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PENSOFT

MUSEUM FÜR NATURKUNDE BERLIN

A historical specimen of the Fishing Cat, *Prionailurus viverrinus* (Bennett, 1833) (Carnivora, Felidae) from Singapore in the zoological collection of the Naturalis Biodiversity Center, Leiden

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http://zoobank.org/E7A90541-F0BE-45BF-A689-91B8B93F732A

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Abstract

The Fishing Cat is not a species known to inhabit Singapore. However, a historical specimen stated to have come from Singapore in 1819 and attributed to Pierre-Médard Diard (RMNH.MAM.59688) is now housed at Naturalis Biodiversity Center, Leiden, the Netherlands. Two hundred years after it was obtained, the mounted skin and skull of this specimen, including specimen labels, were photographed and digitally catalogued. Four sets of annotations from labels and a document detailing records and a receipt of specimens sent by Diard to Leiden are presented to ascertain the specimen's identity, followed by a historical account of Diard based on a reconstruction of the timeline of key events of Singapore's natural history. Subsequently, the specimen is examined to confirm its taxonomic identity using comparative morphometrics with other museum specimens, and data associated with the specimen are analysed to determine the origins of this specimen. We conclude that the current evidence does not allow confirmation of the specimen's status as having been collected in Singapore or being obtained from the pet trade. If the specimen was an imported specimen, it would point towards a trade in rare and large animals in Singapore and the region from as early as 1819. Presently, the specimen remains one of the few extant zoological specimens obtained in Singapore in 1819 and the only one currently known outside of England.

Key Words

digital repatriation, *Felis leucojalamus*, first Singapore expedition, history of mammalogy, Pierre-Médard Diard, Stamford Raffles, zoological collection

Introduction

The Fishing Cat, *Prionailurus viverrinus* (Bennett, 1833) is a medium-sized, nocturnal species of the family Felidae. Its natural distribution is still unclear but current known occurrence records suggest that this species is widely distributed in South and Southeast Asia from Pakistan in the west to Cambodia in the east, and from the Himalayan foothills in the north to Sri Lanka and peninsular Thailand in the south (Mukherjee et al. 2016). Based on museum records, the species has also been reported from the Malay Peninsula, Java and possibly Sumatra (e.g., Blanford 1888–1891; Jentink 1892; Brongersma 1935). These records from the Malay Peninsula that were based solely on museum specimens have generally been assumed to have been the result of mislabelling, misidentification or material obtained from the pet trade (Duckworth et al. 2009).

The Fishing Cat is absent from present-day Singapore and the origins of a museum specimen from Singapore

housed in the Naturalis Biodiversity Center of the Netherlands (**RMNH**) need careful investigation. The first mention of the Naturalis specimen was in Jentink (1887: 83), then again by Jentink (1892: 99) and subsequently by Brongersma (1935: 13). This record was mostly overlooked until van Bree and Khan (1992: 80), citing Brongersma (1935) wrote, "[i]n the National Natural History Museum at Leiden, the Netherlands, there is a Fishing Cat collected by P. Diard in Singapore in 1819". Over a decade later, Duckworth et al. (2009: 7) referred to this same specimen but in reference to Malacca "c.1820s [date inferred from the collector's identity: Diard], RMNH". The authors further stated that the specimen is "presumably the Malacca specimen(s) examined by Swinhoe (1862)" which suggests that they may not have known that there were labels associated with the Singapore specimen and were only aware of the collector, leading them to infer the date and locality. The origin of this Singapore specimen of the Fishing Cat in the RMNH therefore, has not been resolved.

As a follow-up study on the historical account of two French naturalists Diard and Duvaucel who collected with Raffles (see below), researchers from Singapore's Lee Kong Chian Natural History Museum (**LKCNHM**), and the Netherlands' Naturalis Biodiversity Center, Leiden (RMNH) searched through zoological collections in RMNH in November–December 2019 to locate and catalogue, amongst others, the Fishing Cat specimen. This work aims to confirm the taxonomic identity of the Fishing Cat specimen and reconstruct the history of this specimen based on a timeline of key events in the early natural history of Singapore to provide a better understanding of the original fauna of Singapore.

The first Singapore Expedition (May–June 1819)

Two French naturalists, Pierre-Médard Diard (1795–1863) and Alfred Duvaucel (1793–1824), who were employed by Sir Thomas Stamford Bingley Raffles (1781–1826), were among the earliest collectors of zoological material from Singapore and first visited Singapore in early 1819 with much of their collecting taking place between 31 May to 28 June 1819 (Pilon and Weiler 2011; Low 2019; Low et al. 2019; Weiler 2019; Low 2021 in press; Low et al. 2021).

During the four-week period in May and June 1819, which may be referred to as the first Singapore expedition, Diard and Duvaucel appear to have collected the majority of zoological specimens (Low 2021 in press; Low et al. 2021). The expedition resulted in many firsts from Singapore (in the scientific sense): the collection of the first mammal to be recorded, the Dugong (*Dugong dugon* (Müller, 1776)), the earliest natural history illustration (of a Spiny Turtle (*Heosemys spinosa* (Gray, 1831)), the first mammal to be named, the Cream-coloured Giant Squirrel (*Ratufa affinis* (Raffles, 1821)), the first primate to be described, the Banded Leaf Monkey (*Presbytis femoralis* (Martin, 1838)), and the first bird to be named, the Green Broadbill (*Calyptomena viridis* Raffles in Horsfield, 1822) (Low 2019; 2021, in press; Low et al. 2021).

Only two specimens from this 1819 collection are currently known to be extant: the Banded Leaf Monkey, *Presbytis femoralis* (Martin, 1838), and the Green Broadbill, *Calyptomena viridis* Raffles in Horsfield, 1822 (Napier 1985; Wells and Dickinson 2010; Wells 2013; Low and Lim 2015). It is also known that material collected from Singapore in 1819 also resides in other collections (Noltie 2009) and recent research has shown that Raffles gave 21 bird specimens from Sumatra to Lord Edward Smith Stanley (Wilson 2021). There is therefore the possibility that further research may uncover material collected from Singapore in 1819 in other collections in England or elsewhere.

In March 1820, the two French naturalists parted ways with Raffles after a falling out and the vast majority of their collections were seized by Raffles; the French naturalists retained specimens for which there were triplicates (Raffles 1821: 239, 240; Raffles 1830: 713; Burkill 1916; Bastin 2019: 288; Weiler 2019; Low 2021 in press). The duplicates were sent on the *Mary* and used by Raffles in his *Descriptive Catalogue* (Raffles 1821; Raffles 1822) and in Horsfield's *Zoological Researches in Java* (Horsfield 1821–1824). The primary set of material was retained with Raffles in Bencoolen (Bengkulu) but was lost when the *Fame* burned and sank in 1824 (Noltie 2009: 9–13; Wilson 2021: 40, 41).

Raffles explicitly stated in his *Descriptive Catalogue* (Raffles 1821: 249), that only two species of the genus *Felis* were in his collection (which included material from the first Singapore expedition): "the Royal Tiger, and a species of Tiger-cat" identifying the latter as *Felis bengalensis* (now under *Prionailurus*). Following the death of Raffles in 1826, his wife, Lady Sofia Raffles, published his memoirs with an appendix entitled *Catalogue of Zoological Specimens* by Vigors and Horsfield (Raffles 1830: 633–697) detailing the material collected in the two months following the loss of the *Fame* (Noltie 2009: 9–13; Wilson 2021: 40). No species of cat from Singapore is listed in this appendix or in the *Zoological Researches of Java* (Horsfield 1821–1824; Raffles 1830: 636–637).

The context of the RMNH Fishing Cat specimen

Felis leucojalamus: a *nomen nudum*

In 1887, Fredericus Anna Jentink (1844–1913) listed the species name, *Felis leucojalamus* in the synonymy of *Felis viverrina* Bennett, 1833 in his first catalogue of

the mammal collections ("Catalogue Ostéologique des Mammifères") deposited at the National Museum of Natural History (RMNH) in Leiden (i.e., Jentink 1887: 83). Jentink was a curator of vertebrates at RMNH before being appointed as the museum's director in 1884 (Holthuis 1995: 77).

Jentink (1887: 83) listed Diard's specimen as specimen "b" of *F. viverrina*: "Crâne d'un individu adulte. Singapore. Diard, 1819. *Felis leucojalamus* Diard, espèce inédite" (Translation: "Skull of an adult individual. Singapore. Diard, 1819. *Felis leucojalamus* Diard, unpublished species"). In his later systematic catalogue, Jentink (1892: 99) retained the same specimen under *F. viverrina* with the following remarks: "Individu adulte monté. Singapore. Des collections de M. Diard, 1819. *Felis leucojalamus* Diard, MS. (Cr. *b* du Cat. Ost.)" (Translation: "Adult individual mounted. Singapore. From the collections of M. Diard, 1819. *Felis leucojalamus* Diard, MS. (Cr. [= Crâne] *b* du Cat. Ost. [= *Catalogue Ostéologique des Mammifères*, i.e., Jentink 1887])"). The skull is presently catalogued as RMNH.MAM.59688.a (Fig. 1A–D) while the mounted skin is catalogued as RMNH.MAM.59688.b (Fig. 1E) (also see Table 1).

Table 1. List of specimens originating from Diard with "Singapore" given as the source locality in RMNH. Source of information for donor and/or donation date from Naturalis Biodiversity Center, Leiden, the Netherlands (https://bioportal.naturalis.nl/).

Museum Registration Number	Taxon	Date‡	Identity of material is based on source of material of information§
RMNH.AVES.127062	Ave	1858	*Chloropsis cyanopogon* (Temminck, 1829); *Chloropsis cyanopogon* Oates
RMNH.AVES.147120	Ave	1858	*Malacopteron magnirostre* (Moore,1854); *Malacopteron magnirostre* (Moore)
RMNH.AVES.170553	Ave	1858	*Merula obscura*; *Turdus obscurus* Gmelin, J.F., 1879
RMNH.AVES.193050	Ave	1858	*Micrastur semitorquatus* (Vieillot); *Micrastur semitorquatus*
RMNH.AVES.196738	Ave	1858	*Eurystomus orientalis* (Linnaeus); *Eurystomus orientalis deignani*
RMNH.AVES.198076	Ave	1858	*Buceros Rhinoceros Rhinoceros* Linnaeus; *Buceros Rhinoceros Rhinoceros*
RMNH.AVES.199028	Ave	1858	*Eurostopodus temminckii* (Gould); *Eurostopodus temminckii*
RMNH.AVES.200215	Ave	1858	*Calorhamphus fuliginosus hayii* (J.E. Gray); *Calorhamphus fuliginosus hayii*
RMNH.AVES.200551	Ave	1858	*Harpactes diardii sumatranus* Blasius; *Harpactes diardii sumatranus*
RMNH.AVES.202561	Ave	1858	*Picus mentalis humii* (Hargitt);
RMNH.AVES.202562	Ave		*Picus mentalis humii*
RMNH.MAM.39155.a	Mammal	1859	*Presbytis femoralis* (Martin, 1838);
RMNH.MAM.39155.b			*Semnopithecus neglectus* Schlegel, 1876
RMNH.MAM.39156.a	Mammal	1869	
RMNH.MAM.39156.b			
RMNH.MAM.53009.a	Mammal	1858	*Ratufa bicolor* (Sparrman, 1778);
RMNH.MAM.53009.b			*Sciurus albiceps* Desmarest
RMNH.MAM.59688.a	Mammal	1819	*Felis viverrina*;
RMNH.MAM.59688.b			*Felis leucojalamus*; *Prionailurus viverrinus* (Bennett, 1833)

§Source: Naturalis – Zoology and Geology catalogues. Note that species identification follows original species description, specimen label and/or currently accepted name.
‡Date is based on collection label date or museum accession record year.

Over four decades later, Leo Daniel Brongersma (1907–1994), a Dutch zoologist and, from 1958, director of RMNH, re-examined the fossil and recent felid material from the Malay Archipelago in RMNH (Brongersma 1935). He referred *F. viverrina* to its currently accepted generic combination of *Prionailurus viverrinus* (Bennett, 1833) and gave the following remarks: "1 ex., 'Singapore', leg. Diard, cat. syst.: b, mounted, cat. ost.: b, skull" (i.e., specimen *b* of Jentink's catalogue, i.e., Jentink 1887) (Brongersma 1935: p. 13). Brongersma (1935: 13) further stated that "[o]ur Museum possesses a specimen labelled 'Singapore', but as the species has not been recorded from that island in recent times (it is not mentioned by Chasen (1924, 1925) this locality-record seems extremely doubtful to me". Brongersma (1935: 13) was referring to Chasen's preliminary account of mammals in Singapore that were published in two parts. In his conclusion, Chasen (1925: 87–88) made several remarks on species for which he considered "very doubtful records" which was followed by a list of species for which confirmation of local status was needed (while also taking the possibility of some species being imported into Singapore into account), and finally he provided a list of species of what he called "the true Singapore land fauna". The Fishing Cat (either as *Felis* or *Prionailurus viverrinus*) was not listed or discussed by Chasen (1924; 1925).

RMNH.MAM.59688 is the specimen *b* of Jentink and Brongersma

The following four sets of annotations accompany the specimen. The annotations are based on three labels found in the box labelled "cat. ost. b" (i.e., specimen *b* of the "Catalogue ostéologique des Mammifères", i.e., Jentink 1887; Fig. 1D) with a skull specimen in it and one label pasted on the pedestal of the mounted skin (Fig. 2A–D):

1. Handwritten label pasted on a piece of wood (Fig. 2A). The French text is presumed to be in Diard's handwriting because it bears a close resemblance to a letter written by Diard while he was in Singapore (see Tham et al. 2019: 163). While most of the text is easy to read, there are some parts which have become illegible. Also, we suggest that due to variation of spellings, the specific name on the label (the first line) could be interpreted in three different ways. We suggest the following transcription:

   Interpretation 1:
   Felis leucojalamus
   Diard

   Interpretation 2:
   Felis leucojalamis/ *Felis leucopalmis*
   Diard

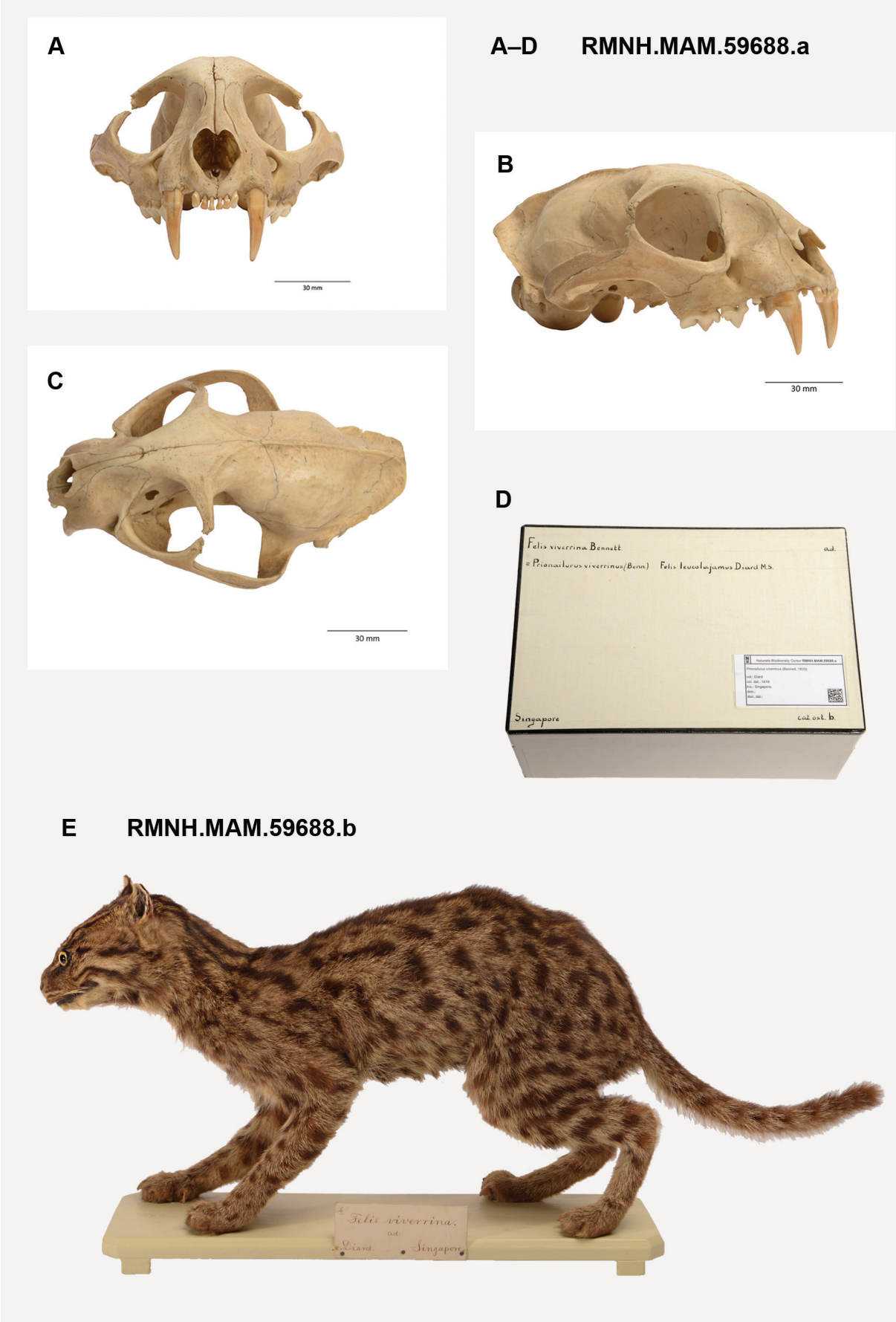

Figure 1. A specimen of *Prionailurus viverrinus* RMNH.MAM.59688, referred to as specimen *b* of *Felis viverrina* in Jentink's two *Catalogues* of 1887 and 1892. **A–C.** The skull from three different angles; **D.** A specimen box containing the skull; **E.** The mounted skin.

Interpretation 3:
Felis bengalensis
Diard

The third and fourth lines are:
[illegible] déterminé en 1819 à Singapour
elle la trouve aussi en Cochinchine et au Cambodge

The phrases "*Felis leucojalamus"*, "Diard", "1819" and "Singapore" appear in Jentink's and Brongersma catalogue. It is possible that Jentink may only have glanced at the label and thought that Diard had intended to propose a new name for a "espèce inédite" (translation: unpublished species) from Singapore. As seen from his catalogue entry, Jentink (1887) read "*Felis leucojalamus*", attributing the name to Diard (interpretation 1). However, after enhancing the image of the label to clarify the handwriting, it clearly shows that the last character of the epithet is an "i", thus it should read "*leucojalamis*" (interpretation 2). Nevertheless, the specific epithet "*leucojalamus*" is incomprehensible: "*leuco*" is derived from the Greek leukós, meaning "white, bright", the second part "*jalamus*" or "*jalamis*" is not found in either Latin or Greek. Furthermore, neither Jentink nor Brongersma mentioned the last line of the note (in translation): "it is also found in Cochinchina and Cambodia".

More details emerged from Natuurkundige Commissie Archives Online (NCO: https://dh.brill.com/nco) published by Gasso et al. (2020), which showcases specimens, drawings and illustrations as well as documents, such as field books, notes, shipping lists, and correspondence of members of *Natuurkundige Commissie voor Nederlandsch-Indië*. From NCO, we discovered a two-page document of shipment sent by Diard to Leiden in March 1830 (Fig. 3A, B). The document listed a specimen of "*Felis leucopalmis du détroit de Singapour*" (translated: "*Felis leucopalmis* from the Strait of Singapore"). We assumed that Schlegel interpreted the name based on Diard's label of the Singapore's specimen of Fishing Cat that was probably already hard to read at the time. In the same shipment as the Singapore's Fishing Cat were specimens from Borneo, Java, Cambodia, Malacca and Sumatra, including a *nomen nudum Felis strepsilura* from Java (now *Prionailurus planiceps*; interestingly another wild cat adapted to hunt aquatic prey, but not presently known from Java).

The third interpretation of the specific name is transcribed as "*bengalensis*" because Diard seemed consistent in writing certain characters such as "i" (with a striking dot) and "s" as in "is" which suggests that the second element after the word "*Felis*" should be read as "*bengalensis*" with a cursive "b" (Fig. 2A). Another possible explanation for "*bengalensis*" is perhaps the specimen was part of triplicates that were allowed to be retained by Diard and Duvacel following the separation with Raffles (as discussed above). *Felis bengalensis* in 1819 was still the only cat of similar description known in South and South-East Asia.

The illegible word or phrase before "déterminé" probably consists of five characters, which could read "Crâne" (translation: skull) or "jeune" (translation: young). The elements "Diard", "1819" and "Singapore" are repeated in Jentink's and Brongersma's catalogues.

In addition, there is an inscription in (possibly) Jentink's handwriting written on the wood: "b *Felis viverrina*,"

2. The second label is in possibly Jentink or Schlegel's handwriting showing catalogue number, species name, year, and locality (Fig. 2B). Note that locality name "Singapore" is spelt in English:

[b] *Felis viverrina*.
ad:
1819 Singapore

3. The third label is the most recent of all available labels written on RMNH's printed card ('sRijks Museum v. Nat. Hist. LEIDEN) by an unknown writer post-1900 which agrees with Brongersma's information on in Brongersma (1935: 13) (Fig. 2C):

Prionailurus viverrinus (Benn.) Cat. n°. b
Felis leucojalamus Diard MS. Sex: -
hoort bij opgezette ex.: b (translation: belongs to mounted specimen: b)
Dat: 1819 leg. Diard
Loc: Singapore

4. The fourth label pasted on the pedestal (Fig. 2D) could be one of the earliest preliminary identifications of this specimen, but the information is not captured in any of the catalogues. The label had the following information written in the style Temminck used, but it is not written by him (compared with the other three labels), with *F. viverrina* as a species name and a reference of author was attributed to "Hardw." (Hardwicke) followed by a publication name, "Ind : Zool:" (= "Illustrations of Indian Zoology", Gray 1832–1835), "Diard" as collector and "Singapoor":

Felis viverrina, Hardw.
Ind: Zool.
voy: Diard. Singapoor.

In addition, the pedestal bears the following inscriptions: "849" (written in ink), "314", and "KOP" (written in pencil, means head or skull) (see Fig. 2D, arrowed), but we were not able to determine the meaning of these numbers or letters.

The reference to "Hardw." is to Thomas Hardwicke (1756–1835) who figured the "Viverine Cat" (with the scientific name erroneously spelled as "*Felis vivirinus*") in the "Illustrations of Indian Zoology" (hereafter the "Illustrations", Gray 1832–1835) which is sometimes

Figure 2. Three labels found in the box labelled "cat. ost. b" (i.e., specimen *b* of the "*Catalogue ostéologique des Mammifères*", i.e., Jentink 1887) with a skull specimen in it (**A–C**) and a label pasted on the pedestal of the mounted skin (**D**).

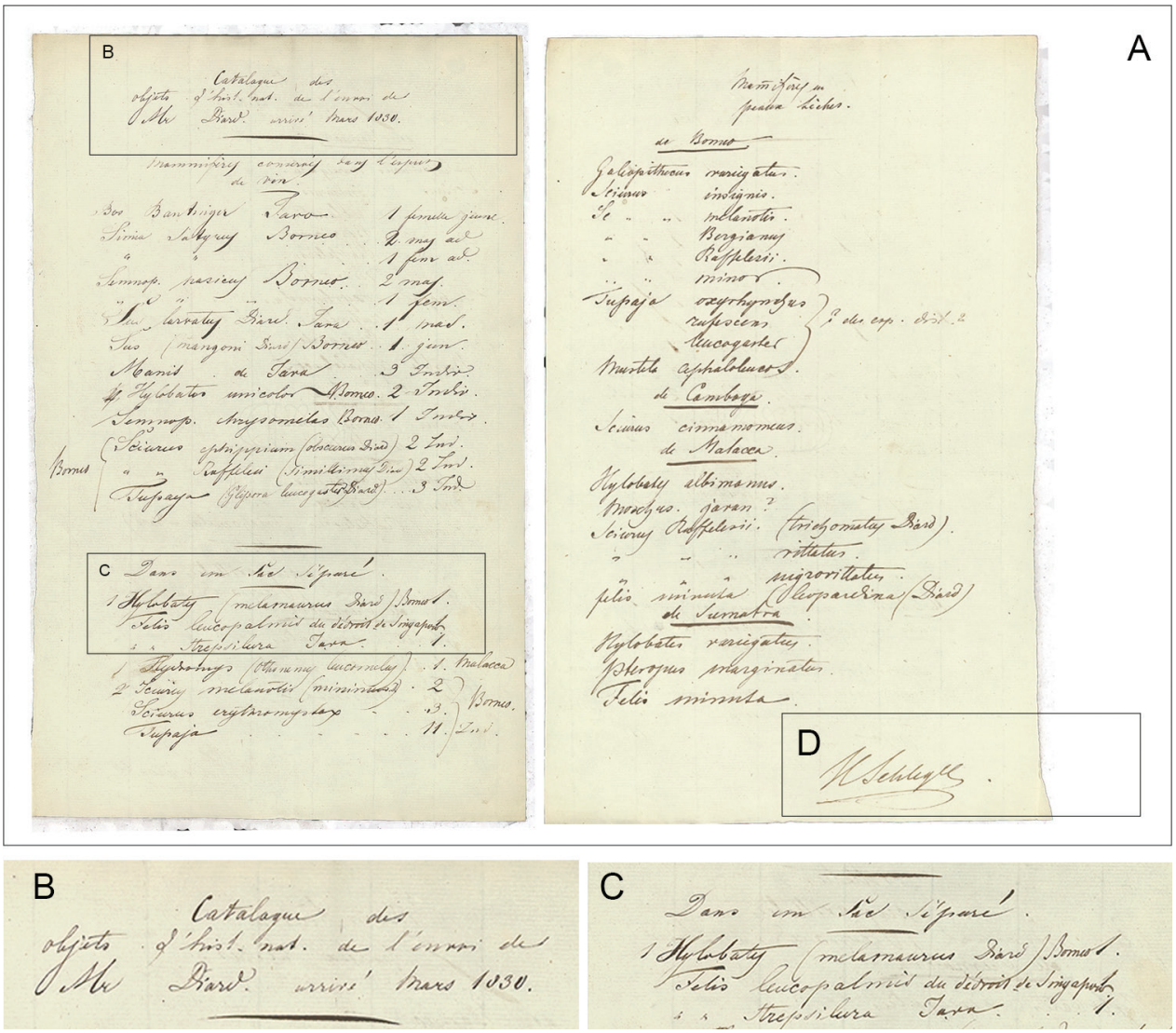

Figure 3. A two-page document listing records of specimens sent by Diard to Leiden in March 1830 (**A**) with the upper part of the first page (**B**), shows a title of the document "Catalogue des objets d'hist. nat. de l'envoi de Mr Diard arrivé mars 1830", while the bottom part of the page (**C**), shows "*Felis leucopalmis* du détroit de Singapour" (translated: *Felis leucopalmis* from the Strait of Singapore) was among the specimens sent by Diard; at the bottom part of the second page, the document was signed by H. Schlegel (**D**). Reproduced from Natuurkundige Commissie Archives Online (Gasso et al. 2020)

attributed to both Hardwicke and John Edward Gray (1800–1875) (see Dawson 1946; Wheeler 1998). The plate (Fig. 4) depicting the "Viverine Cat" is the fourth Mammalia plate in the second part of the "Illustrations" (Gray 1832–1834) which was published between 10 September and 1 October 1834 (Wheeler 1998: 347, 351).

Although some of the material depicted in the "Illustrations" was stated to have come from Singapore (Low and Pocklington 2019: 156–159), the "Viverine Cat" is not one of them. The reference to Hardwicke on the label was probably an 'update' to the identity of the specimen when it was later found to be conspecific with the species figured in the "Illustrations".

But was the specimen RMNH.MAM.59688 that of a Fishing Cat or a misidentified closely related but smaller Leopard Cat, *Prionailurus bengalensis* (Kerr, 1792) that is native to Singapore and Malacca?

RMNH.MAM.59688 is a Fishing Cat

We examined specimens of six Fishing Cats and nine Leopard Cats from the Malay Peninsula from the RMNH and the Zoological Reference Collection of Lee Kong Chian Natural History Museum, National University of Singapore, ZRC; see Suppl. material 1) and compared them with RMNH.MAM.59688 (the Diard specimen). Although no measurements of the live animal are associated with specimen RMNH.MAM.59688 or its labels, the skin and skull provide characters to identify the cat in question (Fig. 1).

We took the following measurements using callipers: i) greatest length of skull from premaxilla to occipital (GL), ii) condylobasal length from back of occipital condyle to premaxilla (CBL), iii) condylocanine length from back of occipital condyle to front of the canine (CCL),

Figure 4. The plate of "Viverine Cat" in the second volume of the "*Illustrations*" (Gray 1832–1834) which was published between 10 September and 1 October 1834. Reproduced from the Biodiversity Heritage Library (http://biodiversitylibrary.com/).

iv) maxillary toothrow length (MT), v) zygomatic width (ZW), vi) height of canine from base to tip (C1H), vii) greatest length of bullae (BL), and viii) greatest width of bullae (BW). One missing data field owing to a broken zygoma was filled with the mean for the species. A principal component analysis (PCA) was performed for the eight cranial measurements transformed to a log scale (Meijaard et al. 2017; Jackson et al. 2021). Statistical analyses were conducted in RStudio 1.1.463 (RStudio, Inc.) using the prcomp operation.

The greatest length of the skull RMNH.MAM.59688.a at 13.4 cm is within the range of Fishing Cat skulls (Pocock 1939), and far exceeds the mean length of Leopard Cat skulls (9.01 cm; range: 8.19–9.55 cm; n = 9) from the Malay Peninsula. The Diard specimen is likely a young adult as the skull's basilar suture has not fused. The PCA revealed that the Diard specimen grouped with Fishing Cats, which were distinctly separated from Leopard Cats from the Malay Peninsula (Fig. 5). In addition, the specimen grouped more closely with Javan Fishing Cat specimens rather than those of Indochina along the PC2 axis. Components 1 and 2 account for 98.6% of the total variance explained (see Suppl. material 1). In addition, the dark spots on the RMNH.MAM.59688 specimen are large and solid (Fig. 1E), which differs from the "shaded" spots of Leopard Cats on mainland Southeast Asia, which are always lighter anteriorly and darker posteriorly (Groves 1997). Further, the proportion of its tail, which is less than half the head and body length is much shorter than that of the mainland Leopard Cat (Pocock 1939; Groves 1997). These characters help determine that the specimen is *P. viverrinus* and not a misidentified Leopard Cat.

With the species identity certain, and given that the place and date of acquisition coincide with Diard being in Singapore during his visits to Singapore in 1819 (as discussed above), how then did a specimen collected by Diard end up in RMNH?

The Singapore collections and Diard's collecting post-1819

To date, apart from the Fishing Cat specimen, all the zoological specimens collected in 1819 that are still extant are currently thought to be in the collections of what is presently known as the Natural History Museum in London (NHMUK) (as discussed above). This material could have entered the collections of the NHMUK from two possible sources. Some material was sent back to the Honourable East India Company's (HEIC) museum in London and was later transferred to the NHMUK after the HEIC museum disbanded in 1858 (Ratcliff 2016). The other possible route was via the material sent back by Raffles that formed the basis of the museum of the Zoological Society of London (Wheeler 1997).

It is also known that Diard and Duvaucel sent material to the Muséum national d'Histoire naturelle in Paris

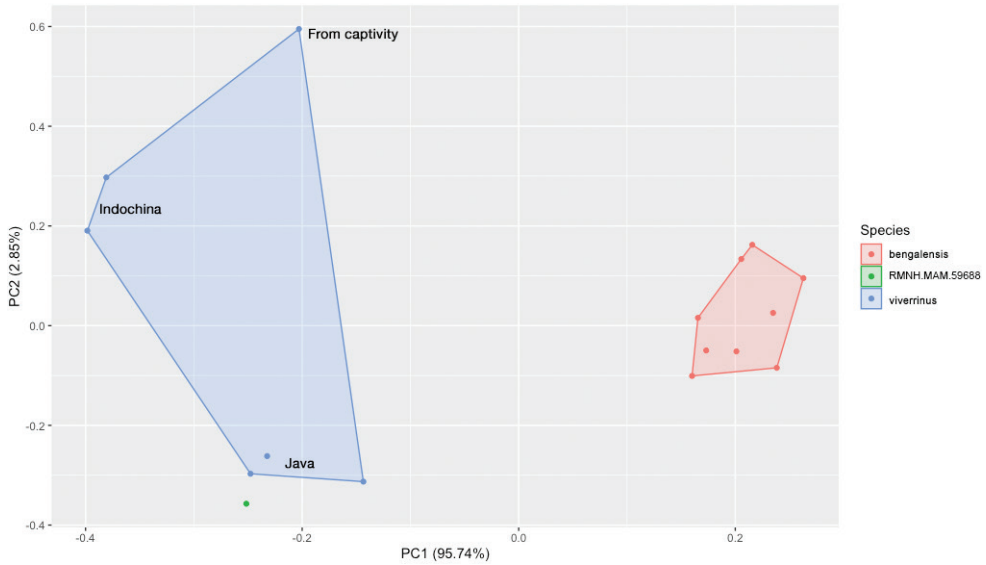

Figure 5. The PCA revealed that the Diard specimen (RMNH.MAM.59688) grouped with Fishing Cats, which were distinctly separated from Leopard Cats from the Malay Peninsula. The specimen grouped more closely with Javan Fishing Cat specimens rather than those of Indochina along the PC2 axis.

(MNHN) in 1820 (Weiler 2019). However, no material from Singapore dating from 1819 is known in the MNHN (Low et al. 2019).

Following the separation with Raffles, Diard and Duvaucel also parted ways and Diard travelled to several places in Southeast Asia (including what is today Vietnam) for 26 years before returning to Europe in 1843, and then once again returning to Southeast Asia in 1848 (Weiler 2019). At this time, Diard was also employed as a member of "Natuurkundige Commissie voor Nederlandsch-Indië" (Committee for Natural History of the Netherlands Indies, hereafter the Committee) (Weber 2019). The Committee's specimens arrived in Europe in 1830 and at that time RMNH regularly exchanged items from Asia with other natural history museums in Europe (Weber 2019).

From the RMNH's public database, BioPortal (https://bioportal.naturalis.nl, accessed on 13 September 2021) and accession records, over 800 specimens were collected or donated by Diard (while he was still alive and some posthumously) from various places ranging from as early as 1818 to as late as 1869, of which 20% are mammals. For the same period, the database contains 19 specimens (representing 13 species) from Singapore associated with Diard of which the 1819 Fishing Cat specimen appears to be the oldest. Other Diard specimens were acquired by the RMNH in 1858 (viz., eleven specimens of birds and a squirrel) either collected and/or donated by Diard himself for the Committee (Table 1). Three specimens of *Presbytis femoralis* (Martin, 1838) from Singapore (identified as *Semnopithecus neglectus* Schlegel, 1876) with Diard as collector were mentioned in Jentink's 1892 catalogue (Jentink 1892: 12–13). In the same catalogue, the two specimens of this species that Jentink referred to as specimens *a* and *c*, were dated in 1869 which suggests that they were donated posthumously while specimen *b* was accessioned in 1859 and could have been donated to RMNH by Diard (Table 1).

In around 1854, Diard was appointed as director of the botanical gardens at Buitenzorg (now Bogor) in the West Java province in which during his tenure, he continued collecting specimens at several places including Ceylon (now Sri Lanka) and sending his collections back to MNHN (Weiler 2019: 40). Diard died on 16 February 1863.

Conclusions

This study concludes that: (1) the Diard specimen is indeed a Fishing Cat, *Prionailurus viverrinus* (Bennett, 1833); (2) that the label was almost certainly written by Diard himself and that the Singapore locality was intended; (3) the 1819 date when it was obtained coincides with Diard's visits to Singapore. It is interesting to note that the handwritten label indicated that the *Felis leucojalamus/leucopalmis/bengalensis* can be found in two other places, Cochinchina (now the southern part of Vietnam) and Cambodia which were part of his later travel routes. Diard's trip to these two places commenced between 1821 and 1822 which means there was a gap of at least two years after the time spent in Singapore in 1819. The inclusion of Cochinchina and Cambodia on the label suggests that Diard wrote this label after he returned from those places but that the specimen had been obtained in Singapore in 1819. However, we are not able to conclusively determine if Diard collected the cat himself in Singapore or if he purchased a specimen that was transported to Singapore.

RMNH.MAM.59688 was accessioned at the RMNH in March 1830 as evidenced by a document signed by H. Schlegel (Fig. 3) which explains how this specimen

of Fishing Cat was brought to Europe from Singapore. However, further analysis will be required to determine how the 1819 specimen evaded Raffles's seizure of Diard's collections given the value of this animal, although it could be postulated that Diard might have hidden it or that it was part of triplicates of the Singapore first expedition. A study of Diard's correspondence with his brother and relevant papers in the archives of the MNHN or RMNH may help to answer these questions, but this is beyond the scope of our study. It should be noted that if RMNH.MAM.59688 was an imported specimen that Diard acquired in Singapore, it would point towards a trade in rare and large animals in Singapore and the region from as early as 1819. The morphological similarity of RMNH.MAM.59688 to Javan Fishing Cat skulls lends support to the possible Javan origin of the specimen through trade.

An unlikely alternative scenario would be that the specimen was part of a native Singapore population and that the distribution of the Fishing Cat was or is a lot more widespread than hitherto known or accepted. To date, however, there have been no confirmed reports of Fishing Cats in the Malay Peninsula while the possibility of their occurrence in Sumatra is considered speculative in light of insufficient evidence (Duckworth et al. 2019).

This reconstruction of the history of Diard's Fishing Cat specimen from Singapore in RMNH suggests that there may be more Singapore material collected in 1819 yet to be discovered. This is the third species (other than the Green Broadbill and the Banded Leaf Monkey) for which the material collected during the first Singapore expedition is still extant.

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References

Bastin J (2019) Sir Stamford Raffles and Some of His Friends and Contemporaries. World Scientific, Singapore, [x +] 477 pp. https://doi.org/10.1142/11196

Bennett ET (1833) Characters of a new species of cat (*Felis*, Linn.) from the continent of India, presented by J. M. Heath, Esq. Proceedings of the Zoological Society of London 1833: 68–69.

Blanford WT (1888–1891) The Fauna of British India, including Ceylon and Burma. Mammalia. Taylor and Francis, London, 617 pp. https://doi.org/10.5962/bhl.title.97003

Bree PJHv, Khan MKBM (1992) On a fishing cat, *Felis* (*Prionailurus*) *viverrina* Bennett, 1833, from continental Malaysia. Zeitschrift für Säugetierkunde 57: 179–180.

Brongersma LD (1935) Notes on some recent and fossil cats, chiefly from the Malay Archipelago. Zoologische Mededelingen 18: 1–89. [pls. 1–11]

Burkill IH (1916) William Jack's letters to Nathaniel Wallich, 1819–1821. Journal of the Straits Branch of the Royal Asiatic Society 73: 147–268.

Chasen FN (1924) A preliminary account of the mammals of Singapore Island. Singapore Naturalist 4: 76–86.

Chasen FN (1925) A preliminary account of the mammals of Singapore Island (concluded). Singapore Naturalist 5: 74–89.

Dawson WR (1946) On the history of Gray and Hardwicke's Illustrations of Indian Zoology, and some bibliographic notes on General Hardwicke, 55–69. https://doi.org/10.3366/jsbnh.1946.2.3.55

Duckworth JW, Shepherd CR, Semiadi G, Schauenberg P, Sanderson J, Roberton SI, O'Brien TG, Maddox T, Linkie M, Holden J, Brickle NW (2009) Does the fishing cat inhabit Sumatra? Cat News 51: 4–9.

Gassó E, Stork L, Weber A, Ameryan, M, Wolstencroft K (2020). Natuurkundige Commissie Archives Online. Brill, Leiden.

Gray JE (1832–1835) Illustrations of Indian Zoology; Chiefly Selected from the Collection of Major-General Hardwicke, F.R.S., L.S., M.R.A.S., M.R.I.A., &c., &c. Vol. II. Treuttel, Wurtz, Treuttel, Jun. and Richter, London / Parbury, Allen and Co., London, [2] pp. [102 pls]

Groves CP (1997) Leopard-cats, *Prionailurus bengalensis* (Carnivora: Felidae) from Indonesia and the Philippines, with the description of two new subspecies. Zeitschrift für Säugetierkunde 62: 330–338.

Holthuis LB (1995) 1820–1958: Rijksmuseum van Natuurlijke Historie. Nationaal Natuurhistorisch Museum, Leiden, 172 pp.

Horsfield T (1821–1824) Zoological Researches on Java, and the Neighbouring Islands. Kingsbury, Parbury, & Allen, London, [296] pp. [71 pls] https://doi.org/10.5962/bhl.title.44848

Jackson SM, Li Q, Wan T, Li X-Y, Yu F-H, Gao G, He L-K, Helgen KM, X-L Jiang (2021) Across the great divide: revision of the genus *Eupetaurus* (Sciuridae: Pteromyini), the woolly flying squirrels of the Himalayan region, with the description of two new species. Zoological Journal of the Linnean Society: zlab018. https://doi.org/10.1093/zoolinnean/zlab018

Jentink FA (1887) Catalogue ostéologique des mammifères. Muséum d'histoire Naturelle des Pays-bas 9: 1–360.

Jentink FA (1892) Catalogue systématique des mammifères (singes, carnivores, ruminants, pachydermes, sirenes et cetaces). Muséum d'histoire Naturelle des Pays-bas 11: 1–219.

Low MEY, Lim KKP (2015) The authorship and type locality of the banded leaf monkey, *Presbytis femoralis*. Nature in Singapore 8: 69–71.

Low MEY (2019) Defining the natural world. In: Murphy SA, Wang N, Green A (Eds) Raffles in Southeast Asia. Revisiting the Scholar and Statesman. Asian Civilisations Museum, Singapore, 256–265.

Low MEY (2021 in press) Raffles and his naturalist friends: social networks of early natural history collecting and studies in Singapore. In: Murphy SA (Ed.) Raffles Revisited: Essays on Collecting and Colonialism in Java, Singapore and Sumatra. Asian Civilisations Museum, Singapore.

Low MEY, Lim KKP, Ng PKL (2021) The first Singapore Biodiversity Expedition: the legacy of Pierre-Médard Diard and Alfred Duvaucel. In: Dorai F, Low M (Eds) Diard and Duvaucel: The French Natural History Drawings of Singapore Southeast Asia. Embassy of France in Singapore and National Library Board, Singapore, Singapore, 36–51.

Low MEY, Pocklington K (2019) 200: Points in Singapore's Natural History. With an Exordium by Peter K. L. Ng. Lee Kong Chian Natural History Museum, Singapore, [xiii +] 607 pp.

Low MEY, Pocklington K, Jusoh WFA [Eds] (2019) Voyageurs, Explorateurs et Scientifiques: The French and Natural History in Singapore. Lee Kong Chian Natural History Museum, Singapore, [xiv +] 398 pp.

Meijaard E, Chua MAH, Duckworth JW (2017) Is the northern chevrotain, *Tragulus williamsoni* Kloss, 1916, a synonym or one of the least-documented mammal species in Asia? Raffles Bulletin of Zoology 65: 506–514.

Mukherjee S, Appel A, Duckworth JW, Sanderson J, Dahal S, Willcox DHA, Herranz Muñoz V, Malla G, Ratnayaka A, Kantimahanti M, Thudugala A, Thaung R, Rahman H (2016) *Prionailurus viverrinus*. The IUCN Red List of Threatened Species 2016: e.T18150A50662615.

Napier PH (1985) Catalogue of Primates in the British Museum (Natural History) and elsewhere in the British Isles – Part Ill: Family Cercopithecidae, Subfamily Colobinae. British Museum (Natural History), London, [xi +] 111 pp.

Noltie HJ (2009) Raffles' Ark Redrawn: Natural History Drawings from the Collection of Sir Thomas Stamford Raffles. British Library, London, 181 pp.

Pilon M, Weiler D (2011) The French in Singapore: An Illustrated History (1819–today). Editions Didier Millet Pte Ltd, Singapore, 239 pp.

Pocock RI (1939) The Fauna of British India, including Ceylon and Burma. Mammalia.—Vol. I. Primates and Carnivora (in part), Families Felidae and Viverridae. Taylor and Francis, London, [xxxiii +] 566 pp. [map]

Raffles S (1830) Memoir of the Life and Public Services of Sir Thomas Stamford Raffles, Particularly in the Government of Java, 1811–1816, and of Bencoolen and Its Dependencies, 1817–1824. With Details of the Commerce and Resources of the Eastern Archipelago and Selections from His Correspondence. John Murray, London, [xvi +] 724 + 100 pp. [frontispiece]

Raffles TS (1821) Descriptive catalogue of a zoological collection, made on account of the Honourable East India Company, in the island of Sumatra and its vicinity, under the direction of Sir Thomas Stamford Raffles, Lieutenant-Governor of Fort Marlborough; with additional notices illustrative of the natural history of those countries. Transactions of the Linnean Society of London 13: 239–274. https://doi.org/10.1111/j.1095-8339.1821.tb00064.x

Raffles TS (1822) Second part of the descriptive catalogue of a zoological collection made in the island of Sumatra and its vicinity. Transactions of the Linnean Society of London 13: 277–340. https://doi.org/10.1111/j.1095-8339.1821.tb00065.x

Ratcliff J (2016) The East India Company, the company's museum, and the political economy of natural history in the early nineteenth century. Isis 107: 495–517. https://doi.org/10.1086/688433

Tham D, Mydin I, Lim S, Yeo S (2019) An Old New World: From the East Indies to the Founding of Singapore, 1600s–1819. National Museum of Singapore, Singapore, 224 pp.

Weber A (2019) Collecting colonial nature: European naturalists and the Netherlands Indies in the early nineteenth century. BMGN: The Low Countries Historical Review 134: 72–95. https://doi.org/10.18352/bmgn-lchr.10741

Weiler D (2019) Pierre Médard Diard and Alfred Duvaucel: Two French naturalists in the service of Sir Stamford Raffles (December 7, 1818–March 27, 1820). In: Low MEY, Pocklington K, Jusoh WFA (Eds) Voyageurs, explorateurs et scientifiques: The French and natural history in Singapore. Lee Kong Chian Natural History Museum, Singapore, 4–45.

Wells DR (2013) Raffles in MacRitchie Forest? An overlooked collecting 'first' for Singapore, with consequences for avian nomenclature. Raffles Bulletin of Zoology supp. 13: 237–241.

Wells DR, Dickinson EC (2010) Authorship of the broadbill genus name *Calyptomena* and the correct citations for this and *Calyptomena viridis* Raffles. Bulletin of the British Ornithologists' Club 130: 143–145.

Wheeler A (1997) Zoological collections in the early British Museum: the Zoological Society's Museum. Archives of Natural History 24: 89–126. https://doi.org/10.3366/anh.1997.24.1.89

Wheeler A (1998) Dates of publication of J.E. Gray's "Illustrations of Indian Zoology" (1830–1835). Archives of Natural History 25: 345–354. https://doi.org/10.3366/anh.1998.25.3.345

Wilson JJ (2021) Birds from Sumatra given by Sir Stamford Raffles to Lord Stanley: links to names, types and drawings. Bulletin of the British Ornithologists' Club 141: 39–49. https://doi.org/10.25226/bboc.v141i1.2021.a4

Supplementary material 1

Raw skull measurements and PCA loading matrix

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Data type: Raw skull measurements and PCA loading matrix (EXCEL file)

Explanation note: This supplementary file contains data on raw skull measurements and PCA loading matrix.

Link: https://doi.org/10.3897/zse.98.76940.suppl1