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Philippe Borsa, Philippe Béarez

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Philippe Borsa, Philippe Béarez. Notes on the origin of Müller and Henle's illustration and type material of the blue-spotted maskray *Neotrygon kuhlii* (Myliobatoidei: Dasyatidae). *Cybium : Revue Internationale d'Ichtyologie*, 2016, 40, pp.255-258. ird-01374770

HAL Id: ird-01374770

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Submitted on 1 Oct 2016

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To be cited as: Borsa P, Béarez P (2016) Notes on the origin of Müller and Henle's illustration and type material of the blue-spotted maskray *Neotrygon kuhlii* (Myliobatoidei: Dasyatidae). *Cybium* 40, 255-258.

**Notes on the origin of Müller and Henle's illustration and type material of the blue-spotted maskray
Neotrygon kuhlii (Myliobatoidei: Dasyatidae)**

PHILIPPE BORSA* (1) & PHILIPPE BÉAREZ (2)

(1) Institut de recherche pour le développement (IRD), UMR 250 "Ecologie marine tropicale des océans Pacifique et Indien", BP A5, 98840 Nouméa, New Caledonia. Tel. +62 81237453473. [philippe.borsa@ird.fr, philippeborsa@gmail.com]

(2) UMR CNRS 7209 "Archéozoologie, archéobotanique, sociétés, pratiques et environnements (UMR 7209), Sorbonne universités, MNHN, CNRS. Muséum national d'histoire naturelle, 55 rue Buffon, CP 56, 75005 Paris, France. Tel. +33 140793736. [bearez@mnhn.fr]

* Corresponding author

Short title. – *On the type material of* *Neotrygon kuhlii* BORSA & BÉAREZ

Abstract. – In a recently published revision of the blue-spotted maskray *Neotrygon kuhlii* (Müller & Henle) species complex, P.R. Last and co-authors reviewed the original description, examined the type series, and designated one of two syntypes from Vanikoro (Santa Cruz archipelago, southwestern Pacific) as lectotype of the species. They also included a specimen from Guadalcanal (Solomon archipelago) in their re-description of the species. In the present paper, we provide so far overlooked, complementary information on the origin of Müller and Henle's illustration and type material of *N. kuhlii*, that challenges several of Last and co-authors' affirmations. We analyze the pigmentation patterns of the lectotype, paralectotype and a third specimen from Vanikoro drawn by J.R.C. Quoy. We also compare these three specimens to the specimen from Guadalcanal and conclude that the latter represents a different species.

Résumé. – Notes sur le dessin original de Müller et Henle et le matériel-type de la raie masquée à points bleus *Neotrygon kuhlii* (Myliobatoidei: Dasyatidae)

A l'occasion d'une révision récente du complexe d'espèces de la raie masquée à points bleus *Neotrygon kuhlii* (Müller & Henle), P.R. Last et co-auteurs examinent la description originale et la série-type, et désignent l'un des deux syntypes de Vanikoro (archipel des Santa Cruz, Pacifique sud-ouest) comme lectotype de l'espèce. Un spécimen de Guadalcanal (archipel des Salomon) est également utilisé pour la re-description de l'espèce. Le présent document fournit des informations complémentaires, négligées jusqu'ici, sur l'illustration originale utilisée par Müller et Henle, ainsi que sur le matériel type de *N. kuhlii*, qui mettent en cause plusieurs des affirmations de Last et co-auteurs. Nous analysons la pigmentation du lectotype, du paralectotype et d'un troisième spécimen de Vanikoro dessiné par J.R.C. Quoy. Nous comparons également ces trois spécimens à l'échantillon de Guadalcanal et concluons que ce dernier représente une espèce différente.

Key words. – *Neotrygon trigonoides*; K. Keiga; J.R.C. Quoy, J.P. Gaimard; morphology; genetics

The blue-spotted maskray *Neotrygon kuhlîi* (Müller & Henle, 1841) has been suspected to consist of a complex of closely related species (Ward *et al.*, 2008; Naylor *et al.*, 2012; Arlyza *et al.*, 2013; Puckridge *et al.*, 2013). Eight mitochondrial clades with parapatric distribution were identified within the species complex (Arlyza *et al.*, 2013; Borsa *et al.*, 2016) in addition to a deeper, external lineage corresponding to the previously-resurrected New Caledonian maskray *Neotrygon trigonoides* (Castelnau, 1873). The syntype series of *N. kuhlîi* included specimens from presumably several species. Last *et al.* (2016) recently designated a lectotype, re-described *N. kuhlîi*, and described or re-described four other species previously under *N. kuhlîi*. The objectives of the present note are to complete the information on the original illustration of the species and on the type material, to point out some problems in Last *et al.*'s (2016) paper, and to highlight some of the taxonomic issues that still require attention.

Original illustration. – The original description of the blue-spotted maskray *Trygon kuhlîi* was accompanied by the matching lithography of a female specimen (Müller & Henle, 1841: pl. 51). Müller and Henle (1841: xxii) declared that the drawing they reproduced had been done by “*Kuhl und Hasselt*”. Last *et al.* (2016) assumed that Müller and Henle's (1841) plate 51 represented a “most likely composite image” partly based on a specimen from Java, but this assumption appears to be unfounded. As stated by Temminck and Schlegel (1843) and confirmed by Duméril (1865), the original drawing was executed from a fresh specimen from Japan under the direction of H. Bürger. Bürger's collection of fishes consisted of samples from the Nagasaki region exclusively (Boeseman, 1947). This original drawing (Fig. 1) is a pencil and watercolour painting by Japanese artist K. Keiga at Deshima, Nagasaki in 1830 (M.J.P. van Oijen, pers. comm., 2015) which is now housed in the collections of the Naturalis Museum, Leiden (no. RMNH.ART.255). Jordan and Fowler (1903) also refer to the original drawing as from a specimen from Nagasaki. Based on its pigmentation patterns, Keiga's specimen markedly differs from the two syntypes from Vanikoro chosen as lectotype and paralectotype of *N. kuhlîi* by Last *et al.* (2016). Pigmentation patterns should be considered carefully as they have proven to be useful in separating *N. trigonoides* from the blue-spotted maskrays from the Coral Triangle region previously under *N. kuhlîi* (Borsa *et al.*, 2013).

Type material and type locality. – The type material of *Trygon kuhlîi* included “*Ein Exemplar trocken in Leyden. In Paris zwei Exemplare in Weingeist von Vanicoro, eines aus Neuguinea durch Quoy und Gaymard*” (Müller & Henle, 1841). “Indien” (India) was mentioned as type locality (p. 165) but the authors presumably referred to the East Indies, which was the term used in colonial times to designate a vast region east of the Indus River, including India, continental South-East Asia and the Indo-Malay archipelago. Puckridge *et al.* (2013) indicated a location midway between the Solomon archipelago and New Caledonia as the type-locality of *N. kuhlîi* but this was not a valid designation in the sense of the International Code of Zoological Nomenclature (International Commission on Zoological Nomenclature, 1999) because no lectotype had then been fixed. The following sections summarize the information currently available on each of the four syntypes mentioned by Müller and Henle (1841).

Leiden syntype. – Last *et al.* (2016) presented the picture of a dry male dasyatid specimen preserved in Leiden (RMNH.PISC.D.2472; labeled “*Trygon; Kuhl en van Hasselt; Java*”). They declared it to be the “*probable*” syntype that Müller and Henle (1841) referred to. However, Last *et al.* (2016) did not specify how they were able to identify this specimen as a blue-spotted maskray. Actually, Müller and Henle's (1841) Leiden syntype cannot be traced with certainty. It may have been lost (Boeseman, 1947) or it may have never existed at all. For instance, Duméril (1865: 604) mentioned a Japanese specimen at the Rijksmuseum van Natuurlijke Historie (RMNH; now Naturalis) in Leiden,

but no mention was made by Temminck and Schlegel (1843) that a specimen departed from Japan, although these two authors had kept track of the specimens from Japan then deposited into the RMNH collections. Duméril (1865) knew that the original drawing was from Japan and might have assumed that the Japanese specimen after which the drawing was made had been deposited at the RMNH. Similarly, Müller and Henle (1841) might have assumed that a specimen accompanied the drawing and since they erroneously believed that the drawing was provided by H. Kuhl, they might have assumed that both the drawing and a presumed associated specimen came from Java. To complicate matters, Duméril (1865) mentioned “*un spécimen de Java (Kuhl et Van Hasselt), donné par le Mus. de Leyde*” to MNHN, Paris (MNHN-IC-0000-2332). The latter being preserved in alcohol, it cannot be the lost Leiden syntype, which is supposed to be a dry specimen (Müller & Henle, 1841). Last *et al.* (2016) wrote that specimen RMNH.PISC.D.2472 is “probably *N. caeruleopunctata* based on its size and capture location”, but this is speculative because adult size may vary among individuals within a species and because at least two species previously under *N. kublii* are present around the island of Java (namely, *Neotrygon caeruleopunctata* Last, White & Séret, 2016 on its southern coast and *Neotrygon orientale* Last, White & Séret, 2016 on its northern coast). Genetic analysis of specimen RMNH.PISC.D.2472 would eventually help ascertain its identification as a blue-spotted maskray, determine the species, and further determine its geographic origin, because of the high level of geographic differentiation among populations of maskrays previously under *N. kublii* (Borsa *et al.*, 2012; Arlyza *et al.*, 2013).

New Guinea syntype. – The MNHN in Paris holds a single specimen of blue-spotted maskray from New Guinea (MNHN-IC-A-7931). This specimen was collected through J. Dumont d’Urville’s hydrographic expedition on board *Astrolabe* in 1826-1829, on which J.R.C. Quoy and J.P. Gaimard had embarked (Dumont d’Urville, 1833; Bauchot, 1994). Last *et al.* (2016) placed the sampling locality of the New Guinea syntype in “West Papua, New Guinea, 7°30'S 132°30'E”. These coordinates actually designate a location in the deep ocean 64 km east-southeast of the eastern tip of Larat Island in the Tanimbar archipelago, Moluccas. The habitat at this location is not suitable to the blue-spotted maskray, which is a shallow-water, demersal chondrichthyan (Last & Compagno, 1999). Moreover, there is no indication from Dumont d’Urville (1833) that the Tanimbar archipelago was visited. Havre Dorei (also spelled “Havre-Dorey”; “00°51'S 131°39'E”) is the only site along the main island of New Guinea to have been called at by the *Astrolabe* (Dumont d’Urville, 1833). Havre Dorei is now Manokwari in West Papua. New Guinea fits, in a loose sense, the definition of East Indies (e.g., Allen & Erdmann, 2012), hence may fit “India” in the sense presumably used by Müller and Henle in their designation of the type locality of *Trygon kublii*. Because of this, it might have been acceptable to designate the New Guinea syntype as lectotype, but Last *et al.* (2016) chose another specimen. Last *et al.* (2016) eventually assigned the New Guinea syntype to *N. australiae*, without justification.

Vanikoro syntypes. – The MNHN also holds the two syntypes from Vanikoro (MNHN-IC-0000-2440) brought back from the *Astrolabe* expedition (Bauchot, 1994). The plate depicting a third specimen from Vanikoro, described as *Raia coerulea* was ready for publication in the *Atlas Zoologique* of the *Astrolabe* expedition (Quoy & Gaimard, 1835) but was eventually excluded from the final publication, along with dozens of other plates (Bauchot, 1994). This unpublished plate, numbered 375-2 is obviously a reproduction, albeit slightly altered, of an original watercolour from Quoy and Gaimard’s field notes (Fig. 2). This watercolour is invaluable as it provides a testimony of the actual pigmentation patterns of the Vanikoro maskray. We analyzed the pigmentation patterns of the foregoing specimens and compared them to those published previously for specimens of blue-spotted maskray from the Coral Triangle

region and *N. trigonoides* (Borsa *et al.*, 2013). Dark spots (> 1% disk width) were present on the dorsal side of the two *N. kublii* syntypes from Vanikoro, and the scapular blotch was visible, albeit faintly, on one syntype, as in *N. trigonoides* (Table I). Dark spots and scapular blotch have also been represented on the additional specimen from Vanikoro drawn by J.R.C. Quoy (Fig. 2). The Vanikoro maskray could not be distinguished from *N. trigonoides* on the basis of pigmentation patterns, as both possess dark spots and scapular blotch (Table I) while it markedly differed from *N. kublii* as understood previously, based on Müller and Henle's (1841) plate 51. Thus, contrary to the assertions of Last *et al.* (2016), the pigmentation patterns of the Vanikoro maskray do not fit those of *N. kublii* as described by Müller and Henle (1841). Last *et al.* (2016) eventually designated one of Quoy and Gaimard's specimens from Vanikoro as lectotype of *N. kublii* and the second specimen as paralectotype.

Guadalcanal specimen. – Last *et al.* (2016) chose to re-describe *N. kublii*, not only from the newly designated lectotype and paralectotype, but also from a single fresh specimen collected in Honiara, Guadalcanal Island, i.e. more than 800 km west of Vanikoro, the type-locality. Guadalcanal is part of the Solomon archipelago whereas Vanikoro is part of the Santa Cruz archipelago, separated from the former by a large (>300 km) and deep (>1000 m) oceanic strait (Ryan *et al.*, 2009). This stretch of oceanic water likely acts as a barrier to gene flow for the blue-spotted maskray. To evaluate whether the Guadalcanal maskray specimen is related to *N. kublii* from Vanikoro, we used pigmentation patterns as a proxy of genetics (Table I). We observed that the Guadalcanal maskray does not possess dark spots or a scapular blotch, leading us to conclude that the Guadalcanal maskray does not represent *N. kublii* as redescribed by Last *et al.* (2016). In summary, the Guadalcanal maskray is morphologically different from *N. kublii* from Vanikoro, while the latter morphologically resembles *N. trigonoides*. To properly represent *N. kublii*, and to formally compare it with *N. trigonoides* and other species previously under *N. kublii* would require the genetic analysis of specimens from the type-locality itself.

Conclusion. – For nearly two centuries, the taxonomy of the blue-spotted maskray has been tainted with neglect, confusion and error. Quoy and Gaimard's description of the Vanikoro maskray (as *Raia coerulea*) was unfortunately unknown from Müller and Henle (1841) when the latter selected Quoy and Gaimard's two specimens from Vanikoro to be included in the type series of *N. kublii* (Bauchot 1994). Müller and Henle (1841) also ignored that the drawing they had obviously based their description on was of a specimen from Japan. Despite subsequent corrections in the relevant taxonomic literature (Temminck & Schlegel, 1843; Duméril, 1865; Jordan & Fowler, 1903), Last *et al.* (2016) persisted to ignore this fact and erroneously assumed that the drawing likely represented a composition from specimens of various origins. Eventually, one of the Vanikoro syntypes was chosen as the sole name-bearing type of *N. kublii*, but the pigmentation patterns of the Vanikoro maskray markedly differ from the description given by Müller and Henle (1841) while apparently matching those of *N. trigonoides*. The genetic relationship of *N. kublii* with *N. trigonoides* should be considered a priority for future taxonomic research on the blue-spotted maskray. The genetic analysis of the lectotype of *N. kublii* would be helpful in this respect, but genetically analyzing fresh specimens from Vanikoro could be an alternative.

Acknowledgements. – We are grateful to M.J.P. van Oijen and R. de Ruiter (Naturalis, Leiden) for help in attempting to track the lost Leiden specimen and for pointing towards several important references. We are grateful to three anonymous reviewers for helpful suggestions on previous versions of the manuscript. We are also grateful to

Bibliothèque centrale du MNHN for allowing us to consult manuscripts and for providing sharp photographs of J.R.C. Quoy's plates; and to L. Randrihasipara for excellent photographs of the New Guinea and Vanikoro syntypes of *Trygon kuhlîi*. C.J. Temminck and H. Schlegel's *Fauna Japonica* was consulted from the Kyoto University Library website (<http://kuline.kulib.kyoto-u.ac.jp/>). J. Müller and F.G.J. Henle's *Systematische Beschreibung der Plagiostomen* and A. Duméril's *Histoire naturelle des poissons* were consulted from the Biodiversity Heritage Library website (<http://www.biodiversitylibrary.org/>). Issues of the *Zoologische Mededeelingen* were consulted online from the Naturalis repository website (<http://www.repository.naturalis.nl/>).

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Table I. – *Neotrygon* spp. Matrix of individuals characterized by the numbers of ocellated spots [*small*: $\leq 2\%$ disk width (DW); *medium*: $> 2\%$ DW and $\leq 4\%$ DW; *large*: $> 4\%$ DW], the number of dark speckles ($\leq 1\%$ DW), the number of dark spots ($> 1\%$ DW), and the absence or presence of a scapular brown blotch on the dorsal surface of left or right half-disk. Sharp photographs of the lectotype and paralectotype of *N. kublii* were used to examine pigmentation patterns, in complement to figure 2 of Last *et al.* (2016). Average ($\pm$ SD) values for *N. trigonoides* and for blue-spotted maskrays previously referred to as *N. kublii* calculated from table 2 of Borsa *et al.* (2013). N: number of speckles or spots. CT: Coral Triangle

Species, Specimen no.	Sampling region	Side of disk	N ocellated spots			N dark speckles	N dark spots	Scapular blotch
			Small	Medium	Large			
<i>N. kublii</i>								
MNHN 2440 lectotype	Vanikoro	left	2	0	0	10	1	present
MNHN 2440 lectotype	Vanikoro	right	3	0	0	6	0	present
MNHN 2440 paralectotype	Vanikoro	left	14	1	0	10	1	?
MNHN 2440 paralectotype	Vanikoro	right	9	0	0	15	1	?
Guadalcanal maskray								
CSIRO H7723-01	Guadalcanal	left	2	1	0	3	0	absent
CSIRO H7723-01	Guadalcanal	right	4	1	0	6	0	absent
Blue-spotted maskrays previously under <i>N. kublii</i>								
12 specimens ^a	Indian O. + CT	average	21.9	11.1	0.6	16.0	0	absent
		$\pm$ SD	± 15.5	± 6.9	± 0.9	± 17.0	-	-
<i>N. trigonoides</i>								
4 specimens ^b	New Caledonia	average	30.7	0	0	49.9	6.5	present
		$\pm$ SD	± 14.6	-	-	± 26.9	± 5.2	-

^a includes K. Keiga's specimen, and specimens nos. BO-424, MZB-20843, MZB-20847, MZB-20850, MZB-20851, MZB-20852, MZB-20864, MZB-20866, and MZB-20867 (Borsa *et al.*, 2013)

^b includes specimens nos. MNHN-IC-2009-0823 and IRDN-20090816, and an unregistered specimen deposited at CSIRO, Hobart by P. Borsa (Borsa *et al.*, 2013)



Figure 1. — Watercolour of a blue-spotted maskray specimen from the Nagasaki region by K. Keiga (RMNH.ART.255), reproduced as lithography by Müller and Henle (1841: plate 51). Photograph from Naturalis Biodiversity Center, Leiden.

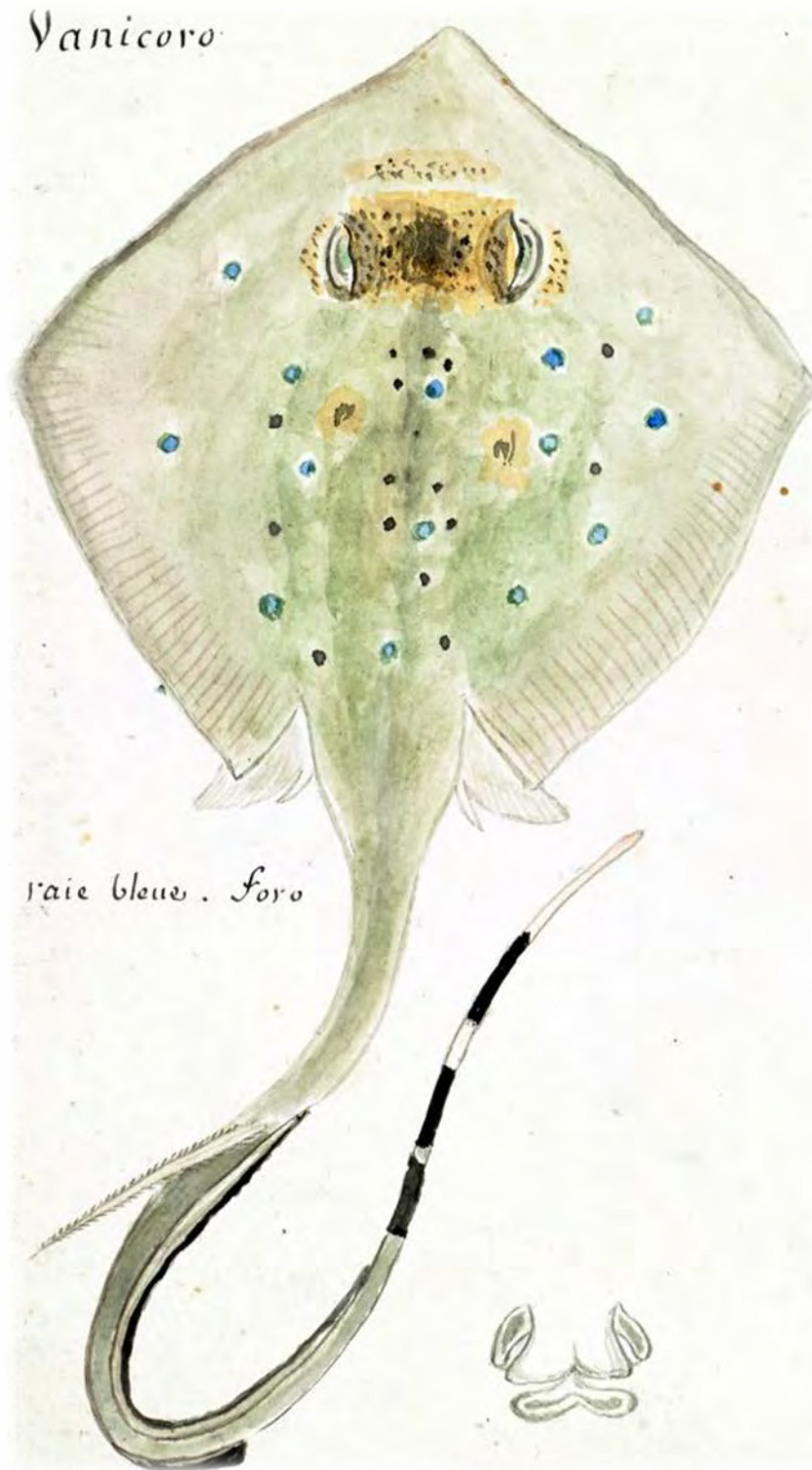


Figure 2. – Vanikoro maskray (*raie bleue*; *foro*; *Raia coerula*), dorsal side. Original watercolour by J.R.C. Quoy executed at Vanikoro in 1828, during the *Astrolabe* expedition (Dumont d'Urville, 1833); p. 89 of Quoy and Gaimard's field notes assembled as MS 840 at Bibliothèque centrale du MNHN, Paris (Bauchot, 1994). Quoy represented ocellated blue spots ($N = 14$), dark-brown spots ($N = 13$), dark speckles ($N = 3$), and lighter-brown scapular blotches ($N = 2$, one on each shoulder). Edited from a photograph by Bibliothèque centrale du MNHN. Copyright: Muséum national d'histoire naturelle (Paris) - Direction des bibliothèques et de la documentation, 2016.