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## Subspecific designation for the Central Appalachian Mountains population of *Argynnis (Speyeria) atlantis* (W. H. Edwards).

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**ABSTRACT.** The population of *Argynnis atlantis* of the central Appalachian Mountains, primarily on the Allegheny Plateau of West Virginia, has long been recognized by entomologists in the eastern United States as distinct from nominotypical populations of *A. atlantis* in the northeastern United States and eastern Canada. Larger size is often cited, but actual comparison of wing markings has not been done to date. This study applies RGB color analysis on a series of adults from both regions and looks at potential differences in wing markings which may distinguish them.

**Additional key words:** Isolate, Allegheny Plateau, Canadian Zone, RGB color code.

**ZooBank registration:** <http://zoobank.org/CB8FCC4A-57DA-4555-AA9E-CAF59761947>

### INTRODUCTION

A difficulty with the identification of specimens in the genus *Argynnis (Speyeria)*, commonly known as “Fritillaries”, is that among many of the populations, especially those in the western portion of the United States, correct determination of specimens to which species or subspecies they belong is often problematic due to similarity in wing patterns, size and ground color. There is considerable character overlap and phenotypic intergradation between species and subspecies, and populations frequently take on the appearance of another species. Thus, several species and subspecies have been reclassified from their originally described rank. Some examples of this close resemblance are subspecies of *A. atlantis*, *A. aphrodite*, *A. zerene*, *A. hesperis*, and *A. hydaspe* (Howe, 1975; Scott, 1986), some of which resemble related species. Additional “problem” pairs include *A. e. egleis* vs. *A. m. mormonia* (Davenport, pers. comm.). The present study will not delve into these, as more involved research on the North American *Argynnis (Speyeria)* will be needed, especially genomic analysis at the species and subspecies level.

The population of *A. atlantis* on the Allegheny Plateau of northeastern West Virginia, also known as the Allegheny Mountains, has been a popular target species of eastern U.S.A. butterfly collectors. Both the late Bill Grooms and Ron Gatrell, as well as a host of other entomologists in this region, have shared with me observations that specimens of the Allegheny Plateau population “differ” from nominotypical populations found in New York, northern New England and eastern Canada, but exact wing characters were often difficult to pinpoint. This study provides a more detailed comparison.

The Allegheny Plateau is known for its “northern” character, primarily consisting of Canadian and Transition Zone habitat types at higher elevations, most pronounced toward the eastern edge along the Allegheny Front. Other endemics with northern affinities are *Colias interior carolae*, *Tharsalea epixanthe nr-michiganensis* and *Chlosyne harrisii liggettii*. *Pterourus appalachiensis* is most common in this region, having evolved from ancient hybrid introgression between *P. canadensis* and *P. glaucus*.

## METHODOLOGY

Specimens from the Allegheny Plateau of West Virginia were compared to specimens from northern New England, New Brunswick, New York and Pennsylvania considered to be nominotypical. The TL of *A. atlantis* is currently recognized as “Hunter, Green County, New York” (dos Passos, 1935), though the original description (W. H. Edwards, 1862) covered a broad area: Catskill Mountains (New York), White Mountains (New Hampshire), Williamstown (Massachusetts), Lake Winnipeg (Manitoba), “Hudson’s Bay” (Canada) and “the north side of Lake Superior”. The original image of *Argynnis atlantis* was published in a later work (Edwards, 1869-1897) and is illustrated below (**Fig. 1**).

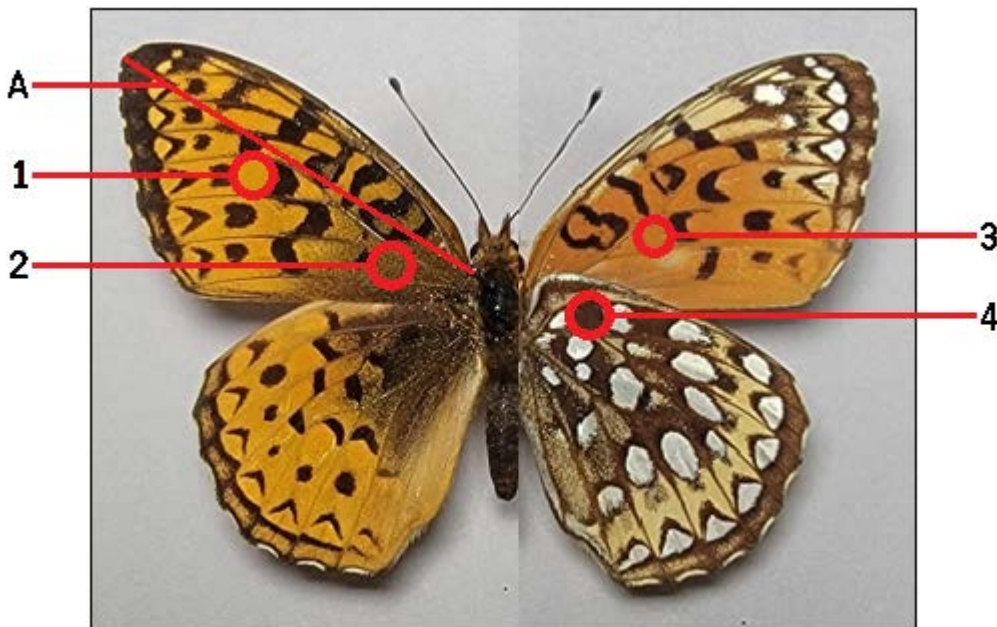


**Fig. 1.** Original illustration of *Argynnis atlantis* (dorsum on left, venter on right) on plate ‘*Argynnis 5*’ from ‘*The Butterflies of North America*’ (W.H. Edwards, 1868-1897).

15 female and 29 male specimens (all fresh-condition) from West Virginia and 17 female and 18 male specimens of nominotypical *atlantis* (similarly fresh-condition) from New York, New England and immediately adjacent areas of New Brunswick were analyzed using the Color Grab™ cellphone application ([www.loomatix.com](http://www.loomatix.com)), version 3.9.2, to establish exacting RGB color codes under “daylight” fluorescent lighting, in combination with the Colblindor™ application ([www.color-blindness.com/color-name-hue/](http://www.color-blindness.com/color-name-hue/)) to produce refined color swatches rather than giving generalized color descriptions as is traditional with taxon descriptions. Determining exact RGB color code of the examined series is important, as specimens fade over long periods of time and their RGB color codes will likely drift. Four areas of the wings were measured (**Fig. 2**): (1) outer dorsal ground color of the forewings in cell  $M_3$ ; (2) inner dorsal ground color of the forewings near the base of cell  $CuA_2$ ; (3) interior ventral ground color of the forewings in cell  $CuA_1$ ; (4) inner ventral ground color of the hindwings at the base of cell  $Sc+R_1$  between the adjacent silver spots within that cell. The RGB values for each series, separately for males and females, was averaged and the results are shown in **Figs. 3 & 4**. While not critical to the description, the color nomenclature from the Colblindor™ application is available in Appendix A for those interested in exacting color names. [It is important for future researchers to note that the RGB color codes of any examined series may not perfectly match the results of the current study due to differences in lighting used and freshness of specimens. Online viewing of this study and hardcopy printing may also distort the colors. A textbook example lies with the original illustration of *atlantis* when viewed and copied off [www.biodiversitylibrary.org](http://www.biodiversitylibrary.org); a very dark version of the male is depicted (**Fig. 1**). The important thing to remember is to be consistent with ALL specimens analyzed in any comparative study employing lighting.]

The specimens used for RGB color analysis in this study were also measured for size. The leading edge of the forewings were measured from the base of the wing at the thorax to the farthest point outward,

to the apex. These measurements are shown in **Figs. 3 & 4**. Howard Grisham, Tom Kral and Ricky Patterson provided additional extensive imagery of West Virginia specimens and Tom Kral provided extensive imagery of nominotypical *atlantis* from McKean County, Pennsylvania collected by William Houtz approximately 100 miles west of the Hunter, New York TL of *atlantis*.



**Fig. 2:** Wing areas measured for RGB color analysis and forewing length in this study. Numbers correspond to charts in Figs. 3 & 4. “A” represents exact area of forewing length measurement. Dorsal view (left), ventral view (right).

outer FW dorsal ground color (area 1)	inner FW dorsal ground color (area 2)	ventral FW ground color (area 3)	ventral HW ground color (area 4)	FW length range (millimeters) (measurement A)	FW length average (millimeters) (measurement A)
<i>Argynnis atlantis</i> West Virginia - ♀ <b>RGB</b> color averages and FW length					
207, 125, 17	102, 60, 24	186, 111, 35	52, 29, 26	30-35	32.42
<i>Argynnis atlantis atlantis</i> - ♀ <b>RGB</b> color averages and FW length					
216, 145, 27	92, 57, 30	190, 124, 57	71, 44, 35	27-31	29.25

**Fig. 3:** RGB color analysis of four female characters and forewing length.

outer FW dorsal ground color (area 1)	inner FW dorsal ground color (area 2)	ventral FW ground color (area 3)	ventral HW ground color (area 4)	FW length range (millimeters) (measurement A)	FW length average (millimeters) (measurement A)
<i>Argynnis atlantis</i> West Virginia - ♂ <b>RGB</b> color averages and FW length					
216, 131, 31	110, 69, 44	190, 129, 53	81, 47, 35	27-31	29.92
<i>Argynnis atlantis atlantis</i> - ♂ <b>RGB</b> color averages and FW length					
226, 145, 37	123, 77, 44	207, 152, 82	109, 73, 57	27-30	28.83

**Fig. 4:** RGB color analysis of four male characters and forewing length.

## DISCUSSION

Though both dorsal and ventral wing markings are variable in both central Appalachian and nominotypical populations, this study finds no consistent differences in wing markings except in the females which have reduced black spotting dorsally and a larger, “brighter” appearance in the central Appalachians than females in the nominotypical region. Three of the measured female characters (2, 3 and 4) showed no appreciable difference in colors, but the outer ground color showed measurable (and visually noticeable) difference. West Virginia females average larger than nominotypical females (**Figs. 3 & 5**) and are occasionally of very large size, some difficult to differentiate from sympatric *A. aphrodite* females when viewed (or photographed) from just the dorsal side. **Fig. 2** displays the largest specimen examined in this study, with a forewing length of 35 mm. Thus, the holotype of the new subspecies is based on the female phenotype.

Males of both nominotypical and Appalachian populations showed no appreciable difference in wing markings, which is variable in both populations. But from the four analyzed characters, the males did show a slight difference in average dorsal ground color, and the forewing length measurements showed West Virginia males to average slightly larger (**Figs. 4 & 6**).

## DESCRIPTION, TYPE SPECIMENS AND DISTRIBUTION

### *Argynnis (Speyeria) atlantis brittanae* - new subspecies

ZooBank registration: [urn:lsid:zoobank.org:act:7675E051-CE5A-4C1D-BA47-C5AE3067DC11](https://zoobank.org/urn:lsid:zoobank.org:act:7675E051-CE5A-4C1D-BA47-C5AE3067DC11)

**Phenotypic description:** Males are like nominotypical *atlantis* (**Fig. 6**) but average a scant 1.09 mm larger in forewing length. Measured length of male forewings in the measured series (n=29) is 27-31 mm, averaging 29.92 mm. Color swatches generated using RGB color codes (**Fig. 4**) show a slight average difference in the shade of dorsal orange-brown ground color in the study series. West Virginia populations (subspecies *brittanae*) males tend to have a subtle “warmer” dorsal reddish orange-brown ground color and the dorsal wing margins are less black as in nominotypical *atlantis*. Nominotypical populations of *atlantis* have a tanner orange-brown ground color and very dark margins. Variability in any specimen series will show considerable overlap. Large series of both subspecies are necessary for ascertaining an average RGB using a color analysis tool.

Females of the West Virginia populations are of a stronger shade of reddish orange-brown than nominotypical *atlantis* females (**Fig. 5**) which appear to be paler and have a slight yellow component. While males of both *atlantis* and *brittanae* have similar, variable dorsal wing pattern, the females differ. Nominotypical *atlantis* females have a more developed pattern of black markings and darker wing margins, while *brittanae* females have a tendency for reduced markings and less dark margins by comparison, most noticeably on the hindwings. This gives the females a “brighter” appearance.

The measured females (n=15) average 3.17 mm larger than nominotypical *atlantis* females in forewing length, ranging from 30-35 mm, averaging 32.42 mm. [Some larger females in West Virginia approach the sympatric *A. aphrodite aphrodite* phenotype (**Fig. 2**), differentiated mainly by more extensive dark wing margins, and the more expansive tan postmedian band on the ventral side of the hindwings, between the outer two rows of silver spots, whereas in *aphrodite* the inner brown ground color of the ventral side of the hindwings encroaches and partially fills in this tan band.] Interestingly, the series of nominotypical *atlantis* females and males were of about the same size; the female forewing length averaging only .42 mm larger than the males. By contrast, subspecies *brittanae* females were markedly larger than the males, averaging 2.5 mm larger.





**Fig. 5.** Comparison of females. Ssp. *brittanae* (above), W.V., Randolph County, Spruce Knob Lake, 25 June, 2009. Ssp. *atlantis* (below), N.Y., Ulster Co., Ellenville, 9 July, 1992.



**Fig. 6.** Comparison of males. Ssp. *brittanae* (above), W.V., Randolph County, Spruce Knob Lake, 15 June, 2014. Ssp. *atlantis* (below), N.Y., Ulster Co., Ellenville, 9 July, 1992.

**Distribution:** The range is basically confined to the Canadian Zone of the central Appalachian Mountains (Allegheny Plateau region). Allen (1997) notes that West Virginia populations are disjunct from northern populations. It is primarily an isolate but some contact with ssp. *atlantis* may occur in southwestern Pennsylvania. County records are as follows: Maryland: Garrett. Virginia: Highland, with an unconfirmed historical sight records in Bath Co. (Clark & Clark, 1951) and Rappahannock Co. (Opler, 1995). West Virginia: Barbour\*, Grant\*, Greenbrier, Hampshire\*, Hardy\*, Marion\*, Mineral\*, Monongalia\*, Pendleton, Pocahontas, Preston, Randolph, Tucker, Webster. Populations in southwestern Pennsylvania on the Allegheny Plateau require confirmation of assignment to *brittanae*. The butterfly is best known from Spruce Knob, Canaan Valley and Dolly Sods Wilderness in West Virginia. Counties indicated with (\*) indicate historic non-breeding (stray) records (Allen, 1997; Olcott, pers. comm.). Interestingly, the West Virginia Butterfly Survey (Olcott, pers. comm.) shows the active, current range very restricted, primarily limited to a relatively small area on the Allegheny Plateau. Past records outside the active range indicates historic strays to neighboring counties or perhaps a slightly greater historic range now contracted.

**Habitat:** Frequently found in high elevation fields, meadows, fens, bogs, pastures and other open areas in association with Canadian Zone and upper Transition Zone forests. They are easily found nectaring on a broad variety of flowers along roadsides in these habitats and through forest.

**Hosts:** *A. atlantis* is known to utilize Violets (*Viola* sp.) range wide but the exact species on the Allegheny Plateau has not been determined.

**Flight Period:** Single brood. Records span June 8 – October 2, with peak flight in late June and early July. Immature stages of this subspecies have not been studied.

**Holotype, allotype, paratypes:** Holotype (female) (**Figs. 7 & 9**): West Virginia, Randolph County, Spruce Knob Lake, 25 June, 2009. Collected by Harry Pavulaan. Allotype (male) (**Figs. 8 & 10**): West Virginia, Randolph County, Spruce Knob Lake, 15 June, 2014. Collected by Harry Pavulaan. Both holotype and allotype to be deposited in the McGuire Center for Lepidoptera and Biodiversity, Gainesville Florida. Paratypes: 28 male and 14 female specimens from Pendleton, Randolph, and Tucker Counties, W.V. retained in the collection of Harry Pavulaan, to be disseminated at a future date. 15 male and 7 female specimens from Pendleton and Tucker Counties, W.V. in the collection of Howard Grisham. 31 male and 11 female specimens from Pendleton and Tucker Counties, W.V., collected by Howard Grisham, John Hyatt and Tom Allen, in the collection of Tom Kral. 14 male and 8 female specimens from Pendleton County, W.V. in the collection of Ricky Patterson.

**Etymology:** I name this subspecies after my daughter Brittany. The latinized equivalent is “brittanae”. I propose the common name “Allegheny Fritillary” due to its small range in that region.



**Fig. 7.** Holotype, W.V., Randolph County, Spruce Knob Lake, 25 June, 2009, female, dorsum. Coll. Harry Pavulaan.



**Fig. 8.** Allotype, W.V., Randolph County, Spruce Knob Lake, 15 June, 2014, male, dorsum. Coll. Harry Pavulaan.



**Fig. 9.** Holotype, W.V., Randolph County, Spruce Knob Lake, 25 June, 2009, female, venter. Coll. Harry Pavulaan.



**Fig. 10.** Allotype, W.V., Randolph County, Spruce Knob Lake, 15 June, 2014, male, venter. Coll. Harry Pavulaan.

















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## APPENDIX

226, 145, 37		Buttercup
216, 145, 27		Buttercup
216, 131, 31		Ochre
207, 152, 82		Whiskey Sour
207, 125, 17		Dark Goldenrod
190, 129, 53		Hokey Pokey
190, 124, 57		Brandy Punch
186, 111, 35		Pirate Gold
123, 77, 44		Korma
110, 69, 44		Cape Palliser
109, 73, 57		Old Copper
102, 60, 24		Baker's Chocolate
92, 57, 30		Dark Brown
81, 47, 35		Indian Tan
71, 44, 35		Morocco Brown
52, 29, 26		Brown Pod

**Appendix A.** Color Nomenclature from Colblindor™ for corresponding RGB color codes used in this study.



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