



On the importance of types and the perils of “*en passant*” taxonomy: a brief history of the typification of *Coluber naja* Linnaeus, 1758 (Serpentes: Elapidae) and its implications, with the designation of a lectotype

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Abstract

In response to the recent in passing (“*en passant*”) taxonomic decision to split *Naja naja* (Linnaeus) and recognise the Sri Lankan populations as a separate species, *N. polyocellata* Deraniyagala, we analyse the evidence underlying the proposal and its nomenclatural implications. The proposed split is weakly supported by the available evidence, so that retaining *N. naja* as a single species seems appropriate until further analysis. Moreover, the proposal raises several issues concerning types, type locality and nomenclature. Linnaeus’ description of *Coluber naja* was based on a single preserved specimen seen by him (now lost) and several illustrations in Seba’s *Thesaurus*. The specimens that were the basis of these illustrations constitute part of the type series. Two of the latter specimens, ZMB 2795 and 2796, have been rediscovered in the collections of the Museum für Naturkunde, Berlin. Here, we describe them, and determine that both are of Sri Lankan origin. To settle the question of the type and type locality of this iconic taxon, we designate ZMB 2796 as lectotype for the species, thereby implicitly restricting the type locality to Sri Lanka. The name “*polyocellata*” thus becomes a subjective junior synonym of *Coluber naja*, and the name *Naja brasiliensis* Laurenti, 1768 an objective junior synonym thereof. Any taxonomic recognition of additional diversity within *N. naja* would thus require the renaming of Indian, not Sri Lankan spectacled cobras, but should await a significant body of convincing evidence. We caution against taxonomic decisions taken “in passing”, based on limited evidence and without in-depth assessment of their nomenclatural implications.

Key words: nomenclature, taxonomy, neotype, lectotype, holotype, *en passant* taxonomy, Linnaeus, Elapidae, *Naja naja*

Introduction

Species delimitation remains a key task in systematic biology (Sites & Marshall 2003): as the smallest units of diversity on an independent evolutionary trajectory (de Queiroz 1998), species are the fundamental constituents of biological diversity. Describing and defining these building blocks thus remains a vital task for systematic biologists, especially against the background of the ongoing Anthropocene mass extinction. This process has been revolutionised by the advent of increasingly sophisticated molecular methods in the 21st century. At the same time, developments in our conceptual understanding of the nature of species (de Queiroz 1998, 2007) and awareness of the limitations of some widely used markers (Hillis 2019) have further changed our methodological approach to the delimitation of species (e.g., Padial *et al.* 2010).

Accurate species delimitation is of key importance as a foundation for further research as well as for applied measures such as conservation planning and action. Of similar importance is a stable nomenclature to provide labels for these units of biodiversity. Despite these considerations, taxonomic decisions such as changes to the status of a taxon, resurrection of names or type designations are all too often taken casually, as a sideline to work with a different focus, and without a thorough review of the pertinent literature—a practice we here term “*en passant* taxonomy”, in reference to the chess move where a pawn can take another “in passing”. Unfortunately, this casual approach to taxonomic decision-making, however well intentioned, risks overlooking important literature with prior

taxonomic and nomenclatural decisions that can invalidate the conclusions of the new work, causing significant subsequent confusion or nomenclatural instability.

Proposed recognition of *Naja polyocellata*

In a recent paper, Shi *et al.* (2022) described a new cobra species, *Naja fuxi*, based on an extensive analysis of morphological and mitochondrial DNA (mtDNA) evidence. Its validity was subsequently confirmed with additional data by Ratnarathorn *et al.* (2023). In the same paper, Shi *et al.* also used the published mitochondrial data underlying the multilocus species tree of Kazandjian *et al.* (2021) to support two additional taxonomic decisions: recognition of the eastern populations of *N. sumatrana* Müller, 1887 as a separate subspecies, *N. sumatrana miolepis* Boulenger, 1896, and recognition of the Sri Lankan populations of the spectacled cobra as a separate species, *N. polyocellata* Deraniyagala, 1939, from Indian *N. naja* (Linnaeus, 1758). Both these decisions were largely based on high levels of sequence divergence between the populations concerned, similar to those observed between separate species in other cobras, with additional supporting evidence from those authors' interpretation of morphology and the toxinological literature.

The recognition of *N. sumatrana miolepis* does not cause any taxonomic or nomenclatural problems beyond the question whether the decision was justified by the evidence presented. However, the splitting of *Naja naja* through the recognition of *N. polyocellata* as a full species raises multiple issues concerning both the biological basis for this decision and the application of scientific names to the resulting, redefined taxa. These issues illustrate the potential for seemingly simple taxonomic decisions made without in-depth study of the pertinent literature to generate taxonomic uncertainty and nomenclatural instability.

The aim of this paper is to assess the evidence for the splitting of *N. naja* presented by Shi *et al.* (2022), to review the status of scientific names applicable to the spectacled cobras and their types, and to recommend a way forward towards evidence-based resolution of both the systematics and the nomenclature of the taxon.

Are Sri Lankan and mainland spectacled cobras different species?

Shi *et al.* (2022) raised the Sri Lankan spectacled cobras to the status of a full species on account of high mtDNA (cytochrome *b*) sequence divergences from Nepalese and Pakistani specimens, literature data on pattern differences (number of ventral bands) and reported venom differences. The basis for this decision is questionable for many reasons.

While the cytochrome *b* sequence divergence between Sri Lankan and Pakistani/Nepalese *N. naja* is indeed high, it seems premature to draw conclusions on the precise geographic boundary between haplotype clades in the presence of a 2000 km sampling gap between Nepal/Pakistan and Sri Lanka. Using multivariate morphometrics (as opposed to a single character), Wüster & Thorpe (1992) demonstrated a northwest-southeast cline in *N. naja* from Pakistan to Sri Lanka, whereby Sri Lankan and southern Indian specimens are much more similar to each other than either are to *N. naja* from Nepal or Pakistan. The rationale for postulating a species limit running through the Palk Strait, the narrow marine passage separating Sri Lanka from the Indian mainland, is therefore unclear. The number of ventral bands was not among the characteristics used by Wüster & Thorpe (1992). However, while specimens from Sri Lanka do normally have more dark ventral bands than Indian *N. naja*, Shi *et al.* misquote Deraniyagala (1939, 1945) and Wüster (1998) as to their number: neither of these references states Sri Lankan cobras to have “15 or more” dark ventral bands. Deraniyagala (1939) does not compare Indian and Sri Lankan cobras, Deraniyagala (1945) notes 1–3 bands in India and 4–28 in Sri Lanka, and Wüster (1998) notes “up to 20” dark bands in Sri Lanka, vs. 1–4 elsewhere. Among the specimens examined as part of Wüster (1990) and Wüster & Thorpe (1992), spectacled cobras from the Asian mainland had 0–8 dark ventral bands (normally 1–3, four exceptions with 0, 7, 7 and 8; $\bar{x}=1.804$, S.D.=1.220, $N=102$) whereas Sri Lankan specimens had 2–22 ($\bar{x}=10.731$, S.D.=5.341, $N=26$) clearly defined bands (Wüster, unpublished data). While ventral band counts over 4 strongly suggest a Sri Lankan origin for a spectacled cobra specimen, there is thus overlap between the ventral patterns of Sri Lankan and mainland spectacled cobras (see also Fig. 1), and moreover, the possibility of geographic variation in this character within Sri Lanka or in adjacent parts of southern India has never been investigated.



FIGURE 1. Comparison between the throat patterns of an (A) an Indian and (B) a Sri Lankan specimen of *Naja naja*, showing overlap in the number of dark ventral bands. Indian specimen from Rathnapuri, Karnataka, Sri Lankan specimen from Kokuvil East, Jaffna, Sri Lanka. Photos by W. Wüster (A) and Aravinth Sukumar (B)

The differences in venom composition cited by Shi *et al.* concern comparisons between populations from Rajasthan and Gujarat and those from Sri Lanka (Sintiprungrat *et al.* 2016), again leaving an enormous sampling gap. Venom composition is often a poor predictor of taxonomic affinities (Strickland *et al.* 2018; Thorpe *et al.* 2007), with startling differences in composition over tens of kilometres persisting even in the face of unrestricted gene flow within continuously distributed species (Zancolli *et al.* 2019). Moreover, extensive differences in venom composition among populations of *Naja naja* within India have also been documented (Deka *et al.* 2023; Saikumari *et al.* 2015; Senji Laxme *et al.* 2021; Shashidharamurthy & Kemparaju 2007), undermining the case for venom composition as supporting a mainland-Sri Lanka split in *N. naja*. In conclusion, while the relatively high mtDNA sequence divergences within *N. naja* suggest the possible existence of additional diversity, there is little published evidence that supports a Sri Lanka-mainland split as the main divergence within this lineage. Given the above, retaining *N. naja* as a single species until more convincing evidence supports a change seems the more parsimonious option. In the rest of this paper, the name *N. naja* will be used in its older sense (Whitaker & Captain 2004; Wüster 1998; Wüster & Thorpe 1992) for both Indian and Sri Lankan spectacled cobras.

Nomenclatural issues, Pt. 1: Linnaean types of *Naja naja* in the Museum Adolphi Friderici.

In addition to the uncertain scientific evidence for a split of *Naja naja*, the recognition of *N. polyocellata* by Shi *et al.* (2022) also raises significant nomenclatural issues, due to the complex and confusing history of typification of Linnaeus' (1758) *Coluber naja*. In order to reassess the status of the name *polyocellata* and the nomenclature of the *N. naja* complex, we here review the history of the description of *Coluber naja* by Linnaeus, and assess the type material and its provenance.

Linnaeus (1758) cited the following material for his description of *Coluber naja*: a male specimen in the Adolphi Friderici museum collection, with 193 ventral scales and 60 subcaudals, also described and depicted in Linnaeus (1754); and images of several specimens reproduced in Seba (1734, 1735), Tome I, plate 44, fig. 1, and Tome II, plate 85, fig. 1, plate 89, figs. 1–4, plate 90, figs. 1–2, plate 94, fig. 1, plate 97, figs. 1–4; additionally, he provided two

further references: Kaempfer (1712) and Linnaeus (1749). No single specimen was designated as holotype, leaving the specimens depicted in his sources as syntypes of equal status. Table 1 summarises the available information on the specimens listed by Linnaeus.

For the sole physical, preserved type specimen listed from the Museum Adolphi Friderici collection, Linnaeus (1758) provided the sex, ventral and subcaudal scale counts, and referred to Linnaeus (1754), p. 30 and Plate 21, fig. 1, for additional information. Linnaeus (1754) provided a description of some additional features of the specimen, including its size (“sesquipedalis” = a foot and a half, or approximately 45 cm), and the thickness “of the smallest finger”. Plate 21, fig. 1 depicts a clearly recognisable specimen of spectacled cobra with, notably, 9 plainly visible dark ventral bands that become progressively more faded towards the rear of the body. The combination of a spectacle mark, nine dark ventral bands, and ventral and subcaudal counts of 193 and 60, respectively, convincingly establish the pictured specimen as originating from Sri Lanka. Unfortunately, this specimen appears to have been lost (Andersson 1899).

The Swedish Museum of Natural History (NRM) contains an additional specimen of *Naja naja* in its Linnean collections: the preserved specimen currently registered as NRM 90 in the collections of the Museum Adolphi Friderici. A photo of this specimen is available on the web page of the Museum (<http://linnaeus.nrm.se/zool/madfrid.html.en>), and a description is given in Table 1. As previously noted by Andersson (1899), this specimen is not the one described by Linnaeus (1754) or used by Linnaeus (1758), on account of its differing size, pattern and scale counts. Wallach *et al.* (2014) designated this specimen as lectotype of *Coluber naja*, without any additional information. This designation is invalid: Linnaeus (1758) makes no mention whatsoever of any specimen matching the description of NRM 90 in his description of *C. naja*, and Wallach *et al.* (2014) provided no evidence that the specimen should be considered part of the type series under Article 72.4.1.1 of the International Code of Zoological Nomenclature (International Commission on Zoological Nomenclature 1999; hereafter “the Code”). Article 74 of the Code stipulates that only a specimen from the original type series can be designated as a lectotype, which therefore excludes NRM 90 from that status. This means that no preserved specimen physically examined by Linnaeus for his description of *Coluber naja* is known to be in existence today.

Among other works cited in *Systema Naturae* in conjunction with the description of *Coluber naja*, the following provide no further insights: Linnaeus (1749) does not provide any description of a cobra: the specimen on p. 305 termed “other *Naja*”, referred to in *Systema Naturae* and depicted in Seba (1734, plate 43, fig. 5), is clearly not a *Naja*; the specimen was identified by Peters (1960) as *Dipsas indica* Laurenti, 1768. Kaempfer (1712) provides a stylised illustration of a spectacled cobra and an account of snakes, snakebites and snake charming in India, but no other pertinent information. The bulk of the syntypes of *Coluber naja* listed by Linnaeus are thus the specimens illustrated in Seba (1734, 1735).

Nomenclatural issues, Pt. 2: rediscovery and evaluation of material illustrated in Seba’s Thesaurus

The fate of the Linnean type specimens depicted in the *Thesaurus* was long unclear due to the scattering of Seba’s second collection after his death (Boeseman 1970; Daszkiewicz & Bauer 2006; Thireau *et al.* 1998). The figures in Seba listed by Linnaeus (1758) are unhelpful in narrowing down the type locality of *Coluber naja*. Descriptions, indications of their stated geographic origins and interpretations of the individual figures are given in Table 1. However, the rediscovery of Seba specimens in the Museum für Naturkunde in Berlin as part of the von Borcke collection by Bauer & Günther (2013), and in particular three specimens identified by them as *Naja naja*, provides the tantalising possibility of elucidating their geographic origin and thus settling the type and type locality of the taxon through the selection of a lectotype.

ZMB 2795 (Fig. 2) is an adult male specimen of *Naja naja* with a distinct spectacle mark, 188 ventral scales, 62/61 subcaudal scales, 23 dorsal scale rows around midbody and approximately 33–37 scale rows around the hood (a precise count is difficult due to the state of preservation of the neck region coupled with the irregular disposition of scale rows on cobra hoods). The dorsum is covered in variegations coalescing into indistinct crossbands. The nape immediately behind the head is noticeably pale, the neck darkens progressively going back, ending in a blackish chevron band behind the hood area. The blackish chevron is clearly demarcated from a conspicuous light chevron band, which is in turn followed by a dark band that then fades into the general dorsal pattern. At least nine increasingly faint dark crossbands are discernible along the ventral surface. The high number of ventral bands strongly suggests

a Sri Lankan origin for this specimen (see above), and the remaining pattern and scalation characters are consistent with that location. The position of the specimen (especially head and neck), the hood mark and the markings behind the hood mark provide a remarkable match for the specimen depicted in Seba (1735), plate 85, figure 1, listed as a syntype of *Coluber naja* by Linnaeus (1758). In agreement with Bauer & Günther (2013), we therefore consider ZMB 2795 to be that specimen, and to originate from Sri Lanka. The locality indicated by Seba (1735) was Peru, clearly in error, as was the case with a majority of Seba's stated localities of origin (Wallach 2011).

ZMB 2796 (Fig. 3) is an immature male specimen of *Naja naja* with a distinct spectacle mark, 193 ventral scales, 61/62 subcaudals, 23 dorsal scale rows at midbody and 36 rows around the hood at the 10th ventral. The dorsum is covered in reticulations and variegations, with more uniform bands interspersed between the more variegated areas. The hood is adorned with a classical spectacle marking, with the further characteristic that each side of the spectacle features an additional small dark ocellus just behind the main ocellus, fully surrounded by light skin. The spectacle is followed by a slightly darker area set off abruptly by a transverse row of dark spots from a lighter crossband. The ventral side is crossed by eight dark crossbands that become increasingly faded towards the rear. The number of ventral bands strongly suggests a Sri Lankan origin for this specimen (see above), and the remaining pattern and scalation characters are consistent with that location. The general appearance of the specimen, and particularly the fully separated and enclosed additional ocelli in its hood mark, provide a close match to the specimen depicted in Seba (1735), plate 89, figure 4, listed as a syntype of *Coluber naja* by Linnaeus (1758) and as the type for *Naja brasiliensis* by Laurenti, 1768 (Fig. 3). While additional dark enclosures within the light spectacle mark in *N. naja* are not unusual, this particularly regular and symmetrical arrangement is rare: out of 232 individual *N. naja* hood mark photos examined on the citizen science platform iNaturalist, only 13 (5.6%) fully replicated the pattern seen in ZMB 2796 and depicted in Seba (1735). Given the combination of this unusual hood mark and the history of the specimen, and in agreement with Bauer & Günther (2013), we consider ZMB 2796 to be that specimen, and to originate from Sri Lanka. The locality indicated by Seba (1735) was Brazil, clearly in error.

ZMB 2797 is a mature specimen of *Naja kaouthia*, with a distinct monocle hood mark and the strongly but irregularly banded body pattern most commonly seen in specimens from northern India. Contrary to Bauer & Günther (2013), the specimen bears no resemblance to the individual depicted in fig. 2, Plate 90 of Seba (1735), which features a spectacle-shaped hood mark and a body pattern consisting of light speckles. No cobra depicted in Seba (1734, 1735) displays a monocle-shaped hood mark, and we therefore believe that this specimen either did not originate from Seba's collection or at least was not depicted in the *Thesaurus*, and thus did not serve as syntype for Linnaeus' *Coluber naja*.

Nomenclatural issues, Pt. 3: validity and type of Deraniyagala's "*Naia naia* colour variety *polyocellata*" and his neotype of *Naja naja*

Deraniyagala (1939) described "*Naia naia* colour variety *polyocellata*" to denote individuals of spectacled cobra from Sri Lanka and southern India that possess additional ocellate markings anterior to the classic spectacle marking of *Naja naja*. Deraniyagala designated as holotype a specimen in the collection of the British Museum (now the Natural History Museum) from Polonnaruva (now Polonnaruwa), Sri Lanka. No catalogue number was given.

The Natural History Museum catalogue lists a female *N. naja* specimen from Sri Lanka, BMNH 1946.1.18.50, donated by P.E.P. Deraniyagala, as type for "*N. naia* var. *polyocellata*". The specimen was originally registered as BMNH 1940.1.30.1 from "Ceylon" and was re-acquisitioned after being retrieved from underground shelters at the end of World War 2, like most other types of reptiles in the Natural History Museum (O'Shea & Kaiser 2018). The specimen (Fig. 4), examined by the first author, is an adult female specimen with a snout-vent length of 1245 mm, a tail length of 234 mm, and a total length 1479 mm. It has 196 ventral scales, 59 divided subcaudals, an undivided cloacal scale, 31 dorsal scale rows around the hood, 21 at midbody, and 15 ahead of the vent. The neck is adorned with a classical spectacle mark, extending from the level of the 10th to that of the 15th ventral, edged in black. Two separate dark-edged lighter ocelli adorn the nape, approximately in line with the lateral ocelli of the main hood mark. A light chevron band terminates the dark neck ground colour at the level of the 22nd ventral; the remainder of the dorsum is medium brown, darkening gradually towards and onto the tail towards a dark brown colour, with only very indistinct and irregular white speckles and variegations, but no clear banded pattern. The ventral side features four clearly defined dark transverse bands.

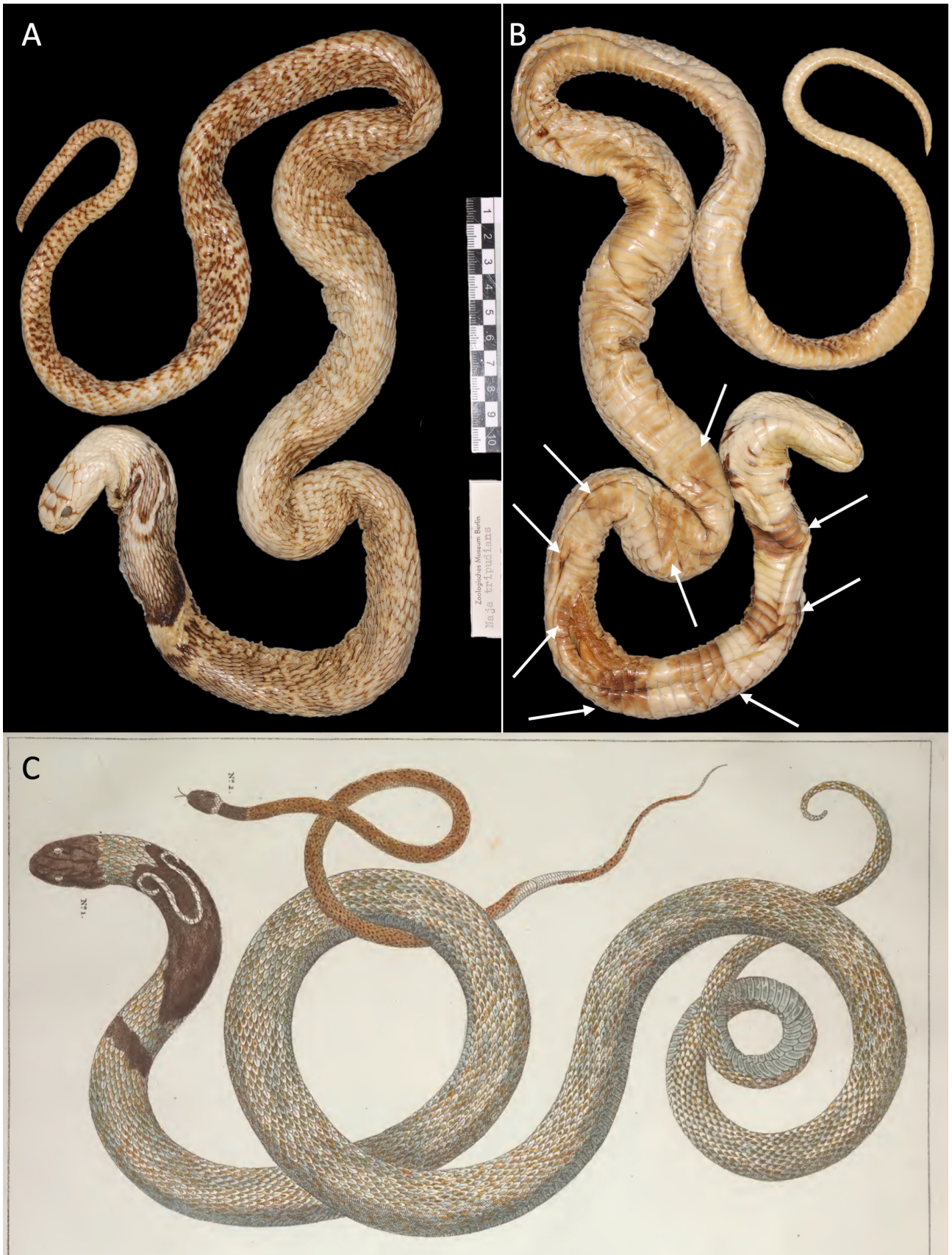


FIGURE 2. ZMB 2795, syntype of *Coluber naja* Linnaeus, 1758, showing the (A) characteristic hood mark of *Naja naja*, and (B) the underside with multiple dark crossbands characteristic of Sri Lankan *Naja naja* indicated by white arrows. (C) Plate 85 from Seba (1735); note the great similarity between the illustration and specimen ZMB 2795.

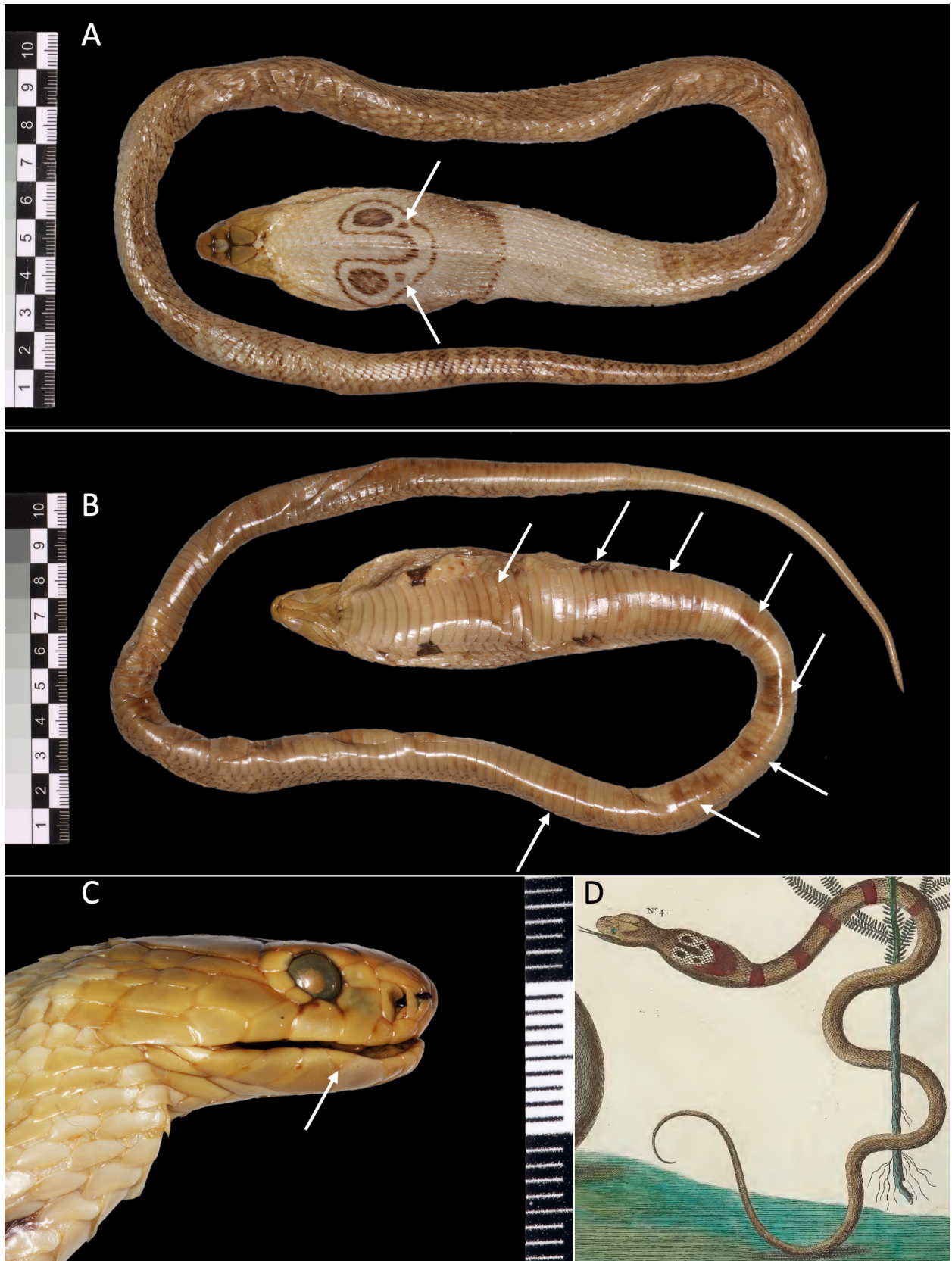


FIGURE 3. ZMB 2796, here designated as lectotype of *Coluber naja* Linnaeus, 1758, also the holotype of *Naja brasiliensis* Laurenti, 1768. (A) Hood mark with additional small ocelli, as shown in Seba (1735, Pl. 89, fig. 4), indicated by arrows. (B) Underside of animal, arrows indicate multiple dark crossbands characteristic of Sri Lankan *Naja naja*. (C) Side view of head, arrow indicates the single cuneate scale. (D) Table 89, fig. 4 in Seba (1735), referenced by Linnaeus (1758) in his description of *Coluber naja* and Laurenti (1768) in his description of *Naja brasiliensis*.

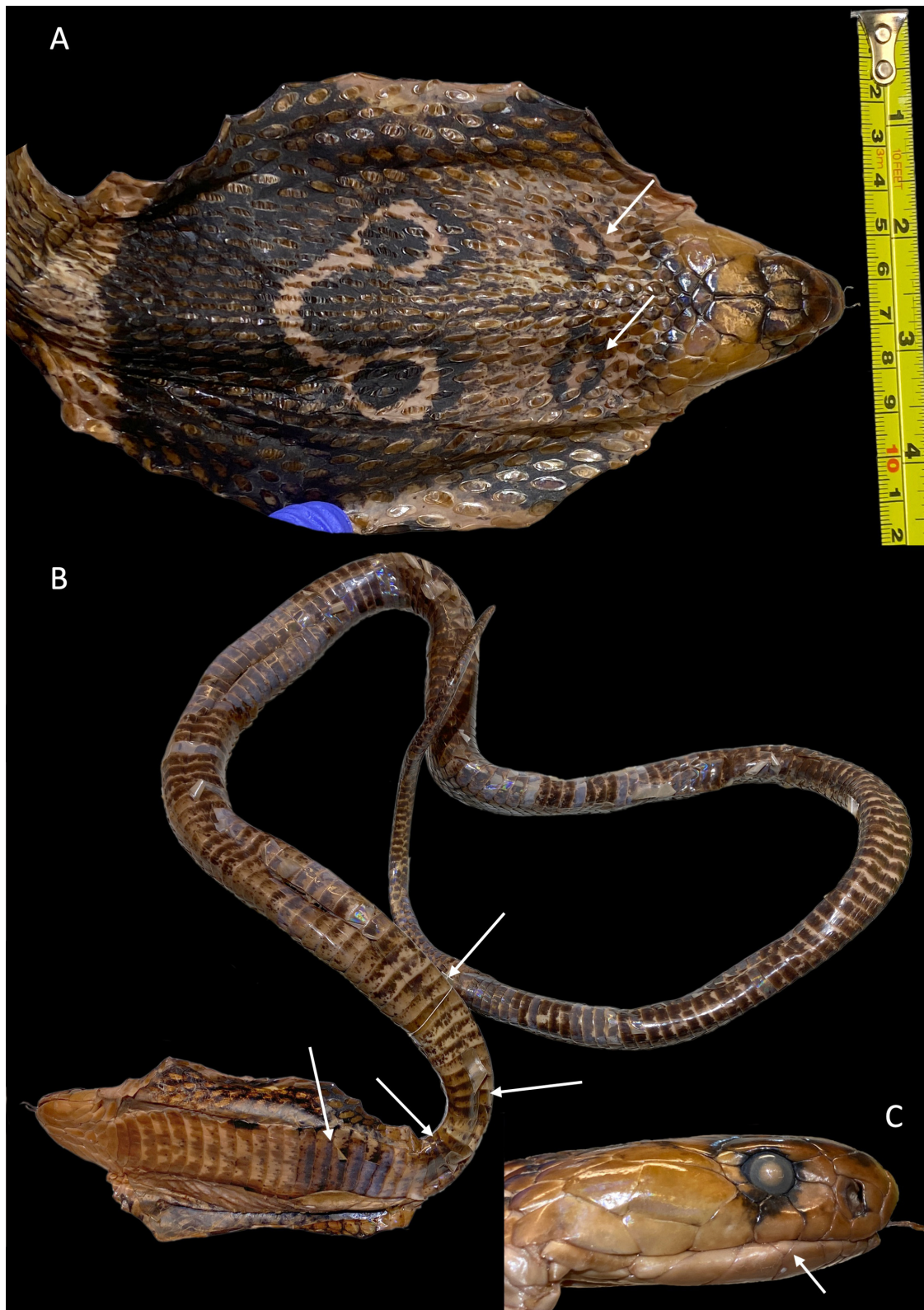


FIGURE 4. Specimen BMNH 1946.1.18.50, from Polonnaruwa, Sri Lanka. Holotype of *Naia naia* colour variety *polyocellata* Deraniyagala, 1939. (A) Top of the head and hood with hood mark. White arrows indicate the additional ocelli underlying the description of Deraniyagala's colour variety *polyocellata*. The blue patch is part of a nitrile glove holding down a flap of skin that is part of the hood. (B) Ventral view. White arrows indicate the four clearly defined ventral bands of the specimen. (C) Side view of the head; white arrow indicates the cuneate scale between the 4th and 5th infralabial, which is absent on the contralateral side of the head.

The term “colour variety” suggests that the name was intended to designate an infrasubspecific taxon outside the remit of the Code, and this is how the form was explicitly treated in subsequent papers by its author (Deraniyagala 1945, 1960, 1961). However, the original description (Deraniyagala 1939) did not “unambiguously reveal[s] that the name was proposed for an infrasubspecific entity” (Code, Article 45.6.4), and the nomen *polyocellata* is therefore available.

The type locality of *Coluber naja* Linnaeus, 1758 has generally been interpreted as “India” on account of Linnaeus’ description and the stated type locality, “Habitat in India orientali”. However, Deraniyagala (1945) noted that Ceylon (now Sri Lanka) is often included in this concept, and that the specific epithet *naja* (with the *j* pronounced as the *y* in “yes”, as would be the case in Linnaeus’s native Swedish) is identical to the Sinhala common name of the spectacled cobra, suggesting Sri Lanka as the type locality. He therefore restricted the type locality of *N. naja naja* to Sri Lanka by designating the holotype of his *Naia naia* colour variety *polyocellata* as neotype of “*Naja naja naja*”. If valid, this would reduce his colour variety *polyocellata* to the status of an objective junior synonym of *Coluber naja* Linnaeus. However, Deraniyagala’s neotype designation for *Naja naja* is highly problematic. Wallach *et al.* (2014) considered it invalid but did not justify that assessment. Article 75.7 of the 4th edition of the Code stipulates that even neotype designations performed before 1961 must meet the requirements of Article 75 to be valid. Deraniyagala’s neotype designation for “*Naja naja*” can be interpreted as meeting the requirements of Articles 75.3.2–3 and 75.3.5–7 of the Code, but not those of 75.3.1 and especially 75.3.4, and is consequently invalid. Moreover, the rediscovery of original syntypes of *Coluber naja* Linnaeus by Bauer & Günther (2013), confirmed here, would require Deraniyagala’s neotype to be set aside in any case (Code, Article 75.8).

Settling the nomenclature: lectotype designation for *Naja naja*

The question of types and type localities of *Coluber naja* Linnaeus had been largely neglected as the species has generally been regarded as monotypic in recent decades (Wüster & Thorpe 1992). However, the possibility that *N. naja* may harbour cryptic diversity creates a new imperative to settle the type and type locality of the taxon to avoid future confusion and nomenclatural instability. Given the rediscovery of the Linnaean syntypes in the ZMB and in accordance with Art. 74.7 of the Code, we here designate ZMB 2796 as the lectotype of *Coluber naja* Linnaeus, 1758 to introduce a standard of application for the species group name *naja* Linnaeus through a single name-bearer. As ZMB 2796 is also the type of *Naja brasiliensis* Laurenti, 1768, this act consigns this geographically inappropriate name to the status of an objective junior synonym of *Naja naja* (Linnaeus).

Description of the lectotype ZMB 2796 (Fig. 3)

An immature male with 684 mm total length and 109 mm tail length. Head length from tip of snout to posterior end of the mandible 26.3 mm, from tip of snout to posterior border of parietals 20.2 mm, head width measured at the level of the parietals 17.6 mm. Frontal 5.5 mm long and 3.6 mm wide. Prefrontals 3.9 mm wide and 4.2 mm long. Internasals 3.5 mm wide and 4.4 mm long. Parietals 5.6 mm wide and 9.0 mm long. Length of anterior pair of submaxillars 5.9 mm, length of posterior pair 5.8 mm. Thirty-six dorsal scale rows around the hood at level of 10th ventral, 23 rows at the level of 40 % ventrals and at midbody (half of ventrals), and 17 rows directly before cloacal scale. Dorsal and dorsocaudal scales smooth, without apical pits. Outer two dorsal scale rows slightly enlarged. Two prefrontals followed by 193 ventrals. Cloacal scale undivided, 61 divided subcaudals on left and 62 on right side. A completely divided nasal scale, one preocular, three postoculars, two anterior and three posterior temporals on both sides of head. Seven supralabials with third and fourth in contact with the eye and eight infralabials with first four in contact with the anterior submaxillars on both sides head.

As described above, the general slender body shape, its size and certain elements, such as the characteristic features of the hood pattern, allow the identification of ZMB 2796 as the specimen depicted in Seba (1735) on plate 89, figure 4. Other characteristics, in particular the dark banding in the first third of the dorsum, are barely visible. This can be explained by the long storage in ethanol over at least 290 years, and the long-time storage of the objects in collection rooms flooded with daylight.

TABLE 1. Type material and other specimens relevant to the status and type locality of *Coluber najia* Linnaeus, 1758 and cobra taxa described by Laurenti (1768).

Specimen	Type status	Stated origin	Description	Comments
Specimen in Museum Adolphi FridERICI	Syntype of <i>Coluber najia</i> Linnaeus, 1758. First specimen mentioned by Linnaeus (1758), with reference to Linnaeus (1754), which contains a figure and more detailed description. Specimen presumed lost (Andersson 1899).	“Habitat in India” (Linnaeus 1754); “Habitat in India orientali” (Linnaeus 1758).	~45 cm (“sesquipedalis”) male specimen; 193 ventrals, 60 subcaudals; spectacle mark; illustration in Linnaeus (1754) shows nine dark ventral bands.	The only physical specimen Linnaeus (1758) mentions in his description of <i>Coluber najia</i> . Ventral banding indicates Sri Lankan origin.
Specimen in Museum Adolphi FridERICI, now NRM 90	No specimen corresponding to NRM 90 mentioned by Linnaeus (1758). Mentioned as paratype and designated as neotype by Wallach (2014), but no evidence for inclusion in type series provided.	None given.	Male; total length 1140 mm, tail length 205 mm, 195 ventrals, 63 subcaudals, 23 dorsal scales at midbody (Andersson 1899); 33 scale rows around hood; spectacle mark, 3 clearly visible but faded dark ventral bands; faint indications of possible additional bands; faded variegated crossbands on posterior dorsum.	Scale counts and ventral banding compatible with Indian or Sri Lankan origin, variegations and possible additional ventral bands suggestive of Sri Lankan origin.
Seba, 1734, Plate 44, fig. 1	Listed by Linnaeus, 1758, presumed lost, syntype of <i>Coluber najia</i> . Illustration of type of <i>Naja lutescens</i> Laurenti, 1768.	“ex Makasser Indiae orientalis oriunda” (Seba 1734), presumably referring to Makassar on Sulawesi. No cobras with hood marks are known from Sulawesi (Wüster 1996). “Habitat in India orientali” (Laurenti 1768).	Yellow-grey, spectacle-shaped hood mark “reminiscent of face of a man” (Seba 1734; Laurenti 1768).	A recognisable but generic cobra with a spectacle mark, no further conclusion possible.
Seba, 1735, Plate 85, fig. 1	Listed in Linnaeus (1758), syntype of <i>Coluber najia</i> . Identified as ZMB 2795 by Bauer & Günther (2013).	“Peru” (in error) (Seba 1735).	Spectacle mark, reddish-grey with light whitish or grey markings.	Reasonably accurate depiction, clearly identifiable as <i>Naja najia</i> based on the Plate. Corresponds closely to ZMB 2795, which originates from Sri Lanka based on scale counts and ventral pattern.

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TABLE 1. (Continued)

Specimen	Type status	Stated origin	Description	Comments
Seba, 1735, Plate 89, fig. 1	Listed in Linnaeus (1758), presumed lost, syntype of <i>Coluber najia</i> ; illustration of original syntype of <i>Naja siamensis</i> Laurenti, 1768.	Siam (Seba 1735); "Habitat in Imperio Siam & Insulis Ternateis" (Laurenti 1768).	Greyish, with reddish tinges. Spectacle mark, hood and spectacle smaller than in Sri Lankan specimens.	Illustrated specimen replaced as type of <i>N. siamensis</i> by BMNH 1987.678 through neotype designation by Wüster <i>et al.</i> (1997).
Seba, 1735, Plate 89, fig. 2	Listed in Linnaeus (1758), presumed lost, syntype of <i>Coluber najia</i> ; illustration of syntype of <i>Naja siamensis</i> Laurenti, 1768.	Ternate, Moluccas (Seba 1735), in error. "Habitat in Imperio Siam & Insulis Ternateis" (Laurenti 1768).	Smaller but otherwise equal to preceding specimen.	Illustrated specimen replaced as type of <i>N. siamensis</i> by BMNH 1987.678 through neotype designation by Wüster <i>et al.</i> (1997).
Seba, 1735, Plate 89, fig. 3	Listed in Linnaeus (1758), presumed lost, syntype of <i>Coluber najia</i> ; illustration of type of <i>Naja fasciata</i> Laurenti, 1768.	"Indicus" / "des Indes" (Seba 1735); "Habitat in India" (Laurenti 1768).	Spectacle mark. Sets of four lighter bands on darker background, separated by wider dark interspaces.	Body pattern most reminiscent of high-contrast, darker Sri Lankan <i>Naja najia</i> .
Seba, 1735, Plate 89, fig. 4	Listed in Linnaeus (1758), syntype of <i>Coluber najia</i> ; illustration of type of <i>Naja brasiliensis</i> Laurenti, 1768. Identified as ZMB 2796 by Bauer & Günther (2013). Designated as lectotype of <i>Coluber najia</i> Linnaeus, this work.	"Brasiliensis" / "du Brésil: (Seba, 1735). "Habitat in Brasilia" (Laurenti 1768). In error.	Derived, heart-shaped spectacle mark with an additional ocellus on each side. Otherwise light reddish with single reddish-brown crossbands on anterior body.	Likely <i>Naja najia</i> based on Seba's plate alone. Key characteristics correspond to specimen ZMB 2796, which is clearly identifiable as a Sri Lankan <i>Naja najia</i> .
Seba, 1735, Plate 90, fig. 1.	Listed in Linnaeus (1758), presumed lost, syntype of <i>Coluber najia</i> ; illustration of type of <i>Naja non Najia</i> Laurenti, 1768 (name unavailable as non-binomial)	None given in Seba (1735). "Habitat in India" (Laurenti 1768).	Female; yellowish-reddish, no hood mark	NB: Figure numbers in Plate 90 are reversed between Plate and text. More likely from India than Sri Lanka due to lack of spectacle mark and uniform body.

.....continued on the next page

TABLE 1. (Continued)

Specimen	Type status	Stated origin	Description	Comments
Seba, 1735, Plate 90, fig. 2	Listed in Linnaeus (1758), presumed lost, syntype of <i>Coluber najia</i> ; illustration of type of <i>Naja maculata</i> Laurenti, 1768. Identified as ZMB 2797 by Bauer and Günther (2013), in error; see text.	“Indicus” / “des Indes” (Seba, 1735); “Habitat in India” (Laurent, 1768).	Spectacle mark, body greyish yellow. Figure shows small black and white spots.	NB: Figure numbers in Plate 90 are reversed between Plate and text. Spectacle marking with large ocelli indicate <i>Naja najia</i> , lack of banding on body suggests India rather than Sri Lanka.
Seba, 1735, Plate 94, fig. 1	Listed in Linnaeus (1758), presumed lost, syntype of <i>Coluber najia</i> .	“Malabarica” / “de Malabar” (Seba 1735).	Greyish-yellow, with spectacle mark.	Clearly <i>N. najia</i> , likely from India as per locality description.
Seba, 1735, Plate 97, fig. 1	Listed in Linnaeus (1758), presumed lost, syntype of <i>Coluber najia</i> .	“Indicus” / “des Indes” (Seba 1735).	Spectacle mark.	“Serpent Noja” may indicate Sri Lankan origin. Recognisably <i>Naja najia</i> .
Seba, 1735, Plate 97, fig. 2	Listed in Linnaeus (1758), presumed lost, syntype of <i>Coluber najia</i> .	“Indicus” / “des Indes” (Seba 1735).	No spectacle mark.	NB: figure erroneously labelled fig. 1 in Plate 97. Absence of spectacle mark suggests India rather than Sri Lanka.
Seba, 1735, Plate 97, fig. 3	Listed in Linnaeus (1758), presumed lost, syntype of <i>Coluber najia</i> .	“Ceylonica” / “de Ceylon” (Seba 1735).	Spectacle mark, body strongly banded.	Likely to depict Sri Lankan <i>Naja najia</i> based on banding.
Seba, 1735, Plate 97, fig. 4	Listed in Linnaeus (1758), presumed lost, syntype of <i>Coluber najia</i> .	“Nova Hispania” / “Nouvelle Espagne” (Seba 1735) (in error).	Spectacle mark, body strongly banded.	May depict Sri Lankan <i>Naja najia</i> ; stated locality in error.
“Specimen in British Museum” (Deraniyagala 1939, 1945); no number stated, now BMNH 1946.1.18.50, previously BMNH 1940.1.30.1. Fig. 2.	Type of <i>Naja naia</i> colour variety <i>polyocellata</i> Deraniyagala, 1939; neotype of <i>Naja najia najia</i> , invalidly designated by Deraniyagala (1945).	“Ceylon” (BMNH catalogue). “Near Polonnaruwa (now Polonnaruwa)”, Sri Lanka, <i>fide</i> Deraniyagala, 1939.	Spectacle mark, four well defined dark bands on venter, <i>polyocellata</i> pattern.	

Conclusions and recommendations

In conclusion, the typification of *Coluber naja* Linnaeus, 1758 can be summed up as follows:

- The only spirit specimen seen and used as a syntype by Linnaeus is lost but appears to have originated from Sri Lanka.
- The surviving specimen of spectacled cobra in the Museum Adolphi Friderici collection (now NRM 90) was not mentioned by Linnaeus (1758) and is therefore not a possible lectotype of *Coluber naja*.
- Two Linnaean syntypes of *Coluber naja* from the Seba collection have survived in the Museum für Naturkunde, Berlin (Bauer & Günther 2013). Both are almost certainly of Sri Lankan origin.
- To settle the question of the type and type locality of *Coluber naja* Linnaeus, we designate ZMB 2796 as lectotype of *Coluber naja* Linnaeus, thereby restricting the type locality of the spectacled cobra to Sri Lanka.
- The lectotype designation renders *Naja brasiliensis* Laurenti, 1768 an objective junior synonym of *Coluber naja* Linnaeus, 1758.
- Deraniyagala's *Naja naia* colour variety *polyocellata* (Deraniyagala, 1939) is an available name, but a subjective junior synonym of *Coluber naja* Linnaeus.
- Deraniyagala's designation of BMNH 1946.1.18.50 as the neotype of *Coluber naja* is invalid under the Code.

The Sri Lankan origin of the lectotype of *Coluber naja* Linnaeus de facto restricts the type locality of this taxon to Sri Lanka. Consequently, the name *polyocellata* Deraniyagala, 1939 becomes a subjective junior synonym of *Naja naja*, barring the extremely unlikely discovery of cryptic species of spectacled cobra within Sri Lanka. As a result, if, based on convincing evidence, Indian and Sri Lankan spectacled cobras were to be considered as separate species, it would be the Indian populations that would require a different name, raising the question of the correct scientific name for these snakes. The oldest available names for spectacled cobras after Linnaeus' *Coluber naja* are all from Laurenti (1768) and also based on illustrations in Seba's *Thesaurus* (Seba 1734, 1735). The relevant names and their illustrations in Seba are *Naja lutescens* Laurenti (Seba, 1734, Plate 44, fig. 1), *N. fasciata* Laurenti (Seba, 1735, Plate 89, fig. 3), and *N. maculata* Laurenti (Seba, 1735, Plate 90, fig. 2). See Table 1 for an evaluation of Seba's illustrations and the likely identity and origin of the specimens. Unfortunately, most of the specimens in Seba's plates are of uncertain geographic origin and the illustrations do not provide sufficient diagnostic detail to determine this. While the designation of neotypes could unambiguously attach Laurenti's names to clearly defined taxa (see Wüster *et al.*, 1997, for a precedent for *N. siamensis* Laurenti, 1768), a major potential complication is the possibility that further Seba *Naja* specimens may survive in other European collections (Bauer & Günther 2013; Boeseman 1970; Daszkiewicz & Bauer 2003; Thireau *et al.* 1998), thereby threatening the status of any neotypes. Consequently, such a step should not only await a thorough, rigorous revision of the entire spectacled cobra complex to enable names to be attached to robustly evidenced lineages, but will also require extensive historical research and potential petitions to the International Commission on Zoological Nomenclature.

As was shown here, Shi *et al.*'s (2022) seemingly simple recognition of the taxon *polyocellata* has raised a large number of hitherto dormant issues on the type status and type locality of *Naja naja*, and thereby provides a potent illustration of the hazards of *en passant* taxonomy. Many taxa, especially widespread, geographically variable species first named in the 18th or 19th centuries, have complex nomenclatural histories, and unravelling these and arriving at a stable nomenclature can be a complex task (e.g., Fritz & Schmidler 2020). Casual taxonomic decisions taken without a full revision of the pertinent literature and material risk creating extensive nomenclatural instability and confusion. In this case, the proposed splitting of *N. naja* by Shi *et al.* (2022) revealed a need for a thorough reassessment of the literature and types underlying the names coined for different populations of the complex, and carries significant implications for the nomenclature of a lineage of iconic and medically highly important snakes.

Shi *et al.* (2022) rightly state that "Taxonomic frameworks for medically important species [...] are essential for the medical treatment of snake bites and accurate antivenin development". It is precisely for this reason that species delimitation affecting medically important taxa should be based on robust evidence and best reasonably feasible practice, to reduce the likelihood of subsequent changes to scientific names through later, better-evidenced classifications or due to overlooked nomenclatural issues. Such instability is likely to hinder information retrieval by a readership unfamiliar with the taxonomic intricacies surrounding their focal taxa (Wüster & McCarthy 1996).

Given the very limited evidence supporting Shi *et al.*'s (2022) division of *Naja naja*, this split should be disregarded until sufficient supporting evidence is available, and the use of *N. naja* in its previous sense retained (Wüster 1998;

Wüster & Thorpe 1992). Resolution of the questions raised by Shi *et al.* (2022) will require a comprehensive range-wide morphological and multilocus genetic reassessment of spectacled cobras, with particular focus on the populations from southeastern India and Sri Lanka, especially along the shores of the two sides of the Palk Strait. The status of Sri Lanka as an island makes it tempting to assume separate status for its biota. However, it is important to recall that, due to lowered eustatic sea levels, India and Sri Lanka were repeatedly connected by broad land bridges during multiple Pleistocene glaciations (Bossuyt *et al.* 2004; Dubey *et al.* 2022; Rohling *et al.* 1998; Vaz 2000), most recently approximately 8000 years ago (Dubey *et al.* 2022). Taxa restricted to higher and more humid habitats in the Western Ghats and the Sri Lankan uplands remained separated by more xeric lowland climates, resulting in high levels of endemism in numerous lineages (Bossuyt *et al.* 2004), but this is unlikely to have affected habitat generalists such as cobras, which are widespread in the lowlands of southeastern India and northern Sri Lanka, including the semi-arid Jaffna Peninsula (Abyerami & Sivashanth 2008). The possibility of extensive recent gene flow between Indian and Sri Lankan spectacled cobras needs to be investigated as part of a comprehensive reassessment of the systematics of *N. naja*. The recent record of a cobra with only three ventral bands from Jaffna (Sukumar 2021; Fig. 1B) is suggestive in this regard. This requires careful, dense sampling of the likely past contact area between Indian and Sri Lankan *N. naja* in southeastern Tamil Nadu and northwestern Sri Lanka (Hillis 2019). These two subregions have traditionally received little attention from herpetological researchers, but are crucial to our understanding of how past land connections between India and Sri Lanka may have shaped animal movements and genetic exchanges. A multilocus approach is essential, since mitochondrial DNA alone cannot reveal genetic introgression and may provide a misleading picture of patterns of genomic differentiation (Hillis 2019): the literature is replete with examples of mitochondrial phylogeography grossly misrepresenting patterns of genomic relatedness and genetic exchange, and thus species-level diversity (e.g., compare Burbrink 2001 and Burbrink *et al.* 2021; Pyron & Burbrink 2009 and Harrington & Burbrink 2022). In summary, the question of species delimitation within *Naja naja* requires dense sampling, a multilocus approach, and careful attention to the tendency of popular species delimitation software to “oversplit” geographically structured taxa (Burriel-Carranza *et al.* 2019; Leaché *et al.* 2019). Given the medical importance and iconic status of *N. naja* and the fact that the bulk of the literature on the taxon relates to Asian mainland populations, a considerable burden of evidence rests on those seeking to divide the species.

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