

## Geographical Variation in the Clouded Leopard, *Neofelis nebulosa*, Reveals Two Species

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### Supplemental Discussion

#### Taxonomic History of the Clouded Leopard

Although the clouded leopard was first brought to the attention of western zoologists by Raffles [S1], who used its local name of “Rimau-Dahan,” from Sumatra, it was first described formally by Griffith [S2] as *Felis nebulosa* based on a captive specimen, which was probably from Canton, South China and which was living in the Exeter Change (a building that housed a menagerie and existed between 1676–1829 in London). Circa

1825, the artist Jacques-Laurent Agasse depicted two clouded leopards from Sumatra in the Exeter Change, and these leopards looked morphologically quite different to Griffith’s Chinese specimen [S3].

Georges Cuvier [S4] described a further species, *Felis diardi*, based on a specimen collected by Diard and Duvaucel from Sumatra, from where Raffles’ specimens originated, but Cuvier believed incorrectly that this species had come from Java, where it has not been recorded since the Neolithic [S5]. No diagnosis was provided for this new taxon.

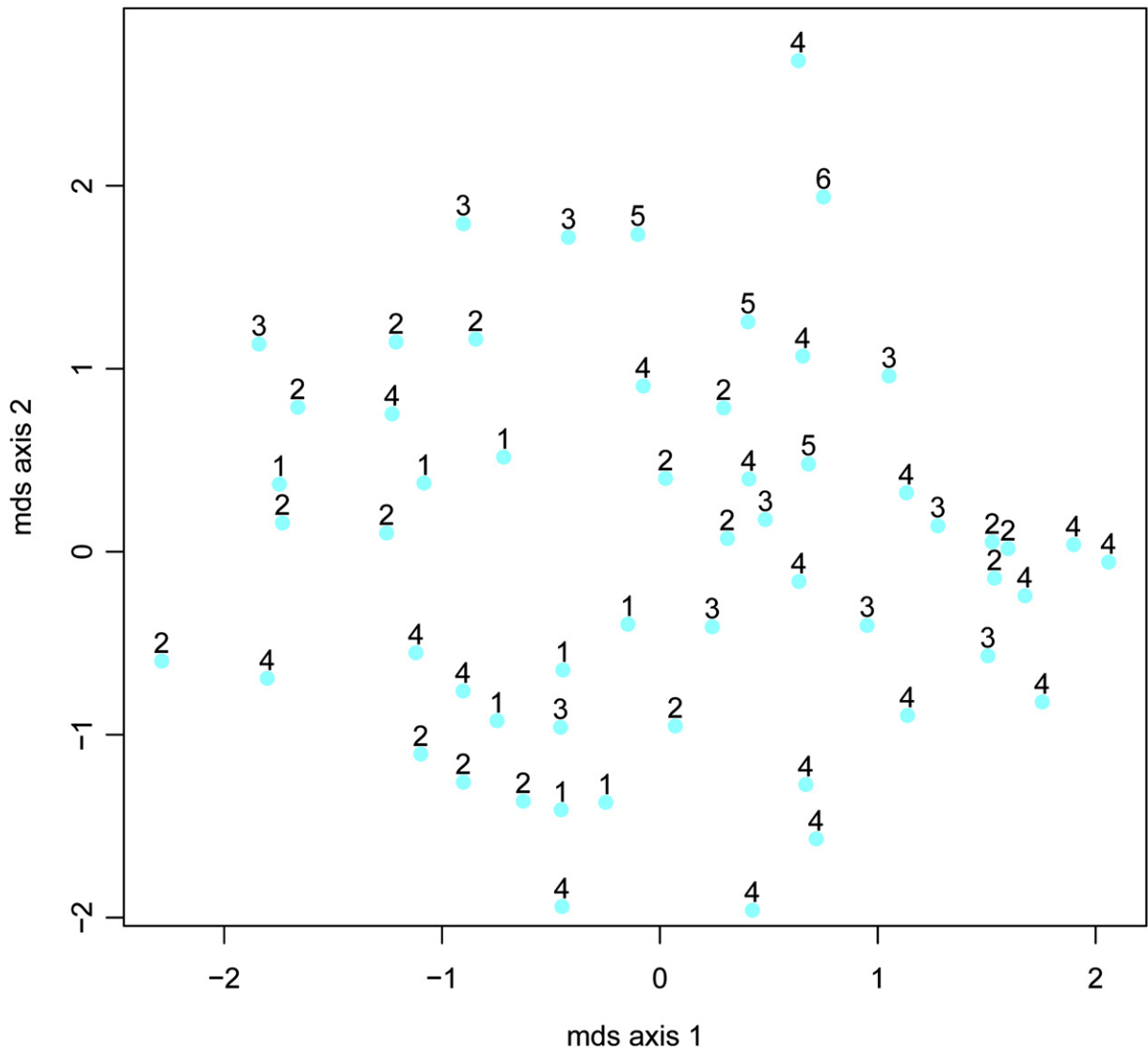


Figure S1. Multidimensional Scaling of Nine Pelage Characters, excluding Cloud Size, CSI, from 57 Clouded Leopards  
 The numbers refer to the populations: 1 = Borneo; 2 = represents Sumatra; 3 = India and Nepal; 4 = China and southeast Asia; 5 = Taiwan; 6 = Palawan.

Table S1. Kendall's Measure of Association,  $\tau$ , for Each Pair of Pelage Characters from the Adjusted Data Matrix

CSP	LGT	BRI	DST	NST	SHP	YEL	TAW	GRY	
<u>-0.37*</u>	<i>0.12</i>	<i>0.14</i>	<u>-0.36*</u>	-0.19	-0.12	<i>0.02</i>	<u>0.53*</u>	<u>-0.5*</u>	CSI
	-0.21	-0.10	<i>0.03</i>	<i>0.10</i>	0.20	<i>0.06</i>	-0.09	<i>0.06</i>	CSP
		<u>0.57*</u>	<i>0.11</i>	-0.18	<i>0.01</i>	<i>0.19</i>	-0.20	<i>0.00</i>	LGT
			<i>0.04</i>	-0.19	<i>0.01</i>	<u>0.36*</u>	<i>0.14</i>	-0.24*	BRI
				-0.13	<i>0.14</i>	-0.1	-0.26*	<u>0.36*</u>	DST
					-0.15	<i>0.15</i>	<i>0.05</i>	<i>0.01</i>	NST
						<i>0.07</i>	-0.04	<i>0.03</i>	SHP
							<i>0.15</i>	-0.23	YEL
								<u>-0.66*</u>	TAW

Neck striping and shoulder patterning seemed to be only weakly associated with any characters. The ten associations that are significant at the 0.01 level or greater can be summarized as follows: Grey pelages tend not to be tawny and not bright. Tawny pelages tend not to be bright. Bright pelages tend to be yellow and light. Grey pelages tend to have a double dorsal stripe, and they tend to have small clouds. Pelages with double dorsal stripes tend to have small clouds. Tawny pelages tend to have large clouds. Pelages with large clouds tend to have few cloud spots. Negative values indicate negative association. Italic values are nonsignificant at the 0.05 level. Values with an asterisk are significant at the 0.01 level. Underlined values with an asterisk are significant at the 0.001 level. The significance levels are uncorrected for multiple comparisons.

Temminck [S6] described *Felis macrocelis* from Bencoolen West Sumatra, presumably in the belief that Cuvier's *F. diardi* did actually originate in Java. However, *F. macrocelis* is a junior synonym of *F. diardi* (i.e., the earlier name takes precedence).

Hodgson [S7] described a further species, *Felis macrosceloides*, based on a specimen from Nepal, although it was incorrectly spelled as *macroselloides* in the text. However, no description or diagnosis was provided beyond the scientific name. Swinhoe [S8] described yet another species, *Leopardus brachyurus*, based on a specimen from Formosa (Taiwan). This species was characterized by its relatively much shorter tail. Finally, Matschie [S9] described *Felis (Neofelis) melli*, which is clearly a junior synonym of *Felis nebulosa* [S2], probably from near Canton, South China.

The main regional species have subsequently been regarded as subspecies of *Felis nebulosa*, albeit within the distinct genus *Neofelis* [S10] (Table 1).

### Specimens Examined in This Study

AMNH—American Museum of Natural History

BMNH—Natural History Museum, London

FMNH—Field Museum of Natural History

RMNH—National Museum of Natural History, Leiden

SMI—National Museum of Natural History, Smithsonian Institution

ZMB—Humboldt Museum, Berlin

China: AMNH 43104; AMNH 28246; BMNH 1939.1657; BMNH 1939.1658; FMNH 42095; ZMB 56135; ZMB 56136; SMI 239907.

Bhutan, India, Nepal, Sikkim: AMNH 186958; BMNH 1845.1.8.211 (holotype of *Felis macrosceloides*) BMNH 1943.65; BMNH 1891.10.7.9; BMNH 1930.3.3.8; BMNH 1947.685; BMNH 1858.6.24.49; FMNH 75831; ZMB 91058; RMNH e.

Burma, Malaya, Thailand, Vietnam: BMNH 1933.4.1.212; BMNH 1955.1644; BMNH 1897.9.25.1; BMNH 1931.11.17.1; BMNH 1931.11.17.2; BMNH 1950.504; BMNH 1950.505; BMNH 1908.7.20.76; FMNH 33580; ZMB 81359; ZMB 84335.

Taiwan: BMNH 1862.12.24.25 (holotype *Leopardus brachyurus*); BMNH 1870.2.10.4; BMNH 1893.12.5.1. Palawan: BMNH 1898.3.11.3

Sumatra: BMNH 1857.12.22.1 (Raffles); BMNH 1939.1656; BMNH 1938.11.30.22; BMNH 1938.11.30.23; RMNH 3517; RMNH 3518; RMNH 1772; RMNH 1780; RMNH 1349; RMNH 1784; RMNH 1981; RMNH b; private collection male and female.

Batu Islands: RMNH c; RMNH d.

Borneo: BMNH 1903.4.9.2; BMNH 1940.374; ZMB 56134; ZMB 1212; RMNH 38148; RMNH a; SMI 196600; SMI 198705.

Table S2. The Degree of Association, Measured by Kendall's  $\tau$ , between Each of the Characters and the Score on the First and Second Axis from Nonmetric Multidimensional Scaling

Characters	First Axis	Second Axis
Cloud size	0.70	0.16
Cloud spots	-0.56	0.14
Lightness	0.28	-0.64
Brightness	0.29	-0.53
Dorsal stripe	-0.29	-0.36
Neck stripes	-0.16	0.25
Shoulder pattern	-0.24	-0.26
Yellow	0.07	-0.22
Tawny	0.37	0.30
Grey	-0.42	-0.17

Table S3. The Coefficients of the First Two Linear Discriminants Based on the Pelage Data, excluding Cloud Size

Characters	First Axis	Second Axis
Cloud spots	0.66	0.21
Lightness	-0.86	0.37
Brightness	0.69	0.60
Dorsal stripe	0.61	0.61
Neck stripes	1.07	0.73
Shoulder pattern	-0.07	0.57
Yellow	0.00	-1.91
Tawny	-1.92	-1.13
Grey	0.56	-2.19
	(0.62)	(0.21)

The numbers in parentheses at the bottom of the table are the proportion of the between-group variance explained by each axis.

### Supplemental References

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- S10. Gray, J.E. (1867). Notes on the skulls of the cats (Felidae). Proceedings of the Zoological Society of London 258–277.