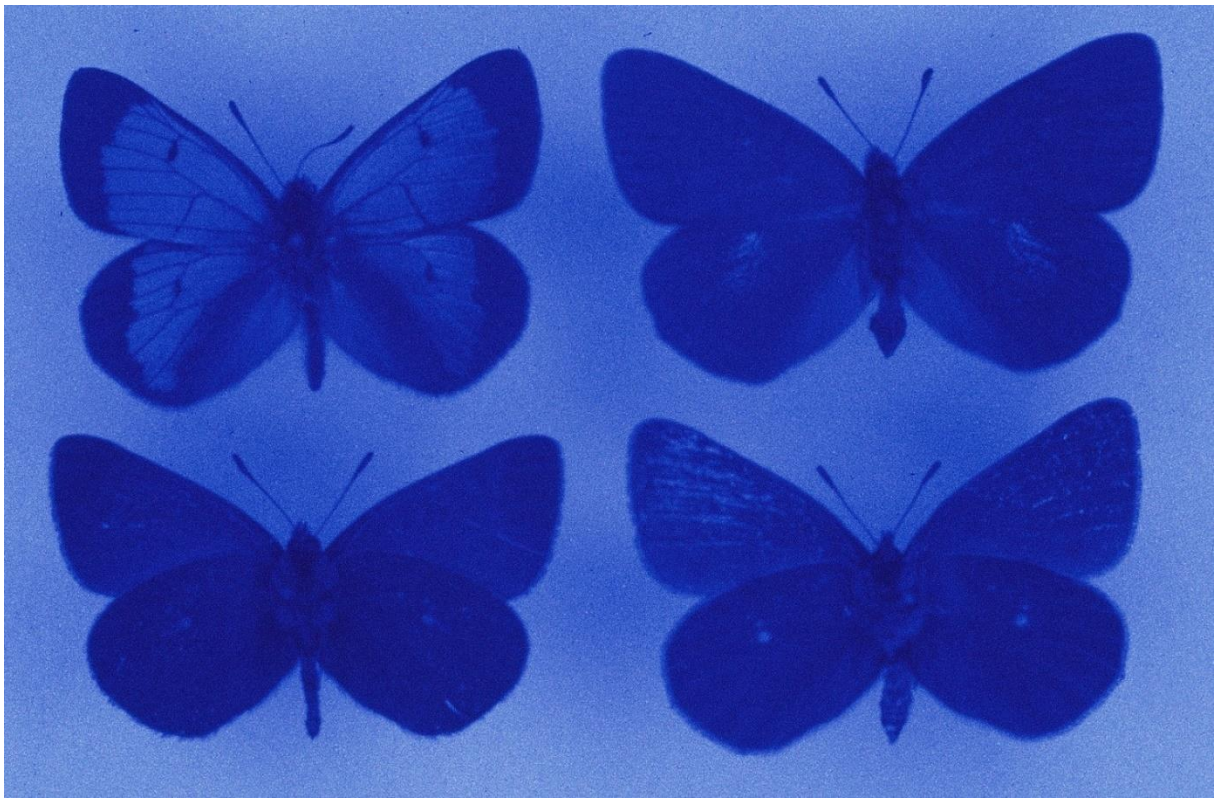

Fig. 14. *Colias hecla* LEFEBVRE, 1836 – N. Sweden: Lapland (UV lighting).

Fig. 15. *Colias hyale* (LINNAEUS, 1758) – Germany: N.W. Bavaria (conventional lighting).

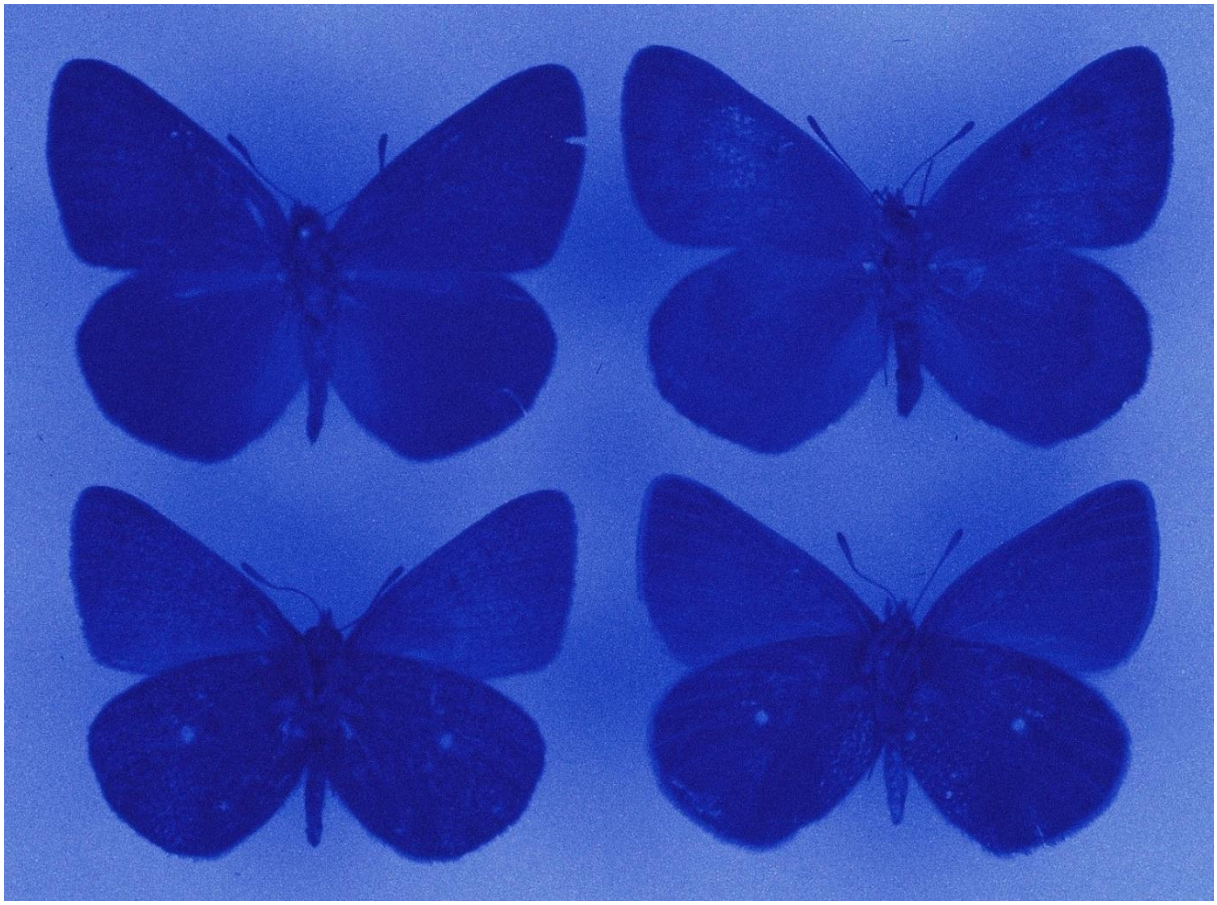

Fig. 16. *Colias hyale* (LINNAEUS, 1758) – Germany: N.W. Bavaria (UV lighting).

Fig. 17. *Colias myrmidone* (Esper, [1781]) – Czechia: S.E. Moravia (conventional lighting).

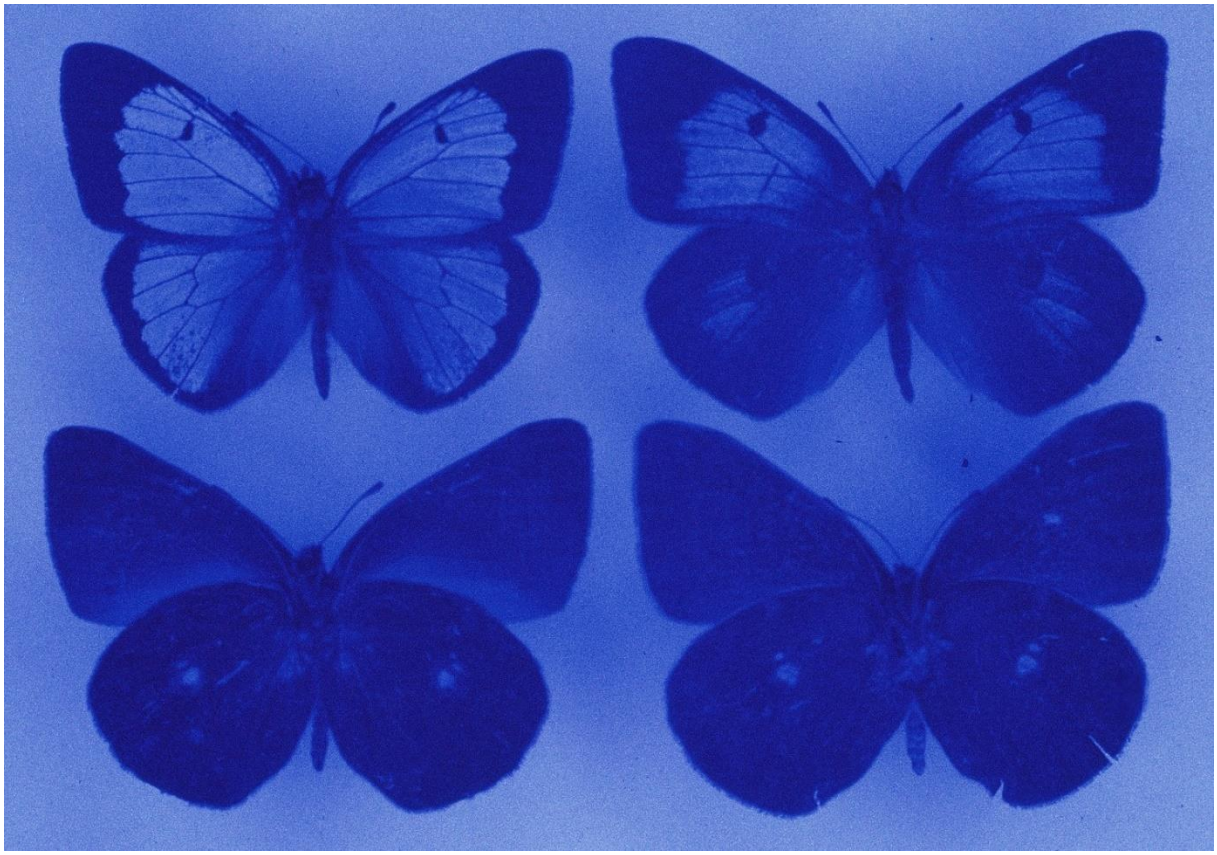

Fig. 18. *Colias myrmidone* (Esper, [1781]) – Czechia: S.E. Moravia (UV lighting).

Fig. 19. *Colias palaeno* (LINNAEUS, 1760) – Czechia: S.W. Bohemia (conventional lighting).

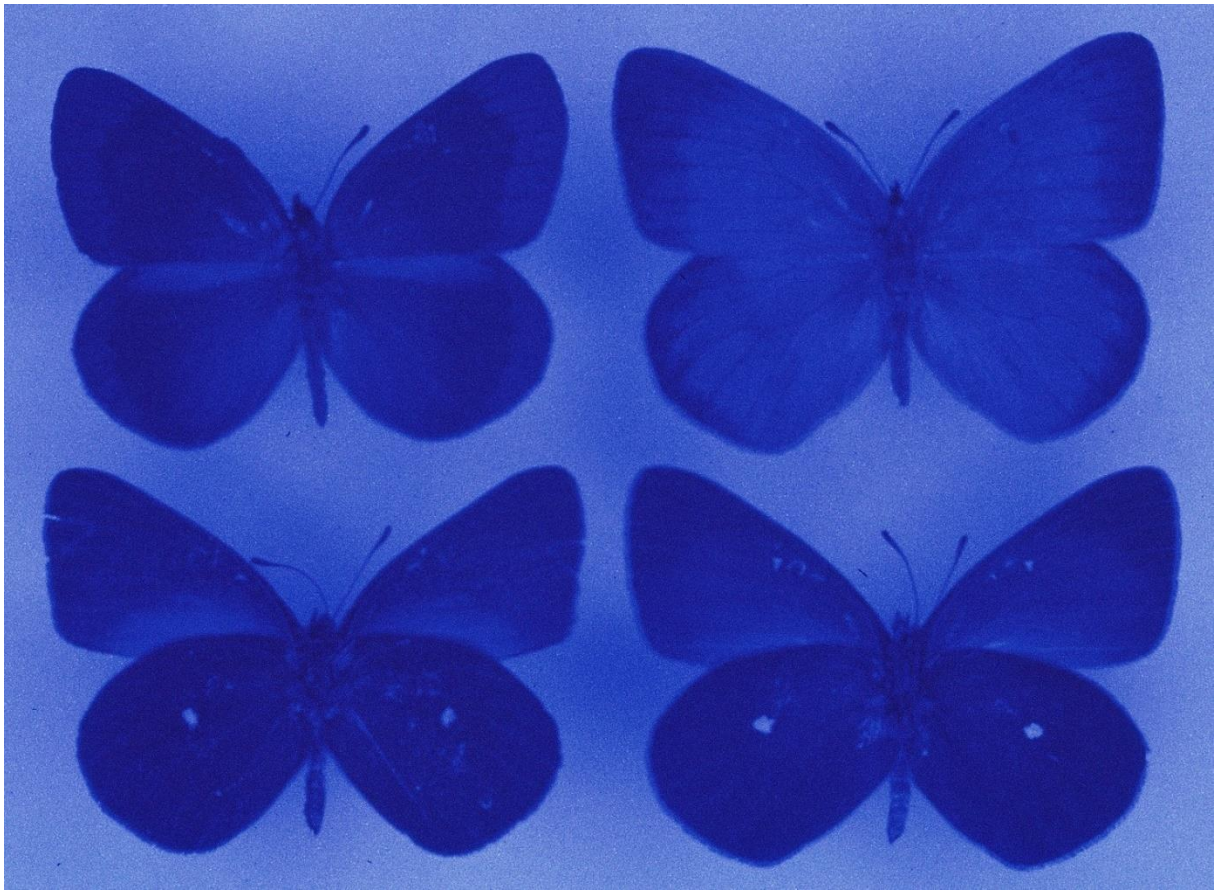

Fig. 20. *Colias palaeno* (LINNAEUS, 1760) – Czechia: S.W. Bohemia (UV lighting).

Fig. 21. *Colias phicomone* (ESPER, [1780]) – Switzerland (conventional lighting).

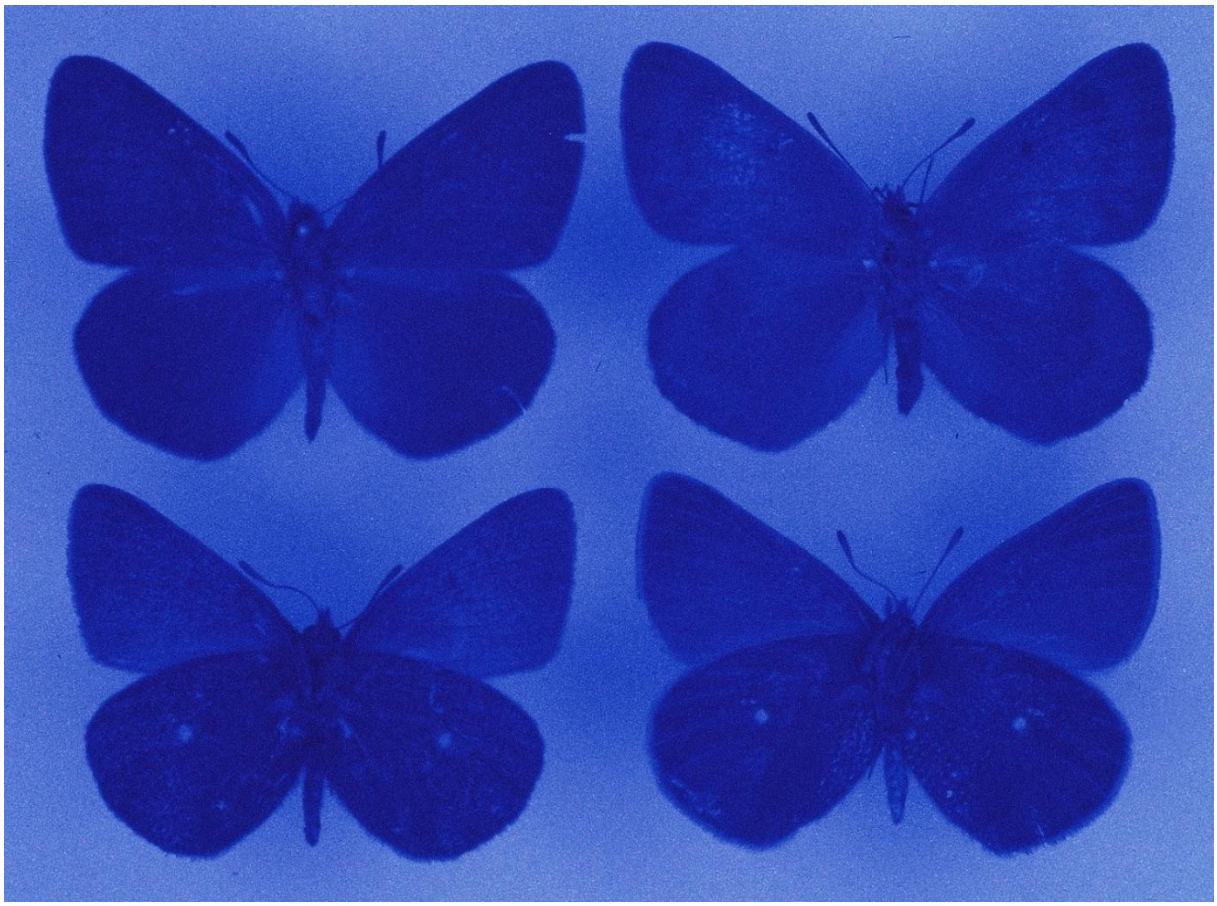

Fig. 22. *Colias phicomone* (ESPER, [1780]) – Switzerland (UV lighting).

Fig. 23. *Colias tyche* BOEBER, 1812 – N. Sweden: Lapland (conventional lighting).

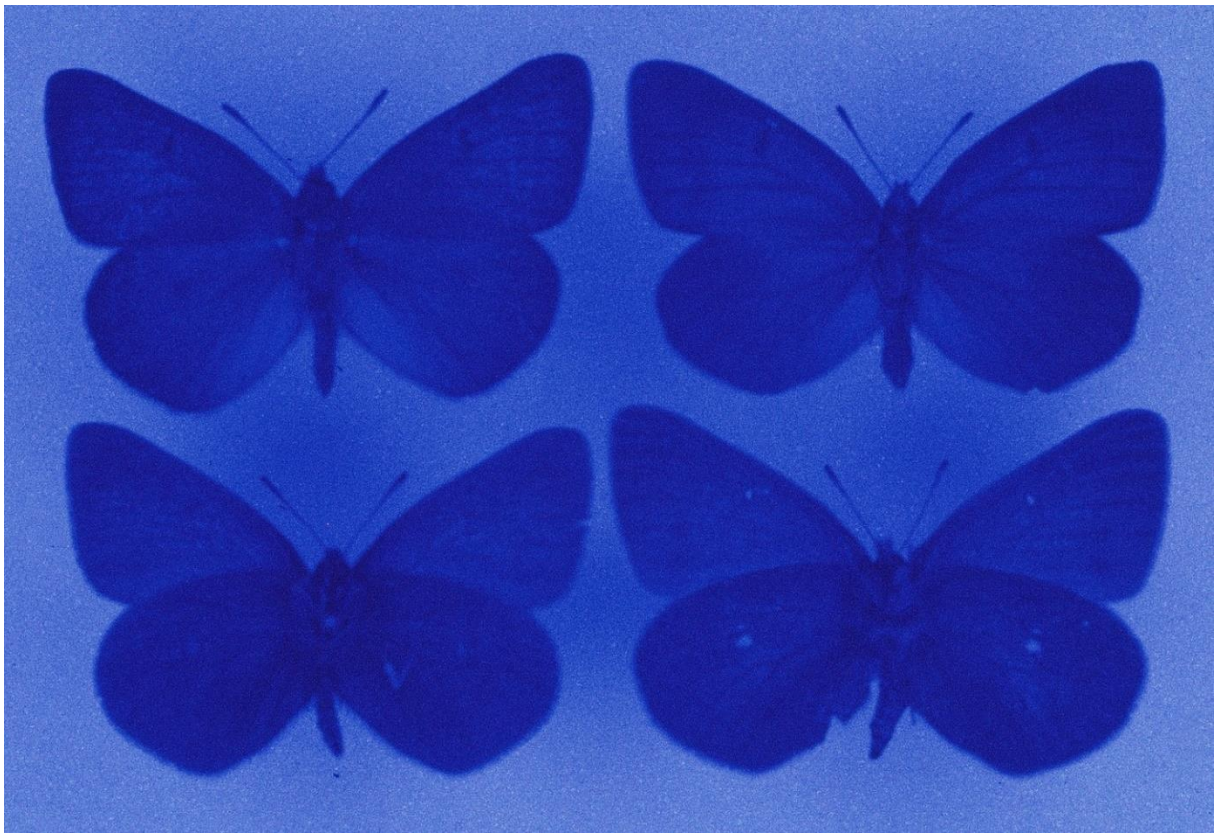

Fig. 24. *Colias tyche* BOEBER, 1812 – N. Sweden: Lapland (UV lighting).