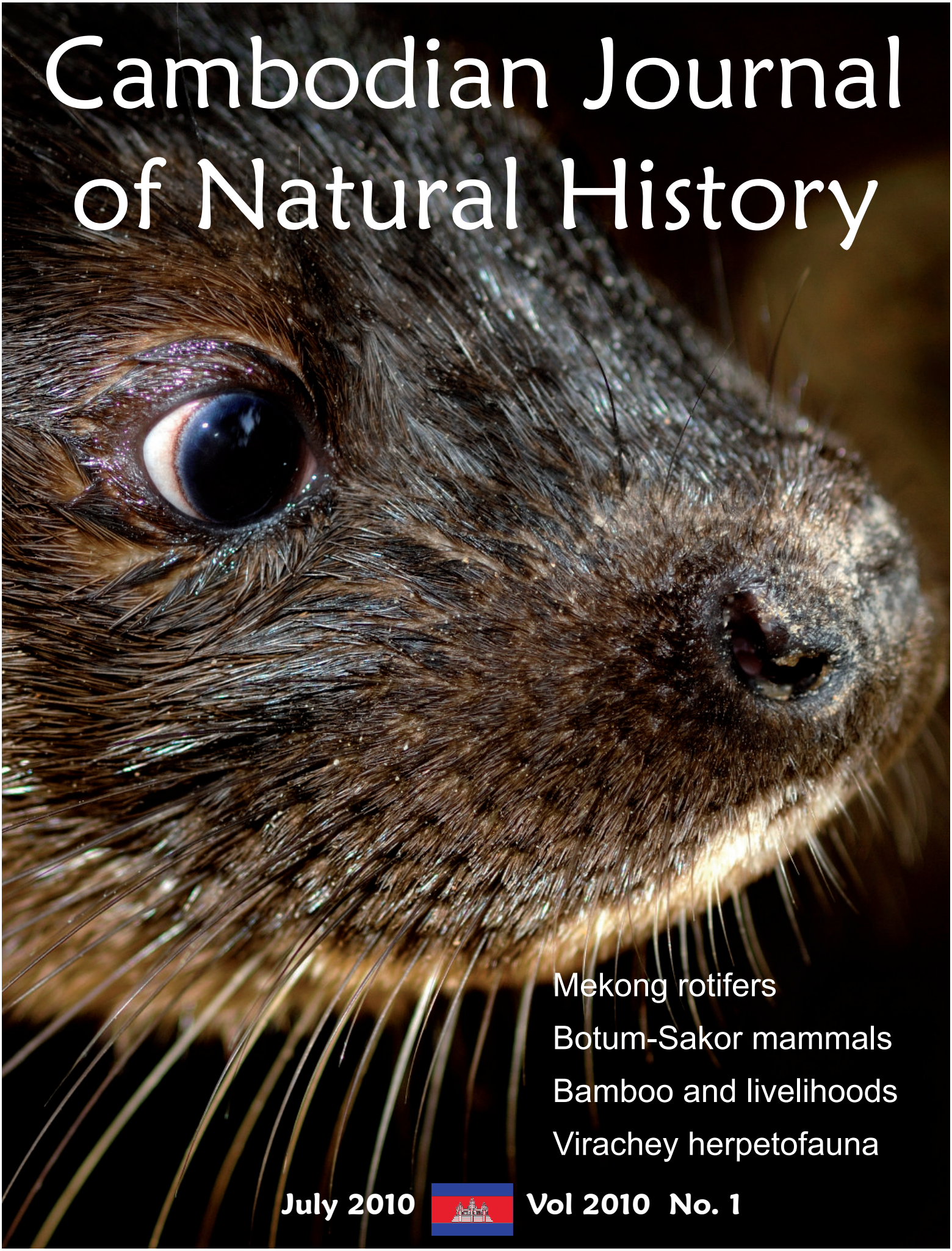
Cambodian Journal of Natural History



Mekong rotifers

Botum-Sakor mammals

Bamboo and livelihoods

Virachey herpetofauna

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Cambodian Journal of Natural History

The *Cambodian Journal of Natural History* is a free journal published by the Centre for Biodiversity Conservation, Royal University of Phnom Penh. The Centre for Biodiversity Conservation is a non-profit making unit dedicated to training Cambodian biologists and to the study and conservation of Cambodian biodiversity.

Cover photo: (© Jeremy Holden/ Global Wildlife Conservation). Possibly the world's rarest otter, the endangered hairy-nosed otter *Lutra sumatrana* has been found in Cambodia's Cardamom Mountains (previous volume), Tonle Sap Great Lake (see Heng, this volume) and Botum-Sakor (Royan, this volume).

Editorial - In memoriam of Lim Kannitha

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Four years ago, in February 2006, Kannitha was one of 24 students who made up the first intake of our new MSc course in Biodiversity Conservation at the Royal University of Phnom Penh. Like most of her peers, Kannitha came from a family of very modest means and her educational background was mixed. As such, it was tempting to think that Kannitha would follow other students out of the course before completing it. But Kannitha defied the odds because she had what many of her peers lacked: determination, an indomitable spirit and a hunger for knowledge that left her eager to learn and to overcome challenges. Rather than being upset about failing her first assignment, Kannitha welcomed the feedback as a chance to improve her research skills. She quickly realised that the MSc course was not only a challenge, but the opportunity of a lifetime, and it made her work harder and become even more determined. She studied hard to reach a level of scientific excellence both for herself and for her country.

Unfortunately, Kannitha's tragic demise to malaria in February 2010 came much too early for her to enjoy life as a scientist - a life she richly deserved and aspired to. She represented the very best of the MSc course and possessed the rare combination of qualities required to make a good scientist: curiosity, commitment, creativity, intelligence and altruism. Kannitha also had the tenacity to break from traditional conservatism and face new challenges with a smile and without prejudice. Her open-minded spirit made her at home amongst all cultures, both in the lab as well as in the field. I had no reservations in recommending her to pursue her studies in Denmark with Prof. Dr Ole Naesby Larsen (Odense University) and Prof. Dr Knud E. Heller (Copenhagen University) who repeatedly acknowledged her outstanding potential as a scientist and appreciated her wonderful demeanour and positive personality.

Lim Kannitha (© Chey Koulang).

While breaking with traditional cultural expectations as a woman and pursuing her studies, Kannitha was also a role model for many of her peers and younger students, whom she never failed to help whenever she could. She had charm, was mild-mannered and possessed a very winning personality that made her a favourite amongst her

peers and teachers. She will leave immense sadness and grief amongst fellow students and scientists in Cambodia and in Europe, and not least amongst her family and friends.

It is not meaningful to say that death is unfair, but in this case I would say that it came at a very untimely and tragic moment because the empty space she has left is far too large. Much has been lost with her demise as one of Cambodia's most promising young researchers in the field of biodiversity.

Kannitha will be sorely missed by students and fellow scientists.

Editor's note:- A trust fund dedicated to the memory of Lim Kannitha is presently being established by Conservation International, Fauna & Flora International and the Royal University of Phnom Penh. The aim of the fund is to sponsor scholarships and research opportunities for Cambodian women in the area of biodiversity conservation. Individuals interested in supporting the Lim Kannitha Trust Fund are encouraged to contact Dr Neil Furey (n.furey.ffi@gmail.com) for further details.

Letters to the Editors

This occasional section presents informative contributions of fewer than 650 words, usually in response to material published in the Journal. Letters to the Editors are not peer-reviewed (unlike Short Communications and Full Papers), but may be edited for length and English grammar.

Obituary to the black-bellied tern

It is with deep sorrow that we report the demise of the last surviving black-bellied tern *Sterna acuticauda* in Cambodia. This species nested on the sandbars of undisturbed rivers and faced many odds during the last few decades. By the late twentieth century, disturbance, nest predation by domestic dogs and opportunistic egg harvesting by local people had already brought it to the verge of extinction, with only two pairs clinging on to sandbars of the Sesan River in Ratanakiri Province. These birds were seen for the last time in 2003, and although one pair hatched two chicks that year, no black-bellied terns have been seen since. A two-day search in 2008 failed to locate any members of the species, and a dedicated three-day search along the Sesan River earlier this year unfortunately confirmed the fears that the population was extinct in Cambodia. The hydrological and ecological impacts of the upstream dams built in Vietnam were arguably the nail in the coffin for the last Cambodian representatives of the black-bellied tern.

After the greater flamingo *Phoenicopterus ruber* (last shot in 1935) and the Indian skimmer *Rynchops albicollis* (early 1960s), this is the third bird species to have been lost in Cambodia, and – a dubious distinction – the first one of this century. More tragically, a species vanishing in the Kingdom today almost always means not only a national loss, but also a regional one: the Cambodian birds were indeed the only survivors in the entire Mekong region.

It is also revealing that the last two bird species extirpated from the country were riverine specialists. So the black-bellied tern followed its relative the Indian skimmer, and is survived by a community of sensitive riverine birds heading towards the same fate at high speed. The river tern *Sterna aurantia*, the river lapwing *Vanellus duvaucelii* and the great thick-knee *Esacus recurvirostris* are bound to join the national cemetery of species if the threats they face are not addressed rapidly. Aside from shedding light on this silent death, this obituary wishes to stress the urgent need of conservation action to save the country's riverine ecosystems and biodiversity. If the proposed government scheme of hydroelectric dams, especially those on the main Mekong Channel, is implemented, not only will it erase a unique wildlife assemblage, but it will also dramatically impact the livelihoods of tens of thousands of fishermen as well as the food security of millions of Cambodians.

May this letter ring an alarm bell that awakens the people of Cambodia, their Royal Government and the conservation community. May it help preserve a priceless and highly threatened riverine heritage and curtail the waiting death list of soon-to-be extinct feathered citizens of the Kingdom.

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The last known brood of the black-bellied tern in Cambodia, April 2003 (© Andrea Claassen).

Sandbars of the Sesan River: critical nesting habitat for a suite of endangered riverine birds, January 2010 (© Howie Nielsen).

Short Communication

A new record of *Macaca fascicularis* x *M. mulatta* hybrids in Cambodia

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Currently, up to 11 species of non-human primate are recognised as occurring in Cambodia, specifically: *Nycticebus pygmaeus, N. bengalensis, Macaca fascicularis, M. leonina, M. arctoides, Trachypithecus margarita, T. germaini, Pygathrix nigripes, P. nemaeus, Nomascus gabriellae* and *Hylobates pileatus* (Rawson & Roos, 2008). All of these species are threatened by habitat degradation and loss, hunting and wildlife trade to some degree, although specific pressures vary between taxa.

Research into Cambodia's macaques has been very limited, largely confined to presence/ absence data from broad scale biodiversity surveys (e.g. Timmins & Men, 1998; Daltry & Momberg, 2000; Walston *et al.*, 2001; Pollard *et al.*, 2007) with no recent attempt to systematically collate survey and other data into up-to-date species distributions. This short communication documents what appears to be the first published instance of naturally occurring *M. fascicularis x M. mulatta* hybrids in Cambodia.

The long-tailed macaque (*Macaca fascicularis*) has a wide distribution, from southern Myanmar eastwards through southern Thailand, Laos and Vietnam, South through Cambodia, down the Malay Peninsula into Sumatra, Java and Borneo, and the Philippines. The rhesus macaque (*M. mulatta*) has a similarly large distribution, ranging from Afghanistan, eastwards through Pakistan and northern and central India across into south-eastern China, southwards to Myanmar, northern Thailand, Laos and northern and central Vietnam (Timmins *et al.*, 2008). The distribution ranges of these two species are parapatric, with a relatively narrow zone of overlap, with *M. fascicularis* being the more southerly taxon (Groves, 2001; Brandon-Jones *et al.*, 2004).

The occurrence of hybrids between *M. fascicularis* and *M. mulatta* where their distribution ranges meet in the eastern half of the Indochinese Peninsula is well documented (e.g. Fooden, 1996, 1997; Fooden & Albrecht, 1999; Tosi *et al.*, 2002; Malaivijitnond & Hamada, 2008). For example, in Vietnam, the 'typical' *M. fascicularis* is distributed up to approximately 12°N, while *M. mulatta* is distributed as far South as approximately 17°N (Fooden, 1996), while between these latitudes the species are sympatric and hybrid animals, showing intermediate characters, can be found (Fooden, 1996, 1997; Groves, 2001). In Laos, animals from the zone of overlap are generally attributable to one or the other taxon, but hybrids may occur across a large area and *M. mulatta* shows less rufous pelage on the hindquarters towards the South (Duckworth *et al.*, 1999). Further West in Thailand, the transition zone between taxa is smaller (Fooden, 1997). It is probable that a zoogeographic barrier existed between the two taxa's distributions in the past which was then lost, most likely in the Pleistocene, later resulting in a zone of parapatry with subsequent and

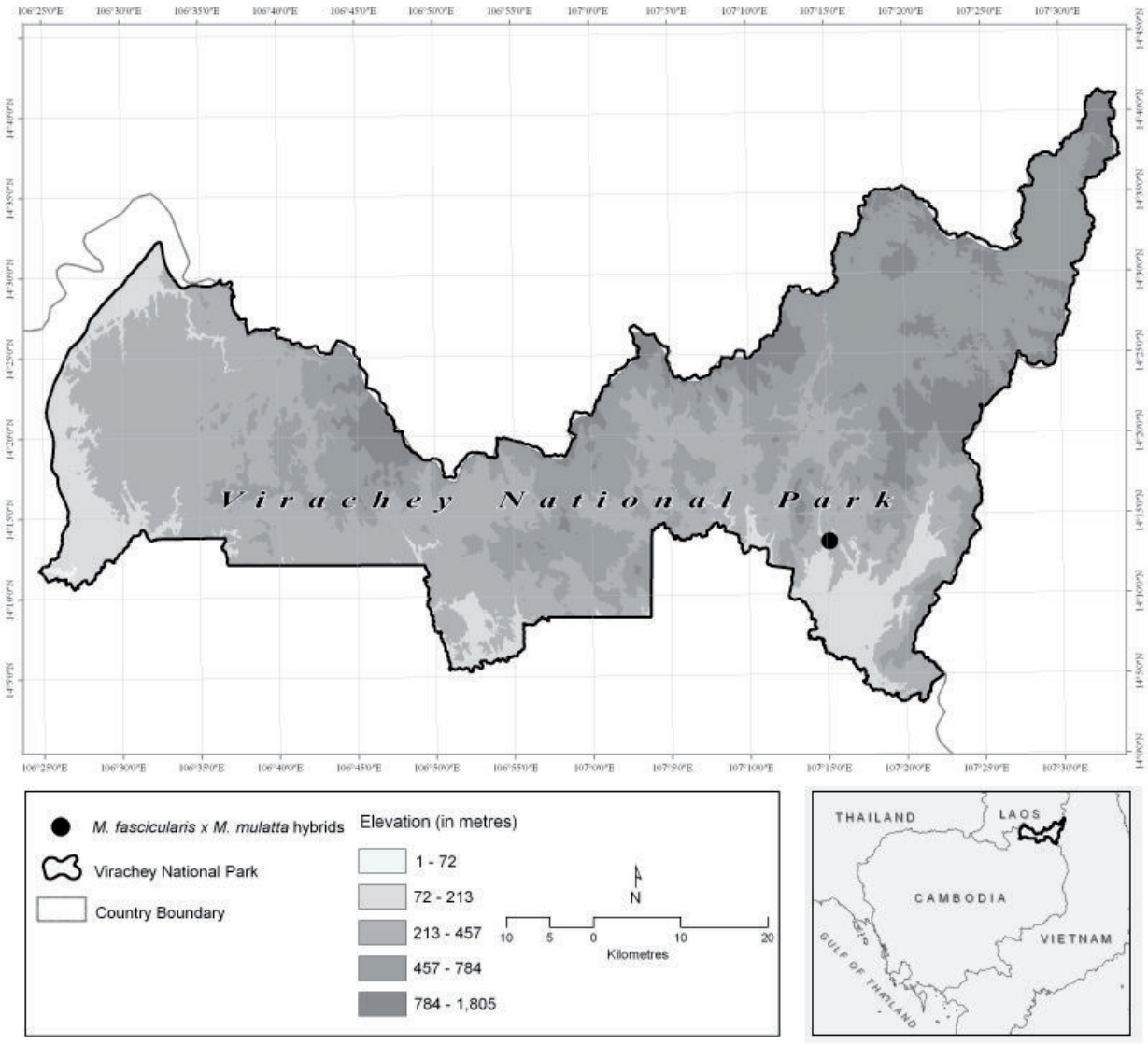

Fig. 1 Map showing the location of *M. fascicularis* x *M. mulatta* hybrids camera trapped in this study.

on-going hybridisation (Fooden, 1997; Fooden & Albrecht, 1999; Malaivijitnond & Hamada, 2008).

One of the best ways of distinguishing between the two taxa is relative tail length (RTL), the percentage ratio of tail length to head and body length. *M. fascicularis* has an RTL usually exceeding 90%, while in *M. mulatta* the figures are usually less than 60%, with hybrids showing intermediate RTLs (Fooden, 1997; Hamada *et al*., 2008). A second appropriate indicator of species is dorsal pelage colour, with *M. fascicularis* showing a relatively uniform grey to brownish colour, while *M. mulatta* has grey to brown pelage on the forequarters with usually strongly contrasting reddish or rufous hindquarters (Fooden, 1997; Hamada *et al*., 2008). Hybrids show a range of intermediate colour variants (Fooden, 1997). Cheek-hair pattern and presence (*M. fascicularis*) or absence (*M. mulatta*) of crests are also good indicators, but only the latter is discussed here due to lack of detail in most photos.

While based on records of hybrid animals from Vietnam, it would be expected that Northeast Cambodia would contain hybrids, this has never been documented with certainty. However, several

Fig. 2 Troop of *Macaca fascicularis* x *M. mulatta* hybrids camera trapped on a mountain stream in northeastern Cambodia.

Fig. 3 Pelage colouration (contrasting rufous hindquarters) and tail length indicate this animals is a *Macaca fascicularis x M. mulatta* hybrid.

Fig. 4 An individual showing no contrast between forequarter and hindquarter pelage, but with a relative tail length (RTL) of approximately 80%.

survey records from Cambodia have suggested that *M. fascicularis x M. mulatta* hybrids may occur in this part of the country, although none have been confirmed by *in situ* photos or genetic evidence. Timmins & Men (1998) recorded a captive animal of unknown provenance with some *M. mulatta*-like characters in Ta Veng District, North of the Tonle Sap, but the animal had an RTL of 100% (Timmins & Men, 1998). Long *et al.* (2000) made two provisional field records on and near the Srepok River very close to the Vietnam border, which may have been hybrids, but species assignation could not be

clearly made and they accepted the possibility that these were pig-tailed macaques (*M. leonina*).

Between 5th and 18th May 2008, as part of an otter survey, we incidentally camera trapped macaques using CamTrakker (unknown film model) camera traps along a mountain stream in evergreen and bamboo forest in northeastern Cambodia (14°13′17.16″N, 107°15′8.52″E, elevation approximately 165 metres above sea level) inside Virachey National Park (Fig. 1). The three camera traps, which were placed several hundred metres apart, captured 26 photographs of macaques containing 37 animals. These included 10 pig-tailed macaques (*M. leonina*) (9 photos) and 27 individuals of ambiguous species designation (17 photos).

The 27 ambiguous individuals varied in tail length and pelage colouration, but none showed characters consistent with either pure *M. fascicularis* or *M. mulatta*, instead showing characteristics of being *M. fascicularis x M. mulatta* hybrids. RTLs appear to be between 60% and 80% in all individuals, although tending towards the long-tailed macaque end of the spectrum (see Figs 2, 3 and 4). Posterior pelage was very variable, but 75% of individuals (12 of the 16 animals which could be assessed) showed some contrasting rufous colouration on the hindquarters. On half of the animals, this was restricted to the outer thigh (although we suspect that we have camera-trapped the same individual with this characteristic several times), with the other half showing distinctive rufous colouration across the whole hindquarters (see Fig. 3). Several individuals with little to no contrast in pelage between fore and hindquarters were also photographed, but RTL was well below 90% in these individuals (Fig. 4). None of the individuals photographed that could be clearly assessed showed the distinctive crest of *M. fascicularis*.

It is suggested that these animals are *M. fascicularis x M. mulatta* hybrids. To our knowledge, this represents the first confirmed *in situ* record of hybridization for Cambodia and shows that the hybrid zone between the two taxa crosses the Northeast of the country through Virachey National Park, although additional data are required to accurately delineate the southern and western limit of the hybrid zone in this area. The camera trapping of northern pig-tailed macaques shows these taxa are broadly sympatric at this site.

Acknowledgements

The authors would like to thank three anonymous reviewers who improved the quality of this manuscript and Dr Ulrike Streicher and Dr Barney Long for comments on the photos. Thanks to the Ministry of Environment and Virachey National Park for facilitating this survey and Disney Wildlife Conservation Fund for funding it.

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About the Authors

HENG SOKRITH has been working with Conservation International Cambodia for more than five years. During the past two years he has been involved in biodiversity research in the Cardamom Mountains and, since 2007, has been responsible for leading the otter project and coordinating Conservation International's research activities. Recently, he has become responsible for developing the strategy for species conservation in the Tonle Sap Lake and for developing tools for improving local livelihoods and improving the areas ecosystem.

HON NAVEN has been working with Conservation International for more than three years, mostly involved with otter research throughout Cambodia. In the last two years, he had been involved in biodiversity research in Virachey National Park and is currently a Tonle Sap Program Associate, involved in biodiversity research and conservation.

BEN RAWSON is the Greater Mekong Region primate specialist for Conservation International and coordinator for the Southeast Asia section of the IUCN/SSC Primate Specialist Group. He has been conducting research and conservation activities on primates in Cambodia and Vietnam for nine years and has a special interest in the population status and ecology of both doucs and gibbons. He is currently landscape manager for Veun Sai Forests in Ratanakiri and Steung Traeng Provinces.

Short Communication

Introducing some charismatic species of Cambodian flora

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Since the end of the colonial period, and Lecomte's nine volume work, *Flore Générale de l'Indochine*, botanical research in Cambodia has been neglected (Killeen, 2009). It is only in the last decade that renewed efforts have been made to investigate the country's largely unknown flora. Recent research has not only found plants not seen for many years, but also uncovered species new to science.

During the botanical expedition conducted by the Ministry of Environment and Fauna & Flora International in the Cardamom Mountains in 2000, for example, a small species of parasitic flower was found growing on a *Tetrastigma* Planch. host vine. This proved to be *Sapria poilanei* Gagnep. (Fig. 7), the only member of the Rafflesiaceae Dumort. known in Cambodia, and a plant not seen in the kingdom since its discovery in the late 1930s (Banzinger & Hansen, 1997). Similarly, the relatively well-studied genus *Nepenthes* L. has remained mysterious within Cambodia (McPherson, 2009). Recent fieldwork has revealed a spectacular endemic form from the Damrei Mountains, *Nepenthes bokorensis* Mey (Mey, 2009) and discovered carpet-like fields of an unknown species of *Nepenthes* in the remote high grasslands of the Cardamom Mountains.

To date approximately 2,300 species of plant have been documented from Cambodia (Dy Phon, 1982). Estimates vary as to the total number likely to be found, but some experts consider the figure might exceed 3,000 (Meng *et al*., 2000). At least 10% of these as yet unidentified species are expected to be endemic, particularly those waiting to be discovered in some of the more geographically isolated areas (Anonymous, 2003).

The following images by the author show some of Cambodia's more unusual and charismatic plants in their natural habitats.

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Fig. 1 Recent surveys in remote areas of the Cardamom Mountains found a series of high altitude grasslands where the carnivorous *Nepenthes* (species undetermined) forms carpets across the ground - perhaps the only place in Indochina where this phenomenon still occurs (© Jeremy Holden).

Fig. 2 *Urticularia odorata* Pellegr. is a member of the bladderwort family, a group of carnivorous plants that capture microscopic invertebrate prey to supplement their nutrient intake. This species was seen in Koh Kong Province and identified by Andreas Fleischmann, Munich University (© J. Holden).

Fig. 3 The spectacular bloom of *Paphiopedilum callosum* Stein. These slipper orchids are represented by around four species in Cambodia. Throughout Indochina they have been eradicated in many localities by over collection for the trade and many species are now extinct in the wild (© J. Holden).

Fig. 4 *Amorphophallus napiger* Gagnep. growing in the dry deciduous forests of Pursat Province. These plants flower before the onset of the monsoon rains (Hetterscheid & Ittenbach, 1996) (© J. Holden).

Fig. 5 The orchid *Habenaria rhodochelia* Hance, beside a waterfall in Mondulkiri (© J. Holden).

Fig. 6 *Nepenthes bokorensis* Mey, an endemic carnivorous pitcher plant recently described from Phnom Bokor (© J. Holden).

Fig. 7 *Sapria poilanei* Gagnep. is a member of the Rafflesiaceae - a family of parasitic plants famous for producing the world's largest flower, *Rafflesia arnoldii* B. Br. *Sapria* is more modest at between 65-12 mm across, but it parasitises the same genus of vines, the *Tetrastigma* Planch., as its larger relative. This flower was first discovered in the Cardamom Mountains in 1938 and rediscovered on Phnom Samkos in the Cardamom Mountains in 2000 (© J. Holden).

Fig. 8 The mountainous jungles of the Cardamom Mountains undoubtedly hold many botanical surprises for future researchers (© J. Holden).

Short Communication

Discovery of a hitherto unknown breeding population of the Asian leaf turtle *Cyclemys aff. atripons* in Phnom Kulen National Park, northwestern Cambodia

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During herpetological baseline surveys in July 2009 by the Angkor Centre for Conservation of Biodiversity (ACCB), in collaboration with the Ministry of Environment and the Zoological Research Museum Alexander Koenig, a single Asian leaf turtle, *Cyclemys aff. atripons*, was discovered in the Kbal Spean River in the western part of Phnom Kulen National Park (PKNP), Siem Reap Province, northwestern Cambodia. To confirm the presence of *Cyclemys* turtles and to provide preliminary information on their population status, a rapid turtle survey was carried out by Frontier-Cambodia and ACCB in collaboration with the Ministry of Environment in March 2010.

Turtle trapping was carried out over ten nights on the Kbal Spean River (c. 200–230 m above sea level) in semi-evergreen forest. In March, at the end of the dry season, the riverbed was partially exposed, allowing slowly flowing water to tenuously connect a series of narrow and mostly shallow pools (Fig. 1). Eight 90 cm x 55 cm x 25 cm mesh traps were baited alternately with chicken or *prahoc* (fermented fish paste) and spaced 50-140 m apart (with two exceptions of 20 m and 350 m apart) in pools in the riverbed. Traps were moved upstream after two to four nights in each location, providing 26 trap locations (17 in rocky-bottomed pools, nine in pools with sandy or muddy substrates) along 2.7 km of the Kbal Spean River.

Five turtles were captured during this survey (Figs 2 and 3). All captures were made in reaches of the river with rocky bottoms and up to 1 m deep sinkholes, which may provide favourable refuges for the turtles during the dry season months. Traps positioned further upstream in locations

Fig. 1 Turtle trap in Kbal Spean River, Phnom Kulen National Park, March 2010 (© Nikki Hulse).

Fig. 2 Juvenile *Cyclemys aff. atripons* captured in Kbal Spean River, March 2010 (© Nikki Hulse).

Fig. 3 Plastron of juvenile *Cyclemys aff. atripons* captured in Kbal Spean River (© Nikki Hulse).

with sandy or muddy substrates yielded no captures. Fewer trap nights at these locations may have affected capture rates, however, plus here the pools were mostly larger and much deeper than on rocky substrate, making captures less likely. Furthermore, there was more evidence of logging and fishing, which may also have affected turtle presence. Three of the turtles captured were juveniles (carapace length 69-119 mm). Thus, there is a previously unknown breeding population present on the Kbal Spean River. The three juveniles were captured using *prahoc* bait, while one adult was captured using chicken bait and one adult was discovered opportunistically, trapped in a dry sinkhole in the riverbed.

Recent DNA sequencing work has clarified some historical confusion over the taxonomy within the genus *Cyclemys*, recognising seven genetically distinct lineages as individual species (Fritz *et al.*, 2008). We putatively identified all of the turtles captured during our survey as *C. aff. atripons*. According to Stuart & Fritz (2008), however, *C. atripons* and *C. pulchristriata* (which so far has only been found in the Mondulkiri region in eastern Cambodia, East of the Mekong River) are morphologically indistinguishable, so genetic sampling of the PKNP population would be necessary to definitively assign a species name.

In Cambodia, *C. atripons* was previously thought to be restricted to the Cardamom Mountains in the Southwest of the country (Emmett, 2009). Based on a closer proximity to this species' known range, the turtles found during our survey likely represent *C. atripons* rather than *C. pulchristriata*. If this is true, then the newly discovered population at PKNP represents a range extension of *circa* 150 km to the East.

The plastron of adult turtles found during this survey was patterned with dense, dark brown radiating lines over a yellow background (Fig. 3), however, similar to the typical plastral pattern for *C. oldhamii* reported by Fritz *et al*. (2008). *Cyclemys oldhamii* has been recorded in Cambodia in Virachey National Park in the Northeast (Conservation International, 2007) and in the Prey Long forest in the North, West of the Mekong River (Som & Kheng, 2007). The Prey Long *C. oldhamii* population is a comparable distance (*circa* 150 km) to Phnom Kulen as the *C. atripons* population of the Cardamom Mountains.

Given that the Kulen Mountain range is located in the mostly flat lowland landscape of northwestern Cambodia and is geographically isolated from other sites of known *Cyclemys* distribution,

however, a genetically distinct, new species of *Cyclemys* cannot yet be ruled out.

Further studies on the taxonomy, distribution, abundance and ecology of the *Cyclemys* turtles of PKNP are planned.

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Short Communication

First record of Eastern grass owl *Tyto longimembris* in Cambodia

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On 20th December 2007, at 'Wat Prohoot' in Chikraeng District, Siem Reap Province, central Cambodia (approx. UTM P48 0442000E, 1440000N), we flushed two Eastern grass owls *Tyto longimembris* from the ground in open, seasonally flooded grassland (Fig. 1). One of the birds was flushed from an active nest and the other individual from a roosting site located c. 25 m from the nest. These observations represent both the first record and first breeding record of the Eastern grass owl in Cambodia.

At first glance the birds resembled the barn owl *Tyto alba*. The first individual (Fig. 2), however, had a mostly dark upper side (crown to rump uniformly medium brown; median, greater and primary coverts dark brown with some irregular and diffuse, slightly paler patches; primaries and secondaries golden-brown with dark brown bars and marks; primaries with blackish tips above and below), in sharp contrast to the pure white face, pale underside (pale brown breast and snowy-white belly), white upper tail coverts, whitish leading edge of the wing, white underwing (with few dark marks, and dark-barred primaries and secondaries), and whitish to pale golden-brown, dark-barred upper tail. The second individual looked similar, differing only in details: it had an obvious golden-buffish patch on the back, the primaries and secondaries appeared paler overall, and the wing coverts were less extensively dark brown, forming a narrower dark band on the upper wing that contrasted both with a broad white band on the leading edge of the wing and the overall paler tail feathers; so, overall, this bird showed more contrast on its upper side. On its underside, some irregularly scattered dark spots were visible. Both birds had very long legs, extending well beyond the tip of the tail in level flight (see Fig. 2) and also obvious when the birds hovered briefly with extended legs (Fig. 3, showing the second individual) before dropping into the grass. Both birds were in primary moult.

The nest was located on dry ground and thus differed to two nests found by Kasorndorkbua *et al.* (2008) in Thailand, in dense patches of thick grasses floating on the surface of a swamp with 30-50 cm deep water. The nest was hidden in a cavity formed by c. 1 m tall, dense grass. The actual nest 'cup' was a simple pad on the ground (no nesting material had been brought in by the birds, but rather the existing grass trampled down) with a c. 1 m long, semi-covered entrance tunnel (Fig. 4). On 20th December, the nest contained five white eggs. On 25th December (when two birds, presumably a male and a female, were flushed), however, it contained only four eggs, two of which were broken (largely dried out already, but with embryos at an early stage of development still recognisable). One was outside the nest 'cup', and the remaining two intact eggs were cold (Fig. 5). On 3rd January 2008, the nest was empty and abandoned.

Thirteen pellets, collected from the nest and the nearby roosting site, mainly contained skulls, bones, and hair of rat-sized rodents, but also of some small passerine birds (according to bill shape, both insectivores and seed-eaters). This is in accordance with the findings of Kasorndorkbua *et al.* (2008) in Thailand (mainly murid rodents) and Lin *et al.* (2007) in southern Taiwan (95% mammals, mainly rats, and 5% birds).

The Eastern grass owl may be a new breeding bird in this part of the Tonle Sap floodplain. Wat Prohoot is a well visited birdwatching site and the wider area has been the location of bird surveys since 1999 (Goes *et al.,* 2001) and an intensive field study on Bengal florican *Houbaropsis bengalensis* since 2002 by several scientists with excellent general ornithological skills (Davidson, 2004; Gray *et al.,* 2007a; Gray, 2008). Moreover, during conversations with local people, who have a generally good knowledge of the grasslands and their birds, it came to light that they did not know this *Tyto* owl, which roosts and nests in the open grassland, while the barn owl is well known. The record presented here, as well as recent breeding records by Kasorndorkbua *et al.* (2008) in northern Thailand, may be indicative of a current range extension of the Eastern grass owl in Indochina, with the birds moving further inland from the species' previously known breeding range that consists of a band along the coast of Myanmar in the West and, geographically isolated, a band along the coast of southeastern China to southern Vietnam in the East (see distribution map in del Hoyo *et al.,* 1999). If true, such movements may be caused by large-scale habitat alterations due to the expansion and intensification of agriculture in traditional breeding areas, such as the Mekong Delta.

It is also conceivable that the Eastern grass owl is a traditional breeding bird of the Tonle Sap floodplain, but has merely been overlooked. The species is little known and rarely observed, and may be under-recorded due to its nocturnal habits. Furthermore, it may be easily confused with the barn owl, which at least in Cambodia, can be found hunting in the same habitat (M. Handschuh, pers. obs.). Moreover, the aforementioned fieldwork on the Bengal florican in the grasslands of the outer Tonle Sap floodplain, where the nest was located, does not usually start until later in the dry season, by which time the owls may have finished nesting and moved to wetter areas in the inner floodplain, which are only rarely visited by observers.

Independent of the scenario, the Eastern grass owl is without a doubt a rare breeding species in the Tonle Sap floodplain that is likely to be threatened by the rapid expansion of agro-industrial plantations and the large scale conversion of grasslands into dry season rice cultivation, and the associated construction of dams and ditches that alter the hydrology and usage patterns by local communities, and thus the vegetation composition of surrounding grasslands (see Gray *et al.* 2007b, Gray, 2008).

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Fig. 1 Nesting habitat of the Eastern grass owl (© Oldrich Rajchl).

Fig. 2 Eastern grass owl (© O. Rajchl).

All five images on this page were taken in Chikraeng District, Tonle Sap floodplain, central Cambodia, in December 2007.

Fig. 3 Eastern grass owl. Note the long legs (© O. Rajchl).

Fig. 4 Nest site of the Eastern grass owl. Note the tunnel-like entrance to the hidden nest (© O. Rajchl).

Fig. 5 Eggs of the Eastern grass owl. The nest originally contained five eggs of the same size and colour (© O. Rajchl).

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About the Authors

SANG MONY had pursued a career in the hospitality sector in Siem Reap before joining the Sam Veasna Center for Wildlife Conservation (SVC) in late 2006. Starting off at the end of the 1990s in a junior position at a beer garden, he worked his way up to the post of Senior Waiter at the Raffles Grand Hotel and later at the Sokha Hotel. At the SVC, Mony was trained to become a bird guide. After successfully completing his training in 2007, he worked as a freelance guide for some time. Since 2008, he has been employed full-time by the SVC as Guide Training Manager/ Bird Guide. Mony has plans for studies in the field of biology or wildlife management in the future.

MARKUS HANDSCHUH started his conservation career during his school days in southern Germany, recording bird nests, breeding birds at home and volunteering on various local projects. After completing his 'civilian service' at a wildlife rescue centre in 1996, he went on to study zoology, botany and palaeontology at the universities of Constance and Tübingen. From 2002 to 2005, he worked as Senior Bird Keeper at the Durrell Wildlife Conservation Trust in Jersey (UK), from where he also undertook overseas fieldwork on critically endangered bird species. He then moved to the British Trust for Ornithology as a Research Ecologist. In 2007, he took up the post of Animal Collection Manager at the ACCB in Siem Reap, where since late 2009 he has been the Project Manager.

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Short Communication

Significant mammals records from Botum-Sakor National Park, Southwest Cambodia

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Located in Koh Kong Province, Southwest Cambodia, Botum-Sakor National Park (NP) comprises a network of forested and coastal habitats over an area of 1,834 km². The NP has a history of unsustainable activities, including logging and hunting and, consequently, many habitats are severely degraded. However, the NP is known to support regionally important, and potentially globally important, populations of several bird species, including green peafowl *Pavo muticus*, white-winged duck *Cairina scutulata*, milky stork *Mycteria cinerea*, lesser adjutant *Leptoptilos javanicus* and grey-headed fish eagle *Ichthyophaga ichthyaetus* (Royan, 2009a). The significance of the mammalian fauna is less understood, but due to the NP's lowland riparian profile, it could be expected to support globally important populations of fishing cat and otter species in particular.

This paper documents the most significant mammal records from Botum-Sakor National Park between July 2005 and September 2009 by Frontier-Cambodia.

Sunda Pangolin *Manis javanica* (IUCN Endangered)

One individual was observed by the author being confiscated from a poacher by park rangers in August 2008. The individual was captured in a snare within the NP boundary South of the National Highway (NH) 48. A close examination of the specimen was not conducted, but the locality implies its identification as *M. javanica*.

Bengal Slow Loris *Nycticebus bengalensis* (IUCN Vulnerable)

Known from four sightings by the author and an individual confiscated by park rangers (Chin Kethya, Wildlife Alliance, pers. comm.), and distinguished from *N. pygmaeus* primarily by size and conspicuous dark stripe on back. Two sightings were near NH 48, another was from Preaek Kon Tourt and one from Preaek Ta Ok.

Indochinese Lutung *Trachypithecus germaini* (IUCN Endangered)

Small groups of up to six individuals were encountered on Preaek Kon Tourt, Preaek Ta Ok, Preaek Kompong Phlu and Preaek Dum Bong Rivers, indicating this species occurs at a low density.

Northern Pig-tailed Macaque *Macaca leonina* (IUCN Vulnerable)

Three records were obtained, with two of single individuals in riverine forest by Preaek Kon Tourt, and a further record from evergreen forest near NH 48. This species was notably less abundant than *M. fascicularis*.

Pileated Gibbon *Hylobates pileatus* (IUCN Endangered)

Based on the prevalence of suitable habitat, Traeholt *et al.* (2005) estimated there were over 2,000 groups in Botum-Sakor NP, at a density of 1.55 groups per km². However, the species appears to be absent from sizeable parts of the southern area of the NP, suggesting this figure is an overestimate.

Dhole *Cuon alpinus* (IUCN Endangered)

One individual was seen in a large grassy clearing (*veal*) to the Northwest of Preaek Kon Tourt in May 2008 by Rosie Irwin (Frontier-Cambodia, pers. comm.). It was identified as *C. alpinus*, and not a feral dog, by its substantially larger size, red pelage and large, bushy, black tail. Feral dogs are known from the area, but are typically small in size and have a malnourished appearance. Potential tracks and scats have been encountered from the northern boundary of the NP, through to the southern grassy clearings of Preaek Ta Ok.

Sun Bear *Helarctos malayanus* (IUCN Vulnerable)

One individual was confiscated from a trader by park rangers by Preaek Roung in 2007 (Chin Kethya, pers. comm.). Scratch marks on fruiting trees that reached considerable heights (perhaps more indicative of *H. malayanus* than *Ursus thibetanus*) were also recorded in evergreen forest near the road NH 48.

Hog Badger *Arctonyx collaris* (IUCN Near Threatened)

One individual was witnessed by Nikki Hulse (Frontier-Cambodia, pers. comm.) being removed from a snare by park rangers (Fig. 1) in September 2009 in evergreen forest, approximately one kilometre South of NH 48.

Hairy-nosed Otter *Lutra sumatrana* (IUCN Endangered)

One individual was witnessed by the author being confiscated from fishermen by park rangers at Preaek Roung in September 2009 (Fig. 2). The otter was subsequently taken to the Phnom Tamao Wildlife Rescue Centre and verified as *L. sumatrana* by Nick Marx (Wildlife Alliance, pers. comm.).

Smooth-coated Otter *Lutrogale perspicillata* (IUCN Vulnerable)

A pair was seen by the author on a sandbank by Preaek Kon Tourt in June 2009. They were identified as *L. perspicillata* by the rounded head, with steep facial profile, and extensive paler fur along the sides of the body. Camera trap photographs have also been obtained from Preaek Kompong Phlu (Timmins & Sechrest, in prep.).

Large-spotted Civet *Viverra megaspila* (IUCN Vulnerable)

One camera trap photograph was obtained in 2005. An additional camera trap record was obtained in 2008 from just outside the NP boundary, within a kilometre of the NP headquarters (Timmins & Sechrest, in prep.).

Leopard *Panthera pardus* (IUCN Near Threatened)

One individual was seen climbing down from a tree in a small *veal* to the North of the NP by Matt

Fig. 1 Hog badger *Arctonyx collaris* in noose snare (© Nikki Hulse).

Fig. 2 Captive hairy-nosed otter *Lutra sumatrana* (© Nikki Hulse).

Maltby (Fauna & Flora International, pers. comm.) in June 2005.

Clouded Leopard *Neofelis nebulosa* (IUCN Vulnerable)

A skin of *N. nebulosa* was confiscated by park rangers from a poacher by Preaek Ta Ok in 2006 (Wildlife Alliance, pers. comm.). Photographic evidence was reviewed and verified by the author and Jeremy Holden (Fauna & Flora International). The finding of this skin suggests that the species occurs within the NP.

Fishing Cat *Prionailurus viverrinus* (IUCN Endangered)

Confirmed from the presence of two captive juveniles at a fishing village on Preaek Kon Tourt (Royan, 2009b). This species could have a widespread distribution and, although it is notoriously difficult to confirm presence and density across much of its range, the NP contains large areas of potentially suitable habitat.

Irrawaddy Dolphin *Orcaella brevirostris* (IUCN Vulnerable)

An individual was sighted by Matt Maltby (pers. comm.) in Preaek Ta Ok in September 2005. A rounded, flat-faced head was clearly visible, along with dorsal fin shape, confirming it was not a porpoise. Two further records were obtained from the West coast beaches in November 2008 and January 2009: one a jawbone and the other a carcass (Timmins & Sechrest, in prep.).

Asian Elephant *Elephas maximus* (IUCN Endangered)

The available evidence suggests one group, estimated to contain 14 individuals in 2008, resides permanently in the Southwest of the NP, with one or perhaps two more groups moving between the NP and the southern Cardamom Mountains (Matt Maltby, pers. comm.).

Sambar *Rusa unicolor* (IUCN Vulnerable)

Tracks were identified by the author at the western end of the Preaek Kon Tourt in January 2009. Tracks were distinguished from similar species (e.g. *Muntiacus muntjak, Axis porcinus* and *Sus scrofa*) by size, elongate shape and lack of dewclaws. This species is rarely encountered and may exist only in isolated pockets in the NP.

Black Giant Squirrel *Ratufa bicolor* (IUCN Near Threatened)

This species was regularly encountered above forested rivers.

Eighteen mammal species listed as globally Threatened or Near Threatened on the IUCN Red List of Threatened Species (IUCN, 2009) have been positively identified within Botum-Sakor NP. In addition, one of only two Southeast Asian populations of hog deer *Axis porcinus,* listed as Endangered, has also been documented within the NP (see Maxwell *et al.,* 2006; Timmins & Sechrest, in prep.). In particular, Botum-Sakor NP may contain globally important populations of fishing cat, hairy-nosed otter, and dhole, all of which are globally Endangered.

In total, 37 mammal species have been positively identified within the NP (Table 1). At present there is a lack of small mammal records, particularly of bats, but with a number of specimen identifications pending, this species list is expected to increase.

The current threats to mammals in Botum-Sakor NP can be summarized as:

- Subsistence hunting for ungulates, felids and viverrids.
- Commercial hunting, with the principal targets being pangolins, slow lorises and macaques.
- A low abundance of prey species for large carnivores.
- Habitat loss to illegal logging, infrastructure development and urban and agricultural encroachment.

These threats are compounded by a lack of law enforcement, and the reliance of peripheral communities upon the NP for forest resources, such as

firewood and food, and land for livestock and agriculture.

Botum-Sakor NP lacks a clear management plan and, as development interests intensify, the future protection that will be afforded to the NP is ambiguous. At the time of writing, a road is being constructed through the middle of the Protected Zone from NH 48 to the Southwest coast, resulting in the destruction and further fragmentation of significant areas of forest habitat. Botum-Sakor NP is characterised by a number of globally threatened species, and therefore warrants greater levels of protection, with efforts made to remove threats to the most vulnerable species.

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About the Author

ALEXANDER ROYAN spent 15 months with Frontier-Cambodia studying the fauna of Botum-Sakor National Park. He now writes for the ARKive website, an initiative of Wildscreen in Bristol, while retaining an active interest in the status of Cambodia's wildlife.

Appendix

Table 1 Confirmed mammals from Botum-Sakor National Park.

Common name	Scientific name	Status	Evidence	Recorder
Short-tailed gymnure	*Hylomys suillus*		C	AR
Southeast Asian shrew	*Crocidura fuliginosa*		C	AR
Northern treeshrew	*Tupaia belangeri*		C	AR
Sunda pangolin	*Manis javanica*	GEn	C	AR
Bengal slow loris	*Nycticebus bengalensis*	GVul	C, S	AR
Indochinese lutung	*Trachypithecus germaini*	GEn	S	AR
Crab-eating macaque	*Macaca fascicularis*		S	AR
Northern pig-tailed macaque	*Macaca leonina*	GVul	S	AR
Pileated gibbon	*Hylobates pileatus*	GEn	AS	AR
Dhole	*Cuon alpinus*	GEn	S, T	RI/ AR
Sun bear	*Helarctos malayanus*	GVul	C, T	Wildlife Alliance, pers. comm./ AR
Burmese ferret badger	*Melogale personata*	DD	C	Schank *et al.* (2009)
Hog badger	*Arctonyx collaris*	GNt	C	NH
Hairy-nosed otter	*Lutra sumatrana*	GEn	C	AR/ Timmins & Sechrest (in prep.)
Smooth-coated otter	*Lutrogale perspicillata*	GVul	S, P	AR/ Timmins & Sechrest (in prep.)
Small Indian civet	*Viverricula indica*		P, T	MM/ AR/ Timmins & Sechrest (in prep.)
Large-spotted civet	*Viverra megaspila*	GVul	P, T	MM/ AR/ Timmins & Sechrest (in prep.)
Asian palm civet	*Paradoxurus hermaphroditus*		C, S, T	AR/ Timmins & Sechrest (in prep.)
Leopard	*Panthera pardus*	GNt	S	MM
Clouded leopard	*Neofelis nebulosa*	GVul	C	Wildlife Alliance, pers. comm.
Leopard cat	*Prionailurus bengalensis*		C	Wildlife Alliance, pers. comm.
Fishing cat	*Prionailurus viverrinus*	GEn		Royan, 2009b
Irrawaddy dolphin	*Orcaella brevirostris*	GVul	S/C	MM/ Timmins & Sechrest (in prep.)
Asian elephant	*Elephas maximus*	GEn	S, T	MM/ AR
Wild boar	*Sus scrofa*		S, T	AR
Lesser mousedeer	*Tragulus kanchil*		S, T	AR
Red muntjac	*Muntiacus muntjak*		S, T	AR
Hog deer	*Axis porcinus*	GEn	P	Timmins & Sechrest (in prep.)
Sambar	*Rusa unicolor*	GVul	T	AR
Black giant squirrel	*Ratufa bicolor*	GNt	S	AR
Finlayson's squirrel	*Callosciurus finlaysonii*		S	AR
Cambodian striped squirrel	*Tamiops rodolphii*		S	AR
Indochinese ground squirrel	*Menetes berdmorei*		S	AR
Indomalayan maxomys	*Maxomys surifer*		C	AR
Fawn-coloured mouse	*Mus cervicolor*		C	AR
Indomalayan vandeleuria	*Vandeleuria oleracea*		S	AR
Malayan porcupine	*Hystrix brachyura*		P	Timmins & Sechrest (in prep.)

Key to table.

Evidence: C: capture and/or specimen; P: camera trap photograph; S: sighting; T: scats and/or tracks; **Status:** DD: Data Deficient; GEn: Globally Endangered; GVul: Globally Vulnerable; GNt: Globally Near Threatened; **Recorder:** AR: Alexander Royan; NH: Nikki Hulse; MM: Matt Maltby; RI: Rosie Irwin.

Assessment of the impact of bamboo harvesting on livelihoods and bamboo resources in the Seima Protection Forest, Mondulkiri, Cambodia

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Abstract

The purpose of this study was to assess the impacts of harvesting practices on local livelihoods and bamboo forests to support recommendations for sustainable management. Bamboo forests in the Seima Protection Forest are subjected to clearance for agriculture, traditional harvesting for family uses, and commercial harvesting for bamboo incense sticks. To study the impact of bamboo harvesting, research was carried out in the villages of Srae Levi and O Rona in Srae Khtum Commune, Keo Seima District, Mondulkiri Province, using family questionnaires, key informant interviews, participatory mapping and direct field observations. The results show that the harvesting of bamboo for incense sticks is conducted only in O Rona, where it helps families to alleviate food shortages during the lean period. Bamboo Harvesting Families (BHFs, who harvest bamboo for incense sticks), can generate significantly more income than non-BHFs (who harvest bamboo for noncommercial purposes only). Importantly, this is an activity that supplements, but does not compete, with farming activities. The commercial harvesting for incense sticks is not entirely sustainable, however, and has negative impact on one bamboo species, locally called *reusei thngor*, whose regeneration capacity cannot meet the current levels of harvesting. Traditional harvesting for domestic uses provides other benefits to families of both villages such as building materials, utensils, farm equipment, bamboo shoots for consumption, use as fallow crops in shifting cultivation and other uses in cultural ceremonies. The traditional management system has a less negative impact on bamboo forest because bamboo plants are given enough time to regrow within the three-to-four-year harvesting cycle. Bamboo clearance for agriculture, on the other hand, has had the most serious impact on the condition of bamboo forests in the study area. O Rona, which has a better road, easy access to markets, a larger population and a higher level of immigration, has a higher rate of bamboo extraction and forest loss than Srae Levi. There is a need for improved land use planning and enforcement to address the clearance of bamboo forests, and local villagers should be encouraged and empowered to use traditional methods to extract bamboo resources more sustainably.

Keywords

Non-timber forest products, bamboo, incense sticks, impact, income, conservation.

Introduction

Bamboos (Family Bambusoideae, Sub-family Bambusoideae) are largely concentrated within the world's tropical and subtropical belt in eastern and southern Asia, and South and Central America (Ohrnberger, 1999). Bamboo can play a very important role in rural poverty alleviation, culture, biodiversity conservation and environmental protection in these regions (INBAR, 2004; Lobovikov *et al.*, 2007). Bamboo resources are not always managed sustainably, however. As an example, Lou and Miao (2006) reported that, in China, managing bamboo

for short-term economic returns has resulted in long-term biodiversity and productivity losses.

In Cambodia, bamboo is distributed throughout the provinces in the southwestern, northeastern and eastern parts of the country. There are at least 10 species of bamboo in Cambodia in four genera: *Bambusa* (the most predominant), *Arundinaria*, *Dendrocalamus* and *Oxytenanthera* (Meng, 1993).

As of 2006, bamboo forest areas covered 35,802 ha, equivalent to 0.33% of forest areas in Cambodia (FA, 2007). As in other countries, the bamboo forests are important in supporting the subsistence livelihoods of rural Cambodians, protecting the environment and conserving biodiversity. Bamboo used to be a vital raw material for the pulp and paper industry with, for example, 50,000 m^3 of bamboo culms extracted for the industry in 1961 (Hang, 1995). Such uses have decreased since bamboo forests have come under threat from land economic concessions, agricultural land expansion, settlement, and dying-back after flowering and forest fires (ESI/SCS, 2007).

The Seima Protection Forest (SPF) in Mondulkiri Province is a protected area of 305,590 ha, of which 6,881 ha is natural bamboo forest (WCS/FA, 2008a). At present, the bamboos in SPF have great value for biodiversity conservation and local livelihoods. Nevertheless, there has been concern about the impacts of harvesting practices on bamboo in the area from such activities as conversion to agriculture, harvesting for making bamboo incense sticks (BIS) and traditional harvesting for household uses. Currently, these threats pose a challenge for SPF. To deal with this challenge, this paper aims to assess the specific impacts of harvesting bamboo on local livelihoods and the natural condition of the bamboo forest, and to develop recommendations for improved management to balance livelihood enhancement and conservation within the protected area.

Methods

The Study Area

The Seima Biodiversity Conservation Area, formerly a forest concession area of the Malaysian company Samling International, was established in 2002 under the *prakas* (Declaration) of the Ministry of Agriculture, Forestry and Fisheries. It became the Seima Protection Forest (SPF) in August 2009. At present, its management is the responsibility of the Forestry Administration (FA) with financial and technical support from the Wildlife Conservation Society (WCS). The SPF has been classified by BirdLife International as covering parts of two Important Bird Areas, by WWF as comprising two Global 200 Ecoregions, and by WCS as a "Last of the Wild" landscape (WCS/FA, 2007).

The SPF covers eight communes (Srae Khtum, Srae Preah, Srae Chhouk, Memong, Chongplas, Saenmonorom and Romanea) in Mondulkiri Province and one commune (Khsem) in Kratie Province. This study was conducted in Srae Khtum Commune where O Rona and Srae Levi villages (Fig. 1) were selected using the cross sectional method. The selection of the two villages was based on two criteria, being (1) largely covered by bamboo forest, but (2) differing in biophysical conditions. O Rona is located closer to a main road and market centre, and has a larger human population than Srae Levi.

Data Collection

Family questionnaires, key informant interviews, participatory mapping and direct field observations were used to collect primary data. With 10% sampling error, 63 out of the total number of 168 families in both villages were sampled (43 out of 139 families in O Rona, and 20 out of 29 families in Srae Levi). Families were randomly chosen for interviews using structured questionnaires to collect socio-economic data related to their income sources, food security and immigration. Income was measured based only on gross annual cash income that each family generated from their main livelihood activities. Key informant interviews

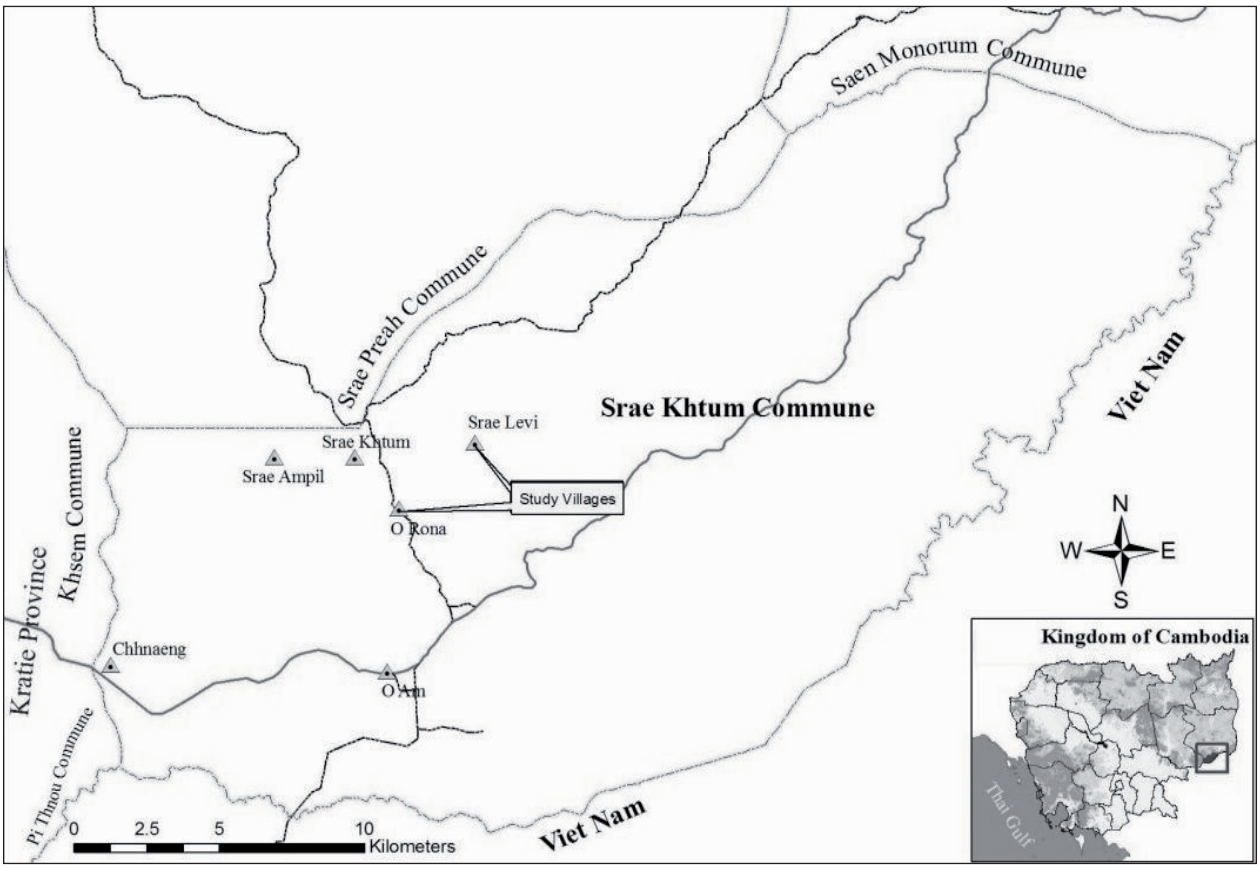

Fig. 1 Map showing the location of Srae Khtum Commune and the selected study villages, O Rona and Srae Levi. O Rona is located in the buffer zone of the Seima Protection Forest and Srae Levi is located in the core zone, 7 km from the main road.

were conducted with two village elders, two key SPF staff, and the head of the Participatory Land Use Planning and Natural Resource Management Committee to collect data on the management system for bamboo resources in the area. Participatory mapping was conducted to delineate village boundaries and identify bamboo harvesting areas. Direct field observations were subsequently made to record the coordinates of the harvested bamboo forest areas using a Global Positioning System (GPS). Two bamboo harvesting plots for making incense sticks, aged from three to four years, were visited to identify the regeneration capacity of bamboo and assess the suitability of current harvesting techniques. Finally, a desk review was employed to collect secondary data related to rules and regulations governing bamboo resources, the population and maps of the bamboo forest areas.

Data Analysis

Descriptive statistics were used to analyse data related to income, food security and immigration, harvesting techniques, harvesting volume, ownership of bamboo and other uses of bamboo. Bivariate analysis was used to test the relationship between the engagement in bamboo harvesting and the period of insufficient rice production. A Mann-Whitney *U* test was used to analyse the impact of bamboo incense stick income on family income at village level by comparing the mean ranks of family income in O Rona with mean ranks of family income in Srae Levi. All sampled families were categorized as Bamboo Harvesting Families (BHFs; $n = 31$) or non-Bamboo Harvesting Families (non-BHFs; $n = 32$). BHFs are families who engage in bamboo harvesting for *commercial* purposes (to

make incense sticks), and non-BHFs refer to families who do not (non-BHFs may collect bamboo for domestic use only). To analyse the specific impact of bamboo incense stick income on the BHFs' income, an independent samples *t*-test was used to compare the income means of both family categories. ArcGIS was used to analyse GIS data and produce maps illustrating the site impacts. To analyse the impact of harvesting practices on the condition of bamboo forest, the bamboo forest area in 2002, mapped by the Japan International Cooperation Agency (JICA) in collaboration with the FA, was used as a baseline to compare with GIS data collected from the field. Finally, qualitative methods were used to analyse qualitative data collected from key informants interviews to assess the effectiveness of the management of bamboo resources in the area.

Results

Village Demographics

The populations in O Rona and Srae Levi are of mixed Khmer, Phnong and Stieng ethnicity. The population of O Rona is 79% larger than that of Srae Levi (Local Administration Unit, 2007). Furthermore, a greater proportion of immigrants (37% of 43 sampled households) was found in O Rona than in Srae Levi (5% of 20 sampled households), possibly because of the better road conditions and market access.

Livelihoods

The important livelihood activities of families in O Rona and Srae Levi include upland rice farming, paddy rice farming, animal raising, cash crop cultivation, resin tapping, bamboo harvesting, labouring, government work, fishing and the collection of other wild products. Rice is produced in upland and paddy fields for consumption, while other activities produce supplementary food and generate cash income.

Income Generation

In Srae Levi, cash crops are the main contributors to total annual family gross income (71%), followed by resin (17%), wage labour (8%), civil service (3%) and livestock (1%). Bamboo incense sticks are not made in this village. In O Rona, however, making bamboo incense sticks is the greatest contributor to gross family income (44%), followed by cash crops (41%), wage labour (10%), resin (2%), civil service (2%) and livestock (1%).

Currently, the income generated from making bamboo incense sticks is essential for the livelihood of 31 BHFs in O Rona, because they have fewer alternative income sources than non-BHFs. The 31 BHFs generate income from making bamboo incense sticks (58%), cash crops (29%), wage labour (12%) and civil service (1%), and have no income from resin or livestock.

Food Security

Food shortages are a major problem for families in O Rona and Srae Levi. Only 3.2% of families reported having sufficient rice to eat year round, while 96.8% (61 out of the 63 households sampled) did not. On average, they face rice shortages for more than nine months per year. This period is even longer for BHF, at almost 11 months. Those who do not produce sufficient rice must search for other livelihood options, including bamboo harvesting, to compensate for this shortage.

The correlation coefficient of a two-tailed Pearson correlation test showed a very strong positive linear relationship between engagement in bamboo harvesting and the period of insufficient rice production ($r = 0.474$; $p < 0.01$). Therefore, it can be concluded that insufficient rice production is one possible motive for families to engage in bamboo harvesting to make incense sticks.

Bamboo Harvesting Practices

Bamboo Harvesting for Making Incense Sticks

72.1% of families in O Rona, but none in Srae Levi, are BHFs. 77.4% of 31 BHFs harvest a bamboo locally called *reusei thngor* (its scientific name has not been

Table 1 Families sampled in the study villages.

Family category	Village	
	Srae Levi	O Rona
BHF	0	31
	0%	72%
Non-BHF	20	12
	100%	28%
Total	20	43
	100%	100%

Key: BHF = Bamboo Harvesting Families, defined as harvesting bamboo for the commercial purposes of making incense; Non-BHF = Non-Bamboo Harvesting Families, who may collect bamboo for domestic purposes only.

identified) for making incense stick from 15-30 days per month, while the remaining 22.6% harvest bamboo from 4-14 days per month, with an average of more than 17 days per month. During each harvesting activity, they harvested 10-50 culms, with a mean of 19.13 culms (standard deviation = 9.875) (n = 31 households). It can be calculated that around 170-850 culms of *reusei thngor* were harvested for making incense stick every month. The large size of this harvest could exert an unsustainable pressure on this species of bamboo.

With regard to harvesting techniques, 93.5% of BHFs reported clear-cutting of bamboo (*reusei thngor*) rather than selective cutting. Bamboo was harvested from the forest largely as an open resource because most BHFs do not own bamboo plots (only 9.7% reported owning bamboo on their farmlands). Such open resources may be more vulnerable to unsustainable exploitation than closed or private resources.

Traditional Bamboo Harvesting for Household Uses

Traditionally, families in both villages have harvested bamboo for construction. Currently, 50.8% of families (n = 63) harvest bamboo for building houses, 15.9% for kitchens and 54% for farm storage huts.

Moreover, most of the families of Khmer (88.2%, n = 17), Phnong (97.6%, n = 42) and Stieng (100%, n = 4) ethnicities use bamboo-made utensils. These include *sas* and *waes* (baskets carried on the back), *kaveng* (a tool for weeding), knife and hoe handles, *chhneang* (a basket for fishing) and *chang a* (a tool for blowing away rice husks). The culms of one bamboo species, *reusei pok* (the species scientific name was not determined) can be split into thin pieces which, in the past, were used to cut the meat of hunted animals. Nowadays, *reusei pok* is still used by Phnong families for slicing tobacco leaves.

Bamboo shoots are an important food source for families in both villages (71.4% of families consume bamboo shoots). In particular, ethnic Phnong and Stieng families eat sour shoots in combination with rice when there is nothing else to eat.

In the past, families of the Phnong and Stieng ethnic minorities traditionally practiced shifting cultivation and used bamboo forest where the field was left fallow for 10-20 years or more before being used again. This system no longer exists because all of the fields are planted with permanent crops, cashew nuts. Even so, bamboo is still used by families of all ethnicities in agriculture for building pig pens (25.4%) and chicken pens (27.0%).

Bamboo used to be commonly used by indigenous families, especially Phnong, in cultural ceremonies, but this practice has decreased. Bamboo is still used by Phnong families for the *saen proloeng srov* (rice spirit ceremony) during the rice growing stage: 66.7% of Phnong families (and none of the Khmer or Steing families interviewed) still use bamboo for this ceremony. The reasons that some Phnong families have stopped using bamboo for *saen proloeng srov* are that there are no upland rice plots and there has been a religious shift to Christianity.

Besides harvesting for making incense sticks, most families harvest *reusei thngor* for domestic uses such as housing materials, animal pens, woven materials, tools and food (85.7%), while 14.3% harvested other species for these purposes.

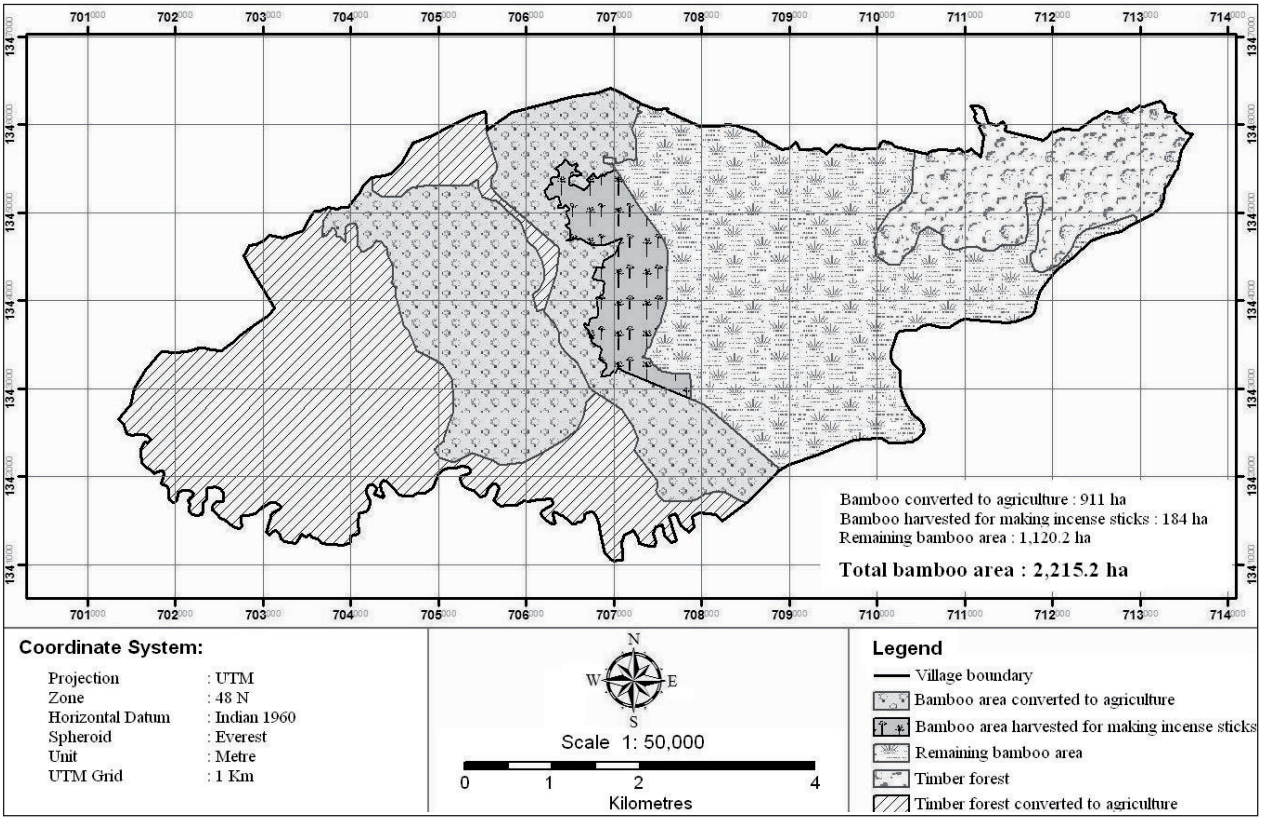

Fig. 2 Map of O Rona illustrating different areas of bamboo forest affected by harvesting to make incense sticks and clearance for agriculture. The map also illustrates the remaining bamboo forest and timber forest areas, and timber forest areas that have been converted to agriculture.

In general, people harvest bamboo for domestic uses only when the bamboo materials in their household have decayed. Reportedly, people harvest bamboo for family uses once every three to four years. This period of time allows the bamboo plants to regrow.

Conversion of Bamboo Forest to Agriculture

Most of the losses of bamboo forests in both villages were caused by clearance for agriculture. In O Rona, within a period of seven years (2002-2008), 911 ha (41.1%) of the total bamboo area was cleared for upland rice, cashew nut and cassava production. Additionally, 184 ha (8.3%) of the area was harvested for making incense sticks. Only 1,120.2 ha (50.6%) of the bamboo forest now remains.

Likewise, in Srae Levi, within the same period of seven years (2002-2008), 179.05 ha (30.3%) of the total bamboo area was cleared for upland rice, cashew nut and cassava production, with 412.1 ha (69.7%) remaining.

In comparison with harvesting for family uses and harvesting for making incense stick, it is clear that clearance for agriculture presents a possible threat to bamboo forest and could more likely lead to the reduction of wildlife habitat if its management is not strengthened.

Rules and Regulations

There are no specific regulations governing bamboo resources in the SPF. Bamboo is classified as a non-timber forest product (NTFP) and managed under the existing Forestry Law together with other forest resources (Royal Government of Cambodia, 2002). Its official management, however, is not sustainable. Similarly, the traditional rules of both villages have proved to be ineffective because bamboo

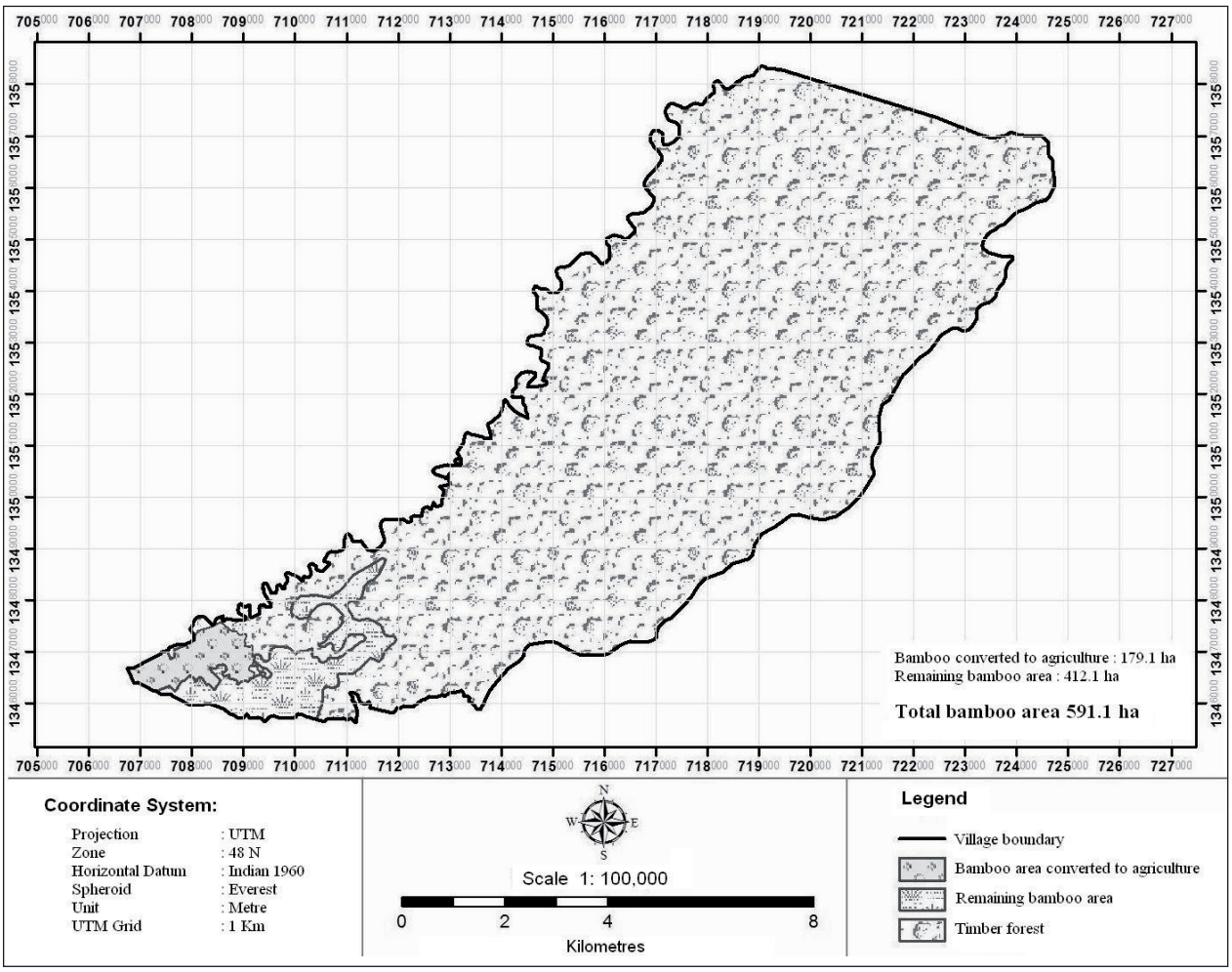

Fig. 3 Map of Srae Levi illustrating the areas of bamboo forest affected by clearance for agriculture. The map also illustrates the remaining bamboo forests and timber forest areas.

resources have been depleted while the demand has increased due to better road access, market availability and increasing immigration.

In O Rona Village, a form of co-management system has been applied through involving local community in managing natural resources, including bamboo. A Participatory Land Use Planning (PLUP) by-law was drafted in O Rona in 2006, which aims to sustainably manage land and natural resources, but tends to be ineffective. The weakness is that Chapter 9, Article 36 of the existing PLUP by-law governs only the management of the forest resources as a whole, and does not specifically guide the sustainable management and use of bamboo (WCS/FA 2008b), even though bamboo is an abundant and important resource in the village. The PLUP committee established in 2006 is still in the process of becoming legally responsible under the national land law for implementing the PLUP by-law, which has to be legalized and registered by the Ministry of Interior.

Discussion

Impact on Income

The Mann-Whitney *U* test revealed that family incomes are significantly lower in Srae Levi Village (n = 20) than O Rona Village (n = 43) ($p < 0.05$). It appears that families in O Rona are able to generate

higher income than those in Srae Levi through harvesting bamboo culms to make incense sticks.

An independent samples *t*-test showed a very significant difference ($t = 4.553$; $df = 2$; $p < 0.001$) between the incomes of BHFs and non-BHFs. The BHFs can generate an average income of 3,530,933 riels (US$ 883) per year, which is higher than the income of non-BHFs. Therefore, it can be stated that bamboo incense stick income does have impact on BHF income. This bamboo incense stick income is vital for BHFs in O Rona to solve the problem of rice shortage for 11 months per year. At present, without harvesting bamboo to make and sell incense sticks, the livelihoods of BHFs would be harder.

Impact on Wildlife Habitat

Factors that have led to the depletion of bamboo forests in both study villages are conversion to agriculture and harvesting for making incense sticks. Traditional bamboo harvesting for family uses appears to have no negative impact on wildlife habitat, because families harvest bamboo for housing materials and other utensils or equipment once every three to four years and only by cutting old culms. This harvesting cycle provides enough time for bamboo plants to regenerate.

It is clear that conversion to agriculture is the leading factor for depleting bamboo forests in both villages. This loss of bamboo forests has negatively impacted wildlife habitats, e.g. those of Asian elephant (*Elephas maximus*) and orange-necked partridge (*Arborophila davidi*) (Pollard *et al*., 2007). Within the same period of time (2000-2008), the total area of bamboo forests converted to agriculture in Srae Levi and O Rona was 1,090 ha, which is about six time greater than the area harvested for incense sticks (184 ha). Harvesting bamboo for making incense sticks is thought to have fewer impacts on wildlife habitat because only one bamboo species is harvested for this purpose.

The areas impacted by bamboo harvesting in O Rona and Srae Levi are illustrated in Figs 2 and 3 respectively. The impact on bamboo forests over seven years has been more serious in O Rona because it has better infrastructure, market accessibility, and a larger immigrant and total population. The level of bamboo clearance and harvesting in O Rona (49% of bamboo forest cleared between 2002 and 2008) is higher than Srae Levi (30%).

Impact on Bamboo Species

The dominant bamboo species in the area is *reusei thngor* which is used by BHFs for making incense sticks, and by BHFs and non-BHFs for family uses. All BHFs reported harvesting *reusei thngor* for making incense sticks because it has long internodes (30-45 cm) and is easy to split and slice into small sticks. This bamboo species is clear-cut. Besides harvesting for making incense sticks, the majority of families harvest *reusei thngor* for household uses such as housing materials, animal pens, woven materials, tools and food. Observations of old bamboo plots harvested in 2005 and 2006 showed poor regeneration after three to four years of harvest. Like other plants, bamboo needs to photosynthesize and absorb nutrients to grow, but this function was completely disabled because all culms were clear-cut from the clumps, weakening regeneration capacity (Figs 4 and 5). It appears that harvesting for incense sticks is a threat to *reusei thngor* because its regeneration capacity cannot respond to the current harvesting. The heavy dependency of households on *reusei thngor* for incense sticks and household uses, together with inappropriate harvesting techniques, may lead to the local extinction of this species.

Conclusions

Bamboo harvesting for making incense sticks has a positive impact on the household economy in O Rona. The income helps BHFs to cope with food shortages during the lean period. It is not sustainable, however, because BHFs do not have appropriate techniques to harvest bamboo culms and good management practices are not in place. Most BHFs (77.4%) freely harvest bamboo almost every day. On average, BHFs harvest bamboo more than 17 days per month, collecting an average of 19 culms per harvest. They clear-cut bamboo culms from the

Fig. 4 Clear-cut bamboo clumps of *reusei thngor* showing no regeneration after four years due to competition with trees for sunlight and nutrients.

Fig. 5 Clear-cut clumps of *reusei thngor* showing poor generation after three years.

clumps for as long as the culms can be sliced into small sticks, without considering the age of the culms to be harvested. Such harvesting does not provide enough time for bamboo plants to regenerate. Hence, it is a threat especially to *reusei thngor,* the target species for both making incense sticks and for family uses. Indeed, field assessments confirm that the regeneration capacity of *reusei thngor* is unable to respond to the current level of harvesting, and that re-growth of new shoots in the harvested clumps is still poor or shows no regeneration after three to four years (Figs 4 and 5).

More seriously, bamboo clearance for agriculture has been identified as having a negative impact on the natural condition of bamboo forest, and the cleared area is a lot bigger than the area harvested for making incense sticks. This will have negative impact on wildlife habitat if its management is not improved.

It can also be concluded that traditional bamboo harvesting for family uses, includes building materials, utensils, farm equipment, shoots, use as fallow crops in shifting cultivation and other uses in cultural ceremony, does not have negative impact on bamboo forest, because this tends to target older culms and allows three to four years for bamboo plants to regenerate to their full size.

Recommendations

Bamboos in this area must be managed sustainably because they are very important resource for income generation and subsistence livelihoods, as well as for biodiversity conservation. To maintain these functions, the improvement of current harvesting practices and management system is critical. The existing co-management system of the local community and the FA in O Rona should be strengthened, and local community rights should be enhanced.

With respect to harvesting technique, agricultural departments or other agencies that specialize in sustainable bamboo forest management should teach appropriate harvesting techniques to BHFs to ensure a sustainable harvest and continued productivity. For instance, Chaturvedi (1988); Prasad (1988) and Suwannapinunt (1988) reported that selective cutting of mature bamboo culms of more than three years of age in plots with a three-four year rotation cycle appears to be sustainable and more productive.

Additionally, the FA should develop a management plan and rule for managing bamboo resource, building upon the existing PLUP by-law in O Rona, by clearly defining the rights, user groups, collective actions arrangements and bamboo areas to be harvested. This will require more research on the bamboo species and their densities in the area in order to develop a management plan and rules. The BHFs should be formed into groups to implement the management plan and rules.

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Significant new records of amphibians and reptiles from Virachey National Park, northeastern Cambodia

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Abstract

The amphibians and reptiles of the uplands of northeastern Cambodia are poorly known. Significant records of nine species of amphibians and reptiles from Virachey National Park, northeastern Cambodia, are provided. These have either not been previously reported from Cambodia or are known here from very few records.

Keywords

Amphibians, reptiles, Virachey National Park, Cambodia, distribution.

Introduction

Knowledge of Cambodia's amphibian and reptile fauna is increasing at a rapid pace. Historical summaries of the amphibians (Bourret, 1942), turtles (Bourret, 1941) and snakes (Bourret, 1936; Saint Girons, 1972) have been greatly supplemented by recent field surveys in the Cardamom Mountains (Daltry & Wüster, 2002; Ohler *et al*., 2002; Stuart & Platt, 2004; Stuart & Emmett, 2006; Grismer *et al*., 2007a,b; Grismer *et al.*, 2008a,b; Grismer *et al.*, 2010), lowlands and low-lying hills of central Cambodia (Bezuijen, 2009; Hartmann *et al*., 2009) and uplands of eastern and northeastern Cambodia (Stuart *et al*., 2006; Rowley *et al*., in press).

The amphibian and reptile diversity in the uplands of northeastern Cambodia, which lie within Virachey National Park in Ratanakiri and Stung Treng Provinces, remains very poorly studied. Most of Virachey's 332,500 ha exceed 400 m elevation (maximum elevations just above 1,500 m near the Laos border) and are covered by bamboo and evergreen forests, often in admixture. The sole report of 12 amphibian and 16 reptile species from Virachey by Stuart *et al.* (2006) suggests the northeastern uplands of Cambodia contain a number of species that are otherwise known from the Annamite (= Truong Son) Mountains of adjacent central Vietnam.

Herein, we report significant records of nine species of amphibians and reptiles obtained in 2006-2007 during herpetological field surveys of Virachey National Park. These species were not previously known from Cambodia, or were known there from only very few records.

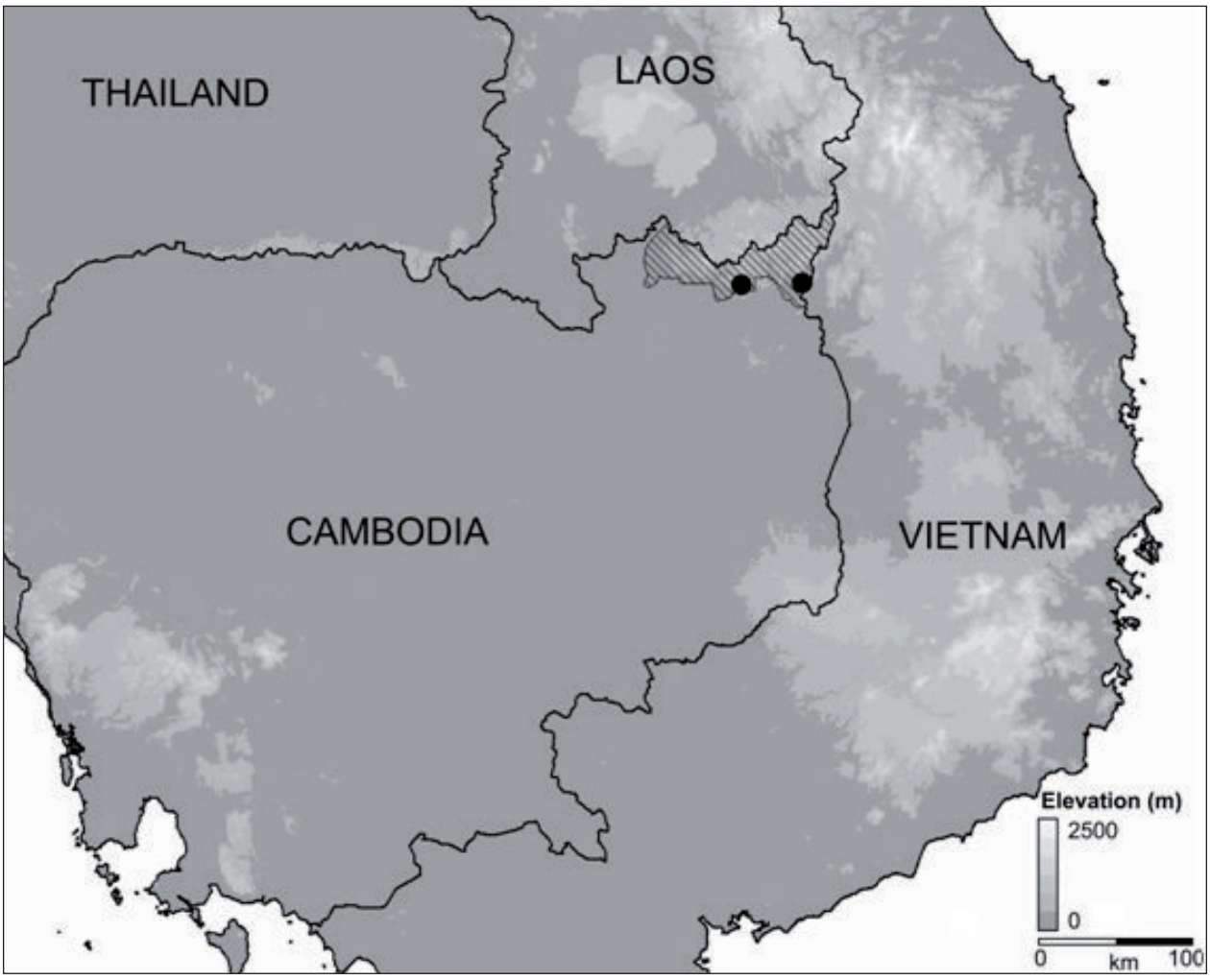

Fig. 1 Map showing amphibian and reptile survey sites conducted in 2006 (eastern dot) and 2007 (western dot) in Virachey National Park (hatched area), northeastern Cambodia.

Methods

Amphibians and reptiles were inventoried in Virachey National Park, Ratanakiri Province, Cambodia from 15–25 June 2006 and 1–15 October 2007 (Fig. 1). Sampling methods included active searching by day and especially night in riparian areas, pitfall traps and baited turtle traps. Sampling sites in 2007 were reached from a centralized base camp on Veal Thom Grasslands (14°12′28.5″N, 107°00′16.4″E, 675 m elevation). Most sampling effort was spent in hill evergreen forest, with some also in grasslands with rocky outcrops and drier forest patches. Specimens were fixed in 10% buffered formalin after preserving pieces of liver or muscle in 95% ethanol or 20% DMSO/EDTA-salt saturated storage buffer. Specimens were deposited at the Museum of Vertebrate Zoology (MVZ), University of California, Berkeley, USA, and transferred to 70% ethanol upon arrival there. Measurements taken are in millimetres.

Results

Megophryidae

***Xenophrys major* (Boulenger, 1908)** (Fig. 2)

MVZ 258094, Ta Veng District, 14°12′N 107°23′E, 700 m elev., coll. D.A. Emmett and J.J.L. Rowley, 20 June 2006.

A juvenile (snout-vent length [SVL] 23.8 mm) has two oval vomerine ridges, closer to choanae than to each other; large gape; no orbital horns; and dark throat and chest colouration with a light stripe on each side extending from the throat to the chest. The Cambodian specimen closely agrees with a juvenile (MVZ 226290) and adults (MVZ 223688-98, 226279-88) of this species from Tam Dao, Vietnam. The specimen was taken during the day (1430 h) in hill evergreen forest under leaf litter 50 m from a temporary stream.

This is the first report of *X. major* from Cambodia. It occurs widely in mountainous parts of mainland Southeast Asia, from Vietnam through southern China to northeastern India (Fei, 1999; Inger *et al.*, 1999; Ao *et al.*, 2003; Chan-ard, 2003; Stuart, 2005; Humtsoe *et al.*, 2008; Nguyen *et al.*, 2009). The species has also been reported under the specific epithet *lateralis*, a taxonomic problem settled by Humtsoe *et al.* (2008).

***Ophryophryne poilani* Bourret, 1937** (Fig. 3)

MVZ 258274-81, 258283-88, Veunsai District, 14°11.572′N, 106°59.767′E, 650 m elev., coll. B.L. Stuart, J.J.L. Rowley and Neang T., 2-13 October 2007. MVZ 258289, Veunsai District, 14°13.397′N, 106°59.145′E, 633 m elev., coll. B.L. Stuart, J.J.L. Rowley and Neang T., 13 October 2007. MVZ 258282, 258290, Veunsai District, 14°11.267′N, 106°59.744′E, 602 m elev., coll. B.L. Stuart, J.J.L. Rowley and Neang T., 6–14 October 2007.

Two females (SVL 47.4–50.8 mm, mean ± SD 49.1 ±2.4, $n = 2$), fourteen males (SVL 32.6–38.1 mm, mean ± SD 35.0 ±1.5, $n = 14$), and a juvenile (SVL 23.8 mm) have shagreened (vs. warty, glandular) skin and lack the anus terminal on a dermal protuberance. Three named species in this genus, *O. poilani, O. microstoma* Boulenger, 1904, and *O. gerti* Ohler, 2003, share these characters. The Cambodian specimens agree with *O. poilani* in size (holotype female SVL 47 mm; Bourret, 1937), but are smaller than *O. microstoma* (BMNH 1947.2.2.50 paralectotype female SVL 57.0 mm; our data) and larger than *O. gerti* (eight uncataloged topotype females from Bi Doup-Nui Ba National Park, Langbian Plateau, Vietnam, SVL 37.5–42.5 mm, mean ± SD 40.4 ±1.6, $n = 8$; our data). Also, the Cambodian locality is located within the same upland block that contains the type locality of *O. poilani* ("Dong-Tam-Ve", Quang Tri Province, central Vietnam), but is geographically distant from that of *O. microstoma* ("Man-Son Mountains" in northern Vietnam) and isolated by extensive lowlands from that of *O. gerti* (Langbian Plateau, Vietnam). We do not follow Ohler's (2003) treatment of *O. poilani* as a junior synonym of *O. microstoma.*

All were taken in hill evergreen forest, within 6 m of swift, rocky streams. MVZ 258285–86 were found in amplexus under a rock overhang 3 m from a 3 m wide water chute. Ohler (2003: 40) stated "there is no evidence for syntopic occurrence of two or more species of *Ophryophryne*", but we regularly found this species in syntopy with *O. hansi* Ohler, 2003 (MVZ 258291–307), a species reported earlier from Virachey (Stuart *et al.*, 2006; Neang & Holden, 2008).

This is the first report of *O. poilani* from Cambodia. Its type locality and presence in Virachey suggest that the species occurs throughout the highlands of central Vietnam and adjacent Cambodia, and probably Laos.

Rhacophoridae

***Philautus abditus* Inger, Orlov & Darevsky, 1999** (Fig. 4)

MVZ 258310, Veunsai District, 14°12.477′N, 107°00.273′E, 674 m elev., coll. P. Naskrecki, B.L. Stuart, J.J.L. Rowley and Neang T., 1 October 2007.

A juvenile (SVL 18.2 mm) has extensive webbing on the foot; tympanum obscured by skin; no vomerine teeth; no dermal fringes or tubercles on limbs; and large black spots on groin, anterior and posterior surfaces of the thigh, ventral surface of shank, and anterior surface of the tarsus, not visible when legs are flexed. The Cambodian specimen closely agrees with five paratypes from Gia Lai Province, Vietnam (MVZ 222118–21, 222101), which we have examined. The specimen was taken at night on a tree leaf 1.5 m above the ground in a patch of semi-evergreen forest, near the edge of a grassland.

This is the first report of the species from Cambodia. It is otherwise known from Gia Lai and Kon Tum Provinces in the highlands of central Vietnam (Inger *et al.*, 1999; Nguyen *et al.*, 2009).

Fig. 2 *Xenophrys major* (MVZ 258094) from Virachey National Park (© J.J.L. Rowley).

Fig. 3 *Ophryophryne poilani* from Virachey National Park (© J.J.L. Rowley).

Fig. 4 *Philautus abditus* (MVZ 258310) from Virachey National Park (© P. Naskrecki).

Fig. 5 *Cyclemys oldhamii* (MVZ 258154) from Virachey National Park (© J.J.L. Rowley).

Fig. 6 *Acanthosaura coronata* (MVZ 258050) from Virachey National Park (© J.J.L. Rowley).

Fig. 7 *Acanthosaura nataliae* (MVZ 258141) from Virachey National Park (© P. Naskrecki).

Fig. 8 *Cyrtodactylus pseudoquadrivirgatus* from Virachey National Park (© P. Naskrecki).

Fig. 9 *Tropidophorus cocincinensis* from Virachey National Park (© P. Naskrecki).

Fig. 10 *Amphiesma leucomystax* (MVZ 258142) from Virachey National Park (© J.J.L. Rowley).

Bataguridae

***Cyclemys oldhamii* Gray, 1863** (Fig. 5)

MVZ 258154, Veunsai District, 14°13.532′N, 107°00.579′E, 544 m elev., coll. Som S., B.L. Stuart, J.J.L. Rowley and Neang T., 6 October 2007.

A subadult (carapace length 120.7 mm; carapace width 107.3 mm; plastron length 110.8 mm) agrees with Fritz *et al.*'s (2008) concept of this species by having a primarily black plastron with a lighter radiating pattern; distinct stripes on neck that extend to chin and side of head; and dark spotting on the dorsal surface of the head. The specimen was taken in a baited turtle trap set in a pond in Veal Thom Grassland.

This is the first vouchered field record of *C. oldhamii* from Cambodia. It is otherwise known in Cambodia by a specimen obtained from a village in Siem Pang District, Stung Treng Province (FMNH 262709). The species was often referred to as *C. tcheponensis* Bourret, 1939 prior to revision by Stuart & Fritz (2008). Elsewhere, it ranges from Vietnam to Myanmar (Fritz *et al.*, 2008).

Agamidae

***Acanthosaura coronata* Günther, 1861** (Fig. 6)

MVZ 258050–51, Ta Veng District, 14°12′N, 107°22′E, 600 m elev., coll. D.A. Emmett and J.J.L. Rowley, 21 June 2006.

An adult male (MVZ 258050) has the rostral divided into two scales; no diastema between nuchal and dorsal crests; and shorter postorbital spine, nuchal spine, nuchal crest, dorsal crest, and tail relative to a series of *A. lepidogaster* (MVZ 224086–101, 226474–80) from Tam Dao, Vietnam. A juvenile (MVZ 258051) with a divided rostral; no diastema between nuchal and dorsal crests; and similar colouration to the adult male is also assigned to this species. Both specimens were taken during the day in hill evergreen forest.

Originally described from Cambodia (Günther, 1861), the species is known in the country only from Mondolkiri Province (Stuart *et al.*, 2006). It otherwise occurs in Lam Dong and Dong Nai Provinces, southern Vietnam (Ananjeva *et al.*, 2008).

***Acanthosaura nataliae* Orlov, Nguyen & Nguyen, 2006** (Fig. 7)

MVZ 258052, Ta Veng District, 14°12′N, 107°22′E, 650 m elev., coll. D.A. Emmett and J.J.L. Rowley, 21 June 2006. MVZ 258141, Veunsai District, 14.22864°N, 106.99454°E, 530 m elev., coll. Som S., B.L. Stuart, J.J.L. Rowley and Neang T., 8 October 2007.

An adult female (SVL 147.5 mm) and a subadult male (SVL 83.0 mm) have a single postorbital spine; no spine between tympanum and nuchal crest; no diamond-shaped dark marking on nape; gular pouch; and large, keeled scales scattered among smaller scales on lateral and dorsal surfaces of body. In life, the female was primarily green and the male brown. Both specimens were taken during the day in hill evergreen forest.

This is the first report of the species from Cambodia. It is otherwise known from the highlands of central Vietnam and southeastern Laos (Orlov *et al.*, 2006; Ananjeva *et al.*, 2008; Nguyen *et al.*, 2009).

Gekkonidae

***Cyrtodactylus pseudoquadrivirgatus* Rösler, Vu, Nguyen, Ngo & Ziegler, 2008** (Fig. 8)

MVZ 258063–64, Ta Veng District, 14°18′N, 107°22′E, 850 m elev., coll. D.A. Emmett and J.J.L. Rowley, 22 June 2006. MVZ 258155–59, 258162–63, 258165–67, Veunsai District, 14°11.572′N, 106°59.767′E, 650 m elev., coll. B.L. Stuart, J.J.L. Rowley and Neang T., 2–13 October 2007. MVZ 258160, Veunsai District, 14°12.228′N, 106°59.836′E, 609 m elev., coll. B.L. Stuart, J.J.L. Rowley and Neang T., 5 October 2007. MVZ 258161, Veunsai District, 14°11.267′N, 106°59.744′E, 602 m elev., coll. B.L. Stuart, J.J.L. Rowley and Neang T., 6 October 2007. MVZ 258164, Veunsai District, 14°14.156′N, 106°58.934′E, 676 m elev., coll. B.L. Stuart, J.J.L. Rowley and Neang T., 10 October 2007.

A series of 15 specimens has medium size (SVL 58.5–87.5 mm, mean ± SD 70.4 ± 9.8, n = 15); lacks transversely enlarged subcaudals; and exhibits highly variable, irregular blotches on the dorsum. The Cambodian series disagrees with the original description (Rösler *et al.*, 2008) by having the nuchal band medially undivided in 11 specimens (MVZ 258155–60, 258162–64, 258166–67), and up to four enlarged, but indistinct, femoral scales in two specimens (MVZ 258157, 258164). Despite this variation, the series appears to contain a single species The specimens were taken at night (1915–2120 h) on boulders, tree roots and trunks, and vines in hill evergreen forest, usually within 10m of rocky streams.

This is the first report of *C. pseudoquadrivirgatus* from Cambodia. It otherwise ranges from Quang Tri to Kon Tum Provinces in central Vietnam (Rösler *et al.*, 2008).

Scincidae

***Tropidophorus cocincinensis* Duméril & Bibron, 1839** (Fig. 9)

MVZ 258138–40, Ta Veng District, 14°12′N, 107°22′E, 400 m elev., coll. D.A. Emmett and J.J.L. Rowley, 18–21 June 2006. MVZ 258324–26, 258329–31, 258339, Veunsai District, 14°11.572′N, 106°59.767′E, 650 m elev., coll. B.L. Stuart, J.J.L. Rowley and Neang T., 2–13 October 2007. MVZ 258327–28,

Veunsai District, 14°11.267′N, 106°59.744′E, 602 m elev., coll. B.L. Stuart, J.J.L. Rowley and Neang T., 6 October 2007. MVZ 258332–36, Veunsai District, 14°14.156′N, 106°58.934′E, 676 m elev., coll. B.L. Stuart, J.J.L. Rowley and Neang T., 9–10 October 2007. MVZ 258337–38, Veunsai District, 14°14.288′N, 106°58.895′E, 603 m elev., coll. B.L. Stuart, J.J.L. Rowley and Neang T., 11 October 2007.

A series of 19 specimens has striated scales on dorsal surface of head; 30–32 midbody scale rows; lateral body scales oblique; strong keels on dorsal and lateral body scales, dorsal keels forming ridges on tail; small scales between loreals and supralabials; and two preanal scales. The frontonasal is weakly divided in four specimens (MVZ 258139, 258329, 258335–36), but undivided in the others. All were taken at night (1900–2120 h) along flowing streams in hill evergreen forest, sometimes mixed with bamboo.

This species is known in Cambodia only by a single specimen from Phnom Kulen, Siem Reap Province (Hartmann *et al.*, 2009). Elsewhere it occurs in central Vietnam from Quang Binh to Kon Tum Provinces (Nguyen *et al.*, 2010) and southern Laos in Champasak and Xe Kong Provinces (Chuaynkern *et al.*, 2005).

Colubridae

***Amphiesma leucomystax* David, Bain, Nguyen, Orlov, Vogel, Vu & Ziegler, 2007** (Fig. 10)

MVZ 258142, Veunsai District, 14°11.267′N, 106°59.744′E, 602 m elev., coll. B.L. Stuart, J.J.L. Rowley and Neang T., 6 October 2007.

A juvenile has a single anterior temporal; 19 midbody dorsal scale rows; 161 ventrals; a broad, white stripe extending below the eye from the snout tip to the neck; and a dorsolateral series of transverse spots. The specimen agrees with two paratypes (FMNH 252118–19) from Vietnam, which we have examined. The specimen was taken at night (2015h) on tree fall debris over a swift, rocky, 2 m wide stream in hill evergreen forest with tree-fall gaps.

This is the first report of the species from Cambodia. It is otherwise known from throughout the Annamite (= Truong Son) Mountains of Vietnam and Laos (David *et al.*, 2007; Stuart & Heatwole, 2008).

Discussion

Two brief herpetological surveys in Virachey National Park have yielded a number of new discoveries for Cambodia. These results support the findings of Stuart *et al.* (2006) that the herpetofauna of the northeastern uplands of Cambodia contains species that are otherwise known from the Annamite Mountains of the adjacent central Vietnam, and that this herpetofauna is distinct from that of the Cardamom Mountains, the other major upland area in Cambodia. That so many significant records could be obtained during such limited sampling suggests that the amphibian and reptile diversity of the uplands of northeastern Cambodia remains underestimated. A recently described species in the megophryid frog genus *Leptolalax* is currently known only from Virachey National Park (Rowley *et al.*, in press). Clearly, additional herpetological survey work there is warranted. Sampling at higher elevations and in wetter forests than those previously surveyed in Virachey is especially likely to result in new discoveries.

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New records of rotifer fauna in the Cambodian Mekong River Basin

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សេចក្តីសង្ខេប: នានាភាពរបស់ rotifers ត្រូវបានសិក្សានៅខេត្តចំនួន៥នៃព្រះរាជាណាចក្រកម្ពុជាដែលទទួលរងឥទ្ធិពលទន្លេមេគង្គ។ សំណាកទឹកចំនួន២០០ សំណាកត្រូវបានចុះប្រមូលបីលើកគឺ នៅដើមរដូវប្រាំង ដើមនិងចុងរដូវវស្សា ពីប្រឡាយតំបន់លិចទឹក បឹង ស្រះ វាលស្រែ ស្ទឹង និងទន្លេ។ មួយរយសែសិបបីប្រភេទត្រូវនឹងពូកនៃ rotifers ត្រូវបានរកឃើញនៅក្នុងការស្រាវជ្រាវនេះ ក្នុងនោះមានចំនួន១០២ប្រភេទ ជាប្រភេទទើបប្រទះនៅប្រទេសកម្ពុជា។ ប្រភេទដែលជួបប្រទះញឹកញាប់មាន *Polyarthra cf. vulgaris* (មាន៨0%នៃសំណាកទាំងអស់) ក្រៅពីនេះមាន *Lecane bulla* (៦៨.៥%), *Filinia opoliensis* (៦៤%), *Brachionus falcatus* (៦១.៥%), *Keratella tropica* (៥៩.៥%), *Lecane leontina* និង *Plationus patulus* (៥៥%), *Lecane curvicornis* (៥៤.៥%), *Lecane papuana* (៥៤%), *Brachionus angularis* (៥៣.៥%), *Brachionus quadridentatus* (៥១%)។ តាមរយៈការសិក្សាស្រាវជ្រាវនេះ តំបន់លិចទឹកចំនួន៥កន្លែងនៅចុងរដូវវស្សាជាកន្លែងដែលសម្បូរ rotifers ច្រើនប្រភេទ (៤៤-៥១ប្រភេទ) បន្ទាប់មកនៅតំបន់លិចទឹកមួយកន្លែងនៅដើមរដូវប្រាំង (៤៥ប្រភេទ)។ Rotifers ចំនួន៨៣ប្រភេទបង្ហាញពីចំនួនខុសគ្នានៃប្រភេទដែលអាចជួបប្រទះនៅរដូវទាំង៣។ តាមរយៈទិន្នន័យដែលប្រមូលបាននៅក្នុងការសិក្សានេះ និងការសិក្សាពីមុនៗមក កម្មវិធី Chao2-bc estimator បានបង្ហាញថា rotifers នៅប្រទេសកម្ពុជាមានចំនួន២២៣ប្រភេទ។

Abstract

Species richness of rotifers (zooplankton) was investigated in five provinces situated along the Mekong River Basin in Cambodia. A total of 200 samples were collected from canals, floodplains, lakes, ponds, rice fields, streams and rivers during three sampling periods (early dry season, early rainy season, late rainy season) in 2005/6. One hundred and forty-three species belonging to 31 genera were found, 102 of which represent new country records. The most commonly recorded species were *Polyarthra cf. vulgaris* (occurring in 80% of samples), followed by *Lecane bulla* (68.5%), *Filinia opoliensis* (64%), *Brachionus falcatus* (61.5%), *Keratella tropica* (59.5%), *Lecane leontina* and *Plationus patulus* (55%), *Lecane curvicornis* (54.5%), *Lecane papuana* (54%), *Brachionus angularis* (53.5%) and *Brachionus quadridentatus* (51%). The highest species counts were obtained from five floodplain samples (44-51 species) in the late rainy season and one floodplain sample (45 species) in the early dry season, and the incidence of 83 species showed significant variation among the three collection periods. From the data collected in this study and previous studies, the Chao2-bc estimator suggests that the number of rotifer species in Cambodia is 223.

Keywords

Species incidence, species richness, freshwater habitats, microscopy.

Introduction

Rotifers are microscopic aquatic animals in the phylum Rotifera which includes some 2,000 species (Wallace & Taylor, 1997). They are present in freshwater bodies and are a natural food link between the primary producers (algae) and zooplanktivorous fish, and therefore important in the maintenance of freshwater ecosystems (Nogrady *et al*., 1995). Members of this phylum primarily consume phytoplankton, bacteria, detritus and other smaller rotifers, and most live only one-to-two weeks although a few can survive for up to five weeks. Rotifers are commonly cultured in fish farms to be used as initial feed for larval fish (Conway *et al*., 2003). Recently, rotifers have been utilized as research models for monitoring pollution (Pechenik, 2005).

Cambodia is a country in tropical Southeast Asia, bordering the Gulf of Thailand and surrounded by Thailand, Vietnam, and Laos. Its major waterways include the Basac, Mekong and Tonle Sap Rivers that meet at Phnom Penh to form the Chaktomuk junction, and there is one great lake (Tonle Sap). The rotifer fauna in Cambodia was first reported by Berzins (1973), who documented four species belonging to four genera in the Mekong River system near Phnom Penh; of which one was described as a new species, *Lecane blachei* Berzins, one was described as a new genus and new species, *Anchitestudinella mekongensis* Berzins, one was described as a new subspecies, *Filinia camasecla cambodgensis* Berzins, and the final one was *Brachionus donnei* Brehm. Since 2004, the Mekong River Commission (MRC) has collected rotifers from river habitats for their biomonitoring programme in the Lower Mekong River Basin (Davidson *et al*., 2006; MRC, 2008; Vongsombath *et al*., 2009) and reported the presence of 74 species. Hitherto, the study of Rotifera in Cambodia is still rare and there is no estimate of the total number of species (i.e. species richness). Because there are many types of freshwater habitats suitable for rotifer in Cambodia, such as canals, floodplains, lakes, ponds, rice fields, streams and rivers, there are likely many more species than those recorded to date. For example, 347 taxa have already been reported in neighbouring Thailand (Savatenalinton & Segers, 2005).

The purpose of this investigation was to survey rotifer species in five of the 24 provinces in Cambodia. All five form part of the Cambodian Mekong River Basin. A large number of new records was found. The present paper provides a description of species diversity and an analysis of species richness, while a forthcoming paper will provide an analysis of community structure and similarity.

Study Area

There are two distinct seasons in the monsoonal climate of Cambodia: the rainy season from May to November, and the dry season from December to April. Rotifer assemblages were sampled in five provinces of Cambodia in the region surrounding Phnom Penh: Kampong Cham, Kampong Chhnang, Kandal, Prey Veng and Takeo (Anonymous, 2007). Kandal Province is where the Mekong, Tonle Sap and Basac Rivers meet. To the Northeast, the Mekong River crosses Kampong Cham Province, and to the East it borders Prey Veng Province. To the Northwest, the Tonle Sap River crosses Kampong Chnnang Province. Takeo Province is in the southern part of Cambodia and contains one lake, Tonle Bati Lake. The Tonle Sap Great Lake is a shallow lake in western Cambodia which forms part of the Mekong River system. It is the largest lake in Southeast Asia and is fed by numerous tributaries. During the dry season it drains into the Mekong River through the Tonle Sap River, the flow of which reverses during the wet monsoon season of June to November, when there is high water in the Mekong River (Kummu *et al*., 2008). This natural mechanism provides a unique and important balance to the Mekong River downstream of the lake, and ensures a flow of fresh water during the dry season into the Mekong Delta in Vietnam that buffers the intrusion of saltwater from the South China Sea into the rich agricultural lands of the delta.

Two hundred samples were collected from 174 freshwater sites, ranging from canals, floodplains

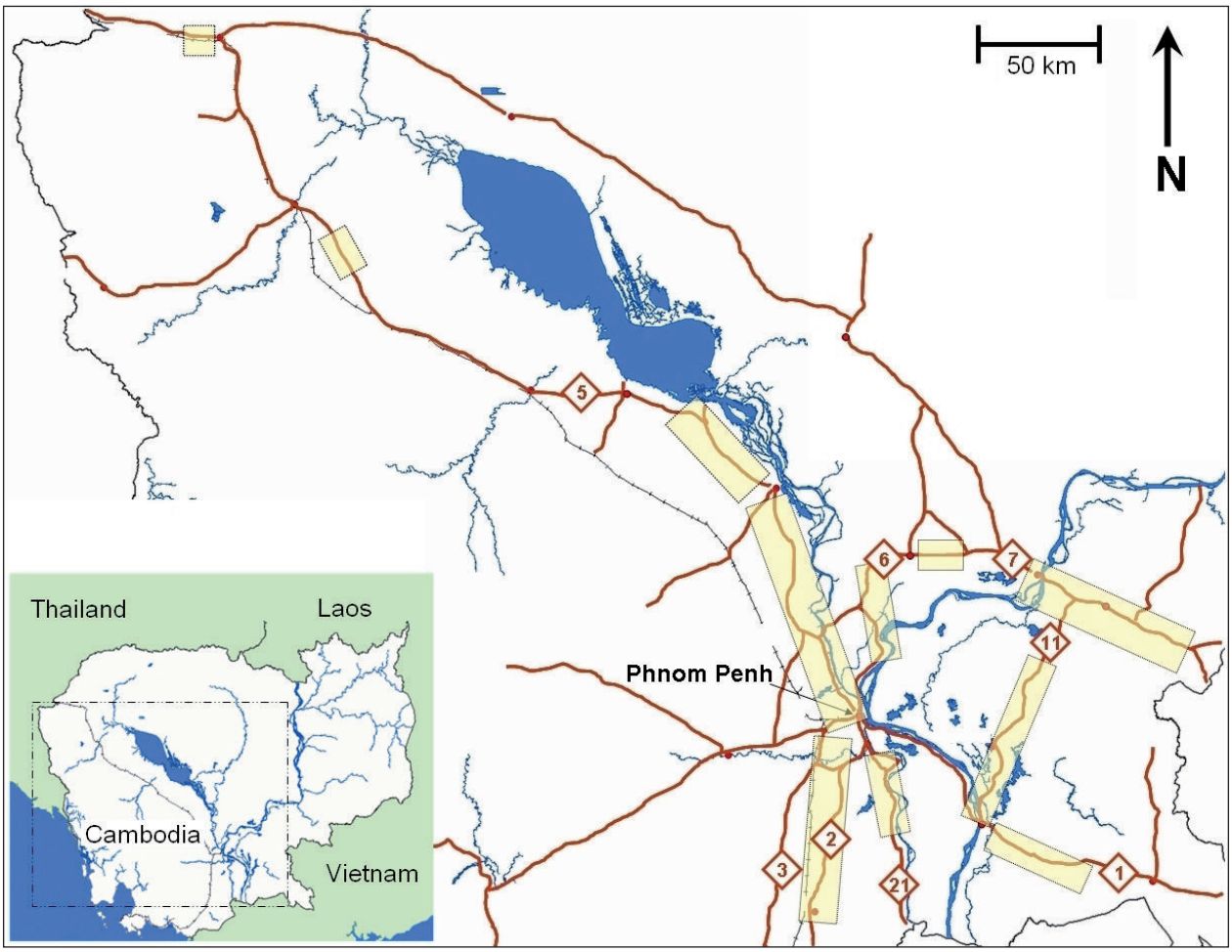

Fig. 1 Map of sampled localities (rectangles), which were accessed via major roads. The major waterways are the Mekong River that reaches Phnom Penh from the North-Northeast and heads East-Southeast, the Tonle Sap River that connects Phnom Penh to Tonle Sap Great Lake in the Northwest direction, and the Basac River that leaves Phnom Penh in the South-Southeast direction.

(seasonally inundated cropland), lakes, ponds, rice fields, streams to rivers. All samples were collected from the provinces mentioned, except for three that were collected from sites West of Tonle Sap Great Lake (Fig. 1).

Methods

Samples were collected using a 60 µm mesh net during two seasons and three sampling periods: early dry season, 10-14 December 2005 (EDry); early rainy season, 11-17 June 2006 (ERain); late rainy season, 16-19 October 2006 (LRain). Geographic and environmental information for the localities sampled was given by Meas (2008). All rotifer samples were immediately preserved by adding a small volume of 5% formalin. Water temperature, conductivity (Paqualab, ELE International), pH and altitude of samples were measured using various field equipment.

Specimens of rotifers were identified to species under compound microscope using key books (Segers, 1995; de Smet & Pourriot, 1997; Nogrady & Segers, 2002). Photographs of rotifers were taken using an Olympus SZX-ILLK 200 compound microscope (Fig. 2). Scanning electron microscopy (LEO

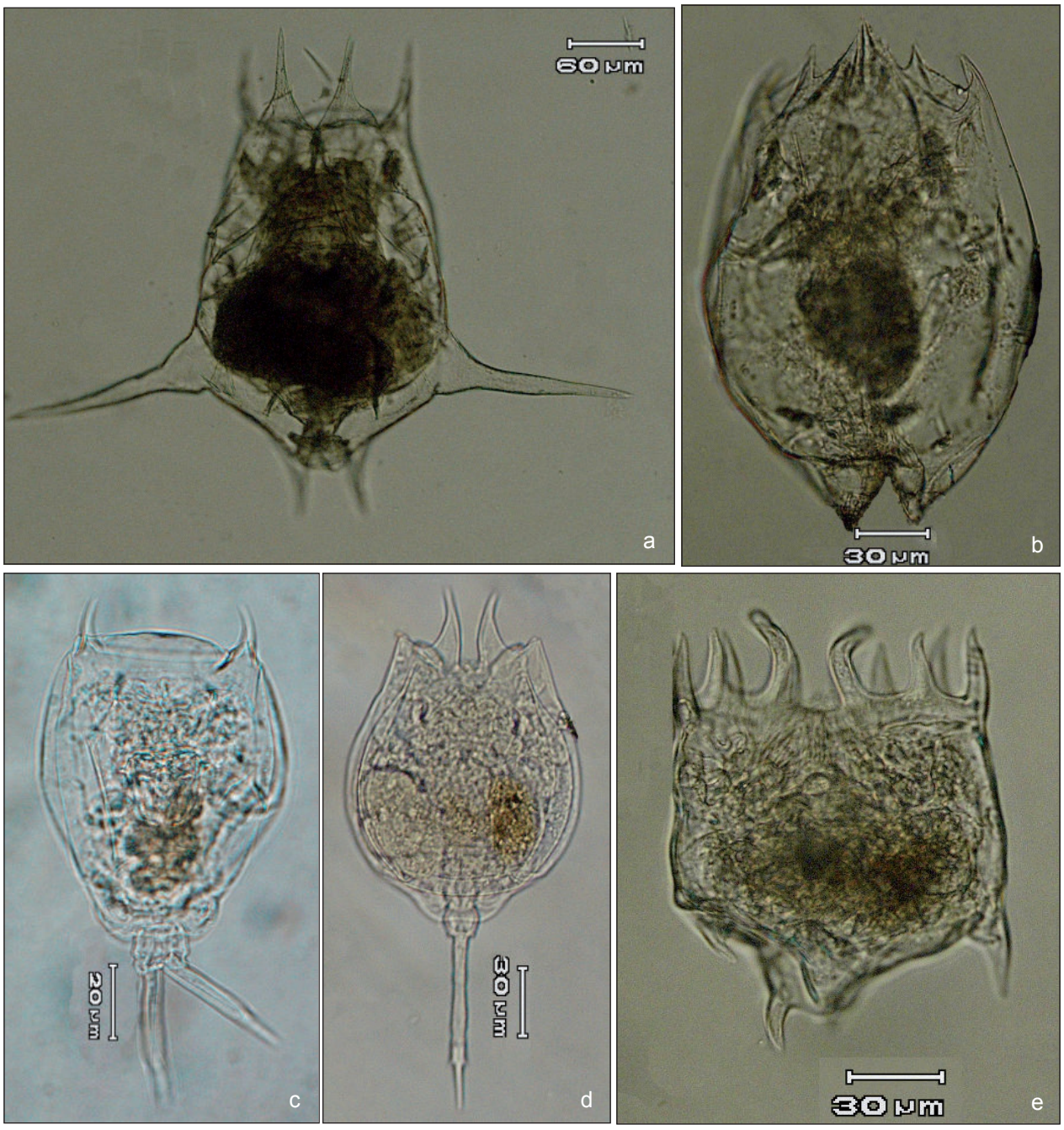

Fig. 2 Some species of Rotifera recorded during the research: (a) *Brachionus calyciflorus*, (b) *Brachionus rubens*, (c) *Lecane chinesensis*, (d) *Lecane quadridentata*, (e) *Plationus patulus*.

1450 VP) was used to examine trophi and lorica of some species, following the methodology of Sanoamuang & Mckenzie (1993) (Fig. 3).

To evaluate whether individual rotifer species occur equally between seasons, Chi-square tests were conducted with the null hypothesis that the incidence of a species is proportional to the number of samples collected during each collection period. *p*-values of < 0.05 were considered significant.

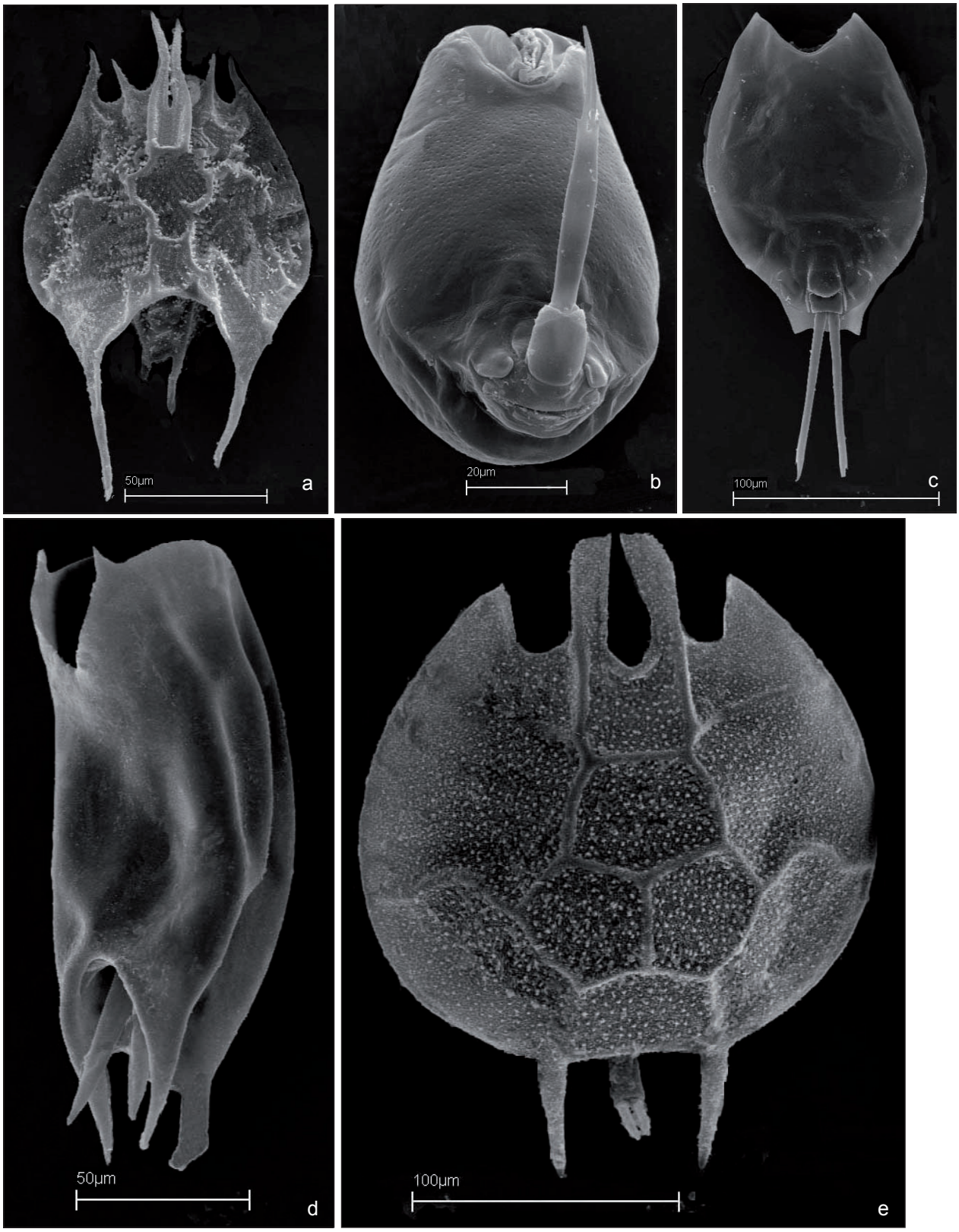

Fig. 3 Electron microscopy scans of rotifers recorded during the study: (a) *Brachionus quadridentatus,* (b) *Lecane bulla,* (c) *Lecane leontina,* (d) *Mytilinia ventralis,* (e) *Platyias quadricornis.*

To estimate species richness (total number of species present) using the number of species found in samples (species count), a number of mathematical algorithms have been developed to analyse the cumulative increase in species count with increasing number of samples. The Chao2-bc estimator, determined using SPADE software (Chao & Shen 2003), was selected for this study because it is well suited for incidence data (i.e. presence or absence of a species in individual samples) and does not require an arbitrary separation of common and rare species.

To determine whether there was any linear relationship between species counts and the various environmental parameters measured, correlation analyses were carried out using the statistical package SPSS v. 13.0 for Windows.

Results

One hundred and forty three species belonging to 31 rotifer genera were found in 200 samples collected from the Cambodian Mekong River Basin (Tables 1 and 2). One hundred and two of these species were new records for Cambodia (Table 2), and the remaining 41 species were previously recorded by Berzins (1973) or recent MRC surveys (Davison *et al*., 2006; MRC, 2008; Vongsombath *et al*., 2009). This study thus increased the number of rotifer species recorded in Cambodia from 78 to 180 species.

The Chao2-bc estimator indicated that species richness of all sites sampled in this study was 174 species (95% CI = 155-224) (Table 3). When the data was combined with raw data published in the earlier reports however, the Chao2-bc estimator indicated that there are 223 species (199-276) of rotifers in Cambodia.

The most common species found in the present study were *Polyarthra cf. vulgaris* (occurring in 80% of the samples, 160/200), followed by *Lecane bulla* (68.5%), *Filinia opoliensis* (64%), *Brachionus falcatus* (61.5%), *Keratella tropica* (59.5%), *L. leontina* (Fig. 3c) and *Plationus patulus* (Fig. 2e) (55%), *L. curvicornis* (54.5%), *L. papuana* (54%), *B. angularis* (53.5%), *B. quadridentatus* (51%), of which *K. tropica* and *L. papuana* were new records for Cambodia (Table 2). One hundred and eight species occurred in fewer-than 40 of the 200 samples collected. Many species were therefore rarely found, with the species found in only one sample including *Brachionus rubens* (Fig. 2b), *Colurella adriatica, C. salina, Euchlanis incisa, Lecane aeganea, L. aspasia, L. chinesensis* (Fig. 2c), *L. decipiens, L. elegans, L. elongata, L. monostyla, L. segersi, L. superaculeata, L. tabida, L. undulata, Lepadella cristata, L. dactyliseta, L. obtusa, L. quadricarinata, Notommata copeus, Synchaeta stylata, Tri-*

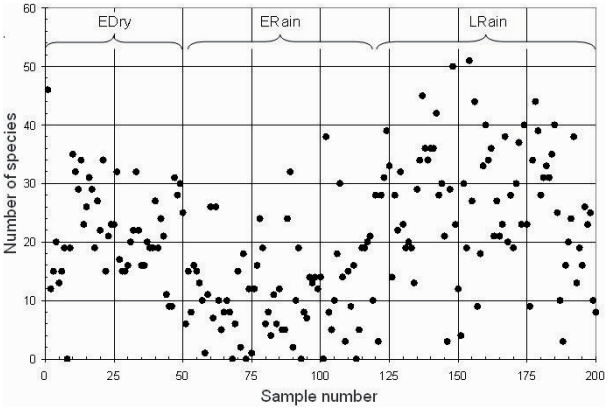

Fig. 4 Number of species found in each sample. A total of 200 samples were collected from various localities during the study.

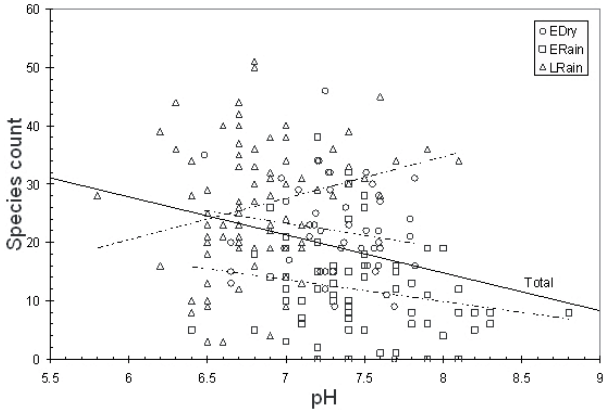

Fig. 5 Correlation between the pH of the habitat (x) and the number of rotifer species recorded (y). All samples: y =-6.51x+66.9, r^2 = 0.076, p < 0.05; EDry: y =-4.21x+52.8, r^2 = 0.026, p >0.10; ERain: y = -3.74x +39.8, r^2 = 0.038, p > 0.10; LRain: y = 7.11x–22.2, r^2 = 0.063, p < 0.05

chocerca agnatha, T. cylindrica, T. longiseta, T. musculus, T. ruttneri, T. tigris and *Tripleuchlanis plicata*. With the exception of *Trichocerca cylindrica* and *T. tigris*, all of these are new records for Cambodia.

The number of species found in each sample ranged from 0-51 species (Fig. 4). The highest count, of 51 species, was recorded in a late rainy season sample from Chorchork floodplain in Prey Veng Province (11°32'55''N, 105°23'35''E, altitude 19 m, temperature 33.3°C, pH 6.8, conductivity 60 μS). Other samples with high species counts were from Chrolong floodplain in Prey Veng Province (50 species), Veal Mong floodplain in Kampong Chhnang Province (46 species), Toul Krasain floodplain in Kandal Province (45 species), Sway Antor floodplain in Prey Veng and Ampel Thom floodplain in Kampong Cham Province (44 species), Steung Khlot floodplain in Prey Veng (42 species), Kdieng Reay floodplain in Prey Veng, Matt Khmourng Lake in Kampong Cham and Kampong Trach rice field in Kampong Chhnang (40 species). With the exception of the sample from Veal Mong floodplain, all of these samples were collected in the late rainy season. These records suggest that floodplains are good habitats for rotifer species richness.

The pH of the water collected during the late rainy season (95% CI = pH 6.74-6.91) was significantly lower than that in the early dry (pH 7.24-7.41) and early rainy seasons (pH 7.35-7.56) (Table 1). The temperature was significantly higher in the late rainy season (30.6-31.7°C) than the early dry season (26.7-27.4°C). However, no significant difference was observed in the altitude of the sampled sites. The abundance of species-rich samples along with some species poor samples from the late rainy season, and the abundance of species-poor samples from the early rainy season, are shown in Fig. 4. The Chao2-bc estimator confirmed that species richness was higher in the late rainy season (95% CI = 132-171 [*figures corrected post-publication on 29 July 2010 - Ed.*]) than in the early rainy season (84-124) and early dry season (87-112) (Table 3). Of the environmental parameters measures, only pH was correlated with species counts. Although a negative correlation was found when samples from all three seasons were considered ($r^2 = 0.076$, $p < 0.05$), a positive correlation was found for the late rainy season samples ($r^2 = 0.063$, $p < 0.05$) (Fig. 5).

Discussion

On the basis of information currently available, rotifer species richness in Cambodia is estimated to be 223 and therefore appears lower than that in Thailand, where 347 taxa have already been reported (Savatenalinton & Segers, 2005). Although many regions and habitats in Cambodia have not yet been sampled, it is possible that Thailand has higher rotifer species richness because the country is larger and spans a much greater range of latitudes.

All species found in this study were previously reported in Southeast Asia, some of which were hitherto considered endemic species, e.g.:

- *Brachionus murphyi* Sudzuki is an eastern oriental taxon recorded in Singapore (Sudzuki, 1989), Thailand (Sanoamuang *et al*., 1995: sub. *B. niwati* Sanoamuang *et al*., 1995: new synonym), and Hainan, South China (Koste & Zhuge, 1998: sub. *B. niwati*).
- *L. baimaii* Sanoamuang & Savatenalinton was first found at Nakhon Rachasima Province, Northeast Thailand (Sanoamuang & Savatenalinton, 1999).
- *L. segersi* Sanoamuang was considered a Thai endemic species, first described from Northeast Thailand (Sanoamuang, 1996).

Among the species found in the present study, the most diverse genus was *Lecane* (43 of the 143 species found, 30.1%), followed by *Trichocerca* (13.2%), *Brachionus* (9.7%) and *Lepadella* (9.1%) (Table 2). This result agrees with the previous studies indicating that *Lecane* is the most diverse genus in the floodplain of Nan River, Mun River and Lake Kud Thing in Northeast Thailand (Sanoamuang *et al*., 1995; Sanoamuang, 1998; Sanoamuang & Savatenalinton, 2001; Segers *et al*., 2004; Savatenalinton & Segers, 2005) and in a floodplain in Northeast India

(Sharma, 2005, 2009). *Lecane* has also been considered by other authors to be the most diverse genus in Southeast Asia (e.g. Segers, 2001).

The results suggested a seasonal pattern in which rotifer species richness was significantly higher in the late rainy season than in the early rainy season or early dry season. It would appear that habitats stressed during the dry season have not yet fully recovered for rotifers by the early rainy season. Of the 143 species recorded in this study, the incidence of 83 species demonstrated seasonal differences (Table 2). Further studies are required to determine whether the observed seasonal differences are cyclical over several years, whether they are related to habitat type or quality, or whether they have any other explanation.

Two previous studies indicated that species counts are inversely correlated with pH (Sharma, 2005; Mieczam, 2007), while one indicated a positive correlation (Duggan *et al.*, 1998). Our results indicated that the correlation could depend on the season (Fig. 5). Therefore, there does not appear to be a simple relationship between species counts and pH, and the factors that may affect species composition warrant further investigation. The sampling of Cambodian habitats and localities for rotifers is far from complete, and new records and perhaps new species could be expected from future surveys of localities such as the upper part of Cambodian Mekong River Basin.

It should be noted that the types of habitats sampled in the three collection periods varied (Table 1), and the comparison of "season" in this paper does not distinguish between the effect of season and habitat. The results indicated that high species counts are found in floodplains and this agrees with earlier investigations in India (Sharma, 2005; Sharma & Sumita, 2005; Sumiti & Sharma, 2008). A subsequent manuscript will provide a more detailed analysis of the data, including the analysis of variance among habitats and geographic localities and the ecological indices for species assemblages and community similarity using the methods of Chao & Shen (2003) and Gotelli & Entsminger (2001).

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About the Author

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Table 1 Physical properties and habitat types associated with rotifer samples collected in three periods.

		Collection period [a]			
		All	*EDry*	*ERain*	*LRain*
Physical properties	Altitude (m)	9.3 (8.3-10.4)	n/a	8.0 (6.6-9.4)	10.4 (8.9-12.0)
	Conductivity (μS cm^{-1})	n/a	n/a	n/a	78.8 (70.2-87.3)
	pH	7.17 (7.10-7.24)	7.32 (7.24-7.41)	7.45 (7.35-7.56)	6.83 (6.74-6.91)
	Temperature (°C)	n/a	27.0 (26.7-27.4)	n/a	31.1 (30.6-31.7)
Number of localities		174	38	70 [b]	80 [c]
Total samples		200	50	70	80
Habitats	Rivers	11	10	0	1
	Streams	12	10	2	0
	Canals	68	11	36	21
	Lakes	11	10	0	1
	Ponds	20	0	10	10
	Temporary ponds	4	0	1	3
	Floodplains	54	7	18	29
	Rice fields	20	2	3	15
Total Species		143	85	80	127

[a] Results in parentheses for altitude, conductivity, pH and temperature are the respective 95% confidence intervals. n/a: indicates data for fewer than 75% of the samples for altitude, conductivity or temperature (no altitude measurements were recorded for the EDry samples, no conductivity measurements were recorded for the EDry and ERain samples, and no temperature measurements were recorded for the ERain samples).

[b] Two of these localities were previously visited when collecting EDry samples.

[c] 12 of these localities were previously visited when collecting ERain samples.

Table 2 Rotifera recorded in Cambodian Mekong River Basin during the present study.

New[a]	Species name	Total	Incidence among samples: Collection period *EDry*	*ERain*	*LRain*	Significant difference [b]
*	*Anuraeopsis coelata* de Beauchamp 1932	25	14	9	2	**
	Anuraeopsis fissa Gosse 1851	41	2	16	23	**
	Ascomorpha ecaudis Petry 1850	8	2	3	3	
*	*Asplanchna brightwellii* Gosse 1850	21	1	18	2	**
*	*Asplanchna priodonta* Gosse 1850	13	10	0	3	**
	Brachionus angularis Gosse 1851	107	40	30	37	**
*	*Brachionus bidentatus* Anderson 1889	13	4	6	3	
*	*Brachionus budapestinensis* Daday 1885	5	0	4	1	
	Brachionus calyciflorus Pallas 1766	18	16	0	2	**
	Brachionus caudatus Barrois & Daday 1894	39	24	10	5	**
*	*Brachionus dichotomus* Shephard, 1911	25	19	0	6	**
	Brachionus diversicornis (Daday 1883)	16	16	0	0	**
	Brachionus donneri Brehm 1951	15	11	1	3	**
	Brachionus falcatus Zacharias 1898	123	43	37	43	**
*	*Brachionus forficula* Wierzejski 1891	52	36	5	11	**
*	*Brachionus kostei* Shiel 1983	6	0	1	5	
*	*Brachionus murphyi* Sudzuki 1989	7	2	4	1	
	Brachionus quadridentatus Hermann 1783	102	21	31	50	
*	*Brachionus rubens* Ehrenberg 1838	1	0	0	1	
	Cephalodella gibba (Ehrenberg 1830)	10	2	0	8	**
*	*Colurella adriatica* Ehrenberg 1831	1	0	1	0	
*	*Colurella salina* Althaus 1957	1	0	1	0	
*	*Colurella uncinata* (Müller 1773)	15	0	0	15	**
*	*Dicranophoroides caudatus* (Ehrenberg 1834)	34	0	18	16	**
*	*Dicranophoroides claviger* (Hauer 1965)	2	0	0	2	
*	*Dicranophorus epicharis* Harring & Myers 1928	14	0	1	13	**
	Dipleuchlanis propatula (Gosse 1886)	55	9	10	36	**
	Euchlanis dilatata Ehrenberg 1832	56	3	7	46	**
*	*Euchlanis incisa* Carlin 1939	1	0	0	1	
	Filinia camasecla Myers 1938	68	37	5	26	**

[a] * = New record for Cambodia from the present study

[b] ** = Significant difference found with x^2 tests, $p < 0.05$. Null hypothesis = incidence of a species is proportional to the number of samples collected in each collection period (EDry = 50, ERain = 70, LRain = 80).

New[a]	Species name	Total	Incidence among samples: Collection period *EDry*	*ERain*	*LRain*	Significant difference[b]
	Filinia longiseta (Ehrenberg 1834)	62	13	31	18	**
*	*Filinia novaezealandiae* Shiel & Sanoa-muang 1993	87	31	25	31	
	Filinia opoliensis (Zacharias 1898)	128	43	43	42	
*	*Hexarthra intermedia* (Wiszniewski 1929)	85	35	25	25	**
	Keratella cochlearis (Gosse 1851)	81	46	7	28	**
*	*Keratella edmondsoni* Ahlstrom 1943	15	9	3	3	**
*	*Keratella lenzi* Hauer 1953	90	35	15	40	**
*	*Keratella procurva* (Thorpe 1891)	26	24	2	0	**
*	*Keratella tecta* (Gosse 1851)	3	0	0	3	
*	*Keratella tropica* (Apstein 1907)	119	47	27	45	**
*	*Lecane aculeata* (Jakubski 1912)	7	0	0	7	**
*	*Lecane aeganea* Harring 1914	1	0	0	1	
*	*Lecane baimaii* Sanoamuang & Savatenal-inton 1999	4	0	0	4	**
	Lecane blachei Bērziņš 1973	15	8	2	5	**
	Lecane bulla (Gosse 1851)	137	34	32	71	**
*	*Lecane chinesensis* Zhuge & Koste 1996	1	1	0	0	
*	*Lecane closterocerca* (Schmarda 1859)	10	5	0	5	**
*	*Lecane crepida* Harring 1914	27	5	4	18	**
	Lecane curvicornis (Murray 1913)	109	27	31	51	
*	*Lecane decipiens* (Murray 1913)	1	0	0	1	
*	*Lecane elegans* Harring 1914	1	0	0	1	
*	*Lecane elongata* Harring & Myers 1926	1	0	0	1	
*	*Lecane furcata* (Murray 1913)	13	0	0	13	**
*	*Lecane haliclysta* Harring & Myers 1926	30	9	11	10	
*	*Lecane hamata* (Stokes 1896)	23	6	2	15	**
	Lecane hastata (Murray 1913)	66	9	21	36	**
*	*Lecane hornemanni* (Ehrenberg 1834)	18	0	0	18	**
*	*Lecane lateralis* Sharma 1978	17	0	0	17	**
	Lecane leontina (Turner 1892)	110	18	24	68	**
*	*Lecane ludwigii* (Eckstein 1883)	55	8	4	43	**
	Lecane luna (Müller 1776)	59	10	13	36	**
	Lecane lunaris (Ehrenberg 1832)	75	20	7	48	**
*	*Lecane monostyla* (Daday 1897)	1	1	0	0	
*	*Lecane nana* (Murray 1913)	2	2	0	0	**
*	*Lecane obtusa* (Murray 1913)	6	0	0	6	**
*	*Lecane papuana* (Murray 1913)	108	22	39	47	

New[a]	Species name	Total	Incidence among samples: Collection period *EDry*	*ERain*	*LRain*	Significant difference [b]
*	*Lecane pertica* Harring & Myers 1926	9	1	0	8	**
	Lecane pusilla Harring 1914	2	1	0	1	
	Lecane quadridentata (Ehrenberg 1830)	66	8	6	52	**
*	*Lecane rhenana* Hauer 1929	12	2	0	10	**
*	*Lecane rhytida* Harring & Myers 1926	4	1	0	3	
*	*Lecane segersi* Sanoamuang 1996	1	0	0	1	
	Lecane signifera (Jennings 1896)	74	20	6	48	**
*	*Lecane sola* Hauer 1936	2	0	1	1	
	Lecane stenroosi (Meissner 1908)	31	7	7	17	
*	*Lecane subtilis* Harring & Myers 1926	3	1	2	0	
*	*Lecane superaculeata* Sanoamuang & Segers 1997	1	1	0	0	
*	*Lecane tabida* Harring & Myers 1926	1	1	0	0	
*	*Lecane thailandensis* Segers & Sanoamuang 1994	2	0	0	2	
*	*Lecane thienemanni* (Hauer 1938)	19	8	3	8	
*	*Lecane undulata* Hauer 1938	1	1	0	0	
*	*Lecane unguitata* (Fadeev 1925)	81	13	9	59	**
	Lecane ungulata (Gosse 1887)	53	5	11	37	**
*	*Lepadella acuminata* (Ehrenberg 1834)	2	0	0	2	
*	*Lepadella apsicora* Myers 1934	1	0	1	0	
*	*Lepadella cristata* (Rousselet 1893)	1	0	0	1	
*	*Lepadella dactyliseta* (Stenroos 1898)	1	0	0	1	
*	*Lepadella discoidea* Segers 1993	12	1	0	11	**
*	*Lepadella heterostyla* (Murray 1913)	4	0	0	4	**
*	*Lepadella latusinus* (Hilgendorf 1899)	6	0	0	6	**
*	*Lepadella obtusa* Wang 1961	1	0	0	1	
*	*Lepadella ovalis* (Müller 1786)	9	2	0	7	**
	Lepadella patella (Müller 1773)	21	2	3	16	**
*	*Lepadella quadricarinata* (Stenroos 1898)	1	0	0	1	
*	*Lepadella quinquecostata* (Lucks 1912)	2	0	0	2	
*	*Lepadella rhomboides* (Gosse 1886)	55	12	19	24	
*	*Lophocharis salpina* (Ehrenberg 1834)	28	1	7	20	**
*	*Macrochaetus collinsii* (Gosse 1867)	30	2	2	26	**
*	*Macrochaetus danneeli* Koste & Shiel 1983	6	0	0	6	**
*	*Macrochaetus sericus* (Thorpe 1893)	17	2	1	14	**
*	*Monommata dentata* Wulfert 1940	29	3	3	23	**
*	*Mytilina acanthophora* Hauer 1938	2	0	1	1	

New[a]	Species name	Total	Incidence among samples: Collection period *EDry*	*ERain*	*LRain*	Significant difference [b]
*	*Mytilina bisulcata* (Lucks 1912)	9	0	0	9	**
*	*Mytilina unguipes* (Lucks 1912)	6	0	2	4	
*	*Mytilina ventralis* (Ehrenberg 1830)	53	7	4	42	**
*	*Notommata copeus* Ehrenberg 1834	1	0	1	0	
	Plationus patulus (Müller 1786)	110	20	30	60	**
	Platyias quadricornis (Ehrenberg 1832)	66	9	14	43	**
	Ploesoma hudsoni (Imhof 1891)	18	8	1	9	**
*	*Ploesoma lenticulare* Herrick 1855	27	12	0	15	**
	Polyarthra cf. vulgaris Carlin 1943	160	46	41	73	**
	Pompholyx complanata Gosse 1851	10	6	2	2	**
*	*Scaridium elegans* Segers & De Meester 1994	4	4	0	0	**
	Scaridium longicaudum (Müller 1786)	14	0	1	13	**
*	*Synchaeta pectinata* Ehrenberg 1832	18	15	1	2	**
*	*Synchaeta stylata* Wierzejski 1893	1	0	0	1	
*	*Testudinella ahlstromi* Hauer 1956	40	5	1	34	**
*	*Testudinella brevicaudata* Yamamoto 1951	11	7	2	2	**
*	*Testudinella greeni* Koste 1981	15	0	5	10	**
	Testudinella patina (Hermann 1783)	86	11	18	57	**
*	*Testudinella tridentata* Smirnov 1931	27	8	3	16	**
*	*Trichocerca agnatha* Wulfert 1939	1	0	1	0	
*	*Trichocerca bicristata* (Gosse 1887)	27	0	0	27	**
	Trichocerca capucina (Wierzejski & Zacharias 1893)	20	8	0	12	**
*	*Trichocerca chattoni* (de Beauchamp 1907)	3	0	1	2	
	Trichocerca cylindrica (Imhof 1891)	1	0	0	1	
*	*Trichocerca elongata* (Gosse 1886)	9	0	2	7	
*	*Trichocerca flagellata* Hauer 1937	9	1	0	8	**
*	*Trichocerca insignis* (Herrick 1885)	8	0	0	8	**
*	*Trichocerca insulana* (Hauer 1937)	5	0	0	5	**
*	*Trichocerca longiseta* (Schrank 1802)	1	0	0	1	
*	*Trichocerca musculus (Hauer 1937)*	1	0	0	1	
*	*Trichocerca myersi* (Hauer 1931)	3	0	0	3	
*	*Trichocerca porcellus* (Gosse 1851)	2	0	0	2	
*	*Trichocerca ruttneri* Donner 1953	1	0	0	1	
	Trichocerca similis (Wierzejski 1893)	96	35	23	38	**
*	*Trichocerca stylata* (Gosse 1851)	2	0	0	2	
	Trichocerca tigris (Müller 1786)	1	0	0	1	

New[a]	Species name	Incidence among samples: Total	Collection period: *EDry*	*ERain*	*LRain*	Significant difference [b]
*	*Trichocerca vernalis* (Hauer 1936)	5	0	0	5	**
*	*Trichocerca voluta* Murray 1913	2	0	0	2	
	Trichotria tetractis (Ehrenberg 1830)	62	15	4	43	**
*	*Tripleuchlanis plicata* (Levander 1894)	1	0	1	0	
*	*Wolga spinifera* (Western 1894)	25	5	8	12	

Table 3 Species richness estimated from the incidence data collected in the present study and those collected by MRC (Davison *et al.*, 2006; MRC, 2008; Vongsombath *et al.*, 2009).

	No. of samples	No. of species recorded	Species richness: Chao2-bc estimator	95% CI
Total	200	143	174	155-224
EDry	*50*	*85*	*92*	*87-112*
ERain	*70*	*80*	*93*	*84-124*
LRain	*80*	*127*	*142* [b]	*132-171* [b]
MRC	30	74	81	76-99
Combined [a]	231	180	223	199-276

[a] The four species reported by Berzins (1973) are also included as one sample.

[b] *These figures were changed at the author's request on 30 July 2010. This version replaces the electronic version of this paper that was first published on 29 July 2010 - Ed.*

Recent theses

This section presents the abstracts of research theses produced by Royal University of Phnom Penh graduates awarded the degree of Masters of Science in Biodiversity Conservation. The abstracts have been slightly edited for English.

An analysis of threats and site-level conservation approaches at Cambodian Protected Forests

Hem Chanrithy

Rapid economic and population growth and poverty have promoted land alienation, deforestation and illegal wildlife trade in Cambodia (Pollard *et al*., 2007). This is likely to cause serious long term impacts on natural forests, wildlife and local livelihoods (Grimm *et al*., 2007). However, Cambodia has allocated large areas of forest for biodiversity conservation, ecosystem protection, environmental sustainability, poverty alleviation and sustainable development. This study sought to identify what kinds of threats are crucial to Cambodian protected forests and to determine the underlying causes of these threats. The study also aimed to determine what kinds of measures have been taken to deal with the identified threats, and their effectiveness. To achieve this, a comprehensive literature review was undertaken and primary data collected through structured and semi-structured interviews, supplemented by field observations.

In Cambodia, five major protected forests (Mondulkiri Protected Forest, Seima Biodiversity Conservation Area, Central Cardamom Protected Forest, Southern Cardamom Protected Forest, and Preah Vihear Protected Forest) have been established to protect and conserve biodiversity. A high diversity of species, communities, ecosystems, and landscapes have been recorded from these sites, including critically endangered, endangered, near threatened, data deficient and endemic species. Unfortunately, these protected forests face 16 kinds of threats with different severities and impacts, such as land encroachment, illegal timber harvesting, wildlife poaching, charcoal making, shifting cultivation, infrastructure development and economic land concession. Among the threats identified, land encroachment appeared the most severe, while shifting cultivation, illegal timber harvesting and wildlife hunting were the most common. Comprehensive approaches have been used to prevent, mitigate and suppress conservation threats, including community livelihood development, land demarcations, in situ and ex-situ species conservation and law enforcement. Fruitful results have been achieved in some areas, but greater participation from relevant stakeholders is necessary. Due to the limited resources and capacity of government agencies, as well as limited stakeholder participation, more extensive and comprehensive efforts are needed to alleviate poverty within rural communities and halt biodiversity destruction.

Overall, the study promotes greater understanding of the effectiveness and processes involved in different site-level approaches in dealing with conservation threats. Knowledge of management alternatives and options are useful for conservationists to choose the most effective and efficient approach for site-level protection of biodiversity within Cambodian protected areas.

Factors affecting site selection and feeding habits of hairy-nosed otter *Lutra sumatrana* and smooth-coated otter *Lutrogale perspicillata* at Tonle Sap Great Lake, Cambodia

Heng Sokrith

The hairy-nosed otter *Lutra sumatrana* and smooth-coated otter *Lutrogale perspicillata* are documented

to occur in the Tonle Sap Great Lake. There is, however, no clear information on their ecology and behaviour. The aim of my study was to determine the habitat selection and major prey of both species in inundated forest habitats at the site. Such information is useful to guide the development of legislative measures and management programmes for conserving otters and their habitats.

Six months of field work were conducted during the wet season, from June to December 2008. The study site comprised 1,125 ha of inundated forest, including gallery forest and short-tree scrubland. Twenty-six field signs of both otter species were encountered during the study and demonstrated that *Lutra sumatrana* and *Lutrogale perspicillata* occur sympatrically in the study site. Both otters had a preference for gallery forest (81% of sign), although within this habitat the two species selected different microhabitats.

Lutra sumatrana (16%) and unidentified otter sp. (66%) preferred to frequent bushes and trees with open spaces where vines or lianas formed an umbrella. *Lutra sumatrana* would drop two to four pieces of spraint per session, either using the same branch or several different branches. Their spraint is long and thin, and contains mucus. This species sometimes re-uses a spraint site, with subsequent spraint deposited in separate areas.

Lutrogale perspicillata exhibited a distinct tendency to deposit sign in open areas on floating logs and in short-tree scrubland, except when using resting sites covered with small branches and lianas. The latter species lives in groups, and individuals share the same spraint sites, which are often revisited and have large quantities of spraint with a strong fishy odour. Ninety-two percent of all spraint encountered was deposited on horizontal branches or branches sloping into the water. Otters typically defecated on *Xanthophyllum glaucum* (65%).

Lutra sumatrana was mainly active at dusk and dawn from 0430h to 0600h and from 1400h to 1900h, while *Lutrogale perspicillata* was also active at these times, but often also active throughout the day.

The diet of both otters was found to consist of at least seven species of fish, two species of reptile, one crab species and one rat species. Fish and reptiles were consumed in comparable quantities by both otters during the wet season. The tentacled snake *Erpeton tentaculatum* constituted the major proportion of the diet of both *Lutra sumatrana* and *Lutrogale perspicillata*, followed by climbing gouramies *Anabas testudineus* and the chevron snakehead *Channa striatus*.

Feeding behaviour, activity patterns and food preferences of juvenile Asian softshell turtles (*Pelochelys cantorii*) in captivity

Kea Ratha

The Asian giant softshell turtle (*Pelochelys cantorii*) is a freshwater turtle and a poorly studied species. To study its feeding behaviour, activity patterns, food preferences and growth rate, two different methods were used. The first entailed interviews in Boeng Cha Commune in Koh Thnort District, which is situated along the Mekong River in Kratie Province, the natural habitat of *P. cantorii*. The aim of the interviews was to obtain general information on ecology, biology, population trend and threats to survivorship of the species. The second method comprised two experiments undertaken at the Conservation International office in Phnom Penh. For this, 12 hatchings of *P. cantorii* were brought from the wild, put together in a glass tank (160cm x 100cm x 70cm) and fed for 45 days prior to the experiments.

The first experiment focussed on the feeding behaviour, activity patterns, growth rate and breathing time of hatchlings and took place for ten weeks from 5 June to 14 August, 2008. Food was provided twice a week, Sunday and Thursday, at 0800h. Four categories of food were provided including small live (i) *Trichopsis schalleri* and *T. vittata*; (ii) *Trichog-*

aster pectoralis and *T. microlepis*; (iii) *Channa striata* and *C. micropeltes*; and (iv) *Palaemonotus paludosus*. Twenty-four hour security cameras were used to record activity patterns, supplemented by direct observation. The second experiment aimed to determine the food preference, amount of food consumption per day, and the growth rate of *P. cantorii*. The experiment lasted for 10 weeks from 25 August until 2 November, 2008. Conditions were similar to the first experiment, except that each hatchling was placed individually in a glass tank (50cm x 30cm x 25cm).

My findings indicate that the most active feeding time of *P. cantorii* is at 0800h every day, while searching, moving and swimming primarily occur at night. During the study, the most frequently consumed food of *P. cantorii* was live *T. schalleri* and *T. vittata* (61% of total). No significant difference was observed in growth rates of *P. cantorii* between the first and second experiment (i.e. when hatchlings occupied the same tank and individual tanks, respectively). Two main periods are particularly important for protection of wild populations of *P. cantorii*: (i) December to late February: important to protect nesting sites and egg-laying females; and (ii) late February to late April: to protect newly emerged hatchlings.

Socio-economic influence of domesticated elephants on Phnong people in Mondulkiri Province, Cambodia

Srey Chansorphea

This study investigated the social-economic influence of domesticated elephants belonging to Phnong people in Mondulkiri Province and was undertaken from 1 May 2007 to 15 December 2009. Fifty-four families that own elephants were interviewed in relation to socio-economic factors in 28 villages, 13 communes, and five districts. Ownership of domesticated elephants within the province has decreased over the last decade: In 2001, 91 domesticated elephants were documented within the study area, while at present, 67 domesticated elephants are known. This decrease is due to many factors including trade, forest loss, altered income levels, culture, and infrastructure. Typically, the income of people in districts with good road access is higher than those living in areas with poor access and the former are characterised by greater forest loss and cultural changes.

I hypothesized that people living in districts with good road access are less interested in raising domesticated elephants due to higher incomes relative to those living in districts with poor access. To test this, I divided the study respondents into those living in districts with good road access (n = 36 households) and those living in districts with poor access (n = 18 households).

My study employed primary data from interviews by questionnaire and secondary data obtained through a literature review. A variety of indicators were employed in the questionnaires, including: house property; health and buying power; agriculture, forest, land clearing indicators; attitudes and behaviour toward elephant conservation; road access; and cultural beliefs. Direct observation was also applied to gather more information during interviews, which were documented using an MP3 recorder. Data were analysed using Chi-square tests with SPSS and the development of graphs using Excel.

In summary, the results did not support the initial hypothesis. All families interviewed benefit from ownership of domesticated elephants, albeit in different ways, and aspire to own additional elephants. Because the only source of additional elephants is presently from the wild populations, elephant conservation is relevant to all areas studied, irrespective of road access.

Recent literature from Cambodia

This new section summarizes many of the most recent scientific publications concerning Cambodian biodiversity and natural resources.

The abstracts of most articles are freely available online (and can be found using Google Scholar or other search engines), but not necessarily the whole article. The lead authors may be willing to provide free reprints or electronic copies on request and their email addresses, where known, are included in the summaries below.

Documents that use the Digital Object Identifier (DOI) System, can be opened from the site http://dx.doi.org (enter their entire DOI code in the text box provided, and then click Go to find the document).

If you or your organization have recently published a technical paper or report that you would like to be listed in the next issue, please send an electronic copy, summary or online link to: Editor.CJNH@gmail.com

New species and taxonomic reviews

Adamson, E.A.S., Hurwood, D.A. & Mather, P.B. (2010) A reappraisal of the evolution of Asian snakehead fishes (Pisces, Channidae) using molecular data from multiple genes and fossil calibration. *Molecular Phylogenetics and Evolution*, **56,** 707-717.

A genetic study indicated the presence of a new undescribed species of *Channa* from the Sekong River (northern Cambodia). Two known species were also examined from Cambodia: *C. lucius* and *C. striata*. Author: eas.adamson@gmail.com

Cheek, M. & Jebb, M. (2009) *Nepenthes* group Montanae (Nepenthaceae) in Indo-China, with *N. thai* and *N. bokor* described as new. *Kew Bulletin,* **64,** 319-325.

A new key to the Montanae pitcher plants in Peninsular Malaysia, Thailand and Cambodia. This paper also describes a new species from Bokor National Park, named here as *Nepenthes bokor [but see Mey, 2009, below - Ed.]*. Author: m.cheek@kew.org

Grismer, J.L., Grismer, L.L. & Chav T. (2010) New species of *Cnemaspis* Strauch 1887 (Squamata: Gekkonidae) from southwestern Cambodia. *Journal of Herpetology,* **44,** 28-36.

A new gecko from Phnom Samkos Wildlife Sanctuary is described as *Cnemaspis neangthyi*, named after Cambodian herpetologist Neang Thy. Author: jesse.grismer@villanova.edu

Hul S. (2010) Two new species of Gentianaceae from Indo-china. *Edinburgh Journal of Botany*, **67,** 155-160.

Includes the description of a new species of flowering plant from Cambodia and Thailand, *Exacum darae*. Author: hul@mnhn.fr

Jenkins, P.D., Abramov, A.V., Rozhnov, V.V. & Olsson, A. (2010) A new species of *Crocidura* (Soricomorpha: Soricidae) from southern Vietnam and north-eastern Cambodia. *Zootaxa,* **2345,** 60–68.

A new shrew, *Crocidura phanluongi*, described from specimens captured in both Vietnam and Virachey National Park, Cambodia. Author: p.jenkins@nhm.ac.uk

Lee, Y.J. (2009) A new genus and new species of the subtribe Cicadina (Hemiptera: Cicadidae: Cicadini). *Florida Entomologist*, **92,** 470-473.

A new genus of cicada, *Qurana*, and a new species, *Q. ggoma*, is described from Siem Reap. Author: cicaderolee@gmail.com. Online: http://www.fcla.edu/FlaEnt/fe92p470.pdf

Lee, Y.J. (2010) A checklist of Cicadidae (Insecta: Hemiptera) from Cambodia, with two new species and a key to the genus *Lemuriana*. *Zootaxa*, **2847,** 19-32.

Twenty-five species of cicadas have been described from Cambodia to date. This paper describes two new species, *Tanna kimtaewooi* (from Seima) and *Lemuriana cambodiana* (from Siem Reap). Author: cicaderolee@gmail.com

Lee, Y.J. & Sanborn, A.F. (2010) Three new species of the genus *Megapomponia* (Hemiptera: Cicadidae) from Indochina, with a key to the species of *Megapomponia*. *Journal of Asia-Pacific Entomology*, **13,** 31-39.

A key provided to the cicada genus *Megapomponia* and two new species are described from Cambodia: *M. atrotunicata* (from Ratanakiri) and *M. castanea* (from Siem Reap). Author: cicaderolee@gmail.com

Lin M., Tavakilian, G., Montreuil, O. & Yang X. (2009) A study on the *indiana* & *galathea* species-group of the genus *Glenea*, with descriptions of four new species (Coleoptera: Cerambycidae: Lamiinae: Saperdini). *Annales de la Société Entomologique de France*, **45,** 157-176.

The longhorn beetles *Glenea indiana* and *G. galathea* are (re)split into nine species, and an identification key is presented. In Cambodia, *G. mouhoti* Thomson 1865 is reinstated as a valid species. Author: yangxk@ioz.ac.cn; Online: http://zoologie.umh.ac.be/asef/pdf/2009_45_02/Compact/Lin_et_al_ASEF_2009_45_2_157_176_compact.pdf

Mey, F.S. (2009) *Nepenthes bokorensis*, a new species of Nepenthaceae from Cambodia. *Carniflora Australis*, **7,** 6-15.

A new species of pitcher plant, *Nepenthes bokorensis*, is described from Bokor National Park. *[Published in March 2009, this name automatically takes precedence over* N. bokor*, published for the same species in June by Cheek & Jebb (2009) - Ed.].* Author: meyfr@yahoo.fr; Online: http://dionee.nuxit.net/files/revue/carniflora_australis_vol_7_no_1_nepenthes_bokorensis.pdf

Middleton, D.J. (2009) A revision of *Aeschynanthus* (Gesneriaceae) in Cambodia, Laos and Vietnam. *Edinburgh Journal of Botany*, **66,** 391-446.

Eighteen species of the 'lipstick plant' genus *Aeschynanthus* are documented in Cambodia, Laos and Vietnam. This paper presents keys to these species, detailed descriptions and conservation assessments. Three new species are described, including one from Ratanakiri: *Aeschynanthus cambodiensis*. Author: d.middleton@rbge.ac.uk; Online: http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=6403548

Praschag, P., Holloway, R., Georges, A., Päckert, M., Hundsdörfer, A.K. & Fritz, U. (2009) A new subspecies of *Batagur affinis* (Cantor, 1847), one of the world's most critically endangered chelonians (Testudines: Geoemydidae). *Zootaxa*, **2233,** 57-68.

Genetic and morphological evidence suggests Cambodia's "royal turtles" are *Batagur affinis*, not *B. baska*. A new subspecies, *B. affinis edwardmolli*, is proposed for the populations in Cambodia and the eastern Malayan Peninsula. Author: uwe.fritz@senckenberg.de; Online: http://www.piku.org.au/reprints/2009_Praschag_etal_Batagur.pdf

Razafindratsimandresy, R., Jeanmaire, E.M., Counor, D., Vasconcelos, P.F., Sall, A.A. & Reynes, J.-M. (2009) Partial molecular characterization of alphaherpesviruses isolated from tropical bats. *Journal of General Virology,* **90,** 44-47.

The discovery of a new herpesvirus in the genus *Simplexvirus* from the Cambodian bat *Pteropus lylei.* Author: jmreynes@pasteur.mg; Online: http://iah.iec.pa.gov.br/iah/fulltext/pc/artigos/2009/jgenvirol2009v90n1p44-47.pdf

Wood Jr., P.L., Grismer, L.L., Grismer, J.L., Neang T., Chav T. & Holden, J. (2010) A new cryptic species of *Acanthosaura* Gray, 1831 (Squamata: Agamidae) from Thailand and Cambodia. *Zootaxa,* **2488,** 22–38.

The discovery and description of the 'Cardamom Mountain horned agamid', *Acanthosaura cardamomensis*, a lizard considered by the authors to be endemic to Southwest Cambodia and adjoining parts of Thailand. Author: perry.wood@villanova.edu

Guides and monographs

Bourret, R.L. (2009) *Les Lézards de l'Indochine.* Edition Chimaira, Frankfurt, and Muséum National d'Histoire Naturelle, Paris, France. 624 pp. (In French and English).

A monograph on the lizards of Cambodia, Vietnam and Laos, which was completed in 1947, but not published until now. In addition to Bourret's original text in French, the book contains recent supplementary papers by other authors in English and French. New copies cost just under $200.

Khou E.H. (2010) *A Field Guide of the Rattans of Cambodia.* WWF Greater Mekong Cambodia Country Programme, Phnom Penh, Cambodia.

Compiled by Cambodian botanist Khou Eang Hourt, this guidebook contains general rattan information, overall rattan characteristics, and detailed accounts for 18 species of the 20 species currently known in Cambodia. Distribution maps and colour photographs are provided to aid field identification. Author: khou_eanghourt@yahoo.com

Lic V. (2009) *Wildlife Biology: Primary Concepts of Wildlife Science*. (In Khmer).

Publication not seen. Author: vutlic@um.dk

Biodiversity inventories

Bezuijen, M.R., Bunna V. & Lieng S. (2009) A collection of amphibians and reptiles from the Mekong River, north-eastern Cambodia. *Hamadryad*, **34,** 135-164.

Findings and recommendations presented from surveys conducted between Kratie and Stung Treng towns. Findings included the second country records for the gecko *Hemiphyllodactylus yunnanensis* and the snake *Homalopsis nigroventralis*, a range extension for the snake *Enhydris longicauda*, and six threatened turtles: *Amyda cartilaginea, Heosemys grandis, H. annandalii, Indotestudo elongata, Malayemys subtrijuga, and Pelochelys cantorii.* Author: bezuijen@dodo.com.au

Eastoe, T., Nelson, O., & Holden, J. (2009) *Island survey of Koh Rong Sanloem Island*. Unpublished report, Fauna & Flora International, Phnom Penh, Cambodia.

The findings of a rapid survey of one of Cambodia's offshore islands. Author: tobyeastoe@gmail.com

Evans, T. & Goes, F. (2010) *Cambodia Recent Bird Reports*. Http://www.samveasna.org/report [accessed 1 July 2010].

A new series of monthly reports, compiling bird counts and unusual records across Cambodia. The reports for January, February and March are available online. Author: tevans@wcs.org

Holden, J. & Neang T. (2009) Small carnivore records from the Cardamom Mountains, south-western Cambodia. *Small Carnivore Conservation (Newsletter of the IUCN/SSC Small Carnivore Specialist Group)*, **40,** 16-21.

Fifteen species of mustelid mammals were identified using camera-traps and other methods, including the second national record of spotted linsang *Prionodon pardicolor* and "significant numbers" of otters. The authors conclude that the Cardamom Mountains support a highly intact community of small carnivores. Author: jeremy_holden1@yahoo.co.uk

Ohtaka, A., Watanabe, R., Im S., Chhay R. & Tsukawaki, S. (2009) Spatial and seasonal changes of net plankton and zoobenthos in Lake Tonle Sap, Cambodia. *Limnology,* **11,** 85-94.

The Tonle Sap lake plankton were found to be dominated by protozoans, rotifers, the diatom *Aulacoseira granulata* and blue-green algae. Species diversity was found to have changed little since the 1950s, but phytoplankton density appeared to have increased. The density of macrozoobenthos was relatively low, possibly due to high predation by benthivorous fish. Author: ohtaka@cc.hirosaki-u.ac.jp

Species ecology and status

Brooks, S.E., Allison, E.H., Gill, J.A. & Reynolds, J.D. (2009) Reproductive and trophic ecology of an assemblage of aquatic and semi-aquatic snakes in Tonle Sap, Cambodia. *Copeia,* **2009,** 7–20.

A detailed study of the reproduction and feeding habits of seven species of aquatic and semi-aquatic snakes, many of which are heavily exploited. Author: sharonelizabethbrooks@googlemail.com

Chey K. (2009) *Behavioural ecology of impressed tortoises* Manouria impressa *(Günther, 1882) via a radiotelemetry study*. MSc thesis, Royal University of Phnom Penh, Cambodia.

See the *Cambodian Journal of Natural History*, volume 2009, for a summary of Chey Koulang's research: http://www.fauna-flora.org/reports.php

Clements, T., Garrett, L., John, A., Keo O., Kongkim S., Pech B., Rours V., Tan S., Thong S. & Rainey, H. (2009) *Bird nest protection program in the Northern Plains of Cambodia*. Unpublished report, Wildlife Conservation Society, Phnom Penh, Cambodia and New York, USA.

Article not seen. Author: tclements@wcs.org

Coudrat, C. (2009) *A multidisciplinary approach to primate conservation in Cambodia: survey and habitat description in Samkos Wildlife Sanctuary, Western Cardamom Mountains, and education project on primate pet trade*. MSc thesis, Oxford Brookes University, Oxford, UK.

The author studied five of the six species of primates known to inhabit the Cardamom Mountains, and trialled a story book for children in Cambodia and Laos. Author: camillecoudrat@gmail.com

Dong T., Tep M., Lim S., Soun S. & Chrin T. (2010) Distribution of otters in the Tropeang Roung, Koh Kong Province, Cambodia. *IUCN Otter Specialist Group Bulletin,* **27,** 63-77.

The distribution of the smooth-coated otter (*Lutrogale perspecillata*) and the hairy-nosed otter (*Lutra sumatrana*) was studied along a stretch of the Tropeang Roung River in Koh Kong Province. The distribution of otters was found to have decreased, possibly due to hunting for skins, traditional medicine and meat, and disturbance from sand mining and fishing. Author: t.dong@conservation.org; Online: http://www.otterspecialistgroup.org/Bulletin/Volume27/Dong_et_al_2010.pdf

Emmett, D. (2009) Current conservation status of turtles in Cambodia. *TurtleLog (Online Newsletter of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group)*, **1,** doi:10.3854/tln.001.2009.

Approximate estimates of the total abundance and population trends are presented for all known Cambodian species. Author: d.emmett@conservation.org; Online: http://www.iucn-tftsg.org/turtlelog_online_newsletter/tln001/

Gray, T.N.E., Collar, N.J., Davidson, P.J.A., Dolman, P.M., Evans, T.D., Fox, H.N., Hong C., Ro B., Seng K.H. & van Zalinge, R.N. (2009) Distribution, status and conservation of the Bengal florican *Houbaropsis bengalensis* in Cambodia. *Bird Conservation International*, **19,** 1-14.

The "first comprehensive breeding season survey" of these critically endangered birds revealed a 30% drop in population size in the Tonle Sap region between 2005 and 2007, putatively due to loss of grassland habitats. In response, almost 350 km^2 have recently been designated as protected areas where special conservation measures are taking place. Author: tomnegray@hotmail.com.

Gray, T.N.E., Hong C., Collar, N.J. & Dolman, P.M. (2009) Sex-specific habitat use by a lekking bustard: conservation implications for the critically endangered Bengal florican (*Houbaropsis bengalensis*) in an intensifying agroecosystem. *The Auk*, **126,** 112–122.

A study in the Tonle Sap floodplain demonstrated the importance of a mosaic landscape, associated with traditional human land uses, to satisfy the breeding season requirements of floricans. Both sexes are detrimentally affected by agricultural intensification. Author: tomnegray@hotmail.com

Gray, T.N.E., Phan C. & Long, B. (2010) Modelling species distribution at multiple spatial scales: gibbon habitat preferences in a fragmented land-

scape. *Animal Conservation*, **13,** 324-332.

An analysis of the distribution of the endangered yellow-cheeked crested gibbon *Nomascus gabriellae* in Phnom Prich Wildlife Sanctuary, Mondulkiri Province, using computer-based models to assess the gibbon's habitat associations and tolerance of fragmentation. Gibbons were found to be significantly more abundant in evergreen forest than in semi-evergreen forest. Author: tomnegray@hotmail.com

Heng S. (2010) *Factors affecting site selection and feeding habits of hairy-nosed otter* Lutra sumatrana *and smooth-coated otter* Lutrogale perspicillata *at Tonle Sap Great Lake, Cambodia*. MSc thesis, Royal University of Phnom Penh, Cambodia.

See the *Cambodian Journal of Natural History*, this volume, for a summary of Heng Sokrith's research.

Hogan, Z., Baird, I. & Tach P. (2009) Threatened fishes of the world: *Probarbus jullieni* Sauvage, 1880 (Cypriniformes: Cyprinidae). *Environmental Biology of Fishes*, **84,** 291-292.

An account of the endangered seven-striped barb. Author: zebhogan@hotmail.com

Hogan, Z., Uthairat N.-N. & Heng K. (2009) Threatened fishes of the world: *Pangasius sanitwongsei* Smith 1931 (Siluriformes: Pangasiidae). *Environmental Biology of Fishes*, **84,** 305-306.

An account of a giant catfish that has reportedly declined by 60% in Cambodia since 1980. Author: zebhogan@hotmail.com

Ith S. (2009) *A taxonomic review of* Rhinolophus coelophyllus *Peters, 1867 and* R. shameli *Tate, 1943 (Chiroptera: Rhinolophidae) in Cambodia, Thailand, Myanmar, and Vietnam*. MSc thesis, Royal University of Phnom Penh, Cambodia.

See the *Cambodian Journal of Natural History*, volume 2009, for a summary of Ith Saveng's research: http://www.fauna-flora.org/reports.php

Kea R. (2010) *Feeding behaviour, activity patterns and food preferences of juvenile Asian softshell turtles (*Pelochelys cantorii*) in captivity*. MSc thesis, Royal University of Phnom Penh, Cambodia.

See the *Cambodian Journal of Natural History*, this issue, for a summary of Kea Ratha's research.

Keo O., Collar, N.J. & Sutherland, W.J. (2009) Nest protectors provide a cost-effective means of increasing breeding success in giant ibis *Thaumatibis gigantea. Bird Conservation International*, **19,** 77-82.

Low-cost devices to exclude mammal predators from nesting trees resulted in a 50% increase in the number of young fledglings. Furthermore, trees with such exclusion devices were found to be significantly more likely to be reused by ibises in the following year than unprotected trees. Author: omaliss@gmail.com

Lammertink, M., Prawiradilaga, D.M., Setiorini, U., Thet Z.N., Duckworth, J.W. & Menken, S.B.J. (2009) Global population decline of the great slaty woodpecker (*Mulleripicus pulverulentus*). *Biological Conservation*, **142,** 166-179.

Surveys of this bird in Indonesia and Myanmar suggest that at least 90% of the global population has been lost in the past 100 years, a decline that would justify upgrading its status to Vulnerable or Endangered. Contributing factors include a long generation time and the loss of old-growth, lower elevation forests. Cambodia is estimated to contain more than 10% of the global population. Author: jml243@cornell.edu

Lim K. (2009) *Variation in vocalizations of the yellow-cheeked crested gibbons (*Nomascus gabriellae*) in Cambodia.* MSc thesis, Royal University of Phnom Penh, Cambodia.

See the *Cambodian Journal of Natural History*, volume 2009, for a summary of Lim Kannitha's research: http://www.fauna-flora.org/reports.php [*Kannitha sadly passed away before completing her thesis. Her obituary forms the Editorial of the current issue - Ed.*].

Loucks, C., Mascia, M., Maxwell, A., Huy K., Duong K., Chea N., Long, B., Cox, N., & Seng T. (2009) Wildlife decline in Cambodia, 1953–2005: exploring the legacy of armed conflict. *Conservation Letters*, **2,** 82–92.

Wildlife abundance and species richness in Cambodia declined from pre-1953 to 2005, with the sharpest declines during the 1970s. Conflict-induced changes in livelihoods and overseas demand for wildlife have continued to drive further losses. Author: colby.loucks@wwfus.org

Miyazawa, Y., Tateishi, M., Kumagai, T. & Otsuki, K. (2009) Leaf gas exchange traits of domestic and exotic tree species in Cambodia. *American Geophysical Union, Fall Meeting 2009*, #B23A-0359.

A comparative analysis of photosynthesis by the indigenous *Dipterocarpus obtusifolius* and *Shorea roxburghii*, and the exotic *Acacia auriculiformis* and *Eucalyptus camaldulensis*. Online: http://adsabs.harvard.edu/abs/2009AGUFM.B23A0359 (abstract only).

Morgan, S. (2010) Application of ISSC-MAP for Cambodian plants. *TRAFFIC Bulletin*, **22,** 96-97.

Describes a two-year project to test the International Standard for the Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP) in the Prek Tnoat Community Protected Area. The project specifically examined the trade in krakao *Amomum ovoideum*, and tepirou *Cinnamomum cambodianum*. Author: smorgan@traffic.netnam.vn; Online: http://traffic.org/traffic-bulletin/traffic_pub_bulletin_22_3.pdf

Nop N. (2009) *Human-related factors impacting on otters at three sites in Cambodia.* MSc thesis, Royal University of Phnom Penh, Cambodia.

See the *Cambodian Journal of Natural History*, volume 2009, for a summary of Nop Navy's work: http://www.fauna-flora.org/reports.php

Owen, M. (2009) *Habitat suitability modelling for Eld's deer* Rucervus eldii siamensis*, Northwest Cambodia.* MSc thesis, Imperial College, London, UK.

A detailed examination of the relationship between the Eld's deer distribution and environmental variables in northern Cambodia. Author: Michelle.Owen@wwfgreatermekong.org; Online: http://www.iccs.org.uk/thesis/consci/msc09-owen,michelle.pdf (Also available in Khmer).

Phan C. (2009) *Habitat utilization of yellow-cheeked crested gibbon in Rattanakiri Province, Cambodia.* MSc thesis, Royal University of Phnom Penh, Cambodia.

See the *Cambodian Journal of Natural History*, volume 2009, for a summary of Phan Channa's research: http://www.fauna-flora.org/reports.php

Phan C. & Gray, T.N.E. (2009) *The Status and Habitat Preferences of Yellow-cheeked Crested Gibbon in Phnom Prich Wildlife Sanctuary, Cambodia.* WWF Greater Mekong, Cambodia Country Programme, Phnom Penh, Cambodia.

Using listening post methods, Phnom Prich wildlife sanctuary was found to contain approximately 150 groups of yellow-cheeked gibbons - the second largest known population in a protected area after the Seima Protection Forest. Online: http://assets.panda.org/downloads/gibbon_pop_survey_report__lowres.pdf

Rawson, B.M., Clements, T. & Nut M.H. (2009) Status and conservation of yellow-cheeked crested gibbons (*Nomascus gabriellae*) in the Seima Biodiversity Conservation Area, Mondulkiri Province, Cambodia. In *The Gibbons: New Perspectives on Small Ape Socioecology and Population Biology* (eds S. Lapan & D.J. Whittaker), pp. 387-408. Springer Science + Business Media, New York, USA.

Trends in the population size and distribution of yellow-cheeked gibbons were studied in the Seima Biodiversity Conservation Area (now called Seima Protection Forest) from 2003 to 2006. During this period, the number of calling gibbons detected increased by 8.5% per year. Author: b.rawson@conservation.org

Rogers, L. (2009) *Preliminary survey, behaviour and ecology of the Bengal slow loris (*Nyctiybus bengalensis*) in Samkos Wildlife Sanctuary, Cambodia.* Unpublished report to Fauna & Flora International, Primate Conservation Inc., and WWF.

One of the first population studies of this rare primate in Cambodia, conducted in the Cardamom Mountains. Author: lararogers@hotmail.com

Royan, A. (2009) Confirmation of the endangered fishing cat in Botum-Sakor National Park, Cambodia. *Cat News (Newsletter of the IUCN/SSC Cat Specialist Group)*, **51,** 10-11.

Two juvenile fishing cats *Prionailurus viverrinus* were found after a forest fire in January 2008. Author: alexroyan@hotmail.co.uk; Online: http://www.frontier-publications.co.uk/reports/Cambodia/PeerReview/CN51%20-%20Royan.pdf

Sasaki, H., Nor, B. Mohd. & Budsabong K. (2009) Past and present distribution of the hairy-nosed otter *Lutra sumatrana* Gray 1865. *Mammal Study,* **34,** 223-229.

Article not seen. Author: hsasakii@chikushi-u.ac.jp

Shank, C., Pollard, E.H.B., Sechrest, W., Timmins, R., Holden, J. & Walston, J. (2009) First confirmed records of large-toothed ferret badger *Melogale personata* in Cambodia, with notes on country records of *Melogale*. *Small Carnivore Conservation (Newsletter of the IUCN/SSC Small Carnivore Specialist Group)*, **40,** 11-15.

Confirms the presence of large-toothed ferret badgers near Botum Sakor National Park, Koh Kong Province, and in the Seima Biodiversity Conservation Area (Seima Protection Forest), Mondulkiri Province. Author: cschank@globalwildlife.org

Srey C. (2010) *Socio-economic influence of domesticated elephants on Phnong people in Mondulkiri Province, Cambodia*. MSc thesis, Royal University of Phnom Penh, Cambodia.

See the *Cambodian Journal of Natural History*, this volume, for a summary of Srey Chansorphea's work.

Starr, A., Daltry, J.C. & Nhek R. (2010) DNA study reveals *C. siamensis* at the Phnom Tamao Wildlife Rescue Centre, Cambodia. *Newsletter of the IUCN/SSC Crocodile Specialist Group*, **28,** 5-7.

Thirty-five captive purebred Siamese crocodiles were identified in Phnom Tamao, which could form the nucleus of a captive breeding and reintroduction programme. Author: adamstarr.ffi@gmail.com. Online: http://iucncsg.org/ph1/modules/Publications/newsletter/CSG_Newsletter_28_4.pdf

Starr, C., Nekaris, K.A.I., Streicher, U. & Leung, L. (2010) Traditional use of slow lorises *Nycticebus bengalensis* and *N. pygmaeus* in Cambodia: an impediment to their conservation. *Endangered Species Research,* **12,** 17–23; doi: 10.3354/esr00285. Online: http://www.int-res.com/articles/esr2010/12/n012p017.pdf

Large numbers of dried pygmy and northern slow lorises are sold for traditional medicine, and market values of both species more than doubled between 1997 and 2007. Most respondents expressed reluctance to substitute loris medicines with alternatives. The authors recommend education and improved law enforcement to conserve slow lorises in Cambodia. Author: c.starr@uq.edu.au

Weygoldt, P. (2009) Courtship and mating in the whip spider *Phrynichus orientalis* Weygoldt, 1998 (Chelicerata: Amblypygi). *Zoologischer Anzeiger*, **248,** 177-181.

A description of the unique mating behaviour and spermatophore morphology of a whip spider that inhabits caves in Cambodia and Thailand. Author: peter.weygoldt@web.de

Wildlife Conservation Society (2009) *Biodiversity Monitoring in the Floodplain of the Tonle Sap in 2008-9*. Wildlife Conservation Society, Phnom Penh, Cambodia.

This volume focuses on birds. Chapters include: The status and distribution of large waterbirds in the Tonle Sap Biosphere Reserve, 2009 update; Bengal floricans in the Integrated Farming and Biodiversity Areas, 2008/9 monitoring report; Census of non-breeding sarus cranes in Cambodia and Vietnam, 2009; Monitoring of large waterbirds at Prek Toal, Tonle Sap Great Lake, 2009. Contact: info@wcscambodia.org; Online: some chapters can be downloaded from www.wcscambodia.org

Wright, H.L., Bou V., Collar, N.J., Gray, T.N.E., Lake, I.R., Sum P., Rainey, H.J., Rours V., Sok K. & Dolman, P.M. (2009) Establishing a national monitoring programme for white-shouldered ibis in Cambodia. *Ibis*, **152,** 206-208.

A total of 310 birds were recorded using coordinated roost counts in July 2009, the highest number of white-shouldered ibis ever recorded and the "best estimate of true population size to date." Author: hugh.wright@uea.ac.uk; Online: http://pubget.com/profile/author/Iain%20R%20Lake

Wright, H.L., Buckingham, D.L. & Dolman, P.M. (2010) Dry season habitat use by critically endangered white-shouldered ibis in northern Cambodia. *Animal Conservation,* **13,** 71-79.

The first scientific study of the habitat preferences of white-shouldered ibises *Pseudibis davisoni* in dry dipterocarp forest. The ibises were found to prefer pools with short vegetation (< 25 cm) and forest sites with bare substrate and few people. Author: hugh.wright@uea.ac.uk

Coasts, wetlands and aquatic resources

Amilhat, E., Lorenzen, K., Morales, E.J., Yakupitiyage, A. & Little, D.C. (2009) Fisheries production in Southeast Asian Farmer Managed Aquatic Systems (FMAS): II. Diversity of aquatic resources and management impacts on catch rates. *Aquaculture,* **298,** 57-63.

A study of farmers in Cambodia, Thailand and Vietnam found they caught more fish, frogs and other wetland species on rice fields than natural wetlands, benefitting household nutrition and income. Author: k.lorenzen@imperial.ac.uk

Asthana, A.N. (2009) Is participatory water management effective? Evidence from Cambodia. *Water Policy*, **12,** 149–164.

Presents evidence that stakeholder participation can lead to improved water management, even in the absence of coherent state bureaucracy. Author: aasthana@pucp.edu.pe

Baran, E. & Myschowoda, C. (2009) Dams and fisheries in the Mekong Basin. *Aquatic Ecosystem Health & Management*, **12,** 227-234.

An assessment of the potentially negative impacts of dams upon the hydrology of the Mekong Basin and its fisheries. Author: e.baran@cgiar.org

Global Witness (2010) *Shifting Sands: How Singapore's Demand for Cambodian Sand Threatens Ecosystems and Undermines Good Governance*. Global Witness Limited, London, UK.

An exposé of how Singapore's rapid expansion is driving an "ecologically and socially devastating" sand-mining industry in Cambodia. Online: http://www.globalwitness.org/data/files/shifting_sand_final.pdf

Loc V.T.T., Bush, S.R., Sinh L.X., Hap N. & Nguyen T.K. (2009) Assessment of value chains for promoting sustainable fisheries development in the Mekong Basin: cases of *Pangasius* in Vietnam and Cambodia. *Vietnam Economic Management Review*, **4,** 57-68.

An analysis of the domestic structure, function and wealth distribution of the trade in iridescent sharks *Pangasius hypothalamus*, a globally-traded aquaculture fish that is native to Vietnam, Cambodia and Thailand. Author: simon.bush@wur.nl

MacAlister, C. & Manithaphone, M. (2009) Mapping wetlands in the Lower Mekong Basin for wetland resource and conservation management using Landsat ETM images and field survey data. *Journal of Environmental Management*, **90,** 2130-2137.

Presents the process used by the Mekong River Commission to classify and map the wetlands of the Lower Mekong Basin, including Cambodia. Author: charlottemacalister@yahoo.co.uk.

Marcussen, H., Dalsgaard, A. & Holm, P.E. (2009) Element concentrations in water spinach (*Ipomoea aquatica* Forssk.), fish and sediment from a wetland production system that receives wastewater from Phnom Penh, Cambodia. *Journal of Environmental Science and Health*, **44,** 67-77.

Evidence of increased levels of lead, zinc and other potentially toxic elements in water spinach and fish from Cheung Ek lake, Phnom Penh. Author: hma@life.ku.dk

Mekong River Commission (2010) *Biomonitoring Methods for the Lower Mekong Basin*. Mekong River Commission, Vientiane, Lao PDR.

Chapters include: Biological, chemical and physical indicators of the ecological health of the Mekong; Habitat assessment and the calculation of a site disturbance score; Environmental variables; Benthic diatoms; Zooplankton; Littoral macroinvertebrates; Benthic macroinvertebrates; Biological metrics calculation; Designation of reference sites. Author: mrcs@mrcmekong.org; Online: http://www.mrcmekong.org/download/free_download/Biomonitorin-%20methods.pdf#page=31

Murphy, T.P., Irvine, K.N., Sampson, M., Guo, J. & Parr, T. (2009) Mercury contamination along the Mekong River, Cambodia. *Asian Journal of Water, Environment and Pollution*, **6,** 1-9.

High concentrations of mercury were found in fish, humans and the liver of an Irrawaddy dolphin. Gold mines were implicated among the likely sources of this contamination. Author: irvinekn@buffalostate.edu; Online: http://geographyplanning.buffalostate.edu/asia_files/Mercury%20in%20Cambodia%20June%2025th.pdf

Nguyen T.H.Y., Sunada K., Oishi S., Ikejima K. & Iwata T. (2009) Stock assessment and fishery management of *Henicorhynchus* spp., *Cyclocheilichthys enoplos* and *Channa micropeltes* in Tonle Sap Great Lake, Cambodia. *Journal of Great Lakes Research,* **35,** 169-174.

An evaluation of the maximum sustainable yield and trends in the most important species for 'middle-scale fisheries' using data collected between 1995 and 1999. Author: trhyen2001@yahoo.com

Nuorteva, P. (2009) *Resilience and adaptation strategies of rural livelihoods in Tonle Sap area, Cambodia*. MSc thesis, University of Helsinki, Helsinki, Finland.

A study of six villages concludes they have a restricted livelihoods base and low resilience towards environmental challenges. Online: http://www.water.tkk.fi/English/wr/research/global/material/nuorteva_2009_MSc_thesis.pdf

Pottenger, S.G. (2009) Biodiversity conservation v. hydropower dams: can saving the fish save the Mekong River Basin? *Pacific McGeorge Global Business & Development Law Journal,* **22,** 111-133.

Article not seen. Author: (c/o) pmglobe_editor@pacific.edu

Sarkkula, J., Keskinen, M., Koponen, J., Kummu, M., Richey, J.E. & Varis, O. (2009) Hydropower in the Mekong region: what are the likely impacts upon fisheries? In *Contested Waterscapes in the Mekong Region - Hydropower, Livelihoods and Governance* (eds F. Molle, T. Foran & M. Käkönen), pp. 227-252. Earthscan, Washington DC, USA.

Article not seen. Author: juha.sarkkula@ymparisto.fi

Tach P., Chea T. & So N. (2009) Current status of fish diseases in Cambodia. *Israeli Journal of Aquaculture*, **61,** 286.

This abstract highlights the risks of exotic carp and tilapia escaping from fish culture systems, potentially threatening indigenous wild fish through competition and the transmission of native and alien diseases. Author: Tach Phanara, Fisheries Administration.

Travers, H. (2009) *Levelling the playing field: the effects of institutional controls on common pool resource extraction*. MSc thesis, Imperial College, London, UK.

A game based on harvesting fish was played in four villages in the Northern Plains to investigate the effects of social approval, external enforcement of extraction rules, and different incentive structures. The results underscored the importance of self-regulation in limiting the extraction of a shared resource. Online: http://www.iccs.org.uk/thesis/consci/msc09-travers,henry.pdf

Werthmann, C. (2010) Water management in seasonal floodplains of the Mekong Delta: a case study from four villages in Cambodia and Vietnam. *Consilience: the Journal of Sustainable Development*, **3,** 139-158.

In all villages studied (including two in Prey Veng and Takeo provinces), people derive their liveli-

hoods from fishing and rice farming, but institutional arrangements differ between the village. This paper describes factors that may be crucial when examining local governance arrangements and their sustainability. Author: c.werthmann@cgiar.com; Online: http://journals.cdrs.columbia.edu/consilience/index.php/consilience/article/view/115/30

Forests and forest resources

Bradley, A. (2009) *Communities & Carbon: Establishing a Community Forestry-REDD Project in Cambodia.* Pact Cambodia, Phnom Penh, Cambodia.

Cambodia's first Reduced Emissions from Deforestation and Degradation (REDD) project was founded in Oddar Meanchey in 2007. This report describes the project and its lessons learned that may benefit future REDD initiatives. Author: abradley@pactworld.org; Online: http://www.focali.se/filer/Communities%20and%20Carbon.pdf

Evans, T.D., Heng B. & Delattre, E. (2009) *Deforestation Rates in and Around the Seima Biodiversity Conservation Area, Cambodia, 2001-2007*. WCS Cambodia Program, Phnom Penh, Cambodia.

Article not seen. Author: tevans@wcs.org

Forestry Administration (2009) *Cambodia Readiness Project Idea Note (R-PIN) for the Forest Carbon Partnership Facility*. Forestry Administration of the Ministry of Agriculture, Forestry and Fisheries, Phnom Penh, Cambodia.

An overview of current land use patterns, causes of deforestation, stakeholder consultation processes, and potential institutional arrangements in addressing REDD (Reducing Emissions from Deforestation and forest Degradation). Co-author: omaliss@gmail.com

Gaughan, A.E., Binford, M.W. & Southworth, J. (2009) Tourism, forest conversion, and land transformations in the Angkor Basin, Cambodia. *Applied Geography*, **29,** 212-223.

Satellite imagery revealed a high net loss of forest cover around the Angkor temple complex, including Phnom Kulen National Park, between 1989 and 2005. This has been attributed partly to charcoal production to serve the tourism industry, and conversion to permanent agriculture. Author: aeb416@ufl.edu

Hem C. (2010) *An analysis of threats and site-level conservation approaches at Cambodian Protected Forests*. MSc thesis, Royal University of Phnom Penh, Cambodia.

See the *Cambodian Journal of Natural History*, this issue, for a summary of Hem Chanrithy's work.

Heng C. (2009) *Gender in Community Protected Area management: a case study in Prey Thom Community Protected Area, Siem Reap Province, Cambodia*. MSc thesis, Royal University of Phnom Penh, Cambodia.

See the *Cambodian Journal of Natural History*, volume 2009, for a summary of Heng Chinda's research: http://www.fauna-flora.org/reports.php

Ito, K. & Mitsugi, H. (2010) Challenges and prospects of community forestry in Cambodia: from the perspective of foresters' performances in the field. *Forum of International Development Studies,* **39,** 41-56.

This study, which was conducted mainly in Pursat and Kampong Speu provinces, found that even though foresters were expected to act as coordinators, facilitators and supervisors of rural people, they lacked sufficient understanding of their social roles. The authors highlighted the need to educate foresters on the social aspects of community forestry. Online: http://www.gsid.nagoya-u.ac.jp/bpub/research/public/forum/39/03.pdf

Kajisa, T., Murakami, T., Mizoue, N., Top N. & Yoshida, S. (2009) Object-based forest biomass estimation using Landsat ETM+ in Kampong Thom Province, Cambodia. *Journal of Forest Research*, 14, 203-211.

This paper describes the development of a forest biomass map for Kampong Thom Province using satellite images. Author: kajisa@ffp.kyushu-u.ac.jp

Long S. (2009) *Livelihood strategies amongst indigenous peoples in the Central Cardamom Protected Forest, Cambodia*. MSc thesis, S. Rajaratnam School

of International Studies, Singapore. 43 pp.

Long Sarou examines how traditional, nature resources-based livelihoods of Cambodians have been challenged by new government policies and the actions of investors and NGOs. Author email: sarouwitharc@yahoo.com; Online: http://www.isn.ethz.ch/isn/Digital-Library/Publications/Detail/?ots591=cab359a3-9328-19cc-a1d2-8023-e646b22c&lng=en&id=102581

Makoto, A, & Eriko, I. (2009) Dry evergreen forests in central flat lowland areas of Cambodia and site environment conditions. *Japanese Journal of Forest Environment,* **51,** 1-11. [In Japanese, English abstract].

The presence of well-developed evergreen forests in central Cambodia, even in areas with a severe dry season, is explained by the moisture-holding properties of their soils. Author: makot@ffpri.affrc.go.jp

Neang T. (2009) *Liquid resin tapping by local people in Phnom Samkos Wildlife Sanctuary.* Unpublished report, Fauna & Flora International, Cambodia.

[*The main findings of this study were also published in the* Cambodian Journal of Natural History, volume *2009, which can be downloaded from http://www.fauna-flora.org/reports.php - Ed.].* Author: neangthy@yahoo.com

Pollard, E., Hing M., Chanthet T. & Pet P. (2009) *Implementation Model for the Commercial Community Forestry Project.* Wildlife Conservation Society and Forestry Administration, Phnom Penh, Cambodia.

A proposed strategy for commercial community forest management in the Seima Protection Forest. Author: epollard@wcs.org; Online: http://www.wcscambodia.org/resources/reports/seima/ccf-model-jan10-v7.pdf

Rerkasem K., Yimyam N. & Rerkasem, B. (2009) Land use transformation in the mountainous mainland Southeast Asia region and the role of indigenous knowledge and skills in forest management. *Forest Ecology and Management,* **257,** 2035–2043.

Case studies show how indigenous technology can enable farmers to improve productivity while also providing services in forest regeneration and biodiversity conservation. (While this paper refers to Cambodia, the field research was in fact conducted in China and Thailand). Author: kanok@chiangmai.ac.th

Tola P. (2009) *Beyond Subsistence: Trade Chain Analysis of Resin Products in Cambodia*. NTFP Exchange Programme for South and Southeast Asia and the Cambodia NTFP Working Group, Phnom Penh, Cambodia.

Tola Prom studied five main trade routes in Preah Vihear, Kompong Thom, Mondulkiri, Kratie and Stung Treng provinces. This report discusses the challenges to resin tappers and traders, and provides recommendations to make this trade more sustainable and beneficial. Author: tolaprom@yahoo.com; Online: http://www.ntfp.org/ntfpadmin/publications-pdf/ResinReport_24 mar_09.pdf

Top N., Mizoue N., Ito S., Kai S., Nakao T. & Sokhun T. (2009) Effects of population density on forest structure and species richness and diversity of trees in Kampong Thom Province, Cambodia. *Biodiversity and Conservation*, **18,** 717-738.

Using data from a 1997 forest inventory, this study found a significant negative correlation between human population density and tree density, basal area, stand volume, above ground biomass, and species richness and diversity. Evidence of human disturbance was pronounced up to 5-7 km from settlements. Author: nethora@gmail.com

Payments for conservation

Clements, T., John, A., Nielsen, K., An D., Tan S. & Milner-Gulland, E.J. (2010) Payments for biodiversity conservation in the context of weak institutions: comparison of three programs from Cambodia. *Ecological Economics*, **69,** 1283–1291.

Payment for Ecological Services (PES) programmes were evaluated according to their institutional arrangements, distribution of costs and benefits, and conservation results. Projects administered

by local organisations were more broadly effective than direct payments to individual villagers. Author: tclements@wcs.org

Milne, S. & Niesten, E. (2009) Direct payments for biodiversity conservation in developing countries: practical insights for design and implementation. *Oryx*, **43,** 530–541.

Describes examples from Conservation International's work in developing countries, including Cambodia. This review identifies a broad spectrum of possible direct payment approaches and considers how to address contractual arrangements, definition of conservation services, performance payments, and monitoring and enforcement systems. The authors conclude that direct payments can usefully engage local communities or resource users in conservation and serve as a mechanism for channelling funding to site-based initiatives. Author: sarahmilne2u@gmail.com

Other livelihoods initiatives

Borrini-Feyerabend, G. & Ironside, J. (2010) *Communities and Bio-cultural Diversity in Cambodia - Options for Policies and Action Whose Time Has Come!* IUCN Commission on Environmental, Economic and Social Policy.

The Convention on Biological Diversity recognises and recommends supporting "Indigenous Territories and Areas conserved by Indigenous Peoples and Local Communities". This paper examines the bio-cultural patrimonies under the Cambodians customarily associated with them. Author: gbf@cenesta.org; Online: http://www.iucn.org/about/union/commissions/ceesp/ceesp_publications/?5297/Communities-and-bio-cultural-diversity-in-Cambodia-options-for-policies-and-action-whose-time-has-come

Guth, E. (2009) *2007/08 Evaluation report of the Sustainable Land Use and Management for Ethnic Bunong Communities Project.* Unpublished report to WCS Cambodia and Cambodian Rural Development Team, Phnom Penh and Kratie, Cambodia.

An appraisal of a project, established in 2006, to support forest conservation and reduce poverty and increase food security for Bunong communities within the Seima Biodiversity Conservation Area (Seima Protection Forest) in Mondulkiri. Author: flairguth@yahoo.com; Online: http://www.crdt.org.kh/uploads/file/20072008%20MDK%20Monitoring%20Report.pdf

Ironside, J. (2009) *Review of the Sustainable Community-Based Livelihood Systems for Peoples in Protected Areas Project, Veal Veng District, Pursat Province.* Unpublished report to Fauna & Flora International, Phnom Penh, Cambodia.

A detailed appraisal of the largely positive impacts of a sustainable livelihoods programme conducted from 2005 to 2008 in all 20 villages in Veal Veng District, most of which are in the Phnom Samkos Wildlife Sanctuary. Author: jeremyi@camintel.com

Climate change

Keskinen, M., Suppakorn C., Kummu, M., Nuorteva, P., Snidvongs, A., Varis, O. & Västilä, K. (2009) *Water and Climate Change in the Lower Mekong Basin: Diagnosis & Recommendations for Adaptation*. Water & Development Publications, Helsinki University of Technology, Espoo, Finland.

This one-year research project examined how climate change could affect water resources in the Lower Mekong Basin, including the Tonle Sap. Author: keskinen@iki.fi; Online: http://users.tkk.fi/~mkummu/water&cc/

Nguyen H., Prabhakar, S.V.R.K. & Shaw, R. (2009) Adaptive drought risk reduction in Cambodia: reality, perceptions and strategies. *Environmental Hazards*, **8,** 245-262.

A case study of drought risk assessment and mitigation in the Svay Rieng Province. Author: sivapuram.prabhakar@gmail.com

Nuorteva, P., Keskinen, M. & Varis, O. (2010) Water, livelihoods and climate change adaptation in the Tonle Sap lake area, Cambodia: learning from the past to understand the future. *Journal of Water and*

Climate Change, **1,** 87-101.

The capacity of villagers to adapt to unusual environmental changes was found to be weak, with the poorest being most vulnerable, partly because they have few opportunities for livelihood diversification. Author: keskinen@iki.fi; Online: http://www.iwaponline.com/jwc/001/0087/0010087.pdf

Poffenberger, M. (2009) Cambodia's forests and climate change: mitigating drivers of deforestation. *Natural Resources Forum*, **33,** 285-296.

A case study of a reduced emissions from deforestation and degradation (REDD) pilot project in Northwest Cambodia. The authors conclude that addressing the causes of deforestation requires a mixed approach whereby local communities control local threats while national threats are addressed through policy actions. Author: mpoffen@aol.com

Sasakia, N. & Yoshimotob, A. (2010) Benefits of tropical forest management under the new climate change agreement - a case study in Cambodia. *Environmental Science & Policy*, doi:10.1016/j.envsci.2010.04.007.

By analysing forest inventory data, this paper assesses the revenues and costs for managing one hectare of evergreen forest against six land use options: business-as-usual timber harvesting, forest management under the REDD-plus mechanism, and conversion to teak, acacia, rubber or oil palm plantations. The timber harvesting and REDD-plus management options were found to give the highest returns. Author: nop.kankyo@ai.u-hyogo.ac.jp; Online (part): http://www.nopheasasaki.net/papers/2010/ensp2010atables.pdf

van Zonneveld, M., Koskela, J., Vinceti, B. & Jarvis, A. (2009) Impact of climate change on the distribution of tropical pines in Southeast Asia. *Unasylva*, **60,** 24-29.

Climate envelope modelling was used to predict possible shifts in the distribution of two Cambodian pine trees, *Pinus kesiya* and *P. merkusii*. The findings suggest Cambodia could become uninhabitable for both species by 2050. Author: m.vanzonneveld@cgiar.org; Online: http://www.indiaenvironmentportal.org.in/files/tropical%20pines%20in%20Southeast%20Asia.pdf

Västilä, K. (2009) *Climate change impacts on floods in the Lower Mekong floodplains: modelling approach for Tonle Sap Lake*. MSc thesis, Helsinki University of Technology, Helsinki, Finland.

This study predicts how climate change might affect the Tonle Sap flood pulse, including the maximum flooded area and duration of flooding. Author: kaisa.vastila@tkk.fi; Online: http://www.water.tkk.fi/English/wr/research/global/publications.html#thesis

Västilä, K., Kummu, M., Sangmanee, C. & Chinvanno, S. (2010) Modelling climate change impacts on the flood pulse in the Lower Mekong floodplains. *Journal of Water and Climate Change*, **1,** 67–86.

Model simulations predict maximum water levels and flood duration will increase from 2010 to 2049 due to climate change, in spite of reductions caused by regional water infrastructure development. Author: kaisa.vastila@tkk.fi

Miscellaneous

Brooks, A. & Ly M. (2010) Faculty virtue and research capacity-building in the context of poorly funded universities: the case of the Royal University of Phnom Penh. *Human Resource Development International*, **13,** 83-98.

This article draws on a qualitative case study of the Royal University of Phnom Penh to identify existing research capacity strengths and the hopes some academic faculty and administrators have for the future in a "resource-limited and politically constrained context". Author: abrooks@txstate.edu

Desvaux, S., Marx, N., Ong S., Gaidet, N., Hunt, M., Manuguerra, J.C., Sorn S., Peiris, M., van der Werf, S. & Reynes, J.-M. (2009) Highly pathogenic Avian Influenza Virus (H5N1) outbreak in captive wild birds and cats, Cambodia. *Emerging Infectious Diseases*, **15,** 475-478.

An outbreak of H5N1 virus in the Phnom Tamao Wildlife Rescue Centre occurred from December

2003 through January 2004, resulting in a number of bird deaths. Author: stephanie.desvaux@cirad.fr

Dondorp, A.J., Nosten, F., Yi P., Das, D., Phyo A.P., Tarning, J., Lwin K.M., Ariey, F., Hanpithakpong, W., Lee, S.J., Ringwald, P., Silamut, K., Imwong, M., Chotivanich, K., Lim P., Herdman, T., An S.S., Yeung, S., Singhasivanon P., Day, N.P.J., Lindegardh, N., Socheat D. & White, N.J. (2009) Artemisinin resistance in *Plasmodium falciparum* malaria. *New England Journal of Medicine*, **361,** 455-467.

Evidence that life-threatening *Plasmodium falciparum* malaria in western Cambodia is becoming resistent to artemisin-based treatments. *[All readers living or working in western Cambodia should be aware of this risk - Ed.]*. Author: arjen@tropmedres.ac

Sodhi, N.E, Posa, M.R.C., Lee, T.M., Bickford, D., Koh, L.P. & Brook, B.W. (2010) The state and conservation of Southeast Asian biodiversity. *Biodiversity Conservation*, **19,** 317–328.

In comparison to other tropical regions around the world, Southeast Asia has the highest mean proportion of country-endemic bird species (9%) and mammal species (11%), and the highest proportion of threatened vascular plants, reptiles, birds, and mammals. This paper examines the broad threats to biodiversity in Cambodia and calls for increasing the capacity of conservation-related institutions and integrating livelihoods into conservation regimes. Author: dbsns@nus.edu.sg

Ryder, G. (2009) *Powering 21st Century Cambodia with Decentralized Generation: A Primer for Rethinking Cambodia's Electricity Future.* The NGO Forum on Cambodia, Phnom Penh, Cambodia, and Probe International, Toronto, Canada.

This report challenges the assumption that large-scale power imports and large hydrodams offer the cleanest and most efficient way to bring electricity to more people. Recent technological advances have made it more economical and reliable to generate power on a much smaller scale, closer to where it is needed. Author: GrainneRyder@nextcity.com; Online: http://www.probeinternational.org/files/Powering%2021st%20Century%20Cambodia%20with%20Decentralized%20Generation.pdf

The Recent Literature section was compiled by JENNY C. DALTRY and NEIL M. FUREY, with additional contributions from Eleanor Adamson, Simon Bush, Tom Clements, Priscilla Joyner, Tom Gray, Khou Eanghourt, Martjan Lammertink, Young June Lee, Vo Thi Thanh Loc, Ouch Ly, Charlotte MacAlister, Annette Olsson, Michelle Owen, Edward Pollard, Hugo Rainey, Kanok Rerkasem, Hiroshi Sasaki, Navjot Sodhi, Peter Weygoldt and Robert van Zalinge. All Internet addresses were correct at the time of publication. Please send contributions (recent published or grey literature) for the next issue by email to: Editor.CJNH@gmail.com

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The *Cambodian Journal of Natural History* is a free journal that is published biannually by the Centre for Biodiversity Conservation at the Royal University of Phnom Penh. The Centre for Biodiversity Conservation is a non-profit making unit, dedicated to training Cambodian biologists and the study and conservation of Cambodia's biodiversity.

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Concise reports (< 300 words) on news of general interest to the study and management of Cambodia's biodiversity. News reports may include, for example:

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Authors should consult examples in this volume for general style. Full papers follow a similar style to those in *Oryx – The International Journal of Conservation*. Contributions should be in English, with UK English spelling (if in doubt, Microsoft Word and similar software can be set to check spelling and grammar for "English (UK)" language). Manuscripts should be double-spaced. Submissions can be in 'doc, 'rtf' or 'wpd' format, preferably as one file attached to one covering email. The cover page should contain the title and full mailing address, email address and address of the Lead Author and all additional authors. All pages should be numbered consecutively, and the order of the sections of the manuscript should be: cover page, main text, short biography of each author, tables, figures and plates. If in doubt, please ask the Editor for advice (Editor.CJNH@gmail.com)

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References: These should be cited in the text as, for example, Stuart & Emmett (2006) or (Lay, 2000). For three or more authors, use the first author's surname (family name) followed by *et al.*; for example, Rab *et al.* (2006) or (Khou *et al.*, 2005). Multiple references should be in chronological order by surname; for example, Holloway & Browne (2004); Kry & Chea (2004), Phan (2005); Farrow (2006).

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Khou E.H. (2010) *A Field Guide of the Rattans of Cambodia.* WWF Greater Mekong Cambodia Country Programme, Phnom Penh, Cambodia.

IUCN (2010) *IUCN Red List of Threatened Species. Version 2010.2.* Http://www.redlist.org [accessed 1 July 2010].

Lic V., Sun H., Hing C. & Dioli, M. (1995) *A brief field visit to Mondolkiri Province to collect data on kouprey (*Bos sauveli*), rare wildlife and for field training.* Unpublished report to Canada Fund and IUCN, Phnom Penh, Cambodia.

MacArthur, R.H. & Wilson, E.O. (1967) *The Theory of Island Biogeography*. Princeton University Press, Princeton, USA.

Maxwell, A.L. (2004) Fire regimes in north-eastern Cambodian monsoonal forest, with a 9300-year sediment charcoal record. *Journal of Biogeography*, **31,** 225-239.

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Sarkkula, J., Keskinen, M., Koponen, J., Kummu, M., Richey, J.E. & Varis, O. (2009) Hydropower in the Mekong region: what are the likely impacts upon fisheries? In *Contested Waterscapes in the Mekong Region - Hydropower, Livelihoods and Governance* (eds F. Molle, T. Foran & M. Käkönen), pp. 227-252. Earthscan, Washington DC, USA.

Sun H. (2000) *Status of the tiger and its conservation in Cambodia*. MSc thesis, University of Minnesota, Minneapolis, USA.

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