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Re-evaluation of *Euchloe olympia* (W. H. Edwards, 1871) (Pieridae: Pierinae) from a geographic and taxonomic perspective.

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ABSTRACT. The taxonomic status of regional populations of *Euchloe olympia* (W. H. Edwards, 1871) is re-evaluated here. A review of pertinent literature and a critique of Clench & Opler (1983) are provided. The taxon *rosa* and two distinct populations of the Great Lakes “dune form” are each proposed for recognition at subspecific rank. The status of synonym *anniha* Ebner (1970) is addressed.

Key words: Apical infuscation, dune form, inland form, isolates.

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INTRODUCTION

William Henry Edwards first described *Anthocaris olympia* (W. H. Edwards, 1871) as follows:

ANTHOCARIS OLYMPIA, n. sp.

Primaries long and narrow.

Male.—Expands 1.6 inch. Upper side pure white, grey at base of wings; a large grey patch at apex of primaries, partially replaced by white; costal margin slightly specked with black; on are a straight black bar, not prolonged above sub-costal nervure. Secondaries have a few black scales at outer angle and a small wedge-shaped black spot nearer base on costa.

Under side white; primaries have a small grey subapical patch on costa, nearly covered with green scales, and a faint greenish patch on hind margin in the discoidal interspaces; discal spot narrow, lunate enclosing a white streak. Secondaries crossed by bands of yellow green on a grey ground, the first, near base forming a segment of a circle; the second, just anterior to the middle of the wing, of irregular width, projecting a short, truncated branch on sub-median nervule that connects with the third band, and ending in a sharp spur a little inside abdominal margin; the third band, commencing on abdominal margin, is at first broad, and after connecting with second band, narrows to half its previous width, then enlarges greatly and curves towards hind margin, which it strikes in three branches, besides sending a fourth to outer angle; sometimes this last branch is disconnected and forms a marginal spot; the bands are more or less marked by small white spots and points.

Body black covered with grey hairs; beneath greenish-white; palpi white, with grey interspersed; antennae grey above, yellowish below; club brown above, bright yellow below and at tip.

Female.—Expands 1.7 inch.

Similar to male; the grey apical patch enclosing a distinct white

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spot; discal spot broader, sinuous, sending a short spur along sub-costal; costal edges more irrorated; under side as in male.

From 1 ♂, 1 ♀, taken at Coalburgh, W. Va., in April, 1871, and 1 ♂, taken by Mr. Boll, at Dallas, Texas, and in collection of the Museum of Comp. Anat. Cambridge.

I was very much surprised at finding this pair at Coalburgh among a lot of *Gemnia*, taken in April, 1871, by a young friend whom I had enjoined to take everything that was white. I had never before met with it, and thought that locality had been pretty well gleaned. It is also remarkable that the next specimen should come from so remote a district as Texas. The species cannot be mistaken for any other, on account of the three bands crossing secondaries.

Interestingly, the species was described from a pair taken at Coalburgh, West Virginia and a male taken at Dallas, Texas. While not illustrated with the original description, *olympia* was later illustrated in W. H. Edwards (1884) (Fig. 1) and a male [top left image of the TTR banner for this paper] was later illustrated in W.H. Edwards (1897). F. M. Brown (1973) designated a male lectotype for *olympia* from the W. H. Edwards collection in the Carnegie Museum of Natural History (fig. 3), which is illustrated in Fig. 1 of F. M. Brown (1973). The type locality was noted from Edwards' original male lectotype label as "Kan". Opler (1966) recommended that the type locality be more precisely stated as: "banks of the Kanawha River, near Coalburgh, West Virginia."

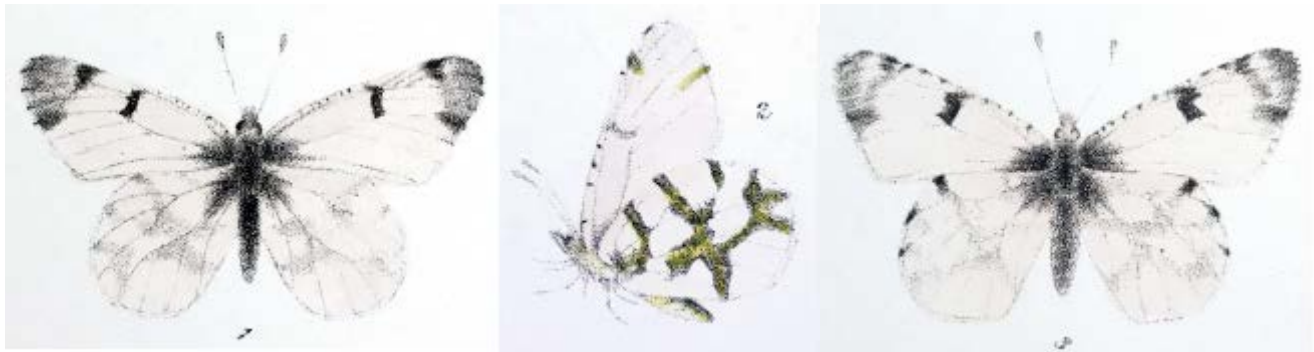


Fig. 1. Original figures of *Anthocharis olympia* (W. H. Edwards, 1884). Male dorsal (left), male ventral (center), female dorsal (right). [photo credit courtesy John Calhoun]

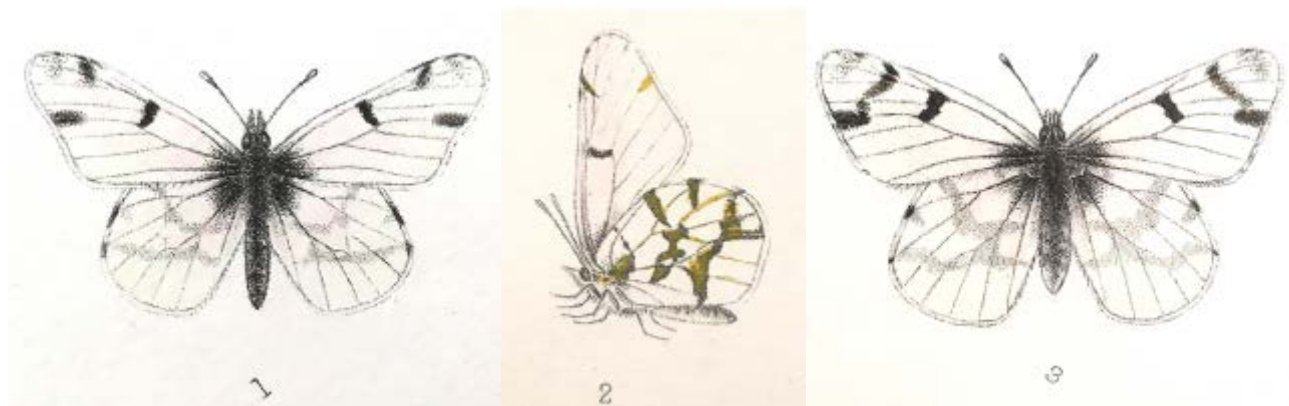


Fig. 2. Original figures of *Anthocharis rosa* (W. H. Edwards, 1897). Male dorsal (left), male ventral (center), female dorsal (right). [photo credit courtesy John Calhoun]

William Henry Edwards later described *Anthocharis rosa* (W. H. Edwards, 1882) as follows:

ANTHOCHARIS ROSA.

Male.—Expands 1.2 inch.

Upper side pure white, gray at bases of wings; primaries have a short, straight, black bar on costal margin near apex, turned back obliquely, which, extended, would strike middle of inner margin; another bar on hind margin on upper branch of median; the apical area between these almost immaculate, a few scattered black scales only lying near costa; on arc of cell, a narrow black bar, bent or a little sinuous; costal edge sometimes pure white, immaculate; sometimes with a few black scales and points. Secondaries are of thinner texture, discovering the markings of under side; at outer angle a slight edging of black at the upper branch of sub-costal, and the fringe against this is black; also, there is black fringe at end of the lower branch of same nervure; otherwise all fringes are white.

Under side white, with a pink tint over costa of primaries and all of secondaries above sub-costal nervure, deepest next base; costal edge either immaculate, or with five or six separate black points; the discal and costal bars repeated, reduced, the latter densely covered with yellow scales; the bar on hind margin suppressed, but represented by yellow; the nervules about apex yellow, and on costal edge a black streak at end of each nervule.

Secondaries have three cross bands of black, sprinkled thickly with yellow scales, with some open spaces or spots, discovering a yellow ground; the anterior band narrow, making a circle about base; the second, discal, sends a short, stout branch along median nervure to third, then narrows and is attenuated to a point at inner margin; the third, starting on inner margin, is broad, and after the junction with second, narrows greatly, then widens and strikes hind margin in a triple fork; at outer angle a short, narrow bar similar to the bands; the nervures and branches on middle of the wing yellow.

Body black; the thorax covered with long gray hairs; beneath, thorax yellow, abdomen white along venter; legs pinkish, the femora covered with long white hairs; palpi white with much gray; antennæ white above, yellowish below; club white above, yellow below and at tip.

Female.—Expands 1.4 inch.

Color of male, on both surfaces, similarly marked; a few black scales are scattered between the ends of the apical bars, suggesting a cross band.

From six examples, 3 ♂ 3 ♀, taken by the late Mr. J. Boll, in western Texas, March, 1878. Mr. Boll informed me, in answer to my inquiry, that he took many more, and all were of the type sent me. The species is nearest *Olympia*, Edw., and the banding of under side is of same character. It differs from that species by the immaculate apex, and by the presence of the straight, oblique costal bar, instead of an irregular patch.

The taxon *rosa* was described as a species from three pairs taken in “western Texas”. The butterfly [top right image of the TTR banner for this paper] was later illustrated in W. H. Edwards (1897) (fig. 2). F. M. Brown (1973) designated a male lectotype for *rosa* (fig. 3) from the W. H. Edwards collection in the Carnegie Museum of Natural History and restricted the TL to “Wichita County, Texas”. This specimen is illustrated in Fig. 2 of F. M. Brown (1973).

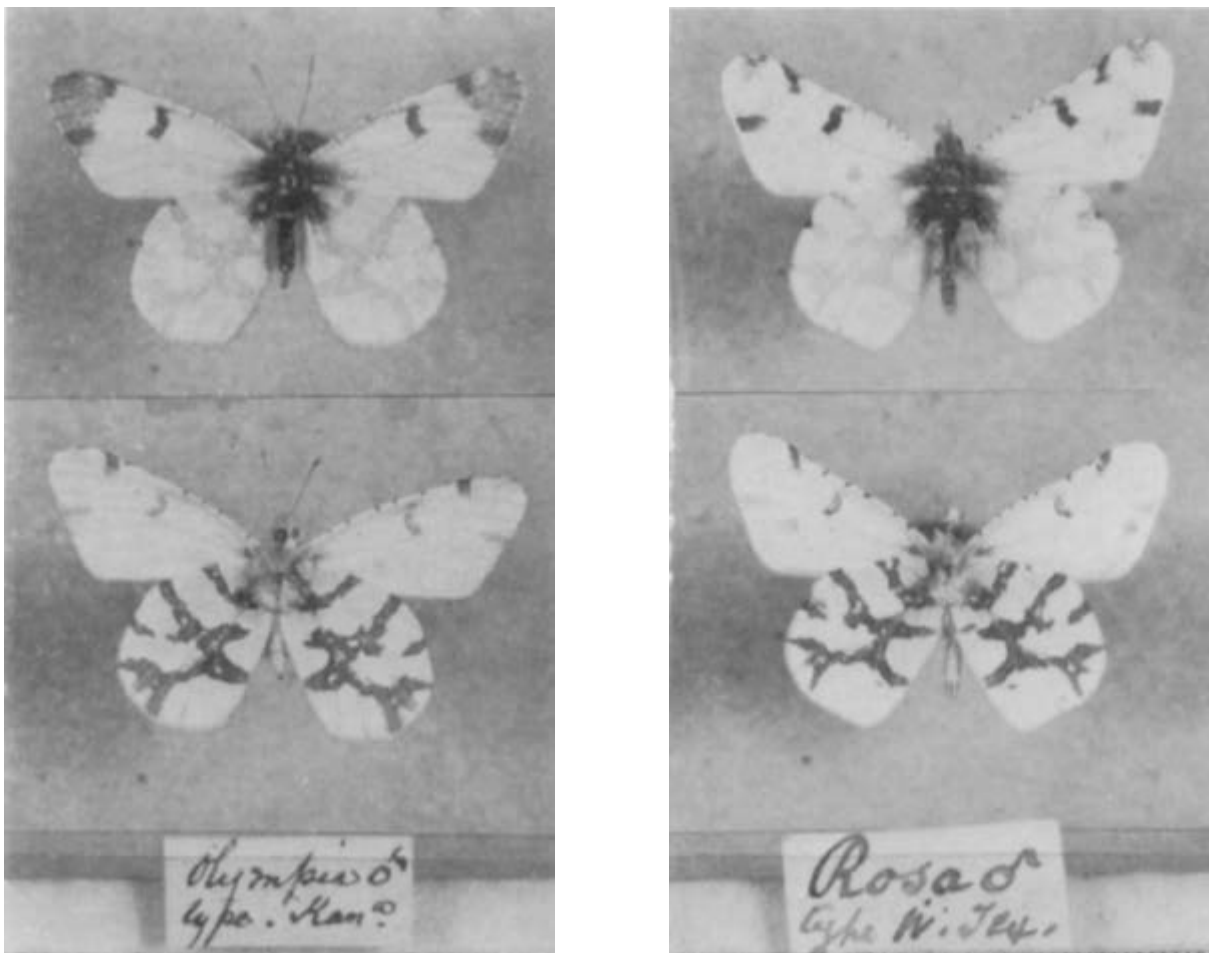


Fig. 3. *Anthocharis olympia* (W. H. Edwards, 1871) lectotype (left image) as illustrated in F. M. Brown (1973). *Anthocharis rosa* (W. H. Edwards, 1882) lectotype (right image) as designated by F. M. Brown (1973). [photo reproductions by permission of American Entomological Society]

REVIEW OF PERTINENT LITERATURE, FOLLOWING ORIGINAL DESCRIPTIONS

(including major synonymic and other works)

H. Strecker (1872): The author followed Edwards' original treatment of *olympia* under genus *Anthocharis*. [*Rosa* had not yet been described.]

W. F. Kirby (1877): The author included *olympia* under genus *Zegris* in the 1877 Supplement to his 'Synonymic Catalogue of Diurnal Lepidoptera'. [*Rosa* had not yet been described.]

H. Strecker (1878): The author again followed Edwards' original treatment of *olympia* under genus *Anthocharis*. [*Rosa* had not yet been described.]

W. H. Edwards (1884): In this edition, the author again listed *Anthocharis olympia*, without mention of *rosa*, but *rosa* was listed in the Edwards (1897) edition.

G. H. French (1886, 1914): In all editions through 1914, only species *Anthocharis olympia* was listed, without mention of *rosa*.

W. S. Blatchley (1891): The author's report of *Anthocharis olympia* is the first published account of the lower Lake Michigan lakeshore population. Blatchley states: "Occurs in small numbers about Whittings, Lake County...It frequents cultivated grounds, gardens and meadows", though this is certainly

not a description of the known dune habitat. There are presently only small fragmented remnants of the ancient dunes along the lakeshore at Whiting, certainly more expansive in the late 1800's.

H. Skinner (1896): In his discussion of *Anthocharis*, the author was first to suggest, contrary to Edwards (1882): “*Rosa* seems to be the same, or at best a var. of *olympia*. I should say it represented the southern end of the vertical distribution.”

Scudder (1889): The author treats *olympia* at species rank under genus *Synchlloe* (and considers *Anthocharis* and *Zegriss* generic-level synonyms) and without mention of *rosa*.

W. H. Edwards (1897): In this edition, the author listed *Anthocharis rosa* as a species-level taxon. He makes notes similarities and differences from *olympia*, which he still considered a separate species but questioned: “It may be that these are properly but forms of one species, *Olympia* the northern, *Rosa* the southern form. As yet not much is known about either...” Interestingly, Edwards seemingly makes reference to the dune populations of *olympia*: “The species [*olympia*] seems particularly abundant at Whiting’s, Lake County, Indiana...One of these is represented in Fig. 5...” Edwards’ fig. 5 may be the first actual depiction of the dune phenotype!

W. Beutenmüller (ed.) (1897): In the Proceedings of the New York Entomological Society, meeting minutes of October 16, 1897, William Beutenmüller quotes himself: “*Rosa* is without much doubt a variety of *olympia*.” In the meeting minutes, Beutenmüller referred to subspecies as “races”, thus he certainly considered *rosa* an infrasubspecific form.

W. Beutenmüller (1898): In the author’s revision of North American *Euchloe*, he includes entries for *Euchloë olympia* and “*Euchloë olympia* var. *rosa*”, providing a description of both. Interestingly, he did not include distribution of nominotypical *olympia*, yet he described the “habitat” of *rosa* as “West Virginia to Texas and Nebraska.” In this paper, Beutenmüller did not elaborate on his application of the term “var.”, thus interpretation of Beutenmüller’s application of the terms “race” and “variety” is based on his quotes from Beutenmüller (1897). Also, interestingly, the author did not illustrate nominotypical *olympia*, yet he illustrated *rosa*. In a response to Beutenmüller (1897), Butler (1899) states: “*Euchloe olympia* is undoubtedly a species of *Zegriss*.”

H. Skinner (1898): The author treats species *Anthocharis olympia* at species rank with the range of “W. Va., Ind., Neb., Col., Minn., Summit, N. W. T.” but treats *rosa* as “var.”, giving the range as “West Texas”. Skinner similarly listed geographical taxa (subspecies) as “var.” and did not employ the term “subspecies”. By giving the range of *rosa*, one can imply that he considered *rosa* as a subspecific taxon.

S. F. Denton (1900): Lists *Anthocharis olympia* but makes no mention of *rosa*. Interestingly, the author misidentified two specimens of what appear to be *Euchloe hyantis* on page 330 as “*olympia*”.

W. J. Holland (1899, 1900, 1902, 1904, 1916a): In ‘The Butterfly Book’, in what seems to be a case of accidental omission, *olympia* is merely illustrated on Plate XXXII (fig. 39) as “*Euchloë olympia*, Edwards, var. *rosa* Edwards”, yet there is no species entry for *olympia* in the text. However, *Euchloë rosa* is given full species treatment (following Edwards).

H. G. Dyar (1902): The author includes *olympia* within the genus *Synchlloe* and treats *rosa* at subspecies rank.

J. H. Comstock & A. B. Comstock (1904): The authors include *olympia* within the genus *Synchlloe* but do not include mention of *rosa*.

W. G. Wright (1906): *Euchloe Rosa* is treated at species rank but with little natural history information. Of great interest is the figured specimen (Plate VII, Fig. 56c), which displays a yellow

ventral ground color instead of the usual white. The specimen was reportedly taken at or near Napa [California]. However, J. W. Tilden (1975) states that the illustrated specimen is “an off-color specimen of *Euchloe ausonides* Lucas.”

M. J. Elrod (1906): The author refers only to *Synchloe olympia* and does not mention *rosa*.

C. A. Shull (1907): The author, referring only to species-rank *Anthocharis (Synchloe) olympia*, published a detailed description of the immature stages and flight characteristics of the lakeside dune population in northern Indiana. Shull did not note subspecific differences between populations of *olympia*.

W. J. Holland (1916b): In ‘The Butterfly Guide’, in what appears to be a repeat of accidental omission from earlier works (Holland, 1900, 1902, 1916a) there again is no species entry for *olympia* in the text [no doubt the work of the publisher]. However, *Euchloë rosa* is given full species treatment (following Edwards) and is illustrated on Plate CI (fig. 2).

W. Barnes & J. McDunnough (1917): In ‘Check List of the Lepidoptera of Boreal America’, *rosa* was listed at subspecific rank under *Zegrus olympia*.

C. M. Weed (1917a, 1917b, 1923): The author refers only to species-rank *Synchloe olympia* and makes no mention of *rosa*.

S. Moore (1922): The author studied butterflies over a five-year period in northern Michigan and documented two specimens listed as *Zegrus olympia rosa*.

A. Seitz (1924) [text and plates separate]: The author lists *Zegrus olympia* and treats *rosa* as an aberrant form. Interestingly, his illustrated specimen of *olympia* (plate 28b) is a *rosa* phenotype.

W. J. Holland (1931, 1951): In ‘The Butterfly Book (New and Thoroughly Revised Edition)’, *olympia* and *rosa* are each given full species treatment. Holland gives the range of *olympia* as “southwestern Pennsylvania and West Virginia westward to Minnesota and Colorado.” He gives the range of *rosa* as “Texas”. *Euchloë olympia* is illustrated on Plate LXVII (fig. 28) and *Euchloë rosa* is illustrated on Plate XXXII (fig. 39).

F. C. Cross (1937): The author lists *Euchloe olympia* at species rank, occurring in the “eastern part of the state and along the foothills”, but interestingly states: “Typical specimens exhibit a rosy flush on the wings which has prompted many collectors to confuse our race with *olympia rosa*. It is unclear if he considered Colorado *olympia* a different “race” from either *rosa* or nominotypical *olympia*.”

W. D. Field (1938): The author discusses differences between the eastern subspecies *olympia* and the western subspecies *rosa* at length.

R. A. Leussler (1938): This is the last known published treatment of *olympia* under genus *Zegrus* and treats *rosa* at subspecific rank.

J. McDunnough (1938): In ‘Check List of the Lepidoptera of Canada and the United States of America’, the author maintained *rosa* at subspecific rank under *Euchloe olympia*.

E. P. Meiners (1939): The author discussed life history stages of *olympia* in Missouri, but did not address taxonomic issues, thus did not treat *rosa* at any rank.

A. H. Clark & L. F. Clark (1939): The authors treated *rosa* as a form of *Euchloë olympia* in Virginia. They first stated: “On May 7 and 8 of this year, although we took a few battered individuals of more or less typical *olympia*, nearly all that we captured were almost, or quite, typical *rosa*.” They go on

to elaborate: “[T]he natural conclusion is that in the cool weather of early spring this species appears in the form *olympia*, but later in the season after warm weather has become established it changes over to form *rosa*. These two forms, therefore, are primarily cool and warm weather forms of the species, and not geographical races.”

Examination of Appalachian specimens in the American Museum of Natural History, Field Museum, National Museum of Natural History, and the Peabody Museum of Natural History, as well as my own specimens from neighboring Maryland, reveals few individual variants qualifying even as intermediates. Most individuals are typical Appalachian *olympia*, and have considerable apical infuscation, though a very small percentage of individuals (<10%) do have reduced apical infuscation. What may factor into the authors’ assertions, is the fact that *olympia*’s wings tend to be very frail and tend to show age wear very quickly within a few days of flight, thus scale loss and fading out of the dark apical area of the forewing. Thus, some later individuals might appear more like *rosa* than the earliest, freshest *olympia* to emerge weeks earlier. However, the authors likely did not notice an important difference between nominotypical *olympia* and Great Plains *rosa*: the different shape of the forewing [discussion to follow].

A. H. Clark (1940): The author treated *rosa* as a form of *Euchloë olympia* in Virginia. The author repeated his earlier description of finding nominotypical *olympia* “earlier in the spring in the same region” and *rosa* later in the spring. He again went on to conclude: “On examining the matter we found that early in spring when it is still cold the typical form, *olympia*, is on the wing. After it becomes hot the butterfly changes over to the western type of coloration.” What is interesting is that Clark illustrated two specimens: a nominotypical *olympia* in very fresh condition collected on April 24, 1938; and a very worn specimen collected in nearby West Virginia on May 8, 1939, which he referred to as *E. o. rosa*. That latter specimen displayed considerable scale wear from age, making it somewhat difficult to conclude that it represented the “form characteristic of the region from Nebraska southward to Texas and New Mexico.” Interestingly, that specimen displayed a wedge-shaped black mark midway along the outer margin of the hindwing which is commonly seen in eastern nominotypical *olympia* and not in Great Plains *rosa*.

R. W. Macy & H. H. Shepard (1941): The authors provided considerable discussion of “race *rosa*”, which implies subspecific treatment.

A. H. Clark & L. F. Clark (1951): The authors again treated *rosa* as a form of *Euchloë olympia* in Virginia. They stated: “[I]ndividuals of this species are always typical *olympia*”, but went on to elaborate with the following: “If during the period of emergence the weather becomes hot and dry, this tendency is carried to an extreme and the form *rosa* appears, quite like specimens from Texas...The form *rosa* flies with worn individuals of typical *olympia* and a more or less complete series of intergrades. In Virginia and West Virginia it is possible to capture on the same day typical *olympia* and typical *rosa*, though most individuals will be intermediate between the two forms.”

A. B. Klots (1951): The author treats *Euchloë olympia rosa* at subspecies rank, but states: “not a very valid subspecies.” Interestingly, Klots provides illustration of a specimen of the distinctive dune population from “N.E. Lake Co., Ill.” (Page 208, illustration 6).

F. M. Brown, D. Eff & B. Rotger (1957): The authors treat *Euchloe olympia rosa* at subspecific rank.

W. T. M. Forbes (1960): The author simply states, under *Euchloe olympia*: “[W]estern specimens from Minnesota to Kansas and Texas considered a race *rosa* Edwards, but not really distinct.”

C. F. dos Passos (1964): In ‘A Synonymic List of the Nearctic Rhopalocera’, *rosa* was listed at subspecific rank under *Euchloe olympia*.

R. R. Hooper (1969): *Euchloe olympia rosa* is listed for Saskatchewan.

J. A. Ebner (1970): The author inadvertently published a new name, *Euchloe olympia anniha* which was attributed to dos Passos & Klots in error. Ebner (personal correspondence) informed me that when the manuscript was submitted to the publisher, the trinomial name was not included, and only appeared when ‘Butterflies of Wisconsin’ went to print: “I have no recollection as to how or why this name was applied”. According to Ebner, the inclusion of the trinomial *anniha* was certainly added by the editorial staff of the publisher. The name is apparently a misspelling and misapplication of *annicka* dos Passos & Klots, 1969, a subspecies of *Anthocharis midea*. Masters (1972) states: “Dos Passos and Klots have never described any subspecies of *Euchloe olympia* nor have described anything with the name of *anniha*. The name *anniha* must be credited to Ebner.” Julia Colby, Vertebrate & Invertebrate Collections Manager, Milwaukee Public Museum (personal correspondence) indicated that there are several specimens identified as “*anniha*” in the museum’s collection, but all were collected “at least a decade after Mr. Ebner’s book was published.”

Reference here is made to phenotype and range: “It is essentially white, although a few black markings accent the forewings. The subspecies *anniha* seems to be prevalent throughout most breeding colonies in the state [Wisconsin]. Here and there an individual with more extensive black markings also turns up, placing it more closely to typical *olympia*”. Reference to the butterfly being “essentially white, although a few black markings accent the forewings” draws up comparison closer to subspecies *rosa*, though some individuals are described as being closer to nominotypical *olympia*. I will add here that *rosa* specimens from central Wisconsin populations compare well with Great Plains specimens as far south as Texas. I consider “*anniha*” as a junior subjective synonym of *rosa*, based on the description above, and on the specimen image in Ebner (1970).

Though a holotype was not designated, nor intended, a male specimen was illustrated (Fig. 4), placing it very closely to the *rosa* phenotype. Ebner (personal correspondence) indicated that the disposition of that specimen is unknown, nor was the location of that specimen documented. The only reference to a Wisconsin location for *olympia* in Ebner (1970) is “Chippewa County”. I have selected an image of a very similar male specimen (Fig. 5) from the National Museum of Natural History to serve as a representative for the illustrated phenotype, from Nekoosa, Wood County, the closest location to Chippewa County (southeast corner) by approximately 62 miles.

The hostplant of *anniha* is described as “Rockcress”, which can apply to several species of *Arabis*, thus it is not known if the illustrated specimen was associated with either *Arabis lyrata*, *Arabis drummondii*, or another species.

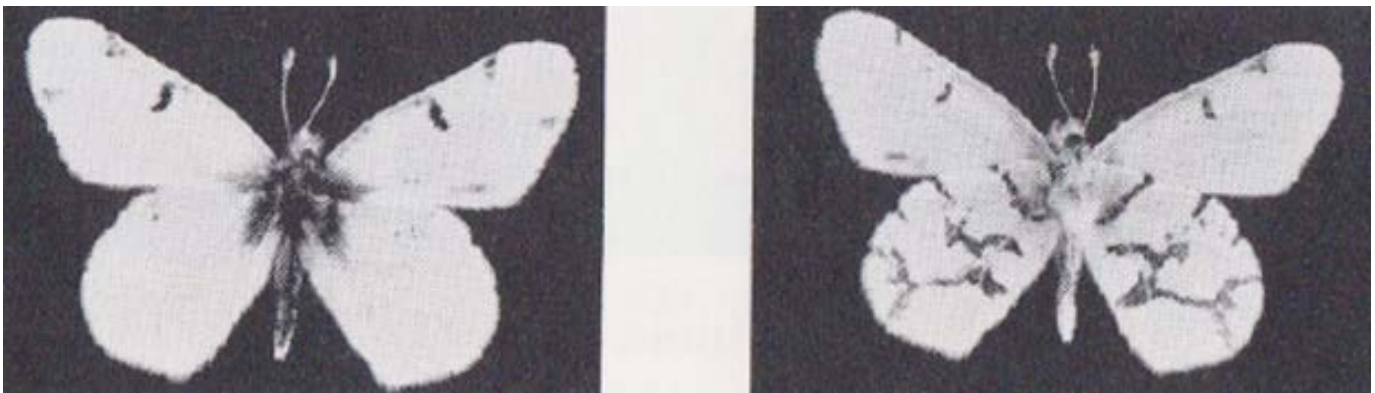


Fig. 4. *Euchloe olympia* “*anniha*” Ebner (1970). Male upper (left), male under (right). [Original images reproduced by permission of Milwaukee Public Museum]



Fig. 5. Representative male specimen of *rosa*, matching image in Ebner (1970), Nekoosa, Wood County, WI., May 5, 1918, leg. E. Beer. Dorsum (left), venter (right). Photograph by permission of the Smithsonian National Museum of Natural History.

C. D. Ferris (1971): The author treats *rosa* at subspecific rank but also suggests that “...subspecies *olympia* (Edwards) also may occur in our area [Wyoming].”

K. Johnson & J. M. Malick (1972): The authors listed subspecies ‘*Euchloe olympia anniha* dos Passos & Klots’ for central Wisconsin, apparently following the treatment of Ebner (1970). The only two records listed are for Portage County, and the only image, one of the *rosa* phenotype, is presumably from the same county.

K. Johnson (1972): The author treats *rosa* at subspecific rank.

J. H. Masters (1973): Interestingly, the author, despite assertion over the inadvertent naming of *anniha* (Masters, 1972), included this subspecific name and wrongly attributed it as “*Euchloe olympia anniha* dP. & Kts.” [This paper was issued in the J. Res. Lepid. 1972(1973), thus was likely submitted for review prior to Masters (1972).] This is the only other literature reference to *anniha* that could be found.

R. R. Hooper (1973): The author treats *rosa* at subspecific rank.

W. H. Howe (1975): In ‘The Butterflies of North America’, the author treats *rosa* at subspecific rank and illustrates *rosa* specimens on plate 71 (no’s 24 & 25).

W. H. Wagner (1977): The author published a detailed description of what he referred to as the distinctive “dune form” of *Euchloe olympia*. Wagner’s first encounter with this phenotype was in the dunes area at the south end of Lake Huron in the Ipperwash Area of Lambton County, west of Grand Bend. His preliminary observations in 1975 suggested that this distinct population “might even represent a distinct subspecies, so numerous were the differences”. Later observations of this diminutive dune phenotype were made in similar habitat at the south end of Lake Michigan in Berrien County, Michigan. Wagner went on to describe differences between the Michigan “Inland Form” and “Dune Form”, noting that: “The Dune Form is readily distinguished from the Inland Form by its smaller size, whiter ground color, and more complex pattern of markings on the secondaries below”, though he did acknowledge that there is some overlap in characters. Wagner also stated: “The Lake Michigan Dune populations are not quite so extremely differentiated as the Lake Huron”.

Of interest is Wagner’s observations regarding differing hostplant preferences of the “Dune” and “Inland” Forms in Michigan. He noted that “Inland Form” populations of *olympia* in Allegan, Montcalm

and Roscommon Counties utilize *Arabis drummondii* while the “Dune Form” populations of Berrien County, MI. and Lambton County, ON. utilize *Arabis lyrata*. Wagner indicated an initial impression that *Arabis lyrata* was “primarily a plant of dunes and shoreline sandy strips” (though it is also found throughout much of Michigan), thus being a valid differentiating biological character (in Michigan). Later plotting revealed that *A. lyrata* also occurred commonly throughout much of Wisconsin, especially in the “Driftless Area” in the southwestern part of the state. He concluded: “On the basis of the phytogeographical data, therefore, it seems unlikely that it is foodplant preference alone that governs the differentiation of the Dune populations.”

S. Kohler (1980): The author listed county distribution of “*olympia* f. “*rosa*”” in Montana but commented: ““*rosa*” is best considered a form rather than a subspecies.”

C. D. Ferris & F. M. Brown (1981): The authors consider *rosa* a form: “Two ssp. Have been described, but one appears invalid as discussed below. The nominate ssp...generally occurs in our region...Throughout this butterfly’s range, and even in a given locality, both phenotypes can be collected. For this reason, “*rosa*” must be considered as a form, not a ssp.” I would like to address these statements here. One specimen illustrated (“fm. “*rosa*” m, D, V.”) is indeed *rosa*. The first specimen (“*olympia* m, D, V”) does not appear to be of the nominotypical phenotype as suggested in the authors’ statements. It is a *rosa* primarily by wing shape, but the gray subapical bar is characteristic of intermediate forms found in Wisconsin. Not knowing where the illustrated specimens originated from, what series the authors examined, or what their experience was, in regard to regional variation in *olympia*, I feel compelled to regard their conclusion as insufficient, given the lack of Rocky Mountain specimens available for examination in collections.

L. D. Miller & F. M. Brown (1981): In ‘A Catalogue/Checklist of the Butterflies of America North of Mexico’, *rosa* is now listed as a junior subjective synonym of *Euchloe olympia*.

R. A. Layberry, J. D. Lafontaine & P. W. Hall (1982): In ‘Butterflies of the Ottawa District’, the authors list subspecies *rosa* as occurring in the Ottawa area (including adjacent Quebec).

R. W. Hodges (1983): In ‘Check List of the Lepidoptera of America North of Mexico’, *rosa* is again listed as a subspecies of *Euchloe olympia*.

H. K. Clench & P. A. Opler (1983): The authors published a study describing geographic variation in *Euchloe olympia*, in which several aggregate population groupings, or biogeographic “isolates”, were identified and statistically analyzed for several adult wing characters, with the result as possible alternative taxonomic treatments. These isolates were also grouped based on distinctive traits relating to hostplants and habitat types. The authors concluded that *rosa* best be treated as a synonym of nominotypical *olympia*, though offering: “[O]ne might restrict nomenotypic *olympia* to isolates with dark apical infuscation...while applying the subspecific name *rosa* to all lightly marked isolates”.

Y. Sedman & D. Hess (1985): The authors simply state: “Specimens from Mason County...are recognized as the form “*rosa*”.

J. W. Tilden & A. C. Smith (1986): In ‘A Field Guide to Western Butterflies’, the authors treat “*rosa*” at subspecific rank and illustrate a specimen designated at subspecific rank (plate 25, illustration 4).

J. A. Scott (1986b): In ‘The Butterflies of North America’, the author does not recognize any subspecies under *Euchloe olympia*. Interestingly, he gives the common name as “Rosy Marble”.

R. A. Royer (1988): Describes the ventral “rosy flush” and “much reduced DFW apical dark markings” as a variable character and states: “this character in the extreme defines form “*rosa*”.

C. A. Bridges (1988). The author treats *rosa* as a junior synonym of *olympia*, citing Ferris & Brown (1981): “Note – Ferris does not consider this a valid subspecies.” [Bridges bibliographic reference: b1386, b1396]

P. Klassen, A. R. Westwood, W. B. Preson & W. B. McKillop (1989): The authors state that “no subspecies are recognized”.

B. D’Abrera (1990): Placed *olympia* back into genus *Zegris*. The author stated: “This species has been shifted around from *Zegris* to *Euchloe*, and back again. The only features it does not share with Palaearctic *Zegris* are the hirsute larvae and pupa within a girdled cocoon. However, the shape of the costal margins of both wings...together with a typical (for *Euchloe*) h.w.v. pattern...all make its placement here more logical. The pinkish ground colour of *olympia* (especially in fresh specimens) also make it a ‘bad’ fit with *Euchloe*, but a ‘good’ one with *Zegris*.” The author illustrates specimens taken in Kansas. This view of including *olympia* in genus *Zegris* did not gain popular acceptance post-1990. The name ‘*rosa*’ was not mentioned.

D. C. Iftner, J. A. Shuey & J. V. Calhoun (1992): The authors treat *rosa* as a form: “Individuals with rosy markings on the ventral hindwing are known as form ‘*rosa*’ (W. H. Edwards, 1882). These rosy markings fade and disappear on pinned specimens.”

R. A. Layberry, P. W. Hall & J. D. Lafontaine (1998): The authors treat *olympia* only at species rank with no mention of *rosa*.

M. C. Nielsen (1999): The author does not treat *rosa*, but in two plates (page 49), he illustrates dorsal differences between a male of “inland” *olympia* and what he refers to as a “Coastal male”.

D. K. Parshall (2002): The author produced a conservation assessment of *Euchloe olympia* for the USDA Forest Service, Eastern Region. A considerable amount of published and new (previously unpublished) information was integrated into this report. Parshall erroneously stated: “No subspecies has ever been described” and cited Edwards (1882) for describing “form” *rosa*. To correct the record here, *Anthocharis rosa* (W. H. Edwards, 1882) was described as a full species, as indicated by the original binomial treatment, making the name available for the Great Plains subspecies. Parshall also summarized variation in *olympia* as: “remarkably uniform in appearance throughout its range in the western and eastern U.S.”, which I find to be inaccurate, and also contradicts the findings of Clench & Opler (1983).

J. P. Pelham (2008): In ‘A Catalogue of the Butterflies of the United States and Canada’, *rosa* is listed as a junior subjective synonym of *Euchloe olympia*.

J. A. Scott (2008): In the ‘Biological Catalogue of North American Butterflies’, the author lists *rosa* as a synonym of *E. olympia*.

M. S. Fisher (2012): The author stated: “*rosa* was used as a form name but is presently considered a synonym.”

G. R. Pohl, G. G. Anweiler, B. C. Schmidt & N. G. Kondla (2010) treat *rosa* at subspecific rank, stating: “...AB [Alberta] populations appear to be distinct from nominate *olympia* and are more properly aligned with the subspecies *rosa* (Edwards).”

G. R. Pohl, J. Landry, C. Schmidt, J. D. Lafontaine, J. T. Troubridge, A. D. Macaulay, E. J. Van Nieukerken, J. R. Dewaard, J. J. Dombroskie, J. Klymko, V. Nazari & K. Stead (2018): The authors treat *rosa* as a junior synonym of *olympia*.

J. A. Scott (2020): The author discusses life history aspects of *E. olympia* in Colorado but does not mention *rosa* in the discussion. However, he refers to the common name as “Rosy Marble (Olympia Marble)”.

Some of the more recent works, mainly state or provincial treatments and regional field guides treat *Euchloe olympia* at species rank only, do not mention *rosa*, nor do they provide assessment of regional variation: Ehrlich & Ehrlich (1961); Clarke (1962); Irwin & Downey (1973); Pyle (1981); Opler & Krizek (1984); Ely, Schwilling & Rolfs (1986); E. M. Shull (1987); Heitzman & Heitzman (1987); Holmes, Hess, Tasker & Hanks (1991); Opler & Malikul (1992); Acorn (1993); Bird, Hilchie, Kondla, Pike & Sperling (1995); Neck (1996); Glassberg (1999); Covell (1999); Opler & Wright (1999); Bouseman & Sternburg (2001); Glassberg (2001); Marrone (2002); Opler & Warren (2003); Brock & Kaufman (2003); Royer (2003); Dole, Gerard & Nelson (2004); Daniels (2004, 2005); Douglas & Douglas (2005); Schlicht, Downey & Nekola (2007); Betros (2008); Chu & Jones (2011); Patterson (2011); Glassberg (2012); Belth (2013); Spencer (2014); Venable (2014); Jeffords, Hall, Jones, Guidotti & Hubley (2014); Post & Wiker (2014); Hardesty (2015); Acorn & Sheldon (2016).

DISCUSSION

I initially examined the specimen series at the Smithsonian National Museum of Natural History, with the intent of better understanding the regional variation as described in Clench & Opler (1983). Utilizing my own reference series, those of the American Museum of Natural History (New York, N.Y.), Field Museum (Chicago, IL.), the National Museum of Natural History (Washington D.C.), Peabody Museum of Natural History (New Haven, CT.) and also a broad range of published and internet sources, it was possible to update and supplement what is now known of the distribution of *olympia* and its regional variation. Despite its broad range and varied habitat choices, the butterfly appears to be highly localized in occurrence (though somewhat more widespread in the Great Plains), with widely scattered colonies consisting of relatively small numbers of observed adults.

Clench & Opler (1983) recognized several regionalized population groupings (isolates) as follows. These were based on the following characters: (1) forewing length (base to apex); (2) width of forewing discal black bar; and (3) degree of black infuscation on forewing apex above.

• **Appalachian isolate:** Ranging from Pennsylvania south through West Virginia. This is among the other isolates with smaller individuals, but with the heaviest apical infuscation (Fig. 6). This “isolate” refers to nominotypical *olympia*.

• **Great Lakes isolates:** Series of populations surrounding the Great Lakes including the diminutive dune populations. The authors divided their ecology discussion into two [sub]isolates:

• **Great Lakes inland isolates:** The authors include here “a mixed lot of populations with quite differing ecological features”. These group with isolates with the smaller individuals; however, Michigan specimens averaged with heavier apical infuscation, thus placing specimens closer to the Appalachian isolate while Wisconsin specimens averaged with lighter apical infuscation (thus being more similar to Plains isolates).

• **Great Lakes dune isolate:** This isolate is found in two disjunctive areas, restricted to lakeside dunes along the south end of Lake Michigan in Wisconsin, Illinois, Indiana and Michigan; also at the “upper edge of Lake Huron” [corrected here to the SOUTH END of Lake Huron]. This isolate has the smallest-sized adults (Wagner, 1977; Clench & Opler, 1983). Apical infuscation is heavy, more like Appalachian isolate.

- ***St. Louis isolate***: A grouping of river bluff colonies in the St. Louis area. This isolate has large individuals, but with heavy apical infuscation, thus identifying the phenotype with the Appalachian isolate. A portion of individuals are intermediate to *rosa* in nature (Fig. 7), thus I place this as a grouping of intermediate populations. Two Missouri colonies that I have studied, one in St. Francois county, the other in Wayne County, similarly have individuals with very dark apical infuscation, placing those closer to the Appalachian populations.
- ***Texas isolate***: A grouping of several central and eastern Texas colonies near several major rivers (Fig. 8). This isolate groups with the other Plains isolates by having large individuals, and with the lightest apical infuscation. This grouping also encompasses the *rosa* TL.
- ***Arkansas River isolate***: A series of populations extending from Arkansas through Oklahoma and Kansas; also along the Canadian River in north Texas. This isolate groups with the other Plains isolates by having large individuals, and with the lightest apical infuscation.
- ***Missouri River isolate***: Essentially applicable to all northern Great Plains populations in the Missouri River watershed from Missouri to North Dakota and then north into Manitoba. This isolate groups with the other Plains isolates by having large individuals, and with the lightest apical infuscation.
- ***Front Range isolate***: Populations residing in the Colorado Front Range and along the western edge of the Great Plains into Wyoming. Specimens of this isolate are small, like the Appalachian and Great Lakes isolates, and in general having light apical infuscation as in the Plains isolates. Occasional individuals with heavy apical infuscation, giving the appearance of nominotypical *olympia*, may be due to elevational influence.

Based on the above, Clench & Opler (1983) left us with three taxonomic choices: (a) apply separate subspecies status to each isolate; (b) consider isolates with dark infuscation (Appalachian, Great Lakes dunes and St. Louis) as nominotypical *olympia*; and all isolates with light infuscation as subspecies *rosa*; (c) not apply subspecific status to any regional isolate. The authors chose option (c). In the present paper, I choose a modified option (b) as discussed below.

HABITATS AND HOSTS

Since publication of the Clench & Opler (1983) paper, new distributional data has filled in many of the regional gaps between these described isolates, thus reason to question their viability as identifiable phenotypes in some regions, from a morphological perspective. I suggest here that, while the 1983 study maintains valid points, the biological aspects of *olympia*'s distribution is apparently more fragmented and complex than that study suggests, yet regional variation based simply upon the degree of gray apical clouding, shape of the forewing, and wing size point to a somewhat more simplified solution. Instead of 8 isolates as proposed by Clench & Opler (1983) the current mapped distribution (Map 1) shows three main population clusters: Appalachian Mountains; Great Lakes; and Great Plains.

First and foremost, it is apparent that *olympia* flies in a very broad range of habitats that varies from region to region and even within regions. For example, Howe (1975) describes the butterflies as favoring “open woodland or nearby meadows” in the east; “river woodlands and on river bank bluffs” in the Great Plains. Pyle (1981) describes the habitat as: “Open woods and meadows in eastern portion of range; watercourses and nearby fields and bluffs, foothill ridges and open grasslands farther west, sandy flats and dunes in Great Lakes area.” Clench & Opler (1983) state that *olympia* occurs in “relatively open native situations with well-drained rocky or sandy substrates”. Scott (1986b) describes the habitat as “usually in fairly dry clearings with few plants in E U.S., also prairie...” and notes that the range is expanding in Ontario. NatureServe (2015) summarizes the habitat as “open woods, barrens, very dry meadows in eastern part of range and open grasslands to the west”. Following are published habitat types

and hosts by state or province. Hostplant synonymy and common names are adapted from the USDA Plants Database (2017).

United States:

• **Arkansas:** Rouse (1969) reports *olympia* to be found in open woodland and nearby meadows. Masters reported the habitat in northwestern Arkansas to be bottomland deciduous forest (Clench & Opler, 1983). This was identified as part of the “Arkansas River isolate” (Clench & Opler, 1983). Opler & Krizek (1984) describe the habitat as “open river forests”. Spencer (2014) describes the habitat as “open areas such as glades and forest edges”.

• **Colorado:** Brown, Eff & Rotger (1957) state that *olympia* “seems to prefer open, dry, grassy areas a the tops of the foothill ridges and on the open rolling plains”. Howe (1975) gives the habitat as “low, open foothills”. Ferris & Brown (1980) describe the habitat as “open prairies and the slopes of the low foothills”, being found in localized pockets. Brown also reported *olympia* as “found on open ridges or low hills in short grass prairie habitat, often not too distant from cottonwood-lined streams (Clench & Opler, 1983). Opler & Krizek (1984) describe the habitat as “rocky foothills”. Scott (1986b) lists “foothill chaparral”. Chu (2009) reported *olympia* from short grass prairie. Chu & Jones (2011) include meadows, rocky ridges and ponderosa pine woodlands, and males are described as patrolling hilltops. Fisher (2012) describes *olympia* as a “true prairie species”, occurring “on the eastern plains, especially the higher prairie and into the foothills and lower mountains along the Front Range where prairie-like sites often persist.” Scott (2020) gives the habitat as “foothills chaparral/open woods, and Great Plains prairie especially with some trees.” Scott (1986a, 1992, 2006, 2020) provides a considerable number of documented host records for the state: *Arabis glabra* (Tower Rockcress or Tower Mustard), *Descurainia pinnata* (Western Tansy Mustard), *Descurainia richardsonii* (Mountain Tansy Mustard) [synonym of *Descurainia incana*], *Descurainia sophia* (Flixweed or Herb Sophia), *Lepidium campestre* (Field Pepperweed), *Lepidium virginicum* (Virginia Pepperweed) and *Sisymbrium altissimum* (Tall Tumblemustard). Wolfe, Harry & Stout (2010) recorded *Arabis fendleri* (Fendler’s Rockcress).

• **Illinois:** Irwin & Downey (1973) stated that the Waukegan Dunes population is “well established, common to abundant. Sedman (1983) described the habitat as “sand and loess hill prairies”. Sedman & Hess (1985) state that *olympia* is “virtually limited...to sand dune areas”, but does not occur in all such areas, even when the hostplants are present. The authors further state that the butterfly occurs “along trails or roads, and also in open woodlands and clearings”. One of the listed records was taken in “Sand Dune-Scrub Oak Prairie.” Bouseman & Sternburg (2001) describe the habitat as “open woods and nearby fields with low vegetation, in arid or semi-arid locales, often sandy”, adding: “Within its general range, scattered populations occur. The species is usually scarce, but in some years may be locally common within a restricted area.” Parshall (2002) describes *olympia* “in small numbers in widely separated populations”. Jeffords, Post & Wiker (2014) state that *olympia* occurs in “dry, sandy, prairie remnants; oak savannas; and sand dunes” but under ‘Status’, describe the species as “locally encountered in sandy areas and dry hill prairies along the Mississippi and Illinois rivers.”

• **Indiana:** W. S. Blatchley (1891) described the habitat at Whiting, in Lake County, as “cultivated grounds, gardens and meadows”. Whiting is at the lower end of Lake Michigan, thus possibly the first published record of the dune population. C. A. Shull (1907) and Wagner (1977) both reported the dune population from lakeside dunes, utilizing *Arabis lyrata* (Lyre-leaved Rockcress or Lyrate Rockcress). Belth (2013) adds sand savannas as habitat in Benton and Newton counties. E. M. Shull (1987) describes *olympia* as local and rare, utilizing both *Arabis lyrata* and *Sisymbrium officinale*, though it is questionable if reference to the latter was specific to Indiana.

• **Iowa:** Schlicht, Downey & Nekola (2007) describe the habitat in western Iowa as “dry gravel prairies” and “sandy bedrock glades” in northeastern Iowa. Orwig (1990) describes *olympia* as “a woodland edge-

savannah species...common on a few of the steepest loess bluffs” along the course of the Missouri River, but generally rare elsewhere in the state.

- **Kansas:** Field (1938) describes the habitat as “meadows and woods”, particularly in moist woods along waterways. *Sisymbrium officinale* (Hedge Mustard) is given as the hostplant. Ely, Schwilling & Rolfs (1986) describe the habitat as: “grasslands, woodland edge, roadsides, fields, riparian border.” They note the butterfly as being uncommon statewide.

- **Kentucky:** Covell (1999) describes *olympia* as “very local and uncommon”. Parshall (2002) describes populations as very small and widely separated.

- **Maryland:** Relatively open or thinly wooded deciduous shale barren habitats; overgrown utility line right-of-ways through mixed deciduous forest (personal observations). I have observed them in very small numbers within a very open patch of deciduous forest with a thin understory of scrub oak on a southeast-facing shale slope and on a shrubby east-facing hillside along a utility right of way, where they utilize both *Arabidopsis thaliana* (Mouse-ear Cress) and to a lesser extent *Cardamine pensylvanica* (Pennsylvania Bittercress). Freshly-laid eggs are reddish orange. Older larvae eat only seedpods of *A. thaliana*, as the flowers and leaves are generally withered at that stage. Opler & Krizek (1984) list shale barrens as the habitat. Parshall (2002) also reports *olympia* as being found in low numbers and comments that Gypsy Moth spraying has severely impacted the species. Maryland populations are nominotypical *olympia*.

- **Michigan:** Nielsen (1966, 1967) first reported utilization of *Arabis drummondii* (Drummond’s Rockcress) as host in Montcalm County, later in Cheboygan County (Nielsen, 1979). Wagner (1977) reported the “Inland Form” from prairies in Allegan County, Michigan, while Bill Bouton (personal communication) describes habitat in Allegan County as advanced second-growth (Oak and Pine) abandoned fields with openings. Opler (1974), Wagner (1977), Bess (1983), and Ronda Spink (personal communication) all reported use of the host *Arabis drummondii* in that area. Bess (1983) also reported *Arabis lyrata* from Allegan County but it is not clear whether this represents a lakeside dune population. Nielsen reported the inland isolate from “openings within scrub oak-jack pine habitat” and an “old pine burn”, both in the northern part of the Lower Peninsula (Clench & Opler, 1983). The “inland isolate” was reported as “restricted to prairies” in several central Michigan counties (Clench & Opler, 1983). Opler & Krizek (1984) list “sand plains” as the habitat. Nielsen (1999) reports the habitat as “Great Lakes dunes and open oak-pine barrens on sandy soils”. Parshall (2002) indicates that the butterfly is “widespread, and locally uncommon to common in much of northern Lower Peninsula, and in the Upper Peninsula”. The dune isolate was reported by Wagner (1977), also by Nielsen from lakeside dunes and was found utilizing *Arabis lyrata* (Opler, 1974; Clench & Opler, 1983). Nielsen (1999) notes: “Coastal specimens are noticeably smaller than those found inland.”

- **Minnesota:** Macy & Shepard (1941) describe the habitat as “dry, stony hillsides near the banks of lakes and streams” and also “scattered woods”. They report the hostplant along the St. Croix River in Washington County as *Arabis lyrata*. Arnhold (1952) describes *olympia* occurring on barren or thinly wooded rocky ridges above the Mississippi River. Masters reported the habitat to be deciduous woods in east-central counties (in Clench & Opler, 1983), whereas Clench and Opler (1983) reported that the species occurs on “open hilltops, surrounded by deciduous woods, overlooking the Mississippi River”. Clench and Opler attribute those populations to the Great Lakes “inland isolate”. Birch, in Blackwater Birds (2010) lists “sandy pine/oak barrens”. An online photo by A. Birch (2010) is captioned as “sandy pine/oak barrens”. Patterson (2011) adds “sandy grasslands” to the list of habitats. A series of specimens at the American Museum of Natural History represents a very small phenotype in Minnesota, intermediate between nominotypical *olympia* and *rosa*, and approximate the size of individuals of the Great Lakes Dune population (noting that Macy & Shepard (1941) reported utilization of *A. lyrata* in a population of *olympia* in Washington County, MN. lends call for future investigation).

- **Missouri:** Meiners (1939, 1956) reports utilization of *Arabis viridis* (Green Rockcress) [synonym of *Arabis missouriensis* (Missouri Rockcress)] in St. Louis county, and the habitat is described as tops of high ridges with cherty soil and sparse vegetation, appearing barren in early spring, with adults rarely straying to lower slopes (presumably forested habitat). Meiners (1939) also commented: “Later authors are nearly agreed that *rosa* is merely a varietal form of *olympia*.” Arnhold (1952) describes *olympia* occurring “on the crests of narrow rocky ridges” in the Meramec Highlands near St. Louis. Opler & Krizek (1984) list “river bluffs” as the habitat. Heitzman & Heitzman (1987) describe *olympia* as occurring in scattered colonies in open woodlands, cedar glades and nearby meadows. I have found *olympia* at a site in dense oak forest (early spring state) on a southward-facing hillside in St. Francois county. In Wayne county, I found them in numbers on a shrubby, gravelly river flat, though I question whether they are able to breed directly on the flat due to occasional flooding conditions.
- **Montana:** Barron (via butterfliesandmoths.org, accessed Dec. 1, 2018) described the habitat as mixed prairie with ponderosa pines.
- **Nebraska:** Johnson (1973) describes *olympia* as a woodland species; occurring in pine forests from Rock county westward; eastward in deciduous forests.
- **New York:** The habitat is known to be alvar barrens with sparse, stunted vegetation on limestone pavement in Jefferson county. Dirig reports utilization of *Arabis divaricarpa* (Spreading-pod Rockcress or Hybrid Rockcress) (in Parshall, 2002). Daniel (2018) photographed and posted to iNaturalist, a photo of a larva feeding on what is identified as *Boechera grahamii*.
- **North Carolina:** The habitat in far western North Carolina is described as “typically open woods or small openings within woods, in uplands, often on mountaintops” and “somewhat dry wooded slope” (LeGrand & Howard, 2019). Cook, in Carolina Nature (2012) photographed larvae on *Boechera laevigata* (Smooth Rockcress).
- **North Dakota:** Royer (1988, 2003) describes the habitat in western North Dakota as open prairies and sage flats. He also reports them in “great numbers” some years, and uncommon in others.
- **Ohio:** The habitat is described as “dry ridgetops in and adjacent to open oak forests” (Iftner, et. al. 1992). Ohio specimens are reported to be nominotypical *olympia*.
- **Oklahoma:** McCoy reported the habitat to be bottomland deciduous forest (Clench & Opler, 1983). This was identified as the Arkansas River isolate (Clench & Opler, 1983). Opler & Krizek (1984) describe the habitat as “open river forests”. Harp (1986) reported larvae on *Thelypodium wrightii* (Wright’s Thelypody). I have found them in central Oklahoma in a dry prairie remnant.
- **Pennsylvania:** Opler (1985) described the habitat as Devonian shale barrens, being found in “somewhat open areas in the barrens and is usually found flying along ridge-tops or through clearings.”
- **South Dakota:** Reported to be local and uncommon, mostly in western South Dakota; isolated occurrences in the east where native prairies remain; preferring short-grass to mid-grass prairies, badlands, dry meadows, river breaks and rocky ridges in open pine forest (Marrone, 2002). Marrone reports the hosts to be *Arabis* and *Chorispora tenella* (Blue Mustard or Crossflower).
- **Tennessee:** Venable (2014) indicates: “[T]hey seem to need areas with rocky outcrops, exposed shale...”
- **Texas:** Freeman (1959) states that *olympia* was found on limestone outcroppings in the Dallas, TX. area. These are identified as the Texas isolate by Clench and Opler (1983). Wauer (2006) describes the habitat as open prairies and “juniper-dotted grassland”. I have found them in central Texas in a rather ordinary weed field surrounded by deciduous forest. Neck (1996) lists the hosts as “*Arabis*, *Descaurania*,

Sisymbrium"; whereas the website of The Dallas County Lepidopterists' Society (2015) specifically lists *Boechnera canadensis* (Sicklepod), *Descurainia pinnata* and *Sisymbrium officinale*.

- **Virginia:** Clark & Clark (1951) describe the habitat as "open woods, especially in the higher portions, and along the rocky exposed crests of high ridges" (primarily in northern Virginia). In southwestern Virginia, *olympia* has been found in limestone pavement habitat characterized by boulders and stunted trees, especially *Juniperus virginiana*, and utilize the host *Boechnera laevigata* (Clench & Opler, 1983). Opler & Krizek (1984) list shale barrens as the habitat. Parshall (2002) also lists shale barrens and indicates that Gypsy Moth spraying has impacted *olympia*. Virginia populations are nominotypical *olympia*.

- **West Virginia:** Clark & Clark (1939) stated that *olympia* "kept to the crests of the ridges and to the higher elevations generally, where it was very common...But in the bottoms of the valleys...absent." Clench and Opler (1983) describe the habitat as: "in or near open, low pine or pine-oak forests on south or southwest facing rocky shale slopes". Opler & Krizek (1984) list shale barrens as the habitat. Allen (1997) refers to the primary habitat as shale barrens, specifically "semi-open, scrub oak-pine habitats...where exposed shale slopes occur", also in "semi-open wooded areas". *Arabis serotina* (Shale Barren Rockcress) is documented as a host in the shale barrens (Clench & Opler, 1983; Allen, 1997). Allen (1997) also lists *Boechnera laevigata* and, "to a lesser degree" *Cardamine hirsuta* (Hairy Bittercress). W. H. Edwards (1897) reported a species of *Sisymbrium* [now split into many genera]. Populations in the northeastern part of the state have been heavily impacted by Gypsy Moth spraying (Allen, personal communication). West Virginia populations are nominotypical *olympia*.

- **Wisconsin:** Arnhold (1952) reports *olympia* occurring along the sides and top of a steep lakeside bank within a "prairie-like" area north of Chippewa Falls. Ebner (1970) describes the habitat as "sandy wastelands". Masters (1973) reported *olympia* in "mixed forest areas of Transition zone character". Balogh (1980) reported *olympia* from sandy pine barrens, primarily dominated by Jack Pine (*Pinus banksiana*). Opler & Krizek (1984) list "river bluffs" as the habitat. The habitat is also described as Jack Pine woods within a matrix of sand prairie (Minnesota Butterfly Walks, 2015). Swengel & Swengel (1997) report *olympia* occurring in oak savannas or "barrens", which consist of open woodlands with an understory of plants associated with dry sandy prairies. Ebner (personal communication, 2010) described in detail his experience collecting the dune isolate in 1953 at Kohler Andrae State Park, which he found in close association with *Arabis lyrata*. Ferge (2011) describes the habitat as "dry sandy areas". Macy and Shepard (1941) report the hostplant along the Wisconsin side of the St. Croix River as *Arabis lyrata*. Balogh (1980) also reports *Arabis lyrata* as the host in pine barrens.

- **Wyoming:** Ferris (1971) lists the habitat (or "ecological zone") as moist meadows.

- **Great Lakes region (Indiana/Illinois/Michigan/Wisconsin/Ontario):** Douglas & Douglas (2005) describe habitats in the Great Lakes region as: "dry areas, including prairie remnants, oak savannas, sand dunes and dry lake plains...dry woodland forests or rocky prairies". Distribution is described, as "highly localized and small populations are the rule."

- **Kansas City region (Kansas/Missouri):** Betros (2008) lists the following habitats in the greater Kansas City region: woodlands/edges, overgrown fields, prairies and cedar glades.

- **Oklahoma, Kansas, North Texas:** Dole, *et al.* (2004) list "prairies, foothills, and open woodlands."

Canada:

- **Alberta:** Acorn (1993) describes *olympia* as being "most common in the valleys of the big prairie rivers." Bird, *et al.* (1995) give the habitat as "native prairie grassland and badlands." Kondla (2004) reports *olympia* as a "prairie butterfly...from a mid-elevation grassland adjacent [to] mountains" and also

specifically from “a site that had been very heavily grazed by livestock.” An anonymous member of the flickr.com online photo gallery reported the habitat as “mountain meadows”. Kondla (pers. corr., 2020) states that *olympia* is not known to occur in the Rocky Mountains of Alberta.

• **Manitoba:** Masters reported *olympia* on a hilltop in Jack Pine forest in the Riding Mountains (in Clench & Opler (1983)). Klassen, *et al.* (1989) describe the habitat as “dry knolls and hills in prairie areas, riverbank bluffs, woods and forests” and list the following hostplants: *Sisymbrium officinale* (Hedge Mustard), *Arabis glabra*, *Arabis lyrata* and *Arabis drummondii* (Drummond’s Rockcress). [However, the authors indicate that only three adult specimens were known from different localities in Manitoba, thus I question whether the listed hosts were interpreted from prior published works.] Murray (2018) described the habitat as “dry mixed grass sand prairie, pasture.”

• **Ontario:** Wagner (1977), reports the “inland form” from “Garden Township” [*sic* – correctly Carden twp.] in open limestone barrens. Layberry, *et al.* (1982) describe the habitat in the Ottawa District as “dry, barren, open areas”. Holmes, *et al.* (1991) list “dry open areas in or near woodlands”. Layberry, *et al.* (1998) describe the habitat in Ontario as dry meadows, open woodlands, alvars and old dunes. Hall, *et al.* (2014) describe the habitat as: “Mostly very dry habitats, such as alvars, Canadian Shield rock barrens and sandy meadows, and also open woodlands”. Lindsay (1971), Handfield (2011) and Hall, *et al.* (2014) reported utilization of *Arabis lyrata*. Layberry, *et al.* (1982), Handfield (2011) and Hall, *et al.* (2014) list *Arabis glabra*. Layberry (1986) reported the host as *Arabis divaricarpa*. Handfield (2011) adds *Arabis drummondii*. Ken Thorne (pers. comm.) describes the dune habitat at the lower end of Lake Huron as “sand dunes with Oak, Pine and Cedar”.

Data provided by the Ontario Butterfly Atlas Online (2016) provides considerable, more detailed habitat and hostplant information. Various habitat descriptions can be summarized as: primarily open, dry habitats with grassy areas and scattered, stunted shrubs, often in areas with exposed granite, limestone or other rocks; rock outcrops and rock barrens; granite barrens; limestone alvars; semi-open pine-oak rock barrens; sandy shrubland (sand barrens); wooded Canadian Shield country; and former pastureland. Host records include: *Arabis albida* (Alpine Rockcress) [synonym of *Arabis alpina*] and *Arabis drummondii* both reported from Peterborough County (W. J. D. Eberlie), *Arabis divaricarpa* reported from Ottawa City (Ross Layberry), *Arabis glabra* reported from Renfrew County (Ross Layberry); an unspecified species of *Boechea* reported from Manitoulin District (Manitoulin Island) (Steven Daniel). These records all apply to the eastward-expanding population of intermediate phenotypes. Additional records of *Arabis lyrata* apply to the dune population in Lambton County (Nick Escott, Quimby Hess, Ken Thorne).

• **Quebec:** Layberry (1985) first reported the host as *Arabis divaricarpa*. Layberry, Hall & Lafontaine (1998) describe the habitat in “Ontario and Quebec” as dry meadows and open woodlands, alvars and old dunes [the “dunes” reference certainly pertains only to the dune-associated populations in Lambton County, Ontario]. Handfield (2011) gives the habitat as uncultivated, open, dry places; also rocky limestone or shale peaks and summits, more indicative of *rosa* habitats. *Arabis glabra* is listed as host. Leboeuf & Le Tirant (2012), similarly list the habitat as: “open and dry habitats: rocky slopes, hilltops, limestone outcrops” [translated from French text]. Handfield (2011) reports the first observation of *olympia* in Quebec occurred on 5/29/1971.

• **Saskatchewan:** Hooper (1973) states that *olympia* “flies at the top of sharp knolls and badland hills.” The hostplants are described as “Hedge Mustard” [*Sisymbrium officinale*] and “Rockcress”, which can apply to several species of *Arabis* or related genera.

• **Eastern Canada:** Acorn and Sheldon (2016) describe the habitat as “dry forests on sand or limestone soils”.

• **Canada:** Layberry, *et al.* (1998) describe *olympia* as: “mainly a species of dryland areas. On the Prairies, it is usually found on grassy knolls or around badlands.” The authors also document the eastward range expansion [through southern Ontario and Quebec] since the 1970’s.

Wolfe, Harry & Stout (2010) recorded *Isatis tinctoria* (Dyar’s Woad) as an acceptable lab host. Scott (1986b) noted that larvae refused *Barbarea vulgaris* (Wintercress or Yellow Rocket) in the lab.

One can readily conclude that the Appalachian and eastern Missouri populations have a greater affinity for woodlands, while the Great Plains populations prefer prairie habitats. The Great Lakes dune-associated populations stand out as having the most restricted range and being extremely habitat-specific. Additionally, it might be noted that eastern populations in general are more localized and uncommon while the western (Great Plains) population is somewhat more common and widely distributed.

PROPOSED TAXONOMIC REVISION

I propose the following subspecific divisions in *Euchloe olympia*. Subspecies *olympia* and *rosa* are differentiated primarily by the degree of dark infuscation on the forewing apex and shape of the forewing. Nominotypical *olympia* is essentially an Appalachian isolate, ranging westward into the Ohio River drainage. Most of the isolates identified by Clench & Opler (1983) comprise the range of subspecies *rosa* in the western (primarily Great Plains) portion of the species’ range. The Great Lakes, Ontario, eastern Missouri and Ozark Regions encompass variable, intermediate populations. Great Lakes Region variants more closely allied to nominotypical *olympia* are predominant east of Lake Michigan while *rosa* phenotypes dominate west of the lake. Intermediates extend to the east through Ontario, into Quebec and northern New York in a recent range expansion from the upper Great Lakes region. Synonym *anniha* is attributed to the Great Lakes grouping, and is considered an available synonym of *rosa*. The previously documented “Dune Isolate” or “Dune Form” (of authors) is differentiated as two phenotypically distinct population groupings, primarily by their diminutive size and very limited range. The lower Lake Michigan dune population is more closely allied with the *rosa* phenotype, while the lower Lake Huron population is more closely allied with the nominotypical *olympia* phenotype; both are proposed here as two distinct subspecies.

The county distributions below list where each actual phenotype was recorded, in an attempt to define the range of the phenotypes, thus the subspecies. Percentages of each phenotype gleaned from specimen series, published and internet resources were not recorded or estimated, as sampling error may factor in. Therefore, one will note the nominotypical *olympia* and western *rosa* phenotypes may be listed among the Great Lakes intermediate populations.

Euchloe olympia olympia (W. H. Edwards, 1871)

Description: Male FW length 15-21 mm (17.6 mm average); Female FW length 14-21 mm (18.8 mm average). I defer to the original description provided by W. H. Edwards (1871). The large gray patch at the apex of the dorsal forewings characterizes the subspecies, and in Appalachian populations there is little tendency for the patch to variably fade to white as in the Plains populations. The marbled markings on the ventral hindwing tend to be more extensive than in Great Plains populations. Also, the forewings tend to be slightly more rounded (the outer margin is convex) than Great Plains populations and many specimens have dark marks in the shape of “V’s” along the dorsal hindwing outer margin where the wing veins end (Fig. 6). The lectotype of *Olympia* is illustrated in F. M. Brown (1973) (Fig. 3).

I restrict the nominotypical subspecies to the Appalachian region from southern Pennsylvania to western North Carolina, eastern Tennessee, west through central Kentucky to southern Indiana. This corresponds with Clench & Opler's *Appalachian isolate*. Michigan, eastern Missouri and Ontario populations, while consisting of variably mixed phenotypes ranging from typical *olympia* to *rosa*, tend toward nominotypical *olympia* but are treated separately as intermediate populations, below. The common name "**Olympia Marble**" applies.



Fig. 6. Typical *Euphydryas editha olympia* male from Green Ridge State Forest, Allegany Co., MD. 4/20/1985, leg. Harry Pavulaan.

Confirmed distribution and/or specimens of nominotypical phenotype viewed or examined:

Kentucky: Bullitt Co., Edmonson Co. **Illinois:** Mason Co. **Indiana:** Clark, Morgan Co's. **Maryland:** Allegany, Washington Co's. **Michigan:** Allegan, Benzie, Berrien, Cheboygan, Huron, Iosco, Kalkaska, Montmorency, Muskegon, Newaygo, Oscoda, Otsego, Wexford Co's. **Missouri:** St. Francois Co., St. Louis Co., Wayne Co. **New York:** Jefferson Co. **North Carolina:** Madison Co. **Ohio:** Lawrence Co. **Ontario:** Algoma Dist., Durham Regional Muni., Frontenac Co., Hastings Co., Kawartha Lakes Div., Lanark Co., Leeds and Grenville United Co., Lennox and Addington Co., Manitoulin Dist., Ottawa Div., Parry Sound Dist., Peterborough Co., Simcoe Co. **Pennsylvania:** Bedford Co. **Quebec:** Les Collines-de-l'Outaouais Co., Témiscamingue Regional Co. Muni. **Tennessee:** Cocke, Greene, Jefferson, Sullivan Co's. **Virginia:** Frederick Co. A well-defined example can be found in Clark & Clark (1951) on plate 16, in which the entire apical area of the forewings is very strongly marked, almost black. **West Virginia:** Hampshire, Hardy, Kanawha, Mineral, Pendleton, Putnam Co's. It is well illustrated in Allen (1997), Plate 5, ♂D, ♀D, ♂V. **Wisconsin:** Columbia Co., Sauk Co.

**Great Lakes, Ontario, eastern Missouri and Ozark region
intermediate and mixed populations**

This is a difficult mix of populations, displaying a range of variation in the degree of infuscation on the forewing apex, and the shape of the forewing. Many specimens display an intermediate character, with a small gray subapical bar crossing the forewing, and the more angular wing shape of *rosa*. Michigan "inland" populations, though highly variable, have a large proportion of specimens that are closer to nominotypical (Appalachian) populations. Ebner (1970) interestingly noted: "Michigan specimens are intermediate between the typical *olympia* and the western race *rosa*". Wisconsin populations vary considerably as well, though most specimens align more closely with *rosa*. Ebner's (1970) general description of Wisconsin populations also places them closer to *rosa* (and includes synonym *anniha*), but Ebner indicates: "Here and there an individual with more extensive black markings also turns up, placing it more closely to typical *olympia*". The specimen illustrated on page 58 (Ebner, 1970) is clearly a *rosa* phenotype (fig. 4). Michigan (lower peninsula) specimens: Male FW length 16-20

mm (18.0 mm average); Female FW length 15-21 mm (19.1 mm average). Wisconsin specimens: Male FW length 15-18 mm (17.0 mm average); Female FW length 17-20 mm (18.0 mm average).

The eastern Missouri (St. Louis area) populations are classified primarily as intermediates but contain a high percentage of individuals with very heavy apical infuscation similar to Appalachian populations, and also individuals with development of a distinct diagonal gray subapical band (fig. 7). Interestingly, the eastern Missouri *olympia* are the largest that I have examined, among all *E. olympia* populations. Male FW length 17-20 mm (18.9 mm average); Female FW length 18-21 mm (19.5 mm average). Clench & Opler (1983) noted these characters for the 'St. Louis isolate'. Specimens and images from the Ozark region were too few to conclude on regional alignment with either subspecies, but appear to range from nominotypical *olympia* to *rosa*.



Fig. 7. Intermediate phenotype (male) from Patterson, Wayne Co., MO. 3/26/1988, leg. Harry Pavulaan.

Inclusion of the northern New York population with this grouping is based on the presence of a mix of nominotypical *olympia* and *rosa* phenotypes, indicative of the well-documented, rapid range expansion of *olympia* from the northern Great Lakes region eastward across southeastern Ontario (first reported expanding eastward in 1966 at Killaloe, Ontario) and then into southern Quebec by 1971. This range expansion extended as far east as Portneuf, Quebec by 1978 and then southward into northern New York by 1986. I exclude the Great Lakes "dune" populations from this grouping.

Not considered part of the Great Lakes, Ontario, eastern Missouri and Ozark Region intermediate population grouping, are additional scant records of intermediate phenotypes mainly at the eastern edge of the range of *rosa*, or at high elevations in Colorado, which are essentially *rosa* variants. These are listed separately, below.

Confirmed distribution and/or specimens of intermediate and mixed phenotypes viewed or examined:

Arkansas: Garland, Hot Spring, Pulaski Co's. **Illinois:** Mason Co. **Kentucky:** Edmonson Co. **Michigan:** Allegan, Arenac, Crawford, Huron, Iron, Kalkaska, Montcalm, Muskegon, Oscoda, Roscommon Co's. **Minnesota:** Anoka, Hubbard, Sherburne, Wabasha Co's. **Missouri:** St. Francois, St. Louis, Wayne Co's. **New York:** Jefferson Co. **Ontario:** Algoma Dist., Durham Regional Muni., Frontenac Co., Kawartha Lakes Div., Leeds and Grenville United Co., Manitoulin Dist., Ottawa Div., Parry Sound Dist., Renfrew Co., Simcoe Co. **Quebec:** Communauté-Urbaine-de-l'Outaouais Co., Les Collines-de-l'Outaouais Co. **Wisconsin:** Adams, Bayfield, Burnett, Columbia, Dodge, Dunn, Grant, Jackson, Juneau, Marinette, Marquette, Sauk, Waushara, Wood Co's.

Confirmed distribution of intermediate and mixed phenotypes outside the Great Lakes and eastern Missouri region:

Occasional specimens of intermediate character, essentially *rosa* based primarily on the more angular forewing shape, but with a heavier degree of apical infuscation occur throughout much of the range of *rosa*. These are considered individual variants of *rosa*. However, a higher percentage of intermediates of diminutive size occur with greater frequency in central Colorado, including some with

very dark, almost blackened apical patches, likely affected by elevation. Clench & Opler (1983) described these as the 'Front Range Isolate' but are primarily *rosa* in nature.

Colorado: Boulder, Jefferson, Park, Pueblo Co's. **Iowa:** Fremont Co. **Kansas:** Greenwood Co. **Missouri:** Jefferson, St. Francois Co., St. Louis, Wayne Co. **Nebraska:** Dawes Co., Otoe Co. **South Dakota:** Lyman Co. **Texas:** McLennan Co.

Euchloe olympia rosa (W. H. Edwards, 1882) - revised status

Description: Male FW length 14-20 mm (18.0 mm average); Female FW length 15-22 mm (18.5 mm average). I defer to the original description provided by W. H. Edwards (1882). The subspecies is characterized by the mostly white apex of the dorsal forewings, in which the gray apical clouding that is characteristic of nominotypical subspecies *olympia* is reduced to two small dark patches situated along the costal and outer wing margins, at both ends of the subapical area. A variable gray subapical bar in some specimens may connect these patches, but this character is more frequent in the Great Lakes region west of Lake Michigan. The marbling on the ventral hindwing tends to be slightly reduced in comparison to nominotypical *olympia*. Also, the forewings are somewhat more angular (pointed) than nominotypical *olympia*, with the outer margin being either straight, or having a very slight concavity in many specimens (fig. 8). The lectotype of *rosa* is illustrated in F. M. Brown (1973) (Fig. 3).



Fig. 8: Typical *Euchloe olympia rosa* male (from near TL). L. B. J. National Grassland, Alvord, Wise Co., TX. 3/23/2015, leg. Harry Pavulaan.

I restrict subspecies *rosa* to the Great Plains region from Texas to Alberta. This corresponds with Clench & Opler's 'Texas', 'Arkansas River', 'Missouri River' and 'Front Range' isolates. Of interest are two distinctly *rosa* specimens from Arizona in the National Museum of Natural History collection labeled: Chiricahua Mtns., Cochise Co., 4/29/1979 (J. Legge); and Baboquivari Mtns., Pima Co., June 1923 (Barnes collection). I have no reason to doubt they are authentic but further inquiry is needed to determine the circumstances of these specimens. I propose the common name "**Rosy Marble**" be restricted to subspecies *rosa*, primarily to reflect the latin name and not the ventral slightly "rosy" tint which also occurs in nominotypical *olympia*.

Confirmed distribution and/or specimens viewed or examined:

Alberta: Brooks, Calgary, Cavendish, Champion, Drumheller, Empress, Finnegan, Jenner, Lethbridge, Medicine Hat, Redcliff, Waterton Park, Veteran, Writing-on-Stone Provincial Park. **Arkansas:** Carroll, Hot Spring, Pulaski Co's. **Arizona:** Cochise, Pima Co's. **Colorado:** Arapahoe, Boulder, Denver, Dolores, Douglas, El Paso, Jefferson, Larimer, Pueblo, Weld, Yuma Co's. **Illinois:** Mason Co. **Iowa:** Fremont, Woodbury Co's. **Kansas:** Cowley, Douglas, Franklin, Greenwood, Harper, Johnson, Leavenworth, Pottawatomie, Reno, Riley, Rooks, Scott, Sumner Co's. **Manitoba:** Aweme, Spruce Woods Provincial Park. **Michigan:** Cheboygan, Huron, Montmorency, Muskegon, Otsego Co's. **Minnesota:** Crow Wing, Hubbard, Mille Lacs, Sherburne, Wadena, Washington Co's. **Missouri:** Benton, Jackson, Reynolds, St. Louis Co's. **Montana:** Blaine, Cascade, Custer, Fallon, Fergus, Gallatin, Golden Valley, Hill, Musselshell, Park, Prairie, Rosebud, Sweet Grass, Yellowstone Co's. **Nebraska:** Cass, Cherry, Dodge, Douglas, Lancaster, McPherson, Nemaha, Otoe, Platte, Saunders, Sioux, Thomas Co's. **North Dakota:** Billings, Slope Co's. **Oklahoma:** Cleveland, Comanche, Le Flore, Murray, Oklahoma, Payne, Texas, Tillman, Washita, Woodward Co's. **Ontario:** Algoma Dist., Hastings Co.,

Leeds and Grenville United Co's., Muskoka Dist., Ottawa Div., Parry Sound Dist., Peterborough Co. **Quebec:** Communaute-Urbaine-de-l'Outaouais Co., Les Collines-de-l'Outaouais Co. **Saskatchewan:** Big Beaver, Cypress Hills, Divide, Regina. **South Dakota:** Brookings, Lyman, Pennington Co's. **Texas:** Carson, Comanche, Cottle, Crosby, Dallas, Ellis, Hale, Kent, Lynn, Mason, McLennan, Motley, Randall, Smith, Wichita, Wise Co's. **Wisconsin:** Adams, Burnett, Clark, Dane, Douglas, Dunn, Eu Claire, Grant, Jackson, Juneau, Marinette, Menominee, Oneida, Polk, Sauk, St. Croix, Washburn, Waushara, Wood Co's. **Wyoming:** Natrona.

Wagner's "Dune Form"

Wagner's (1997) description: I refer here to the original description provided by Wagner (1997), which differentiates the "Dune Form" from the "Inland Form" of Michigan, the latter of which I consider to be highly variable and intermediate between nominotypical *olympia* and subspecies *rosa*. Wagner first gives a brief comparison: "The Dune Form is readily distinguished from the Inland Form by its smaller size, whiter ground color, and more complex pattern of markings on the secondaries below. The Lake Michigan Dune populations are not quite so extremely differentiated as the Lake Huron." This latter comment is important. Wagner's original full description is as follows:

KEY TO DUNE AND INLAND FORMS OF *EUCHLOE OLYMPIA*

Smaller, forewing averaging 16-18 mm in length; ground color chalky white; forewing slightly more rounded, the fringe distinctly checkered dorsally from veins M₃ to R₂; dark markings above more "smudged," more confluent; basal dark areas on dorsal surfaces darker and more extensive, running to and commonly beyond the medial transverse dark band of the ventral surface (as visible through the wing); black patch at end of M₃ on dorsal surface of forewing usually similar to those on M₂ and M₁; dark bands on ventral surface of hind wings below usually darker and greener, wider and more irregular with more projections and hair-line; Cu₂ usually with a dark terminal patch 1-2 mm long
 DUNE FORM

Larger, forewing averaging 18-20 mm in length; ground color pale ivory-white; forewing slightly more pointed, the fringe usually only weakly checkered to lacking any black scales dorsally from veins M₃ to R₂; dark markings above not so "smudged," more discrete; basal dark areas on dorsal surfaces paler and smaller, running only as far as the postbasal transverse dark band on the ventral surface (as visible through the wing); black patch at end of M₃ on dorsal surface of forewing usually darker and more conspicuous than those on M₂ and M₁; dark bands on ventral surface of hind wings below usually paler and yellow, narrower and more regular with fewer projections and hair-lines; Cu₂ usually with terminal patch vestigial, less than 1 mm long INLAND FORM

Wagner's key to the "Dune Form" serves as the baseline description of what I propose as two distinct, allopatric "dune" subspecies, each representing the lower Lake Michigan and lower Lake Huron population groupings. Wagner, however, grouped both the Lake Michigan and Lake Huron populations together as a single "Dune Form" entity, while each is decidedly differentiated from the other in extent of ventral markings. Most of the biological information provided by Wagner and earlier workers pertains to the lower Lake Michigan population cluster. Less is known of the Lake Huron population.

Wagner noted greater similarities to subspecies *olympia* [than to the "Inland Form"] except that the ventral markings in subspecies *olympia* are not as intricate and extensive, and that nominotypical *olympia* in West Virginia is "of decidedly larger dimensions". Wagner & Hansen (1980) noted that "the dunes form of the marbled white, *Euchloe olympia* (Edwards) runs smaller in Berrien County [Michigan] (also in Lambton County, Ontario) than does the inland form of savannahs and prairies which flies at the same time (late April, May). The smaller size of the dunes form of *E. olympia* may be a consequence of

unusual climatic and edaphic conditions in the dunes: exposure, winds, permeable sands, and lowered growth potential in food plants.” There has yet been no published account of any attempts to rear “dune” vs. “inland” populations under identical, artificial conditions to determine if this is a factor. Interestingly, according to Wagner (1977), the closest that the dune populations come, in distance, to inland populations of *olympia* in Michigan is 50 miles! He suggested that, with future efforts, populations of the inland form might be found closer to the dune populations, possibly coming into contact and intergrading. To date, no such contact has been documented.

Of interest are previous illustrations of the Dune populations in the literature: Klots (1951) illustrates a specimen of *olympia* from “northeastern Illinois” on Page 208 (no. 6), most certainly based on specimens with similar labels in the NMNH (collected by H. M. Bower) which are determined to be of dune habitat origin. Klassen, et. al. (1989) illustrate a pair of specimens taken at Ipperwash, Ontario (lower Lake Huron population) on plate 9 (figs. 15 & 16). Opler & Malikul (1992) illustrate a specimen of *olympia* from Lake County, IL. on plate 17. Nielsen (1999) illustrates a “Coastal male” in the plate on Page 49 (collected at Grand Mere State Park, Berrien Co. MI.). Most recently, the specimens illustrated in Belth (2013) on pages 15, 133 (egg; fig. 4), 226 and 227 were photographed in Porter County, IN. Jeffrey Belth (personal comm.) reported that the Porter County images were taken at Indiana Dunes National Lakeshore, thus representing the lower Lake Michigan population grouping.

***Euchloe olympia wagneri* - new subspecies**

ZooBank registration: urn:lsid:zoobank.org:act:7922E1E7-E749-49D3-8E4F-1F627B41481F

Description: (Figs. 10, 11, 12). Male FW length 14-18 mm (15.8 mm average); Female FW length 15-19 mm (17.0 mm average). Primary phenotypic difference is consistently smaller size in comparison to either subspecies *olympia* and *rosa*. Similar in size to subspecies *huron* (described below). Similar to the ventral hindwing pattern of *rosa*; and dorsally in the extent of black markings at the forewing apex, though many individuals have slightly greater apical infuscation. The basal dark areas on the dorsal surfaces are considerably darker and more extensive than in *rosa*. The ventral hindwing “marbling” pattern is relatively narrow and well-defined. The color of the marbling is yellowish-gray (appearing green). Interestingly there appears to be less individual variation within the lower Lake Michigan populations than within adjacent “inland” populations, with few individuals approaching the *olympia* form in extent of black markings at the FW apex.

Host: The only documented host for this subspecies, in Indiana (C. A. Shull, 1907) and Michigan (Nielsen, 1999), is *Arabis lyrata* (Fig. 13). Ebner (personal communication, 2010) indicated a close association of Wisconsin lakeside dune populations with *Arabis lyrata*, though no direct ovipositions were recorded. Hostplant choice may be further indicative of ecological differences from inland populations that might be considered diagnostic. Wagner (1977) however notes that the range of *Arabis lyrata* extends over a broad area covering Michigan, Wisconsin, northern Indiana and northern Illinois, and concludes: “therefore, it seems unlikely that it is foodplant preference alone that governs the differentiation of the Dune populations”.

Immature stages: C. A. Shull (1907) described the immature stages of the dune population at the southern end of Lake Michigan in Indiana. He described the eggs as “orange yellow”, deposited singly “on the sepals of the younger, centrally-located buds, rarely on the peduncle just below the bud”; usually only one, very rarely more than two, eggs per plant. When ready to hatch, the eggs turn “dull yellowish brown”. C. A. Shull collected eggs on May 12, 1905. Belth (2013) illustrates an egg on page 133 (fig. 4).

The newly hatched larvae measure “a little over 1 mm” but less than 1.5 mm., which eat away only one side of the egg shell, and immediately begin feeding on the host *Arabis lyrata*. C. A. Shull noted the length of time between moults, and based his observations on a captive larva that hatched on May 13. The first molt occurred on May 16, the second on May 18, the third on May 20 and the fourth on May 22.

The fully developed larva measured 28 mm., and on May 25, left its host and began searching for a place to pupate. Pupation occurred on May 26. C. A. Shull noted that the entire larval period of his captive stock measured 12-14 days, though he indicated that by May 26, wild larvae were found in various stages from second to fifth instars. He attributed this to the time period over which eggs were laid, cooler nights in the habitat, and “less abundant food” in nature. By the time of a visit to the habitat on June 1, a single fully grown larva was located.

C. A. Shull noted changes in larval color as they grew. Newly hatched larvae were lemon-yellow with a black head. After the first molt, they were green with the head being greenish-gray. After the second molt, the larval colors become “fully developed” with dorsal and lateral lines and become brighter and more contrasted in the fourth and early fifth instar. Toward the end of the fifth instar, the “brilliance of the color pattern is lost” and the larvae develop a purplish color, becoming very dark just prior to pupation. The freshly formed pupa is described as rosy purple, changing to various shades of brown within a few hours.

C. A. Shull removed the fully-grown larva of June 1 from its host, placed it on the ground and followed it to see where it would pupate. The larva entered a clump of *Andropogon scoparius* grass, abundant in the habitat, and chose a pupation site within the grass clump. A return visit on June 9 found the pupa that had formed.

Fight Period: April 14 – May 31 (Fig. 9).

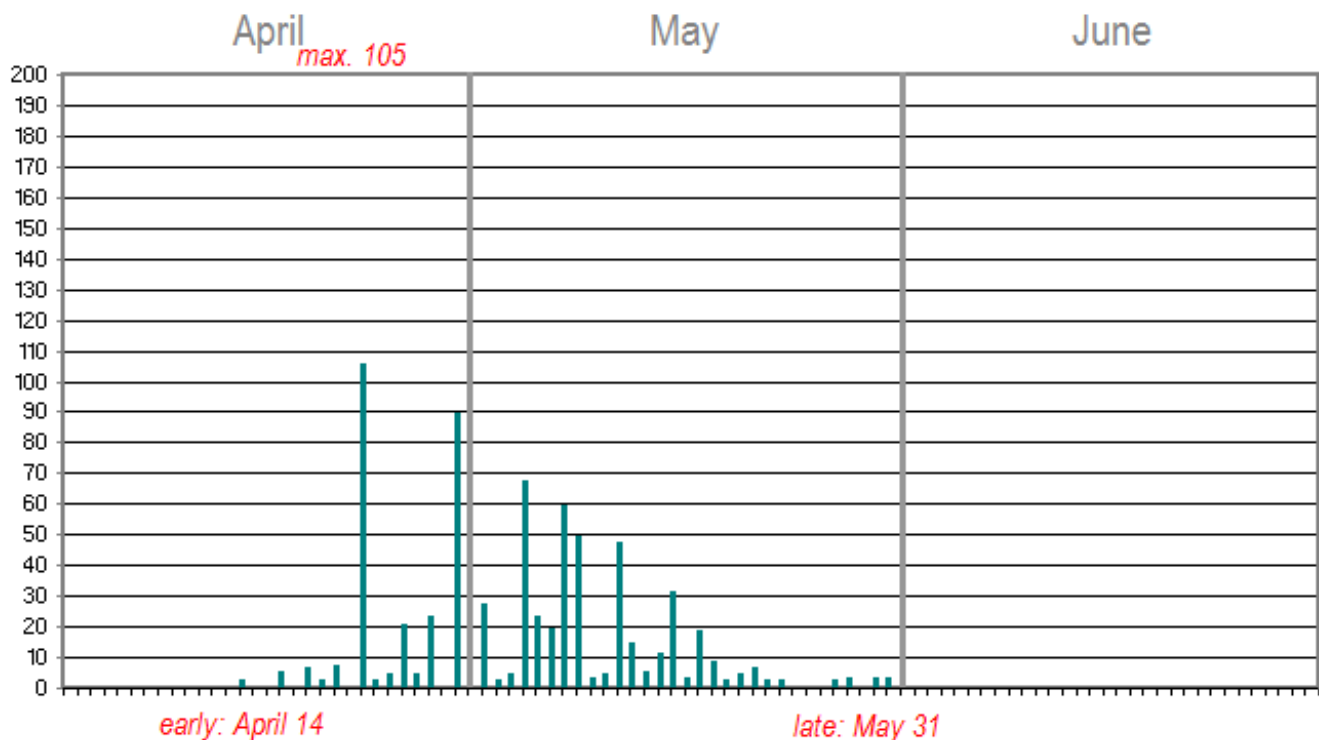


Fig. 9: Flight phenogram for *Euchloe olympia wagneri* rangewide. Bars represent total cumulative reported count for each date.

Habitat: Subspecies *wagneri* is endemic to lakeshore dune habitat around the south end of Lake Michigan in the United States. The habitat consists of ancient dunes with extensive open, sandy areas, with varied growth of coniferous and deciduous trees (Fig. 14).

Confirmed range and/or specimens examined: The following locations comprise the known distribution:

Illinois: Cook Co.: Chicago (leg. O. Buchholz). Lake Co.: “northeastern Lake County” (leg. H. M. Bower); Illinois Beach State Park (legs. W. J. Gerhard, I. Leeuw, R. Leuschner, E. Liljablad, J. Skrentny [photos], P. Sweet [photos], D. Taron [photos]); Waukegan (legs. I. Leeuw, A. K. Wyatt); Waukegan Dunes (leg. A. K. Wyatt). **Indiana:** Lake Co. (leg. W. H. Wagner); Gary “sand dunes” (G. Wren). Porter Co. (leg. C. A. Shull); Dune Acres (leg. W. Henderson); Indiana Dunes National Lakeshore (Bentley, 2010; Belth, 2013; Sass, 2015); Indiana Dunes State Park (M. Beatty [photo]). **Michigan:** Berrien County: New Buffalo (leg. W. H. Wagner); Grand Mere Lakes Dunes (leg. M. Nielsen). **Wisconsin:** Sheboygan Co.: Kohler Andrae State Park (leg. James Ebner). Milwaukee Co.: Texas Rock (leg. not indicated).

Etymology: The subspecies is named in honor of Warren Herb Wagner, Jr., who described this distinct taxon but declined to name it. I propose the common name “**Lake Michigan Dune Marble**”.

Holotype, allotype and paratypes:

Holotype: Male (Fig. 10), IL., Lake Co., Illinois Beach State Park, May 15, 1951 (leg. R. Leuschner). Specimen resides in the National Museum of Natural History, Washington, D.C. Allotype female (Fig. 11), Waukegan, Lake Co., IL., USA. 5/14/1988, leg. Irwin Leeuw. Specimen resides in the present author’s collection.



Fig. 10. Holotype male, *Euchloe olympia wagneri* (Pavulaan, 2020). Dorsum (left), venter (right). Photograph by permission of the Smithsonian National Museum of Natural History. [Note distinct ventral chain-like marbling]



Fig. 11. Allotype female, *Euchloe olympia wagneri* (Pavulaan, 2020). Dorsum (left), venter (right). Waukegan, Lake Co., IL., USA. 5/14/1988, leg. Irwin Leeuw. [Note distinct ventral chain-like marbling]

Paratypes in the Field Museum, Chicago, IL:

- IL., Cook Co., Chicago, May 13, 1917 (leg. A. K. Wyatt).
- IL., Lake Co., "Beach" (Illinois Beach?), May 21, 1922 (leg. W. J. Gerhard, 5 specimens).
- IL., Lake Co., Illinois Beach State Park, May 18, 1972 (G. Nielsen, 2 specimens).
- IL., Lake Co., Waukegan, May 17, 1931 (leg. A. W. Herz, 2 specimens).
- IL., Lake Co., Waukegan, May 15, 1932 (leg. A. W. Herz, 3 specimens).
- IL., Lake Co., Waukegan, May 23, 1950 (leg. Banks).
- IL., Lake Co., Waukegan, May 28, 1960 (leg. D. H. Kistner).
- IN., Lake Co., East Gary, May 11, 1913.
- IN., Lake Co., Hammond, May 10, 1903 (leg. Sala).

Paratypes in the McGuire Center for Lepidoptera and Biodiversity, Gainesville, FL:

- IL., Lake Co., Illinois Beach State Park, May 15, 1951 (2 specimens).
- IL., Lake Co., Illinois Beach State Park, May 5, 1974.
- IL., Lake Co., Illinois Beach State Park, May 19, 1974.
- IL., Lake Co., Illinois Beach State Park, May 14, 1988 (leg. Irwin Leeuw).
- IL., Lake Co., Waukegan, May 11, 1991 (leg. Irwin Leeuw).
- IN., Lake Co., "Duros State Park", May 7, 1959.

Paratypes in the Museum of Comparative Zoology, Cambridge, MA.:

- IL., Lake Co., Waukegan, May 18, 1950 (leg. A. K. Wyatt), accession #MCZ-ENT 00134124.
- IL., Lake Co., Waukegan, May 18, 1950 (leg. A. K. Wyatt), accession #MCZ-ENT 00134126.

Paratypes in the National Museum of Natural History, Washington, D.C.:

- IL., Lake Co., May 17, 1931 (leg. H. M. Bower, 6 specimens).
- IL., Lake Co., Illinois Beach State Park, May 20, 1930 (leg. E. Liljablad).
- IL., Lake Co., Illinois Beach State Park, May 13, 1931.
- IL., Lake Co., Illinois Beach State Park, May 15, 1951 (R. Leuschner, 2 specimens).
- IL., Lake Co., Illinois Beach State Park, May 15, 1951 (leg. E. Liljablad, 2 specimens).
- IL., Lake Co., Illinois Beach State Park, May 9, 1973 (I. Leeuw, 2 specimens).
- IL., Lake Co., Illinois Beach State Park, May 20, 1973 (I. Leeuw).
- IL., Lake Co., Waukegan, May 17, 1931 (leg. A. K. Wyatt).
- IL., Lake Co., Waukegan, May 14, 1933 (leg. A. K. Wyatt).
- IL., Lake Co., Waukegan Dunes, May 17, 1931 (leg. A. K. Wyatt, 3 specimens).
- IL., Lake Co., Waukegan Dunes, May 15, 1932 (leg. A. K. Wyatt).
- IL., Lake Co., Waukegan Dunes, May 14, 1933 (leg. A. K. Wyatt, 3 specimens).
- IN., Lake Co., Gary, May 3, 1908 (leg. A. K. Wyatt).
- IN., Lake Co., Miller (Miller Beach), May 13, 1917 (leg. A. K. Wyatt, 3 specimens).
- IN., Lake Co., Miller (Miller Beach), April 27, 1919 (leg. A. K. Wyatt, 4 specimens).
- IN., Lake Co., Miller (Miller Beach), May 11, 1922 (leg. E. Liljeblad, 3 specimens).
- IN., Lake Co., Miller (Miller Beach), May 4, 1924 (leg. W. J. Gerhard, 10 specimens).
- IN., Lake Co., Miller (Miller Beach), May 30, 1924 (leg. W. J. Gerhard, 3 specimens).
- IN., Lake Co., Miller (Miller Beach), April 14, 1929 (leg. A. W. Herz).

Paratypes in the Peabody Museum of Natural History, New Haven, CT.:

- IL., Lake Co., Illinois Beach State Park, (undated), accession #YPM ENT 433066.
- IL., Lake Co., Illinois Beach State Park, May 16, 1971 (leg. I. Leeuw),
accession #YPM ENT 433067.
- IL., Lake Co., Illinois Beach State Park, May 10, 1971 (leg. I. Leeuw),
accession #YPM ENT 433068.
- IL., Lake Co., Zion, Illinois Beach State Park, (undated), accession #YPM ENT 569514.
- IL., Lake Co., Zion, Illinois Beach State Park, (undated), accession #YPM ENT 569515.
- IL., Lake Co., Zion, Illinois Beach State Park, (undated), accession #YPM ENT 569516.
- IL., Lake Co., Zion, Illinois Beach State Park, (undated), accession #YPM ENT 570386.
- IL., Lake Co., Zion, Illinois Beach State Park, (undated), accession #YPM ENT 570387.

- IL., Lake Co., Illinois Beach State Park, May 16, 1971 (leg. I. Leeuw),
accession #YPM ENT 570388.
- IL., Lake Co., Zion, Illinois Beach State Park, (undated), accession #YPM ENT 570389.
- IL., Lake Co., Illinois Beach State Park, May 10, 1971 (leg. I. Leeuw),
accession #YPM ENT 570390.
- IL., Lake Co., Illinois Beach State Park, May 15, 1971 (leg. I. Leeuw),
accession #YPM ENT 724214.
- IL., Lake Co., Illinois Beach State Park, May 15, 1971 (leg. I. Leeuw),
accession #YPM ENT 724215.
- IL., Lake Co., Illinois Beach State Park, May 15, 1971 (leg. I. Leeuw),
accession #YPM ENT 724219.
- IL., Lake Co., Illinois Beach State Park, May 15, 1971 (leg. I. Leeuw),
accession #YPM ENT 724220.

Paratypes in the collection of Andrew D. Warren, Castle Rock, Colorado, USA:

- IL., Lake Co., Illinois Beach State Park, May 11, 1991 (leg. I. Leeuw, 18 specimens).
- IL., Lake Co., Illinois Beach State Park, May 8, 1992 (leg. I. Leeuw, 6 specimens).
- IL., Lake Co., Illinois Beach State Park, May 31, 1992 (leg. I. Leeuw, 3 specimens).
- IL., Lake Co., Illinois Beach State Park, May 7, 1993 (leg. I. Leeuw, 8 specimens).
- IL., Lake Co., Illinois Beach State Park, April 30, 2002 (leg. I. Leeuw, 32 specimens).
- IL., Lake Co., Illinois Beach State Park, May 4, 2002 (leg. I. Leeuw, 16 specimens).

Paratypes in the collection of the present author:

- IL., Lake Co., Waukegan, May 17, 1931 (leg. I. Leeuw, 4 specimens).
- IL., Lake Co., Illinois Beach State Park, April 17, 1976 (leg. I. Leeuw).
- IL., Lake Co., Illinois Beach State Park, May 9, 1987 (leg. I. Leeuw).
- IL., Lake Co., Illinois Beach State Park, May 7, 1988 (leg. I. Leeuw).
- IL., Lake Co., Illinois Beach State Park, May 14, 1988 (leg. I. Leeuw, 4 specimens incl. allotype).
- IL., Lake Co., Illinois Beach State Park, May 15, 1988 (leg. I. Leeuw, 4 specimens).
- IL., Lake Co., Illinois Beach State Park, May 11, 1991 (leg. I. Leeuw, 19 specimens).
- IL., Lake Co., Illinois Beach State Park, May 8, 1992 (leg. I. Leeuw, 10 specimens).



Fig. 12. *Euchloe olympia wagneri* resting, Miller Beach, IN. (left). [Photo © by courtesy of Jeffrey Belth]



Fig. 13. Host *Arabis lyrata*. [Photo © by courtesy of Jeffrey Belth]



Fig. 14. *Euchloe olympia wagneri* habitat at Miller Beach, IN. [Photo © by courtesy of Jeffrey Belth]

***Euchloe olympia huron* - new subspecies**

ZooBank registration: [urn:lsid:zoobank.org:act:691D3ED0-CA09-4E7D-B7C4-71D4BCC8758B](https://zoobank.org/act:691D3ED0-CA09-4E7D-B7C4-71D4BCC8758B)

Description: (Figs. 16, 17). Consistently smaller size in comparison to either subspecies *olympia* and *rosa*. Male FW length 14-18 mm (15.9 mm average); Female FW length 14-19 mm (16.3 mm average). Similar to subspecies *olympia* in extent of black markings at the dorsal forewing apex, but dissimilar from either *rosa* or *wagneri*, in which both the black subapical bar is narrowed or reduced (mainly in *rosa*) to two black subapical spots. The ventral hindwing is most distinct from all other *olympia* subspecies, being characterized by an enlarged, smeared, and more complex pattern of yellowish gray patterns (Figs. 16, 17, 18, 19). This pattern is differentiated from subspecies *wagneri* by being ventrally paler overall.

Host: The only documented host for this subspecies (in Ontario) is *Arabis lyrata* (Wagner, 1977; Hall, *et al.*, 2014; J. Cossey, photos; K. Thorne, pers. comm.).

Fight Period: April 14 – June 13. Notable maximum single day report of 200 on April 29, 1990 by the Toronto Entomologists' Association, with cumulative maximum of 208 reported for April 29 (Fig. 15).

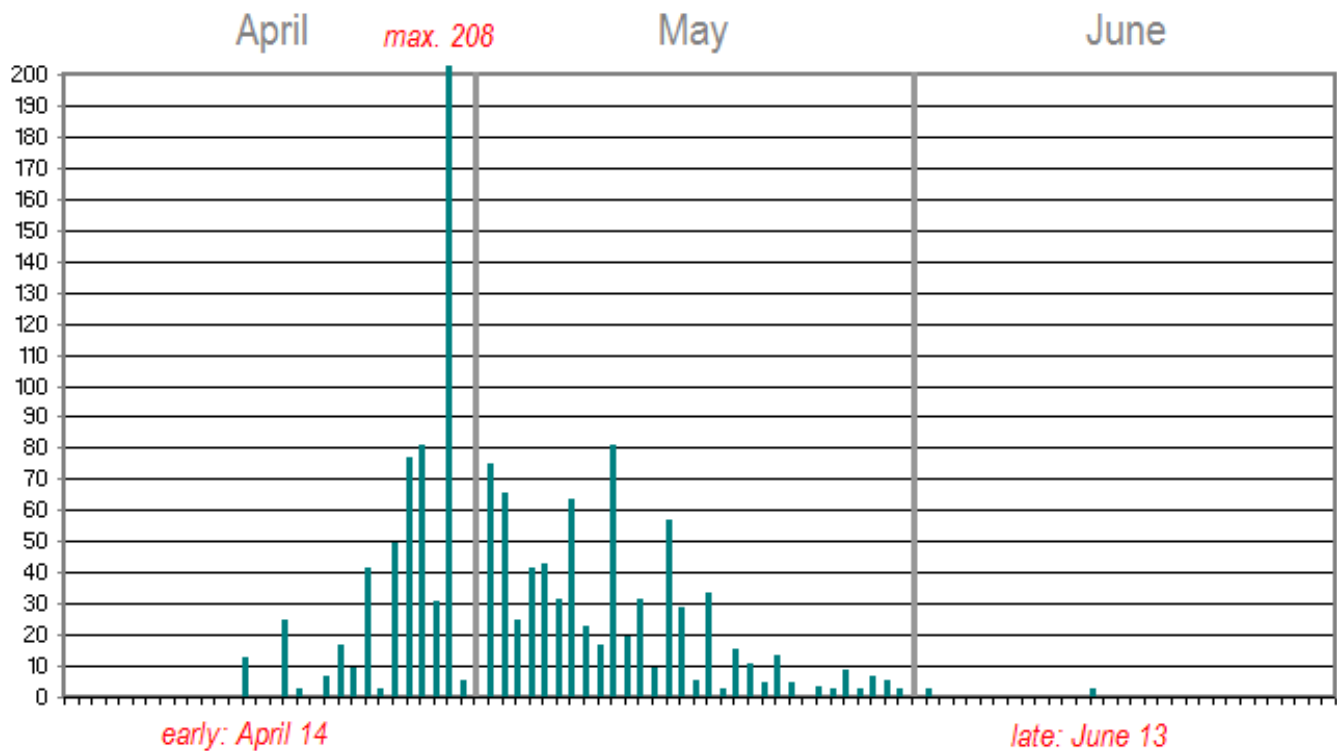


Fig. 15. Flight phenogram for *Euchloe olympia huron* at Lambton County, Ontario. Bars represent total cumulative reported count for each date.

Habitat: Subspecies *huron* is endemic to lakeshore dune habitat around the south end of Lake Huron in Canada. The habitat is confined to a very limited area and consists of ancient dunes with extensive open, sandy areas, but overgrown with Junipers, Pines and Oaks (Fig. 20). The butterfly appears to be reasonably more common in this area than in other portions of *Euchloe olympia*'s range.

Confirmed range and/or specimens examined: Essentially all known locations are within two miles of Lake Huron in Lambton County, Ontario. The following locations comprise the known distribution based on photos and specimens:

Ontario: Lambton Co.: Ausable River Cut Conservation Area (R. McLeod); Grand Bend (Q. F. Hess, D. Murphy); Ipperwash (G. Clements, J. Cossey, B. Curry, Q. F. Hess, J. Holdsworth, K. Hoo, B. Kulon, B. Lamond, A. Rocchi, T. Sabo, J. Skevington, K. Stead, K. Thorne, J. Troubridge, G. Vogg, W. H. Wagner, B. Yukich, K. Zufelt); Ipperwash Provincial Park (J. A. Brown, B. Curry, Q. F. Hess, B. Kulon, J. Larson, S. T. Pike, J. E. Pilkington, T. Sabo, G. Sutton, W. H. Wagner, C. Wood, S. Wood, A. Wormington); Karner Blue Sanctuary (P. Deacon); Kettle Point Indian Reserve 44 (J. Cossey, A. H. Rider); Lambton Shores (anonymous, iNaturalist); Pinery (Q. F. Hess, B. Kulon, J. Skevington, T. Toyomi); Pinery Provincial Park (P. Carter, G. Clements, J. Cossey, T. Crabe, S. Daniels, P. Deacon, W. Gregory, Q. F. Hess, A. M. Holmes, B. Kulon, L. MacGregor, A. MacKenzie, S. McEwan, B. Ottaway, J. E. Pilkington, M. van der Poorten, N. van der Poorten, R. E. Scott, D. Scovell, J. Skevington, G. Sutton, K. Thorne, W. H. Wagner, J. Walty, J. G. Woods, K. Zufelt); Port Franks (B. A. Mann, G. Clements, B. Curry, P. Deacon, Q. F. Hess, B. Kulon, B. Lamond, J. Larson, B. Mann, S. T. Pike, T. Sabo, K. Sealy, K. Stead, K. Thorne, A. Wormington, K. Zufelt).

Etymology: The subspecies is named to reflect its association with Lake Huron. I propose the common name "**Lake Huron Dune Marble**".

Holotype, allotype and paratypes:

Holotype: Male (Fig. 16). ON., Lambton Co., Ipperwash, May 12, 1983 (leg. K. Thorne). Specimen resides in the National Museum of Natural History, Washington, D.C. Allotype female (Fig. 17), Ipperwash, Lambton Co., ON., Canada, 5/7/2015, leg. K. Thorne. Specimen resides in the present author's collection.



Fig. 16. Holotype male, *Euchloe olympia huron* (Pavulaan, 2020). Dorsum (left), venter (right). Specimen is identified as “*Euchloe olympia rosa*” on the original label. Photograph by permission of the Smithsonian National Museum of Natural History. [Note distinct heavy ventral marbling]



Fig. 17. Allotype female, *Euchloe olympia huron* (Pavulaan, 2020). Dorsum (left), venter (right). Ipperwash, Lambton Co., ON., Canada. 5/7/2015, leg. K. Thorne. [Note distinct heavy ventral marbling]

Paratypes in the Lyman Museum, Hilo, HI:

ON., Lambton Co., Ipperwash, April 22, 1986 (leg. W. H. Wagner).

Paratypes in the McGuire Center for Lepidoptera and Biodiversity, Gainesville, FL:

ON., Lambton Co., Ipperwash, May 7, 2015 (leg. K. Thorne, 2 specimens).

Paratypes in the National Museum of Natural History, Washington, D.C.:

ON., Lambton Co., Ipperwash, May 10, 1980 (leg. K. Thorne, 3 specimens).

ON., Lambton Co., Ipperwash, May 21, 1980 (leg. K. Thorne).

ON., Lambton Co., Ipperwash, May 12, 1983 (leg. K. Thorne, 3 specimens).

Paratypes in the collection of Ken Thorne:

- ON., Lambton Co., Ipperwash, May 2, 1978 (leg. K. Thorne, 2 specimens).
- ON., Lambton Co., Ipperwash, May 19, 1979 (leg. K. Thorne, 2 specimens).
- ON., Lambton Co., Ipperwash, May 20, 1979 (leg. K. Thorne).
- ON., Lambton Co., Ipperwash, May 22, 1979 (leg. K. Thorne).
- ON., Lambton Co., Ipperwash, May 23, 1979 (leg. K. Thorne, 2 specimens).
- ON., Lambton Co., Ipperwash, May 23, 1984 (leg. K. Thorne, 2 specimens).
- ON., Lambton Co., Ipperwash, May 8, 1999 (leg. K. Thorne, 2 specimens).
- ON., Lambton Co., Ipperwash, May 7, 2015 (leg. K. Thorne, 19 specimens).
- ON., Lambton Co., Ipperwash, April 27, 2017 (leg. K. Thorne, 30 specimens).
- ON., Lambton Co., Pinery Provincial Park, May 3, 1970 (leg. K. Thorne, 10 specimens).
- ON., Lambton Co., Pinery Provincial Park, May 7, 1971 (leg. K. Thorne, 5 specimens).

Paratypes in the collection of the present author:

- ON., Lambton Co., Ipperwash, May 11, 1980 (leg. J. Troubridge, 6 specimens).
- ON., Lambton Co., Ipperwash, May 7, 2015 (leg. K. Thorne, 14 specimens incl. allotype).
- ON., Lambton Co., Ipperwash, April 27, 2017 (leg. K. Thorne, 8 specimens).



Fig. 18. *Euchloe olympia huron* nectaring on hostplant *Arabis lyrata*, Ipperwash Beach, ON. (left). *Euchloe olympia huron* chrysalis, same location (right). [Photos © by courtesy of Jay Cossey]



Fig. 19. *Euchloe olympia huron* larva on hostplant *Arabis lyrata*, Pinery Provincial Park, ON. (left). *Euchloe olympia huron* ventral hindwing scales magnified, Ipperwash Beach, ON (right). [Photos © by courtesy of Jay Cossey]



Fig. 20. *Euchloe olympia huron* habitat at Ipperwash, Ontario. [Photo © by courtesy of Ken Thorne]

CONCLUSION

Appalachian and Great Plains populations of *Euchloe olympia* are here separated as nominotypical subspecies *olympia* and as subspecies *rosa*, respectively. Great Lakes regional (“inland”) populations are intermediate, displaying a broad range of variation between Appalachian and Great Plains populations, with populations east of Lake Michigan tending more toward nominotypical *olympia*, and populations west of Lake Michigan tending more toward subspecies *rosa*. The eastern Missouri populations are similarly considered intermediates but appear closer to nominotypical *olympia*. Great Lakes dune populations are here treated as new subspecies *wagneri* (lower Lake Michigan) and *huron* (lower Lake Huron).

Wagner (1977) left us with the following comment: “As to whether the Dune Form merits designation as a subspecies, only the future can tell. I am hesitant to affix a new name on populations that are still so little known or understood”. The present paper fulfills this role. Torre-Bueno (1930) stated this well: “A description has one primary purpose: to make a category *known* to those whom it is *unknown*; to ticket it for future reference.” Based on the present study, the following subspecific arrangement is hereby proposed:

- *Euchloe olympia olympia* (W. H. Edwards, 1871)
- *Euchloe olympia rosa* (W. H. Edwards, 1882)
= *anniha* Ebner, 1970
- *Euchloe olympia wagneri* Pavulaan, 2019
- *Euchloe olympia huron* Pavulaan, 2019

In NatureServe (2017), under Conservation Status, it is stated: “If they were treated separately the Appalachian populations would be at least globally uncommon if not imperiled”. Hopefully this paper, if anything, will help provide some level of framework to help facilitate future conservation strategies for the Appalachian and Great Lakes Dune-associated populations.

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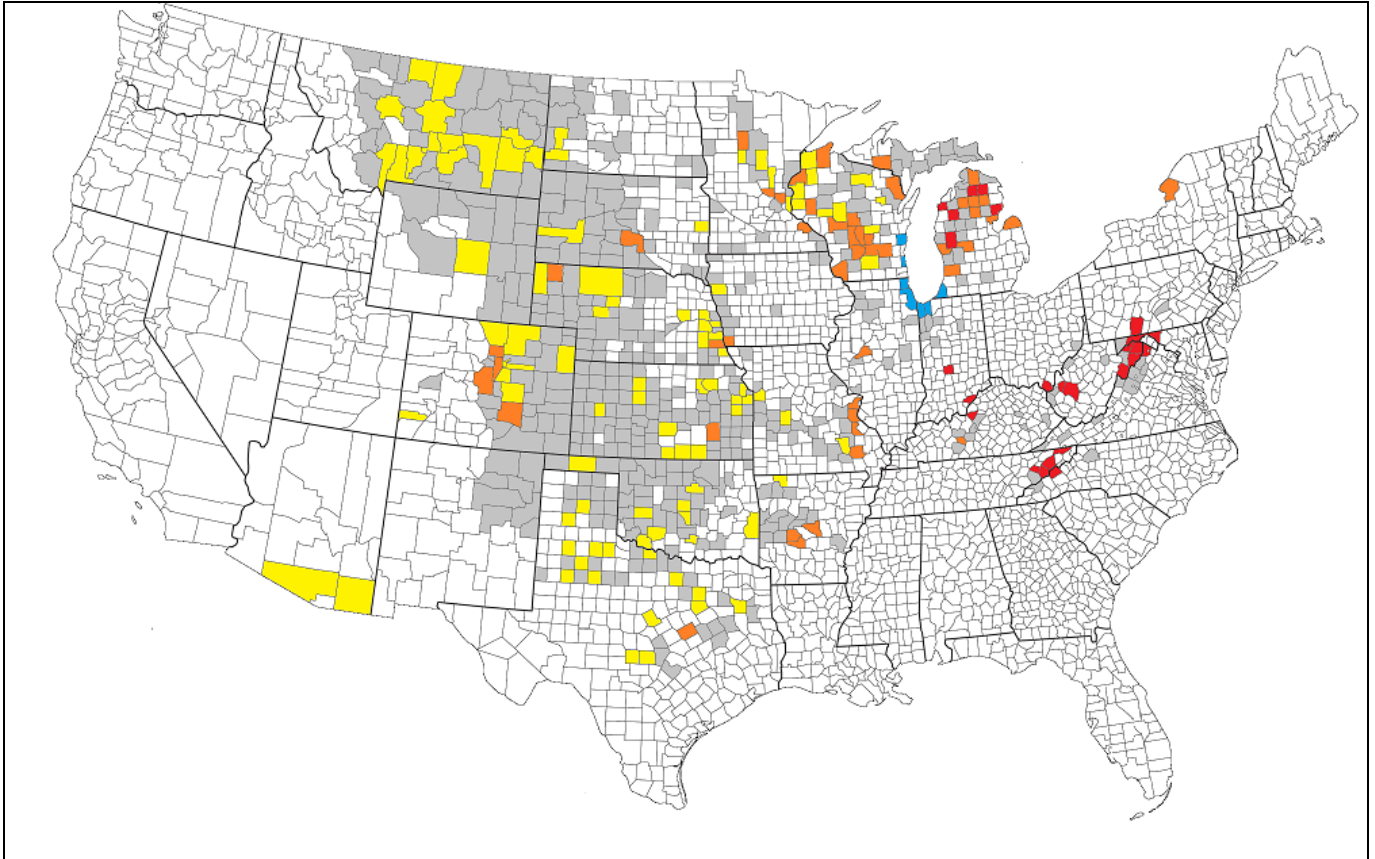
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APPENDIX A (SUMMARY OF HOSTPLANTS)

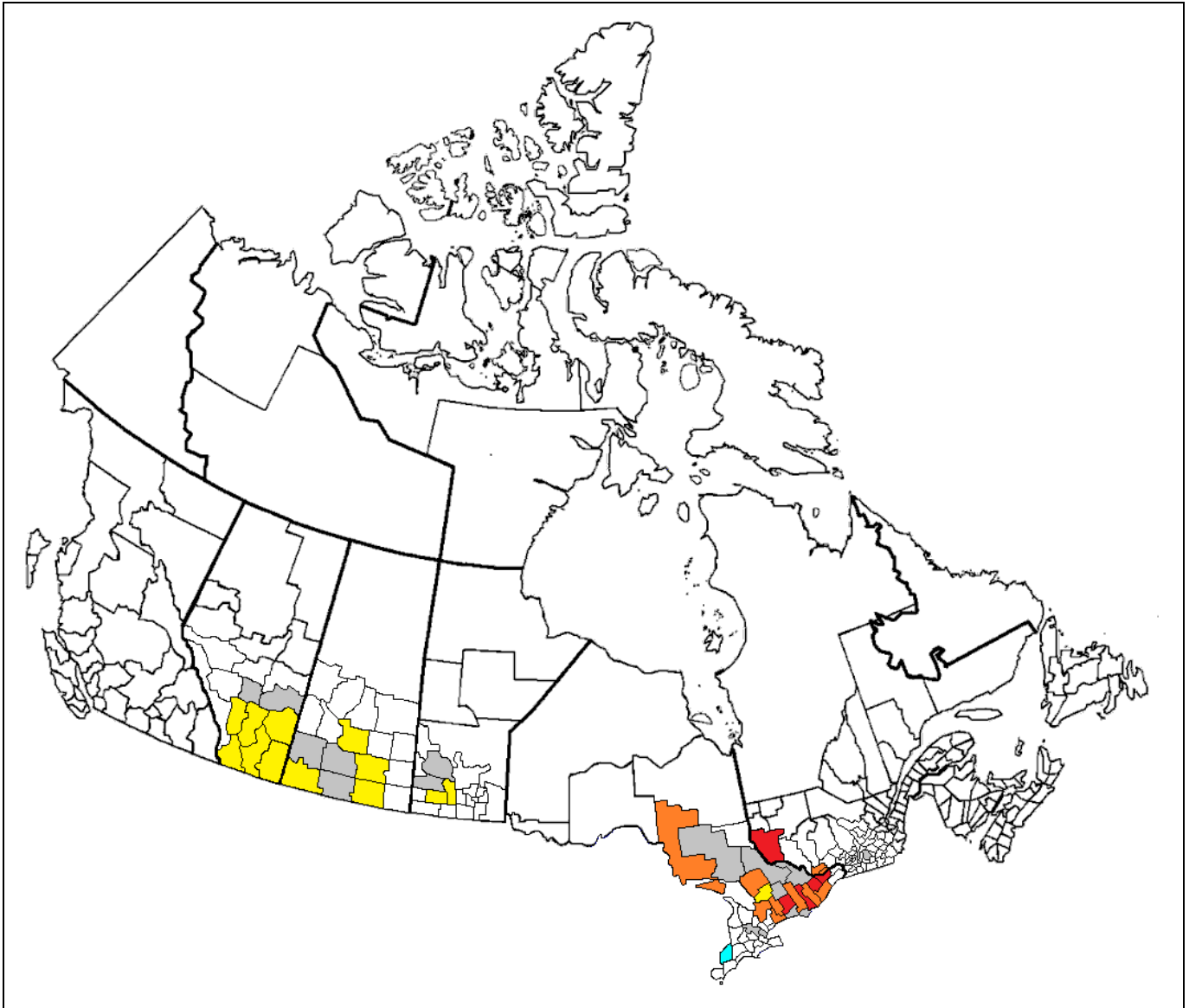
HOSTPLANT	STATE/PROVINCE	SUBSPECIES
<i>Arabidopsis thaliana</i>	MD	<i>olympia</i>
<i>Arabis alpina</i> (=albida)	ON	intermediate population
<i>Arabis divaricarpa</i>	NY	intermediate population
	ON	intermediate population
	QC	intermediate population
<i>Arabis drummondii</i>	CO	<i>rosa</i>
	MI	intermediate 'inland' population
	ON	intermediate population
<i>Arabis fendleri</i>	CO	<i>rosa</i>
<i>Arabis glabra</i>	QC	intermediate population
	ON	intermediate population
<i>Arabis lyrata</i>	MN, ON, WI	intermediate population
	IN, MI, WI	<i>wagneri</i>
	ON	<i>huron</i>
<i>Arabis missouriensis</i> (=viridis)	MO	intermediate population
<i>Arabis serotina</i>	WV	<i>olympia</i>
<i>Boechera canadensis</i>	TX	<i>rosa</i>
<i>Boechera grahamii</i>	NY	intermediate population
<i>Boechera laevigata</i>	NC, VA, WV	<i>olympia</i>
<i>Boechera</i> (sp.)	ON	intermediate population
<i>Cardamine hirsuta</i>	WV	<i>olympia</i>
<i>Cardamine pensylvanica</i>	MD	<i>olympia</i>
<i>Chorispora tenella</i>	SD	<i>rosa</i>
<i>Descurainia incana</i> (=richardsonii)	CO	<i>rosa</i>
<i>Descurainia pinnata</i>	CO, TX	<i>rosa</i>
<i>Descurainia sophia</i>	CO	<i>rosa</i>
<i>Isatis tinctoria</i>	unspecified (lab host)	<i>rosa</i>
<i>Lepidium campestre</i>	CO	<i>rosa</i>
<i>Lepidium virginicum</i>	CO, IL	<i>rosa</i>
<i>Sisymbrium altissimum</i>	CO	<i>rosa</i>
<i>Sisymbrium officinale</i>	KS, SK, TX	<i>rosa</i>
<i>Thelypodium wrightii</i>	OK	<i>rosa</i>

DISTRIBUTION OF *EUCHLOE OLYMPIA* SUBSPECIES IN THE UNITED STATES OF AMERICA



Map 1. Key: Gray counties = published records of *Echinochloa ol ympia* for which no specimens or images were available for evaluation. Red counties = records of only ssp. *olympia* phenotype based on examined specimens or images. Yellow counties = records of only ssp. *rosa* phenotype based on examined specimens or images. Orange counties = records of intermediate phenotypes or presence of BOTH *olympia* and *rosa* phenotypes based on examined specimens or images. Blue counties = ssp. *wagneri*.

DISTRIBUTION OF *EUCHLOE OLYMPIA* SUBSPECIES IN CANADA



Map 2. Key: Gray counties = published records of *Echinochloa ol ympia* for which no specimens or images were available for evaluation. Red counties = records of only ssp. *olympia* phenotype based on examined specimens or images. Yellow counties = records of only ssp. *rosa* phenotype based on examined specimens or images. Orange counties = records of intermediate phenotypes or presence of BOTH *olympia* and *rosa* phenotypes based on examined specimens or images. Blue county = ssp. *huron*. [Note: For the purpose of this atlas, the western provinces of Alberta, Saskatchewan and Manitoba are represented by their census divisions (see Google Earth for exact boundaries), because counties are not established as they are in the eastern provinces of Ontario and Quebec. This is partly to maintain a visual consistency with the mapping scheme applied to the eastern provinces and to the map of the United States.

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