

## A reassessment of the distribution and taxonomy of the Endangered otter civet *Cynogale bennettii* (Carnivora: Viverridae) of South-east Asia

Géraldine Veron, Philippe Gaubert, Neil Franklin, Andrew P. Jennings and Lon I. Grassman Jr

**Abstract** The otter civet *Cynogale bennettii* is a specialized, semi-aquatic viverrid found throughout the forests of South-east Asia. Although described over 160 years ago, little is known of the species' natural history, and questions remain regarding its taxonomy and distribution. We compiled an exhaustive list of museum specimens and observations to reassess the conservation status, taxonomy and distribution of this species. Data were collected from museums, literature, field surveys, and from other field scientists. Although two species of otter civet have been described, *C. bennettii* and *C. lowei*, our morphological examinations do not support specific differentiation. The presence of the otter civet was confirmed for peninsular Thailand, Malaysia and the islands of Sumatra and Borneo. However, more

northerly distributions were not confirmed, including the supposed origin of *C. lowei* from northern Vietnam. Based on the scarcity of recent observations or carcasses, otter civet populations are probably in decline. Recent increases in the number of wildlife surveys throughout the putative range of the otter civet have rarely documented the species. The reduction in primary forest habitat has probably reduced otter civet populations and threatens the persistence of this unique species.

**Keywords** Conservation, *Cynogale bennettii*, distribution, otter civet, South-east Asia, taxonomy, Viverridae.

This paper contains supplementary material that can only be found online at <http://journals.cambridge.org>

### Introduction

The otter civet *Cynogale bennettii* is a specialized semi-aquatic viverrid (Carnivora, Viverridae) of the subfamily Hemigalinae. The species is adapted to aquatic life, with webbed feet, and nostrils and ears that can be closed by flaps. It is also characterized by a muzzle bearing long, white and stiff vibrissae. Little is known of otter civet biology. However, it is usually found near streams and swampy areas, is primarily nocturnal, and is known to forage in the water (Medway, 1978; Lekagul & McNeely, 1988; Yasuma, 1994). The otter civet is known to occur in South-east Asia, but its northern limit is unknown. Two species have been described, *C. bennettii* Gray, 1837 and

*C. lowei* Pocock, 1933, but the latter is included as a subspecies of *C. bennettii* by several authors (Ellerman & Morrison-Scott, 1951; Wozencraft, 1993), whereas others consider it a distinct species (Corbet & Hill, 1992).

Museum specimens of *C. bennettii* are estimated to number 40 from Borneo, 12 from Sumatra, and eight from Peninsular Malaysia (Schreiber *et al.*, 1989). The specimen described by Blainville (1837) was suspected to be from Java, but the specific locality is unknown. The species *C. lowei* is known only from one specimen, acquired in north Vietnam. In Yunnan and Thailand there are no confirmed records (Schreiber *et al.*, 1989) but according to Lekagul & McNeely (1988) the otter civet occurs in Thailand in forested areas south of the Isthmus of Kra.

A description of the otter civet by Gray (1837a) was read at the Zoological Society of London on 11 October 1836 (publication date 20 February 1837). The type specimen was said to be part of the collection of Stamford Raffles and to have been collected in Sumatra (Type BMNH 1907.01.01.192). Subsequent publications by Gray (1864, 1869) mentioned the locality as Borneo and the collector as Honeywood. This refers to specimen BMNH 173a, which is not mentioned in the first publication of this species (Gray, 1837a). The description by Blainville (1837) of *Viverra (Lamictis) carcharias* dates from the later half of 1837, thus it is a junior synonym of *C. bennettii*. Blainville (1837) stated that *V. carcharias* was similar to

Géraldine Veron (Corresponding author), Philippe Gaubert and Andrew P. Jennings Muséum National d'Histoire Naturelle, Département Systématique et Évolution, USM 601-UMR CNRS 5202 Origine, Structure et Évolution de la Biodiversité, CP 51, 57 rue Cuvier, 75231 Paris Cedex 05, France. E-mail [veron@mnhn.fr](mailto:veron@mnhn.fr)

Neil Franklin The Tiger Foundation & Sumatran Tiger Trust – Indonesia Program and Sumatran Tiger Conservation Programme, c/o Prima Lingkar Asri B2/12, Jatibening, Indonesia 17412.

Lon Grassman Jr Feline Research Program, Caesar Kleberg Wildlife Research Institute, MSC 218, 700 University Blvd., Texas A&M University-Kingsville, Kingsville, 78363, Texas, USA.

Received 25 June 2004. Revision requested 9 November 2004. Accepted 7 March 2005. First published online 19 January 2006.

the *Cynogale* of Gray, but differed based on a more detailed description by Gray (1837b) in the shape of the upper carnassial teeth. Another synonym of *C. bennettii* is *Potamophilus barbatus* Müller, 1838, based on a specimen from Borneo.

The otter civet is listed in appendix II of CITES (CITES, 2005) and categorized as Endangered on the IUCN Red List (IUCN, 2004). Its current status is, however, difficult to assess because of a scarcity of sighting records. The aim of this paper is to update the list of otter civet museum specimens and observations, and to reassess the distribution and conservation status of this poorly-known carnivore.

## Methods

Data from museums were collected from seven European museums by GV and PG. For US, Asian and Australian museums, the curators provided information. Data were also gathered from the literature. Specimens from the Muséum National d'Histoire Naturelle, Paris (MNHN) and British Museum (Natural History), London (BMNH) were specifically studied by GV to re-evaluate the systematic status of *C. lowei*. Field surveys have been undertaken within the putative range of the otter civet in Thailand since 1995 (LG) and in Krau Wildlife Reserve, Pahang, Peninsular Malaysia in 2001 (GV), 2004 (AJ, GV and PG) and 2005 (AJ and GV), and we also acquired further data from other field scientists. Camera trapping studies in Sumatra, Indonesia (Way Kambas National Park and Riau Province peat swamp forests) were carried out during 1996–2005 under the Sumatran Tiger Conservation Programme (NF). Additionally, we collected information on captive specimens from the literature, ISIS (2005), and zoo keepers.

## Results

We examined the type specimen of *C. lowei* Pocock, 1933 (BMNH 27.12.1.93), a skin with no skull or skeleton. Our observations are congruent with the description by Pocock (1933). It is characterized by its small size, white hairs along the sides of the fore part of the body and no speckling in the coat. Its locality was listed as 'Backan, Tonkin (500 ft.)' in North Vietnam, but it was acquired from 'natives' by Delacour and Lowe in 1927. We documented 84 museum records of otter civets from Brunei, Indonesia, Malaysia and Singapore (Appendix). However, six were endocranial casts of other specimens, and three were mentioned in the literature but not found in the collections. Thus, we estimate that there are 75 museum specimens. It is possible that there are additional specimens in Asian and Australian museums or other institutions.

This investigation of collections also allowed us to rediscover one of the oldest otter civet specimens, the type specimen of *Viverra (Lamictis) carcharias* (MNHN A-3484), a junior synonym of *C. bennettii* described by Blainville in 1837. It was collected by Diard in Java or in 'the other parts of India [= Asia]' (Blainville, 1837) in 1826, and preserved in alcohol in the MNHN collections. The skeleton was prepared and mounted in 1837. The only older specimen is the type of *Cynogale bennettii* Gray, 1837, which was said to be part of the collection of Stamford Raffles and was thus probably collected in Sumatra (Type BMNH 1907.01.01.192). If acquired by Raffles, it was collected before 1826, the date of his death. There is no date of arrival of this specimen in the British collections. It was described by Gray (1837a) when held by the Zoological Society of London Museum, later acquired by R.F. Tomes, and then finally acquired by the BMNH in 1907 (P. Jenkins & D. Hills, pers. comm.).

There have been 19 otter civet sightings in Indonesia, Malaysia and Thailand, including six unpublished records and one photograph (Table 1, Fig. 1). Fifty-nine camera trapped pictures of otter civets were obtained in lowland forests of Way Kambas National Park, Sumatra (January 1996–December 1998; 3,920 camera trap days) and more recently one in peat swamp forests of northern Riau province, Sumatra (February 2005). Four were photographs of two individuals together (one was mother and young), two photographs of three individuals together (one was mother and two young). All other photographs were of single individuals (Plate 1). One shows a civet climbing a tree. Photographs were obtained at all times of day and were all in close proximity to water. In other parts of the range we were unable to obtain camera trap photographs. We did not camera trap or observe the otter civet during our field work in Thailand or Peninsular Malaysia. However, because otter civet habitat requirements are not clearly understood, much of the camera trapping in these studies could have occurred outside its habitat range.

The collection locations of Museum specimens and observation localities are given in Fig. 1. Information on formerly captive otter civets is summarized in Table 2. There are currently no known captive specimens, nor has captive breeding been reported.

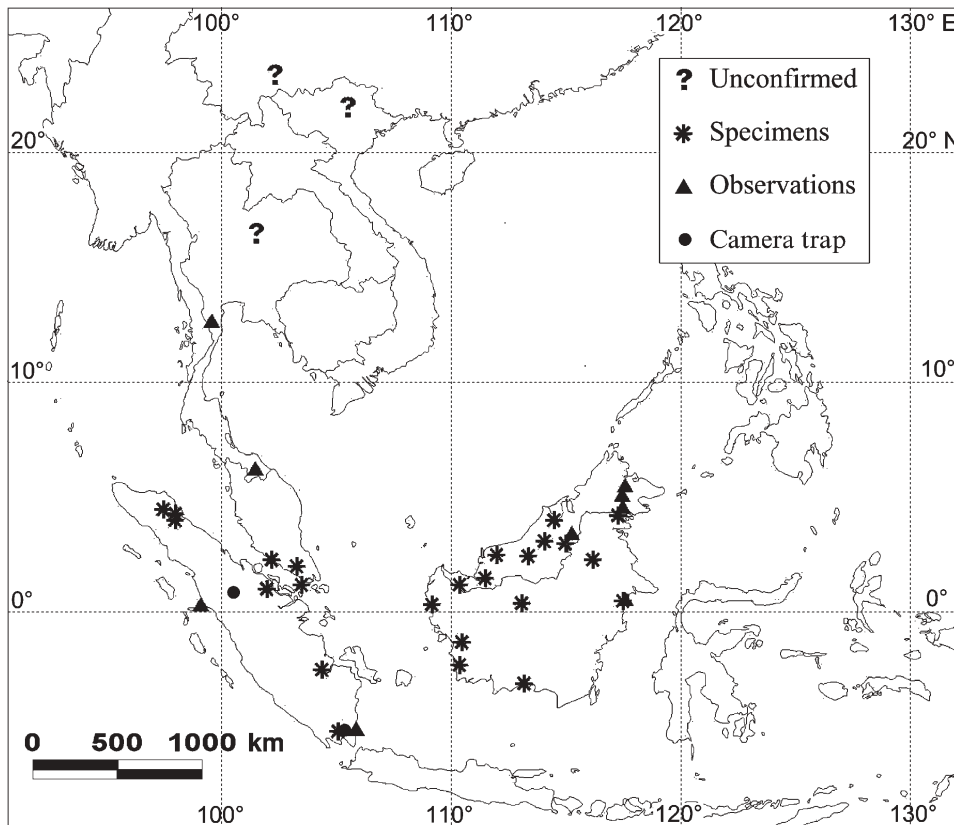
## Discussion

### Systematic status of *C. lowei*

According to Pocock (1933) *C. lowei* can be distinguished from *C. bennettii* by its smaller size, by the extension of white hairs along the sides of the muzzle, cheek, neck and throat, and by the absence of silvery speckling in the pelage. The skin of the type specimen was that of an immature civet, and thus its small size should not be

**Table 1** Summary of the known field observations of otter civets, by country, with localities, coordinates and dates where known, any additional relevant observations, and the observer, where known, and/or reference as appropriate.

Country	Locality	Coordinates	Date	Observation	Observer	Reference
Malaysia	Unknown		c. 1966	Sighting & photographs 'in the jungle' & 'in a bamboo near a stream'	F.C. Allen	Allen (1966)
Malaysia	Borneo, Sarawak (above Bario, 1,370 m)	3.45°N, 115.27°E	1970s		T. Harrison	Medway (1977)
Malaysia	Borneo, Sarawak (Bukit Sarang, S of Bintulu)	2.39°N, 113.03°E	25 April 2005	Sighting, at c. 6 m distance, for c. 20 seconds at 20.15	Bjorn Lardner	B. Lardner (pers. comm.)
Malaysia	Peninsular Malaysia	5.52°N, 117.58°E	1986	One killed	Mohd Khan	Schreiber <i>et al.</i> (1989)
Malaysia	Borneo (Sepilok Forest Reserve)	5.52°N, 117.58°E	Before 1986	One observed		Payne, cited by Schreiber <i>et al.</i> (1989)
Malaysia	Borneo, Sabah	4.58°N, 117.48°E	c. 1988?	Solitary individual observed along a stream close to the Bole River	A.D. Grieser Johns	Chen (1988)
Malaysia	Borneo, Sabah (Ulu Segama Forest Reserve)	4.58°N, 117.48°E	1988			Heydon & Ghaffar (1997)
Malaysia	Borneo, Sabah (Ulu Segama Forest Reserve)	4.58°N, 117.48°E	1992	At 21.00, individual observed foraging along a vehicle track, in primary riverine forest, near Danum River	N. Ghaffar, P. Hurrel	Heydon & Ghaffar (1997)
Malaysia	Borneo, Sabah (Ulu Segama Forest Reserve)	4.58°N, 117.48°E	1992	Tracks along primary forest stream	A. Hamid Ahmad	Heydon & Ghaffar (1997)
Malaysia	Borneo, Sabah (Ulu Segama Forest Reserve)	4.58°N, 117.48°E	1993	At 20.20, individual seen crossing a logging road in an area of forest logged in 1988	M.J. Heydon, N. Ghaffar	Heydon & Ghaffar (1997)
Malaysia	Borneo, Sabah (Danum Valley)	5.10°N, 117.46°E	2001	At 07.45, individual observed in a stream gully	Tan Cheng Yam, Miri Branch, John Parr	J. Parr (pers. comm.)
Indonesia	Sumatra			Record in logged forest		Bristow (1997, in Heydon & Ghaffar, 1997)
Indonesia	Sumatra (Aceh Selatan, Suaq Balimbing)	0.34°N, 99.10°E	c. 1995	One seen in swamp forest	C. Van Schaik	I. Singleton (pers. comm.)
Indonesia	Borneo, East Kalimantan (Peleben, near Sangkulirang)	0.59°N, 117.58°E	before 1994			Yasuma (1994)
Indonesia	Borneo, East Kalimantan (Bukit Soeharto)	0.59°N, 117.58°E	before 1994			Yasuma (1994)
Indonesia	Sumatra (Way Kambas National Park, Lampung Province)	4.96°S, 105.75°E	1996–1998	59 remote camera photographs at several sites in secondary & primary lowland forest, all times of day	Sumatran Tiger Conservation Programme	Franklin (2001)
Indonesia	Sumatra (Way Kambas National Park, Lampung Province)	5.01°S, 105.78°E	1997	At 18.00, direct observation of individual in lowland forest pool	Sumatran Tiger Conservation Programme	N. Franklin (pers. obs.)
Indonesia	Sumatra (Senepis Tiger Conservation Area, Dumai, Riau Province)	2.11°N, 101.18°E	2005	At 03.20, remote camera photo of single individual in peat swamp forest	Sumatran Tiger Conservation Programme	N. Franklin (pers. obs.)
Thailand	Phu Kraung National Park	16.52°N, 101.52°E	1986	One seen by warden in the park		Nabhitabhata, cited by Schreiber <i>et al.</i> (1989)
Thailand	Phru Toa Daeng Peat swamp Forest (Narathiwat Province)	6.25°N, 101.52°E		One seen in swamp forest	Budsabong Kanchanasaka	B. Kanchanasaka (pers. comm.)
Thailand	Kaeng Krachan National Park (Phetchaburi Province)	12.7°N, 99.5°E	1998	Two observed	Shanna Sheridan-Johnson	



**Fig. 1** Localities of otter civets in South-east Asia based on museum specimens, observations, and camera trap records. Presence of the species north of 13°N has not been confirmed.



**Plate 1** Camera trap picture of an otter civet in Way Kambas National Park, Sumatra, 1996 (Sumatran Tiger Conservation Program, Ditjen PHKA-TTF-STF; ©1997–2005).

considered diagnostic for the species (Pocock, 1933). It was identified by Thomas (1928) as an immature *C. bennettii*. It is difficult to confirm the status of *C. lowei* because the small number of museum specimens of *C.*

*bennettii* prohibits an estimation of individual variation in this species. However, the specimens from the MNHN and BMNH (Appendix) displayed slight variation in pelage (GV, pers. obs.). Similarly, Pocock (1933) mentioned two juveniles from Sumatra with no speckling in the coat, which is a feature considered diagnostic of *C. lowei*. Pocock (1933) also observed individual variation in *C. bennettii*, and suggested molting as a source of colour variation that reduced the quantity of speckled hairs and exposed, often in patches, paler portions of the underwool.

Because the *C. lowei* specimen acquired by Delacour and Lowe was a trade skin, we could not confirm where it was collected. Moreover, no further specimens of otter civets have been acquired from this region. Wang Yingxiang (pers. comm.) reported animal skins that he suspected were otter civet. One specimen was said to be trapped by fishermen from Yi-Long lake (23.39–23.42°N, 102.30–102.40°E; Shiping County, southern Yunnan, China) in 1978, and two other specimens were said to be trapped from the same lake and Chi-rui Lake (23.44°N, 102.22°E; Baoxiu, Shiping County, Yunnan) and were seen in a market in 1982 and 1985. However, these records were not confirmed by collected specimens or photographs.

Field surveys in Vietnam since the early 1990s have failed to document otter civet (B. Long, pers. comm.). However, these investigations did not incorporate night surveys or camera trapping, and thus it is possible that otter civet remained undetected. Because lowland forest in Vietnam is scarce, future surveys should focus on these remaining patches.

Our morphological study of *C. lowei* does not support a specific distinction from *C. bennettii*. Furthermore, the presence of otter civet in northern Vietnam, Yunnan (China) and northern Thailand has never been confirmed. If it does occur in these countries it is likely to also occur in Lao PDR, although it has never been observed there (Duckworth *et al.*, 1999).

### Reassessment of the distribution of *C. bennettii*

The data suggest that the range of *C. bennettii* comprises peninsular Thailand and Malaysia, and the islands of Sumatra and Borneo. Except for the locality of the junior synonym *V. carcharias* of Blainville, there is no data from Java. However, the locality of this type specimen is doubtful. Otter civet presence in Thailand, suspected by many authors (Lekagul & McNeely, 1988; Schreiber *et al.*, 1989) was confirmed for the first time by accurate sightings (Table 1). The two unpublished sightings in southern Thailand (Narathiwat Province) and Kaeng Krachan National Park (Petchaburi Province) were the first documented records for this country, but the sighting in north Thailand (Phu Kradung National Park) is suspect because the observer was not a naturalist. Furthermore, LG did not document otter civet presence during a 4-year study in Phu Khieo Wildlife Sanctuary, which is adjacent to Phu Kradung National Park. Surveys by LG in Kaeng Krachan National Park in 1995–1997 and in Khao Aung Rui Nai Wildlife Sanctuary (Chaochongsao Province) in 1998 did not document this species.

The presence of otter civet in Vietnam and southern China cannot be confirmed. The only specimen from Vietnam was the type specimen of *C. lowei*. A specimen labelled 'Paguma, China' from the Heude collection (Zoological Institution, Beijing) was reidentified as an otter civet by C. Wozencraft (pers. comm.). However, the exact origin of the specimen is unknown (this specimen is a part of a collection that was removed from Shanghai and given to the Zoological Institution in Beijing). The species is not listed by Yongzu (1997), which is the most recent reference on mammal distribution in China. Investigations in Cambodia, Burma, Lao PDR, from the literature (notably Schreiber *et al.*, 1989, and Duckworth *et al.*, 1999), and by local field workers did not provide evidence for the presence of this species.

Camera trapping surveys in Peninsular Malaysia (Merapoh, Kuala Terenggan, and Kuala Koh in Taman

Negara National Park, Malaysia, in 1999–2001, Kawanishi, 2002; Krau Wildlife Reserve, Temenggor, Bintang Hijau, Gunung Tebu, Jengai, Ulu Temiang, Lepar, Ayer Nyah, Cameron Highlands, in 1999–2001, R. Laidlaw, pers. comm.; Krau Wildlife Reserve, in 2005, N. Grimwood, pers. comm.) did not document the species. Whilst otter civets have been recorded in Peninsular Malaysia by this method (R. Laidlaw, pers. comm.), camera traps were generally not set close to rivers to avoid possible flooding, and this may explain the absence of otter civet records during these surveys (K. Kawanishi, pers. comm.). However, intensive and widespread camera trapping in Sumatra by the Sumatran Tiger Conservation Programme (Franklin *et al.* 1999; Franklin, 2001) has provided a total of 60 photographs of otter civets in three different habitat types, although overall results suggest a highly localized and patchy distribution across the island as a whole.

Habitat preferences seem to include lowland primary forest streams and swamp areas, but there have also been some observations in logged forests (Borneo; Heydon & Bulloh, 1996; Franklin, 2001). The highest locality was at 1,200 m, whereas the majority of localities were in lowland forests. The species is said to be nocturnal (Kanchanasakha *et al.*, 1998) and some observations were at night or in the early morning (20.20, 21.00 and 07.45), but camera trapping in Sumatra shows the species active at all times of the day.

The otter civet has a range typical of a Sundaic species (Lekagul & McNeely, 1988), thus its presence north of the Indochinese peninsula is unlikely, even though this region shares some fauna with the Sundaic region (Duckworth *et al.*, 1999). But, as an elusive species, rarely seen or collected, and probably often misidentified, we believe otter civets are often overlooked by field scientists. The conservation status of this species is unknown and difficult to establish but, as with the Sulawesi palm civet *Macrogalidia musschenbroekii* (Lee *et al.*, 2003), it does not appear to be abundant. Most of the specimens were collected between 1826 and 1940, with only 2 specimens since then. Although field surveys and camera trapping have been intensive in some parts of the region, records are rare, except at a few sites (i.e. Sabah, Borneo; Way Kambas National Park, Sumatra).

### Conservation

Civets play important roles in the structure of biological communities (Wemmer & Watling, 1986; Rabinowitz, 1991; Grassman, 1998). They are nearly always at the top of their trophic levels, and as such are particularly sensitive to disturbances of habitat and prey. The scarcity of recent records raises the question of the impact of human activities on otter civet populations. The impact

**Table 2** Summary of otter civets known to have been held in zoos. No captive breeding has been reported.

Zoo	Date	Origin	Specimens	References
Wassenaar, Holland	1967–1972 (–1973?)	Unknown	F	<i>International Zoo Yearbook</i> , 9–14 (1969–1974)
London Zoo, UK	1954	Unknown		Schreiber <i>et al.</i> (1989)
San Diego Zoo, CA, USA	1970–1971	Unknown	1 M, 2 F	<i>International Zoo Yearbook</i> , 11 (1971); Goldman (1982)
Zoo Negara, KL, Malaysia	1993– (at least) 1995	Unknown	2 M in 1993; 1 M in 1994– (at least) 1995	<i>International Zoo Yearbook</i> , 33–35 (1993–1995); Sebastian (1994)
Bangkok Zoo, Thailand	1973–1974; 1978–1983	Thailand	2 M (1973–74); 1 M (1978–1983)	Schreiber <i>et al.</i> (1989)
Zoological Garden, Calcutta, India	before 1894	Borneo		Sanyal (1894)
Taiping, Malaysia	1969	Malaysia	M	<i>International Zoo Yearbook</i> , 9 (1969); Schreiber <i>et al.</i> (1989)

of selective logging on small carnivores has seldom been addressed and this issue may be responsible for the rarity of otter civets. Heydon & Bulloh (1996) showed that the abundance of civets (including palm civets, banded palm-civet, otter civet, terrestrial civets and linsangs) in northern Borneo was significantly lower in logged forest than in primary forest. They further stated that the most specialized civets, which include otter civet, were less tolerant of logged forests than generalist civets (i.e. palm civets; see also Jennings *et al.*, in press, for Malay civets).

Wildlife conservation is often based around habitat and species protection (Seidensticker *et al.*, 1980; Nowell & Jackson, 1996; Duckworth, 1997; Sunquist *et al.*, 1999) and for the maintainance of ecological processes (Balmford *et al.*, 1998; Weddell, 2002). Conservation of the otter civet requires the protection of forest and riverine habitat, and policing against illegal harvesting. Future field surveys are needed to further assess otter civet distribution and monitor their populations. For this purpose, live trapping and camera trapping are being conducted in Krau Wildlife Reserve in Peninsular Malaysia (Malaysia Carnivore Project, 2005).

### Acknowledgements

We thank the Museum curators who responded to our requests, and Chris Wozencraft (Bethel College, Mishawaka, USA) and Wang Yinxiang (Kunming Institute of Sciences, China) for information on China's specimens. We are indebted to Joe Walston (WCS Cambodia Program) for his help and to the people who provided information from their field surveys. We thank Kae Kawanishi, Ruth Laidlaw and Nicola Grimwood for information on their camera trapping results in Malaysia, and Barney Long for information on field surveys in North Vietnam and for his comments on this manuscript. AJ, GV and PG thank the Economy Planning Unit (Prime Minister's Department) and the Department of Wildlife and National Parks for supporting this work, and Zubaid

Akbar (University Kebangsaan Malaysia) for his help and support. Funding for field work in Malaysia is acknowledged in Malaysia Carnivore Project (2005). The camera trapping surveys in Way Kambas National Park are part of the Sumatran Tiger Conservation Programme (STCP), an ongoing collaboration between the Indonesian Ministry of Forestry, The Tiger Foundation (Canada) and Sumatran Tiger Trust (UK). NF would like to thank these partners, additional funding agencies and private donors, the Forestry Department of Way Kambas National Park (Lampung) and Riau province, and in particular the staff of STCP. GV and PG have received financial support from the Bioresource and Synthesis Project (SE-TAF-468; AT-TAF-463) for visiting European museums. Thanks to P. Jenkins, D. Hills, L. Houseago (BMNH), C. Smeenk (RMNH), G. Lenglet (IRSNB), B. Herzig, A. Bibl, B. Wimmer, A. Larnhof (NMW), P. Ericson, O. Grönwall, A. Constantinides, I. Bisang (NRM) and M. Ade (ZMB) for their help during our visits to the collections.

### References

- Allen, F.G. (1966) I saw an otter civet. *Animals*, **8**, 120–121.
- Balmford, A., Mace, G.M. & Ginsberg, J.R. (1998) The challenges to conservation in a changing world: putting processes on the map. In *Conservation in a Changing World* (eds G.M. Mace, A. Balmford & J.R. Ginsberg), pp. 1–28. Cambridge University Press, Cambridge, UK.
- Blainville, H. de (1837) Rapport sur un mémoire de M. Jourdan concernant deux nouvelles espèces de mammifères de l'Inde. *Annales des Sciences Naturelles, Zoologie*, **8**, 270–281.
- Bristow, M. (1997) Spotlight on Sumatra. *BBC Wildlife*, **15**, 66–69.
- Chen, H. (1988) Update on otter-civet. *Malayan Nature Journal*, **41**, 67.
- CITES (2005) *The CITES Appendices*. <http://www.cites.org/eng/app/index.shtml>, accessed 20 October 2005.
- Corbett, G.B. & Hill, J.E. (1992) *The Mammals of the Indomalayan Region: A Systematic Review*. Natural History Museum Publications, Oxford University Press, Oxford, UK.
- Deignan, H.G. (1959) Harry Cusheir Raven's travels in Eastern Borneo. *Sarawak Museum Journal*, **9**, 267–269.

- Duckworth, J.W. (1997) Small carnivores in Laos: a status review with notes on ecology, behaviour and conservation. *Small Carnivore Conservation*, **16**, 1–21.
- Duckworth, J.W., Salter, R.E. & Khounbolin, K. (eds) (1999) *Wildlife in Lao PDR: 1999 Status Report*. IUCN, Wildlife Conservation Society, and Centre for Protected Areas and Watershed Management, Vientiane, Laos.
- Ellerman, J.R. & Morrison-Scott, T.C.S. (1951) *Checklist of Palaearctic and Indian Mammals 1758 to 1946*. Trustees of the British Museum (Natural History), London, UK.
- Franklin, N. (2001) *Conservation biology of the Sumatran tiger in Way Kambas National Park, Sumatra, Indonesia*. PhD thesis, University of York, UK.
- Franklin, N., Bastoni, Sriyanto, Siswomartono, D., Manansang, J. & Tilson, R. (1999) Last of the Indonesian tigers: a cause for optimism. In *Riding the Tiger: Tiger Conservation in Human Dominated Landscapes* (eds J. Seidensticker, S. Christie & P. Jackson), pp. 130–147. Cambridge University Press, Cambridge, UK.
- GBIF (2005) *Global Biodiversity Information Facility*. [Http://www.gbif.org](http://www.gbif.org), accessed 26 October 2005.
- Goldman, C.A. (1982) Management of the civets, genets and their allies (Mammalia: Viverridae) in captivity: Part. 1. Paradoxurinae, Hemigalinae and Cryptoproctinae. In *American Association of Zoological Parks Aquariums Regional Conference Proceedings*, pp. 14–34.
- Grassman, L.I., Jr (1998) Movements and fruit selection of two Paradoxurinae species in a dry evergreen forest in southern Thailand. *Small Carnivore Conservation*, **19**, 25–29.
- Gray, J.E. (1837a) Characters of some new species of Mammalia in the Society's collection, with remarks upon the dentition of the Carnivora and upon the values of the characters used by M. Cuvier to separate the plantigrade from the digitigrade Carnivora. *Proceedings of the Zoological Society of London*, **1837 (1836)**, 87–90.
- Gray, J.E. (1837b) Description of some new or little known Mammalia, principally in the British Museum. *Magazine of Natural History*, **1**, 579.
- Gray, J.E. (1864) A revision of genus and species of Viverrinae animals found in the Collection of the British Museum. *Proceedings of the Zoological Society of London*, **1864**, 502–579.
- Gray, J.E. (1869) *Catalogue of Carnivora, Pachyderm and Edentate Mammalia in the British Museum*. British Museum, London, UK.
- Heydon, M.J. & Bulloh, P. (1996) The impact of selective logging on sympatric civet species in Borneo. *Oryx*, **30**, 31–36.
- Heydon, M.J. & Ghaffar, N. (1997) Records of otter civet (*Cynogale bennettii*) from northern Borneo. *Small Carnivore Conservation*, **16**, 27.
- ISIS (2005) *International Species Information System*. [Http://www.isis.org](http://www.isis.org), accessed 20 October 2005.
- IUCN (2004) *2004 IUCN Red List of Threatened Species*. IUCN, Gland, Switzerland [<http://www.redlist.org>, accessed 29 June 2005].
- Jennings, A., Seymour, A. & Dunstone, N. (in press) Ranging behaviour, spatial organisation, and activity of the Malay civet (*Viverra zibetha*) on Buton Island, Sulawesi. *Journal of Zoology*.
- Jentink, F.A. (1897) Zoological results of the Dutch scientific expedition to central Borneo. *Notes from Leyden Museum*, **19**, 26–66.
- Kanchanasakha, B., Simcharoen, S. & Than, U.T. (1998) *Carnivores of Mainland South-east Asia*. WWF, Bangkok, Thailand.
- Kawanishi, K. (2002) *Population status of tigers (Panthera tigris) in a primary rainforest of Peninsular Malaysia*. PhD thesis, University of Florida, Gainesville, USA.
- Kool, K.M. & Nawi, Y. (1995) *Catalogue of Mammal Skins in the Sarawak Museum, Kuching Sarawak, Malaysia*. University Malaysia, Sarawak, Malaysia.
- Lee, R.J., Riley, J., Hunowu, I. & Maneasa, E. (2003) The Sulawesi palm civet: expanded distribution of a little known endemic viverrid. *Oryx*, **37**, 378–381.
- Lekagul, B. & McNeely, J.A. (1977) *Mammals of Thailand*. Association for the Conservation of Wildlife, Bangkok, Thailand.
- Lyon, M.W., Jr (1908) Mammals collected in eastern Sumatra by Dr. W.L. Abbott during 1903, 1906, and 1907, with descriptions of new species. *Proceedings of the United States National Museum*, **34**, 619–679.
- Lyon, M.W., Jr (1911) Mammals collected by Dr. W.L. Abbott on Borneo and some adjacent islands. *Proceedings of the United States National Museum*, **40**, 53–146.
- Malaysia Carnivore Project (2005) [Http://www.carnivoreproject.org](http://www.carnivoreproject.org), accessed 26 October 2005.
- Medway, L. (1977) *Mammals of Borneo*. Monographs of the Malaysian Branch of the Royal Asiatic Society, Kuala Lumpur, Malaysia.
- Medway, L. (1978) *The Wild Mammals of Malaya (Peninsular Malaysia) and Singapore*. 2nd edition. Oxford University Press, Oxford, UK.
- Müller, S. (1838) Over eenige nieuwe zoogdieren van Borneo. *Tijdschrift Voor Natuurlijke Geschiedenis en Physiologie*, **5**, 134–150.
- Nowell, K. & Jackson, P. (1996) *Wild Cats: Status Survey and Conservation Action Plan*. IUCN, Gland, Switzerland.
- Osgood, W.H. (1932) Mammals of the Kelley-Roosevelts and Delacour Asiatic expeditions. *Field Museum of Natural History Zoological Series*, **18**, 193–339.
- Pocock, R.I. (1915) On some of the external characters of *Cynogale bennettii*, Gray. *Annals and Magazine of Natural History*, **15**, 351–360.
- Pocock, R.I. (1933) The rarer genera of Oriental Viverridae. *Proceedings of the Zoological Society of London*, **1933**, 969–1035.
- Rabinowitz, A.R. (1991) Behavior and movements of sympatric civet species in Huai Kha Khaeng Wildlife Sanctuary, Thailand. *Journal of Zoology*, **223**, 281–298.
- Sanyal, R.B. (1894) Notes on *Cynogale bennettii*, Gray. *Proceedings of the Zoological Society of London*, **1894**, 269–297.
- Schreiber, A., Wirth, R., Riffel, M. & Van Rompaey, H. (1989) *Weasels, Civets, Mongooses, and their Relatives. An Action Plan for the Conservation of Mustelids and Viverrids*. IUCN/SSC Mustelid and Viverrid Specialist Group, IUCN, Gland, Switzerland.
- Sebastian, A.C. (1994) News. *Small Carnivore Conservation*, **10**, 15.
- Seidensticker, J., Suyono, I. & Thomas, T. (1980) *The Javan Tiger and the Meru-Betiri Reserve: A Plan for Management*. IUCN, Gland, Switzerland.
- Sunquist, M.E., Karanth, K.U. & Sunquist, F. (1999) Ecology, behaviour and resilience of the tiger and its conservation needs. In *Riding the Tiger: Tiger Conservation in Human Dominated Landscapes* (eds J. Seidensticker, S. Christie & P. Jackson), pp. 5–18. Cambridge University Press, Cambridge, UK.
- Thomas, O. (1928) The Delacour exploration of French Indo-China. II. On mammals collected during the winter of 1926–1927. *Proceedings of the Zoological Society of London*, **1928**, 139–150.

- Timm, R.M. & Birney, E.C. (1980) Mammals collected by the Menage scientific expedition to the Philippine Islands and Borneo, 1890–1893. *Journal of Mammalogy*, **61**, 566–571.
- Van Peenen, P.F.D. (1969) *Preliminary Identification Manual for Mammals of South Vietnam*. Smithsonian Institution, Washington, USA.
- Weddell, B.J. (2002) *Conserving Natural Living Resources in the Context of a Changing World*. Cambridge University Press, Cambridge, UK.
- Wemmer, C. & Watling, D. (1986) Ecology and status of the Sulawesi palm civet *Macrogalidia musschenbroeki* Schlegel. *Biological Conservation*, **35**, 1–17.
- Wozencraft, W.C. (1993) Order Carnivora. In *Mammal Species of the World: A Taxonomic and Geographic Reference* (eds D.E. Wilson & D.M. Reeder), pp. 279–348. Smithsonian Institution Press, Washington, USA and London, UK.
- Yasuma, S. (1994) *An Invitation to the Mammals of East Kalimantan*. Special Publication no. 3. Tropical Rainforest Project, Japan International Cooperation Agency, Directorate General of Higher Education, Pusrehut, Republic of Indonesia.
- Yongzu, Z. (ed.) (1997) *Distribution of Mammalian Species in China*. China Forestry Publishing House, Beijing, China.

## Appendix

The appendix for this article is available online at <http://journals.cambridge.org>

## Biographical sketches

Géraldine Veron is a member of the Small Carnivore Specialist Group of the IUCN and her main research interests are small carnivore systematics, biogeography and conservation, focusing particularly on Asian species of herpestids and viverrids.

Philippe Gaubert studies the systematics and evolution of the Viverrinae and Pholidotes in Asia and Africa. He is a member of the Small Carnivore Specialist Group and his research includes the reassessment of the conservation status of elusive small carnivores.

Neil Franklin is the director of The Tiger Foundation & Sumatran Tiger Trust's Indonesia Program and senior advisor to the Sumatran Tiger Conservation Programme. He has worked on conservation of the tiger and Sumatran ecosystems in Indonesia since 1995 and is a member of the IUCN Cat Specialist Group.

Andrew P. Jennings has worked on carnivore projects in North and South America and in Sulawesi. He is the leader of a project on small carnivore ecology and conservation in Peninsular Malaysia.

Lon Grassman has conducted field research on carnivore ecology and conservation in Thailand since 1995. He is a member of the IUCN Small Carnivore and Cat Specialist Groups.