

## Odonata of the Cambodian coastal regions revisited: beginning of dry season in 2010

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### Abstract

Results of the odonatological survey of the coastal SW regions of Cambodia on November 28 - December 11, 2001, are presented, including field notes, enumeration of all records by locality, discussion of interesting specimens and their taxonomy and of seasonality aspects. Fifteen (14 named) species have been added to the known fauna of Cambodia: *Aristocypha fenestrella* (Rambur, 1842), *Rhinagrion viridatum* Fraser, 1938, *Lestes elatus* Hagen in Selys, 1862, *L. platystylus* Rambur, 1842, *Aciagrion tillyardi* Laidlaw, 1919, *Agriocnemis f. femina* (Brauer, 1868), *Archibasis viola* Lieftinck, *Ceriagrion calamineum* Laidlaw, 1951, *Mortonagrion aborense* (Laidlaw, 1914), *M. falcatum* Lieftinck, 1934, *Pseudagrion microcephalum* (Rambur, 1842), 1948, *Paragomphus capricornis* (Förster, 1914), *Hemicordulia* undescr. spec., *Macrodiplax cora* (Brauer, 1867), *Nannophya pygmaea* Rambur, 1842, plus a provisionally identified *Ceriagrion indochinense* Asahina, 1976. The country list now achieves 106 named species (not counting *Prodasineura verticalis* sensu Asahina, 1983, *C. indochinense* and *Hemicordulia* sp.). *Coeliccia megumii* Asahina, 1984 is synonymised with *C. kazukoae* Asahina, 1984. The differences between *Ceriagrion olivaceum* Laidlaw, 1914 and *C. calamineum* Lieftinck, 1951 are discussed.

### Introduction

In April 2010, I studied the Cardamon foothills in SW Cambodia for their Odonata (Kosterin 2010). The photos of this trip are now available at <http://asia-dragonfly.net> and at my site at <http://pisum.bionet.nsc.ru/kosterin/odonata/cambodia.htm>. Half a year later, in late November/early December, I managed to make a next odonatological trip to the same area accompanied by my friend Nikita Vikhrev, a dipterologist



from Moscow. Results of this trip are presented hereby. (The final revision of this report took place shortly after my next trip to the same area in August 2011, few observations from which are briefly mentioned here in the 'Notes on specimens' section in cases when they provided answers to some questions raised by the November/December trip.)

Meanwhile the 2010 summer monsoon passed, so whereas on the first trip I witnessed the very end of the dry season, this time I observed the very beginning of the next dry season. This was a more humid time of the year that allowed observing more dragonflies and damselflies than during the April trip and make more new country records.

The photos made during this trip will shortly be available on the two above mentioned internet sites. The hereby reported records are to be included into a database of all Cambodian Odonata records run by Hanns-Jürgen Roland. The database is available upon request addressed to him (Hjuergenroland@aol.com). Locality maps and photos of Cambodian Odonata may be found at his site [http://www. Dragonflies-cambodia.com](http://www.Dragonflies-cambodia.com).

### **Area: omissions and additions**

In general, the study area in April and November 2010 was the same, with the following exceptions: I did not visit the sites on the Kampong Saom Peninsula near Sihanoukville, and was now more focused on the Koh-Kong environs. New sites were: the valley of an anonymous river joining the Koh-Kong estuary from its right bank (over the town of Koh-Kong) and a number of sites along the road to Pursat, which leads inside the gentle Cardamon foothills and which we followed for 38 km from Koh-Kong until it reaches the Right Tatai River. Besides, the most interesting Bokor Plateau (Kampot Province) was investigated for three days compared to two hours in April, and Kep (Kep Province) was revisited. The localities visited are shown on a small map of Cambodia in Fig. 1a.

### **'Veals'**

A highlight of the recent trip was examination of open landscapes in the Cardamons. Those are scattered above 300-400 m a.s.l. on the top of gentle ridges and plateaux. They are characterised by open tree stand or absence of trees, the ground formed by bright white silica sand rather than laterite elsewhere, and swampy-looking grassy vegetation. They are confined to very acidic sandy podzol soils accumulated on plateau-like surfaces without drainage necessary for existing of most tree species



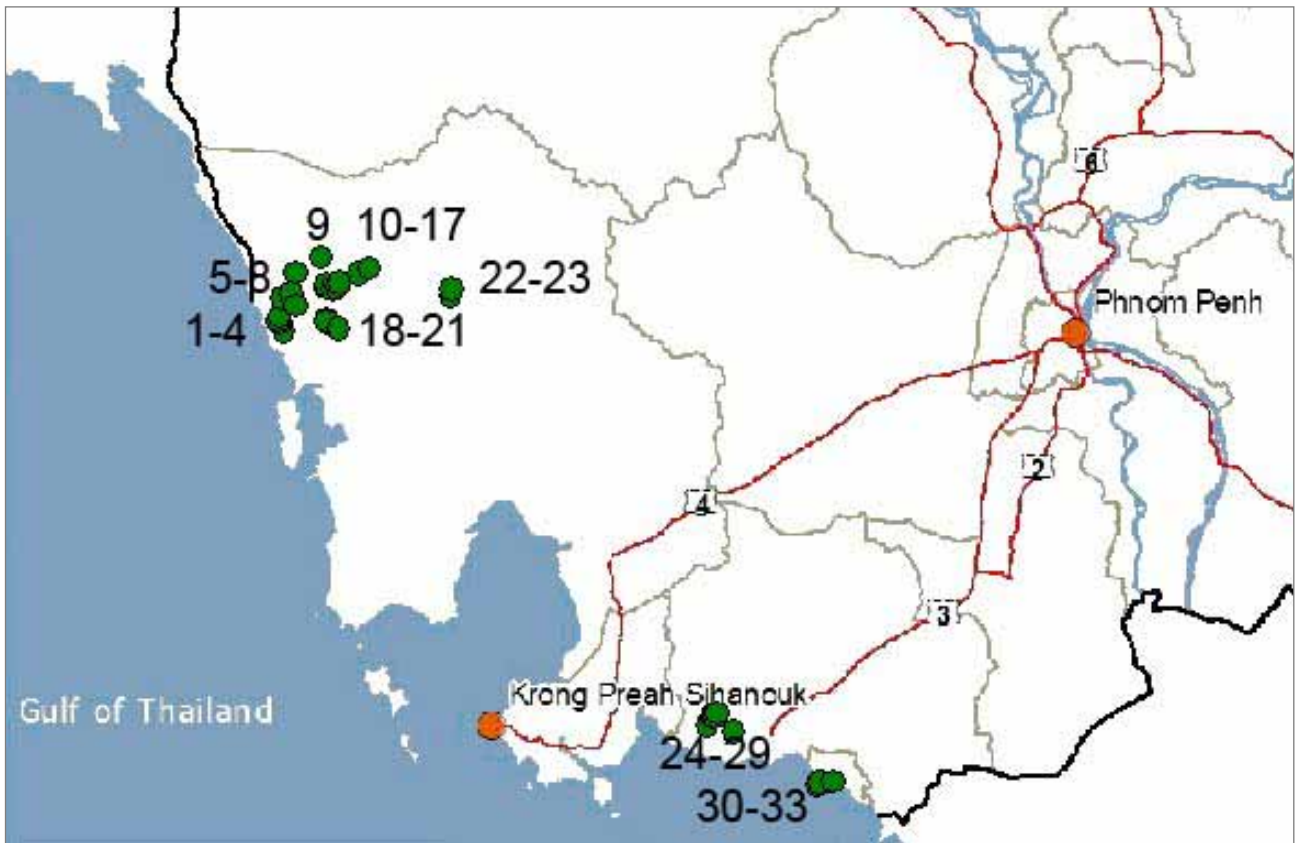


Figure 1a. Disposition of localities examined in November-28 – December-11, 2010 on the map of the Kingdom of Cambodia: 1-4, Peam Krasaop Wildlife Sanctuary surroundings; 5-8, marshes and mangroves north of Koh Kong, ‘Poacher River’, ‘Femina Swamp’; 9, Koh Por Waterfalls; 10, localities along the road from Koh Kong towards Pursat; 18-21, localities at Tatai village and waterfall; 22-23, Thma Bang environs; 24-29, localities on Bokor Plateau; 30-33, localities at Kep. Figure 1b. Provinces visited during the study.

Figure 1b. Provinces visited during the study.



(François Mey pers. comm.). These open areas are very typical for the Cardamons. François Mey kindly provided me a special Khmer word ‘veal’ which denotes them and I will use it below. In his paper on Cambodian pitcher plants, he characterised veals as “seasonally wet habitats such as open sandy savannahs and grasslands” (Mey, 2010: 113). Indeed, large veals above 400-500 m are truly savannah-looking due to sparse stand of trees (often represented by pines).



**Figure 2. A sandy grassland, ‘veal’, 13 km ENE from Koh-Kong, conventionally called ‘Lispe veal’, 4.12.2010.**

However, lower veals are small and often treeless. We examined one of such treeless veal at ca 300 m a.s.l., conventionally called the ‘Lispe veal’. It had sharp margins of dense but rather low forest. Some of its margins, as becoming very gentle slopes, were occupied by very tall invasive grass *Saccharum ravennae*. Some of the veals may have resulted from the forest being burnt for agriculture in the past but then abandoned for being poorly fertile. In Google Earth small lower veals are seen as concentrating along roads (hardly vice versa) and sometime having straight margins, so most probably humans helped their origin. However there were no sign of human activity in that ‘Lispe veal’ (Fig. 2) such as stumps or ash, so it could be of natural origin determined by the leading edaphic factor. The ‘Lispe veal’ had vegetation for-



med mostly by some Juncaceae (perhaps *Juncus*, with slightly winding stems), Poaceae and Cyperaceae (mentioned according to decrease of dominance). There were some very shallow pools with almost hot water with emergent Juncaceae, while the neighbouring ground was very dry, so looking rather 'steppe-like'; nevertheless there is no doubt these areas turn into temporary swamps during the rainy season, that would explain dominance of Juncaceae and Cyperaceae. Of remarkable plants, there were tight bunches of young, still not climbing individuals of the pitcher plant *Nepenthes smilesii* Hemsl. (Fig. 3, left) (sparse) and some *Tradescantia* sp. with tall inflorescences (frequent), which neighbored to the common bracken (*Pteridium aquilinum* (L.) Kuhn.). Quite weird for our northern view was presence of an annual sundew *Drosera burmanii* Vahl., red leaf rosettes sitting on short 'stumps' of which being quite dense on open patches of sandy ground not far from pools (Fig. 3, right) (here and on the carnivorous plants were kindly identified by photos by François Mey). However, abundance of carnivorous plants was explainable on the very poor soils.



Figure 3. Carnivorous plants at the 'Lispe veal', *Nepenthes smilesii*, left; *Drosera burmanii*, right.





Figure 4. A large *Sphagnum* mire conventionally called ‘Bokorensis mire’ on the Bokor Plateau, along the road to Popokwil Waterfalls, 09.12.2010.

### Mires of the Bokor Plateau

The Bokor Plateau, elevated to 900-1000 m a. s. l., is clad with the upper hill and low montane evergreen forest types, The latter is a true elfin wood, “a distinctive dwarf forest 5-10 meters in height [...] on the acid and skeletal soils on the sandstone plateau ... dominated by *Dacrydium elatum*, with another conifer, *Podocarpus (Dacrycarpus) imbricatus*, also commonly present. Other important associates in this dwarf forest are a variety of Fagaceae and Myrtaceae, *Vaccinium visciifolium*, and *Schima crenata*.” (<http://caaltd.org/Rainforest/Cambodia/CaramonMountains.aspx>). It was *Dacrydium elatum* (Roxb.) Wahl. ex Hook (Podocarpaceae) which I erroneously called



'a pine' in Kosterin (2010): for 2 hours on Bokor in April I had no time to examine the trees closely. Besides, large *Sphagnum* mires are found on the plateau. I was happy to examine one of them (the 'Bokorensis mire', as called below) occupying a large part of an open area sized 1.2 x 0.8 km (Fig. 4).

Superficially it looked somewhat as our northern mires. It was covered mostly with sedge (Cyperaceae, but not forming tussocks), Juncaceae (more abundant at pools with water), Poaceae, very abundant club mosses, and had scattered shrubs among which even some *Vaccinium* sp. with either red or black berries was noticed. As in our mires, there were small but lovely ground orchids flowering, of three genera: yellow *Spathoglottis* sp. - most numerous and also growing outside the mire (Fig. 5, top middle), pink *Arundina* sp. (Fig. 5, bottom middle) and an unidentified mottled one (Fig. 4, right). Instead of sundew, the insectivorous plants were represented by frequent *Nepenthes bokorensis* Mey (Fig. 5, left), which is an endemic species to this



**Figure 5. Conspicuous plants at the 'Bokorensis mire' on Bokor Plateau: *Nepenthes bokorensis*, left; *Spathoglottis* sp., top middle; *Arundina* sp., bottom middle; an unidentified orchid and *Pteridium aquilinum*, right.**

plateau described just 3 years ago. The watering of the mire was variable, from ca 0.5 m deep, with floating *Sphagnum* and emergent Juncaceae, through shallow pools with luxuriant *Sphagnum* to rather dry places with bracken appearing (Fig. 5. right). On the mire that I examined, the water regime was strongly affected by the road to Popokvil Waterfall, which interrupted the water flow, so that most pools were situated along it. Adjacent to this mire there was a sandy grassland with Junca-



ceae, *Drosera burmanii* and very shallow pools, which was fully analogous to the above described veals in Koh-Kong Province. Here and there on Bokor Plateau in hollows among elfin wood, mostly roadside, there appeared some patches of *Sphagnum* as well. All the brooks and Popokvil River flowing there had reddish-black water, as it should be for a humic acid rich water flowing from *Sphagnum* bogs.

So, open areas on flat surfaces at lower elevations of the Cardamons are sandy grasslands becoming swampy in rainy season. At higher elevations they acquire more precipitation round the year and so may become peat-moss bogs (mires). Noteworthy, sparse peat-moss cushions appear under the canopy of low forest in the near proximity of the low elevation 'Lispe veal'.

### **Nature extermination**

The most sad observation during this trip was the devastating human activity in the area. In April I was informed that a hydropower station is being constructed somewhat 2 km upstream of the magnificent Koh Por Waterfalls (in fact, three stations in total are being constructed on this river and its main tributaries). One may understand what I felt when on December 1 I witnessed that the forest was totally logged on the Koh Por river bank downstream to the left tributary mouth, right at the most impressive 'niche' waterfall (Fig. 6). The 'work' was continuing uphill, and we heard a lorry signal from the opposite site of the main river as well. Mr Jason David Webb, who runs the Oasis Resort in Koh-Kong and arranges ecotours around, told me that the Koh Por Waterfalls were the number one site but he can no longer lead people there for it lost any attractiveness as a wildlife object. So the Cambodian government does not care of compromise between the energy demand and touristic attractiveness. The dam is also being constructed on the Left Tatai River, somewhat upstream the serene places we visited in April; and they are going to enclose as much as 7 km of the river into the energy producing channel.

The Preah Monivong National Park on the Bokor Plateau once was a gem of Nature conservation, and was recently inhabited by elephants, tigers and pangolins. Now the guides accompanying tourists complain that the beasts have gone scared by construction, "only squirrels left". The magnitude and intensity of construction appeared scaring indeed. The unique elfin wood covering the plateau is cut off for about 50 m stripes along the new roads, even for 7 km along the road to the famous Popokvil Waterfall, that is across locus classicus of *Nepenthes bokorensis* Mey, 2009, the plateau endemic. Huge areas are deforested in addition. The headwaters of brooks were crossed by rivers and polluted by wastes of the constructors. One of the famous ruins of the French buildings, the hospital, was ruined completely in the course of road extension. Near the notorious (and very beautiful) Lutheran Church there is a board showing what the Sokimex (=Soha) firm is going to construct (Fig. 7): a huge complex







**Figure 6. Views at the same part of the Koh Por River valley (the Niche Waterfall is just behind the left bend) taken 201 days one after another, on 13.04.2010 and 01.12.2010.**

of buildings including a new casino, three thousand (!) houses, golf courses, lawns, fountains, roads, a kind of a small Las Vegas, but in place of the former vibrant Natio-



nal Park rather than in a desert. I did not hear on some broad international campaign to stop all this. Really, a national park may mean nothing nowadays! We met rangers who asked who we are and what are doing but in fact there is no more any care on Nature protection on top of the Bokor Plateau, for it is too late now...



**Figure 7. What they are constructing on the Bokor Plateau within the Preah Monivong National Park (photo courteously by François Sockhom Mey).**

Noteworthy, all the construction in Cambodia is carried out by Chinese firms, and the guides in Bokor referred to the constructors plainly as ‘the Chinese’. The customers of the monstrous entertainment town being built on Bokor are expected to be Chinese as well. In the Lonely Planet Guide for Cambodia (Ray & Robinson 2008), already quite outdated with respect to the rapidly spoiled Bokor, we find the following concerning another, Botum-Sokor National park: “Grandiose tourist development seems to be on the cards for the park’s west coast. A Chinese company has plans to build seven new cities (no, that’s not a typo), an airport, golf courses and lots of hotels, though things are on hold while a three-year study is carried out. Another potential threat to the area comes from offshore oil rigs.”

I may only add information found in internet: “Cambodia has the second highest rate of deforestation in the world third to only Nigeria and Vietnam. Since 1970, Cambodia’s primary rainforest cover fell dramatically from over 70% in 1970 to just 3.1% in 2007. Deforestation is accelerating at an alarming rate with overall rate of total forest loss at nearly 75 percent since the end of the 1990s. In total, Cambodia lost



25,000 km<sup>2</sup> of forest between 1990 and 2005, 3,340 km<sup>2</sup> of which was primary forest. As of 2007, less than 3,220 km<sup>2</sup> of primary forest remain with the result that the future sustainability of the forest reserves of Cambodia is under severe threat." (<http://caaltd.org/Rainforest/Cambodia/seampang/forest.aspx>)

## Weather

Normally, the rainy season in Cambodia lasts from early May to late October, with the total amount of precipitation at the coastal slope of the Cardamons as much as 5,000 mm and with August, September and October receiving about twice as much precipitation as four preceding rainy months. Mr. Webb told us that at Koh-Kong, the rains cease usually at November 12-15 while this year they prolonged until November 24-25 but were less intensive. This corresponds finely for the weather review shown by Euronews and at [weather.yahoo.com](http://weather.yahoo.com) for Phnom Penh: 29-31°C and scattered thunderstorms between November 1 and 24, sunny weather and 32°C on November 24-25. So, we arrived just 4-5 days after the actual end of the rainy season.

Unfortunately, I made no measurements but, after a hardly bearable heat of April, I enjoyed the most comfortable weather, with moderately hot (ca 30°C) sunny days much resembling the Siberian summer (instead of vertical sunbeams at midday) but warm nights. The rivers had pleasantly slightly cool water, compared to nearly body temperature in April. At the Bokor Plateau, the pools were rather chilly to watch for dragonflies being immersed up to neck. There were very few rains: a heavy shower at the sunset of Nov. 28, a moderate one at in the evening of Nov. 29 at Koh-Kong, and a thunderstorm at the sunset on Dec. 5 in Kep.

Again, the seasonality seemed to change rather sharply at a short distance between Kampot, situated at the foot of the Elephant Mts., and Kep, situated around a group of limestone hills of a 'Vietnamese' outlook. During our visit on December 4-11, the rice-fields between Srae Ambel and Kampot were grey stubble grazed by buffaloes, but were green with almost ripen yield from Kampot to Kep. (Between Veal Rihn and Kampot, peasants just dried rice right on the asphalted road surface.) Provided in April I witnessed the rice culture quite in advance in Kep than more north-westerly (Kosterin 2010) and in December as seemingly delayed, I have to suppose that while I was absent they almost took two yields at Kep but one north-west of Kampot. The Kep and Koh-Kong surroundings differed as to the odonate seasonal aspect as well (see below).

## Field notes

They are delivered in a geographical order (from NW to SE). For better description of places visited in April see references to Kosterin (2010). With so many anonymous



brooks and rivulets revisited or to be revisited in the area, I came to a necessity to grant those conventional names (in single quotations), mostly after most remarkable dragonfly or damselfly species but sometimes after flies, plants or people. Asterisks indicate species upon their first findings in Cambodia.

### I. Peam Krasaop Wildlife Sanctuary and surroundings.

→ December 4 and 11 afternoons (compare Kosterin 2010: 10-12).

Little has changed in this weird but poor in dragonflies kingdom of mud and mangroves, but yet odonates appeared somewhat not so scanty. On Dec. 11 we followed the same route I did on Apr. 12 but did not enter the area where mangrove trees *Rhizophora* form a forest above the permanent water surface. Nikita collected a female of *Pseudagrion australasiae* Selys, 1876 at a pool at the Sanctuary parking place, rather unexpectable for brackish water. No dragonflies flew above 'the small market', however, the roadside ditch with a brackish water leading to it, which was devoid of odonates last trip, now provided a male *Trithemis pallidinervis* (Kirby, 1889) perching at an emergent stick. Males of *Diplacodes trivialis* (Rambur, 1842) were sometimes disturbed from roads among mangroves (none in April). At transitory bushes, including a lot of the *Acrostychnum* fern and some tall trees, the same dragonflies as if waited for me since that my last visit: two males of *Neurothemis fluctuans* (but this time immature, with weakly coloured wings) and a female *Tholymis tillarga* (Fabricius, 1798), but an individual of *Orthetrum sabina* (Drury, 1770) and a male of *Aciagrion borneense* Ris, 1911 were added.

On Dec. 4 at around 4 p.m. I took right before the Ang Kayak village along a good and straight ground embankment road leading straight to the left bank of the Koh Kong estuary. The mangroves at the right (upstream) side stood in water, those at the left (downstream) side stood in mud (with crabs crawling on) and the water was flowing furiously through several huge tubes under the embankment from right side to the left one. On December 11 both parts were watered, and I guessed this was a matter of tide, for some reasons going from the upper side, but anyway, the embankments and other irrigation interfered the native water regime, that may cause impact on odonates. The road ended at a beach with a snow-white sand on the estuary bank, which would be beautiful if not so deadly rich in rubbish. There were pools of different size and with sedge banks nearby. A small one abounded with *Ischnura senegalensis* (Rambur, 1842), including teneral. I tried to get *Agriocnemis* by net sweeping and succeeded only in two females of *A. pygmaea* (Rambur, 1842) but also a female of *A. borneense*. Over a large pool, a male *T. tillarga* patrolled and I wondered why just one.

Both days I revisited also a very shallow 'pond', bordered with a stripe of bunches of tall Juncaceae grass, and nearby a muddy (with several feeding white herons) marsh



with bush mangroves (*Lumnitzera?*) obviously affected by the tide. They were situated at an old cemetery W of the road to Peam Krasaop just after it leaves Koh-Kong at a school. Let us call this place "Cora marsh". While I found no odonates there on Apr. 14 (Kosterin 2010: 12-13), this time it provided the only newly added mangrove species, \**Macrodiplax cora* (Brauer, 1867). On Dec. 4 I collected a female among the tall grass bunches. In the evening on Dec. 11 two males kept to the nearly barren or with trampled grass bank of the 'pond'; one saturate red and one still tan (Fig. 8). They landed invariably on tops of scarce and hence prominent tall grasses but did not hold territories. Common odonates also appeared in this place: numerous *D. trivialis*, common *Neurothemis tullia* (Drury, 1773), some *O. sabina* and *Crocothemis servilia* (Drury, 1770), and on Dec. 4 a male *T. tillarga* patrolled the water surface at still high sun at ca 4 p.m. Zygoptera were again represented by *I. senegalensis* at water, while sweeping provided a single *A. borneense* but no *Agriocnemis*. So, the rainy season passed seemed to have made this obviously brackish habitat useful for odonates.



Figure 8. Two males of *Macrodiplax cora* on the 'Cora Marsh' at the southern margin of Koh-Kong, a mature (top left) and immature (others) ones, 11.12.2010.



## II. Marshes and mangroves north of Koh-Kong

→ Nov. 28 morning.

Two hours (10-12 a.m.) of our first day in Cambodia were devoted to a small area just north of the town Koh-Kong, namely between the Oasis Resort and the bank of a left arm of the estuary. It was partly marshy, with shallow or dried out pools overgrown with *Juncus*, partly with bushy mangroves (perhaps mostly *Lumnitzera*) and *Nypa fruticans* but not tree-like mangroves. The difference from the above described area consisted in a firm sandy ground and bottom of water bodies. Odonates were not more abundant than at Peam Krasaop. On marshes, there were the same generalists *I. senegalensis* (common), *A. pygmaea* (rare), *D. trivialis* (common, keeping to barren



Figure 9. A male of *Lestes concinnus* on a bank of a sparse mangrove left arm of the Stung Koh-Kong estuary north of Koh-Kong, 28.11.2010.

ground) and more freshwater dragonfly species: *Diplacodes nebulosa* (Fabricius, 1793) (abundant in *Juncus* and sedge at pools, more females), *Neurothemis tullia* (Drury, 1773) (rare), *Brachythemis contaminata* (Fabricius, 1793) (a male at a pool sedge), *Crocothemis servilia* (Drury, 1770) (a male at a channel). A male of *Tamea trans-*



*marina euryale* Selys, 1878 ranged over the road going along a channel. In shade among bushes there occurred a female of *B. contaminata*, a male and female of *N. fluctuans* (among bushes), a female of *Aciagrion pallidum* Selys, 1891 and a male of *A. borneense*. The firm sandy bank was almost a beach, with scarce grass and sparse, large and impressive mangrove bushes. Odonates were scarce there, for the water should be brackish: a male of *A. pygmaea*, a tandem and female of *I. senegalensis* and, rather unexpectedly, a male of *Lestes concinnus* Hagen in Selys, 1862 (Fig. 9). The latter strictly kept to a small and low sedge bunch just at the water edge, perched on stems and made short feeding flight without necessarily returning to the same stem.

### III. Anonymous 'Poacher river' at W bank of Stung Koh-Kong

→ Nov. 30.

Mr. Jason David Webb kindly arranged a trip to a nameless forest rivulet descending to the Koh-Kong Estuary from its gentle western bank, opposite to Koh-Kong town and covered by seemingly pristine vegetation. Two local guides carried us in a boat to its mouth where it streamed beautifully over broad sandstone plates. I had no much time to examine the mouth and walked twice for a couple of hundred metres upstream and back, to meet two males and a female of *Heliocypha biforata* (Selys, 1859) perching on bushes hanging over the water, a female of *Neurobasis chinensis* (Linnaeus, 1758), a tandem (hovering over the water) and a male (perching on leaves at the level of my eyes) of *Prodasineura verticalis* sensu Asahina, 1983, a tandem and a male of *Copera marginipes* (Rambur, 1842) (howering over the water of a shallow bay of the rivulet). Of dragonflies, there were several immature *N. fluctuans* on bushes and one *Trithemis festiva* (Rambur, 1842) sitting on a stone. Nice species, but not so much for such a lovely place. On a very shallow open bank of the estuary nearby I observed several *D. trivialis*, *C. servilia*, *O. sabina* and a male of *Pseudagrion rubriceps* Selys, 1836 which was flying over obviously brackish water (perhaps it had migrated from the rivulet).

From there we ascended to a bank terrace and went over it to a hill slope, passing through dense bamboo and tall *Saccharum ravennae* grass thickets or better to say forest. There were really numerous immature *Neurothemis intermedia atalanta* Ris, 1919 (males still had yellowish body and wingspots which turn reddish in mature specimens), common and also immature, with still not saturated wing coloration *N. fluctuans*, two or three fully coloured *Neurothemis fulvia* (Drury, 1773), two *O. sabina* and even a male of *N. tullia*, not expected in a closed habitat. On a pool over a sandstone rock in a small opening there was a male *C. servilia*. Further the path was very gently ascending through a dense mixed tree/bamboo forest. *N. intermedia atalanta* proceeded to be immense (making Nikita to suppose they propagate by budding) while *N. fluctuans* - just common. In addition to the former, another dry



season forest species was added as quite common: *A. borneense*. But now, as soon as deeply shaded places were passed we repeatedly met schools (from 2 to 10 individuals) of obviously aggregating *Vestalis gracilis* (Rambur, 1842) of both sexes. As additional signs of river closeness we encountered an immature (with vague wing coloration and brick-red rather than violet spots on the thorax) male of *H. biforata* and a mature female of *Euphaea masoni* Selys, 1859. Twice I observed a dragonfly which extremely swiftly ranged over the path in a very erratic way, both at last landed and I recognised females of *T. tillarga*, still active (but in shade) at 10 a.m.

The forest became denser with more trees and less bamboo, the ground became wetter, and we were surprised seeing many not so big trees with long planks leaned against their trunks. Suddenly from one of them a man fell wearing the climbing equipment and run away as quick as he could. Obviously they collected illegally some sap or resin from those trees. We crossed three strongly overshadowed brooks with black waters and muddy grounds with lot of litter, just with some stretches of water running fast over stones. The habitat looked promising but there were only a species more than expectable for it, *Copera vittata* (Selys, 1863): one 'ghost' (de-coloured immature) form and two mature males, that is one damsel per a brook. At last we reached again the main rivulet running through a half shaded bed of rocks and boulders, covered with a slippery green slime in shade. And again, only few *C. vittata*. Then we ascended a hill slope through dense jungle until the path just ended (so the program for trekking tourists appeared to be). The features of the forest were abundance of gingers (Zingiberaceae), diverse and impressive mushrooms and several hungry leeches. In this shady forest something interesting at last appeared: on a way to we collected a female of *Coelliccia kazukoae* Asahina, 1984 and another one on the way back. Near the place where the path disappeared Nikita noticed a male *Ceriagrion* sp. with a bright-red abdomen and greenish thorax but it escaped behind a spiny palm frond.

Noteworthy, not a single *D. nebulosa* (abundant elsewhere in Koh-Kong Province) neither *Orthetrum chrysis* (Selys, 1891) (expected) were observed during this day.

#### IV. Koh Por Waterfalls

→ Dec. 1 (compare Kosterin 2010: 14-21).

The weather was the finest: sunny and moderately hot; however, due to the above mentioned forest logging at the very Niche Waterfall and the resulting missing of this gorgeous Nature monument, this was a sad visit. More water ran and seeped here and there down the shady cliffs of the valley. Often it brought quite a lot of orange laterite clay due to erosion of the forest soil (could it be due to human activity upstream?). At the same time the main river did not get so much higher (although the waterfall niche appeared inaccessible) and had clear water now (turbid in April).





Surprisingly, there were even less butterflies than in April, while odonates were about the same abundant but represented by more species. Something as if did not change as to dragonflies: *Pantala flavescens* (Fabricius, 1798) flying above wide rocky banks (more in number, one female ovipositing into a pool), *D. trivialis* perching on rocks, *O. chrysis* (Selys, 1891) abundant at pools, and water holes upon rocks and tiny slow streams with silty ground (one female also ovipositing into a pool, harassed by a male), *N. fulvia* and *N. fluctuans* frequent at bushes of forest margins, the formers mature and saturated while the latter immature and weakly coloured (both being the same saturated in April). *Trithemis aurora* (Burmeister, 1839) was still common but less abundant. At the same time not a single *Lathrecista asiatica* (Fabricius, 1798) was met. I was rather surprised not having seen *Zygonyx iris malayana* Laidlaw, 1902 on the wing, as well I did not saw them in April but found exuviae. Some dragonflies added. Along with *P. flavescens*, one male of *T. transmarina euryale* ranged over flat rocks upstream of the left tributary mouth. Thrice (twice at banks of the tributary) I saw males of *Orthetrum glaucum* (Brauer, 1865) along with *O. chrysis*. On stones near the tributary bank, a male and female of *T. festiva* were seen, and one male at the main river bank upstream of its mouth. Scarce *N. intermedia atalanta* appeared, more frequent at the withering foliage of trees cut and left lying in the logged area (this species prefers forest clearings).

There were not a single individual of *Dysphaea gloriosa* Fraser, 1938, which so appeared strictly seasonal, as well as of any other calopterigoid (including chlorocyphids), that was so strange for such a rich system of riverine habitats. None *Prodasineura autumnalis* (Fraser, 1922) were encountered as well. At an open pool with some grass above the rocks we found three damselflies being males of three species: *A. pygmaea*, *Pseudagrion rubriceps* Selys, 1876 and *Ceriagrion calamineum* Lieftinck, 1951 (see below 'Notes on specimens and their taxonomy', 10).

Upstream the left tributary, the rocky main river left bank was bordered with low bluffs once having the forest but now the logged area piled with cut trees above it. This time water seeped from the foots of these bluffs above sunny rocks forming tiny shallow and so almost hot pools, with scarce grass soaking with water and a rim of three species of carnivorous herbs: two vigorously flowering species of 'terrestrial' (that is almost without foliage) bladderworts, *Utricularia odorata* Pellegr. and *U. delphinioides* Thorel ex Pellegr. (with small yellow and large violet-blue flowers, respectively) and, at one pool, sundew *Drosera burmanii* (Fig. 10). These unusual pools seemed to either support or attract a set of the commonest lentic odonates: I found numerous *A. pygmaea*, several *I. senegalensis*, one *P. rubriceps*, many *O. sabina* and one *T. pallidinervis*. In April there were no water there and no unusual plants were noticed, while of the mentioned odonates just one *O. sabina* was observed.



In April and now I examined two moist shady bluffs at the valley left bank: the larger open one and the smaller one hidden in vegetation. This time more water showered from the top of the large one and some sprinkling also from the top of the small one (not so in April) and a turbid pool up to 0.5 m deep appeared at its foot (none in April).



**Figure 10.** Very warm seepages above flat rocks of the Koh Por River left bank just upstream of the left tributary mouth, with rosettes of *Drosera burmanii* and flowering *Utricularia delphinooides*, 01.12.2010.

Both times the larger bluff had no odonates, and both times I encountered one individual of the butterfly *Chersonesia* sp. there (and nowhere else during entire both trips). And both times beneath the small one I found one male of *C. vittata* (Selys, 1863) and several males (2 in April, 3 this time) of *C. kazukoae* Asahina, 1984; now they perched on leaf tips just above the pool surface. This time *C. kazukoae* had a fully mature black pattern (see 'Notes on specimens and their taxonomy', 13). Added were rather numerous *\*Mortonagrion aborense*, which rested on foliage at and near the pool (including at quite a height above it), and a saturated violet male of *\*Archibasis viola* Lieftinck, 1948 captured while flying above the pool surface.



## V. Road towards Pursat

→ Nov. 28-29, Dec. 4

When still planning the first trip to the area in February and looking at it in Google Earth, I got obsessed with the road going through the Cardamoms from Koh-Kong to the north towards Pursat Province. It looked as the narrowest thread through an untouched ocean of jungles, passing some creeks and sometimes approaching to the Right Tatai River. The Lonely Planet guide told: "A very rough road goes north through the wild Cardamoms to Pailin and Battambang, passing by remote mountain towns such as Veal Veng, O Som (where there's a ranger station) and Promoui (the main town of the Phnom Samkos Wildlife Sanctuary [...]). It should be attempted only in the dry season by dirt bikers with oodles of off-road experience" (Ray & Robinson, 2008: 187). In April we were told that the road had become inaccessible due to forest logging, and its beginning on a hillside looked so from distance. Now Mr. Webb informed us that the road has been improved, and kindly supplied us with its hand drawn map. He said that this road would provide us with so diverse habitats that it would take several days for us to explore it. Being an expert in the area he was of course right. We made three excursions each time starting from Koh-Kong.

This ground road started with a left turn marked with a road sign in Chinese for it was constructed by that Chinese company which is also constructing hydropower stations at the Koh Por and its tributaries. The road was fairly broad and still being reconstructed by heavy road technique which concentrated at two considerable rises uphill which were quite unpleasant for passing with a small motorbike maneuvering among bulldozers and excavators. Then it was just a regular and not so bad ground road going through a plateau with alternating plantations and sparse dwellings, seemingly native open areas and jungles. Traffic was represented by local people riding motorbikes, including several cavalcades of armed militaries, and Chinese lorries loaded with ground or rocks. At ca 17 km from Koh-Kong the new broad road turned left but it was closed with a crossing bar and a police post who did not allow us to pass. From this point the old road branched and proceeded ahead through continuous pristine jungle and was desolate (with rare motorbike-riders and no dwelling) and beautiful, although rough in several places. On our second day we proceeded along it until an absolutely paradise place ca 25 km from the Koh-Kong margin, where the road was crossed by a considerable brook immediately joining the Right Tatai. Below I report observations at different sites along the road according to the distance from Koh-Kong.

→ 1. Forest 'Femina swamp' (Nov. 28).

Soon from its beginning the road went between a forested hill (with ruins of a logging factory atop), just under its shady steep W slope, and an arm of the main river. The water descending from the hill slope and crossing the road as small streams and in the ground, made the forest behind a kind of a swamp, which looked extremely



promising. The ground soaking with water and curiously crackling under feet was covered with a carpet of ferns and other delicate wining plants which also rose as green coats high to the tree trunks; the larger *Ligodium* fern and abundant club-mosses adding between trees (Fig. 11). In several dozen metres the orange turbid water appeared above the ground; first flowing through large sedge and grass tussocks and then entering an inundated, uniform and dense stand of *Melaleuca cajuputi* Powel (a small eucalypt-like tree with white and soft bark which dominates in swampy lowland habitats of the Cambodian coast). Odonates, however, were not diverse. Of dragonflies, there were numerous and all immature individuals of *N. intermedia atalanta* and *N. fluctuans* (forest species), a female of *D. nebulosa* and a female of *N. tullia* (lentic generalists). Damselflies were represented by numerous mature (blue) males of *A. borneense*, two males of *Aciagrion pallidum* Selys, 1891 (a dry season forest species), a male of *Ceriagrion cerinorubellum* (Brauer, 1865) and several *Agriocnemis* spp. (lentic generalists). The latter genus was represented by several common *A. pygmaea*, a male and female of *A. nana* (Laidlaw, 1914) and a male of *\*A. f. femina* (Brauer, 1868). So, three species of *Agriocnemis* were recorded at this swamp. Besides, it was quite curious that it was the only individual of the latter elsewhere commonest species so far recorded in Cambodia.



**Figure 11. Forest 'Femina swamp' ca 1 km NE of Koh-Kong; the left photo also shows Nikita Vikhrev in it, 28.11.2010.**

→ 2. Dry sandy 'Lispe veal' (evening Nov. 28, morning Nov. 29, midday Dec. 4).

At a distance of 13 km ENE from Koh-Kong we explored an open grassy area, 2.2 x 0.5-0.8 km (Fig. 2), as described above. Very shallow pools with emergent *Juncus* (?) with winding stems were mostly examined on Nov. 29: numerous *D. nebulosa*, several *P. flavescens* (ranging above them) and *B. contaminata*, *D. trivialis*, *T. pallidinervis*, *O. sabina* and *O. chrysis* represented by a male each were quite expectable but the last, which obviously migrated from nearby forest streams. A male *L. concinnus* looked



quite at home there, as well as some *A. pygmaea* and a male *P. australasiae*. There was a male of *Ceriagrion calamineum*, a species which later appeared to prefer shallow pools as well.

Most of the open area was perfectly dry and sandy, although grown up with the same *Juncus* with addition of some sedge and short grass, and naturally was devoid from odonates. Walking through tall *S. ravennae* grass at its lowering part provided just several *N. intermedia atalanta*, as well as at all forest margins. Somewhere at the margin Nikita collected a male *C. cerinorubellum* and I observed *Rhyothemis phyllis* (Sulzer, 1776) or *R. variegata* (Linnaeus, 1763) flying above it (one of only two met in Koh Kong Province during the trip).

→3. Forest 'Aciagrion rivulet' headwater (the same days).

The open area was abruptly margined with rather low and thick forest including some palms and *Dacrydium* trees. At the middle of this margin there was a small natural pond or a grassy swamp several dozens of metres in diameter and about 0.5 m deep. It had warm water and was overgrown with fine emergent Poaceae grass and some tall Juncaceae (Fig. 12, bottom). It was remarkable for immense emerging *Aciagrion* sp. (Fig. 12, top, see 'Notes on specimens...', 8 and Fig. 72) observed in their maiden flight all the three times I visited it. There were also a lot of *D. nebulosa*, a male and female *N. tullia* (the latter I saw as captured a teneral *Aciagrion* sp., Fig. 12, top right) and several fully coloured (with red abdomens and saturated amber wingspots) males of *N. intermedia atalanta*; and I also witnessed a copula. A rarely seen occurrence at water, the full coloration of males and the copula suggested that this dry season forest species bred there. There were another male of *C. calamineum* (see Fig. 74a) and a female probably of the same species (see Fig. 74 c); see below 'Notes on specimens...', 10. Another highlight at that swamp was a male of *Nannophya pygmaea* Rambur, 1842.

The swamp entered the low forest and became deeper (up to 1 m), cooler, clearer, turned to a winding channel several metres wide until it became clear that it was a source of a forest rivulet, although still without a noticeable current. At this part, there was another male of *N. pygmaea*, *P. australasiae* appeared over the water and *A. borneense* on arboreal vegetation. The individuals of *A. borneense* were all mature and I saw a copula (Fig. 13); in August 2011 I found this species emerging from the above considered grassy swamp along with the mentioned *Aciagrion* sp.





Figure 12. *Aciagrion* sp. (see also Fig. 72), a teneral male (top left) and a teneral female being eaten by a female of *Neurothemis tullia* (top right) at a grassy swamplet of the 'Aciagrion rivulet' source (bottom), 29.11.2010.





Figure 13. *Aciagrion borneense*, a copula at the in-forest part of the 'Aciagrion rivulet' source, 29.11.2010.



→ 4. 'Hemicordulia brook' (Dec. 4).

On December 3 Nikita proceeded along the road alone and reported me that he found a path leading from the 'Lispe veal' to a brook with a clear pool over which a medium sized grey dragonfly ranged restlessly. None of the species seen so far fitted this description, so next morning I naturally rushed there. I found the path which went through that low forest for cf 750 m NWN and offered groups of *V. gracilis* until it reached a small young plantation with a house where several men had a meal. They kindly allowed me to examine their allotment. The brook bordered the cleared area and indeed flowed through a crystal-clear pool 3 x 8 m, ca 1.5 m deep (Fig. 14, left). The mysterious dragonfly was there, restlessly flying and hovering up to 1 m above the water, without any steady trajectory. I spotted it to find a male of \**Hemicordulia* sp. (see 'Comments on specimens and their taxonomy', 15). Besides, this fascinating pool was appraised by presence of a lot of many other gentlemen: several males and one copula of *N. pygmaea* (Fig. 15), several males of *T. aurora*, *D. nebulosa* and *N. fluctuans*, a male of *Acisoma panorpoides* (Rambur, 1842), many males of *Pseudagrion williamsoni* Fraser, 1922 (Fig. 16, right) and less of *P. australasiae* (Fig. 16, left).

Upstream that pool, under a wall of *Pandanus* intervened with Glenceniaceae ferns (with a perching male of *N. fulvia*), there was another, more shallow pool with some



Figure 14. Two pools on the 'Hemicordulia brook', each of which was guarded by a male of *Hemicordulia* sp., 04.12.2010.







Figure 15. Female (above) and copula (below) of *Nanophya pygmaea* at a pool (the left one on Fig. 13) on the 'Hemicordulia brook'; 4.12.2010.





Figure 16. Males of *Pseudagrion australasiae*, left, and *P. williamsoni*, right, at a pool (the left one on Fig, 13) on the ‘Hemicordulia brook’, 04.12.2010.

large-leaved submerged plants (Fig. 14, right). Low above its water another *Hemicordulia* male flew, a male of *R. phyllis* or *R. variegata* (the second and last met in Koh Kong Province) flew 3-5 m high and some large aeshnid very high in the air. The third *Hemicordulia* male was spotted downstream of the first pool low above another small and very shallow pool. So, three males of this uncommon dragonfly ranged over sunny almost currentless places of the brook bordering the clearing within several tens of metres.

Upstream the clearing, the brook entered coppice and a deeply shaded pool. Under these conditions there were no *Hemicordulia* but a female of *A. viola*, plus several ‘regular’ individuals of *V. gracilis* on shaded vegetation. Downstream the clearing the brook became flowing fast over rock, with a male *T. festiva* perching on a stone and two males of *P. rubriceps*. Everywhere at vegetation near this brook there were many *N. intermedia atalanta* and several *A. borneense*, and an individual of *O. sabina* was at the clearing. The path crossed the brook and went further, at first through a wet place with Gleicheniaceae ferns (with a male of *N. tullia*), then through the forest (with a ‘ghost form’, immature *C. vittata* in shade and an immature female of *E. masoni* in a small clearing) to the shady old forest road overgrown with coppice (with numerous *V. gracilis*).



## → 5. 'Archibasis brook' (Dec. 4).

Let us return to the 'main' Pursat road and proceed further along it examining sites good for Odonata which are brooks and rivulets. The first small and quite cool brook was situated at the foot of a hill seen from the 'Lispe veal', which made the road to bend. Upstream the road, it has a deep (to 0.7 m) rather shaded pool, with several *T. aurora* and one *O. chrysis* males (in sunlit spots) and several *V. gracilis* (in shade) at banks and several *P. australasiae* and one *P. rubriceps* males at and above water. Besides, a male *Archibasis viola* (Fig. 17) perched on a sunlit leafy branch hanging over the pool deepest shaded place, to where it returned from four observed short flights to examine surrounding branches, to disappear afterwards. The place looked good for *Hemicordulia* and was ca 1 km from the above described habitat but they were not there. Downstream the road, the brook ran over sandstone rock; there were a ranging (!) female of *O. chrysis* and, in grass, several males of *D. nebulosa* and one (rather unexpectedly) of *D. trivialis*.

## → 6. 'Glaucum brook' (Nov. 28).

The next brook was quite near and somewhat larger. It formed several pools on the road. Above one of them a tandem of *P. flavescens* ranged and a female oviposited into another pool. The forest margin was curtained with Gleicheniaceae, there were common dragonflies: many *N. intermedia atalanta*, several *A. borneense* and *D. nebulosa* (as elsewhere), a male *D. trivialis* and a female of *N. tullia*. On a large stone (sometimes also on ferns) a male of \**Orthetrum glaucum* (Brauer, 1865) perched (Fig. 18), soon after I had captured it a female appeared to rest on the same stone. A male *O. chrysis* was found on a stone nearby. Very unexpectedly in a woody habitat, on a grass bunch at the forest margin, I encountered a female of *L. concinnus*. Most probably it migrated there from the open area along the road. A male *N. fulvia* perched high over a swift brook section between two concrete tubes. I entered the deep forest along the overshadowed by its canopy brook bed formed by a broad sandstone staircase. The brook formed a chain of rather cool pools connected by rapid sections; most probably it was temporary. Strikingly there was a complete absence of any rubbish or other signs of human presence, but in spite the gorgeous habitat, almost no odonate species were observed as well except one mature male of *C. vittata*. Even *V. gracilis* were absent (my April trip showed that seasonal drought of brooks does not prevent existence of diverse odonate populations).

## → 7. 'Nannophya rivulet' (Nov. 28, Dec. 4).

Next was a rivulet rather than a brook; it served as a border between a virgin area and a considerable clearing with a pasture, fruit trees and some huts, a kind of tiny village. The rivulet was amazing for having so dissimilar images in its very close sections. Upstream the bridge it has a deep part with grassy banks, in a more shallow place there were long submerged green plants (looking like our *Sparganium*) winding inside



the stream (Fig. 18). Above the water there were several males of *P. australasiae*, few males and (on 4.12.2010) a copula (Fig. 20) of *P. williamsoni*, and, in the shady upstream part, a male of *Pseudagrion pruinosum* (Burmeister, 1839). On the banks there were males of *A. borneense*, one male of *O. chrysis* but the most striking were



Figure 17. A male of *Archibasis viola* at a shady pool on the 'Archibasis brook', 04.12.2010.





Figure 18. A male of *Orthetrum glaucum* at a forest margin at the 'Glaucum brook', 28.11. 2010.





**Figure 18. A deeper part of the 'Nannophya rivulet' supporting an abundant population of *Nannophya pygmaea*, 28.11.2010.**

dozens of bright-red and not at all cautious males of \**N. pygmaea* (Fig. 21), which I would not expect at a rivulet with a considerable current. Further upstream the river became quite fast flowing as several arms in a deep shade of trees and *Pandanus* and



got a very boggy bottom, impossible to walk on. This place, promising for Aeshnidae, yielded no dragonflies, but only one damselfly – a male *A. borneense* which flew above water (that is rarely seen). Downstream the bridge there was another very deep, slow and shady section of the rivulet, but with a firm ground. There were many *N. fluctuans* (both mature and immature, with pale wing coloration, Fig. 22), quite a few *N. pygmaea*, an individual of *V. gracilis* and a number of *Pseudagrion*: two males of *P. rubriceps*, one of *P. williamsoni* and a tandem of *P. australasiae*. Besides, I photographed a female of *P. rubriceps* carrying a male's abdomen on her neck, the owner of



Figure 20. A copula of *Pseudagrion williamsoni* at the deeper part of the 'Nannophya rivulet' supporting an abundant population of *Nannophya pygmaea* (see Fig. 19), 04.12.2010.

which has been most probably eaten by some predator (a situation often seen in coenagrionids) (Fig. 23). Then the rivulet ran across a grassy pasture though a series of shallow pools which expectedly supported a 'boring' dragonfly community represented by several *D. nebulosa* of both sexes, two males of *T. aurora*, a male *B. contaminata* and female of *N. tullia*. Then the rivulet again entered the deep forest shade and started to descend over a staircase of broad sandstone plates. There were invariably present in such places *V. gracilis* (2 individuals) and *C. vittata* (an individual of 'ghost' age).





Figure 21. Males of *Nannophya pygmaea* at the banks of the deeper part of the ‘*Nannophya rivulet*’ (see Fig. 19), 28.11.2010.

→ 8. ‘*Nepenthes brook*’ (Nov. 29)

After ‘the *Nannophya rivulet*’ we omitted the next one at last passed the police post where the ‘Chinese road’ branched left and further enjoyed resonance of vibrant jungle. We stopped at a brook which was curious as flowing for some distance over rather an open area in quite a deep bed entrenched into flat sandstone rocks. Several pitcher plants grew over the rock, with its pitchers almost lying on it; besides a lovely yellow-and-white orchid flowered. The odonate fauna was quite rich for a brook but already seen elsewhere. The deep rocky part provided males of all *Pseudagrion* species already seen before: 1 *P. australasiae*, 1 *P. rubriceps*, 1 *P. williamsoni* and 2 *P. pruinosum* (Fig. 24, top), plus 2 females of *A. viola* (Fig. Fig. 25 and see ‘Comments on specimens’, 15). A tandem of *P. verticalis* sensu Asahina, 1983 hovered above the water; from banks I disturbed a male of *T. aurora*, 2 males of *N. pygmaea*, 2 females of *D. nebulosa*. At the ‘entrance to jungle’ there were a male of *O. glaucum*, 2 males and 1 female of *A. borneense*, an immature young male of *H. biforata*, a female of *H. perforata* (see ‘Discussion of specimens ...’, 4) and 2 males of *E. masoni* (one at the sunlit margin, one under the canopy). About four individuals of *V. gracilis* seemed to repeatedly move, as a group, along the brook either under the fo-







Figure 22. An immature male of *Neurothemis fluctuans* with still weak wing coloration at the 'Nannophya rivulet', 28.11.2010.



Figure 23. A female of *Pseudagrion rubriceps* retaining a male's abdomen on its thorax at the 'Nannophya rivulet', 28.11.2010.



rest canopy or to the sunny margin. A large flat rock at the road attracted a male *D. trivialis*, while a male *P. flavescens* ranged above.

→ 9. 'Capricornis rivulet' (Nov. 29)

We proceeded forward and at last came to a beautiful rivulet with sandy banks which crossed the road being about 5 m wide. It seemed problematic to cross with a motorbike but later we saw several riders to do this. But we did not intended this, for everything indicated that at last we found, thanks to Mr. Webb's hint, where the paradise is in fact located on the earth. First it was a large butterfly puddle on wet sand, composed of males of diverse but rather expected species: *Pathysa agetes*, *Graphium sarpedon*, *G. doson*, *Paranticopsis xenocles*, *Appias lyncida*, *A. albina*, *Cepora nadina*, *Hebomoia glaucippe*, *Eurema* sp. (3 spp.?), *Gandaca harina*, *Vindula erota* (Fig. 26) and, wandering some apart, sole males of *Papilio memnon* and *Polyura athamas*. (It should be noted that butterflies were generally scanty elsewhere, most common being *Jamides* spp., *Prosotas* spp. and *Tanaecia lepidea*). Upstream the road, the river hid in a mysterious shade where its bed was formed by rocks and boulders covered with very slippery, green algal slime. Downstream it flowed just for some hundred metres in a sunlit sandy bed of varying depth and still with huge solitary boulders and rocks (Fig. 27), to join the major Right Tatai River, which in turn flowed through a chain of lake-like reaches connected with rapids and small waterfalls (and hence resembled me the Thma Bang River I saw in April) (Fig. 28). I do not know if there exist other large tropical rivers not in high mountains which would be as perfectly virgin: there were still not a single token of human presence and everything was looking as our planet thousands if not millions years ago. Alas, we knew the 'civilisation' to be so near already! One of the most remarkable features of the landscape was some of the highest trees being conifers with loose crowns and leaves dimorphic in a juniper style (scale-like elsewhere but fluffy needles at lowest branches), which should be *Dacrydium*.

The shady part was insufficiently examined at ca 15:30-16:00; there were several *N. chinensis* of both sexes and I spotted an old and somewhat pruinosed female of *V. gracilis*. The sunny part of the rivulet (Fig. 27) appeared very fruitful. Several males of *T. festiva* perched on rocks (Fig. 29) and, less frequently, dry branches but the only female perched on a branch. Several males of *O. chrysis* perched either on stones or ferns. There were quite a number of *N. intermedia atalanta*, an immature male of *N. fluctuans* and a mature one of *N. fulvia* (a standard set). A male of *T. aurora* and a male of *B. contaminata* kept to the most open and shallow reach. At the middle of rather a fast and shallow reach there was a sunlit flat stone on which a beautiful male of *\*Paragomphus capricornis* (Förster, 1914) perched (exactly as described in Orr 2005); by the way it was the only gomphid individual met with during the entire trip. Individuals of both sexes of *N. chinensis* sometimes arrived from the more shady





Figure 24. Males of *Pseudagrion pruinosum*: top, at the 'Nepenthes brook', 29.11.2010; bottom, at the 'Microgomphus river', 02.12.2010.



Figure 25. A female of *Archibasis viola* at 'Nepenthes brook', 29.11.2010.



Figure 25. Butterfly puddle at 'Capricornis rivulet'. Seen are *Pathysa agetes*, *Graphium sarpedon*, *G. doson*, *Paranticopsis xenocles*, *Appias lycida*, *A. albina*, *Cepora nadina*,



*Hebomoia glaucippe*, *Eurema* sp. (3 spp.?), *Gandaca harina*, *Vindula erota*. 29.11.2010.





Figure 27. The sunny section of the 'Capricornis rivulet' near its mouth, a habitat of *Neurobasis chinensis*, *Euphaea masoni*, *Agriocnemis pygmaea*, *A. nana*, *Prodasineura autumnalis*, *Heliocypha perforata limbata*, *Paragomphus capricornis*, *Brachythemis contaminata*, *Neurothemis fluctuans*, *N. fulvia*, *Orthetrum chrysis*, *Trithemis aurora*, *T. festiva*, 29.11.2010.



Figure 28. The Tatai River near the 'Capricornis rivulet' mouth, 29.11.2010.





Figure 29. A male of *Trithemis festiva* perching on a rock on the 'Capricornis rivulet', 29.11.2010.

reach to sit on sand or rocks at the very water level (Fig. 30). There were two males of *E. masoni* perching only on bare branches, while two males of *H. perforata limbata* (Selys, 1879) would perch on stones but were in almost a permanent quarrel (one perched immediately after I captured the other). On shrubs near the rivulet there were *A. borneense*; a male of *Prodasineura autumnalis* (Fraser, 1922) with some glaucous pruinosion at the prothorax lower part hovered over the water. There were scanty bunches of small grass at the banks; one provided three *A. pygmaea* altogether, another a female of *A. nana*. Hence, the fauna was rich but many species were represented by 1-2 individuals, in spite of quite a long examination of the place.

By contrast, the main river, with so encouraging appearance, was almost devoid of Odonata. Just above the rivulet mouth a male of *Z. iris malayana* soared loftily but low (only one seen), several *P. flavescens* did so at greater height over flat rocks, on which few males of *D. trivialis* perched; besides, scarce males of *H. perforata limbata* were sometimes found to perch on edges of large rocks near the banks (Fig. 31). Moist and shady ground and rocky bluffs of the banks provided nothing. Scantily of Odonata on major rivers, even in an untouched condition, seems to be rather a general rule in this area.





Figure 30. A male of *Neurothemis chinensis* on a bank of the 'Capricornis rivulet', 29.11.2010.

## VI. Tatai Waterfall and surroundings

→ Dec. 2 (compare Kosterin 2010: 21-25).

→ 1. Tatai Waterfall.

It was somewhat lifeless (except for humans) in April while full of insect life and abandoned by people in December, yet the major river, provided being the same as discussed above, did not offer a rich fauna. I mostly examined the reach above the waterfall, where water broadly overflowed flat rocks. There were quite a number of soaring *P. flavescens* (as in April); I encountered many males of *T. aurora* and *O. chrysis*, several of *O. sabina*, *O. glaucum*, *D. trivialis*, *N. intermedia atalanta*, *N. fulvia* and *N. fluctuans* (with pale to almost full saturated wing coloration) and one of *T. festiva*. At the mouth of a small ('3rd') brook, a male of *Z. iris malayana* flew but none were at the main waterfall. At the banks I observed four males and one tandem of *P. autumnalis*, many *P. rubriceps* and *P. williamsoni*, one male of *P. australasiae*, one of *I. senegalensis* and, in scanty grass, quite a number of *A. pygmaea*. At vegetation I met found *E. masoni*, *A. borneense* and *A. pallidum*, one male each. No chlorocyphids were observed but on a large broad rock I found the thorax and wings of *H. perforata limbata* rested from some predator.





Figure 31. A male of *Helioocypha perforata limbata* on a rock on the Tatai River at the 'Capricornis rivulet' mouth, 29.11.2010.

The brooks crossing the ground road leading to the waterfall were again more interesting than the main river.

→ 2. 'Masoni brook' ('1<sup>st</sup> brook' in Kosterin 2010: 22-23)

This time its bottom was bright brick-red due to fine laterite alluvium. I still have no idea if it is natural after the rain season or appears only if a brook crosses some road or other ground disturbed by human activity. I examined it briefly ca 2 p.m. and curiously, for a number of species only a single individual was seen, these were *V. gracilis*, *A. borneense* (female), *P. pruinatum* (male), *T. aurora* (male), *T. festiva* (male) and *D. trivialis*. *P. verticalis* sensu Asahina, 1983 was represented by a tandem, *H. biforata* by two, now fully coloured, males perching on vegetation, and *C. vittata* and *N. intermedia atalanta* by three individuals. This time I did not meet *E. masoni* here, that was compensated by it has been quite common elsewhere.

→ 3. 'Rhinagrion brook' ('2nd brook' in Kosterin 2010: 23-24)

There were no water in April but quite a lot this time (both with respect to depth and speed in some places); and again, the brook looked reddish due to the fine laterite alluvium. In April just two odonate species were observed, and both this time as well, namely *V. gracilis* (1 female in April versus 3 males and 2 females in December) and *C. vittata* (2 males versus 6 males and 2 female). But there were quite a number of additional species. Most surprising there was a male of \**Rhinagrion viridatum* Fraser, 1938 (see 'Discussion of specimens ...', 5), which landed on a sunlit leaf at





about 1 m over a shady bank and disappeared immediately. Quite unexpected was *C. kazukoae*; 3 males were captured at deeply shaded banks (one at a clayey bluff over a large and deep pool, Fig. 32). In the same shady part there were 2 males and 1



Figure 32. The deep pool with a bluff at the 'Rhinagrion brook', 02.12.2010.

tandem of *P. verticalis* sensu Asahina, 1983, the latter oviposited into a brush of very short scoring rush (*Equisetum* sp.) growing on a very shallow and strongly tinted with laterite clay seepage at the brook bank (Fig. 33). So, this species prefers shaded small brooks while *P. autumnalis* prefers open river banks. So far I've never met both species together. At quite a wide and deep and not so shaded reach downstream the road I found male and female of *A. viola*, so deep and very slowly flowing pools proved to be its preferred habitats. There were females of *Heliocypha*, one *biforata*, one *perforata*, and another one of either, and also a male *T. aurora*, a female of *N. fluctuans* and an individual of *D. trivialis* at the road clearing.

→ 4. Twilight.

Thanks to hospitality of Andy Schneidegger I had an opportunity to overnight in the nearby Nature Waterway Resort and so spent the twilight in this area, mostly at the main waterfall and 'Rhinagrion brook', in a non-fading hope to meet crepuscular species. Nothing was observed at the waterfall except for a flock of white herons



which flew graciously downstream the river. On grassy open patches on the way to waterfall I witnessed many *P. flavescens* landing onto the grass (Fig. 34). Once I saw something like an erratic flight of *T. tillarga*. In a deep shade of the 'Rhinagrion brook' valley I at last noticed (that was not easy) two large and truly crepuscular insects swiftly flying to and from about 3 m above the brook chasing each other, that looked quite mysteriously. But these were butterflies, *Discophora timora* from Amathusinae. Curiously, in April I saw one at daytime, modestly fluttering in shade over the dry stony brook bed ... Looking up I saw against the still light sky a most elegant



Figure 33. Ovipositing *Prodasineura verticalis* sensu Asahina, 1983 at a seepage at the 'Rhinagrion brook', 02.12.2010.



falcon-like silhouette of a goatsucker. Riding a motorbike back in almost complete darkness, I disturbed another one from the road. At night, a male *T. tillarga* visited a lamp at Andy's resort.



Figure 34. A male of *Pantala flavescens* resting in grass in the evening 02.12.2010 at the Tatai Waterfall.

## VII. 'Oculata brook' at Phnom Doung bridge

→ (= 'dry torrent at Tatai River right bank' in Kosterin 2010: 27-30). Dec. 3.

To revisit this brook, situated right at Andy's place, was among my plans but they appeared so tight that I could afford myself this only once early in the morning, at 6:30-9:00. In April it was dry, now there was a very weak brook. I saw a squirrel and found a common [very] green pit viper (*Trimeresurus* s. l. sp.) rolled in a crevice between stones, but, perhaps for being too early, did not find any of the Odonata I observed in April (including that impressive one after which I had to name this brook). Instead I met two mature males and one 'ghost' female of *C. vittata*, and among huge stones at the lowermost and most steep part of the valley, I collected a late teneral, still pinkish with a blueish spot on S8, male of *\*Mortonagrion falcatum* Lieftinck, 1934.



At the foot of the slope *N. intermedia atalanta* occurred. The grassy banks of the pond accepting the water of that brook (let us call it Andy's pond) abounded in *N. fluctuans* (many immature) (Fig. 35), plus just one *T. aurora*. Sweeping for damselflies provided three *A. borneense* and just one *A. pygmaea*. Anyway this was much more than in April.

### VIII. Thma Bang environs

→ Dec. 3 (compare Kosterin 2010: 32-36).

→ 1. 'Microgomphus River' (= 'Thma Bang River left tributary' in loc. cit. 33-35; 12-14 hr).

This was the only overcast and relatively 'cool' day that made my quite long sole motorbike trip to Thma Bang easier; besides, the rough part of the road has been improved and only a wheel puncture added some adventure. The 'Microgomphus' River looked exactly the same as in April. There was the same amount of water in its deep part but more in the fast running and shallow part, and mostly the same odonates which, however, were much more numerous. Nevertheless, the seasonal *D. gloriosa* and gomphids were absent. *V. gracilis* were not more abundant: just 2-3 individuals were found at the forest margin at the shallow part, near a mouth of a tiny brook. *N. chinensis* became very numerous throughout the banks but seemed most abundant at the medium deep part at the bridge. Both sexes similarly sat at the ground or stones at the very water edge (Fig. 36). Several males of *E. masoni* occurred at the shallow part, they perched on stones or leaves at a height of 0.5-2 m. Both *Heliocypha* species were abundant: *H. biforata* at the deep part where it perched on vegetation, *H. perforata* occurred at both parts but was more frequent at the shallow parts and preferred to perch on rocks, although was rarely seen on vegetation. *P. autumnalis* was more and *Pseudagrion* spp. much more abundant than in April. Of the latter, *P. williamsoni* prevailed, *P. rubriceps* were frequent, *P. australasiae* was more rare and I saw only four *P. pruinosum* (Fig. 24, bottom), the two latter species not observed in April. There were no other coenagrionids, although I expected *A. viola*. As in April, I saw *Copera ciliata*, but this time also *C. marginipes* (a male and a tandem of each). Four times I observed males of *R. viridatum*. They kept to low vegetation at the very banks and were very motile, resembling in habits a wasp rather than a damselfly. There were no big surprises among dragonflies: males *T. festiva* occurred by several in convenient places; an individual of *O. sabina* kept to a log floating at the deep reach; there were several males of *O. chrysis* (a species I missed in April), including perching on vegetation at the deep part without rocks; *N. fluctuans* were not abundant and I twice observed a female ovipositing under the bank of the deep reach. *N. intermedia atalanta* was not observed at water but only on a plantation behind the trees. Noteworthy I did not see any aeshnids or gomphids. Following an advice by Vincent Kalkman I tried to





Figure 35.  
Two females of *Neurothemis*  
*fluctuans*

in grass at the bank of 'Andy's pond' at the mouth of the 'Oculata brook', 03.12. 2010.





Figure 36. A female of *Neurothemis chinensis* on a bank of the 'Microgomphus River', 03.12.2010.

find *Microgomphus* larvae dragging the silty bottom with my net, but this yielded only a larva of *Macromia* sp. (Fig. 37). As a bonus, in a riparian stripe of jungle I observed a tree monitor (*Varanus* spec.) who captured a smaller but still large skink. (I recalled as after our visit to Thma Bang in April, Alan Andrews said: "It was jungle, my friend! We saw an eagle, a snake and a squirrel!".)

→ 2. Thma Bang River (14:30-15:30).

It was a very brief excursion, coinciding with the sun appearing for a while. The path to the Thma Bang Waterfall led along plantations (with numerous *N. intermedia a-talanta* and *N. fluctuans*) along the forest growing on the valley slope, when I entered it I found not less numerous *V. gracilis*. The waterfall was weird: the flat and very broad rocky bed of the river gradually curved downstream, so that looking in that direction one sees as if a very close horizon and has no idea what is behind (Fig. 39). The water very shallowly ran over that bed, which was covered as if a dark brownish carpet of a kind of a stiff liverwort, to form rapids and low waterfalls here and there. Maybe due to quite late time there were few odonates represented almost exclusi-





**Figure 37.** A larva of *Macromia* sp. Collected at the bottom of the 'Microgomphus River', 03.12.2010.

vely by demoiselles: I saw a male and female of *N. chinensis*; two males of *E. masoni* perched on the same lonely bush or the wet liverwort carpet nearby; a male *H. perforata* perched on a rock rib. Of dragonflies I saw only several *O. chrysis*. I went upstream along the left bank of the river, which became slower and deeper, to the lake-like reach where I witnessed emergency of *Burmagomphus* sp. in April, not seen this time as any other gomphid. Instead, I saw several males of *P. autumnalis* and *P. williamsoni*, one male of each *P. australasiae* and *P. pruinosum*, and two males of *R. viridatum*. I observed one of them getting into a cobweb (Fig. 38) but releasing itself after a minute of struggle for life. And again, a larger river exhibited less odonates that day.

## IX. Bokor Plateau

→ Dec. 8-10 (compare Kosterin 2010: 41-44)

→1. Jungle path (Dec. 8, 10).

The order of getting tourists to Bokor Hill Station did not changed since April: they had to disembark from a vehicle and to walk a part of forested slope following an armed ranger via a path, to be picked up by the same vehicle and brought to the station.

But the path itself had changed: now it was not so steep to climb with all the four limbs but allowing just an hour of intensive walking uphill. A peculiarity of the day we took it uphill was a very strong SE wind well penetrating to the ground of quite a



dense primary forest. Soon after we entered the forest I disturbed an *olivaceous-green Gynacantha* which immediately sat back into low vegetation but in place inconvenient to either photograph or catch it. An odonate really filling the forest was *C. olivaceum*, which was seen quite frequently all the way. There was no clearing along the path so it had to have an even density all over the forest and, taking into account the enormous total area of the forested S slope of the Bokor Plateau, the amount of individuals which had emerged somewhere was really impressive.



Figure 38. A male of *Rhinagrion viridatum* in a cobweb at the Thma Bang River left bank upstream the waterfall, 03.12.2010.





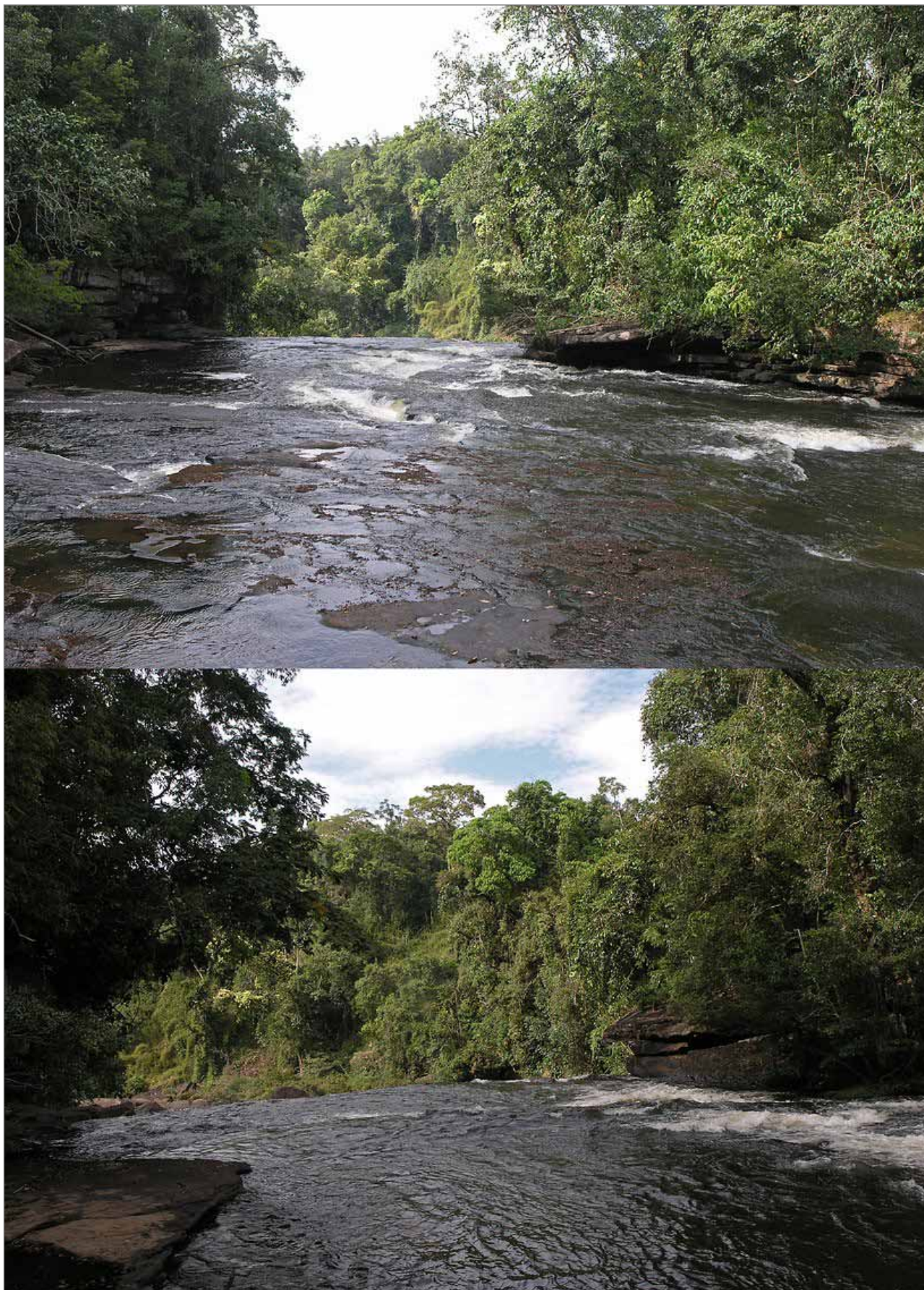


Figure 39. The Thma Bang Waterfall, 03.12.2010.



Besides, we met with one *D. trivialis*, several *A. borneense*, *N. i atalanta* and, most interesting, both sexes of *Lestes elatus* Hagen in Selys, 1862 (Fig. 40), which kept low in herbs. Taking into account the strong wind making damselflies to hide, one may conclude that this time the forest contained quite a lot of them (none in April). This was proved on December 10 when we came back and saw the same 3 species but not *Gynacantha* and *D. trivialis*.



Figure 40. A male of *Lestes elatus* in a forest on the Bokor Plateau S slope, 08.12.2010.



## → 2. Bokor Hill Station (Dec. 8-9).

Unusual for Phnom Bokor was a bright sunny weather, with just some light cirrus in the sky, for the first two days of our visit until, and only at midday December 10 the fogs returned to their native realm. In addition, on December 8 there was a strong wind. Another difference from what I saw in April was a reddish aspect of vegetation since most of the coppice trees and bushes had many young red leaves (Fig. 41).



Figure 41. A view on the Bokor Hill, 08.12.2010.

Quite surprising was the fact that there were no more water than in April; most probably it was due to the elevated plateau is well drained and water does not accumulate, plus quite an amount of fog and dew precipitation round the year. In spite of the great (from a human point of view) weather, insects were very scarce; the few butterflies seen seemed to belong to the most widespread ubiquitous species. A peculiarity was some large, broad-winged and brilliantly coloured Zygaenidae moth which flew high above the coppice, mostly in the morning and evening. For several hours of electric light at night at the headquarters, just one huge moth arrived.

I would not say I expected something particular from odonates on the Bokor Plateau but certainly not what I found: it seemed to harbour immense numbers of several common species most probably bred elsewhere at lower elevations; that is vertical dispersal takes place there something like in the mountains of Central Asia. However, this time there were no *P. flavescens*, observed here in plenties in April. While *P. flavescens* and *T. t. euryale* were very abundant just 40 km apart in Kep, on Bokor Plateau I observed only several individuals of the former above the Popokvil River (plus one dead in a pool at the Bokor Palace) and one of the latter over the road. At the same time, almost at every point on the Plateau one at once could see at least one (as



a rule female) individual of *Potamarcha congener* (Rambur, 1842) perching high on a dry branch behind the wind (noteworthy it was the same abundant in Kep, along with the two above mentioned species). They were all immature, still without pruinescence. Lower branches were occupied by hardly less abundant *N. intermedia atalanta*, also immature (males yellowish rather than red), while *D. trivialis* quite often and *O. sabina* very rarely occurred on rocks. Quite often throughout the day but very often in the evening one could see flying or resting *T. tillarga*, which seemed to be almost exclusively females. As to damselflies observed beyond water, everything was filled with astonishingly numerous *C. olivaceum* of both sexes showing no interest in each other. They made it difficult to notice anything else. However, during Dec. 8 I managed to find five individuals of the similarly coloured *L. concinnus* of both sexes (Fig. 42) in sedge growing at open places and small bogs along the roads, that is in its favourite habitat. Besides, scarce *A. borneense* occurred in coppice. Very unexpectedly, under the walls of the 'Bokor Palace' ruin Nikita captured a chlorocyphid female (?*Heliocypha* sp.) which hid in the dense grass from a strong wind; being obviously not at home there. I cannot identify the species since the specimen was among several specimens eaten at night by some rat at the ranger station.



Figure 42. A female of *Lestes concinnus* on the Bokor Hill, 08.12.2010.

The brook at the 'worker hostel' had polluted and naturally dark water; there were several *I. senegalensis* and a male of *Orthetrum pruinosum neglectum* (in April I met *O. chrysis* there); these species seemed to breed there. Some other brooks were dammed by terrible 'roads' in construction, with coppice cut around the formed dead ponds with black water. Nevertheless, even in this situation some *I. senegalensis* occurred.

I was happy to find small *Sphagnum* mats at some holes and small pools along the retained section of the modest old road, but was rather disappointed not to find any-



thing specific except for one teneral \**Aciagrion tillyardi* Laidlaw, 1919 which seemed to emerge from an already waterless pool, and, of course, omnipresent *C. olivaceum* in the grass.

The pond at the ranger station for some reason appeared nearly lifeless (not so in April): no dragonflies and only two damselfly species, *A. pygmaea* rare in grass and *I. senegalensis* common in one corner; but I examined it only early in the morning on Dec. 9.

→ 3. 'Praemorsus pond' (Dec. 9-10).

The Popokvil waterfalls were our main target, but more interesting sites were found along the way. After the road turned at the pagoda we followed the recently widened road through the coppice, at sides of which we met a male of *O. chrysis* and two rival males of *O. glaucum* at a tiny roadside spring (Fig. 43), which is so favoured as a habitat by the latter species. Soon we reached a small but deep (to 1.2 m) roadside pond with quite cold 'black' water and grassy banks (Fig. 44), formed by a brook flowing from dense elfin wood (where a female of *C. vittata* was found in shade). All the three times I visited it, at 10 a.m. and 4 p.m. on Dec. 9, at 10 and at 8 a.m. on Dec. 10, there was one or two females of *T. tillarga* skimming over it and often touching the water (a habit often observed in this species), but the first time there flew also a dragonfly which seemed to be *Hemicordulia*. Unfortunately, I missed in my stroke and did not see any more. But the pond was generous as to damselflies. Very abundant in grass were *A. tillyardi*, including copulae and tandems (Fig. 45), as well as the common *A. pygmaea*, *I. senegalensis* and *C. olivaceum*, and much less abundant (but possibly breeding) *A. borneense*. On stems emerging from water a male of *P. australasiae* and two males of *Lestes praemorsus decipiens* Kirby, 1893 perched (Fig. 46, left).

→ 4. Huge *Sphagnum* 'Bokorensis mire' (15-16 hr Dec. 9, 11-12 hr Dec.10).

It was situated immediately further at the road to the Popokvil Waterfalls and was described above in 'The place...' section and depicted on Fig. 4. Not much left to report on odonates. The omnipresent individuals of *C. olivaceum* remained so over the mire, although somewhat less abundant and with no sign of special relation to it. At a shallow pool I collected a male of *C. calamineum*, which looked guarding the breeding place, but for walking across the mire for two hours in total in two days I met five individuals of *C. cerinorubellum* in their maiden flight (Fig. 47). At another pool I collected, rather unexpectedly, a teneral, with still greyish ground colour male of *A. viola*. While the same walking I met also 11 individuals of *L. concinnus* which looked at home there. There were also scarce *D. trivialis* and a female *D. nebulosa*. Pools with open water near the road appeared richer but due to common species: *A. pygmaea* (too scarce for such seemingly a favourable habitat), *A. borneense* (males perched on stems low above open water and so seemed to be at breeding places), *I. senegalensis*





Figure 43. A male of *Orthetrum glaucum* at the road to the Popokvil Waterfalls, near the 'Praemorsus pond', 09.12.2010.





Figure 44. The 'Praemorsus pond' at the road to the Popokvil Waterfalls, 09.12.2010.



(not many), *P. australasiae* (1 male), *D. nebulosa* (1 male), *B. contaminata* (2 males and 1 female met), *O. sabina* (few).



Figure 45. *Aciagrion tillyardi* (male, left; copula, right) at the 'Praemorsus pond' on the Bokor Plateau, 09.12.2010.



Figure 46. Males of *Lestes praemorsus decipiens* on the Bokor Plateau, at the 'Praemorsus pond', 09.12.2010, left, and the lower 'Limbata pond', 10.12.2010, right.







Figure 47. A teneral male of *Ceriagrion cerinorubellum* at the 'Bokorensis mire' on the Bokor Plateau, 10.12.2010.





**Figure 48. The 'Limbata ponds' on the Bokor Plateau, the lower below and the upper above, 10.12.2010.**





Figure 49. A male of *Trithemis pallidinervis* at the lower 'Limbata pond' on the Bokor Plateau: 10.12.2010.

→ 5. 'Limbata ponds' (12-13 hr Dec. 10)

At the margin of the 'Bokorensis mire', next to a large blue roofs and a column of a concrete station, there were two broad but very shallow ponds formed by a small brook flowing to the nearby Popokvil River. In front of them there was a sandy area with scattered *Drosera burmanii* which was flowering. The lower pond (Fig. 48, be-



low) had a clear water with some emergent large Juncaceae (*Juncus?*), it was about 0.5 m deep; from the bank I disturbed some quite large fishes. The fauna was rich. At and over the water there were quite many *I. senegalensis* and common *P. australasiae*, several *A. tillyardi*, a male of *C. calamineum* (Fig. 74 b) and two males, one mature and one teneral, of *L. praemorsus decipiens* (Fig. 46, right). On the bank there were many *D. trivialis*, several *D. nebulosa* and *O. sabina*, a male and female of *B. contaminata*, a male of *C. servilia*, and a male of *Nannophya pygmaea*, the only individual of this lovely species seen on the Bokor Plateau. Quite a number of odonates perched on 'Juncus' emerging from the water: four males of *T. pallidiner-vis* (Fig. 49), several of *T. aurora* and not less than ten of *Indothemis limbata* (Selys, 1891) (Fig. 50, top and bottom left). The latter were very active (as they should be,



Figure 50. *Indothemis limbata* at the lower 'Limbata pond' on the Bokor Plateau: 10.12.2010: males, top and bottom left; females, bottom middle and right.

see Orr, 2005) and cautious. Curiously, when I attempted to approach and photograph them, they at last moved to short grass on the banks (where were less noticeable, by the way). On the bank, I found a female of *I. limbata* which looked as it 'should be' (Fig. 50, bottom middle); but on ferns at the forest margin in several hundred metres I have photographed a dragonfly which I identified with a slight



doubt as a female of this species as well but darkened and pruinosed as a male, perhaps 'superadult' (Fig. 50, bottom right). There was one more unresolved libellulid, large and dark-red with black, which flew low above the water surface and for a while sat on emerged grasses. I bet it was *M. cora* but failed to catch it to check.

The upper pond was very shallow and had a lot of grasses (Fig. 48, above). There I found two more males of *C. calamineum* and two more teneral males of *L. prae-morsus*, several males of *P. australasiae*, quite many of *B. contaminata* of both sexes and an immature (reddish rather than pink) male of *T. aurora*. Obviously, both ponds deserved more attention.

→ 6. Popokvil River (Dec. 9-10)

This is a medium-sized river with an incredible red-to-black water indicating its flowing from turfous areas (e. g. the mire described above) (Fig. 51); it brought some thick yellowish foam formed at rapids. We met it twice, when the road to the waterfalls (Fig. 51, left) crosses it and at the waterfalls themselves. In the first case it flew for quite a distance exposed to the sun between concrete banks at the bridge. There were several males of *O. chrysis* and one of *O. pruinorum neglectum* (Fig. 52). I had a chance to photograph them perching closely on the same stick but missed it. Females of both species appeared as well, on Dec. 9 the male *O. p. neglectum* captured a



Figure 51. The Popokvil River: upstream the waterfalls, left; a shaded arm upstream the waterfalls, top right; downstream the waterfalls, right, 09.12.2010.





Figure 52. A male of *Orthetrum pruinosum neglectum* on the Popokvil River bank at the bridge upstream the waterfall, 09.12.2010.

female into a copula. On Dec. 10 I observed a copula of *O. chrysis* which then separated and the female immediately started to oviposit, being guarded by the male. On emergent sticks I observed a male of *P. australasiae* and a male of *B. contaminata*. The stones at banks were occupied by several males of *T. festiva*.

Just above the waterfall, the water produced a shady left arm slowly and shallowly flowing over intricately eroded sandstone plates (Fig. 51, top right), with lots of *V. gracilis* perching on bushes and some males of *Aciagrion tillyardi* above the water.

The waterfalls (examined on Dec. 9) had two steps, 15 and 18 m high, and were very impressive (Fig. 53). No odonates were found at their nearest vicinity, while the broad rocky valley descending downstream through the tall primary forest at quite an angle (Fig. 51, bottom right) was a bit more fruitful. Several *P. flavescens* flew over it and I noticed one male of *O. chrysis*. Shady and moist bluffs provided a 'ghost' *C. vittata*. Near the forest margin I collected a male of *H. biforata* on a bush;



while at sunlit rocks around the black pools (Fig. 51, bottom right), males of *Aristocypha fenestrella* (Rambur, 1842) (Fig. 54) started to occur. Each perched on either of several favourite place situated within several metres (stone surface or sticks), sometimes two rival males kept to the same area. I suddenly collected a young, with still glittering discoloured wings, male of *E. masoni* (see 'Comments on specimens...', 13 and Fig. 69 and 70 c). So, there were at least two interesting species but I expected more from such a gorgeous place.



Figure 53. The Popokvil Waterfalls, 09.12.2010.

## X. Kep surroundings

→ 1. Tree Top Bungalow (Dec. 5-7).

That was the name of the resort we accommodated in. It was situated on the Kep hill slope near the upper limit of its habitated part, that is just below the primary forest, and was extremely lovely, with high wattled bungalows allowing a beautiful view onto the Vietnamese Phu Quic Island. Among them, sparse trees were planted and adorned with lamps, and there were lawns, lovely looking but in places overgrown with very thorny *Mimosa pudica* with tiny globular pink inflorescences which teared nets. Quite a piece of handmade paradise! And there was enormous amount of dragonflies and damselflies, immature and most probably stopped by forest margins in their dispersal from lower lying breeding places. Numerous *T. transmarina euryale* (so rare at Koh-Kong), immature as the males were tan rather than saturated dark-red, not only barraged in the sky but often perched on sticks (Fig. 55), unless they were not occupied by not less numerous and also immature (still not pruinosed) *Potamarcha congener* (Fig. 56) (none seen in Koh-Kong Province). *P. flavescens* were also present but not abundant here, although we were impressed by huge amount of them swarming over the roads and opening at the sea level in Kep. In grass there





Figure 54. A male of *Aristocypha fenestrella* in the Popokvil River valley downstream the waterfalls, 09.12.2010.







Figure 55. Females of *Tramea transmarina euryale* at Treetop Bungalow in Kep, 05.12.2010





Figure 56. Immature *Potamarcha congener* at Treetop Bungalow in Kep; female, above; males, below; 05.12.2010.

were immense *A. pygmaea* and *D. trivialis* (this time without any relation to barren ground) and very numerous dull *C. olivaceum*, the latter seemed to aggregate (Fig. 57) at denser herbage up to 10 individuals within about a square metre, mostly at trees. *I. senegalensis* (frequently), *A. borneense*, *N. intermedia atalanta* (several individuals) and one *Acisoma panorpoides* Rambur, 1842 (Fig. 58, left) also occurred in that grass and, very unexpectedly on a slope, I encountered a male of *L. concinnus* (Fig. 58, right).





Figure 57. Aggregated *Ceriagrion olivaceum* at Treetop Bungalow in Kep; male, right; females, middle and left; 05.12.2010.



Figure 58. A male of *Acisoma panorpoides*, left, and a male of *Lestes concinnus*, right, at Treetop Bungalow in Kep, 05.12.2010.

Nearby was a deep and shady but dry ditch overgrown with trees, on the branches of which I at least found perching immature (still not red) males of *Lathrecista asiatica* (not yet appeared at the Koh Por), while in the shaded grass there were a male and female of *Lestes elatus*. More individuals of the latter were found to keep in grass around bunches of spiny bamboo in the 'park' (Fig. 59, bottom right).





Figure 59. *Lestes elatus* in Kep; male, top left; females, others; Treetop Bungalow, 06.10.2010, bottom right; the forest road around Kep Hill, 07.10.2010, others.

It turned out very interesting to observe Odonata at night attracted by 'day light' lamps hanging on trees at about my height; they usually sat at illuminated leaves nearby. For three nights and about dozen of lamps I observed many *A. pygmaea* (up



to several altogether under a lamp), *D. trivialis* (about one per two lamps; I saw an individual captured by tailor ants, Fig. 60, left), several *I. senegalensis*, only two *C. olivaceum* (obviously underrepresented at light), one *A. borneense*, one male of *P. flavescens* and as much as four individuals of *T. transmarina euryale* (Fig. 60), but not a single *P. congener* or *T. tillarga* (the latter observed flying in abundance more uphill). At night on Dec. 7 a female of *Anax ?guttatus* (Burmeister, 1839) arrived under the illuminated terrace. I collected it, but it appeared that just to have fed the above mentioned rat, so I failed to check it against a possible *A. panybeus* Hagen, 1867; I only remember that it missed yellow colour on the hind wings (not a diagnostic character).



Figure 60. Dragonflies attracted by light in Treetop Bungalow in Kep: a male of *Diplacodes trivialis* captured by tailor ants, 05.12.2010, left; *Tramea transmarina euryale*, 06.12.2010, right.

→ 2. Lowland 'Ludwigia pond' (Dec. 6-7; compare Kosterin 2010: 44-45).

This time *Ludwigia adscencens* flowered scarcely but *Utricularia aurea* Lour. with yellow flowers abundantly (Fig. 61, right). The odonate aspect also changed. There was a big swarm of *P. flavescens* in the air. In grass at and over the water there were numerous *D. trivialis* and only one male of *D. nebulosa* (a picture opposite to what was observed at Koh-Kong); two males of *Brachydiplax farinosa* Krüger, 1902 (Fig. 61), three citron-yellow males of *Ceriagrion ? indochinense* Asahina, 1983 (Fig. 62 and see below 'Notes on specimens...', 11), which looked at breeding place, and just one male of *C. olivaceum* (compare to the abundance of the latter out of water). None of these species were there in April. Of those which were, I found *I. senegalensis* (very abundant, against 2 seen in April), many *N. tullia* of both sexes, several *A. panorpoides* and one male of *Brachydiplax c. chalybea* Brauer, 1868. I noticed that the latter perched at high grasses emerging from water while males of *B. farinosa* at



low grasses, just near the water surface. This time none *Ceriagrion malaisei* Schmidt, 1964 was observed, as well as some common species seen in April, which most probably would be found if one devotes more time to the pond.



Figure 61. A male of *Brachydiplax farinosa* at the 'Ludwigia pond' in Kep, 06.12.2010.

→ 3. Kep Hill (Dec. 5-7; compare Kosterin 2010: 45-50).

This time the road embracing the virgin forested upper part of the Kep hill was found remarkable by abundance of one butterfly species, *Tanaecia julii* (quite worn out). At daytime, some *T. t. euryale* and, less frequent, *P. flavescens* and few *T. tillarga* flew above the road; the latter were seen in abundance in twilight of December 5, just before a thunderstorm. An occasional stop at midday December 7 allowed to find a male and two females of *L. elatus* at the scanty half-shaded grass at a small roadside bluff (Fig. 59, top and bottom left); it looks like this species abounded in the forest, similarly to once on the Bokor Plateau slope. Few *V. gracilis* could also be met with at vegetation.

On December 6, I entered into overshadowed lower parts of three small and quite steep beds of temporarily waterless brooks regularly descending from the slopes. I was surprised to soon disturb two females of *Gynacantha subinterrupta* Rambur,



1842 at the first one and one at the second one; they immediately sat again and were easy to photograph (Fig. 63, the flash was deadly needed) and even to catch by hand. The small concrete reservoir, where in April I met some *V. gracilis*, *C. vittata*, *O. chrysis*, this time provided only several *A. pygmaea*.



Figure 62. A male presumably of *Ceriagrion indochinense* at the 'Ludwigia pond' in Kep, 06.12.2010.

The larger brook with a pond (let us call them 'Platystylus brook' and 'Zyxomma pond') surprisingly had even less water than in April! The pond became shallower and more filled with aquatic vegetation (including something like frogbit – *Hydrocharis*, and flowering *Utricularia aurea*) and so seemed to have temporarily lost Odonata diversity. All high branches around were occupied by *P. congener* and low ones by *O. sabina*, while *D. trivialis* abounded at the ground. At leafy bushes I met a male and a female (in different days) of *Rhodothemis rufa* (Rambur, 1842) (Fig. 64). At the water I noticed a male and female *N. tullia* and, of damselflies, *I. senegalensis* and (as well as in April) a tandem of *C. marginipes*. Between the margins of the pond depression and the road bent around it, a huge amount of *T. t. euryale* swarmed, seemingly without a single *P. flavescens* but with one female of *R. variegata* participating, androchromic but with additional spots (the only *Rhyothemis* individual seen at this visit to Kep).





Figure 63. Females of *Gynacantha sub-interrupta* in shady understorey under the forest canopy at steep dry brook valleys on Kep Hill slopes, 06.12.2010.







Figure 64. *Rhodothemis rufa* at the 'Zyxomma pond' on Kep Hill: male, 06.12.2010; female, 07.12.2010.

The pools formed by the brook just upstream the pond, in front of the road, had *\*Pseudagrion microcephalum* (Rambur, 1842) (here mistaken by me for *P. australasiae* in April, true *P. australasiae* being found at 'Zyxomma pond'), *B. chalybea*, *N. tullia* (Fig. 65, top) and *C. servilia*. The forested valley was examined on December 6 and 7, to be found as usual rich in biodiversity, of which huge noctuid moths of different species in herbage and dragon-like hornbills at the forest canopy, producing a mighty noise of their wings while flying, were most impressive. There were still quite a lot of common dragonfly species: many *D. trivialis* (rested on vegetation in open places), quite common *N. intermedia atalanta*, *T. tillarga* (active in spite of daytime), several *L. asiatica* (Fig. 66) (I met one male with already a red abdomen) and *N. fulvia* (Fig. 65, bottom) (but not a single *N. fluctuans*, as well as in April). Quite abundant were *C. olivaceum*, frequent *A. borneense* (mostly greenish females). A male of *C. marginipes*, of *C. vittata* and of *A. pallidum* and a female of *P. microcephalum* were also found. The open secondary small valley offered space for swarming of *P. flavescens* and *T. t. euryale*, instead of *Rhyothemis* 3 spp. and *Pseudothemis* observed there in April. In two different days I disturbed two females of *G. subinterrupta*, one at this place and one at the upper, steep and dry part of the main brook valley, where it resembled those examined at the road. (No males were seen at this visit.) In the latter site I observed the only individual of *V. gracilis*, which were frequent in April. Noteworthy, this time I did not find *P. verticalis* sensu Asahina, 1984, while quite a lot in Koh-Kong Province. But we found more interesting species. At small shady pools formed by the brook, where the last mentioned species were observed in April, Nikita collected a male and, in a distance about 3 m, a female of *Argiocnemis rubescens rubeola* Selys, 1877, both at the stage when the end of abdomen was still reddish. (I must say, for some reason it is only Nikita who was proved to be able to see this spe-





Figure 65. A male of *Neurothemis tullia*, 07.12.2010, top, and a female of *Neurothemis fulvia*, 06.12.2010, bottom, at the lower valley and pools of the 'Platystylus brook' on Kep Hill.





Figure 66. An immature male of *Lathrecista asiatica* at the lower valley of the 'Platystylus brook' on Kep Hill, 07.12.2010.



Figure 67. Males of *Lestes platystylus* in the valley of the 'Platystylus brook' on Kep Hill: 06.12.2010, left; 07.12.2010, right.



cies in our joint trips.) At similar shady pools (where I wished to find some Platystictidae) and elsewhere in deep shade of dense herbage I found *Lestes platystylus* Rambur, 1842, weirdly-looking with their scorpio-like habit to slightly wave their abdomens curved up in a scorpio-like manner (Fig. 67). For two walks up- and downstream for two days I counted nine immature (still brownish-grey without a greenish hue) males, some infested by many mites.

→ 4. Abandoned salt fields (Dec. 7)

This was a short sortie east of Kep. The former salt fields were a stripe of muddy squares, separated with low dams accompanied with ditches, between rice fields and a narrow stripe of tall but ugly since mostly cut off mangroves. At the flowing ditch closest to the rice fields there were many *O. sabina* (Fig. 68, bottom left) and *D. trivialis* and less numerous *C. servilia* (Fig. 68, top left) and *T. pallidinervis* (Fig. 68, right). I noticed that *T. pallidinervis* perched on highest sticks, *C. servilia* on low sticks, *O. sabina* on any as well as on the ground, *D. trivialis* on the ground. Near the water there were common *I. senegalensis*, one male of *B. contaminata* and an individual of *P. flavescens* flew low above the ditch. Not many, but quite more than in the similar habitats at Peam Krasaop.



Figure 68. Females of *Crocotthemis servilia*, top left, *Orthetrum sabina*, bottom left, and *Trithemis pallidinervis*, right, at a ditch between rice fields and the abandoned salt fields E of Kep, 07.12.2010.



## Short synopsis of all Odonata records during the trip.

Coordinates were obtained either from GPS or Googleearth. Generic names are given in full upon the first mentions of species in this section. 'Released' means captured, examined and released. Collections were made by the author unless otherwise stated. Any specimens are available for investigation upon request, but take into account great difficulties with sending specimens abroad from Russia.

### Koh-Kong Province

#### I. Peam Krasaop Wildlife Sanctuary surroundings.

1. A road near the Peam Krasaop Wildlife Sanctuary 'market'. 11°33.5' N, 102°59.5', 2 m, 11.12.2010. *Pseudagrion australasiae* – 1 ♀ collected by N. Vikhrev; *Diplacodes trivialis* – several ♂♂ seen; *Trithemis pallidinervis* – 1 ♂ photographed.
2. Transitory thickets at Boyen Kayak village. 11°34.5" N, 102°59' E 2 m, 11.12.2010. *Aciagrion borneense* – 1 ♂ seen; *Neurothemis fluctuans* – 2 ♂♂ seen; *Orthetrum sabina* – 1 ind. seen; *Tholymis tillarga* – 1 ♀ seen.
3. Near beach on the Stung Koh-Kong estuary left bank. 11°34'54" N, 102°58'34" E 2 m, 4 & 11.12.2010. *Ischnura senegalensis* – 1 ♂, 1 ♀ collected 4.12, many seen; *A. borneense* – 1 ♀ collected 4.12; *Agriocnemis pygmaea* – 2 ♀♀ collected 4.12; *T. tillarga* – 1 ♂ seen 4.12.
4. 'Cora marsh', at an old cemetery, W of the road to Peam Krasaop just behind it leaves Koh-Kong. 11°35'27" N, 102°58'53" E, 3 m, 4 & 11.12.2010. *A. borneense* – 1 ♂ and released 4.12; *I. senegalensis* – several seen; *D. trivialis* – numerous seen; *Crocothemis servilia* – several seen; *Macrodiplax cora* – 1 ♀ collected 4.12, 1 ♂ collected and 1 ♂ photographed 11.12; *O. sabina* – several seen; *T. tillarga* – 1 ♂ seen 4.12.

#### II. Marshes and mangroves north of Koh-Kong. 11°38'05" N, 102°59'11" E, 4 m, 28.11.2010.

*Lestes concinnus* – 1 ♂ photographed and collected; *A. borneense* – 1 ♂ collected; *Aciagrion pallidum* – 1 ♀ released; *A. pygmaea* – several released; *Ischnura senegalensis* – many released and seen; *C. servilia* – 1 ♂ seen; *Brachythemis contaminata* – 1 ♂ seen, 1 ♀ released; *Diplacodes nebulosa* – numerous seen; *Diplacodes trivialis* – quite many seen; *N. fluctuans* – 1 ♀ seen; *Neurothemis tullia* – several seen; *Tamea transmarina euryale* – 1 ♂ seen.



### III. Anonymous 'Poacher river' at W bank of Stung Koh-Kong. 30.11.2010.

1. At the mouth. 11°38'41-55" N, 103°00'10-58" E, 2-100 m. *Vestalis gracilis* – many released and seen, 1 ♀ photographed; *Neurobasis chinensis* – 1 ♀ seen; *Euphaea masoni* – 1 ♀ collected; *Heliocypha biforata* – 3 immature ♂♂, 1 ♀ collected; *A. borneense* – many released and seen; *Pseudagrion rubriceps* – 1 ♂ seen; *Copera marginipes* – 1 ♀ collected, 1 ♂ released, 1 ♂ seen; *Prodasineura verticalis* sensu Asahina, 1983 – 1 ♂, 1 ♀ collected, 1 ♂ photographed; *C. servilia* – several seen; *D. trivialis* – several seen; *N. fluctuans* – many immature ind. seen; *Neurothemis fulvia* – 2-3 mature ♂♂ seen; *Neurothemis intermedia atalanta* – many immature ind. seen; *N. tullia* – 1 ♂ seen; *O. sabina* – several seen; *T. tillarga* – 2 ♀♀ seen; *Trithemis festiva* – 1 ♂ visually.
2. Uphill. 11°39'00-33" N, 103°01'00-30" E, 100-220 m. *Ceriagrion* sp. (red) – 1 ♂ seen; *Coelliccia kazukoae* – 2 ♀♀ collected; *Copera vittata* – several (1 'ghost form') released and seen.

### IV. Koh Por Waterfalls. 11°43'11"-44'58" N, 103°04'28"-05'09" E, 11-20 m, 01.12.2010.

- A. borneense* – 2 ♂♂ collected; *A. pygmaea* – 3 ♂♂, 2 ♀♀ collected, many seen; *Archibasis viola* – 1 ♂ collected; *Ceriagrion calamineum* – 1 ♂ collected; *I. senegalensis* – 1 ♂ collected, several ind. seen; *Mortonagrion aboreense* – 3 ♂♂, 2 ♀♀ collected, many seen; *P. rubriceps* – 1 ♂ collected, 1 ♂ seen; *C. kazukoae* – 3 ♂♂, 1 immature ♀ collected; *C. vittata* – 1 ♂ seen; *D. trivialis* – 1 ♀ collected, many ind. seen; *N. fluctuans* – many young ind. seen; *N. fulvia* – quite many mature ind. seen; *N. intermedia atalanta* – several immature ind. seen; *Orthetrum chrysis* – 1 ♀ collected, many ♂ seen; *Orthetrum glaucum* – 1 ♂ collected, 2 ♂♂ seen; *O. sabina* – many ind. seen; *Pantala flavescens* – many seen; *T. transmarina euryale* – 1 ind. seen; *Trithemis aurora* – many ♂ seen; *T. festiva* – 2 ♂♂, 1 ♀ seen; *T. pallidinervis* – 1 ♂ seen.

### V. Road towards Pursat

1. Forest 'Femina swamp', Koh-Kong E suburbs. 11°37'11" N, 103°01'25" E, 16 m, 28.11.2010. *A. borneense*, 2 ♂♂, 2 ♀♀ collected, many seen; *A. pallidum* – 2 ♂♂ collected; *Agriocnemis nana* – 1 ♂, 1 ♀ collected; *Agriocnemis femina* – 1 ♀ collected; *A. pygmaea* – 3 ♂♂, 5 ♀♀ collected; *Ceriagrion cerinorubellum* – 1 ♂ released; *D. nebulosa* – 1 ♀ released; *N. intermedia atalanta* – many immature ind. released and seen; *N. fluctuans* – many immature ind. seen, 1 ♀ photographed; *N. tullia* – 1 ♀ seen.



2. Dry sandy 'Lispe veal', 13 km ENE Koh-Kong. 11°39'34" N, 103°05'45" E, 316 m, 28-29.11 and 4.11.2010. *L. concinnus* – 1 ♀ collected 29.11; *C. cerinorubellum* – 1 ♂ collected by N. Vikhrev 3.12; *C. calamineum* – 1 ♂ collected 29.11; *A. pallidum* – 1 ♂ collected 4.12; *P. australasiae* – 1 ♂ seen 29.11; *B. contaminata* – 1 ♂ seen 29.11; *D. nebulosa* – numerous seen; *D. trivialis* – 1 ♂ seen 29.11; *N. intermedia atalanta* – several seen; *O. chrysis* – 1 ♂ seen 29.11; *O. sabina* – 1 ♂ seen 29.11; *P. flavescens* – several seen; *T. pallidinervis* – 1 ♂ seen 29.11; *Rhyothemis* sp. (*phyllis* or *variegata*) – 1 ind seen 04.12.
3. Forest 'Aciagrion rivulet' source, 13 km ENE Koh-Kong. 11°39'35" N, 103°05'44" E, 316 m, 28-29.11 and 04.12.2010. *A. borneense* – 6 ♂♂ collected, 1 tandem photographed 29.11, several seen; *Aciagrion* sp. – 2 teneral ♂♂, 2 teneral ♀♀ collected 28.11, numerous teneral ind. seen; *C. calamineum* – 1 ♂ photographed, 1 ♀ (the same species?) photographed and collected 29.11; *P. australasiae* – 1 ♂ collected 28.11, several ♂♂ seen; *D. nebulosa* – many seen; *Nannophya pygmaea* – 2 ♂♂ seen 29.11; *N. intermedia atalanta* – 1 mature ♂ collected 28.11, several mature ♂ and a copula seen 4.12; *N. tullia* – 1 ♂ seen, 1 ♀ photographed 29.11.
4. 'Hemicordulia brook', 13 km ENE Koh-Kong. 11°39'55" N, 103°05'34" E, 315 m, 04.12.2010. *V. gracilis* – 1 ♂, 1 ♀ collected, numerous seen; *E. masoni* – 1 ♀ collected; *A. pallidum* – 1 ♂ collected; *A. pygmaea* – 1 ♂, 1 ♀ collected; *A. viola* – 1 ♀ collected; *P. australasiae* – 1 ♂ photographed, several ♂ seen; *P. rubriceps* – 2 ♂♂; *Pseudagrion williamsoni* – 1 ♂ photographed, many ♂ seen; Aeshnidae gen sp. – 1 ind. seen; *Hemicordulia* sp. – 3 ♂♂ collected; *Acisoma panorpoides* – 1 ♂ seen; *D. nebulosa* – several ♂♂ seen; *N. pygmaea* – 1 ♂, 1 ♀ photographed, several ♂♂ seen; *N. fluctuans* – several ♂♂ seen; *N. fulvia* – 1 ♂ seen; *O. sabina* – 1 ind. seen; *N. tullia* – 1 ♂ seen; *T. aurora* – several ♂♂ seen; *T.s festiva* – 1 ♂; *Rhyothemis* sp. (*phyllis* or *variegata*) – 1 ind. seen.
- 5 'Archibasis brook', 14.5 km ENE Koh-Kong. 11°39'19" N, 103°06'47" E, 344 m, 04.12.2010. *V. gracilis* – several ind. seen; *A. viola* – 1 ♂ photographed; *P. australasiae* – 1 copula photographed, several ♂♂ seen; *P. rubriceps* – 1 ♂ seen; *D. nebulosa* – several ♂; *D. trivialis* – 1 ♂; *T. aurora* – several ♂ seen; *O. chrysis* – 1 ♂, 1 ♀ seen.
6. 'Glaucum brook', 15 km ENE Koh-Kong. 11°39'51" N, 103°07'09" E, 317 m, 28.11.2010. *L. concinnus* – 1 ♀ collected; *A. borneense* – several ind. seen; *C. vittata* – 1 ♂ collected; *D. nebulosa* – several ind. seen; *D. trivialis* – 1 ♂ seen; *N. intermedia atalanta* – many immature ind. seen; *N. tullia* – 1 ♀; *O. glaucum* – 1 ♂ collected, 1 ♂, 1 ♀ photographed; *P. flavescens* – 1 tandem released.



7. 'Nannophya rivulet', 16 km ENE Koh-Kong. 11°40'14-22" N, 103°07'32-38" E, 296 m, 28.11 and 04.12.2010. *V. gracilis* – several seen; *A. borneense* – 1 ♂ collected 28.11, several seen; *P. australasiae* – 2 ♂♂, 1 ♀ collected 28.11, several seen; *Pseudagrion pruinosum* – 1 ♂ collected 28.11; *P. rubriceps* – 1 ♂, 1 ♀ photographed, 1 ♂ released 28.11; *P. williamsoni* – 1 ♂ collected, 1 ♂ seen 28.11, 1 copula photographed 04.12.2010; *C. vittata* – 1 'ghost' individual seen 28.11; *B. contaminata* – 1 ♂ seen 28.11; *D. nebulosa* – several ind. seen; *N. pygmaea* – 2 ♂♂ collected, 3 ♂♂ photographed, 28.11, many seen; *N. fluctuans* – many seen, 1 immature ♂ photographed; *N. tullia* – 1 ♀ seen 28.11; *O. chrysis* – 1 ♂ seen; *T. aurora* – 2 ♂♂ seen 28.11.
8. 'Nepenthes brook', 22.5 km ENE Koh-Kong. 11°41'43" N, 103°10'21" E, 286 m, 29.11.2010. *V. gracilis* – 1 ♂ collected, 3 ind. seen; *E. masoni* – 1 ♂ collected, 1 ♂ seen; *H. biforata* – 1 immature ♂ collected; *Heliocypha perforata* – 1 ♀ collected; *A. borneense* – 1 ♂ collected, 1 ♂, 2 ♀♀ seen; *A. viola* – 1 ♀ collected, 1 ♀ photographed; *P. australasiae* – 1 ♂ released; *P. pruinosum* – 1 ♂ collected, 1 ♂ photographed; *P. rubriceps* – 1 ♂ seen; *P. williamsoni* – 1 ♂ seen; *P. verticalis* sensu Asahina, 1983 – 1 ♂, 1 ♀ collected; *D. nebulosa* – 2 ♀♀ seen; *D. trivialis* – 1 ♂ seen; *N. pygmaea* – 2 ♂♂ seen; *O. glaucum* – 1 ♂ seen; *P. flavescens* – 1 ♂ seen; *T. aurora* – 1 ♂ seen.
9. 'Capricornis rivulet', 25.5 km ENE Koh-Kong. 11°42'31" N, 103°11'55" E, 306 m, 29.11.2010. *V. gracilis* – 1 ♀ collected; *N. chinensis* – 1 ♂ collected, 1 ♂ photographed, several m and ♀ seen; *E. masoni* – 2 ♂♂ seen; *H. perforata limbata* – 1 ♂ collected, 1 ♂ photographed, several seen; *A. borneense* – several ind. seen; *A. nana* – 1 ♀ collected; *A. pygmaea* – 2 ♂♂, 2 ♀♀ collected; *Prodasineura autumnalis* – 1 ♂ seen; *Paragomphus capricornis* – 1 ♂ collected; *B. contaminata* – 1 ♂ seen; *D. trivialis* – several ♂♂ seen; *N. fluctuans* – 1 immature ♂ seen; *N. fulvia* – 1 mature ♂ seen; *N. intermedia atalanta* – many immature ind. seen; *O. chrysis* – several ♂♂ seen; *P. flavescens* – several ind. seen; *T. aurora* – 1 ♂ seen; *T. festiva* – 1 ♀ collected, 1 ♂ photographed, several ♂ seen; *Zygonyx iris malayana* – 1 ♂ collected.

## VI. Tatai Waterfall and surroundings. 02.12.2010.

1. Tatai Waterfall. 11°35'13" N, 103°05'45" E, 18-26 m. *V. gracilis* – 2 ♂♂, 2 ♀♀ collected; *E. masoni* – 1 ♂ collected; *H. perforata limbata* – 1 ♂ (remnants) collected; *A. borneense* – 1 ♂ seen; *A. pallidum* – 1 ♂ collected; *A. pygmaea* – 1 ♂ collected, several seen; *I. senegalensis* – 1 ♂ seen; *P. australasiae* – 1 ♂ seen; *P. rubriceps* – many seen; *P. williamsoni* – many seen; *P. autumnalis* – 1 ♂ collected, 4 ♂♂, 1 ♀ seen; *D. trivialis* – several seen; *N. fluctuans* – several seen; *N. fulvia* – several seen; *N. intermedia atalanta* – several immature ind. seen; *O. chrysis* –





many ♂♂ seen; *O. glaucum* – several seen; *O. sabina* – several seen; *P. flavescens* – several seen, 1 ♂ photographed; *T. aurora* – many ♂♂ seen; *T. festiva* – 1 ♂ seen; *Z. iris malayana* – 1 ♂ seen.

2. 'Masoni brook', 1.2 km S Tatai Waterfall ('1<sup>st</sup> brook' in Kosterin 2010: 22-23). 11°34'39" N, 103°05'51" E, 68-70 m. *V. gracilis* – 1 ind. seen; *H. biforata* – 1 ♂ collected, 1 ♂ photographed; *A. borneense* – 1 ♀ released; *P. pruinosum* – 1 ♂ collected; *C. vittata* – 3 ind. seen; *P. verticalis* sensu Asahina, 1983 – 1 tandem photographed; *D. trivialis* – 1 ♂ seen; *T. aurora* – 1 ♂ seen; *T. festiva* – 1 ♂ seen; *N. intermedia atalanta* – 3 ind. seen.
3. 'Rhinagrion brook', 0.8 km S Tatai Waterfall ('2<sup>nd</sup> brook' in Kosterin 2010: 23-24). 11°34'52" N, 103°05'37" E, 80 m. *V. gracilis* – 3 ♂♂, 2 ♀♀ seen; *H. biforata* – 1 ♂, 1 ♀ collected; *H. perforata limbata* – 1 ♀ collected; *Rhinagrion viridatum* – 1 ♂ seen; *A. viola* – 1 ♂ collected, 1 ♀ seen; *P. australasiae* – 1 ♂ collected; *P. pruinosum* – 1 ♂ collected; *C. kazukoe* – 3 ♂♂ collected; *C. vittata* – 6 ♂♂, 2 ♀♀, released and seen; *P. verticalis* sensu Asahina, 1983 – 1 ♂, 1 collected, 1 ♂ seen; *D. trivialis* – 1 ♂ seen; *N. fluctuans* – 1 ♀ seen; *T. aurora* – 1 ♂ seen;

**VII. 'Oculata brook' at Phnom Doung bridge (dry torrent at Tatai River right bank' in Kosterin 2010: 27-30). 11°33'46-50" N, 103°07'23-30" E, 30-100 m, 03.12.2010.**

1. The stony brook valley. *Mortonagrion falcatum* – 1 immature ♂ collected; *C. vittata* – 2 mature ♂♂, 1 immature ♀ seen; *N. intermedia atalanta* – several immature ind. seen.
2. Andy's pond on the floodplain where the brook falls. *A. borneense* – 3 ♂♂ collected; *A. pygmaea* – 1 ♂ collected; *N. fluctuans* – numerous seen, incl. teneral, 2 ♀♀ photographed; *T. aurora* – 1 ♂ seen.

**VIII. Thma Bang environs. 03.12.2010.**

1. 'Microgomphus River' 6.5 km SW Thma Bang village (=Thma Bang River left tributary' in Kosterin 2010. 33-35; 12-14 hr). 11°38'42-47" N, 103°23'43-51" E, 343-346 m. *V. gracilis* – 2-3 ind. seen; *N. chinensis* – 1 ♀ collected, 1 ♀ photographed, numerous ♂♂ and ♀ seen; *E. masoni* – 1 ♂ collected, several seen; *H. biforata* – 1 ♂, 2 ♀♀ collected, many seen; *H. perforata limbata* – 2 ♂♂, 1 ♀♀ collected, many seen; *R. viridatum* – 2 ♂♂ collected, 2 ♂♂ seen; *P. australasiae* – 1 ♂ collected, several seen; *P. pruinosum* – 1 ♂ collected, 1 ♂ photographed, 2 ♂♂ seen; *P. rubriceps* – many seen; *P. williamsoni* – numerous seen; *Copera ciliata* – 1 ♂, 1 tandem seen; *C. marginipes* – 1 ♂, 1 tandem seen; *P. autumnalis* – 2 ♂♂ (1 immature) collected, many seen; *Macromia* sp. – 1 larva collected; *N.*



*intermedia atalanta* – several immature ind. seen; *N. fluctuans* – several ♂♂ and ♀♀ seen; *O. chrysis* – several ♂♂ seen; *O. sabina* – 1 ind. seen; *T. aurora* – 1 ♀ collected; *T. festiva* – several ♂♂ seen.

2. Thma Bang River, from the waterfall 7 km SW Thma Bang village to 5 km SW it. 11°39'31-40" N, 103°23'46"-24'14" E, 337-366 m. *N. chinensis* – 1 ♂, 1 ♀ seen; *V. gracilis* – numerous seen; *E. masoni* – 1 ♂ collected, 1 ♂ seen; *H. perforata* – 1 ♂ seen; *R. viridatum* – 1 ♂ photographed, 1 ♂ seen; *P. australasiae* – 1 ♂ seen; *P. williamsoni* – several ♂♂ seen; *P. pruinosum* – 1 ♂ seen; *P. autumnalis* – several ♂♂ seen; *N. intermedia atalanta* – numerous immature ind. seen; *N. fluctuans* – numerous seen; *O. chrysis* – several ♂♂ seen.

## Kampot Province

### IX. Phnom Bokor

1. Jungle path. ?ca 10°36'23"-36'06" N, 104°05'11-18" E, 1030-1037 m, 08 and 10.12.2010. *Lestes elatus* – 1 ♂, 1 ♀ photographed, several ind. seen; *A. borneense* – several seen; *Ceriagrion olivaceum* – immense numbers of ♂♂ and ♀♀ seen; *Gynacantha* sp. – 1 ind. seen 8.12; *D. trivialis* – 1 seen 8.12, *N. intermedia atalanta* – several seen.
2. Bokor Hill Station. 10°37'19-55" N, 104°01'18-38" E, 1030-1037 m, 08-09.12,2010; *Heliocypha* or *Aristocypha* sp. – 1 ♀ collected and missed; *L. concinnus* – 2 ♂♂, 2 ♀♀ collected, 1 ♀ photographed 08.12; *A. borneense* – many seen; *Aciagrion tillyardi* – 1 teneral ♂ collected at a *Sphagnum* ground hole 08.12; *A. pygmaea* – 5 ♂♂, 2 ♀♀ collected at the pond 09.12; *C. olivaceum* – 4 ♂♂, 3 ♀♀ collected 08.12; immense seen; *D. trivialis* – many seen; *I. senegalensis* – 1 ♂, 3 ♀♀ collected at the pond 09.12, several seen at dammed brooks 08.12; *N. intermedia atalanta* – 1 ♀ collected 08.12, 1 immature ♂ photographed 07.12, numerous seen; *Orthetrum pruinosum neglectum* – 1 ♂ seen at the brook 08.12; *O. sabina* – several seen; *P. flavescens* – 1 dead ind. seen 08.12; *Potamarcha congener* – numerous seen; *T. tillarga* – numerous ♀ seen.
3. 'Praemorsus pond', 2.9 km NE Bokor Palace. 10°38'44" N, 104°02'21' E, 926 m, 09-10.12.2010. *Lestes praemorsus decipiens* – 1 ♂ collected, 1 ♂ photographed 09.12; *A. borneense* – 6 ♂♂, 3 ♀♀ collected 09.12; 1 ♂ collected 10.12, many seen; *A. tillyardi* – 10 ♂♂, 1 ♀ collected, 1 ♂, 2 copulae photographed 09.12, 8 ♂♂, 1 ♀ collected 10.12, many seen; *A. pygmaea* – 1 ♀ collected 09.12, many seen; *C. olivaceum* – numerous seen; *I. senegalensis* – 1 copula photographed 09.12; *P. australasiae* – 1 ♂ seen; *C. vittata* – 1 ♀ collected at the brook under coppice 09.12; *O. chrysis* – 1 ♂ seen at the roadside brook; *O. glaucum* – 1 ♂



collected and 1 ♂ photographed at the brook 10.12; *T. tillarga* – 1 ♀ collected 09.12, several seen; ? *Hemicordulia* sp. – 1 ind. seen.

4a. Huge *Sphagnum* 'Bokorensis mire', 3-3.7 km NE Bokor Palace. 10°38'47"-39'12" N, 104°02'16"-02'35" E, 920 m, 09-10.12.2010. *L. concinnus* – 2 ♂♂, 1 ♀ collected 09.12, 1 ♀ photographed 10.12, 7 more individuals seen on both days; *A. viola* – 1 immature ♂ collected 09.12; *C. cerinorubellum* – 3 teneral ♂♂ collected 09.12, 1 teneral ♂ photographed, 1 teneral ♂ released on 10.12; *C. calamineum* - 1 ♂ collected 09.12; *C. olivaceum* – many ♂♂ and ♀♀ seen; *D. trivialis* – several seen; *D. nebulosa* – 1 ♀ seen 09.12.

4b. Deeper roadside pools at the mire. 09.12.2010. *A. borneense* – several ♂ seen; *A. pygmaea* – several seen; *I. senegalensis* – several seen; *P. australasiae* – 1 ♂ released; *Brachythemis contaminata* – 2 ♂♂, 1 ♀ seen; *D. nebulosa* – 1 ♂ seen; *O. sabina* – several seen.

5. 'Limkata ponds' 3.7 km NE Bokor Palace. 10°39'04-06" N, 104°02'35-39" E, 920 m, 10.12.2010.

5a. The deeper lower pond. *L. p. decipiens* – 2 ♂♂ (1 teneral) collected, 1 of them photographed; *A. tillyardi* – several seen; *C. calamineum* – 1 ♂ photographed; *I. senegalensis* – many seen; *P. australasiae* – 2 ♂♂, 1 ♀ collected, many seen; *B. contaminata* – 1 m, 1 ♀ seen; *C. servilia* – 1 m seen; *D. nebulosa* – several seen; *D. trivialis* – many seen; *Indothemis limbata* – 2 ♂♂, 1 ♀ collected, 2 ♂♂, 2 ♀♀ photographed, about 5 more ♂♂ seen; *N. pygmaea* – 1 ♂ collected; *O. sabina* – several seen; *T. aurora* – 1 ♂ photographed, several ♂ seen; *T. pallidinervis* – 1 ♂ photographed and collected, 3 ♂♂ seen; Libellulidae gen. sp. (?*Macrodiplax cora*) – 1 ind. seen.

5b. The shallower upper pond. *L. p. decipiens* – 2 teneral ♂♂ released; *C. calamineum* – 2 ♂♂ collected; *P. australasiae* – several ♂♂; *B. contaminata* – many ♂♂ and ♀; *T. aurora* – 1 immature ♂ seen.

6a. Popokvil River, the bridge, 3.9 km NE Bokor Palace. 10°39'06" N, 104°02'43" E, 920 m, 9-10.12.2010. *P. australasiae* – 1 ♂ seen 9.12; *B. contaminata* – 1 ♂ photographed 9.12; *O. chrysis* – 1 ♂, 1 ♀ photographed, several ♂ seen; *O. p. neglectum* – 1 ♂ photographed 9.12, 1 ♂ collected 10.12, 1 ♀ seen; *P. flavescens* – several seen; *T. transmarina euryale* – 1 ind. seen 9.12; *T. festiva* – 1 ♂ collected 9.12, several seen.

6b. Popokvil River at the waterfalls, 4.9 km NE Bokor Palace. 10°39'32-34" N, 104°03'04" E, 912-918 m, 09.12.2010. *V. gracilis* – 1 ♂, 1 ♀ collected, many seen



on a shaded arm; *Aristocypha fenestrella* – 3 ♂♂ collected, 1 ♂ photographed, several seen; *E. masoni* – 1 aberrant ♂ collected; *H. biforata* – 1 ♂ collected; *A. tillyardi* – several ♂♂ seen on a shaded arm; *C. vittata* – 1 ‘ghost’ ind. seen; *A. pygmaea* – 1 ♀ collected; *P. flavescens* – several seen; *O. chrysis* – 1 ♂ seen.

## Kep Province

### X. Kep surroundings

1. Tree Top Bungalow. 10°29'37" N, 104°17'45" E, 51 m, 05-07.12.2010. *A. borneense* – 1 immature ♂ collected 05.12, several seen; *A. pallidum* – 1 ♀ collected 05.12, several ind. seen; *A. pygmaea* – 4 ♂♂, 5 ♀♀ (1 immature) collected 05.12, immense seen; *C. olivaceum* – 4 ♂♂, 1 ♀ collected, 1 ♂, 3 ♀♀ photographed 05.12, immense seen; *I. senegalensis* – 2 ♂♂ collected 05.12, many seen; *L. concinnus* – 1 ♂ collected and photographed 05.12; *L. elatus* – 1 ♂, 1 ♀ collected, 1 ♀ photographed 06.12; *Anax ?guttatus* – 1 ♀ collected on 07.12 but missed; *A. panorpoides* – 1 ♂ photographed; *D. trivialis* – 1 ♂, 1 ♀ photographed 05.12, 1 ♂ photographed 06.12, immense numbers seen; *Lathrecista asiatica* – 1 immature ♂, 1 ♀ collected, 1 immature ♂ photographed 06.12, several seen at trees; *N. intermedia atalanta* – 1 immature ♂ collected 05.12, several ind. seen; *P. flavescens* – 1 ♀ collected 05.12, numerous seen; *P. congener* – 1 ♂, 2 ♀♀ collected, 1 ♂, 1 ♀ photographed 05.12, immense numbers seen, all immature; *T. transmarina euryale* – 3 ♀♀ photographed, 2 ♀♀ collected 05.12, immense numbers seen, all immature.
2. Lowland ‘Ludwigia pond’. 10°29'10" N, 104°17'36" E, 27 m, 06-07.12.2010. *Ceriagrion ?indochinense* – 1 ♂ photographed, 2 ♂♂ seen 06.12; *C. olivaceum* – 1 ♂ seen 06.12; *I. senegalensis* – many seen; *A. panorpoides* – several seen; *Brachydiplax c. chalybea* – 1 ♂ seen 06.12; *Brachydiplax farinosa* – 1 ♂ photographed, 1 ♂ seen 06.12; *D. nebulosa* – 1 ♂ seen 07.12; *D. trivialis* – many seen; *N. tullia* – many ♂♂ and ♀♀ seen; *P. flavescens* – immense numbers seen.
- 3a. Kep Hill, ‘Zyxomma pond’. 10°29'25" N, 104°18'13" E, 91 m, 06-07.12.2010. *I. senegalensis* – several seen; *C. marginipes* – a tandem seen 06.12; *D. trivialis* – numerous seen; *N. tullia* – 1 ♂, 1 ♀ seen 06.12; *P. congener* – numerous immature ind. seen; *O. sabina* – numerous seen; *Rhodothemis rufa* – 1 ♂ photographed 06.12, 1 ♀ photographed 07.12; *Rhyothemis variegata* – 1 ♀ (intermediate between androchromic and gynochromic) collected 06.12; *T. transmarina euryale* – 1 ♀ collected 06.12, numerous immature seen.
- 3b. Polls at the ‘Platystilus brook’ near the road. 10°29'25" N, 104°18'09" E, 90 m, 06-07.12.2010. *Pseudagrion microcephalum* – 1 ♂ collected, 1 ♂ seen 06.12; *C.*



*servilia* – 1 ♂, 1 ♀ seen 06.12; *B. chalybea* – several seen; *N. tullia* – 1 ♀ photographed, several seen.

Note: a specimen collected here on 21.04.2010 and reported as *P. australasiae* (Kosterin 2010: 57) was in fact *P. microcephalum*; that collected on 22.04.2010 at 'Zyxomma pond' (Kosterin 2010: 56) was *P. australasiae* indeed."

3c. Kep Hill, 'Platistylus brook'. 10°29'25" N, 104°18'09-13" E, 90-110 m, 06-07.12.2010. *V. gracilis* – 1 ind. seen; *Lestes platystylus* – 3 ♂♂ collected, 1 ♂ seen, of them 2 photographed 06.12, 1 ♂ photographed, 4 ♂♂ seen 07.12; *A. borneense* – many, mostly ♀♀, seen; *A. pallidum* – 1 ♂ collected 06.12; *Argiocnemis rubescens rubeola* – 1 ♂, 1 ♀ (still with red on abdomen) collected 06.12; *C. olivaceum* – many seen; *P. microcephalum* – 1 ♀ collected 06.12; *C. marginipes* – 1 ♂ seen 07.12; *C. vittata* – 1 ♂ collected; *Gynacantha subinterrupta* – 1 ♀ photographed and collected but missed, 1 ♀ seen 06.12, 1 ♀ seen 07.12; *D. trivialis* – many seen; *L. asiatica* – 1 ♂ photographed, several seen; *N. fulvia* – 1 ♀ photographed, several ♂ and ♀ seen; *N. intermedia atalanta* – many immature ind. seen; *P. flavescens* – numerous seen; *T. tillarga* – 1 ♀ photographed, several ♀ seen; *T. ransmarina euryale* – many immature seen.

3d. Several smaller brooks, including that with a reservoir at Kep National Park margin, ca 2.5 km N of Kep centre. 10°29'31" N, 104°17'50" E, 88 m, 06.12.2010. *A. pygmaea* – several released and seen (the only species at the reservoir); *V. gracilis* – several seen; *G. subinterrupta* – 2 ♀♀ photographed.

3e. The forest road around Kep hill between 3a-c and 3d, 05-07.12.2010. *V. gracilis* – several seen; *L. elatus* – 1 ♂, 2 ♀♀ photographed; *P. flavescens* – several seen; *T. tillarga* – several seen, *T. t. euryale* – many seen.

4. Abandoned salt fields. 10°29'38" N, 104°19'57" E, 1 m, 07.12.2010. *I. senegalensis* – many seen; *B. contaminata* – 1 ♂ seen; *C. servilia* – 2 ♀♀ photographed, several seen; *D. trivialis* – many seen; *O. sabina* – 1 ♂ photographed, many seen; *P. flavescens* – 1 ind. seen; *T. pallidinervis* – 1 ♀ photographed, several ind. seen.

## Notes on specimens and their taxonomy

The photos or specimen details were prepared from serial photographs obtained via lens Zeiss Stemi 2000-C using the software Helicon Focus 5.1 (<http://www.photosoft.ru/heliconfocus.html>).



### 1. Wingtip darkening in *Vestalis gracilis*

In April, all either seen or collected individuals of *Vestalis gracilis* without exception had more or less enfumed wingtips throughout the area studied (Kosterin 2010). Not less invariably, all individuals observed or captured during this November/December trip had clear wingtips, only some individuals at the Popokvil River shaded arm had a slight intensification of the costal yellowing at the wingtips. This species exhibit no noticeable seasonality, so a supposition that all they were young can be ruled out. Moreover, at the 'Capricornis rivulet' an obviously old female was collected, with worn out wing margins and some white pruinescence present at the ventral side of the body, from the labium to the abdomen tip, were slight pruinescence extended to sides of the last three abdominal segments; yet this female had clear wingtips. I suppose that the wingtip darkening is a manifestation of neither geographical variation, as supposed earlier (Kosterin 2010), nor ageing but of the season of larval development (or its critical stages). Individuals met with in April should most probably have developed during dry season while those observed this time - in rainy season, most probably at lower temperatures. So the wingtip darkening in *V. gracilis* is likely an environmental modification and surely has no taxonomical value.

### 2. Wing coloration of females of *Neurobasis chinensis*

Of many females of *Neurobasis chinensis* observed on the 'Microgomphus River', the Thma Bang River left tributary, some had and some had not a noticeable darkening of the hind wing between the nodus and pseudostigma: a feature often observed in continental populations (Orr & Hämäläinen 2007).

### 3. *Euphaea masoni*

Four males of *Euphaea masoni* were collected and they shared similar morphological features with two more males collected in April. They have their hind wings 26-27 mm long, with the transparent tip 1-2.5 mm long (that is 4-9% of the wing length) and the fore wing base hyaline for 11-12 mm (39-44% of the wing length). According to Asahina (1985b; 1977), the length of the hind wings corresponds to ssp. *inouei* Asahina, 1977, the relative length of its hyaline apex corresponds to *E. m. masoni*. The relative length of the fore wing basal hyaline part in newly collected specimens is even bigger than stated for ssp. *inouei*. Although measuring method could differ from that used by Asahina (1977, 1985b) and the data provided here are very scarce, they are in favour of the proposition by Hämäläinen & Pinratana (1999) to cancel the subspecies within *E. masoni*.

The male from beneath the Popokvil waterfalls was collected (on 09.12.2010) young, with still glittering wings which missed pigmentation beyond some slight and rather uneven enfuming. This male lived in captivity for five days, its wings became fully harden but did not gain in colour. However, two teneral males collected by me on



23.08.2011 at the 'Microgomphus River' and kept in captivity acquired a vague dark coloration allowing to see the wingspot limits within 4-5 hours. Thus I conclude the lack of the wing coloration in the Popokvil male was a matter of aberration rather than age. Matti Hämäläinen kindly informed me that the 'smoky winged' males occur throughout the range of *E. masoni*. Since the male discussed was the first *Euphaea* individual reported for the entire Elephant Mts., I retained some doubts in attributing it to *E. masoni* until next year, on 19.08.2011, I collected a normally coloured male and a female from the Popokvil River just upstream the waterfall. The Popokvil males are somewhat larger (hind wing 29.5 mm in the discoloured 09.12.2010 specimen, 30.5 mm in 19.09.2011 specimen; abdomen 34.5 mm in the former, 35.5 mm in the latter) than those of *E. masoni* from Koh-Kong Province (hind wing 25.5-27.5 mm, abdomen 32.5-33.5 mm) (Fig. 69). Nevertheless, examination of the secondary genitalia (Fig. 70) did not show differences (beyond the colour and position of the ligula which are irrelevant for identification, the colour most probably darkening with age). Noteworthy, this male and three males of *E. masoni* from Koh Kong Province have one pair of strong setae on the penis shaft (Fig. 70), while the setae were missed in one male from Koh Kong Province; not two pairs of setae as Asahina (1985b) reported for *E. masoni*.

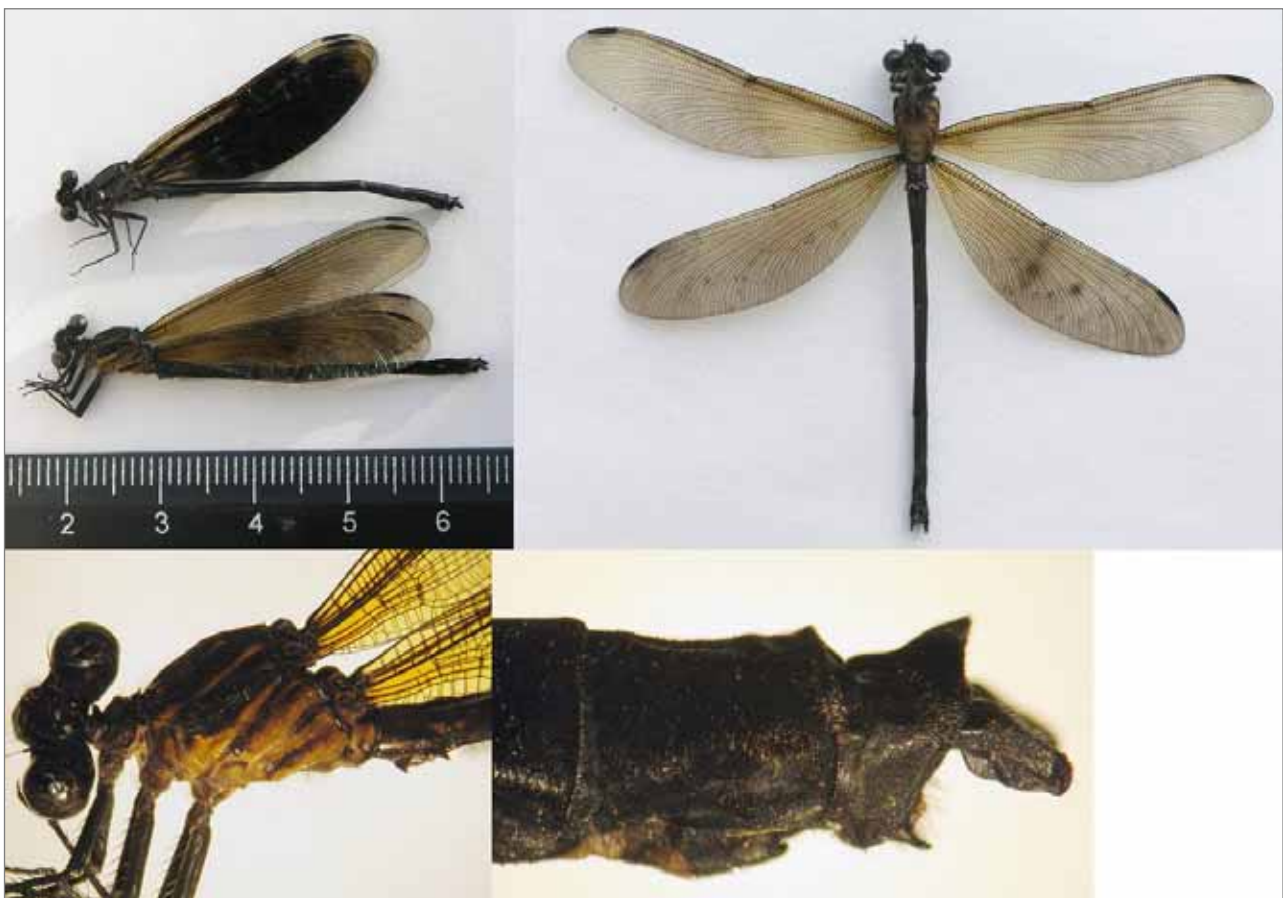


Figure 69. Details of a male *Euphaea masoni* with discoloured wings, collected on the Popokvil River under the waterfalls on 09.12.2010. In a top left corner a normal male of *E. masoni* from Tatai Waterfall, 02.12.2010 is shown for comparison.



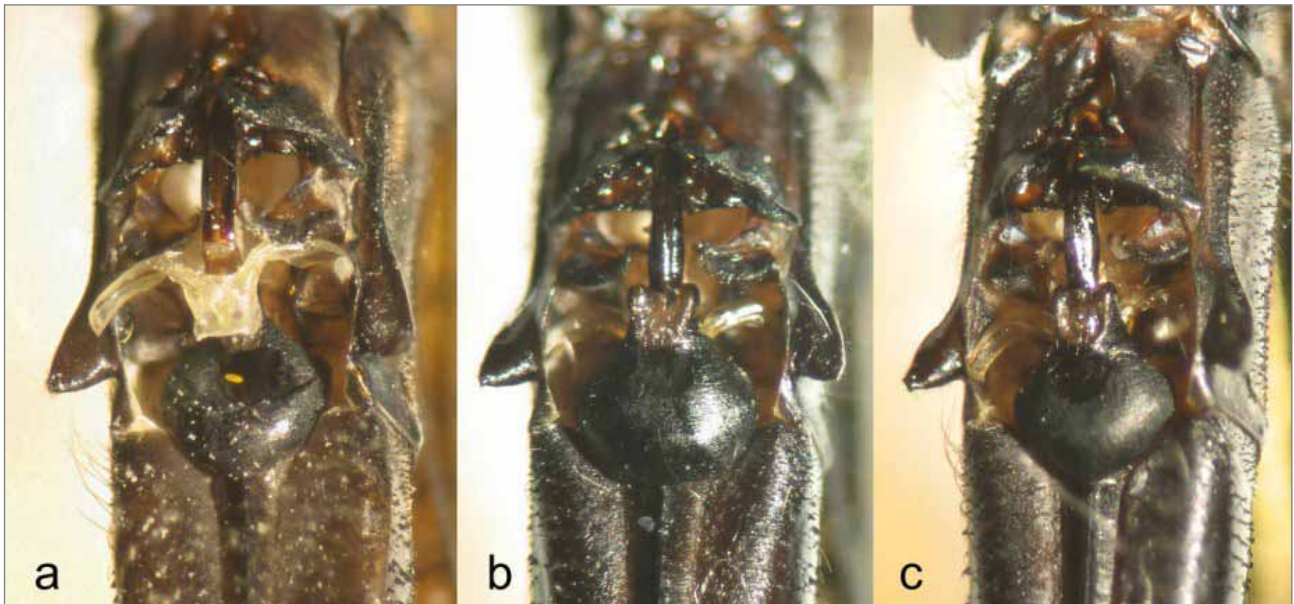


Figure 70. Secondary genitalia of males of *Euphaea masoni*: a, Tatai Waterfall, 02.12.2010; b, 'Microgomphus River, 03.12.2010; c, the Popokvol River, 09.12.2010, see Fig. 68.

#### 4. Coloration pattern of *Heliocypha* females

The coloration pattern of *Heliocypha* females varies between specimens and the light pattern shrinks with age (e. g. labrum may become entirely black). Asahina (1985a) depicted the head and thorax patterns for *H. biforata* and *H. perforata limbata* but did not indicate which differences could be diagnostic. The only diagnostic character allowing to distinguish these females that I found published was provided by Phan et al. (2011). The authors describe the light humeral stripe on the metepisternum being hooked at its base in *H. biforata* and not hooked in *H. perforata perforata* (Percheron, 1835). My female specimens, although not many, fall into two distinct classes:

Class A (Fig. 71 a, b). This humeral stripe on the metepisternum is strongly hooked at its fore end and not inflated at its hind end, when reduced leaving none or a tiny remnant in front of the fore wing base. The mesothoracic triangle is slightly shorter than in the next class. On the poststernum, the light spots of the fore pair are much broader and extend inwards almost to meet each other. Four such females were collected.

Class B (Fig. 71 c, d). The humeral stripe is only slightly hooked at its fore end and is inflated at its hind end. When the stripe is frequently reduced then this inflation leaves as a remnant a considerable broad light spot in front of the fore wing base (indicated by white arrowheads on Fig. 71). The mesothoracic triangle slightly longer than in the previous class. On the poststernum, the light spots of the hind pair are somewhat broader than those of the fore part. Three such females collected.





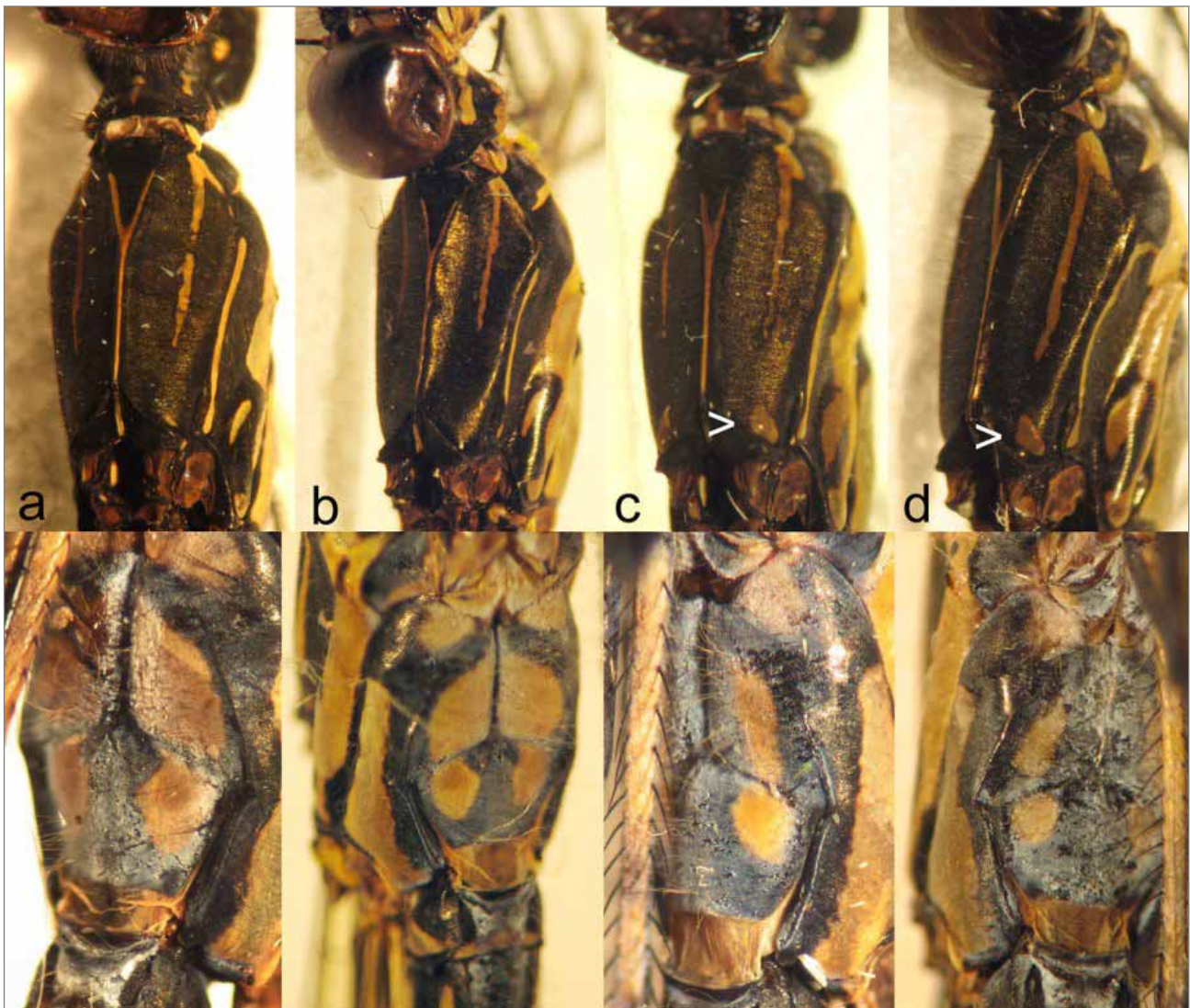


Figure 71. Female thoracic pattern (metepisternum, top; poststernum, bottom) of *Heliocypha biforata* ('Class A') (a, 'Microgomphus River', 03.12.2010; b, 'Masoni brook', 02.12.2010) and *H. perforata limbata* ('Class B') (c, 'Microgomphus River', 03.12.2010; d, 'Masoni brook', 02.12.2010). White arrowheads indicate at the spot supposed to be diagnostic.

Of the characters mentioned, the presence/absence of large spots in front of the fore wing base and the relative breadth of the poststernum spots were distinct and correlated with each other at least among the seven females collected, so it was tempting to conclude that they represent two species. Class A no doubt represented *H. biforata*. Basing on rather indirect information available from different sources, e. g. Figs 19 and 23 in Asahina (1985a) and photographs in [www.asia-dragonfly.net](http://www.asia-dragonfly.net) taken together with males, I supposed that Class B had to be *H. perforata limbata* (provided I collected in Koh-Kong Province in total comparable numbers of males of both species and so expected comparable numbers of their females as well). However, the poststernum character did not match Asahina's (1985a) figures 20 and 25.

Additional data collected by me in August 2011 appeared decisive for attribution of class B to *H. perforata limbata*, with some reservation as to the poststernum spots,



so they worth to be presented already here:

- On 23.08.2011 at the 'Microgomphus River' I observed numerous males of *H. perforata limbata* and no males of *H. biforata* (both presented on 03.12.2010) and collected nine *Heliocypha* females. All they appeared to belong to Class B; in two of them all the poststernum spots were reduced in size but those of the hind pair were still broader.
- On 16.08.2011 at the 'Nannophya Rivulet', to the contrary, I observed numerous males of *H. biforata* and no males *H. perforata limbata* (neither seen in November/December 2010), collected eight *Heliocypha* females and found all them to belong to Class A, as expected.
- On 26.08.2010 at the 'Oculata brook', which that time had a considerable amount of water, I as well observed numerous males of *H. biforata* and no males *H. perforata limbata* (neither seen in April and December 2010 when the brook was waterless and very weak, respectively) and collected 14 *Heliocypha* females. None of them had light spots in front of the fore wing bases, as expected. Six of them had the spots of the fore pair on the poststernum very broad, as expected. However, in eight other females, the poststernum spots of both pairs were reduced in size, so that in one female the spots of both pairs were equal in breadth, in six females the fore spots were narrower than the hind spots, contrary to the expectation, and in one female the fore spots disappeared at all. In these eight females which did not fit class A as to the poststernum spots, the humeral stripe on the metepisternum was strongly or completely reduced and they generally looked overmelanised and no doubt were aged.

Hence, the characters differentiating classes A and B, that is *H. biforata* and *H. perforata limbata*, especially the absence/presence of a broad light spots or the humeral stripe broadenings in front of the fore wing bases, work well for young females but the poststernum spots do not work for old ones. Besides, these characters could be of a local importance for the area studied.

The males of *H. perforata* demonstrate the characters of ssp. *limbata* as mentioned by Fraser (1934): the translucent rim at the hind wing goes around the wing apex to pt, the costal dark coloration starts at postnodal 1-3 (at the node as to Fraser) on the fore wing and at postnodal 1-2 on the hind wing.

##### **5. *Rhinagrion viridatum* Fraser, 1938**

Recently Kalkman & Villanueva (2011) restored *Rhinagrion viridatum* Fraser, 1938 to a full species differing from *Rhinagrion mima* (Karsch, 1891) by a substantially more



contrasted abdomen coloration with distinct blueish spots on S2-5. No structural differences were found. The range of the latter appeared disjunctive: NW Thailand and Peninsular Malaysia, the two isolates being separated by a solid range of *R. viridatum* occupying Indochina from Central-West Thailand to S Vietnam, a pattern not looking justified biogeographically. I may however note that such colourational differences alone, although substantial, may be due to just a single gene encoded dimorphism within the same species, so the specific status of these taxa is still to prove. Anyway, my specimens fit *R. viridatum* well.

### 6. *Agriocnemis nana*

The male of *Agriocnemis nana* has the pattern of S8 as a pointed black mark at the tergite base, which corresponds to the description of *Agriocnemis naja* Fraser, 1923 (see Fraser, 1933), which was later synonymized with *A. nana* (Kimmins, 1966). This pattern seems to prevail in Thailand and Indochina (Kosterin & Vihrev 2009).

### 7. *Aciagrion tillyardi*

*Aciagrion tillyardi* from the Bokor Plateau meets the main specific characters as indicated by Laidlaw (1924): deeply bifid upper appendages (Fig. 72), a built rather robust for the genus, with the last three abdominal segments noticeably inflated (Fig. 45), but differ in a slightly longer abdomen: 27.5-28.3 mm in males, 24.8-25.7 mm in females, with the hind wing 16.8-18.5 mm (abdomen 24.5 in males and 22.5 mm in



Figure 72. Abdomen tips of two males of *Aciagrion tillyardi* from the 'Praemorsus pond', Bokor Plateau, 09.12.2010.



females and hind wing 17.5 mm according to the cited author). Laidlaw (1924: 3) wrote that in males, “dorsum of segment 10 black” while his fig. 15 shows S10 entirely black. In males from Bokor, S10 has a narrow but inflated to tergite margins, rather X-like, black dorsal mark (Fig. 72), that coincides with Laidlaw’s textual statement. The colouration of females is as described by the cited author.

### 8. *Aciagrion* sp.

*Aciagrion* sp. observed in large quantities when commencing their maiden flight at the ‘*Aciagrion rivulet*’ source (Fig. 12, top left). They had relatively very long abdomens – 29 mm in males, 28.5 mm in females, with the hind wing only 18.2-18.5 mm in males, 19.8 in females (Fig. 73). The males have processed conical upper anal appendages, with the lower angle not seen from the lateral view. This shape somewhat resembles that of *Aciagrion occidentale* Laidlaw, 1919 as depicted in Fraser (1933), but this species is smaller (abdomen 22-24 mm and hind wing 15-16 mm) (Laidlaw, 1924; Fraser, 1933). Mature specimens are necessary for identification but none was met with.

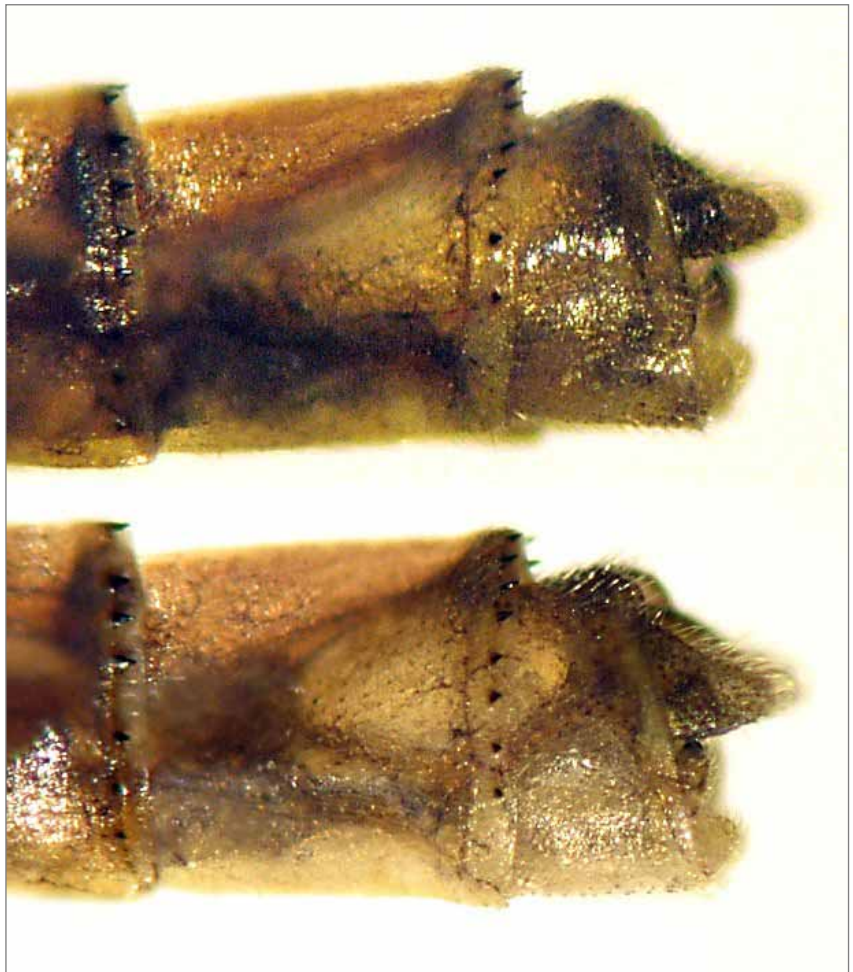


Figure 73. Abdomen tips of two teneral males of *Aciagrion* sp. from the ‘*Aciagrion rivulet*’ source on 28.11.2010.

### 9. *Aciagrion pallidum*

All males of *Aciagrion pallidum* collected were not blue and had bluntly cut upper appendages typical for the species, without any inclination to the processed ones in two blue males collected at ‘*Oculata brook*’ on April 18 (see Kosterin 2010: 60-62 and Fig. 42). This suggests that the latter mentioned males had no relation to *A. pallidum* and probably represented an undescribed species.



### 10. *Ceriagrion calamineum* vs *Ceriagrion olivaceum*

In the original description, *Ceriagrion calamineum* was said to differ from *C. olivaceum* “by its much brighter colours, smaller size, and different appendages” (Liefstinck 1951: 193). The revision of Asian *Ceriagrion* species by Asahina (1967b), who had specimens from wider ranges, does not support the differences in size (the limits of variation of measurements are indicated almost identical for both species) and the male appendages (if to take into account the variation shown between specimens from Java and Luzon for *C. calamineum* and between specimens from S India and Thailand for *C. olivaceum*). In that revision, *Ceriagrion calamineum* and *C. olivaceum* are considered at distant pages, but both texts and figures suggest that they do not differ morphologically and in addition have some variation of morphological characters within each species. Only the darkened holes behind the mesostigmal plate in females of *C. calamineum* are shown to be situated more laterally (Asahina 1967b: fig. 54) than in *C. olivaceum*. (loc. cit., fig. 183). In his key (Asahina 1967b: 321-323) the species are differentiated by step 10: “abdomen mostly reddish” (to *calamineum*) versus “abdomen brownish or bluish” (to *olivaceum*, said at step 24 to have “body pale brownish, often tinted reddish on dorsum if matured”). Chapter VIII, “Systematic arrangement...” (p. 327) says: “*Calamineum* is reddish orange in the male, and the pale brownish *olivaceum* often shows a reddish tint, otherwise both species seem very much allied.” In the main text (p. 274), males of *C. calamineum* are said to have the “abdomen orange-yellow, more or less reddish on the dorsum”. Hence, identification of males of *C. calamineum* and their differentiation from *C. olivaceum* was presumed by Asahina (1967b) to base solely on the verbal colour description, which may be subjective, especially in foreign languages. In the original description, the colour of the abdomen of mature males of *C. calamineum* was characterised with the aid of quite precious English epithets: “dorsally bright chrome-yellow (Hardmuth’s Koch-i Noor), turning lighter aside and acquiring ventrally a light yellow tint” for the holotype, “above throughout cadmium yellow, the sides and under surface pale orange-yellow” for the last colour phase A, “above apricot orange or rufous, sides and under surfaces lightly chalcedony yellow” for the last colour phase B (Liefstinck 1951: 191). Based on this, I identify as *Ceriagrion calamineum* my seven males of which five were collected (from Koh Por, ‘Lispe veal’ in Koh-Kong Province, ‘Bokorensis mire’ and ‘Limбата ponds’ on Bokor Plateau). They had bright chrome yellow abdomen and the pterothorax dorsal surface, greenish pterothorax sides and blueish-green eyes (Fig. 74 a, b) and were nearly identical to *C. olivaceum* structurally. This is indirectly supported by the record of this species from the nearby Trat Province of Thailand (Hämäläinen & Pinratana 1999). The existing literature contains only drawings of morphological details of both species, hence I provide here the photographs of their mesostigmal plates (Fig. 75) and appendages (Fig. 76). It may be noted that *olivaceum* males have a deeper central dimple in the mesostigmal plate and, correspondingly, slightly more convex anterior margin of the rami of





Figure 74. Males of *Ceriagrion calamineum* (a, b) and a presumed female of this species or *C. olivaceum* (c); a, c, at 'Aciagrion rivulet' source, Koh-Kong Province, 29.11.2010; b, at the lower 'Limbata pond' on the Bokor Plateau, 10.12.2010.



the medial carina, which in *calamineum* males look more straight. However, these differences are weak: quantitative and almost without a hiatus. The anal appendages (Fig. 76) look somewhat variable in both species and do not differentiate them.

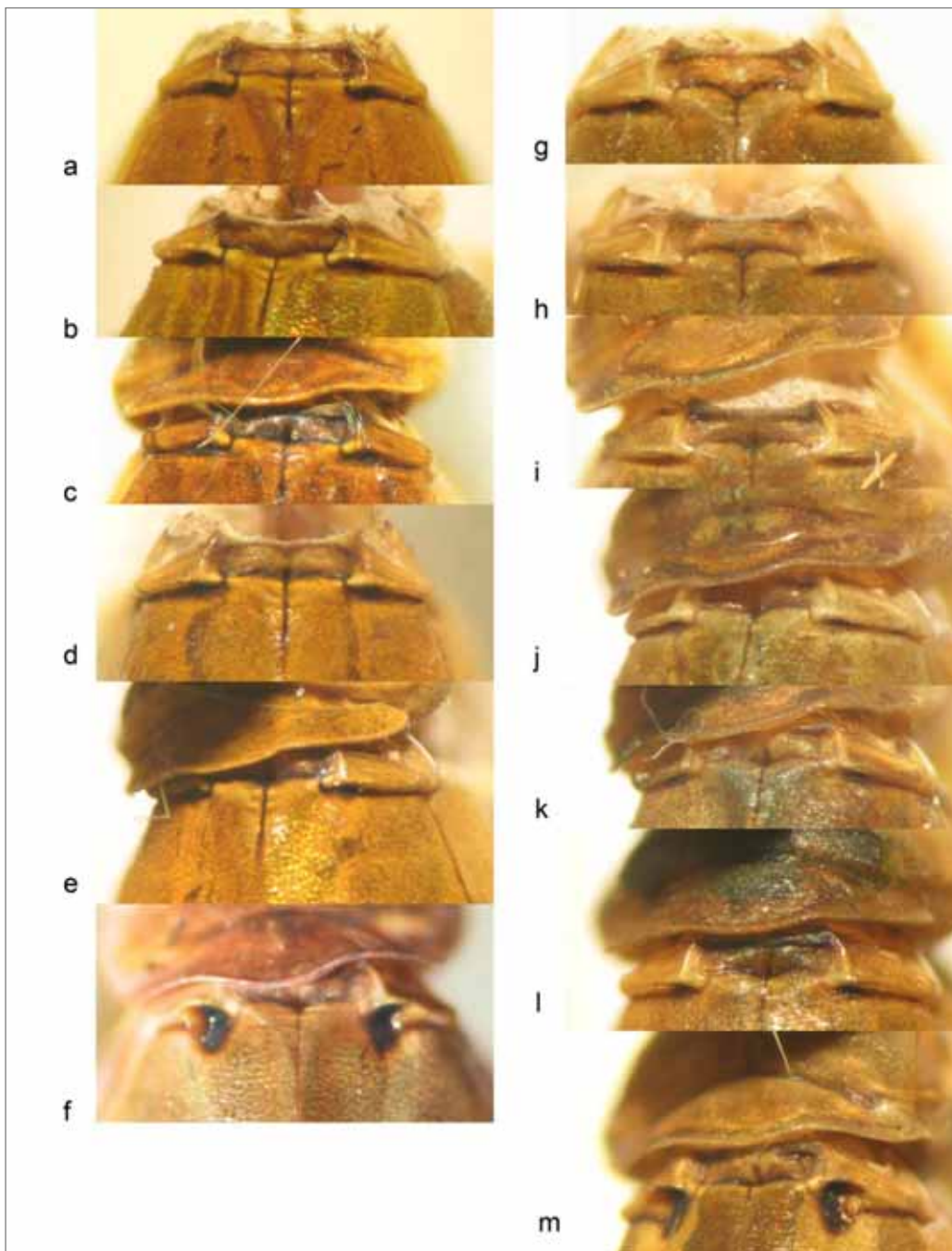


Figure 75. Mesostigmal plates of *Ceriagrion calamineum* (a-e), *Ceriagrion* sp. (probably also *calamineum*) (f) and *C. olivaceum* (g-m); a-e and g-l, males; f and m, females; a, a pool on rocks at Koh Por River left bank downstream the waterfalls, 01.12.2010; b, a pool at 'Lispe veal', 29.11.2010; c, 'Bokorensis mire', Bokor Plateau, 09.12.2010; d-e, 'Limbata ponds', Bokor Plateau, 10.12.2010; f, 'Aciagrion rivulet' source, 29.11.2010 (the same individual as in Fig. 73 c); g-i, Bokor Hill Station, 08.12.2010; j-m, Treetop Bungalow, Kep, 05.12.2010.

A yellowish-orange *Ceriagrion* male shown in Fig. 3 by Roland et al. (2011) is most probably *C. calamineum* as well.

The female collected at the 'Aciagrion rivulet' along with a male of *C. calamineum* looks like that of *C. olivaceum* (Fig. 74 c), in particular it has the same position of the dark holes on the thorax (Fig. 75 f) as the female of *C. olivaceum* from Kep (Fig. 75 m). However, it is not known if their position is a reliable character, so this female is



most probably *C. calamineum* as well, provided no males or other females of *C. olivaceum* were at all met in Koh-Kong Province.

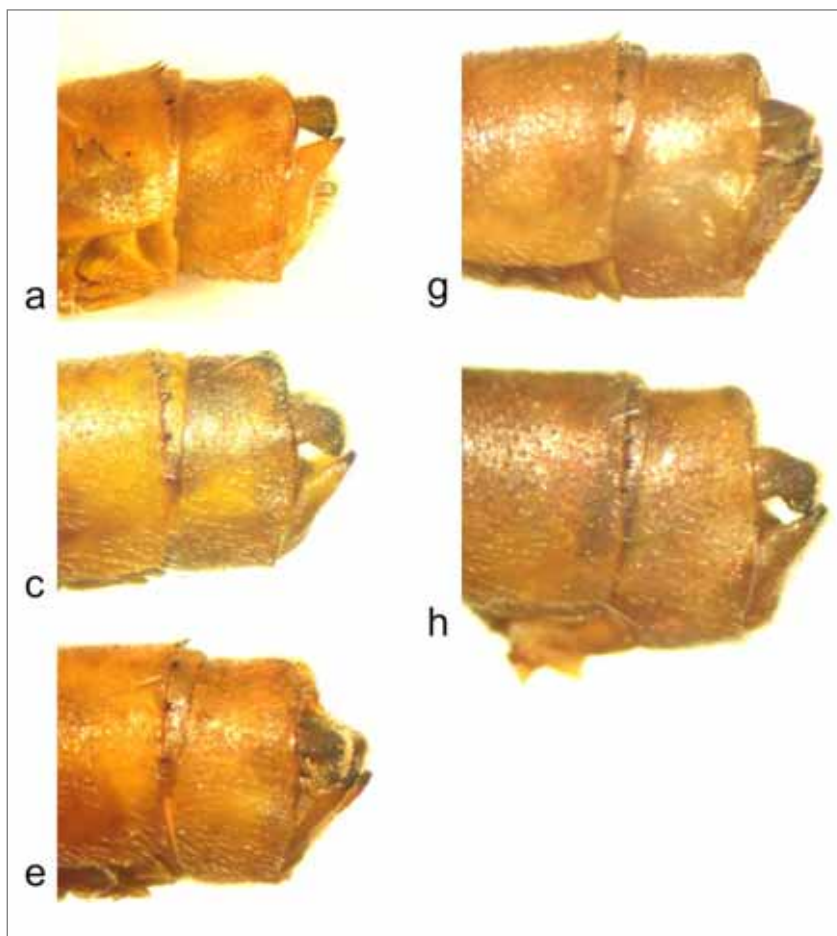


Figure 76. Male anal appendages of *Ceriagrion calamineum* (a, c, e) and *C. olivaceum* (g, h). The specimens are the same as denoted with respective letters on Fig. 74.

### 11. *Ceriagrion* males at ‘Ludwigia pond’ in Kep

Unfortunately no citron-yellow, with green eyes and pterothorax, *Ceriagrion* males at ‘Ludwigia pond’ in Kep (Fig. 62) were collected. The coloration suggests *C. indochinense* Asahina, 1976 but the mesostigmal plate, quite peculiar in that species, is not adequately seen on the photos presented on Fig. 62 (although it obviously differs from that of *C. calamineum* as having the posterior carinae developed and the rami of the dorsal carina narrower). An analogous photo of a similar male with a similarly looking mesostigmal plate is given in Roland et al. (2011: Fig. 4) taken on 26.11.2010 in the Seima forest, Mondulkiri Province.

### 12. Coloration of *Mortonagrion aborens*

Structurally perfect males of *Mortonagrion aborens* (collected in the Koh Por valley) are strongly melanised, with black stripes along the lower tergite margins, as in females. In three of four males the dorsal black pattern is further extended so that the pair of blue ocular spots on S2 disappear and the blue ground colour is darkened near the black pattern elements, perhaps due to the age; in two males small irregular dark marks appear at S9 lower margins.





### 13. *Archibasis viola*

Identification of the saturated dark-violet *Archibasis* males as *A. viola* Lieftink, 1948 is unambiguous due to the appendage morphology and other characters provided in Lieftink (1949). As to females, the cited author wrote: "as far as colours are concerned they greatly resemble the males and the characters employed for the latter can be applied in some extent also to the other sex" (Lieftink, 1949: 184). However, the abdominal pattern of S2 and S8-10 differs between males and females at least in some *Archibasis* spp. (Fraser, 1933). I collected two females, photographed one and seen one more in the same habitats as *A. viola* males. They corresponded to the males in size, missed the oval light spot on S2, had a black dorsal mark on S8, black lateral marks on S9 and light dorsal spot on S10; besides, their ground colour was light blue (see Fig. 12) or dull blue rather than violet. Nevertheless, I provisionally identify them as *A. viola* as well.

### 14. Synonymy of *Coeliccia kazukoae* and *Coeliccia megumii*

Kosterin (2010) reported males of *Coeliccia kazukoae* having the appendages typical for this species but with the head and even thoracic patterns varying between those of *C. kazukoae* and *C. megumii*. The head pattern variation can be seen in loc. cit. in Fig 43, for variation in the thoracic pattern in two males from Koh Por compare Fig. 12 and 43, top. Now, three males were collected at the same bluff in the Koh Por valley plus three males at the 'Rhinagion brook' near Tatai Waterwall. All they have the black pattern identical to that of *C. megumii* (Fig. 77, right; compare Figs. 53 in Asahina 1984). At the same time in both male specimen triplets, the profile outline of the subapical ventral lobe of their upper appendages varies in the lateral view from that depicted for *C. kazukoae* on Figs 58 in (Asahina 1984) (Fig. 77, b) to almost that depicted for *C. megumii* on Fig. 54 in loc. cit (Fig. 77, a), that in a given projection mostly depends on variable inclination of that projection.

All this undoubtedly suggests that *C. kazukoae* and *C. megumii* are the same species, with the structural character thought to be diagnostic being variable continuously, the colour phenotypes '*kazukoae*' and '*megumii*' being respectively the immature and mature state of the same insect. Coloration changes with age (pattern darkening and becoming more distinct) are common among *Coeliccia* species. Curiously, the only male specimen, the paratype, of *kazukoae* available to Asahina at the moment of description was collected at 'Rest area' at Pong Nam Ron, Chanthaburi Province, Thailand (very close to the Cambodian border) on 11.02.1965 while the two males comprising the type series of *C. megumii*, the holotype and paratype, were collected exactly in the same locality on 26.05.1980. Until now, few records of *C. megumii* were reported and only from Chanthaburi Province (Hämäläinen & Pinrattana 1999).



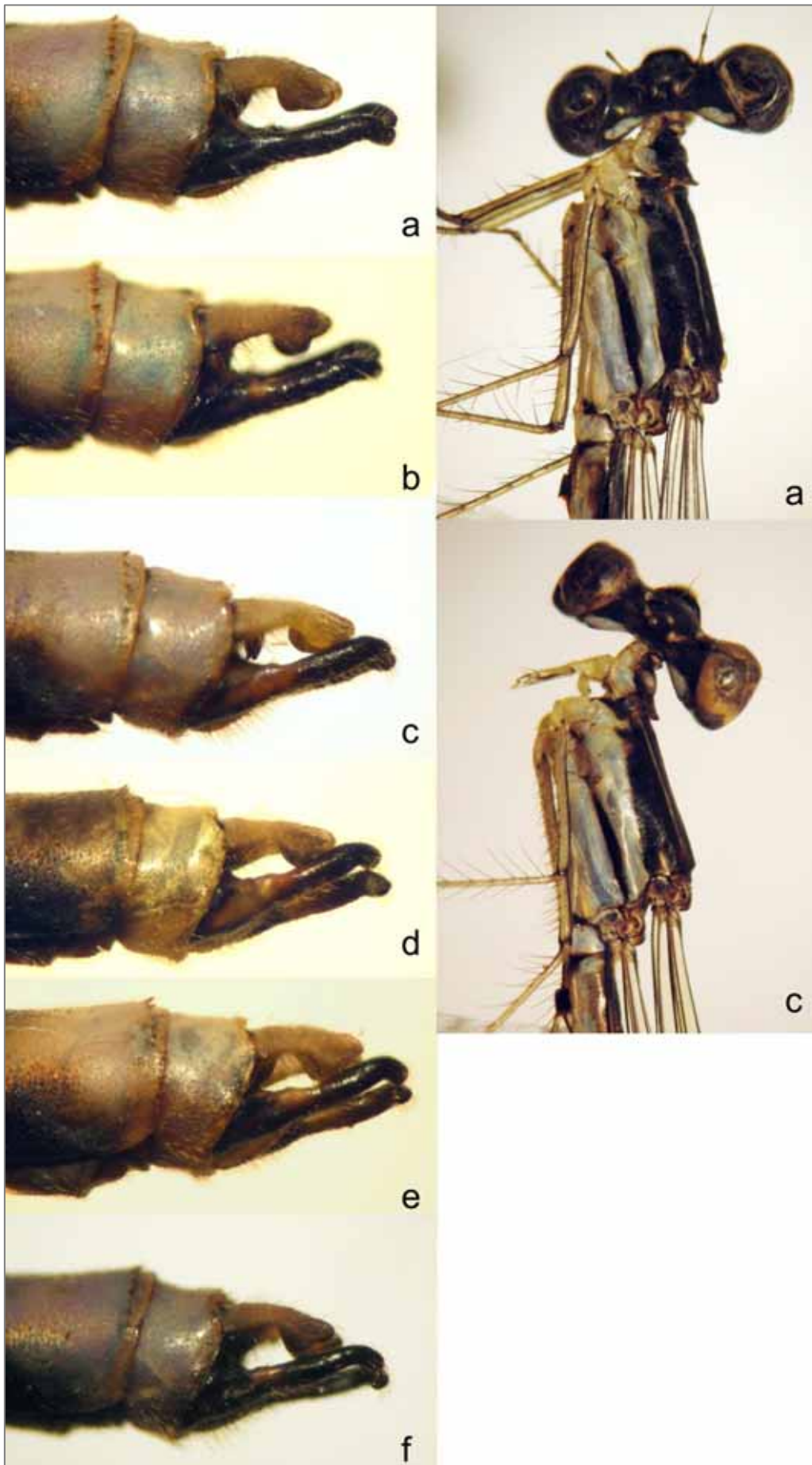


Figure 77. Anal appendages (left) and head and thoracic pattern (right) of *Coeliccia kazukoae* males; a-c, Koh Por River valley at the waterfalls, 01.12.2010; d-f, 'Rhinagrion brook' at the Tatai Waterfalls, 02.12.2010.



Noteworthy the two species being synonymised were described in the same work (Asahina 1984). In this case the valid name should be chosen by the First Reviser, that is the person who first mentions in a publication both names as related to the same taxon and deliberately chooses one as the valid (International Code ... 1999: Art. 24.2.2). As appearing the First Reviser, I select *Coeliccia kazukoe* Asahina, 1984 as the valid name, due to the Western principle 'ladies first': *C. megumii* was named in honour of Dr. Megumi Hasegawa while *C. kazukoae* in honour of his wife, "Mrs. M. Hasegawa" (Asahina, 1984: 16-17). So:

*Coeliccia kazukoae* Asahina, 1984; valid name = *Coeliccia megumii* Asahina, 1984.

It is unclear if the species has a seasonality. Hämäläinen & Pinratana (1999) summarised occurrence of *C. kazukoae* (that is immature specimens) as September-January (and my mature male from Chanthaburi, Thailand, was also collected in January) and of *C. megumii* (mature specimens) as May-October. On the contrary, in Cambodia I observed all males mature in December and at variable states of maturation going on in April.

### 15. *Hemicordulia* sp.

Males of *Hemicordulia* sp. collected in Koh-Kong Province undoubtedly are very close to *H. tenera* Lieftinck, 1930. They differ by much less processed upper appendages, so that they have the value of the ratio of the lengths of the lower to upper appendage greater than in any other species occurring west and north of the Wallace line. If to measure a distance from the apices of the upper and lower appendage to the point where, in the lateral view, the upper margin of the lower appendage meets the lower margin of the upper appendage, then the length of the lower appendage comprises in my specimens about 91% of the length of the upper appendage. In other species, this ratio is second large in *H. tenera*, 76-82%, and smaller in other species, e. g. 71-79% in *H. asiatica* Selys, 1878, 78-79% in *H. mindana* Needham & Gyger 1937. If to take into account the length of S10, it becomes evident that in the Cardamonian specimens the lower appendage is of the same relative length as in *H. tenera* (the longest among the so far known Asian species) while the upper ones are not so processed as in this species. Another difference of the three Cardamonian males from *H. tenera* is a complete absence of yellowish spots on the abdomen. But this is most probably the age dependent feature, for among additional specimens I collected in the same locality and at the nearby 'Nannophya Rivulet' in August 2011 (to be published in the next report) some had and some had not vague yellowish spots.

A male identified as *H. tenera* from Loei Province of Thailand, kindly provided by Brother Anmuay Pinratana, has about the same ratio of the lower to upper appendage lengths, 89%, and appears conspecific to the Cardamonian males, although it



has both appendages somewhat more arched (and has the abdominal yellow spots). This specimen belongs to the series upon which a record of *H. tenera* for Loei Province in (Hämäläinen & Pinratana 1999) was based; so, no true *H. tenera* has been collected from the continent. Specimens of “*Hemicordulia* undescr. sp.” which “is similar to *tenera* but has a different appendage and is larger”, reported by Donnelly (1994: 86) for Doi Inthanon National Park Headquarters, Chaing Mai Province, Thailand, most probably belong to the same undescribed species. Based on the photos of the male appendage that I had provided, Haruki Karube kindly confirmed conspecificity of the Cambodian and Loei specimens to his specimens from North Laos which are to be soon described by him as a new species. This species should be considered as a continental derivative of *H. tenera*.

## Discussion

### Update to the country fauna - succession on knowledge of Cambodian Odonata

On the basis of up to date available literature, Kosterin (2010) counted 83 Odonata species for Cambodia but omitting *Cratilla lineata calverti* Förster, 1903 and *Tholymis tillarga* (Fabricius, 1798) reported for the first time by Asahina (1967a). Besides, *Prodasineura verticalis* sensu Asahina, 1983 was in fact previously reported by Asahina (1967a) as *Prodasineura* sp. and was not newly reported by Kosterin (2010), besides, the species actually remains nameless. I doubted the report without details of *Tramea virginia* (Rambur, 1842) (as *T. chinensis*) for Cambodia by Martin (1904), while later Watson (1967) confirmed this species for Angkor Wat. This year, Roland et al. (2011) reported nine more species new for Cambodia: *Libellago l. lineata* (Burmeister, 1839), *Lestes praemorsus decipiens* (Kirby, 1889), *Argiocnemis rubescens rubeola* Selys, 1877, *Ischnura a. aurora* (Brauer, 1865), *Pseudagrion pruinatum* (Burmeister, 1839), *Ephthalmia f. frontalis* Selys, 1871, *Indothemis limbata* (Selys, 1891), *Indothemis carnatica* (Fabricius, 1798) and *Orthetrum glaucum* (Brauer, 1865).

So, the correct numbers of species reported for the first time for Cambodia in the respective papers (and not excluded as dubious by Kosterin 2010) are as follows:

- |                                |   |
|--------------------------------|---|
| → Martin (1904): 24            | → Benstead (2006): 6                      |
| → Asahina (1967a): 24          | → the two latter papers simultaneously: 1 |
| → Asahina (1967b): 1           | → Roland & Roland (2010): 5               |
| → Asahina (1984): 1            | → Kosterin (2010): 13                     |
| → Tsuda (1991) or elsewhere: 3 | → Roland et al. (2011): 9                 |
| → Kosterin & Vihrev (2006): 5  |   |

In total 92 species.



This my November/December trip added to the known fauna of Cambodia 13 named species (among 69 identified species seen): *Aristocypha fenestrella* (Rambur, 1842), *Rhinagrion viridatum* Fraser, 1938, *Lestes elatus* Hagen in Selys, 1862, *L. platystylus* Rambur, 1842, *Aciagrion tillyardi* Laidlaw, 1919, *Agriocnemis f. femina* (Brauer, 1868), *Archibasis viola* Lieftink, 1948, *Ceriagrion calamineum* Laidlaw, 1951, *Mortonagrion aborense* (Laidlaw, 1914), *M. falcatum* Lieftinck, 1934, *Pseudagrion microcephalum* (Rambur, 1842), *Paragomphus capricornis* (Förster, 1914), *Macrodiplax cora* (Brauer, 1867), *Nannophya pygmaea* Rambur, 1842. So, at the moment 106 named species (not counting *Prodasineura verticalis* sensu Asahina, 1983, the provisionally identified *C. indochinense* and the undescribed *Hemicordulia* sp.) have been reported for Cambodia.

Addition to locality details referring Kosterin & Vikhrev (2006):

Kosterin & Vikhrev (2006) noted two localities ambiguously since they had scarce information on their route to Siem Reap. The "border pass at Ban Laem" was the so-called Pailing border pass (12°55'37" N, 102°29'38" E). The "large lake at Phumi Kdol Kraom, between Ban Laem and Battambang, surrounded with several hills, with the surface clad with lotos and *Salvinia*" was situated elsewhere (for there is no such lake at Phumi Kdol Kraom) but I have no idea where. Being so enormous, it could be a margin of the great Lake Tonle Sap, but it could not be met before passing Battambang.

## Seasonality

This trip took place in late November/early December soon after cessation of the rainy season and I expected to witness much more water and more odonates. These expectations turned fully true as to odonates at any site and as to water in brooks and rivers in Koh-Kong Province but not so in the east: Bokor Plateau seemed to have the same amount of water as in late April, while the brook in the Kep National Park had somewhat less water than in April. The three rains for a fortnight were even less in number than for the same period in April.

In April, some lotic species were found to emerge abundantly: *Dysphaea gloriosa* and *Burmagomphus* sp. None of them was encountered in November/December so we should conclude their adult life to be completed before. *Prodasineura autumnalis*, which emerged simultaneously in April, was still abundant and common. On the other hand, such round-the-year lotic demoiselles as *Euphaea masoni*, *Helio-cypha* spp. and *Neurobasis chinensis* were more abundant, as well as many other riverine species, such as *Trithemis festiva* and *Orthetrum glaucum* (not observed in April). Rather unexpected was scantily of *Zygonyx iris malayana*.



The second noticeable peculiarity of the seasonal odonate aspect compared to that in April was omnipresence of two species characteristic for the dry season: *Neurothemis intermedia atalanta* (especially abundant in Koh-Kong Province) and *Aciagrion borneense*. Both were found only once in April, that is at the end of dry season: *N. intermedia atalanta* at Tatai and *A. borneense* at Koh-Kong (Kosterin 2010). Two other dry season species were abundant either in the west (Koh-Kong Province) or east (Kampot+Kep Provinces): *Aciagrion pallidum* frequently occurred in the west; in the east it was found only once in Kep. Contrary, *Ceriagrion olivaceum*, a species typical of the first half of dry season (Hämäläinen & Pinratana 1999), occurred in immense number in the east, on Bokor Plateau and Kep, but was absent or probably represented by only one female discussed above in the west.

Some more differences in odonate seasonality were observed between west and east. So, *Lathrecista asiatica* was common (mature) in the west and absent from the east in April but absent from the west and common (immature) in the east in December. *Prodasineura verticalis* sensu Asahina, 1983 recorded only in the east in April and only in the West in December. *Neurothemis fluctuans* was very abundant in the west in December as well as in April, but, although known as a year-round species, in December most individuals were immature as all males had a very pale wing coloration. Strangely, not a single individual of this common species was met in Kep for both trips and only one male in Bokor (in April). *Pantala flavescens* and immature *Tramea transmarina euryale* and *Potamarcha congener* were extremely abundant in the east; in the west the first species was observed in moderate quantities, the second was rare and the third not found, although common elsewhere. In the west, *Diplacodes nebulosa* was abundant in grass and sedge at any small water bodies while in the east it was only once found at the pond in Kep. *Diplacodes trivialis* was common in the west and extremely abundant in Kep, but in the west individuals (mostly males) were rather strictly associated with the barren ground while in Kep they were literally omnipresent and well occurred in grass. This may be interpreted so that they emerged rather recently in Kep and were observed at their dispersal while in the west mature individuals kept to open ground as a 'meeting place' of sexes for reproduction. *Rhyothemis* decreased their frequency dramatically since April, just three individual being observed during the recent trip.

If to compare only the localities which were examined in both trips, in November / December I encountered 16 species not observed in April: *Heliocypha biforata*, *Rhinagrion viridatum*, *Lestes concinnus*, *L. elatus*, *L. platystilus*, *Mortonagrion aborense*, *M. falcatum*, *Argiocnemis rubescens rubeola*, *Ceriagrion calamineum*, *C. olivaceum*, *C. ?indochinense*, *Pseudagrion pruinatum*, *Archibasis viola*, *Brachydiplax farinosa*, *Orthetrum glaucum*, *O. pruinatum neglectum* while only 8 species: *Dysphaea gloriosa*, *Ceriagrion malaisei*, *Burmagomphus* sp., *Microgomphus* sp., *Brachygonia ocula-*



*ta*, *Pseudothemis jorina*, *Rhyothemis phyllis*, *Rh. ?plutonia* were found in April but not in November/December. The observation of more odonate species at the start of the dry season than at its end was anticipated. Many of the added species seem to be loosely associated with the rainy season. Noteworthy was finding in November/December of four species of *Lestes* compared to none in April, *L. concinnus* being widespread.

Only three species (*Pseudagrion australasiae*, *Trithemis pallidinervis* and *Macrodiplax cora*) were added to scanty Odonata of the vast mangroves SE of Koh-Kong (towards Peam Krasaop Wildlife Sanctuary) as observed in April.

On the Bokor Plateau I witnessed signs of changing seasonal aspect of *Ceriagrion* spp. All open places, including bogs and pool banks, were evenly filled with immense dull-coloured *C. olivaceum* of both sexes without signs of reproductive behaviour. I suppose they all just dispersed from the coastal lowland at the Bokor foot. On pools and shallow ponds at the peat-moss bog, males of *C. calamineum* were perching on sparse grass emerging from water table, they seemed to be at breeding sites awaiting females (the term 'territorial' used to be used in this context is rather misleading, for in most species such males do not have individual territories). At the same time, seven teneral individuals caught during their maiden flight in the same place were all *C. cerinorubellum*. Hence, the presumed temporal succession of species emergency was *C. calamineum* then *C. olivaceum* followed by *C. cerinorubellum*. At the pond in Kep, noteworthy occurrence of only *C. malaisei* in April but only *C. ?indochinense* in December.

Some of the above discussed regularities may be of rather a local importance or peculiarities of just 2010 season. Nevertheless, we see that a more humid time of dry season brought far more species. Now the area is to be revisited during the summer monsoon.

### Notes on habitats of some species.

1. Habitat segregation was observed in Koh-Kong Province as described by Orr (2005) of *Heliocypha perforata* (open wide river valleys) and *H. perforata* (more close habitats, usually at smaller rivulets): the males of the former at the Right Tatai, those of the latter at its tributaries, at the 'Poacher River' over the Koh-Kong estuary, and both at the Thma Bang Tributary. But the *Heliocypha* females supposed above to represent these two species were found at vegetation side-by-side, so if the supposition is correct then the females show no habitat preference beyond reproduction.



2. *Lestes concinnus* was encountered in quite dissimilar places: at mangrove bank of the Koh-Kong estuary at sea level, on a weed 'meadow' on a slope at a resort in Kep, at an open area with shallowest pools on the Cardamonian foothills and nearby at a road going through primary forest at 313-317 m, and on a huge peat-moss bog, as well as at small sedge pools, on the Bokor Plateau at 960-1030 m a. s. l. However, in all cases it occurred at sunny and grassy (sedgy) open areas, often with shallow pools nearby. These habitats superficially resembled those of many European species, first of all of *Lestes dryas* Kirby, 1890. In Kampot and Kep Provinces, *L. elatus* was invariably found either in open forest or at wood margins (or huge bamboo bunches), partly overshadowed but with sunlit spots. In this way it resembled the European *Lestes viridis* (Vander Linden, 1825). *L. (P.) platystylus* were found in deep shade of bush and herbaceous thickets at the narrow forest brook valley on the Kep Hill, while males *L. praemorsus decipiens*, including teneral individuals, were found over open water surface of two very close ponds near the huge *Sphagnum* bog on the Bokor Plateau.

3. *Ceriagrion olivaceum* is common in the continental S and SE Asia and is most abundant in the beginning of dry season. For such a common species it looks strange that its breeding places appear unclear and confusing from the existing literature. Fraser (1933: 326) provided the following information as to the habitat: "in large colonies, inhabiting wet jungle and usually well away from water. ... also found swarming in long dry grass. Contrary to the general habitat of the genus, they appear to breed in streams". To my opinion, the latter statement looks rather unlikely. Quite contrarily, Orr (2005: 36) wrote: "occasional inhabitants of shallow ponds, drains and marshes, in open country in lowlands and hills". I witnessed *C. olivaceum* very common in Pattaya in January 2006 (Kosterin & Vikhrev, 2008) and incredibly abundant all over my recent route over the Bokor Plateau at its slope and at Kep, but these all were non-breeding individuals on dispersal, showing no interest to each other or water bodies, although occasionally occurring at water at much lower frequency than beyond; no tandem was seen. It was curious to observe on the same Bokor Plateau (and also in three localities in Koh-Kong Province) scarce males of the very close species *C. calamineum* which obviously were at the breeding places being shallow pools and ponds. Curiously, Lieftinck (1951: 193) wrote about *C. calamineum*: "this new species is often encountered far away from its breeding places (marshes, ponds and lakes), and in this respect seems to resemble the Indian species *olivaceum* Laidlaw ... It tends to congregate in immense numbers where found and, if this be the case, swarms of both sexes may be found in long dry grass well away from water". This is indeed what we observed in Cambodia for *C. olivaceum* but not for *C. calamineum*.

4. In most examined habitats of *Pseudagrion* being slow rivulet and creek sections, a handful of species occurred together: *P. australasiae*, *P. williamsoni*, *P. rubriceps*





and *P. pruinatum* (the latter prefers partly shaded areas), here enumerated according to decrease in frequency. The first and commonest one extended also to shallow open pools. At the same time, elsewhere common *P. microcephalum* (Rambur, 1842) was found only on the Kep Hill. It seems that identically coloured *P. australasiae* and *P. microcephalum* generally exclude each other. Even on the Kep hill the former was found at a large deep pond (in April) while the latter at very small pools within a dozen of metres apart (in April and November). Fraser (1934) associated the former (under the name *Pseudagrion bengalense* Laidlaw, 1919; for the identity and priority of the name *P. australasiae* Selys, 1867 see Lieftinck (1936) with mountainous areas and the latter with lowlands; yet in Cambodia both found at the lowland near Siem Reap, although by different authors (Kosterin & Vikhrev 2006; Benstead 2006). *Archibasis viola*, superficially similar to *Pseudagrion*, invariably occurred on shaded, rather deep and nearly currentless pool-like reaches of brooks and rivulets, often together with *P. pruinatum*.

5. Near Tatai Waterfalls, habitat segregation was obvious between *Prodasineura autumnalis* and *P. verticalis* sensu Asahina, 1983. The former flew over the water of the major river of Tatai while the latter inhabited a shady temporary brook nearby, oviposition being observed into tiny brush-like semisubmerged scoring rush (*Equisetum* sp.) dyed red by a clay ooze. Respective habitats of *P. autumnalis* at Thma Bang and of *P. verticalis* sensu Asahina along the road to Pursat were analogous.

6. As mentioned above, in Koh-Kong Province *Diplacodes trivialis* kept to barren ground of any kind, while *D. nebulosa* to sedge and grass at pools and rivulets.

7. My personal experience at Kyoto, Japan, would suggest a warm grassy swamp at the 'Aciagrion rivulet source' to best fit to *Nannophya pygmaea*. And indeed, this species occurred at the same water body but only at its banks where it became 1-1.5 m deep and freed from grass as it entered the coppice. Not far from there it became abundant at clean and quite deep pools of 'Hemicordulia brook' and at grass of banks of a medium-fast reaches of a medium-sized 'Nannophya Rivulet', that I would never expect. At the Bokor Plateau, *N. pygmaea* was found, but a single male only, at a shallow pond with grassy banks near the huge peat-moss bog.

8. As elsewhere, *Orthetrum glaucum* co-occurred with *O. chrysis* in rocky areas with shallow water, but was less abundant and preferred very small, often roadside, streams. *O. pruinatum neglectum* was added to *O. chrysis* on the Bokor Plateau only, both at a tiny pool and the considerable Popokvil River.

9. A vast *Sphagnum* bog at the Bokor Plateau did not meet my expectations to find species specific to such habitats. However, at least *Lestes praemorsus*, *Aciagrion*



*tillyardi* and *Indothemis limbata* were found on this trip only at ponds and pools nearby; a male *A. tillyardi* being witnessed to have a maiden flight from a shady roadside ground hole with *Sphagnum* but already without water; so *A. tillyardi* seems to be the most sphagnophylic Odonata species of all met with.

10. The enigmatic *Aciagrion* sp., collected only as teneral, has a peculiar breeding place: the small grassy swamp at a margin of an open area margin at 286 m elevated plateau, being a very source of a forest 'Aciagrion rivulet' (Fig. 12, bottom). Noteworthy, few mature males and a copula of the dry season species *Neurothemis intermedia atalanta* were found at that swamp as well. This swamp appeared to be a breeding place of another dry season forest species, *Aciagrion borneense*, which was found to emerge from there in August 2011, while in the November/December trip mature specimens presented there in abundance and there was a copula.

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