








# New records of *Lestes nigriceps* Fraser, 1924 (Odonata: Lestidae) from Maharashtra, India, with notes on *L. patricia* Fraser, 1924 and an updated key to *Lestes* of the Western Ghats, India

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## Research Article

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All relevant data are within the paper.

**Abstract.** Damselflies of the genus *Lestes* Leach, 1815 are represented in India by 11 species. Using specimens collected over the last five years, we report on the rediscovery of *Lestes nigriceps* in India after 98 years, at two new localities in the Western Ghats. This species was observed at the Aarey Milk Colony, Mumbai, and in the Sindhudurg District, Maharashtra, India. The diagnosis of the subspecies *Lestes patricia taamrpatti* Bhakare, Bhoite & Pawar, 2020 is re-assessed, found insufficient for differentiation, and this taxon is synonymized with *Lestes patricia* Fraser, 1924, as a consequence. We present an updated key to the species of *Lestes* of the Western Ghats biodiversity hotspot.

**Key words.** Dragonfly, *Lestes patricia*, *Lestes*, Aarey Milk Colony, range extension, Sindhudurg, species rediscovery, taxonomic key

## Introduction

Damselflies of the genus *Lestes* Leach, 1815 are characterized by their peculiar behavior of resting with the wings spread, bestowing upon them the moniker of “spreadwings”. Eleven *Lestes* species have been recorded from India (Kalkman et al., 2020; Subramanian & Babu, 2017), of which nine occur in the Western Ghats (Subramanian, 2018).

*Lestes nigriceps* Fraser, 1924 was originally described from “Pusa” [presumed to be Pusa, Bihar], India. Subsequently, this taxon was recorded only once more, i.e., from the Mondulkiri Province in Cambodia (Kosterin, 2018) where several males and females were found and described. We here provide detailed descriptions of both the male and female, and comment on the intraspecific variation in *L. nigriceps* based on recently collected specimens and photographic evidence. For its

part, *Lestes patricia* Fraser, 1924 was recently rediscovered at Satara, Maharashtra, India. Our study concluded that there is insufficient justification for recognizing a separate subspecies, and as a consequence we here propose that the subspecific taxon *Lestes patricia taamrpatti* Bhakare, Bhoite & Pawar, 2020 be synonymized with *Lestes patricia* Fraser, 1924.

Many species of *Lestes* encountered in India are difficult to identify due to high intraspecific variation. Kosterin (2019) updated the key to the species of *Lestes* of India that was given by Fraser (1933). We found a few discrepancies in this key based on (a) examination of a series of specimens of *L. nigriceps*, and (b) images of the holotypes of *L. patricia* and *L. nigriceps*, and here provide an updated key to the species of *Lestes* found in the Western Ghats.

## Material and methods

The present authors conducted odonate surveys at the Aarey Milk Colony and in Sindhudurg District, Maharashtra, from August 2019 to August 2021. The Aarey Milk Colony (19.14612° N, 72.87535° E, 52 m a.s.l.) is a forested area, situated in the Mumbai Suburban District near the Sanjay Gandhi National Park. Four locations in Sindhudurg District, namely Bhekartaka (16.39850° N, 73.47557° E, 116 m a.s.l.), Chipi (15.99429° N, 73.52074° E, 61 m a.s.l.), Dhamapur (16.03413° N, 73.58550° E, 110 m a.s.l.), and Vimalleshwar (16.43437° N, 73.39621° E, 27 m a.s.l.) are lateritic plateaus with ephemeral ponds where *Lestes nigriceps* was found. Field photography was done with a Nikon D5600 DSLR Camera (Nikon Inc., Japan), Canon 760D DSLR Camera, Canon 100-mm macro lens (Canon Inc., Japan) and a Tamron 90-mm macro lens (Tamron Co. Ltd., Japan). Specimens were collected with insect nets and were either preserved in 70% or 99% ethanol or pinned and deposited in the Biodiversity Lab Research Collections at the National Centre for Biological Sciences, Bengaluru (hereafter, NCBS; <http://biodiversitycollections.in/>). Details of collected specimens are given in Table 1. All specimens used in this work were collected on private land, outside of protected areas (wildlife sanctuaries and reserve forests), and the species studied here are not legally protected under any schedules of the Indian Wildlife (Protection) Amendment Act, 2022.

The specimens were examined and photographed using Leica (Leica Microsystems, Germany) stereomicroscopes for close-up images and Canon 1200D with a Canon 50-mm Macro lens (Canon Inc., Japan). Images were stacked to generate a greater depth of field. Scale bars were added with the Leica Application Suite (Leica Microsystems, Germany) or ImageJ (Schneider et al., 2012).

Morphological terms are based on Garrison et al. (2010). All measurements are given in mm unless mentioned otherwise. Abbreviations in the text: FW = fore wing, HW = hind wing, Ax & Px = antenodal and post-

nodal nervures, respectively, Pt = pterostigma, S1–10 = abdominal segments 1 to 10. The map used in Figure 6 was created with QGIS v3.10.2 software.

## Results

### Rediscovery of *Lestes nigriceps* in India (Figs 1–4)

#### Material examined

5 ♂♂ (IBC-BH983, IBC-BM101, IBC-BM103, IBC-BM104, IBC-BM105), Lotus Lake, Aarey Milk Colony, Goregaon (East), Mumbai Suburban District, Maharashtra, India, (19.14612° N, 72.87535° E, 52 m a.s.l.), 21.viii.2019, Shantanu Joshi leg.

1 ♂ (IBC-BN786), Dhamapur, Sindhudurg District, Maharashtra, India, (16.03413° N, 73.58550° E, 110 m a.s.l.), 26.viii.2021, Akshay Dalvi leg.

2 ♂♂ (IBC-BN787, IBC-BN788), 2 ♀♀ (IBC-BN791, IBC-BN792), Chipi, Sindhudurg District, Maharashtra, India, (15.99429° N, 73.52074° E, 61 m a.s.l.), 31.viii.2020, Akshay Dalvi leg.

2 ♂♂ (IBC-BN789, IBC-BN790), location and collector the same as IBC-BN787, date of collection 04.ix.2020.

1 ♂ (IBC-BN793), 1 ♀ (IBC-BN794), location and collector the same as IBC-BN787, date of collection 26.viii.2021.

1 ♂ (IBC-BN829), Bhekartaka, Talebazar, Sindhudurg District, Maharashtra, India, (16.39850° N, 73.47557° E, 116 m a.s.l.), 26.viii.2021, Dattaprasad Sawant leg.

#### Description of the male (IBC-BM101) (Fig. 1)

Head (Fig. 1a). Labrum pale turquoise blue, dark yellow postmortem; mandible yellowish green; base of mandible pale turquoise blue, dark yellowish orange postmortem; labrum with small faint blue spots; anteclypeus blue, postclypeus bluish black; frons and rest of head black; ocelli brownish black; antennae black; eyes pale turquoise, dark brown postmortem; postocular area bluish gray with faint brown spots on the dorsal side; occiput gray.

Prothorax (Fig. 1b). Bluish gray; anterior and median lobes bluish gray with dark markings on latter, posterior lobe dark gray; pronotum pruinosed.

Synthorax (Fig. 1b). Mesostigmal plates medially gray, laterally pale yellow with black border on the lateral edge in life, dark bluish gray postmortem; mesepisternum dorsally black with metallic green stripes on both sides of dorsal suture; lateral half of mesepisternum greenish yellow to orange yellow; mesepimeron pale grayish blue, anteriorly black along with mesopleural suture; black marking tapering along the mesopleural suture posteriorly; vertical black mark on anterior mesepimeron resembling an inverted triangle; metepisternum and metepimeron grayish blue; dorsal half of metepimeron and poststernum pale orange brown;

**Table 1.** Details of *Lestes nigriceps* specimens collected in Maharashtra state, preserved wet only, and deposited in the National Centre for Biological Sciences, Bengaluru (NCBS).

Voucher Code (IBC-)	Sex	Collection site (place, district)	Collection date	Collector
BH983	Male	Aarey Milk Colony, Mumbai Suburban	21 VIII 2019	Shantanu Joshi
BM101	Male	Aarey Milk Colony, Mumbai Suburban	21 VIII 2019	Shantanu Joshi
BM103	Male	Aarey Milk Colony, Mumbai Suburban	21 VIII 2019	Shantanu Joshi
BM104	Male	Aarey Milk Colony, Mumbai Suburban	21 VIII 2019	Shantanu Joshi
BM105	Male	Aarey Milk Colony, Mumbai Suburban	21 VIII 2019	Shantanu Joshi
BN786	Male	Dhamapur, Sindhudurg	28 VII 2021	Akshay Dalvi
BN787	Male	Chipi, Sindhudurg	31 VIII 2020	Akshay Dalvi
BN788	Male	Chipi, Sindhudurg	31 VIII 2020	Akshay Dalvi
BN789	Male	Chipi, Sindhudurg	04 IX 2020	Akshay Dalvi
BN790	Male	Chipi, Sindhudurg	04 IX 2020	Akshay Dalvi
BN791	Female	Chipi, Sindhudurg	31 VIII 2020	Akshay Dalvi
BN792	Female	Chipi, Sindhudurg	31 VIII 2020	Akshay Dalvi
BN793	Male	Chipi, Sindhudurg	21 VI 2021	Akshay Dalvi
BN794	Female	Chipi, Sindhudurg	21 VI 2021	Akshay Dalvi
BN829	Male	Bhekartaka, Sindhudurg	26 VIII 2021	Dattaprasad Sawant

metapleural suture with a circular to oval black spot in the posterior third of the suture; antelar ridge, subalar ridge, metascutum pruinose, bordered with black; synthorax pale ventrally.

Legs. Coxae pale blue, ventrally pale yellow; femur, tibiae with a lateral black stripe, anteriorly and posteriorly metallic green in life, pale orange postmortem; tibiofemoral joint, tarsus and spines black.

Wings (Fig. 1c). Hyaline; venation dark brown; pt blackish brown in life, orange brown postmortem, bounded with black nervures, covers just a little more than two cells. Two Ax in all wings. Px: 11 to 13 in FW, 11 in HW. Discoidal cells in FW and HW triangular.

Abdomen (Fig. 1b). S1 dorsally brownish black with iridescent greenish tinge, pale laterally and ventrally with a black spot on either side; S2–6 dorsally black with a metallic green iridescence and a narrow pale marking at the anterior end, laterally and ventrally pale; an oval black spot on either side of S2 just near the secondary genitalia; in S3–6, dorsal black areas with projections on the ventral side at the posterior end of each segment; S7 dorsally black with a metallic green iridescence except in the posterior third, which is jet black, ventrally pale blue; S8 black without iridescence, ventrally a narrow pale blue streak at the anterior end; S9–10 pruinose, bluish gray.

Caudal appendages (Figs 1d–f). Cerci pale yellow, strongly bent inwards in the distal third, at an angle of  $\sim 110^\circ$  with the rest; tips of cerci rounded and touching each other; each cercus with a sub-basal tooth at its inner margin, sky-blue in life, dark brown postmortem; inner trapezoid lamina, sky-blue in life, creamy white postmortem; inner margin of lamina proximally smooth, distally with irregular teeth; cerci apex black

with teeth-like projections on the outer margin; length of cercus greater than S10, almost equal to S9; paraprocts long, ca 45% as long as cerci in dorsal view, ca 50% as long as cerci in lateral view; paraprocts broad at the base, conical distally, flat in longitudinal plane, with blunt ends and sparsely distributed short hairs.

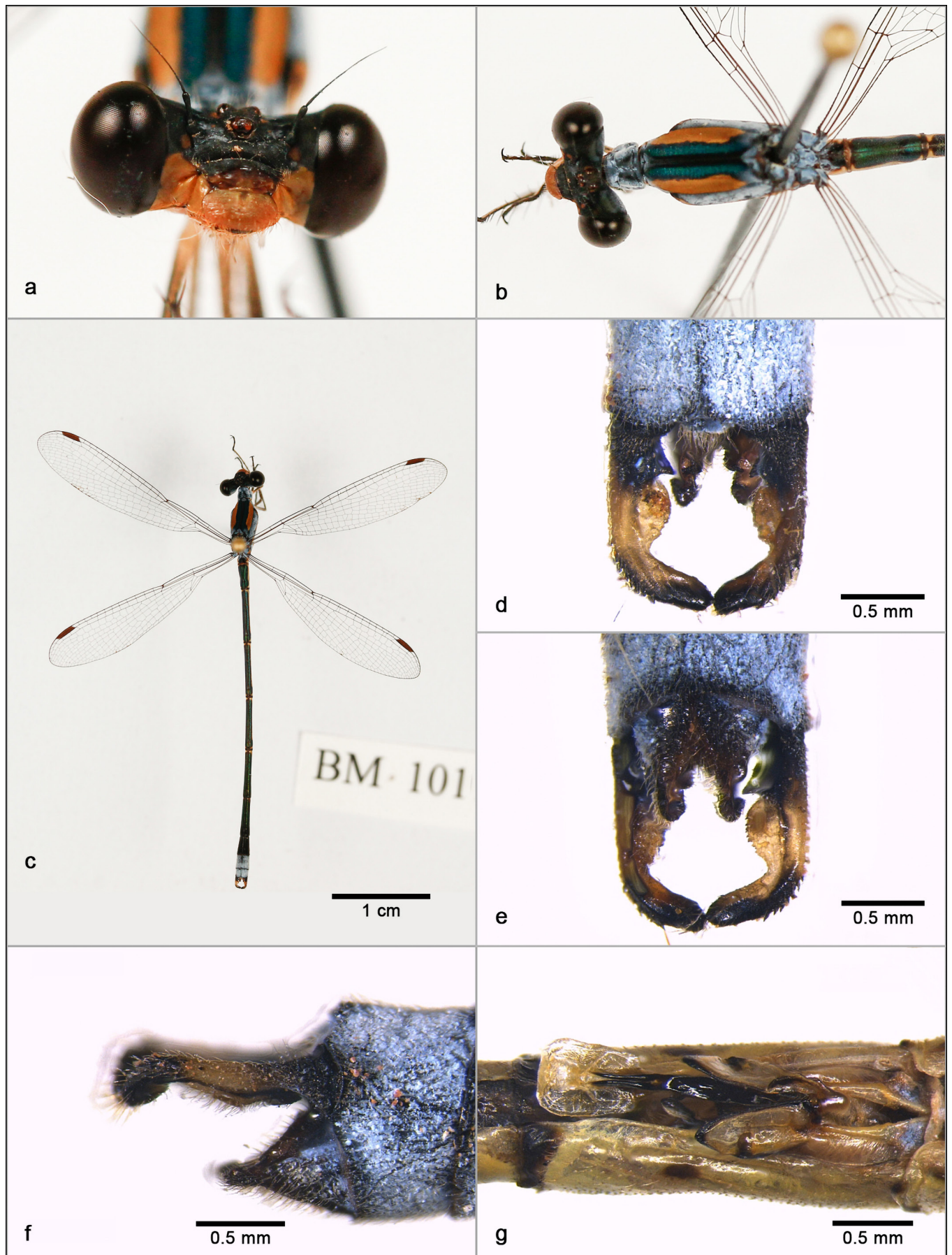
Genitalia (Fig. 1g). Ventral two-thirds of first and second segments black, dorsally light brown; third segment pale, spatulate.

Measurements (in mm). Abdomen without appendages 30–31; HW 20; total length 39–41.

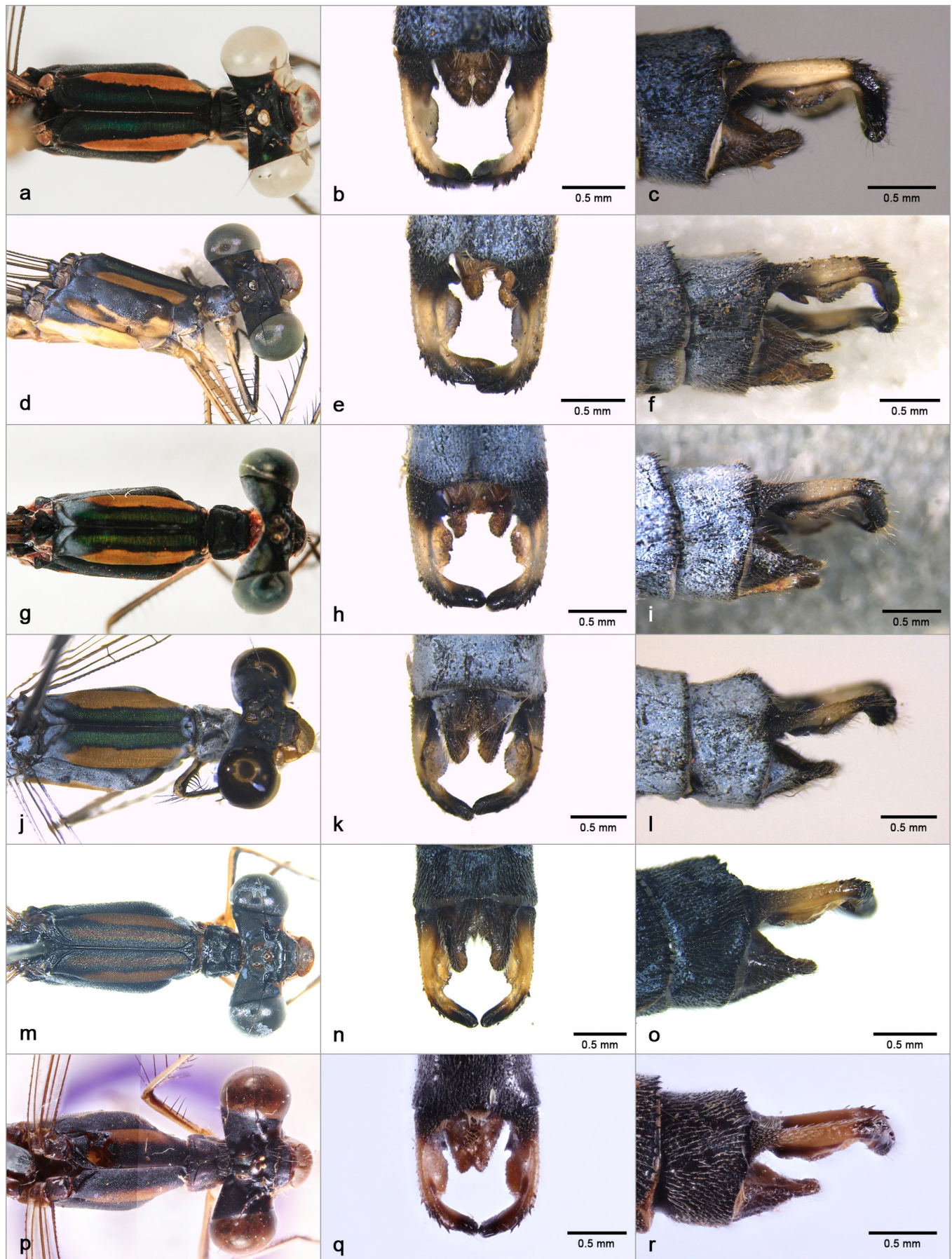
#### Variation in males (Fig. 2)

In life, teneral and immature individuals are pale orange to brown, changing to blue or grayish blue in mature individuals. The length and width of the dorsal green metallic stripe is variable (Figs 2a, d, g, j). Dorsolateral metallic stripes are variable in shape, often expanded slightly midway and posteriorly (Figs 2a, g, j, m). Lateral half of mesepisternum highly variable in terms of coloration (wet-preserved IBC-BM104 shows a yellowish green coloration whereas pinned dry specimens usually are pale orange to orange). In life, the same area ranges from greenish yellow (Fig. 4h) to pale orange (Figs 4a–b, g). A few individuals have a very narrow stripe of pale orange, whereas a few have a grayish blue one on the lateral half of the mesepisternum (Fig. 4c).

Mesopleural suture with a black marking that tapers along with it posteriorly. Four individuals show such tapering just near the anterior vertical black triangular marking, whereas in five specimens it extends to the midpoint of the suture. Dry specimens show complete black band-like markings of variable width on the mesopleural suture (Figs 2a, d, g, j). A vertical black marking



**Figure 1.** *Lestes nigriceps*, male, IBC-BM101: (a) head in anterior view; (b) head and thorax, dorsal view; (c) dorsal habitus; (d) caudal appendages in dorsal view; (e) caudal appendages in ventral view; (f) caudal appendages in lateral view; (g) accessory genitalia.



**Figure 2.** *Lestes nigriceps*, males: IBC-BH983: (a) thorax; (b–c) caudal appendages; IBC-BM103: (d) thorax; (e–f) caudal appendages; IBC-BM104: (g) thorax; (h–i) caudal appendages; IBC-BM105: (j) thorax; (k–l) caudal appendages; IBC-BN790: (m) thorax; (n–o) caudal appendages; NHMUK 013384634: (p) thorax; (q–r) caudal appendages. Images p–r courtesy Natural History Museum UK (2023a).

on the anterior mesepimeron resembling an inverted triangle in living specimen is variable in its extent; it darkens with maturity and its upper part tapers along with the mesopleural suture.

Caudal appendages undergo a significant color change with maturation. From pearly white in immatures, they become multicolored with age. Mature individuals have a dark brown apex and base, a sky-blue basal tooth and lamina, and the rest is yellow to dark yellow (Figs 2e, h, 4d). In pruinosed specimens it becomes darker yellow to dark brown. The number of thick spines on the apex of cerci are variable. Angle of cerci ranges from  $\sim 90^\circ$  to  $\sim 110^\circ$ . Depending on the angle, the trapezoidal lamina may appear differently. Figure 2 shows the variation in shape of the caudal appendages of different males.

Measurements (in mm). Px varies from 9 to 13 in FW, 9 to 12 in HW.

#### Description of female (IBC-BN791) (Fig. 3)

Head (Fig. 3a). Labium pale yellow; labrum, mandible, base of mandible pale yellow to yellowish green; anteclypeus, postclypeus, frons black with dark blue markings at midline; ocelli dark brown; area between eyes and ocelli dark metallic green with a brownish tinge; antennae black; posterior part of head pale brown; eyes

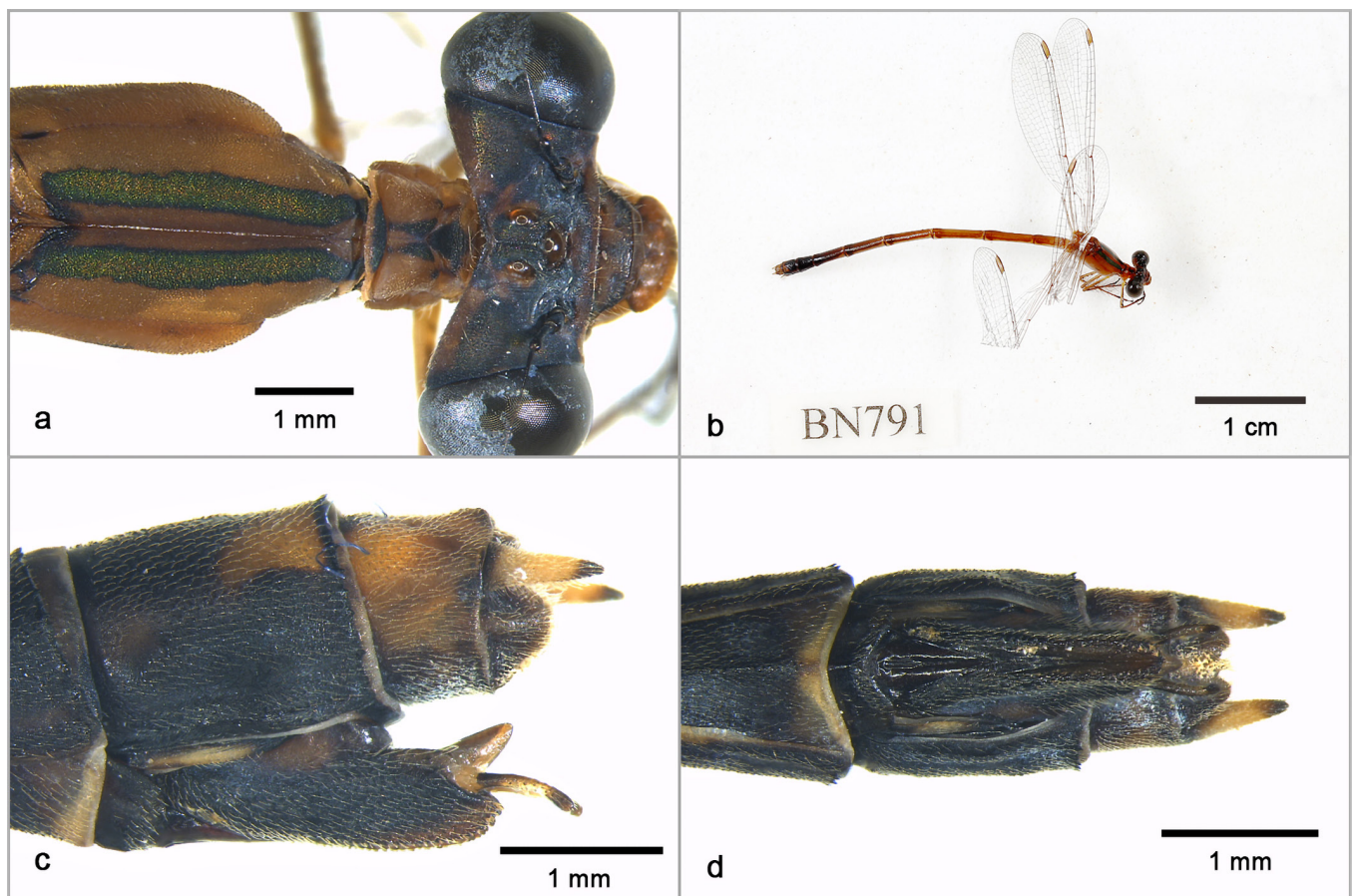
greenish in upper half, turquoise in lower half antemortem, anteriorly pale brown around pseudopupil.

Prothorax (Fig. 3a). Pale brown with wide metallic green dorsal band on all lobes; paler on lateral side; a thin black line on both lateral surfaces.

Synthorax (Fig. 3a). Similar to male except metallic green stripes are wider; ground color pale brown; mesepisternum with metallic green stripe on each side of dorsal suture; mesepisternum lateral half pale brown; mesepimeron pale brown; oval black spot at the posterior end of the mesopleural suture; intersegmental suture abruptly ending at anterior, a small black spot just anterior to it; metepimeron pale brown in upper half, pale creamy yellow in lower half; poststernum pale; antealar ridge pale greenish brown; subalar ridge and metascutum pale bluish brown.

Legs. Dorsally and ventrally pale greenish yellow, laterally with a black stripe; coxae pale greenish yellow; femur and tibia pale yellow with a lateral black stripe; tarsus dark; spines black.

Wings (Fig. 3b). Hyaline; venation blackish brown; pt blackish brown in life, covers two cells; two Ax in all wings. Px: 11 to 13 in FW, 13 in HW. Discoidal cells in FW and HW triangular.



**Figure 3.** *Lestes nigriceps*, female, IBC-BN791: (a) head and thorax, dorsal view; (b) dorsal habitus; (c) caudal appendages in lateral view; (d) caudal appendages in ventral view.

Abdomen (Fig. 3b). S1–6 similar to male, the yellow tinge more intense, dorsally paler blue; S7 dorsally black, ventrally pale, posteriorly jet black; S8 completely black; S9 anterior half black dorsally, posterior half pruinose, pale yellow postmortem, dorsally black; S10 pale blue dorsally, black ventrally.

Caudal appendage (Figs 3c–d). Cerci pale yellow with black tips, slightly shorter than S10; paraprocts black, shorter than cerci; ovipositor black.

#### Variation in females

Two females show variable bluish black markings on the mesepimeron with a paler brown color. The dorsal metallic green stripes are bounded by a black border of variable width (Figs 4e–h). In one female (Fig. 4e), the metallic green stripe expands at the posterior end, forming an indistinct 'J'-shaped mark, less sharply defined than that in *L. elatus* Hagen in Selys, 1862 (Fig. 4e).

#### Differential diagnosis of *L. nigriceps* in India based on new material

*Lestes nigriceps* males can be easily distinguished from males of *L. concinnus* Hagen in Selys, 1862 (= *L. thoracicus* Laidlaw, 1920; = *L. umbrinus* Selys, 1891; see Dumont et al., 2017; Kalkman, 2020), *L. dorothea* Fraser, 1924, *L. elatus*, *L. garoensis* Lahiri, 1987, *L. nodalis* Selys, 1891, and *L. praemorsus* Hagen in Selys, 1862. *Lestes nigriceps* has thoracic markings as follows: dorsal narrow metallic green stripes bounded with a variable greenish yellow to orange stripe laterally. *Lestes concinnus*, *L. garoensis*, and *L. nodalis* do not have any metallic green markings on the synthorax. *Lestes dorothea* and *L. praemorsus* have crenulated markings on the dorsal synthorax. *Lestes elatus* has metallic green stripes, but it can be easily distinguished from *L. nigriceps* by the shape of the cerci and the very short paraproct of the male. *Lestes nigriceps* is similar to *L. malabaricus* Fraser, 1929, *L. patricia* Fraser, 1924, and *L. viridulus* in terms of male caudal appendages structure. *Lestes malabaricus* can be distinguished from *L. nigriceps* by: (a) smaller size: abdominal length of *L. malabaricus* is 24–25 mm (Fraser, 1929), vs. 30–32 mm in *L. nigriceps*; (b) wider metallic green stripes on the synthorax dorsally; (c) a dark grayish band on the lateral synthorax (*L. nigriceps* has black markings as specified in the description above); (d) male caudal appendages darker, with apices of cerci curved at ~90° in dorsal view; and (e) paraprocts more rounded (pointed in *L. nigriceps*) in the male.

*Lestes patricia* can be distinguished from *L. nigriceps* by: (a) larger size (abdominal length of *L. patricia*: 35–37 mm vs 30–32 mm in *L. nigriceps*); (b) narrow black stripes on the dorsal synthorax enclosing a coppery red area in between; and (c) absence of black markings on the lateral thorax.

*Lestes viridulus* can be distinguished from *L. nigriceps* by: (a) narrow green metallic stripes on 'warm reddish brown on dorsum, with a cupreous reflex' on the syn-

thorax; (b) plain brown lateral synthorax with no black markings; (c) S9 with a blackish brown inverted triangular marking on the dorsum; and (d) pale brown caudal appendages with darker apex (multicolored in *L. nigriceps*) in the male.

The Cambodian population of *L. nigriceps* discovered by Kosterin in 2018 has a more extensive pruinosity compared to the specimens examined in the present study, which could be due to either geographical or seasonal variation. Cambodian specimens have a black band-like marking along the mesopleural suture with the lateral half of the mesepisternum being pale greenish, whereas Indian specimens have an inverted triangular marking anteriorly and faint black markings as described above, and are greenish yellow to orange yellow in the lateral half of the mesepisternum (Figs 4a–b, f–h). In females, the thorax exhibits variable melanization in both populations (Figs 4e–h).

#### Habitat of *L. nigriceps* (Fig. 5)

*Lestes nigriceps* was found in shallow, heavily vegetated ponds or small lakes. The Aarey Milk Colony is a forested area, situated in the Mumbai Suburban District near the Sanjay Gandhi National Park, Maharashtra. The water body, locally known as Lotus Pond, obviously makes for a good breeding habitat (Fig. 5a) for this species and it occurs here in abundance. It was found along with *L. viridulus* at this pond. For a full list of sympatric odonates and information on the habitat see Sawant & Sanap (2022).

The lateritic plateaus of Bhekartaka, Chipi, Dhampur, and Vimalleshwar in the Sindhudurg District, Maharashtra, sport many ephemeral pools (Figs 5b–d). These serve as breeding habitats for *L. nigriceps* and many other zygopterans such as *L. viridulus*, *Agriocnemis pygmaea* Rambur, 1842, *A. splendidissima* Laidlaw, 1919, *Ceriagrion chromothorax* Joshi & Sawant, 2019, and *Ceriagrion coromandelianum* Fabricius, 1798. Except for the Aarey Milk Colony pond (50 m a.s.l.), the remaining habitat patches are ephemeral pools on lateritic plateaus (approx. elevation range: 100–200 m a.s.l.). All habitats from which *L. nigriceps* was recorded so far are temporary and have adequate water only from about mid-June to October/November. This species prefers perching among dense reeds or grasses along the edges of ponds.

#### Distribution of *L. nigriceps* (Fig. 6)

The present records from the Mumbai Suburban District (Aarey Milk Colony) and Sindhudurg District (Bhekartaka, Dhampur, and Vimalleshwar) extend the known range of *L. nigriceps* from Bihar to the northern Western Ghats. Additionally, Dattaprasad Sawant has observed it in the Pune (Bhimashankar) and Ratnagiri Districts (Devihasol and Kasop). Recently, Bharati & Koparde (2022) recorded a *Lestes* sp. from the Gondia District of Maharashtra and preliminarily identified it as *Lestes* cf. *malabaricus*. Considering the morphology

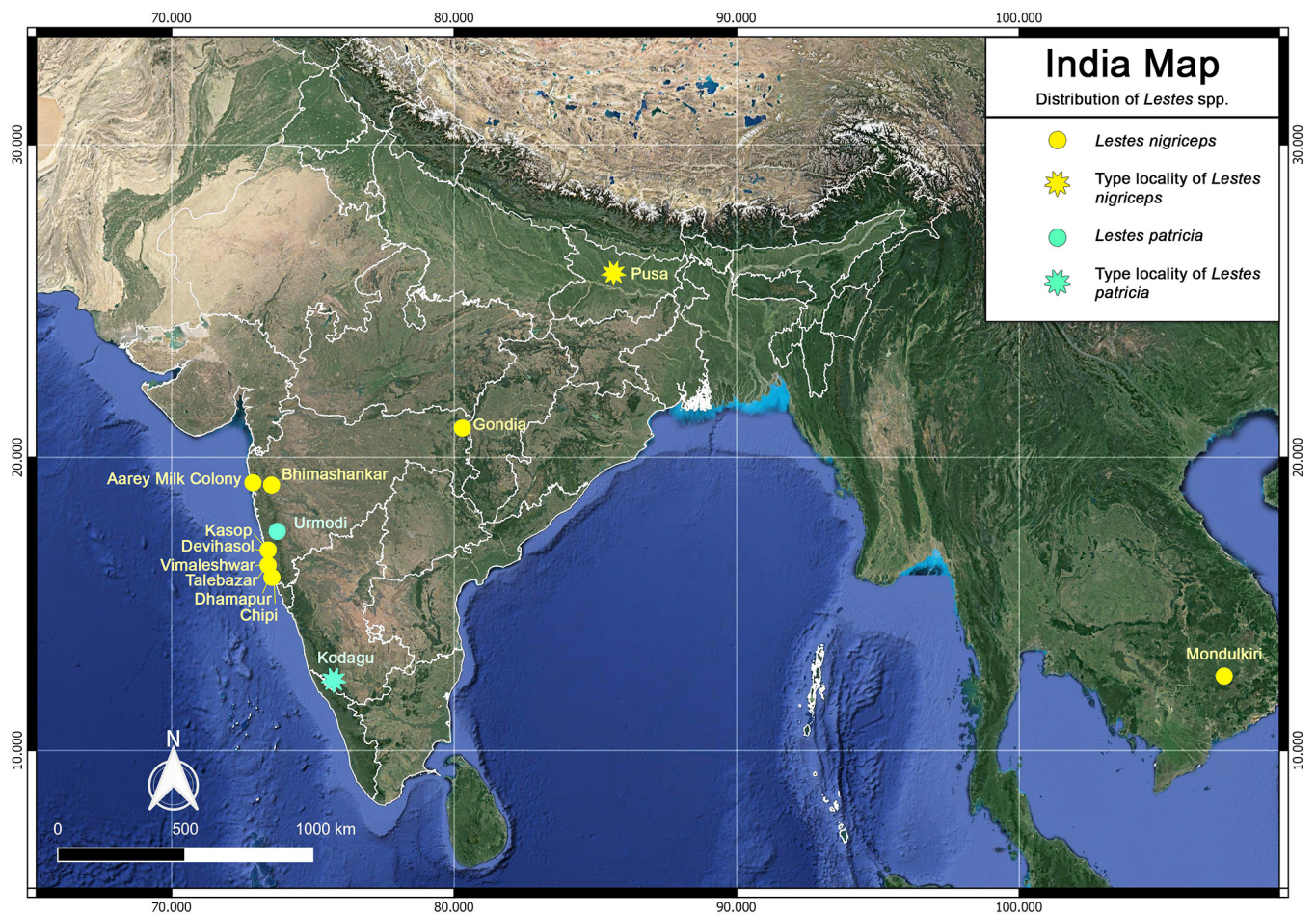


**Figure 4.** *Lestes nigriceps* in situ: (a–c) male, 18.viii.2019, Lotus Pond, Aarey Milk Colony; (d) male caudal appendages, 03.ix.2018, Lotus Pond, Aarey Milk Colony; (e) female, 02.ix.2018, Lotus Pond, Aarey Milk Colony; (f) copula, 03.ix.2018, Lotus Pond, Aarey Milk Colony; (g) copula, 03.ix.2020, Chipi; (h) copula, 24.viii.2021, Bhekartaka.





**Figure 5.** Habitats of *Lestes nigriceps*: (a) Lotus Pond, Aarey Milk Colony; ephemeral pools at (b) Dhamapur, (c) Chipi, and (d) Bhekartaka.



**Figure 6.** Distribution map depicting records of *Lestes nigriceps* and *Lestes patricia*.

and geographical location provided by said authors, it is likely to be a male *L. nigriceps*. Curiously, the Cambodian locality of *L. nigriceps* (Kosterin, 2018) is situated far to the east from India

#### **Note on the distribution ranges of *L. nigriceps*, *L. patricia*, and *L. malabaricus***

All these three species seem to be either rare or are underreported. The current records indicate that *L. patricia* is found in hills of the Western Ghats whereas both *L. nigriceps* (currently reported from ~50–110 m a.s.l.) and *L. malabaricus* are restricted to the foothills of the northern and southern Western Ghats, respectively.

#### **Comments on the original description of *Lestes nigriceps***

Fraser (1924) correctly described the postmortem color changes of the thorax and caudal appendage structure in males, and the same anatomy and morphology can be observed in the specimens collected at the Aarey Milk Colony and in the Sindhudurg District (Figs 1–2). However, he did not mention the typical dark markings on the thorax, or the sky-blue basal spine and lamina in male cerci in life. Additionally, the description of the female (Fraser, 1924) well matches that of the female of *L. viridulus* Rambur, 1842. All the females photographed at the Aarey Milk Colony differ considerably from that original description in that they have broad stripes. Although Indian females of *L. nigriceps* differ slightly from Cambodian ones as described by Kosterin (2018), we concur with the hypothesis put forth by Kosterin (2018) that the original female description by Fraser (1924) most likely refers to the female of *L. viridulus*.

#### **Recent records of *L. patricia* Fraser, 1924, and the taxonomic status of *L. p. taamrpatti* Bhakare, Bhoite & Pawar, 2020**

*Lestes patricia* was described based on a single male collected at Kodagu (= Coorg), Karnataka, India (Fraser, 1924) (Fig. 7). This species was recently reported from Urmodi Dam, Maharashtra, India, by Bhakare et al. (2020), which represents the first confirmed record after the original species description. These specimens were described as a new subspecies, *Lestes patricia taamrpatti* Bhakare, Bhoite & Pawar, 2020, based on minor differences. They mention that in this subspecies “Frons [are] black (azure blue vide Fraser [1924])”, but Figure 5 (Bhakare et al., 2020: 89) shows that the antefrons in their specimens are indeed blue. In the original description, Fraser (1924: 486) stated that “A middorsal stripe of matt black with straight borders, extending on each side to about half way to the humeral stripe”. However, a close examination of the holotype shows a middorsal coppery red area that is enclosed by narrow dark olivaceous stripes (Figs 7a–c), exactly as described by Bhakare et al. (2020).

With regards to the caudal appendages, Bhakare et al. (2020) state “Paraprocts very short, not extending to the end of expanded part of cerci (extending nearly to the end of expanded part vide Fraser [1924] [Fig. 7e]).”

The use of long paraprocts and number of crossveins as diagnostic characters in *L. patricia* were most likely based on the key to the species of *Lestes* provided by Kosterin (2019). However, a year later the same author (Kosterin, 2020) published an errata to the keys that removed the relevance of both characters (with respect to *L. patricia*, see the same photos of its holotype that are provided here in Fig. 7), rendering the characters used by Bhakare et al. (2020) to substantiate their subspecies based on literature irrelevant. The males illustrated in Bhakare et al. (2020) indeed agree very well with the images of the holotype of *L. patricia* (Fig. 7).

Since the type locality and the locality surveyed by Bhakare et al. (2020) are part of the Western Ghats mountain region there is no geographical support for recognizing a different subspecies either. Thus there are no conclusive characters to warrant a separate subspecies status for the population reported by Bhakare et al. (2020). We therefore find *Lestes patricia taamrpatti* to be a junior synonym of *Lestes patricia* (*Lestes patricia* = *Lestes patricia taamrpattii* syn. nov.).

#### **Comments on the updated keys of Kosterin (2019, 2020)**

Fraser (1933) worked out the first key to Indian *Lestes* spp. and Kosterin (2019) provided an updated key for the Indian *Lestes* spp. to eliminate the following shortcomings due to: (a) a missing key to *L. nigriceps*; and (b) there was ambiguity in the identification of *L. malabaricus* and *L. patricia*. We furthermore found some discrepancies in the key provided by Kosterin (2019) on the basis of our recent observations of fresh material that we have noted below.

- (1) Couplet 3, option 2 [*L. patricia*]. “Synthorax with a broad black dorsal stripe; occiput mat black” should read Synthorax with a brown dorsal stripe surrounded on both sides by thin black stripes, occiput brown (Bhakare et al., 2020).
- (2) Couplet 6, option 1 [*L. nigriceps*]. “Synthorax with a uniform narrow antehumeral stripe on each side”. This statement is inaccurate considering the substantial variation in thoracic markings of *L. nigriceps* (Figs 2, 4). The antehumeral stripe is neither consistently uniform nor narrow. In fact, in many individuals, the antehumeral stripe is prominently expanded posteriorly and in some expanded to the mesepimeron (Figs 2a, g, m), while in others the stripe is not visible clearly due to pruinescence.
- (3) Couplet 9, option 2 [*L. malabaricus*]. “Sides of thorax with two thick black bands enclosing a medial narrow brown stripe”. This is a variable character, and in *L. malabaricus*, it is often obscured by pruinescence; it is also found in young *L. nigriceps* and therefore cannot be considered diagnostic on its own (Figs 4 a–b).



**Figure 7.** *Lestes patricia*, male, NHMUK 013324315: (a) head in dorsal view; (b) thorax in dorsal view; (c) dorsal habitus; (d) thorax in lateral view; (e) caudal appendages in dorsal view. Images courtesy Natural History Museum UK (2023b).

Coloration and markings in this genus are subject to ontogenetic and postmortem variation. As a result, many traits were described erroneously as diagnostic by Fraser and then adopted by subsequent authors. We attempt to provide an updated key to male and female *Lestes* spp. of the Western Ghats below.

**Key to males of *Lestes* spp. of the Western Ghats, India**

- 1. Synthorax without metallic markings ..... 2
- 1'. Synthorax with green metallic stripes ..... 4
- 2. Pterostigma unicolored ..... 3
- 2'. Pterostigma bicolored ..... *L. nodalis*
- 3. No broad black dorsal stripe on synthorax (mid-dorsal carina can be finely with black); paraprocts extend up to 1/3 of lamina of cerci ... *L. concinnus*
- 3'. Synthorax dorsally reddish brown with thin dark olive green stripes; paraprocts longer, extend over about half the lengths of the cerci ..... *L. patricia*
- 4. Synthorax with dorsal dark metallic stripes deeply scalloped or crenulated on the outer sides ..... 5
- 4'. Synthorax with dorsal metallic stripe uniform or expanded posteriorly ..... 6
- 5. Small, abdomen 30–32 mm and hindwing 20–21 mm; paraprocts longer relative to cerci ..... *L. praemorsus*
- 5'. Larger, abdomen 36–41 mm and hindwing 24–32 mm; paraprocts shorter relative to cerci ..... *L. dorothea*
- 6. Abdomen length equal or greater than 30 mm ..... 7
- 6'. Abdomen 24–25 mm ..... *L. malabaricus*
- 7. Dorsal green metallic stripes on thorax prominently expanded at posterior end making a distinct 'J'- or hockey-stick shaped mark ..... *L. elatus*
- 7'. Dorsal green metallic stripes on synthorax straight or very slightly expanded posteriorly ..... 8
- 8. Vertex of head pale brown; dorsum of thorax pale brown, with thin dorsal metallic green stripes; S9 with an inverted triangular marking ..... *L. viridulus*
- 8'. Vertex of head dark with an olivaceous sheen; dorsum of thorax black with metallic green stripes and yellow to pale orange area laterally; S9 with a small basal streak or pruinosed ..... *L. nigriceps*

**Key to females of *Lestes* spp.**

- 1. Synthorax without metallic markings ..... 2
- 1'. Synthorax with green metallic stripes ..... 4
- 2. Pterostigma unicolored ..... 3
- 2'. Pterostigma bicolored ..... *L. nodalis*
- 3. Synthorax usually pale brown, unmarked. Variable in color from brown to pale blue or olivaceous; abdomen pale brown to dark brown .... *L. concinnus*
- 3'. Synthorax dorsally black with dark olivaceous stripes enclosing dark reddish brown mid-dorsal area ..... *L. patricia*

- 4. Synthorax with dorsal metallic stripes deeply scalloped or crenulated on the outer sides, often obscured by pruinescence ..... 5
- 4'. Synthorax with the dorsal metallic stripe uniform or expanded posteriorly ..... 6
- 5. Small, with abdomen 30–32 mm and hind-wing 20–21 mm; sides of thorax plain yellowish green; S10 mostly black ..... *L. praemorsus*
- 5'. Larger, with abdomen 36 mm and hind-wing 27 mm; a green to olivaceous band on sides of thorax; S10 blue ..... *L. dorothea*
- 6. Dorsal green metallic stripe of uniform width ..... 7
- 6'. Dorsal green metallic stripe expanded posteriorly . 8
- 7. Vertex of head pale brown; synthorax with very narrow metallic green stripes enclosing a pale brown area; no black markings on sides of synthorax; posterior half of S9 white with a black central stripe ..... *L. viridulus*
- 7'. Vertex of head metallic dark with small irregular brown spots posteriorly; synthorax with broad metallic green stripes enclosing a black mid-dorsal area; 2 black spots on thorax on each side; posterior margin of S9 dorsally with a pair of small pale blue triangular markings ..... *L. nigriceps*
- 8. Synthorax with broad metallic green stripes, slightly expanded posteriorly; 5 black spots on thorax on each side ..... *L. malabaricus*
- 8'. Synthorax with a distinct 'J'- or hockey-stick shaped metallic green stripe, thinner anteriorly; about 10 black spots on thorax on each side ..... *L. elatus*

**Discussion**

In this paper, we report on the first record of the enigmatic species *L. nigriceps* from India after 98 years from the Aarey Milk Colony and from Sindhudurg, Maharashtra. This species was observed at a pond at the Aarey Milk Colony in a semi-urban area at the periphery of India's most populous city, Mumbai, highlighting the diversity of a highly threatened and disturbed area.

The rediscovery of *L. nigriceps* in the Western Ghats underscores the fact that large stretches of suitable habitats have remained unexplored. Along this line, it still remains to be determined whether the Cambodian population discovered by Kosterin (2018) is isolated, or *L. nigriceps* enjoys a continuous distribution from the Western Ghats to Indochina.

Whereas most *Lestes* species are widespread and well studied, some species such as *L. malabaricus* and *L. patricia* have remained poorly known. Considering recently collected specimens and the availability of high-resolution images of type specimens, we have here provided an updated key to the *Lestes* spp. of the Western Ghats.

Despite our study there is still some confusion regarding the *Lestes* of India. For example, differences

between *L. nodalis* and *L. garoensis* have proved difficult to establish. Intensive fieldwork in conjunction with molecular analyses (e.g., Dumont et al., 2017) will therefore be key to accurately documenting the diversity of Indian *Lestes* damselflies in the future.

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### References

- Bhakare, S. D., Bhoite, S. H. & Pawar, P. A. (2020). *Lestes patricia taampatti* ssp. nova (Insecta: Odonata: Lestidae) from Maharashtra, India. *Bionotes*, 22(2), 85–91.
- Bharathi, D. & Koparde, P. (2022). Records of Dragonflies Damselflies (Insecta: Odonata) from Gondia district, Maharashtra, India. *Journal of Insect Biodiversity and Systematics*, 8(3), 379–387. <https://doi.org/10.52547/jibs.8.3.379>
- Dumont, H. J., Ikemeyer, D. & Scheider, T. (2017). *Lestes concinnus* and *L. pallidus*: two non-metallic species with wide, complementary ranges (Odonata: Lestidae). *Odonatologica*, 46(1), 99–110.
- Fraser, F. C. (1924). Notes on Indian Odonata in the Pusa collection. *Memoirs of the Department of Agriculture in India*, 8(8), 69–87.
- Fraser, F. C. (1929). Indian dragonflies. Part XXXIV. Family Coenagrionidae (= Family Agrionidae Selys, and subfamily Coenagrioninae Kirb.). *Journal of Bombay Natural History Society*, 33, 834–850.
- Fraser, F. C. (1933). *The fauna of British India, including Ceylon and Burma. Odonata. Vol. I.* London: Taylor and Francis.
- Garrison, R., von Ellenrieder, N. & Louton, J. (2010). *Damselfly genera of the New World: An illustrated and annotated key to the Zygoptera*. Baltimore: The Johns Hopkins University Press. <https://doi.org/10.56021/9781421410616>
- Kalkman, V. J., Babu, R., Bedjanič, M., Conniff, K., Gyltshen, T., Khan, M. K., Subramanian, K. A., Zia, A. & Orr, A. (2020). Checklist of the dragonflies and damselflies (Insecta: Odonata) of Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka. *Zootaxa*, 4849(1). <https://doi.org/10.11646/zootaxa.4849.1.1>
- Kosterin, O. E. (2018). Rediscovery of *Lestes nigriceps* Fraser, 1924 (Odonata: Lestidae) in eastern Cambodia. *Zootaxa*, 4526(4), 561–575. <https://doi.org/10.11646/zootaxa.4526.4.8>
- Kosterin, O. E. (2019). Amendments and updates to F. C. Fraser's key to Indian *Lestes* spp. (Odonata: Lestidae) to resolve confusion of *L. patricia* Fraser, 1924 and *L. nigriceps* Fraser, 1924, with notes on *L. nodalis* Selys 1891 and *L. garoensis* Lahiri, 1987. *Zootaxa*, 4671(2), 297–300. <https://doi.org/10.11646/zootaxa.4671.2.12>
- Kosterin (2020). Erratum. *Zootaxa*, 4885(4): 600. <https://doi.org/10.11646/zootaxa.4885.4.10>
- Natural History Museum (2023a). *Data Portal Query on "Specimens" created at 2023-06-20 18:02:46.542862*. PID <https://doi.org/10.5519/qd.zsfxetyg>. Subset of "Collection specimens" (dataset) PID <https://doi.org/10.5519/0002965>. Retrieved from: <https://data.nhm.ac.uk/doi/10.5519/qd.xn2spgj1>
- Natural History Museum (2023b). *Data Portal Query on "Specimens" created at 2023-06-20 18:03:05.214796*. PID <https://doi.org/10.5519/qd.xn2spgj1>. Subset of "Collection specimens" (dataset) PID <https://doi.org/10.5519/0002965>. Retrieved from: <https://data.nhm.ac.uk/doi/10.5519/qd.zsfxetyg>
- Paulson, D. & Schorr, M. (2020). *World Odonata List*. Retrieved from: <https://www.pugetsound.edu/puget-sound-museum-natural-history/biodiversity-resources/insects/dragonflies/world-odonata-list>.
- Subramanian, K. A. & Babu, R. (2017). *Checklist of Odonata (Insecta) of India (Version 3.0)*. Retrieved from: [www.zsi.gov.in](http://www.zsi.gov.in) (accessed 15 March 2021)
- Subramanian, K.A., Emiliyamma, K.G., Babu, R., Radhakrishnan, C. & Talmale, S.S. (2018). *Atlas of Odonata (Insecta) of the Western Ghats*. Kolkata: Zoological Survey of India.