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## Odonata of the south-west and north-east of Cambodia as studied in early rainy season of 2013

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### Abstract

Results of an odonatological survey of the coastal SW regions and continental NE regions of Cambodia in May 22 – June 8, 2013 are presented. All Odonata recorded are listed by localities. Of 107 Odonata species encountered, 104 were identified to species level, of which 15 are reported for the first time for Cambodia, namely *Macromidia genialis shanensis* Fraser, 1927 in Koh Kong Province, *Chalibeothemis fluviatilis* Lieftinck, 1933 in Kampong Saom Province and *Ceriagrion azureum* (Selys, 1891), *Prodasineura coerulescens* Fraser, 1932, *Protosticta caroli* van Tol, 2008; *Gomphidia abbotti* Williamson, 1907, *Lamelligomphus castor* (Lieftinck, 1941), *Macrogomphus kerri* Fraser, 1922, *Nychogomphus duaricus* (Fraser, 1924), *Orientogomphus minor* (Laidlaw, 1931), *Macromia aculeata* Fraser, 1927, *Macromia chaiyaphumensis* Hämäläinen, 1985, *Macromia cincta* (Rambur, 1842), *Nesoxenia lineata* (Selys, 1879) and *Palpopleura sexmaculata* (Fabricius, 1787) in Ratanakiri Province. Besides, *Ceriagrion indochinense* Asahina, 1967 is confirmed for Cambodia. Cambodian specimens of *Hemicordulia* sp. are re-identified as *Hemicordulia tenera* ssp. The country list now reaches 152 named species. Of them, most interesting are 5 species with generally Malay ranges: *Archibasis viola*, *Aethriamanta gracilis*, *M. cincta*, *C. fluviatilis* and *Nesoxenia lineata*. Characters and/or taxonomy are also discussed of *Vestalis gracilis* (Rambur, 1842), *Euphaea masoni* Selys, 1859, *Rhinagrion viridatum* Fraser, 1938, *Aciagrion* spp., *Archibasis* spp., *P. caroli*, *Gynacantha subinterrupta* Rambur, 1842, *Idionyx thailandica* Hämäläinen, 1985, *Neurothemis fluctuans* (Fabricius, 1793) and *P. sexmaculata*. Notes on habitats and habits of some species are provided. General notes on the areas and their Odonata as well as field impressions are briefly outlined and illustrated by photos.

### Key words

*Vestalis gracilis*, wing enfumation, confrontational flight, *Euphaea masoni*, *Rhinagri-*



*on viridatum*, *Rhinagrion mima*, *Aciagrion hisopa*, seasonal variation, *Archibasis viola*, *Archibasis oscillans*, *Protosticta caroli* - description of female, *Gynacantha sub-interrupta*, wing membrane colour, off-water oviposition, *Hemicordulia tenera*, *Idionyx thailandica*, *Neurothemis fluctuans*, *Palpopleura sexmaculata*, *Lestes platystylus*, *Protosticta caroli*, *Macromidia rapida*, diel periodicity, *Brachygonia oculata*, *Brachythemis contaminata*, *Nannophya pygmaea*, *Zygonyx iris malayana*, Odonata attracted by light, Koh Kong Province, Cardamom coastal foothills, Kampong Saom Province, Ratanakiri Province

## Introduction

Talking wildlife in Cambodia is painful. Anyone interested will feed you with very similar reports: “Ministry of Environment has sold Phnom Samkos Wildlife Sanctuary for concession”, “Now there is a lot of construction in Ream National Park”, “Because of recent ‘illegal’ logging in Virachey National Park, the place is no more like it once was” (others advertising an alternative trekking will just tell you “Virachey is sold”). As I already reported, I witnessed myself how they exterminated wetlands at Bokor Hill Station replacing them with a gambling town (Kosterin 2012a, b), and starred at logged forest at once vibrant Koh Por Waterfalls (Kosterin 2011). It has been just reported that Cambodia lost more than 7% of its forest cover (12,595 km<sup>2</sup> of forest lost and 1,096 km<sup>2</sup> of secondary forest regrew) over the past 12 years — the fifth fastest rate in the world, following only Malaysia, Paraguay, Indonesia and Guatemala (Hansen et al. 2013; Zsombor 2013). Satellite images suggest that the area of Cambodia covered in forest has fallen from about 72.11% in 1973 to only about 46.33%, inclusive tree plantations (!), in 2013. In 1973 about 42% of land was covered with dense forest, but only 11% in 2013. “Analysis of Cambodia’s pre-war forest, compared to forest cover in 1989, showed only minor changes, while significant changes were observed between 2000 and 2013” (Worrell 2013). “In the early 2000s, the government began using land to lure investors and introduced a new land law that, in part, focused on the awarding of economic land concessions. Millions of hectares have since been awarded to private companies for development and hundreds of thousands of people have been affected by land disputes.” (Worrell 2013). A saddening article about deforestation in and around Virachey National Park has been published in *Cambodia Daily* (Clais 2013); unfortunately, I have now witnessed this to be true. In 2010, I discovered for myself the seemingly endless and partly virgin evergreen forests of the coastal Cardamom foothills and the mysterious elfin woods of the Bokor Plateau (Kosterin 2010). I have seen with my own eyes that some of these places of paradise have already gone. Some still remain, yet it is clear that I started too late with Cambodia. I should not have waited four years since my first two-day long visit there (Kosterin & Vikhrev 2006). Presently I feel the necessity to occur at many different places simultaneously to reveal their Odonata diversity before it disappears;





however, each 2-3 week long trip provides data demanding months of camera treatment. Anyway, the present day tropical entomology has in fact a great deal of paleontology in it (I would even call this *recental paleontology*), being just documentation of biodiversity that once existed, for it is believed that all tropical natural habitats will disappear in 30-50 years. We are going to leave our children no wildlife to explore.

Yet we still have some left for ourselves. So, in 2013, after two year long breaks, I planned to visit the two most remote regions of Cambodia, the south-west (Koh Kong and Kampong Saom Provinces) and north-east (Ratanakiri Province), which I believed to retain large areas of natural habitats. I was going to visit them in the early rainy season, which I expected to be the best time to get many interesting lotic species represented in this area by Gomphidae and the genera until recently included into Corduliidae in the broad sense. My expectations turned true only in part. Natural habitats were still vast in the south-west but nearly absent in north-east, except for a hardly accessible core of the Virachey National Park. Besides, the north-east appeared poor with water bodies. Surprisingly, these scarce water bodies surrounded with negligible remnants of nature appeared to abound in diverse Odonata. As to the season, the expectations came true with Corduliidae s.l. while Gomphidae appeared diverse and abundant only in the north-east but surprisingly not in the south-west where they were scarce compared to their abundance in August 2011 (Kosterin 2012a).

The results of the trip are presented herein. The paper is split into two parts, 'scientific' and 'informal'. The scientific part (pages 3-48) starts with a formal enumeration of localities visited and Odonata found in each of them. An update for the country fauna is then discussed in general. Further a section dealing with noteworthy peculiarities of morphology and/or colour pattern of collected specimens and including taxonomical comments is given. This section does not treat specimens of Gomphidae and *Macromia* spp. collected during this trip, as separate papers on variation of Gomphidae and taxonomy of *Macromia* of Cambodia are in preparation. The next section contains notes on habitats and habits of some species. The informal part (pages 49-91) follows with general notes on the places visited and their Odonata. Illustrations are placed in the text where they are most relevant and numbered accordingly, although I have to reference many of them ahead of the numeration order, e.g. when photographs are mentioned among the data for specific localities. More photos are soon to be available at <http://asia-dragonfly.net> and at my own site at <http://pisum.bionet.n-sc.ru/kosterin/odonata/cambodia.htm>.

## Material and Methods

Well recognizable common species were recorded by sight, some individuals were captured by a hand net, examined in hand and released. In complicated and otherwise interesting cases singular voucher specimens or small series were collected and



preserved on cotton layers with paper covers. Where possible, Odonata were photographed with Olympus Camedia C8080 or Pentax WG10 camera in purely natural conditions, in some cases also in hand to register living colours. The photos of specimen details were prepared from serial photographs obtained via lens Zeiss Stemi 2000-C with digital camera Canon PowerShot A640. Images with broad focus zones were obtained from serial photos with shifted focus using the software Helicon Focus 5.1 (<http://www.photo-soft.ru/heliconfocus.html>). Coordinates were recorded by Garmin eTrex H personal GPS navigator but the provided ranges for the areas actually examined, as well as elevations above sea level, were revised using Google-Earth.

### Localities visited and Odonata recorded

For convenience I named nameless Odonata sampling sites after conspicuous / important species observed at the spot. The conventional names proposed earlier (Kosterin 2011; 2012a) are retained here and some new ones are introduced. Localities visited for the first time are marked with “#”, conventional names associated with them, if any, are new. All localities are enumerated throughout with Arabic numerals and so shown as dots on a general map of Fig 1, Roman numerals are used for natural blocks of localities.

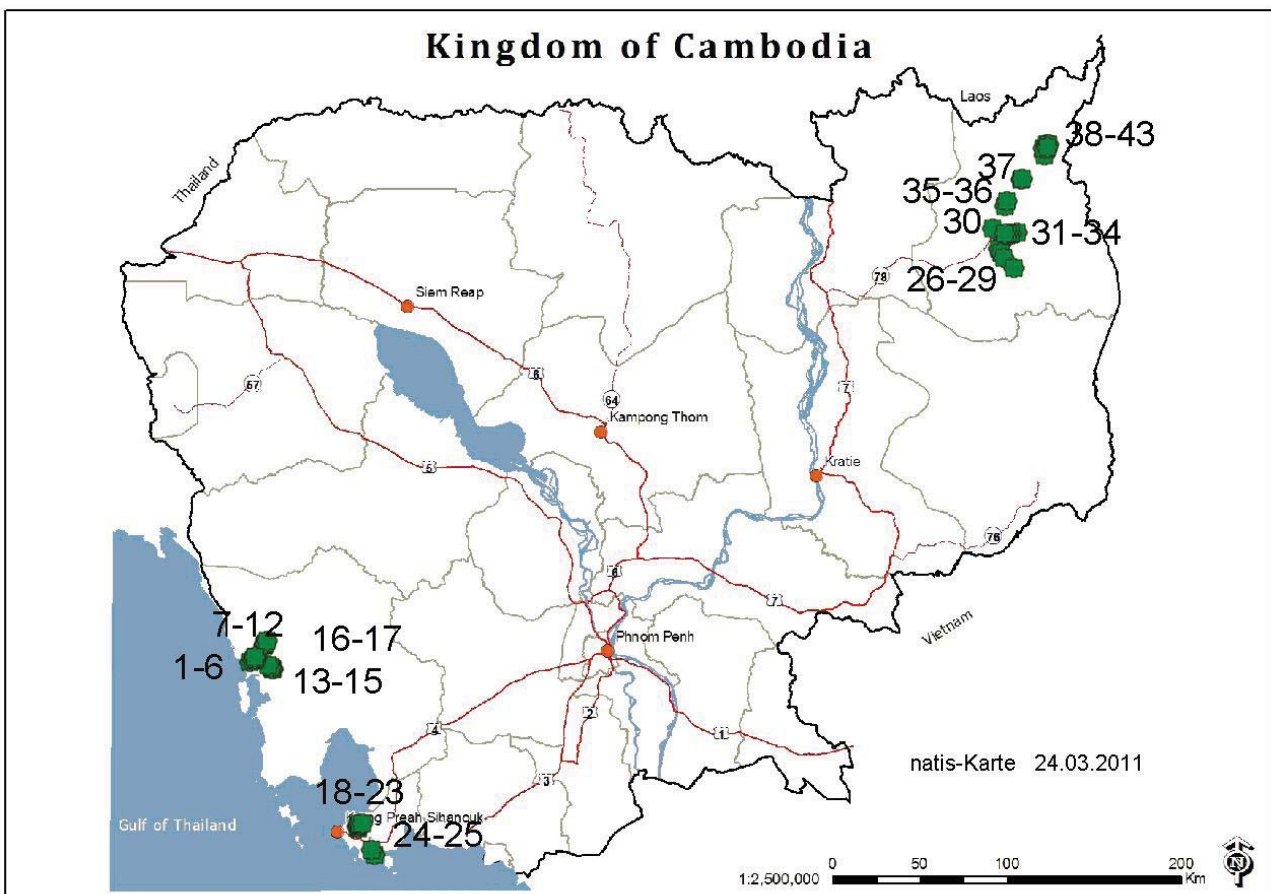


Figure 1. Localities visited on the map of Cambodia, for explanation of their numbers see the text.



Generic names in full and species authors are given upon the first mentions of species in each paper section, but generic names are always expanded in the cases of identical species names in different genera, to avoid confusion through typos. Asterisks indicate the very first findings of new species for Cambodia. The specimens are kept partly in Naturalis Biodiversity Center, Leiden (RMNH) and partly with the author, the latter are available for investigation upon request.

## Koh-Kong Province

### I. Peam Krasaop Wildlife Sanctuary to Koh Kong

1. Bushes behind Boeng Kachan village, transitory from mangroves to open *Melaleuca cajeputi* Powell stand, temporarily inundated by shallow water. 11°33'54' N, 102°59'29'' E, 5 m a.s.l.. 22.05.2013: ca 10:45 a.m. *Orthetrum sabina* (Drury, 1770) - 1 ♂ seen; *Rhyothemis phyllis* (Sulzer, 1776) or similar forms of *R. variegata* (Linnaeus, 1763) - 1 ind seen; *Tholymis tillarga* (Fabricius, 1798) - 1 ♂ seen (at a larger mangrove swamp).

2. 'Hisopa swamp' (#): a temporary grassy swamp at the road from Boeng Kachan village to Koh Kong, shallow and hot, with fine bright-green emerging grass ca 20 cm high, and sparse bushes and bunches of *Acrostichum* (Fig. 18b). 11°34'39-46' N, 102°59'08-15'' E, 4-6 m a.s.l.. 25.05.2013: 11:30-11:50 p.m., 25.05.2013: 3:00-4:00 p.m. (most data and specimens). *Lestes platystylus* Rambur, 1842 - 1 mature ♂ collected; *Aciagrion hisopa* (Selys, 1876) - 1 ♂, 1 ♀ collected; *Aciagrion borneense* Ris, 1911 - 2 ♀♀ collected; *Agriocnemis pygmaea* (Rambur, 1842) - 1 mature ♂ released, 2 teneral ♀♀ seen; *Ceriagrion malaisei* Schmidt, 1964 - many ♂♂ seen, 2 tandems collected 25.05.; *Pseudagrion australasiae* Selys, 1876 - 1 ♂ collected; *Anax guttatus* (Burmeister, 1839) - 1 ♂; *Acisoma panorpoides* Rambur, 1842 - 1 ♂ seen; *Brachydiplax c. chalybea* Brauer, 1868 - 1 ♂ seen; *Brachythemis contaminata* (Fabricius, 1793) - 1 ♂ seen; *Diplacodes nebulosa* (Fabricius, 1793) - 1 ♂ seen; *Neurothemis fluctuans* (Fabricius, 1793) - few ♂♂ seen; *Neurothemis tullia* (Drury, 1773) - few ♂♂, ♀♀ seen; *O. sabina* - 1 ♂ seen; *R. phyllis* or similar forms of *R. variegata* - 1 ind. seen; *T. tillarga* - 1 ♂ seen.

3. 'Pygmaea swamp' (#) (Fig. 18a): a temporary swamp behind Boeng Kachan village mosque, similar to the previous one but with some deeper roadside ditches. 11°35'14-17' N, 102°59'21-24'' E, 4 m a.s.l.. 25.05.2013: 4:10-4:40 p.m. *L. platystylus* - 2 mature ♂♂ collected, another ♂ photographed (Fig. 17); *Agriocnemis pygmaea* (Rambur, 1842) - many ♂♂, ♀♀ seen; *C. malaisei* - many ♂♂ seen; *A. guttatus* - 1 ovipositing ♀ released; *B. c. chalybea* - 1 ♂ seen; *B. contaminata* - few ♂♂ seen; *Crocothemis servilia* (Drury, 1770) - 1 ♂ seen; *D. nebulosa* - 1 ♂ seen; *Nannophya pygmaea* Rambur, 1842 - 1 ♂, 1 ♀ collected; *N. fluctuans* - few ♂♂ seen; *N. tullia* - few ♂♂, ♀♀ seen; *T. tillarga* - few ♂♂ seen.





4. 'Calamorum ponds' at the road to Peam Krasaop. 22.05.2013: 9:00-10:00 a.m.

4a. The larger of 'Calamorum ponds': banks partly barren, partly with emerging grass. 11°35'04-06' N, 102°59'08-10'' E, 4 m a.s.l.. *A. borneense* – 1 teneral ind. released; *Agriocnemis minima* Selys, 1877 – 1 teneral ♀ collected; *Agriocnemis* sp. – few teneral ind. seen; *Ischnura senegalensis* (Rambur, 1842) - many ♂♂, ♀♀ released and seen; *Pseudagrion australasiae* - 1 ♂ collected; *Pseudagrion microcephalum* (Rambur, 1842) – 1 ♂ collected, 2 other ♂♂ (1 teneral) seen; *B. contaminata* – many ♂♂, ♀♀ seen; *N. tullia* – 1 ♀ seen; *O. sabina* - 1 ♂ seen; *R. phyllis* or similar forms of *variegata* - 2 ind. seen; *Rhyothemis triangularis* Kirby, 1889 - 1 ♂ collected, 1 ♂ seen; *T. tillarga* – 1 ♀ collected (from a robber fly); *Trithemis pallidinervis* (Kirby, 1889) - few ♂♂ seen.

4b. The smaller of 'Calamorum ponds', very shallow, trampled by cattle, with abundant emerging grass, surrounded by *Lygodium* thickets. 11°35'02' N, 102°59'15'' E, 5 m. 22.05.2013. *Agriocnemis* sp. – 1 ♀ seen; *A. panorpoides* -1 ♂ seen; *N. fluctuans* – few ♂♂ seen; *B. contaminata* – few ♂♂, ♀♀ seen.

5. A crossroad at the road to Boeng Kachan village. 11°35'33" N, 103°00'07" E, 4 m a.s.l.. 22.05.2013: ca 10:00 a.m. *R. phyllis* – 1 ♂, 3 ♀♀ and *R. variegata* - 1 ♂, 2 ♀♀ (1 gynochromic, 1 intermediate) (as identified by the key in Fraser 1936; see also Kosterin 2010) collected in a swarm at a concrete road sign.



Figure 2. A male of *Anax guttatus* captured and released above a pool at Koh Kong Estuary bank.



6. Near beach on the Koh Kong River estuary left bank, a very shallow grassy ?brackish pool. 11°34'51-55" N, 102°58'22-24", 2 m a.s.l.. 22.05.2013: 10:00-10:20 a.m. *A. guttatus* – 1 ♂ released (Fig. 2); *Pantala flavescens* (Linnaeus, 1758) – 1 ♂ seen.

## II. Road towards Pursat

7. 'Lispe veal', an open savannah (loc. *veal*) area 13 km ENE Koh-Kong, shallow roadside pools. 11°39'34" N, 103°05'45" E, 286-316 m a.s.l.. 22.05.2013: ca 3:00 p.m. *Cerriagrion cerinorubellum* (Brauer, 1865) – 1 ♂ seen, 1 ♀ collected; *Nannophya pygmaea* – few ♂♂ seen.

8. 'Aciagrion rivulet' source at the 'Lispe veal' margin, 13 km ENE Koh-Kong: a natural pond 0.5-0.7 m deep (now deeper and free from emerging vegetation abundant in November 2010, see Kosterin 2011: fig. 12 below), with grassy banks and an outlet becoming a slow forest rivulet. 11°39'35" N, 103°05'44" E, 316 m a.s.l.. 22.05.2013: ca 4:00-4:15 p.m. *Lestes praemorsus decipiens* Kirby, 1893 - many ♂♂ seen, 1 collected; *A. hisopa* – few ind. seen; *P. australasiae* - 1 ♀ collected; *Brachydiplax farinosa* (Krüger, 1899) – 2 ♂♂ collected, few seen; *Nannophya pygmaea* – few ♂♂ seen; *Neurothemis intermedia atalanta* Ris, 1919 - 1 mature ♂ photographed.

9. 'Hemicordulia brook' 13 km ENE Koh-Kong, a clear forest brook entering a small open cultivated area where forming a deep pool: the only remained (Kosterin 2011: fig. 14 right), two other ones destroyed while setting a plantation. 11°39'55" N, 103°05'34" E, 315 m a.s.l. (not proved by GPS). 22.05.2013: ca. 3:20-3:40 p.m. *V. gracilis* – few ♂♂ seen; *Copera vittata* (Selys, 1863) - 1 ♂ seen; *Prodasineura verticalis* sensu Asahina, 1983 - 1 ♂ collected; *Rhyothemis obsolescens* Kirby, 1889 - few ♂♂ seen.



Figure 3. A tandem of *Cerriagrion cerinorubellum* at 'Nannophya rivulet', Koh Kong Province.



10. 'Nannophya rivulet', 16 km ENE Koh-Kong, a small rivulet swiftly flowing through primary forest then forming a short half-shaded slow reach (Kosterin 2011: fig. 18), crossing the road under the bridge, then flowing through an open pasture and then becoming rapidous as entering the forest again. 11°40'44-51" N, 103°06'58"-07'09" E, 318-327 m a.s.l. [the coordinates 11°40'14-22" N, 103°07'32-38" E, 296 m, provided in Kosterin (2011; 2012a), were incorrect]. 23.05.2013: 9:45 – 12:00 a.m. *Vestalis gracilis* (Rambur, 1842) – few ind. seen; *C. cerinorubellum* – 1 tandem photographed (Fig. 3); *Pseudagrion pruinatum* (Burmeister, 1839) - 1 ♂ seen; *Pseudagrion williamsoni* Selys, 1836 – 1 ♂ seen; *Nannophya pygmaea* – many ♂♂ seen; *N. fluctuans* – few ♂♂, ♀♀ seen; *N. i. atalanta* - 1 mature ♂ seen; *Orchithemis pulcherrima* Brauer, 1878 – many ♂♂ seen; *Orthetrum chrysis* (Selys, 1891) – 1 ♂ photographed; *R. obsolescens* – many ♂♂ seen; *Trithemis aurora* (Burmeister, 1839) – few ♂♂ seen.

11. 'Macromia rivulet', 17 km ENE Koh-Kong, a forest rivulet larger than the previous one, with a half-open reach up to ca 1.5 m deep with sandy bottom (Kosterin 2012a: fig. 59b). 11°40'17" N, 103°07'28-29" E, 294-296 m [the coordinates 11°40'51" N, 103°07'38" E, 305 m a.s.l., provided in Kosterin (2011; 2012a), were incorrect]. 23.05.2013: 12:30 a.m. – 1:30 p.m. *V. gracilis* – few ind. seen; *Dysphaea gloriosa* – 1 ♂ collected, another ♂ seen; *Heliocypha perforata limbata* (Selys, 1879) – 1 ♂ seen; *P. pruinatum* – few ♂♂ seen, 1 collected; *Prodasineura verticalis* sensu Asahina, 1983 - 1 ♂ seen; *Hemicordulia tenera* ssp. – 4 ♂♂ collected; *Macromia cincta* (Rambur, 1842) – 1 ♂ collected; *Diplacodes trivialis* (Rambur, 1842) – 1 ♂ (seen on a road apart); *Nannophya pygmaea* – few ♂♂, 1 ♀ seen; *O. pulcherrima* – many ♂♂ seen; *O. chrysis* – 1 ♂ seen; *R. obsolescens* – very many ♂♂ seen; *T. aurora* – few ♂♂ seen; *Trithemis festiva* (Rambur, 1842) – few ♂♂ seen.

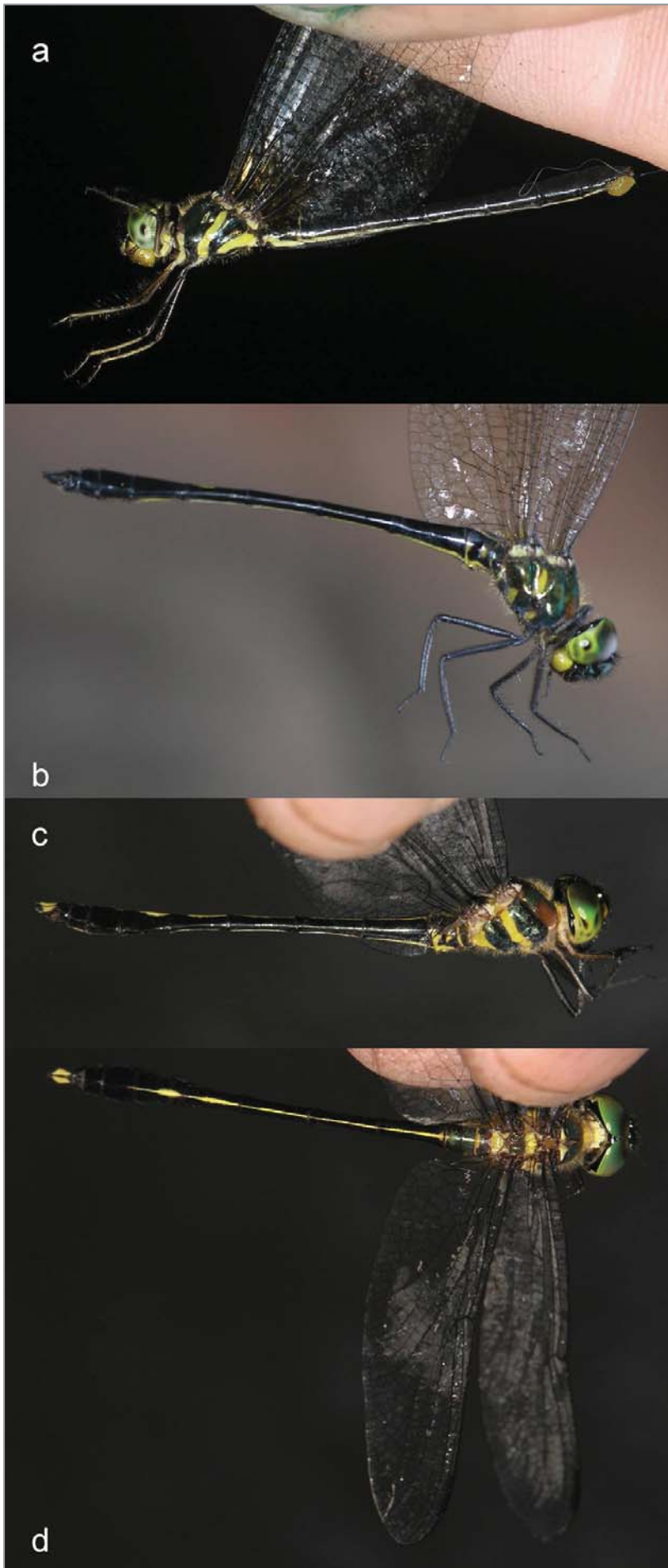
12. 'Kazukoae brook' (#): a small brook with rocky bed in a dense secondary, mostly bamboo forest. 11°41'27-32' N, 103°09'25" E, 280-300 m, 21 km ENE Koh-Kong, a small brook flowing towards Kep ('Right Tatai') River in secondary, mostly bamboo forest, slow to rapidous. 23.05.2013: 2:30-4 p.m. *V. gracilis* - many ind. seen, *Euphaea masoni* Selys, 1879 – 1 ♂ seen; *Coeliccia kazukoae* Asahina, 1984 – 1 ♂ collected, few ♂♂, 1 tandem seen; *C. vittata* – 1 ♂ collected; *Gynacantha* sp.- 1 ind. seen at a rapidous reach with large rocks.

### III. Tatai village environs.

13. 'Macromidia rivulet' (#), a medium-sized rapidous rivulet with sandstone bed, mostly shaded by seemingly primary forest, forming a silty stagnant pond upstream the road it crosses, 10 km E of Koh Kong and 7 km NW of Tatai village. 11°36'03-06" N, 103°04'15" E, 114-123 m a.s.l.. 25.05.2013: 2:20-2:50 and 5:00-5:10 p.m. *V. gracilis* – many ind. seen; *E. masoni* – few ♂♂ seen; *Heliocypha biforata* (Selys, 1859) - few ♂♂ seen; *Agriocnemis nana* (Laidlaw, 1914) – 1 teneral ♀ collected at the pond;







*Idionyx ? thailandica* Hämäläinen, 1985 – 1 ovipositing ♀ collected at a pool in a shady stretch with rapids (Fig. 4a); \**Macromidia genialis shanensis* Fraser, 1927 – 1 ♂ collected at a tine shady pool under the bridge (Fig. 4b); *O. chrysis* – few ♂♂ seen; *T. aurora* – few ♂♂ seen at the pond.

Figure 4. Corduliids (in traditional sense) captured: *Idionyx ? thailandica*, female (a) and *Macromidia genialis shanensis*, male (b) at 'Macromidia rivulet', Koh Kong Province; *Macromidia rapida* at Katieng Waterfall, Ratanakiri Province (c-d).





14. 'Oculata brook', a small temporary brook flowing in the rainy season through a chain of pools in rather a steep sandstone forested valley just above Phum Doung Bridge in Tatai village (Kosterin 2010: fig. 17), 11°33'46-50" N, 103°07'23-29" E, 30-100 m a.s.l., 25.05.2013: 8:20-12:00 a.m.. *V. gracilis* – many ind. seen; *E. masoni* – 1 ♂ seen; *H. biforata* – 1 ♂ seen; *Rhinagrion viridatum* Fraser, 1938 – 1 ♂ seen; *Archibasis viola* Lieftink, 1949 – 1 ♀ collected; *C. kazukoeae* – 4 ♂♂ seen; *Brachygonia oculata* (Brauer, 1878) – 1 ♂ collected, 2 ♂♂, 1 ♀ photographed (Fig. 24), few other ♂♂ seen; *Cratilla lineata calverti* Förster, 1903 – 1 ind. seen; *O. chrysis* – 1 ♂ seen; *R. obsolescens* – 1 ♂ seen.

15. Andy's pond on the floodplain where the 'Oculata brook' falls, 11°33'50" N, 103°07'29" E, 3 m a.s.l., 25.05.2013: 8:00-8:20 a.m. *C. malaisei* – many ♂♂ seen, 1 ♂ collected (also 2 ♂♂ seen at a nearby roadside ditch); *Pseudagrion microcephalum* – few ♂♂ released; ?*Epophthalmia* sp. – 1 ind. seen; *N. fluctuans* – many ♂♂, ♀♀ seen; *T. aurora* – few ♂♂ seen; *O. sabina* – ♂ seen.

#### IV. The Thma Bang environs.

16. 'Microgomphus River' 6.5 km SW Thma Bang village, a medium-sized river flowing among forested hills, partly at plantations. 24.05.2013: 9:00 a.m. – 2 p.m., also a short visit at 4:15 p.m.

16a. The reach with rapids downstream of the bridge and a transitory rather slow and shallow section at the bridge (see Kosterin 2010: fig. 23, left; Kosterin 2012a: fig. 25). 11°38'44-57" N, 103°23'40-48" E, 338-340 m a.s.l.. *V. gracilis* - few ind. seen; *D. gloriosa* – numerous ♂♂, ♀♀ seen, 2 ♂♂, 1 ♀ collected; *E. masoni* - many ♂♂, ♀♀ seen; *H. perforata* – numerous ♂♂, ♀♀ seen; *Gomphidictinus perakensis* (Laidlaw, 1902) - 1 exuvia; *Paragomphus capricornis* (Förster, 1914) - 1 ♂ collected (Fig. 5b); Gomphidae gen. sp. – 3 ind. seen (1 in maiden flight); *Macromia septima* Martin, 1904 – 2 ♂♂ collected (Fig. 5a), another ♂ seen; *B. contaminata* – 1 ♂ seen; *Onychothemis testacea* Laidlaw, 1902 - 1 ♂ collected, another ♂ seen; *O. chrysis* - 1 ♂ seen; *T. aurora* – few ♂♂ seen; *T. festiva* – many ♂♂, 1 ♀ seen; *Zygonyx iris malayana* Laidlaw, 1902 - 1 ♂ collected; another ♂ seen.

16b. The slow and deep (up to 2 m) reach upstream the bridge (see Kosterin 2010: fig. 23, right). 11°38'39-44" N, 103°23'48-51" E, 341 m a.s.l.. *V. gracilis* – few seen; *D. gloriosa* – few ♂♂ seen; *H. perforata* - few ♂♂, ♀♀ seen; *P. pruinosum* – many ♂♂ seen; *P. williamsoni* - 1 ♂ seen; *P. autumnalis* - many ♂♂ seen.

17. Thma Bang River rapids 6 km SW Thma Bang village [considered as 'waterfall' in Kosterin (2011: 46-47, 82, fig. 39)]. 11°39'38-40" N, 103°23'59'-24'00" E [incorrectly stated as 103°23'46' E in Kosterin (2012a, b)], 351-353 m a.s.l., 24.05.2013: 3:00-3:30 p.m. *D. gloriosa* – many ♂♂ seen, *V. gracilis* – many ind. seen; *N. chinensis* – 2 ♂♂, 1 ♀ seen; *E. masoni* – many ♂♂, ♀♀ seen; *H. perforata limbata* – many ♂♂ seen.



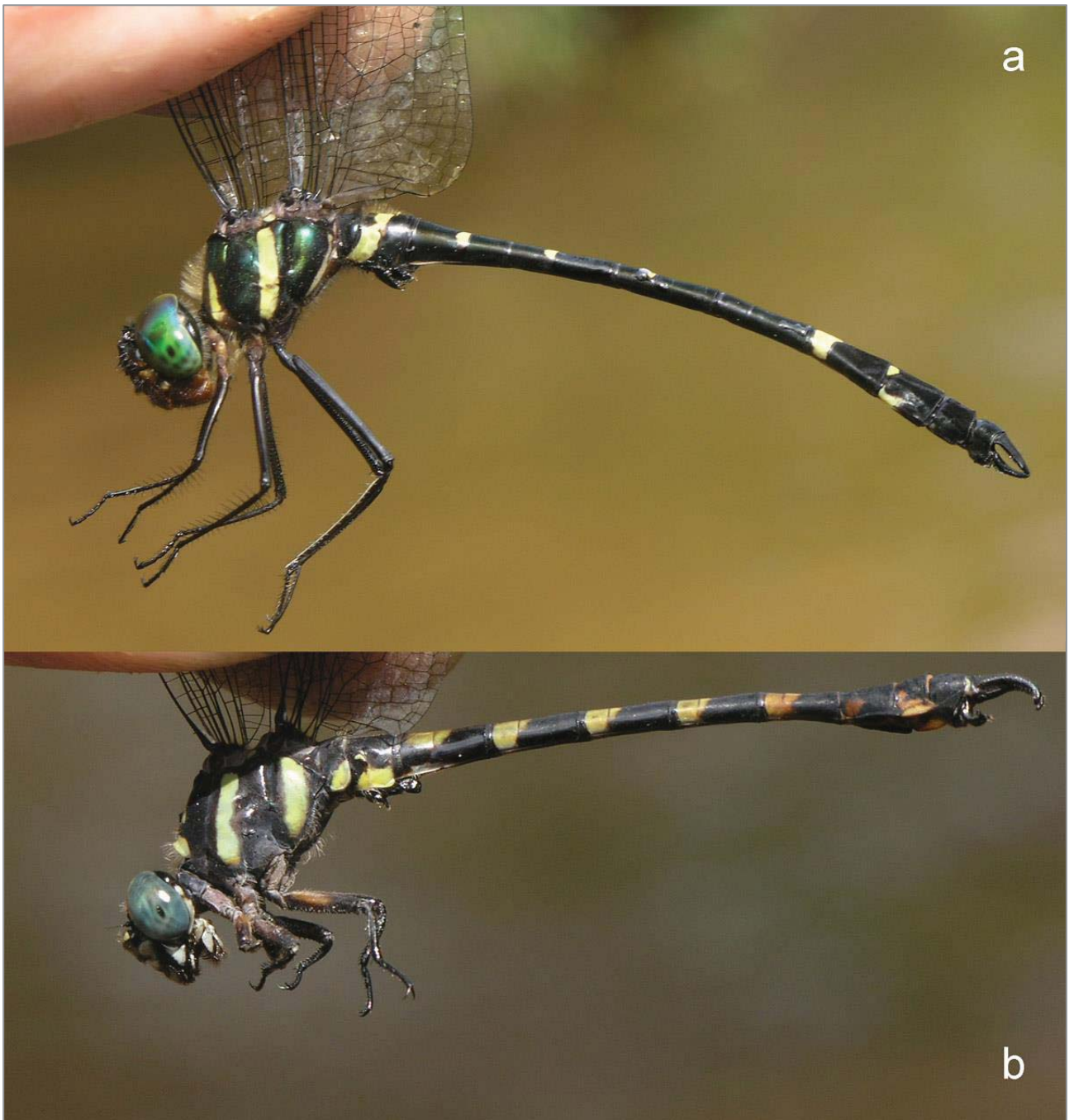


Figure 5. Males of *Macromia septima* (a) and *Paragomphus capricornis* (b) captured at 'Microgomphus River', at 'Macromidia rivulet' 8.5 km SW of Thma Bang.

## Kampong Saom Province

### V. Environs of Kbal Chhay Waterfall

18. 'Dead rivulet' (#): the former river course crossed by a dam and temporarily inundated by a water reserve; when examined it had barren muddy banks, dark brown stagnant water with thread algae and numerous logs. 7 km NE of Sihanoukville. 10°38'54" N, 103°34'46" E, 71 m a.s.l.. 26.05.2013: 11:30-12:00 a.m. *Pseudagrion* sp. (blue) – 1 ♂ seen; *Ictinogomphus decoratus melaenops* (Selys, 1858) – many ♂♂ seen,



1 ♂ collected; *A. panorpoides* – 1 ♂ seen; *B. chalybaea* – few ♂♂ seen; \**Chalibeo-themis fluviatilis* Lieftinck, 1933 – few ♂♂ seen; *N. fluctuans* – many ♂♂ seen; *O. sabina* – 1 ♂ seen; *R. phyllis* (or ♂♂ *variegata*) – 2 ind. seen; *R. obsolescens* – few ♂♂ seen; *Urothemis signata* (Rambur, 1842) – few ♂♂ seen, 1 ♂ collected.

19. 'Epophthalmia reserve' (#): a very large water reserve, no submerged or emerged vegetation, barren firm banks with numerous stumps, surrounded by sparse paper-back tree stand and then a rather intact forest. 10 km NE of Sihanoukville. 10°39'44" N, 103°36'09" E, 72 m a.s.l.. 26.05.2013: 12:20-2:40 p.m. *P. australasiae* – 1 ♂ collected; *I. decoratus melaenops* – many ♂♂ seen; *Epophthalmia* sp. – very numerous exuvia seen, some collected and photographed (Fig. 26); *B. contaminata* – few ♀♀ seen; *C. fluviatilis* – 1 ♂ seen; *O. sabina* – few ind. seen; *R. variegata* – 1 gynochromic ♀ seen; *T. pallidinervis* – many ♂♂ seen.

20. 'Fluviatilis pond' (#) at the main river right bank: nearly rectangular 50x30 m, 50-70 cm deep, obviously a long ago abandoned rice field, with emerging *Eleocharis* grass and banks with dense Gleicheniaceae thickets and *Pandanus* (Fig. 28). 11 km NE of Sihanoukville. 10°40'25-27" N, 103°36'23-25" E, 53 m a.s.l.. 26.05.2013: 3:20-4:30. *C. cerinorubellum* – many ♂♂, 2 tandems seen; *Paracercion calamorum dyeri* (Fraser, 1919) – few ♂♂, 1 copula collected; *Pseudagrion australasiae* – 2 ♂♂, 1 ♀ collected; 1 ♂ photographed, few other ♂♂, ♀♀ seen; *P. williamsoni* – 1 ♂ collected; *Pseudocoptera ciliata* (Selys, 1863) – very many ♂♂, ♀♀ seen; *Anax guttatus* – 1 ♂ seen (not checked); *I. decoratus melaenops* – many ♂♂ seen; *A. panorpoides* – 1 ♂ seen; \**C. fluviatilis* – 3 ♂♂ collected, another ♂ photographed (Fig. 29); *N. tullia* – 1 ♂, 1 ♀ seen; *R. phyllis* (or *variegata*) – 2 ind. seen; *R. obsolescens* – many ♂♂ seen; *T. til-larga* – 1 ♂ seen.

21. Left tributary of the main river: a rivulet with rapidous and, mostly, deeper reaches, shady, with *Pandanus* and trees at banks, 10°40'35" 103°36'31" E, 53 m a.s.l.. 26.05.2013: 4:40-5:00 p.m. *V. gracilis* – many ind. seen.

22. Kbal Chhay Waterfall. 11.3 km NE of Sihanoukville. 10°40'27-31" N, 103°36'32" E, 47-51 m a.s.l.. 26-27.05.2013.

22a. Small pools at the river right bank at the very waterfall. 27.05.2013. *I. decoratus melaenops* – 1 ♂ seen; *O. sabina* – 1 ♂ seen; *N. fluctuans* – 1 ♂ seen.

22b. Wooden awnings on the left bank. 26.05.2013: 5:10-5:20 p.m. *R. phyllis* – 1 ♂ collected; *R. variegata* – 1 gynochromic ♀ collected; *I. thailandica* – 1 ♂ collected (Fig. 14).

23. The main river downstream waterfall (#): rather a shallow river with wide and powerful rapids but with forested right bank and arboreal vegetation and some agriculture at the left bank (Fig. 27); banks overgrown mostly with *Pandanus* and some other trees, with barren sandstone plates, some small streams and seepages. 12 km NE of Sihanoukville. 10°39'58-40'08" N, 103°37'18-23" E, 12-16 m a.s.l.. 26.05.2013:



5:40-6:20 p.m., 27.05.2013: 10:00-12:00. *V. gracilis* –1 ind. seen. *D. gloriosa* – 2 ♂♂ seen; *Libellago lineata* (Burmeister, 1839) –1 ♂ seen; *P. verticalis* sensu Asahina, 1983 - 1 ♂ collected; *I. decoratus melaenops* – 1 ♂ seen; *Epophthalmia* sp. – few ind. seen; *B. contaminata* – many ♂♂, ♀♀ seen; *N. fluctuans* - few ♂♂ seen at road pools nearby; *Onychothemis testacea* – 1 ♀ collected, 1 ♂ seen; *O. chrysis* - few ♂♂ seen at a shady brook and road pools nearby.

## VI. Ream National Park

24. A forest rivulet crossing the park, partly shaded, 2-3 m wide, bordered with sandy loam bluffs ca 1 m high. 10°31'25" N, 103°41'44" E, 17 m a.s.l.. 27.05.2013: 1:00-1:20 p.m. *V. gracilis* – 2 ind. seen; *N. fluctuans* - 1 ♂ seen.

25. A small hot and brackish lagoon at the mouth of a forest rivulet at the National Park beach (Fig. 30). 10°30'18-21" N, 103°42'37-41' E, 4 m a.s.l.. 27.05.2013: 2:30-15:00 a.m. *I. senegalensis* – 1 ♂ seen; *P. microcephalum* - few ♂♂, 1 tandem seen, of which 1 ♀ collected, 1 ♂ photographed; *Macrodiplax cora* (Kaup in Brauer, 1867) – 1 ♀ seen.

## Ratanakiri Province

### VII. Ban Lung broad environs.

26. O'Sieng Lei (O'Seng Eall, O Sin Laer) Waterfalls (#): a series of few tiles of low cascade (Fig. 33 top) at a medium-sized river with red-brown water; surrounded by a 5 x 9 km area of disturbed dipterocarp forest. 19 km SE of Ban Lung. 2.06.2013.

26a. Slow reaches upstream the waterfalls, mostly knee-, locally to waist-deeps, with banks overgrown with bamboo. 13°35'38-40" N, 107°05'09-19' E, 181-185 m a.s.l.. 9:40-11:00 a.m. *D. gloriosa* – many ♂♂ seen, 1 ♂ photographed (Fig. 34, top); *H. biforata* –1 ♂ seen (resting on an *Alocasia* leaf); *Libellago lineata* – many ♂♂, ♀♀ seen, 1 ♂ collected, 1 ♂ photographed (Fig. 38b); *C. vittata* – 1 mature ♂ collected at a tiny shady pool with clay bottom; *P. autumnalis* – 2 ♂♂ seen; *Gomphidia abbotti* Williamson, 1907 – 1 ♂ seen; \**Orientogomphus minor* (Laidlaw, 1931) - 1 ♂ collected; ? *Idionyx* sp. – 1 ind. in maiden flight; \**Macromia aculeata* Fraser, 1927 - 1 ♂ collected; *Z. iris malayana* –few ♂♂, 1 tandem seen, 1 ♂ photographed (Fig. 27a).

26b. Still slow river just upstream of the waterfall but flowing over rock plates. *E. masoni* – few ♂♂ seen; *H. perforata limbata* – many ♂♂, ♀♀ (resting on rocks) seen; *D. trivialis* – 1 ♂ seen; *O. glaucum* – 2 ♂♂ seen, of them 1 photographed; *O. pruinosum neglectum* - 3 ♂♂ seen, of them 1 photographed.

26c. Rocky rapids downstream the waterfall, with some slower sections with a sandy bottom between rocks (Fig. 33, bottom). 13°35'29-41" N, 107°05'00-09' E,







Figure 6. Gomphidae captured in Ratanakiri Province: *Gomphidia abbotti*, male at Kachan Waterfall (a, b) and female at 'Asahinai brook' (c), *Lamelligomphus castor*, male at the same place (d) and female at O'Sieng Lei waterfalls (e, f), and *Nychogomphus duaricus*, male at the same place (g, h).

160-178 m a.s.l.. 11:00 a.m.-3:50 p.m. *N. chinensis* - few ♂♂ seen; *V. gracilis* - many ind. seen, 1 ♀ collected; *E. masoni* - very many ♂♂, few ♀♀ seen, 1 ♂ photographed; *D. gloriosa* - many (close to the waterfall, few downstream) ♂♂ seen; *Aristocypha fulgipennis* (Guerin, 1871) - 2 ♂♂, 1 ♀ collected, 1 ♂ photo-



graphed (Fig. 34, bottom), few ♂♂ seen only at troubled water; *H. perforata limbata* – very many ♂♂, few ♀♀ seen; *C. marginipes* (Rambur, 1842) – 1 mature ♀ photographed and collected, 3 immature (“ghost stage”) ind. seen; *G. perakensis* – 1 ♂ photographed; *O. minor* – 1 ♂ collected; \**Nychogomphus duaricus* (Fraser, 1924) – 3 ♂♂ collected (1 released) (Fig. 6g-h); *Lamelligomphus castor* (Lieftink, 1941) – 2 ♂♂ seen (id. uncertain), 1 ♀ collected (Fig. 6e-f), another ♂ seen; *Macromidia rapida* Martin, 1907 – 1 ♀ photographed (Fig. 23); *Cratilla lineata* – 1 ♂ photographed; *Onychothemis testacea* – many ♂♂, 1 ovipositing ♀ seen; *Z. iris malayana* – few ♂♂ seen.

26d. a shady pool in surrounding forest: *Cratilla lineata* – 1 ♂ collected, 2 other ind. seen.

27. ‘Idionyx river’ (#): a smaller river surrounded by rubber and banana plantations with very scarce dipterocarp forest remnants at banks; wide and calm (Fig. 22a), then falling by tiles of large rapids (Fig. 22b). 9 km SSE of Ban Lung, 13°39'32-40" N, 106°59'48-54' E, 216-223 m a.s.l.. 31.05.2013: ca 4:30-5:10 p.m. *N. chinensis* – few ♂♂ seen; *V. gracilis* – few ind. seen; *E. masoni* – many ♂♂, 1 ♀ seen; *D. gloriosa* – 1 ♂ seen; *A. fulgipennis* – 1 ♂ seen; *H. perforata limbata* – 1 ♂ seen; *P. pruinosum* – 3 ♂♂, 1 ♀ seen; *Copera* sp. – 1 “ghost stage” ind. seen; *Burmagomphus divaricatus* Lieftink, 1964 – 1 ♂ collected; *I. decoratus melaenops* – 1 ind. seen (id. uncertain); *Idionyx ? thailandica* – 7 ♀♀ collected, 1 ♀ photographed in cobweb (Fig. 22c), many ♀♀ seen; *B. contaminata* – few ♂♂ seen; *O. luzonicum* – 1 ♂, 1 ovipositing ♀ seen; *O. pruinosum neglectum* – 1 ♂ seen; *T. aurora* – few ♂♂ seen at a slow reach; *T. festiva* – 1 ♂ seen.

28. Kachan Waterfall (#): a river with red-brown water downstream of the high waterfall, below which it forms a large pond, then fast flowing among large boulders and bushes; the valley surrounded by very narrow stripes of remained dipterocarp forest. 5 km S of Ban Lung, 13°41'31-33" N, 106°59'20-22' E, 244-253 m a.s.l.. 31.05.2013: 5:30-6:00 p.m., 1.06.2013: 9:00-10:40 a.m. (most collections). *N. chinensis* – few ♂♂ seen; *E. masoni* – very many ♂♂, few ♀♀ seen; *D. gloriosa* – many ♂♂ seen, 1 collected; *H. biforata* – 1 ♂ collected; *H. perforata limbata* – 1 ♂ collected; *Libellago lineata* – few ♂♂, ♀♀ seen; *Burmagomphus asahinai* Kosterin, Makbun et Davvrueng, 2012 – 2 ♂♂, 1 ovipositing ♀ collected; *B. divaricatus* – 1 ♂ collected; \**G. abbotti* – 1 ♂ collected (Fig. 6a, b); \**L. castor* – 1 ♂ seen 31.05, 1 ♂ collected 01.06.2013; *M. rapida* – 2 ♀ seen, of which 1 collected, in deep twilight of 31.05; *B. contaminata* – 1 ♂ seen; *Onychothemis testacea* – few ♂♂, 1 ♀ seen; *O. chrysis* – 1 ♂ seen; *Z. iris malayana* – many ♂♂, 1 tandem seen, 1 ♀ photographed (Fig. 37b).

29. Katieng Waterfall (#) (Fig. 32), 3 km downstream the same river as above. 8 km SSW of Ban Lung. 1.06.2013: ca 1:00-5:00 p.m.



29a. Upstream of the waterfall, the river is slow, knee to waist deep, with some rapids, surrounded by trees. 13°40'01-04" N, 106°58'32-37' E, 206-207 m a.s.l.. *V. gracilis* – 2 ind. seen; *E. masoni* – many ♂♂ seen; *D. gloriosa* – few ♂♂ seen; *H. biforata* – 1 ♂ collected; *Libellago lineata* – 1 ♂ collected; few ♂♂, ♀♀ seen; *P. pruinosum* – 1 ♂ collected; *Copera vittata* – 1 “ghost stage” ind. seen; *P. autumnalis* – many ♂♂ seen, 1 collected; *Gomphidia* ? *abbotti* – 1 ♂ seen; *I* ? *thailandica* – 1 ♀ collected at huts; *B. contaminata* – 1 ♂ seen; *O. glaucum* – 1 ♂ seen; *O. pruinosum neglectum* – 1 ♂ collected; *Z. iris malayana* – many ♂♂, seen.

29b. Downstream of the high waterfall; the river is wider and shallower than above flowing over a stony bed with the banks shaded by broader forest stripes. 13°39'55-40'01" N, 106°58'31-32' E, 200-203 m a.s.l.. *N. chinensis* – few ♂♂ seen; *E. masoni* – very many ♂♂, few ♀♀ seen; *D. gloriosa* – many (close to the waterfall, few downstream) ♂♂ seen, 1 collected; *A. fulgipennis* – 1 ♂ collected; *H. perforata limbata* – many ♂♂, few ♀♀ seen, 1 ♂, 1 ♀ collected; *G. perakensis* – 1 ♂ photographed (Fig. 35); *L. castor* – 1 ♂ collected, another ♂ seen; *M. rapida* – 3 ♂♂ (Fig. 4c, d), 1 ♀ collected, beyond them 2 ♂♂, 1 ♀ seen; *B. contaminata* – 1 ♂ seen; *Onychothemis testacea* – few ♂♂ seen, 1 collected; *O. chrysis* – 1 ♂ seen; *Z. iris malayana* – few ♂♂ seen.



Figure 7. *Macrogomphus kerri*, a male captured at Cha Ong Waterfall, Ratanakiri Province.

30. Cha Ong Waterfall (#). 7 km WNW of Ban Lung. 31.05.2013: ca 9 a.m.-2 p.m.

30a. The rivulet, with red-brown water, upstream of the waterfall, partly fast flowing openly above flat rocks, partly slow and shaded with bushes or tall bamboo. 13°45'33" N, 106°55'48-55' E, 219-221 m a.s.l.. *V. gracilis* – 1 ind. seen; *E. masoni* – 3 ♂♂ collected, many ♂♂, few ♀♀ seen close to waterfall; *P. ciliata* – few ♂♂ seen; *P. autumnalis* – many ♂♂ seen; *I. decoratus melaenops* – few ♂♂





seen, 1 ♂ photographed (Fig. 31); \**Macrogomphus kerri* Fraser, 1922 – 1 ♂ (Fig. 7), 1 exuvia collected (Fig. 40); *Idionyx* sp. (id. uncertain) – 1 ind. seen fluttering; *B. contaminata* – few ♂♂, ♀♀ seen; *Onychothemis testacea* – 1 ♂ collected, another ♂ seen; *O. glaucum* – 1 ♂ collected; *Orthetrum pruinosum neglectum* – 1 ♂ collected, another ♂ seen; *Pseudothemis jorina* Förster, 1904 - few ♂♂ seen; *T. aurora* – few ♂♂ seen; *T. festiva* – 1 ♂ seen; *Z. iris malayana* – 1 ♂ seen.

30b. Downstream of a very high waterfall from a basalt rock plate, below which the rivulet rushes among large rocks, partly shaded with bushes and surrounding tall *Dipterocarpus* trees the deep valley which is deeply shaded (Fig. 19). 13°45'29-33" N, 106°55'45-48' E, 192-217 m a.s.l.. *N. chinensis* -few ♂♂ seen; *E. masoni* – many ♂♂, few ♀♀ seen; *D. gloriosa* - 2 ♂♂ seen; *A. fulgipennis* -few ♂♂ seen, 2 collected; *Libellago lineata* - 1 ♂ collected, another ♂ seen; \**Protosticta caroli* van Tol, 2008 - 7 ♂♂, 1 ♀ collected (Fig. 12), few other ♂♂ seen, of which 3 ♂♂ photographed (Fig. 13); *Z. iris malayana* – few ♂♂ seen, 2 ovipositing ♀♀ seen (one collected), 1 ovipositing tandem seen.

31. 'Orolestes pool' (#): a shallow hot pool ca 50x20 m with dirty yellowish water where two converging gullies meet a road embankment; a small dipterocarp forest remnant at a hill, a small banana plantation on slopes, rubber plantations around (Fig. 50). 7 km NEE of Ban Lung, 13°44'51-52' N, 107°02'49-50' E, 368 m a.s.l..

31a. The pool itself. 30.V.2013: ca 11:30-12:00 a.m., 6.06.2013: 5:00-6:20 p.m., 7.06.2013: ca 9:30-12:00 a.m. and 6:10-6:30 p.m. *V. gracilis* – few ind. seen 7.06; *Libellago lineata* – 2 ♂♂, 1 ♀ collected, 2 other ♂♂ seen; *Orolestes octomaculatus* Martin, 1902 - 1 ♂ photographed; *Argiocnemis rubescens rubeola* Selys, 1877 – 1 ♂ collected, 1 ♂ seen 6.06; *C. malaisei* – 2 ♂♂, 1 ♀ collected 30.05, 1 ♂ collected 6.06; *P. australasiae* – 1 ♂ collected, *P. rubriceps* – 1 ♂, 1 tandem collected 30.05, 1 tandem collected 6.06, few tandems seen; *P. williamsoni* – 1 ♂ collected 7.06; *Copera marginipes*– 2 ♂♂ seen 6.06, 1 tandem collected and few seen 7.06; *C. vittata* – few ♂♂ and tandems seen, 1 tandem collected 30.05, 1 ♂ collected 7.06; *Anax* sp. – 1 ♂ seen in deep twilight 6.07; *Gynacantha subinterrupta* Rambur, 1842– 3 ♂♂ collected 6.06, 1 ♂, 2 ♀♀ collected 7.06, few ♂♂ and ovipositing ♀♀ seen, 6-7.06, of which 1 ♂, 3 ♀♀ photographed (Fig. 20); *Epophthalmia* sp. – 1 exuvia seen; *I. decoratus melaenops* – few ♂♂ seen; *B. farinosa* - few ♂♂ seen, 1 collected 6.06; *B. contaminata* - many ♂♂, few ♀♀ seen; *C. lineata calverti* - 1 ♂ collected 6.06 at bushes on the nearby slope; *Lathrecista asiatica* (Fabricius, 1798) – 1 ♂ seen 7.06; *N. fluctuans* - many ♂♂, few ♀♀ seen, 6 ♂♂ collected 7.06; *Neurothemis fulvia* (Drury, 1773) - few ♂♂, 1 ♀ seen both days, 1 ♀ collected 6.06; *Potamarcha congener* (Rambur, 1842) – 1 ♂ collected 30.5, 1 ♀ collected 6.06, very many ♂♂, few ♀♀ seen; *Pseudothemis jorina* Förster, 1904 – 1 ♂ seen 30.05 and 7.06; *O. chrysis* – 2 ♂♂ collected, few seen; *O. pruinosum neglectum* – few ♂♂ seen; *O. sabina* – few ♂♂, 1 ovipositing ♀ (7.07) seen; *R. phyllis* – 1 ♂



collected; *R. variegata* – 1 gynochromic ♀ collected 30.05; *T. aurora* – 1 ♂ seen; *T. tillarga* – many ♂♂ seen 6.06;

31b. Three tiny (ca 1-1.5 m) shallow (not more than 10 cm) grassy pools with whitish turbid water at the very road just by the previous site (Fig. 25). 6.06.2013: 11:30-12:00 a.m. \**Aciagrion* sp. – 4 ♂♂ collected, ♂ photographed (Fig. 11), 2 other ♂♂ seen; *C. servilia* – 1 ♂ seen; *N. fluctuans* – few ♂♂ seen; *T. aurora* - few ♂♂ seen; *O. glaucum* – 1 ♂ seen; *O. pruinosum neglectum* - 1 ♂ seen; \**Palpopleura sexmaculata* (Fabricius, 1787) – 1 ♂, 3 ♀♀ collected (Fig. 16), 1♂, another ♀ photographed (Fig. 51).

32. 'Asahinai brook' (#) near Lake Yak Lom (the headwaters of the river of locs. 28-29). 3 km ENE of Ban Lung. 30.05.2013: ca 4:30-5:00 p.m., 6.06.2013: ca 10:20-10:40 a.m.

32a. upstream the road: slow, almost hidden among *Alocasia*, with wider pools, surrounded by rubber plantations; the water turbid, looking greyish. 13°44'20-21" N, 107°01'01-04" E, 300 m a.s.l.. *Ceriagrion auranticum* Fraser, 1922 – 1 ♂ collected 30.05; *P. ciliata* – 1 ♂ collected 30.05; *P. autumnalis* - 2 ♂♂ seen 06.06; *C. marginipes* - ♂ collected 30.05; *T. tillarga* - ♂ seen 30.05; *T. aurora* – few ♂♂ seen 06.06; *T. festiva* – 1 ♂ seen 06.06; *Orthetrum luzonicum* (Brauer, 1868) – 1 ♂ collected, 1 ♂ photographed 06.06 (Fig. 42a).

32b Downstream of the road: rapidous (Fig. 43), with stony bed and some slower pools with *Ludwigia* and *Marsilea* growing, partly shaded by trees, bordered by bush/herb thickets or small plantations. 13°44'17-20" N, 107°00'56"-01'01" E. *N. chinensis* – few ♂♂ seen, 1 collected; *V. gracilis* – very many ind. seen, 1 ♂, 1 ♀ collected; *E. masoni* – very many ♂♂, few ♀♀ seen on both days, 2 ♂♂, 1 ♀ collected, 1 copula photographed 30.05 (Fig. 9); *Libellago lineata* – 2 ♂♂ seen 06.06; *P. pruinosum* – 2 ♂♂, 1 ♀ collected, few ♂♂ seen 30.05, 1 ♂ 06.06; *C. marginipes* – few ♂♂ seen on both days; *P. autumnalis* – 1 ♂ collected 30.05, many ♂♂ seen 06.06; *B. asahinai* – 1 ♂ seen 30.05, 3 ♂♂ collected, 3 other ♂♂ seen and photographed 6.05; *G. abbotti* - 1 ♀ collected 6.06 (Fig, 4c); *L. castor* – 1 ♂ collected 06.06 (Fig. 6d); *Macromia cupricincta* Fraser, 1924 – 1 ♀ seen 30.05, collected 6.06; *N. fluctuans* – 1 ♂ seen 6.06; *Orthetrum luzonicum* (Brauer, 1868) – 1 ♀ photographed and collected 6.06 (Fig. 42b); *T. tillarga* – 1 ♀ seen 6.06; *Z. iris malayana* – 1 ♂ seen 6.06.

33. Yak Lom (Yeak Lom) Lake (#) (Fig. 47): a perfectly round crater lake, 720 x 750 m, with a clean warm water, banks partly rocky, overgrown with bamboo and/or dip-terocarp forest occupying low crater inner slopes. 2.5-3-3 km ESE of Ban Lung, 13°43'36-59" N, 107°00'41"-01'07" E, 302 m a.s.l., 30.05.2013: 1:00-4:20 p.m. (most data), 6.06.2013: 11:00-12:00 a.m. *V. gracilis* – 1 ♂ collected, 1 other ind. seen; *Libellago lineata* – many ♂♂ seen; *Pseudagrion ? australasiae* – 1 ♂ seen; *Pseudagrion rubriceps* Selys, 1876 – 1 tandem seen; *Burmagomphus* sp. – 1 ♂ seen; *I. decoratus*



*melaenops* – very many ♂♂ seen; *B. contaminata* – 1 ♀ seen; *P. jorina* – extremely numerous ♂♂, few ovipositing ♀♀ seen, 1 ♂, 1 ♀ collected ; *U. signata* – few ♂♂ seen.

34. Kan Seng Lake (#): in fact a large (720 x 320 m) pond with clear water formed by a dammed brook within the town of Ban Lung.

34a. Firm grassy SW bank (Fig. 48, left). 13°44'49-55" N, 106°58'54-59" E, 289 m a.s.l.. 30.05.2013: 7:00-9:30 a.m. (most observations and collections), 6.06.2013: 3:00-4:00 p.m. *C. malaisei* - 2 ♂♂ collected; *P. australasiae* - 1 ♂ collected, another ♂ seen; *A. panorpoides* – 1 ♂ collected, many ind. seen; *B. contaminata* – many ♂♂, ♀♀ seen; *O. sabina* – few ind. seen; *R. phyllis* – 1 ♂ seen; *R. triangularis* – 1 teneral ♂ collected; *R. variegata* – 1 ♂ collected 30.05, 2 gynochromic ♀♀ seen 06.06 (1 of them ovipositing); *T. tillarga* – 1 ♂ seen; *Urothemis signata* – few ♂♂ seen, 1 ♂ collected.

34b. Small shallow bays at SW bank with dark bottom and some trees, with *Lygodium* thickets and some bushes at their banks. The same coordinates and dates. *C. auranticum* - 1 ♂, 1 ♀ collected; *P. australasiae* - 1 ♂ seen; *P. ciliata* – 2 tandems, 1 ♂ collected; *P. autumnalis* – 1 ♂ collected; *I. decoratus melaenops* – few ♂♂ seen, 1 ♂ collected; *Aethriamanta gracilis* (Brauer, 1878) – 1 teneral ♀ collected; *P. jorina* – few ♂♂ seen, 2 collected; *R. obsolescens* – 2 teneral ♀♀ collected, another ♀ seen; *U. signata* – many ♂♂ seen.

34c. A very large floating boggy vegetation mat at S bank, formed by grasses and ferns, with some *Alocasia* and *Lygodium* (Fig. 48, right). 13°44'48-50" N, 106°59'00-10" E, 289 m a.s.l.. 30.05.2013: 7:00-9:30 a.m. *C. cerinorubellum* – 1 ♂ collected, few ♂♂, 1 ♀ seen; *Onychargia atrocyana* Selys, 1865 – many teneral ind. seen, 1 ♀ collected, 1 ♀ photographed; ? *Epophthalmia* sp. – 1 ovipositing ♀ seen; *A. panorpoides* – few ind. seen; *Aethriamanta brevipennis* (Rambur, 1842) – many ♂♂ seen, 2 ♂♂ collected, 1 ♂ photographed (Fig. 49); *A. gracilis* – few ♂♂ seen, 2 collected; *Nesoxenia lineata* (Selys, 1879) – 1 ♂ seen (id. uncertain); *R. obsolescens* - many ♂♂ seen; *Rhyothemis plutonia* Selys, 1883– 1 ♂ collected; *R. variegata* – 1 ♂ collected; *R. phyllis/variegata* – 1 ind. seen; *U. signata* – many ♂♂, 1 ovipositing ♀ collected.

34d. Cheng Lok Lakeside Hotel, in the lobby. *M. rapida* - ♀ collected 6.06.2013; *A. brevipennis* – 1 ♂ collected 31.05.2013.

35. O'Chum River (#) (Fig. 44): examined within O'Chum (Thlang Svay) village upstream of the bridge: a small river, rather fast but with scarce rapids, partly under trees and bushes, partly with grassy (pasture) banks; for some distance it forms two arms, at the bridge there are areas of inundated low grass and pools surrounded by high grass and bushes. 13°47'56-58" N, 106°59'29-35" E, 250 m a.s.l.. 7.06.2013: ca 2:30-3:45 p.m. *N. chinensis* – few ♂♂, ♀♀ seen; *V. gracilis* – many ♂♂, ♀♀ seen; *D. glo-*



*riosa* – 1 ♂ seen; *Libellago lineata* – many ♂♂, few ♀♀ seen, 1 ♀ photographed (Fig. 38c); *H. biforata* – 2 ♂♂ seen; *Agriocnemis femina* (Brauer, 1868) – 1 ♂, 2 teneral ♀♀ collected; *A. minima* – 1 ♂, 1 ♀ collected; *A. nana* – 2 teneral ♂♂, 1 teneral ♀ collected; *P. pruinosa* – 1 ♂ seen; *P. autumnalis* – many ♂♂ seen; *I. decoratus melanops* – few ♂♂ seen; *Epophthalmia frontalis* Selys, 1871 – 1 ♂ photographed (Fig. 43a) and collected, 1 ovipositing ♀ collected; *A. panorpoides* – 1 ♀ collected; *B. chalybea* – few ♂♂ seen, 1 collected; *L. asiatica* – 1 ♂ collected, 2 other ♂♂ seen; *N. fluctuans* – few ♂♂, ♀♀ seen; *Onychothemis testacea* – few ♂♂ seen, 1 ♀ photographed (Fig. 43b); *O. chrysis* – few seen; *O. luzonicum* – 1 ♂ collected, 1 ♂ seen; *O. pruinosa neglectum* – many ♂♂ seen; *O. sabina* – 1 ♂ seen; *R. variegata* or *phyllis* – few ind. seen; *R. variegata* – 1 ♂ collected, 1 ♀ of intermediate form seen; *Rhodothemis rufa* (Rambur, 1842) – 1 ♀ collected; *T. tillarga* – few ♂♂, ♀♀ seen; *T. aurora* – many ♂♂, 1 ♀ seen.

36. 'Abisaria brook' (#) at Veal Rum Plang Stone Field: a temporal brook with a flat rocky bed shaded by forest, when visited missing flowing water reduced to few pools; flows at a large massif of open dipterocarp forest growing on top of a gentle hill over flat basalt rocks, the flat surface of which is seen on vast openings; the area is legally protected but in fact suffers from logging from the expanding farms. 13°49'58"-50'00" N, 107°00'14-19" E, 315-317 m a.s.l.. 7.06.2013: ca 4-5 p.m. *V. gracilis* – very many ind. seen; *E. masoni* – 1 ♂ seen; *H. biforata* – 2 ♂♂ seen; *O. octomaculatus* – 1 ♂ collected, another ♂ photographed (Fig. 46); *G. subinterrupta* – 1 ♂ collected, few ♂♂, ♀♀ seen; *Cratilla lineata* – few ♂♂, ♀♀, 1 copula seen, another copula photographed (Fig. 45); *O. chrysis* – few ♂♂ seen.

### VIII. Virachey National Park buffer zone.

37. Se San (Tonle San) River right bank at Ta Veng village (#) (Fig. 52): a major river with clear water, the level of which fluctuates greatly because of the dam upstream, in Vietnam; banks formed by barren clayey ground, mostly with low but steep bluffs, surrounded by small farms. 14°03'02" N, 107°06'28" E, 100 m a.s.l.. 3.06.2013: 1:00-1:20 p.m. *D. gloriosa* – few ♂♂ seen; *Libellago lineata* – 1 ♂ seen; *D. trivialis* – 1 ♂ seen; *P. flavescens* – 1 ind. seen.

38. O'Tabok River at Yorn village (#) (Fig. 53): a considerable river 20-30 m wide with calm flow and clear water, surrounded by small farms still practicing slash-and-burn agriculture and scarce remnants of dipterocarp forest. Examined sites included a long section of a left bank, detritus, with frequent inundated logs, low clayey bluffs with scarce trees and bamboo patches, and a small silty stretch with inundated Poaceae grass of the right bank. 14°08'38-40" N, 107°13'38-45" E, 110-115 m a.s.l.. 3.06.2013 (most data): 2:30-5:00 p.m., 5.06.2013: 1:00-2:00 p.m. *V. gracilis* – few ind. seen, 1 ♂ photographed (Fig. 8); *N. chinensis* – many ♂♂, ♀♀ seen; *D. gloriosa* – very many ♂♂, few ♀♀, 2 tandems seen, 1 ♂ collected; *Libellago lineata* – many ♂♂, ♀♀ seen,





2 ♂♂ collected 3.06, 2 ♂♂ photographed 5.06 (Fig. 38a); *H. biforata* - 1 ♂ seen; *P. rubriceps* - 2 ♂♂; \**Prodasineura coerulescens* Fraser, 1932 - 1 ♂ collected 1 ♂ seen 3.06, 1 tandem collected, 1 ♂ seen 3.05; Onychogomphinae indet. 1 - numerous exuvia seen, 9 collected, many photographed; Onychogomphinae indet. 2 - 1 exuvia collected; *Gomphidia ? abbotti* - 1 ♂ seen 5.06., 1 exuvia collected 3.06; *B. contaminata* - 1 ♂ seen; *Onychothemis testacea* - few ♂♂ and exuviae seen; *O. pruinorum neglectum* - 2 ♂♂ seen, 1 ♂ photographed.

### 39. Yorn village.

39a. The village itself. 14°08'39" N, 107°13'32" E, 120 m a.s.l. 4.06.2013: 7:00-8:10 a.m. *B. farinosa* - 1 ♂ collected; *B. contaminata* - 1 ♂ seen; *N. fluctuans* - 1 ind. (♂ or ♀) with coloured wings seen, 1 ♀ with clear wings released.

39b. 'Marginipes brook' (#), a temporal forest brook at the village margin, at the time represented by separated pools, of which one open with grassy banks and one deeply shaded with barren ground banks were examined. 14°09' N, 107°13' E, 120 m a.s.l. (coordinates uncertain). 3.06.2013: 5:40-6:20 p.m.; 4.06.2013: 8:10-8:30 a.m. *V. gracilis* - 1 ind. seen; *H. biforata* - 1 ♂ seen 4.05; *Archibasis oscillans* (Selys, 1877) - 1 ♂ collected 4.05; *C. marginipes* - many ♂♂ and immature ind. seen, 2 ♂♂ collected; *C. vittata* - 1 ♂ released; *N. fluctuans* - 1 ind. with coloured wings seen 3.06; *T. aurora* - 1 ♀ released 3.05; *Zyxomma petiolatum* Rambur, 1842 - 1 copula seen, of which ♂ collected, 3.05.

39c. Partly logged dipterocarp forest with tall bamboo thickets between Yorn village and O'Tamol Meik rivulet. 14°09'00-09'30" N, 107°13'30"-14'00" E (coordinates uncertain), 5.06.2013: 10:30-11:30 a.m. *P. verticalis* sensu Asahina, 1983 - 1 ♀ collected; *Cratilla lineata* - few ind. seen, 1 ♂ photographed; *N. fluctuans*. - 2 ♀♀ with coloured wings collected; 1 similar ♀ photographed (Fig. 15); *O. chrysis* - few ♂♂ seen; *O. pruinorum neglectum* - few ♂♂ seen.

40. 'Indochinense pool' (#) (Fig. 54b): a very shallow pool with emergent fine low grass in the centre of a *veal* (open savannah of *Dipterocarpus obtusifolius* on flat rocky basis) 1.6 km W of Yorn village. 14°08'41" N, 107°12'40" E, 124 m a.s.l. 4.06.2013: 10:00-10:30 a.m. *L. praemorsus decipiens* - 1 ♂ collected; *A. hisopa* - 1 ♂, 2 ♀♀ collected, few ind., 1 tandem seen; *Ceriagrion calamineum* Lieftink, 1951 - 2 ♂♂ collected, many ♂♂, 1 tandem seen; \**Ceriagrion indochinense* Asahina, 1967 - 1 ♂ collected; *B. farinosa* - few ♂♂ seen; *Indothemis* sp. - few ♂♂ seen; *O. chrysis* - 1 ♂ seen; *Tramea transmarina euryale* Selys, 1878 - 1 ♂ seen; *T. aurora* - 1 ♂ collected.

41. Yak Kae rivulet (#): in fact a chain of up to 1-1.5 m deep pools, mostly shaded by bushes, united by a rapidous brook, in secondary tall bamboo stand with solitary trees remaining from recently logged forest. 14°10'01" N, 107°12'45" E, 139 m a.s.l. 4.06.2013. 1:00-3:00 p.m. *N. chinensis* - 1 ♂ seen; *V. gracilis* - few ind. seen; *E. ma-*



*soni* – very many ♂♂, few ♀♀ seen; *A. fulgipennis* – 1 ♂ seen; *H. biforata* – many ♂♂ seen; *H. perforata limbata* – few ♂♂ seen; *R. viridatum* – 1 ♂ collected (Fig. 10), another ♂ seen; *P. pruinorum* – 1 ♂, 1 ♀ collected; *P. autumnalis* – 1 tandem collected, another tandem seen; *Gynacantha* sp. – 2 ♂♂ seen; *P. capricornis* – 1 ♂ collected; \**Nesoxenia lineata* (Selys, 1879) – 1 ♂ collected; *O. chrysis* – few ♂♂ seen; *O. pruinorum neglectum* – 1 ♂♂ seen; *T. aurora* – few ♂♂ seen; *T. festiva* – 1 ♂ seen; *Z. iris malayana* – 1 ♂ seen.

42. O'Tamol Meik rivulet (#): a brook like the previous one but even smaller. Examined at two points:

42a. The brook still flowing between pools but scarcely. 14°10'22" N, 107°13'27" E, 201 m a.s.l.. 4-5.06.2013: 5:00 p.m. - dusk. *N. chinensis* – 1 ♂ seen; *V. gracilis* – few ind. seen; *E. masoni* – many ♂♂ seen; *A. fulgipennis* – 1 ♂ seen; *H. biforata* – 1 ♂ seen; *H. perforata limbata* – few ♂♂ seen; *C. vittata* – 1 ♂ seen.

42b. Downstream of the previous site; two separate pools in a clayey gully with the brook no longer flowing. 14°09'46" N, 107°13'56" E, 124 m a.s.l.. 5.06.2013. 10:00-10:20 a.m. *V. gracilis* – few ind. seen; *H. biforata* – 1 ♂ seen; *C. vittata* – 1 ♂ seen; *P. autumnalis* – few ♂♂, 1 tandem seen; \**Macromia chaiyaphumensis* Hämäläinen, 1985 - 1 ♀ collected; \**M. cupricincta* - 1 ♂ collected; *O. chrysis* – 1 ♂.

43. 'Azureum pool' (#): a very shallow pool ca 20 x 8 m with fine grass, like loc. 40, surrounded by numerous pitfalls of wild buffaloes and some smaller artiodactyls, at Kong Kreav Veal (Fig. 54a) - a very open dipterocarp savannah, scarcely covered with grass, on a flat surface of a rocky hill Kong Kreav (about 100 m high). 14°10'29" N, 107°13'07" E, 240 m a.s.l.. 4.06.2013. 3:30-4:30 p.m. \**Ceriagrion azureum* (Selys, 1891) – very many tandems and ♂♂ seen, 5 ♂♂, 4 ♀♀ collected, 1 ♂, 1 tandem photographed (Fig. 55); *C. calamineum* – many tandems and ♂♂ seen; *A. guttatus* - 1 ♂ released; *D. trivialis* – few ♂♂ seen; *N. fulvia* – 1 ♂; *N. intermedia atalanta* – 2 ♂♂ seen; *O. chrysis* - 1 ♂ seen; *O. pruinorum neglectum* - 1 ♂ seen; *O. sabina* – few ind.; *P. flavescens* – 1 ♂ seen; *P. congener* – many ♂♂, 2 ovipositing ♀♀ seen; *T. transmarina euryale* – 1 ♂ seen.

### Updates to the country fauna

A checklist of Odonata of Cambodia at the state of to the end of 2012 was published in (Kosterin et al 2012b) and counted 135 named species. During this three week long trip, 107 Odonata species were encountered with, 104 of which identified to species. Fifteen of them are recorded for the first time in Cambodia, namely *Macromidia genialis shanensis* Fraser, 1927 in Koh Kong Province, *Chalibeothemis fluviatilis* Lieftinck, 1933 in Kampongsoam Province and *Ceriagrion azureum* (Selys, 1891), *Prodasineura coerulea* Fraser, 1932, *Gomphidia abbotti* Williamson, 1907, *Lamelligomphus castor* (Lieftinck, 1941), *Macrogomphus kerri* Fraser, 1922, *Nycho-*



*gomphus duaricus* (Fraser, 1924), *Orientogomphus minor* (Laidlaw, 1931), *Macromia aculeata* Fraser, 1927, *Macromia chaiyaphumensis* Hämäläinen, 1985, *Nesoxenia lineata* (Selys, 1879), *Palpopleura sexmaculata* (Fabricius, 1787) in Ratanakiri Province.

Of these species, *C. azureum*, *P. coerulescens*, *G. abbotti*, *L. castor*, *M. kerri*, *N. duaricus*, *M. genialis shanensis*, *M. chaiyaphumensis* and *P. sexmaculata* were quite expected as occurring in the neighboring East Thailand (Hämäläinen & Pinratana 1999). *P. caroli* was expected because of its being described from S Vietnam (Tol 2008). Besides, *Ceragrion indochinense* Asahina, 1967, tentatively reported based on photos by Roland et al. (2011) and Kosterin (2011), is now confirmed for Cambodia by a male specimen, while *Hemicordulia* sp. mentioned in (Kosterin 2011; 2012a, b; Kosterin et al. 2012a) is re-identified as *Hemicordulia tenera* undescr. ssp. *M. cincta* has not been reported so far from Thailand but might have been confused with and reported as *Macromia cupricincta* (Rambur, 1842). A female of "*Macromia cupricincta*" reported from the "*Macromia rivulet*" in Kosterin 2012a) was re-identified as *M. cincta*, but the true *M. cupricincta* was now collected in Ratanakiri Province; this case will be discussed in detail elsewhere. So, the country list now reaches 152 named species.

Ten years ago Hämäläinen (2003: 297) pointed out that "the Cambodian and South Vietnamese fauna has also an interesting Sondaic element", which may be interpreted as odonate species ranging in Sundaland but unknown from the continental Thailand and most of Indochina. Among Odonata species reported for Cambodia in literature to the moment of that publication, this element included only *Coelicia octogesima* (Selys, 1863) (misidentification not excluded), *Brachygonia oculata* and *Lyriothemis cleis* Brauer, 1868 reported by Martin (1904). However, five more such species have now been added: *Archibasis viola* (Kosterin 2011), *Aethriamanta gracilis* (Roland & Roland 2010), *M. cincta*, *C. fluviatilis* and *Nesoxenia lineata* (this paper). The known localities of these species in Thailand closest to Cambodia are as follows: of *N. lineata* at Nang Kroan, Kanchanaburi Province (Hämäläinen 2002), of *L. cleis* in Ranong Province, of *A. gracilis* in Phang Nga Province (Hämäläinen & Pinratana 1999), of *A. viola* at Pakweeb village, Hao Lak, Phang Nga Province (Day et al 2012), of *B. oculata* and *C. fluviatilis* at a peatmoss forest at Pru Toh Daeng in Sungai Kolok, the southernmost Narathiwat Province (Pinratana 2003).

The newly found population of *C. fluviatilis* on Kampongsaom Peninsula is remote and most probably isolated from the species main range that could challenge its conspecificity to the mentioned species, especially in view of the recent description of two related species from Peninsular Malaysia (Dow et al. 2007). However, according to a detailed list of diagnostic characters given by Dow et al. (2007), my specimens fit exactly the characters of *C. fluviatilis*.

Further studies will undoubtedly increase the number of Odonata species known from Cambodia greatly, since not less than a hundred of them are still expected in Cam-





bodia basing on the fauna of the adjacent East Thailand and South Vietnam, and we cannot predict the number of unexpected findings. The targets of further trips, ranged according to priority, could be as follows: 1) Phnom Samkos and Phnom Aoral Wildlife Sanctuaries embracing the highest mountains of the Cardamoms within Pursat and Kampong Speu Provinces, respectively (most threatened, as both recently offered for logging; 2) Mondulkiri Province in south-east of the country, rather elevated as occupying the western foothills of the Annamite Mts. (quite degraded because of human activity, yet with a number of protected areas); 3) higher mountains in Virachey Natural Park; 4) lowland deciduous dry dipterocarp forests and savannah in the north and east of the country.

### Notes on specimens' characters and taxonomy

#### 1. *Vestalis gracilis* (Rambur, 1842) / seasonal changes in wing enfumation

All specimens seen, of both sexes and in all three provinces, had the wing tips enfumed with brown (Fig. 8), as they were in April 2010 (Kosterin 2010). This is in line with the supposition that this enfumation results from development at higher temperatures at the end of dry season (Kosterin 2011).



Figure 8. A male of *Vestalis gracilis* with enfumed wing tips at the O'Tabok River right bank at Yorn village, Ratanakiri Province.





Figure 9. A copula of *Euphaea masoni* at 'Asahinai grook', Ratanakiri Province.



## 2. *Euphaea masoni* Selys, 1859 / unusual wing lustre in Ratanakiri populations

As situated in NE Cambodia, Ratanakiri Province was a place to expect occurrence of *Euphaea guerini* Rambur, 1842, which is common in Vietnam and reported for Cambodia without exact locality by Martin (1904). This species differs from *E. masoni* by the male hind wing coloration occupying the wingtip and having a strong greenish lustre (Hämäläinen & Karube 2001) which, however, does not extend to the wing apices leaving them broadly black, as is well seen in photos in Karjalainen & Hämäläinen (2013). No such demoiselles were found. However, the Euphaeas which were extremely abundant at any stream or rivers with rapids in Ratanakiri Province, were uniform in demonstrating some combination of the characters of *E. masoni* and *E. guerini*. All the males had the very apices of the hindwing transparent (Fig. 9), so I identified them preliminarily as *E. masoni*. They had a general very strong coppery lustre, well seen in flight (while in Koh Kong Province the males of *E. masoni* have a very slight purple lustre). However, the pigmented areas of their wing underside had a slight deep-greenish-blue lustre which again did not extent to the wing apical area leaving their apices broadly black (but with shortly transparent tips). This feature resembles the green lustre of *E. guerini* although was far from being so obvious: I was unable to make it seen on photographs, either taken in nature or from dead specimens. These hues of diffractive colouring more or less correspond to the expression “a mixture of iridescent bluish-green and coppery lustre” mentioned in the diagnosis of *E. hirta* Hämäläinen et Karube 2001, described from Bao Loc in South Vietnam (Hämäläinen & Karube 2001: 2012), that is ca 250 km SSE of the here considered area. However, Ratanakiri specimens had none of the diagnostic features of *E. hirta* and morphologically fitted *E. masoni* perfectly. It would be interesting to evaluate genetic distances between these Ratanakiri Euphaeas from doubtless *E. masoni*, *E. guerini* and *E. hirta* from elsewhere.

## 3. *Rhinagrion viridatum* Fraser, 1938 / problems with delimitation from *R. mima* Karsch, 1891 and with the diagnostic key provided by Kalkman & Villanueva (2011)

While all so far seen or collected specimens of this species from Koh Kong Province had the coloration typical for *R. viridatum*, with blueish-green spots of S2-S5, the only specimen collected in Ratanakiri Province (at the Yak Kae rivulet) differed from them in having these spots inconspicuous yellowish-white (Fig. 10). If to formally follow couplet 4 by Kalkman & Villanueva (2011: 28) (“... although pale white-yellow spots can be present”) it would be identified as *Rhinagrion mima* s. str. However, the first author of the cited paper, V. Kalkman (pers. comm.), kindly identified it as *R. viridatum* because of the dark-brown rather than yellowish ground colour of the first abdominal segments – a character not mentioned in the key. Besides, the Ratanakiri male is larger (total length 41 mm, abdomen 31 mm, hind wing 25 mm) than the only Koh Kong male in my present disposal (total length 38 mm, abdomen 29.5 mm, hind wing 23 mm). No doubt, the Ratanakiri population deserves further collecting and studying.







Figure 10. *Rhinagrion viridatum*, a male captured at Yak Kae Rivulet, Ratanakiri Province.



Note that in the cited paper, the diagnoses of *R. mima* and *R. viridatum* unfortunately swapped places: the statement “S3-5 black with a distinct blue apical spot, S7-9 largely yellow”, placed with *R. mima* (Kalkman & Villanueva 2011: 19) in fact refers to *R. viridatum* while the statement “Abdomen yellow and black, S3-5 with no distinct blue apical spot” (Kalkman & Villanueva 2011: 27), placed with *R. viridatum*, in fact refers to *R. mima* (the rest of the diagnoses of these species are identical verbatim). As published, these statements contradict to the key but Vincent Kalkman (pers. comm.) kindly confirmed that the key is correct and it was the diagnoses which were confused. This confusion is especially misfortunate since the mentioned spots are not seen in males of both species in the loc. cit. Fig. 3b-c, while the black versus grey dots referring to *R. mima* and *R. viridatum* look indistinguishable in the distribution map in the loc. cit Fig. 4. Besides, the very assumption of *R. mima* and *R. viridatum* as different species is still questionable (Ibid. and V. Kalkman, pers. comm.).

#### 4. *Aciagrion* sp. / what is ‘Violet Aciagrion’?

So far five species of *Aciagrion* have been reported for Cambodia: *A. pallidum* Selys, 1891, *A. borneense*, *A. occidentale* Laidlaw, 1919, *A. hisopa* and *A. tillyardi* Laidlaw, 1919. *A. pallidum* is a common large species well recognisable for its coloration (Kosterin et al. 2012a). *A. borneense* and *A. occidentale* are related small species, the first common while the single old report of the second (Asahina 1967) is dubious. *A. hisopa* and *A. tillyardi* are not closely related medium-sized species with a lot of taxonomical confusion around both, yet I am quite sure in my earlier identification of the Cambodian specimens made after consideration of all the available sources of information (Kosterin 2012a). A detailed paper devoted to these species is in preparation. *A. hisopa* was earlier found in Koh Kong Province (Kosterin 2012a) and now also in Ratanakiri Province. *A. tillyardi*, fitting well the descriptions by Laidlaw (1919) and Fraser (1919; 1933, but under other names, see comments in Kosterin 2012a) was found in Cambodia so far only on the Bokor Plateau (Kosterin 2011; 2012a, b).

Now four males of one more species of *Aciagrion* have been collected at tiny roadside pools (Fig. 25) at the ‘Orolestes pool’. These damselflies are small (but variable in size, with abdomen 22-25 mm), have a violet ground colour, a narrow transversal postocular streak rather than large postocular spots, S10 black dorsally (Fig. 11), bifid upper appendages and a light-coloured lower terminus of the lower appendage. The violet ground colour is a feature not shared by the five *Aciagrion* spp. recorded in Cambodia earlier. The above mentioned combination of characters exactly corresponds to the damselfly from Hong Kong identified by Wilson (2000) as *Aciagrion tillyardi* Laidlaw, 1919. Moreover, my specimens are virtually indistinguishable from two males from China, Guandong Province, Gonghna city, Weidong village, 15.04.2011, collected, identified as *A. tillyardi* and kindly provided for examination by Haomiao Zhang.





**Figure 11.** *Aciagrion* sp., a male at a tiny roadside pool 7 km NEE of Ban Lung, Ratanakiri Province.

However, this is by no means *A. tillyardi* (type locality: Cheerapunji, currently Meghalaya State of India) since, according to its author Laidlaw (1919; 1924), *A. tillyardi*, has a blue or greenish-blue ground colour and large postocular spots just connected by a narrow streak: see detailed comments in Kosterin (2012a). So let us for the time being call the species in question by the vernacular name ‘Violet Aciagrion’ given to it by Wilson (2000)

The valid name for this ‘Violet Aciagrion’ is most probably *krishna* Fraser, 1921 (type locality: Mahabaleshwar, Maharashtra, India), characterised by its author (Fraser 1921; 1933) as having a lilac ground colour, deeply bifid cerci and black marked S10. It was proposed for a ‘race’ of *A. hisopa*, the species of which F.C. Fraser had a wrong notion.

However, the very rank of ‘Violet Aciagrion’ is unclear as well, since the violet ground colour so far seems to be the only trait distinguishing it from *A. migratum* (Selys, 1876), widely ranging in Japan, Korea and China, which is blue (note that *A. tillyardi* and *A. migratum* have similar bifid cerci). A relevant solution of the problem is to be found in the context of a substantial analysis of the systematical and nomenclatural situation around Asian representatives of *Aciagrion* as a whole.

I should make a reservation that the photos by Dennis Farrell of “*A. tillyardi*” from North Thailand (Chiang Mai, Phetchabun and Loei Provinces), discussed in Kosterin (2012a), in fact showed the ‘Violet Aciagrion’, that is *A. tillyardi* sensu Wilson, 2000 nec Laidlaw, 1919.

### **5. *Aciagrion hisopa* (Selys, 1876) / seasonal variation**

This species has now been unexpectedly found in a swamp behind mangroves in Koh Kong Province as well as in Ratanakiri Province, in a habitat identical to the one where





it is invariably most numerous in Koh Kong Province, namely a shallow grassy pool amidst a *veal* that is a savannah area on rocky/sand ground (Kosterin 2012a and this paper). In all now collected specimens, the thoracic pattern is light reddish-tan, not darker than the blue ground colour, as well as in specimens collected in April 2010 (Kosterin 2010, fig. 41, as *Aciagrion* sp. cf. *pallidum*) (and as well as in some males from Peninsular Malaysia, Kuala Lumpur and Tasek Bera, photographed by Rory Dow in RMNH). This was not surprising as April is seasonally close to early June. All specimens taken in August 2011, similar otherwise, had a contrasted black pattern, even in teneral specimens (Kosterin 2012a) (as well as in other photographed males from Peninsular Malaysia). I believe this is a seasonal variation of the broods developing in different conditions. Specimens from Ratanakiri Province have the abdomen length 30 mm (two males) and 27 mm (the female). This corresponds to the mentioned two males from Koh Kong Province taken in April 2010, which had the abdomens 30.0 and 30.5 mm long, versus males taken in August 2011 having it 27.5-28.0 mm. Most probably, the abdomen length differs in seasonal broods as well, as supposed in Kosterin (2012a) for this species and is known for *A. migratum* (Selys, 1876) in Japan (Sugimura et al. 1999).

#### **6. *Archibasis viola* Lieftinck, 1948 / *A. oscillans* (Selys, 1877)**

Only two specimens representing two species were collected. A female of *A. viola* from the 'Oculata brook' had a saturated-violet ground colour as in males. In this it corresponds to the characters of a female given by Lieftinck (1949) while all females encountered in Koh Kong Province in November/December 2010 and identified as *A. viola* had a blue ground colour (Kosterin 2011). With all three males encountered in Koh Kong Province during 2010 trip being *A. viola*, with saturated violet ground colour, I find it very improbable that all the four females collected at the same time belonged to some other morphologically similar species of *Aciagrion*. (In August 2011 in the same area I found many males of *A. viola* but no females, see Kosterin 2012a.) In the newly reported violet female, the black dorsal spot on S8 almost reaches the segment anterior margin which is another difference compare to the blue females discovered in 2010.

*A. oscillans* was reported for Cambodia by Martin (1904). The male of *A. oscillans* from 'Marginipes brook' at Yorn village fits the redescription and figure in Lieftinck (1949) very well. The following combination of variable characters (yet fitting the redescription) was used in identification: total length 44 mm, abdomen 36 mm, hind wing 25 mm; fore wing with 13 antenodals, ground colour of head, thorax, S1 and S8-10 and the dorsal oval spot on S2 saturated turquoise-blue, sides of abdominal S2-S7; the lower 1/3 of the humeral stripe the black colour is replaced by hazel-brown, the same colour finely margins the dorsal stripe.





## 7. *Protosticta caroli* van Tol, 2008 / coloration peculiarities of Cambodian specimens and brief description of not yet described female.

*Protosticta* found below Cha Ong Waterfall belongs to the *curiosa*-group (see Van Tol 2008). The male specimens bear dorsal cup-like structures on the inferior appendages (Fig. 12 a-f). Among species of the mentioned group known from Thailand and Indochina, two have not these structures (*Protosticta curiosa* Fraser, 1934 and *P. khaosoidaoensis* Asahina, 1984) and three have them, namely *P. satoi* Asahina 1997, *P. caroli* and *P. linnaei* van Tol, 2008. Noteworthy that the two latter species were both described from Chu Yang Sin National Park, Da Lak Province, South Vietnam (van Tol 2008), that is just 200-210 km SE of Cha Ong. *P. satoi* was described from Tam Dao, Vinh Phuc Province, North Vietnam (Asahina 1997), that is 880 km NNW from our site. *P. linnaei* has long and tapering parts of inferior appendages apically of the cup-like structures (van Tol 2008) and so can be ruled out, since in my males the cup-like structures are placed terminally, as in the two other species mentioned. *P. satoi* (together with its probable senior synonym *P. beaumonti* Wilson, 1997 described from Hong Kong) can be ruled out as having a non-contrasted coloration of synthorax, either rather light with a weak stripe along the mesopleural suture weakly expressed (Asahina, 1997), or entirely dark (van Tol 2008). In my specimens the synthorax is contrastedly coloured with a broad and distinct stripe along the mesopleural suture (Figs. 12, 13) as in *P. khaosoidaoensis*, *P. caroli* and *P. linnaei*. Besides, a remote known range of *P. satoi*, in North Vietnam and probably South China, makes its finding in Cambodia improbable. The species left is *P. caroli*. My males differ from its original description in having the dark pattern less extended in fine details:

- 1) Prothorax is white with the posterior lobe black and some darkening at posterior margins of the lateral lobes (in specimens described from Vietnam there are black markings also at the anterior and median lobes);
- 2) black markings on S9 variable but in general less extended than in the original description: the anterior dorsal mark occupies 1/3 or slightly less of the segment length (instead of 3/5 as in the described Vietnamese males); the posterior dark border is very narrow dorsally (much less than 1/6 of the segment as in the Vietnamese males).

I assume these differences to be quite intraspecies and identify my specimens as *P. caroli*.



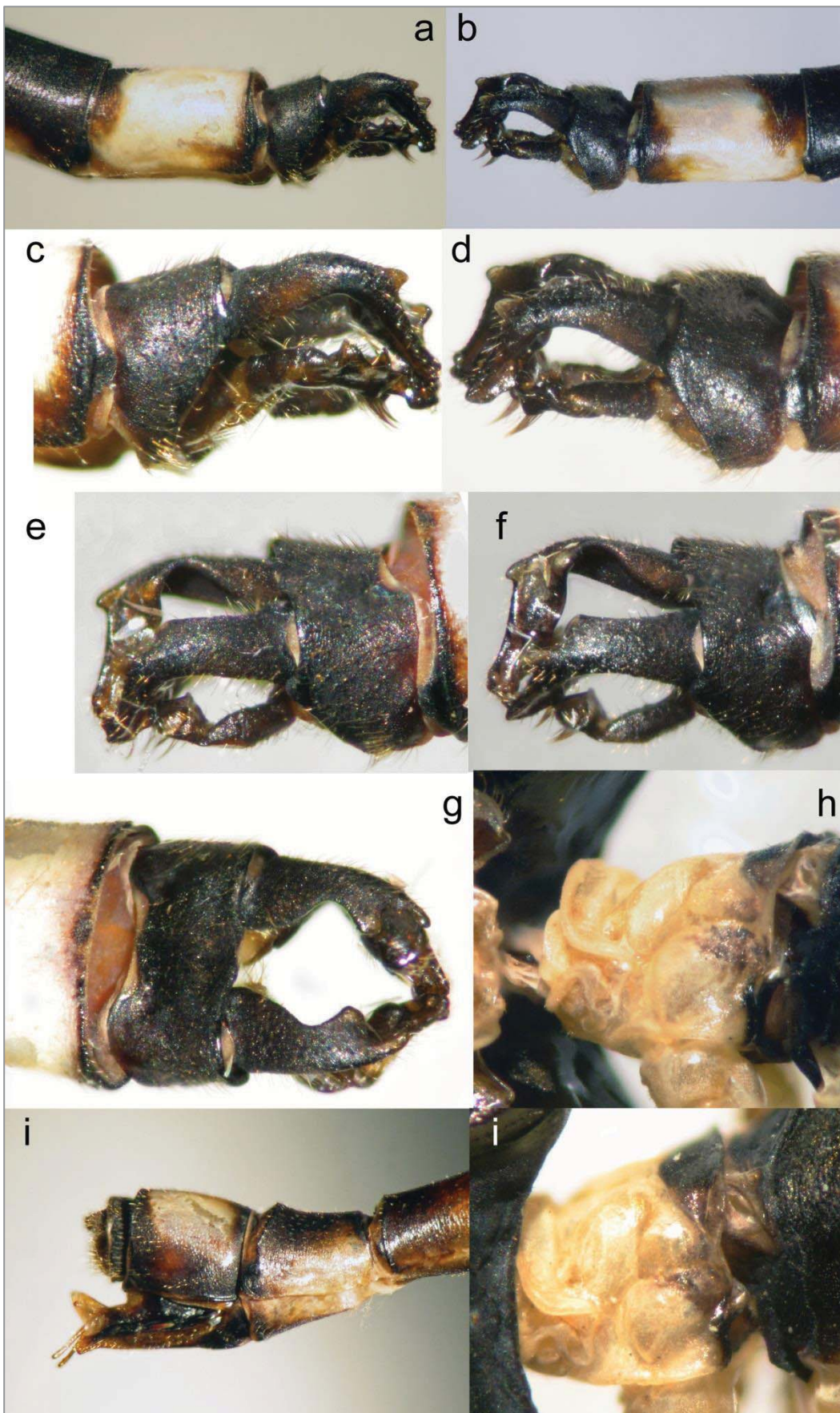


Figure 12. *Protosticta caroli*, morphological details of two males (a-h, the left images refer to one male and the right ones to another) and a female (i-j) collected below Cha Ong Waterfall, Ratanakiri Province. Not to scale.







Figure 13. Males of *Protosticta caroli* below Cha Ong Waterfall, Ratanakiri Province.



Female of *P. caroli* has not yet been described but this sex is not expected to be diagnostic in this group, so below I mention its characters briefly. Total length 39 mm, abdomen 32 mm, hind wing 20 mm (as in males). Coloration as in male except for last abdominal segments (Fig. 12i-j). S8 blackish dorsally, gradually lightens, through brownish, to creamy anterolateral parts; anterior margin accompanied with a blackish semi-ring. S9 blackish at all margins, its most area occupied by a large creamy dorsolateral spot with indistinct lower borders. S10 blackish, appendages brownish. Ovipositor black with light-brownish tip and processes.

#### **8. *Gynacantha subinterrupta* Rambur, 1842 / wing membrane colour**

Three of the four males and both females collected at 'Orolestes pool' have identical wing darkening: the membrane has an even dirty-ochraceous brownish tint throughout, of the same colour as the costal and subcostal veins, bases of some other main veins and pterostigma; the rest of the venation is dark. One more male from the same locality and the male from 'Abisaria brook' have clear membrane and the same venation colour. Although the difference in the membrane colour is very distinct, there are no other differences. Most probably, the wings are darkened in aged specimens. The body colours in males are moderately vivid.

#### **9. *Hemicordulia tenera* / need for subspecific differentiation**

Variation of the relative length and shape of the anal appendages in four series of *Hemicordulia* specimens collected in Cambodia suggest them to be rather conspecific to *Hemicordulia tenera* Lieftinck, 1930 than an undescribed species, as was supposed in Kosterin (2011; 2012a,b) and Kosterin et al. (2012b). However, their cerci are relatively shorter than in the typical *H. tenera* from the Malay Peninsula (Kosterin 2012a). Thomas W. Donnelly kindly offered for study three of his male specimens collected in Chiang Mai Province (Donnelly 1994) and Bro. Amnuay Pinrtana offered a male from Phu Kradung National park in Loei Province, both in North Thailand. These North Thai specimens have the cerci further shortened but otherwise indistinguishable from *H. tenera* from the Malay Peninsula as well, hence confirming them to be conspecific to *H. tenera* (T. Donnelly pers. comm.) and not the undescribed species as thought earlier (Donnelly 1994). However, both N. Thai and SW Cambodian populations deserve a subspecific rank so a description of two subspecies is forthcoming.

#### **10. *Idionyx thailandica* Hämäläinen, 1985 / problems of identification of females**

The only male collected at Kbal Chhay Waterfall in Kampongsaom Province fits well to the original description by Hämäläinen (1985a) and details of additional specimens given by Asahina (1987b). The illustrations in the two last cited papers differ in the





apparent relative length of the anal appendages: in very schematic figs.1 and 3 in (Hämäläinen 1985a) they are shown to terminate in line while in figs. 53 and 54 in (Asahina 1987b) the cercus is shown substantially longer than the epiproct. I believe these differences are insufficient as depending on the variable degree of curvature of both cercus and epiproct while the principal structure or the appendages is identical in all figures and my male, which is worth illustrating by photographs of its appendages (Fig. 14).



Figure 14. Anal appendages of a male of *Idionyx thailandica* collected at Kbal Chhay Waterfall, Kaomongsaom Province.

All *Idionyx* females collected during this trip (one from Koh Kong Province (Fig. 4a) and eight from Ratanakiri Province) correspond to females of *I. thailandica* Hämä-



läinen, 1985 as characterised by Hämäläinen (1985a) and Asahina (1987b). However, those from Ratanakiri Province are slightly larger (hw 28-29, mostly 29 mm) and have the strong wing basal amber extending to embrace the triangles rather than to the arculus, as stated by Asahina (1987b) and as observed in the Koh Kong female, whose hw is 26 mm long. For *I. thailandica*, the hind wing was reported to be 28-30 mm long (Hämäläinen 1985; Asahina 1987b). Earlier I reported about a female supposedly of *I. thailandica* from Bokor Plateau which missed the basal amber (Kosterin 2012a, b), but this could be because of its teneral condition.

The *I. yolanda*-group supposed to include a series of geographically vicariant species (to my opinion better fit the role of subspecies): *I. victor* Hämäläinen, 1991 in S China, *I. thailandica* Hämäläinen in Thailand and Cambodia, *Idionyx* sp. in the Malay Isthmus, *I. yolanda* Selys, 1871 in Sundaland and *I. philippa* Ris, 1912 in the Philippines (Hämäläinen 1985a; 1991; 2002). The Cambodian females cannot be confidently identified to species level without any accompanying males. However, even margins of all thoracic yellow stripes and an even width of the stripe going through the spiracle observed in the Cambodian females correspond just to *I. thailandica* rather than to *I. yolanda* (see Hämäläinen 1985a) or *I. victor* (see Hämäläinen 1991).

### 11. *Neurothemis fluctuans* (Fabricius, 1793) / females with pigmented wings

For the two days spent in Virachey National Park buffer zone at Yorn village, I registered only four females of this species. These females were unusual. First, all they had bright purple-red abdomen, while normally the abdomen, as in males, is brownish in females of this species. Second, three females had the wings heavily pigmented in a bit more than their basal halves (Fig. 15). Only one female had clear wings, as usual for the species. (I observed two more individuals of that species with coloured wings but cannot say of which sex they were.) All the specimens were found in open dipterocarp forest disturbed by logging.



Figure 15. Females of *Neurothemis fluctuans* with heavily pigmented wings, collected between Yorn village and O'Tamol Meik Rivulet, Ratanakiri Province.

The wing pigmentation of the two collected female specimens is quite dark but rather sepia-brown than reddish-brown, as usual in males of this species. In live individuals





this colour quite contrasted to their bright purple-red abdomens. The border of the pigmented zone is rather indistinct, on the fore wing it starts at the costa at about 2/5 of the distance from the nodus to the pterostigma (at about postnodals 5-6). It goes to the wing hind margin perpendicularly, in the photographed female and one of the collected females, and somewhat obliquely in the second collected female. On the hind wing it starts at the costa at about half of that distance and gradually curves towards the wing base at the wing hind margin. In the collected females, the pigmentation distinctly weakens in centres of all cells except for those at the costa, in one of the females also along most veins, while in normal males of this species the wing coloration is even.

The closest population of *N. fluctuans* was found as distantly as 48 km SSE and across the major Se-San River, at 'Orolestes pool', in an open rubber plantation area. There I observed many males and few common clear-winged females, no females with coloured wings being registered.

Earlier a female of *N. fluctuans* with heavily pigmented wings was reported for Cambodia, from Bantea Srei, by Roland et al. (2011). Unlike the above considered females from Virachey buffer zone, its wings were pigmented up to proximal ends of pterostigmata, with margins of coloration nearly perpendicular to costa (loc. cit.: fig. 9).

## 12. *Palpopleura sexmaculata* (Fabricius, 1787) / curious spot on female hindwing

Among three collected females, one had a dark-brown transversal patch with vague margins, about 2 cells wide and 4 cells long, across the hind wing, roughly between veins R2 and Rspl at the level of the pterostigma anterior end (Fig. 16, left). I did not find mentions of such a patch on the hind wing of this species in literature.



Figure 16. Females of *Palpopleura sexmaculata* collected at a tiny roadside pool 7 km NEE of Ban Lung, Ratanakiri Province.



## Notes on habitats and habits of some species

### 1. Confrontational flight of *Vestalis gracilis* above rivers

*Vestalis gracilis* is known as keeping to shady places where it tends to aggregate (Karjalainen & Hämäläinen 2013). However, I twice observed (at 'Microgomphus River' and O'Sieng Lei waterfalls), a typical confrontational behaviour which took place at bright sun: two individuals (most probably males) appeared from shade and hovered face-to-face over the surface of troubled water of a swift river, their wings flushing light-green in sunlight. This confrontational flight lasted for several seconds, and then the participants disappeared in shade of vegetation. The shade could serve this species as a territory of peace, to feed and rest together, while the males go to sunshine to rival. While the contest behaviour is usually so common in such Calopterygidae as *Calopteryx* or *Neurobasis*, it is intriguing that these two cases of such were the only which I observed in *V. gracilis* during all my trips in SE Asia, in total comprising about an year of observation time.

### 2. Probable maturation and reproduction sites of *Lestes platystylus*

At present, *Lestes platystylus* (Fig. 17) has been found in Cambodia in two rather contrasted habitats: (i) few immature (still grey) males in a closed forest dell of 'Platystylus brook' at the hillside in Kep in Decemper (Kosterin 2011) (probably maturation site) and (ii) few mature (already light-green) males at 'Pygmaea' (Fig. 18a) and 'Hisopa' (Fig. 18b) swamps near Koh Kong in May (this paper) (probably reproduction site). These swamps were similar: just behind mangroves, very shallow, almost hot and probably mineralised, with fine green grass ca 10 cm high with sparse bushes and *Acrostichum* fern. It cannot, however be excluded that this rare species has nevertheless broad range of breeding habitats.

### 3. Restricted habitat of *Protosticta caroli*

*P. caroli* was found below Cha Ong Waterfall as confined to two small areas, not more than a dozen of square metres each and ca 100 m apart from each other:

(i) on a rather deep shady slope with sparse huge trees and scarce understory above the river (there were 3 males and 1 female) (Fig. 19b) and

(ii) among shaded huge boulders at the very bank of a river with rapids, where not less than 10-15 males hid in shade among bush branches (Fig. 19a). In spite of rather a high density of individuals on both areas, no individuals were encountered between them, so the factor delimiting these spots to which *P. caroli* seemed to be confined remained unclear. The damselflies perched on fine twigs very low at the ground, did not show perch fidelity or aggression to other individuals near and were not at all cautious.







Figure 17. A mature male of *Lestes platystylus* at 'Pygmaea swamp' at Koh Kong suburbs.





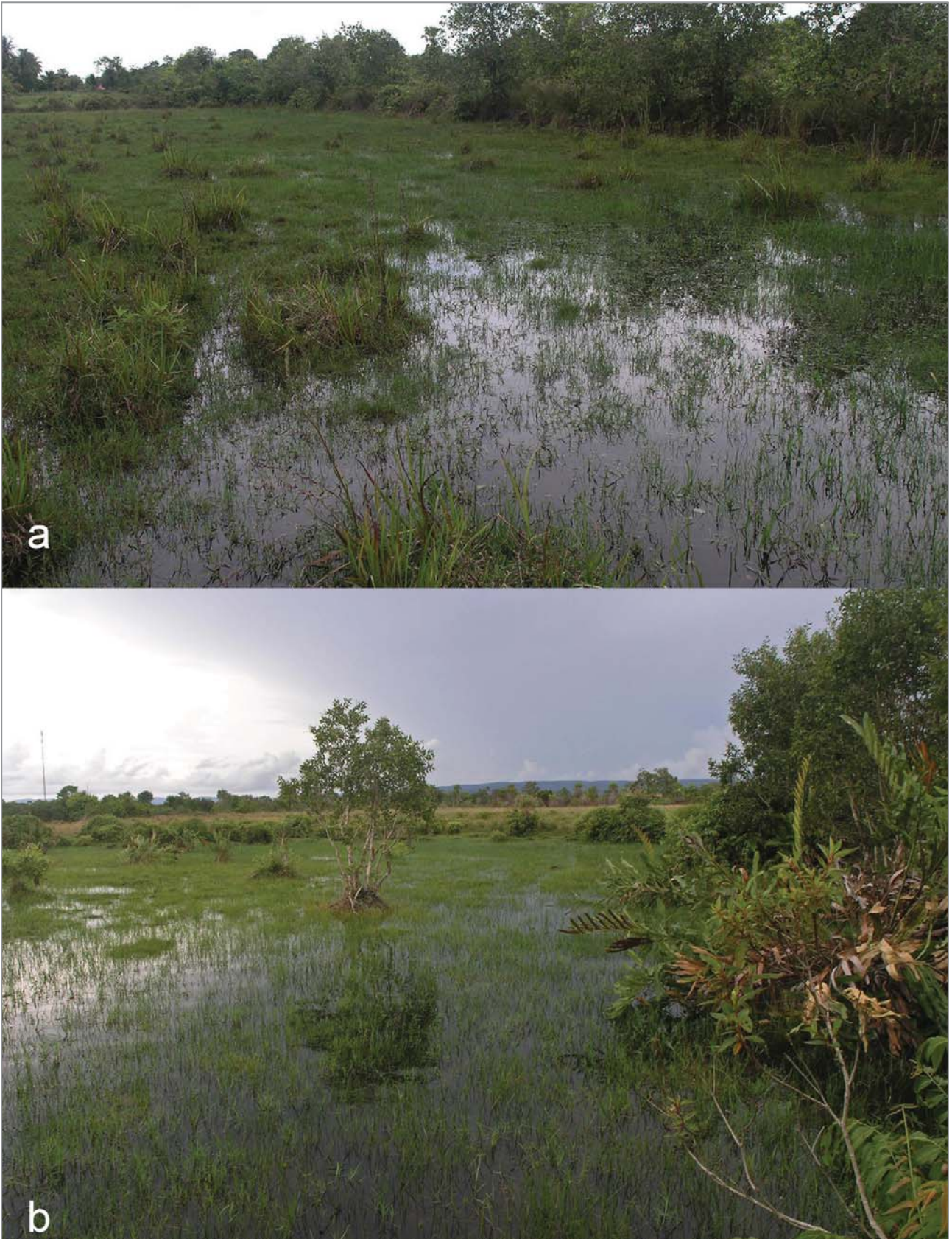


Figure 18. Shallow grassy swamps behind mangroves at Koh Kong suburbs: a, 'Pygmaea swamp'; b, 'Hisopa swamp'; habitats of *Lestes platystylus*, *Aciagrion borneense*, *A. hisopa* (b), *Agriocnemis pygmaea*, *Ceriagrion malaisei*, *Pseudagrion australasiae* (b), *Anax guttatus*, *Acisoma panorpoides* (b), *Brachydiplax chalybea*, *Brachythemis contaminata*, *Crocothemis servilia*, *Nannophya pygmaea* (a), *Neurothemis fluctuans*, *N. tullia*, *Orthetrum sabina*, *Tholymis tillarga*.







Figure 19. Below Cha Ong Waterfall, Ratanakiri Province. Habitat of *Protosticta caroli* (in a the exact habitat is at the remote end of the visible brook reach), and also *Neurobasis chinensis*, *Euphaea masoni*, *Dysphaea gloriosa*, *Aristocypha fulgipennis*, *Libellago lineata*, *Zygonyx iris*.





#### 4. Off-water oviposition by *Gynacantha subinterrupta*

*Gynacantha* spp. are known to breed in forest pools (Orr 2005). I observed active oviposition by *Gynacantha subinterrupta* (Fig. 20) in the evening on 6.06 and 7.06 at 'Orolestes pool'. It may be called a 'former forest pool', as there was a very small forest remnant on a small hill at its side; it has very dirty, turbid water. Few females oviposited at its banks, covered with scarce low herbage (Fig. 21), into the ground, openly or, less frequently, hidden in grass (Fig. 20, below), 3-5 m apart from water. They were very cautious but did not fly far; their flight was an uneven series of hoverings. Above this area, not less than 6-10 males ranged low above grass, or hovered, sometimes for a very long time (Fig. 20, above), perhaps due to having seen an ovipositing female. They chase each other and try to catch females; one pair copulated for a second while another took up into the tree canopy. On 6.06, mating and ovipositing already went on at 5:00 p.m. and on both dates lasted at least until complete darkness at 6:30 p.m. At 'Abisaria brook', a female was observed ovipositing at around 4:30 p.m., also into the ground in deep shade, away from clear pools of its temporary forest brook.



Figure 20. *Gynacantha subinterrupta* at 'Orolestes pool', Ratanakiri Province, dusk of 6.06.2013: ovipositing females (bottom) and a male hovering above one (top).







Figure 21. Ovipositing site of *Gynacantha subinterrupta* at 'Orolestes pool'.

### 5. Why females predominate overwhelmingly among *Idionyx ?thailandica*?

During the trip, I encountered *Idionyx* in four localities: 'Macromidia river' in Koh Kong Province (a female), at Kbal Chhay Waterfalls in Kampongsaom province (a male), at 'Idionyx River' (numerous females) and 'Katieng Waterfall' (a female) in Ratanakiri Province. So, I found a male only once. These dragonflies were observed only at times without direct sun light: in shady places at overcast weather (the two former localities), or in the beginning rain (Katieng Waterfalls), or in the evening ('Idionyx Rivulet'). The male was ranging to and fro 1.5-2 m above the ground, in a characteristic weak fluttering manner, at wooden awnings near and above the waterfall, at 5:18 p.m. At 'Macromidia River', a female oviposited while fast flying to and fro for a very short distance above the very water margin of a shallow basin formed by a stream flowing over a sandstone bed of large rocks and boulders, which was in the deep shade of tall primary forest.

In Ratanakiri Province, many females but not a single male were encountered. At Katieng, the female was fluttering chaotically and low above the ground under the rain. At 'Idionyx River', numerous females exhibited all the above mentioned types of







Figure 22. 'Idionyx River', Ratanakiri Province, a, flat reach; b, reach with rapids: a habitat of numerous *Idionyx ?thailandica* females (c), and also of *Neurobasis chinensis*, *Vestalis gracilis*, *Euphaea masoni*, *Dysphaea gloriosa*, *Aristocypha fulgipennis*, *Heliocypha perforata*, *Pseudagrion pruinosum*, *Burmagomphus divaricatus*, *Brachythemis contaminata*, *Orthetrum luzonicum*, *O. pruinosum*, *Trithemis aurora*, *T. festiva*.



flight. Some oviposited at a tiny brook with grassy banks being in fact a river arm (Fig. 22a); some were ranging to and fro at ca 1.5 m above an open patch of a bank of a slow river; and many (a few in view at once) flew at much greater height above step-wise riffles of its stretch with rapids (Fig. 22b). Restless flying above the breeding place seemed as if a 'male-like' behaviour, and I did not manage to find a single male at this river. An unjustified thought about possibility of parthenogenesis in some populations like this came to my mind.

## 6. Flexible behaviour of the crepuscular *Macromidia rapida*

*Macromidia rapida* is a species strictly keeping to shade, but its behaviour seems to be of some plasticity. In deep dusk of 24.08.2011 at 'Andy's pond' (Koh Kong Province), I collected two males one by one as swiftly flying just above shallow water of a small bay at a brook mouth (Kosterin 2012a). In Ratanakiri Province I made a number of observations. On 31.05.2013, also in deep twilight, I caught a female swiftly crossing a medium-sized and very fast river downstream of Kachan Waterfall, and then saw another one doing the same. In the morning of 6.06.2013 I found a female, obviously attracted by light at night, in the lobby of the hotel close to Kan Seng Lake (Ratanakiri Province, as well as the rest observations), far from brooks and rivers. On 02.06.2013, I observed and photographed a male which sat on a branch at a bank of rather a slow reach of a larger river downstream of O'Sieng Lei waterfall, in shade but at overcast midday, about 2:00 p.m. (Fig. 23). On 01.06.2013 I observed 5 males and 2 females at sunny midday (at ca 2:00-3:00 p.m.) but on a deeply shady left bank at a shallow of the river (the same as at Kachan) downstream of Katieng Water-



Figure 23. A male of *Macromidia rapida* photographed in the afternoon downstream of O'Sieng Lei Waterfall, Ratanakiri Province.

fall, with tiny pools connected by seepages. They flew chaotically low above the seepages, being very hard not only to catch but even to see. Although only one dragonfly was seen at any moment: very soon after I collected one, a next one appeared at the





same place, as if they were in a queue for it. Only once I saw two: when a male appeared and captured a female, to immediately form a copula and disappear. Another female oviposited to a somewhat less shady pool. A male of *Macromidia genialis shanensis* at 'Macromidia rivulet' showed a similar behaviour: it was swiftly ranging to and fro for a short distance, very low above a tiny shallow pool in deep shade under a bridge at overcast midday, at about 2:30 p.m.

### **7. *Brachygonia oculata* is not confined to swamp forest**

This species has now been found at the rapidous 'Oculata brook' on a hill slope both in dry (Kosterin 2010) and rainy seasons (this trip, both sexes, Fig. 24) suggesting its residence here. Therefore, at least in this area it is not confined to 'lowland swamp forest', as indicated in Orr (2005), in a strict sense: this is still a lowland forest, but by no means swampy.

### **8. Accompanying, misdirected aggressive and crepuscular behaviour of *Brachythemis contaminata***

*Brachythemis contaminata* has proved to be very ready for *accompanying behaviour* (Corbet & Miller 1991); many times following my feet at different places ('Epophthalmia reserve', 26.05.2013 – few females altogether; the river below Kbal Chhay Waterfall, 26.05.2013 – few ind. of both sexes), as discussed in Kosterin (2012a). Downstream of Katieng Waterfall, I observed a male which made several subsequent persistent attempts to either attack a perching male of *Dysphaea gloriosa* or perch on it, perhaps taking it for a conspecific match because of a similar, fulvous coloration. In the evening both sexes of *B. contaminata* were observed to remain very active until dark, as already noted in Tang et al. (2010).

### **9. Oviposition of *Nannophya pygmaea* in floating grass-and-litter mats along a rivulet**

It turned out that the presence of many *Nannophya pygmaea* at the medium-sized 'Nannophya' and 'Macromia' rivulets detected in November/December 2010, August 2011, and May 2013 (Kosterin, 2011; 2012a and this paper) did not result from dispersal from pools and swamplets at surrounding savannah-like *veals*. On 23.05.2013 at 'Nannophya rivulet', these tiny dragonflies kept to floating grass-and-litter mats along its banks. I observed a female ovipositing into such a mat and grasped by a male to form a copula.

### **10. Courtship behaviour of *Palpopleura sexmaculata***

Both sexes of *Palpopleura sexmaculata*, found only at tiny roadside pools near 'Orolestes pool' (Fig. 25), perched on tops of high grasses, up to 1 m above the ground.







Figure 24. A female (above) and male (below) of *Brachygonia oculata* at 'Oculata brook', Koh Kong Province.





Twice I observed courtship as follows: a female perched on its grass while a male in the air made two very swift rounds around her, about 20 cm in diameter, then hovered at one point in front of her for not less than a second, then made two next rounds and so on.



Figure 25. Tiny roadside pools 7 km NEE of Ban Lung, Ratanakiri Province: habitat of *Palpopleura sexmaculata*, and also *Aciagrion* sp., *Trithemis aurora*, *Orthetrum glaucum*, *O. pruinosum*.

### 11. Flexible oviposition in *Zygonyx iris malayana*

Below Cha Ong Waterfall (Fig. 19), oviposition of *Zygonyx iris malayana* was observed over a shady tiny arm of the main river filled with dark leaf litter (as at the Thma Bang River as described in Kosterin (2012a)): once by two free females, once by a tandem.

### 12. Odonata attracted by light

Two species can be added to the list by Umar et al. (2012) of Odonata registered as attracted by light to the lobby of Lakeside Chenglok Hotel near Lake Kan Seng: *A. brevipennis* (a male arrived during downpour after sunset on 31.05) and *M. rapida* (a female found in the morning of 6.06). Besides, the above cited authors missed *Acia-*



*grion borneense*, *Ceriagrion olivaceum* and *Tamea transmarina euryale*, whose attraction by light was registered in Kosterin (2011).

## Notes and impressions about the areas visited and Odonata observed.

### 1. Weather, seasonal conditions and threats

There were moderate amount of water in rivers in Koh Kong Province. In Kampong Saom Province, as well as in the Central Cambodia, the rice was generally not yet planted and paddy fields were still grazed by buffaloes.

The rainy season was formally going on but rains did not interfere with the field work at all. For four days spent in Koh Kong Province, 22-25.05.2013, there were short rains in the mornings of 22-23 and 25.05.2013, a considerable rain in the afternoon of 22.05 and strong downpours at noon on 23.05.2013 and at night 25-26.05.2013. There was good weather for 26-28.05.2013 in Kampong Saom Province, if sunny weather can be considered good in the rainy season. In Ratanakiri Province, visited for nine days, 30.05–7.06.2013, the weather was remarkable for its regularity: most days it was fine throughout the day following a thunderstorm downpour around sunset (mostly shortly before it); only three days, June 4 and 6-7 were rainless.

Mosquitoes were the scarcest I saw in tropics: even guesthouses appeared nearly free from *Anopheles*, and no more than 2-3 individuals of *Aedes* were met in forests for the entire trip. Leeches were numerous in forests of Koh Kong Province while in Ratanakiri Province we found just three in Virachey National Park buffer zone. A huge green-bottomed water leech attacked me in Lake Kan Seng, but its bite was less injuring than those of the terrestrial leeches. For three weeks I saw just one small snake in Ratanakiri Province and one black scorpion in Kampong Saom Province.

Immediately after (fortunately not before) I left Tolmachevo airport of Novosibirsk on 12.06 upon return to Novosibirsk, I felt my temperature rising. There were three waves of high temperature and strong fatigue, with liver and gut problems in addition; so twelve days since 15 to 27.06,2013 I spent in an infection hospital but they failed to provide a diagnosis. On 28-30.06.2013 the temperature rose again so on 1.07.2013 I decided to intake, for my own responsibility, 6g of prasiquantel at once, following the instruction applied. I did this since the acute schistosomiasis, so-called Katayama fever, was my most probable guess. I visited the region endemic for *Schistosoma mekongi* Voge, Bruckner et Bruce, 1978: rivers descending from the Annamese Mts. to the Mekong in NE Cambodia and southern Laos. Unlike other *Schistosoma* ssp., which are lentic, this species occurs in rivers: those with hard water, moderate current and beds with rock platforms, inhabited by the intermediate host, lithophilic snail *Neotricula aperta* (Temcharoen, 1971) (Atwood et al. 2004). Wandering in rivers all day long placed me well into the risk group. The self-medication





seemed to have worked: the symptoms disappeared, those of the liver gradually for about a week.

## 2. Cardamom coastal foothills revisited the fourth time.

These foothills were visited at the end and beginning of the dry season in 2010 (Kosterin 2010, 2011) and in the late rainy season in 2011 (Kosterin 2012a), as described in detail in the respective publications. The seasonal conditions and Odonata aspect I observed during my rather brief visit in May 2013 resembled those I saw in August 2011 (Kosterin 2012a), although Odonata seemed somewhat less diverse. Table 1 enumerates species which I have encountered during my previous visits but not during this visit (19 species), and vice versa (two species). Note that for recent years in this area, Gerard Chartier has been conducting permanent observations of Odonata being a resident of Rainbow Lodge near Tatai. His records up to 2012 has been published in Kosterin et al. (2012b) and in 2013 he already recorded two more species for the first time in Cambodia, which will be published elsewhere.

**Table 1. Comparison of lists of species found in Koh Kong Province during this visit in April 2013 and three previous visits in 2010-2012.**

Species found in April and November / December 2010 and August 2011 (Kosterin 2010; 2011; 2012b) but not in May 2013	Species found in May 2013 but not in 2010-2012
<b>Common species:</b> <i>Lestes concinnus</i> ; <i>Aciagrion pallidum</i> ; <i>Pseudocopera ciliata</i> ; <i>Copera marginipes</i> ; <i>Burmagomphus divaricatus</i> ; <i>Lathrecista asiatica</i> ; <i>Neurothemis fulvia</i> ; <i>Potamarcha congener</i>	
<b>Rare species:</b> <i>Aristochypha fenestrella</i> ; <i>Libellago hyalina</i> ; <i>Agriocnemis f. femina</i> ; <i>Mortonagrion aborense</i> ; <i>M. falcatum</i> ; <i>Anax immaculifrons</i> ; <i>Burmagomphus asahinai</i> ; <i>Ictinogomphus decoratus melaenops</i> ; <i>Merogomphus parvus</i> ; <i>Microgomphus</i> sp.; <i>Nepogomphus walli</i> ; <i>Macromidia rapida</i> ; <i>Agrionoptera insignis</i> ; <i>Indothemis limbata</i> ; <i>Macrodiplax cora</i>	<b>Rare species:</b> <i>Lestes platystylus</i> ; <i>Macromidia genialis shanensis</i>

Dry season species were represented by scarce *Neurothemis intermedia atalanta* and *Aciagrion borneense* while *Lestes concinnus* Hagen in Selys, 1862, *Aciagrion pallidum*, *Lathrecista asiatica* (Rambur, 1842) or *Potamarcha congener* were not observed. Of large rangers, *Rhyothemis phyllis/variegata* were rather abundant, *Anax guttatus* (Fig. 2) common, *Pantala flavescens* scarce and *Tramea transmarina euryale* absent.



At shallow swamps behind mangroves, similar Odonata were observed as in August 2011 (Kosterin 2012a) but *Lestes praemorsus decipiens*, *Ceriagrion calamineum* and *Paracencion calamorum dyeri* were not found. However species appeared that are usually seen at grassy shallow lentic habitats elsewhere far from the coast: *Aciagrion hisopa*, *Ceriagrion malaisei* (in numbers but seemingly immature, with males ochraceous-reddish rather than crimson-red), *Nannophya pygmaea* and *Lestes platystylus* (Fig. 17).

At shady forest brooks, *Pseudagrion pruinosum* was as frequent as it was in late rainy season in August 2011 (Kosterin 2012a) but only one female of *Archibasis viola* was found although this species was more abundant than the former in August. *Nannophya pygmaea* re-appeared at the banks of 'Nannophya rivulet' where it was abundant in December 2010 but absent in August 2011, perhaps these are insignificant fluctuations. Noteworthy that *Neurobasis chinensis* and *O. chrysis* were scarce at all brooks and *Orthetrum glaucum* (Brauer, 1865) was not found. The same situation was observed in April 2010, that is at the end of dry season (Kosterin 2010); now it was early rainy season but these species seemed to have no time to re-appear in abundance, as they were observed in late rainy season 2011 (Kosterin 2012a) and early dry season 2010 (Kosterin 2011).

The main purpose of my visit to the area, which I studied in three of my previous trips, was an attempt to get as many lotic species as possible, since the beginning of the rainy season is considered the best time for this. They tend to spend the rainy season on wing rather than in the larval stage to avoid washing out by high water. Most of them emerge in advance (as I observed for some species in April 2010 (Kosterin 2010)) or during the very onset of rains. And indeed, May is the month covered by flight spans of the most species as provided in the Atlas of Dragonflies of Thailand (Hämäläinen & Pinratana, 1999). However, some species could be at the immature age at this time and hence be dispersed over the area rather than concentrated at their breeding places. Among my particular purposes there was an intention to confirm by males the records of two *Macromia* species made on the base of females collected in August (Kosterin 2012a): odonate males as a rule are more frequent in the beginning of the flight period while females longer remain on the wing.

My hopes turned into reality exactly with respect to Corduliidae s. l. but not to Gomphidae. Immediately upon arrival to the 'Macromia rivulet' on May 23, I collected a male of *Macromia* at the same place where I collected its female on August, 2011. I expected it to be *M. cupricincta*, but in the lab it turned out to be a close, generally Malay species *M. cincta*, as well as the female collected at that very place on 16.08.2011. So the record of *M. cupricincta* based on that female in Kosterin (2012a: 80 and fig. 50c, d) was erroneous. Immediately upon arrival to the 'Microgomphus river' I collected two males (Fig. 5a), and saw another one, of *M. septima* at the same place where I collected three females on August 2011. This time no female of



both species were seen. In addition to these expected findings, two more corduliids in broad sense were added to the area. In the overcast afternoon of May 25, at a new locality of 'Macromidia rivulet', I obtained a male of *Macromidia genialis shanensis* (Fig. 4b) patrolling a tiny shallow pool under the bridge; while at a shady rocky bed I spotted a female of *Idionyx ? thailandica* (Fig. 4a) ovipositing at a shallow basin. Quite a number of *Hemicordulia tenera* ssp. (*Hemicordulia* sp. in Kosterin 2011; 2012a) were observed at 'Macromidia rivulet', as in August 2011 (but not at adjacent rivulets).

At the same time Gomphidae appeared strikingly scarce. They were found only at 'Microgomphus river' visited on May 24, and as few as four individuals. That individual which I managed to collect sat at the barren bank of the transitory shallow and slow part of this river, just upstream of the bridge, in a place and manner exactly as *Burmagomphus divaricatus* did in August 2011, but turned to be a male of *Paragomphus capricornis* (Fig. 5b), the only lotic gomphid found in November/December 2010 (Kosterin 2011). Three other gomphids which I failed to catch were of the same rather small size: one of them commenced a maiden flight. On a stone on the bank I found exuvia of *Gomphidictinus perakensis*, a species recorded from this locality in August 2011 (Kosterin 2012a). Weirdly, on the same day not a single odonate beyond numerous representatives of Calopteroidea was observed at the nearby Thma Bang River, where *Burmagomphus asahinai* (in its type locality) co-occurred with *B. divaricatus* in August 2011 (Kosterin 2012a, Kosterin et al. 2012b). So, during this my four day visit to Koh-Kong Province in May 2013, I found none of six gomphid species found by me there earlier (Table 1). Perhaps, most of gomphids were still on dispersal beyond rivers. This negative result was curiously contrasting to the diversity and abundance of Gomphidae discovered few days later in Ratanakiri Province, which has lost most of its natural habitats (see below).

So now I have visited the coastal Cardamom foothills four times, in the beginning and end of the dry and rainy season. I consider my preliminary assessment of this area as completed and am going to shift my further activity in this area deeper into the Cardamoms.

### 3. Kampong Saom Peninsula

This two day long visit in May 2013 can hardly be compared to the same short visit in April 2010 (Kosterin 2010). Although I visited the same two wildlife sites (the only two in this area), Kbal Chhay Waterfall and Ream National Park, even there I examined different localities.

On the road to Kbal Chhay Waterfalls we examined the banks of a huge water reserve. The road went through eucalypt plantation but the reserve itself was surrounded by good forest, from which we heard the calls of squirrels and once even of gibbons.





The water level in the reserve changes profoundly round the year and at the time of our visit was still low. At first we examined the upper part of the inundated area, once being a brook and now a chain of separated black ponds with dead tree trunks rising from water lacking vegetation except for 'clouds' of some thread algae, and with impermeable banks of deep mud. I could not conventionally name it otherwise than 'Dead rivulet'. There were quite a lot of dragonflies but only one damselfly, a male of *P. australasiae*, suggesting that the water body was rather unsuitable for larval development and dragonflies most probably arrived from elsewhere. Still at the road between eucalypts I noticed many flying large dragonflies that appeared to be *I. decoratus melaenops*, quite abundant at the water and around. Other conspicuous dragonflies were few males of *Urothemis signata* (earlier I noticed its tending to inhabit large inundated pits with barren banks). Other dragonflies were few in number, all representing widespread and common species: *Acisoma panorpoides*, *Brachydiplax chalybea*, *Neurothemis fluctuans*, *Orthetrum sabina*, *Rhyothemis* of the 'phyllis-type' (either *phyllis* or males or androchromic females of *P. variegata*, according to Fraser, 1936). Among them I noticed some dragonflies, but failed to catch them because of the impermeable muddy banks. Few hours later, at another pond, they were identified as *Chalybeothemis fluviatilis*.

Further we examined a huge reserve: the broad barren banks, as well as water surface, were spotted by numerous stumps and logs. It looked even more dead than the previous site, although my companion Olga Averyanova, a Sihanoukville resident, informed me that as a rule this area is "boiling" of diverse dragonflies. On 26.05.2013 we observed at banks just expectable *Trithemis pallidinervis* (many), *Brachythemis contaminata* (few), *O. sabina*, *R. variegata* and *P. australasiae* (one each). *I. decoratus melaenops* was absent from the banks, most probably because of overcast weather, but many of them were found at a road going along the bank between the forest margin and a stripe of bushes and forked ferns (Gleicheniaceae). At midday 27.05.2013 we revisited the site in bright sunshine but the difference was only that males of *I. d. melaenops* were now perching on sticks above the water. A visit there at dusk of 26.05.2013 yielded nothing.

The main feature of the reserve were numerous exuviae of *Epophthalmia* sp. on tree trunks, up to three one on the top of another (Fig. 26). This was not much surprising since epophthalmias are known as lentic species. Curiously, not a single imago was noticed all the three times we visited the reserve. I found these imagines at a quite contrasting, lotic locality. It was the main river downstream of the Kbal Chhay Waterfall, which had brown water about waist deep and run rather slowly over a wide bed formed by sandstone plates, having forest on its right bank and some farms beyond the stripe of trees on the left bank (Fig. 27). The banks were rimmed mostly by *Pandanus* and some other trees and bushes, with some clearings; at the left bank there were a number of seepages and a small shady brook. We visited this site in the evening of 26.05.2013 and in the first half of the next day. In twilight, at 6:00-



6:10 p.m., two large dragonflies, obviously *Epophthalmia*, appeared flying 4-5 m over a certain reach of the river, more or less aggregated as they appeared and disappeared from sight simultaneously. For a shorter time I saw three ones. In the morning I saw *Epophthalmia* again at that place: now they slowly ranged along the water course 2-3 m above the water. Once I saw two of them chasing each other but most time I observed only one individual, alternatively flying upstream then downstream. If it was the same one (more probably), it should have patrolled a really long section of the river, since the regular interval between its appearances was as long as 5-10 min, if it were different ones then they hardly had individual territories. The fact that *Epophthalmia* flew over a river but not over a reserve from where they emerged so abundantly was striking. Perhaps they were evenly dispersed over a territory and were just more noticeable at a river. By the way, I saw another lotic species at the same river: a male of *I. decoratus melaenops*.



Figure 26. *Epophthalmia* sp. exuviae on stumps at the bank of a large water reserve not far from Kbal Chhay Waterfall, Kampongsaom Province.

That river section was beautiful and rather undisturbed but not so rich in other odonates. Of riverine species there were few males of *Dysphaea gloriosa* perching on stones amidst the river, but no *Euphaea*, although François Mey once collected *E. ochracea* Selys, 1859 at this river (Kosterin et al. 2012a). There were also a male and female of *O. testacea*, the former perching on a dry tree branch. At slimy seepages at







Figure 27. The river downstream Kbal Chhay Waterfall, Kampongsaom Province, patrolled by *Ephthalmia* sp. adults; also a habitat of *Vestalis gracilis*, *Dysphaea gloriosa*, *Libellago lineata*, *Ictinogomphus decoratus*, *Onychothemis testacea*, *Brachythemis contaminata*.





rock plates, there were quite a lot *Brachythemis contaminata*. At the mouth of a tiny brook I found a male of *L. lineata* perching on a bamboo branch, and at another shady brook, a hovering male of *Prodasineura verticalis* sensu Asahina, 1983. At both brooks there were males *O. chrysis*. In surrounding trees I found a single *V. gracilis*. Maybe the large reserve upstream made the water quality insufficient for the lotic species to flourish, which were fewer here than at other similar rivers visited during this trip.

Contrary to the water reserve, the 'Fluviatilis pond' (Fig. 28), one of a series of former rice paddy fields at the main river left bank upstream of the waterfall, appeared very fruitful, in spite of the overcast weather. It was ca 50-70 cm deep, with clear water and moderately dense emerging spikerush (*Eleocharis* sp.) over its surface and also at the banks, which were rimmed with forked fern thickets and some bushes. The most numerous damselflies were *Pseudocoptera ciliata*, followed by *Ceriatagrion cerinorubellum* and then others: *P. calamorum dyeri* kept to emerging spikerush at the water surface, while both sexes of *P. australasiae* and one male of *P. williamsoni* were mostly found at banks. Dragonflies were represented by many males of *I. decoratus melaenops*, *R. obsolescens*, one red dragonflies looking like *O. chrysis*, that was not confirmed, two individuals of the *phyllis*-type *Rhyothemis*, one ranging male of *Anax* (most probably *guttatus*) and also scarce but less spectacular *A. panorpoides*, *Neurothemis tullia* and *Tholymis tillarga*. When the sun at last glanced through the clouds, few small elegant green-eyed dragonflies appeared which perched on large forked fern fronds or bush branches. When startled, they flew towards the water surface with spikerush but never rested on it. They appeared to be males of *Chalybeothemis fluviatilis* (Fig. 29), a species I did not expect in Cambodia. This pond could be a good habitat for *Nannophya pygmaea*, earlier found at the Kbal Chhay Waterfalls environs by Francois Mey (pers. comm.) but I did not find it.

In Ream National Park we took a road directly crossing its forested core towards the beach. The good and very broad road went through evenly dense and tall forest, sometimes passing large boards showing gambling youth: construction of casinos was supposed to go on hidden behind the forest, although others said it was just claimed rather than actually started. The road crossed two brooks. I examined one of them (perhaps the lower reaches one of the sites that I examined in April 2010) 2-3 m wide and flowing half shaded between sandy loam bluffs without rocks about 1-2 m high. It looked very promising in each its metre but the yield was strikingly poor: just two individual of *V. gracilis* and one male of *N. fluctuans* at the road.

At the beautiful and peaceful beach of the Ream National Park we examined a lagoon separated from the sea by a gapped sand bar and being the mouth of another forest rivulet (Fig. 30), with almost hot, brackish water and sandy bottom furrowed by numerous curious large gastropods with corkscrew-like shells. To our surprise, there were damselflies: a male of *I. senegalensis* (the only one seen this time in Kampong Saom







Figure 28. 'Fluviatilis pond' at Kbal Chhay Waterfall, Kampongsaom Province: a habitat of *Chaelybeothemis fluviatilis*, and also of *Ceriagrion cerinorubellum*, *Paracercion calamorum*, *Pseudagrion australasiae*, *P. williamsoni*, *Procopera ciliata*, *Ictinogomphus decoratus*, *Acisoma panoroides*, *Neurothemis tullia*, *Orthetrum chrysis*, *Rhyothemis obsolescens*, *Tholymis tillarga*.







Figure 29. A male of *Chalybeothemis fluviatilis* at 'Fluviatilis pond' near Kbal Chhay Waterfall, Kampongsaom Province.





Province) and a number of males and a tandem (probably indicating breeding at this site) of *P. microcephalum*. They kept to scarce grass at tiny islands at roots of mangrove trees. At the beach itself I saw a female of *Macrodiplax cora*, which perched on a scarce grass on a sandy bar at the very sea but after it was startled it hovered in front of me and so following me for a very long time, persistently exhibiting a kind of accompanying behaviour (Corbet & Miller 1991).

Anyway, results of a brief examination of the Ream Natural Park appeared extraordinarily poor.



Figure 30. A brackish lagoon at the beach of Ream National Park: a habitat of *P. microcephalum* and *Ischnura senegalensis*.

#### 4. Ratanakiri Province: environs of Ban Lung

##### 4.1. The area

Ratanakiri Province possesses considerable, up to 1,500 m a.s.l., mountains at the Lao and Vietnam borders, which are scarcely accessible because of the protection regime of Virachey National Park and of which I had an opportunity to see only the very foothills. Elsewhere, the province looks quite different. Its core is a very gentle







Figure 31. Semi-evergreen forest dominated by *Dipterocarpus alatus* at Yorn Village, Ratanakiri Province.

dome-like elevation formed by almost flat basalt rocks, with the capitol Ban Lung in its very centre. Its smoothly rolling hills have been nearly completely deprived of their natural vegetation, replaced by vast rubber (mostly south of Ban Lung) or





cashew (mostly north of Ban Lung) plantations, leaving no room for any other tree and allowing very scarce grass on generally barren dark-red ground. Some patches of *Gewea* trees are pretty old now, no doubt having personally witnessed Pol Pot, and looking like a very loose forest; they are presently logged and replaced by young saplings, so the land for a long time has been undergoing plantation turnover. Only scarce tops of the most considerable hills (still very low) are occupied by tiny remnants of once contiguous forest, often just being logged at present. The forest in Ratanakiri, including that in at the O'Tabok River already in the Virachey National Park buffer zone, looks very different from that in Koh Kong Province. There it is a typical evergreen tropical forest formed by a great diversity of tree species without any recognisable dominant; from the side it looks like a green wall of a complicated structure, in which only some palms with huge fronds could be recognised. The Ratanakiri forests were semi-evergreen forests, with *Dipterocarpus alatus* Roxb. predominating overwhelmingly (maybe together with some similar species). This is very tall and magnificent tree with almost white trunk columns. This forest type is less dense than the evergreen forest, so that huge trees well seen even from inside the forest (Fig. 31). Among them, sparse tall but small-leaved bamboo and rattan palms are recognised in the canopy.

#### 4.2. Waterfalls, rivers and brooks

Waterfalls are probably another reason for the locals to leave poor forest remnants in this area. Investigating empirically the reasons why common people travel, I came to a conclusion that they have an utmost need in two things: temples and waterfalls. There are no famous temples in Ratanakiri Province, so the waterfalls appear the main item of tourist attraction there. For this reason, stripes of forest are as a rule left between the course of a river with a waterfall and plantations, although sometimes they are just a few trees wide. Only O'Sieng Lei waterfalls were surrounded by a considerable (ca 9 x 5 km) area of forest, although substantially disturbed, for some reason with sparse wild-looking bananas in the understory. Three other waterfalls I visited had a river passing a village immediately upstream of the waterfall. Noteworthy that because of considerable erosion at vast plantations with barren ground, all the rivers had turbid red-brown water. In spite of all seemingly unfavorable circumstances exerted by human activity, lotic dragonflies were diverse and numerous at these rivers, which strikingly contrasted to their relative scarcity at crystal-clear rivers and brooks flowing among virgin forest in Koh Kong Province.

Waterfalls attract odonatologists even more than common people, because they provide a variety of riverine habitats: those with slow current and silty bottom, rapids with rocky beds, as well as such specific habitats as cliffs permanently wetted by spray and deep pools with disturbed water below waterfalls. These habitats are usually inhabited by different sets of lotic species, according to their habitat preferen-





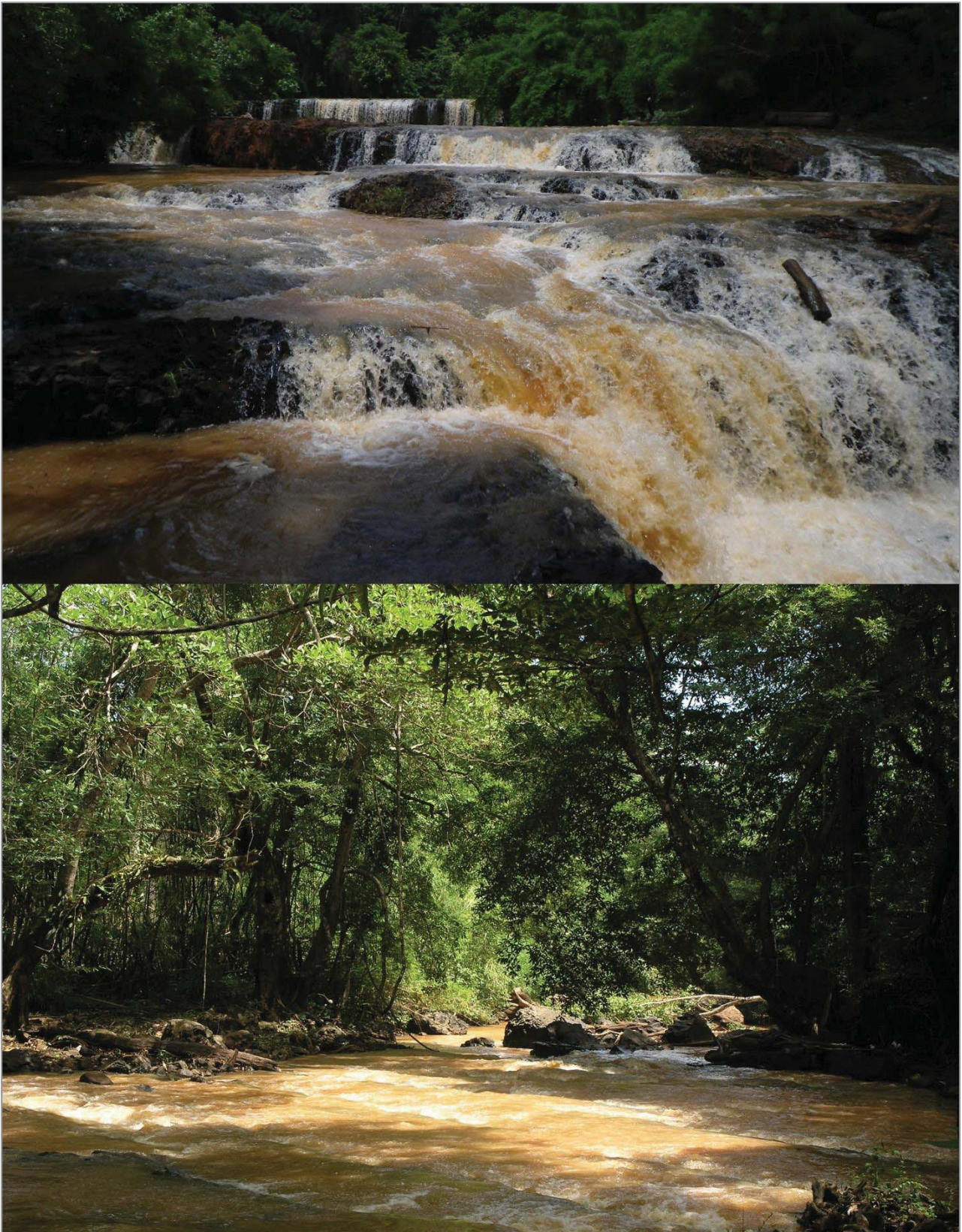


Figure 33. O'Sieng Lei Waterfalls, Ratanakiri Province (above) and the river downstream them (below): a habitat of *Neurobasis chinensis*, *Vestalis gracilis*, *Euphaea masoni*, *Dysphaea gloriosa*, *Aristocypha fenestrella*, *Heliocypha perforata*, *Copera marginipes*, *Gomphidictinus perakensis*, *Orientogomphus minor*, *Lamelligomphus castor*, *Macromidia rapida*, *Cratilla lineata*, *Onychothemis testacea*, *Zygonyx iris*.





ces, with some generally lentic species adding at slow reaches. Below I attempted a summation of my experience in Ratanakiri Province with these sets of species at different river positions with respect to waterfalls.

The Kachan, Katieng (Fig. 32) and Cha Ong (Fig. 19) Waterfalls were very high, with a river rushing freely from a margin of a horizontal plate of basalt rock (trapp) leaving a huge, partly dry niche behind a waterfall. Upstream of each waterfall a river flowed over flatland and was slow. Under each waterfall there was a lake-like widening (small at Cha Ong Waterfall). Downstream of the widening the river was rather calm in Katieng Waterfall, moderately rapidous at Kachan Waterfall, and very rapidous among huge rocks at Cha Ong Waterfall. O'Sieng Lei Waterfalls were represented by a few low steps, rather riffles than waterfalls (Fig. 33 top), below which the river was still rapidous crossing many rocks (Fig. 34, bottom) (and accumulating much rubbish at its banks, for this remote waterfall is visited mostly by locals, while the three others, close to Ban Lung, are visited by foreigners and so are cleaned).

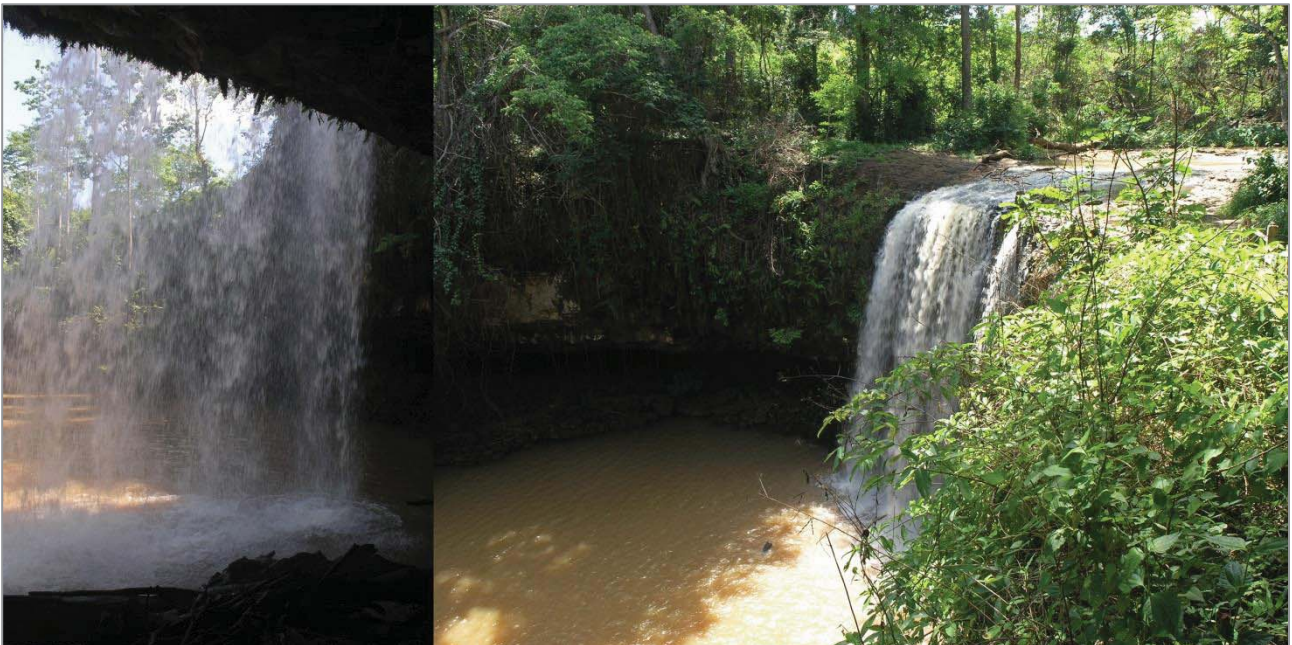


Figure 32. Katieng Waterfall, Ratanakiri Province.

Downstream but close to each waterfall, where the river was dominated by rapids, there was a similar set of Odonata dominated by demoiselles: in each case there were very numerous *Euphaea masoni*, many beautiful, flashing copper and violet *Aristocypha fulgipennis* (Fig. 34 bottom), as a rule few *Neurobasis chinensis*, *Dysphaea gloriosa* (few close to waterfall but becoming more abundant downstream), *Heliocypha perforata limbata* (not observed at Cha Ong and Kachan), few *Libellago lineata*. There were invariably a few males of *Zygonyx iris malayana* hovering and of *Onychotemis testacea* perching on dry branches. In shade among rocks pale immature individuals (at “ghost stage”) of *Copera* were seen at O'Sieng Lei and Katieng (of mature individuals, *C. marginipes* was found at the former and *C. vittata* at the latter).



In shade at Cha Ong Waterfall I discovered quite a few *\*Protosticta caroli* (see 'Notes on habitats and habits', Fig. 13): at last in Cambodia I found some Platystictidae.



Figure 34. Males of *Dysphaea gloriosa* (above) and *Aristocypha fulgipennis* (below) upstream and downstream of O'Sieng Lei Waterfalls, Ratanakiri Province, respectively.







Figure 35. A male of *Gomphidictinus perakensis* downstream of Katieng Waterfall, Ratanakiri Province.

Further downstream of the waterfalls (not examined at Cha Ong as impermeable), the same odonates were as a rule seen, but the demoiselles were fewer in number (this does not concern *D. gloriosa*), scarce *B. contaminata* appeared, and some more interesting species adding. At all three waterfalls but Cha Ong, *Macromidia rapida* was found, invariably at shade. At these river sections, very interesting were gomphids, including new species for the country. At Kachan, males of *\*Lamelligomphus castor* hovered (observed at twilight and noon) over swift river surface, narrowed between bushes and boulders. Males of *\*Gomphidia abbotti* were observed to perch at bamboo branches hanging over a calmer reach. Males of two species of *Burmagomphus* perched at boulders among troubled water. To my surprise, one of them appeared to be *B. asahinai*, the species which I and two Thai colleagues described a year before from SW Cambodia and Thailand. To be true, I did not expect to find it at the opposite end of the country. Meeting it there inspired a complex of feelings, all misleading: a pride of having it described, a suspicion that something was wrong and a bore of not spotting something newer instead. The other species was *B. divaricatus*, which also accompanied *B. asahinai* at its type locality. Besides, I got a female







Figure 36. A slower reach downstream of a riffle and further downstream of O'Sieng Lei Waterfalls, Ratanakiri Province, the place where 3 males of *Nychogomphus duaricus* (found nowhere else) were collected as patrolling its surface.





of *B. asahinai* ovipositing on the water margin with a barren ground at a small shady reach. All these gomphids were absent from downstream the Katieng Waterfall at the same river where I instead observed an impressive male of *Gomphidictinus perakensis* that perched about 1.5 m above the river on a hanging bamboo branch (Fig. 35). It was not at all cautious and allowed to pull the branch closer for easier photographing. O'Sieng Lei Waterfalls, perhaps because of a larger river, appeared most fruitful. I twice observed males of *L. castor* hovering above slower places between riffles, collected a male of *Orientogomphus minor* hovering in the same manner above small riffles; and (in overcast conditions ca 15:20) one by one caught three males of *\*Nychogomphus duaricus* which hovered over a calmer reach downstream of a large skewed riffle (Fig. 36): these seemed to be congregated. Just at this place I collected a female of *L. castor* which ranged over and oviposited to a small and shallow seepage-like river arm with a dark ground bottom.

The set of species registered further upstream of waterfalls where the rivers were still calm (not examined at Kachan) was rather different at different waterfalls. At all them there were males of *Prodasineura autumnalis* and *Z. iris malayana* (Fig. 37), hovering over the water, and, curiously, one individual *Idionyx* sp. was seen at each waterfall but Kachan. Others were demoiselles: *D. gloriosa* (Fig. 34 top), *Libellago lineata* (Fig. 38b), many *H. perforata limbata* and optionally scarce *H. biforata* (males of the former species perched invariably on rocks, of the latter on vegetation, e.g. *Alocasia* leaves), *V. gracilis*, *B. contaminata* and *G. abbotti*. Other species were seen upstream of only one waterfall each. A male of *Pseudagrion pruinosum* was collected at Katieng. Slowly hovering in a similar manner over a wide and calm river of O'Sieng Lei at sunny noon, another male of *\*O. minor* (in contrast to finding the other at the fast reach) and a male of *\*Macromia aculeata* (the only one of this species seen) were collected. The river upstream Cha Ong revealed few males of species not seen at other waterfalls: *P. ciliata*, *I. decoratus melaenops* (Fig. 39), *Pseudothemis jorina*, *Trithemis aurora* (the three latter being rather lacustrine species) and *T. festiva*. Besides, I managed to catch a male of *\*Macrogomphus kerri* perching at a height of about 2 m among intervening branches at the margin of a bamboo thicket crossing the river. A peculiar exuvia of this species was found just above the waterfall and downstream of the first riffle, in rather a calm section surrounded by *Alocasia* (Fig. 40).

Closer to each waterfall from upstream, where a river flowed above flat rocks, *Euphaea masoni* (at branches), and few males of *Orthetrum glaucum* (not at Kachan) and *Orthetrum pruinosum neglectum* (on rocks) appeared; and at O'Sieng Lei a male of *Diplacodes trivialis* was observed. At pools apart from the waterfalls, *O. chrysis* was observed at Kachan and two individuals of *Cratilla lineata* at O'Sieng Lei.



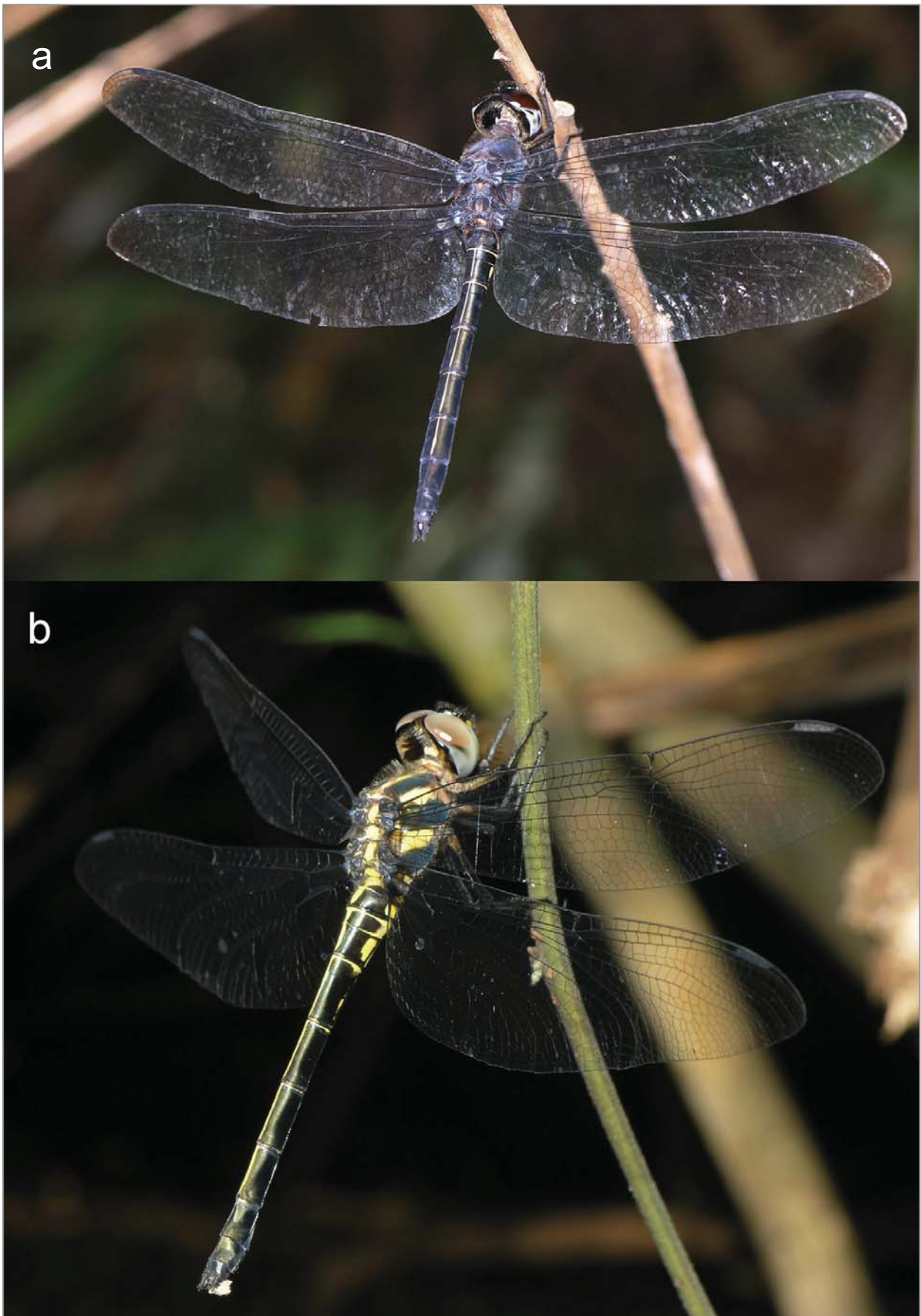


Figure 37. Rare cases of *Zygonyx iris malayana* were spotted resting: a, male upstream of O'Sieng Lei Waterfalls, 2.06.2013; b, female downstream of Kachan Waterfall, Ratanakiri Province.







Figure 38. *Libellago lineata* in Ratanakiri Province: a, males matching above O'Tabok River at Yorn village; b, male perching upstream of O'Sieng Lei Waterfall; c, female ovipositing at O'Chum River.





Figure 39. A male of *Ictinogomphus decoratus melaenops* upstream of Cha Ong Waterfall, Ratanakiri Province.







Figure 40. Exuvia of *Macrogomphus kerri* upstream of Cha Ong Waterfall, Ratanakiri Province.

I also examined four water courses without waterfalls. The 'Idionyx river' was discussed in 'Notes on habitats...', otherwise it offered only most common for this province lotic species plus less common *O. luzonicum* and *T. festiva* and a rare *B. divaricatus* (a male with additional small teeth on the hamuli, to be considered in detail elsewhere). The 'Asahinai brook' was in fact headwaters of the river that formed Kachan and Katieng Waterfalls. It had turbid water and was flowing between plantations and farms, behind some bush, herb and low bamboo thickets, with sparse trees. Upstream of a road it crossed, it was slow, partly hidden by *Alocasia* leaves but with open pools. Downstream of the road it had a stony bottom but some slower pools, with *Ludwigia* and *Marsilea* growing (Fig. 41). In spite of quite a mediocre outlook as a habitat, odonates virtually swarmed there mostly representing the same species as seen at Kachan and Katieng waterfalls far downstream: very numerous *V. gracilis* and *E. masoni*, many *P. autumnalis*, a few *N. chinensis*, *Libellago lineata*, *P. pruinatum*, *C.*







Figure 41. 'Asahinai brook', Ratanakiri Province, downstream the road, a habitat of diverse odonates: *Neurobasis chinensis*, *Vestalis gracilis*, *Libellago lineata*, *Ceriatagrus auranticum*, *Pseudagrion pruinosum*, *Pseudocopteryx ciliata*, *C. marginipes*, *Prodasineura autumnalis*, *Burmagomphus asahinai*, *Gomphidia abbotti*, *Lamelligomphus castor*, *Macromia cupricincta*, *Neurothemis fluctuans*, *Orthetrum luzonicum*, *Trithemis aurora*, *Tholymis tillarga*, *Zygonyx iris*.





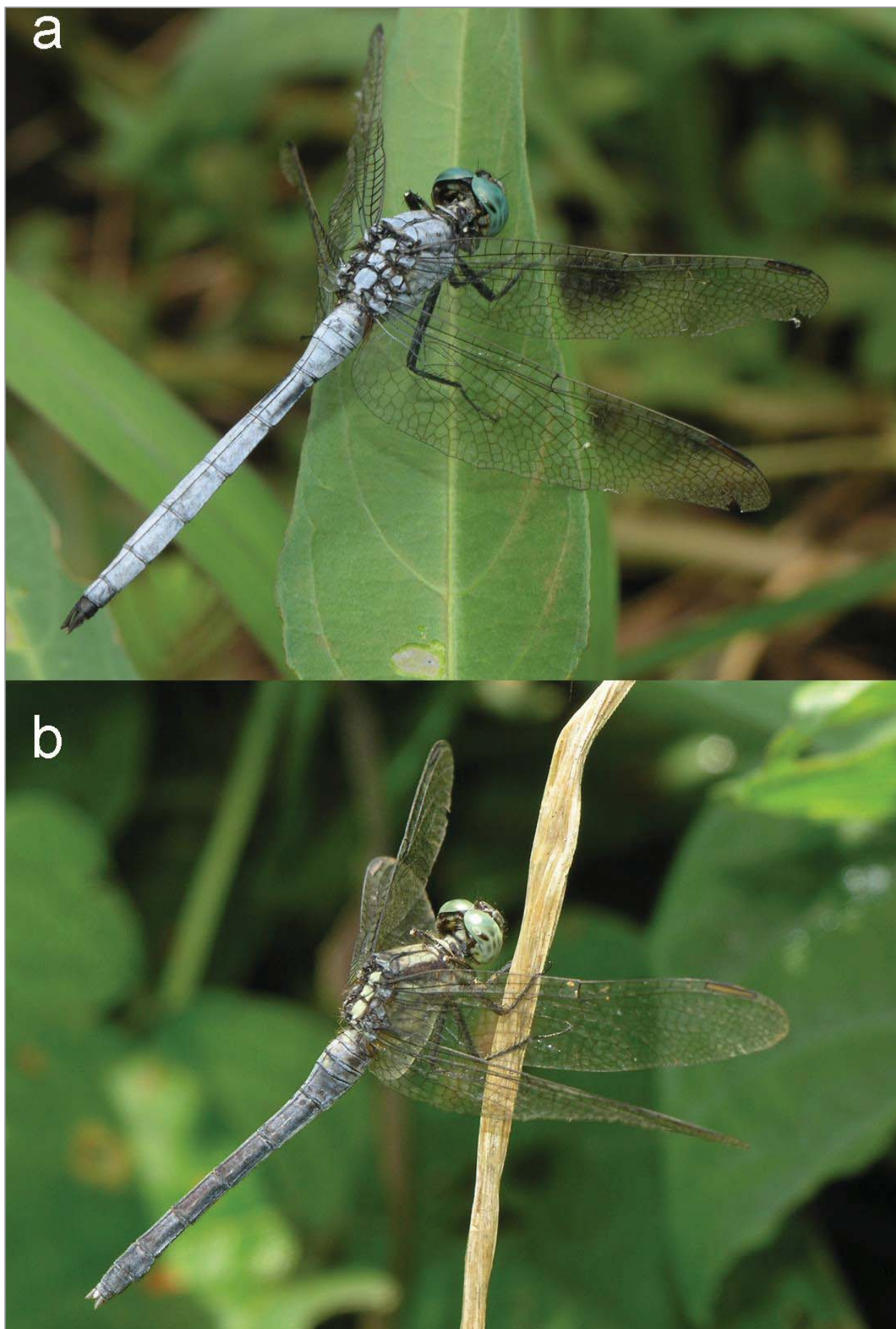


Figure 42. *Orthetrum luzonicum* at 'Asahinai brook', Ratanakiri Province: a, male; b, female.



*marginipes*, *Orthetrum luzonicum* (Fig. 42), *T. aurora* (at the slow reach), *T. tillarga*, and one individual of *P. ciliata* (at the slow reach), *N. fluctuans* and, *Z. iris malayana*. Gomphids appeared numerous at this brook, of three species found also at Kachan Waterfall, and *B. asahinai* most abundant of them. I have seen not less than six males. They mostly perched at grasses amidst the brook or on vegetation at its sides, only once a male perched on a stone (as I used to see them elsewhere), but there were just not so many suitable stones. Besides, I saw a hovering male of *L. castor* and caught a female of *G. abbotti*. There was also a female of *M. cupricincta* ranging along the brook (in late afternoon of 30.05.2013 and morning of 6.06.2013).



**Figure 43. Males of *Epopthalmia frontalis* (a) and *Onychothemis testacea* (b), with a *Mycalesis* butterfly prey, at O'Chum River at Thlang Svay village, Ratanakiri Province.**

The O'Chum Rivulet, situated north of Ban Lung, was examined as flowing through a village in a broad valley occupied by pasture rather than plantations. Just upstream of the bridge there was an area of inundated grass and some small pools surrounded by higher grass. At these lentic habitats I obtained the only *Agriocnemis* I found at Ratanakiri Province but three species altogether, *A. femina*, *A. minima* and *A. nana*. Also there were few common *B. chalybea* and *T. aurora*, and, surprisingly, three males (one at the river) of *Lathrecista asiatica*, which is a species much more common in dry season. Odonata at the river banks were also represented by a mixture of lotic and lentic species. Demoiselles were numerous: *N. chinensis*, *E. masoni*, and *H. perforata limbata*, plus a male of *D. gloriosa* (at rather a small rivulet) and two males of *H. biforata* (rare in the area). Of slow river damselflies, there were many males of *P. autumnalis* and one of *P. pruinosum*. There was a long list of lentic and slow current libellulids: *O. pruinosum neglectum*, *T. aurora* (many), *N. fluctuans*,





*Orthetrum chrysis*, *O. luzonicum*, *T. tillarga* (few), *A. panorpoides*, *O. sabina*, *Rhodothemis rufa* (one individual each), and one obviously lotic species, *Onychothemis testacea* (Fig. 43b). There were a few males of *I. decoratus melaenops* (although I expected more). Besides, low along the water course there ranged a male of *Epophthalmia frontalis* (Fig. 43a) and, some time after I collected it, I spotted a female ovipositing at a shady and rather slow reach (Fig. 44). So, in spite of *Epophthalmia* being considered as rather a lentic genus (like the above considered unidentified species observed at Kampongsaom Peninsula), this species revealed itself as lotic rather than lentic.

On a flat hill north of O'Chum there considerable large area of natural and legally protected forest signposted as Veal Rum Plang (Stone Field). Indeed, amidst it there were large areas of perfectly flat rock appearing above the soil, only slightly covered by gravel or finest grass, and no doubt the same was very close under shallow soils elsewhere. There was no surprise they chose to protect the area so unfit for agriculture. But nevertheless, the humans were offensive against this remnant of nature, as here and there in the open forest there were small farms and plantations. At the evening, in the forest shade, but quite close to the open stone field, I found the flat stony bed of a temporary brook (which I called 'Abisaria brook'), with some round porous boulders, but there were not many dark pools of water remaining. To my surprise, Odonata were quite abundant; I would never find so many at a temporary brook in Koh Kong Province. Of more common species there were numerous *V. gracilis*, two males of *H. biforata* and even a male of *E. masoni* (now without any rapids nearby), few males of *O. chrysis* and a few *Cratilla lineata* of both sexes. Of the latter, I saw two copulas (Fig. 45) and a female hovering at ca 1 m above a pool, making some sways while sprinkling eggs onto it. There were a few males and females of *Gynacantha subinterrupta*, elusively ranging over the dry brook bed; a female was ovipositing on the ground in a deep shade. And twice an impressive male of *Orolestes octomaculatus* appeared, as if from nowhere, sitting on some stem in front of me (Fig. 46), and disappeared in the same instant way.

### 4.3. Lakes and pools

I knew the crater lake Yak Lom (or Yeak Lom, or Yak Loum) as a famous gem, doubtless must see of Ratanakiri Province (conveniently situated almost in the Ban Lung suburbs). It is almost perfectly round (750 x 720 m), and said to be up to 48 m deep and to have been formed 700 thousand years ago (Ray & Robinson 2008). I found it beautiful indeed: azure-blue, with a clear and warm water and banks (partly formed by large basalt plates) overgrown with tall dipterocarp forest or bamboo thickets.





Figure 44. O'Chum River at Thlang Svay village, Ratanakiri Province, a habitat of *Epopthalmia frontalis*, and also *Dysphaea gloriosa*, *Heliocypha biforata*, *Pseudagrion pruinosum*, *Prodasineura autumnalis*, *Ictinogomphus decoratus*, *Acisoma panorpoides*, *Neurothemis fluctuans*, *Onychothemis testacea*, *Orthetrum chrysis*, *O. luzonicum*, *O. pruinosum*, *O. sabina*, *Trithemis aurora*, *Tholymis tillarga*.







Figure 45. A copula of *Cratilla lineata* at 'Abisaria brook' at Veal Rum Plang, Ratanakiri Province.

The forest occupied all inner slopes of the crater, which were rather low (Fig. 47). There were about four dried out beds of tiny brooks descending from them to the lake. There was a shady ground road/path around the lake. The perfect shape of the lake resulted in habitat uniformity around its banks: only bamboo thickets alternated with forest in places (mostly on the SE bank). As to my purpose the lake appeared rather disappointing. Dragonflies were extremely numerous, but just two species pre-





Figure 46. A male of *Orolestes octomaculatus* at Abisaria brook' at Veal Rum Plang, Ratanakiri Province.

dominated overwhelmingly: *I. decoratus melaenops* and, especially, *Pseudothemis jorina*. Because of high density, they were very active at banks in shade of large trees: even males of *I. decoratus melaenops*, which normally prefer to perch rather than fly, had to restlessly chase out their rivals. A female of *P. jorina* oviposited onto a half-inundated branch, returning to it repeatedly. Abundance and activity of these species made it fairly difficult to notice something else. The water was scarcely accessible because of permanent vegetation, and was rather deep already at the banks, so I made a few attempts to investigate the banks by swimming along, that was not easy because of many drawn logs. I found males of *Libellago lineata*, few males of *U. signata*, a female of *B. contaminata*, a blue male of an unidentified *Pseudagrion* (either *australasiae* or *microcephalum*, the former more probable because of quite large size) and a tandem of *P. rubriceps*. Besides, I saw a tandem of dark-bluish pruinosed damselflies flying over the surface which could be *P. pruinosum*. Anyway, odonates were much scarcer at the sunny water front than in shade under trees occupied by the two above mentioned abundant species. Although I went round the lake both days I visited it, I observed only two *V. gracilis* and a very cautious male of *Burmagomphus* sp. on a sunny branch at a road few metre from water, all on 30.05.2013. So, my hope to find some peculiar gomphid or corduliid adapted to the unique warm but oligotrophic lake failed. Strangely, not a single aeshnid was seen at all. In general, a beautiful crater lake with very abundant two odonate species, surrounded by vast agrocenoses, somewhat reminded me of Lake Zengena in Ethiopia (Kosterin 2013).







Figure 47. Lake Yak Lom, Ratanakiri Province: habitat of extremely numerous *Ictinogomphus decoratus* and *Pseudothemis zonata*, and also *Vestalis gracilis*. *Libellago lineata*, *Pseudagrion rubriceps*, *Urothemis signata*.





Kan Seng Lake, being in fact a huge pond formed by a dammed brook within the town of Ban Lung, was as large as Yak Lom at its long side and also had clear water. It was quite deep at the grassy and firm SW bank but formed some shallower bays with dark water, half shaded by trees and bushes (Fig. 48, left). The SE bank was occupied by a very large and beautiful floating vegetation mat composed of grasses and ferns, with some larger *Lygodium* ferns and *Alocasia*. This type of habitat I have never seen in Cambodia before (Fig. 48, right). The lake in general was full of lentic Odonata species but none of those which prefer shallow eutrophic waters. At once there were three species of *Ceriagrion*: *C. malaisei* (at the firm bank), *C. auranticum* (at bays) and *C. cerinorubellum* (on the floating bog), and five of *Rhyothemis*: *R. phyllis* and *variegata* at any bank (if they are different species indeed, see Kosterin 2010), *R. obsolescens* (males observed at the floating bog but three teneral females at once at bays), *R. plutonia* (a male at the floating bog), and *R. triangularis* (a teneral female at the firm bank). The floating vegetation mats appeared to be a home of two *Aethriamanta* species: more *A. brevipennis* (Fig. 49) and fewer *A. gracilis*; the latter kept closer to the water margin, where the bog hardly bore my weight, hence were harder to get. Among large libellulids, *U. signata*, a species generally preferring generally large ponds, dominated at the bays and floating mat. The dark shaded bays produced the same two species as the analogous habitats at Lake Yak Lom banks: *I. decoratus melaenops* and *P. jorina*, but also offered *P. ciliata* and *P. autumnalis*. To complete the picture I had to mention *A. panorpoides*, *B. contaminata*, *O. sabina*, *T. tillarga* at the firm bank (the first I would expect at the bog), a female of *Epophthalmia*



Figure 48. Lake [pond] Kan Seng within Ban Lung, Ratanakiri Province; left, firm bank; right, floating bog; habitats of *Onychargia atrocyana*, *Ceriagrion auranticum*, *C. cerinorubellum*, *C. malaisei*, *Pseudagrion australasiae*, *Pseudocoperia ciliata*, *Prodasineura autumnalis*, *Ictinogomphus decoratus*, *Aethriamanta brevipennis*, *A. gracilis*, *Acisoma panorpoides*, *Brachythemis contaminata*, *Orthetrum sabina*, *Pseudothemis jorina*, *Rhyothemis phyllis*, *R. obsolescens*, *R. plutonia*, *R. triangularis*, *R. variegata*, *Tholymis tillarga*, *Urothemis signata*.







Figure 49. A male of *Aethriamanta brevipennis* at the floating bog at Lake Kan Seng, Ban Lung, Ratanakiri Province.





sp. ovipositing at the floating bog water margin, numerous teneral stout damselflies with milky wings which appeared to be *Onychargia atrocyana*, and a male of *Nesoxenia lineata* which I saw hovering just for a blink. Its characteristic bright bicoloured body with slightly swollen abdomen was a good cue but I would not be certain if I did not have collected this species four days later at the Virachey National Park buffer zone.



**Figure 50.** Roadside ‘Orolestes pool’ 7 km ENE of Ban Lung, Ratanakiri Province; habitat of *Libellago lineata*, *Argiocnemis rubescens*, *C. malaisei*, *Pseudagrion australasiae*, *P. rubriceps*, *P. williamsoni*, *Copera marginipes*, *C. vittata*, *Orolestes octomaculatus*, *Gynacantha subinterrupta*, *Ictinogomphus decoratus*, *Brachydiplax farinosa*, *Brachythemis contaminata*, *Lathrecista asiatica*, *Neurothemis fluctuans*, *N. fulvia*, *O. chrysis*, *O. pruinosa*, *Orthetrum sabina*, *Potamarcha congener*, *Pseudothemis jorina*, *Rhyothemis phyllis*, *R. variegata*, *Tholymis tillarga*, *Urothemis signata*.

The last and seemingly the worst habitat appeared, nevertheless, as rich as the previous one, so that I had to visit it four times. It was just a dirty roadside pool 7 km ENE of Ban Lung (called ‘Orolestes pool’), 50 x 20 m in size, ochre-yellow in colour, with poor grassy bank (Fig. 50). It laid in a deep hollow formed by the road embankment crossing two joining gullies; above the pool there was a small hill with a small banana plantation and small remnants of tall forest. There is no surprise that the pool offered some common lentic species, scarcely or not at all found elsewhere in Ratanakiri: *C. malaisei*, *P. australasiae*, *P. rubriceps*, *P. williamsoni*, *N. fluctuans*, *N. fulvia*, *Potamarcha congener* (the most numerous and indeed a species most fitting





a muddy pool with yellowish water), omnipresent *B. contaminata*, *T. tillarga*, common at shade *C. lineata calverti*, and a male of *Anax* sp. which could be expected everywhere, although rare in this area. But the pool harboured also species more expected at clear water: *Argiocnemis rubescens rubeola*, *C. marginipes*, *I. decoratus melaenops*, *Brachydiplax farinosa*, *P. jorina* (one male); or at small pools filled with litter: *C. vittata*, *O. chrysis*; rather riverine species *Libellago lineata* and *O. pruinatum neglectum*; rather a dry-season species *L. asiatica* (one male); and even 'noble forest species': *V. gracilis* (among nearby bushes), *O. octomaculatus* (one male unexpectedly spotted in grass in twilight) and *Gynacantha subinterrupta* (ovipositing females and males hunting for them in the evenings, see fig. Fig. 20).



Figure 51. *Palpopleura sexmaculata* at tiny roadside pools 7 km ENE of Ban Lung, Ratanakiri Province: a female (top right) and a male (others).

But that was not the end. At my third visit there I paid attention at three tiny pools situated at the very road, just 1-1.2 m in diameter and not more than 10 cm deep, with whitish turbid water (Fig. 25). Being so negligible they had small but maybe most



peculiar set of species than any other habitat. Beyond the anticipated *N. fluctuans*, *T. aurora* and *C. servilia* (although notoriously common, this one was not seen elsewhere!) there were less natural at such habitats *O. glaucum*, *O. chrysis*, *O. pruinosum neglectum*, and two unique participants: few small dull-violet males of *Aciagrion* (Fig. 11) scarcely noticeable among sparse grass at the very water surface, and few males and females of *Palpopleura sexmaculata* occupying prominent grass stems (Fig. 51).

### 5. Virachey National Park buffer zone

The cost of a three day long trek to Virachey National Park buffer zone was \$142, and I was the only customer at that time and so could not share the cost. Nevertheless I bought it since I could not miss an opportunity to see some of that hilly and still forested area. In fact, the highest point visited, although situated in a hilly land indeed, was just 240 m a.s.l., that is about 40 m lower than Ban Lung, and most of the forest was already logged and replaced by tall bamboo thickets. However, the land north of the Se San River looked quite different from south of it, and added quite a number of species, so I did not regret.



Figure 52. The Se San River at Ta Veng village, Ratanakiri Province: habitat of *Dysphaea gloriosa*, *Libellago lineata*, *Diplacodes trivialis* and *Pantala flavescens*.





First I was brought to Ta Veng village at one of the major Cambodian rivers, Se San or Tonle San River (Fig. 52). It was very broad and had barren and slippery banks under barren clayey bluffs and slightly turbid water. Its level strongly depends on the dam upstream in Vietnam: at my first visit it was very low and most of the bed was occupied by a vast barren island; two sunny days later it was much higher and the island was under water. To my surprise, even at such seemingly unfavorable conditions there were males of *D. gloriosa* perching at sparse sticks. I also saw a male of *Libellago lineata* at the water, *D. trivialis* on the bank, and a flying *P. flavescens*.

On a motor boat we travelled downstream on the Se San and entered its right tributary O'Tabok. We ascended quite a distance upstream to Yorn village (Phum Yorn) situated at a sharp river loop and inhabited by the Brau minority. O'Tabok appeared a lovely medium-sized river with clear, only slightly turbid water, rather calm but with some rapids permeable for the motorboat (Fig. 53). Noteworthy that north of Se San all waters were rather clean and I no more saw red turbid water. The banks, marked with low bluffs, were rimmed by impressive trees remaining from the tall dipterocarp forest that once covered them but now are completely eradicated by slash-and-burn agriculture, of which Yorn village was a current doorpost. At the village, first patches of the retained forest appeared. All the way upstream on the O'Tabok, I observed from the boat frequent males of *D. gloriosa* and rare ones of *Onychothemis testacea*. Examining the river thoroughly at Yorn, I followed quite a distance along the left bank under a low bluff. Odonata were neither diverse nor numerous: *D. gloriosa* appeared the most frequent and conspicuous of them indeed, *Libellago lineata* were numerous, *N. chinensis* were also frequent, *V. gracilis* occurred at bushes on the banks, and a male of *H. biforata* was seen: the standard set of non-rapid Calopterigoidea of Ratanakiri. Of dragonflies, only males of *Onychothemis testacea* were often seen, and two males of *O. pruinosum neglectum* occupied a clay bank in the village. New to me, as well as to the country, were blue-patterned males (I also saw a tandem) of *\*Prodasineura coerulescens*, which were far from being numerous. At the medium-sized river of O'Tabok it obviously replaced *P. autumnalis*, so common in the central province areas but also at small forest rivulets not far from that river (see below). Exuviae – they were numerous at this river. Most of them were clung to logs protruding from the water but some were on grass. As to the expertise by Richard Seidenbusch, overwhelming majority of collected ones turned out to belong to Onychogomphinae gen. sp., plus one of another genus of the same subfamily. None of these gomphids was seen as imago. Among exuviae, I found much less numerous ones of *O. testacea*, and one of *Gomphidia* sp. The male imago of the latter, tentatively identified by sight as *G. abbotti*, was seen as landed for a moment on a high bush branch at the village bank. There was a slow reach with silty bottom and fine emerging grass just downstream of the village, which seemed like the most preferred habitat for *P. ciliata* which, however, was absent from there. Instead there were few *P. rubriceps* and a male *B. contaminata*.





Figure 53. The O'Tabok River (the right tributary of Se San River), Ratanakiri Province: habitat of *Neurobasis chinensis*, *Vestalis gracilis*, *Dysphaea gloriosa*, *Heliocypha biforata*, *Libellago lineata*, *Pseudagrion rubriceps*, *Prodasineura coerulescens*, *Brachythemis contaminata*, *Diplacodes trivialis*, *Onychothemis testacea*, *Orthetrum pruinosum* and numerous unidentified gomphids.

In the evening and next morning I examined also a gully separating secondary growth from quite a natural tall dipterocarp forest. It once had a temporary brook and now was just a chain of pools. A shady one supported a considerable population of *C. marginipes*, but I also caught a male of *C. vittata* and a male of *Archibasis oscillans*. In deep twilight I spotted a copula of *Zygomma petiolatum* above the surface of an exposed pool. *V. gracilis* and *T. aurora* were found nearby while *B. farinosa*, *B. contaminata* and *N. fluctuans* - at bushes just in the village.

Our one-and-half-day long trek had a destination of the Kong Kreav hill, which was just 3.5 km NW of Yorn village and 120 m above it. On the Internet the trek is still advertised as going through forest but at the National Park headquarters they honestly notified in advance that "the place is no more like it once was, because of a lot "illegal logging". In fact the area had once been a dipterocarp forest which was logged, with sparse tall trees left, and generally replaced by thickets of low or, mostly, tall bamboo. For some reason, the tall bamboo thickets were pressed and crushed by numerous chaotic temporary roads and tracks of heavy vehicles, perhaps in the course of logging the remaining trees. That area was very unpleasant to see and hard to cross, especially in the hot daytime, in spite of numerous 'roads' which were full of bristling broken bamboo. At road pools there were *O. chrysis* and *O. pruinosum neglectum*,





and also *Cratilla lineata* in shade. On the second day I at last realised that the individuals *N. fluctuans* I saw at sunny openings in a secondary forest were something unusual. For a long time I thought they were males with an intensive but curiously restricted wing coloration, and only much later found them to be even more unusual females (see above). Besides, I collected there a female of *P. verticalis* sensu Asahina, 1984.

That bamboo hell was crossed by two brooks, Yak Kae and O'Tamol Meik. At the first we had a lunch while at the second we overnighted in hammocks. These brooks were very much alike. The former being somewhat bigger and offering more species of Odonata. I'll consider them together. They were chains of quite deep (up to 1-1.5 m) pools, mostly shaded by bushes, which were united by a brook with rapids, and so represented a variety of microhabitats. Therefore, there was a full set of Ratanakirian Calopteroidea, for some reason except for *Libellago lineata*. Of their riffle species, *E. masoni* was very numerous, *H. perforata limbata* represented by few males seen, and *A. fulgipennis* by one. However, *H. biforata* predominated over *H. perforata*. As a rule, the former perched only on plants while the second on rocks but sometimes on plants as well. Damselflies were represented by species of small rivers: *P. pruinatum* and *P. autumnalis* (and a male of *C. vittata* at the second river). It seemed to me that once a violet *Archibasis* slipped by me but I was not certain. In tangled branches of bushes I managed to notice two grey *Gynacantha* males that were not at all cautious but occupied inconvenient positions so I failed to catch and identify them. There were also two very cautious males of *Rhinagrion viridatum*, of which I caught one. An even more cautious male of *P. capricornis* twice, the second time after quite a while, appeared at the same tiny patch of barren ground near the water. Libellulids were rather expectable: *O. chrysis*, *O. pruinatum neglectum*, *T. aurora*, *T. festiva* (one male, of a species quite rare in this area), *Z. iris malayana* (only one male was observed), except for a male of an unexpected species \**Nesoxenia lineata* which appeared to perch on a thin dead branch over a pool.

Downstream from the previously examined site, the O'Tamol Meik turned into a chain of separated pools. At one such place, with the ground freshly dug by wild pigs, along with some of the above species I unexpectedly caught one by one a female of *Macromia chalybaphumensis* and a male of *M. cupricincta*.

The last very specific type of habitats to be mentioned were 'veals', patches of savannah formed by open stand of low trees, mostly *Dipterocarpus obtusifolius* Tejism. ex Miq., on a flat rocky basis. We visited two of those, one at the very village (Fig. 54b) and Kong Kreav Veal occupying the flat surface of Kong Kreav hill (Fig. 54a). At the season of my visit, both had fine emerald-green grass and some low bushes with nice white flowers, and both had one very shallow pool occupying a depression of the basis. The fauna of 'Indochinense pool' on the former *veal* resembled that an analogous 'Aciagrion rivulet source' in Koh Kong Province (see above and Kosterin 2011, 2012a): there also were *Ceriagrion calamineum* and *Aciagrion hisopa* (many),







Figure 54, *Veals* (loc. for savannah communities on flat rocky ground) in Virachey National Park buffer zone: a, the hilltop Kong Kreav Veal with 'Azureum pool', habitat of *Ceriagrion azureum*, *C. calamineum*, *Anax guttatus*, *Diplacodes trivialis*, *Neurothemis fulvia*, *N. intermedia*, *Orthetrum chrysis*, *O. pruinatum*, *O. sabina*, *Pantala flavescens*, *Potamarcha congener*, *Tamea transmarina*; b, the veal at Yorn village with 'Indochinese pool', habitat of *Lestes praemorsus*, *Aciagrion hisopa*, *Ceriagrion calamineum*, *C. indochinense*, *Brachydiplax farinosa*, *O. chrysis*, *T. transmarina*, *Trithemis aurora*.





*L. praemorsus decipiens* (one male found), a black cautious male of *Indothemis* (probably *limbata* (Selys, 1891)), males of *B. farinosa*, a ranging male of *Tramea transmarina euryale*, plus elsewhere common *T. aurora* and *O. chrysis*. An important finding of this pool was the only found and very conspicuous lemon-yellow male of *Ceragrion indochinense*, at last confirmed for Cambodia by a voucher specimen.

The 'Azureum pool' on Kong Kreav Veal was situated 3.4 km apart and 120 m above 'Indochinense pool', 20x80 m, and was in general similar to that, but was remarkable for numerous tracks of wild buffaloes and some smaller artiodactyls in the surrounding dried mud. Its Odonata community was remarkable for a great number of ovipositing tandems and incredibly beautiful blue males of *Ceragrion azureum*. Tandems oviposited very actively into inundated grass but were hard to photograph among it (Fig. 55). Somewhat less numerous *C. calamineum* were present as well. Otherwise the species set was shifted towards those preferring habitats disturbed by humans, with the only difference that this habitat was disturbed by wild buffaloes that come there for watering (yet the water was clear). There was a ranging male of *A. guttatus* (checked in hand) and libellulids: numerous *P. congener* (there were two ovipositing females guarded by males), *D. trivialis*, *N. intermedia atalanta*, *O. sabina* (few) and *N. fulvia*, *O. chrysis*, *O. pruinatum neglectum* and *T. transmarina euryale* represented by one male each.

When we ascended that Kong Kreav hill we startled some animal of a small dog size, which rushed from us with a great noise among rocks and dipterocarp understory, very hard to see. It was grey with something reddish, and I could not recognise it at all. Our local Brau guide tried to follow it and searched for it in tree branches, although it obviously just escaped by land among rocks. When Sou, the Natural Park guide reached us I asked him to learn from the guide what it was. "Oh", he said, "just a dragon". Seeing my inability to understand, he specified: "A kind of lizard".

## 6. Preliminary comparative notes

During this trip I have visited lowland habitats of south-western Koh Kong and north-eastern Ratanakiri Provinces. The former is now relatively well studied while the former just once examined. They are dominated by different habitats: mangroves and large areas of evergreen forests over sandstone hills in Koh Kong Province and plantations and scarce remnants of semi-evergreen forest on basalt traps and volcanic lakes in Ratanakiri Province. Nevertheless, my impression is that their odonates appeared more similar than I expected. Rare species are not informative in this respect, but some differences were noticeable in common species. The set of Calopteroidea was similar but in Ratanakiri Province, *Libellago lineata* was abundant and omnipresent while not seen in Koh Kong Province. In Ratanakiri Province, the luxuriant *A. fulgipennis* was an invariable and quite numerous demoiselles at waterfalls and rapids. In each of the two latter genera, there was another representative in Koh Kong Provin-





Figure 55. *Ceriagrion azureum* at 'Azureum pool' on Kong Kreav Veal, Virachey National Park Buffer Zone: a, tandem; b, male fallen in the water.





ce, *L. hyalina* and *A. fenestrella*, but both rare and not seen during the 2013 visit. *D. gloriosa* appeared very common in Ratanakiri Province, being present at any flowing water, from small brooks like that below Cha Ong Waterfall (Fig. 19) to the major Se San River. *Ceriagrion azureum* could be a feature of north-eastern Annamite Mountains in Cambodia, as in Thailand it is mostly a northern species (Hämäläinen & Pinratana 1999). Of 15 species of Gomphidae recorded in both provinces, only 5 were in common: *B. asahinai*, *B. divaricatus*, *G. perakensis*, *I. decoratus melaenops* and *P. capricornis*. *B. asahinai* and *B. divaricatus* occurred together in both provinces, but in Ratanakiri the former prevailed. This makes this species, earlier known to occur in SW Cambodia and N, W and E Thailand, to be expected also in neighbouring S Vietnam. Among libellulids, absence of *Nannophya pygmaea* in Ratanakiri Province was strange, in spite of being invariably common in Koh Kong Province. *Aethriamanta brevipennis*, *A. gracilis* (also found by Roland & Roland (2010) in Mondulakiri Province) and *Nesoxenia farinosa* (not found in Koh Kong Province) seem to be more common in or even confined to eastern Cambodia. Of elsewhere common species, it was remarkable not to see *Ischnura senegalensis* and *N. tullia* in Ratanakiri Province, as well as to find *Agriocnemis* (two species) and *C. servilia* at no more than one locality each. These species are usually flourishing in areas strongly affected by human activity.

Abundance of Odonata at scarce remnants of natural habitats, usually at rivers and lakes, in Ratanakiri Province south of the Se San River, as compared to their relative scarcity in almost entirely forested Koh Kong Province, may have a simple explanation: in the latter they have a possibility to disperse over a large area of natural habitats while in the former, imagines of all ages have to be confined to their breeding places. We have to suppose that many dragonflies and damselflies do not use plantations as feeding habitats, while in Koh Kong Province they are dispersed in forests far from water, hence remaining mostly unseen.

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## Corrigenda to Cambodian Odonata reports published by O.E. Kosterin between 2010 and 2012

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This note includes shortcomings and corrections to four previously published reports (see references) on the Odonata fauna of Cambodia.

### 1) Missing information

Kosterin (2012a): page 55: The following paragraph (which contained the main references to Figs. 32 and 33) got missed (before that starting with "Andy's pond ..."): "*The 'Triangularis pond' (Fig. 32) was examined for the first time but briefly because a thunder downpour was approaching; however a rich fauna was revealed. The damselflies were represented by L. praemorsus decipiens (abundant), Ceriagrion malaisei (many), Pseudagrion australasiae and P. williamsoni (few) keeping to the water table with sparse emerging vegetation and Argiocnemis rubescens rubeola (one) in sedge. Dragonflies were represented by an individual of Rhyothemis phyllis or R. variegata fluttering high, a male R. triangularis (Fig. 33) perching on a short stem over the water, many D. nebulosa, Brachydiplax chalybea chalybea and B. farinosa, one O. sabina and one I. limbata. Males of Anax guttatus (not checked against much less probable close species A. indicus and A. panybeus) patrolled margins of the sedge thickets.*"

### 2) Geographical coordinates for some localities, earlier incorrectly inferred from GoogleEarth, were now verified by GPS.

a) Kosterin (2011: 46-47 (as 'waterfall'), 2012a: 35; 2012b): Thma Bang River rapids 6 km SW Thma Bang village correct data 11°39'38-40" N, 103°23'59'-24'00" E.



b) Kosterin (2011: 77): Near beach on the Koh Kong River estuary left bank, correct data: 11°34'51-55' N, 102°58'22-24", 2 m.

c) Kosterin (2011: 79): 'Glaucum brook', correct data: 11°39'31" N, 103°06'56" E.

d) Kosterin (2011: 80; 2012a: 29): 'Nannophia rivulet', correct data: 11°39'44-51" N, 103°06'58"-07'09" E.

e) Kosterin (2012a: 29): 'Macromia rivulet' correct data: 11°40'17" N, 103°07'28-29" E.

### 3) Misspelling

Kosterin (2010; 2011; 2012a): Phum DOUNG Bridge was misspelled as 'Phnom DOUNG Bridge'.

### References

- Kosterin, O.E. 2010. A glance at the Odonata of the Cambodian coastal regions: end of dry season in 2010. International Dragonfly Fund Report 29: 1-75.
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64	2010	Kosterin, O.E., Russia	The Odonata of the Cardamon mountains in Cambodia – progress study November 2010
65	2010	Villanueva, Reagan, Philippinen	Fieldwork on dragonflies on Samar Island (Philippines)
66	2010	Villanueva, Reagan, Philippinen	Fieldwork at Balut/Saranggani (Philippines) and Talaud islands (Indonesia)
67	2010	Villanueva, Reagan, Philippinen	Endemic species of the Diomabok-Lake region south of Davao, The Philippines
68	2010	Graham Reels, Hong-Kong	African Odonata (Dijkstra & Clausnitzer, Eds) text edit
69	2011	Rory Dow, Niederlande	Expedition to the Odonata of the Hose Mts., Sarawak, Malaysia
70	2011	Dejan Kulijer, Bosia & Herzegovina	Odonata of the Livanjsko poljekarst wetland area, with special emphasis on Coenagrion ornatum
71	2011	Do Manh, Cuong, Hanoi, Vietnam	Study of Odonata in north central Vietnam
72	2011	Kosterin, O.E., Russia	The Odonata of the Cardamon mountains in Cambodia – progress study August 2011
73	2011	Villanueva, Reagan, Philippinen	Odonata of Tawi-Tawi-Island, The Philippines
74	2011	Elena Dyatlova, Ukraine	Odonata of Moldavia – progress study
75	2011	Zhang, Haomiao, Guangzhou, China	The Superfamily Calopterygoidea in South China: taxonomy and distribution III – Travelling grant to the Guizhou and Yunnan Provinces, Summer 2011
76	2011	Marinov, Milen, Christchurch, New Zealand	Odonata at artificial light sources – review paper
77	2011	Do Manh, Cuong, Hanoi, Vietnam	Providing the Odonatological literature database
78	2010	Villanueva, Reagan, Philippinen	Stereomikroskop
79	2010	Villanueva, Reagan, Philippinen	Odonata of the Diomabok-Lake region south of Davao, The Philippines Follow-up
80	2011	Villanueva, Reagan, Philippinen	Odonata of the Catanduanes-Island, The Philippines
81	2012	Villanueva, Reagan, Philippinen	Odonata of Dinapigue, The Philippines
82	2012	Dow, Rory, UK/The Netherlands	Odonata of Kalimantan, Borneo, Malaysia
83	2012	Marinov, Milen, Christchurch, New Zealand	Odonata species diversity of the "Eua Island, Kingdom of Tonga"
84	2012	Marinov, Milen, Christchurch, New Zealand	Odonata of Solomon-Islands
85	2012	Villanueva, Reagan, Philippinen	Palawan-Odonata, The Philippines
86	2012	Do Manh, Cuong, Hanoi, Vietnam	Mau Son Mountain Odonata, Vietnam
87	2012	Dow, Rory, UK/The Netherlands	Odonata of Gunung Pueh, Borneo, Malaysia
88	2013	Garrison / Ellenrieder, Sacramento, USA	Argia in Costa Rica
	2013	Villanueva, Reagan, Davao, Philippinen	Odonata of Mt. Lomot and Mt. Sumagaya, The Philippines
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