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A previously unrecognized cryptic taxon within the Eastern United States *Celastrina* (Tutt) species complex.

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Abstract. A unique population of *Celastrina* is described from the highest elevations, 2784-6643' (848-2027 m.), of the southern Appalachian Mountains, centered on Great Smoky Mountains National Park. Life history aspects are still incomplete, calling for future field research.

Keywords. Great Smoky Mountains National Park, Maggie Valley, *Celastrina neglecta* summer phenotype.

INTRODUCTION

Anecdotal observations by Dr. Reginald Webster prior to 1984 suggested to me that there might be an unrecognized high-elevation *Celastrina* species on Balsam Mountain in Great Smoky Mountains National Park (GSMNP) in the delayed, high-elevation, early spring conditions. No further information was available. I proposed an investigation, related to my research on the *Celastrina* butterflies, and received a permit [GRSM-N-029-0039] to conduct investigative fieldwork. During my fieldwork on the lower slopes of Balsam Mountain on 30–31 May, 1988, I made an intriguing observation. Along a sand bank bordering Straight Fork Creek above the area known as Big Cove, at approximately 3000 ft. (914.4 m.) elevation, I observed an aggregation of 100–200 very large male *Celastrina neglectamajor*. The individuals appeared to be freshly emerged, as indicated by their bright coloration and absence of wing wear.

Notably, a number of considerably smaller, age-worn individuals were also present within the aggregation. These were initially identified as the summer phenotype of *Celastrina neglecta*. Four specimens were collected for further evaluation. This observation immediately raised a question regarding emergence timing between two *Celastrina* species. Across its range, *C. neglectamajor* is known to emerge shortly after the flights of *Celastrina ladon* and the spring brood of *C. neglecta*, but prior to the second brood (summer form) of *C. neglecta* in areas where the three taxa occur in sympatry (Opler & Krizek, 1984). However, on these dates it was evident that a summer phenotype resembling *C. neglecta* at this locality had emerged several days, or perhaps more than a week, before the emergence of *C. neglectamajor*. One flight worn male was collected along the Appalachian Trail at elevation approximately 6523' (1988 m.) elev. west of Clingman's Dome. Additional specimens were collected along various forest roads north of Maggie Valley, Haywood County, on 6/1/1988.

These observations suggested that the small, white-ventered *C. neglecta*-like individuals represented the earliest-emerging *Celastrina* in the late-winter/early spring environment. In contrast, *C. ladon* and the spring brood of *C. neglecta* typically exhibit darker gray ventral surfaces with heavier maculation. The occurrence of the white-ventered *neglecta* phenotype was therefore phenologically anomalous within this late-winter setting and suggested it might be an unrecognized taxon.

The Great Smoky Mountains contain a broad, diverse assemblage of forest types influenced by elevation, soil and localized climate. Three of which were of most interest in this study. Cove Forests contain the broadest diversity of plant species and support a considerable assemblage of herbivores. Over 130 tree species have been recorded in Cove Forests. The Cove Forest along Straight Fork Creek contains a number of characteristic tree species: Red Maple (*Acer rubrum*), Sweetgum (*Liquidambar styraciflua*), Yellow Buckeye (*Aesculus flava*), American Basswood (*Tilia americana*), Tuliptree (*Liriodendron tulipifera*), Black Birch (*Betula lenta*), Carolina Hemlock (*Tsuga caroliniana*), Eastern Hemlock (*Tsuga canadensis*), and several species of Rhododendron (*Rhododendron* sp.) which grow in thickets on slopes. Northern Hardwood Forest occurs on mid and upper elevations and contains a number of characteristic tree species: American Beech (*Fagus grandifolia*), Sugar Maple (*Acer saccharum*), Yellow Birch (*Betula alleghaniensis*), Black Cherry (*Prunus serotina*), American Chestnut (*Castanea dentata*), and several Hickory species (*Carya* sp.). Of interest is the high-elevation Spruce-Fir Forest found above 5,500' (1676 m.) elevation. Red Spruce (*Picea rubens*) and Fraser Fir (*Abies fraseri*) are the dominant tree species, though the Firs are in danger of being wiped out by the introduced Balsam Woolly Adelgid (*Adelges piceae*). Few butterflies inhabit this forest type and most observed species appear to be strays from lower elevations.

STUDY METHODOLOGY AND OBSERVATIONS

A formal 2-year study was conducted in 2007-2008 [park-assigned study #GRSM-00451, park-assigned permit #GRSM-2007-SCI-0026]. 2007 fieldwork began with co-researcher Dr. David Wright's visit on 5/5 and 5/6 on Balsam Mountain and Clingman's Dome. Weather during those days was very poor, with temperatures in the 53-58°F (11.67-14.44°C) range, not conducive to butterfly activity, so a search for potential hostplants was conducted. A number of plant species documented as *Celastrina* hosts in flower-bud stage were inspected for eggs, without result. Suspected hostplants in flower bud stage occurring above 4000' (1219.2 m.) included Highbush Blueberry (*Vaccinium corymbosum*), Black Cohosh (*Actaea racemosa*), Hydrangea (*Hydrangea* sp.), and Black Cherry (*Prunus serotina*) which formed a considerable proportion of the forest canopy. Only Hobblebush (*Viburnum alnifolium* (=*lantanoides*)) was in ideal floral bud stage at approx. 6000' (1829 m.) elev. at Clingman's Dome.

2007 fieldwork by the present author and assistant, Sandra Pavulaan, was initially conducted on 5/7 along Straight Fork Road, from approx. 1.5 miles into Great Smoky Mountains Nat. Park, to the parking location at Round Bottom. Floral progression along Straight Fork Creek on this date was notably advanced and approaching complete leaf-out. The only butterflies observed along Straight Fork were: *Gesta juvenalis, Erynnis icelus, Battus philenor, Pterourus troilus, Pterourus appalachiensis, Nymphalis antiopa,* and *Vanessa atalanta* – all indicative of early spring butterfly phenology. No *Celastrina* were observed. From the parking location at Round Bottom, walking uphill on Straight Fork Road, only *Erynnis brizo* was observed every few hundred feet to just below Pin Oak Gap, at about 4320' elev. (1317 m.).

In contrast to floral phenology along Straight Fork Creek on 5/7, the higher elevations of Balsam Mountain revealed that forest canopy conditions above 4000' (1219.2 m.) elevation remained characteristic of late winter. Butterfly activity at these elevations was sparse. At Pin Oak Gap, only small numbers of *Erynnis brizo* and two individuals of *Phyciodes tharos* were observed along the higher stretches of Straight Fork Road. *C. neglectamajor* had not yet emerged above 3000' (914.4 m.). At about 4320' (1317 m.) elevation, about .25 mi. below Pin Oak Gap, several *Celastrina* were observed. An additional two female

specimens were obtained along various mountain roads north of Maggie Valley, east of GSMNP. These bore a superficial resemblance to the *C. neglecta* summer form, but the seasonality of this phenotype was clearly out of place. The forest was in early spring floral phenology, with much of the forest canopy still bare or in very early leaf-out. Compared to similar seasonal floral phenology in states further north (VA, PA), an early spring *Celastrina* phenotype with a strongly-marked venter was expected. Interestingly, the *neglecta* second brood summer form had been observed emerging just a day before, at Ridgeway, S.C. at 280' (85.34 m.) elevation. The disjunction in the emergence between these two observed populations of summer form *neglecta* is significant. While the Ridgeway population of *neglecta* was producing a second brood of fresh summer form individuals, the Balsam Mountain population of *neglecta*-like individuals was clearly the first brood in the late-winter/early-spring conditions. No other *Celastrina* species were observed at various locations elsewhere between the Great Smoky Mountains and Ridgeway. However, several additional butterfly species were observed singly or in small numbers in GSMNP along Straight Fork Road at Pin Oak Gap: *Gesta juvenalis, Erynnis icelus, Erynnis brizo, Pieris rapae, Colias philodice, Everes (Cupido) comyntas, Phyciodes tharos, Vanessa atalanta, Vanessa virginiensis, Junonia coenia* and *Danaus plexippus* – the latter four species being elevational migrants from lower elevations.

On 5/8, the Pavulaan team managed to collect 2 male specimens along forest roads north of Maggie Valley, then drove up to Clingmans Dome. Virtually no butterflies were present on the summit area at 6643' (2025 m.) elevation, in stark late-winter floral phenology. Only two butterflies were observed along Clingmans Dome Road: a single *Colias eurytheme* and remarkably a single fresh *Argynnis cybele* which was likely an elevational migrant. However, a single male individual of an unidentified *Celastrina* was observed along the Appalachian Trail about .5 mi. (0.8 km.) south of Clingman's Dome at elevation 6550' (2000 m.). The 2007 study was concluded on 5/8 due to inclement weather conditions, predicted for several more days.

In 2008, the Pavulaan team revisited GSMNP on 5/1 and 5/2. On 5/1, we surveyed butterflies along Heintooga Ridge Road from Bear Camp to about 2 miles (3.2 km.) north, at elevation ranging 4500-5200' (1372-1585 m.). Forest was in late winter state, with a bare tree canopy (**Fig. 1**). The only potential associated host was abundant Highbush Blueberry (*Vaccinium corymbosum*) in bud and early flowering stage. No *Celastrina* were observed. The following butterflies were recorded along the road: *Erynnis brizo, Gesta juvenalis, Pieris virginiensis, Everes (Cupido) comyntas, Phyciodes tharos, Vanessa virginiensis, Vanessa atalanta, Battus philenor, and Pterourus appalachiensis.* Due to the late-winter state of the forest, most of these species no doubt migrated up from lower elevations. On 5/2, the Pavulaan team proceeded north along Route 441 in the direction of Clingman's Dome. At elevation 2359' (719 m.), the following butterflies were recorded: *Pterourus appalachiensis, Battus philenor, Pieris virginiensis, Parhassius m-album, Erynnis brizo, Phyciodes tharos.* These species reflected the advancing spring phenology at that elevation. Backtracking and continuing north along Route 441, at elevation 2731' (832 m.), the following were observed: *Pterourus appalachiensis, Battus philenor, Erynnis brizo, Gesta juvenalis, Pieris virginiensis, Phyciodes tharos,* and *Vanessa virginiensis*. The only specimens of *Celastrina* that were found within GSMNP over the 2-day period was a pair of spring form *C. neglecta* on 5/2 (**Figs. 8-10**) at the Kephart Prong trailhead, at elev. 2725' (831 m.). This pair of specimens closely resembles typical spring form *neglecta* from other regions further north, being solid metallic blue dorsally. What is interesting is the late date of these specimens in GSMNP, which normally emerge in northern Virginia in late March. Elevation certainly influenced the emergence period of these specimens. Along the Appalachian Trail south of Clingman's Dome summit, elevation 6550' (2000 m.), the following were recorded in late-winter floral phenology: *Pterourus appalachiensis, Papilio polyxenes, Colias eurytheme, Calycopis cecrops, Everes comyntas, Phyciodes tharos,* and *Vanessa virginiensis*. Along Clingman's Dome Road, the following two butterflies were observed: *Colias eurytheme,* and *Phoebis sennae*. No *Celastrina* were observed on Clingman's Dome on this date. It should be noted that several of the species recorded at

high elevation were likely elevational migrants from warmer conditions at lower elevation: *P. sennae*, *V. virginiensis, V. atalanta.* Several specimens were, however, collected along various mountain roads north of Maggie Valley on 5/2.

In 2018, additional fieldwork was initiated [park-assigned study #GRSM-00451, park-assigned permit #GRSM-2018-SCI-0451]. Our goal was to locate additional sites where the unique *Celastrina* occurs within GSMNP and nearby Maggie Valley. Poor weather, with 2018 being no exception, had hampered previous fieldwork in GSMNP. As such, our fieldwork in 2018 was limited to a handful of vouchered specimens and observations.

Unfortunately, vehicle access to Balsam Mountain in the spring was not possible due to fallen trees. However, we were able to confirm the presence of the studied "*neglecta*"-like entity at Purchase Knob (1♀, May 13) and later along Straight Fork Road below Round Bottom bridge (6 ♂♂, May 14 & 15). The "*neglecta*"-like entity occurred at several "puddle party" hotspots along Straight Fork, though in very small numbers. Both locations attracted typical early spring species, characteristic of species recorded during prior fieldwork, with *C. neglectamajor* just freshly emerging. Unfortunately, a week of rain arrived mid-day on May 15, thus ending a planned week of fieldwork.

Of great significance to our study is the capture of a pair of specimens of *Celastrina ladon* at Purchase Knob and of a heavily-maculated "spring form" *C. neglecta* at Round Bottom. The presence of 4 easily differentiated, fully sympatric *Celastrina* species in the study area aligns with the diversity of flora of the southern Appalachian Mountains. It also supports the notion that the target "*neglecta*"-like entity is a cryptic sibling species, which we referred to as "*C.* near-*neglecta*" during our fieldwork. Species *C. neglecta* is believed to spin off localized ecotypes in the northeastern United States (Pavulaan, in press). Thus, the presence of spring form *neglecta* at warmer, lower elevations in the southern Appalachians, while the near-*neglecta* (summer form) phenotype flies at colder, higher elevations, supports the conclusion that these are separate species.

Examination of additional collected specimens by Ron Gatrelle and Irving Finkelstein (see paratypes below) indicates this phenotype occurs southward in the Appalachians, at high elevation sites as far as northern Georgia. Gatrelle had done extensive fieldwork in Clay Co., N.C. and in later discussions indicated that he felt there was an undescribed *Celastrina* at Buck Creek, thus the holotype of the new species comes from Gatrelle's collection.

A review of *Celastrina* images in western North Carolina on iNaturalist.org shows a confusing assemblage of forms, certainly influenced by elevation differences throughout the area. Undetermined ventral images of individuals of either *C. ladon* or spring form *C. neglecta* in early April indicate heavily patterned forms dominate the lower elevations a full month before the current species under study.

***Celastrina angelina* Pavulaan - new species**

ZooBank registration: http://zoobank.org/5EEB7768-1827-491E-94B1-C76E53EB37A6

Description: Males (**Figs. 2, 4 & 14**) are very similar to nominotypical *C. neglecta*. Many specimens are bluer dorsally, some uniformly blue, with less white on the secondaries. Dorsal wing scale structure as in neglecta, displaying scales arranged in even rows with androconia (Ômura, et al, 2015). 32 male specimens in this study measured 13.6 mm average (leading edge of FW length), ranging 12-15 mm. Series of 31 nominate, summer form *neglecta* males and one female from Ridgeway, S.C. (**Figs. 5-7**), 9 males from Spartanburg, S.C., and 9 males from Buck Creek, Clay Co., N.C. (**Fig. 14**) averaged 13.7 mm, 13.9 mm and 14.6 mm respectively. Females (**Fig. 3**) are very similar to *neglecta* females, tending to be

less white dorsally. The females measure 13.8 mm average, ranging 13-15 mm. Ventrally, the spot pattern of *angelina* is slightly less developed than *neglecta* on average, though there is considerable overlap.

Distribution: Currently only known from the highlands of the southern Appalachian Mountains, including the Great Smoky Mountains. Likely occurs throughout higher elevations of the Appalachian Mountains in western North Carolina, eastern Tennessee, and northern Georgia. Range extension further north in the Appalachian Mountains requires further investigation.

Flight period: One brood presently known. Documented flight dates April 30-June 6. Further research is needed to determine presence of additional broods.

Hosts: Natural host preference is presently undocumented (see discussion above for hypothetical hosts). Following a storm prior to our fieldwork on 5/1/2007, a considerable amount of the forest canopy along Straight Fork Road was wind-pruned and littered the forest floor. Interestingly, most of the debris consisted of branchlets containing abundant Black Cherry (*Prunus serotina*) flower buds, known to serve as host to a number of *Celastrina* species. Gathering a considerable amount of this debris, hundreds of flower buds were later examined for evidence of eggs. None were found.

Holotype, allotype, paratypes: Holotype (male) N.C., Clay County, Nantahala National Forest, Buck Creek Road, 4/29/2004, leg. Ron Gatrelle, (**Figs. 2 & 4**). Allotype (female) N.C., Haywood County, Maggie Valley, 5/18/1985, leg. Ron Gatrelle (**Fig. 3**). Holotype male and allotype female to be deposited with the McGuire Center for Lepidoptera and Biodiversity. Paratypes: 51 paratypes (listed below). 14 specimens*[1] deposited with the GSMNP collection. Remaining paratypes remain with the author for further analysis, to be disseminated at a later date.

GA., Cobb Co., Kennesaw Mountain, Kennesaw, 4/30/1974, leg. I. Finkelstein (1 male).
N.C., Haywood Co., Maggie Valley, 5/18/1985 (1 male, 1 female), leg. R. Gatrelle.
GA., Fannin Co., Chattahoochee-Oconee Nat. Forest, Cooper Creek Recreation Area, 5/30/1987, leg. I. Finkelstein (1 male).
N.C., Swain Co., GSMNP, Straight Fork Road nr. Round Bottom, Straight Fork Creek, 5/31/1988 (4 males).
N.C., Swain Co., GSMNP, Appalachian trail west of Clingman's Dome, 6/1/1988 (1 male).
N.C., Haywood Co., various mountain roads above Maggie Valley, 6/1/1988 (9 males).
N.C., Clay Co., Nantahala Nat. Forest, Buck Creek Road, 5/10/2001, leg. Ron Gatrelle (1 male).
N.C., Rutherford Co., South Mountains Game Land, 6/6/2003, leg. T. Moore (1 male).
N.C., Clay Co., Nantahala Nat. Forest, Buck Creek Road, 4/29/2004, leg. Ron Gatrelle (1 male).
N.C., Swain Co., GSMNP, Straight Fork Road, Balsam Mountain, el. 4428' (1349 m.), 5/7/2007 (4 males, 2 females)*[1].
N.C., Haywood Co., various mountain roads above Maggie Valley, 5/7/2007 (2 females).
N.C., Haywood Co., various mountain roads above Maggie Valley, 5/8/2007 (2 males).
N.C., Haywood Co., various mountain roads above Maggie Valley, 5/12/2008 (8 males, 1 female).
N.C., Haywood Co., GSMNP, Purchase Knob, 5/13/2018 (1 female)*[1].
N.C., Swain Co., GSMNP, Straight Fork Road, el. 2784' (849 m.), 5/13/2018 (1 male)*[1].
N.C., Haywood Co., various mountain roads above Maggie Valley, 5/14/2018 (3 males).
N.C., Swain Co., GSMNP, Straight Fork Road, el. 3000' (914 m.), 5/14/2018 (5 males)*[1].
N.C., Swain Co., GSMNP, Straight Fork Road, el. 2784' (849 m.), 5/15/2018 (1 male)*[1].

Etymology: This butterfly name is twofold. It represents the perceived "angelic" nature of the butterfly, residing in the cloudy late-winter/early-spring environment in the highest elevations of the Great Smoky Mountains in North Carolina, "where angels could be envisioned". It is also a personal tribute to my AI assistant "Angel", who assists with all my writing, editing, and proofreading of my research. The name *angelina* itself means "Little Angel", reflective of the small size of this species. Tentatively proposed common name is **Smoky Mountains Azure**.

Conclusion: Currently, much of the life history of *C. angelina* is unresolved. The hostplant remains unknown, as no females have been observed in association with known or potential *Celastrina* host plants. However, evidence shows that the tree canopy consists partly of towering *Prunus serotina* in flower bud stage at the time *angelina* is on the wing. *P. serotina* is a commonly favored hostplant of several *Celastrina* species. Therefore, there is a likelihood that the butterfly uses this as a host, making it primarily a canopy-dweller within GSMNP.



Fig. 1. Heintooga Ridge Road, GSMNP, 4500' elev. Late winter habitat condition of *C. angelina.*



Fig. 2. *C. angelina*, holotype male. N.C. Clay Co., Nantahala Nat. Forest, Buck Creek Road, 4/29/2004, leg. Ron Gatrelle



Fig. 3. *C. angelina*, allotype female. N.C. Haywood Co., Maggie Valley, 5/18/1985, leg. Ron Gatrelle.



Fig. 4. *C. angelina*, holotype male (same data as Fig. 2). Ventral view.



Fig. 5. *C. neglecta*, summer form male. S.C., Fairfield Co., Ridgeway, 5/7/2009, leg. Harry Pavulaan.



Fig. 6. *C. neglecta*, summer form female. S.C., Fairfield Co., Ridgeway, 5/7/2009, leg. Harry Pavulaan.



Fig. 7. *C.neglecta*, summer form male. (Same data as Fig. 5.) Ventral view.



Fig. 8. *C. neglecta***,** spring form male. N.C., Swain Co., GSMNP, 5/2/2008, leg. Harry Pavulaan.



Fig. 9. *C. neglecta***,** spring form female. N.C., Swain Co., GSMNP, 5/2/2008, leg. Harry Pavulaan.



Fig. 10. *C. neglecta***,** spring form male. (Same data as Fig. 8.) Ventral view.



Fig. 11. *C. ladon*, male. N.C., Haywood Co., GSMNP, Purchase Knob, 5/13/2018 leg. Harry Pavulaan.



Fig. 12. *C. ladon*, female. N.C., Haywood Co., GSMNP, Purchase Knob, 5/13/2018 leg. Harry Pavulaan.



Fig. 13. *C. ladon*, male. (Same data as Fig. 11.) Ventral view.



Fig. 14: Comparative sample. *C. angelina* (left side), *C. neglecta* summer brood (right side). Data as follows: *C. angelina* (top to bottom): N.C., Haywood Co. 5/12/2010; N.C., Haywood Co. 5/10/2009; N.C., Haywood Co., 5/12/2010; N.C., Haywood Co. 5/14/2018; N.C., Clay Co. 4/29/2004; N.C., Haywood Co. 5/14/2018. *C. neglecta* (top to bottom): N.C., all ex-Clay Co., N.C., 6/18/2001, leg. Ron Gatrelle.

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ADDENDUM

Following is the current, tentative list of North American *Celastrina* taxa:

Celastrina argiolus (Linnaeus, 1758) [extralimital (Eurasia)]
Celastrina ladon (Cramer, 1780)
=*pseudargiolus* (Boisduval & Le Conte, [1835])
=*violacea* (W. H. Edwards, 1866)
Celastrina lucia (W. Kirby, 1837)
ssp. *Celastrina lucia lucia* (W. Kirby, 1837)
=*marginata* (W. H. Edwards, 1883)
=*quesnellii* (Cockle, 1910)
ssp. *Celastrina lucia sidara* (Clench, 1944)
ssp. *Celastrina lucia lumarco* J. Scott, 2006
ssp. *Celastrina lucia valeriia* Pavulaan, 2025
Celastrina neglecta (W. H. Edwards, 1862)
=*argentata* (Fletcher, 1903)
Celastrina echo (W. H. Edwards, 1864)
ssp. *Celastrina echo echo* (W. H. Edwards, 1864)
ssp. *Celastrina echo cinerea* (W. H. Edwards, 1883)
=*arizonensis* (W. H. Edwards, 1885)
ssp. *Celastrina echo bakeri* (Clench, 1944)
Celastrina gozora (Boisduval, 1870)
Celastrina nigra (W. Forbes, 1960)
Celastrina neglectamajor Opler & Krizek, 1984
Celastrina humulus J. Scott & D. Wright, 1998
Celastrina idella D. Wright & Pavulaan, 1999
Celastrina serotina Pavulaan & D. Wright, 2005
Celastrina asheri LaBar, Pelham & Kondla, 2022
Celastrina iryna Pavulaan, 2025
Celastrina isadora Pavulaan, 2026
Celastrina angelina Pavulaan, 2026

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