Description of an enigmatic new species of *Chloreuptychia* Forster, 1964 from Panama (Lepidoptera: Nymphalidae: Satyrinae)

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Abstract: We here describe a new satyrine species in the genus *Chloreuptychia* Forster, 1964, *C. gordonsmalli* Thurman, MacDonald & Nakahara, **n. sp.,** based on four historical specimens all originating from central Panama. Despite the lack of genetic data for this new taxon and the polyphyletic nature of *Chloreuptychia*, some genitalic characters suggest that this new species might be a member of true *Chloreuptychia*, and if so would represent the first known species of the genus outside of the Amazon basin. We provide illustrations of the adults and genitalia, as well as images of the habitat of the type locality visited by the pioneering and imaginative lepidopterist, Gordon B. Small, Jr., who collected the entire type series of *C. gordonsmalli* **n. sp.** about 45-50 years ago. *Chloreuptychia gordonsmalli* **n. sp.** has not been observed subsequently, despite extensive field work in Panama by a number of butterfly researchers.

Key Words: Euptychiina, Gordon B. Small, taxonomy

INTRODUCTION

Although the nymphalid genus *Chloreuptychia* Forster, 1964 is highly polyphyletic (Nakahara *et al*., 2019), all taxa associated with this genus in the Lamas (2004) checklist are found exclusively east of the Andean divide, with the exception of the genus *Amiga* Nakahara *et al.*, 2019. In particular, a number of taxa (*Chloreuptychia marica* (Weymer, 1911); *C. herseis* (Godart, [1824]) and *C. rectilinea* Brévignon *et al*., 2019) are concentrated in the so-called "*Archeuptychia* clade", which contains over 30 species, most of which are almost entirely cis-Andean in distribution with the exception of *Pseudeuptychia hemileuca* (Staudinger, [1886]). Nevertheless, the type species of *Chloreuptychia*, *Papilio chloris* Cramer, 1780 (replacement name: *Euptychia chlorimene* Hübner, [1819]) is distantly related to these taxa (Espeland *et al*., 2019), suggesting that the clade consisting of a few species, all known from the Amazon basin, including *P. chloris*, should be regarded as true *Chloreuptychia*, and a generic revision is underway by SN and collaborators (Nakahara *et al.*, in prep). Thus, the generic classification of aforementioned taxa in the "*Archeuptychia* clade" (*sensu* Espeland *et al.,* 2019) should be evaluated based on the ongoing molecular phylogenetic study with support from morphology (Nakahara *et al*., in prep.). The ongoing molecular work further suggests that *Euptychia hewitsonii* Butler, 1867 and several other morphologically similar species, all known from the Amazon basin, form a clade; a study is underway by SN, KRW and collaborators to describe a new genus for this clade.

Recent years have seen a number of new butterfly species discovered from Panama and neighboring countries, resulting from an extensive faunistic study of Panamanian butterflies by JRM, AT and colleagues (e.g., Anderson *et al*., 2019; Nakahara *et al*., 2018a; 2020a; 2021). However, it must be noted that our knowledge of Panamanian butterflies was already significantly advanced by the efforts of the pioneering lepidopterist, Gordon Burgess Small, Jr. (1934-1989) (Nicolay, 1989) (Fig. 1), whose collection now housed at the USNM perhaps represents one of the most comprehensive butterfly collections generated for a country of such diversity. The significance of Gordon's collecting in Panama can be seen through a remarkable fourteen species-group names of butterfly taxa dedicated to him as a result of his collecting, with him being the sole collector of the entire type series on several occasions (*Catasticta sisamnus smalli* Eitschberger & Racheli, 1998 (Pieridae); *Symbiopsis smalli* Nicolay, 1971 (Lycaenidae); *Nymphidium smalli* Callaghan, 1999; *Detritivora smalli* Gallard, 2008; *Metacharis smalli* Hall, 2005; *Archaeonympha smalli* Hall & Harvey, 1998; *Charis smalli* Hall & Harvey, 2001 (all Riodinidae); *Myscelia leucocyana smalli* Jenkins, 1984; *Callithomia hezia smalli* Fox, 1968; *Memphis smalli* Riley & Dias, 2021; *Agrias zenodorus smalli* Miller & Nicolay, 1971; *Adelpha leucophthalma smalli* Willmott, 2003; *Morpho cypris smalli* Blandin, 2007; *Praepronophila perperna smalli* Pyrcz & Viloria, 2006 (all Nymphalidae); all taxa listed in their original combination). We here name and describe a new species of *Chloreuptychia* known to us from four individuals all collected by Gordon Small to once again remind us of his efforts and seemingly

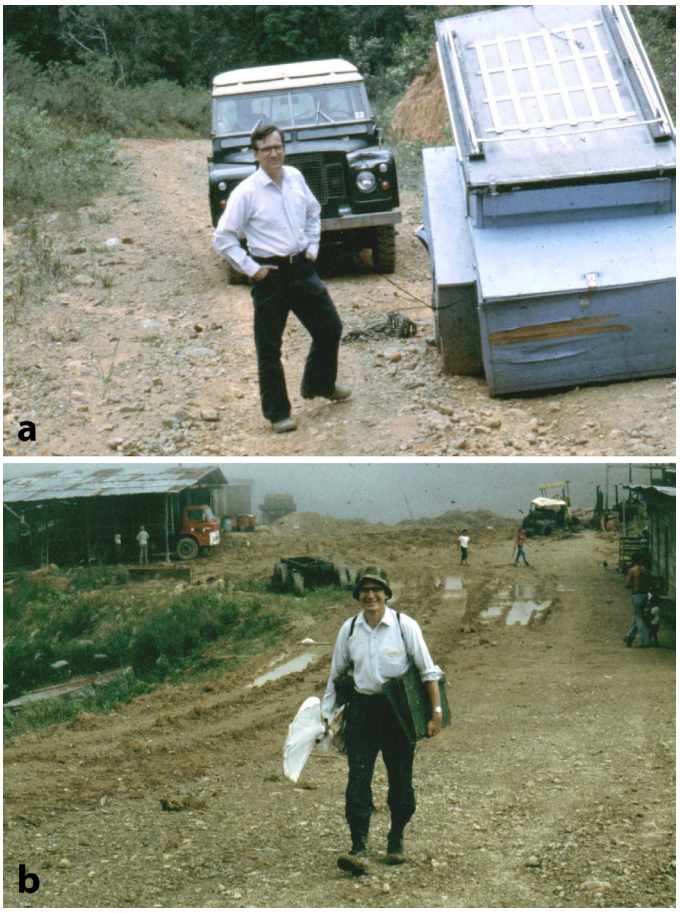

Figure 1. The late Gordon Small in Panama (photographed by AT): a) at Azuero Peninsula in 1978 during AT's first collecting trip with Gordon, where he collected specimens of what was described as *Adelpha leucophthalma smalli* in 2003; b) at Cerro Colorado in 1978, during AT's second and last trip with Gordon.

endless contributions toward documenting the rich Panamanian butterfly fauna. As indicated below, this new *Chloreuptychia* species may form a clade with the type species of the genus (*Papilio chloris*), but DNA sequence data are needed to confirm its generic classification. We believe that description of this distinctive and rare species is important to hopefully enable its rediscovery and eventual confident evaluation of its higher classification.

MATERIALS AND METHODS

Standard techniques were used for genitalic dissection, namely, abdomens were broken off and heated in 10% KOH at 80°C, dissected, and subsequently stored in a small glycerol-filled vial (male genitalic dissection vial no. SN-20-88; female genitalic vial no. KRW-USNM-06 4/15). We used a Leica MZ 16 stereomicroscope with a camera lucida attached for dissection and genitalia illustration. All relevant morphological study was conducted at the McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, Gainesville, USA (**FLMNH**); two individuals were borrowed from the National Museum of Natural History, Smithsonian Institution, Washington, DC, USA (**USNM**). The terminology associated with wings and genitalia follows Nakahara *et al*., (2018a, b), and the following abbreviations are used: **DFW**: dorsal forewing; **DHW**: dorsal hindwing; **VFW**: ventral forewing; **VHW**: ventral hindwing.

RESULTS AND DISCUSSION

Chloreuptychia gordonsmalli Thurman, MacDonald & Nakahara, **new species**
(Figs 2-5)

Systematic placement and diagnosis. Attempts to amplify fragments of the COI "barcode" of the female paratype (DNA voucher LEP-17008) failed (see Nakahara *et al.* 2020b: Table 1 for primer information). In addition, despite the extensive field work of AT and JRM in Panama over the past couple of decades, *Chloreuptychia gordonsmalli* **n. sp.** was not encountered, and we have not located any recently collected individuals in private or public collections. Therefore, the systematic placement of *Chloreuyptychia gordonsmalli* **n. sp.** is based solely on interpretation of morphology. As stated above, *Chloreuptychia* is polyphyletic, and some superficially similar species discussed below do not form a clade with the type species of the genus. The following characters support a close relationship between *C. gordonsmalli* **n. sp.** and the type species of *Chloreuptychia*, *Papilio chloris* (i.e. *C. chlorimene*): 1) distal portion of the valvae not terminating in a blunt projection ; 2) membranous lamella antevaginalis. On the other hand, *C. gordonsmalli* **n. sp.** differs from *C. chlorimene* and *C. agatha* in possessing a forewing recurrent vein, in having forewing discocellular vein m_1-m_2 rather straight (not curved inwards), and lacking the androconial scales folded inside the inter-segmental membrane between the 8th and 9th (genital capsule) abdominal segments (visible after heating in KOH), a potentially significant morphological character; obtaining molecular data would thus be extremely valuable towards assessing its systematic placement. The male of *C. gordonsmalli* **n. sp.** is phenotypically easily distinguished from males of *C. chlorimene* and *C. agatha* (Butler, 1867) by the presence of a purple sheen on both DFW and DHW, whereas lilac coloration is restricted only to the posterior side of the DHW in male specimens of *C. chlorimene* and *C. agatha. Chloreuptychia herseis* (Godart, [1824]) and *C. rectilinea* Brévignon, Rosant, Lamas & Willmott, 2019 also possess a purple sheen on the DFW and DHW, but this feature is somewhat insignificant in the male of these two species, whereas clearly visible in the male of *C. gordonsmalli* **n. sp.** The male of *Chloreuptychia marica* (Weymer, 1911) is similar in this respect to *C. gordonsmalli* **n. sp.**, but a number of characters mentioned below separate these two taxa. The male of *C. gordonsmalli* **n. sp.** possesses a single pupil in the ocellus in VHW cell Cu_1, whereas *C. herseis*, *C. rectilinea*, and *C. marica* all possess two pupils in this ocellus. These three species also exhibit a distally bent VHW postdiscal band, where the bent portion touches the incomplete elongated ocellus in VHW cell M_3 (note the VHW postdiscal band of some specimens of *C. marica* is straight). *Chloreuptychia herseis* and *C. marica* also exhibit a posteriorly curving VHW postdiscal band (i.e., bends inwards below 2A), whereas this band is

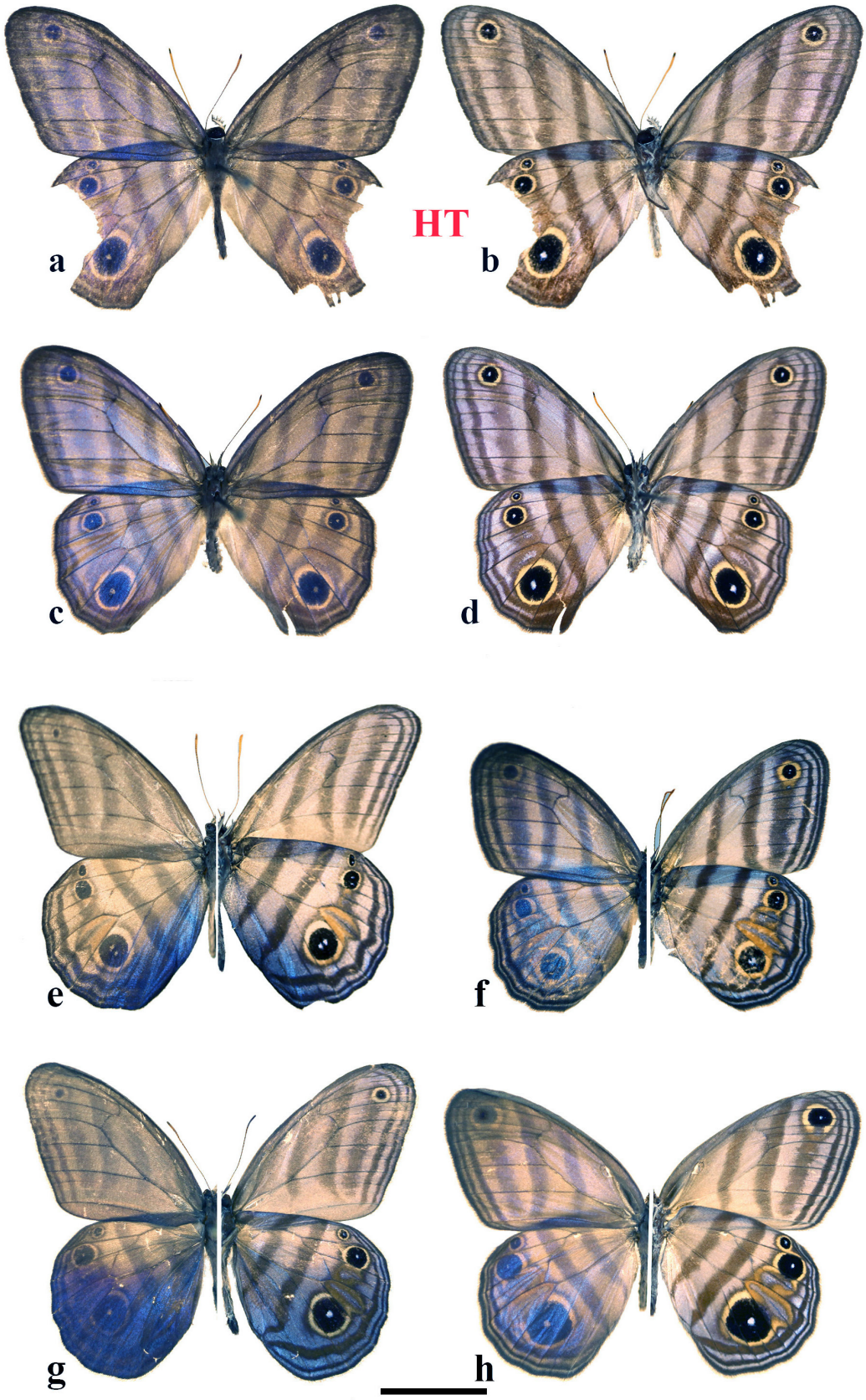

Figure 2. Adults of *Chloreuptychia gordonsmalli* **n. sp.** and members of true *Chloreuptychia*: a) dorsal surface of holotype male from "Colon", Panama (USNM 2073014); b) ventral surface of (a); c) dorsal surface of paratype female from Cerro Jefe, Panama; d) ventral surface of (c); e) *Chloreuptychia chlorimene* male from Pará, Brazil [?] (FLMNH-MGCL Specimen 295861); f) *Chloreuptychia chlorimene* female from Orellana, Ecuador (FLMNH-MGCL Specimen 263427); g) *Chloreuptychia agatha* male from Amazonas, Brazil (FLMNH-MGCL Specimen 263388); h) *Chloreuptychia agatha* female from Amazonas, Brazil (FLMNH-MGCL Specimen 263391). Scale bar = 10 mm.

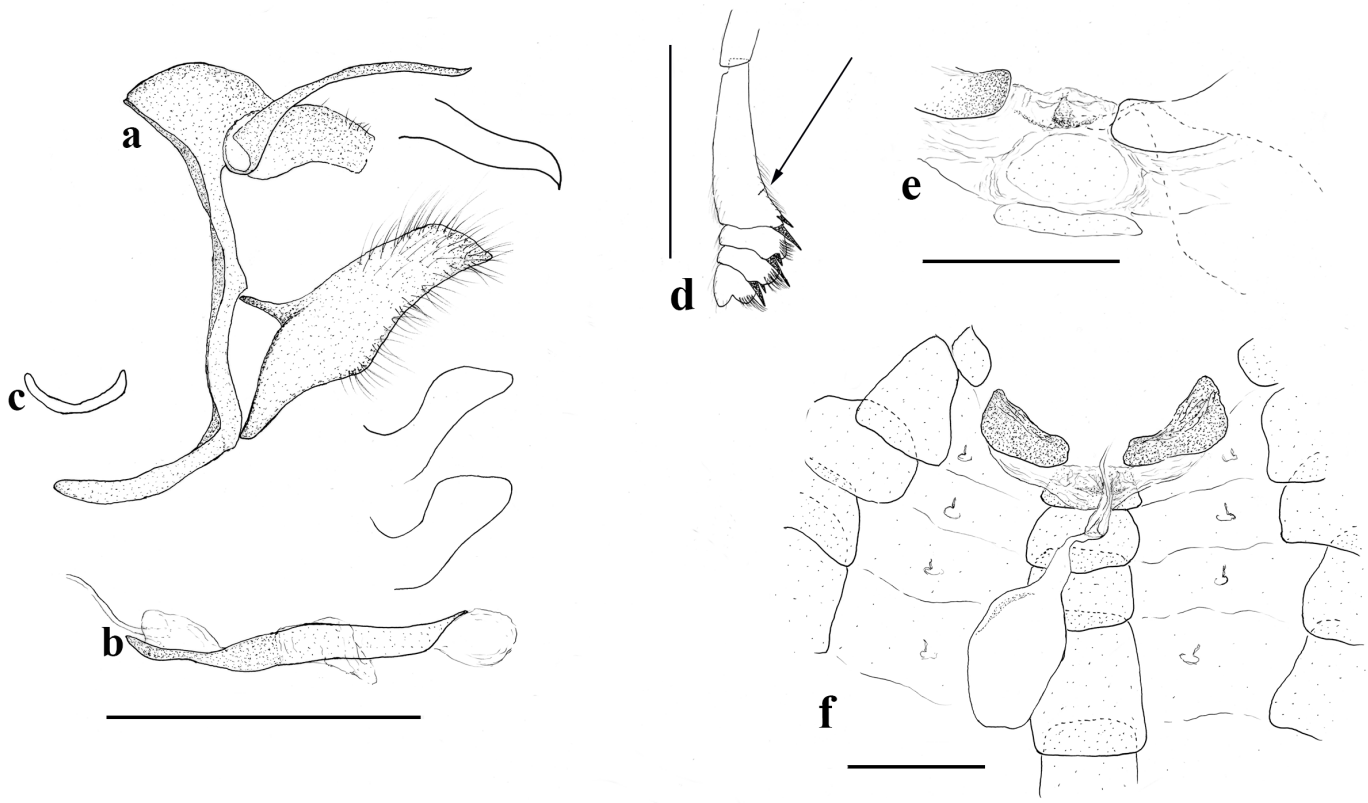

Figure 3. Genitalia and female foreleg of *Chloreuptychia gordonsmalli* **n. sp.**: a) male genitalia in lateral view (without phallus, posterior half of uncus drawn from HT by rubbing scales off abdomen), with outline of the distal side of valvae of *C. chlorimene* (above) and *C. agatha* (below) based on males figured in Fig. 2; b) phallus in lateral view; c) juxta in posterior view (this illustration is not to the scale); d) female foretarsus indicating fused first and second segment; e) female genitalia in ventral view (intersegmental membrane expanded); f) female genitalia in dorsal view (intersegmental membrane folded). See "Types" section for genitalic vial information. Scale bar = 1 mm.

straight and fused with the VHW submarginal band posteriorly in *C. gordonsmalli* **n. sp.** These aforementioned phenotypic characters can be used to distinguish females of these relevant taxa in the same way, except for the purple sheen on both DFW and DHW, which is a character present on the females of *C. chlorimene* and *C. agatha.* Thus, it would be important to consult the genitalic characters as provided below. The male genitalia of *C. gordonsmalli* **n. sp.** are also distinguishable from those of *C. agatha*, *C. chlorimene*, *C. herseis*, *C. rectilinea*, and *C. marica* by having a rather evenly broad distal half of the valvae with an angular dorsal margin (resulting in a somewhat rectangular appearance in lateral view). The dorsal margin of the distal portion of the valvae is more rounded, in particular, in *C. herseis*, *C. rectilinea*, and *C. marica*, resulting in the distal portion of the valvae appearing inflated. Furthermore, the valvae terminate distally in a short blunt projection in these three species (most apparent in *C. marica*). On the other hand, *C. chlorimene* and *C. agatha* share a somewhat similar overall appearance of the valvae with *C. gordonsmalli* **n. sp.** compared to these three species, except for having a concavity just distal of costa in lateral view (straight in *C. gordonsmalli* **n. sp.**) (see Fig. 2), although the apparent lack of androconial scales folded inside the inter-segmental membrane between the 8th and 9th (genital capsule) abdominal segments distinguishes *C. gordonsmalli* **n. sp.** from *C. chlorimene* and *C. agatha*. The female genitalia are also informative since *C. herseis*, *C. rectilinea*, and *C. marica*

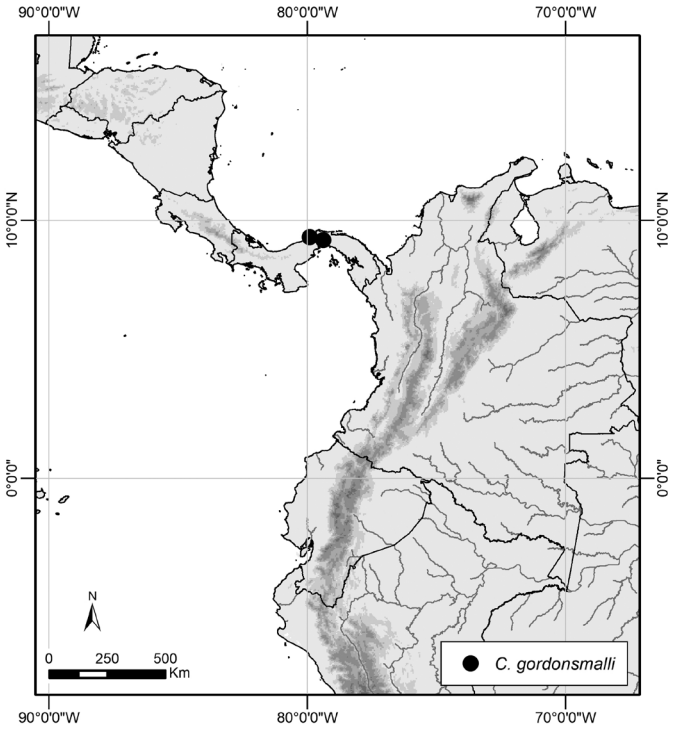

Figure 4. Distribution of *Chloreuptychia gordonsmalli* **n. sp.** in Central America.

Figure 5. Type locality of *Chloreuptychia gordonsmalli* **n. sp.** in Panama: a) general view of the type locality, Santa Rita Ridge; b) one of the authors (JRM) in the habitat of *Chloreuptychia gordonsmalli* **n. sp.** (Gordon Small's "Colon").

all possess a plate-like weakly sclerotized lamella antevaginalis as opposed to the almost membraneous (slightly sclerotized just ventral of ostium bursae) lamella antevaginalis of *C. gordonsmalli* **n. sp.** This membranous lamella antevaginalis is also shared with *C. chlorimene* and *C. agatha*, but the lateral plate of the 8th abdominal segment is more triangular (near ostium bursae) in ventral view in these two species, in addition to the weakly sclerotized region in the intersegmental membrane of 7th and 8th abdominal segment being more triangular. The fused first and second female tarsomer (Fig. 3d) is also distinctive and separates the female of *C. gordonsmalli* **n. sp.** from taxa discussed herein.

Description. MALE: Forewing length 21.0-22.8 mm (n=2). **Head.** Eyes naked (i.e., no visible setae); labial palpi with white and brownish scales and elongated hair-like scales, third segment porrect; antennae orangish, distal few antennomers darker, antennae shorter than length of forewing discal cell (from base to discocellular vein), club insignificant. **Thorax.** Pterothoracic leg femur grayish, tibia and tarsus ocher with pair of tibial spurs equal in length at distal end of tibia, spines present mainly on ventral side as well as laterally on tibia and tarsus (due to limited number of specimens, further examination not performed). **Abdomen.** 8th tergite a narrow strip at base of 8th abdominal segment; androconial scales not observed during the dissection of SN-20-88. **Wing venation, shape and pattern.** Forewing recurrent vein present in discal cell; hindwing humeral vein developed; purple sheen present on DFW and DHW, otherwise wing shape and pattern as illustrated, and described in comparison with phenotypically similar species above (see "Systematic placement and diagnosis"). **Genitalia.** Setae visible on dorsal surface of uncus, posterior half of uncus not found in SN-20-88, otherwise male genitalia as illustrated (Figs 2a-c), and described in comparison with phenotypically similar species (see "Systematic placement and diagnosis").
FEMALE: Forewing length: 2.07-21.4 mm (n=2)
Similar to male except as follows: Foretarsus first and second segment apparently mostly fused and distal three tarsomers divided (Fig. 3d) (n=1); forewing somewhat rounded and broader. **Abdomen and genitalia.** Eighth tergite fully developed; as illustrated (Figs 2d, c); intersegmental membrane of 7th and 8th abdominal segment pleated and expandable, weakly sclerotized region present as rounded patch, lamella antevaginalis membranous, apparently slightly sclerotized just ventral of ostium bursae; ductus seminalis exiting roughly at middle of ductus bursae, pair of rather short signa located laterally on corpus bursae.

Types. HOLOTYPE male from Colón , Panama (i.e. Santa Rita Ridge; see discussion below), with the following labels written verbatim: // Colon 1500 Panama 3 Jan 69// Gordon B. Small Collection// Genitalic dissection, USNM KRW-USNM-05 4/15 S. Nakahara, *Chloreuptychia* sp. ♂ [dissection not performed]// Loan from USNM 2073014// (USNM).
PARATYPES: male with the following labels written verbatim: //Colon Pan. 1500' 2-9-69// FLMNH-MGCL Specimen 295850// Genitalic vial SN-20-88 S. Nakahara// Allyn Museum Acc. 1974-9// (FLMNH); two females with the following labels written verbatim: //Colon Pan. 2-2-69// FLMNH-MGCL Specimen 263381// Allyn Museum Acc. 1974-9// EUPTYCHIA agatha// (FLMNH); //PANAMA : Panama prov. Cerro Jefe 2000' coll. G.B. Small// Gordon B. Small Collection// DNA voucher LEP-17008// Loan from USNMNH 2073014// Genitalic dissection, USNM KRW-USNM-06 4/15 S. Nakahara, *Chloreuptychia* sp. ♀// (USNM).

Etymology. This specific epithet is in honor of Gordon B. Small, Jr., a prolific, energetic, imaginative and pioneering lepidopterist who collected the entire type series of this species and brought many new butterfly taxa to science through his extensive collecting in Panama, as well as serving as an inspiration and mentor to many who knew him. The name is considered as a Latinized masculine noun in the genitive case.

Distribution and Habitat (Figs 4-5)**.** *Chloreuptychia gordonsmalli* **n. sp.** is known to date from two sites in central Panama, Cerro Jefe and "Colon" (i.e. Santa Rita ridge). The handwritten label associated with the holotype and pair housed at FLMNH indicates the type locality as "Colon, Pan. [Colón, Panama] 1500' without more detailed information about the provenance of these specimens. Despite not having its collector indicated on the label, the handwriting of the label is that of Gordon Small and it is typical of his labels from 1969 (R. K. Robbins, pers. comm.). This inference is supported by a male paratype with an identical handwritten locality label from the Gordon B. Small Collection housed at the USNM (see label information above). Furthermore, JRM took notes based on the labels from some of Gordon Small's collection at USNM and also found evidence that Gordon Small was at his "Colon" location

of 1500' on the same date indicated on the male paratype at FLMNH (9 Feb 1969), based on another specimen (*Paiwarria antinous* (C. Felder & R. Felder, 1865)) (Lycaenidae) in his collection which bears the same data as the male paratype of *C. gordonsmalli* **n. sp.** According to R. K. Robbins (pers. comm.), "*Gordon Small started collecting in the 1960s along a forested road that began to the southeast of Colón on the Trans Isthmus highway. The forest along the road began at about 500 feet of elevation and continued to over 1500 feet of elevation, although the road was not possible to pass beyond this point. Gordon mentioned [to R. K. Robbins] that it was the highest elevations in the Canal Zone area, and he found many species at 1,500 feet that were rarely encountered in the Canal Zone lowlands (e.g.,* Evenus candidus*). Gordon was not sure how to label specimens from this area. Although residents in the area called this place "Santa Rita Ridge", the name never appeared on any map that Gordon could find and there were no named towns anywhere along the road. Eventually, Gordon decided to label specimens from this site Santa Rita Ridge, "Colon, 1500'". Despite the name "Colon" used as part of the locality, Gordon intended to distinguish this site from Colon by specifying its elevation as 1,500 feet since Colon is at much lower elevation.*" This site corresponds to the site described as "Cerro Santa Rita" in Ridgely (1976: 359). In March 2021, during the course of preparing this article, JRM and AT visited Santa Rita Ridge (recorded GPS point: 9°21'54.0"N, 79°42'11.5"W; 473 m; see Figs 5a-b) to assess the habitat and attempt to record further individuals of this enigmatic species. Although no *C. gordonsmalli* **n. sp.** were observed, we are able to provide information about other species collected at that site by JRM and AT: *Evenus candidus* (Druce, 1907) (Lycaenidae), *Caligo atreus* (Kollar 1849), *Haetera macleannania* (Bates, 1865), *Pierella luna* (Fabricius, 1793), *Euptychia favonius* Nakahara *et al*. 2016, *Amiga arnaca adela* Nakahara & Espeland, 2019 (all Nymphalidae). In particular, *E. candidus* was captured by JRM and AT for the first time during their extensive butterfly survey of Panama, which has involved more than 600 days of field work (see Nakahara *et al.*, 2018a: 283). Interestingly, *E. candidus* was also captured by Gordon Small at his "Colon" locality, based on notes taken by JRM from Gordon Small collection housed at the USNM, perhaps suggesting that this is a localized species and that this is indeed the same locality where *C. gordonsmalli* **n. sp.** was captured about 50 years ago. Based on observations of JRM and AT, Santa Rita Ridge can be characterized as Atlantic lowland tropical forest (sea level to 500 m) *sensu* DeVries (1987: 46). The female housed at USNM is from Cerro Jefe, which is situated at approximately 9°13'48"N, 79°22'59"W. Cerro Jefe reaches over 1000 m and harbors several butterfly taxa that are known only from this area, such as *Nymphidium balbinus* Staudinger, [1887], *Metacharis smalli* (Riodinidae) and *Morpho cypris smalli* (Nymphalidae).

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