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Small-toothed Palm Civet *Arctogalidia trivirgata* records from human-influenced habitats in Vietnam

D. H. A. WILLCOX¹, TRAN Quang Phuong¹, VU Long², TRAN Van Bang² and HOANG Minh Duc²

Abstract

Small-toothed Palm Civet *Arctogalidia trivirgata* is rather rarely included on mammal survey lists for Vietnamese protected areas. This has often led to its being declared rare, and therefore a priority for national small carnivore conservation. Evidence from outside Vietnam suggests that this paucity of records in Vietnam is due at least largely to the reliance on inappropriate survey methods, i.e. ground-based camera-trapping and diurnal surveys, that will fail to record this nocturnal, very arboreal civet. Presented here are several recent confirmed records from both protected and non-protected areas in Vietnam, all of which have undergone major anthropogenic disturbances, including hunting and illegal logging. The ability of this species to survive in these areas where most similar-sized or larger animal species have become reduced or extirpated indicates that it is not a conservation priority among Vietnam's mammals. Consideration of other information from throughout its range suggests that the conservation focus for this genus should be on the Javan taxon *A. (t.) trilineata*. These records from Vietnam have also extended the documented altitude range for this species in Vietnam to above 1,000 m a.s.l., consistent with other parts of the species's range, and have added a habitat type not previously recorded for the species: *Melaleuca*-dominated wetland forest.

Keywords: camera-trapping, conservation priorities, conservation status, habitat use, spotlighting

Ghi nhận Cây tai trắng *Arctogalidia trivirgata* tại các sinh cảnh chịu tác động bởi con người ở Việt Nam

Tóm tắt

Cây tai trắng *Arctogalidia trivirgata* thường ít được ghi nhận trong các kết quả khảo sát thú tại các khu rừng đặc dụng ở Việt Nam. Do vậy, chúng thường được xem là loài hiếm và là loài thú ăn thịt nhỏ cần được ưu tiên bảo tồn ở cấp quốc gia. Các bằng chứng từ những khu vực ngoài Việt Nam cho thấy việc có ít ghi nhận loài này ở Việt Nam chủ yếu là do phương pháp khảo sát không thích hợp, ví dụ sử dụng bẫy ảnh đặt trên mặt đất và khảo sát ban ngày sẽ không ghi nhận được loài thú ăn đêm và chuyên hoạt động trên cây này. Bài báo này trình bày một số ghi nhận chắc chắn gần đây về loài cây tai trắng tại các khu vực được bảo vệ lần không được bảo vệ nhưng đều chịu nhiều tác động của con người, bao gồm cả săn bắn và khai thác gỗ trái phép. Khả năng tồn tại ở những nơi mà các loài thú có kích thước tương tự hoặc lớn hơn loài này suy giảm hoặc bị tuyệt diệt cho thấy đây không phải là loài cần ưu tiên bảo tồn ở Việt Nam, và ở cấp độ vùng, nên tập trung bảo tồn phân loài ở Java *A. (t.) trilineata*. Từ các ghi nhận mới này, giới hạn về độ cao phân bố của loài ở Việt Nam được mở rộng lên đến 1.000m so với mặt nước biển, phù hợp với vùng phân bố của loài ở những khu vực khác, và sinh cảnh rừng tràm với ưu thế loài *Melaleuca* là sinh cảnh được ghi nhận mới so với các ghi nhận trước đây.

Introduction

The wide deployment of camera-traps across Southeast Asia over the last 15–20 years has generated many images of small carnivores and, although these were rarely the target species of the survey in question, where their records are collated and published, they have advanced considerably the understanding of species' conservation status (e.g. Holden 2006, Than Zaw *et al.* 2008), including of some globally threatened species (e.g. Veron *et al.* 2006, Dang & Le 2010, Gray *et al.* 2010). Small-toothed Palm Civet *Arctogalidia trivirgata* occurs almost throughout Southeast Asia, and into adjacent northeast India and southern China (Corbet & Hill 1992). It has been found by many surveys using methods other than camera-trapping, often frequently (e.g. Duckworth 1997, Walston & Duckworth 2003, Duckworth & Nettelbeck 2008, Eaton *et al.* 2010, Low 2010, Moore 2011). By contrast, most camera-trap surveys do not

find this species, even when they are of long duration, use many camera-trap sites, and are within habitat-types likely to be used by this species (e.g. Azlan 2006, Azlan & Lading 2006, Suzuki *et al.* 2006, Than Zaw *et al.* 2008, Holden & Neang 2009, Johnson *et al.* 2009, Lau *et al.* 2010, Gray & Phan 2011). Although some of the former surveys might have been in areas where Small-toothed Palm Civets do not occur, there are many camera-trap surveys that have not found the species at sites where remains of dead animals or live field sightings showed it to be present (e.g. Conforti 1996, Walston & Duckworth 2003, Borissenko *et al.* 2004, Wells *et al.* 2005, Holden 2006, Long & Minh 2006, Belden *et al.* 2007, Wilting *et al.* 2010, and, apparently, Cheyne *et al.* 2010, Mathai *et al.* 2010, Brodie & Giordano 2011). By contrast, we traced no surveys where Small-toothed Palm Civet was camera-trapped, but not found by spotlighting, where this latter method was used. The species is categorised as Least Concern on *The IUCN Red List of Threatened Species* (IUCN 2012).

Over a century ago, Small-toothed Palm Civet's use of Coconut *Cocos nucifera* plantations on Bunguran, in the Natuna islands (Indonesia) was remarked (Miller 1901). Relatively few recent records from highly modified habitats have been published, such as those from Bukit Kiara Recreational Park, West Malaysia (Eaton *et al.* 2010) and Singapore, where Small-toothed Palm Civet is one of only two civet species (without suspicion of captive origin) persisting in the island's remaining small forest isolates (Chua *et al.* 2012). The species is highly arboreal (e.g. Payne *et al.* 1985, Duckworth & Nettelbeck 2008), and arboreality is sometimes considered *a priori* to increase the sensitivity of species to human pressures, particularly habitat disruption (e.g. Ochoa & Soriano 2001). This seems reasonable, given the possibility for canopy change to affect such species' daily movements, episodic dispersal, food sources, sleeping sites and other resources. A general, and understandable, tendency for wildlife surveys to occur in areas likely to be of high importance to threatened species means that there are few hard data giving evidence to the extent to which Small-toothed Palm Civet survives in fragmented, isolated, heavily degraded and/or heavily hunted areas.

This note presents observations of Small-toothed Palm Civets from several sites in Vietnam, in both protected and non-protected areas, where habitat has been highly degraded and fragmented. Even by regional standards, Vietnam has a high human population density, very heavy hunting (including in most protected areas) and pervasive wildlife trade, of which civets are a key part (Bell *et al.* 2004, Robertson 2007). It is therefore unlikely that species which are highly sensitive to hunting and/or habitat disturbance will be found widely and easily in the country away from relatively well-protected sites. Spotlighting has been relatively little-used as a survey technique in Vietnam to date (or, at least, there are few available survey results from the method), and some such surveys (e.g. Le *et al.* 1997) have focused on deciduous forest which, based on confirmed records from throughout the species's range, is not thought to be suitable habitat for Small-toothed Palm Civet (Robertson 2007).

Records

Ke Go Nature Reserve – Khe Net proposed Nature Reserve, Ha Tinh and Quang Binh provinces

Ke Go Nature Reserve (NR) and Khe Net proposed NR comprise lowland evergreen forest but are presently 'paper parks'. Evidence of anthropogenic disturbance, both past and current, can be seen almost throughout both nature reserves and extends into some of their least accessible parts, such as the tops of the small but fairly steep hills. There are indications of high levels of hunting (about 1,200 cable snare traps were recorded in approximately 30 km² over several weeks of surveying, in October–November 2006 and March–May 2010) and illegal logging (Willcox *et al.* in prep. a). Over the course of the March–May 2010 survey, 17 illegal logging/hunting camps were recorded, chainsaws were heard on at least four occasions and approximately 130 domestic buffaloes *Bubalus bubalis* were recorded (Willcox *et al.* in prep. a). Although there are few published quantifications of such human activities from other surveys in either protected or non-protected areas in Vietnam

with which to compare, clearly many people use, illegally, the Ke Go–Khe Net lowland landscape. A 1996 survey of Ke Go NR (Le *et al.* 1999) classified vegetation types into four broad categories based on the level of human impact: lightly disturbed broad-leaved evergreen forest, heavily disturbed broad-leaved evergreen forest, plantation, scrub and grassland. Lightly disturbed broad-leaved evergreen forest is primary forest, and though commercial tree species are selectively logged from these patches of forest, much of this vegetation type remains little changed. Heavily disturbed broad-leaved evergreen includes areas that have been completely cleared and are now secondary forest, and some areas that have managed to retain some plant species and structure associated with primary forest, despite heavy anthropogenic disturbance.

A targeted small carnivore survey of approximately 100 hours of spotlighting and 1,300 camera-trap-nights during October 2006 – March 2007 and January–July 2010 recorded Small-toothed Palm Civet three times. On 18 March 2010, one individual spotlighted at 20h00 in lightly disturbed primary broad-leaved evergreen forest at approximately 300 m a.s.l. (18°07'N, 105°54'E) gave a clear view for about 5 seconds only 4–5 m away. On 26 March 2010, at 20h10, one was seen in secondary broad-leaved evergreen forest at about 150 m a.s.l. (18°06'N, 105°56'E), in a small tree, about 3 m from a well-used path, 15 m from a small stream, 50 m from the field team's camp and 100 m from an active hunters' camp. The final confirmed record was on 28 April 2010 at 21h30, when one was seen in a tree covered with thick woody creepers in heavily disturbed primary evergreen forest at approximately 160 m a.s.l. (18°07'N, 105°55'E), 15 m to the side of the main pathway, for about 4 seconds through binoculars until it disappeared into the foliage.

The three confirmed records for Small-toothed Palm Civet at this site were more than for Common Palm Civet *Paradoxurus hermaphroditus*, and were exceeded, among small carnivores, only by ferret badgers *Melogale*. This suggests that it is one of the more common small carnivores left in this landscape.

U Minh Ha Fishery and Forestry Enterprises, Ca Mau province

On the moonless, warm and cloudy night of 4 September 2010, at about 21h30, a Small-toothed Palm Civet was seen in a Custard-apple tree *Annona reticulata*, a non-native fruit species, at 9°31'N, 104° 57'E in the U Minh Ha Fishery and Forestry Enterprises (FFEs). Once disturbed, it ran along the main branch, down the trunk to the ground and away from view, an unusual behaviour for this arboreal species, which typically escapes through the canopy (DHAW pers. obs.). This was presumably because the *Melaleuca cajuputi* trees next to the *A. reticulata* were too weak to support the civet's weight. This sighting was amid a young (about five years old) *M. cajuputi* plantation, with canal embankments lined with banana and other fruit trees which had been planted and left untended by local people. The nearest extensive older forest is U Minh Ha NP, which is approximately 30 years old and 40 km away. The nearest forest on dry land, of the sort sometimes assumed to be typical of the species, i.e. evergreen forest (e.g. Robertson 2007), is approximately 150 km away. The U Minh Ha FFEs are active forestry enterprises, and their *M. cajuputi* and *Acacia* plantations are commercially harvested in large quantities (Fig. 1). Local people live within about 50 m of the observation

site and during a previous spotlighting session (3 September 2010), two hunters were seen scouring the banks in the same area using torches, accompanied by six dogs. A bank near this sighting had six cable-snare traps, although only one was seen elsewhere on the survey. Relative to the authors' observations of hunting pressures in Vietnam's protected areas, hunting using cable-snare traps seems to be scarce, but human activity (with dogs) high. Nylon nets (strongly corded, suitable for catching medium-large species of fish; Fig. 2) were placed along most of the banks, reportedly to help catch Sunda Pangolins *Manis javanica*. Apparently, hunters search the banks using torches and dogs; any tree containing something marketable is cut down, while other animals are caught on the ground or in one of the nets.

Total survey effort for the U Minh Ha FFEs was approximately 800 camera-trap-nights and 40 hours spotlighting. This produced confirmed records for three other small carnivore species; six for Common Palm Civet, 23 for Leopard Cat



Fig. 1. *Melaleuca cajuputi* being harvested with a Jackfruit tree *Artocarpus heterophyllus* on the canal embankment. This is typical habitat for this field site. U Minh Ha FFEs, Ca Mau Province, December 2010.



Fig. 2. An example of the hunting nets that lined the canal embankments, U Minh Ha FFEs, Ca Mau Province, September 2010.

Prionailurus bengalensis and five for Small Asian Mongoose *Herpestes javanicus*. These three species were recorded mainly by camera-traps. There were few suitable pathways for spotlighting in the U Minh Ha FFEs, so nearly all spotlighting involved going along canals in a small boat with a loud outboard engine, allowing search only of vegetation along the canal embankments. Controlling pace and noise, important when spotlighting for small carnivores, was difficult. The low number of Small-toothed Palm Civet records relative to the camera-trapped species may reflect limitations of spotlighting in this habitat type, more than Small-toothed Palm Civet's relative status in this area.

Ta Kou Nature Reserve, Binh Thuan province

Ta Kou Nature Reserve (NR) is characterised by a dry coastal monsoon climate and includes a 10,762 ha coastal sandy flat area dominated by deciduous dipterocarp trees, and 1,000 ha of evergreen and semi-evergreen forest on the 697 m high Ta Kou Mountain (Hoang *et al.* 2010). Approximately 45,000 people live in the buffer zone, and the nature reserve's biodiversity is threatened by hunting, illegal encroachment and over-exploitation of non-timber forest products (Birdlife International 2004, Luu 2008). The survey site on the mountain has evergreen forest dominated by species of figs *Ficus*. Near the top, mixed broadleaf and bamboo forest is also found.

A spotlighting survey of approximately 40 hours from 17h00 to 23h00 during May–July 2009 and January–April 2010 on Ta Kou Mountain resulted in nine sightings with a total of 18 'animals' (not necessarily all different individuals) in an area within 10°48'39"–54"N, 107°53'56"–57'57"E (all coordinates for this site use the WGS84 datum), whilst about 15 hours spotlighting in the lowland area of the NR resulted in no sightings. The disturbance in the surveyed area gives it the highest level of encroachment in Ta Kou Mountain, although hunting signs were relatively few compared with the other three field sites. The area receives over 200,000 visitors (by day and night) annually, most of whom come to visit its famous pagoda, which has the largest statue of a reclining Buddha in Vietnam.

All Small-toothed Palm Civet sightings were made within about 600 m of the reclining Buddha statue and of the 1.2 ha that was cleared by the NR's management for two pagodas, a cable car station, a guesthouse and restaurants, all for tourists. Hunting traps were rarely seen on Ta Kou Mountain during these surveys in 2009 and 2010, but a group of 20 cable-snare traps (with an ensnared dead Leopard Cat) and a box trap set for primates were seen. No hunting with guns or crossbows was seen.

The first sighting was made on 1 May 2009 at 19h40. One animal was observed on a small Malaysian *Eugenia* fruit tree (10°48'39"N, 107°53'56"E) planted near the edge of the forest. The distance between animal and observers was 14 m. It appeared to be a juvenile with a head-and-body length less than 400 mm (Fig. 3). The animal showed no fear and kept feeding while spotlit and photographed. After 10 minutes, it moved to another branch, away from the reach of the spotlight.

The second sighting, on 11 July 2009, at 20h45, was of one animal photographed (Fig. 4) feeding on a tall fig tree *Ficus* (10°48'43"N, 107°57'57"E). The animal, an adult male, was about 20 m above ground and about 5 m from the statue. After 5 minutes' observation from about 25 m range, it retreated into the forest.



Fig. 3. Small-toothed Palm Civet *Arctogalidia trivirgata*. Ta Kou Nature Reserve, Binh Thuan Province, 1 May 2009.



Fig. 5. Two Small-toothed Palm Civets *Arctogalidia trivirgata*. Ta Kou Nature Reserve, Binh Thuan Province, 27 January 2010.



Fig. 4. Small-toothed Palm Civet *Arctogalidia trivirgata*. Ta Kou Nature Reserve, Binh Thuan Province, 11 July 2009.



Fig. 6. Two Small-toothed Palm Civets *Arctogalidia trivirgata*. Ta Kou Nature Reserve, Binh Thuan Province, 20 March 2010.

Four Small-toothed Palm Civets were observed and photographed in a tall fig tree (at 10°48'44"N, 107°53'56"E) on 27 January 2010, at 19h40 (Fig. 5). The animal-observer distance was more than 20 m. Near the Civet group was one Indian Giant Flying Squirrel *Petaurista philippensis*. Both species were eating fruits of the same tree, with no conflict. After over 20 minutes' observation, all animals moved away in the same direction.

On 28 January 2010, at approximately 20h30, six Small-toothed Palm Civets were observed and photographed feeding in a fig tree, about 30 m from the Buddha statue (10°48'43"N, 107°57'56"E). The animal-observer distance was about 7 m. At 60 m from the first observation, on 28 January 2010, a solitary Small-toothed Palm Civet was observed climbing on some bamboo (10°48'53"N, 107°53'44"E) at 20h50, near the top of the mountain. This animal-observer distance was only 4 m.

On 27 February 2010, at 19h30, a pair of Small-toothed Palm Civets was observed in a small Java rose-apple tree *Syzygium* near a small stream at 490 m a.s.l. (10°48'51"N, 107°57'42"E). The animal-observer distance was about 7 m. One climbed to a higher branch and retreated into thicker canopy; the other stared at the spotlight, then slowly followed the first.



Fig. 7. Small-toothed Palm Civet *Arctogalidia trivirgata*. Ta Kou Nature Reserve, Binh Thuan Province, 27 April 2010.

Two Small-toothed Palm Civets, which looked to be juveniles, were observed eating figs on 20 March 2010, at about 21h00 (10°48'53"N, 107°57'43"E). The animal-observer distance was 10 m. The animals fed on the figs for 5 minutes after being spotlighted and were photographed (Fig. 6). Five days later,

at 21h00, one Small-toothed Palm Civet was observed and photographed on a fig tree (10°48'43"N, 107°57'57"E). After being spotlighted the animal stared at the observers for about 3 minutes, and then moved to another branch, away from the reach of the spotlight.

The ninth encounter was on 27 April 2010, at 19h14. A pair of Small-toothed Palm Civets was observed climbing on a small fig tree beside a forest trail (10°48'54"N, 107°57'42"E) (Fig. 7). After observation for about 15 minutes at a distance of 7 m, both civets retreated into the thicker canopy.

Despite a survey lasting over several months, the only other small carnivore species recorded were Yellow-throated Marten *Martes flavigula* and Leopard Cat, each only once or twice. Two captive Large-spotted Civets *Viverra megaspila* were observed in a village near the border of Ta Kou NR, and although exact provenance could not be confirmed, it is very probable they had been sourced from the protected area. The low number of records for other small carnivore species is in obvious contrast to the number of Small-toothed Palm Civet sightings.

Phuoc Binh National Park, Ninh Thuan province

Phuoc Binh National Park (NP), within 11°58'–12°10'N, 108°43'–49'E, covers 19,814 ha, and is on the margins of the Da Lat Plateau. Phuoc Binh NP is covered by hill and montane evergreen broadleaf forest, with some coniferous tree species (Birdlife International 2004). Most of its lowlands have been converted into agriculture. Forested areas up to approximately 1,000 m a.s.l. continue to experience illegal logging and exploitation of non-timber forest products (Tordoff 2002). Above this elevation the forest remains little disturbed, although hunting is prevalent and a key threat to the site's biodiversity (Hoang 2007, Rawson *et al.* 2011), with over 100 cable-snare traps collected during a 10-day survey in 2009 (TVB pers. obs.). During a 10-hour spotlighting survey in August 2009, a Small-toothed Palm Civet was seen at 21h00 on a tree at a measured altitude of 1,024 m a.s.l., in evergreen forest. The animal was 10 m up the tree on a small branch and about 15 m from the observers. On being seen, the civet moved down the tree and approached within 5 m of the observers. It was observed for 5 minutes, and photographed (Fig. 8). The animal then climbed to a higher branch and retreated into the forest.



Fig. 8. Small-toothed Palm Civet *Arctogalidia trivirgata*. Phuoc Binh National Park, Ninh Thuan Province, August 2009.

No other small carnivore species were recorded during the survey. However, Black-shanked Douc *Pygathrix nigripes* and Yellow-cheeked Crested Gibbon *Nomascus gabriellae* were both recorded. The presence of these globally threatened primate species, despite prevalent wildlife hunting and other anthropogenic disturbances, may indicate that the single Small-toothed Palm Civet record is due to low survey effort, rather than an indication of the species's status, and that other small carnivore species may persist in the NP.

Discussion

A previous wildlife survey in the Ke Go Nature Reserve – Khe Net proposed Nature Reserve using diurnal direct observation and ground-level trapping (approximately 50 non-lethal snares set over a maximum of 10 days in mixed forest) failed to find Small-toothed Palm Civet (Eames *et al.* 1994), as did the camera-trapping on the present surveys there (Willcox *et al.* in prep. a). Past camera-trapping in U Minh Thuong National Park, close to U Minh Ha FFEs, also failed to find Small-toothed Palm Civet (Nguyen *et al.* 2004), as did camera-trapping in U Minh Ha National Park and the U Minh Ha FFEs (Willcox *et al.* in prep. b). These records thus add to the many instances elsewhere in South-east Asia (see above) where Small-toothed Palm Civet did not appear on photographs from camera-traps although spotlighting or other techniques showed it to be present. Previous records of Small-toothed Palm Civet across Vietnam with altitude traced by Robertson (2007) came only from the narrow range of 600–750 m; these records extend the documented altitude range of the species from sea-level to over 1,000 m a.s.l., consistent with elsewhere (e.g. Duckworth 1995, 1997).

Dang & Pham (1974) collected two Small-toothed Palm Civet specimens in Hoa Binh province and noted that up until then very few specimens had been lodged in Vietnamese collections. Quoting the villagers around the two collection sites as saying that they very often saw and hunted the species, they themselves opined that it was probably scarce. This thinking probably guided its assignment of the 'Rare' category in the 2000 edition of the Vietnam Red Book (MoSTE 2000) and Near Threatened in the 2007 version (MoST & VAST 2007). Given the records in this paper, the villagers may well have been correct, and these records support Robertson's (2007) suspicion that the species is overlooked, rather than rare, in Vietnam.

The ability of the species to survive in landscapes where hunting, illegal logging and other anthropogenic disturbances are intensive and widespread and where, in some cases, the observation sites are remote from large tracts of less-encroached forest, suggests it is under little threat from these activities. Although this statement is based on incidental sightings from a handful of surveys, all but one of the records (that from Phuoc Binh NP) are the result of intensive field surveys that also collected baseline data on the status of other mammal fauna, including other species of small carnivore, in addition to anthropogenic pressures. The confirmed evidence from these surveys is not contradicted by information from any other Vietnamese site with suitable spotlighting survey.

Hunting and habitat loss appear to have greatly reduced or extirpated most mammal species of a similar and larger size from all four field sites. Intensive camera-trapping that surveyed a number of different habitat and microhabitat types

in Ke Go NR – Khe Net proposed NR produced few mammal records and the fauna was noticeably impoverished. Common Palm Civet, a species commonly active at ground level that is readily recorded using camera-trapping and is known to be tolerant of habitat disturbance (e.g. Su Su 2005), was recorded only twice over the entire survey in this landscape.

Given its persistence in sites where few other mammals of comparable size remain, Small-toothed Palm Civet is unlikely to be a conservation priority in Vietnam. More spotlight surveys in fragmented, isolated, heavily degraded and/or heavily hunted areas would allow a more confident assessment. The addition of 15–20 hours spotlighting into mammal/biodiversity surveys in known Small-toothed Palm Civet habitats could clarify the species's geographical and altitudinal distribution in Vietnam, and keep coarse track of its conservation status, and would be relatively simple. Rigorous population quantification, by contrast, would be challenging: the basic assumptions of available techniques are very difficult to meet when surveying arboreal nocturnal species. Difficulties in applying Distance analysis (or any other line-transect-based population estimation) to nocturnal arboreal mammals were discussed by Duckworth (1998), and similar problems exist for occupancy analysis.

Conservation prioritisation at the site, landscape and species levels is invaluable in optimising the use of limited financial and human resources. The evident positive conservation status of Small-toothed Palm Civet in Vietnam, relative to other small carnivore species, means that survey and conservation resources directed towards sympatric mammal species clearly at high risk of extinction are likely to provide more information of direct management significance. However, the main technique used for intensive wildlife hunting in Vietnam presently is unlikely to affect this arboreal species of civet: ground-level trapping. Should more hunters in Vietnam adopt spotlighting techniques to target arboreal animal species, as observed in the U Minh Ha FFEs, then the conservation status of Small-toothed Palm Civet could conceivably worsen. It is not possible at this stage to speculate meaningfully on how resilient Small-toothed Palm Civet would be to very heavy offtakes. Clear reporting of hunting pressures (specific types and intensities) at field sites, in addition to the spotlighting surveys mentioned in the previous paragraph, will be necessary to track any changes in the species's conservation status.

Whilst Small-toothed Palm Civet in Vietnam presently has an evident positive conservation status, this cannot yet be confirmed for the entire genus. The conservation status of the Javan taxon *A. (t.) trilineata* remains uncertain, and given the paucity of records of it (Eaton *et al.* 2010, Moore 2011) and the possibility that it is a distinct species, clarification of its taxonomic and conservation status is the clear conservation research priority with this genus.

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References

- Azlan J. B. A. G. A., Mohd. 2006. Mammal diversity and conservation in a secondary forest in Peninsular Malaysia. *Biodiversity and Conservation* 15: 1013–1025.
- Azlan J., Mohd. & Lading, E. 2006. Camera-trapping and conservation in Lambir Hills National Park, Sarawak. *Raffles Bulletin of Zoology* 54: 469–475.
- Belden, G., Stuebing, R. & Nyegang, M. 2007. Small carnivores in mixed-use forest in Bintulu division, Sarawak, Malaysia. *Small Carnivore Conservation* 36: 35–37.
- Bell, D., Robertson, S. & Hunter, P. R. 2004. Animal origins of SARS coronavirus: possible links with the international trade in small carnivores. *Philosophical Transactions of the Royal Society of London, B* 359: 1107–1114.
- Birdlife International 2004. *Sourcebook of existing and proposed protected areas in Vietnam*. BirdLife International Vietnam Programme and the Forest Inventory and Planning Institute, Hanoi, Vietnam.
- Borissenko, A. V., Ivanova, N. V. & Polet, G. 2004. First recent record of the Small-toothed Palm Civet *Arctogalidia trivirgata* from Vietnam. *Small Carnivore Conservation* 30: 5–6.
- Brodie, J. & Giordano, A. 2011. Small carnivores of the Maliau Basin, Sabah, Borneo, including a new locality for Hose's Civet *Diplogale hosei*. *Small Carnivore Conservation* 44: 1–6.
- Cheyne, S. M., Husson, S. J., Chadwick, R. J. & Macdonald, D. W. 2010. Diversity and activity of small carnivores of the Sabangau Peat-swamp Forest, Indonesian Borneo. *Small Carnivore Conservation* 43: 1–7.
- Chua, M. A. H., Lim, K. K. P. & Low, C. H. S. 2012. The diversity and status of the civets (Viverridae) of Singapore. *Small Carnivore Conservation* 47: 1–10.
- Conforti, K. 1996. *The status and distribution of small carnivores in Huai Kha Khaeng/Thung Yai Naresuan Wildlife Sanctuaries, West-Central Thailand*. University of Minnesota (MSc thesis), Minneapolis, U.S.A.
- Corbet, G. B. & Hill, J. E. 1992. *The mammals of the Indomalayan region*. Natural History Museum Publications and Oxford University Press, Oxford, U.K.
- Dang H. H. & Pham T. A. 1974. Ve loại cay *Arctogalidia trivirgata* Gray o mien bac Viet Nam [The civet *Arctogalidia trivirgata* Gray in northern Vietnam]. *Tap San Sinh Vat-Di Hoc* 12: 124–125.
- Dang N. C. & Le T. T. 2010. Southward extension of known range of Owston's Civet *Chrotogale owstoni* in Vietnam. *Small Carnivore Conservation* 43: 44–46.
- Duckworth, J. W. 1995. Mammal records from Similajau National Park. *Sarawak Museum Journal* 48: 157–161.
- 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. 1998. The difficulty in estimating population densities of nocturnal forest mammals from transect counts of animals. *Journal of Zoology, London* 246: 466–468.

- Duckworth, J. W. & Nettelbeck, A. R. 2008. Observations of Small-toothed Palm Civets *Arctogalidia trivirgata* in Khao Yai National Park, Thailand, with notes on feeding technique. *Natural History Bulletin of the Siam Society* 55: 187–192.
- Eames, J. C., Lambert, F. R. & Nguyen C. 1994. A survey of the Annamese Lowlands, Vietnam, and its implications for the conservation of Vietnamese and Imperial Pheasants *Lophura hatinhensis* and *L. imperialis*. *Bird Conservation International* 4: 343–382.
- Eaton, J. A., Wüst, R., Wirth, R., Shepherd, C. R., Semiadi, G., Hall, J. & Duckworth, J. W. 2010. Recent records of the Javan Small-toothed Palm Civet *Arctogalidia (trivirgata) trilineata*. *Small Carnivore Conservation* 43: 16–22.
- Gray, T. N. E. & Phan C. 2011. Habitat preferences and activity patterns of the larger mammal community in Phnom Prich Wildlife Sanctuary, Cambodia. *Raffles Bulletin of Zoology* 59: 311–318.
- Gray, T. N. E., Pin C. & Pin C. 2010. Status and ecology of Large-spotted Civet *Viverra megaspila* in eastern Cambodia. *Small Carnivore Conservation* 43: 12–15.
- Hoang M. D. 2007. *Ecology and conservation status of the Black-shanked Douc (Pygathrix nigripes) in Nui Chua and Phuoc Binh National Parks, Ninh Thuan Province, Vietnam*. School of Natural and Rural Systems Management, University of Queensland (PhD thesis), Brisbane, Australia.
- Hoang M. D., Tran V. B., Covert, H. H., Luu H. T. & Tran Q. T. 2010. Conservation status of primates in Ta Kou Nature Reserve. Pp. 91–98 in Nadler, T., Rawson, B. M. & Van N. T. (eds) *Conservation of primates in Indochina*. Frankfurt Zoological Society and Conservation International, Hanoi, Vietnam.
- Holden, J. 2006. Small carnivores in central Sumatra. *Small Carnivore Conservation* 34&35: 35–38.
- Holden, J. & Neang T. 2009. Small carnivore records from the Cardamom Mountains, southwestern Cambodia. *Small Carnivore Conservation* 40: 16–21.
- IUCN 2012. *IUCN Red List of Threatened Species*. Version 2012.2. (<http://www.iucnredlist.org>). Downloaded on 11 October 2012.
- Johnson, A., Vongkhamheng, C. & Saithongdam, T. 2009. The diversity, status and conservation of small carnivores in a montane tropical forest in northern Laos. *Oryx* 43: 626–633.
- Lau, M. W.-N., Fellowes, J. R. & Chan, B. P. L. 2010. Carnivores (Mammalia: Carnivora) in South China: a status review with notes on the commercial trade. *Mammal Review* 42: 247–292.
- Le T. T., Nguyen H. D., Nguyen C., Le V. C., Eames, J. C. & Chicoine, G. 1999. *An investment plan for Ke Go Nature Reserve, Ha Tinh province, Vietnam: a contribution to the management plan*. BirdLife International Vietnam Programme, Hanoi, Vietnam.
- Le X. C., Pham T. A., Duckworth, J. W., Vu N. T. & Lic V. 1997. *A survey of large mammals in Dak Lak Province, Vietnam*. WWF Indochina Programme / IUCN, Hanoi, Vietnam.
- Long, B. & Minh H. 2006. Recent records of and notes on the conservation of small carnivores in Quang Nam province, central Vietnam. *Small Carnivore Conservation* 34 & 35: 39–46.
- Low, C. H. S. 2010. Observations of civets on Fraser's Hill, Peninsular Malaysia. *Small Carnivore Conservation* 43: 8–11.
- Luu H. T. 2008. *Ta Kou Nature Reserve as a key biodiversity area for the coastal most southern central of Vietnam*. Centre for Biodiversity and Development, Ho Chi Minh City, Vietnam.
- Mathai, J., Hon, J., Juat, N., Peter, A. & Gumal, M. 2010. Small carnivores in a logging concession in the Upper Baram, Sarawak, Borneo. *Small Carnivore Conservation* 42: 1–9.
- Miller, G. S. 1901. Mammals collected by Dr. W. L. Abbott on the Natuna Islands. *Proceedings of the Washington Academy of Sciences* 3: 111–138.
- Moore, R. S. 2011. Sightings of Javan Small-toothed Palm Civets *Arctogalidia trivirgata trilineata* on Gunung Salak, West Java, Indonesia. *Small Carnivore Conservation* 44: 38–39.
- [MoST and VAST] Ministry of Sciences and Technology and Vietnam Academy of Sciences and Technology 2007. *Red data book of Vietnam, part 1: animals*. Natural Sciences and Technology Publishing House, Hanoi, Vietnam.
- [MoSTE] Ministry of Science, Technology and the Environment 2000. *The red book of Vietnam, II: animals*. Science and Technology Publishing House, Hanoi, Vietnam.
- Nguyen X. D., Pham T. A., Nguyen M. T. & Le H. T. 2004. Mammals. Pp. 85–103, 133–138 in Sage, N., Kutcher, S., Nguyen X. V., Wilson, P. & Dunlop, J. (eds) *Biodiversity survey U Minh Thuong National Park*. Agriculture Publishing House, Ho Chi Minh City, Vietnam.
- Ochoa, J. & Soriano, P. J. 2001. The effects of logging on nonvolant small mammal communities in Neotropical rain forests. Pp. 125–152 in Fimbel, R. A., Grajal, A. & Robinson, J. G. (eds) *The cutting edge: conserving wildlife in logged tropical forest*. Columbia University Press, New York, U.S.A.
- Payne, J., Francis, C. M. & Phillipps, K. 1985. *A field guide to the mammals of Borneo*. The Sabah Society with WWF Malaysia, Kota Kinabalu and Kuala Lumpur, Malaysia.
- Rawson, B. M., Insua-Cao, P., Nguyen M. H., Van N. T., Hoang M. D., Mahood, S., Geissmann, T. & Roos, C. 2011. *The conservation status of gibbons in Vietnam*. Fauna & Flora International and Conservation International, Hanoi, Vietnam.
- Robertson, S. I. 2007. *The status and conservation of small carnivores in Vietnam*. University of East Anglia (PhD thesis), Norwich, U.K.
- Su Su 2005. Small carnivores and their threats in Hlawga wildlife park, Myanmar. *Small Carnivore Conservation* 33: 6–13.
- Suzuki, S., Kitamura, S., Kon, M., Poonswad, P., Chuailua, P., Plongmai, K., Yumoto, T., Noma, N., Maruhashi, T. & Wohandee, P. 2006. Foraging activity patterns of frugivorous or omnivorous animals on the forest floor of a tropical seasonal forest in Thailand, with reference to seasonal changes. *Natural History Bulletin of the Siam Society* 54: 177–194.
- Than Zaw, Saw Htun, Saw Htoo Tha Po, Myint Maung, Lynam, A. J., Kyaw Thinn Latt & Duckworth, J. W. 2008. Status and distribution of small carnivores in Myanmar. *Small Carnivore Conservation* 38: 2–28.
- Tordoff, J. 2002. *Directory of IBAs (Important Bird Areas) in Vietnam*. BirdLife International Vietnam Programme, Hanoi, Vietnam.
- Veron, G., Gaubert, P., Franklin, N., Jennings, A. P. & Grassman, L. I., Jr. 2006. A reassessment of the distribution and taxonomy of the endangered Otter Civet *Cynogale bennettii* (Carnivora: Viverridae) of South-east Asia. *Oryx* 40: 42–49.
- Walston, J. L. & Duckworth, J. W. 2003. The first record of Small-toothed Palm Civet *Arctogalidia trivirgata* from Cambodia, with notes on surveying this species. *Small Carnivore Conservation* 28: 12–13.
- Wells, K., Bium, A. & Gabin, M. 2005. Viverrid and herpestid observations by camera and small mammal cage trapping in the lowland rainforests on Borneo including a record of the Hose's Civet, *Diplogale hosei*. *Small Carnivore Conservation* 32: 12–14.

- Willcox, D., Do T. H., Tran Q. P., Nguyen V. N. & Robertson, S. in prep. a. Conservation status of small carnivores in the Ke Go–Khe Net Lowlands, Central Vietnam.
- Willcox, D., Do T. H., Tran Q. P., Nguyen V. N. & Robertson, S. in prep. b. Conservation status of small carnivores in the U Minh wetlands, Vietnam.
- Wilting, A., Samejima, H. & Mohamed, A. 2010. Diversity of Bornean viverrids and other small carnivores in Deramakot Forest Reserve, Sabah, Malaysia. *Small Carnivore Conservation* 42: 10–13.

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