A comparison of three survey methods for detecting the elusive pygmy slow loris *Nycticebus pygmaeus* in Eastern Cambodia

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មូលន័យសង្ខេប

វិធីសាស្ត្រផ្សេងៗក្នុងការអង្កេតសត្វព្រៃត្រូវបានបង្កើតឡើងសម្រាប់ប្រភេទធំៗ និងទាក់ទាញចំណាប់អារម្មណ៍នៅឥណ្ឌូចិន ប៉ុន្តែមិនមែនសម្រាប់ប្រភេទថនិកសត្វតូចៗផ្សេងទៀតឡើយ។ ការសិក្សានេះមានគោលបំណងវាយតម្លៃវិធីសាស្ត្រ៣ដើម្បីសិក្សាពីចំនួនប្រហាក់ប្រហែលរបស់រញ្ជីក្រិស *Nycticebus pygmaeus* ដែលរងការគំរាមកំហែងដោយការធ្វើអាជីវកម្មហួសប្រមាណ និងការបាត់បង់ទីជម្រក។ ការសិក្សានេះគឺត្រូវបានធ្វើឡើងដោយប្រើទីតាំងកាត់ទទឹង(transect)ពីរកន្លែង នៅក្នុងព្រៃពាក់កណ្តាលបៃតងនៃតំបន់ព្រៃការពារសីម៉ា ប្រទេសកម្ពុជា ក្នុងកំឡុងពីថ្ងៃទី២-២០ ខែឧសភា និងពីថ្ងៃទី៣-១៤ ខែធ្នូ ឆ្នាំ២០០៧។ (១) សំណាញ់ទ្រុងធ្វើពីខ្សែត្រូវបានដាក់នៅលើដើមឈើ >១.៥ម៉ែត្រ ប៉ុន្តែវាអាចចាប់បានតែសត្វកកេរ *Niviventer* spp. មួយប៉ុណ្ណោះ ក្នុងកំឡុងពេលដាក់សំណាញ់នោះ៦៥០យប់។ (២) ចានផ្តានយកស្នាមជើងដែលមាននុយត្រូវបានដាក់នៅលើដើមឈើ ហើយផ្តិតយកស្នាមជើងថនិកសត្វទំហំមធ្យមបានយ៉ាងតិច៥ប្រភេទដែលមានដូចជាសំពោចដូង*Paradoxurus hermaphrodites* ពួកស្កាកលឿង*Martes flavigula* កំប្រុកយក្ស(*Ratufa* and/or *Petaurista* spp.) សំពោចដូងពាក់មុខ*Paguma larvata* ឆ្មា *Prionailurus bengalensis* និង/ឬ ឆ្មា *Pardofelis mamorata* ក្នុងកំឡុងពេល៧៦៣យប់។ នៅលើចានផ្តានស្នាមជើងទាំងនោះមានស្នាមជើងច្រើនពេកដែលពិបាកកំណត់ឈ្មោះប្រភេទឲ្យបានត្រឹមត្រូវ ក៏ប៉ុន្តែស្នាមជើងរបស់សត្វរញ្ជីមិនត្រូវបានរកឃើញឡើយ។ (៣) ការឆ្លុះពេលយប់ដោយប្រើពន្លឺពណ៌ក្រហមបានប្រទះឃើញថនិកសត្វ៩ប្រភេទគឺរញ្ជីក្រិស (0.៣៣ km^{-1}) សំពោចដូង(0.៥0 km^{-1}) ថនិកសត្វ chevrotain *Tragulus kanchil* (0.៣៣ km^{-1}) និងកំប្រុកយក្សហើរ *Petaurista* spp. (0.៣៣ km^{-1})។ ទោះបីជាការធ្វើតេស្ត និងការសិក្សាបន្ថែមគួរតែត្រូវបានធ្វើឡើងក៏ដោយ ក៏យើងអាចសន្និដ្ឋានថា ការឆ្លុះមើលពេលយប់គឺជាវិធីសាស្ត្រដ៏ល្អមួយសម្រាប់ស្វែងរករញ្ជីក្រិសនៅក្នុងតំបន់នេះ។

Abstract

Wildlife survey methods have been well developed for large and/or charismatic species in Indochina, but not for many smaller mammals. This study aimed to evaluate three methods for sampling the relative abundance of the pygmy loris *Nycticebus pygmaeus*, which is threatened by overexploitation and habitat destruction. The study was conducted using two transects in a semi-evergreen forest in the Seima Protection Forest, Cambodia, from 2–20 May and 3–14 December 2007. (1) Wire cage traps were set >1.5 m high in trees, but caught only one rodent *Niviventer* spp. during 650 trap-nights. (2) Track plates with bait were placed in trees and recorded at least five medium-sized mammals: common palm civet *Paradoxurus hermaphroditus*, yellow-throated marten *Martes flavigula*, giant squirrel (*Ratufa* and/or *Petaurista* spp.),

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masked palm civet *Paguma larvata*, leopard cat *Prionailurus bengalensis* and/or marbled cat *Pardofelis marmorata*, over 763 track plate-nights. There were often too many footprints on the arboreal track plates to correctly identify species, but no loris prints were detected. (3) Spotlighting at night, using a light with a red filter, detected four mammal species: pygmy slow loris (0.33 km^{-1}), common palm civet (0.50 km^{-1}), lesser Oriental chevrotain *Tragulus kanchil* (0.33 km^{-1}) and giant flying squirrel *Petaurista* spp. (0.33 km^{-1}). Whilst further testing and refinement is warranted, we conclude that spotlighting is the most effective method for detecting pygmy slow lorises in this site.

Keywords

abundance, fauna survey, spotlight, track board, trap.

Introduction

Small and medium-sized nocturnal mammals tend to be less frequently studied than large mammals in Indochina, and their distribution and abundance is poorly known (Tam *et al.*, 2002). This is partly due to the lack of effective and efficient survey methods for these animals (Lunde *et al.*, 2003). Previous surveys of slow lorises have detected animals visually with white halogen spotlights or headlamps (Duckworth, 1994; Singh *et al.*, 1999; Evans *et al.*, 2000; Singh *et al.*, 2000), or halogen headlamps with a red light filter (Nekaris, 1997; Nekaris & Jayewardene, 2003, 2004; Nekaris & Nijman, 2008; Das *et al.*, 2009; Starr *et al.*, 2011). The latter has been the preferred method because it is considered less likely to disturb encountered animals. Wiens & Zitzmann (2003) successfully captured the greater slow loris (*Nycticebus coucang*) in arboreal cage traps for a radio-tracking study in Malaysia.

The pygmy slow (hereafter pygmy) loris (*Nycticebus pygmaeus*) is endemic to Vietnam, Laos, southern China and eastern Cambodia (Nisbett & Ciochon, 1993; Fooden, 1996; Ratajszczak, 1998; Brandon-Jones *et al.*, 2004; Groves, 2007). Published reports on wild pygmy lorises were until recently limited to a few short surveys in Vietnam and Laos (Duckworth, 1994; Tan & Drake, 2001; Vu, 2002) and a radio-tracking study of reintroduced animals in Vietnam (Streicher, 2004a). The majority of knowledge of their ecology and biology had come from captive colonies (e.g. Jurke *et al.*, 1997, 1998; Fisher *et al.*, 2003; Fitch-Snyder & Ehrlich, 2003; Fitch-Snyder & Jurke, 2003; Streicher, 2004b) and reintroduced trade animals (Streicher & Nadler, 2003; Streicher, 2004a, 2009). However, there has been one recent long-term study of their wild ecology and conservation in Cambodia (Nekaris *et al.*, 2010a,b; Starr *et al.*, 2010, 2011, 2012; Starr 2012; Starr & Nekaris, in press).

The pygmy loris is known to be hunted for traditional medicines in Cambodia (Walston, 2005; Starr *et al.*, 2010), and there is an urgent need to monitor any decline in these populations. This knowledge is vital for developing strategies for their conservation. The present study therefore aimed to develop and test improved methods for determining the presence and relative abundance of pygmy lorises by evaluating the effectiveness of three detection methods: wire cage traps, track plates and spotlighting.

Methods

Study site

The study was conducted in the Seima Protection Forest, in southern Mondulkiri Province, Cambodia (Fig. 1). The conservation area encompassed approximately 3,050 km^2 at the time of our study. The study was conducted on two transects (UTM 48P 708205E; 343141N) in the wet season from 2–20 May 2007 and during the early dry season from 3–14 December 2007. Encounter rates of pygmy loris were known to be high on these transects from surveys conducted in early 2007 (Starr *et al.*, 2011).

The dry season extends from November to April and the rainy season from May to October in Mondulkiri and the mean annual rainfall is approximately 2,000–2,500 mm (Javier, 1997). Rainfall in the southern, more mountainous part of the province is considerably higher, with an annual mean of over 3,200 mm. The conservation area lies between 100–700 m a.s.l. on the western slopes of the Sen Monorom Plateau, and the southern part is in the Annamite Range (Evans *et al.*, 2003).

The vegetation of Seima Protection Forest consists of a mosaic of forest types, including semi-evergreen, mixed deciduous, deciduous dipterocarp and evergreen forests (Walston *et al.*, 2001). This study took place in semi-evergreen forest.

Transects

Two transects were used during both the wet and dry season sampling periods. The transects were approximately 3.0 km and 2.5 km in length and they were spaced 1.0 km apart to maximise sampling independence. Spot-

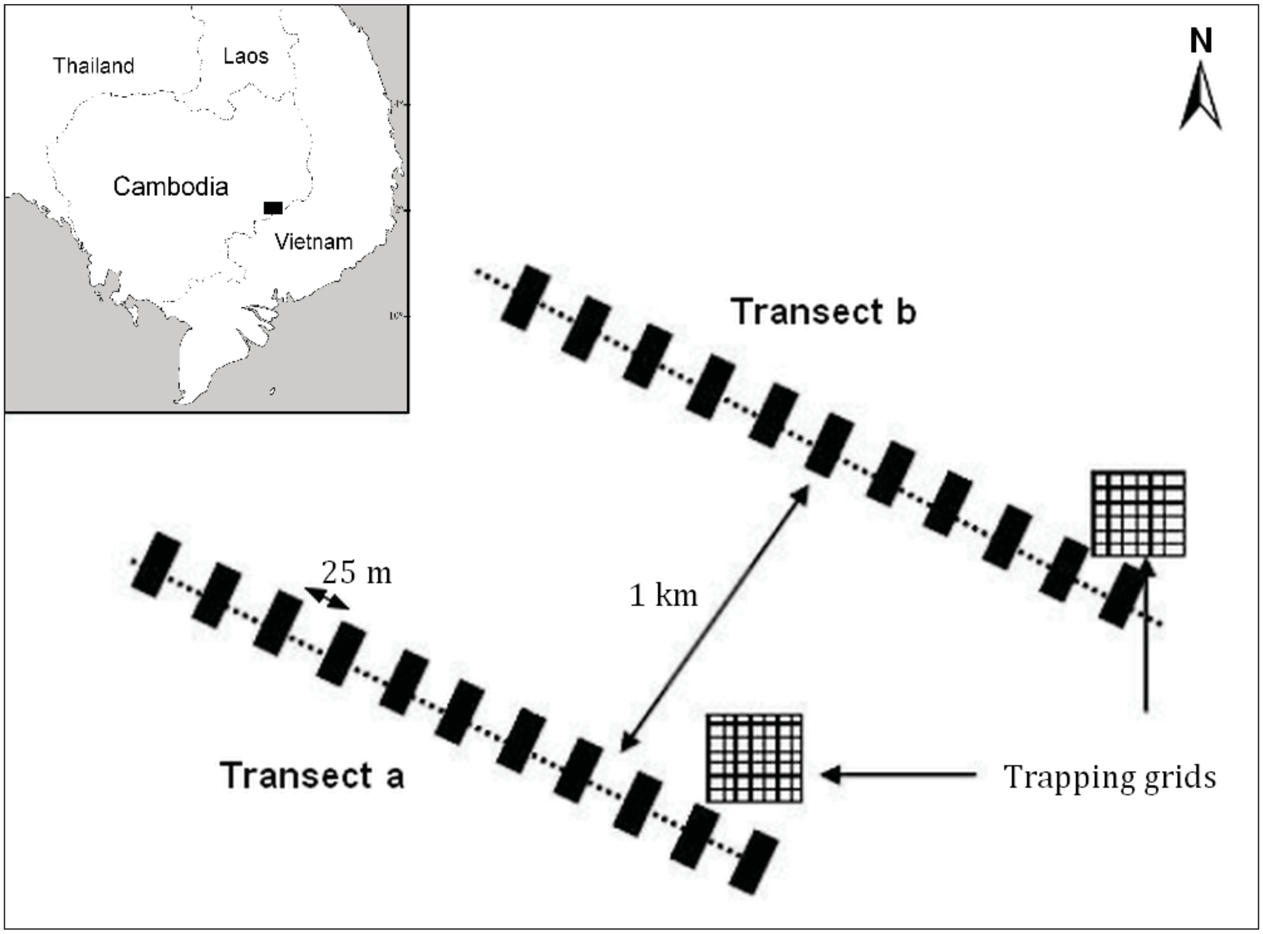

Fig. 1 The shaded square on the insert indicates the location of the survey site in Cambodia (not to scale). The main diagram shows how tracking plates and grids were distributed along transects a and b. Filled rectangles represent the tracking plates.

lighting, wire cage trapping grids and arboreal track plates were used on both transects, as described below.

Spotlighting

Petzl® Zoom 4.5 volt headlamps (Petzl, Crolles, France) with a red light filter were used to detect animals visually at night. This method has been successfully used in field studies of various slow loris species (Nekaris, 2003; Nekaris & Jayewardene, 2004; Nekaris *et al.*, 2008). Animals were located by their reflective eye shine, which appears orange when viewed with a headlamp.

Transects were walked slowly (500–1,000 m/hr) and all levels of the vegetation were scanned by three surveyors who were spaced at least 10 m apart. Both transects were walked three times during each of the two study periods. Surveys began after 1800 h and finished between 0100 h and 0400 h. Once an animal was sighted by a surveyor, a halogen spotlight was used to confirm identification with the aid of 10 x 40 binoculars.

Arboreal track-plate

Sampling stations for arboreal tracking plates were placed *circa* 25 m apart along each transect with 60 and 40 sampling stations on each transect respectively. They were set over eight consecutive nights during each survey period. The arboreal track plates were made from a thin piece of plywood (2.5 mm x 40 cm x 22 cm) with a smooth gloss-white laminated surface. Small holes were drilled near the edge of the plate so it could be secured with wire to one end of a long bamboo culm.

The plate was then placed flat on a tree branch by hoisting it into the canopy with a second long bamboo culm (Fig. 2). The bamboo culm was then secured tightly with a rope to the base of the same or a nearby tree. This method allowed the plate to be easily lowered to the ground to check it for footprints.

Two types of bait – a piece of sugar palm block or a piece of banana and a piece of chicken or a boiled egg –

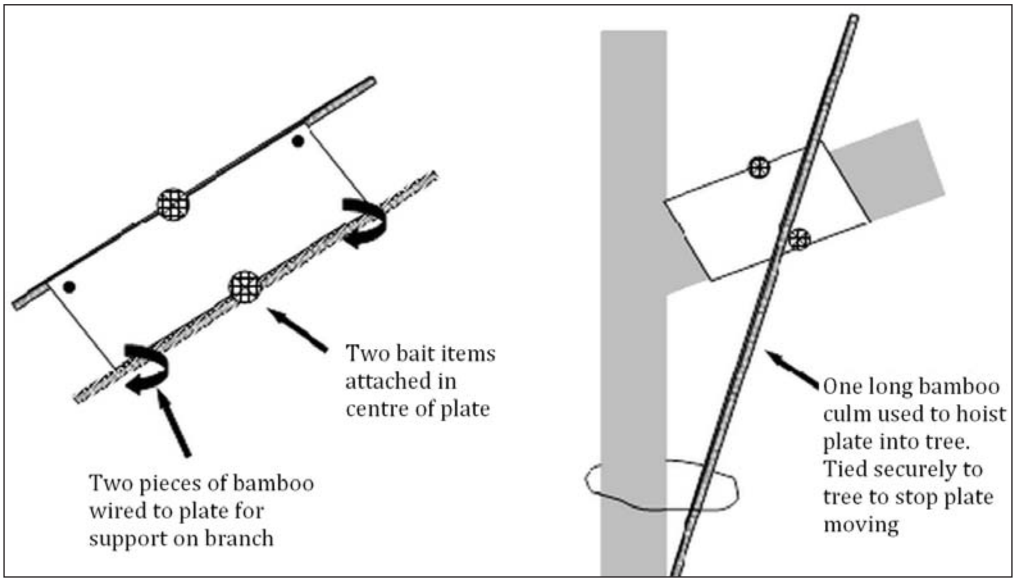

Fig. 2 The construction and placement of arboreal tracking plates in trees or bamboo.

were tied to each plate with string. Plates were checked and re-baited every second morning over eight consecutive days for each sampling period. The bait type and the identification of species (based on footprints on the plate) were recorded to assess the attractiveness of bait type.

Tracks were identified in the field with a mammal key where possible (Greenworld Foundation, 1999) or photographed for later identification. Reference footprints were photographed from some captive animals (leopard cat *Prionailurus bengalensis*, yellow-throated marten *Martes flavigula*, common palm civet *Paradoxurus hermaphroditus*, Northern slow loris *Nycticebus bengalensis*, small-toothed palm civet *Arctogalidia trivirgata* and binturong *Arctictis binturong*) at Phnom Tamao Wildlife Rescue Centre, Takeo Province.

Wire cage trap

A small (450 x 150 x 150 mm) steel cage trap with 10 mm mesh was used to target pygmy lorises. This design was chosen because it was light enough to lift into trees, and because it was effective in capturing the greater slow loris in Malaysia (Wiens, 2002). The trap was secured in trees in the same way as described for the arboreal track plate and baited with half a fresh banana (Fig. 3).

Fig. 3 Placement of arboreal traps on bamboo or trees.

Traps were pre-baited for two weeks with banana prior to the trapping period to improve the probability of sampling any trap-shy species. All traps were checked and re-baited if necessary each morning.

The wire cage traps were placed in a trapping grid (100 x 100 m) randomly located along the transect: the grid consisted of 5 x 5 trap stations placed 25 m apart, with one wire cage trap at each station. These were set for 17 and eight consecutive nights during the wet and dry season sampling periods respectively.

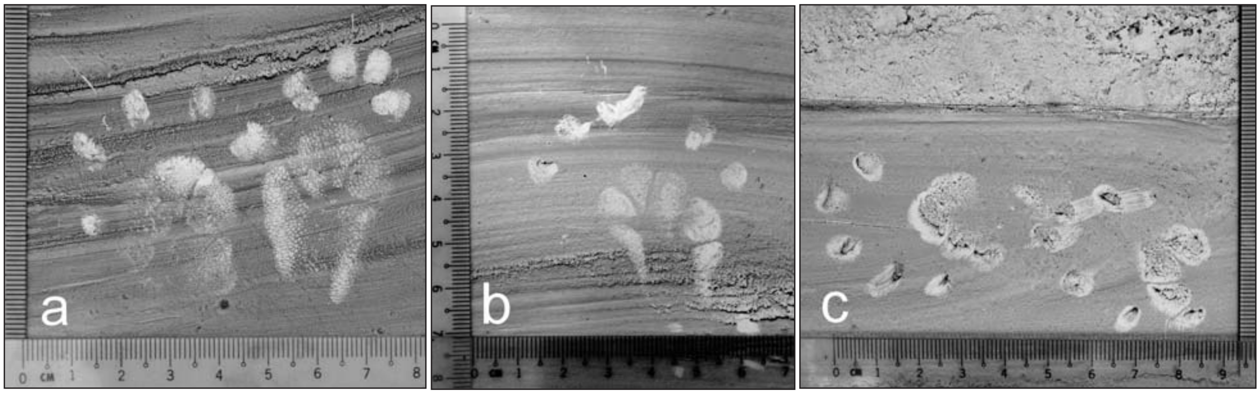

Fig. 4 Examples of footprints recorded on track plates: **a.** common palm civet *Paradoxurus hermaphroditus*; **b.** small-toothed palm civet *Arctogalidia trivirgata*; **c.** yellow-throated marten *Martes flavigula*.

Abundance indices

The relative abundance of species was indexed by the number of individual animals caught per 100 trap-nights and the number of intrusions (the presence of footprints of the species on a plate over one night) per 100 track-plate-nights. The index used for assessing the relative abundance on spotlighting transects was the linear encounter rate, i.e. the number of animals encountered per kilometre (Sutherland, 2002).

Results

The abundance indices for every species detected by each survey method are given in Table 1. A total of 650 wire cage trap-nights and 763 arboreal track-plate-nights were conducted. Many tracks could not be identified to a genus or species level because footprints overlapped each other and, therefore, indices reported here are likely to be underestimates. No loris prints were detected on any of the track plates. The tracks of three species are shown in Fig. 4.

We used 200 items of each type of bait across the study. Boards baited with banana had the highest bait uptake by mammals (Table 2).

Table 1 Abundance indices for species recorded using each survey method (* tentative identification).

Taxon	Wire cage trap	Arboreal track-plate	Spotlighting with red head lamps
Niviventer spp.	0.31	–	–
Ratufa and/or *Petaurista* spp. *	–	0.13	0.33
Martes flavigula	–	0.39	–
Paradoxurus hermaphroditus	–	6.55	0.50
Tragulus kanchil	–	–	0.33
Nycticebus pygmaeus	–	–	0.33
Prionailurus bengalensis or *Pardofelis marmorata* *	–	0.26	–
Paguma larvata	–	0.26	–

Table 2 Number of bait items taken on arboreal track plates with the corresponding identified tracks (* tentative identification).

Taxon	Banana	Egg	Chicken	Sugar palm
Paradoxurus hermaphroditus	32	18	19	17
Martes flavigula	2	0	1	2
Paguma larvata	2	1	1	0
Ratufa and/or *Petaurista* spp. *	1	1	0	0
Prionailurus bengalensis and/or *Pardofelis marmorata* *	1	1	0	0
Unidentified small mammals*	17	8	8	8

Discussion

The wire cage traps used in this study were ineffective in sampling lorises, even with two weeks of careful pre-baiting. This contrasts with the effectiveness of these traps in capturing greater slow lorises in Malaysia (Wiens & Zitzmann, 2003; Wiens *et al*., 2008). Fresh droppings and signs of civet species were present near many cage traps, and civets may enter a larger trap design, but only a single rodent was captured. These findings indicate that other small-to-medium-sized mammals (suitable for traps of this size) in the site are also likely to be highly trap-shy. We do not recommend the cage traps used here for future studies of pygmy lorises, or other arboreal small-to-medium-sized mammals in the site.

Arboreal tracking plates were often covered by too many overlapping footprints to identify the species, but no pygmy loris tracks were identified from the boards. The problem of overlapping tracks may be resolved by reducing or removing bait and/or by using a larger plate. A larger plate would also be useful for assessing the gait of animal, and may improve species identification in future studies. The track plate's failure to detect lorises may also be related to its flat surface, which pygmy lorises may have been reluctant to move across. Their digits are adapted to grip around tree branches, rather than flat surfaces, and shaping plates to fit around branches may prove useful. Captive Northern slow lorises were also observed to be reluctant to cross track plates in enclosures (C. Starr, pers. obs.), despite their placement near food dishes at Phnom Tamao Wildlife Rescue Centre when collecting reference prints for this study.

The track plates are cheap, easy to use and labour-efficient when compared to trapping methods and may be valuable for future studies. The carbon tracking surface of this plate was resistant to light showers, but not heavy rain. Identification based on only the track plate method might not be reliable for some species that have similar footprints (e.g. the leopard cat and marbled cat). Recent studies have investigated the use of arboreal camera trapping as a tool for surveying and studying arboreal mammals (Oliveira-Santos *et al.*, 2008). This tool may assist in improving identifications if placed near the track boards. We recommend further development of arboreal tracking plates to detect slow lorises and other arboreal mammals.

Calls of wild pygmy lorises were heard, but it took the lead researcher five months of field work to be able to clearly recognise these calls (Starr *et al.*, 2011). Calls may differ between seasons, sexes and age classes and this knowledge would be useful to develop a call-based method for monitoring this species.

Despite our substantial trapping and tracking effort, no pygmy lorises were captured in traps or crossed track boards during this study. Of the three methods tested, spotlighting was found to be the most effective method to detect pygmy lorises. Until an improved trapping method can be identified, studies where animals need to be captured (e.g. to attach radio-collars or collect morphological data) must rely on hand capture, which may be difficult in field sites with tall vegetation.

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