



A new species of silverline butterfly, *Cigaritis* Donzel, 1847 (Lepidoptera: Lycaenidae), from the Western Ghats biodiversity hotspot, India

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Abstract

A new species, *Cigaritis conjuncta* sp. nov. (Lepidoptera: Lycaenidae), is described based on five male and four female specimens from Honey Valley, Kodagu District, Karnataka, which is part of the Western Ghats biodiversity hotspot, India. *Cigaritis conjuncta* sp. nov. is distinguished from all other congeners in India and Sri Lanka based on the following combination of diagnostic characters in the male: (a) dorsal forewing outer half, costal margin and nearly upper half of the cell black without orange markings, the remaining wing shining deep blue, (b) dorsal hindwing tornus pale orange-red with two black spots, (c) ventral forewing bands at end of discal cell conjoined, and (e) ventral hindwing subbasal and discal bands composed of spots that are not separated but conjoined to form broad bands that have irregular outlines, leaving only a narrow background colour in between. Female is similar on the ventral side, but entirely dark brown above. Male and female genitalia are dissected and figured for two paratypes of each sex, and natural history notes on the species are provided.

Key words: Species discovery, species description, butterfly taxonomy, Indian butterflies

Introduction

The genus *Cigaritis* Donzel, 1847 (Lepidoptera: Papilionoidea: Lycaenidae: Theclinae: Aphnaeini), with *Cigaritis zohra* Donzel, 1847 as its type-species (Hemming 1967), is distributed from Africa and Arabia east to South and Southeast Asia, with its centre of diversity in equatorial Africa, India and Indo-China. It includes *Spindasis* Wallengren, 1857 (type-species *Spindasis masilikazi* Wallengren) and *Apharitis* Riley, 1925 (type-species *Polyommatus epargyros* Eversmann), two generic names that are often applied to Asian species, as junior synonyms (Heath 1997; Heath *et al.* 2002). Riley (Riley 1925) summarised differences between *Aphnaeus*, *Apharitis*, *Cigaritis* and *Spindasis* as follows:

- | | | | |
|--------|---|-------|------------------|
| 1. (2) | Forewing with twelve veins | | <i>Aphnaeus</i> |
| 2. (1) | Forewing with eleven veins | | 3 |
| 3. (4) | No lobe to hindwing; filamentous tails at veins 1 and 2 subequal in length, about 1mm long, the margin considerably excavate between them | | <i>Cigaritis</i> |
| 4. (5) | Lobe not very marked; filamentous tail at vein 2 less than half as long as tail at vein 1, generally 1 to 2 mm. long | | <i>Apharitis</i> |
| 5. (4) | Lobe well developed; tails both long | | <i>Spindasis</i> |

Subsequent major works on Oriental butterflies (Cantlie 1962; Corbet *et al.* 1992; d'Abrera 1986; Io 2000; Larsen 2004; Pinratana 1981; Smith 1989; Wynter-Blyth 1957) followed this generic classification. However, based on similarity of structures of male genitalia, Heath synonymised *Spindasis* and *Apharitis* with *Cigaritis* (Heath 1997; Heath *et al.* 2002). This arrangement still needs to be confirmed with a molecular phylogenetic analysis.

The following nine *Cigaritis* species occur in peninsular India, which were previously listed under *Spindasis* except for *C. acamas* and *C. lilacinus* that were listed under *Apharitis*: (1) *C. abnormis* (Moore, [1884]), (2) *C. acamas* (Klug, 1834), (3) *C. elima* (Moore, 1877), (4) *C. ictis* (Hewitson, 1865), (5) *C. lilacinus* (Moore, 1884), (6) *C. lohita* (Horsfield, [1829]), (7) *C. schistacea* (Moore, [1881]), (8) *C. syama* (Horsfield, [1829]), included in peninsular India based on recent records from Odisha and Madhya Pradesh (Kunte 2023), and (9) *C. vulcanus* (Fabricius, 1775) (Bhakare & Ogale 2018; d’Abrera 1986; Evans 1932; Kunte *et al.* 2023). The following species occur in the neighbouring Sri Lanka with which the Western Ghats are recognised as a global biodiversity hotspot: (1) *C. elima*, (2) *C. greeni* (Heron, 1896), (3) *C. ictis*, (4) *C. lohita*, (5) *C. nubilus* (Moore, [1887]), (6) *C. schistacea*, and (7) *C. vulcanus* (d’Abrera 1986; Evans 1932; van der Poorten & van der Poorten 2016; Woodhouse 1949).

Recently, we discovered populations of a species of *Cigaritis* while surveying for butterflies in the Western Ghats, which did not match any known species listed above. Close examination of specimens revealed that they belonged to a new species, which is described below.

Materials and Methods

We encountered the first individual, a female, of the new *Cigaritis* on the path to Iruppu Falls within the Brahmagiri Wildlife Sanctuary (‘WLS’), Kodagu District (formerly known as Coorg), Karnataka, on 2008/04/06. We subsequently encountered approx. 30 individuals at Honey Valley, Kodagu District, Karnataka, in March 2021, from which we collected five male and four female specimens for a taxonomic study (Fig. 1–2). We pinned and dried four male and two female specimens, and preserved one male and two female specimens in 100% molecular-grade ethanol for molecular work. The specimens are deposited in the Biodiversity Lab Research Collections of National Centre for Biological Sciences (NCBS), Tata Institute of Fundamental Research (TIFR), Bengaluru (=Bangalore), India (<http://biodiversitycollections.in>).

We dissolved extraneous tissue using 10% KOH for dissecting male and female genitalia (Fig. 2), and then preserved the genitalia in anhydrous glycerol at 4° C in a laboratory fridge.

We photographed pinned specimens using a Canon 1200D DSLR camera body with Canon 60mm macro lens. We photographed the dissected genitalia with Leica DFC425 digital camera mounted on a Leica M250 C stereomicroscope. We focus-stacked all the genitalia images with Leica application suite software. A millimetre scale was included while taking images of female genitalia. It was not possible to take images of the male genitalia with a scale bar.

We took morphometric measurements (forewing length and antenna length) from images of pinned specimens using ImageJ ver. 1.53F (Schneider *et al.* 2012)—an open-source image-processing software.

Terminologies for numerical venation system and genitalia follow Kunte *et al.* (2019). The following abbreviations are used: FW=forewing, HW=hindwing, NCBS=National Centre for Biological Sciences, TIFR, UN=ventral side, UNF=ventral side of forewing, UNH=ventral side of hindwing, UP=dorsal side, UPF=dorsal side of forewing, UPH=dorsal side of hindwing, v=vein, WLS: Wildlife Sanctuary. Dates are given in YYYY/MM/DD format.

Taxonomic Description

Cigaritis conjuncta sp. nov. Kunte & Sengupta

Holotype (Fig. 1, 3): Voucher code IBC-BO833. ♂. Honey Valley, Kodagu District, Karnataka, India (lat-long: 12.21512 N, 75.65743 E). Approx. 1,300 m asl. Collected on 2021/03/27, by Krushnamegh Kunte. Preserved dry, pinned, deposited in the Biodiversity Lab Research Collections at NCBS.

Description: *Forewing length:* 16 mm. *Length of antenna:* 8 mm. Head white and pale yellowish-brown on the ventral side, and black with an inconspicuous red collar on the dorsal side. Antennae black, finely white-ringed on the shaft, and with a yellowish-orange tip. Proboscis dark yellow. Thorax pale yellowish-brown on the ventral side, and black on the dorsal side, covered in pale scales that shine black or blue on the dorsal side. Abdomen pale yellowish-brown with dark bands on the ventral side, much darker with black bands on the dorsal side. Legs white and ochreous in patches.

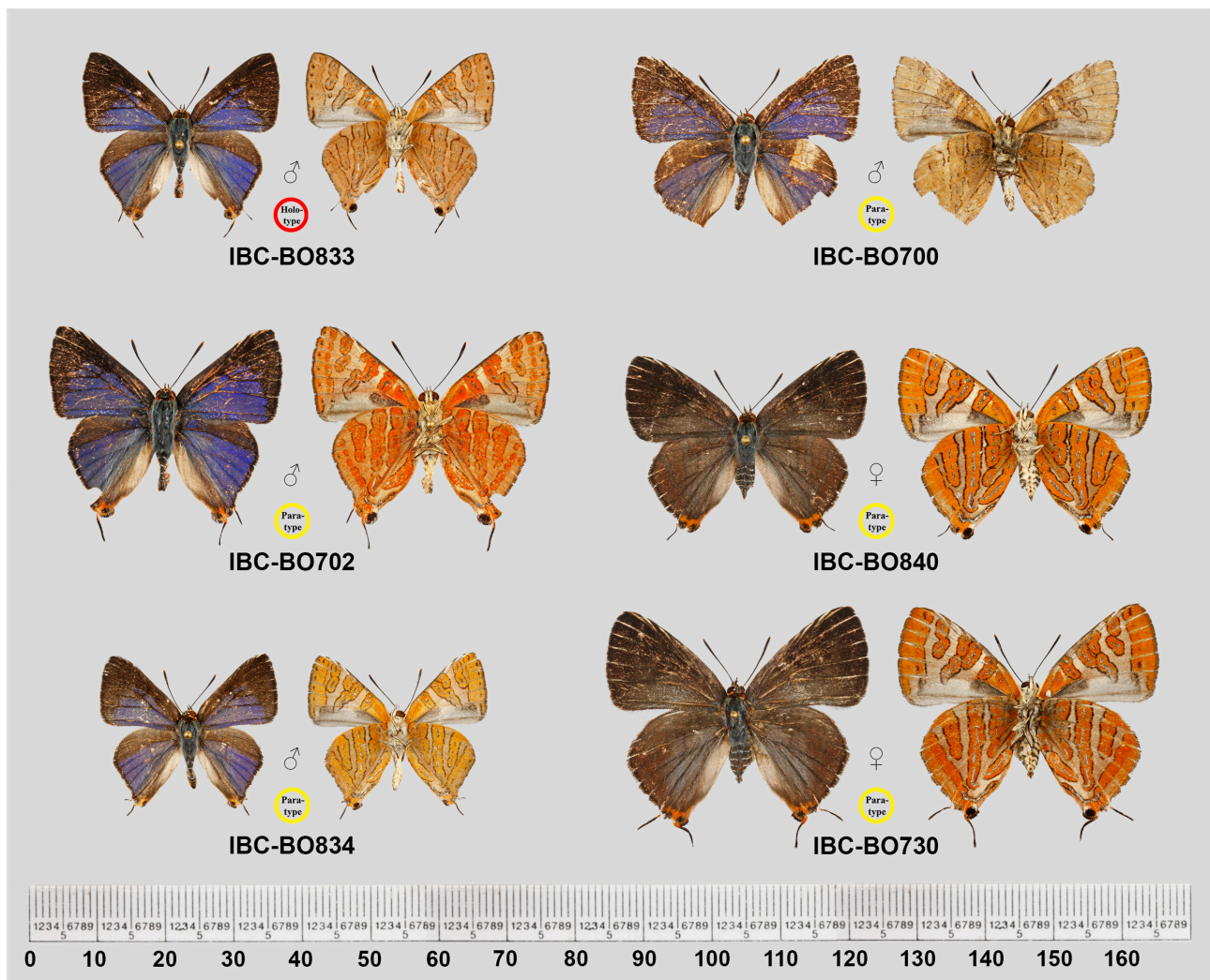


FIGURE 1. Type specimens of *Cigaritis conjuncta* sp. nov. A millimetre scale is at the bottom.

Dorsal side: Forewings costal margin, nearly upper half of the cell, and outer half of the wing black. Remaining wing dark shining blue, from dorsum to more than half-way through interspace 2, nearly to the origin of v3. Hindwings shining deep blue from v2 to v6 and up to the upper edge of the cell. Interspaces 1a and more than half of 1b nearly white, the outer part of 1b and 1c dark brown. Area above the cell, which is usually covered by forewing in life, dark brown. Terminal border and cilia black. Tornus pale orange-red with two black spots, the lower spot being more than twice the size of the upper one. These spots are placed on the protruding and out-turned wing lobe which, along with white-tipped black tails at the ends of v1 and v2, form the tornal false head that presumably deflects predatory attacks from the real head of many theclines.

Ventral side: pale yellow with darker yellow or ochreous broad bands that have narrow silver lines at the centre and narrow black edges. Forewings have the following markings: (a) a basal, length-wise yellow band from the thoracic attachment of forewing till approx. basal 1/3rd of the cell, (b) a transverse band across the cell, from costal margin to the vein along the lower edge of the cell, placed in the centre of the cell between the wing attachment and end of the discal cell, (c) a similar band at the end of the discal cell, (d) a band immediately outside of the cell, conjoined with the cell-end band, (e) a band half-way between the conjoined bands at the end of the discal cell, starting from the lower ends of these bands and extending down to middle of interspace 1b, (f) a post-discal band from the costal margin to interspace 3, (g) a small, isolated spot on v3, just below the post-discal band, (h) submarginal and marginal ochreous area without silver lines but with narrow black borders, and with four submarginal small black spots and one longer black line embedded on the ochreous area. Interspaces 1a and 1b largely pale dirty white. Hindwings have the following markings: (a) an orange, black-bordered spot in interspace

8, at the wing-base, (b) four large spots conjoined together to form a broad subbasal band, (c) an elongated spot in interspace 1b, (d) a central band from costal margin to interspace 1c, (e) a post-discal band from costal margin to the centre of interspace 3, (f) an outer post-discal/submarginal band from wing apex to v2, (g) a long silver line from dorsal margin in interspace 1b, bent upward to meet the lower margin of the second post-discal band, (h) a large, black tornal spot below v1, and a small, black spot between v1 and v2. All the ocherous bands are broad, with uneven outlines. The subbasal and central bands are placed very close to each other, leaving only a narrow strip of the pale yellow background colour in between.

Paratypes, and intraspecific variation: 4 ♂ (voucher codes IBC-BO700, IBC-BO702, IBC-BO749, and IBC-BO834; Fig. 1–2) and 4 ♀ (voucher codes IBC-BO730, IBC-BO752, IBC-BO825, and IBC-BO840; Fig. 1–2). Collection locality same as the holotype. Specimens IBC-BO700, BO702, BO730, BO834 and BO840 preserved dry, pinned, and BO749, BO752 and BO825 preserved wet in 100% molecular-grade ethanol for DNA sequencing. Specimens BO700, BO702 collected on 2021/03/24; BO730, BO749, BO752 collected on 2021/03/25; BO825, BO834, BO840 collected on 2021/03/27. All specimens collected by Krushnamegh Kunte. Since the designation of allotype is not regulated but it is allowed by ICZN rules, IBC-BO730 may be considered an allotype of the species.

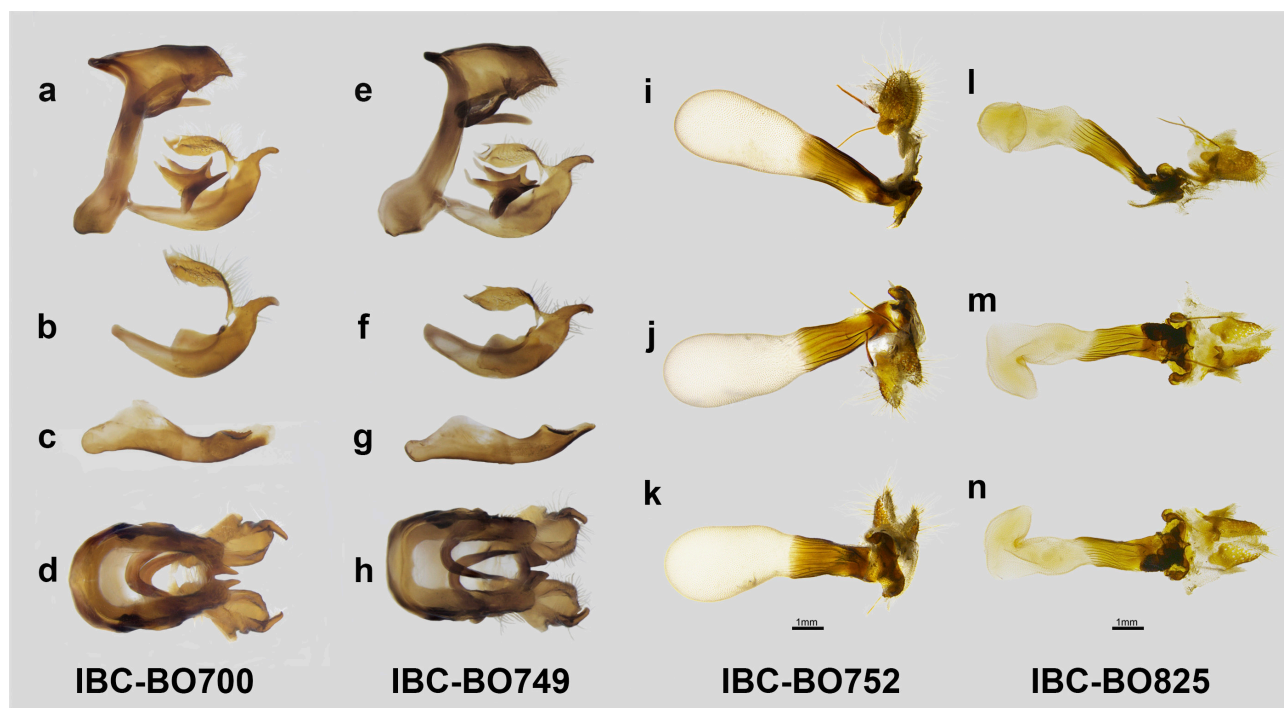


FIGURE 2. Male and female genitalia of paratypes of *Cigaritis conjuncta* sp. nov. **Male genitalia:** **a and e:** lateral view of genital capsule or armature (showing outside of right valve), **b and f:** valve (inside of left valve), **c and g:** phallus (aedeagus), **d and h:** dorsal view of genital capsule. **Female genitalia:** **i and l:** lateral view, **j and m:** dorsal view, **k and n:** ventral view.

Body size of the paratypes varied considerably, with females being larger on average. Forewing length, as a proxy for body size, ranged as follows:

♂: IBC-BO700: 17 mm, IBC-BO702: 19 mm, IBC-BO749: 16 mm, and IBC-BO834: 14 mm (mean±SD: 16.4±1.82 mm, including the holotype).

♀: IBC-BO730: 21 mm, IBC-BO752: 19 mm, IBC-BO825: 20 mm, and IBC-BO840: 18 mm (mean±SD: 19.5±1.29 mm).

Paratypes and other specimens photographed in the field (Fig. 4) show a largely constant phenotype of this species, similar to the male holotype, with only relatively minor variations. *Dorsal side:* Male paratypes have a more or less constant colour pattern. IBC-BO834 varies in being slightly paler blue. Specimens may appear much paler blue when a combination of sunlight and camera flash light is used (Fig. 4g). *Female* is dark brown, with plumbeous scales overlaid in interspaces 1a–1b UPF and interspaces 1c–3 and cell UPH. The tornal orange-red is deeper and more extensive compared with that in males. Female forewings are broader, and termen more convex, compared

with that in males. Ends of veins appear to be white because scales were lost from them during pinning under field conditions.

Ventral side: The pale yellow wing background colour was more or less constant. The relative widths of the broad bands and their relative placements were also similar. The colour of the bands varied from dark yellow (IBC-BO700 and IBC-BO834) to dark ochreous (IBC-BO702, IBC-BO730 and IBC-BO840). The band immediately outside of the UNF cell was not complete, ending half-way of the band at the end of discal cell, in IBC-BO702. Apart from these minor individual variations, there was no sexual dimorphism in wing colouration and markings on the ventral side.

Genitalia: *Male* (Fig. 2a–h): Tegumen robust. Uncus short, stout, in lateral view distally sloping sharply and ending as a narrow point, inwardly excavated, and in dorsal view with a prominent cleft. Gnathos narrow, nearly straight. Vinculum straight, stout. In lateral view, valve narrow, sharply curved, with a narrow, pointed, prominently downturned cuiller, and a very large dorsal process. Phallus (aedeagus) stout, basally raised, and with a flattened, pointed end. *Female* (Fig. 2i–n): Of ordinary *Cigaritis* type, without prominent signa.

Diagnosis (Fig. 3): *Cigaritis conjuncta* sp. nov. is readily distinguished from other congeners in India and Sri Lanka based on the following combination of diagnostic characters in the male: (a) dorsal forewing outer half, costal margin and nearly upper half of the cell black, without orange-red markings, the remaining wing shining deep blue, (b) dorsal hindwing shining deep blue from v2 to v6 and up to the upper edge of the discal cell; above the cell and v6 dark brown; in interspace 1 white and brown; tornus pale orange-red with two black spots, (c) ventral side pale yellow or ochreous with broad, silver-centred, black-edged dark yellow or red bands, (d) UNF bands at end of the discal cell conjoined or nearly so, and (e) ventral hindwing subbasal and discal bands composed of spots that are not separated but conjoined to form broad bands that have irregular outlines, leaving only a narrow background colour in between. Female is similar on the ventral side, but entirely dark brown above, with more extensive, considerably darker orange-red tornal patches. *Cigaritis conjuncta* sp. nov. has a unique characteristic of ventral bands being very broad and conjoined in two places, which readily distinguishes it from all other Sri Lankan and Indian *Cigaritis*: (a) UNF bands at end of the discal cell being very closely applied, and therefore forming a very broad, conjoined marking, (b) UNH subbasal band being composed of very closely fused, large spots.

Cigaritis conjuncta sp. nov. differs from the sympatric *C. vulcanus*, *C. schistacea*, *C. elima* and *C. ictis*, in lacking orange markings on the dorsal forewing. Male *C. conjuncta* sp. nov. differ from *C. lohita* in having the outer half of dorsal forewing black (black border less than 1/3rd the width of the wing in *C. lohita*), and in both sexes having very broad but considerably paler bands on ventral side, with UNH subbasal band not extending along v2 (ventral bands in *C. lohita* are much darker, deeper red/brown and narrower, with the subbasal band prominently extending along v2 to join the central band at its lower end). *Cigaritis conjuncta* sp. nov. differs from the sympatric *C. vulcanus*, *C. schistacea* and *C. lohita* in having the UNH tornal area with a much reduced, much less conspicuous red patch (tornal red extensive and brighter in *C. vulcanus*, *C. schistacea* and *C. lohita*). *Cigaritis conjuncta* sp. nov. differs from *C. abnormis* in having very broad and many more bands on the ventral side (ventral side of *C. abnormis* only has very narrow, dark brown central bands on both wings, and a narrow cell line UNF, with very few other markings), and in female lacking blue on the dorsal surface (female *C. abnormis* is largely pale blue on the dorsal side). *Cigaritis conjuncta* sp. nov. differs from the allopatric *C. syama* in having UPH tornus much more narrowly orange-red, which is also considerably paler, and ventral bands being much broader and paler. *Cigaritis conjuncta* sp. nov. differs from the allopatric *C. rukma*, *C. rukmini*, *C. evansii*, *C. elwesi*, and *C. nipalicus* in having ventral bands much broader, and the UNH subbasal spots being prominently conjoined (ventral bands in *C. rukma*, *C. rukmini*, *C. evansii*, *C. elwesi*, and *C. nipalicus* are much narrower, and subbasal spots not prominently fused). *Cigaritis conjuncta* sp. nov. differs from the allopatric *C. acamas* and *C. lilacinus* in having a shining dark blue UPF without orange markings in male (*C. acamas* has extensive orange UPF, and *C. lilacinus* is very pale lilac purple-blue), and in having a very broad subbasal band UNH, which is composed to closely conjoined spots (subbasal spots prominently separated in *C. acamas* and *C. lilacinus*). *Cigaritis conjuncta* sp. nov. differs from the Sri Lankan-endemic: (a) *C. greeni* in having the outer half of UPF black in male (the black border is less than 1/3rd the forewing length in male *C. greeni*) and lacking any blue on UPF in female (female *C. greeni* is largely pale blue above), and in having very broad, conjoined bands on ventral side (ventral bands are very narrow, broken and well-separated from each other in *C. greeni*), and (b) *C. nubilus* in having black colouration on the outer half of UPF sharply defined in male (narrower and with a more diffused edge in male *C. nubilus*), in being plain dark brown with plumbeous scales in interspace 1b UPF and 1c–3 UPH in female (UPF post-discal area conspicuously paler

brown, without conspicuous plumbeous scales on FW and HW, in female *C. nubilus*), and in both sexes having the UNH subbasal spots completely fused into a broad band (three subbasal spots being prominently separated in *C. nubilus*).

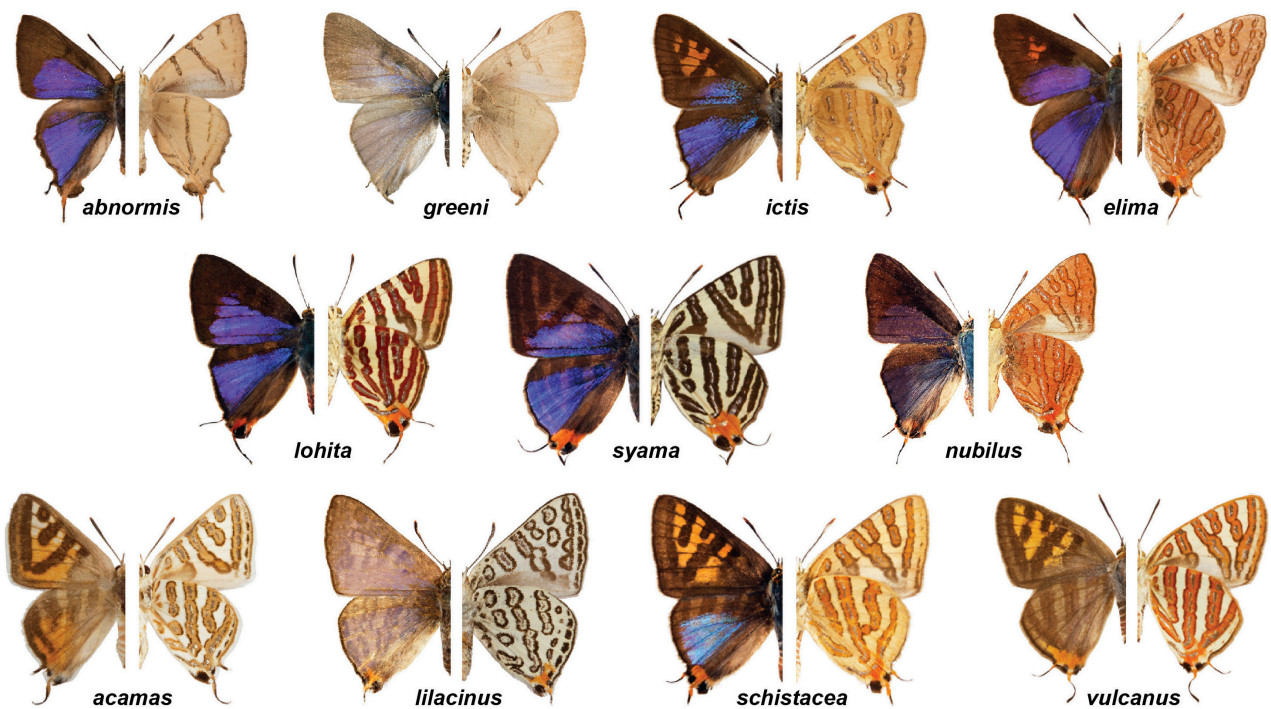
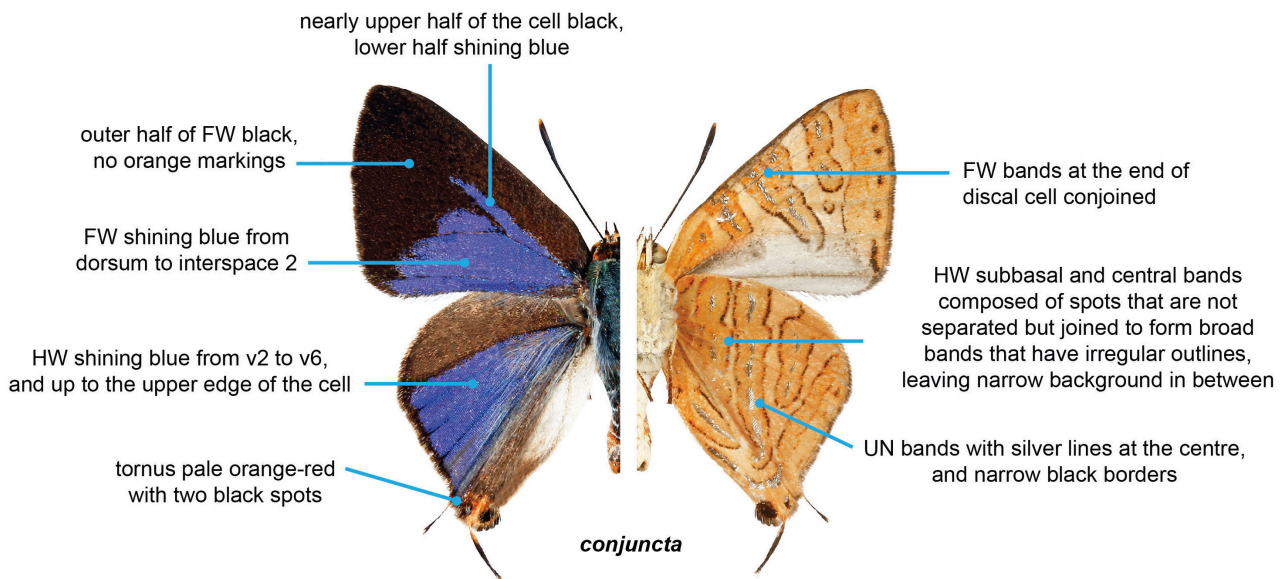


FIGURE 3. Diagnostic characters of *Cigaritis conjuncta* sp. nov., marked on digitally enhanced images of the holotype from which damage to the wings has been removed to illustrate the distinctive phenotype of the species. Males of other *Cigaritis* species that are found in the Western Ghats and Sri Lanka are illustrated below for reference. Images are not to scale.

Finally, no other Sri Lankan or Indian *Cigaritis* has UNF bands at the end of discal cell being so broad and prominently conjoined as in *C. conjuncta* sp. nov.

These diagnostic characteristics may be compared in pictorial guides of S. Asian, S. Chinese and Indo-Chinese butterflies, which reveal no closely resembling species in the Indo-Malayan Region (Bhakare & Ogale 2018; d’Abrera 1986; Ek-Amnuay 2012; Evans 1932; Inayoshi 2023; Io 2000; Kinyon 2003; Pinratana 1981; van der Poorten & van der Poorten 2016; Woodhouse 1949).

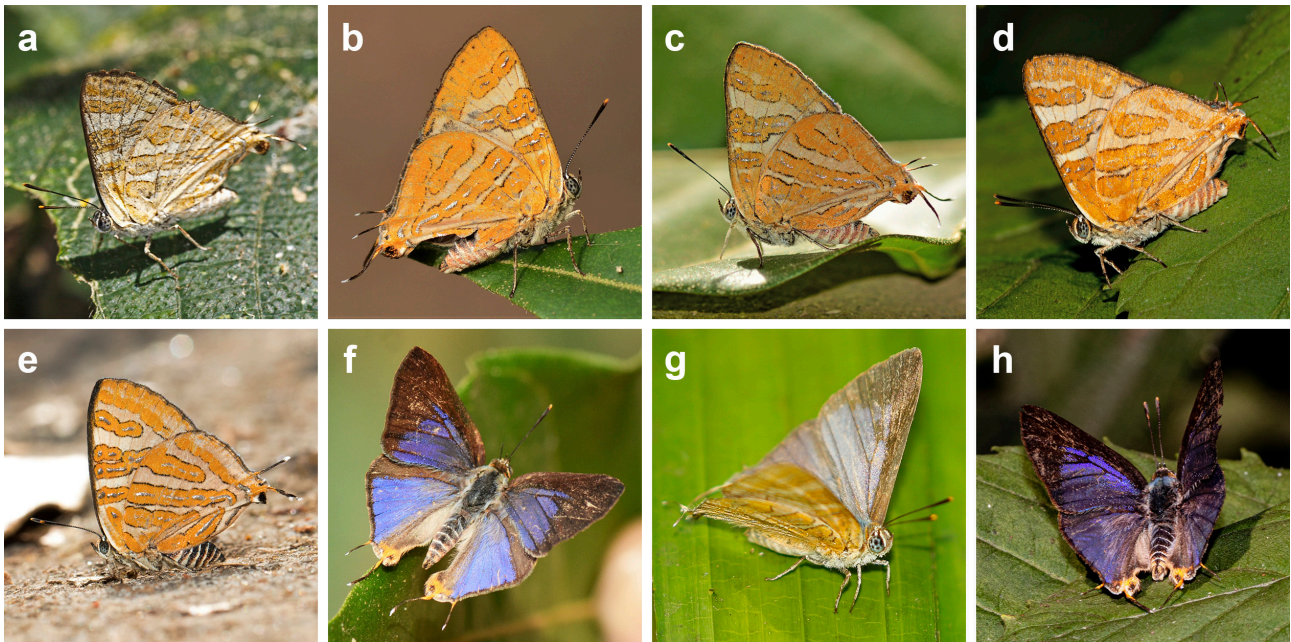


FIGURE 4. *Cigaritis conjuncta* sp. nov. in life. **a:** Female. Near Iruppu Falls, Brahmagiri WLS, Kodagu District, Karnataka, India. 2008/04/06. Photo by Krushnamegh Kunte. **b–h:** Honey Valley, Kodagu District, Karnataka, India. **b, c, f:** Males. 2021/03/13. Photos by Rohit Girotra. **d, h:** Males. 2021/03/27. Photos by Viraj Nawge. **e:** Female. 2021/03/14. Photo by Ashok Sengupta. **g:** Male (blue appearing pale because of the camera flash). 2021/03/27. Photo by Krushnamegh Kunte.

Genitalia of most Indian *Cigaritis* have not been dissected and properly illustrated yet, so it is not possible at present to compare them. Diagnostic characters of the genitalia, and phylogenetic relationships among species, may be studied in the future.

Etymology

Scientific name: *Cigaritis conjuncta* sp. nov. is named after the conjoined silver-centred dark yellow or red bands at the end of discal cell on UNF and subbasal bands on UNH (Fig. 3), which are two of the most distinctive, unique characters of the species.

English name: We propose the English name ‘Conjoined Silverline’ for this species based on the same conjoined bands on the UNF end of discal cell and UNH subbasal bands mentioned above.

Species Biology

Distribution: *Cigaritis conjuncta* sp. nov. is known so far only from the Iruppu Falls area of the Brahmagiri WLS (the place where the first female of the species was first photographed on 6 April 2008; Fig. 4) and from the type locality of Honey Valley, both in Kodagu District of Karnataka, within the Western Ghats biodiversity hotspot. We expect it to be more widely distributed, occurring in other forests of Kodagu and central Western Ghats of Karnataka, extending perhaps as far south in the Western Ghats as hill ranges of Tamil Nadu (Nilgiris) and southern Kerala (up to Peppara WLS).

Status, habitat, and habits: *Cigaritis conjuncta* sp. nov. appears to be patchily distributed and localized in its occurrence, but locally and seasonally common (we encountered approx. 30 individuals of the species within a 100-m stretch in Honey Valley), in the mid-elevation evergreen forests of the Western Ghats. It is so far recorded at elevations of approx. 900 m (Iruppu Falls) and 1,300 m (Honey Valley). It is active on sunny days from early in the morning to afternoon. Both sexes rest on shrubbery from ca. 0.5 to 2 m, some males taking up vantage points

nearly 3 m off the ground. Males bask with wings opened up half-way, and females also apparently do so, similar to other *Cigaritis*. Males appear to be more active in sunny patches, and therefore more readily detected, compared with females.



FIGURE 5. Evergreen forest at Honey Valley, the type locality of *Cigaritis conjuncta* sp. nov. (a–b), and perching habits of the species (c–d). **a:** A path through the shaded evergreen forest at Honey Valley. **b:** Forest floor crowded with tree saplings, ferns and bushes, on which individuals of *Cigaritis conjuncta* sp. nov. basked (c–d, butterflies pointed out with white lines). Photos by Ujwala Pawar and Viraj Nawge.

Flight period: Sightings of *C. conjuncta* sp. nov. were made in March and April, i.e., early summer in the Western Ghats. We expect it to be multi-voltine, but the exact number of generations per year and precise flight period are currently not known.

Larval host plants and early stages: Unknown.

Sympatric *Cigaritis*: We have recorded *C. lohita*, *C. schistacea*, and *C. vulcanus* in sympatry with *C. conjuncta* sp. nov. It is possible that *C. ictis* and *C. elima*, which are recorded from this region, may also eventually be recorded at the type locality. We have not yet seen *C. conjuncta* sp. nov. side-by-side and specifically interact with other *Cigaritis* species.

Further information will be made available on the species page of the Butterflies of India website (<https://www.ifoundbutterflies.org/Cigaritis>) as additional observations accumulate.

Discussion

The Western Ghats biodiversity hotspot is well-known for its species diversity and endemism. The butterfly fauna of the Western Ghats is believed to be especially well characterised where species discovery has plateaued off for decades, although taxonomic revisions are required for many taxa (Hou *et al.* 2023; Huang *et al.* 2019; Kunte *et al.* 2019). Butterflies were collected extensively in Kodagu and Nilgiris around the British tea and coffee plantations in the late 1800s and early 1900s (Kunte *et al.* 2019). The discovery of a distinctive new butterfly species in the coffee-dominated area of Kodagu, reported above, is therefore remarkable, revealing that undescribed species may still exist in relatively unexplored small pockets within the Western Ghats. It underscores a need to initiate more intensive studies of the butterfly fauna of the Western Ghats, including field surveys and museum inspections. Indeed, extensive sampling, taxonomic reassessments based on modern taxonomic and evolutionary principles, understanding of biogeography and endemism, and molecular phylogenetic analyses, have already led to considerable taxonomic changes to known taxa as well as discoveries of new species in several flagship vertebrate and invertebrate groups (Biju *et al.* 2014; Condamine *et al.* 2023; Garg *et al.* 2017; Joshi *et al.* 2020; Kunte *et al.* 2019; Robin *et al.* 2017). Our discovery of a new *Cigaritis* takes a further step in building a more robust faunal checklist of the Western Ghats that will help advance the taxonomic, systematic, ecological and evolutionary studies of this iconic biodiversity hotspot.

Author contributions

KK collected and pinned type specimens, prepared figures, and wrote the manuscript including species description and diagnosis. AS discovered the Honey Valley population (along with Rohit Girotra, Arun Urs and Namrata Urs), and assisted in diagnosis of the species. UP and VN processed the specimens, including assistance in collecting, pinning, drying and databasing, and processed specimen photographs. UP performed and photographed genitalia dissections, and also photographed type specimens. All authors read and approved the manuscript.

Acknowledgements

We thank Rohit Girotra, Arun Urs and Namrata Urs for assistance in field work and for providing information; Archan Paul and Swathi HA for assistance in processing of specimens; Suresh Chengappa for logistical support; the Range Forest Officer and other forest staff for support with field work; David Lohman for advice on the systematics of Aphnaeini; and Michael Braby and an anonymous reviewer for comments on an earlier draft of the manuscript. We collected specimens under a research and collection permit (No. PCCF/WL/E2/CR/227/2014-15, dated 26 May 2017) from the Karnataka Forest Department, Government of Karnataka, for which we thank the Principal Chief Conservator of Forest (WL) and Chief Wildlife Warden of the state. The work was funded by an NCBS Research Grant to KK.

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