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COMMUNICATION

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Kalesh Sadasivan, Baiju Kochunarayanan, Rahul Khot & S. Ramasamy Kamaya Naicker

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COMMUNICATION

A new taxon of *Nacaduba* Moore, 1881 (Lepidoptera: Lycaenidae: Polyommatini) from Agasthyamalais of the Western Ghats, India

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Abstract: A new butterfly taxon, *Nacaduba sinhala ramaswamii* ssp. nov. (Lepidoptera: Lycaenidae: Polyommatini), is described from Agasthyamalais of southern Western Ghats in peninsular India. The new taxa can be diagnosed from all other *Nacaduba* of southern India and *N. sinhala* Ormiston, 1924 from Sri Lanka, by its distinct male genitalia. The early stages, larval hostplants, flight periods, ecology and the known distribution of the new taxa are discussed. The revised keys to all known *Nacaduba* of Western Ghats of peninsular India are provided.

Keywords: Butterfly, distribution, ecology, genitalia, Kerala, larval host plants, new taxa, subspecies.

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Author contribution: KS—discovered the lifecycle, photographed and dissected the species for confirmation. BK—reared and documented the lifecycle. RK—manuscript revision and taxonomic comparison with related species. SRKN—reared and documented the lifecycle, Manuscript revision.

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INTRODUCTION

Line blues are small butterflies belonging to the subfamily Lycaenidae; essentially Indo-Australian in distribution (Corbet 1938). Their distribution ranges from India and Sri Lanka, to the whole of southeastern Asia, Australia, and Samoa. They are characterised by hairy eyes, anastomosis of veins 11 and 12 on forewings, male wings with purple gloss on the upperside, and underside of both sexes with dull whitish striae. Males of all species have battledore-shaped specialised androconial scales and some species have long ribbon scales on the upperside of wings that gives them a frosted look (Corbet & Pendlebury 1992).

Line blues are broadly classified according to the number of lines or bands seen in the underside of the forewing as four-line blues and six-line blues. Evans (1932) considered all line blues under the genus *Nacaduba* Moore, 1881. But according to the present taxonomic placements following Tite (1963), the old genus has been split into several genera under *Prosotas* Druce, 1891, *Petrelaea* Toxopeus, 1929, and *Ionolyce* Toxopeus, 1929, in addition to *Nacaduba*. *Prosotas* differs from *Nacaduba* by being smaller, having hindwing spaces between the striae more or less darkened, and the valva (claspers) of males being simple and ending in a long incurved point. *Prosotas* may or may not be tailed while *Nacaduba* are always with the tail on the hindwing (Corbet & Pendlebury 1992). The genus *Prosotas* has three species in peninsular India, namely: Common Line Blue *Prosotas nora ardates* (Moore, [1875]), Tailess Line Blue *Prosotas dubiosa indica* (Evans, [1925]), and White-tipped Line Blue *Prosotas noreia hampsonii* (de Nicéville, 1885). The genus *Petrelaea* and *Ionolyce* have one species each, namely, Dingy Line Blue *Petrelaea dana* (de Nicéville, [1884]) and Pointed Line Blue *Ionolyce helicon viola* (Moore, 1877) in peninsular India.

The *Nacaduba* males are dark blue or violet above, while females are paler or white with dark border on the upperside; and the underside of both sexes are brownish to grey with linear parallel white lines (Evans 1932). At present, eight species of the genus *Nacaduba* are recorded in peninsular India. This includes two species of four-line blues, viz., Large 4-line Blue (*Nacaduba pactolus continentalis* Fruhstorfer, 1916) and Pale 4-line Blue (*N. hermus sidoma* Fruhstorfer, 1916) as well as four species of six-line blues, viz., Trasparent 6-line Blue (*N. kurava canaraica* Toxopeus, 1927), Opaque 6-line Blue (*N. beroe gythion* Fruhstorfer, 1916), Rounded 6-line Blue (*N. berenice plumbeomicans* (Wood-Mason & de Niceville, 1881)), and Dark Ceylon 6-line Blue (*N. calauria evansi* Toxopeus, 1927) (Larsen, 1987). *Nacaduba calauria evansi* Toxopeus, 1927 and *N. berenice plumbeomicans* (Wood-Mason & de Niceville, 1881) were the two taxa that were only added later to southern Indian fauna from Nilgiris by Larsen (1987). The keys to the Indian forms of *Nacaduba* were given by Evans (1932), which are still being followed, except for the 4-line blues, whose markings lend themselves for easy identification, others of the genus need an examination of male genitalia for species confirmation (Corbet 1938). Ribbon scales in males are helpful in narrowing down the species, and these are absent in *N. kurava canaraica* Toxopeus and *N. calauria* evansi Toxopeus (Corbet & Pendlebury 1992).

Two individuals of *Nacaduba* line blues were photographed in October 2011 from Bonaccord Estate and later in September 2013 from a homestead in Vithura in Thiruvananthapuram District of southern Kerala, by the first author. These individuals were paler in coloration in comparison to the other *Nacaduba* line blues that were mud-puddling with them on a damp patch on the ground. Similar pale coloured individuals were also observed and photographed at Rosemala, Thenmalai in January 2018, and Thenkasi in Tamil Nadu in October 2018. A few days later in the same month, a *Nacaduba* female was observed ovipositing on young sprouting leaves from the cut stem of *Dimocarpus longan* Lour. (Sapindaceae) sapling, in Vithura (Fig. 1). Further investigation of the leaves revealed early stages of the *Nacaduba* species in different stages from egg to final instar larvae. These larvae were reared and details of the adults noted. The dissection of genitalia of male specimens were done and they were unlike any known *Nacaduba* from southern India and on further investigation they were found matching the Sri Lankan species *Nacaduba sinhala* Ormiston, 1924. The adults, early stages and larval host plant were similar to the Sri Lankan taxon, but the genitalia of the males were structurally different from it. This is the first confirmed record of this taxa occurring in the Western Ghats and thus the Indian mainland. We describe here the early stages and ecology of the taxa as well as provide a modified key to all known *Nacaduba* of the Western Ghats in peninsular India.

MATERIALS AND METHODS

The larvae of *Nacaduba* were raised on the leaves of its natural host plant *Dimocarpus longan* Lour. (Sapindaceae) under laboratory conditions and the details of each stage noted. The eclosed butterflies were

Figure 1. The study areas in Agasthyamalais in southern India.

studied. Taxonomy of *Nacaduba* follows Tite (1963). Identification of species follows Ormiston (1924), Evans (1932), Woodhouse (1947), and van der Poorten & van der Poorten (2018). Genitalia and external morphology were compared with specimens of *Nacaduba sinhala* Ormiston 1924, in the Ormiston's collection from Sri Lanka, housed in Bombay Natural History Society (BNHS), Mumbai, India. The genitalia were studied by soaking overnight in KOH, then dissected under Stereo-zoom microscope (HEADZ Model HD81) and preserved in glycerol. Illustrations were drawn by the first author using the Stereo-zoom microscope. The length of the forewing (FW) is measured as the longest straight-line distance from the wing base to the wing tip following Van hook et al. (2012). Terminology for wing patterns follows Evans (1932) and genitalia descriptions follow Corbet & Pendlebury (1992). Holotype and four paratypes are deposited in the insect collection of National Centre for Biological Sciences (NCBS), Bengaluru; other paratypes will be subsequently deposited in Zoological Survey of India (ZSI), Kozhikode and Bombay Natural History Society (BNHS), Mumbai.

RESULTS

***Nacaduba sinhala ramaswamii* Sadasivan ssp. nov.**

(Image 1A,B; Figure 2E)

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Materials examined (n= 5, 3 males and 2 females)

Holotype (Image 1A&B): NCBS-BH870, September 2018, male, Vithura (8.676N, 77.095E), Thiruvananthapuram District, Kerala, India, at 100m, both ex. larvae on *Dimocarpus longan* Lour. (Sapindaceae), coll. Kalesh Sadasivan.

Paratypes/Allotypes: NCBS-BH871 and NCBS-BH872, both males, bearing the same data as the holotype NCBS-BH870. NCBS-BH873 (Image 1C&D) and NCBS-BH874, both females, bearing the same data as the holotype NCBS-BH870.

Additional field records (Image 4)

1. Two male specimens were observed and photographed in the field by the authors from Rosemala, Shendurney Wildlife Sanctuary, Kollam District, Kerala State, India, January 2018, at 100m, from a habitation near secondary forest.

2. Four male specimens and three female specimens were observed and photographed in the field by the authors from a private estate plantation, Tenkasi, in October 2018.

3. One male specimen and one female specimen were observed in the field by Kalesh Sadasivan from Bonaccord Estate, Peppara Wildlife Sanctuary, Trivandrum District, Kerala State, India, October 2011 at

100m, from a habitation near secondary forest.

Description (Image 1A&B)

Male

Forewing length 14mm (n= 2). Antennae black checkered in jet black and white on the underside, apiculus white spotted on the lateral aspect; eyes black; palpal bases white haired, rest is greyish and tips black; legs vertically streaked in black and white, tarsus checkered in black and white; whole thorax dorsally covered in pale violet blue hairs laterally almost white above the origins of the wings, the hairs extending into the proximal abdominal segments; thorax underside clothed in white hairs; abdomen with shorter greyish-violet hairs on dorsum, underside paler, almost whitish, and the tip of the abdomen paler; hindwings tailed, tails black, tipped with white and with a brownish area in between them almost as wide as the white tip. Termen and tornus rounded more so in hindwing.

Upperside: General color is pale violet-blue with the central areas of both wings transparent and showing the bands on the underside. The whole wing surface is smeared in battledore androconial scales and long narrow ribbon scales, the latter giving a frosted look in photographs (Image 1A).

UpF: Upperside violet-blue; the underside forewing markings showing on upperside in males, especially in the discal and post discal regions. The transparent regions of wings more of brownish. Basal areas of wings: sub-marginal areas are more opaque with iridescent pale violet scales. Long pale bluish-violet hairs along vein 1a and dorsal margin (a continuation of the paler cilia), which may be lost in older individuals. A very thin marginal line brownish-black and this colour extends as short black streaks along all the veins reaching the proximal sub-marginal region. Cilia dark grey, turning paler at the tonus and dorsum. UpH: The general scheme is as in the forewing, with discal and post discal regions transparent and the underside bands showing through; basal, sub-marginal areas are opaque and clothed in iridescent violet scales. Marginal line black and extending though the veins into the sub-marginal region. Cilia dark greyish-brown, turning paler basally after the tornus and apex. Space 1a is ashy in the basal region and turning into brownish towards the tornus. The basal region, cell and the space 1b is clothed in very long pale violet blue hairs. Tornal region is darker at the areas of reflection of the tornal spots on the underside (Image 1A).

Underside: Generally pale brownish-grey with the basal, discal and post discal broad prominent bands on

Image 1. *N. sinhala ramaswamii* ssp. nov. Holotype male NCBS-BH870: A—Upperside | B—Underside. Allotype female NCBS-BH873: C—Upperside | D—Underside | © Kalesh Sadasivan.

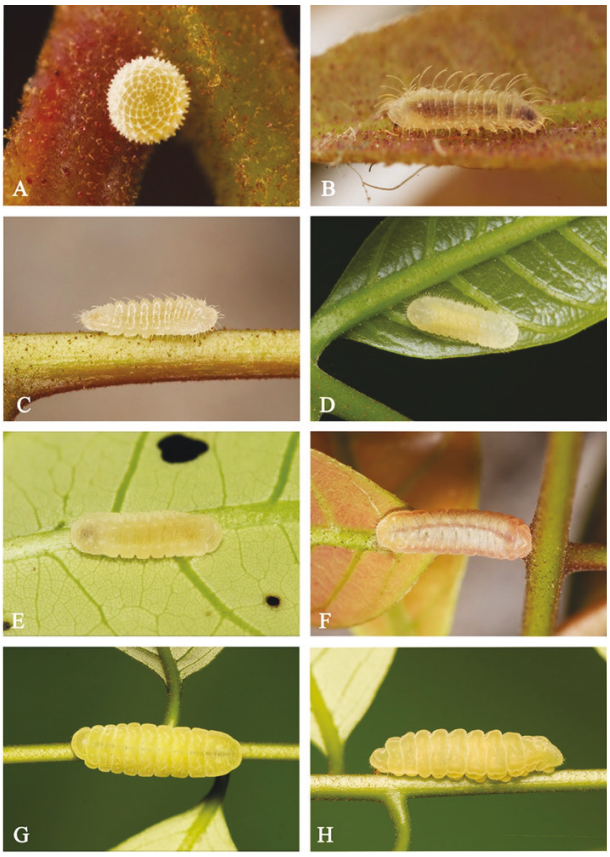

Image 2. *N. sinhala ramaswamii* ssp. nov. early stages: A—Egg | B—Egg-Larva | C—First Instar | D—Second Instar | E—Third Instar | F—Fourth Instar | G—Final instar dorsal view | H—Final instar lateral view | © Kalesh Sadasivan.

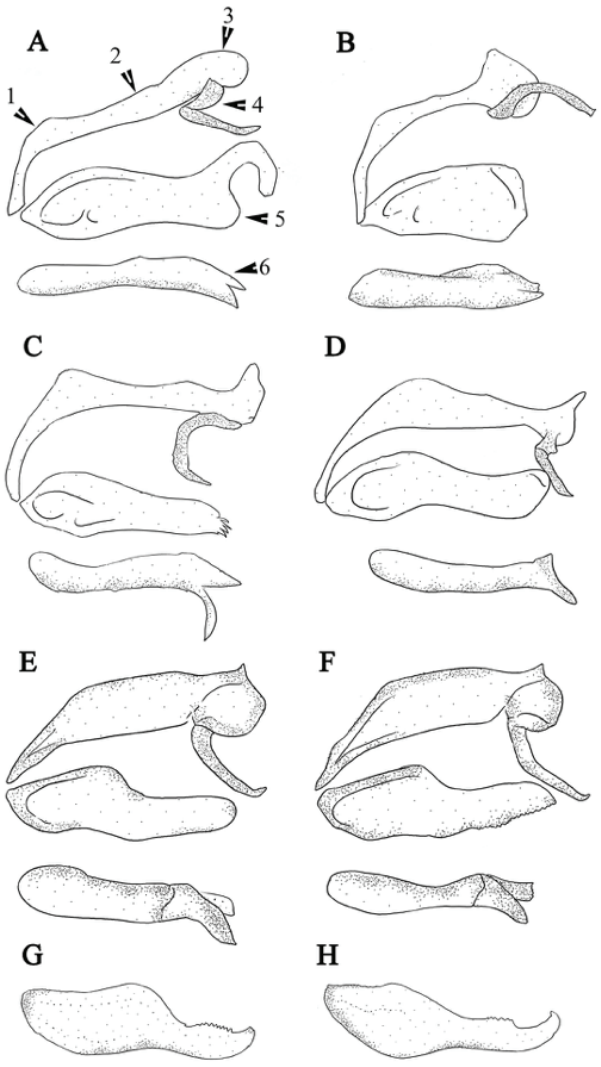

Figure 2. Male genitalia of *Nacaduba* with valva and allied structures from left lateral view with aedeagus separated (Parts labeled in A: 1—vinculum | 2—tegumen | 3—uncus | 4—sub-uncal process | 5—valva | 6—aedeagus): A—*N. kurava* | B—*N. calauria* | C—*N. beroe* | D—*N. Berenice* | E—*N. sinhala ramaswamii* ssp. nov. | F—*N. sinhala* | G—Valva *N. sinhala ramaswamii* ssp. nov. ventral view | H—Valva *N. sinhala sinhala* ventral view.

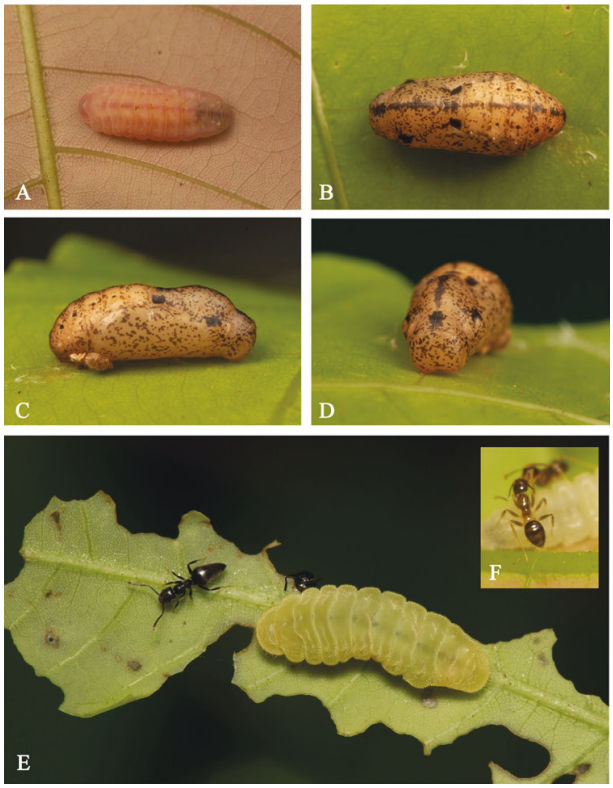

Image 3. *N. sinhala ramaswamii* ssp. nov. early stages: A—Pre-pupa | B—Pupa dorsal view | C—Pupa lateral view | D—pupa front view | E—Final instar larva with *Technomyrmex* ants attending them | F—Final instar larva with *Nylanderia* | © Kalesh Sadasivan.

both wings, these bands appearing crowded in the post-discal region of the hindwing; a sub-marginal series of almost heart-shaped greyish-brown spots basally and apically white bordered; and a marginal series of streaks of the same color capped with thin white marginal line and the thin dark marginal line. Three tornal spots on hindwing in spaces 2, 1a and 1b. UnF: The usual series of basal, discal and post discal bands, bounded by broad white streaks on either sides and grey on the inner side. The basal band is unbroken and extends from 1b-outer vein of the cell, and represented by a spot there after near the leading margin of the wing. The discal band is broken and a segment is seen in the cell and its distal continuation is broken into two parts; one part in space 7 is shifted outwards, lying between the discal and post-discal band; while the second part in space 8 is in line with the band. Segments of discal band in 1c and 2 are continuous and lies between the segment in outer cell and the postal discal band, thus making a 'Y' formation with them, though disjunct from distal cell band. The post-discal band is a zig-zag stack of parts in spaces 3–6, though more or less in continuity. The sub-marginal series of large heart-shaped dark grey spots spaces 2–6, whose sharp apices are directed towards the wing bases in spaces 1b-6. Marginal series of flattened crescentic dark grey spots from 1b-6. A thin inner marginal line of white from tornus to apex made of a series of thin curved lines in each space, fading after space 6. Another marginal line of dark grayish black is seen outside the white marginal line. Cilia greyish-brown, paler towards the tornus and almost whitish towards the dorsum. UnH: All the bands are broken and discontinuous. The basal band middle segment in cell is shifted basally in relation to the segments in spaces 1c and 7. A 'Y' shaped intersection is seen between continuous segments of

bands in space 1c and 2, with the distal cell segment of the discal and the post discal band segments in spaces 4 and 5. In addition the other segments of the band are seen just distal to mid space in spaces 1b 6 and 7. The heart-shaped sub-marginal series spots of dark grey are seen from space 3-6, that in space 7 is distorted. Marginal series of flattened crescentic dark grey spots from 3-6, followed by the white sub-marginal line and the marginal grey-black line. Cilia paler than that of forewing, greyish, and darker towards the tornus. Large tornal spot in space 2 occupying the position of the heart spots on other spaces, black at the center, distally laced with iridescent pale blue metallic scales, this is margined in pale orange all around and the orange margin is thin distally. Two smaller tornal markings of black orange and the metallic pale blue scales in spaces 1a and 1b, less than one-fourth size of the tornal spot in 2. Tail extending from vein between spaces 1c and 2, black and tipped with white (Tail on the left side of the Type male was lost in preservation). Bases of hindwings may have pale yellow and greenish-black scales below the basal band (Image 1B)

Male genitalia (Fig. 2E&G): From among the known species of *Nacaduba* from the Western Ghats, the general structure of the male genitalia of *N*. *sinhala* resembles *N*. *berenice* to some extent. The similarity is in the general morphology of valva, but the structure of vinculum, size and stricture of uncus and the anterior end of tegumen is quite different (Fig. 2E&G). The armature is very different from *N*. *kurava*, *N*. *beroe* and *N*. *calauria*. The nearest match is to that of *N. sinhala* from Sri Lanka, though there are some consistent differences. The shape and structure of annulus, vinculum and tegumen were similar to the nominate subspecies. The uncus was also similar in structure, but its size and that of the sub-uncal process was very variable amongst individuals of the same subspecies. The valva had significant structural differences from the nominate subspecies. On lateral view, with the whole armature in-situ, the harpe was smoother and shorter with the rounded distal coronal margin in *ramaswamii,* while it was more slender with irregular inferior margins and down-sloped coronal margin in *sinhala*. The first concavity on the inferior margin was place more proximally nearer to the angle of sacculus in *ramaswamii* while it was placed more distally in *sinhala* (Fig. 2F&H). On ventral view, the structure was similar in both subspecies, but the shape of valva was very different. The proximal part of the valva was thicker and medial border more angulated in *ramaswamii,* while it was thinner and margins sloping in *sinhala*.

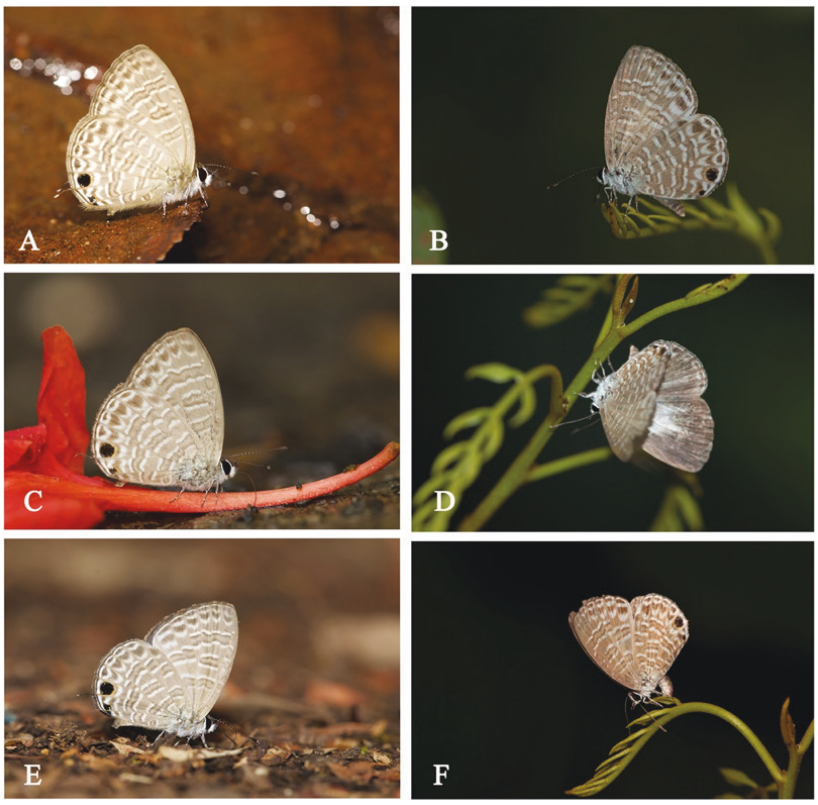

Image 4. Field images of *N. sinhala ramaswamii* ssp. nov.: A—Male from Rosemala, Kollam, Kerala | B—Female from Thenkasi | C—Male from Thenkasi | D & F—Female ovipositing | E—Male Vithura, Trivandrum, Kerala | © Kalesh Sadasivan.

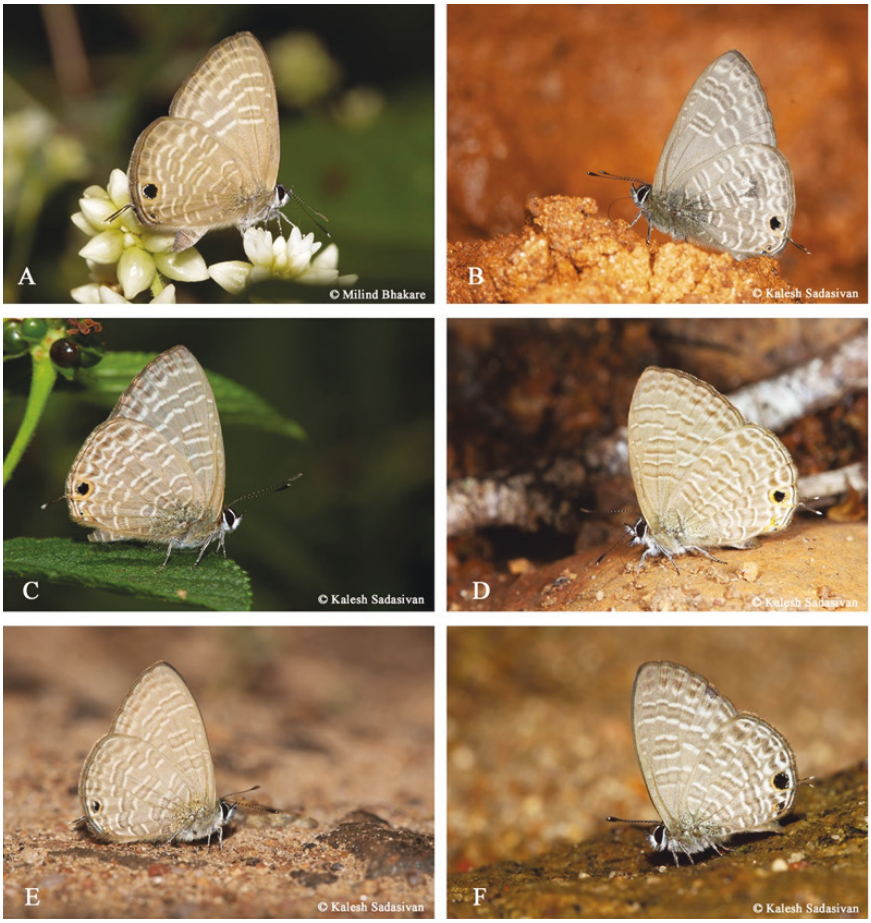

Image 5. Field images of *Nacaduba*: A—*Nacaduba pactolus continentalis* Fruhstorfer, 1916 | B—*N. hermus sidoma* Fruhstorfer, 1916 | C—*N. kurava canaraica* Toxopeus, 1927 | D—*N. beroe gythion* Fruhstorfer, 1916 | E—*N. berenice plumbeomicans* (Wood-Mason & de Niceville, 1881) | F—*N. calauria evansi* Toxopeus, 1927.

The harpe was thicker and less curved in *ramaswamii*, while it was slender and tip curved much more inward in *sinhala* (Fig. 2F). On detaching the claspers, the shape was almost as seen in the in situ view, but the distal end angle appeared more downcurved in *sinhala*, while it was slightly upcurved in *ramaswamii*, this was more evident on the ventral view (Fig. 2G&H). The aedeagus was more stockier and shorter in *ramaswamii*, while it was slender in *sinhala* (Fig. 2E&F). The coecum was larger and much globular in *ramaswamii*. The shaft was constricted a little distal to the middle of the shaft in *sinhala,* while no such constriction was seen in *ramaswamii*. The inferior border was more angulated in *sinhala*, in contrast it was smooth in *ramaswamii*. The supra-zonal sheath was sharper, more angulated and its tip angulated upwards in *ramaswamii*, while it was more smooth with a straighter tip in *sinhala*.

Female: Forewing length 13–14 mm (n= 2). The female is similar to the male on the underside. The termen and apices are more curved in comparison (Image 1C&D).

Upperside: General color is dark greyish-brown. UpF: Wing margins are broadly marked in dark grayish-brown, this band being thicker at the apex, followed by the termen, the leading edge and the distal half of the dorsum. The discal area with white patch, occupying the lower half of the cell, half of space 2, 3 from the origin and basal two-third of space 1b and basal half of space 1a. The basal half of the discal patch with pale blue iridescent scales and laterally the patch is pearly white. UpH: a pale discal patch of white that extends from the base to the sub-marginal zone, where the heart-shaped spots on underside are reflected as a series of spots. Space 1a is pale greyish. Reflections of the heart shaped sub-marginal dark spots, the marginal dark crescents, marginal lines are as in the males. Of the largest spot is the reflection of the tornal spot. Cell and proximal part of space 1 is clothed in long greyish blue hairs (Image 1D).

Underside: UnF and UnH as in male, except that the bands are a bit broader and so are the sub-marginal heart-shaped spots and the sub-marginal lines are more arched (Image 1C).

Variation

Male paratypes show little variation in patterns on upper and underside. The only difference in pattern was in the size of the heart shaped spots on hindwing spaces 4 and 5 which may be occasionally larger and meet the post-discal band, giving a crowded look. Size variation was considerable with forewing length varying from 13–15 mm. The females had significant individual variation, in addition to the size of the heart shaped spots on hindwing spaces 4 and 5, the extend of white coloration in uppersides of forewing disc and the hindwing was very variable. In a few individuals there were three well defined white spots in spaces 1b, 2 and 3. Size variation was observed with forewing length varying from 12 to 14 mm.

Diagnosis

Male upperside violet-blue, below ground colour is greyish to ashy, markings underside larger, ribbon scales present. The underside forewing markings well showing on uppersides in males. Male genitalia unlike any other species in peninsular India. Female upperside with shiny blue restricted to the basal half of both wings, upperside forewing with rest of the pale patch white.

Keys to *Nacaduba* of *Berenice* group from other regions of south-eastern Asia may not hold for taxa from Western Ghats, because of clinal variations and subspecies differences. We observed that the disposition of bands on underside are very variable, even on wings of a single specimen, and are not useful characters in diagnosing species. But the prominence of white streaks in them and the thickness of bands may be useful in identification. Males have straighter termens compared to females and this feature is more appreciable in open wing images. The transparency of wings and the underside marking showing through them is a useful character, but it must be used with caution, because in almost all species including the Opaque Six Line Blue *N. beroe*, the wings are transparent to a certain extend. This this is useful only in comparison of specimens in hand. The presence of ribbon scales are a useful character in males. But these must not be confused with normal long hairs in the cell and space 1b on upperside and the normal battledore shaped androconial scales. Androconial scales are structurally elongated, blunt ended short hair like scales distributed on the upperside of the male wings. Colors will sometimes loose brilliance, hairs may be lost in preservation and the colour of upperside may change with angles of incident light. The final word in determination of species must be based on male genitalia, which is distinct in each species.

Generally, in *Berenice* group (6-line *Nacaduba*) prominent white lines on the broad bands are characters that are exclusive to *N. kurava* and *N. sinhala*, while all other species have narrower bands with dirty or brownish stripes instead of pure white. The male *N. sinhala* is easily distinguished from all other *Nacaduba* in Western Ghats. Ground colour on underside is pale greyish compared to brownish of *N. beroe*, *N. calauria*, and *N. berenice* and much darker of *N. kurava.* The species has the palest blue on the upperside of males compared to all other *Nacaduba*. The rounded forewing termen of this species distinguishes it from species with straight termen, namely males of *N. kurava* and *N. beroe*. The presence of ribbon scales in males giving the frosted look on the upperside helps to differentiate the species, from males of *N. kurava* and *N. calauria*, that lack them. The species that have ribbon scales are *N. beroe* and *N. berenice*. From *N. berenice*, it can be differentiated by much large and prominent bands (narrow in *N. berenice)*, sub-marginal series of large heart-shaped dark grey spots (about the size of the tornal spot), with apices elongated towards the base of the wing, much darker than the grey inner stripes of the bands, more prominent on hindwings. From *N. beroe*, it can be distinguished by the rounded termen and the heart-shaped sub-marginal series. Females of *N. kurava* has heart-shaped sub-marginal series, but these are flattened and not elongated, and are always smaller than the tornal spot and not prominent on the hindwing and upperside of *N. kurava* has white discal patches. The male *N. sinhala* can be confused with females of other species too by the underside because of the rounded termen, but may be distinguished by the white discal patches of the other *Nacaduba* females. The distinct male genitalia in *N. sinhala*, compared to all other species is the final method of species confirmation in case of any ambiguity. Four-line *Nacaduba* of *Pavana* group are easily told apart by the lack of the basal band. But aberrations in *N. hermus* are known with extra band in basal region, in which case male genital differences have to be resorted to.

The female *N. sinhala,* cannot be confused with males, but they may be confused with other female *Nacaduba*. All are variable on the upperside with respect to the extent of blue and white. *N. kurava* and *N. sinhala* females have forewing distal end of the discal patch pure white. The blue of this patch is very pale sky-blue and is restricted towards the wing bases. In all other species the discal patch is darker blue completely with or without a purplish hue. Sometimes in *N. sinhala* females the discal patch may end in three post-discal

small white spots in spaces 1b, 2 and 3, clearly disjunct from the disco-basal patch. It is easily differentiated from *N. kurava* females by much the smaller size and the low elevational distribution <300m. Regarding elevational distribution, *N. kurava* is distributed above 700m in the subtropical and temperate forests; *N. beroe* is distributed from 200–700 m in mid-elevation forests, and all other species are seen commonly below 300m in evergreen and semi-evergreen jungles.

Etymology

The species is named after Lord Rama, signifying the connections across the sea to Sri Lanka.

Life History

Egg: The egg is a flat disc or turban shaped with the central region around the micropyle depressed a little. The superior surface is reticulated in a lotus petal pattern making quadrangular cells, the intersections of these lines bearing a centrally hollow tubercle. The color is dirty white. The egg is laid on the undersurface of the young leaves, axils and buds of the host plant *Dimocarpus longan* Lour. (Sapindaceae). Oviposition was observed usually in the afternoons where the females were seen in a fluttering weak flight searching for the best sites to lay eggs. Occasionally more than one egg was laid on same leaf but by different individuals (Image 2A). Size 0.75–1 mm

Larvae*:* The eggs hatched in about 2–3 days. The color of the egg larva was pale honey yellow (Image 2B). Head capsule is of the same color as the body, mouthparts brown and eyes are black. The bod bears moderately long pale yellowish semitransparent hairs, of these those on the dorsum and near the legs are longer. The tiny larva was seen keeping to the underside and scraping the lilac cuticle of that side, giving the larva its pinkish tinge when eaten. It is of the same color as the young leaf and very tiny to be seen, unless some sort of magnification was used. The young larva eats a part of the egg shell around the micropyle leaving behind the major part of the egg shell intact. The larva moves very slowly keeping to the undersurface of the leaf. The presence of these hatched out shell points out the presence of the egg larva. Size 2 mm. First instar: (Image 2C). The larva is pale waxy serous yellow in colour. The eye spots are black. The structure is like that of the egg-larva. Hairs are much shorter. The small caterpillar keeps to the underside of the freshest leaves, eating the substance in an irregular moth-eaten pattern. Size 2–3 mm. Second Instar: (Image 2D). The shape becomes more flattened. Colour is pale yellowish-white with a waxy appearance. Like in the previous instars it keeps to the concavities of the underside of the young leaves, eating in a moth-eaten pattern. Hairs are present, obvious and much shorter. Size 3–4 mm. Third Instar: (Image 2E). Similar to the second instar but a bit larger and coloured pale greenish white. The habits are as the previous instars. At this stage ants begin to attend to the larvae. Size: 0.5–0.75 cm. Fourth Instar: (Image 2F). The shape is almost onisciform and triangular in cross section. Colour is pale serous white with pink as follows- a dorsal thin line extending from segment 3 to 12, latero-basal thicker lines just above the flange covering the legs all along the side from the segment 2–12, whole of the segment 2 and 3. Of these three lines the dorsal line is the darkest. The central triangular plate on segment 2 is milky white so are the lateral organs on segment 12. The whole body is covered in very small, transparent star shaped tubercles giving a rough appearance on magnification. Hairs are seen on the lateral flanges, front and rear ends. Those on the lateral flanges are the shortest and curved and that on the front end and anal plate are longer, the latter being the longest. Size: 0.75–1 cm, habits are like the previous instars, but this a much bolder in feeding facilitated by the ants that attend it. Feeding is more active and the whole leaf margin is consumed instead of the cuticle and it prefers a little more mature leaflet. Final Instar: (Image 2G&H). The shape is onisciform. Segment 2 and anal plate is semi-circular. Mid dorsal plate in segment 2 is flower shaped and milky white. Each segment is flanged out and tumid giving a blunted serrated look. The highest point is at about the middle of the body. Colour is pale sap green with a waxy yellow shade especially along the baso-lateral flanges. Sometimes pink forms are also seen. Head is completely hidden under segment 2 and is pale greenish-yellow, eyes black and mouthparts pale brown. Body has sparse hairs along the baso-lateral flanges, on the edge of segment 2 and anal plate. Whole body is clothed in tiny tubercles giving a rougher texture on magnification. Spiracles circular and white. Segment 11 has the transverse gland opening at its hinder margin. Segment 12 bears the lateral organs, just postero-lateral ton the spiracles, and the tip of the thin extruded gland is pale pinkish-brown. Length 10–15 mm. Breadth 5–6 mm. The total duration of larval stage is 18–20 days.

Pupa: (Image 3B–D). Shape of the pupa is as in all *Nacaduba*, a short spindle with wide abdomen. On dorsal view, front is almost squarish with sides rounded off. The anal end is rounded. The broadest part on the pupa is around the level of the distal end of the wing cases. On lateral view, the head has a dorsal convexity,

the angle between head and thorax is obtuse, thorax is humped, the constriction between thorax and abdomen is very shallow and a smooth concavity. The highest point is at the mid-level of the wing cases. The abdomen has a uniform convexity. Pupa is secured with the mid-body band and the cremaster. The whole surface is finely reticulo-rugose and bears large black spots and tiny brown spots that coalesce to form blotches. The general colour is waxy pale yellowish-brown with a hue of rose on the head, thorax and wings; and opaque yellowish-pink with a brown wash on the abdomen. Wing cases are pale waxy brown. The whole body is marked in dark brown and black as follows- there is a dorsal band running from head to tail, this band has a large black spot near the joint of the head and thorax, there are two black spots as large as the anterior one, just above where the wings begin, another pair of black spots are present in the lateral ends of the first thoracic segment. A pair of spots in all segments on the dorsolateral aspect except in second thoracic segment. The dorsal band may form a large spot the rear end. Rest of the body bears tiny blackish-brown spots that may join with the adjacent ones. Pupation takes place under the leaf or on the stem of the plant (Image 3A). The butterfly eclosed in 7–10 days.

Ecological notes

The species appears to breed more during the north-east monsoons, though the breeding season extends from September to January, with peak in October. In Sri Lanka the larvae are attended by *Technomyrmex* (van der Poorten & van der Poorten 2013), while it is occasionally attended by *Technomyrmex albipes* (Smith, 1861) and *Nylanderia* species in southern India from stages 3-final instar (Image 3E&F).

Distributional range

This is the first record of the species *N. sinhala* outside its endemic range in Sri Lanka. Thus, the endemicity of the taxon is now limited to the Western Ghats complex (Western Ghats and Sri Lanka), more specifically Agasthyamalais and Sri Lanka. The altitudinal range is

Revised Key to *Nacaduba* line blues of Western Ghats of peninsular India

A. Underside forewing no basal pair of pale lines 4-line blues (*Pavana* group)

a) Underside forewing inner sub-marginal band on forewing continuous, broad and diffuse and continuous in both sexes (Image 5A) .... *Nacaduba pactolus continentalis* Fruhstorfer, 1916

b) Underside forewing inner marginal band of forewings made of separate narrow lunules in both sexes (Image 5B) .... *N. hermus sidoma* Fruhstorfer, 1916

B. Underside forewing with basal pair of pale lines: 6-line blues (*Berenice* group)

a) Termen of forewing straight in middle in spaces 2–6 in males, forewing apex produced, especially evident in open wing

i. Males pale violet blue, below markings regular and prominent ground color greyish, clearly showing through above, upperside hindwing disc in males not clothed in hair-like scales thus lacking the frosted look, females upperside forewing and upperside hindwing discal patch broad, pale bluish-white and lacks the white post discal spots (Image 5C). Male genitalia distinct (Fig. 2A) .... *N. kurava canaraica* Toxopeus, 1927

ii. Males upperside dark violet blue, below markings narrower, duller not clearly showing through above, ground color brownish, wings rounded than *N. kurava*; UPH disc in males clothed in hair like ribbon scales giving frosted look, females UFW discal patch restricted, bluish and traces of pale post discal spots, female UPH brown with bases purple blue (Image 5D). Male genitalia distinct (Fig.2C) ....*N. beroe gythion* Fruhstorfer, 1916

b) Termen of forewing convex, forewing apex rounded in both sexes

i. Ground color on underside browner, stripes narrow off-white; males upperside dark steely shining blue, ground color brownish, no ribbon scales hence lacking frosted look; markings on underside well-defined and narrow. Females upperside forewing discal patch restricted with bluish scales and traces of pale post discal spots, female UP purple (Image 5F). Male genitalia distinct (Fig. 2B)..... ..... *N. calauria evansi* Toxopeus, 1927

ii. Males upperside violet blue, below ground color greyish to ashy, markings on underside larger, ribbon scales present

a. Ground color browner in dry season and greyish in wet season form, stripes narrow off-white (Image 5E); underside forewing markings not well showing on upperside forewing. There may be heart-shaped spots on the sub-marginal areas of both wings in the west season form, but the spots are never elongated or thicker as in *N. sinhala,* especially in the forewings; females UPF and upperside hindwing broad discal bluish patch with no discal bluish spots, female upperside shining blue beyond the half of the wings, ribbon scales present on male forewing giving a frosted look. Male genitalia distinct (Fig. 2D).....*N. berenice plumbeomicans* (Wood-Mason & de Niceville, 1881)

b. Ground color pale greyish, stripes broad and white giving a crowded appearance especially on the post-discal region of hindwing. UNF markings well showing on UPF in males, female UP with shiny blue restricted to the basal half of both wings, UPF with rest of the pale patch white. Both sexes both wings with a sub-marginal series of large heart-shaped dark grey spots (about the size of the tornal spot), with apices elongated towards the base of both the wings, much darker than the grey inner stripes of the bands, more prominent on hindwings where they almost touch the post-discal bands (Image 4). Male genitalia distinct (Fig. 2E&G) .... ***N. sinhala ramaswamii* ssp. nov.**

below 300m (Fig. 1).

DISCUSSION

This paper adds one more taxa to the butterfly list of Western Ghats and hence to that of butterflies of mainland India. The Sri Lankan taxon was originally described as '*Nacaduba berenice ceylonica* Fruhstorfer'. Later, Ormiston (1924) renamed this, accepting the morphological differences as *Nacaduba sinhala;* and the Sri Lankan taxon representing *Nacaduba berenice* was named *Nacaduba berenice ormistoni* by Toxopeus (1927). *N. sinhala* was believed to be restricted to Sri Lanka as per Ormiston (1924), Evans (1932), Woodhouse (1947), and van der Poorten & van der Poorten (2018). The early stages and the larval hostplants of *Nacaduba sinhala* were documented by van der Poorten & van der Poorten (2013), as *Dimocarpus longan* Lour. (Sapindaceae). The species is said to be distributed from 100–900 m. The butterfly flies year round and is migratory, the peak flight season appears to be just before the start of the south-west monsoons according to van der Poorten & van der Poorten (2018). In contrast, the southern Indian subspecies seems to be non-migratory as far as known and present in low numbers all around the year. The peak flight season being during the North-East monsoons from September to November. The larva of the species is monophagus and feeds on *Dimocarpus longan* Lour. (Sapindaceae) both in Sri Lanka and South India. We found that the southern Indian taxon is morphologically similar to the nominate species from Sri Lanka but differs in its male genitalia structure. The differences and the geographical locations, suggest they have diverged possibly to a subspecies level. Further phylogenetic works might be needed to elucidate the molecular divergence and with sufficient variation it may be subsequently raised to species status.

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