

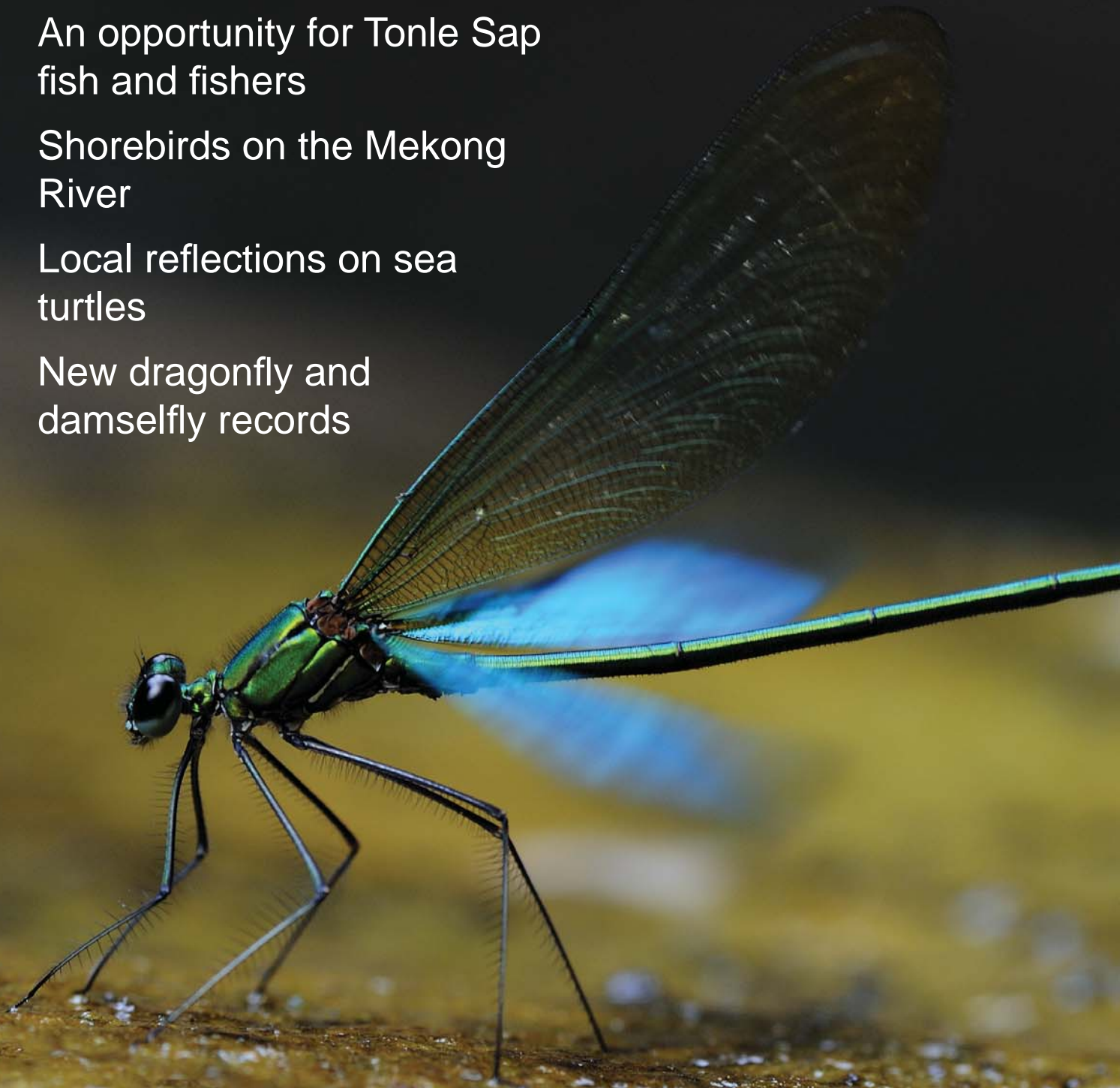
Cambodian Journal of Natural History

An opportunity for Tonle Sap
fish and fishers

Shorebirds on the Mekong
River

Local reflections on sea
turtles

New dragonfly and
damselfly records



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Cover photo: A male *Neurobasis chinensis* in Phnom Samkos Wildlife Sanctuary flashes his metallic hind wings (© Jeremy Holden). One of Cambodia’s most spectacular damselflies, this species can be found along fast-flowing streams and rivers. Recent surveys of dragonflies and damselflies are presented by Oleg Kosterin *et al.* in this issue.

Editorial—How to write a winning paper

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The *Cambodian Journal of Natural History* was launched in 2008 to help address the critical need for information on the status, use and management of the biodiversity of Cambodia. Besides publishing and distributing peer-reviewed papers in a free, open-access forum, this journal also aims to strengthen the writing skills of Cambodian conservation researchers and managers.

In the last issue (Volume 2012, number 1), one of us (MF) offered some personal advice to would-be writers, based on long experience as both an author and an editor. Here, we thought it would be helpful to provide some more detailed advice on how to construct a winning scientific article and how to avoid some common pitfalls.

The sections outlined below follow the structure of full papers in most scientific journals, including the *Cambodian Journal of Natural History*. When preparing a manuscript, however, you should always read and heed the journal's own Instructions for Contributors (the instructions for this journal can be found at the back of this issue). It is also a good idea to look at recent issues of the journal to gain a feel for its style and gauge whether it will suit your material.

Title

This is the hook to capture your readers, and should be fairly short—ideally not more than 10 words. The title should give an honest indication of the contents of the paper, but does not need to be dry and dull. For example, the title “Is fire good for forests?” could arouse more interest than “A study of the impacts of anthropogenic burning on the composition of plants in dry forests”. Some authors like to include their principal aim or conclusion in the title, e.g. “First census of white-shouldered ibis *Pseudibis davisoni* reveals roost-site mismatch with Cambodia's protected areas”.

Authors

Will you be the only author of the paper, or should there be one or more coauthors? It is entirely up to you to decide, but a useful rule of thumb is that every coauthor

ought to have made at least two of the following four contributions:-

- *Planning/facilitating the research*: e.g. figuring out how to collect data, identifying the research questions, securing grants to fund the work, providing essential equipment, identifying the research site.
- *Collecting data*: e.g. interviewing villagers, setting camera traps, conducting a literature review, identifying species.
- *Analysing data*: e.g. statistical and graphical analysis, providing new insights from the results.
- *Writing the paper*: e.g. writing some sections of the manuscript, giving extensive comments on early drafts.

For the *Cambodian Journal of Natural History*, we urge all foreign authors to invite their Cambodian counterparts and assistants to be coauthors.

There is practically no limit on the number of people who can coauthor a paper—the current record being 2,926 authors for one paper on the Large Hadron Collider! However, it is important that every author agrees to their name being included. Every coauthor should have a chance to review successive drafts of the paper and approve the final version.

Deciding the order in which names are presented can be difficult. We recommend: (i) The person who has done the most work in writing the paper should be the First Author (the first name in the list); (ii) If another person has done a large share of the writing, they can be the second name in the list; (iii) Most coauthors can then be listed in alphabetical order, using their family names; (iii) If there are a lot of coauthors it is a common practice for the most senior member (e.g. the professor or head of the department) to be placed last. However, decisions about authorship and the order of names should be made by the First Author in consultation with the other authors.

The ‘Corresponding Author’ is the person to whom questions or requests should be directed by readers. This is usually the First Author, but can be one of the coauthors, by mutual consent.

Abstract (Summary)

Apart from the title, most people read only the Abstract. It must therefore be understandable on its own. The Abstract helps readers to decide whether to read the entire article and, more importantly, tells them your main findings.

A recommended structure for the Abstract is as follows (but do not include subheadings): *Background*: A simple opening sentence to give the context of your study; *Aims*: One or two sentences giving the purpose of the work; *Methods*: One or two sentences explaining what you did; *Results*: One or two sentences to summarise your main findings; *Conclusions*: One sentence giving the most important consequences or implications of the work, e.g. What do the results mean? How will they be used? What recommendations are you making as a result of this work?

The Abstract should not contain any references or abbreviations. Most journals set a strict word limit for abstracts. The *Cambodian Journal of Natural History* permits a maximum of 250 words.

Although the Abstract appears at the start, this is usually the last section to be written. We suggest you re-read your entire paper from start to finish and then draft the Abstract without looking back at the text. Try to avoid copying entire sentences—you are liable to include too much information, or too little.

Keywords

Keywords are used by database search engines to help people locate articles containing subjects of interest to them. Most journals set a maximum of eight keywords, but check the Instructions for Contributors for guidance.

Here are some suggestions for picking keywords:

- If your paper focuses on a particular region, habitat, species or community, use that as a keyword e.g. Annamite Mountains, mangroves, tiger, dipterocarps, Stung Treng.
- Consider using your materials or techniques e.g. camera-trapping, electron microscope, animal tracks, Participatory Land Use Planning, interviews.
- If they were discussed in your paper, include important issues or phenomena e.g. climate change, pollution, habitat fragmentation, fisheries, Forestry Law.
- If covered in your Discussion, refer to possible future applications or recommendations e.g. sustainable harvesting, habitat restoration, species conservation, payments for environmental services, training.

Introduction

The purpose of the Introduction is to present the subject of your work and place it in the context of what is already known about this topic. Write this section in the past or present tense, *not* in the future tense (avoid expressions such as “This study will examine...”).

The first and last paragraphs of your Introduction are the most important. First, you must provide some context and background for your work, referring to the work of others as appropriate. Try to avoid mentioning your study organism and study location in the first paragraph. The Introduction is meant to introduce the reader to your research, not summarise and evaluate everything that has ever been written on the subject.

Depending on the journal you are submitting to, you should consider whether the audience is likely to be general or specialised. For example, if you submit an article on Asian elephants to the *Cambodian Journal of Natural History* you ought to provide more background information on elephants than if you submit it to *Gajah* (the journal of the IUCN/SSC Asian Elephant Specialist Group).

You also need to consider whether to use the passive or active voice in your article. For example, the *passive voice* would say “the work was carried out” and “it was observed that...”, whereas the *active voice* would say “I carried out the work” or “we observed that...” (use the singular ‘I’ if you are the only author). Whichever style you choose, be consistent throughout your article. We recommend you use the active voice.

The final paragraph or last few sentences (depending on the length of the Introduction) should contain your research questions or the aims of your work.

Methods

This is often the easiest section to write and many authors prefer to write this section first.

The Methods should provide a clear description of how you carried out your study. A good way to approach this section is to imagine that one of the readers wants to replicate your study. Your methods must be sufficiently clear for them to repeat your study accurately, without asking you for further information. This section also allows other researchers to evaluate your methodology and judge whether your conclusions are valid.

Methods sections are normally fairly short and do not require subsection headings. (As a general rule, use subsections only if the Methods section is longer than five paragraphs). Your Methods should contain a thor-

ough description of the study design and methodology, including the location and any equipment used. Provide the make and manufacturer of the equipment if it is a specialised item that is not in common use—there is no need to provide the model and manufacturer of common equipment such as binoculars, tape measures, or hand-held global positioning systems. If any of your methods have been fully described in a previous, readily available publication (yours or someone else's), you can cite that instead of describing the procedure again.

It is very important to state *when* your work was carried out and *where*. If your study took place in the field, provide a map to show the location. A written description of the study area is also warranted if your work was carried out in the field e.g. vegetation types, climate, altitude, topography, soils, local human populations, or other matters. This content will depend on what is relevant to the focus of your article. For example, if your paper is about community fisheries, you ought to provide more details about the rivers or lakes in your study area, the number and distribution of people involved in fishing, and the names of the villages, communes and districts. Use the *past tense* when describing the situation particular to the time when your work was carried out (e.g. “during our study, mean rainfall was 112 mm per month”; “the village had 423 residents”). If describing the general, ongoing situation in your study area, you can use the *present tense* (e.g. “mean annual rainfall in Phnom Penh is 1,635 mm per year”; “Ta Sal Commune is in Aoral District”).

The Methods section must contain a full description of any statistical or modelling methods used, including equations. There is no need to say your data were written in notebooks or entered into a spreadsheet, but if you used a statistical package to analyse your data, you should explain which one (including version and the company concerned); e.g. R, Minitab, SPSS.

The amount of information you should give about a method will depend on how well known the technique is. For well-known methods, such as camera-trapping, the name of the method and one or two references (citations) will generally suffice. Completely new methods will require a more detailed description.

Results

The function of this section is simply to summarise trends in your own data without any interpretation or discussion. All statements must be directly based on your data, and this section should not contain references to the literature.

The results of statistical tests (if used) can be presented in parentheses after a verbal description: e.g. “fruit size was significantly greater in trees growing alone ($t = 3.65$, $df = 2$, $P < 0.05$).”

The Results section typically contains tables and figures (graphs, drawings, photographs, maps) to present the data. Avoid unnecessary duplication between the text, figures and tables: the tables and figures contain the details whereas the text presents a summary of the findings. Whenever possible, use graphs instead of tables because relationships between numbers are more easily grasped when presented graphically.

When using tables: (i) Avoid repeating data in a table if it is depicted in a graph, or *vice versa*; (ii) It is easier to compare numbers by reading down a column rather than across a row, so list data you wish your reader to compare in vertical form; (iii) Give every table a number (Table 1, Table 2, etc.) and a self-explanatory caption; (iv) Refer to the table number at the appropriate place in the text (this will help the editor or layout designer to decide where to place the table when your paper is published).

When preparing figures (graphs, drawings, photographs, maps): (i) Consider what size they will be in the final publication and ensure the text and symbols will be clearly legible; (ii) Avoid using cluttered maps or graphs that are hard to read, especially 3-D graphs; (iii) Avoid using colour because the readers may wish to print pages using a black-and-white printer or photocopier; (iv) For all types of graphs, plot the independent variable on the horizontal x axis and the dependent variable on the vertical y axis, and label both axes, including units of measurement; (v) Most journals will not publish photographs of a study species or site unless they are an important part of the evidence (e.g. a rare species photographed with a camera trap); (vi) Give every figure a number (Fig. 1, Fig. 2, etc.) and a self-explanatory caption; (vii) Refer to the figure number in the text.

Most journals, including the *Cambodian Journal of Natural History*, require tables and figures to be submitted at the end of the manuscript or on separate files.

Discussion

The function of this section is to interpret your findings and explain what they mean for the understanding of this topic. What is obvious to you may not be obvious to all your readers, so try to spell this out clearly. You can assume your readers are intelligent but probably not experts on the subjects covered by your paper.

The first paragraph should begin with a brief summary of the main findings in two or three sentences, or a short paragraph. If the purpose of your study was to test a hypothesis or solve a particular problem, refer to this in the first paragraph.

The second and later paragraphs should contain a discussion and comparison of your research and findings with previous studies and/or work that has been carried out in similar areas. For example, if you have compiled a checklist of the birds of Kirirom National Park, compare your findings with inventories of birds in other protected areas in Cambodia, and attempt to explain any similarities or differences. Here, you may also discuss gaps or shortcomings in your own study, but keep this brief.

You may, if you wish, include speculation (opinions based on incomplete evidence) in the Discussion as long as it is clear you are speculating. For example, "We suspect that many of the large mammals move from high elevations to lower elevations during the dry season, but the data from this study are insufficient to confirm this".

The final paragraph(s) should discuss what happens next. For example, are there any management implications from your study? Do you have any recommendations; e.g. further research, new policies or other actions that should be taken? This last paragraph can also focus on the wider implications of your work, setting it into a broader context. Avoid ending your paper with the tired cliché that "more studies should be done". If you believe more research is necessary, explain why, and be very specific about what type of study is needed.

Unless it is required by the journal, there is no need to add a section entitled Conclusions. Instead, put any concluding remarks in the final paragraph of the Discussion.

Acknowledgements

This is the place to publicly, but briefly, thank the authorities that gave permission for the work to be carried out. You can also thank donors, assistants, people who have commented on the article, participating communities and any other individuals or organisations who have facilitated the work. One paragraph will do. There is no need to thank all of your friends, relatives and pets!

References

In alphabetical order, give full details of every reference that has been cited in your paper (including sources cited in your tables, figures and annexes, if any).

The best way to create a complete and tidy reference section is to use a bibliography manager. This will keep track of your citations and link them automatically to the reference section and thus ensure that all citations have matching references. Most bibliography managers contain a range of styles to suit most journals. There are several suitable pieces of software available, but we recommend Zotero, which is freely available for all computing platforms from <http://www.zotero.org/>

Your manuscript is now almost ready for submission. Check the journal's Instructions for Contributors one last time to make sure that you have prepared it correctly. For example, most journals (including the *Cambodian Journal of Natural History*) require the text to be double-spaced, to give the reviewers and editors room to write their comments by hand.

If the editors are satisfied that your manuscript meets the journal's criteria, they will forward it in confidence to a number of experts in the same field. These peer reviewers are asked to evaluate whether the work is genuinely original and of sufficient quality to be published, and to advise on whether any changes ought to be made. Peer-reviewing is a free service carried out by tens of thousands of scientists worldwide on the understanding that when they submit their manuscripts to journals their work will be reviewed in the same way, without payment.

Do not be disheartened if the comments from reviewers appear critical. This is normal, even for the most accomplished scientists. Reviewers often concentrate so intently on finding even the smallest errors that they forget to praise what they like about the work! Most of their advice will in fact be sensible and fair, so try to heed as much as you can—but never be afraid to tell the editor if you strongly disagree with any point. It is your name on the paper after all.

Having successfully passed careful scrutiny and corrected any mistakes, it is a proud moment when you see your work in print. On behalf of scientists, conservationists and natural resource managers everywhere, we applaud you for it. All too often, hard-earned data and insights remain hidden in notebooks or consigned to donor reports that are seen by only a handful of people. By sharing precious knowledge, experiences and opinions in open-access journals, all of us can gain a better understanding of this remarkable world. More importantly, your work will help your fellow scientists, sponsors and managers decide what needs to be done next.

Short Communication

A watershed moment for the Mekong: newly announced community use and conservation areas for the Tonle Sap Lake may boost sustainability of the world's largest inland fishery

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Freshwater biodiversity and ecosystem services are critically important to human wellbeing throughout the Lower Mekong River watershed and particularly so around the Tonle Sap Great Lake of Cambodia (hereafter the Tonle Sap Lake). Though seemingly lacustrine, the Tonle Sap Lake is actually an enormous wetland within a

major tributary of the Lower Mekong River. The wetland is the largest natural freshwater body in Southeast Asia, a UNESCO Biosphere Reserve, the epicenter of the region's incredible freshwater biodiversity, and the foundation of food security for Cambodia. Its fisheries directly yield ~350,000 tonnes of the 2.6 million-tonne annual fresh-

CITATION: Cooperman, M.S., So N., Arias, M., Cochrane, T.A., Elliott, V., Hand, T., Hannah, L., Holtgrieve, G.W., Kaufman, L., Koning, A.A., Koponen, J., Kum V., McCann, K.S., McIntyre, P.B., Min B., Ou C., Rooney, N., Rose, K.A., Sabo, J.L. & Winemiller, K.O. (2012) A watershed moment for the Mekong: newly announced community use and conservation areas for the Tonle Sap Lake may boost sustainability of the world's largest inland fishery. *Cambodian Journal of Natural History*, 2012, 101–106.

water fish harvest of the Lower Mekong watershed and the Tonle Sap Lake serves as a crucial nursery ground for migratory fish populations throughout the 606,000 km² watershed (Hortle, 2007; MRC, 2010). The importance of this fishery is immense. Mekong fishes provide the majority of the animal protein consumed by >50 million people in the basin (Hortle, 2007) and ~2 million Cambodians are directly involved in the Tonle Sap Lake fishery (Nam & Song, 2011). However, multiple indicators — including declining fish size and catch-per-unit-effort, elimination of the largest and most valuable species, and increasing prevalence of less desirable species in the catch (Enomoto *et al.*, 2011) — reveal severe challenges to the sustainability of the fishery.

Amid growing concerns over the present status and potential future impacts on Cambodia's freshwater fisheries from hydropower dams, expanding agro-industry in the upper watershed, climate change, a rapidly increasing human population, and inequity in the distribution of benefits derived from these fisheries, in February 2012 Prime Minister Hun Sen announced the permanent cancellation of all 80 commercial fishing lots in the Lower Mekong watershed in Cambodia. Of the lots closed, 38 were in the Tonle Sap Lake (Fig. 1). These 38 fenced lots have been fished intensively for decades, resulting in the nearly complete removal of fish from approximately 20% of the area of the Tonle Sap Lake every year. From 10 April 2012, the Tonle Sap Lake lots will be apportioned as community-use areas (~76%) and conservation areas (no-harvest reserves, ~24%).

This bold move may prove to be an essential first step toward maintaining fishery productivity and protecting the biological diversity that supports it. Yet the new management regime will be beset with challenges as it makes the transition from delineated fishing concessions with strict enforcement of boundaries, a closed season, and habitat protection, to a diffuse and mobile fleet of tens of thousands of fishers using a vast diversity of gear types and organised into hundreds of fishing communities overseen by officials with limited enforcement capacity. We suggest the odds of success — i.e. protecting and enhancing the sustainability of the fishery — will be enhanced if the new system draws upon lessons from marine protected areas, adds auxiliary protections for migratory species, and actively governs against a "tragedy of the commons" scenario.

The proposed network of conservation areas totals ~600 km², comparable in size to the largest intensively-studied marine protected areas (MPAs) (Lester *et al.*, 2009). Management of this unparalleled collection of freshwater conservation areas should start with lessons learned from its marine counterparts. Perhaps the most

notable lesson from MPAs is that size and location of conservation areas (also known as no-harvest zones or reserves) are crucial decisions. The benefits to both fisheries yield and biodiversity conservation from MPAs have been shown to increase with reserve size (Claudet *et al.*, 2008), and enforcement is more straightforward in a few large reserves than in many small ones. The efficacy of such reserves also depends on protecting both a range of habitat types and the connections among them (Sala *et al.*, 2002), and fisheries benefits may be optimised when habitat type is consistent on both sides of a conservation area boundary (Forcada *et al.*, 2008). Unlike MPAs, the Tonle Sap Lake conservation areas must account for seasonal fluctuations in water level. Provision of an adequate quantity and quality of low water habitats is critical, lest protected fishes be flushed from conservation areas by annual changes in water levels.

Hence, detailed spatial planning should play a central role in designing the Tonle Sap Lake reserve network. We suggest that the conservation portions of the 38 lots be consolidated into a smaller number of large reserves distributed along the Southeast-Northwest axis of the Tonle Sap Lake and include the mouth of the Tonle Sap River and other large tributaries (i.e., Pursat River, Sangkea River, etc.) to ensure there is biological connectivity to the rest of the watershed. The proposed conservation areas should encompass the best remnants of forests and other riparian habitats that flood seasonally because these areas are important for fish recruitment. Lake circulation patterns should also be accounted for, as they likely dictate where larval settlement, retention, and survival rates are highest. If large reserves are embedded within community-managed fishing areas, "spill-over" benefits may accrue from the export of post-reproductive adults and new recruits (Halpern *et al.*, 2010).

Another lesson from MPAs is that fish life history strategies matter. Almost all of the several hundred fish species known or suspected to use the Tonle Sap Lake are harvested, but only some are likely to benefit from the conservation areas in the absence of other forms of protection. In general, species with long-lived sedentary adults and dispersing progeny usually benefit from no-harvest areas while migratory species are more problematic (Russ & Alcala, 1996). Winemiller (2005) provides a framework for predicting how the fishes of the lake will respond to the conservation area network (Fig. 2). *Opportunistic species* are small, rapidly-maturing and have a high reproductive effort and a relatively short lifespan. This group of species comprises the bulk of both species diversity and catch in the current Mekong fishery, and these species should respond rapidly to reserves. However, they typically have low market value.

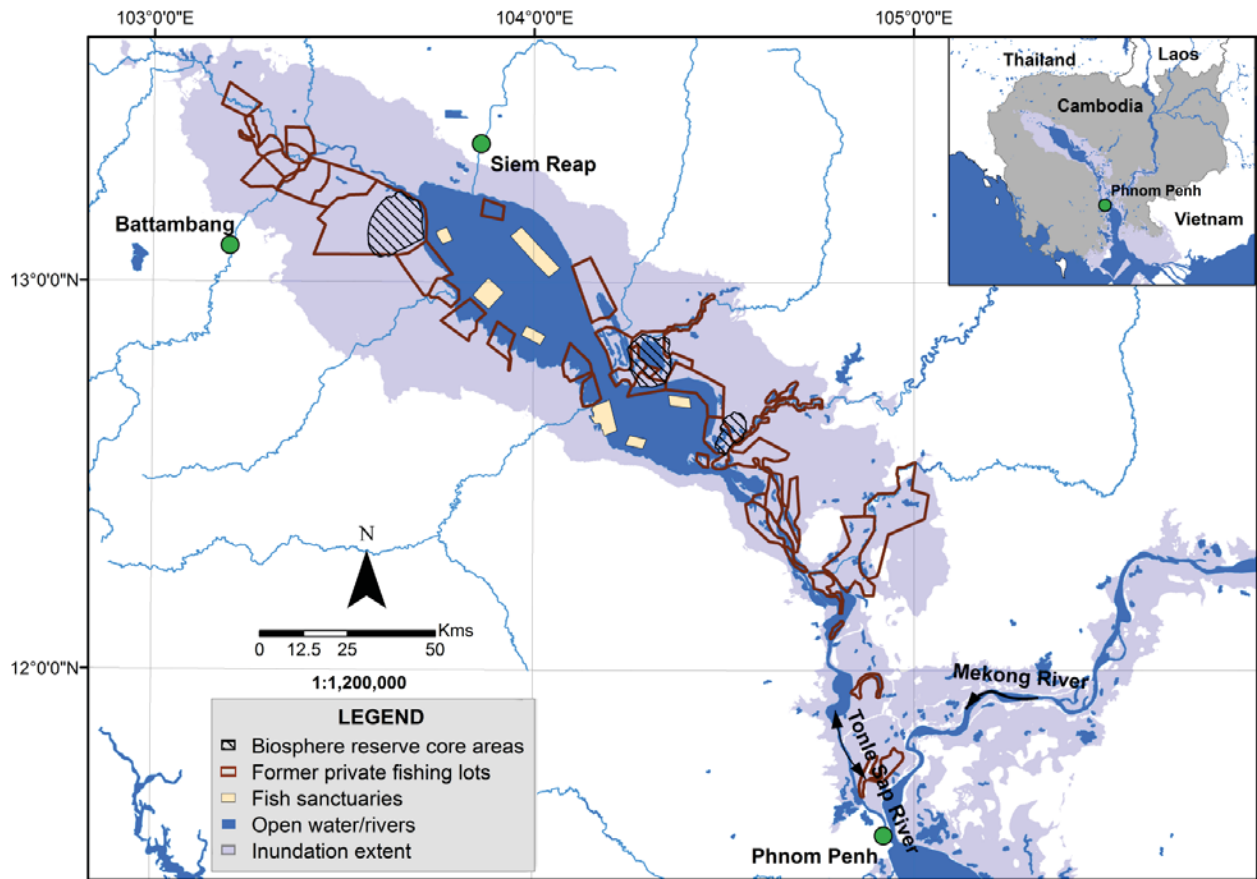


Fig. 1 The Tonle Sap Lake ecosystem of Central Cambodia, showing the tremendous annual change in lake surface area between dry and wet seasons and locations of the now-closed fishing lots.

Equilibrium strategists have relatively low fecundity, high parental investment per offspring, and tend to be sedentary. Despite low demographic resilience, these species should benefit from reserves both via adults in reserves surviving to older ages with greater fecundity, and via juveniles that seed fished areas where growth rates will be high due to low competition for resources. Finally, *periodic strategists* tend to be larger and migrate long distances to exploit spatial and temporal variation in the environment. They mature at larger sizes and ages, and they release huge batches of tiny eggs during discrete spawning periods. Many periodic breeders spawn in the Lower Mekong or Tonle Sap rivers with their young transported into the Tonle Sap Lake during annual floods. Conservation areas in flooded forests and shrublands of the Tonle Sap Lake may aid smaller and rapidly maturing periodic-type species by increasing survival of early life stages. However, the far-ranging movements of these species will keep them vulnerable to over-exploitation as they move beyond the boundaries of reserves. Indeed, the most valuable species in the fishery are peri-

odic breeders that mature at older ages, and these species are unlikely to benefit from the Tonle Sap Lake reserves unless granted additional protection outside the reserve network.

Harvest regulations to complement the Tonle Sap Lake conservation areas are therefore essential for protecting economically-valuable migratory fishes. Currently, the dai fishery in the Tonle Sap River uses rows of barge-mounted drift nets to non-selectively harvest fishes migrating between the Tonle Sap Lake and the Mekong River. This fishery harvests ~15,000 tonnes annually, including harvest rates of up to 500 kg of small 'trey riel' (*Henicorhynchus siamensis* and *H. lobatus*) per 15-minute set for each individual net from December–February (Halls *et al.*, in press). Nearby, the barrage system of river-spanning fences guides fish of all sizes into nets as they move downstream. Together, these methods reduce escapement of adults and recruits to the point that some large, migratory species are on the brink of extinction (e.g. giant catfish *Pangasianodon gigas*,



Fig. 2 Sorting the fish catch from the barrage fishery of the Tonle Sap River. Insets: (Top) *Paralaubuca typus*, an example of fish with an opportunistic life history strategy; (Middle) *Channa micropeltes*, a fish with an equilibrium life history strategy; (Bottom) *Pangasius larnaudii*, a fish with a periodic life history strategy.

and giant barb *Catlocarpio siamensis*), and the fishery is dominated by a handful of resilient, small and low value species. We support the recommendation of both Cambodia's Inland Fisheries Research and Development Institute (INFRDI) and the Mekong River Commission to Cambodia's Fisheries Administration that the Tonle Sap River fisheries be closed periodically to enhance escapement (Nam, 2010). Expanding harvest restrictions and

reserve-style protections to deep pools of the Mekong River would also benefit the migratory fishes of the Tonle Sap Lake (Baird, 2006).

Experience shows that no-harvest reserves are most effective when coupled with active management of fished areas (Hilborn *et al.*, 2006). Curtailing the use of poisons, explosives and ultra-effective gear that catch entire

schools of migrating fishes is essential. Such measures have proven successful elsewhere in the Lower Mekong, as have seasonal closures to protect spawning aggregations (Coates *et al.*, 2003). Regulating the mesh size of gill nets to limit harvest of either small or exceptionally large fishes is another potential approach. Support for gear exchange programmes (i.e. a “trade-in” programme whereby “undesirable” fishing equipment is exchanged for approved gear at no or low cost to the owner) is one way the international community could assist Tonle Sap Lake management. Low household income within local fishing communities would make it difficult to prohibit existing fishing gears in the absence of such support.

Both community acceptance and enforcement will need to be put in place rapidly to prevent the new conservation and community use areas from turning into de facto open-access fisheries because even low levels of poaching within these areas will erode their benefits to legal fishers (Sethi & Hilborn, 2008). Procedures for garnering community support for no-harvest reserves include: involving the affected communities within a participatory planning process; clearly articulating broad goals and specific catch quotas; acknowledging trade-offs between maximising economic benefits, food production, and biodiversity; recognising strong community leaders coupled with building local capacity (Gutierrez *et al.*, 2011); and empowering the fishing community via property rights and representation in future management (Ostrom, 2009).

Managing public expectations through education is particularly important due to the unavoidable time lag between establishing conservation areas and observing demographic responses in the long-lived fish species that are prized by commercial and community fisheries (Halpern, 2003). The transition from commercial lots to community fisheries also increases the need for communication among fishers and managers, because the mobility of the target fishes vastly exceeds the area governed by any single authority. Boosting capacities for this coordination is a potential role for international nongovernmental organisations.

At present, the governance structure that will emerge for the new conservation and community use areas is unclear. Adequately defining the responsibilities of the numerous government institutions and community organisations active within the Tonle Sap Lake ecosystem will be critical to the success of the newly established community use and conservation areas. A comprehensive assessment of Tonle Sap Lake governance is beyond the scope of this paper, but we note that a recent review describes a history of competing mandates and professional rivalries amongst multiple government

agencies which collectively have retarded the emergence of a unified vision for the ecosystem and its resources (Keskinen & Varis, 2012). Given its importance and recent history, it appears reasonable that addressing the questions of how and for what purposes the Tonle Sap Lake will be managed is a compelling need. As above, this may be an area where international nongovernmental organisations could provide assistance.

Prime Minister Hun Sen should be applauded for moving boldly to address impending threats to Cambodia’s freshwater fisheries. The decision to eliminate harvest from a substantial portion of the Tonle Sap Lake ecosystem and transition to community-based fisheries and conservation areas is a laudable first step towards protecting the globally-recognised resources of this ecosystem. However, if these actions are not supported by complementary measures – including optimising the design of the conservation area network, designing enforceable fishery laws and regulations that include explicit protection for migratory fishes, and cultivating support within local communities – they are likely to realise only part of their promise. Momentous decisions remain to be made, and recent insights into the hallmarks of successful fishery management provide clear guidance that can readily be applied to the Tonle Sap Great Lake of Cambodia.

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Short Communication

First record of the Asian paradise-flycatcher subspecies *Terpsiphone paradisi indochinensis* for Cambodia, and an undetermined species of *Zoothera*CHHIN Sophea^{1,*}, Howie NIELSEN² and Robert L. THOMSON³¹ Centre for Biodiversity Conservation, Room 415, Department of Biology, Faculty of Science, Royal University of Phnom Penh, Confederation of Russia Boulevard, Phnom Penh, Cambodia.² Sam Veasna Center, #0552, Group 12, Wat Bo, Siem Reap Province, Cambodia.³ Department of Biology, University of Turku, FI-20014 Turku, Finland.*Corresponding author. Email sophea.chhin@fauna-flora.org*Paper submitted 30 September 2012, revised manuscript accepted 8 December 2012.*

The Cardamom Mountains host one of Asia's largest remaining blocks of continuous forest, encompassing a Biodiversity Hotspot, a Global 200 Ecoregion and three Important Bird Areas (BirdLife International, 2004). Located in Southwest Cambodia, the region was largely forgotten during 25 years of civil conflict and effectively closed to the outside world until fighting ended in 1998 (Daltry & Momberg, 2000). As a result, the Cardamom Mountains are still largely intact, unlike most forested areas in Southeast Asia. At least 324 bird species can be observed in this region (FFI/ Ministry of Environment Cardamom Mountains Wildlife Sanctuaries Project, unpublished data, 2004), and with the recent resurgence in biodiversity surveys, knowledge of this area's avifauna continues to increase. This paper presents a new country record for Cambodia of a subspecies of Asian paradise-flycatcher *Terpsiphone paradisi* and a possible new record of White's thrush *Zoothera aurea*, both from Phnom Samkos Wildlife Sanctuary in the Cardamom Mountains.

The Asian paradise-flycatcher is a medium-sized passerine that is native to Asia and inhabits forests (Salomonsen, 2008). The colour of the plumage of male Asian paradise-flycatchers changes during their first few years. Sub-adult males look very much like females, but have a black throat and blue-ringed eyes (Salomonsen, 2008). The type specimen of this species, originally named *Corvus paradisi* by Linnaeus in 1758, was collected from India (Xin *et al.*, 2007). Thirteen subspecies have been

described, which are identified mainly by the plumage of adult males. According to Robson *et al.* (2008), only *T. p. incei* (Gould, 1852) is known to occur in Cambodia, as a winter visitor. *Tersiphone paradisi incei* breeds in East, Northeast and Central China, the Russian Far East and North Korea, while non-breeding populations occur in Southeast Asia. Asian paradise-flycatchers have been recorded in lower evergreen forest in the Cardamom Mountains on several occasions (e.g. Steinheimer *et al.*, 2000; Long *et al.*, 2002; Pierce & Pilgrim, 2003; Daltry & Traeholt, 2003), but these records failed to assign them to any particular subspecies.

On 31 March 2011, we captured a male Asian paradise-flycatcher in a mist net at 0845 h at 923 m elevation on Mount Dalai, in an area of hill evergreen forest (12°26.068N, 103°04.232E) that had been selectively logged for high value timber two decades previously (Chhin, 2011). Upon examination in the hand, the individual was found to have a rufous-chestnut upperside and an extremely long rufous-chestnut tail (Fig. 1). The head and breast were slaty-grey, while the crown was black and crested with dark bluish-green to light green colour. The belly was whitish and the bird had a stout blue bill and a broad blue eye ring. These characteristics accord well with those described for *T. p. indochinensis* by Robson *et al.* (2008). *Tersiphone p. indochinensis* (Salomonsen, 1933) inhabits the eastern regions of Myanmar, Yunnan Province in South China and migrates through

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Fig. 1 Male Indochinese Asian paradise-flycatcher (*Tersiphone paradisi indochinesis*), Mount Dalai, Phnom Samkos Wildlife Sanctuary, Southwest Cambodia (© Chhin S.).

Thailand and Indochina to Malaysia, Sumatra and neighbouring islands.

On 24 March 2011, a single *Zoothera* thrush (family Turdidae) was captured at 0810 h in a mist-net set in hill evergreen forest at 1,163 m elevation on Mount Tumpor in Phnom Samkos Wildlife Sanctuary. The mist-net was set about 15 m from the main stream in the area, called O'Cran (12°22.932N, 103°03.412E), approximately 10 km from the nearest settlement of Tumpor Village. Upon capture, the bird was measured, identified and photographed by the lead author and then released at the point of capture. The measurements of our specimen were: bill length (from the base of the upper mandible to the tip of bill) 24.8 mm; bill depth (at the back end of nostrils) 7.6 mm; tarsus length (from the calcaneal ridge to the base of basal phalanx) 34.8 mm; wing length (the longest of primary wing feathers) 150 mm; tail length (the longest tail feather) 100 mm.

Experts we subsequently consulted were severely divided in their opinions as to whether our bird is a White's thrush *Z. aurea* or a scaly thrush *Z. dauma*. Both species look very similar (Rasmussen & Anderton, 2005). *Zoothera aurea* is typically distinguished by a longer bill,

more prominent whitish eye-ring and heavily mottled cheek with a less prominent blackish spot at the rear of auricular and heavier spots on the malar. In addition, the upperparts of *Z. aurea* are often paler than those of *Z. dauma*, with bolder, broader and more rounded "scales" that are denser and more distinct on the rump and especially prominent on the upper tail coverts. The wings of *Z. aurea* are also dark olive-brown, boldly variegated with rufous-buff and black, while the median coverts are black with very large triangular pale buff tips. Finally, the greater coverts are olive-brown and of moderate-width with a strongly contrasting wing-bar, while the tertials usually have slightly darker inner webs which contrast sharply with their small paler tips (Robson *et al.* 2008). Although the individual we captured on Mount Tumpor exhibited features more consistent with *Z. aurea* than *Z. dauma* (Fig. 2), we concede that separation of these taxa is difficult in the field.

It must also be noted that while White's thrush and scaly thrush are recognised by some authorities as separate species (Rasmussen & Anderton, 2005), the *IUCN Red List of Threatened Species* still refers to *Z. aurea* as a synonym of *Z. dauma* (and considers this thrush to be Least Concern: BirdLife International, 2009).



Fig. 2 Head and right wing of an unidentified thrush (*Zoothera* sp.) from Mount Tumpor, Phnom Samkos Wildlife Sanctuary, Southwest Cambodia (© Chhin S.).

Zoothera dauma was first recorded from Phnom Samkos Wildlife Sanctuary in 2000 (Steinheimer *et al.*, 2000) and from Phnom Aural Wildlife Sanctuary, also in the Cardamom Mountains, in 2001 (Swan & Long, 2002), but no detailed information was provided for either of these records. *Zoothera aurea* is known to be a shy species, often flushed from the ground, and breeds in Siberia, Ussuri (Russia), Mongolia, Northeast China, North and South Korea, Japan and the Philippines. It is a winter visitor to parts of Southeast Asia including North and East Myanmar, West, Northwest and Northeast Thailand, and North and Central Laos (Robson *et al.*, 2008).

As no previous records of *T. p. indochinensis* exist for Cambodia (F. Goes, pers. comm.), this paper constitutes the first confirmed record of this subspecies for the country. However, additional research is required to determine the identity of the *Zoothera* thrush, which we can only tentatively refer to *Z. aurea*. The discovery of both birds during relatively brief and localised surveys suggests that Cardamom Mountains could support additional species that have not been reported for Cambodia. For this reason, further investigation of the avifauna of this region is warranted.

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About the Author

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Short Communication

Evidence of the Mekong River as a migratory corridor for shorebirds, including the first record of slender-billed gull *Chroicocephalus genei* for Cambodia

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Many bird species use geographical features such as rivers, coastlines, and mountain ranges to help them navigate during migration. Also, many long-distance migratory birds are unable to complete their migrations in one continuous flight, but need to stop to forage at sites with abundant food resources. Thus, large North–South oriented rivers may be particularly important as migratory corridors for birds because they are easily followed linear geographical features, and provide crucial food resources in a connected series of stopover sites.

The use of large rivers as migration routes by birds has been documented in other regions of the world such as North America (Bagg, 1923; Bellrose & Sieh, 1960; Martell *et al.*, 2001; Lehnen & Kremetz, 2005) and Africa (Reed & Lovejoy, 1969), but has not so far been widely documented in Southeast Asia. The Mekong River provides habitat for both passage migrants and wintering bird species (Bezuijen *et al.*, 2008; Timmins, 2007). As such, it may be a potentially important migratory corridor for birds within the East Asian–Australasian Flyway traveling between southern non-breeding areas and eastern Palearctic breeding grounds. However, there has been little documentation of the use of the Mekong River by migratory birds.

Many birds migrate at night or at elevations that are too high to be visible. However, inclement weather (especially wind and rain) can cause migrating birds to fly low or even force them to land until weather conditions

improve (Newton, 2010). Here we present post-storm observations of migrating shorebirds on the Mekong River in Cambodia, including the first country record of slender-billed gull *Chroicocephalus genei*.

Our observations took place within the “Mekong Flooded Forest” of Cambodia (previously known as the “Central Section”: see Bezuijen *et al.*, 2008). This section of the Mekong River extends from 49 km North of Kratie Town to 14 km North of the Kratie–Stung Treng provincial border. The Mekong Flooded Forest is a complex mosaic of numerous islands, seasonally emergent sandbars and beaches, seasonally flooded forests and shrublands, deep pools and rapids (Bezuijen *et al.*, 2008). This section of river has a low human population and thus contains some of the most intact riverine habitats left on the Cambodian section of the Mekong River. The area supports a number of globally and regionally threatened species, including some of Indochina’s largest remaining populations of riverine bird species such as the river tern *Sterna aurantia* and white-shouldered ibis *Pseudibis davisoni*.

Post-storm bird observations

Around 0100 h – 0200 h on 17 March 2012, a storm hit the island of Koh Preah (approximately UTM 48P 602000E 1474000N) at the northern end of the Mekong Flooded Forest area. Gale force winds and torrential rains pounded the island until just before dawn. We arrived

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at an extensive mudflat near the Northwest end of Koh Preah around 0600 h. Due to the storm, numerous shorebirds, as well as large flocks (1,500+) of barn swallows *Hirundo rustica*, were forced down to make a migratory stopover on the mudflat. Barn swallows covered the shrubs and ground along the edge of the mudflat, and all along the shoreline shorebirds were observed feeding, resting and preening. The shorebird species observed included two red-necked phalaropes *Phalaropus lobatus*, two Eurasian curlews *Numenius arquata*, one black-tailed godwit *Limosa limosa*, 20-30 spotted redshanks *Tringa erythropus*, three black-winged stilts *Himantopus himantopus*, two Oriental pratincoles *Glareola maldivarum*, three to five Kentish plovers *Charadrius alexandrinus*, about 25 Caspian terns *Sterna caspia*, one whiskered tern *Chlidonias hybrida*, and a group of about eight brown-headed gulls *Chroicocephalus brunnicephalus*. Amongst the group of brown-headed gulls we also observed one smaller gull, which we identified as a slender-billed gull. This list includes species that are considered to be passage migrants, as well as species which are non-breeding seasonal visitors to Cambodia, but which had not been observed at Koh Preah before the storm. Also present at the site were resident and breeding visitor shorebird species such as the river tern *Sterna aurantia*, river lapwing *Vanellus duvaucelii*, small pratincole *Glareola lactea*, and little ringed plover *Charadrius dubius*.

Slender-billed gull: first record for Cambodia

The first author is familiar with slender-billed gulls from the Delta de Ebro on the Mediterranean coast of Spain where they are a breeding visitor. In particular, the long slender neck, long thin red bill, pale eyes, and very pale primary tips on the wing clearly identified the bird described here as a slender-billed gull. This bird was noticeably smaller than the brown-headed gulls and had a very long slender "giraffe-like" neck, a long thin scarlet-red bill, and a long sloping forehead. The head was pale with only a very faint smudge behind the eye. It also had very pale whitish-coloured eyes. The upper wing had black along the trailing edge, and white outer primaries and leading edge. The bird we observed appeared to be in its third year of age (second winter), as evidenced by its orange legs and a single remnant outer dark juvenile tail feather (Olsen & Larsson, 2003). On 18 March, we again observed the slender-billed gull at the same location amongst the flock of brown-headed gulls and the first author was able to photograph it (Fig. 1).

In comparison to the slender-billed gull, brown-headed gulls (a regular non-breeding seasonal visitor) have a larger overall body size, larger head without a sloping forehead, shorter stockier neck, and shorter



Fig. 1 Slender-billed gull *Chroicocephalus genei*, Mekong River, Stung Treng Province, 18 March 2012: (Top) profile; (Middle) in flight; (Bottom) compared to brown-headed gull *C. brunnicephalus*, on left (© Jeffrey A. Schwilk).

stockier black-tipped bill. Brown-headed gull wing patterns also differ, with winter-plumage adults having broad black wing tips with white mirrors, and winter-plumage immature gulls having more extensive black on the primaries and trailing edge of the wing than slender-billed gulls. Slender-billed gulls can also be distinguished from the similarly-sized and plumaged

black-headed gull *Chroicocephalus ridibundus* (a primarily coastal non-breeding seasonal visitor) by their pale eye, lack of an obvious dark patch behind the eye, and distinctive profile and posture.

The slender-billed gull has a scattered distribution. It has been recorded at isolated locations ranging from Senegal and Mauritania in West Africa, through the Iberian Peninsula, Mediterranean, Black Sea and Middle East to Central Asia, from western Kazakhstan through Northwest India (del Hoyo *et al.*, 1996; Olsen & Larsson, 2003). It breeds coastally, at inland seas and lakes, and at wide river deltas (del Hoyo *et al.*, 1996), and nests in dense colonies on islands, beaches, meadows, and freshwater and saline marshes (Olsen & Larsson, 2003). During the non-breeding season, this species is primarily coastal (del Hoyo *et al.*, 1996).

The slender-billed gull has been recorded a handful of times in East and Southeast Asia, where it is considered to be a vagrant because these areas are well outside of its normal range. There are several records from East Asia, including eastern China, Nepal, Hong Kong, Japan, and South Korea (del Hoyo *et al.*, 1996; Brazil, 1991). In Japan, two birds were recorded from Fukuoka Prefecture, with one spending every winter from 1984 to 1992 at an estuary with a large mudflat (Brazil, 1991; Moores, 2002). In South Korea, there is a single record of a non-breeding adult from the south coast in January 2002 (Moores, 2002).

In Southeast Asia, the slender-billed gull has been recorded as a vagrant in northern Myanmar and Thailand (Robson, 2008). In central and southern Thailand it has been recorded in winter at a handful of coastal sites. On the central coast, one to three birds have been recorded near-annually since the mid-2000s at Bang Poo and Khok Khan, Thailand. This species has also been recorded twice in southern Thailand: once in September 2007 at Na Thung, Chumpon Province, on the West side of the Thai-Malay Peninsula, and once at a marsh near Thai Muang on the East side of the Thai-Malay Peninsula (Upton, 2012).

This is the first record of a slender-billed gull in Cambodia, and one of the only non-coastal records of this species outside of the breeding season. The individual described here was likely a migrating bird that was blown off course by strong winds. Wind drift is the leading cause of birds going off course during migration, but other weather factors, such as rain and clouds can also cause the disorientation of migrating birds (Newton, 2010). Upon being blown off course, the slender-billed gull likely began following the Mekong River, or else

began following brown-headed gulls as they followed the Mekong River.

Discussion

The observations reported here were made incidentally, while conducting a larger study of sandbar-nesting shorebird breeding ecology on the Mekong River. Despite their incidental nature these observations suggest that the Mekong River may serve as an important migratory corridor for shorebirds passing through Southeast Asia *en route* between southern non-breeding areas and northern breeding grounds. Additionally, the Mekong River may be important for other groups of migratory birds such as raptors and passerines. On two consecutive days in March 2010, we observed flocks of 20-30 unidentified migrating raptors. Also, in March and April 2010-2012, we observed large flocks (500-1,000) of migrating Eastern yellow wagtails *Motacilla tschutschensis* using river mudflats and sandbar islands as stopover habitat, as well as a number of other migratory passerines using riverine forest habitat.

Populations of many migratory bird species are declining. Worldwide, 11% of migratory species are classified as globally threatened or near-threatened (Kirby *et al.*, 2008). The Asia-Pacific region has the highest proportion of its migratory species classified as globally threatened (23% of migratory waterbirds, and 33% of migratory soaring birds) of any region of the world (Kirby *et al.*, 2008). Furthermore, 62% of Asian waterbirds are declining or have become extinct, and only 10% are increasing (Delany & Scott, 2006). Conservation of migratory bird species hinges on protection of habitat needed during all seasons: breeding, non-breeding, and migration. For migration, birds require quality habitat resources before departure, upon arrival, and at foraging stopover sites during migration. Although further research on migratory bird use is needed, the Mekong River likely serves as important migratory stopover habitat for shorebirds and other migrating bird species. Habitat loss and degradation from habitat conversion to agriculture, as well as from hydropower development, are likely the leading threats to migratory shorebirds using the Mekong River. Migratory shorebird conservation should therefore focus on maintaining the natural hydrological cycles that create riverine mudflats and sandbars, and support abundant food resources. Also, floodplain wetlands need to be protected from conversion to agricultural use.

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Short Communication

Helminths of the Asian house shrew *Suncus murinus* from Cambodia

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Although native to Southern and Southeast Asia, the Asian house shrew *Suncus murinus* Linnaeus, 1766 has been introduced to many other areas such as Japan and many parts of Africa (Hutterer *et al.*, 2008). These shrews are commensal with humans and are primarily found near human habitation and other synanthropic habitats such as rice fields and grain warehouses (Corbet & Hill, 1992).

The only previous study to cover the multiple groups of helminths that parasitise *S. murinus* within its native range was conducted in Taiwan by Tung *et al.* (2009), who reported two cestodes and four nematodes. Other studies have reported on just one class of helminths, either Cestoda (Crusz & Sanmugasunderam, 1971, in Sri Lanka; Sawada & Harada, 1989, in Taiwan) or Nematoda (Chen, 1937a, in Southern China; Sapong, 1963, in Taiwan). In addition, there have been a number of studies of specific helminth species, including a study of *Pseudophysaloptera riukiwana* in Japan (Lincicome & McConaughy, 1948), the description of *Seuratium nguyenwanaii* from Vietnam (Le, 1964) and the first report of three *Hymenolepis* species in *Suncus murinus* in Afghanistan (Vaucher & Tenora, 1971). Studies of the parasitic worms in introduced populations of *S. murinus* include the work

by Barré & Moutou (1982) on the island of Réunion, in which one cestode (*Staphylocystis suncusensis*) and two nematodes (*Pseudophysaloptera soricina* and *Aonchotheca minuta*) were reported.

The aims of the present study were: (1) to provide the first descriptive data of the helminth fauna of *Suncus murinus* from Cambodia, and (2) to collate data from all previous studies on the helminth parasites of *S. murinus* throughout its natural distribution range.

This study was conducted using specimens collected during 2009 in Veal Renh, Sihanoukville, Kampong Saom Province, Cambodia (10°71.67'N, 103°86.54'E). The shrews were captured with locally made, baited cage traps or Sherman traps. Traps containing shrews were labelled to indicate the place and date of capture and then transported to the field laboratory. There, the shrews were euthanised with an inhalant anaesthetic inside a closed container and dissected. We followed the protocols suggested by Herbreteau *et al.* (2011), which aim to guarantee the health of field parasitologists and ensure the generation of quality data. Viscera were preserved in 70% ethanol in the field laboratory. To collect the helminth parasites, samples were dissected under a binocular stereo microscope. Nematodes were studied

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using Amman lactophenol wet mounts in depression slides, while for cestodes the hooks were counted and measured from samples in Amman lactophenol. Trematodes were isolated and preserved in 70% ethanol and later stained with Acetic Carmine and Fast Green dye and mounted in Canada Balsam. All helminth samples were examined under a microscope and identified on the basis of their morphological characteristics and measurements (in micrometres, μm). All photographs were taken using a microscope-mounted camera.

This study also examined previous reports of helminths in the Asian house shrew in Asia. We found references in the database of the Natural History Museum in London, UK (www.nhm.ac.uk), and in the databases of other entities such as the National Center for Biotechnology Information (NCBI), the U.S. National Library of Medicine (www.ncbi.nlm.nih.gov/pubmed) and Science Direct (www.sciencedirect.com) using keywords referring to *S. murinus* and its synonyms.

Thirty-nine individuals of *Suncus murinus* (21 males, 16 females and two of undetermined sex) were trapped. Five helminth species were recovered, with a mean intensity of 10 worms per infected host. Helminth species included one cestode, Hymenolepididae gen. sp. (Fig. 1a), three nematodes – *Aonchotheca minuta* (Capillariidae) (syn. *Capillaria minuta*) (Fig. 1b-g), *Pseudophysaloptera* sp. (Physalopteridae) (Fig. 1h) and *Seuratium nguyenvanaii* (Seuratidae) (Fig. 1i-j) – and one trematode, Echinostomatidae gen. sp. (Fig. 1k).

These are the first data on the parasitic helminths of *Suncus murinus* from Cambodia, and only the second study (after Tung *et al.*, 2009) to consider the whole helminth spectrum of the Asian house shrew. Data on the prevalence, abundance, mean intensity and range of all these helminth species are given in Table 1. The general prevalence was 66.67% of shrews had one or more helminth parasite. The hymenolepidid cestode was the most prevalent species (present in 48.72% of shrews, with a mean intensity of 10.54 individuals per infected shrew), while the echinostomatid trematode had the lowest prevalence (only 2.56% of shrews infected).

In Table 2 the measurements of *Aonchotheca minuta* found in *Suncus murinus* from Cambodia are compared to the measurements in the original description of this parasite by Chen (1937b). Although there are differences in the non-diagnostic characters, similar values were found in spicule length (a diagnostic character). The nematode *A. minuta* was originally described as *Capillaria minuta* in Vietnam and was later reported in Taiwan by Sapong (1963). The present study represents only the second record of this species from Southeast Asia.

Table 1 Prevalence (percentage of shrews infected), mean abundance (mean number of individuals per shrew), mean intensity and range (number of individuals in infected shrews only) for parasitic helminths in *Suncus murinus* from Cambodia.

Taxon	Prevalence (%)	Mean Abundance \pm SD	Mean Intensity \pm SD	Range
Cestoda				
Hymenolepididae gen. sp.	48.72 (n = 19)	4.92 \pm 1.56	10.11 \pm 7.31	1–41
Nematoda				
<i>Aonchotheca minuta</i>	33.33 (n = 13)	3.51 \pm 1.09	10.54 \pm 6.29	2–26
<i>Seuratium nguyenvanaii</i>	7.69 (n = 3)	0.13	1.67	1–2
<i>Pseudophysaloptera</i> sp.	5.13 (n = 2)	1.21	23.50	15–32
Trematoda				
Echinostomatidae gen. sp.	2.56 (n = 1)	0.15	6	6

Table 2 Measurements of *Aonchotheca minuta* in *Suncus murinus* from Cambodia and the measurements given in the original description by Chen (1937b). Mean values are given in parentheses.

	This study		Chen (1937b)	
	Male	Female	Male	Female
Total length, μm	3,610–4,264 (3,855) (n = 3)	5,783–3,550 (4,121) (n = 11)	5,300	7,750
Oesophagus length, μm	–	1,743–2,437 (2,203) (n = 12)	2,580	3,130
Spicule length, μm	353–402 (353) (n = 2)	–	290	–
Length from vulva posterior to end of oesophagus, μm	–	25–49 (38) (n = 11)	–	66
Width at vulva, μm	–	35–45 (40) (n = 13)	–	–
Egg length x width, μm	–	39–54 x 16–24 (48 x 21) (n = 53)	–	53 x 24
Total number of eggs	–	16–58 (34) (n = 13)	–	12–20

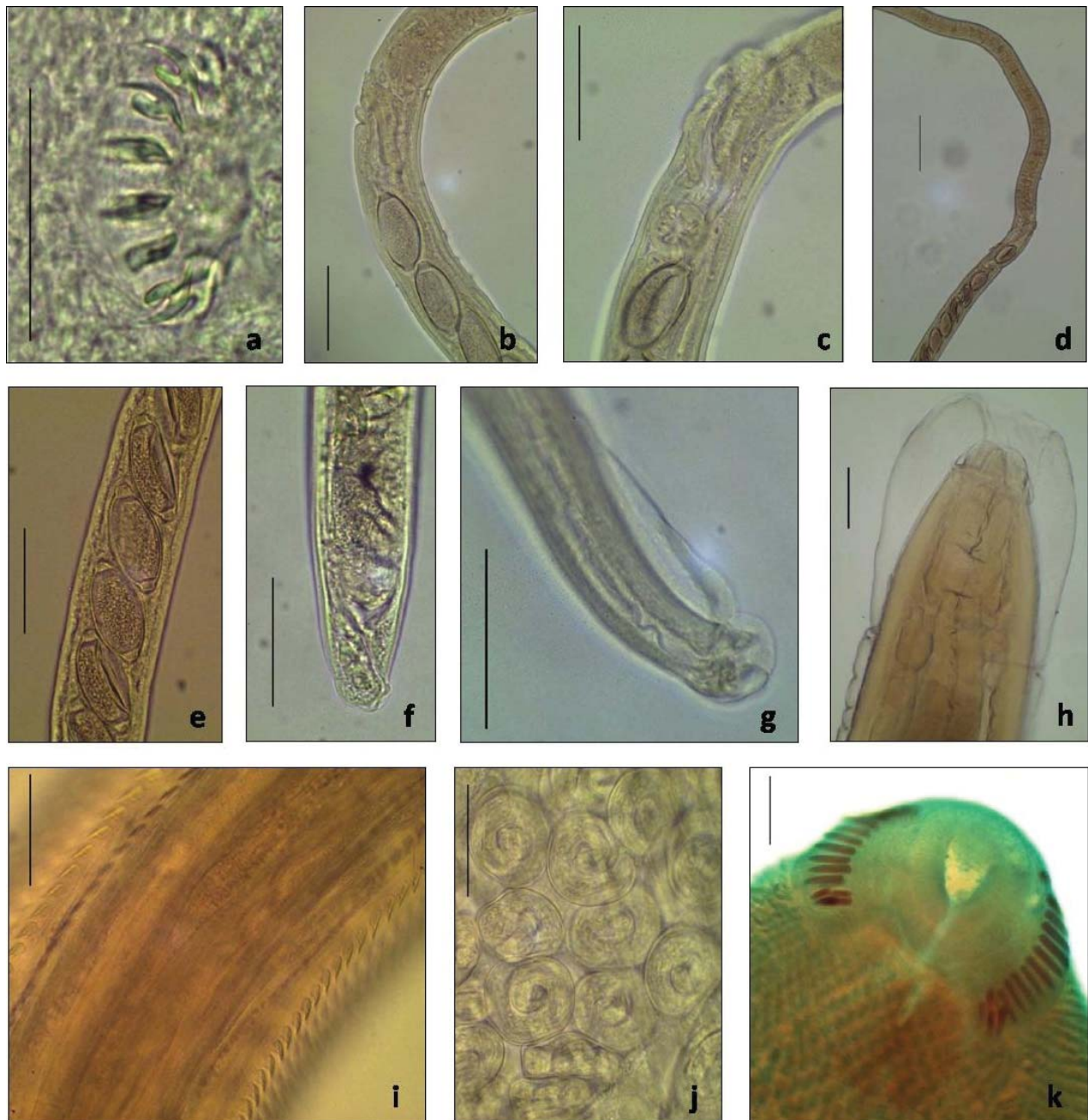


Fig. 1 a. Detail of the scolex of Hymenolepididae gen. sp. (x40, scale bar 50 μm); b. Vulva of *Aonchotheca minuta* (x10, scale bar 100 μm); c. Detail of the vulva appendage of *A. minuta* (x40, scale bar 50 μm); d–e. Detail of *A. minuta* eggs (x40, scale bar 50 μm); f. Posterior end of *A. minuta* female (x40, scale bar 50 μm); g. Posterior end of *A. minuta* male (x40, scale bar 50 μm); h. Anterior end of *Pseudophysaloptera* sp. female (x10, scale bar 100 μm); i. Detail of spines on *Seuratium nguyenvanaii* (x10, scale bar 50 μm); j. Detail of embryonated eggs of *S. nguyenvanaii* (x40, scale bar 50 μm); k. Anterior end with spines of Echinostomatidae gen. sp. (x10, scale bar 100 μm).

Although several species of *Pseudophysaloptera* have previously been reported in *S. murinus* and other shrews from Asia (Table 4), we believe that a re-evaluation of the *Pseudophysaloptera* species in Asian house shrews will probably lead to the synonymy of some of these species.

The measurements obtained from two female *Seuratium nguyenvanaii* were compared with the measurements given by Le (1964) in the original description and were found to have similar values: distance of cuticular dentate bands from the anterior end (98 μm vs 120 μm),

Table 3 Cestodes reported in *Suncus murinus* in its natural range. ¹Sawada *et al.* (1993); ²Sawada (1999); ³Vaucher & Tenora (1971); ⁴Nama (1990); ⁵Tung *et al.* (2009); ⁶Sawada & Yasuma (1994); ^{7a}Sawada & Koyasu (1991a); ^{7b}Sawada & Koyasu (1991b); ⁸Sawada & Oda (1993); ⁹Shafi & Rehana (1986); ¹⁰Crusz & Sanmugasunderam (1971); ¹¹Sawada & Harada (1994); ¹²Gupta & Parmar (1988); ¹³Sawada (1997); ¹⁴Sawada & Ohono (1993); ¹⁵Sawada & Hasegawa (1992); ¹⁶Olsen & Kuntz (1978); ¹⁷Sawada & Harada (1989); ¹⁸Sawada & Hasegawa (1993); ¹⁹Noor & Rehana (1995); ²⁰Noor (2001); ²¹Meggitt (1927).

Taxon (Cestoda)	Afghanistan	Borneo	Myanmar	India	Japan	Java	Nepal	Pakistan	Sri Lanka	Taiwan	Thailand
FAMILY ANOPILOCEPHALIDAE											
<i>Mathevoaenia sanchorensis</i> (Nama & Khichi, 1975)	-	-	-	1,2	-	-	-	-	-	-	-
FAMILY DAVAINIIDAE											
<i>Raillietina madagascariensis</i> (Davaine, 1869)	-	-	-	-	-	-	-	-	-	-	1
FAMILY HYMENOLEPIDIDAE											
<i>Hymenolepis</i> sp.	3	-	-	-	-	-	-	-	-	-	-
<i>Hymenolepis calva</i> (Cruz & Nuguliyadda, 1978)	-	-	-	-	-	-	-	-	4	-	-
<i>Hymenolepis diminuta</i> (Rudolphi, 1819)	-	-	-	-	-	-	-	-	-	5	-
<i>Hymenolepis furcata</i> (Stieda, 1862)	-	2,6	1,2	-	8	2	-	-	-	1,2,7a	-
<i>Hymenolepis jacobsoni</i> (Linstow, 1907)	1,2,3,4	-	-	1,2	-	1,2,4	-	1,2,9	-	-	-
<i>Hymenolepis mujibi</i> (Bilquees & Malik, 1974)	4	-	-	-	-	-	-	1,2,4	-	-	-
<i>Hymenolepis sunci</i> (Crusz & Sanmugasunderam, 1971)	1,2,3,4	-	-	-	-	-	-	-	2,10	-	-
<i>Pseudhymenolepis</i> sp.	-	2	-	-	8,11	-	-	-	-	-	-
<i>Pseudhymenolepis eisenbergi</i> (Crusz & Sanmugasunderam, 1971)	-	-	-	-	-	-	-	-	1,2,10	-	-
<i>Pseudhymenolepis guptai</i> (Gupta & Singh, 1988)	-	-	-	1,2,12	-	-	-	-	-	-	-
<i>Pseudhymenolepis nepalensis</i> (Sawada & Koyasu, 1991)	-	-	-	-	-	-	1,7b,13	-	-	-	-
<i>Rodentolepis</i> sp.	-	-	-	-	1	-	-	-	-	-	-
<i>Rodentolepis nana</i> (Siebold, 1852)	-	-	-	-	-	-	-	-	-	5	1,2
<i>Staphylocystis sindensis</i> (Nama, 1979)	-	-	-	1,2	-	-	-	-	-	-	-
<i>Staphylocystis delicata</i> (Sawada & Koyasu, 1991)	-	-	-	-	-	-	-	-	-	1,2,7a,13	-
<i>Staphylocystis magnisaccus</i> (Sawada & Ohono, 1993)	-	2,6	-	2,14	8	2	-	-	-	-	-
<i>Staphylocystis indicus</i> (Nanda & Malhotra, 1990)	-	-	-	1,2,13	-	-	-	-	-	-	-
<i>Staphylocystis kathmanduensis</i> (Sawada, Koyasu & Shrestha, 1993)	-	2,6	-	2,14	8	2	1	-	-	-	-
<i>Staphylocystis multihamata</i> (Sawada & Ohono, 1993)	-	2,6	-	13,14	8	2	1	-	-	-	-
<i>Staphylocystis suncusensis</i> (Olsen & Kuntz, 1978)	-	-	-	-	1,2,15	-	-	-	-	1,2,16	-
<i>Staphylocystis trisuliensis</i> (Sawada, Koyasu & Shrestha, 1995)	-	-	-	-	-	-	1,2,13	-	-	-	-
<i>Vampirolepis allahabadensis</i> (Srivastava & Pandey, 1982)	-	-	-	1,2	-	-	-	-	-	-	-
<i>Vampirolepis bahli</i> (Singh, 1957)	-	-	-	1	-	-	-	-	-	-	-
<i>Vampirolepis gracilistrobila</i> Sawada & Harada, 1989	-	-	-	-	1,2,18	-	-	-	-	1,2,13,17	-
<i>Vampirolepis jakounezumi</i> (Sawada & Hasegawa, 1992)	-	-	-	-	2,11,13,15,18	-	-	-	-	-	-
<i>Vampirolepis microcolex</i> (Sawada & Koyasu, 1991)	-	-	-	-	-	-	-	-	-	1,2,13,17	-
<i>Vampirolepis molus</i> (Srivastava & Capoor, 1979)	-	-	-	1,2	-	-	-	-	-	-	-
<i>Vampirolepis montana</i> (Crusz & Sanmugasunderam, 1971)	-	-	-	-	-	-	-	-	1,2,10	-	-
<i>Vampirolepis murini</i> (Noor & Rehana, 1995)	-	-	-	-	-	-	-	19,20	-	-	-
<i>Vampirolepis okinawaensis</i> (Sawada & Hasegawa, 1992)	-	-	-	-	1,2,13,15	-	-	-	-	-	-
<i>Vampirolepis sessilhamata</i> Sawada & Harada, 1989	-	-	-	-	-	-	-	-	-	1,2,13,17	-
<i>Vampirolepis sunci</i> Sawada & Harada, 1989	-	-	-	-	-	-	-	-	-	1,2,13,17	-
<i>Weinlandia minutissima</i> (Meggitt, 1927)	-	-	1,2	-	-	-	-	-	-	-	-
<i>Weinlandia solitaria</i> (Meggitt, 1927)	-	-	1,2,21	-	-	-	-	-	-	-	-

Table 4 Nematodes reported in *Suncus murinus* in its natural range. ¹Sapong (1963); ²Le & Pham (1968); ³Ding *et al.* (1993); ⁴Tung *et al.* (2009); ⁵Shimabukuro *et al.* (1995); ⁶Farooqui & Ali (1965b); ⁷Noor (2001); ⁸Lincicome & McConnaughey (1948); ⁹Chen (1937a); ¹⁰Le (1964); ¹¹Singh (1934); ¹²Smith & Little (1973); ¹³Justine (1992); ¹⁴Mirza & Narayan (1935); ¹⁵Durette-Desset (1973); ¹⁶Sood (1972).

Taxon (Nematoda)	China	India	Japan	Malaysia	Nepal	Pakistan	Taiwan	Thailand	Vietnam
FAMILY ANCYLOSTOMATIDAE									
<i>Ancylostoma</i> spp.	-	-	-	1	-	-	-	-	-
FAMILY GONGYLONEMATIDAE									
<i>Gongylonema bigeti</i> (Le & Pham, 1968)	-	-	-	-	-	-	-	-	2
FAMILY GNATHOSTOMATIDAE									
<i>Gnathostoma hispidum</i> (Fedstchenko, 1872)	3	-	-	-	-	-	-	-	-
FAMILY HELIGMONELLIDAE									
<i>Nippostrongylus brasiliensis</i> (Travassos, 1914)	-	-	-	-	-	-	4	-	-
FAMILY METASTRONGYLIDAE									
<i>Parastrongylus cantonensis</i> (Chen, 1935)	5	-	-	-	-	-	4	-	-
FAMILY PHYSALOPTERIDAE									
<i>Physaloptera</i> sp. (Rudolphi, 1819)	-	-	-	-	-	-	4	-	-
<i>Pseudophysaloptera indiana</i> (Farooqui & Ali, 1965)	-	6	-	-	-	-	-	-	-
<i>Pseudophysaloptera petaloidi</i> (Rehana, 1981)	-	-	-	-	-	7	-	-	-
<i>Pseudophysaloptera riukiwana</i> (Lincicome & McConnaughey, 1948)	-	-	8	-	-	-	-	-	-
<i>Pseudophysaloptera soricina</i> (Baylis, 1934)	9	-	-	-	-	-	-	-	-
FAMILY SEURATIDAE									
<i>Seuratium nguyenvanaii</i> (Le, 1964)	-	-	-	-	-	-	-	-	10
FAMILY SPIROCERCIDAE									
<i>Cylicospirura strasseni</i> (Singh, 1934)	-	11	-	-	-	-	-	12	-
<i>Spirocerca lupi</i> (Rudolphi, 1809)	-	13	-	-	-	-	-	-	-
FAMILY STRONGYLOIDEA									
<i>Strongyloides akbari</i> (Mirza & Narayan, 1935)	-	-	14	-	-	-	-	-	-
<i>Strongyloides ratti</i> (Sandground, 1925)	-	-	-	-	-	-	14	-	-
<i>Suncinema murini</i> (Durette-Desset, 1973)	-	-	-	-	15	-	-	-	-
FAMILY TRICHINELLIDAE									
<i>Capillaria caeruleaii</i> (Sood, 1972)	-	16	-	-	-	-	-	-	-
<i>Capillaria ohbayashii</i> (Justine, 1992)	-	-	-	-	13	-	-	-	-
FAMILY TRICHURIDAE									
<i>Aonchotheca minuta</i> (Chen, 1937)	-	-	-	-	-	-	1	-	-

oesophagus anterior width (64 μm vs 72 μm), oesophagus mid-section width (46 μm vs 57 μm), oesophagus distal width (94 μm vs 110 μm) and total oesophagus length (1,089 μm vs 1,000 μm). Embryonated eggs differed slightly and measured 39 μm (33–50 μm) \times 44 μm (39–52 μm) (vs 50 μm \times 57 μm). This study contains the first report of the nematode *S. nguyenvanaii* since its original description in *Suncus murinus* from Vietnam (see Table 4), which suggests that this nematode has a wider distribution than previously thought.

The echinostomatid trematode we obtained had an interrupted crown of 34 spines (see Fig. 1k). In South-

east Asia, echinostomes are considered to be food-borne intestinal flukes that parasitise the human intestinal tract (Chai *et al.*, 2009). Our results suggest that, as in commensal rodents, shrews that are associated with humans also play a role in perpetuating the life cycle of echinostomes in human settlements. To date, the only reports of *Artyfechinostomum malayanum* (Leiper, 1911) in *S. murinus* are from Malaysia (Lie, 1963), the Philippines (Monzon & Kitikoon, 1989) and Thailand (Namee & Wongsawad, 1997). The echinostomatids reported in rodents from Southeast Asia are as follows: *Echinostoma cinetorchis* (Ando & Ozaki, 1923) from Vietnam (Nguyen, 1991), *E. ilocanum* (Garrison, 1908) from the Philippines

Table 5 Trematodes reported in *Suncus murinus* in its natural range. ¹Hasegawa *et al.* (1986); ²Lie (1963); ³Monzon & Kitikoon (1989); ⁴Namue & Wongsawad (1997); ⁵Sapong (1963); ⁶Sudomo (1984).

Taxon (Trematoda)	China	Indonesia	Japan	Malaysia	Philippines	Thailand
FAMILY BRACHILAIMIDAE						
<i>Brachylaima ishigakense</i> (Kamiya & Machida, 1977)	-	-	1	-	-	-
FAMILY ECHINOSTOMATIDAE						
<i>Artyfechinostomum malayanum</i> (Leiper, 1911)	-	-	-	2	3	4
FAMILY PLAGIORCHIIDAE						
<i>Plagiorchis</i> sp.	5	-	-	-	-	-
FAMILY SCHISTOSOMATIDAE						
<i>Schistosoma japonicum</i> (Katsurada, 1904)	-	6	-	-	-	-

(Namue & Wongsawad, 1997) and Thailand (Cross & Basaca-Sevilla, 1986), and *A. malayanum* from Malaysia (Sinniah, 1979). Our record of an echinostomatid in *S. murinus* is only the second such record. Although *A. malayanum* has been reported previously in the Asian house shrew (in Lie, 1963, see Table 5), the examples we examined from Cambodia had 34 collar spines, which does not agree with the number previously reported in *A. malayanum* (41 spines: Tesana *et al.*, 1987; 43 spines: Belizario *et al.*, 2007). Furthermore, the helminths we found do not correspond to other Echinostomatidae reported in rodents from Southeast Asia (*E. cinetorchis* with 37–38 spines: Lee *et al.*, 1992; *E. ilocanum* with 49–51 collar spines: Belizario *et al.*, 2007).

Due to the conditions in which our samples were preserved (70% ethanol), we were unable to determine which species of hymenolepidid cestode we had captured. This species had 12 rostral hooks and a mean length of 19 μm (18–20 μm). Many species of hymenolepidids have been reported in Asian house shrews in Asia (Table 3).

Two genera of platyhelminthes – *Hymenolepis* and *Echinostoma* – have been identified as the possible origin of zoonotic helminthiases (Belizario *et al.*, 2007; Warwick *et al.*, 2012). However, due to the mild clinical symptoms that occur in human patients – mainly in cases of heavy infections that can cause damage to the intestinal

mucosa, abdominal pain, diarrhoea and vomiting – these helminthiases may be regarded as neglected diseases.

The lack of research on helminths in small mammals in Cambodia (to date, studied only in rodents by Chaisiri *et al.*, 2010, and shrews in the present study) makes further health-related helminthological surveys necessary. We hope that such studies will provide greater understanding of helminth diversity and lead to the description of new helminth species.

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

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មូលនិយមរង្វេប

វិធីសាស្ត្រផ្សេងៗក្នុងការអង្កេតសត្វព្រៃត្រូវបានបង្កើតឡើងសម្រាប់ប្រភេទធំៗ និងទាក់ទាញចំណាប់អារម្មណ៍នៅឥណ្ឌូចិន ប៉ុន្តែមិនមែនសម្រាប់ប្រភេទថនិកសត្វតូចៗផ្សេងទៀតឡើយ។ ការសិក្សានេះមានគោលបំណងវាយតម្លៃវិធីសាស្ត្រដើម្បីសិក្សាពីចំនួនប្រហាក់ប្រហែលរបស់រង្វេបក្រិស *Nycticebus pygmaeus* ដែលរងការគំរាមកំហែងដោយការធ្វើអាជីវកម្មហួសប្រមាណ និងការបាត់បង់ទីជម្រក។ ការសិក្សានេះគឺត្រូវបានធ្វើឡើងដោយប្រើទីតាំងកាត់ទទឹង(transect)ពីរកន្លែង នៅក្នុងព្រៃពាក់កណ្តាលបៃតងនៃតំបន់ព្រៃការពារសីម៉ា ប្រទេសកម្ពុជា ក្នុងកំឡុងពីថ្ងៃទី២-២០ ខែឧសភា និងពីថ្ងៃទី៣-១៤ ខែធ្នូ ឆ្នាំ២០០៧។ (១) សំណាញ់ទ្រង់ធ្វើពីខ្សែត្រូវបានដាក់នៅលើដើមឈើ >១.៥ម៉ែត្រ ប៉ុន្តែវាអាចចាប់បានតែសត្វកកេរ *Niviventer* spp. មួយប៉ុណ្ណោះ ក្នុងកំឡុងពេលដាក់សំណាញ់នោះ៦៥០យប់។ (២) បានផ្តានយកស្នាមជើងដែលមាននុយត្រូវបានដាក់នៅលើដើមឈើ ហើយផ្តិតយកស្នាមជើងថនិកសត្វទំហំមធ្យមបានយ៉ាងតិច៥ប្រភេទដែលមានដូចជាសំពោចដូង *Paradoxurus hermaphroditus* ពួកស្ពាកលៀង *Martes flavigula* កំប្រុកយក្ស(*Ratufa* and/or *Petaurista* spp.) សំពោចដូងពាក់មុខ *Paguma larvata* ឆ្មា *Prionailurus bengalensis* និង/ឬ ឆ្មា *Pardofelis mamorata* ក្នុងកំឡុងពេល៧៦៣យប់។ នៅលើបានផ្តានស្នាមជើងទាំងនោះមានស្នាមជើងច្រើនពេកដែលពិបាកកំណត់ឈ្មោះប្រភេទឲ្យបានត្រឹមត្រូវ ក៏ប៉ុន្តែស្នាមជើងរបស់សត្វញីមិនត្រូវបានរកឃើញឡើយ។ (៣) ការឆ្លុះពេលយប់ដោយប្រើពន្លឺពណ៌ក្រហមបានប្រទះឃើញថនិកសត្វ៤ប្រភេទគឺរង្វេបក្រិស (0.៣៣ km⁻¹) សំពោចដូង(0.៥0 km⁻¹) ថនិកសត្វ chevrotain *Tragulus kanchil* (0.៣៣ km⁻¹) និងកំប្រុកយក្សហើរ *Petaurista* spp. (0.៣៣ km⁻¹)។ ទោះបីជាការធ្វើតេស្ត និងការសិក្សាបន្ថែមត្រូវបានធ្វើឡើងក៏ដោយ ក៏យើងអាចសន្និដ្ឋានថា ការឆ្លុះមើលពេលយប់គឺជាវិធីសាស្ត្រដ៏ល្អមួយសម្រាប់ស្វែងរករង្វេបក្រិសនៅក្នុងតំបន់នេះ។

Abstract

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

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

Keywords

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

Introduction

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

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

The pygmy loris is known to be hunted for traditional medicines in Cambodia (Walston, 2005; Starr *et al.*, 2010), and there is an urgent need to monitor any decline in these populations. This knowledge is vital for developing strategies for their conservation. The present study

therefore aimed to develop and test improved methods for determining the presence and relative abundance of pygmy lorises by evaluating the effectiveness of three detection methods: wire cage traps, track plates and spotlighting.

Methods

Study site

The study was conducted in the Seima Protection Forest, in southern Mondulakiri Province, Cambodia (Fig. 1). The conservation area encompassed approximately 3,050 km² at the time of our study. The study was conducted on two transects (UTM 48P 708205E; 343141N) in the wet season from 2–20 May 2007 and during the early dry season from 3–14 December 2007. Encounter rates of pygmy loris were known to be high on these transects from surveys conducted in early 2007 (Starr *et al.*, 2011).

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

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

Transects

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

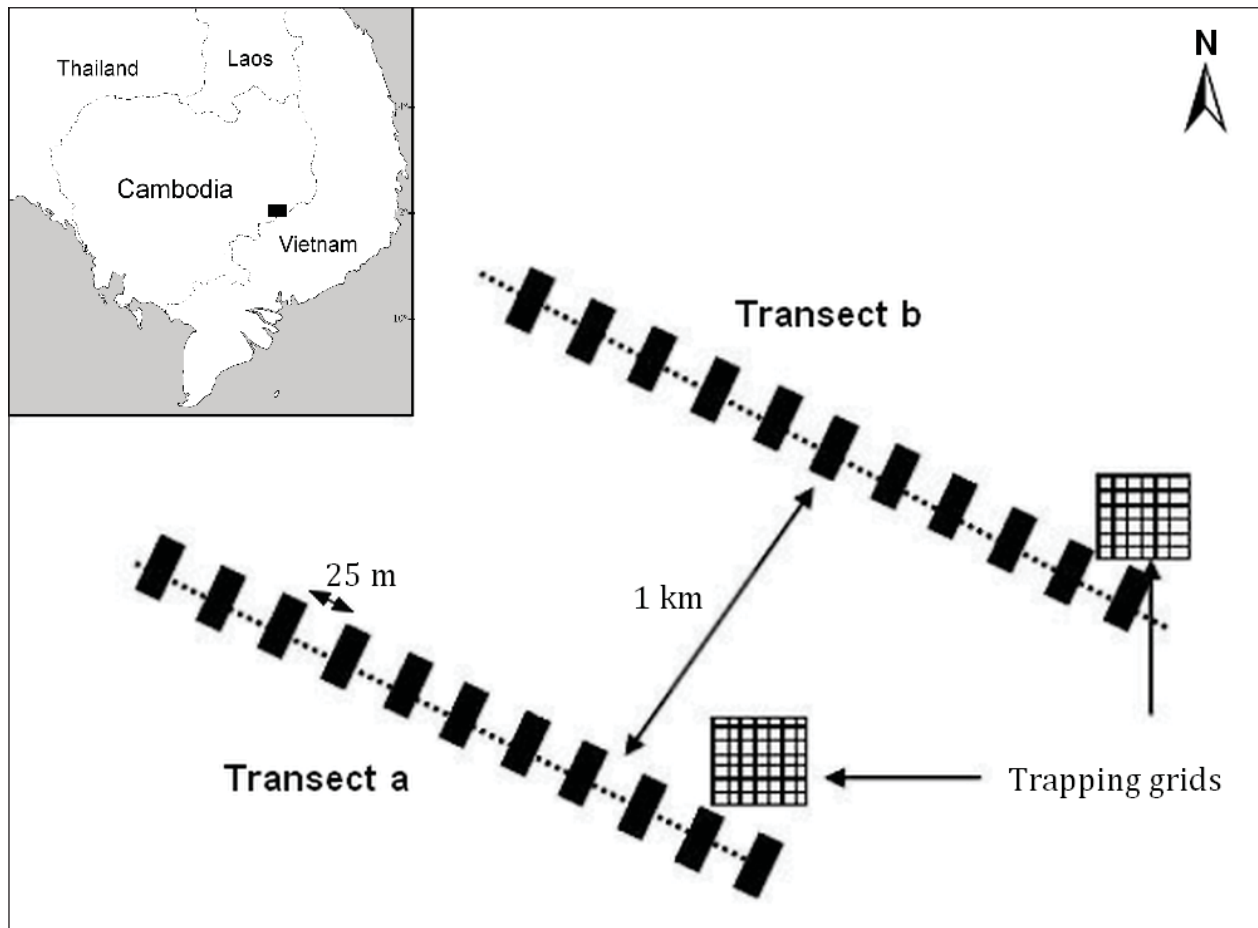


Fig. 1 The shaded square on the insert indicates the location of the survey site in Cambodia (not to scale). The main diagram shows how tracking plates and grids were distributed along transects a and b. Filled rectangles represent the tracking plates.

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

Spotlighting

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

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

Arboreal track-plate

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

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

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

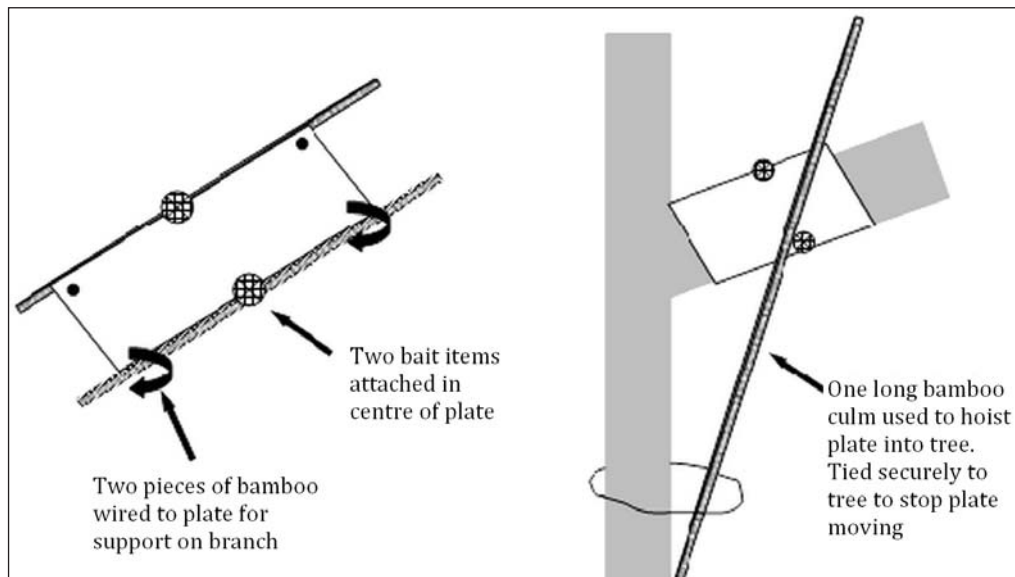


Fig. 2 The construction and placement of arboreal tracking plates in trees or bamboo.

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

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

Wire cage trap

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

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

The wire cage traps were placed in a trapping grid (100 × 100 m) randomly located along the transect: the



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

grid consisted of 5 × 5 trap stations placed 25 m apart, with one wire cage trap at each station. These were set for 17 and eight consecutive nights during the wet and dry season sampling periods respectively.

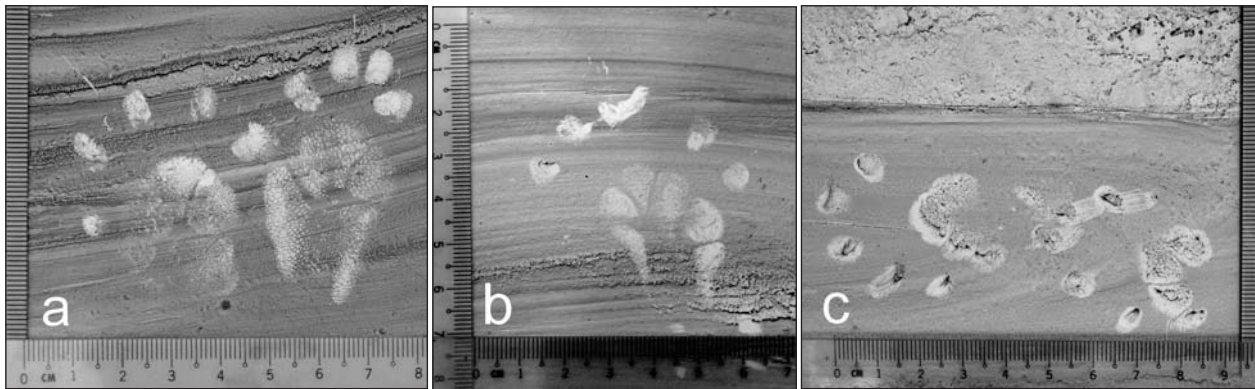


Fig. 4 Examples of footprints recorded on track plates: **a.** common palm civet *Paradoxurus hermaphroditus*; **b.** small-toothed palm civet *Arctogalidia trivirgata*; **c.** yellow-throated marten *Martes flavigula*.

Abundance indices

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

Results

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

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

Discussion

The wire cage traps used in this study were ineffective in sampling lorises, even with two weeks of careful pre-baiting. This contrasts with the effectiveness of these traps in capturing greater slow lorises in Malaysia (Wiens & Zitzmann, 2003; Wiens *et al.*, 2008). Fresh droppings and signs of civet species were present near many cage traps, and civets may enter a larger trap design, but only a single rodent was captured. These findings indicate

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

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

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

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

that other small-to-medium-sized mammals (suitable for traps of this size) in the site are also likely to be highly trap-shy. We do not recommend the cage traps used here for future studies of pygmy lorises, or other arboreal small-to-medium-sized mammals in the site.

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

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

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

Despite our substantial trapping and tracking effort, no pygmy lorises were captured in traps or crossed track boards during this study. Of the three methods tested, spotlighting was found to be the most effective method to detect pygmy lorises. Until an improved trapping method can be identified, studies where animals need to be captured (e.g. to attach radio-collars or collect

morphological data) must rely on hand capture, which may be difficult in field sites with tall vegetation.

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Knowing sea turtles: local communities informing conservation in Koh Rong Archipelago, Cambodia

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មូលនិយមសង្ខេប

អណ្តើកសមុទ្រប្រភេទដែលរងការគំរាមជាសកល ត្រូវបានរកឃើញនៅតំបន់ជុំវិញប្រជុំកោះរុង ដែលស្ថិតនៅតំបន់ឆ្នេរភាគនិរតីនៃប្រទេសកម្ពុជា។ ប្រភេទទាំងនោះគឺ *Chelonia mydas*, *Eretmochelys imbricata* និង *Dermochelys coriacea*។ ដើម្បីសិក្សាថាតើសហគមន៍នៅជុំវិញប្រជុំកោះរុងមានអន្តរកម្មជាមួយប្រភេទទាំងនេះយ៉ាងដូចម្តេចនោះ យើងបានធ្វើការសិក្សាទៅលើការយល់ដឹងរបស់គាត់អំពីអណ្តើកសមុទ្រ និងការប្រើប្រាស់អណ្តើកសមុទ្រទាំងនោះ។ ក្នុងការសិក្សានេះ យើងបានប្រើវិធីសាស្ត្រស្រាវជ្រាវគុណភាពបែបវិទ្យាសាស្ត្រសង្គម និងបានកំណត់ក្របខណ្ឌគោល (frames of reference) សម្រាប់អណ្តើកសមុទ្រ គឺអណ្តើករងគ្រោះ អណ្តើកជាអាហារម្តងម្កាល អណ្តើកក្នុងជំនឿ និងអណ្តើកជាសក្តានុពលទៅអនាគត។ ក្របខណ្ឌគោលទាំងនេះត្រូវបានពន្យល់បង្ហាញនៅគ្រប់ភូមិ និងក្នុងចំណោមក្រុមជំរុំភាគច្រើនក្នុងសហគមន៍។ ការសិក្សារបស់យើងក៏បានរកឃើញផងដែរនូវកត្តាគំរាមកំហែងដល់ការរស់នៅរបស់អណ្តើកសមុទ្រដែលនៅជុំវិញប្រជុំកោះរុង។ កត្តាគំរាមកំហែងញឹកញាប់ជាងគេគឺទូកអូសអ៊ុន សំណាញ់ អ្នកនេសាទជនជាតិវៀតណាម សន្ទូច ការនេសាទខុសច្បាប់ និងការនេសាទហួសកំរិត។ ការយល់ដឹងពីរបៀបដែលសហគមន៍យល់ចំពោះអណ្តើកសមុទ្រនិងធ្វើអន្តរកម្មជាមួយអណ្តើកសមុទ្រ និងរបៀបដែលពួកគេយល់ដឹងពីកត្តាគំរាមកំហែងដល់ការរស់នៅរបស់វា ផ្តល់នូវការយល់ដឹងត្រឹមត្រូវយ៉ាងសំខាន់សម្រាប់ការអភិរក្សធម្មជាតិ និងកម្មវិធីអប់រំ។

Abstract

Three globally threatened species of sea turtle have been recorded in the waters around the Koh Rong Archipelago off Cambodia's southwest coast: the green turtle *Chelonia mydas*, the hawksbill *Eretmochelys imbricata* and the leatherback *Dermochelys coriacea*. To learn how human communities around the Koh Rong Archipelago interact with these turtle species, we investigated their perceptions and use of sea turtles. Our study used qualitative social science research methods and identified four frames of reference for the sea turtle: turtles as victims, turtles as occasional food, turtles as spiritual beings, and turtles as a promise for the future. These frames of reference were expressed in all villages and among most demographic groups. Our study also identified several perceived threats to sea turtle survival around the Koh Rong Archipelago. The most frequently cited threats were trawling boats, nets, Vietnamese fishermen, hooks, illegal fishing and overfishing. Understanding how local people interpret and interact with sea turtles and perceive threats to their survival provides important insights for nature conservation and education programmes, which our study aims to inform.

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Keywords

Cambodia, community-based conservation, Koh Rong, qualitative research, sea turtle, social study.

Introduction

Sea turtles are globally widespread and have varying uses, roles and relationships in different coastal communities around the world (Lück, 2008). From being a main income and food source (Garland & Carthy, 2010; Parsons, 2000) to having ancestral and cultural significance (Rudrud, 2010; Morgan, 2007), marine turtles are experienced and inhere a range of interpretations by the people who interact with them. Threats to marine turtles around the world today are primarily anthropogenic. These include over-harvesting of eggs (Settle, 1995; Parsons, 2000), fishing activities that catch juvenile and adult turtles in nets during migration (Wallace *et al.*, 2010; Lewison *et al.*, 2004; Oravetz, 1999), oceanic pollution (Bugoni *et al.*, 2001; van der Merwe 2010) and degradation of nesting habitats (National Research Council, 1990; Lutz & Musick, 2003; Gilman *et al.*, 2010).

Until recently, knowledge of sea turtles in Cambodia was limited. In 1999 and 2000, an initial study was conducted by Ing (1999, 2000), wherein three species were identified in the waters off Cambodia's coast. These were the green turtle *Chelonia mydas*, the hawksbill *Eretmochelys imbricata* and the leatherback *Dermochelys coriacea*. In the Koh Rong Archipelago, however, there have been no recent leatherback recordings. All three species are globally threatened, with the hawksbill and the leatherback listed as Critically Endangered by IUCN (Sarti Martinez, 2000; Seminoff, 2004; Mortimer & Donnelly, 2008). The social status and use of sea turtles around Cambodia were examined by Ing (1999, 2000), while Fauna & Flora International conducted a rapid assessment of nesting sites along the coastline (Eastoe & Ke, 2011). These studies found that some turtles are eaten but not hunted, that turtles are frequently caught as by-catch, and that they are sometimes considered to bring good luck, such as by performing a merit release (Gilbert *et al.*, 2012). In addition to these studies, numerous sea turtle nesting and feeding locations were identified in 2004, including sites on Koh Rong and Koh Rong Samloem (Ing, 2004).

At the time of this study, several marine conservation and research initiatives were underway in the Koh Rong Archipelago. Two examples included efforts by Marine Conservation Cambodia in M'pei Bi Village and Coral Cay Conservation in Koh Toch Village. In addition, at the time of this study, plans were underway to establish

a Marine Fisheries Management Area around the archipelago.

Considering the existence of other conservation initiatives, the records of sea turtle presence in rapid assessment studies, and the possibility of a Marine Fisheries Management Area, Koh Rong Archipelago was seen as an ideal location to examine the relationship between Cambodians and sea turtles more closely. Initiated by Song Saa Private Island's Conservation and Community team to aid in their possible implementation of a sea turtle conservation project, this study identifies the dietary and economic uses of the turtles and exposes variation between villages in the study area. It also reveals people's socio-cultural sentiments towards, and interpretations of, the sea turtles across the five villages studied.

Methods

Study Sites

The study area consisted of five villages, namely, Prek Svay, Daem Thkov, Koh Toch, M'pei Bi, and Sok San (Table 1) situated on the two main islands and associated small islands of Koh Rong and Koh Rong Samloem (10°46'23.8074"N, 103°10'36.228"E to 10°32'25.6914"N, 103°20'24.5394"E). The largest, Prek Svay Village, was reportedly established on Koh Rong under King Norodom Sihanouk's rule (1953-1970) (Seak *et al.*, 2010). From 1975 to 1979, during the Pol Pot era, the inhabitants were evacuated to the mainland (Seak *et al.*, 2010). The first reported individuals to return to the islands were in 1989 and 1990 (Seak *et al.*, 2010; Ouk *et al.*, 2011).

In 2011 a socio-demographic survey was conducted in three of the four remaining study site communities around the islands: Daem Thkov, Koh Toch, and M'pei Bi (Ouk *et al.*, 2011). Sok San, perhaps because it is not officially a village, was not examined. This survey found that in all four assessed villages, the vast majority of inhabitants were Khmer and Buddhist, with a few representatives from the Cham (Cambodian Muslim) community as well as a few Thai, Chinese and Vietnamese individuals (Ouk *et al.*, 2011). The study also revealed that an average of 46% of the population in all villages were employed in fishing-related activities. Tourism, local commerce, farming, construction and teaching were also listed as occupations of residents. In M'pei Bi, Daem Thkov and

Table 1 Number of individuals and families in the five villages where interviews were conducted in the Koh Rong Archipelago (Prak Saran, pers. comm. 2012).

Island/ Village	No. of people	No. of families	No. of responses
<i>KOH RONG</i>			
Daem Thkov Village	384	90	10
Prek Svay Village	679	154	17
Koh Toch Village	318	82	7
Souk San Village	303	82	9
<i>KOH RONG SAMLOEM</i>			
M'pei Bi Village	404	94	8

Prek Svay villages, literacy was found to be over 70% while Koh Toch Village had a literacy rate of 49.6%. Age composition was similar in M'pei Bi, Koh Toch and Daem Thkov villages, showing a very young population with an average of 41% under 18 years old and 28% between 19 and 30 years. Prek Svay had a significantly older population, with 60% over the age of 30 (Seak *et al.*, 2010; Ouk *et al.*, 2011).

Data collection

This study utilised several different qualitative social science research methods, including semi-structured interviews, participatory mapping, ethnographic participant observation and a focus group (Neuman, 1997). Only the results from the semi-structured interviews are discussed in this paper. The lead author carried out field research in March and April 2012, which included 51 semi-structured interviews with people from the five villages across the two largest islands.

For the semi-structured interviews, a translator and the lead researcher, using convenience sampling, approached individuals who were available to talk while they walked around the villages, usually between 0700–1700 h, with occasional evening interviews from 1800–2000 h. We explained the study to prospective participants and if they were interested in participating, we discussed the project thoroughly and asked for their verbal consent. To achieve a representative sample, we aimed to interview a variety of different ages and an even number of women and men. We approached individuals who appeared to be doing a variety of activities, but were also frequently guided to individuals who had personal experiences with sea turtles.



Fig. 1 Map of Koh Rong Archipelago showing the locations of the five villages. Villages with Community Fisheries are marked with an asterisk.

The interviewees ranged from individuals to small groups, but usually resulted in one individual answering the majority of the questions. It was that individual's demographic information that was recorded. The interviews lasted between 30 and 60 minutes and questions revolved around their knowledge of sea turtles. Specifically: how they thought of and felt about sea turtles, and what role sea turtles had in their life, or their community's life – whether spiritual, dietary or economic. Because the first author and translator were not associated with any government agency, it appeared that participants were mostly honest in discussing more controversial aspects of their relationship to turtles, including threats and personal consumption.

Given that it was not possible to verify interviewees' responses, they were taken at face value. One demo-

graphic group that was under-represented in the study was the under-40-year-olds. We suspected that this was because the majority of this age group were either sea fishing, or working somewhere on the mainland, away from their family.

Frames of reference were drawn from the analysis of the interview data, which were coded by collating common themes. A frame of reference draws on the metaphor of a frame that serves to bound, include and exclude. It is a useful analytical tool to identify “coherent sets of beliefs and values [that] provide a frame of reference within which actions and events are interpreted and made meaningful” (Miller, 1984/85, cited in Swaffield 1998, p 496). Of course, these can only be partial representations that reveal “the linkage between attitudes and wider institutional positions” (Swaffield, 1998) because they are always contingent.

Results

Frames of reference

The four frames of reference presented below are: turtles as victims, turtles as occasional food, turtles as spiritual beings, and turtles as a promise for the future (Fig. 2). Each of these frames, or themes, encompassed

the nature of each individual’s thoughts and interactions with turtles and were prevalent throughout the different villages and demographic groups. See Fig. 2 for a breakdown of expressions incorporated into the frames of reference.

Turtles as Victims

The *Turtles as Victims* frame of reference reflects the sentiments that regarded the turtle as a victimised species. It was stated repeatedly that sea turtles have been impacted by a variety of pressures (Fig. 3). Almost all interviewees agreed that there have been changes in the turtle populations over the past 20 years; most stating that there had either been a decrease in numbers or that the turtles have moved away. Perceived reasons for the decline are broken down by village in Fig. 3. One comment summarised the variety of fishing techniques that were perceived to have led to turtle fatalities and subsequent decline: “There has been a rapid decrease due to trawling nets, crab nets, and fishing by local people and the Vietnamese diving fishermen” (statement from a carpenter and former fisherman who has lived in Prek Svay Village since 1994).

Another point that was raised was the destruction of turtle habitat and the loss of turtle food in the region. It was stated that due to trawling and dynamite fishing in particular, the turtles’ living space has deteriorated,

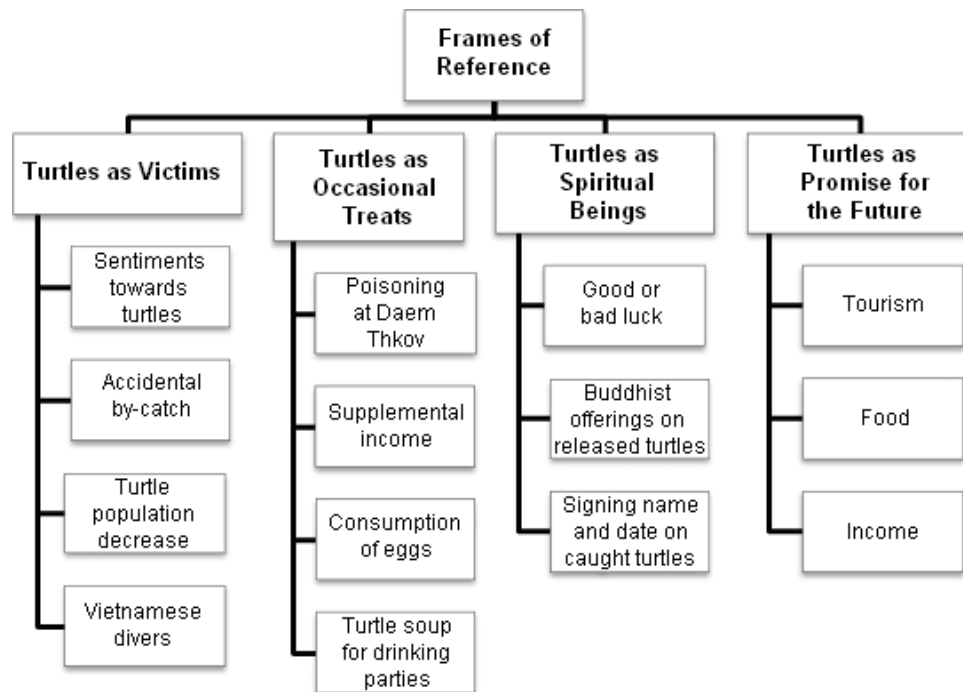


Fig. 2 Representation of several statements encompassed in the frames of reference or themes, in no particular order or hierarchy.

reducing the likelihood of their survival. Villagers from M’pei Bi, Daem Thkov and Koh Toch discussed this most extensively.

One theme that recurred in all the villages was that Vietnamese divers were the main reason for the declining turtle population. They were reported to specifically hunt turtles at night, using dive equipment to find sleeping turtles, as well as using baited hook lines (participants did not identify what the lines were baited with). It was stated that the Vietnamese use the turtles’ shells for traditional medicine and would frequently share the meat with the Cambodian community members. Several interviewees said they had eaten sea turtle meat only with the Vietnamese, claiming that the Vietnamese hunters knew better how to prepare the turtle meat, which was simply eaten and not used for traditional medicine.

This was recalled to happen mostly about 5–10 years ago, and it was perceived that due to developments in community fisheries, as well as local conservation efforts in some villages, the occurrence of Vietnamese hunters has significantly reduced. An example of this was mentioned by a community member who has lived in the village of M’pei Bi since 2008 and stated that concerted efforts to reduce illegal fishing by outsiders, as well as a hard push for no-net fishing practices within the commu-

nity fishery, has led to regrowth of the sea bed and even to some recent sightings of sea turtles.

Turtles as Occasional Food

Almost half of the interviewees had eaten sea turtle meat or eggs at least once (Table 2), and stated that sea turtle meat was an occasional food for drinking parties or other special events. Of the interviewees under the age of 30 years, however, only one had consumed turtle meat. Consumption of sea turtle eggs was mentioned only by interviewees over the age of 50, who referred to eating them before the Pol Pot era.

The habit of eating sea turtle meat reportedly changed after one significant poisoning event that took place in the Daem Thkov Village in December 2001. According to the village chief of Daem Thkov Village, a large hawksbill turtle was gifted to the village and the meat was distributed amongst the villagers, while some was sent to the mainland. The meat was mainly prepared in a soup and shared over a drinking party. This hawksbill allegedly caused sea turtle food poisoning (cheloniotoxicism) among 90% of the village. Five people died: three from the village and two on the mainland. Those that did not die were sick for months and, according to several interviewees, were still not fully recovered as of April 2012, and remained weak and in sub-par health.

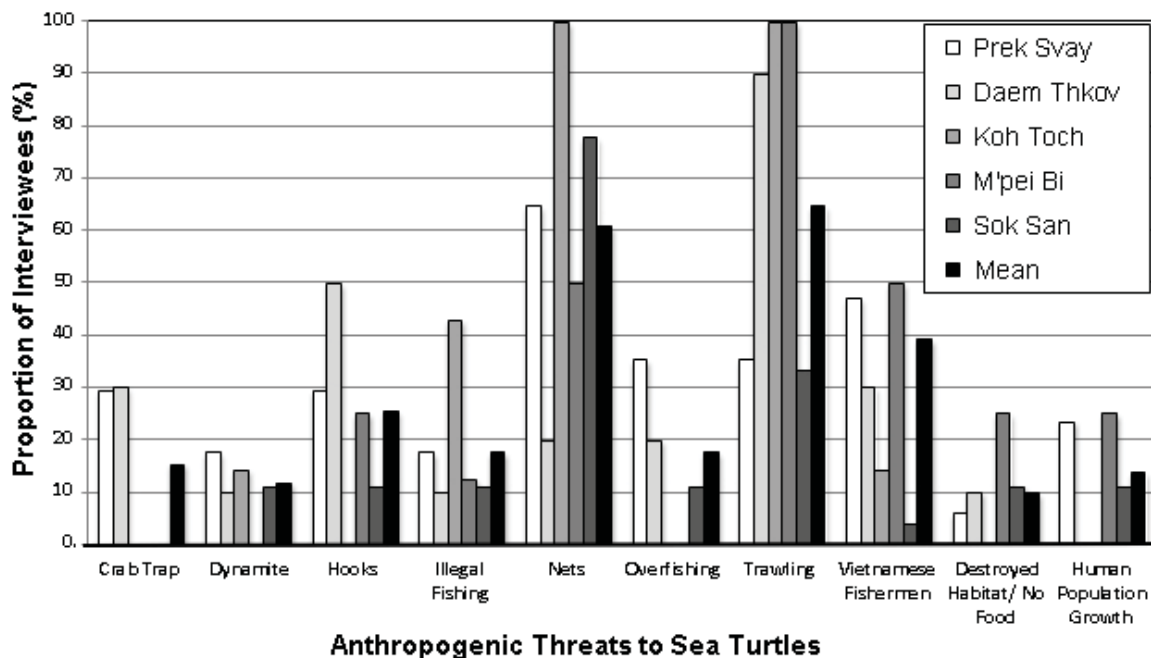


Fig. 3 Proportion of interviewees mentioning each potential threat for sea turtles in each village, and across the whole study site.

The prominence of this story in the interviews was understandably higher in the Daem Thkov Village, where the poisoning was mentioned in all but one interview. This news also travelled around the islands and created a 'scare story'; with 72% of interviewees overall referencing turtle poison (Table 2). This appeared to play a role in community members avoiding eating sea turtle meat at least for a few years, but not entirely, since many interviewees also discussed a technique to test the blood to tell if the turtle was poisonous or not. This might have allowed a few more turtles to be consumed, but many still admitted that they would not trust such a testing technique and were unsure which turtles were poisonous.

Even though sea turtles did not appear to be a common food item for the families living on Koh Rong and Koh Rong Samloem, they were mentioned as something that can be eaten occasionally, especially at times when fishing catches are smaller. *"The people eat it [sea turtle] here, but not often. They catch them by accident and eat them sometimes"* (community fisheries leader who has lived in Koh Toch Village since 1995).

When asked *who* was culturally allowed to consume sea turtle, almost everyone agreed that there were no restrictions. In terms of what species could be eaten though, several interviewees mentioned that only the green turtle should be eaten because they are the ones that they believe do not contain poison.

Turtles as Spiritual Beings

All participants in this study identified themselves as Buddhist. Although several interviewees said that they do not believe that sea turtles are spiritual animals, even some of those individuals mentioned that they would adorn a sea turtle with Buddhist offerings before letting it go. Many interviewees said that if a sea turtle is caught, a fisherman will write their name and the date on the shell to let other fishermen know that the turtle is theirs. Overall, 61% of interviewees said they believed the sea turtle was spiritual, or could bring good or bad luck (Table 2). *"The people [who catch the turtle] mark on the sea turtle to mark it for their own. And when another person catches it, they cannot take them. The mark shows that the turtle belongs to someone"* (a carpenter, former fisherman and soldier, who has lived on the islands since 1994).

Turtles as a Promise for the Future

When discussing the future of the sea turtle in the Koh Rong Archipelago, several recurring ideas exposed themselves, all of which surrounded an optimistic view of the future. A possible increase in turtle populations meant positive things for the communities. According to the

interviewees, turtle population growth could mean three main prospects: tourism, food and income. Although it was clear from the interviews that the turtles themselves were not directly related to the villagers' current livelihoods, people saw the growth of sea turtle populations being positively linked to economic development possibilities for their communities.

One major aspect of the *Turtles as a Promise for the Future* frame of reference was tourism. Many interviewees said that an increase of turtles in the waters of the archipelago would lead directly to an increase in tourism. According to the participants, this would be a positive development for the community, contributing to income generation and development. Some individuals also predicted tourists coming to see the turtles would help to discourage their consumption.

Despite the confidence that tourism would discourage the consumption and exploitation of the turtles, some community members still believed that the turtles would be susceptible to capture and sale. Several individuals said that if there was an increase in turtles in the region, a market in Cambodia would be developed for them and they would be purposefully caught for it. It was stated that this used to happen in Kampong Saom Province. *"Maybe some people will eat them, and some will sell them. Even though there is a law, maybe they will do it illegally, if there is a market to sell them to"* (saleswoman who has lived in Daem Thkov Village since 1990).

Village and demographic findings

Occupationally, 47% of our interviewees were fishermen/women, 15% were salespeople, 12% were village chiefs or fisheries committee leaders, 4% were construction workers, 4% housewives and 4% farmers. The remaining interviewees were said to have been working in a variety of fields such as chef, police officer, thatch maker, soldier, international organisations and tourism. Occupation did not appear to be an influential factor because all the frames of reference were represented in the different fields. Personal beliefs about sea turtles were mixed within the occupational groups as well, with some fishermen and salespeople believing the turtle was spiritual and some not, as well as some having consumed them and some who had never tried.

Some notable findings in Prek Svay Village were that 76% of individuals interviewed mentioned the poisoning event of 2001, and 58% of males and 60% of females interviewed in Prek Svay had eaten sea turtles. In Daem Thkov Village, 90% of the individuals interviewed reported that the turtle was spiritual (Table 2). 100% of interviewees from Koh Toch Village mentioned trawling and nets as

Table 2 Proportion of interviewees from each village, gender and age group that mentioned turtles being spiritual, having eaten turtle and knowing about turtle poison during semi-structured interviews, where *n* is the number of interviewees.

	<i>n</i>	Turtles are spiritual (%)		Have eaten turtle (%)		Mentioned poison (%)	
		Male	Female	Male	Female	Male	Female
Daem Thkov Village							
18–30 years	2	100	100	0	0	100	0
30–50 years	6	66	100	33	66	100	100
>50 years	2	100	–	50	–	100	–
Total	10		90		40		90
Prek Svay Village							
18–30 years	3	100	0	50	0	50	100
30–50 years	7	40	50	60	20	80	50
>50 years	7	60	50	60	100	80	100
Total	17		53		59		76
Koh Toch Village							
18–30 years	0	–	–	–	–	–	–
30–50 years	4	66	0	66	0	66	100
>50 years	3	50	0	50	0	50	0
Total	7		43		43		57
Souk San Village							
18–30 years	1	100	–	0	–	0	–
30–50 years	6	75	50	25	50	75	50
>50 years	2	50	–	100	–	50	–
Total	9		66		44		55
M'pei Bi Village							
18–30 years	0	–	–	–	–	–	–
30–50 years	4	25	–	50	–	75	–
>50 years	4	66	100	66	0	100	0
Total	8		50		50		75
All five villages							
18–30 years	6	50	50	0	0	25	0
30–50 years	27	42	50	32	37	58	62
>50 years	18	82	66	82	66	91	66
Grand Total	51		61		49		72

reasons for declining sea turtle populations. In M'pei Bi Village, 50% of interviewees mentioned Vietnamese fishermen as a main threat to sea turtles, the highest of all the villages (Fig. 3).

While length of stay did not appear to be a prominent factor, all participants who had lived in the villages for less than 10 years explained the decrease in turtle populations as being due to trawling, but their thoughts on spirituality and consumption tended to be mixed.

Discussion

Given that this was a social study focused on eliciting sentiments and interpretations, it should be noted that

the results aggregate individual's statements about sea turtles that have been taken at face value. Furthermore, our questions are likely to have invoked emotions, recent life activities and experiences and personal interest. As such, there is scope for unavoidable bias, which can occur in any study (Holroyd, 2012). In addition, the results need to be interpreted within the specific cultural context of the villages and do not necessarily reflect the actual dietary and economic uses of sea turtles in Cambodia as a whole. A countrywide study of these aspects can be found in Eastoe & Ke (2011). These issues notwithstanding, this study illuminates the frequency of thoughts and impressions, especially those that were important enough to be expressed (Arts & Buizer, 2009). They provide insights

into how people might act and what their priorities are when it comes to sea turtles and their conservation in a developing country.

Socio-cultural explanations and explorations

Undoubtedly, local circumstances and socio-cultural experiences within each village underpin the findings of this study. To explain these aspects, and the perceived threats, examples from several of the villages are set out below.

In the largest village, Prek Svay, where 17 individuals were interviewed, a higher consumption rate of sea turtle meat was expressed. This could be because 76% of interviewees were over the age of 40, implying they may have had greater exposure to the practice of eating turtles. Also, 41% of the interviewees had resided on the island for over 20 years, making them more likely to have encountered turtles when they were more abundant.

Daem Thkov, the village that experienced the sea turtle poisoning event in 2001, had the lowest percentage of interviewees that had consumed sea turtle. This is likely to be related to the fear of food poisoning from consuming sea turtle meat. This event clearly had an impact on the community's relationship to the turtle, but it was also easy to see how an event like this could fade in time. We experienced this when interviewing one woman who had only lived in the village for six years; during her interview she did not mention or appear to know about the poisoning. 90% of interviewees from Daem Thkov Village also stated that they thought sea turtles were spiritual. This could also be related to the traumatic poisoning. The experience of such a powerful event, such as that caused by the hawksbill, could leave a lingering sentiment that the sea turtle itself is mystical. Individuals who have not had that interaction with the turtle might not hold those beliefs, such as the woman who was not aware of the poisoning.

As mentioned above, all interviewees from Koh Toch Village described trawling and nets as two main reasons for a perceived decline in turtle population. We suspected this could be related to how frequently these methods are used in this village for fishing; therefore being something community members are aware of as having an impact on sea life. Koh Toch, while having diversified its income streams through the development of bungalows and guesthouses, was still primarily a fishing village at the time of this study (Ouk *et al.*, 2011). It has a fisheries committee, but not yet any restrictions on fishing techniques, which is likely to mean that these lucrative fishing practices were probably still being utilised. This village also previously hosted Coral Cay Conserva-

tion, which conducted research on the local reefs, and this organisation could also have influenced what local people knew about fishing practices that destroy habitat and cause by-catch.

M'pei Bi Village participants also frequently stated trawling, as well as Vietnamese hunters, as a main reason for the perceived decline in turtle populations. This could be because the fisheries committee is relatively strong in this village and has effectively enforced a no-net policy in the bay, as well as had success in pushing out illegal fishermen (according to a community member who has lived in the village since 2008). This awareness of sustainable fishing practices is likely to be due to the influence of Marine Conservation Cambodia and the dive shop, EcoSea (both foreigner-run operations located in the village), which could have enabled interviewees to be more knowledgeable of risks to sea life. M'pei Bi was also the only village that had recently seen two sea turtles, perhaps allowing individuals to make the connection that regrowth of the seabed, following more sustainable fishing practices, may have provided an attractive site for turtles seeking food and shelter (Lutz & Musick, 2003).

Sok San is the only community without a specified fisheries committee because at the time of this study they were not officially a village. On paper, they are part of Prek Svay Village (according to a community member and village chief who has lived in Sok San since 1998). Interestingly, Sok San was also the only village not to frequently discuss illegal fishing or Vietnamese divers. This could be related to their location, perhaps not being a destination for outsider fishing; but perhaps also since there is no community fishery, there is technically no such thing as "illegal fishing" in their eyes. These circumstances could explain why this was not discussed.

In the Koh Rong Archipelago today, sea turtles are not a staple food item for local people. It is clear, however, that the inhabitants of Koh Rong and Koh Rong Samloem are not strangers to the consumption and exploitation of sea turtles. The apparent lack of economic, dietary, cultural or spiritual need for the turtle in these communities could be encouraging for conservation efforts. Considering these human communities are not indigenous to the islands, with the majority of inhabitants only having arrived from the mainland within the past 20 years, their relationship to the sea turtle is not deeply entrenched in their culture. Although it can be a strategy for conservation to build on existing cultural affiliations, it can also be a significant challenge when the cultural norms include consumption and exploitation of turtles, as seen in countries like Nicaragua and areas of Polynesia (Rudrud, 2010; Garland, 2010). It appears that this is not the case here.

The communities around Koh Rong Archipelago tend to have a convenience-based relationship with sea turtles. According to the findings of this study, there is an overall perception of turtle population decline and individuals appear amenable to conserving sea turtles to ensure that the next human generation can see them as well. This shows that sympathy and hope are entwined through the sometimes consumptive and often reverent relationship between people and turtles. As can be seen from the perceived threats and reasons for decline expressed by participants, sea turtles in the Koh Rong Archipelago are still likely to be subject to similar threats as those experienced in other parts of the world (National Research Council, 1990; Lutz & Musick, 2003; Gilman *et al.*, 2010) and identified in previous studies around Cambodia's coast (Ing, 1999; Eastoe & Ke, 2011). These challenges are not insurmountable, however, and lessons learned through this study on how the communities interpret the turtles could make a useful contribution to educational and conservation programmes.

Conclusions

In summary, the themes that emerged, as revealed across the four frames of reference, were prevalent in all the villages studied. They exposed sympathies for turtles and the recognition that improved conditions for the turtles could also be beneficial to the human population. This study showed that many individuals were well aware of the possible threats to sea turtles and were also concerned about the impact of intensified fishing practices.

We also found that while many individuals revered the turtle and almost everyone desired the turtles' long-term survival, this did not necessarily mean they would not consume a sea turtle themselves. These findings indicate that multiple frames of reference are held simultaneously and in complex relation to one another. While further research is needed to fully understand these relations, they are important insights for conservation practitioners, who are developing programmes that build on the knowledge and beliefs of these unique communities.

In addition to the frames of reference, specific village circumstances, as discussed in this paper, indicate that needs-tailored conservation programmes are necessary to accommodate the strengths and priorities of individual communities. These concepts of 'bottom-up' approaches and participatory conservation are not new, and recent examinations of how they can be successfully implemented have been described by Lejano *et al.* (2007), Marie *et al.* (2009), Sodhi (2011) and Mulrennan (2012). There is a clear opportunity now (December 2012), with

the planned Marine Fisheries Management Area, and the engagement of local community fisheries, for effective turtle conservation in the Koh Rong Archipelago. By regulating fishing practices through the Marine Fisheries Management Area and community fisheries, the sea bed will ideally begin to regrow, which, if aligned with an effective conservation and education programme for sea turtles, could allow for an increase in the turtle population. According to participants of this study, this could be a win-win for conservation and communities.

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New country records for five bat species (Chiroptera) from Cambodia

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មូលនិយសរង្ខេប

សត្វប្រចៀវ៦១ប្រភេទត្រូវបានកត់ត្រាក្នុងឯកសារស្រាវជ្រាវសំរាប់ប្រទេសកម្ពុជា។ តាមរយៈការសិក្សាកាយវិភាគឡើងវិញនៃសំណាកចាស់និងថ្មីដែលបានត្រូវប្រមូល យើងអាចបញ្ជាក់បានថាសត្វប្រចៀវប្រភេទបន្ថែមទៀតត្រូវបានកត់ត្រា៖ *Macroglossus minimus*, *Pipistrellus paterculus*, *P. javanicus*, *Hypsugo cadornae* និង *Miniopterus pusillus*។ បីប្រភេទក្នុងចំណោមប្រភេទទាំងនោះ ត្រូវបានទាយទុកមុនថាមាននៅក្នុងប្រទេសកម្ពុជា និងត្រូវបានជួបប្រទះទាំងអស់ក្នុងការសិក្សាស្រាវជ្រាវដោយប្រើអន្ទាក់មង (Mist nets) និងអន្ទាក់រាំង (Harp traps) នៅតាមតំបន់ការពារនិងតំបន់មិនការពារមួយចំនួនក្នុងប្រទេសកម្ពុជា។ ទោះបីជាមានការសិក្សាស្រាវជ្រាវតែក្នុងតំបន់មួយចំនួនក្នុងប្រទេសកម្ពុជាក៏ដោយ ក៏គ្មានប្រភេទណាមួយនៃប្រភេទដែលត្រូវបានកត់ត្រាថ្មីនេះបិតក្នុងការព្រួយបារម្ភនៃការអភិរក្សជាសកលឡើយ។

Abstract

Sixty-one bat species are currently reported in the peer-reviewed literature for Cambodia. Through a morphological review of historical and recently collected specimens, we confirm the occurrence of five additional species: *Macroglossus minimus*, *Pipistrellus paterculus*, *P. javanicus*, *Hypsugo cadornae* and *Miniopterus pusillus*. Three of these species were previously predicted for Cambodia and all five were encountered during recent surveys using mist nets and harp traps in several protected and non-protected areas around the country. Though presently known only from a small number of sites in Cambodia, none of the newly recorded species are thought to be of global conservation concern.

Keywords

Cambodia, bat taxonomy, new records.

Introduction

Knowledge of the Cambodian bat fauna has grown in recent years. Following the checklist of Kingsada *et al.*

(2011), which cited 50 species in the peer-reviewed literature for Cambodia, three bat species new to science were described from the country (Csorba, 2011; Csorba *et al.*,

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2011). Ith *et al.* (2011) added a further seven species in a review of historical and more recently collected material, while Francis & Eger (2012) subsequently reassigned a specimen originally identified as *Murina peninsularis* by Matveev & Csorba (2007) to the newly described *M. fionae*. As a consequence, the known bat fauna of Cambodia currently stands at 61 species.

A number of additional bat species were included in range maps or reported for Cambodia by Corbet & Hill (1992) and Francis (2008) without explanation. The purpose of this paper is to confirm the presence of three such species and document the occurrence of two additional, previously unreported species through a morphological review of historical and recently collected specimens. All five species were encountered during an ongoing series of nationwide field surveys aimed at determining the composition, biogeography and status of Cambodian bats and subsequently identifying national priorities for conservation action. Notes on the distribution of each species are provided and future research needs are briefly discussed

Methods

Study areas

Bat specimens were collected by B. Hayes and J. Walston in Kirirom National Park and Seima Protected Forest in February 2001 and December 2003, respectively (Fig. 1). These were deposited at the Hungarian Natural History Museum (HNHM, Budapest, Hungary) and Harrison Institute (HZM, Sevenoaks, United Kingdom) and subsequently examined by the authors.

From February 2010 to April 2011, further specimens were collected during field studies by the authors in several parts of the country, as summarised below (Fig. 1). Four-bank harp traps and mist nets of varying sizes were employed in the surveys and selection of sampling locations largely focused on water bodies and flyways in forest areas, such as trails, watercourses and natural linear breaks in the vegetation.

Specimens from these studies were deposited at the Centre for Biodiversity Conservation (CBC) Zoological Collection, Royal University of Phnom Penh.

In February and March 2010, field studies were undertaken in the Veun Sai Proposed Protected Forest by Ith S., G. Csorba and Phauk S. The Veun Sai Proposed Protected Forest covers approximately 55,000 ha in Veun Sai District (Ratanakiri Province) and Siem Pang District (Steung Treng Province) in Northeast Cambodia. The

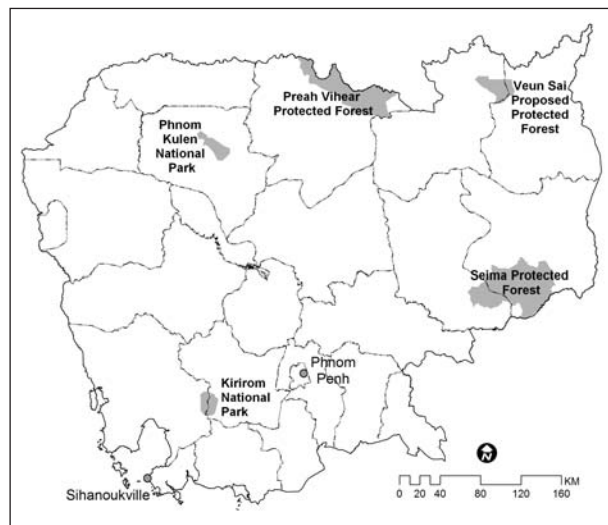


Fig. 1 Location of bat survey areas in Cambodia.

habitats at this site comprise lowland evergreen and semi-evergreen forest at elevations of 100–400 m, with more northerly areas mountainous and southern parts characterised by grasslands (B. Rawson, pers. comm.).

From April to July 2010, Phauk S. and Phen S. undertook bat surveys in the Northeast section of Phnom Kulen National Park, in Siem Reap Province. The national park covers an area of 37,350 ha and consists of lowland areas and hills over sandstone that reach 450 m above sea level (a.s.l.). Habitats in this site include semi-evergreen forest on hillsides, while lowland areas were originally dominated by dry dipterocarp forest, of which only small, degraded areas now remain (Neou *et al.*, 1998). Phauk S. also undertook one night of opportunistic sampling in cultivated areas in Sihanoukville Town on the Cambodian coast in May 2010.

In February and March 2011, bat surveys were undertaken in Preah Vihear Protected Forest by Ith S., G. Csorba, N. Furey, Seng R., Nget C. and M. Csorba. Preah Vihear Protected Forest covers an area of 190,000 ha in the northern plains of Cambodia (Preah Vihear Province) and abuts the Cambodia–Thailand border. This area is dominated by dry dipterocarp forest and grassland, interspersed with patches of semi-evergreen forest (Walston & Bates, 2001) and includes areas used by local communities for rice cultivation (Clements *et al.*, 2010).

Morphological assessment

Age and reproductive status were assessed following Anthony (1988) and Racey (1988). External measurements were taken from dry skins and alcohol preserved

specimens to the nearest 0.1 mm, while craniodental and bacular measurements were taken to the nearest 0.01 mm using digital calipers under a stereo microscope. Measurements herein include only those taken from non-juveniles, as indicated by the presence of fully ossified metacarpal-phalangeal joints.

Definitions for external measurements were as follows: FA – forearm length, from the extremity of the elbow to the extremity of the carpus with the wings folded; HB – head and body length, from the tip of the snout to the anal opening; T – tail length, from the anal opening to the tip of the tail; E – ear length, measured from the lower border of the external auditory meatus to the tip of the pinna, excluding any hair; TIB – tibia length, from the knee joint to the ankle; HF – hindfoot length, from the tip of the longest digit, excluding the claw, to the extremity of the heel, behind the os calcis. Illustrations of these measurements are provided by Bates & Harrison (1997).

Definitions for craniodental measurements were as follows: GTL – greatest antero-posterior length of the skull, taken from the most projecting point at each extremity along the median line of the skull; CBL – condylobasal length, from the exoccipital condyle to the anterior rim of alveolus of the first upper incisor; CCL – condylo-canine length, from the exoccipital condyle to the most anterior part of the canine; ZYW – zygomatic width, the greatest width of the skull across the zygomatic arches; MAW – mastoid width, the greatest distance across the mastoid region; CM³L – maxillary tooththrow length, from the front of upper canine to the back of the crown of the third molar; C¹C¹W – greatest width across the upper canines, taken across the outer borders of upper canines; M³M³W – greatest width across the upper molars, taken across the outer crowns of the last upper molars; ML – mandible length, from the anterior rim of the alveolus of the first lower incisor to the most posterior part of the condyle; CM₃L – mandibular tooththrow length, from the front of the lower canine to the back of the crown of the third lower molar; CPH – least height of the coronoid process, from the tip of the coronoid process to the apex of the indentation on the inferior surface of the ramus adjacent to the angular process.

Species sequence and nomenclature follow Simmons (2005), with some modifications (Appleton *et al.*, 2004; Tian *et al.*, 2004). A full list of specimen material examined is given in Annex 1.

Results

Macroglossus minimus (E. Geoffroy, 1810)

Material examined: Single female from Sihanoukville (Fig. 1, Annex 1).

Although the single specimen had a forearm length intermediate between *M. sobrinus* and *M. minimus* (Table 1), the specimen was referred to *M. minimus* due to its dorsal buffy-brown pelage with paler, grey bases; presence of a distinct internarial groove on the muzzle; smaller and non-overlapping skull measurements (Table 2) compared to published ranges for *M. sobrinus* from Vietnam (Hendrichsen *et al.*, 2001a; Borissenko & Kruskop, 2003) and the Indian subcontinent (Bates & Harrison, 1997).

The single parous female was caught in a mist net at ca. 1800 h in a garden with bananas and durian trees in Sihanoukville. *Macroglossus minimus* is a widespread species ranging from Thailand to the Philippines, Indonesia and Solomon Islands through to northern Australia (Simmons, 2005), apparently occurring mostly in coastal habitats in mainland Southeast Asia (Francis, 2008). Previous reports of the species in Cambodia (Corbet & Hill, 1992; Hayes, 2000; Kock, 2000) were questioned by Hendrichsen *et al.* (2001b) due to lack of voucher specimens. Our record consequently validates the more recent suggestion of Francis (2008) that the species occurs in Cambodia.

Though also widespread in Southeast Asia, similarly little is known about the status of *M. sobrinus* in Cambodia, with only a single record confirmed to date (Matveev, 2005). It should be noted, however, recent DNA barcode analysis (Francis *et al.*, 2010) has shown little differentiation between *M. minimus* and *M. sobrinus*, with the observed genetic variation not closely matching the morphological species limits currently recognised.

Pipistrellus paterculus Thomas, 1915 (Fig. 2)

Material examined: One male from Kirirom National Park, one female from Veun Sai Proposed Protected Forest, and 10 males and five females from Preah Vihear Protected Forest (Fig. 1, Annex 1).

Seventeen specimens were referred to *P. paterculus* on the basis of the following characteristics: dorsal pelage uniformly medium-brown (reddish-brown in some specimens), ventral hair with dark brown roots and sandy-brown tips; external and craniodental measurements (Table 1 and 2) according well with published ranges (Bates & Harrison, 1997; Hendrichsen *et al.*, 2001a); braincase variably bulbous and elevated; presence of slight concavity where rear of rostrum meets anterior part of



Fig. 2 *Pipistrellus paterculus*: CSOCA251, Preah Vihear Protected Forest (© G. Csorba).



Fig. 3 *Pipistrellus javanicus*: CBC01255, Preah Vihear Protected Forest (© G. Csorba).



Fig. 4 *Hypsugo cadornae*: CBC00643, Veun Sai Proposed Protected Forest (© G. Csorba).



Fig. 5 Baculum of *Pipistrellus paterculus*: CBC01239, Preah Vihear Protected Forest.



Fig. 6 Baculum of *Pipistrellus javanicus*: CBC01256, Preah Vihear Protected Forest.

braincase in lateral view; upper canine (C^1) unicuspid, not in contact with incisors and posterior premolar; anterior upper premolar (P^2) approximately equal in crown area to anterior incisor (I^2), sometimes visible in lateral view; lower molars nyctalodont; lower anterior premolar (P_2) subequal in crown area to posterior premolar (P_4); baculum very long (total length: 10.7–11.6 mm, $n = 5$), with a relatively straight narrow shaft and strongly bifid tip with ventrally deflected horns (Fig. 5).

Aside from a singleton caught at 1830 h in a harp trap set along a dry streambed in dry dipterocarp forest, the remainder of specimens captured in Preah Vihear Protected Forest were caught in mist nets set near waterholes in clearings or on dry streambeds in forest areas before 2030 h. The single specimen encountered in Veun Sai Proposed Protected Forest was caught at 1915 h in a mist net set in semi-evergreen forest. Capture data were lacking for the single specimen collected at

Table 1 Selected external measurements of specimens examined in this paper. Values are given as mean, standard deviation (if $n \geq 5$), and range (min–max), number of specimens. Acronyms and definitions for measurements are given in the text.

Taxon	FA	HB	T	E	TIB	HF
<i>Macroglossus minimus</i>	45.4, – (–) 1	62.0, – (–) 1	0, – (–) 1	13.9, – (–) 1	17.7, – (–) 1	9.3, – (–) 1
<i>Pipistrellus paterculus</i>	29.0, 1.2 (26.0–31.2) 17	40.2, 1.5 (37.6–43.0) 17	27.9, 1.8 (25.1–31.1) 17	11.1, 0.6 (10.0–12.0) 17	11.1, 0.5 (10.0–11.8) 17	5.3, 0.4 (4.5–6.2) 17
<i>Pipistrellus javanicus</i>	33.3, – (32.0–35.1) 3	44.5, – (43.9–45.6) 3	33.1, – (30.3–34.8) 3	12.1, – (11.6–12.8) 3	12.4, – (11.8–13.3) 3	6.2, – (6.1–6.3) 3
<i>Hypsugo cadornae</i>	36.1, – (–) 1	45.8, – (–) 1	36.0, – (–) 1	15.4, – (–) 1	16, – (–) 1	7.3, – (–) 1
<i>Miniopterus pusillus</i>	41.0, – (39.8–41.8) 3	47.2, – (46.7–47.8) 3	49.8, – (49.8) 1	10.2, – (9.2–11.4) 3	17.0, – (16.5–17.2) 3	8.1, – (7.9–8.2) 3

Kirirom National Park. *Pipistrellus paterculus* is found in India, Myanmar, Laos, Vietnam and southwest China (Simmons, 2005; Francis, 2008) and the above specimens constitute the first records for Cambodia. Other pipistrelles confirmed for Cambodia are *P. coromandra*, *P. tenuis* (Kingsada *et al.*, 2011) and *P. javanicus* (below).

Pipistrellus javanicus (Gray, 1838) (Fig. 3)

Material examined: One male and two females from Preah Vihear Protected Forest (Fig. 1, Annex 1).

The three specimens were referred to *P. javanicus* on the basis of the following characters: dorsal pelage medium brown with lighter brown tips, ventral hair slightly paler with dark roots; external and cranio-dental measurements (Table 1 and 2) agreeing well with published ranges (Bates & Harrison, 1997; Hendrichsen *et al.*, 2001a); tragus moderately narrow, relatively straight with rounded tip; upper canine (C^1) bicuspid; upper anterior premolar (P^2) slightly displaced inwards, not greatly reduced, with crown area exceeding that of first upper incisor (I^2); upper posterior premolar (P^4) with distinct antero-lingual projection and wide anterior cingulum forming a distinct shelf; lower molars nyctalodont; baculum relatively long (7.5 mm), with narrow shaft and deeply bifid tip (Fig. 6).

The three specimens were caught before 2100 h in a mist net set beside a pool in semi-evergreen forest. *Pipistrellus javanicus* occurs from North Afghanistan eastwards through Southeast Asia to Indonesia and the Philippines (Simmons, 2005). Reports of this species in Cambodia (Corbet & Hill, 1992) were rejected by Kock (2000) due to lack of reliable evidence. The present records conse-

quently confirm its occurrence, as predicted by Francis (2008).

Hypsugo cadornae (Thomas, 1916) (Fig. 4)

Material examined: One female from Veun Sai Proposed Protected Forest (Fig. 1, Annex 1).

The single female specimen was referred to *H. cadornae* on the basis of chestnut brown dorsal pelage with darker roots; reduced calcar lobe; cranial profile essentially straight in lateral view; zygoma strong, with a well-defined dorsal process; basisphenoid pits large and deep; upper incisors (I^2 , I^3) similar in crown area; upper canine (C^1) unicuspid; upper anterior premolar (P^2) very small, less than half the crown area of second upper incisor (I^3); lower molars myotodont; lower anterior premolar (P_2) half the crown area of posterior (P_4) premolar.

The single specimen was caught in a mist net set over a stream in semi-evergreen forest at 2000 h. *Hypsugo cadornae* occurs in northeast India, northern Myanmar and Thailand, Laos and Vietnam (Simmons, 2005). The above specimen constitutes the first record of a member of the *Hypsugo* genus in Cambodia (Kingsada *et al.*, 2011).

Miniopterus pusillus Dobson, 1876

Material examined: Three males: two from Seima Protected Forest and one from Phnom Kulen National Park (Fig. 1, Annex 1).

Species within the *Miniopterus* genus in Southeast Asia are very similar in appearance, and our diagnosis

Table 2 Selected craniodental measurements of specimens examined in this paper. Values are given as mean, standard deviation (if $n \geq 5$), and (min–max), number of specimens. Acronyms and definitions for measurements are given in the text.

Taxon	GTL	CBL	CCL	ZYW	MAW	CM ³ L	C ¹ C ¹ W	M ³ M ³ W	ML	CM ₃ L	CPH
<i>Macroglossus minimus</i>	26.96, – (–) 1	24.71, – (–) 1	23.05, – (–) 1	14.20, – (–) 1	9.59, – (–) 1	9.16, – (–) 1	5.07, – (–) 1	6.42, – (–) 1	20.16, – (–) 1	10.00, – (–) 1	6.02, – (–) 1
<i>Pipistrellus paterculus</i>	12.17, 0.21 (11.84– 12.65) 17	11.18, 0.23 (10.86– 11.70) 17	11.02, 0.26 (10.61– 11.55) 17	8.11, 0.30 (7.46– 8.61) 15	7.10, 0.22 (6.79– 7.62) 17	4.25, 0.14 (4.05– 4.56) 17	4.02, 0.13 (3.80– 4.21) 16	5.31, 0.21 (4.98– 5.66) 16	8.64, 0.23 (8.24– 9.05) 17	4.53, 0.13 (4.32– 4.76) 17	2.67, 0.13 (2.45– 2.91) 17
<i>Pipistrellus javanicus</i>	14.09, – (13.71– 14.77) 3	13.17, – (12.71– 13.86) 3	12.78, – (12.43– 13.38) 3	9.28, – (8.81– 9.75) 2	7.88, – (7.58– 8.20) 3	5.20, – (5.07– 5.44) 3	4.70, – (4.51– 5.03) 3	6.24, – (6.03– 6.60) 3	10.38, – (10.12– 10.88) 3	5.54, – (5.34– 5.78) 3	3.02, – (2.79– 3.15) 3
<i>Hypsugo cadornae</i>	13.93, – (–) 1	12.80, – (–) 1	12.79, – (–) 1	8.95, – (–) 1	7.82, – (–) 1	4.77, – (–) 1	4.75, – (–) 1	6.20, – (–) 1	9.86, – (–) 1	5.21, – (–) 1	2.81, – (–) 1
<i>Miniopterus pusillus</i>	14.30, – (14.15– 14.42) 3	13.46, – (13.26– 13.77) 3	12.63, – (12.30– 12.96) 3	7.86, – (7.72– 8.01) 3	8.14, – (8.05– 8.19) 3	5.23, – (5.08– 5.33) 3	4.12, – (4.07– 4.16) 3	5.70, – (5.58– 5.84) 3	10.08, – (10.05– 10.14) 3	5.61, – (5.46– 5.69) 3	2.37, – (2.26– 2.50) 3

was based on size. The three specimens from Cambodia were referred to *M. pusillus* on the following basis: forearm and all craniodental measurements (Tables 1 and 2) according with published ranges for *M. pusillus*, while being distinctly less than *M. fuliginosus* and *M. magnater* (Hendrichsen *et al.*, 2001a; Borissenko & Kruskop, 2003; Matveev, 2005; Francis, 2008); skull measurements (CBL, CM³L & M³M³W) also smaller than recorded for *M. medius*, for which the most northerly locality known at present is in southern Thailand (Francis, 2008).

The single specimen from Phnom Kulen National Park was caught in a harp trap at 2005 h in closed-canopy forest. No capture data were available for specimens collected from Seima Protected Forest. *Miniopterus pusillus* is presently thought to occur from South India (Nicobar Islands) through Myanmar to Vietnam and Hong Kong (Simmons, 2005; Francis, 2008). Borissenko & Kruskop (2003) referred three specimens from Cambodia to *M. pusillus* without details, but as the subsequent checklist of Matveev (2005) excluded the species, these were presumably the unnamed form discussed by Matveev (2005) and Matveev & Csorba (2007). Our specimens confirm the occurrence of *M. pusillus* in Cambodia, as predicted by Francis (2008).

Only one other species of *Miniopterus* is currently known to occur in Cambodia: *M. fuliginosus* (formerly included in *M. schreibersii*) (Kingsada *et al.*, 2011).

Discussion

Our confirmation of five additional bat taxa for Cambodia increases the total number of bat species currently confirmed for the country to 66. While presently known only from a small number of sites nationally, none of the newly recorded species are thought to be globally threatened, being considered Least Concern by IUCN (2012).

Because national survey coverage remains limited, the discovery of additional species appears likely, particularly in understudied forests in the country's border regions. This may be especially true for forested areas of karst, which in Southeast Asia support exceptional and vulnerable bat assemblages that can comprise substantial portions of a national fauna (Furey *et al.*, 2010, 2011). While the total extent of Cambodian karst is not accurately known (estimated at 20,000 km²: Kiernan, 2010), large outcrops occur in the western and southern provinces of Battambang and Kampot. More than 100 caves have been registered in these areas by speleologists (Denneborg *et al.*, 2002; Laumanns, 2009), yet only a tiny minority have been surveyed for bats to date, and most of these only once, more than a decade ago.

Much research consequently remains to be done. While only three bat species in Cambodia appear on the IUCN Red List of Threatened Species (IUCN, 2012) in categories other than Least Concern (*Otomops wroughtoni*: Data Deficient; *Murina harrisoni*: Data Deficient; and *Pteropus lylei*: Vulnerable), rates of habitat destruction have

increased in this country in recent years and hunting of bats for bushmeat is commonplace in many areas. The fact that karst ecosystems in Cambodia, as throughout the region, are experiencing increasing habitat loss and pressure from tourism and extractive industries, coupled with the reality that few, if any, are legally protected for their biodiversity (Clements *et al.*, 2006), raises the need for basic species inventories and status assessments to provide cogent arguments for their conservation.

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Appendix 1

Specimens denoted 'CSOCA' are presently held at the Centre for Biodiversity Conservation and intended for deposition at the Hungarian Museum of Natural History and the Cambodian Forestry Administration collection.

Macroglossus minimus: CBC01045, parous female, in spirit, skull removed, collected by Phauk S. in May 2010, Sihanoukville, 10°36.632N, 103°31.868E, 22 m a.s.l.

Pipistrellus paterculus: HZM 8.36144, mature male, in spirit, skull removed, collected by J. Walston in February 2001, Kirirom National Park, 11°30'N, 104°13'E; CBC00608, nuliparous female, in spirit, skull removed, collected by G. Csorba and S. Ith in February 2010, Veun Sai Proposed Protected Forest, 14°00.828N, 106°45.383E; CBC.020511.7, CBC.020511.8, CSOCA225, CSOCA226, CSOCA227, CSOCA229, five mature males and one nuliparous female, in spirit, skulls removed, collected by G. Csorba and N. Furey in February 2011, Preah Vihear Protected Forest, 14°03.556N, 105°17.017E, 110 m a.s.l.; CSOCA251, nuliparous female, in spirit, skull removed, collected by G. Csorba, N. Furey and Ith S. in February 2011, Preah Vihear Protected Forest, 14°00.686N, 105°39.900E, 130 m a.s.l.; CBC01239, CBC01245, CBC01246, CBC01247, CBC01249, CBC01254, three mature males and three nuliparous females, in spirit, skulls

removed, collected by G. Csorba and N. Furey in April 2011, Preah Vihear Protected Forest, 14°03.556N, 105°17.017E, 110 m a.s.l.; CBC01266, CBC01284, two mature males, in spirit, skulls removed, collected by G. Csorba and N. Furey in April 2011, Preah Vihear Protected Forest, 14°00.686N, 105°39.900E, 130 m a.s.l.

Pipistrellus javanicus: CBC01255, CBC01256, parous female and mature male, in spirit, skulls removed, collected by G. Csorba, N. Furey and Ith S. in February 2011, Preah Vihear Protected Forest, 14°03.556N, 105°17.017E, 110 m a.s.l.; CSOCA237, female, in spirit, skull removed, collected by G. Csorba, N. Furey and Ith S. in February 2011, Preah Vihear Protected Forest, 13°53.235N, 105°22.309E, 105 m a.s.l.

Hypsugo cadornae: CBC00643, parous female, in spirit, skull removed, collected by Phauk S., G. Csorba and Ith S. in March 2010, Veun Sai Proposed Protected Forest, 14°00.828N, 106°45.383E.

Miniopterus pusillus: HNHM 2005.82.14, HNHM 2005.82.15, adult males, in spirit, skulls removed, collected by B. Hayes and J. Walston in December 2003, Seima Protected Forest, 12°10'49N, 106°58'55E, 290 m a.s.l.; CBC00951, adult male, in spirit, skull removed, collected by Phauk S. and Phen S. in July 2010, Phnom Kulen National Park, 13°39.810N, 104°01.862E, 68 m a.s.l.

New records of Odonata from Cambodia, based mostly on photographs

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មូលនិយសង្ខេប

កន្លែងប្រាំបួនប្រភេទក្នុងលំដាប់ Odonata – *Euphaea ochracea*, *Lestes nodalis*, *Gynacantha phaeomeria*, *Gynacantha demeter*, *Microgomphus chelifera*, *Amphithemis curvistyla*, *Orthetrum triangulare*, *Rhyothemis plutonia* និង *Tetrathemis platyptera* ត្រូវបានកត់ត្រាប្រភេទទៀតទៅលើប្រភេទកន្លែង (Dragonfly និង Damselfly) ដែលកើនរហូតដល់១៣៥ ប្រភេទសម្រាប់ប្រទេសកម្ពុជា។ កំណត់ត្រាប្រភេទថ្មីទាំងនោះ គឺផ្អែកទៅលើការថតរូបនៅក្នុងធម្មជាតិ លើកលែងតែប្រភេទ *E. ochracea* ដែលត្រូវបានវិភាគតាមសំណាកកន្លែង។ អាស្រ័យលើការថតរូបនេះផងដែរ កំណត់ត្រាបាយថ្មី (new distributional records) សម្រាប់កន្លែង៩៣ប្រភេទត្រូវបានផ្តល់សំរាប់តំបន់ផ្សេងៗនៃភ្នំក្រវាញ រួមមានតំបន់ជុំវិញភូមិតាតៃក្នុងខេត្តកោះកុង តំបន់ជុំវិញភូមិអូរសោមនិងប្រមោយ និងតំបន់មួយចំនួនទៀតនៅក្នុងដែនជម្រកសត្វព្រៃភ្នំសំកុស ខេត្តពោធិសាត់។ ក្នុងការសិក្សានេះផងដែរ ប្រភេទសត្វល្អិតបរាសិតក្រៅ (Ectoparasitic midges) ក្នុងពួក *Forcipomyia* (*Pterobosca*) ត្រូវបានប្រទះឃើញនិងកត់ត្រានៅលើកន្លែងមួយប្រភេទក្នុងអំបូរ Coenagrionidae និង១១ប្រភេទផ្សេងទៀតក្នុងអំបូរ Libellulidae។

Abstract

Nine species of Odonata – *Euphaea ochracea*, *Lestes nodalis*, *Gynacantha phaeomeria*, *Gynacantha demeter*, *Microgomphus chelifera*, *Amphithemis curvistyla*, *Orthetrum triangulare*, *Rhyothemis plutonia* and *Tetrathemis platyptera* – are reported for the first time for Cambodia, raising the number of named Odonata species recorded in this country to 135. All of the new records are based on photographs taken in nature apart from *E. ochracea*, which is supported by a voucher specimen. Also based on photographs, new distributional records for 93 Odonata species are provided for a number of localities in the Cardamom Mountains: the environs of Tatai Village in Koh Kong Province, and the environs of Ou Saom and Pramoui villages, including parts of Phnom Samkos Wildlife Sanctuary, in Pursat Province. Ectoparasitic midges in the genus *Forcipomyia* (*Pterobosca*) were recorded on one species in the family Coenagrionidae and 11 species in the family Libellulidae.

Keywords

dragonflies, damselflies, ectoparasites, insects, *Forcipomyia*, new records, *Pterobosca*.

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Introduction

Until recently, very little was known about the dragonflies and damselflies (Odonata) of Cambodia. A number of species records and distributional data have been published since 2010, reporting a total of 125 named species of Odonata in Cambodia (Kosterin, 2010, 2011, 2012a,b; Roland & Roland, 2010; Day, 2011; Kosterin & Holden, 2011; Roland *et al.*, 2011; Kosterin *et al.*, 2012). However, this seems to be only about a half the number of species expected for this country, based on the better known faunas of the neighbouring Thailand and Vietnam, so any additional data are important.

Odonata are considered to be good indicators of the state of ecosystems (Clausnitzer & Jödicke, 2004). When tropical forests are transformed or replaced by secondary ecosystems, many species that have relatively small ranges and inhabit undisturbed areas tend to be replaced by commoner species with large ranges. The Cardamom Mountains in Southwest Cambodia and the southern Annamite Mountains in the East, are among the largest areas of primary, broadleaved, tropical evergreen forests in the Indo-Burma Ecoregion (Reels *et al.*, 2012). Knowledge of their Odonata fauna are of both theoretical interest with respect to understanding biodiversity patterns, and of practical interest with respect to nature conservation. So far, the territory of Cambodia appears as almost a blank spot on the maps of species richness, endemic species, globally threatened species and even Data Deficient species within the Indo-Burma Ecoregion (Reels *et al.*, 2012). That is, no doubt, the result of gaps in our knowledge, because the aforementioned mountains are expected to be hotspots of biodiversity.

Photographs of wild dragonflies and damselflies are a considerable source of such data. They have the advantage of ease of accumulation using digital photography and are non-invasive, but have the strong disadvantage of being insufficient for confident identification of some species – at least for specimens of certain sexes or ages – including some of the most interesting and complicated ones (Day *et al.*, 2012). Also, photographs cannot be used to describe species new to science unless they are accompanied with voucher specimens, although they may contribute to a description of their colours in life.

Two of the authors have taken photographs of Odonata in the Cardamom Mountains (Fig. 1). Some of these records were made by Jeremy Holden during survey work under the auspices of Fauna & Flora International and have been published (Kosterin & Holden, 2011), but many new photographs were taken in 2012, mostly in the Phnom Samkos Wildlife Sanctuary and around the communes of Ou Saom (O'Som) and Pramoui

(Pramaoy) in Veal Veang District, Pursat Province. Gerard Chartier has been photographing Odonata in the southern foothills of the Cardamom Mountains in the vicinity of Tatai Village since 2010. Most of the species he has photographed will be soon available at <http://www.rainbowlodgecambodia.com/wildlife.php?group=2>. In addition, François Mey recorded two additional species of Odonata while travelling in Cambodia for a botanical survey in 2007.

Most of the species were provisionally identified by their respective photographers; the rest by Oleg Kosterin who checked and revised all identifications. This bulk of data refers to 93 species, of which nine had not previously been recorded in Cambodia and are herein reported and illustrated. In view of the paucity of distributional data for dragonflies in Cambodia, we also provide locality lists of all species recorded using photographs (where there is no doubt as to their identification). However, one should keep in mind the aforementioned limitations of photographic records for Odonata and it would be desirable to further support all of these records with voucher specimens.

Methods

Gerard Chartier photographed Odonata using a Canon EOS 500D camera with 18–55 mm and 55–250 mm lenses. Since August 2010, he has made regular excursions in Tatai Commune, Koh Kong District, Koh Kong Province. The survey area is a rough triangle formed by the following three points: Rainbow Lodge on the Kep River (“Left Tatai River”), 1.6 km North of Phum Doung Bridge in Tatai Village (11.580°N, 103.127°E), the widening of the Sala Munthun River (“Right Tatai River”) locally called the “lake area”, 3.9 km North-Northwest of Phum Doung Bridge (11.599–11.601°N, 103.120–121°E) and the Tatai Waterfall at the same river, 4 km Northwest of Phum Doung Bridge (11.586°N, 103.097°E). The same area was examined by Day (2011). This area is a low ridge between the aforementioned rivers, covered partly with seemingly primary broad-leaved evergreen forest and partly a dense bamboo jungle (most probably secondary), with some swamped clearings and small brooks. The Sala Munthun River banks are mostly rocky, those of the Kep River at Rainbow Lodge are rather swampy and outlined by a stripe of the *Nyssa* palm and other mangrove species.

Kosterin (2010, 2011, 2012a,b) examined nearby localities, involving taking some voucher specimens, on three short visits in 2010 and 2011. His data were taken into account when assessing Gerard Chartier's photos.

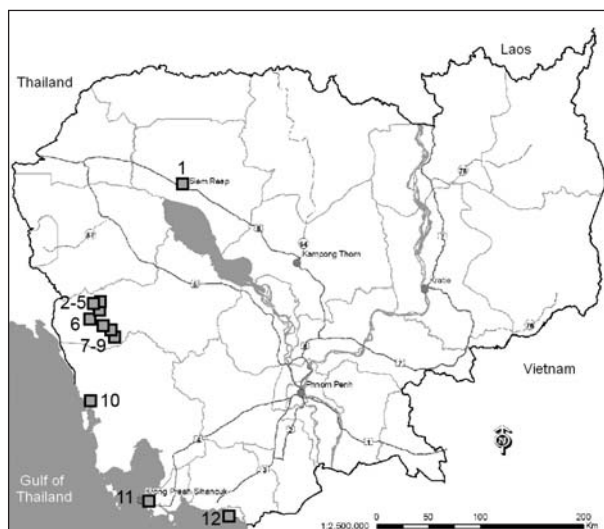


Fig. 1 A schematic map of the localities examined in Cambodia: 1: Angkor Wat; 2–5 (from North to South): Phnom Dalai, Tumpor Village, Pramoui Village, Anglong Reap Village; 6: Phnom Khmaoch, 7–9 (from North to South): Tuok Vei Village, Atay River, Ou Saom Commune; 10: Tatai Village; 11: Kbal Chhay Cascades; 12: Kep.

Jeremy Holden took photographs using a Nikon D3 camera with a 105 mm macro lens at a number of localities on his several trips to the Cardamom Mountains within Pursat Province, mostly around Ou Saom Commune in the Central Cardamoms Protected Forest and in the Phnom Samkos Wildlife Sanctuary in April, May, August and September 2012. Locality details are given below in the Results section.

François Mey took photographs using a simple compact Canon camera and collected one voucher specimen of *Euphaea ochracea*. His observations were made opportunistically during a botanical survey of Kampong Saom, Kep and Siem Reap provinces in July 2007.

Females of *Heliocypha biforata* and *H. perforata*, which are very similar in appearance, were distinguished according to the characters suggested by Kosterin (2011).

Results

New country records

Euphaeidae

Euphaea ochracea Selys, 1859

About six individuals, both males and females, were observed by F. Mey in July 2007 resting on emerging

rocks or flying over the rapids of Kbal Chhay Cascades, 12 km Northeast of Sihanoukville (10.675°N, 103.608°E). A voucher male specimen (Fig. 2) was collected on 16 July 2007.

When F. Mey returned to the same spot in August 2011, he did not find this species again.

Lestidae

Lestes nodalis Selys, 1891

A photo of a male, keeping low to the ground, was taken by J. Holden in low forest away from any water at Phnom Dalai, 12.4345°N, 103.0863°E, Phnom Samkos Wildlife Sanctuary, at 900 m a.s.l. on 8 April 2012 (Fig. 3).

This is sufficient for identification, based on such specific wing characters as spots at nodes, bicoloured pterostigmata and bluntly rounded wings, as well as the bluish abdomen with dark stripes (Lieftink, 1960; Asahina, 1985a).

Aeschnidae

Gynacantha demeter Ris, 1911

Nine males were photographed by G. Chartier in the forest on the hill behind Rainbow Lodge, *circa* 2 km North of Phum Doung Bridge in Tatai Village, Tatai Commune, Koh Kong Province (11.580°N, 103.127°E) on 22 September 2012 (Fig. 4a,b), 22 October 2012, 5 November 2012 (2 males), 12 November 2012 (2 males, Fig. 4c), 13 November 2012 (Fig. 4d–e), 16 November 2012 and 19 November 2012. The photographs clearly show the basal swelling of the cerci (a diagnostic character for a group of related species), their externally directed apices and the relative length, which fit this particular species (Asahina, 1986). Note also the very light-coloured epiproct with dark base and tip. Asahina (1986) noted: "... top of antefrons only darkened transversally without making any T-mark". Our photos show the top of the frons to be dark brown which obscures the darker marking (represented at least by a darker transversal bar), so no obvious T-mark is seen. On 24 October 2012, in the same locality, a copula was photographed that was most probably this species: the colouration of the male was identical and the epiproct seen on the photo has the same short length and light colour (Fig. 4f).

Gynacantha phaemeria Lieftinck, 1960

Four identifiable males were photographed by G. Chartier at Rainbow Lodge, Kep River, 1.6 km North of Phum Doung Bridge in Tatai Village on 5 May 2011 (Fig. 5c), 16 April 2012 (Fig. 5a) and 3 and 8 May 2012 (Fig. 5b). The photographs show the diagnostic appendages,

including black, broadly inflated and externally pointed cerci and a very long and conspicuously light-ochraceous coloured epiproct (Lieftinck, 1960).

Gomphidae

Microgomphus chelifer Selys, 1858

Two teneral males were photographed by G. Chartier on 4 August 2011 and 22 September 2012 (Fig. 6) at the widening of the Sala Munthun River (“lake area”) 3.9 km North-Northwest of Phum Doung Bridge in Tatai Village (11.599–11.601°N, 103.120–103.121°E). The thoracic pattern and appendage structure are clearly visible



Fig. 2 Male *Euphaea ochracea* collected in July 2007 at Kbal Chhay Cascades, 12 km NE of Sihanoukville. (© F.S. Mey).



Fig. 3 Male *Lestes nodalis*, understorey forest, Phnom Dalai, Phnom Samkos Wildlife Sanctuary, 900 m a.s.l., April 2012 (© J. Holden).

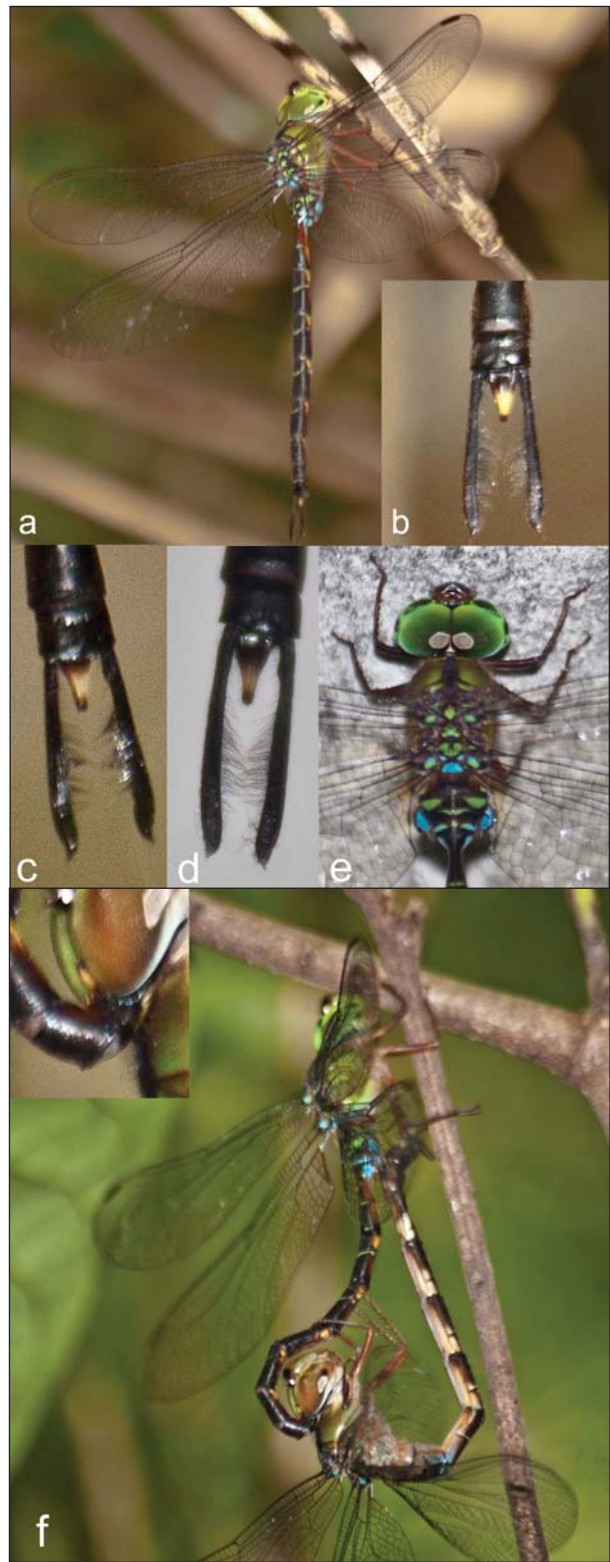


Fig. 4 *Gynacantha demeter* on the Kep River, 1.6 km North of Phum Doung Bridge, Tatai Village: **a**: general habitus (male); **b–d**: appendages; **e**: head and thorax; **f**: copula (© G. Chartier).



Fig. 5 *Gynacantha phaeomeria* males at Rainbow Lodge, Kep River, 1.6 km North of Phum DOUNG Bridge in Tatai Village: **a**: appendages, April 2012; **b**: appendages, May 2012; **c**: general habitus, May 2011. (© G. Chartier).



Fig. 8 Male *Orthetrum triangulare* at a forest pool at 1,100 m a.s.l. on Phnom Khmaoch, Phnom Samkos Wildlife Sanctuary, December 2010 (© J. Holden).

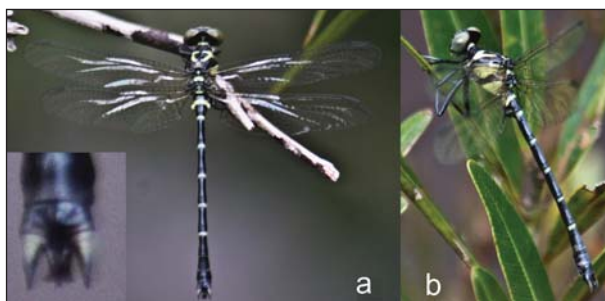


Fig. 6 Teneral male *Microgomphus chelifera* at the widening of the Sala Mūnthūn River ("lake area"), 3.9 km North-Northwest of Phum DOUNG Bridge, Tatai Village: **a**: dorsal view; **b**: lateral view (© G. Chartier).



Fig. 9 Male *Rhyothemis plutonia* at a small pond near the tourist office within Kep, December 2010 (© F.S. Mey).



Fig. 7 Female *Amphithemis curvistyla* at Rainbow Lodge, the Kep River, 1.6 km North of Phum DOUNG Bridge in Tatai Village, September 2012. (© G. Chartier).



Fig. 10 Male *Tetrathemis platyptera* at a small permanent forest pond on the Phnom Dalai Mountain, Phnom Samkos Wildlife Sanctuary, 1,000 m a.s.l., April 2012 (© J. Holden).

and are diagnostic for this species (Asahina, 1990), but subspecific attribution is hardly possible.

Libellulidae

Amphithemis curvostyla Selys, 1891

A female with characteristic venation and body pattern (Fig. 7) was photographed by G. Chartier at Rainbow Lodge, Kep River, 1.6 km North of Phum Doung Bridge in Tatai Village, on 28 September 2012.

Orthetrum triangulare (Selys, 1878)

A male was photographed (Fig. 8) by J. Holden on 13 December 2010 at a forest pool at 1,100 m a.s.l. on Phnom Khmaoch, Phnom Samkos Wildlife Sanctuary (circa 12.150°N, 103.0832°E). The broad abdomen with a distinct, non-pruinose, black tip occupying segments 7-10, black basal spots on the hind wing and a dark thorax are unmistakable for this species. It was observed by J. Holden to be common at forested pools, all slightly above 1,000 m a.s.l., on three mountains in the wildlife sanctuary: Phnom Dalai, Phnom Khmaoch and Phnom Tumpor.

Rhyothemis plutonia Selys, 1883

A male was photographed (Fig. 9) by F. Mey on 17 July 2007 in a small artificial pond near the tourism office in Kep, Kep Province (10.486°N, 104.292°E). Three or four specimens were observed in total at this pond. When F. Mey and O. Kosterin returned to that site on August 2012, the pond was nearly dry and no *R. plutonia* were seen.

A seemingly well established population of *R. plutonia* (circa 20 specimens seen) was also observed by F. Mey in July 2007 in one of the outlying archeological sites of the Angkor temple complex, Siem Reap Province. The XIIth century site, Neak Pean, includes an artificial square pond, in the middle of which lies a small island made of various sculptures.

This pond was first visited by F. Mey in 1999 when it was full of water, but in July 2007 he found it was dry and the water replaced by grass. In spite of this, many specimens of *R. plutonia* and other Odonata, including *Camacinia gigantea* (Brauer, 1867), were observed hovering around that site.

Tetrathemis platyptera Selys, 1878

A male was photographed (Fig. 10) by J. Holden at a small permanent artificial pond in primary forest on Phnom Dalai, Phnom Samkos Wildlife Sanctuary, at 1,000 m a.s.l. on 7 April 2012. The amber of the basal half of the hind wing is very faint, as in specimens from Thailand (Asahina, 1988). It was not recorded at a further visit to this small pool in September 2012.

Site records

In this section, reliably identified photographic, and in some easiest cases, visual records of species or genera are listed. Uncertain identifications are marked with "?". ♂♂ signifies that more than one male was recorded, and ♀♀ signifies that more than one female was recorded.

Tatai Commune, Koh Kong District and Province, (records by Gerard Chartier)

In the list below, dates of photographs, and the sexes of individuals photographed between August 2010 and November 2012 are provided in parentheses for rare species. Only the total number and seasonality of records and/or short notes on abundance are given for locally common species.

Calopterygidae: *Neurobasis chinensis* (♂♂, ♀♀: 11 & 14 May 2010; 14 August 2011; 22 October 2011; 24 June 2012; 24 August 2012; 21 & 22 September 2012; 5, 14, 19 & 30 November 2012); *Vestalis gracilis* (many records throughout the year, but localised to some forest patches).

Chlorocyphidae: *Heliocypha biforata* (♂: 24 August 2012); *Heliocypha perforata limbata* (♂♂, ♀♀: 11 records in March–November, 2011–2012); *Libellago hyalina* (or what we presently understand to be *L. hyalina*) (♂♂: 9 January 2012; 23 April 2012).

Euphaeidae: *Dysphaea gloriosa* (♂♂: 25 April 2011 and 4 May 2012; teneral ♀: 11 May 2011); *Euphaea masoni* (♂♂: 25 April 2011; 26 September 2011; 24 & 26 June 2012; 24 August 2012; 22 September 2012).

Lestidae: *Lestes praemorsus decipiens* (♂♂: 19 & 23 June 2012; 9 July 2012; tandem: 18 August 2012); *Orolestes octomaculata* (♂: 25 March 2011).

Megapodagrionidae: *Rhinagrion viridatum* (♂: 31 March 2011).

Coenagrionidae: *Aciagrion borneense* (♀: 3 May 2012; ♂: 8 November 2012); *A. hisopa* (♂♂, ♀♀: 34 records June–October, 2011–2012); *Agriocnemis minima* (♂♂, ♀♀: 16 records June–November 2012), *A. nana* (♂♂, ♀♀: 35 records throughout the year), *A. rubescens rubeola* (♂♂: 15 records, mostly in November 2010–2012, but also 25 October 2011; 10 January 2012; 19–21 June 2012; 9 July 2012), *Ceriagrion calamineum* (♂♂: 25 June 2011; 8 August 2011; 15, 16 & 22 June 2012; 15 October 2012); *C. cerinorbellum* (♂♂, ♀♀: 15 records throughout the year), *Ischnura senegalensis* (♂: 18 February 2012; ♂♂, ♀♀, tandem: 15 October 2012); *Pseudagrion australasiae* (♂♂: 4 February 2012; 4 March 2012); *P. microcephalum* (♂♂: 6 January 2012; 27 January 2012; 7 October 2012; 6 November 2012); *P. rubriceps* (♂: 25 March 2011), *P. williamsoni* (♂: 7 October 2012).

Platycnemididae: *Coeliccia kazukoae* (♂♂, ♀♀: 12 records 20 April 2011; 5 November 2012; tandem 28 November 2012); *Copera vittata* (♂♂, ♀♀: 25 records throughout the year, plus many of immature individuals inferred to be this species).

Disparoneuridae: *Prodasineura autumnalis* (♂♂, ♀♀: 15 records throughout the year); *P. verticalis* sensu Asahina, 1983 nec Selys, 1860 (♂♂, ♀♀: 2 June 2011; 22 October 2011).

Aeshidae: *Anax guttatus* (♂♂: 21, 25 & 31 May 2012, 19 August 2012); *Gynacantha basiguttata* (♂: 11 February 2012); *G. demeter* (♂♂: 22 September 2012 [Fig. 4a,b]; 22 October 2012; 5 November 2012; 12 November 2012 [Fig. 4c]; 13 November 2012 [Fig. 4d–e]; 16 & 19 November 2012; tandem of this species? 24 October 2012 [Fig. 4f]); *G. phaeomeria* (♂♂: 5 May 2011 [Fig. 5c], 16 April 2012 [Fig. 5a], 3 May 2012, 8 May 2012 [Fig. 5b]); *Gynacantha subinterrupta* (♂: 4 February 2012); *Heliaeschna crassa* (♂: 24 October 2012); *H. uninervulata* (♀: 14 August 2011).

Gomphidae: *Burmagomphus asahinai* Kosterin, Makbun & Dawwrueng, 2012; *Microgomphus chelifera* (teneral ♂♂: 4 August 2011, 22 September 2012 [Fig. 6]); *Nepogomphus walli* (teneral ♂, 26 June 2012).

Macromiidae sensu lato: *Macromia* sp. (Fig. 11) (♂♂: 11 October 2011; 19 September 2012).

Libellulidae: *Amphithemis curvistyla* (♀: 28 September 2012, Fig. 8); *Brachydiplax c. chalybea* (♂♂, ♀♀: 20 records June–November 2012); *Cratilla lineata calverti* (♂♂, ♀♀: 12 records July–August 2011; April–September 2012); *Crocothemis servilia* (♂: 24 December 2010; ♀♀: 17 November 2010; 3 May 2012); *Diplacodes nebulosa* ♂: 24 November 2010; ♀: 28 June 2012); *Diplacodes trivialis* (♂♂, ♀♀: 36 records throughout the year); *Hydrobasileus croceus* (♂♂: 13, 17 & 21 September 2012); *Indothemis carnatica* (♀: 18 September 2012); *Indothemis limbata* (♂♂: 26 September 2011, 5 & 6 October 2012; ♀: 5 October 2012); *Lathrecista asiatica* (♂♂, ♀♀: 8 records April 2011, March–May 2012); *Neurothemis fluctuans* (♂♂, ♀♀: very common year-round); *Neurothemis fulvia* (♂♂, ♀♀: 21 records April–November 2010–2012); *Neurothemis intermedia atalanta* (♂♂: 20 November 2010; 3 July 2011; 24 August 2011; 23 January 2012; 19 February 2012; 19 & 20 May 2012; ♀: 19 November 2012); *Neurothemis t. tullia* (♂♂, ♀♀: 18 records throughout the year); *Orchithemis pulcherrima* (♂♂: 31 March 2011; 12 April 2012); *Orthetrum chrysis* (♂♂, ♀♀: common throughout the year); *Orthetrum glaucum* (♂♂, ♀♀: 16 records throughout the year); *Orthetrum prunosum neglectum* (♂♂: 9 July 2012; 30 November 2012); *Orthetrum sabina* (common year-round); *Pantala flavescens* (♂♂, ♀♀: 10 records throughout the year); *Potamarcha*

congener (♂♂: 20 January 2012; 27 November 2012; ♀♀: 1, 3 & 15 September 2011; 27 January 2012; 7, 14 & 15 September 2012); *Pseudothemis jorina* (♀: 14 January 2012; ♂♂: 30 November 2012); *Rhodothemis rufa* (♂♂: 10 records 15 April 2012, 22 April 2012 and 28 September 2012 – 18 October 2012; ♀♀: 25 August 2011; 14 September 2012); *Rhyothemis obsolescens* (♂♂, ♀: 8 records 23 April 2012 – 5 October 2012); *Rhyothemis phyllis* (many records, June–November 2012); *Rhyothemis triangularis* (♂: 3 October 2012; ♀: 8 September 2012); *Rhyothemis variegata* (♂♂: 15 July 2011; 20 November 2012; gynochromic ♀♀: 19 September 2010; 10 April 2012, 14 August 2012; 2 October 2012); *Tholymis tillarga* (♂♂, ♀♀: 15 records throughout the year); *Tramea transmarina euryale* (♂♂: 23 June 2012; 7 September 2012; 19 November 2012; ♀: 27 September 2012); *Trithemis aurora* (♂♂, ♀♀: 17 records throughout the year); *Trithemis festiva* (♂: 10 November 2012; ♀: 14 January 2011); *Trithemis pallidinervis* (♀: 5 November 2012); *Urothemis signata* (♂: 23 June 2012); *Zygonyx iris malayana* (♂♂: 14 May 2011; 14 October 2011; 5 March 2012; 3 May 2012; 24 August 2012; 29 October 2012); *Zygomma petiolatum* (♂♂: 18 April 2012; 21 June 2012; 9 September 2012, 2 October 2012).

Central Cardamoms Protected Forest and Phnom Samkos Wildlife Sanctuary, Pursat Province (records by Jeremy Holden)

In this section, the number of individuals is from visual observations and confirmed by photographs of one or two individuals. For rare species, their habitats are also mentioned.

Phnom Dalai, Phnom Samkos Wildlife Sanctuary (12.4345°N, 103.0863°E): *Lestes nodalis* (♂: 8 April 2012, 900 m a.s.l., understory forest, Fig. 3); *Orolestes octomaculatus* (♂: 8 April 2012, 300 m a.s.l., puddle along open forest track); *Aciagrion pallidum* (1♂: 11 September 2011); *Copera vittata* (1♂, 2 ♀♀: 25 September 2011); *Orthetrum triangulare* (♂♂: September 2012); *Tetrathemis platyptera* (♂: 7 April 2012, 1,000 m a.s.l., in small temporary forest pond [Fig. 10]).

Tumpor Village environs, a medium-sized fast-flowing river with an adjacent forest and arable land, (12.3811°N, 103.1001°E), 300 m a.s.l.: *Neurobasis chinensis* (1♂, 1♀: 27 September 2012); *Heliocypha bifurcata* (1♂, 1♀: 22 September 2012); *Libellago lineata* (5♂♂, 1♀: 10 May 2012); *Euphaea masoni* (♀: 10 May 2012; ♀: 22 September 2012); *Prodasineura autumnalis* (a tandem, 22 September 2012, at Tumpor River); *Cratilla lineata* (several ♂♂, 1♀, 21 September 2012, along forest puddles).

Pramoui Village environs, Phnom Samkos Wildlife Sanctuary (12.3715°N, 103.1010°E): *Agriocnemis pygmaea*

(several individuals, 26 September 2012); *Brachythemis contaminata* (1♂, 1♀: September 2010); *Neurothemis fluctuans* (numerous); *N. intermedia atalanta* (several individuals: August 2012); *N. tullia* (1♂, 1♀: May 2010); *Orthetrum sabina* (♂: September 2010)

Anglong Reap Village (near Pramoui Village) environs, Phnom Samkos Wildlife Sanctuary, an open stream in secondary evergreen forest at 300 m a.s.l.: *Neurobasis chinensis* (several individuals: September 2010); *Helioocypha biforata* (several ♂♂: September 2010); *Agriocnemis pygmaea* (2♂♂, 1♀: September 2010), *Prodasineura autumnalis* (♂: December 2010, along Thom River); *Acisoma panorpoides* (♂: December 2010); *Neurothemis fluctuans* (numerous, September 2010).

Tuok Vei Village environs; two small artificial ponds at the Pramoui – Ou Saom road, Phnom Samkos Wildlife Sanctuary, surrounded by secondary regrowth (12.1716°N, 103.1155°E). 18–20 August 2012: *Lestes elatus* (♂: 18 August 2012); *Orolestes octomaculatus* (1♂, 1♀); *Ceriagrion* sp. (?indochinense) (2♂♂); *Copera vittata* (1♀ away from water); *Ictinogomphus decoratus* (1♂); *Brachydiplax farinosa*: (4♂♂); *Neurothemis fluctuans* (several individuals); *N. intermedia atalanta* (several individuals); *Trithemis aurora* (1♂); *Euphaea masoni* (6♂♂: October 2011).

Phnom Khmaoch, Phnom Samkos Wildlife Sanctuary (circa 12.150°N, 103.0832°E): *Aciagrion pallidum* (1♂: 18.12.2010); *Coelliccia yamasakii* (1♂, 1♀: 20.12.2010; photographed in primary evergreen forest between 800–1,100 m a.s.l.; usually seen in the vicinity of shallow forest streams and along forest paths); *Orthetrum triangulare* (♂: 12 December 2010, 1,000 m a.s.l. [Fig. 8]).

The inundation zone of the Atay River hydroelectric dam, Phnom Samkos Wildlife Sanctuary, composed of open grassy “veals” crossed by small streams and flooded in the wet season. These will eventually all be lost under the Atay River reservoir. A swampy grassland on roadside inundation area (12.1032°N, 103.1747°E), 19 August 2012: *Lestes praemorsus decipiens* (♀); *Agriocnemis lacteola* (few ♂♂); *Ceriagrion* sp. (?calamineum) (5♂♂); *Neurothemis intermedia atalanta* (2♂♂); *N. tullia* (1♂). The same locality, 8 January 2011: *Ischnura senegalensis* (♂).

Nearby, a similar, small slow-moving stream with some deep pools, in a deforested area at the end of the Stung Atay inundation zone, 9–10 May 2012: *Helioocypha biforata* (1♀: 10 May 2012); *Aciagrion borneense* (1♂: 9 May 2012); *Prodasineura verticalis* sensu Asahina, 1983 nec Selys, 1860 (2♂♂, 1♀: 9 May 2012, 1 tandem laying eggs in bank-side rootlets); *Nannophya pygmaea* (3♂♂: above stream pool); *Rhyothemis obsolescens* (1♂).



Fig. 11 Male *Macromia* sp. at Rainbow Lodge, April 2012 (© G. Chartier).

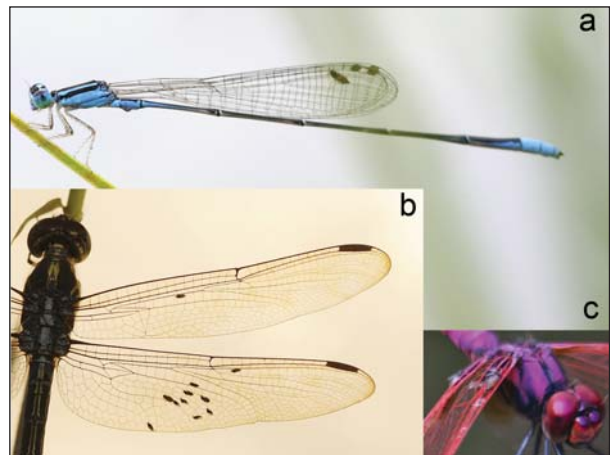


Fig. 12 *Forcipomyia* (*Pterobosca*) sp. midges on Odonata wings: **a**: on male *Aciagrion hisopa*, Atay River Dam, August 2012; **b**: on male *Cratilla lineata*, Ou Saom Commune, April 2012 (© J. Holden); **c**: on male *Trithemis aurora*, Kep River, 1.6 km North of Phum Doung Bridge, June 2012 (© G. Chartier).

A swift-flowing stream at the end of the above mentioned inundation zone, with adjacent swampy grassland, shallow pools and reeds (12.1374°N, 103.1858°), 20 August 2012: *Lestes praemorsus decipiens* (1♀: in flooded grass); *Aciagrion hisopa* (3♂♂, 1♀: in swampy pool); *Agriocnemis lacteola* (3♂♂, 1♀: in short reeds in shallow swamp beside stream); *A. nana* (2♂♂, 1♀: among the former species); *Ceriagrion ?calamineum* (2♂♂, 1♀: in swampy pool); *Diplocades nebulosa* (♂); *Indothemis carnatica* (♂: on reeds above stream); *Nannophya pygmaea* (~20 ♂♂, 1♀: on short reeds along stream or close to stagnant pools beside stream); *Neurothemis fluctans* (2♂♂); *N. intermedia atalanta* (♂); *Onychothemis testacea* (♂ perched on reeds above swift flowing stream); *Orthetrum chrysis* (♂); *O. luzonicum*

(♂); *Rhyothemis triangulare* (2♂♂); *Trithemis aurora* (♂); *T. festiva* (♂).

Ou Saom Commune forest (Tasok River), Central Cardamoms Protected Forest, circa 500 m a.s.l., 25–26 May 2012: *Vestalis gracilis* (♂: 3 more individuals, 25 April 2012, evergreen forest); *Copera vittata* (♂: 25 April 2012, a deep puddle in evergreen forest); *Cratilla lineata calverti* (♂: 26 April 2012, a drier forest [Fig. 12b]; teneral ♀: 19 August 2012, forest tracks).

Parasitic midges on Odonata wings

The subgenus *Pterobosca* of the genus *Forcipomyia*, Cera-topogonidae, Diptera, mostly comprises specialised parasites of Odonata (Orr & Granston, 1997). Among the numerous photos referred to in this paper, these midges were seen on the wings of one species of Coenagrionidae and eleven species of Libellulidae. The Coenagrionidae were represented by a male *Aciagrion hisopa*, photographed at the Atay River Dam inundation zone on 20 August 2012 (1 individual, Fig. 12a). In the Libellulidae, these parasites were seen twice on *Cratilla lineata calverti*, on individuals photographed at Tatai and Ou Saom communes (Fig. 12b), on *Trithemis aurora* (Fig. 12c), and once each on *Hydrobasileus croceus*, *Lathrecista asiatica*, *Neurothemis fluctuans*, *Orthetrum chrysis*, *O. glaucum*, *O. sabina*, *Potamarcha congerer* and *Zygonyx iris malayana*, all in the Tatai area.

Discussion

Eight of the nine species hereby reported for the first time for Cambodia were found in the Cardamom Mountains. Six of them, namely *Euphaea ochracea*, *Lestes nodalis*, *Gynacantha demeter*, *G. phaomeria*, *Orthetrum triangulare* and *Tetrathemis platyptera*, were expected to occur in this area because they have previously been recorded in the same mountain chain in the neighbouring Thailand (i.e. in Chanthaburi Province: Hämäläinen & Pinratana, 1999). *Amphithemis curvistyla* is a rare species that has been recorded in Thailand only in four western and central provinces (Hämäläinen & Pinratana, 1999; Donnelly, 2000). *Microgomphus chelifera* was previously known in Thailand only from the southern areas along the Burmese border: on the Malayan Peninsula isthmus and in Ratchaburi Province (Hämäläinen & Pinratana, 1999; Ferro et al., 2009; Day et al., 2012). A voucher specimen from the Cardamom Mountains would be useful for examination of finer morphology to confirm the species identity, although the photo shows the known diagnostic characters. Note that another, perhaps undescribed species of *Microgomphus*, with both its thoracic pattern and cercus

structure differing from *M. chelifera*, was earlier collected on a river at Thma Bang Village, circa 40 km Northeast of Tatai Village (Kosterin, 2010).

Rhyothemis plutonia is also known from Chanthaburi Province in Thailand (Hämäläinen & Pinratana, 1999) but despite being a conspicuous dragonfly, it still has not been found in the Cambodian Cardamom Mountains. Here we report it for the more easterly Kep and Siem Reap provinces of Cambodia, hence corroborating a distant sighting of what was presumably this species in Kep Province by Kosterin (2010).

With nine males and a supposed copula photographed, *Gynacantha demeter* appeared a common species in the Tatai area, at least during autumn 2012. This is in contrast to its scarcity in neighbouring Thailand, from which only two specimens have been so far recorded in Chanthaburi Province (Hämäläinen & Pinratana, 1999). Three more species of this genus have also been registered in the Tatai area (but, somewhat surprisingly, still missing the expected *G. bayadera*). Generally, the still-forested low foothills of the Cardamom Mountains seem to be a paradise for *Gynacantha* species. They have been depleted in Thailand because “the habitats of *Gynacantha* larvae are generally lowland wetlands which are easily destroyed to make paddies, or are much polluted by human activity” (Asahina, 1986, p. 86).

Heliaeschna uninervulata, now found at Rainbow Lodge, Kep River, was previously reported for Cambodia by Lieftinck (1953), who mentioned a pair from “Cambodge” in the Museum National d’Histoire Naturelle in Paris, which were labelled “*uninervulata*” by the species’ author, René Martin. However, these specimens did not belong to the type series and Martin did not mention the species in his Indochinese review (Martin, 1904). This (very imprecise) record was overlooked in Cambodian listings by Tsuda (2000) and Kosterin (2010). Now at least one precise Cambodian locality is on record.

Taking into account the earlier missed *H. uninervulata*, the nine species new for Cambodia, the previous count in Kosterin (2012a), a recently described species (Kosterin et al., 2012), and with some reconsideration of reliability of old records, the national list of Odonata has been increased to 135 named species (Appendix 1). Based on the better known faunas of the neighbouring Thailand and Vietnam, 135 species may be only about a half of the actual dragonfly and damselfly species in Cambodia. Note the absence of as many as five families known from both Thailand (Hämäläinen & Pinratana, 1999) and Vietnam (Tsuda, 2000): Amphipterygidae, Synlestidae, Platystictidae, Cordulegasteridae and Chlo-

rogomphidae. Of these, at least Platystictidae and Chlogomphidae must be present in Cambodia as well.

Our findings have also extended the known distribution ranges of several species in Cambodia. Important new distributional records included the first finding in the Cardamom Mountains of *Indothemis carnatica*, a species first reported from the Seima Protected Forest in Mondulokiri Province (Roland *et al.*, 2011); *Orthetrum pruinatum neglectum*, previously known from Bokor Plateau in the Damrei Mountains (Kosterin, 2011; 2012b); *Orthetrum luzonicum* and *O. testaceum*, previously known from Kep (Kosterin, 2012a) and *Lestes elatus*, known from both Bokor and Kep (Kosterin, 2011). *Indothemis carnatica* and *O. p. neglectum* seem to be rare in the Tatai area in the Cardamom Mountains foothills, having been recorded only once each during two years of continuous observations.

The unidentified *Macromia* sp., twice photographed at the Kep River (Fig. 11), is neither *M. septima* nor *M. cupricincta*, recorded from other localities in the Cardamom Mountains foothills within Koh Kong Province by Kosterin (2012a). Quite likely it could be an undescribed species. Voucher specimens are needed for reliable identification in this genus.

In contrast to most explorers who have investigated Odonata during trips, G. Chartier is a permanent resident of the foothills of the Cardamom Mountains and has been investigating Odonata all year round. As a result, his list of 72 identified species is quite rich and the records more or less reflect the relative abundance and seasonality of species, although a further 10–30 rare species are still expected in this area. Some of the species recorded by G. Chartier were previously reported for the exactly the same area by Day (2011), who also took pictures, and by Kosterin (2010, 2011, 2012a) who mostly examined the Sala Munthun River around the Tatai Waterfall and took voucher specimens. In addition to the species revealed by G. Chartier, Day (2011) reported *Copera marginipes* and *Brachygonia oculata* while Kosterin (2010, 2011, 2012a) reported *Aciagrion pallidum*, *Agriocnemis pygmaea*, *Archibasis viola* and *Pseudagrion pruinatum*, which were not recorded by G. Chartier. Some more species were found by Kosterin (2010, 2011, 2012a) at Phum Doung Bridge, at the junction of the Kep and Sala Munthun rivers: *Mortonagrion falcatum*, *Ictinogomphus decoratus melanops*, *Idionyx* sp. and *Macromidia rapida*.

Our hundreds of dragonfly and damselfly photos made in nature have provided a good opportunity to register unidentified *Forcipomyia* sp. (or spp.) midges on their wings (see Fig. 12 for examples). They were seen once on the wings of one Coenagrionidae species, nine

Libellulidae species and twice on *Trithemis aurora* and *Cratilla lineata*. The latter species seems to be especially prone to infestation by these parasites in Cambodia, for the midges were also seen also on a male photographed by Kosterin (2012a: Fig. 26) at the “Lake area” of the Sala Munthun River. Also, Kosterin (2012a: Fig. 20) registered a midge on the wings of *Archibasis viola* in Koh Kong Province. In the Oriental region, information on infected Odonata species has been published from Brunei, where two species of Chlorocyphidae and Coenagrionidae were found to have been infected by midges attached to the thorax (Orr & Granston, 1997), while in Europe *Forcipomyia paludis* has been found on the wings of representatives of nine families of dragonflies and damselflies (Martens *et al.*, 2007).

At present, the gentle, coastal foothills of the Cardamom Mountains in the Koh Kong Province have been rather well assessed as to the Odonata fauna (Kosterin, 2010, 2011, 2012a; Day, 2011; this paper), although up to 30 additional species may be still found here, mostly from the families Gomphidae and Corduliidae *sensu lato*. However, only occasional data exist for the central areas of this mountain range, in Pursat Province (Kosterin & Holden, 2011; this paper). This elevated area, with more diverse habitats, should support a far richer fauna of Odonata.

Our next goal in assessing the dragonfly and damselfly fauna of Cambodia will be a special, thorough survey of the Central Cardamoms Protected Forest and Phnom Samkos Wildlife Sanctuary. Our second target for an Odonata survey is the extreme East of the country, in the provinces of Ratanakiri and Mondulokiri, which occupy the western slopes of the Annamite Mountains and which are expected to have a somewhat different, “more Vietnamese” fauna. We should expedite our surveys before potentially significant areas for biodiversity are lost. Logging of primary forests, inundation of valleys by hydropower dam reservoirs and mining are going on very actively, in spite of more than 20% of the Cambodian territory being protected areas of various types.

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Appendix 1

Updated Checklist of Species Reported for Cambodia

In the following list, only the reliably identified, named species are numbered. Subspecies are not included. A reference to the first report for Cambodia is provided for each species. (Tsuda, 2000, attempted to summarise data known at the time of his publication, but his listing of *Copera ciliata*, *Pantala flavescens* and *Trithemis festiva* for Cambodia were based either on earlier published records, which we failed to find, or on unpublished data; these common species being repeatedly reported later).

- | | | |
|--|--|--|
| <p style="text-align: center;">Calopterygidae</p> <p>1. <i>Vestalis gracilis</i> (Rambur, 1842)
Martin (1904).</p> <p>2. <i>Neurobasis chinensis</i> (Linnaeus, 1758)
Kosterin (2010).</p> <p style="text-align: center;">Chlorocyphidae</p> <p>3. <i>Aristocypha fenestrella</i> (Rambur, 1842)
Kosterin (2011).</p> <p>4. <i>Aristocypha fulgipennis</i> (Guerin, 1871)
Martin (1904).</p> <p>5. <i>Heliocypha biforata</i> (Selys, 1859)
Kosterin & Vikhrev (2006).</p> <p>6. <i>Heliocypha perforata</i> (Percheron, 1835)
Martin (1904).</p> <p>7. <i>Libellago hyalina</i> (Selys, 1859)
Martin (1904).</p> <p>8. <i>Libellago lineata</i> (Selys, 1859)
Roland <i>et al.</i> (2011).</p> <p style="text-align: center;">Euphaeidae</p> <p>9. <i>Euphaea guerini</i> Rambur, 1842
Asahina (1985b).</p> <p>10. <i>Euphaea masoni</i> Selys, 1879
Kosterin (2010).</p> <p>11. <i>Euphaea ochracea</i> Selys, 1859
This paper.</p> <p>12. <i>Dysphaea gloriosa</i> Fraser, 1938
Kosterin (2010).</p> | <p style="text-align: center;">Lestidae</p> <p>13. <i>Lestes concinnus</i> Hagen in Selys, 1862
Kosterin & Vikhrev (2006).</p> <p>14. <i>Lestes elatus</i> Hagen in Selys, 1862
Kosterin (2011).</p> <p>15. <i>Lestes nodalis</i> Selys, 1891
This paper.</p> <p>16. <i>Lestes platystylus</i> Rambur, 1842
Kosterin (2011).</p> <p>17. <i>Lestes praemorsus</i> (Selys, 1862)
Roland <i>et al.</i> (2011).</p> <p>18. <i>Orolestes octomaculata</i> Martin, 1902
Martin (1904).</p> <p style="text-align: center;">Megapodagrionidae</p> <p>19. <i>Rhinagrion viridatum</i> Fraser, 1938
Kosterin (2011).</p> <p style="text-align: center;">Coenagrionidae</p> <p>20. <i>Aciagrion borneense</i> Ris, 1911
Kosterin & Vikhrev (2006).</p> <p>21. <i>Aciagrion pallidum</i> Selys, 1891
Asahina (1967a).</p> <p>22. <i>Aciagrion tillyardi</i> Laidlaw, 1919
Kosterin (2011).</p> <p>23. <i>Aciagrion hisopa</i> (Selys, 1876)
Kosterin (2012a).</p> <p>--- <i>Aciagrion</i> sp.
Roland <i>et al.</i> (2011).</p> <p>24. <i>Agriocnemis femina</i> (Brauer, 1868)
Kosterin (2011).</p> | <p>25. <i>Agriocnemis lacteola</i> Selys, 1877
Kosterin & Holden (2011).</p> <p>26. <i>Agriocnemis minima</i> Selys, 1877
Kosterin & Vikhrev (2006);
Benstead (2006).</p> <p>27. <i>Agriocnemis nana</i> (Laidlaw, 1914)
Kosterin & Vikhrev (2006).</p> <p>28. <i>Agriocnemis pygmaea</i> (Rambur, 1842)#
Asahina (1967a).</p> <p>29. <i>Archibasis oscillans</i> (Selys, 1877)
Martin (1904).</p> <p>30. <i>Archibasis viola</i> Lieftinck, 1948
Kosterin (2011).</p> <p>31. <i>Argiocnemis rubescens</i> Selys, 1877
Roland <i>et al.</i> (2011).</p> <p>32. <i>Ceriagrion auranticum</i> Fraser, 1922
Benstead (2006).</p> <p>33. <i>Ceriagrion calamineum</i> Lieftinck, 1951
Kosterin (2011).</p> <p>34. <i>Ceriagrion cerinorubellum</i> (Brauer, 1865)
Asahina (1967a).</p> <p>-- ? <i>Ceriagrion indochinense</i> Asahina, 1967
Roland <i>et al.</i> (2011); Kosterin (2011):
insufficiently convincing photographic
records.</p> <p>35. <i>Ceriagrion malaisei</i> Schmidt, 1964
Asahina (1967b).</p> <p>36. <i>Ceriagrion olivaceum</i> Laidlaw, 1914
Asahina (1967a).</p> |
|--|--|--|

37. *Ceriagrion praetermissum* Lieftinck, 1929 --- *Prodasineura verticalis* sensu Asahina nec --- *Hemicordulia* sp.
Kosterin & Vikhrev (2006). Selys, 1860 Kosterin (2011).
38. *Ischnura aurora* (Brauer, 1865) Asahina (1967a). 74. *Idionyx thailandica* Hämäläinen, 1985
Roland et al. (2011). Kosterin (2012a).
39. *Ischnura senegalensis* (Rambur, 1842) 56. *Anax guttatus* (Burmeister, 1839) 75. *Macromia cupricincta* Fraser, 1924
Asahina (1967a). Martin (1904). Kosterin (2012a).
40. *Mortinagrion aborensense* (Laidlaw, 1914) 57. *Anax immaculifrons* Rambur, 1842 76. *Macromia septima* Martin, 1904
Kosterin (2011). Kosterin (2012a).
41. *Mortonagrion falcatum* Lieftinck, 1934 58. *Gynacantha basiguttata* Selys, 1882 --- *Macromia* sp.;
Kosterin (2011). Martin (1904). This paper.
42. *Onychargia atrocyana* (Selys, 1865) 59. *Gynacantha demeter* Ris, 1911 77. *Macromidia rapida* Martin, 1907
Kosterin (2010). This paper. Kosterin (2012a).
43. *Paracercion calamorum* (Ris, 1916) 60. *Gynacantha subinterrupta* Rambur, 1842 **Libellulidae**
Benstead (2006). Asahina (1967a).
44. *Pseudagrion australasiae* Selys, 1876 61. *Gynacantha phaeomeria* Lieftinck, 1960 78. *Acisoma panorpoides* Rambur, 1842
Asahina (1967a). This paper. Benstead (2006).
45. *Pseudagrion microcephalum* (Rambur, 1842) 62. *Heliaeschna crassa* Krüger, 1899 79. *Aethriamanta aethra* Ris, 1912
Kosterin (2011). Day (2011). Roland & Roland (2010).
46. *Pseudagrion pruinosum* (Burmeister, 1839) 63. *Heliaeschna uninervulata* Martin, 1909 80. *Aethriamanta brevipennis* (Brauer, 1842)
Roland & Roland (2010).
47. *Pseudagrion rubriceps* Selys, 1876 **Gomphidae** 81. *Aethriamanta gracilis* (Brauer, 1878)
Benstead (2006). 64. *Burmagomphus divaricatus* Lieftinck, 1964 82. *Agrionoptera insignis* (Rambur, 1842)
Kosterin (2012a).
48. *Pseudagrion williamsoni* Fraser, 1922 65. *Burmagomphus asahinai* Kosterin, 83. *Amphithemis curvostyla* Selys, 1891
Asahina (1967a). Makbun et Dawwrueng, 2012 Kosterin (2012a).
- Platynemididae** 66. *Gomphidictinus perakensis* (Laidlaw, 1902) 84. *Brachydiplax chalybea* Brauer, 1868
Asahina (1967a).
49. *Coeliccia kazukoae* Asahina, 1984 67. *Ictinogomphus decoratus* (Selys, 1854) 85. *Brachydiplax farinosa* Krüger, 1902
Asahina, 1967 (unnamed); Asahina, 1984 (named). Martin (1904). Kosterin (2012a).
50. *Coeliccia ocotgesima* (Selys, 1863) 68. *Ictinogomphus rapax* (Rambur, 1842) 86. *Brachydiplax sobrina* (Rambur, 1842)
Martin (1904).
51. *Coeliccia yamasakii* Asahina, 1984 69. *Merogomphus parvus* Krüger, 1899 87. *Brachygonia oculata* (Brauer, 1878)
Kosterin & Holden (2011). Kosterin (2012a). Martin (1904).
- *Coeliccia* sp. 1. 70. *Microgomphus chelifer* Selys, 1859 88. *Brachythemis contaminata* (Fabricius, 1793)
Roland et al. (2011). This paper. Asahina (1967a).
- *Coeliccia* sp. 2. 71. *Nepogomphus walli* (Fraser, 1924) 89. *Camacinia gigantea* (Brauer, 1878)
Roland et al. (2011). Kosterin (2010). Martin (1904).
52. *Copera ciliata* (Selys, 1863) 72. *Paragomphus capricornis* (Förster, 1914) 90. *Cratilla lineata* (Brauer, 1878)
? Tsuda (2000). Kosterin (2011). Martin (1904).
53. *Copera marginipes* (Rambur, 1842) 73. *Epophthalmia frontalis* Selys, 1871 91. *Cratilla metallica* (Brauer, 1878)
Kosterin (2010). Roland et al. (2011). Martin (1904).
54. *Copera vittata* (Selys, 1863) **Corduliidae sensu lato** 92. *Crocothemis servilia* (Drury 1770)
Kosterin (2010). Asahina (1967a).
- Disparoneuridae** 93. *Diplacodes nebulosa* (Fabricius, 1793) 94. *Diplacodes trivialis* (Rambur, 1842)
Asahina (1967a).
55. *Prodasineura autumnalis* (Fraser, 1922) Kosterin (2010).

95. *Hydrobasileus croceus* (Brauer, 1867) Benstead (2006).
96. *Indothemis carnatica* (Fabricius, 1798) Roland *et al.* (2011).
97. *Indothemis limbata* (Selys, 1891) Roland *et al.* (2011).
98. *Lathrecista asiatica* (Fabricius, 1798) Kosterin (2010).
99. *Lyriothemis cleis* Brauer, 1868 Martin (1904).
100. *Lyriothemis elegantissima* Selys, 1883 Kosterin (2012a).
101. *Macrodiplax cora* (Brauer, 1867) Kosterin (2011).
102. *Nannophya pygmaea* Rambur, 1842 Kosterin (2011).
103. *Neurothemis fluctuans* (Fabricius, 1793) Asahina (1967a).
104. *Neurothemis fulvia* (Drury, 1773) Asahina (1967a).
105. *Neurothemis intermedia* (Rambur, 1842) Martin (1904).
106. *Neurothemis tullia* (Drury, 1773) Martin (1904).
107. *Onychothemis testacea* Laidlaw, 1902 Kosterin (2012a).
108. *Orchithemis pulcherrima* Brauer, 1878 Day (2011).
109. *Orthetrum chrysis* (Selys, 1891) Kosterin (2010).
110. *Orthetrum glaucum* (Brauer, 1865) Roland *et al.* (2011).
111. *Orthetrum luzonicum* (Brauer, 1868) Kosterin (2012a).
112. *Orthetrum pruinatum* (Burmeister, 1839) Martin (1904).
113. *Orthetrum sabina* (Drury, 1770) Asahina (1967a).
114. *Orthetrum testaceum* (Burmeister, 1839) Kosterin (2012a).
115. *Orthetrum triangulare* (Selys, 1878) This paper.
116. *Pantala flavescens* (Fabricius, 1798) Donnelly (2000).
117. *Potamarcha congener* (Rambur, 1842) Asahina (1967a).
118. *Pseudothemis jorina* Förster, 1904 Benstead (2006).
119. *Rhodothemis rufa* (Rambur, 1842) Martin (1904).
120. *Rhyothemis obsolescens* Kirby, 1889 Kosterin (2010).
121. *Rhyothemis phyllis* (Sulzer, 1776) Martin (1904).
122. *Rhyothemis plutonia* Selys, 1883 This paper.
123. *Rhyothemis triangularis* Kirby, 1889 Roland & Roland (2010).
124. *Rhyothemis variegata* (Linnaeus, 1763) Martin (1904).
125. *Tetrathemis platyptera* Selys, 1878; This paper.
126. *Tholymis tillarga* (Fabricius, 1798) Asahina (1967a).
127. *Tremea transmarina* Brauer, 1867 Kosterin (2010).
128. *Tremea virginia* (Rambur, 1842) Martin (1904).
129. *Trithemis aurora* (Burmeister, 1839) Asahina (1967a).
130. *Trithemis festiva* (Rambur, 1842) ? Tsuda (2000).
131. *Trithemis pallidinervis* (Kirby, 1889) Martin (1904).
132. *Urothemis signata* (Rambur, 1842) Martin (1904).
133. *Zygonyx iris* Selys, 1869 Kosterin (2010).
134. *Zyxomma petiolatum* Rambur, 1842 Kosterin (2010).
135. *Zyxommoides breviventre* Martin, 1921 Asahina (1967a).

Excluded records:

- *Aciagrion occidentale* Laidlaw, 1919: Reported by Asahina (1967a), but most probably it was *A. borneense*, which was not well known at that time.
- *Neurothemis ramburii* (Kaup in Brauer, 1866): Reported by Roland & Roland (2010), but biogeographically unexpected. Most probably aberrant *N. fluctuans*.
- *Rhyothemis fuliginosa* Selys, 1883. Reported by Martin (1904), but biogeographically hardly possible. Most probably *R. plutonia*.
- *Rhyothemis regia* (Brauer, 1867): Reported by Donnelly (2000), but too uncertain a sighting. Could also be *R. plutonia*.

Recent Master's 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.

Cambodian bats: a review of farming practices and economic value of lesser Asiatic yellow house bat *Scotophilus kuhlii* (Leach, 1821), in Kandal and Takeo provinces, Cambodia

CHHAY Sokmanine

មូលនិយមសង្ខេប

មានការយល់ដឹងតិចតួចអំពីការធ្វើជម្រកសិប្បនិម្មិតពីស្លឹកត្នោតឲ្យសត្វប្រចៀវរបស់ប្រជាជនកម្ពុជា ដើម្បីប្រមូលយកលាមករបស់វា មកប្រើប្រាស់និងលក់ជាជីធម្មជាតិ។ គោលបំណងនៃការសិក្សារបស់ខ្ញុំគឺសិក្សាឡើងវិញលើការធ្វើកសិកម្មចិញ្ចឹមសត្វប្រចៀវ និង តម្លៃសេដ្ឋកិច្ចនៃប្រភេទ *Scotophilus kuhlii* នៅក្នុងខេត្តកណ្តាល និងខេត្តតាកែវ។ ខ្ញុំបានធ្វើការអង្កេតលើកសិដ្ឋានសត្វប្រចៀវចំនួន ៤០កន្លែងក្នុង៤ឃុំ ដែល២ឃុំស្ថិតនៅក្នុងខេត្តកណ្តាល(ឃុំស្វាយប្រទាល និងឃុំតាឡាន) និង២ឃុំទៀតស្ថិតនៅក្នុងខេត្តតាកែវ(ឃុំចា និងឃុំបាស្រ្តា)។ ម្ចាស់កសិដ្ឋានចំនួន១០នាក់ត្រូវបានសំភាសន៍ក្នុងឃុំនីមួយៗ។ ការសិក្សាដើម្បីប៉ាន់ប្រមាណពីចំនួនសត្វប្រចៀវ ដែលរស់នៅក្នុងជម្រកសិប្បនិម្មិតក្នុងកសិដ្ឋានសិក្សាចំនួន២០បានត្រូវធ្វើឡើង ហើយសំណាកលាមកបានត្រូវប្រមូលដើម្បី កំណត់បរិមាណសារធាតុចិញ្ចឹមដែលរុក្ខជាតិត្រូវការ។

ចំនួនជម្រកសិប្បនិម្មិតរបស់សត្វប្រចៀវដែលមានច្រើនជាងគេបំផុតគឺនៅក្នុងឃុំតាឡាន ទោះបីជាជម្រកចំនួនពាក់កណ្តាលមិនមាន ប្រចៀវរស់នៅក៏ដោយ (៦៥ក្នុងចំណោមជម្រកទាំង១៥០)។ អត្រាខ្ពស់បំផុតនៃការចូលមករស់នៅក្នុងជម្រកសិប្បនិម្មិតគឺនៅក្នុងឃុំ ស្វាយប្រទាល (៦០ក្នុងចំណោមជម្រកទាំង៦២)។ ពេលវេលារស់នៅក្នុងជម្រក ក៏ដូចជាប៉ុណ្ណយឡាស្យុងសត្វប្រចៀវគឺប្រែប្រួល ក្នុងចំណោមកសិដ្ឋានទាំង៤០។ តាមការបញ្ជាក់របស់ម្ចាស់កសិដ្ឋាន ប្រចៀវ *S. kuhlii* បន្តពូជចាប់ពីខែមេសាដល់ខែឧសភា ហើយវា អាចបង្កើតកូនបានមួយជំនាន់ក្នុងមួយឆ្នាំ ដែលក្នុងមួយជំនាន់មានកូនតែ១២ប៉ុណ្ណោះ។ នៅក្នុងសំណាកលាមករបស់ប្រចៀវ អាសូតនិងផូស្វ័រគឺមានបរិមាណខ្ពស់ ដែលស្រដៀងគ្នាទៅនឹងលទ្ធផលនៃការសិក្សាផ្សេងៗទៀតដែរ ថ្វីបើបរិមាណប៉ូតាស្យូមមានតិច ជាងក៏ដោយ។ តាមការសិក្សានេះ ការប្រមាញ់ប្រចៀវ ការដាច់ធ្លាក់នៃជម្រក និងការប្រើប្រាស់ថ្នាំសម្លាប់សត្វល្អិតគឺជាការគំរាម កំហែងដ៏ចំបងសម្រាប់សត្វប្រចៀវ។

បរិបទអេកូឡូស៊ីនៃកសិដ្ឋាននិងការអនុវត្តចិញ្ចឹមសត្វប្រចៀវប្រែប្រួលពីឃុំមួយទៅឃុំមួយ។ តាមការប្រៀបធៀប ប្រាក់ចំណូល ទទួលបានពីការចិញ្ចឹមសត្វប្រចៀវគឺខ្ពស់បំផុតនៅឃុំបាស្រ្តា និងទាបបំផុតនៅឃុំចា។ កសិករចំនួន៥ក្នុងឃុំបាស្រ្តាដែលផ្តល់ ប្រាក់ចំណូលខ្ពស់ត្រូវបានចាត់ទុកជាកសិដ្ឋានគំរូ។ កសិកម្មចិញ្ចឹមសត្វប្រចៀវនេះគួរតែត្រូវបានលើកកម្ពស់ ព្រោះវាផ្តល់អត្ថ ប្រយោជន៍ច្រើនយ៉ាងដល់ជីវភាពរស់នៅតាមជនបទ និងដល់បរិស្ថាន។ អត្ថប្រយោជន៍ទាំងនេះរួមមាន ប្រភពជីធម្មជាតិមិនប៉ះពាល់ ដល់បរិស្ថានដែលមានតម្លៃសមរម្យ ប្រាក់ចំណូលពីការលក់ដីទាំងនោះ និងការកាត់បន្ថយការប្រើប្រាស់ថ្នាំសម្លាប់សត្វល្អិត (ព្រោះ

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ប្រចៀវស៊ីសត្វល្អិតយ៉ាងច្រើនជាអាហារ)។ ការសិក្សាបន្ថែមដើម្បីលើកកម្ពស់ការអនុវត្តល្អៗ និងបង្កើនការចិញ្ចឹមសត្វប្រចៀវយកលាមកគួរតែត្រូវបានធ្វើឡើង។

Abstract

Little is known about the Cambodian practice of building artificial roosts from palm leaves to farm free-ranging bats for their guano which is used and sold as a natural fertiliser. The aim of my study was to review bat farming practices and economic value of *Scotophilus kuhlii* in the Kandal and Takeo provinces. I surveyed 40 bat farms across four communes, two in Kandal (Svay Prateal and Ta Lon) and two in Takeo (Char and Ba Srea). Ten bat farmers were interviewed in each commune. Attempts were made to estimate bat numbers occupying roosts at 20 study farms and guano samples were collected to determine their plant nutrient content.

The highest number of artificial bat roosts was found in Ta Lon, though less than half were occupied (65 out of 150 roosts). Roost occupancy rates were highest in Svay Prateal (60 out of 62 roosts). Periods of roost occupation varied across the 40 farms, as did population sizes. According to farmers, *S. kuhlii* breeds from April to May and bears one cohort of young a year, with one or two young per cohort. Nitrogen and phosphorus levels in guano samples were high and similar to those found in other studies, though potassium levels were slightly lower. Hunting, felling of roost palms and pesticide use were seen as major threats to bats in the study area.

The ecological context of bat farms and farming practices varied between communes. Comparisons suggested that incomes generated from bat farming were highest and lowest in the Ba Srea and Char communes, respectively. Five bat farms with especially high incomes in the Ba Srea commune were identified as model farms. Bat farming deserves promotion as it benefits rural livelihoods and environments in several ways. These include a cheap source of environmentally-friendly and rich fertiliser, incomes generated from its sale, and reduced need for agricultural pesticides (as the bats consume large quantities of major insect pests). Further studies to promote best practice and wider uptake of bat guano farming are recommended.

Forest butterfly assemblages (Lepidoptera, Rhopalocera) of the Phnom Samkos Wildlife Sanctuary, Southwest Cambodia

HUN Seiha

មូលនិយមសង្ខេប

មានការសិក្សាតិចតួចពីសត្វមេអំបៅនៃប្រទេសកម្ពុជា។ ក្រៅពីឯកសារពីសម័យអាណានិគមដែលសរសេរពីមេអំបៅប្រមាណ៣០ប្រភេទនៅប្រទេសកម្ពុជា ព័ត៌មានដែលត្រូវបានបោះពុម្ពផ្សាយពីសត្វមេអំបៅគឺមានតែទីតាំងថ្នាក់ជាតិមួយកន្លែង គឺដែនជម្រកសត្វព្រៃភ្នំសំកុសនៃជួរភ្នំក្រវាញតែប៉ុណ្ណោះ។ គោលបំណងនៃការសិក្សារបស់ខ្ញុំគឺពង្រីកព័ត៌មានបឋមដែលអាចរកបាននៅក្នុងដែនជម្រកនេះ និងវាយតម្លៃបំរែបំរួលរយៈកំពស់តំបន់ព្រៃដែលសហគមន៍មេអំបៅកំពុងរស់នៅ។

ដើម្បីសម្រេចគោលបំណងនេះ ខ្ញុំបានធ្វើការអង្កេត (តាមវិធីសាស្ត្រ Transect-based) ទៅលើសត្វមេអំបៅនៅតាមដងភ្នំចំនួន២ (ភ្នំសំកុស និងភ្នំដាឡៃ) ក្នុងតំបន់ដែនជម្រក ចាប់ពីខែមីនាដល់ខែឧសភា ឆ្នាំ២០១២។ ខ្ញុំបានធ្វើការបែងចែកភ្នំទាំងពីរជាបីរយៈកំពស់

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(៤០០-៦០០ម៉ែត្រ ៦០០-៨០០ម៉ែត្រ ៨០០-១០០០ម៉ែត្រ ធៀបនឹងកំរិតទឹកសមុទ្រ) និងបង្កើតជាទីតាំងកាត់ទទឹង (transect) ដែលមានវិមាត្រ៥០០ x ១០ម៉ែត្រ ក្នុងរយៈកំពស់នីមួយៗ។ រាល់មេអំពៅទាំងអស់ត្រូវបានកត់ត្រាបន្តគ្នាតាមទីតាំងកាត់ទទឹងនីមួយៗ ក្នុងរយៈពេល៤ថ្ងៃ ដោយអ្នកអង្កេតពីរនាក់។ អ្នកអង្កេតប្រើសំណាញ់ដៃ (hand-held net) និងសំណាញ់នុយ (baited canopy) ក្នុងការចាប់ ដោយប្រើរយៈពេល២៤ថ្ងៃ (24 person-days) សម្រាប់ភ្នំមួយ ហើយជាសរុបត្រូវប្រើ៤៨ថ្ងៃ (48 person-days)។

ខ្ញុំបានកត់ត្រាមេអំពៅចំនួន១៥០៣ ដែលតាងឲ្យ២២៩ប្រភេទ (រួមទាំង៦ប្រភេទដែលមិនអាចកំណត់ឈ្មោះបាន) ក្នុង៦អំបូរ។ ភាពសំបូរបែបនៃប្រភេទដែលត្រូវបានអង្កេតគឺមានខ្ពស់បំផុតក្នុងអំបូរNymphalidae (១០២ប្រភេទ ស្មើនឹង៤៥%) បន្ទាប់មកគឺអំបូរLecaenidae (៦៣ប្រភេទ ស្មើនឹង២៨%) អំបូរHesperidae (៣៩ប្រភេទ ស្មើនឹង១៧%) អំបូរPieridae (១២ប្រភេទ ស្មើនឹង៥%) អំបូរPapilionidae (៨ប្រភេទ ស្មើនឹង៣%) និងអំបូរRiodinidae (៥ប្រភេទ ស្មើនឹង២%)។ ការប្រៀបធៀបជាមួយឯកសារដែលត្រូវបានបោះពុម្ព និងមិនទាន់ត្រូវបានបោះពុម្ពផ្សាយបង្ហាញថា ១០៦ប្រភេទជាកំណត់ត្រាប្រភេទថ្មីសម្រាប់ដែនជម្រកសត្វព្រៃភ្នំសំកុស ហើយ៨២ប្រភេទជាកំណត់ត្រាប្រភេទថ្មីសម្រាប់ប្រទេសកម្ពុជា។ មានតែមេអំពៅចំនួន២៩ប្រភេទប៉ុណ្ណោះ ដែលត្រូវបានរកឃើញតាមរយៈកំពស់សិក្សាទាំងអស់។ លទ្ធផលនៃការសិក្សានេះបង្ហាញថា បំរែបំរួលគួរឲ្យកត់សំគាល់កើតមានឡើងចំពោះសហគមន៍មេអំពៅក្នុងតំបន់ដែនជម្រកសត្វព្រៃភ្នំសំកុស ហើយខ្ញុំចាត់ទុកថាបំរែបំរួលទាំងនេះទាក់ទងជាមួយនឹងភាពខុសគ្នានៃរយៈកំពស់ និងជម្រកព្រៃឈើ។

Abstract

Few studies have been conducted on the Cambodian butterfly fauna. Aside from colonial-era literature which mentions approximately 30 species for the country, published information on the butterfly fauna of a particular area currently exists for only one site: Phnom Samkos Wildlife Sanctuary in the Cardamom Mountains. The aim of my study was to extend the preliminary information available for the wildlife sanctuary and to assess altitudinal variations in the forest-dwelling butterfly assemblages that occur there.

To achieve this, I conducted transect-based surveys of butterflies on two mountains (Phnom Samkos and Phnom Dalai) inside the wildlife sanctuary from March to May, 2012. I divided both mountains into three elevation bands (400–600 m, 600–800 m and 800–1,000 m above sea level) and established a single 500 x 10 m transect in each band. Butterflies were recorded continuously along each transect for four days by two surveyors using a combination of hand-held nets and baited canopy traps, giving 24 person-days of sampling effort per mountain and 48 person-days of sampling effort in total.

I recorded 1,503 butterflies representing 229 species (including six unidentified but distinct taxa) in six families. Observed species richness was highest in the Nymphalidae (102 species, 45%), followed by the Lycaenidae (63 species, 28%), Hesperidae (39 species, 17%), Pieridae (12 species, 5%), Papilionidae (8 species, 3%) and Riodinidae (5 species, 2%). Comparisons with published and unpublished literature data indicate that 106 of these species represent new records for Phnom Samkos Wildlife Sanctuary, while 82 species represent new country records for Cambodia. Only 29 butterfly species were found to occur at all elevations studied. This finding alone suggests that marked variations occur in forest butterfly assemblages at Phnom Samkos Wildlife Sanctuary, and I relate these variations to differences in elevation and forest habitat.

A systematic review of reptiles in Phnom Samkos Wildlife Sanctuary, Southwest Cambodia

MEANG Moeurn

មូលនិយមសង្ខេប

សត្វល្អិតប្រទេសកម្ពុជាពុំសូវទទួលបានការចាប់អារម្មណ៍ដូចប្រទេសមួយចំនួនទៀតក្នុងតំបន់ត្រូពិចអាស៊ីអាគ្នេយ៍ទេ ថ្វីបើចំណាប់អារម្មណ៍ថ្មីៗបាននាំមកនូវរបកគំហើញកំណត់ត្រាប្រភេទថ្មីសម្រាប់ប្រទេស និងប្រភេទថ្មីសម្រាប់វិទ្យាសាស្ត្រក៏ដោយ។ គោលបំណងនៃការសិក្សានេះគឺរៀបចំឡើងវិញជាប្រព័ន្ធត្រឹមត្រូវអំពីល្អិត ដែលត្រូវបានប្រមូលមកពីដែនជម្រកសត្វព្រៃភ្នំសំកុស ដើម្បីបង្កើត (១)បញ្ជីឈ្មោះសត្វល្អិតក្នុងតំបន់សិក្សា (២)ទិន្នន័យលំអិតអំពីប្រភេទនីមួយៗ រួមទាំងការពិពណ៌នារូបរាងនិងកំណត់ត្រាប្រវត្តិសាស្ត្រធម្មជាតិរបស់វា របាយរបស់ប្រភេទ និងស្ថានភាពអភិរក្សក្នុងតំបន់។

ដើម្បីសម្រេចគោលបំណងនេះ ខ្ញុំបានអានឯកសារផ្សេងៗ និងបានពិនិត្យមើលសំណាកនៅសារមន្ទីរសត្វក្នុងមជ្ឈមណ្ឌលអភិរក្សជីវៈចម្រុះនៃសាកលវិទ្យាល័យភូមិន្ទភ្នំពេញ។ សំណាកសម្រាប់ត្រួតពិនិត្យទាំងនោះគឺត្រូវបានប្រមូលតាមវិធីសាស្ត្រផ្សេងៗគ្នា ក្នុងកំឡុងពេលចុះស្រាវជ្រាវនៅ៤កន្លែងនៃដែនជម្រកសត្វព្រៃភ្នំសំកុស (អូរពាម អូរជ្រុកព្រល ទឹកវេ និងភ្នំដាឡៃ) ចាប់ពីឆ្នាំ២០១០-២០១១។ បន្ថែមលើការវាស់វែងតាមលក្ខណៈស្តង់ដារមួយចំនួន និងការរាប់ចំនួនស្រកានៃសំណាកនីមួយៗ ខ្ញុំបានពិនិត្យមើលលក្ខណៈគុណភាពដូចជាពណ៌របស់វានៅពេលនៅរស់ និងនៅពេលរក្សាទុក ហើយធ្វើការប្រៀបធៀបទិន្នន័យទាំងនេះជាមួយនឹងការពិពណ៌នាប្រភេទដែលបានត្រូវបោះពុម្ពផ្សាយ។

ក្នុងកំឡុងពេលនៃការសិក្សា ខ្ញុំបានពិនិត្យមើលសំណាកសរុបចំនួន១៧៤ ហើយដាក់បញ្ចូលវាជា៣៩ប្រភេទ។ ប្រភេទភាគច្រើនហាក់ដូចជាប្រភេទជួបប្រទះញឹកញាប់ក្នុងដែនជម្រកសត្វព្រៃនោះ លើកលែងតែ៣ប្រភេទប៉ុណ្ណោះ គឺ *Oligodon kamphucheaensis* *Ovophis convictus* និង *Dendrelaphis ngansonensis*។ ប្រភេទ *O. kamphucheaensis* ត្រូវបានពិពណ៌នាពីដែនជម្រកសត្វព្រៃនេះនៅក្នុងឆ្នាំ២០១២ ហើយថ្មីៗនេះ វាត្រូវបានចាត់ទុកជាប្រភេទប្រចាំប្រទេស ចំណែកឯប្រភេទ *O. convictus* និង *D. ngansonensis* គឺត្រូវបានគេស្គាល់ពីទីតាំងផ្សេងៗក្នុងតំបន់អាស៊ី ប៉ុន្តែវាទើបតែបានត្រូវប្រទះឃើញនៅប្រទេសកម្ពុជាថ្មីៗនេះប៉ុណ្ណោះ។ គេក៏មិនទាន់បានដឹងថា តើការបាត់បង់ទីជម្រក និងការប្រមាញ់បានធ្វើឲ្យមានការធ្លាក់ចុះនូវចំនួនប្រភេទល្អិតនៅក្នុងដែនជម្រកសត្វព្រៃនោះឬក៏យ៉ាងណាទេ ប៉ុន្តែសកម្មភាពទាំងនេះពិតជាផ្តល់ការព្រួយបារម្ភសម្រាប់ការអភិរក្ស។ ដោយសារតំបន់មួយចំនួនធំនៃតំបន់ដែនជម្រកនេះមិនទាន់ត្រូវបានធ្វើការអង្កេតនៅឡើយ ដូច្នេះវាអាចនឹងរំពឹងថា ការអង្កេតនៅពេលខាងមុខនឹងអាចរកឃើញប្រភេទល្អិតបន្ថែមនៅក្នុងទីតាំងនេះ។

Abstract

Cambodia's reptile fauna has received less attention than most other countries in tropical Southeast Asia, though recent interest has led to the discovery of many new country records and species to science. The aim of my study was to undertake a systematic review of reptiles collected in Phnom Samkos Wildlife Sanctuary to create: (i) a checklist of reptiles for the site, and (ii) detailed accounts for each species confirmed, including morphological descriptions and notes on their natural history, distributions and local conservation status.

To achieve this aim, I undertook a literature review and examined specimen material held at the Centre for Biodiversity Conservation Zoological Museum at the Royal University of Phnom Penh. The specimens I examined were collected using a variety of sampling methods during expeditions to four parts of the wildlife sanctuary (O'Peam,

CITATION: Meang M. (2012) A systematic review of reptiles in Phnom Samkos Wildlife Sanctuary, Southwest Cambodia. *Cambodian Journal of Natural History*, 2012, 167-168.

O'Chruk Prul, Teuk Ve and Phnom Dalai) from 2010–2011. In addition to taking a series of standard measurements and scale counts from every specimen, I examined qualitative features such as colour in life and preservative and compared all these data with published species descriptions.

During my study, I examined a total of 174 specimens and referred these to 39 species. Most of these species appear to be variably common at the wildlife sanctuary, except for three: *Oligodon kamphucheaensis*, *Ovophis convictus* and *Dendrelaphis ngansonensis*. *Oligodon kamphucheaensis* was described from the wildlife sanctuary in 2012 and is currently thought to be nationally endemic, whereas *Ovophis convictus* and *D. ngansonensis* are known from other Asian sites, but were also only recently found in Cambodia. It is currently unknown whether habitat loss and wildlife poaching have led to declines in any reptile species in the sanctuary, but these activities are certainly of conservation concern. As large areas of the sanctuary remain uninvestigated, it is also likely that future surveys will result in the discovery of additional reptile species in this site.

Rotifer communities within the Lumphat Wildlife Sanctuary, Ratanakiri and Mondulakiri provinces, Cambodia

MIN Malay

មូលនិយមសង្ខេប

ការស្រាវជ្រាវលើរូងទឹកប្រទេសកម្ពុជាត្រូវបានដំណើរការតិចតួចប៉ុណ្ណោះនាពេលប៉ុន្មានឆ្នាំថ្មីៗនេះ។ ការសិក្សារបស់ខ្ញុំផ្ដោតសំខាន់ទៅលើសហគមន៍រូងទឹកដែលរស់នៅតាមតំបន់ដីសើមធម្មជាតិក្នុងដែនជម្រកសត្វព្រៃលំដាប់ជាតិភាគឥសានប្រទេសកម្ពុជា ដែលជាតំបន់ដីសើមដំបូងបំផុតសម្រាប់ប្រទេសយើង។ គោលបំណងរបស់ខ្ញុំគឺធ្វើការប្រៀបធៀបកម្រិតសំបូរបែបនៃប្រភេទរូងទឹកក្នុងតំបន់ដីសើមតាមរដូវ និងតំបន់ដីសើមអចិន្ត្រៃយ៍ និងប្រៀបធៀបការប្រមូលផ្តុំនៃរូងទឹកដែលរស់នៅក្បែរច្រាំង និងរស់នៅឆ្ងាយពីច្រាំង។

ខ្ញុំបានប្រមូលសំណាកពីទីតាំងសិក្សានៃតំបន់ដីសើមចំនួន៣២កន្លែង ក្នុងដែនជម្រកសត្វព្រៃ ក្នុងកំឡុងខែកុម្ភៈ ឆ្នាំ២០១២ និងបានកត់ត្រារូងទឹកចំនួន២៣៥៦កតាចំណែកថ្នាក់។ កំណត់ត្រាប្រភេទរួមមាន៤៧ប្រភេទដែលជាកំណត់ត្រាប្រភេទថ្មីសម្រាប់ប្រទេស១៦កតាចំណែកថ្នាក់មិនអាចត្រូវបានកំណត់ឈ្មោះបាន និង៥០៦កតាចំណែកថ្នាក់ខុសគ្នាដែលអាចត្រូវបានកំណត់ត្រីមតែឈ្មោះពួកប៉ុណ្ណោះ។ ចំនួនប្រភេទនៅក្នុងទីតាំងសិក្សានីមួយៗគឺចន្លោះពី៦-៨៦ប្រភេទ។ អំបូរដែលមានប្រភេទច្រើនជាងគេគឺ Lecanidae (៤៧ប្រភេទ) Notommatidae(៤០ប្រភេទ) និងColurellidae(៣៩ប្រភេទ) ហើយPolyarthra vulgaris គឺជាប្រភេទដែលជួបញឹកញាប់ជាងគេ។

កម្រិតសំបូរបែបនៃប្រភេទរូងទឹកមានភាពខុសគ្នារវាងតំបន់ដីសើមតាមរដូវ(១៦៧ប្រភេទ) និងតំបន់ដីសើមអចិន្ត្រៃយ៍(១៩៦ប្រភេទ) តែវាមិនមានភាពខុសគ្នាដាច់នោះទេ។ រូងទឹកចំនួន១២៨ប្រភេទត្រូវបានប្រទះឃើញក្នុងតំបន់ដីសើមទាំងពីរ ទោះបីជាតម្លៃចម្រុះគ្នាពីសន្ទស្សន៍ស្រដៀងគ្នា(Similarity index) នៃការជួបប្រទះ មានកម្រិតទាបគួរសមក៏ដោយ គឺប្រមាណ៥៤.៤%។ ក្នុងចំណោមតំបន់ដីសើមទាំង២១ ពុំមានភាពខុសគ្នាខ្លាំងត្រូវបានរកឃើញរវាងរូងទឹកដែលរស់នៅក្បែរច្រាំង(១៩២ប្រភេទ) និងរូងទឹកដែលរស់នៅឆ្ងាយពីច្រាំង(១៨៧ប្រភេទ)នោះទេ។ រូងទឹកចំនួន១៥៥ប្រភេទអាចរស់នៅក្នុងតំបន់ទាំងពីរនេះ ហើយតម្លៃសន្ទស្សន៍ស្រដៀង

CITATION: Min M. (2012) Rotifer communities within the Lumphat Wildlife Sanctuary, Ratanakiri and Mondulakiri provinces, Cambodia. *Cambodian Journal of Natural History*, 2012, 168–169.

គ្នារបស់វាគឺ៦៩.២%។

ទោះបីភាពខុសគ្នានៃសមាសភាពរ៉ូទីហ្វេរ តំបន់ដីសើមតាមរដូវនិងតំបន់ដីសើមអចិន្ត្រៃយ៍មានកម្រិតសំបូរបែបនៃរ៉ូទីហ្វេរស្រដៀងគ្នា។ តំបន់ដីសើមទាំងពីរប្រភេទផ្តល់ទីជម្រកដ៏សំខាន់សម្រាប់សត្វនិងរុក្ខជាតិក្នុងទឹក ក៏ដូចជាអាហារនិងទឹកសម្រាប់សត្វរស់នៅក្នុងព្រៃ ជិតៗនោះដែរ។

Abstract

Research on Cambodian rotifers is limited to a few studies conducted in recent years. My study focused on rotifer communities inhabiting natural wetlands in the Lumphat Wildlife Sanctuary of northeast Cambodia, the first of its kind for the country. My aim was to compare levels of rotifer species richness between seasonal and permanent wetlands and to compare rotifer assemblages occupying near-shore and open-water habitats.

To this end, I sampled 32 wetland sites in the wildlife sanctuary in February 2012 and recorded a total of 235 taxa. Species recorded included 47 species which represent new country records, one unknown taxon and 50 distinct taxa that were identified to genus level only. Species numbers at each sampling site ranged from 6-86 species. The most diverse families observed were Lecanidae (47 species), Notommatidae (40 species) and Colurellidae (39 species) and *Polyarthra vulgaris* was the most frequently recorded species.

Levels of species richness differed between seasonal wetlands (167 species) and permanent wetlands (196 species), though these differences were not statistically significant. One hundred and twenty eight rotifer species were found to occur in both types of wetlands, though the associated value from an incidence-based similarity index was relatively low at 54.47%. No significant difference was found in rotifer species richness between near-shore (192 species) and open-water (187 species) habitats across 21 wetlands. One hundred and fifty-five species were shared between these two habitats, and their similarity index value was 69.2%.

Despite differences in species composition, seasonal and permanent wetlands possess similar levels of rotifer species richness. Both types of wetlands provide important habitat for aquatic animals and plants, as well as food and water for consumption of forest-dwelling animals.

Interactions between wetland resources and livelihoods in Lumphat Wildlife Sanctuary, Ratanakiri Province, Cambodia

SVEAN Vuth

មូលនិយមរង្វេប

ប្រទេសកំពុងអភិវឌ្ឍន៍មួយចំនួនពឹងផ្អែកយ៉ាងខ្លាំងលើធនធានធម្មជាតិ និងជាពិសេសធនធានជីវសាស្ត្រ។ ធនធានទាំងអស់នេះតែងតែមាននៅតាមតំបន់ដាច់ស្រយាល ដែលសហគមន៍នៅតាមតំបន់នោះប្រើប្រាស់វាជាប្រចាំសម្រាប់ការប្រកបរបរចិញ្ចឹមជីវិតប្រចាំថ្ងៃ។ គោលបំណងនៃការសិក្សារបស់ខ្ញុំគឺវាយតម្លៃថា តើធនធានតំបន់ដីសើមក្នុងដែនជម្រកសត្វព្រៃលំដាប់ជាតិបានផ្តល់ការរួមចំណែកដល់ការលើកកម្ពស់ជីវភាពរស់នៅតាមជនបទដោយផ្តល់ប្រាក់ចំណូលដោយផ្ទាល់ និងការរួមចំណែកដល់សន្តិសុខស្បៀងដែរឬទេ។

ការសិក្សារបស់ខ្ញុំផ្តោតសំខាន់លើការប្រើប្រាស់គ្រូពាំងនិងវាលស្រែនៅជុំវិញភូមិចំនួន៤ នៃឃុំ២ ក្នុងស្រុកលំដាប់ ខេត្តរតនគិរី។ ការ

CITATION: Svean V. (2012) Interactions between wetland resources and livelihoods in Lumphat Wildlife Sanctuary, Ratanakiri Province, Cambodia. *Cambodian Journal of Natural History*, 2012, 169–170.

សម្ភាសន៍សហគមន៍ចំនួន៦០ក្រុមគ្រួសារ ការពិភាក្សាជាក្រុម និងការសង្កេតផ្ទាល់ត្រូវបានប្រើប្រាស់សម្រាប់ប្រមូលព័ត៌មាន។ ខ្ញុំ បានយកតម្លៃទីផ្សារក្នុងតំបន់ដើម្បីគណនាកតិកតម្លៃសេដ្ឋកិច្ចផ្ទាល់ សំរាប់ផលិតផលច្រើនយ៉ាងនៃធនធានដីសើមនៅទីនេះដែលរួម មានត្រី អំបូរកង្កែប និងសត្វព្រៃដទៃទៀត និងទឹកប្រើប្រាស់លើបន្លែនិងសត្វស្រុក។ ការធ្វើតេស្តតាមបែបស្ថិតិច្រើនយ៉ាងត្រូវបាន ដំណើរការដើម្បីកំណត់នូវសារសំខាន់នៃទិន្នន័យទាំងនេះ។

លទ្ធផលនៃការសិក្សារបស់ខ្ញុំបង្ហាញថា ១)ការពឹងផ្អែកនិងការប្រើប្រាស់ធនធានដីសើមមានសារសំខាន់សម្រាប់ក្រុមគ្រួសារមានដើម កំណើតនៅទីនោះ និងប្រែប្រួលទៅតាមស្ថានភាពសេដ្ឋកិច្ចសង្គមរបស់គាត់ ២)ក្រុមគ្រួសារជាច្រើនប្រើប្រាស់ធនធានដីសើមជាវិធី សាស្ត្រដោះស្រាយបញ្ហាខ្វះស្បៀង ៣)បំបែបប្រែប្រួលខ្លាំងកើតមានក្នុងការប្រើប្រាស់តំបន់ដីសើមនាពេលប៉ុន្មានឆ្នាំថ្មីៗនេះ ដោយសារ សកម្មភាពនេសាទខុសច្បាប់និងសម្បទានដីសេដ្ឋកិច្ច ដែលកើតមានដោយផ្នែក ដោយសារឱកាសរាយកដីដែលតំបន់ដីសើមផ្តល់ ឱ្យ និង ៤)បញ្ហាទាំងនេះ ដែលគួបផ្សំជាមួយកង្វះរបរចិញ្ចឹមជីវិតផ្សេងៗទៀត និងកង្វះសមត្ថភាពក្នុងការការពារតំបន់ដីសើម បាននាំ ឲ្យមានការធ្លាក់ចុះជាទូទៅនូវទំហំនិងលក្ខខណ្ឌតំបន់ដីសើមនៅទីនោះ។

Abstract

Most developing countries depend heavily on their natural and especially biological resources. These resources are frequently located in poor rural areas whose communities typically also depend heavily on their use for daily survival. The aim of my study was to assess whether wetland resources in Lumphat Wildlife Sanctuary make appreciable contributions to rural livelihoods in terms of direct income and contributions to food security.

My study focused on local use of ponds and paddy fields surrounding four villages in two communes of Lumphat District, Ratanakiri Province. A mixture of interviews with 60 households, group discussions and direct observations were used to gather information. I used local market prices to calculate direct economic values for a variety of local wetland products including fish, amphibians and other wildlife, and water for vegetable gardens and domestic livestock. A variety of statistical tests were undertaken to test the significance of these data.

My results suggest that: (i) dependence and hence demand for wetland resources is significant among indigenous households and varies according to their socio-economic status; (ii) many households use wetland resources as a coping strategy to overcome periods of food scarcity; (iii) significant changes have occurred in local wetland use in recent years due to illegal fishing activity and economic land concessions, the latter arising in part because of the land clearance opportunities that wetlands provide; and (iv) these issues, coupled with lack of livelihood alternatives and capacity for wetland protection have led to a general decline in the extent and condition of local wetland habitats.

Recent literature from Cambodia

This section summarises recent scientific publications concerning Cambodian biodiversity and natural resources. The complete abstracts of most articles are freely available online (and can be found using Google Scholar or other Internet search engines), but not necessarily the whole article. Authors are usually willing to provide free reprints or electronic copies of their papers on request and their email addresses, where known, are included in the summaries below.

If you or your organisation 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 Internet link to Editor.CJNH@gmail.com

New species and taxonomic reviews

Jiang, W., Wang, G. & Liu, X. (2012) New fishfly species of the *Neochauliodes bowringi* group (Megaloptera: Corydalidae: Chauliodinae). *Zootaxa*, **3230**, 59–64.

A new species of fishfly, *Neochauliodes cambodianus* sp. nov. is described from Cambodia. This paper contains a key to the males of the new species and similar species of the *N. bowringi* species group. Author: liu_xingyue@yahoo.com.cn

Kosterin, O.E. (2012) *Burmagomphus asahinai* sp. nov., a new species from Cambodia and Thailand, with a description of the male of *B. graciosus* Chao, 1954. *International Journal of Odonatology*, **15**, 275–292.

The holotype of the new dragonfly, *Burmagomphus asahinai* sp. nov., was collected by rapids in Thma Bang District, Koh Kong Province, within the Cardamom Mountains range. The new species has also been found in Nakhon Nayok, Chiang Mai and Prachaup Khiri Khan provinces of Thailand. Author: kosterin@bionet.nsc.ru

Lim, J. & Lee, S. (2012) Taxonomic notes of family Bethyilidae (Hymenoptera: Chrysoidea) in Cambodia: Generic list and their diagnoses. *Abstracts of the Annual Conference of the Entomological Society of Korea, 1-2 April, 2011, Hannam University, Daejeon City, South Korea*, p. 38.

Most members of the Bethyilidae are ectoparasites of immature beetles, butterflies and moths. Although 368 species have been discovered in the Oriental region, only one, *Sulcomesitius cambodianus* Moczar, 1976 had been recorded in Cambodia. Using malaise traps in the Central Cardamoms Protected Forest from May to October 2010, the authors captured 14 genera, of which 13 are new records for Cambodia. Author: seung@snu.ac.kr

Lourenço, W.R. (2012) More about the genus *Chaerilus* Simon, 1877 in Vietnam and Cambodia, with descriptions of two new species. *Arthropoda Selecta*, **21**, 235–241.

Two small, similar new species of scorpions are described from Southeast Asia: *Chaerilus anneae* sp. nov. from Vietnam and *Chaerilus kampuchea* sp. nov. from Cambodia. The Cambodian species was discovered by a cave on Phnom Laang, Kampot Province. Author:

arachne@mnhn.fr; Online: http://arthropodaselecta.britishtspiders.org.uk/articles/21_3_235_241_Lourenco.pdf

Maruyama, M. (2012) A new genus and species of flightless, microphthalmic Corythoderini (Coleoptera: Scarabaeidae: Aphodiinae) from Cambodia, associated with *Macrotermes* termites. *Zootaxa*, **3555**, 83–88.

A new beetle genus and new species, *Eocorythoderus incredibilis*, was discovered in the fungus gardens of the termite *Macrotermes gilvov* in Angkor Wat, Cambodia. The beetle is a flightless, microphthalmic species and was observed being carried by worker termites. Author: dendrolasius@gmail.com; Online: <http://www.mapress.com/zootaxa/2012/f/zt03555p088.pdf>

Murphy, J.C., Voris, H.K., Murthy, B.H.C.K., Traub, J. & Cumberbatch, C. (2012) The masked water snakes of the genus *Homalopsis* Kuhl & van Hasselt, 1822 (Squamata, Serpentes, Homalopsidae), with the description of a new species. *Zootaxa*, **3208**, 1–26.

Masked water snakes are abundant in the wetlands of Southeastern Asia. Until now, two species were recognized – the widespread *Homalopsis buccata* Linnaeus and the Mekong endemic *H. nigroventralis* Deuve. This paper resurrects *H. hardwickii* Gray and *H. semizonata* Blyth, and describes a new species, *Homalopsis mereljcoxi* sp. nov., from Thailand, Cambodia and Vietnam. The new Indochinese species is heavily exploited in the Tonle Sap Lake. A key to the species of *Homalopsis* is provided. Author: fordonia1@comcast.net

Nemoto, F., Kojima, H., Ohtaka, A. & Fukui, M. (2012) Filamentous sulfur-oxidizing bacteria of the genus *Thioploca* from Lake Tonle Sap in Cambodia. *Aquatic Microbial Ecology*, **66**, 295–300.

The genus *Thioploca* are sulphur-oxidising bacteria that live in freshwater or brackish sediments and can store nitrate in high concentrations in their cells. To date, they have been reported only in temperate and subarctic areas. This discovery of *Thioploca* in the Tonle Sap Lake is the first report of this genus in the Tropics. Phylogenetic analysis revealed three distinct lineages in this lake. Author: kojimah@pop.lowtem.hokudai.ac.jp

Nguyen V.X. (2012) *Macrobrachium hungi*, a new freshwater palaemonid prawn (Decapoda: Caridea: Palaemonidae) from the Tonle Sap Great Lake of Cambodia. *Zootaxa*, **3560**, 32–40.

A new species of prawn, *Macrobrachium hungi* sp. nov., was collected in the Tonle Sap Lake. Adult males look similar to *M. saigonense*. Brief notes on the prawn's economic importance and its habitat are provided. Author: nvxuan_uaf@yahoo.com.vn

Schumm, F. & Aptroot, A. (2012) *A Microscopical Atlas of Some Tropical Lichens from SE-Asia (Thailand, Cambodia, Philippines, Vietnam): Volume 1*. Books on Demand, Herstellung und Verlag, Norderstedt, Germany.

Schumm, F. & Aptroot, A. (2012) *A Microscopical Atlas of Some Tropical Lichens from SE-Asia (Thailand, Cambodia, Philippines, Vietnam): Volume 2*. Books on Demand, Herstellung und Verlag, Norderstedt, Germany.

The first two volumes in a series of fully illustrated books on Indochinese and Philippine lichens. Volume 1 covers the genera *Anisomeridium* to *Lobaria* (455 pages), Volume 2 covers *Malmidea* to *Trypethelium* (406 pages). Each volume currently costs >US\$140. Author: fschumm@online.de

Sohn, W.-M., Yong, T.-S., Eom, K.S., Pyo, K.-H., Lee, M.Y., Lim, H., Choe, S., Jeong, H.-G., Muth S., Duong S. & Chai, J.-Y. (2012) Prevalence of *Opisthorchis viverrini* infection in humans and fish in Kratie Province, Cambodia. *Acta Tropica*, **124**, 215–220.

The liver fluke *Opisthorchis viverrini* is a medically important food-borne parasite in Indochina. Within Cambodia, this trematode was previously reported to occur only in Takeo Province. This paper reports on the discovery of adult worms in villagers in Kratie Province, as well as their larvae (as metacercariae) in seven species of freshwater fish. Author: wmsohn@gnu.ac.kr

Vikhrev, N.E. (2012) Revision of the *Lispe longicollis*-group (Diptera, Muscidae). *ZooKeys*, **235**, 23–39.

This review includes probably the first Cambodian records of the flies *Lispe manicata* Wiedemann, 1830 (a specimen from Ream National Park, Kampong Saom Province) and *L. pacifica* Shinonaga & Pont, 1992 (specimens collected in Koh Kong Province). Both species are widespread in Southeast Asia. Author: nikita6510@ya.ru; Online: <http://ia600803.us.archive.org/29/items/RevisionOfTheLispe-Longicollis-groupdipteraMuscidae/3306-G-3-layout.pdf>

Biodiversity inventories and monitoring

Allen, D.J., Smith, K.G. & Darwall, W.R.T. (2012) *The Status and Distribution of Freshwater Biodiversity in Indo-Burma*.

IUCN, Cambridge, United Kingdom, and Gland, Switzerland.

The three-year Indo-Burma Project focused on assessing the conservation status of all described species of freshwater fishes, molluscs, odonates and selected families of aquatic plants native to the Indo-Burma Biodiversity Hotspot. Approximately 13% of freshwater species are globally threatened, most of them occur along the Mekong River. Major threats include pollution, direct exploitation, deforestation and dams. The proportion of fish species threatened by hydroelectric dams is projected to increase from 19% to 28% over the next decade. The report points out that most protected areas in this region were based on terrestrial needs, and may fail to adequately protect freshwater ecosystems. The authors call for wiser use of Environmental Impact Assessments, and advise that monitoring of fisheries should consider species diversity, not just kilograms, dollars or catch per unit effort. Author: david.allen@iucn.org; Online: https://cmsdata.iucn.org/downloads/indo_burma_report_complete_low_res_28_aug.pdf

BirdLife International Cambodia Programme (2012) *The Biodiversity of the Proposed Western Siem Pang Protected Forest Stung Treng Province, Cambodia*. BirdLife International Cambodia Programme, Phnom Penh, Cambodia.

Western Siem Pang is one of very few sites worldwide that support five Critically Endangered bird species: white-shouldered ibis *Pseudibis davisoni*, giant ibis *Thaumatibis gigantea* (25% of the global population), white-rumped vulture *Gyps bengalensis*, slender-billed vulture *G. tenuirostris*, and red-headed vulture *Sarcogyps calvus*. This 203-page report focuses principally on birds, large mammals and threats to the proposed protected forest, with a short chapter on incidental observations of reptiles, amphibians and butterflies. Online: <http://birdlifeindochina.org/sites/default/files/WSP-Biodiversity-report-%28small%29.pdf>

Bishop, K.D. & Duong N. (2012) *Cambodia: February 18 – March 1, 2012*. Victor Emanuel Nature Tours, Austin, TX, USA.

A report on 273 species of birds observed during a tour of several sites in Cambodia. Some incidental records of mammals and reptiles are also included. Author: kdbishop@ozemail.com.au; Online: <http://www.samveasna.org/userfiles/Vent%20Trip%20Report%20&%20Bird%20list%20Cambodia%20February%202012.pdf>

Cox, M., Taylor, M., Braber, B.D., Mahmoud, N. & Fanning, E. (2012) *Frontier - Cambodia Forest Phase 122: Science Report: Phase Dates: 2nd April – 6th June 2012*. Frontier, London, United Kingdom.

Technical progress report on inventories and other research projects carried out in Kulen Promtep Wildlife

Sanctuary. This report covers bears and other mammals, butterflies, amphibians, reptiles, birds and illegal logging. Online: http://www.frontier.ac.uk%2FPublications%2FFiles%2F2012_08_02_16_12_01_944.pdf&ei=9V7wUNyaEqWM0wWbsIG4Cg&usg=AFQjCNEbS-BGKAcj4aZl4_uB631KG0dKow&bvm=bv.1357700187,d.d2k&cad=rja

Evans, T. & Goes, F. (2012) *Cambodia Recent Bird Reports, November–December 2011*. http://www.samveasna.org/userfiles/cambodia_rr_nov-dec2011.pdf

Quarterly round-up of unusual and important bird sightings in Cambodia. Author: fredbaksey@yahoo.com

Goes, F. (2012) *Cambodia Quarterly Bird Reports, January–March 2012*. http://www.samveasna.org/userfiles/cambodia_quarterly_bird_reports__january-march_2012.pdf

Recent unusual and important bird sightings throughout Cambodia. Author: fredbaksey@yahoo.com

Goes, F. (2012) *Cambodia Quarterly Bird Reports, April–June 2012*. http://www.samveasna.org/userfiles/cambodia_rr_apr-june2012%281%29.pdf

A blog was launched in April 2012 to share bird observations in Cambodia (www.cambodiabirdingnews.blogspot.fr). Author: fredbaksey@yahoo.com

Goes, F. (2012) *Cambodia Quarterly Bird Reports, July–September 2012*. http://www.samveasna.org/userfiles/cambodia_quarterly_bird_reports__july-september_2012.pdf

The national vulture census was repeated in June and September. On both occasions, a relatively low count of 204 vultures was recorded across six restaurant sites in four provinces, including red-headed vultures (34 birds), white-rumped vultures (115) and slender-billed vultures (55). Bird sightings included the first national record of a sharp-tailed sandpiper. Author: fredbaksey@yahoo.com

Seak S., Schmidt-Vogt, D. & Thapa, G.B. (2011) Biodiversity monitoring at the Tonle Sap Lake of Cambodia: a comparative assessment of local methods. *Environmental Management*, **50**, 707–720.

The authors evaluated current methods of monitoring fish, birds, reptiles, mammals and vegetation in the Great Lake area using the criteria of methodological rigour, perceived cost, ease of use, compatibility with existing activities, and effectiveness of intervention. Information was collected from interviews, focus group discussions, and the researchers' own observations. Most methods were found to serve the purpose of monitoring resources rather than biodiversity *per se*. Methods should be better integrated with one another, adjusted to existing norms and regulations, and institutionalized within community-based organisations. Author: schmidt@ait.ac.th

Taylor, M., Braber, B.D., Mahmoud, N. & Fanning, E. (2012) *Frontier Cambodia Forest Programme Phase 123: Science*

Report: July 2nd–August 20th 2012. Frontier, London, United Kingdom.

Progress report on the last round of inventories and other research by Frontier in Kulen Promtep Wildlife Sanctuary. This report covers insects (Odonata, Lepodoptera), amphibians, reptiles, birds and mammals (including bats and primates). Online: http://www.frontier.ac.uk/Publications/Files/2012_10_15_10_17_21_832.pdf

Tordoff, A.W., Baltzer, M.C., Fellowes, J.R., Pilgrim, J.D. & Langhammer, P.F. (2012) Key Biodiversity Areas in the IndoBurma Hotspot: process, progress and future directions. *Journal of Threatened Taxa*, **4**, 2779–2787.

Key Biodiversity Areas (KBAs) identify sites of conservation importance. Based on the status and distribution of various taxa (but predominantly birds, for which more complete data are available), 438 KBAs have been identified in the Indo-Burma Biodiversity Hotspot, covering 11.5% of the region. Of these, 58% are wholly or partly included within protected areas. KBAs have been used to set conservation priorities, guide investments by various donors (e.g. CEPF) and guide the application of environmental safeguard policies by international financial institutions. Author: j.tordoff@conservation.org; Online: <http://threatenedtaxa.org/ZooPrintJournal/2012/August/o300006viii122779-2787.pdf>

Species ecology and status

Anonymous (2012) *Endangered Birds Released in Stung Treng Province*. Press release from Angkor Centre for Conservation of Biodiversity, Siem Reap, Cambodia, and BirdLife International in Indochina, Phnom Penh, Cambodia.

Two Critically Endangered white-shouldered ibises were released into the wild in Siem Pang District, Stung Treng Province. The birds had been confiscated from local villagers by Forestry Administration rangers in Western Siem Pang. Author: lara.rogers@accb-cambodia.org

Bird, J.P., Mulligan, B., Rours V., Round, P.D. & Gilroy, J.J. (2012) Habitat associations of the Manchurian reed warbler *Acrocephalus tangorum* wintering on the Tonle Sap floodplain and an evaluation of its conservation status. *Forktail*, **28**, 71–76.

The Tonle Sap floodplain in Cambodia may be the most significant wintering site of the Vulnerable migrant Manchurian reed warbler. This study found the birds were significantly associated with tall (>1.0 m) grassland. Author: jezbird@gmail.com

Clements, T. Gilbert, M. Rainey, H.J., Cuthbert, R., Eames, J.C., Pech B. & Seng T. (2012) Vultures in Cambodia: population, threats and conservation. *Bird Conservation International/ FirstView Article*, 1–18, doi: 10.1017/S0959270912000093

Vultures have declined by 90–99% in the Indian Subcontinent due to poisoning by veterinary use of the drug diclofenac. Cambodia supports among the last populations of white-rumped vulture, slenderbilled vulture and red-headed vulture because diclofenac is not widely used here. Population sizes of each species are estimated at 50–200+ individuals, ranging across approximately 300 km by 250 km, including adjacent areas of Laos and Vietnam. The principal causes of vulture mortality are poisoning (73%) – probably an unintended consequence of local hunting and fishing – and hunting or capture for traditional medicine (15%). Cambodia's vultures are heavily dependent on domestic ungulate carcasses because wild ungulates have declined. Limiting the use of poisons and providing supplementary food ('vulture restaurants') are necessary to conserve these birds. Author: tclements@wcs.org; Online: http://www.vulture-rescue.org/index_files/2012%20Clements%20et%20al%20Cambodia%20vultures.pdf

Edwards, S. & Demski, M. (2012) Asiatic golden cat record from the Kulen-Promtep Wildlife Sanctuary, Cambodia. *CATnews (Newsletter of the IUCN/SSC Cat Specialist Group)*, **57**, 32.

A camera trapping survey from January to August 2011 provided the first evidence of Near Threatened Asiatic golden cats *Catopuma temmincki* in the Oddor Meanchay Province side of Kulen-Promtep Wildlife Sanctuary. Six consecutive images were obtained. Author: sarah-edwards1985@yahoo.co.uk

Gray, T.N.E., Phan C., Pin C. & Prum S. (2012) Establishing a monitoring baseline for threatened large ungulates in eastern Cambodia. *Wildlife Biology*, **18**, 406–413.

The densities of large (> 15 kg) ungulates in Mondulkiri Protected Forest and Phnom Prich Wildlife Sanctuary, were estimated using distance sampling along line transects. Estimated densities (\pm SE) were 1.1 ± 0.2 banteng/km², 1.4 ± 0.4 wild pigs/km² and 2.2 ± 0.2 red muntjacs/km². Overall large ungulate density was lower than expected, with a notable scarcity of large deer due to hunting. An increase in ungulate density, driven by strong protected area management, is required before tiger populations can be restored. Author: tomne.gray@hotmail.com

Gray, T.N.E., Prum S., Pin C. & Phan C. (2012) Distance sampling reveals Cambodia's Eastern Plains Landscape supports the largest global population of the Endangered banteng *Bos javanicus*. *Oryx*, **46**, 563–566.

Distance sampling using line transects produced an estimate of 3,200 \pm 703 Endangered banteng *Bos javanicus* in Mondulkiri Protected Forest and Phnom Prich Wildlife Sanctuary. This is a major proportion of the estimated global population of 5,000–8,000 banteng. Increased anti-

poaching patrols plus integrated land use planning are essential for safeguarding banteng and their habitats in the Eastern Plains. Author: tomnegrays@hotmail.com

Handschuh, M. (2012) How to catch a green peafowl. *G@llinformed (Newsletter of the Galliformes Specialist Group)*, **7**, 5–10.

This paper describes the lessons learned from efforts to catch wild green peafowl *Pavo muticus* for a radiotagging study in Seima Protection Forest. Whoosh nets, combined with bait, proved to be safer and more effective than other methods tested. Author: markus.handschuh@gmx.de; Online: <http://birdlifeindochina.org/sites/default/files/How-to-catch-a-green-peafowl.pdf>

Johnson, K. (2012) Recent Amphibian Conservation Needs Assessment workshops. *AArk Newsletter*, **19**, 2–3.

The conservation needs of 203 species of amphibians in Vietnam, Laos and Cambodia were assessed during a five-day workshop in Hanoi in March 2012. Very little is known about many amphibian species in Indochina and more research is required. Although a number of species occur in protected areas, many of these areas fail to provide effective protection from hunting and habitat destruction for agriculture and mining, especially in Cambodia. Author: KevinJ@AmphibianArk.org; Online: http://www.amphibianark.org/Newsletters/AArk_Newsletter_19.pdf [According to results posted on http://www.amphibianark.org/resources/assessment-results_of_the_65_species_assessed_in_Cambodia, 22 species require in situ conservation action to ensure their survival, 22 species require research to determine their distribution or threats, 30 species are "suitable for conservation education purposes" and only 18 species require no action – Ed.].

Kuenzel, T. & Bou V. (2012) *Local Communities and Conservation of Critically Endangered Ibis Species: Case Study from Western Siem Pang (WSP), Cambodia*. Report to the Mohammed bin Zayed Conservation Fund from BirdLife International, Phnom Penh, Cambodia.

Progress report on a community-based project to conserve giant and white-shouldered ibises. Online: <http://www.speciesconservation.org/projects/Giant-Ibis/2482>

Mahood, S. (2012) *Preventing Poisoning of Cambodia's Vultures*. Final report to CEPF from Wildlife Conservation Society, Phnom Penh, Cambodia.

Progress and lessons learned from a one-year project focused on white-rumped vultures, slender-billed vultures and red-headed vultures. The project aimed to educate villagers to avoid accidental poisoning of vultures with pesticides, provide safe food to vultures and protect and monitor nests. Cases of accidental poisoning of vultures dropped sharply, putatively due to increased awareness of safer use and disposal of pesticides. Author:

s.mahood@wscambodia.org; Online: http://www.cepf.net/SiteCollectionDocuments/indo_burma/FinalProject-CompletionReport_WCS_Vultures.pdf

Mahood, S. (2012) Conserving a suite of Cambodia's highly threatened bird species. *The Babbler*, **42**, 27.

Progress report from the Wildlife Conservation Society, covering a number of bird species in multiple sites. The author noted that the cancellation of a fishing lot that overlapped with Prek Toal triggered more illegal fishing and more disturbance to waterbirds in this area. Author: s.mahood@wscambodia.org; Online: <http://birdlifeindochina.org/sites/default/files/Babbler42.pdf>

Mlup Baitong (2012) Cambodia – community based ecotourism and sarus crane conservation. *The Babbler*, **42**, 26–27.

Anlong Pring Sarus Crane Reserve was established in 2011 in Kampong Trach District, Kampot Province, and is managed by Forestry Administration. This is an important area for cranes outside of the breeding season. Mlup Baitong is working with poor farmers who live around the reserve to tackle disturbance of the cranes and promote alternative ways of generating income. A tourist guide service for bird watching began in March 2012. Author: info@mlup-baitong.org; Online: <http://birdlifeindochina.org/sites/default/files/Babbler42.pdf>

O'Kelly, H.J., Evans, T.D., Stokes, E.J., Clements, T.J., An D., Gately, M., Nut M., Pollard, E.H.B., Men S. & Walston, J. (2012) Identifying conservation successes, failures and future opportunities; assessing recovery potential of wild ungulates and tigers in Eastern Cambodia. *PLOS ONE*, **7**, e40482, doi:10.1371/journal.pone.0040482

Despite the presence of extensive areas of habitat, Indochina's tigers and their ungulate prey have declined severely. The Eastern Plains was identified in 2000 as a Global Priority Tiger Conservation Landscape. Since 2005, distance-sampling, camera trapping and surveys using detection dogs have been employed to assess the recovery potential of ungulate and tiger populations in Seima Protection Forest. Overall ungulate populations remain well below the expected carrying capacity, and there is no resident population of tigers, putatively due to both intensive hunting and low prey density. Eastern Cambodia no longer meets the criteria of a Global Priority Tiger Landscape, but Seima Protection Forest still holds other globally important biodiversity. It has potential to support tigers only on condition there is adequate prey and protection. Author: hokelly@wcs.org; Online: <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0040482>

Perlman, L. (2012) *Improving Wildlife Law Enforcement in Cambodia to Protect CEPF Priority Species from Overexploita-*

tion and Illegal Wildlife Trade. Report to CEPF from Wildlife Alliance, Phnom Penh, Cambodia.

Achievements and lessons learned from a project that aimed to institutionalize government action against illegal wildlife trade, implement the ASEAN-WEN (Wildlife Enforcement Network) in Cambodia, and improve the law enforcement on the ground by strengthening the capacity of the existing Wildlife Rapid Rescue Team (establishing this team as the national-level task force of Cambodian-WEN). In two years, 9,659 wild mammals, birds and reptiles were seized from poachers and traders, including Asiatic black bears, fishing cats, douc langurs, various freshwater turtles and sarus cranes. Author: lperlman@online.com.kh; Online: http://www.cepf.net/Documents/Final_wildlife_alliance_law_enforcement_to_protect_priority_species_indoburma.pdf

Ren T., Sorn S., Holl D., Lofti A. & Lu, H. (2012) New outbreaks of H5N1 highly pathogenic avian influenza in domestic poultry and wild birds in Cambodia in 2011. *Avian Diseases*, **56**, 861–864.

Five outbreaks of H5N1 avian influenza were detected in domestic poultry in Kandal, Banteay Meanchey and Battambang provinces and wild birds in Phnom Tamao Wildlife Rescue Centre in 2011. Some affected birds showed sudden death without obvious clinical symptoms. All domestic poultry flocks with infected birds were culled immediately in accordance with national strategies to control this disease. Author: hxl15@psu.edu

Voeun V. (2012) Zooarchaeology at Phum Snay, a prehistoric cemetery in Northwestern Cambodia. *Advances in Asian Human-Environmental Research*, **2013**, 229–246.

More than 2,000 years ago, people living at Phum Snay in Rohal Commune (Preah Net Preah District, Banteay Meanchey Province) were already engaged in animal processing. Author: vuthyvoeunkh@yahoo.com

Wright, H.L. (2012) *Synanthropic survival: low-impact agriculture and white-shouldered ibis conservation ecology*. PhD thesis, University of East Anglia, Norwich, United Kingdom.

The status and ecology of white-shouldered ibises was investigated by censuses, foraging observations, prey sampling, experimental exclusion of grazing and burning at foraging habitats, and experimental protection of nests. Ibis ecology was found to be closely associated with local livelihood practices, with the birds favouring dry forests created or maintained by livestock-grazing, anthropogenic fire and rice cultivation. Not all human practices are beneficial, however, as ibis nests are exploited for food by local people. The use of nest guardians does not appear to improve nest success. Author: wright@uea.ac.uk; Online: <https://ueaeprints.uea.ac.uk/40591/1/2012WrightHLPd.pdf>

Wright, H.L., Collar, N.J., Lake, I.R., Bou V. & Dolman, P.M. (2012) Foraging ecology of sympatric white-shouldered ibis *Pseudibis davisoni* and giant ibis *Thaumatibis gigantea* in northern Cambodia. *Forktail*, **28**, 93–100.

Giant ibises forage in wetter areas than white-shouldered ibises during the dry season, suggesting the species occupy different niches. Although conservation actions can address both species in dry dipterocarp forests, their ecological differences must be taken into account. Author: wright@uea.ac.uk

Coasts, wetlands and aquatic resources

Almack, K. & Kura, Y. (2012) Stung Treng Ramsar Site in Cambodia: integrating fisheries management and wetlands conservation. *The Babbler*, **42**, 28–29.

The World Fish Centre has a project to assist local community fisheries groups to develop and test the conservation of deep pools as dry season fish refuges. Although it is too soon to determine whether this will boost fisheries productivity, community members have been active in preventing fishing in three pilot pools. Author: hello@kaitlinalmack.ca; Online: <http://birdlifeindochina.org/sites/default/files/Babbler42.pdf>

Arias, M.E., Cochrane, T.A., Piman, T., Kummu, M., Caruso, B.S. & Killeen, T.J. (2012) Quantifying changes in flooding and habitats in the Tonle Sap Lake (Cambodia) caused by water infrastructure development and climate change in the Mekong Basin. *Journal of Environmental Management*, **112**, 53–66.

The Mekong River Basin is changing rapidly due to water infrastructure development (hydropower, irrigation, flood control, etc.) and climate change. Maps of water depth, annual flood duration and flood frequency were created to examine recent hydrological changes and predict future changes. It was found that water infrastructure development will increase the area of open water by at least 18% and rain-fed habitats by at least 10%, and reduce the area covered with seasonally flooded habitats by at least 13% and gallery forest by at least 75%. Meanwhile, climate change will drive an increase in open water, and reduce rainfed habitats and seasonally flooded habitats. Author: mauricio.arias@pg.canterbury.ac.nz

Baran E. & Guerin E. (2012) *Fish Bioecology in Relation to Sediments in the Mekong and in Tropical Rivers*. WorldFish Center, Phnom Penh, Cambodia.

The Mekong River contains an exceptionally high diversity of fish, which increases downstream. Plans to construct 88 hydropower projects by 2030 will have a very substantial impact on the river's sediment load

(due to sediment trapping by dams). Sediments influence fish in various ways, particularly respiration, nutrition, reproduction and migration. This detailed technical report reviews the interactions between sediments and fish in tropical rivers, and predicts the likely impacts of significantly reduced sediment loads in the Mekong River if the dams are constructed. Author: e.baran@cgiar.org; Online: http://www.worldfishcenter.org/resource_centre/WF_3137b.pdf

Burnett, W.C., Peterson, R.N., Chanyotha, S., Wattayakorn, G. & Ryan, B. (2012) Using high-resolution *in situ* radon measurements to determine groundwater discharge at a remote location: Tonle Sap Lake, Cambodia. *Journal of Radioanalytical and Nuclear Chemistry*, doi: 10.1007/s10967-012-1914-8

This study examined the northern section of the lake and measured natural radon, temperature, conductivity and water depth. Results show that groundwater discharge accounts for 10–20% of the freshwater flow of the Tonle Sap River, and the authors infer that a significant quantity of nutrients are transported via this groundwater, especially during the draining (dry season) portion of the annual flood cycle. Author: wburnett@fsu.edu

Cartin, M., Welling, R., Pangare, G. & Rattanasorn, T. (2012) *Mekong River Basin: Mobilising Grassroots Engagement and Facilitating High-Level Dialogue for Transboundary Water Management*. Demonstration Case Study No.3, Water and Nature Initiative, IUCN, Gland, Switzerland

Brief report on the activities and lessons learned from the Water and Nature Initiative's activities in the Mekong Basin, including Cambodia. Author: water@iucn.org; Online: <http://data.iucn.org/dbtw-wpd/edocs/2012-009.pdf>

Chap S., Meng K., Tep C. & Joffre, O. (2012) *Crab Fisheries in Cambodia and the Development of Crab Banks*. The WorldFish Center, Phnom Penh, Cambodia.

Swimming crabs *Portunus pelagicus* have declined due to overfishing, but remain an important source of income for coastal households. Mean crab catches vary from 4.5–39.0 kg/day/fisher, with many fishers specialising on crabs. Several initiatives are underway to test stock enhancement techniques through the release of crab larvae. The “crab bank” initiative entails keeping gravid crabs alive until they spawn. Crab fishers perceive that stocks have increased as a result of this approach, but their fishing effort has also increased, by using loans to buy more gear. This report calls for monitoring of the crab catch by fishers and enhancing the capacity of community fisheries organisations to manage crab fishing activities, including combating illegal fishing and avoiding over-exploitation. Author: worldfish-cambodia@cgiar.org; Online: http://www.worldfishcenter.org/resource_centre/WF_3261.pdf

Chheang V. (2012) A Cambodian perspective on Mekong River water security. *The Babbler*, **42**, 11–12.

Lao PDR's planned construction of the Xayaburi hydro-power dam will cause severe negative impacts on the Lower Mekong Basin. The food source of 80% of Cambodians will be affected, including the wild fish stocks in the Tonle Sap Lake that feed 1.6 million people and contribute 10% of national GDP. This paper calls for improved regional cooperation in the management of the Mekong River, including greater exchanges of scientists, engineers and data between the Upper and Lower Mekong Basin countries. (First published on www.stimson.org, 4 April 2012). Online: <http://birdlifeindochina.org/sites/default/files/Babbler42.pdf>

Hamilton, M. (2012) Perceptions of fishermen towards marine protected areas in Cambodia and the Philippines. *Bioscience Horizons*, **5**, 10.1093/biohorizons/hzs007

Marine protected areas (MPAs) can be used to conserve parts of marine ecosystems, including fish stocks exploited by fisheries. Fishers from two areas were surveyed: Koh Rong Island in Cambodia, where MPAs are a new concept to fishers, and Southern Leyte in the Philippines, where MPAs have been used for >10 years. Cambodian fishers reported that the state of marine resources had worsened in the past decade (in terms of the number of individuals, the size of fish and the number of species), whereas Filipino fishers had noticed the opposite trend and perceived that MPAs had improved their catches. Older Cambodian fishers displayed a greater acceptance of MPAs than younger ones. Community-based management of MPAs was preferred by fishers at both sites. The study shows evidence of MPA support in Cambodia, with mobile gear users being the most willing to be involved in management. Author: m.hamilton.08@aberdeen.ac.uk; Online: <http://biohorizons.oxfordjournals.org/content/5/hzs007.full.pdf+html>

Herbertson, K. (2012) *The Xayaburi Dam: Threatening Food Security in the Mekong*. International Rivers, Berkeley, CA, USA.

This report chiefly focuses on the implications of the dam for people in Laos, but criticises the Lao Government for not studying the dam's likely impacts on Cambodia and Thailand, in breach of the 1995 Mekong Agreement. The dam developers promise that their proposed mitigation measures will work, but this is refuted by scientists with the Mekong River Commission Secretariat, International Centre for Environmental Management and WWF, who assert that no mitigation solutions have been found to fully compensate for the food that will be lost by building the such dams. The author concludes that given the risks involved, the Xayaburi Dam builders must cease construction until the dam's impacts have been studied.

Only then can the four Mekong governments proceed towards an informed, agreeable solution. Author: kherbertson@internationalrivers.org; Online: <http://www.internationalrivers.org/resources/the-xayaburi-dam-threatening-food-security-in-the-mekong-7675>

Le X.S., Do M.C., Hap N., Un S., Tray B., Pomeroy, R.S. & Grimm-Greenblatt, J. (2011) *Value Chain of Snakehead Fish in the Lower Mekong Basin of Cambodia and Vietnam*. Cantho University, Vietnam, Inland Fisheries Research & Development Institute (IFReDI), Cambodia, and Connecticut University, USA.

70% of aquaculture production in Cambodia uses cage culture. The most important and valuable fish species in the cage system is the *chhdaur* or giant snakehead, *Channa micropeltes*. Thousands of cages were established during the early 2000s, along the Mekong River, the Great Lake and Tonle Sap River, but in 2005, the Cambodian government banned farming of snakehead fish to protect wild stocks. Wild fish remain scarce, and around 400 tonnes of cultured snakeheads are imported to Cambodia from Vietnam annually to meet demand. This report provide costed details of fishing activities and trade chains, from supplier to consumer. The authors recommend developing a snakehead action plan for Cambodia that includes measures to prevent over-fishing of wild stocks and support well-managed snakehead farms for the domestic and even international market. Author: robert.pomeroy@uconn.edu

Li, Z., Saito, Y., Mao, L., Tamura, T., Li, Z., Song, B., Zhang, Y., Lu, A., Sotham S. & Li, J. (2012) Mid-Holocene mangrove succession and its response to sea-level change in the upper Mekong River Delta, Cambodia. *Quaternary Research*, **78**, 386–399.

Middle Holocene vegetation and mangrove successions were found in the palynological records of two cores from the upper Mekong River Delta in Cambodia, dating from approximately 9,400 to 6,300 years ago. Pioneer mangrove species, *Sonneratia alba* and *S. caseolaris*, appeared in the sediments around 8,300 years ago, corresponding to sea-level rise, and were subsequently succeeded by *Rhizophora apiculata* and *Bruguiera* spp. From 7,500–7,000 years ago, the thickening intertidal sediments may be explained by continuous sea-level rise. Author: imlizhen@hotmail.com

Nguyen V.T., Choi, J.-H. & Won, J.S. (2012) A land cover variation model of water level for the floodplain of Tonle Sap, Cambodia, derived from ALOS PALSAR and MODIS data. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, **PP**, 1–16. [Pre-print version].

To estimate changes in the areas of six land cover classes during the annual flood pulse, this study used the Phased Array L-band Synthetic Aperture Radar (PALSAR) back-

scattering coefficients, normalised difference vegetation index values, and tasseled cap transformations of Terra and Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) data from 2007 to 2010. This model provides insight into flood dynamics that could aid flood management. Author: nvtrungvn@yonsei.ac.kr

Orr, S., Pittock, J., Chapagain, A. & Dumaresq, D. (2012) Dams on the Mekong River: lost fish protein and the implications for land and water resources. *Global Environmental Change*, **22**, 925–932.

Dam construction in the Lower Mekong Basin will significantly reduce fish stocks, driving people to require increased livestock production for their animal protein. Depending on the number and locations of dams, this study estimates that water demand will increase by 4–17% across the region (at least 29% increase in Cambodia) to support the additional livestock. The livestock will also require an extra 4,863–24,188 km² of grazing land (13–63% increase). These results suggest that basic food security is at a high risk of disruption and stakeholders should be fully engaged in designing strategies to offset these impacts. Author: sorr@wwfint.org

Pham A.D., Nguyen T.M.L. & Pham V.M. (2012) Study on migration of marine organisms into inland and changes of biodiversity at water bodies in Mekong Delta for evaluation of saline intrusion of sea level rise. *APCBEE Procedia*, **1**, 252–257.

In recent decades, negative impacts of human activities on natural resources and the environment have worsened in the Mekong River Basin and Delta. Climate change is accelerating the rate of degradation. This report examines evidence for the migration of marine organisms inland and the changes in biodiversity in the Mekong Basin. For example, marine polychaetes and crustaceans have appeared in the Mekong River and Tonle Sap River at Phnom Penh. Author: phamanhduc@tdt.edu.vn

Phauk S., Komatsu, T., Sawayama, S. & Noiraksar T. (2012) Marine habitat mapping: using ALOS AVNIR-2 satellite image for seagrass beds at Rabbit (Koh Tonsay) Island, Cambodia. *Proceedings of SPIE Conference 8525: Remote Sensing of the Marine Environment II, November 21, 2012, Kyoto, Japan*, doi: 10.1117/12.999310

Article not seen. Author: phauk.sophany@rupp.edu.kh

Trandem, A. (2012) The Mekong River reaches critical point as the Xayaburi dam advances. *The Babbler*, **43**, 6–7.

The government of Lao PDR announced that they will proceed with constructing the Xayaburi dam, in spite of objections from other Mekong nations. As the first dam on the main Mekong River, this will have severe ecological and socio-economic consequences for Cambodia and Vietnam, potentially leading to conflict over water within this region. The author dismisses claims that the

dam can be constructed in such a way as to mitigate its impacts on fisheries and sediment flows. Author: ame@internationalrivers.org; Online: <http://birdlifeindochina.org/sites/default/files/Babbler43.pdf>

Werthmann, C. (2012) Helpless in fighting free-riding: the influence of exogenous factors on collective action for small-scale aquaculture in the Mekong Delta of Cambodia and Vietnam. *Paper presented to the conference 'Design and Dynamics of Institutions for Collective Action', 29 November - 1 December 2012, Utrecht University, the Netherlands.*

A collective, community-based approach for small-scale fish farming was implemented in the Mekong Delta to test whether it could improve food security and reduce poverty. In three of the four case study sites, the aquaculture project was discontinued due to technical and natural reasons as well as unwelcome “free-riding” by project members and non-members. Although farmers were willing to cooperate and trust each other, it appeared that exogenous factors made the experiment fail. Author: christine.werthmann@agrar.hu-berlin.de; Online: http://www.collective-action.info/conference/sites/default/files/Werthmann_abstract.pdf

Ziv, G., Baran, E., So N., Rodríguez-Iturbe, I. & Levin, S.A. (2012) Trading-off fish biodiversity, food security, and hydropower in the Mekong River Basin. *Proceedings of the National Academy of Sciences of the United States of America*, **109**, 5609–5614.

The Mekong River Basin supports the world’s biggest inland fishery. Planned dams will block critical fish migration routes between the river’s downstream floodplains and upstream tributaries. Using modelling, this study finds that the construction of 78 dams on tributaries will have catastrophic impacts on fish productivity and biodiversity. The authors call for a reassessment of several of the planned dams, and for a new regional agreement on development on tributaries of the Mekong River. Author: guyziv@stanford.edu

Forests and forest resources

Chae H.S., Khiev P., Lee, H.K., Oh, S.R. & Chin, Y.W. (2012) Anti-allergic effect of a chloroform-soluble extract of *Cinnamomum cambodianum* in bone marrow-derived mast cells. *Immunopharmacology and Immunotoxicology*, **34**, 639–644.

The tree *Cinnamomum cambodianum* has long been used as a traditional medicine in Cambodia. This study tested the effect of a chloroform-soluble extract of *C. cambodianum* on allergic mediators. The results revealed that the chloroform-soluble extract inhibits the production of interleukin-6, prostaglandin D₂ and leukotriene C₄, and the expression of cyclooxygenase-2 in phorbol 12-myristate 13-acetate (PMA) plus calcimycin-stimulated bone

marrow-derived mast cells (BMMCs). This indicates that extracts of *C. cambodianum* could be used to treat allergies. Author: seiryang@kribb.re.kr

Eames, J.C. (2012) Western Siem Pang: towards a vision for biodiversity conservation in the dry forests of Cambodia. *The Babbler*, **43**, 4–5.

Brief report on the first year of a three-year project to seek endorsement from stakeholders for the feasibility study for a Forest of Hope at Western Siem Pang; to improve the status of biodiversity in Western Siem Pang; to secure sustainable financing for a feasibility study; and to increase awareness of Western Siem Pang. Author: Jonathan.Eames@birdlife.org; Online: <http://birdlifeindochina.org/sites/default/files/Babbler43.pdf>

Eames, J.C. & Bou V. (2012) Cambodia: the destruction of Lomphat Wildlife Sanctuary. *The Babbler*, **42**, 46–47.

The 250,000-ha Lomphat Wildlife Sanctuary in Monduliri and Ratanakiri provinces supports five Critically Endangered bird species, notably white-shouldered ibises and giant ibises. Despite not having an approved zoning plan, six Economic Land Concessions have been authorised in this wildlife sanctuary. The authors fear this will jeopardise the area's ibises and other wildlife. Author: Jonathan.Eames@birdlife.org; Online: <http://birdlifeindochina.org/sites/default/files/Babbler42.pdf>

Keating, N.B. (2012) From spirit forest to rubber plantation: the accelerating disaster of “development” in Cambodia. *ASIANetwork Exchange*, **19**, 68–80.

Despite Cambodia's rising GDP and other development indicators, the rapid conversion of traditional subsistence lands, forests and waters into land concessions is leading to intensified land insecurity issues and other problems. This paper examines how life is changing for indigenous Kuy peoples in the vicinity of Boeng Peae (Beng Per) Wildlife Sanctuary, Preah Vihear Province. Author: nkeating@brockport.edu

Khiev P., Kwon, O.K., Song, H.H., Oh, S.R., Ahn, K.S., Lee, H.K. & Chin, Y.W. (2012) Cytotoxic terpenes from the stems of *Dipterocarpus obtusifolius* collected in Cambodia. *Chemical and Pharmaceutical Bulletin (Tokyo)*, **60**, 955–961.

Five new triterpenes were collected from stems of the tree *Dipterocarpus obtusifolius*, together with 13 known compounds, including diterpene, sesquiterpenes and triterpenes. All isolates were tested for their cytotoxicity against human cancer cells. Of the tested compounds, eight were found to be toxic to one or more human cancer cell lines. Author: seiryang@kribb.re.kr

San V., Spoann V., Ly D & Chheng N.V. (2012) Fuelwood consumption patterns in Chumriey Mountain, Kampong Chhnang Province, Cambodia. *Energy*, **44**, 335–346.

Approximately 96% of sampled households depend on

fuelwood for cooking, boiling water and preparing animal feed, and use wood smoke to repel insects from cattle. Average daily fuelwood consumption per family is 5.21 kg for cooking and 2.82 kg for boiling water, with additional large quantities used by households that have cattle or pigs. The favourite fuelwood species is *Shorea obtusa* followed by *Dipterocarpus obtusifolius*, *Xylia xylocarpa*, *Cratoxylon prunifolium* and *D. tuberculatus*. Author: san.vibol@rupp.edu.kh

San V., Sriv T. Spoann V., Var S. & Seak S. (2012) Economic and environmental costs of rural household energy consumption structures in Sameakki Meanchey District, Kampong Chhnang Province, Cambodia. *Energy*, **48**, 484–491.

This study in Kampong Chhnang Province found that most households consume a variety of energy sources, including fuelwood, plant waste, kerosene and liquefied petroleum gas (LPG). Fuelwood and plant waste is used for cooking and boiling water, while rechargeable batteries are used for lighting and run home devices. Mean monthly energy cost per household is \$33.23 with electricity and \$19.11 without, but electricity was calculated to have a lower environmental cost. Both environmental and economic costs are reduced when biogas is used, so this should be promoted throughout rural Cambodia. Author: san.vibol@rupp.edu.kh

Singh, S. (2012) Borderland practices and narratives: illegal cross-border logging in northeastern Cambodia. *Ethnography*, doi: 10.1177/1466138112463805

Booming regional demand for luxury rosewood timber has seen the recent expansion of illegal logging along the border of Northeast Cambodia and Laos. This article examines how cross-border logging works, and the interactions and roles of villagers and border authorities. Author: s.singh2@uq.edu.au

Wyatt, T. (2012) From the Cardamom Mountains of Southwest Cambodia to the forests of the world: an exploration of the illegal charcoal trade. *International Journal of Comparative and Applied Criminal Justice*, **37**, 15–29.

Charcoal is used by rural and urban people for cooking, but contributes to deforestation, desertification and climate change. Using a literature review and data from Wildlife Alliance and the Forestry Administration, this study predicts dire consequences for the environment and people unless illegal charcoal trade is treated as a serious crime. Author: tanya.wyatt@northumbria.ac.uk

Yen, H.M., Preece, L., Nguyen N.L. & Colfer, C.J.P. (2013) A review of conservation area governance in Cambodia, Laos and Vietnam. In *Evidence-based Conservation: Lessons from the Lower Mekong* (eds T.C.H. Sunderland, J.A. Sayer & Hoang M.-H.), pp. 273–308. Earthscan, London, United Kingdom.

This review summarises the management of conservation areas in Indochina based on an appraisal of 15 sites, including five in Cambodia. The authors compare the activities, progress and constraints to managing conservation areas. Cambodia, for example, is distinguished for having a greater focus on development activities (education, training, healthcare, etc) within its conservation areas, but poorer inter-organisational collaboration than in Vietnam and Lao PDR. NGOs in Cambodia are criticised for paying significantly more than the standard government salaries. Author: lukepreece@gmail.com

Payments for conservation services, including carbon

Biddulph, R. (2012) *REDD and Poverty in Cambodia*. Focali Report No 2012:03, Focali, Gothenburg, Sweden.

In Cambodia, the rate of deforestation was 0.5% per year during 2000-2005. A national taskforce was established in 2010 by the government, donors and NGOs to develop a "roadmap" to enable Cambodia to qualify for emissions payments for REDD by 2015. Pilot activities are underway to link forest preservation to the voluntary carbon market; the most advanced being the Oddar Meanchey Community Forest REDD pilot and the Seima Protected Forest REDD pilot. Problems to date include the relatively low projected payments to local communities (\$17 per person per year anticipated for Oddar Meanchey), many community forestry members still need to clear land for agriculture, and local ownership of forest areas risks being undermined as authorities take greater control. It is uncertain whether REDD will improve or worsen the livelihoods of forest communities. Attempts have been made to secure individual tenure for farm plots in the forest using informal agreements with the Forestry Administration. If this could be upgraded to formal land registration with the Ministry of Land Management, it could be a valuable outcome for local farmers from REDD-related activities. Author: robin.biddulph@geography.gu.se; Online: http://www.focali.se/filer/Focali%20report%20nr.2012.03-%20REDD%20and%20Poverty%20in%20Cambodia_final.pdf

Ly S. (2012) Findings from the Ministry of Environment Gender Assessment. *Paper presented to National Seminar on Gender, Forestry and REDD+, 27th July 2012, Phnom Penh, Cambodia.*

Powerpoint in Khmer on the Ministry's gender assessment, with reference to REDD+. Online: http://www.pactcambodia.org/Programs/Synopsis/Ly_Sophorn_MOE.pdf

Milne, S. (2012) Grounding forest carbon: property relations and avoided deforestation in Cambodia. *Human Ecology*, **40**, 693-706.

Forest carbon has become a commodity to be produced and traded through market mechanisms that reduce emissions from deforestation and forest degradation (REDD). This paper compares two REDD-like contracts that are being implemented in the Cardamom Mountains by an international conservation organisation and the Forestry Administration, and examines how they affect local communities. Author: sarah.milne@anu.edu.au

Net C. (2012) Gender and REDD+: an assessment in the Oddar Meanchey Community Forestry REDD+ site, Cambodia - Part 2. *Paper presented to National Seminar on Gender, Forestry and REDD+, 27th July 2012, Phnom Penh, Cambodia.*

A study in the Oddar Meanchey REDD+ site found men taking a much greater role than women in meetings, training, patrolling and other forest management activities. Women explained they were not invited or were too busy with household chores. Importantly, men and women each bring different knowledge, skills and interests to forest management, e.g. women play a greater role in trading forest NTFPs. Recommendations from this study include gender sensitivity training, training of women (literacy, leadership, marketing, financial management), routine monitoring of female involvement in the programme, and ensuring there is equal access to benefit-sharing and decision-making. Author: caminfo@pactworld.org; Online: http://pactcambodia.org/Programs/Synopsis/Net_Channa_Pact.pdf

Raetz, S., Bradley, A., Seng S. & Net C. (2012) *Oddar Meanchey Community Forestry REDD+ Frontline SMS Pilot*. Community Forestry Partnership Program, Pact, Phnom Penh, Cambodia.

Frontline SMS is an open-source mobile phone SMS (short message service) communication interface. The application *Frontline Forms* was tested as a tool for patrol reporting by three community forest management teams. It was easy to set up and enter data in compliance with the basic monitoring requirements of the Voluntary Carbon Standard. *Frontline Forms* enabled the community forestry teams to swiftly and regularly submit their findings to the central database. Some data entry mistakes were experienced, however, highlighting the need for manual or automatic checking of data. Author: ABradley@pactworld.org; Online: <http://www.frontlinesms.com/wp-content/uploads/2011/12/FINAL-OM-REDD-FrontlineSMS-Trial-Report-2012.pdf>

Vong S. (2012) Gender mainstreaming in the Forestry Administration. *Paper presented to National Seminar on Gender, Forestry and REDD+, 27th July 2012, Phnom Penh, Cambodia.*

The Forestry Administration has conducted a nationwide training programme to increase female involvement in the forestry sector, with reference to REDD+. Trainees

have included Forestry Administration staff and community forestry teams in many provinces. Online: http://www.pactcambodia.org/Programs/Synopsis/Vong_Panha_FA.pdf

Yeang D. (2012) Gender and REDD+: an assessment in the Oddar Meanchey Community Forestry REDD+ site, Cambodia - Part 1. *Paper presented to National Seminar on Gender, Forestry and REDD+, 27th July 2012, Phnom Penh, Cambodia.*

Initiated in 2008, the Oddor Meanchey REDD+ site contains 13 community forests, which cover 64,318 ha and contain 58 villages. This paper outlines the aims and methods of a study to determine how women can equably benefit from REDD+ when carbon credits are traded. (The findings of this study were presented by Net, 2012, above). Author: yeangdonal@gmail.com; Online: http://pactcambodia.org/Programs/Synopsis/Donal_Yeang_Pact.pdf

Climate change

Rodgers, M., Nash, E., Blate, G., Congdon, G. & Ryan, G.E. (2012) *Resilience on the Mekong: a Vulnerability and Adaptation Assessment in North-East Cambodia*. WWF-Cambodia, Phnom Penh, Cambodia.

The combined impacts of climate change and other threats on communities and their environment were assessed in the Mekong Flooded Forest, between Stung Treng and Kratie. Here, villagers have largely subsistence livelihoods and are highly dependent on forests, the river, NTFPs, fish and farmland. Climate change will exacerbate threats to this ecosystem, including forest clearing, logging, burning, unsustainable fishing, hunting and mining. Possible solutions include: improve governance and natural resource management in the Mekong Flooded Forest; improve land-use planning; raise the profile of the site and improve understanding of its value; and address the threat from hydropower. This report argues that grassroots stewardship of the environment is key to resisting the pressures of climate change. Author: gblate@wwfgreatermekong.org; Online: http://wwf.panda.org/what_we_do/where_we_work/greatermekong/publications/?206139/Resilience-on-the-Mekong-A-Vulnerability-and-Adaptation-Assessment-in-North-East-Cambodia

Other livelihoods initiatives

Sun M. & McCormick, R. (2012) Sustainable livelihoods for Mekong biodiversity and critical wetland resource conservation in Cambodia. *The Babbler*, **42**, 29–30.

The Cambodian Rural Development Team works with 30 community-based organisations (CBOs) in 19 villages in Sambo District, Kratie Province. After training CBO members in animal raising techniques and System of Rice Intensification, and all committees in financial management, there is evidence of participants gaining improved income and working together more effectively to solve problems. Author: info@crdt.org.kh; Online: <http://bird-lifeindochina.org/sites/default/files/Babbler42.pdf>

Miscellaneous

Bourdier, F. (2012) The forgotten people: recent explorations of the past in the borderlands (Northeast Cambodia, South Lao PDR and highlands of Viêt Nam). *Paper presented to the CAIP Workshop, 27-28 February, Vientiane, Lao PDR.*

Includes a discussion of the hill peoples of Ratanakiri. Author: fredericbourdier@yahoo.com; Online: http://www.rencontres-shs-cambodge.ird.fr/content/download/49985/382597/version/1/file/Bourdier_Forgotten%2Bpeople%2Bventiane%2B2012.pdf&sa=X&scisig=AAGBfm1SuV0Ku0FZBQuPKa3A2e5AL0CPew&oi=scholarlr

Zeitoun, V., Forestier, H., Heng S., Puaud, S. & Billault, L. (2012) Direct dating of a Neolithic burial in the Laang Spean cave (Battambang Province, Cambodia): First regional chrono-cultural implications. *Comptes Rendus Palevol*, **11**, 529–537. [In English and French].

In a cave on Phnom Teak Trang, analysis of a Neolithic burial confirms that people lived in Battambang Province 3,310 years ago. Items found around the human skeleton included tortoise shell and the pierced canine of a wild boar; Author: pythecanthro@gmail.com

The Recent Literature section was compiled by JENNY C. DALTRY, with additional contributions from Sarah Edwards, Frédéric Goes, Tom Gray, Oleg Kosterin, James F. Maxwell and Tran Thanh Huong. Please send contributions (published or grey literature, including project technical reports and conference abstracts not more than 18 months old) by email to: Editor.CJNH@gmail.com

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Updated December 2012

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The following are examples of house style:

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Tanaka, S. & Ohtaka, A. (2010) Freshwater Cladocera (Crustacea, Branchiopoda) in Lake Tonle Sap and its adjacent waters in Cambodia. *Limnology*, **11**, 171–178.

Books and chapters:

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

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

Rawson, B. (2010) The status of Cambodia's primates. In *Conservation of Primates in Indochina* (eds T Nadler, B. Rawson & Van N.T.), pp. 17–25. Frankfurt Zoological Society, Frankfurt, Germany, and Conservation International, Hanoi, Vietnam.

Reports:

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.

Theses:

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Conferences papers (published or unpublished):

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Miyazawa, Y., Tateishi, M., Kajisa, T., Ma V., Heng S., Kumagai, T. & Mizoue, N. (2012) Transpiration by trees under seasonal water logging and drought in monsoon central Cambodia. *Paper presented to the European Geosciences Union General Assembly, 22–27 April, 2012, Vienna, Austria*.

Websites:

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