

**OBSERVATIONS ON THE RELIABILITY OF EXTERNAL  
CHARACTERISTICS TO DISTINGUISH ADULTS OF THE BRITISH  
COPPER UNDERWING SPECIES *AMPHIPYRA PYRAMIDEA* (L.) AND  
*A. BERBERA* RUNGS (LEP.: NOCTUIDAE)**

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**Abstract**

Differences in external morphological characteristics in British adult *Amphipyra pyramidea* (L.) and *A. berbera* Rungs are discussed. The hindwing underside characteristics are the most reliable feature in both species when specimens are in pristine condition; all other characteristics are unreliable, irrespective of specimen condition, when used in isolation, although a combination can be used to make a putative determination. In such cases, reference must be made to the hindwing underside for confirmation. When characters are contradictory or inconclusive, reference to the genitalia is essential.

**Keywords:** *Amphipyra pyramidea*, *Amphipyra berbera*, Noctuidae, morphology, Britain.

**Introduction**

Discussions with many British lepidopterists suggest that significant difficulties arise when attempting the separation of adults of *A. pyramidea* and *A. berbera* using external morphological features alone. The confusion is especially pronounced when the moths under examination are in less than pristine condition – something that is frequently the case with live moths in light traps. The purpose of this review is to investigate the various characteristics mentioned in the British identification literature and Internet sources to determine their true reliability.

**The British “copper underwing” species**

***Amphipyra pyramidea* (Linnaeus, 1758) Plate 1.**

This species was described, as *Phalaena (Noctua) pyramidea*, “solely on the basis of previously published illustrations” as Linnaeus “did not have any specimens of this species at the moment of description”. Fletcher selected as a neotype, not a holotype as stated in Fibiger & Hacker (2007), a male *A. pyramidea* (Plate 2), as it is now known, from the series in the Natural History Museum collection in London (Mikkola & Honey, 1993).

*A. pyramidea* is widespread across Europe apart from northern Scandinavia where it was formerly rare and is now expanding rapidly (J. Kullberg, pers. comm.). Outside Europe its range extends from Turkey through most of Asia to Japan. In Britain (Map 1) it is widespread across England and Wales, except on higher ground. It has spread north and east since the 1970s across Yorkshire, Cumbria and southern parts of Northumberland where it was formerly rare. In Scotland it is local and restricted to the lowland south-west and central parts. It is widely scattered in Ireland, but much more local in the west. It has one generation, flying from about the end of June (later in Scotland and Ireland) through to the beginning of November.

***Amphipyra berbera* Rungs, 1949 Plate 3.**

The “Dusky/Drab Copper Underwing” or “Svensson’s Copper Underwing” was originally described as subspecies *berbera* of *A. pyramidea* (Plate 4) by Rungs. In 1967, Ingvar Svensson recognised that there were two externally similar species that differed in their genital morphology [Rungs described the genital parts as conforming to *pyramidea*] being confused under the name of *A. pyramidea*. He wrote to the Natural History Museum in London with his findings and as a consequence, *berbera* (Plate 5) was redefined as a valid species (Fletcher, 1968). The status of *A. berbera* as a distinct species is supported by mitochondrial COI “barcode” data (Chen *et al.*, 2013). *A. berbera* is widespread across much of central and southern Europe, parts of North Africa and Asia Minor. It is known from Scandinavia where like *A. pyramidea* it is expanding, but not as quickly (J. Kullberg, pers. comm.). In Britain



**Plate 1.** *Amphipyra pyramidea* ♂. Les Evans-Hill.



**Plate 2.** *Amphipyra pyramidea* ♂ neotype. Natural History Museum London courtesy of the Trustees.



**Plate 3.** *Amphipyra berbera* ♀. Les Evans-Hill.



Plate 4. *Amphipyra pyramidea* subsp. *berbera* ♀ allotype. MNHN Marion DEPRAETRE -2019.

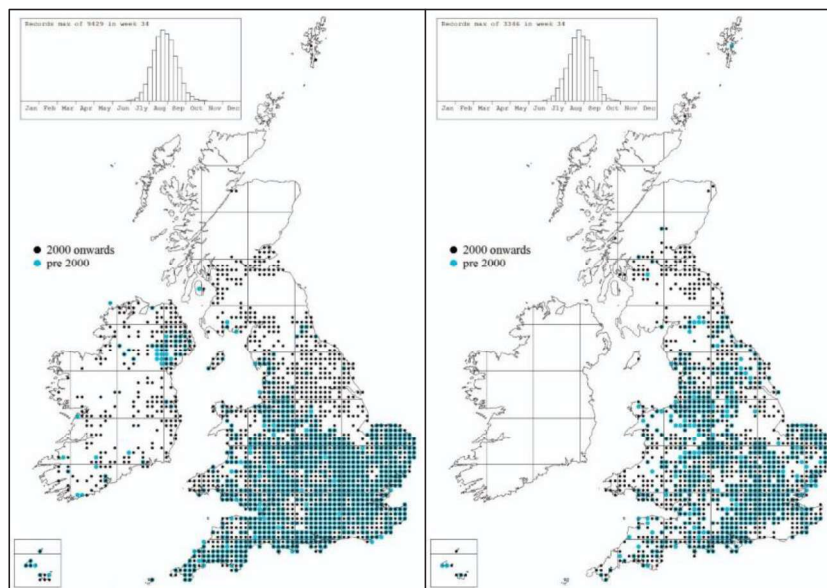


Plate 5. *Amphipyra berbera svenssoni* ♂ holotype. Natural History Museum London courtesy of the Trustees.

(Map 2) it is considered widespread across England, less so in Wales where it is expanding. It is local in Scotland, expanding through south-east and central parts. It is not known in Ireland. Due to identification difficulties the true distribution in Britain is not known. It has one generation, flying earlier than *A. pyramidea* from mid-July (later in Scotland) through to late October.

#### Is *svenssoni* a valid subspecies?

The subdivision of *A. berbera* into the two subspecies by Fletcher is not universally accepted. Fibiger & Hacker (2007) synonymised the British *svenssoni* with non-British *berbera* as, in their opinion there were no external morphological or genitalia structure differences. Fletcher (1968) did describe some morphological differences with emphasis on *berbera* being larger and more vivid than the smaller and duller *svenssoni*. Fletcher also noted that examples of supposed *svenssoni* were frequently found to have a distribution that is sympatric with *berbera* in Europe; modern concepts of a subspecies require these to be allopatric (i.e., not overlapping in geographical distribution). The first full genome sequence for any of the genus *Amphipyra* was published in Boyes, Crowley, Holland *et al* (2021); unfortunately, this being the first for the genus, there is nothing to compare it to. A much smaller DNA fragment, the mitochondrial cytochrome oxidase (COI) gene, has been sequenced from many individuals, but while such barcoding can distinguish distinct species, it cannot reliably distinguish subspecies. However, the “barcode” phylogenetic tree does show British *berbera* being sympatric with non-British *berbera*; consequently, there is no evidence of geographical distinction and thus no hint of a subspecies in Britain, unless there is any aspect of unusual biology in British *berbera* that could be reflected in consistent differences at other genetic loci (L. Crowley & P.W.H. Holland, pers. comm.).



**Map 1.** Distribution of *Amphipyra pyramidea* (left) and **Map 2.** *Amphipyra berbera* (right). Data courtesy of the National Moth Recording Scheme, Butterfly Conservation and MothsIreland. Maps produced by MapMate® using Digital Map Data © Bartholomew 2022.

### Methods

A total of 100 examples of adult moths was analysed. In order to minimise any geographical bias, material was obtained from Dorset (VC 9), Surrey (VC 17), Hertfordshire (VC 20), Bedfordshire (VC 30), Huntingdonshire (VC 31) and South Lancashire (VC 60). No specimens were available from Wales, Scotland, or Ireland. Although there is no known sexual dimorphism, only males were considered for the results and 100 males were selected for analysis. Each specimen was graded according to its condition (Table 1), extremely worn specimens were rejected from the original sample collected.

TABLE 1. Condition and number of specimens in the sample (confirmed by genitalia dissection).

Species	Excellent (n = 23)	Good (n = 35)	Worn (n = 42)
<i>A. pyramidea</i> (n = 41)	14	18	9
<i>A. berbera</i> (n = 59)	9	17	33

Worn = general wear and tear but most characteristics discernible.

Good = some wear, some scales missing but most characteristics discernible.

Excellent = fresh, pristine.

The list of external characteristics examined is as follows:

1. Colouration of the scales of the ventral face of the labial palpi
2. Contrast of the abdominal lateral chequered marking
3. Forewing underside
4. Forewing underside: postmedian line
5. Forewing upperside: angle of antemedian line at one-third costa
6. Forewing upperside: antemedian line and postmedian line contrast
7. Forewing upperside: convergence of postmedian line and termen
8. Forewing upperside: discal spot
9. Forewing upperside: distance between antemedian line and postmedian line ventral peaks
10. Forewing upperside: measurement by ratio of division of antemedian line and tomus by the postmedian line along the dorsum
11. Forewing upperside: median contrast
12. Forewing upperside: overall appearance
13. Forewing upperside: postmedian line, second-most ventral peak shape
14. Forewing upperside: shape of lighter area between costa and the discal spot
15. Hindwing underside

Each characteristic was examined by the unaided eye and/or 10X hand lens and the specimen assigned to *A. pyramidea* or *A. berbera*, or “inconclusive”. Following this initial allocation, the true identification of each specimen was ascertained by genitalia dissection.

### Results

Table 2 analyses the results of this examination and allocation process. Each of the characters used is now examined.

#### 1. Colouration of the scales of the ventral face of the labial palpi (Plate 6)



**Plate 6.** Colouration of the scales of the ventral face of the labial palpi. Ben Smart.

The labial palpi characteristic is used with regularity in Britain and too often as the only method of determination. Plant (2008) has shown that the extent of white on the labial palps (referring to Winter (1988) and “subsequent plagiarists”), is known

TABLE 2. Overall results in order of % reliability of the characteristics tested.

Characteristic	<i>A. pyramidea</i> (n = 41)			<i>A. berbera</i> (n = 59)			Overall (n = 100)		
	Correct n   %	Incorrect n   %	Inconclusive n   %	Correct n   %	Incorrect n   %	Inconclusive n   %	Correct (%)	Inconclusive (%)	
1. Hindwing underside	39 95.12	1 2.44	1 2.44	57 96.61	0 0	2 3.39	95.87	1.22	2.91
2. Forewing underside	37 90.24	3 7.32	1 2.44	48 81.36	3 5.08	8 13.56	85.8	6.2	8
3. Forewing upperside convergence of postmedian line and termen	36 87.80	3 7.32	2 4.88	49 83.05	10 16.95	0 0	85.43	12.13	2.44
4. Abdominal lateral chequered marking	37 90.24	4 9.76	0 0.00	46 77.97	13 22.03	0 0	84.11	15.89	0
5. Forewing upperside distance between antemedian line and postmedian line ventral peaks	36 87.80	0 0.00	5 12.20	43 72.88	6 10.17	10 16.95	80.34	5.08	14.57
6. Forewing upperside measurement by ratio of division of antemedian line and tornus by the postmedian line along the dorsum	29 70.73	3 7.32	9 21.95	49 83.05	3 5.08	7 11.86	76.89	6.2	16.91
7. Forewing underside postmedian line	36 87.80	3 7.32	2 4.88	38 64.41	4 6.78	17 28.81	76.11	7.05	16.85
8. Forewing upperside discal spot	38 92.68	2 4.88	1 2.44	34 57.63	8 13.56	17 28.81	75.16	9.22	15.63
9. Forewing upperside antemedian line and postmedian line contrast	35 85.37	2 4.88	4 9.76	33 55.93	5 8.47	21 35.59	70.65	6.68	22.67
10. Forewing upperside angle of antemedian line at one-third costa	27 65.85	2 4.88	12 29.27	40 67.8	2 3.39	17 28.81	66.83	4.13	29.04
11. Forewing upperside postmedian line, second-most ventral peak shape	34 82.93	0 0.00	7 17.07	27 45.76	8 13.56	24 40.68	64.34	6.78	28.88
12. Colouration of the scales of the ventral face of the labial palpi	26 63.41	6 14.63	9 21.95	38 64.41	3 5.08	18 30.51	63.91	9.86	26.23
13. Forewing upperside shape of lighter area between costa and the discal spot	19 46.34	4 9.76	18 43.90	41 69.49	0 0	18 30.51	57.92	4.88	37.21
14. Forewing upperside median contrast	24 58.54	5 12.20	12 29.27	33 55.93	3 5.08	23 38.98	57.23	8.64	34.13
15. Forewing upperside overall appearance	27 65.85	0 0.00	14 34.15	16 27.12	2 3.39	41 69.49	46.49	1.69	51.82

to be unreliable. The overall reliability of this characteristic in the present sample was 63.91%.

## 2. Contrast of the abdominal lateral chequered marking (Plate 7)



**Plate 7.** Contrast of the abdominal lateral chequered marking. Les Evans-Hill.

Described as a contrast of pale straw and black in *A. pyramidea*, and fulvous and black in *A. berbera* (Goater & Christie, 1969). In essence, it is more contrasting in *A. pyramidea*, weakly-chequered black with thin band of pale straw scales at each abdominal segment, while less contrasting with strongly-chequered black and fulvous scales in *A. berbera*. The reliability of this characteristic was inconsistent irrespective of condition due to subtle variations in both species, though the overall reliability was 84.11%.

## 3. Forewing underside (Plate 8)



**Plate 8.** Forewing underside. Les Evans-Hill.

The forewing underside is more difficult to view than the hindwing underside and cannot be viewed easily in a glass container as it is obscured by the hindwing. However, with careful handling it can be viewed along with the hindwing underside. The dark suffusion from the base to the postmedian line in *A. pyramidea* is generally glossy, straw-coloured and does not extend to the costa. In *A. berbera* it is duller and almost uniformly fuscous-shaded and usually extends to the costa. The overall reliability of this characteristic was 85.8%. It scored 100% in *A. pyramidea* in pristine condition. The reliability dropped significantly with wear in *A. pyramidea* making the feature difficult to distinguish from *A. berbera*, in which this characteristic scored consistently <90% irrespective of condition.

#### 4. Forewing underside: postmedian line (Plate 9)



**Plate 9.** Forewing underside postmedian line. Les Evans-Hill.

The forewing underside postmedian line is almost straight and does not reach the costa in *A. pyramidea* and is more curved with a pronounced inward curve at the costa in *A. berbera*. The overall reliability of this characteristic was 76.11%. It scored 100% in *A. pyramidea* in pristine condition; however, the reliability dropped significantly with wear as the postmedian line starts to purport to either species. The overall reliability in *A. berbera* was <77%.

#### 5. Forewing upperside: angle of antemedian line at one-third costa (Plate 10)



**Plate 10.** Forewing upperside angle of antemedian line at one-third costa. Natural History Museum London courtesy of the Trustees.

A useful characteristic if the angle is in line with the discal spot in *A. Pyramidea* and in-line with the 2 ventral peaks in *A. berbera*. However, the angle varies widely in both species making it of limited use if the above criteria are not met. The overall reliability of this characteristic was 66.83%.

#### 6. Forewing upperside: antemedian and postmedian lines contrast (Plate 11)



**Plate 11.** Forewing upperside antemedian line and postmedian line contrast. Natural History Museum London courtesy of the Trustees.

Although for *A. pyramidea* in pristine condition a score of 100% was achieved, as the contrast reduces with wear the reliability drops off substantially as the feature starts to resemble *A. berbera*. Specimens of *A. berbera* in pristine condition can appear to have contrasting lines similar to *A. pyramidea*. The overall reliability of this characteristic was 70.65%.

#### 7. Forewing upperside: convergence of postmedian line and termen (Plate 12)



**Plate 12.** Forewing upperside convergence of postmedian line and termen. Natural History Museum London courtesy of the Trustees.

The overall reliability of this characteristic was 85.43%. An approximate straight line from the apex to the termen on both species should be relatively straightforward to envisage while the mean straight line of the postmedian line may be open to interpretation. In *A. pyramidea* the two straight lines converge from the costa to the dorsum, while in *A. berbera* the two straight lines are relatively parallel. While this convergence is relatively stable in *A. pyramidea* in good to excellent condition, it varies widely in *A. berbera* irrespective of condition to the point the characteristic purports to *A. pyramidea*. Reliability drops off significantly in worn specimens.

#### 8. Forewing upperside: discal spot (Plate 13)



**Plate 13.** Forewing upperside discal spot. Natural History Museum London courtesy of the Trustees.

Usually circular, small and straw-coloured with a blackish centre in *A. pyramidea* and usually much larger and more oval in *A. berbera*. This characteristic scored 92.68% overall in *A. pyramidea* in which there was found little variation in shape or size, but only 57.63% overall in *A. berbera* due to the widely varying shape and size. There is without doubt a crossover point where this characteristic cannot be assigned to either species with certainty. The overall reliability of this characteristic was 75.16%.

### 9. Forewing upperside: distance between antemedian line and postmedian line ventral peaks (Plate 14)



**Plate 14.** Forewing upperside distance between antemedian line and postmedian line ventral peaks. Natural History Museum London courtesy of the Trustees.

Described as the ventral peak pair in *A. pyramidea* being judged equidistant while in *A. berbera* the peak pair adjacent to the dorsum are closer together in (Owen, 1993). Owen tested this against his collection of 36 specimens reporting it “worked well” on 33 specimens with three specimens being too worn to determine. However, Owen does caveat he suspects some *A. berbera* would share the same equidistant peak pairs and “would not be astonished to hear this method does not always work”. Of the *A. berbera* examined, the results would concur with Owen’s observation that some *A. berbera* will purport to *A. pyramidea*. The overall reliability of this characteristic was 80.34%. Both species in pristine condition scored 100%; however, reliability was inconsistent and dropped dramatically with wear. A similar method is described using only the antemedian ventral peaks and their alignment with the discal spot, whereby if the alignment intersects or is immediately adjacent to the discal spot *A. pyramidea* is presumed (Clancy, 1997).

### 10. Forewing upperside: measurement by ratio of division of antemedian line and tornus by the postmedian line along the dorsum (Plate 15)



**Plate 15.** Forewing upperside measurement by ratio of division of antemedian line and tornus by the postmedian line along the dorsum. Natural History Museum London courtesy of the Trustees.

This method measures the ratio of division of the antemedian line and tornus by the postmedian line along the dorsum. It is ~1:2 in *A. pyramidea* and ~1:1 in *A. berbera*. The overall reliability of this characteristic was 76.89%. This method works better the shorter the distance between antemedian line and postmedian line along the dorsum which makes the “ratio of division” suggest *A. pyramidea*; however, this characteristic in *A. berbera* varies widely and in some specimens will purport to *A. pyramidea*. Reliability was inconsistent across all conditions due to the variability in *A. berbera*.

**11. Forewing upperside: median contrast (Plate 16)**

**Plate 16.** Forewing upperside median contrast. Natural History Museum London courtesy of the Trustees.

The similarities and variability of shading and contrast both species made this characteristic unreliable, increasingly so with wear. The overall reliability of this characteristic was 57.23%.

**12. Forewing upperside: overall appearance (Plate 17)**

**Plate 17.** Forewing upperside overall appearance. Natural History Museum London courtesy of the Trustees.

*A. pyramidea* is generally brighter, crisper, glossy and contrasting while *A. berbera* is overall duller and less contrasting. This characteristic is also commonly used in Britain and with *A. berbera* being previously known as the dusky or drab copper underwing it is understandable why it is often referred to; however, worn *A. pyramidea* can easily purport to *A. berbera*. Although for *A. pyramidea* in pristine condition a score of 100% was achieved, the score for *A. berbera* was inconsistent throughout. The overall reliability of this characteristic was 46.49%.

**13. Forewing upperside: postmedian line, second-most ventral peak shape (Plate 18)**

A very subjective character. The overall reliability of this characteristic was 64.34%.



**Plate 18.** Forewing upperside postmedian line, second-most ventral peak shape. Natural History Museum London courtesy of the Trustees.

#### 14. Forewing upperside: shape of lighter area between costa and the discal spot (Plate 19)



**Plate 19.** Forewing upperside shape of lighter area between costa and the discal spot. Natural History Museum London courtesy of the Trustees.

The lighter area between the costa and the discal spot forms a rhombic in *A. pyramidea* and a square in *A. berbera*. The overall reliability of this characteristic was 57.92%. The shape of this characteristic will be influenced by the angle of antemedian line at one-third costa; however, the similarities and variability of both species made this unreliable and almost impossible to use in worn specimens.

#### 15. Hindwing underside (Plate 20)



**Plate 20.** Hindwing underside. Les Evans-Hill.

Hindwing morphology was among the features used to add *A. berbera* to the British fauna; however, only the intensity of copper on the hindwing upperside was described (Fletcher, 1968). It was not until a year later that differences with the hindwing undersides of *A. pyramidea* and *A. berbera* were discovered (Goater & Christie, 1969). The differences were described as follows: “(i) the wings of *berbera* are drab and smooth in texture, whereas those of *pyramidea* are bright with contrasting pattern and are ‘rough’ with a peppering of dark scales which are particularly evident towards the anterior margin of the hindwings. We would say that these scales are always present in *pyramidea* and that it is rare to find them in *berbera*. Only in very worn specimens is it difficult to decide whether or not these scales are present.

(ii) the discal area of the hindwing of *berbera* is fuscous and does not contrast in depth of colour with the subterminal area beyond the postmedian line; in *pyramidea*

it is pale straw coloured and usually distinctly paler than the subterminal area.  
(iii) the reddish colouration which is present in the posterior subterminal area of the hind wings of every specimen of both species extends as a warm suffusion towards the base of the wing in *berbera*, but stops sharply at the postmedian line in *pyramidea*.

(iv) the postmedian line of the hindwings is nearly always a complete band in *berbera*; in *pyramidea* it is broken anteriorly into usually three separate spots. These are often heavily dusted with black scales, a feature never present in *berbera*."

An overall reliability of 95.87% was achieved in this review. For both species, 100% was achieved for specimens in pristine condition, while for specimens in good condition *A. berbera* scored 100% and *A. pyramidea* dropped slightly to 94.44%. The results suggest for specimens in pristine condition, one should use these characteristics to determine with certainty, though caution applied with moths in "good" condition and reference to genitalia must be made where there is uncertainty. With worn specimens, reference to genitalia is essential.

#### Discussion

Due to the similarities and subtle variation in both species, along with a quick rate of wear, it is doubtful the results obtained by the author will be replicated precisely in a different series, though the overall trend is likely to be repeated. A score of <95% is considered to indicate that the character is unreliable, at least on its own. Features that score <95% should not be used in isolation to determine the species, but they can be used in combination with as many other features as possible to make a putative determination. The score is treated the same for overall score in Table 2 and where indicated in the results. A score of  $\geq 95\%$ , while not totally reliable, is considered reliable beyond reasonable doubt.

#### Implications for recording

The known British distribution for both species is imperfect due to identification difficulties; however, both species appear to be reasonably widespread in England and Wales. *A. berbera* appears to be not as widespread as *A. pyramidea* and some areas of southern England appear devoid of this species. This may be genuine, or it may reflect misidentified *pyramidea*. In Ireland, only *A. pyramidea* is known, to date.

There is no consistency in the recording of *A. pyramidea* and *A. berbera* in Britain. County Moth Recorders (CMRs) either aggregate both species, accept dissected records only, accept records if the hindwing underside was examined or accept all records without any robust scrutiny. Many recorders refer to a single characteristic that can be viewed with ease such as the labial palpi or the contrast of the abdominal lateral chequered marking, without reference to any other or to genitalia. Recorders and CMRs are encouraged to take a more robust and consistent approach to distinguishing and recording *A. pyramidea* and *A. berbera* in order to ascertain true abundance and distribution of both species in Britain.

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