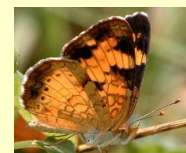


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DESCRIPTION OF A MULTILEVEL CRYPTIC NEW SPECIES OF *PHYCIODES* (NYMPHALIDAE: MELITAEINAE) FROM THE SOUTHERN APPALACHIAN MOUNTAINS.

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ABSTRACT. *Phyciodes incognitus* is described as a new species from the medium to high elevation hardwood forests of the southern Appalachian Mountains, type locality: Duncan Ridge Road, 3700 ft., Union County, Georgia. *P. incognitus* is verified from four colonies in Union County, Georgia and Clay and Macon counties, North Carolina. It is projected to range, in suitable habitat, as far north as montane Pennsylvania (indicated by photos). *P. incognitus* possesses a unique set of character traits that are virtually identical to both *Phyciodes tharos* and *Phyciodes cocyta* but at differing character positions – biology, morphology, genitalia, mtDNA, phenology. *P. incognitus* is multi-brooded and sympatric with *P. tharos* and *P. batesii maconensis*. *P. incognitus* can usually be easily distinguished in the field from sympatric *tharos* – especially males. Where *incognitus* ranges north into the range of *P. cocyta*, it will be difficult to distinguish their females, and many males, except by mtDNA or phenology. A lectotype of *marcia* Edwards, 1868 is designated from Kanawha River, Kanawha County, WV. *P. marcia* is a synonym of *P. cocyta*. The currently known mtDNA data for the *tharos*-group of taxa is determined to have limited, but specific, usefulness as a taxonomic tool in this group. It is concluded that sibling biological species are present with similar mtDNA. Thus, mtDNA is only useful in this group to determine speciation where taxa have significantly different mtDNA. Similar mtDNA does not indicate multiple species are not present. Specimens collected during this study suggest that a second undescribed *tharos*-like species is present in the study area.

Additional key words: rearing, *diminutor*, *orantain*, *marcia*

TAXONOMIC OVERVIEW OF EASTERN *PHYCIODES*

Scott (1994) examined all the original descriptions and status of type specimens associated with the *tharos*-group of North American *Phyciodes* Hübner, 1819. At that time, *Phyciodes tharos* (Drury, 1773), *Phyciodes cocyta* (Cramer, 1777), and *Phyciodes batesii* (Reakirt, 1865) were considered the only taxa (species or subspecies) in this group to occur in the eastern region of the continent. Of these, *tharos* and *cocyta* can be very similar, especially in females. In examining the descriptive literature, Scott found that even though there were only two (then known) species in the eastern region that could be confused, the literature was not only inconclusive but potentially disruptive to the long held stability of what the names *tharos* and *cocyta* delimited. Scott correctly designated neotypes for *tharos* Drury, *cocyta* Cramer, and *euclea* Bergsträsser, 1780 to preserve stability. Scott noted the name *marcia* W. H Edwards, 1868 and while he did not recognize it as a subspecies of *tharos* himself, he pointed out that the name was validly proposed at the species level and was thus available to any who wanted to “split” *tharos* into black clubbed (*tharos tharos*) and red clubbed (*tharos marcia*) subspecies.

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Scott's 1994 paper resolved any possible historical ambiguity of the names *tharos* and *cocyta*. Some workers (personal communication) have questioned some of his neotypifications. I do not. As Scott points out, Drury described *tharos* as a taxon with brown antennal clubs. It does not matter that some of the OD and associated paintings present red clubbed specimens. This is because female *tharos* frequently have either brown or red nudums on their clubs and some males have red tipped clubs. Plus, paintings are subject to artistic license, even failure. There are also various arguments about *cocyta*, *selenis* W. Kirby, 1837, and *morpheus* Fabricius, 1775. However, these arguments are precisely why neotypes needed to be designated to settle the nomenclature and preserve stability. These names are left as Scott dealt with them (Scott 1994, 1998). The stabilizing approach is to deal only with present taxonomic issues in this genus – which are still many and complex.

In 1998, Scott published again on the North American *Phyciodes* and presented significant new discoveries. This included the description of an easterly western subspecies (*orantain*) and an eastern subspecies (*diminutor*) which were tentatively, and ambiguously, placed in *tharos* and *cocyta* respectively. The ambiguity exists because after describing these as subspecies of *tharos* and *cocyta*, Scott then presents alternate taxonomic placement of both as subspecies of one another and as individual species. While unorthodox, this was nonetheless reasonable because it correctly reflected two things: 1) that these taxa exist in nature as distinct organisms and 2) that their correct specific status was then uncertain due to various factors indicating different possible relationships. Technically, it is important for taxonomists to note that Scott acted as first reviser within his own paper and thereby presented both *orantain* and *diminutor* as species. It is this researcher's position that while these two taxa may be subspecies of something, they are not subspecies of *tharos* or *cocyta* respectively (discussed later in this paper).

In his 1998 paper, Scott reexamined the name *marcia* and determined that the lectotype designated by F. M. Brown (1966) was invalid. However, only one of his reasons for invalidation is Code compliant - it is not a syntype (as confirmed later herein). Scott then left the name *marcia* without a singular type and without species level circumscription. Scott focused on the common usage of "*marcia*" as a form name and left it at that. However, it was proposed at species rank and remains available, and more importantly, applicable to a specific organism. Therefore, this name remains as a "loose cannon" among the available names within the eastern *Phyciodes* and is thus specifically addressed and resolved herein.

Wahlberg, Oliveira and Scott (2003) studied the mitochondrial DNA variation in *Phyciodes* and concluded the following.

"The results indicate that mitochondrial DNA sequences must be used with great caution in delimiting species, especially when infraspecific samples are few, or introgression seems to be rampant"; and, "... the utility of mtDNA on its own in assessing the boundaries of traditionally recognized species (e.g. Weins & Penkrot, 2002) is suspect. One must combine all possible knowledge, including morphological, ecological and molecular, to understand the species boundaries of groups of very closely related species. Our study has raised more questions than it has answered and will certainly help focus future research on the process of speciation in the *tharos*-group of species of *Phyciodes*".

This researcher was in periodic contact with Wahlberg and Scott contributing some specimens and comments toward their study. They have also been consulted at various times on matters relating to the research presented herein. Chiefly, several NC specimens of both *tharos* and new species *incognitus* (described herein) were sent to Wahlberg for mtDNA sequencing, and photos of immatures and adults were sent to Scott for taxonomic assessment. This current paper, by documenting the existence of two genetically cryptic and two phenotypically cryptic species within *Phyciodes*, confirms the Wahlberg et al. 2003 conclusions quoted above re determining taxonomic relationships in *Phyciodes*.

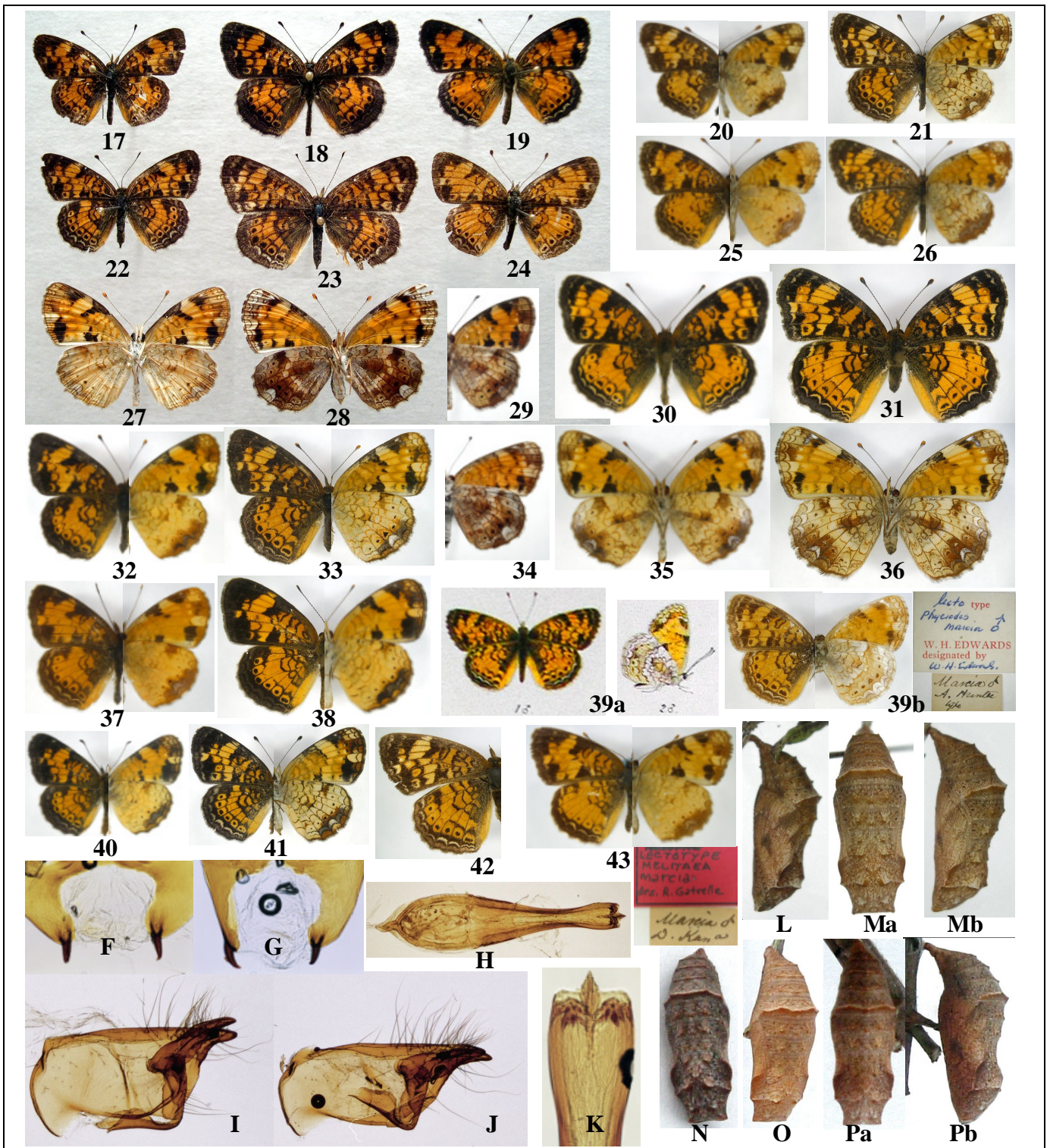
In 1998, this author published the discovery and description of *Phyciodes batesii maconensis* from the southern Appalachian mountains, type locality: Jones Knob, Macon County, NC. In May 2002, it was discovered that a *cocyta*-like taxon also existed at the Jones Knob TL. It has now been determined that three sympatric *Phyciodes* species occur in the Jones Knob general area: *batesii maconensis*, *tharos*, and

new species *incognitus*. This new species was not noted during the years of *maconensis* study for two reasons. First, was a preoccupation with studying *maconensis*, and second, it occurs in a micro habitat within the Jones Knob general area not previously searched until 2002. While *tharos* occurs ubiquitously throughout the Jones Knob area, this new species is habitat restricted.

Today, there are six known and described *Phyciodes* taxa in eastern North America: *tharos* Drury, 1773, *cocyta* Cramer, 1777, *batesii* Reakirt, 1865, *maconensis* Gatrell, 1998, *diminutor* Scott, 1998 and *incognitus* Gatrell, 2004 (herein), with *marcia* W. H. Edwards, 1868 determined a synonym of *cocyta*.



Figures 1-9. Mature larval heads of *P. incognitus* and *P. tharos* at varied angles. **Figs. 1, 2, 5 & 6** left. *P. incognitus*. Note more rectangular shape and darker face. **Figs. 3, 4, 6** right, **7 & 9.** *P. tharos*. Note round face and heavy markings, especially around mouth and eyes (handlebar mustache). **Fig. 8.** Face of *Phyciodes tharos* from Edwards' Butterflies of North America. **Figures 10-15.** Larvae of *P. tharos* and *P. incognitus*. **Figs. 10 & 14.** Mature larvae of *P. incognitus*. **Figs. 11-13.** Mature larvae of *P. tharos*; **12** in extremely bright light to artificially enhance colors. **Fig. 15.** Clutch of mature first instar, and newly molted second instar, larvae of *P. incognitus*. First instar larvae appear hairless to naked eye and in low magnification. **Figure 16.** Eggs of *P. tharos*. **Figures A-E.** Antennal shafts and clubs of *P. tharos* and *P. incognitus*. **Fig. A.** Round club with black nudum: male *P. tharos*. **Fig. B.** Oval club with black nudum: female *P. tharos*. **Fig. C.** Round club with partial orange nudum, female *P. tharos*. **Fig. D.** Elongate club with orange nudum: male *P. incognitus*. **Fig. E.** Oval-elongate club with orange nudum: female *P. incognitus*. Photos: Joseph Mueller.



Figures 17-43, *Phyciodes* species (exact size). *P. tharos*: figs. *17 ♂, *18/29 ♂, *19 ♀, *22 ♀, *23/34 ♀, *24 ♂, 39b, 40 ♂, 41 ♀: figs. 17-19, 22-24 all: 7 May 02, Buck Creek, Macon Co., NC; fig. 39a, Edwards' BNA *marcia* figures; 39b, lectotype, *P. tharos* f. *marcia* 1875 (data in text); figs. 40-41: ex pupa 21 Aug. 04 (same site as 17). *P. (?) orantain*: figs. 20 ♂, 21 ♀, paratypes: ♂, 8 Sept. 87, ♀, 6 Sept. 88, Barr Lk., Adams Co., CO, leg Scott. *P. diminutor*: figs. 25 ♂, 26 ♀, paratypes: ♂ 11 June 95, ♀ ex pupa 31 July 96, 3 mi. NE of Alden, Freeborn Co., MN, leg Scott. *P. cocyta*: fig. 37. ♂ topotype, *P. cocyta*, 10 July 92, Sydney, Cape Breton Is., Nova Scotia, leg. Banks; fig. 42. ♀ paralectotype; fig. 43. ♂ lectotype: *Melitaea marcia* Edwards, 1868 (= *P. cocyta*) (data in text). *P. incognitus*: figs. *27 ♂, *28 ♀, 30/35 ♂, 31/36 ♀, *32 ♂, *33 ♀, 38 ♂: figs. 30/35 holotype (data in text); figs. 31/36 allotype (data in text); fig. 27 paratype, 9 May 03, Union Co., GA, Duncan Ridge Rd; fig. 28 paratype, 16 May 02, Jones Knob, Macon Co., NC; figs. 32-33 paratypes, 5 Sept. 03, Clay Co., NC, Sally Gap Rd.; fig. 38 paratype, ex pupa 19 June 03, (same site as 27). **Figures F-K, genitalia** (key in text): *P. tharos*: F & I; *P. incognitus*: G-H, J-K. **Figures L-P, pupae**: figs. L-M, *P. tharos* (M, dominant phenotype); figs. N-P, *P. incognitus* (O, dominant phenotype). Photos: Joseph Mueller. * mtDNA examined. All leg. Gatreille unless noted.

EDWARDS' *MARCIA*

The name *marcia* W. H. Edwards, 1868 was not dealt with fully by Scott (1994 & 1998) and thus remains as potentially disruptive to the nomenclature. This is because its typification remains unsettled. This is corrected herein by lectotypification. The following is an enumeration of the problems that presently exist that make this lectotypification necessary.

1) Scott (1994) addressed W. H. Edwards' 1868 name *marcia* and noted it is an available species level name. Scott also noted that in the OD Edwards stated that species *marcia* was large and had red antennal clubs in both sexes. Scott then followed the tradition based association of the name *marcia*, 1868 with *tharos* – an association began by Edwards in his 1874-1884 *Butterflies of North America*². Scott stated that there existed in nature a small sized northern *Phyciodes* with orange-red nudums on its antennal clubs, which he, at that time, assumed to be a *tharos*. Scott gave its range as, “ S Maine to C N.Y. (and some Pnn. colonies) W to Sask.-Alta.-Dakotas-W Neb.-Wyo.-Colo.-extreme W Okla.” Scott then applied the 1868 **large** species name *marcia* to this **small**, orange clubbed entity concluding it was a weak northern subspecies of *tharos* differing only in having orange-red nudums. Scott gave no indication in 1994 that “*marcia*” was **only** a form name.

In his 1998 paper, Scott had decided that his 1994 *tharos marcia* concept was an undescribed taxon which he then described as, “*tharos orantain* or *cocyta orantain* or *orantain*”. However, Scott noted that the name *marcia* was problematic to his describing the new taxon *orantain* as 1) both his *orantain* and *marcia* 1868 had orange clubs and 2) in 1994, Scott had applied the name *marcia* to this **same** organism. Scott (1998, page 7) presents a largely subjective analysis and reasons why he concludes F. M. Brown's 1966 lectotype of *marcia* is invalid and why *marcia* (of 1868) is a *tharos* “form” only (even though described as a species) limited in range to the eastern US. Scott did not examine the lectotype nor any of the many Edwards *marcia* specimens in the Carnegie Museum. He simply based his assessment on the black and white photo of the lectotype in Brown's 1966 paper. Scott then described *orantain* as a western taxon (by above multi-combinations) and states that *orantain* “... does not occur in eastern North America”. Scott then redescribes the **remainder** of his 1994 *tharos marcia* concept organism as taxon “*cocyta diminutor* or *orantain diminutor*”. This position is untenable. The name *marcia* is not a form per its 1868 OD. The OD range of *marcia* included montane New York which is well within the range of *diminutor*. Thus, the name *diminutor* has to be considered as possibly what Edwards meant by species *marcia* 1868. If northern and eastern *diminutor* is the same species as *orantain*, the combinations, by priority, would then be *marcia marcia* [= *diminutor*] and *marcia orantain* and not *orantain orantain* and *orantain diminutor* as Scott proposed as first reviser.

2) The discovery of a multi-brooded, large-winged, orange-red nudum *cocyta*-like non-*cocyta* taxon in the southern Appalachian mountains that is sympatric with black clubbed *tharos* necessitated that this researcher also examine Edwards' *marcia* to determine if this “new” taxon was what Edwards meant by species *marcia*. Scott's relevant papers were in hand. Copies of Edwards' 1868 species *marcia* description, Edwards' 1874-84 section on *Phyciodes tharos* (introducing form *marcia*), and Brown's 1966 lectotypification paper were obtained; also, Brown's *marcia* lectotype and 66 syntypes by loan from the Carnegie Museum. Together, these resources provide the evidence of what Edwards found, where he erred, and what is the best way to move forward with the least damage to current usage of names.

² The problem is that Edwards' 1868 *marcia* and Edwards' 1874-84 *marcia* apply to two different species. In the former, Edwards described a new species – thus, *marcia*, 1868 is both available and delimited per the 1868 description and those syntype specimens. Edwards 1874-84 used the name *marcia* for a form of species *tharos* – thus, *marcia* 1874-84, as an infrasubspecific homonym, is unavailable from that date and application. Edwards did this because he erred in confusing his first entity (= species *cocyta*) with the spring form of species *tharos* (and other taxa) he reared years later. See points 3 & 4.

3) Edwards' 1868 description of *Melitaea marcia* is textually thorough but lacks illustrations. Two features stand out in this description. First, the large wing expanse of the new species: 1.3 to 1.5 inches in the male and 1.7 inches in the female. Second, the orange nudum of the antennal club of **both** males and females, "...antennae black above, whitish below; annulated with white; club black above, fulvous below." Because the dorsal and ventral wing markings of the eastern *tharos*-group *Phyciodes* are so similar and variable, only *batesii* can be descriptively eliminated by Edwards' wing description. The large size and club color specifically indicates something other than *tharos*, as *tharos* is relatively small in the Appalachian region and the clubs of eastern male *tharos* are either all black or only slightly red tipped (Allen 1997). There are two large sized *Phyciodes* species with orange-red nudums in the Appalachian region – *cocyta* and *incognitus* (described herein). Edwards' 1868 *marcia* is likely one of these two with high probability.

Edwards stated that he considered *marcia* to range from New York to Louisiana, but he mentioned only one actual site, stating, "I have found *Marcia* common on the Kanawha River, W. Va., in June. *Batesii* is of earlier flight and rather rare in that region." This site is thus where Edwards collected the syntypes of his new species and establishes the Kanawha River, WV as the *marcia* type locality.

There are a large number of specimens labeled "*marcia*" in the Edwards collection at the Carnegie Museum (Brown 1966). These are apparently assumed to all be syntypes because they have Edwards' hand written labels on them. Sixty six of these "syntypes" and the *marcia* lectotype (invalidated by Scott (1998)) were sent on loan for this research. One box of 30 specimens was almost totally destroyed in the mail, but 22 of those still possessed enough wing fragments and antennae to be determinable to species or species group. Thus, a total of 58 "syntype" specimens, all labeled "*marcia*" by Edwards, were assessed.

Thirteen of the 58 specimens are reared individuals with 6 of those being aberrations due to being placed on ice as pupae. One aberration lacks antennae and is thus not determinable to species. The 12 with antennae are comprised of 3 *tharos* and 9 with orange nudums and of larger size which are thus not *tharos*. None of the reared specimens have locality data.

There are 7 collected *tharos* for a total of 10 *tharos* out of 58 total specimens. These 7 are from NC (3), TX (2), Hunter, NY (2). The 8 destroyed specimens have only the thorax remaining on the pin. From their labels and small thorax size, it is probable that 5 were *tharos* – GA (3) and NC (2). This is because the 3 other NC specimens among those determinable are clearly *tharos*. This would make a maximum potential of 15 *tharos* out of 66 specimens sent (22%). The remaining 38 specimens all have strongly orange nudums on their clubs. Of these 38, 20 males and 7 females (27) are strongly to likely determinable as species *cocyta* (6 being Canadian – Labrador, Anticosta and Montreal; and 1 from New Mexico). Three are possible *incognitus*. The remaining 8 specimens are either small *cocyta* or *diminutor*.

The 66 specimens sent may or may not be a typical sample of Edwards' specimens – both in phenotype and location. The high percentage of non-*tharos* was unexpected (58 minus 10 *tharos* for 48, mostly larger, orange nudum specimens = 82% non-*tharos*). It was also surprising to find only 1 probable and two possible new species *incognitus* among them. It was expected that many *P. incognitus* would be among the "syntypes" and that it would thus be demonstrable that the "new" entity found at Jones Knob, North Carolina would be a rediscovery of Edwards' 1868 species *marcia*. But such is not the case. As stated earlier, there are two large winged, orange nudum *Phyciodes* species in the Appalachians and one of them is what Edwards called species *marcia*. From the material examined, that species is *cocyta*, to which *marcia* Edwards, 1868 is thus a synonym. This is further confirmed by the following.

Alex Grkovich (pers. comm.) had a very large female specimen he collected from Greenbrier County in southeast West Virginia determined by Wahlberg as species *cocyta* by mtDNA analysis. This is the furthest south in the Appalachians that *cocyta* has been confirmed by mtDNA examination. This confirms that *cocyta*'s range extends fully into the area from which Edwards collected his specimens of *marcia* on the "Kanawha River, West Virginia". Edwards' 1868 Kanawha River site is the same location as Coalburg, where he lived. In 1894, the town of Coalburg had its name changed to Cabin Creek. This area is only 55 miles west northwest of Greenbrier County.

In examining the Edwards series, 18 *cocyta* specimens are labeled (by Edwards) from “Ka”, “Kan” or “Kan^a”. At first, this was thought to mean Kansas. However, this *cocyta* phenotype does not occur anywhere near Kansas (Wahlberg et al. 2003). It was noticed that two forms of location notations are on his labels. They either have a location of US state or CA province (Texas, Ga., NC., W. Va., N. Mex., Colo., Labrador, Anticosti) or specific local sites (Montreal, Coal, Coal b, Ka, Kan, Kan^a, Hunter, W mtns.) In reading Edwards 1868 and 1874-84 all these locations are mentioned, but not Kansas. This worker’s position is that Ka, Kan and especially Kan^a is the Kanawha River site. If so, then specimens so labeled are most likely the valid syntypes of Edwards’ 1868 species *marcia*. This locality comprises the largest percent of specimens (of those sent). Additional proof of this is a unique inscription on one specimen. It is a small *cocyta* or normal sized *diminator* female specimen with one intact antennal club with an extensive orange nudum. The label says “Marcia female, C Kan^a Sept, caught”. The word caught surely refers to Edwards having caught this himself versus having reared it. “Caught” is on the bottom line by itself, the same area Edwards made his rearing notations (e.g. “on ice” or “reared”).

4) Type localities, types, and Edwards point of error re *marcia* as a form. According to the International Code of Zoological Nomenclature (ICZN), where syntypes are involved, they collectively constitute the type and the sum of their locations comprises the type locality. A **type** locality is the place the **type** specimen(s) is/are from. Edwards’ 1868 type locality is NOT “New York to Louisiana” – that was his range statement. The type locality is the place the syntypes he had come from, and the only site he stated having specimens from is “Kanawha River”. Only specimens seen or referred to by Edwards for his 1868 description of *Melitaea marcia* are syntypes. Any of Edwards’ specimens not utilized in his 1868 description of *marcia* **can not be syntypes**. The fact that Edwards has labeled all of these “*marcia*” does not make them syntypes. That is simply an ID he wrote on them some time during his life.

Several of the specimens on loan have dates on them around 1877 – years after the species *marcia* description. All specimens with post 1868 dates are excluded from being syntypes by the Code. Of those without dates, a great many are disqualified as syntypes simply by their location (e.g. Canada). In the OD, the only specific location is the Kanawha River. However, in Edwards’ *Butterflies of North America* (1874-1884), two primary areas are specified relative to his research into *tharos* seasonal polymorphism. These primary areas are Coalburg³, WV and Hunter, in the Catskills of NY. Specimens from these, and any other locations mentioned in his BNA in conjunction with his polymorphism studies, are excluded because those studies did not begin until after 1875. In the *Butterflies of North America Phyciodes tharos* account, Edwards states that he did not rear any specimens before 1875 (emphasis mine).

“In 1868, I described, as a distinct species, ... calling it *Marcia*. ... But there were such resemblances also to *Tharos* that it was not possible to determine its specific value, unless the butterflies could be bred from eggs, and as yet [1868] the food-plant of the larvae, and the larvae themselves, of **both** *Marcia* and *Tharos* were unknown. But **in 1875**, the food-plant was **discovered** by Mr. Mead. He states, in *Can. Ent. VII.*, p. 161, that he planted ... all common composites... introduced a number of females of this species. A few days later, on examining the leaves, he found eggs deposited on the *Aster Nova-Angliae*, and on no other plant... This happened in the month of **July**, near the last of the month, at Hunter, N.Y., among the Catskill Mountains.”

There are 5 Hunter, NY specimens among those on loan for this study. Three have dates of 1876 or 1877, two lack dates. There is no evidence Edwards had any specimens from Hunter, NY in 1868. There is sufficient evidence, including specimen dates, to show that all Hunter, NY specimens are not 1868 syntypes – including the “lectotype” designated by F.M. Brown in 1966. It is further reasonable to conclude that most specimens labeled “*marcia*” by Edwards’ (some dated as late as 1886), from many locations, are from his extensive post 1868 collecting and rearing of Pearl Crescents and not 1868 syntypes.

³ Coalburg and Kanawha River are the same site. In 1868, Edwards referred to (and labeled) specimens from that site as “Kan, Ka or Kan^a”. By 1875, he was referring to (and labeling) specimens from that site as “Coal, Coal b”.

It is a fact that Edwards described *marcia* as a species distinct from *tharos* as he states, "...hitherto considered a variety of *Tharos*, from which it is readily distinguished by the purple or pearly hue of the underside of secondaries." It is factual that Edwards did not consider *marcia* a mere seasonal form until after 1875. It is a fact that a great many (perhaps vast majority) of what Edwards considered *tharos* form *marcia* are species *P. cocyta* as evidenced by his extant collection. It is a fact that Edwards also had specimens of *tharos* he considered form *marcia*. Because specimens of both *cocyta* and *tharos* (and likely *diminutor*) are among the specimens reared by Edwards, it is unarguable that Edwards was confused about what species he was dealing with because he didn't detect these species in hand. How did this happen?

The above quote in Edwards' *marcia* OD states that he considered the coloration of the ventral surface the character of differentiation between *marcia* and *tharos* rather than size and club color. While Edwards noted wing size and club color in the 1868 OD, it is apparent from his specimen IDs, that he had become oblivious to the major differences in size, dorsal markings, and club color between *tharos* and *cocyta* just seven years later as being indicative of speciation. In reading his presentation of means and methods, it is stated that he only gathered egg masses from wild females and never tried to cross any of the phenotypes. He simply focused on rearing one seasonal form from the previous seasonal form.

It is now well known, from various rearings of Eastern *tharos* and *cocyta* in this region, that *cocyta* always has bold orange clubs while *tharos* always has all black clubs (with occasional red tips) in males and mixed clubs in females (Allen 1997, Scott 1994) (Figs. A-C). It is thus knowable that all the egg clusters that Edwards reared would have each produced the above distinctively different, and species specific, adult antennal morphology. Perhaps some egg clusters were combined on feeding plants as he was only after seasonal variation (season to season, not family to family comparisons) and may have thought he was getting variable nudums and phenotypes from the same clusters. However, we know from his accounts that he did segregate some egg clusters. In fact, it is his account of such segregation that reveals his error. Here is the BNA quotation (emphasis mine).

"This second generation was just **one month** behind the second at Coalburgh. So far only could I trace the Catskill [Hunter, NY] generation this year; but as, in 1875, Mr. Mead obtained eggs on the 27th **July** and following days, the larvae from which **all hibernated**, that would be the second laying of eggs of the season, and the resulting butterflies the first generation of the following year.

"The foregoing Coalburgh [=Kanawha River] observations were supplemented by others in August, 1877. Between 14th and 20th, I obtained three lots of eggs, from which the larvae in due time emerged. Those of the first all went on to maturity, giving butterflies after middle of September, the last emerging 26th. But of the other two lots **all became lethargic** [diapause]. **The reason for this difference I could not conjecture**. It certainly was not owing to any change in the weather [evidencing outdoor rearing]. In the field the species was abundant from 15th to 25th August (this being the third brood of the year). But one month later, when the fourth brood should be flying, examples were **remarkably scarce**."

The "reason" that eluded him is quite evident today, they were *Phyciodes cocyta*; whose larvae all go into diapause at that time of year (end of July through late August). This is also what happened to Mr. Mead's larvae. It is also why the supposed second generation was on the wing only one month after the previous emergence. The previous entity would have been *tharos* and/or *diminutor* and/or *incognitus*. It takes a minimum of 35 days to rear these species indoors under perfect warm conditions. In the mountains, with long and humid cool nights, mornings, and evenings it takes much longer. Thus, one brood being virtually on the heels of another is an indication of multiple species being present. Larvae from multiple females obtained at the normal flight season of *cocyta* and which all enter diapause strongly indicates a non-*tharos* species being present.

These accounts and the Edwards specimens evidence that Edwards was so focused on seasonal variation that he missed the fact he was dealing with two to four species – *tharos*, *cocyta*, *diminutor* and *incognitus*. All of which likely occur in West Virginia and at least two of which (*tharos* and *cocyta*) have been unequivocally identified among the specimens he both collected and reared, and labeled as "*marcia*".

5) *Melitaea marcia* typification. Edwards never provided any evidence showing *marcia* of 1868 to not be a species. He merely reared and collected parallel seasonal forms from multiple species and arbitrarily called them all “*marcia*”. Edwards applied an 1868 valid species name to a seasonal form after 1875. There are thus two types of taxa going by the name *marcia* – one a valid species (*marcia* = *cocyta*) and one a seasonal form occurring in many *Phyciodes* species (inc. *tharos* f. *marcia*, *cocyta* f. *marcia*, *diminutor* f. *marcia*, *incognitus* f. *marcia*.). Though the same, the names have no taxonomic connection. A species can not be changed to a form **solely** because someone gives it a different concept.

Brown (1966) approached Edwards’ *marcia* specimens as *tharos* forms because of Edwards’ erroneous presentation of *marcia* as only a seasonal variant in his Butterflies of North America. Brown designated a lectotype for the species *marcia* 1868, but did so per an infrasubspecific concept authored in 1874-1884. The Brown specimen has a notation on its label by Edwards that it is the “type” of Edwards’ form concept (Fig. 39b). The specimen Brown utilized is not a syntype of *marcia* 1868 and is thus invalid as a lectotype (per Scott 1998). This is because the specimen is from Edwards’ post 1875 research as evidenced by 1) appearing bred, 2) matching the BNA form A 1-2 figures and, 3) being labeled from Hunter. The “A” is part of a form code (A, B, C & D) created and employed by Edwards in his post 1875 research. The primary disqualifying factor is its place of origin – Hunter, NY. (This situation was presented to the official ICZN internet list serve. The only thing that can invalidate this lectotype is if it is not an 1868 syntype. Which it is not.)

The above research into species *marcia* W. H. Edwards, 1868 supports and confirms Scott’s 1998 invalidation of Brown’s 1966 lectotype of *marcia* 1868. However, this specimen is the actual “type” of Edwards’ infrasubspecific BNA early season form *marcia* of species *tharos*. This is because it is labeled as “type” by Edwards and is clearly the BNA model for figure A 1-2. While no longer having antennae (Figs. 39b), the painting made while it did, has black clubs (Fig. 39a). The wing shape, all markings, and size confirm Scott’s 1998 diagnosis of this specimen as female – not male. Thus, being female and having black clubs confirms that this specimen is a partially aberrant reared *tharos*. The name *marcia* may therefore continue to be used for the heavily marked spring forms of *Phyciodes* in general and *tharos* specifically.

The preceding means that a proper lectotype for *Melitaea marcia* Edwards, 1868 is needed to provide what the Code refers to as the “objective standard of reference” by which taxonomists can apply this name to a taxon that bears this name. Among the Edwards specimens sent, a male and a female stand out as likely true syntypes and typical examples of his 1868 original description. The male has orange nudum and is 1.3 inches in expanse. The female lacks antennae but is 1.7 inches and with contrasting forewing colors typical of *cocyta*. Both are from the Kan^a location. The male has a “D” on its label which would have been added later. Also, many of these specimens were surely relabeled because the labels are all so similar (same paper and pen markings) even among those that have very different dates (e.g. 1876 & 1886). Because 1) both his 1868 species and post 1875 form have the same name and 2) all specimens have the name *marcia* on them, one can not use the presence of the name *marcia* on a label to date specimens or confirm syntypic status.

Trying to do the best one can with this complex situation, I here designate this male (Fig. 43) as the lectotype of *Melitaea marcia* Edwards, 1868. This retains the type locality as Kanawha River (Coalbrug), West Virginia. This specimen and the paralectotype female (Fig. 42) are, with very high probability, species *Phyciodes cocyta*. *Melitaea marcia* Edwards, 1868 is thus either a synonym of *Phyciodes cocyta cocyta* or a valid name for a “southern” brighter subspecies (compared to typical Canadian *cocyta* (Fig. 37)) of *cocyta* in the mid Appalachian Mountains – *Phyciodes cocyta marcia*. Its labels are figured with the lectotype and the specimen is returned to the Carnegie Museum, Pittsburgh, PA.

This maintains stability of all eastern North American *Phyciodes* names in their current usage. It insulates the new species/subspecies (*orantain*, *diminutor*, *incognitus*) from any potential confusion with the name *marcia*. These recently described non-*tharos* taxa need to be free from any associations with the long *tharos*-associated and form-associated name *marcia*.

SPECIES STATUS OF *PHYCIODES DIMINUTOR* SCOTT, 1998

Alan Wormington of Ontario, Canada has relayed the results of his Ontario *Phyciodes* studies and details of his discovery of what he identified as *P. cocyta* in Union County, Georgia on 18 August 2002. The following are selected comments from his personal communications on his Ontario research.

"Here where I live, Point Pelee National Park in southern Ontario, I have been studying butterflies for decades and have written several annotated lists... In 1995 I put in a special effort to understand the brood relationships of crescents here, when I realized the whole thing was a complete mess. Finally, I came to the conclusion that the "mess" was actually the result of a third entity involved that obviously had never been described in the literature. The two species that "normally" are mapped for this area, and across much of southern Ontario, etc., are *cocyta* and *tharos*.

"In addition, I worked on determining which "new" species was actually new. *Cocyta* is obviously distinct, but of the other two I couldn't determine which was true *tharos* and which one was undescribed. Shortly thereafter I was able to visit the National Museum in Ottawa, where Don Lafontaine showed me the original drawings of Drury (1773) that apparently act as the type for *tharos*.

"The drawing matched what I had been calling "Summer" Crescent (since the first brood does not emerge until very late in June). The drawing showed orange tips to the antennae clubs, which is what I had isolated as "Summer" Crescent. Thus the other entity, by default, is the undescribed taxon -- or is it? This other entity is the one with very rounded and jet black antennae clubs, and tends to be small in size (also, there is less size differences between the sexes compared to other crescent species). I have given it the name "Early" Crescent since the first brood appears very early, starting most years around May 10 or shortly thereafter. In southern Ontario, it tends to be slightly less common than the other crescents, and tends to be found on dunes, alvars, very dry fields, etc. Some of what I discuss above is briefly mentioned in *The Butterflies of Canada* text".

Scott's 1994 neotypification of *tharos* stabilized that name to its traditional concept as the small sized, round club with black nudum, early and multiple brooded Eastern species = Wormington's Early Crescent. In 1998, Scott described *diminutor* = Wormington's Summer Crescent. In 1995, Wormington had correctly determined three **species** to be present in Ontario – *tharos*, *cocyta* and *diminutor*. He also relayed this significant range observation about species *diminutor*.

"I don't like the name "Northern" Crescent, since Summer Crescent [*diminutor*] occurs farther north in Ontario than *cocyta*. I prefer the common name "Orange" Crescent, which I think was used first by some authors."

Wormington's range observations, in conjunction with Scott's 1998 *diminutor* and *cocyta* range data, confirms that the ranges of *diminutor* and *cocyta* broadly overlay one another over thousands of square miles and that in many areas the two are sympatric. This makes it impossible that these two are "subspecies" of one another. Scott (1998), as first reviser, proposed *diminutor* as a species distinct from *cocyta* specifically because of their overlaying ranges, sympatry, and different phenology. That status is followed herein. The taxonomic assignment of *diminutor* as a subspecies of *cocyta* in Wahlberg et al. (2003) is incorrect. It is a falsifiable taxonomic conclusion. The similar mtDNA of *cocyta* and *diminutor* must be assessed taxonomically against their biology, phenology and morphology which renders the conclusion that they are distinct, often sympatric, species with very similar (to identical) COI mtDNA.

While common names have no scientific standing, their greatly expanded use today calls for a reexamination of the common names for these species. Wormington's common names of Early Crescent (*tharos*), Orange Crescent (*cocyta*) and Summer Crescent (*diminutor*) are good common names for these species (especially in the northern US and Canada) and this usage is supported here. The term "pearl crescent" was coined only in reference to **form** *marcia* – which occurs in many early season *Phyciodes* species. In other words, there is no single *Phyciodes* species that is a "pearl" or "pearly". With the modern knowledge that there are multiple species in eastern North America which all may have pearly undersides in spring and at times late fall, the name Pearl Crescent should be dropped as a common name because it can lead observers (especially beginners) into confusion. This is because they may ID all short photo period pearly HW marked individuals incorrectly as species *tharos*, and in summer be confused because no species have pearly markings at that season.

DOCUMENTING A NEW SPECIES

DETERMINATION OF SPECIES

The most recent taxonomic placement of *tharos*-group *Phyciodes* to species and subspecies is in Wahlberg et al. 2003. That paper is here considered to have two foundational taxonomic flaws. One, is the acceptance of the taxonomic determinations of specimens sent per the determinations by their senders. Second, is a presupposition that the overall taxonomy (strictly following that of Scott) was correct. The mtDNA sequences and resulting tree diagrams were molded together with that taxonomy and those identifications. The product is various taxa (names) being found in multiple (polyphyletic) locations in clades B, C, D, and E (pg. 262). Primary among them is the name *selenis* which is found in all four clades. It is suggested here that 1) various named individuals may be misidentifications and 2) various taxonomic associations may be incorrect. Incorrect either to subspecific associations or undescribed taxa being named as something they are not. See Funk and Omland (2003) relative to taxonomic assumptions and gene trees.

This assessment seems to be indicated by comments in the paper itself.

“However, species defined using non-DNA characters were not well defined using mtDNA characters, and indeed there were a large number of poly- and paraphyletic mtDNA lineages in different taxa of *Phyciodes*.” (pg. 263) and:

“...we prefer to interpret our results in the framework of the traditionally held concepts of species in the *tharos*-group. Our results can be interpreted to be in strong conflict with the traditionally defined species in the *tharos*-group, especially if one would redefine species based on mtDNA. Since mtDNA disagrees so strongly with what any good field biologist can observe in nature regarding *Phyciodes*, we will question the traditional concepts, but will defer any actual changes to them until further investigations have taken place.” (pg. 264).

The phrases “prefer to interpret” and “can be interpreted” are significant because this renders all such derived at conclusions as unauthoritative due to their subjectivity and reasonable alternatives. The flaw in this paper was a predetermined, but partially erroneous, taxonomy and/or occasional incorrect individual specimen identifications. It is the view here that not nearly enough “field biology” has been done to definitively place various *Phyciodes* taxa in correct taxonomic associations. Too many specific and subspecific associations are still being based simply on the general “look” of various entities.

The mtDNA sequences presented in the Wahlberg study should be applied in two different ways in determining taxonomic relationships in the *tharos*-group of taxa. One, is that significantly dissimilar haplotypes between populations should be taken as evidence of speciation regardless of phenotypes where no other data (e.g. biological) is available. Second, is that similar and even identical haplotypes should be rendered null as taxonomic indicators when biological data shows two or more taxa to have species integrity when sympatric in nature.

Example. In clade C, both the *batesii batesii* male and *cocyta selenis* female are from the same date and location. (Males of *cocyta selenis* were also sequenced from this site and date.) It is very possible that **this** “*selenis*” female is actually a misidentification of an atypical *batesii* female (compare this female with *batesii* females 73-10 and 95-9). It has also long been this author’s position that *batesii lakota* and *batesii batesii* are the same subspecies with variable phenotypes (this is supported by the similar haplotypes in C of MN “*lakota*” and Ont. “*batesii*”). One can see from the phenotype why the C *cocyta selenis* identification was made, but the mtDNA would demonstrate that that taxonomic “visual” determination is in error and it is actually a variant female of *batesii* – with which it was collected. Thus, everything in C would actually be *P. batesii batesii* and C would be monophyletic rather than paraphyletic.

Example. The taxa *orantain* and *diminutor* are therein considered subspecies (per Scott) of *tharos* and *cocyta* respectively. However, this is not possible with *diminutor* and *cocyta* (as detailed above) due to their wide sympatry. They are simply a pair of cryptic species with similar phenotypes and mtDNA. Scott was correct in 1998 to suggest these two might prove to be two species.

Example. It is also unlikely that *tharos* and *orantain* are conspecific because Scott (1998) easily crossed *orantain* with a “*selenis*”. (Some of those crosses are housed here in the TILS collection.) The taxonomic association of the orange nudumed *orantain* with true eastern black nudumed *tharos* is simply an assumption. The biological compatibility of *orantain* and this “*selenis*” supports their being conspecific and works against the hypothesis that *orantain* is a *tharos* merely because they have some superficial wing similarity. But what is Scott’s *selenis* used in this cross? (And what are the many “*selenis*” spread throughout Wahlberg’s clades B, C, D and E?. It is possible that those “*selenis*” are actually a menagerie of taxa perhaps described or undescribed.) Scott was correct to postulate that *orantain* might be a species – so likely so in fact, that he actually described it as such therein as first reviser! It is just as logical to consider it a subspecies of “*selenis*” or a full species than a subspecies of *tharos* with which no biological connection has been demonstrated. The fact that *orantain* has mtDNA similar to species *tharos* only proves it is not species *cocyta*. This is because *cocyta* and *tharos* were demonstrated by their mtDNA to not be closely related (Wahlberg et al., pg. 263).

Example. The nesting of *batesii anasazi* Scott, 1994 in clade E should be taken as evidence that *anasazi* is actually a genetically cryptic full species or a subspecies with the “*selenis*” with which it is nested rather than a subspecies of *batesii*.

Example. The location of various individuals, as those of *batesii lakota* in clades B, D, and H, can be taken as evidence that peripheral populations (e.g. Alberta “*lakota*”) are not subspecifically equivalent. Or, that a specific individual may be a hybrid.

The larger issue however, is that it is now evident that there are an undetermined number of *Phyciodes* species within both the *tharos* and *cocyta* mtDNA general haplotypes. This helps to explain the why of this statement in Wahlberg et al.: “However, species defined using non-DNA characters were not well defined using mtDNA characters, and indeed there were a large number of poly- and paraphyletic mtDNA lineages in different taxa of *Phyciodes*.” One point here, is that this is due (to an unknown degree) to the flaw of assuming the taxonomic delineations were correct to begin with, and then maintaining and incorporating them into the taxonomic placement of names within the cladistic conclusions.

The paper, *On the use of genetic divergence for identifying species*, by J. Willem H. Ferguson (2002), offers perspectives applicable to the taxa in the *tharos*-group of *Phyciodes*. Here are some excerpts (emphasis mine). The last quote is the final concluding remark.

“Coyne & Orr (1989) investigated pre-mating and post-mating isolation in several *Drosophila* species and concluded that, **among sympatric species pairs**, pre-mating isolation arise more rapidly than post-mating isolation. ...pre-mating isolation may arise before post-mating isolation in many cases. This would appear to indicate that the degree of genetic divergence required for pre-mating isolation is often less than that required for post-mating isolation.

“Firstly, species with strong pre-mating isolation and weak post-mating isolation are likely to have **little genetic divergence** because pre-mating isolation could be brought about by fewer than 10 loci.

“The aim of this paper is to contribute towards operational molecular yardsticks for identifying separate species. It does not aim to disqualify genetic divergence as a useful tool in systematics. It is useful in many ways, e.g. in population-level analysis and phylogeography, but **on its own it is not useful for identifying separate species**. Systematists need tools that are parsimonious, have well understood foundations, and that can be used consistently across a wide range of taxa. In terms of the identifications of new species, **genetic divergence fails** on all three of these criteria.”

The pattern emerging out of the *tharos*-group is that several to many species are present that are cryptic to human detection in one character but not in others (i.e. biological vs. molecular). Thus, to detect and define species, multi-level data **must** be examined. With respect to mtDNA analysis, a species will be demonstrated to be distinct from one species thereby, but not distinct from another thereby. For example, *P. diminutor* is proven to not be *P. tharos* thereby, but can not be proven to not be *P. cocyta* thereby. Likewise, *P. incognitus* is confirmed to not be *P. cocyta* thereby, but can not be proven to not be a *P. tharos* thereby. In both instances, sympatry and biology reveal the false positive of the mtDNA data.

A NEW CRYPTIC APPALACHIAN SPECIES

This author has been collecting and researching butterflies in the southern Appalachian Mountains since the mid 1970s. This has involved scores of days in the field over nearly 30 years at many and diverse locations in northern Georgia and western North Carolina. The areas of heaviest concentration have been in Macon and Clay counties, NC and Union and Rabun counties, GA.

Phyciodes tharos is common throughout the southern Appalachian region – except in dense forest. Many specimens of *tharos* were sporadically collected over those years from many sites. Due to the discovery of *P. batesii maconensis* in this region in June, 1992, all regionally encountered *Phyciodes* were given at least some visual attention during the *maconensis* May - June flight period and 1992 to 1998 research period. It was thus surprising on 16 May 2002 to discover a *cocyta* like *Phyciodes* phenotype never before personally encountered in the southern Appalachian region, and to do so within the *P. batesii maconensis* Jones Knob type locality area of Macon County, NC.

The area was a small narrow ridge top meadow surrounded by hardwood forest. This area had not been previously investigated. It is a man made meadow which exists as a remnant of an old apple orchard (determined by size/condition of apple trees). Both *tharos* and this large, red clubbed, *cocyta* looking entity were equally common on 16 May 2002. They were fairly easy to determine even in flight by size and flight pattern: *tharos* having a lower, faster and more zigzag flight. *P. tharos* tended more to the central meadow area while the large orange clubbed entity flew more to the margins, esp. females. *P. batesii maconensis* was also present but uncommon. In addition, a single *Chlosyne gorgone* (Hübner, 1810) was found that day for a new county record and only the second record for the state of North Carolina. This all indicated this small site to be rich in regionally unusual and rare butterflies. These butterflies would have simply been identified as *P. cocyta* had they been found later in the year – late June through August. But mid May is at least a month before the beginning of the *cocyta* flight period.

After this initial find, intensive searching was conducted in 2002, 2003 and spring of 2004 to locate new colonies from north Georgia through western North Carolina into extreme southwestern Virginia. Dozens of areas were searched but only two other colonies located, both in Clay County, NC. A third colony was discovered 18 August 2002 in north Georgia in Union County when Alan Wormington visited the area. Wormington's Georgian discovery and observations are significant in light of his research of Ontario *Phyciodes*. Wormington provided a copy, as follows, of his full report to the *Southern Lepidopterists News* (SLN) editor detailing his discovery and determination of this population.

“On August 18 I drove along Duncan Ridge Road (about 15 miles?) which is a gravel hne which starts at Hwy. 180 in Union County, Georgia. There were hundreds of crescents here and of dozens closely examined, all were definitely Orange (=Northern) Crescent (*cocyta*). According to various books, the species should not be present within 200-300 (?) miles of this area. Elsewhere on my trip (at lower elevations) I saw other crescents that were obviously *tharos*.

“Here in southern Ontario, I closely scrutinize all crescents as I have isolated a third "species" that is not recognized in the scientific literature. So I am quite familiar with crescents in a broad sense. The *cocyta* that I saw in Georgia looked no different than the *cocyta* in Ontario -- same for the *tharos*.”

By the time this record was published in the SLN, the *cocyta*-like Jones Knob entity had also been found at two sites in Clay County, NC and observed to be multiple brooded by rearing and wild caught specimens. Thus, when Wormington's record appeared in the SLN, the immediate suspicion here was that this was actually another colony of this *cocyta*-like taxon and not *P. cocyta*. This was confirmed in May of 2003 when I found it to also occur commonly at the Duncan Ridge Rd. site in a spring brood. This brood began to emerge May 2nd and was in full flight by May 10. *P. tharos* was already present in this area on April 15. These four *cocyta*-like populations have now been demonstrated to not be species *cocyta*, *diminutor* or *tharos* by collecting of adults, rearing families from all sites of sympatric taxa, and by mtDNA sequencing of sympatric specimens of both species.

Sites and Occurrence

The four sites new species *Phyciodes incognitus* has been found to occur at are: Jones Knob, 4000 ft., Macon County, NC; Buck Creek, 3200 ft., Clay County, NC; Sally Gap Rd., 2200, Clay County, NC; Duncan Ridge Rd., 3700 ft., Union County, GA. At Jones Knob, Sally Gap, and Duncan Ridge the species is common and found in narrow openings in rather day hardwood forest. At Buck Creek, it is uncommon and found either as a stray into more open areas or (more commonly) at the edges of hardwood forest or specific micro areas (i.e Jeep trails through forest).

At Buck Creek, *P. tharos* is very dominant. This is an extensive generally open Serpentine area.

At Sally Gap and Jones Knob, both species are found in equal numbers. Both areas are long narrow “cuts” through mature forest. Jones Knob is a ridge meadow, Sally Gap a gravel road. However, at the Sally Gap road location, *P. incognitus* is only found in one 300 ft. section going up a hill.

At Duncan Ridge Road, new species *P. incognitus* is very dominant. *P. tharos* is quite uncommon in this area and usually found in the few more open areas the road passes through. This is a narrow, shaded, one lane jeep trail often going along the side of the mountain with steep slopes on either side of the roadway. *P. tharos* is common on Hwy 180 leading to Duncan Ridge Road, especially at the open base areas at Vogel State Park. *P. incognitus* is absent from these lower open areas along the highway.

From May of 2002 to July of 2004 the following counties were searched extensively for additional colonies of *P. incognitus*. Rabun and Union counties, GA; Oconee County, SC; Grayson and Carroll counties, VA; Clay, Macon, Avery, Yancy, Haywood, Watauga, and Alleghany counties, NC. A few other counties were spot checked (stop and scan immediate area) while driving to / from main search areas. Field research dates were as follows: 2002: 18 April, 7 May, 16 May, 24-25 May, 2 Aug.; 2003: 14-15 April, 26 April, 2 May, 9-10 May, 27 May, 2 June, 5 Aug., 12-15 Aug., 21-22 Aug., 5 Sept.; 2004: 19-20 April, 20-21 May, 8-9 June, 28 June, 8 July. In the mountain region, *P. tharos* begins its flight between the end of March and mid April depending on elevation. *P. tharos* is more or less continual until frost. *P. incognitus* begins its flight between first and mid May depending on elevation. *P. incognitus* is mostly absent by the first week in July and does not appear again in numbers until late July and becoming common again by mid August with stragglers through September.

This phenology helps explain why *P. incognitus* has been missed by collectors in the historically well known, long, and heavily collected region of Duncan Ridge Road. (The overall region is known as Cooper’s Creek.) Most collectors do not venture into this area until the first of July when they are seeking *Speyeria diana* (Cramer, 1775), *Erora laeta* (W.H. Edwards, 1862) and other choice species found there. At that time, *P. incognitus* is virtually absent except for rare out of season solitary emerging individuals. Further, it is likely that its similarity to the common *P. tharos* would contribute to its being ignored by visiting lepidopterists interested in uncommon to rare taxa at that time.

Three other sites have been identified that appear to harbor populations of *P. incognitus*.

1) The historical site of the junction of the Kanawha River and Cabin Creek at Coalburg, West Virginia. At least one and possibly three of Edwards’ specimens sent for study are of this taxon.

2) The figures in *Butterflies of Ohio* (1992) of *P. pascoensis* (= *cocyta*) on Plate 29 from Elk County, PA are, with high likelihood, *P. incognitus*. These specimens are of the *incognitus* phenotype and lack the broad “smeared” dorsal patches of *cocyta*. Thus, *P. incognitus* ranges north well into the range of both *P. diminutor* and *P. cocyta*. Also, the 5th row figures on Plate 28 of this book are species *P. diminutor* not *tharos* f. *marcia* as indicated by smeared pattern, dates, small size, and red nudums.

3) Ted Wilcox of North Carolina has confirmed (pers. comm.) that a colony of *P. incognitus* occurs in Watauga County, NC. Ted stated: “The site is located in southwest Watauga County, NC near Avery County, NC and the Tennessee state line. Mostly wooded area with a narrow driveway with grassy area on each side. Elevation 3500ft.” Ted sent several diagnostic photos of specimens from this population (header figs., page 1). Photos taken 9 August 04.

Rearing

At least one family of both *P. tharos* and *P. incognitus* were each reared from Macon, Clay, and Union counties. Females of both species were collected the same day and same spot for each comparative rearing. 100% (n=300 +/-) of reared *P. incognitus* had fully orange to red nudums in both sexes (Figs. D & E). Five males had dark red nudum. 100% (n=140 +/-) of all reared *P. tharos* males had black nudums (Fig. A) with about 15% of those having orange-red tipped clubs. Approximately 70% of reared *P. tharos* females (n=200 +/-) had partially orange nudums (Fig. C), 25% all black nudums (Figs. B), and 5% all orange nudums. Both all black and all orange nudum female *tharos* were utilized as parent stock. Parent female club color had no relativity to female nudum color or male % of red tips in reared offspring.

All specimens of both species were reared under identical conditions and on the same species of Aster (not determined). The first rearing of each species was conducted under continual light to prevent diapause. All subsequent rearing was under natural photo period (reared in north facing windows). No larvae of either species entered diapause from May through August rearings. All rearings were in an air-conditioned environment with a consistent temperature of 75 to 78 degrees. The glass rearing containers (small baby food jars for early instars and gallon jars for final instars and pupation) were kept unventilated to insure high humidity (+90%). In the wild, this temp would not be much higher during the day but would be much lower at night. This would make the larvae develop slower in the wild. Humidity in their natural mountain habitat would be about the same. Food was changed daily.

In captivity, the minimum time from egg to adult was 35 days for each species. *P. tharos* tended to have a more extended developmental period – maximum of 59 days with about 20% of immatures taking prolonged developmental time. The *P. incognitus* egg to adult maximum was 50 days with only sporadic individuals taking prolonged development. This reflected the occurrence in nature of *P. incognitus* having two more or less well defined broods while *P. tharos* tends to occur in long overlapping ill-defined brood waves. The lowest numbers of *P. tharos* tend to occur in July (at locations over 3000').

The larvae of both species are very similar in all instars except for the shape and markings on the mature head capsules (Figs. 1-9). In *P. incognitus*, the head is frontally flatter and from the frontal view looks rectangular (height greater than width) or egg shaped; with less extensive white markings about the eye and toward the lower area of the frontoclypeus (Figs. 1-2, 5-6 left). In *P. tharos*, the head is frontally more bulbous and rounded in outline; with extensive markings about eyes and up aside the frontoclypeus (Figs. 3-4, 6 right, 7-9). The sum effect is that the heads are diagnostic for species determination. Note the similarity of Edwards' BNA drawing of a *tharos* larval head (Fig. 8) and the specimen in Fig. 9.

The pupae vary greatly in color in both *P. tharos* and *P. incognitus* (Figs. L-P) in the region, and to the same degree. (*P. tharos* also has a blackish gray morph (rare) and a pale morph (uncommon) as in Figs. N & O.) However, in *P. tharos* the vast majority of all pupae from 4 families were form M, while in 5 families of *P. incognitus*, the majority of pupae were form O. The pupae of *P. tharos* seemed "rougher" on the thorax than in *P. incognitus* (Figs. Mb & Pb). No definitive pupal color or morphological character differentiating the two species has been determined – only generalities.

All reared *tharos* (Figs. 40-41) were smaller than reared *incognitus* (Fig. 38) (as they are in nature). All reared specimens of both species had the VHW marginal dark patch correspondingly darker than in their wild counterparts. All reared specimens were very uniform in their respective phenotypes for each species. This was surprising for *tharos* as it has a wide variety of co-occurring dorsal pattern phenotypes in the wild. Note that figures 17-19, 22-24 were all caught the same day and place. All of these specimens were also sent to Wahlberg for mtDNA sequencing who reported that their sequences all nested within *tharos*. The variation contrast between wild and reared *tharos* poses the possibility that another undescribed *tharos* like species is present in this region. This is especially true at the Buck Creek location where a "tharos" (Fig. 24) is found throughout the season with heavily patterned dorsal wings as in *P. diminutor* (Fig. 25) but with all black clubs and *tharos* mtDNA.

Uniformity of captive rearing conditions alone would not account for the lack of this phenotypic variation in *tharos*. This is because in the wild all simultaneous broods are also subject to identical (though different from captive) conditions. It is not logical that large numbers of similarly fresh, or worn, wild individuals of the same species would be found at the same place and time with notably different markings, yet have this variation non-existent in reared families. What has been found in many rearings (by this worker) of the *Phyciodes* species in western North Carolina, is that all three taxa (*maconensis*, *tharos*, and *incognitus*) produce very stable phenotypes rearing after rearing (family after family) for each species.

Further, we now know that the many phenotypes reared and figured by Edwards are partially due to his having reared multiple species and not “merely” seasonal forms of one species. Thus, it has never been demonstrated that rearing single eggs clusters will yield very different dorsally marked *tharos* individuals. (Edwards’ obtained dorsal variants by placing some pupae “on ice”, which yields aberrations, not natural forms.)

With the recognition of species *tharos*, *diminutor*, *cocyta* and *incognitus* in the East, it is now evident that all that was considered “*tharos* variation” by past generations of lepidopterists was a severely flawed assessment of the Eastern *Phyciodes*. Hopefully, this old mindset will not be hard to discard. Today, the occurrence of phenotypically different sympatric *tharos*-group populations should be viewed with an inclination that sibling species may be present. This is complicated by the fact that we now know that some species in this group have similar mtDNA (i.e. *diminutor* and *cocyta*, and *tharos* and *incognitus*). All of this emphasizes Scott’s 1998 position that rearing is essential to correctly determining the taxonomy of the *tharos*-group.

Independent Analysis (Single vs. Multi-tool Analysis)

Twelve specimens of *P. incognitus* were sent to Wahlberg for mtDNA sequencing. They were from various sites and dates. All of these individuals had COI sequences similar or identical to *P. tharos*. As a molecular biologist, Wahlberg determined these specimens as *P. tharos* regardless of their larger size, different phenotype, different morphology, and sympatry. However, when later presented with the rearing data, he also acknowledged the potential of a genetically cryptic species. Photos of larvae, pupae and adults of *P. incognitus* were sent to Scott for his assessment. As a taxonomist, Scott determined these **same** specimens as *P. cocyta*. In this we see how specialists tend to render conclusions out of their own field of expertise. Without any other data, their conclusions (while opposite) would both be considered correct from the limited perspective of **single tool analysis**.

But when assessed with **multi tool analysis**, this taxon was evidenced to be neither species *cocyta* or *tharos* – thus exposing both single-tool based conclusions as incorrect. One element of the multi-tool analysis was Wahlberg’s mtDNA sequencing which confirmed that this Appalachian taxon is not species *cocyta*. Another element was Scott’s determination (which included knowledge of rearing results) that this taxon is not species *tharos*. In these conclusions, they were both correct. The third element was the consistent rearing data (including larval head morphology). The fourth was sympatry, but restricted to select locations – *tharos* being found almost everywhere but *incognitus* restricted to forest ecotones and, so far, at only a few sites from north GA to PA (suspected).

One specimen each of *P. tharos* and *P. incognitus* was sent to David Wright for dissection and photography of genitalia (Figs. F-K), and his opinion. His observations were:

“On the balance, after studying the male genitalic mounts under the microscope and as digital images, I can not find any significant differences between your *Phyciodes tharos* and new species. That may be an important finding, indicating that the n. sp. is closely related to *tharos*, at least closer to *tharos* than to *batesii* or any stray western taxon. In summary, these findings place these two species (*tharos* and n. sp.) in the *tharos*-group, according to Scott (1994), and closest (or identical) to the *tharos-cocyta* subgroup.”

Figures F (*tharos*) and G (*incognitus*) are dorsal views of the tegumen and the two gnathos hooks. Figures H and K are the aedeagus of *incognitus*, with K being a magnification of its strongly toothed terminal tip. Figures I (*tharos*) and J (*incognitus*) are of the medial view of the valve. Personally, I find the differences in overall shape of the structure, number and positions of hairs worthy of further investigation. In particular, the tuft of hairs on the lower valve stem of *tharos* which is absent in *incognitus*. (These printed images can be greatly magnified (zoomed) in the CD version of this paper.) At high magnification, several minute differences can be noted in Figs. I & J. The question of whether any of this is taxonomically significant will require multiple dissections. The female genitalia remain to be examined.

Phyciodes incognitus Gatrell, new species

Diagnosis and description. (Figs. 1-43). The primary distinguishing character traits between *P. tharos* and *P. incognitus* are: **1)** larger size of *incognitus* (often much larger (Figs. 17 vs. 30)), **2)** orange nudum in both sexes of *incognitus*, all black nudum in *tharos* males and variable nudum color (all orange to all black) in female *tharos*, **3)** less seasonal variation of male VHW color & pattern in *incognitus* (Figs. 27, 32, 35 vs. 29, 40); striated lines on VHW in *incognitus* males always (and many females) rust-orange and well developed in all broods, often brown in *tharos* and less developed (to absent) in *tharos* summer broods; VHW ground color of *incognitus* males a dark rich yellow in summer brood, usually a pale straw color in summer *tharos* (both males and females), **4)** DHW of *tharos* with black line predominantly continuous across postmedian area (through fulvous patch), in *incognitus*, this line is either faint to broken at cells M₁ and M₂, esp. M₂, **5)** central black patch along inner margin of DFW of *incognitus* always large, squarish, and prominent in both sexes, this patch very variable in *tharos*, usually narrow, when wide, dusted in center with fulvous scales, female *tharos* often lack this dark patch; dorsal pattern much the same in both sexes of *incognitus*, often moderately different between sexes in *tharos*, **6)** shape and light markings of larval heads: head elongate and less marked in *incognitus*, head round and heavily marked in *tharos*. The primary distinguishing character traits between *P. incognitus* and *P. cocyta* are: **1)** dorsal fulvous markings in *incognitus* males more broken into spot-bands with median and submarginal bands of FW different shades of fulvous, in *cocyta* males, both fore and hind wing fulvous areas usually same color with median and submarginal bands usually fused (however, the DHW dark postmedian line is often lacking in *incognitus* fusing the fulvous patch also), **2)** VHW of *incognitus* usually with darker marginal brown patch, **3)** dorsal markings in sexes of *cocyta* dissimilar to each other (Figs. 42-43), in *incognitus* the sexes are usually marked nearly alike dorsally (30-33), **4)** size difference between sexes in *cocyta* much greater than in sexes of *incognitus*, **5)** mtDNA of *cocyta* and *incognitus* distinct, **6)** *cocyta* single brooded (late summer & fall), *incognitus* multi-brooded (spring to fall).

Types. *Holotype* ♂ (Figs. 30/35): GEORGIA: Union County, Duncan Ridge Road, 20 May 2004, 3700', leg. R. Gatrell. *Allotype* ♀ (Figs. 31/36): same data as holotype. *Paratypes*: 94 ♂♂, 43 ♀♀ (wild caught: 83 ♂♂, 32 ♀♀; reared: 11 ♂♂, 11 ♀♀). Wild caught paratypes. By dates: earliest, 27 April 1999, latest, 5 September 2003, none ex. July. By location and total number: GEORGIA: Union County, Duncan Ridge Road: 58; NORTH CAROLINA: Macon County, Jones Knob: 29; Clay County, Buck Creek: 8; Sally Gap: 20. I prefer to not use reared specimens as type material, these are included as a reared sample. The 1999 specimen was found in old papered material from Jones Knob. Holotype, allotype and all but 2 paratypes are currently housed in the TILS Museum of the Hemispheres, Goose Creek, South Carolina. Some of the paratypes will be deposited in other Museums to be determined later. One pair of topotypical paratypes in collection of David Wright, Lansdale, PA. The holotype may be transferred to the Carnegie Museum, Pittsburgh, PA.

Type locality. Duncan Ridge Road, Union County, Georgia.

Etymology. *Incognitus* refers to its similarity with *P. cocyta*. **Common name:** Mimic Crescent.

Remarks. In the mountains, *P. tharos* is smaller than at lower, warmer locations. The Figs. 17 & 22 pair are smaller than average size for the mountain region. The two males and female in Figs. 19, 24, and 23 are average sized for that region. Male specimen Fig. 18 is large for that region. The Figs. 27 & 28 *P. incognitus* specimens are somewhat small for this taxon, the holotype is a bit larger than average and allotype very large. It is actually larger than it looks as its forewings are drooped at the tips; it is 42mm across with wings flattened to proper position. 34 mm is average expanse (outer margin to outer margin) for males and 38 mm for females of *P. incognitus*. Thus, *P. incognitus* and *P. tharos* size comparisons must be done based on a same location to same location basis. *P. tharos*, for example, from places like Florida in fall can be quite large. This would make museum comparisons falsely express just how much bigger *incognitus* is than *tharos*.

P. incognitus is difficult to describe in unique character traits due to its similarity to both *tharos* and *cocyta* and variability of all three taxa. It is thus hard to state that X character is always a sure ID field mark – except, for the club color in male *incognitus* compared to *tharos*. In subtle characters, and in side by side comparison, the darker (richer) ground of the VHW and strong orange lines are a good ID character between *incognitus* and *tharos*, except for those occasional *tharos* which are also marked like this. There is a tendency for *incognitus* to have a complete, and at times quite prominent, black

medial line of spots on the VFW – even more pronounced than in the holotype. However, *tharos* will at times have this developed also but not to such a high degree. This line may be a good character to separate *incognitus* from *cocyta* as I have not seen *cocyta* exhibit this character. The only sure way to tell some specimens of *incognitus* from *cocyta* will be by DNA. A few *incognitus* were collected with fused large patch dorsal fulvous and very light hindwings with light brown marginal patches that look identical to *cocyta*. *P. diminutor* was not mentioned in the comparative diagnosis because it is so small and should be easily distinguished by that character alone if and when *P. diminutor* and *P. incognitus* are found together. *P. cocyta* is in-between *P. diminutor* and *P. incognitus* in size and the confusion is expected to be between *cocyta* and *diminutor* which look exactly alike except for size.

Many more specimens were seen in this study than were collected. Many were netted, examined, and released.

Future research is planned, depending on financial support, to rear specimens from female “*tharos*” that seem to be phenotypically coordinated with the very fulvous form of *tharos* in this region (Fig. 24). Copulated pairs have not often been encountered in this region of any *Phyciodes*. It would be ideal to rear specimens from such females. It is normal to find very fulvous individuals of *P. tharos* very early in spring from the mountains to the coastal plain. But that (cold induced) phenotype is simply boldly and broadly patterned, while the suspicious smeared form is found consistently all season.

With four taxa now known to be present in the East that were formerly all considered just forms of species *tharos*, conservationists need to realize that the “abundant” *tharos* is not nearly as common as formerly supposed. Studies are called for to determine just what taxa are present in any given area in the East and what is the populational size and habitat area for each of these species. In this vein, *P. incognitus* is presently confirmed by voucher specimens from only four sites in three counties. One would be remiss to assume that this taxon will be found “throughout” the Appalachians. There have been a lot of collectors, and now watchers, documenting butterflies in southern Appalachians for a long time and this taxon, if found, would have at least shown up as an incorrect ID of *P. cocyta*. But, it is reasonable to assume that it will be found in other locations with the aided awareness provided by this research. The Wilcox find is a good example of this.

Evolutionally, the view here is that *P. incognitus* is ancestral to both *P. tharos* and *P. cocyta*, that is, it is older than both. It is also interesting to this author that this region (mid to high elevation Appalachians) and habitat (dry hardwood forest) is the eco-niche of the univoltine very large swallowtail, *Pterourus appalachiensis* Pavulaan & Wright, 2002, and also the large univoltine Appalachian Azure, *Celastrina neglectamajor* Tutt, 1908. These three mostly Appalachian endemics are all considered by this worker to be older taxa than their regional congeners. While all their respective nearest relatives are smaller, the size and voltinism of these three would indicate a more highly evolved adaptation to the cooler climate of these mountains – they have been there longer or, even evolved there. In other words, their multi-brooded wide ranging kin would have evolved elsewhere and are still in the process of adapting to this wetter, colder, and shorter summer environment.

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