Odonata of the Cambodian coastal regions in late rainy season of 2011

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Abstract

Results of the odonatological survey of the coastal SW regions of Cambodia in August 12-28, 2011 are presented. Those include general notes on the Odonata fauna in late rainy season, enumeration of all records by locality, discussion of interesting specimens and their taxonomy, and notes on habitats and habits of some species. Of 87 named Odonata species encountered during the trip, 15 are reported for the first time for Cambodia, namely *Aciagrion hisopa* (Selys, 1876), *Anax immaculifrons* Rambur, 1842, *Burmagomphus divaricatus* Lieftinck, 1964, *Gomphidictinus perakensis* (Laidlaw, 1902), *Merogomphus parvus* (Krüger, 1899), *Nepogomphus walli* (Fraser, 1924), *Idionyx thailandica* Hämäläinen, 1985, *Macromia cupricincta* Fraser, 1024, *Macromia septima* Martin, 1904, *Macromidia rapida* Martin, 1907, *Agrionoptera insignis* (Rambur, 1842), *Lyriothemis elegantissima* Selys, 1883, *Onychothemis testacea* Laidlaw, 1902, *Orthetrum luzonicum* (Brauer, 1868), *Orthetrum testaceum* (Burmeister, 1839). The country list now reaches 125 named species.

Introduction

The Cambodian fauna of Odonata is still insufficiently known. The number of species recorded up to date is 110 (Kosterin 2011; Kosterin & Holden 2011; Day 2011) but my expectations are that not less than 200 inhabit the country, based on the fact that the adjacent but larger Thailand harbours ca 300 species (Hämäläinen & Pinratana 1999). Cambodia still retains the treasure of one of the largest in SE Asia area of contiguous and nearly virgin tropical forests of the Cardamom Mts., including vast lowland tropical forests at their coastal foothills, nearly exterminated in most tropical regions. They are still represented by a full catena of biocoenoses from mangro-

ves through swampy *Melaleuca cajuputi* Powell stands to foothill jungle. For this reason I found it useful to start survey of Cambodian Odonata from the coastal regions. In 2010, I made two fortnight-long trips in late (Kosterin 2010) and early (Kosterin 2011) dry season. They added to the known Cambodian fauna in total 27 odonate species. At last I managed to visit the area in rainy season, where many lotic species, which are seasonal even in tropics, were on wings. The best time would be the light rainy May/June, that is soon after or during the emergence of those species, but I could afford myself a trip only in August 2011. Nevertheless the trip appeared fruitful and completed the preliminary survey of the coastal regions hence making further regions, e. g. the main range of Cardamoms, to be next on schedule. I was lucky to join for 5 days an international team composed of François Mey, an expert on carnivorous plants and an amateur odonatologist of Khmer origin from France (Fig 29a), Alastair Robinson, a botanist from Great Britain currently living in Malaysia, and Jeremy Holden, a naturalist and photographer from Great Britain currently living in Cambodia. This allowed me to penetrate somewhat deeper into the Cardamoms, while their diverse knowledge on the local and generally tropical nature were extremely helpful.

The results of this trip are presented herein. The photos are to be available soon after publication of this paper at http://asia-dragonfly.net and at my site at http://pisum.bionet.nsc.ru/kosterin/odonata/cambodia.htm. The 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.

Many figures need to be referenced in text many times but are placed in those sections where they are most relevant as to the subject discussed, so their numeration below does not follow the usual order in which they were first mentioned.

Weather and seasonal conditions

The 2011 year was unusual due to an atypical early onset of the rainy season. March and April are usually the hottest months of the year in this area; however, this year they were windy and as ‘cold’ (in the local scale) as in midwinter, while regular rains started since the second week of March (pers. comm. by Jason David Webb, Leslie Day and Gee Chartier). Some slight ‘mango rains’ are common in March but this year they were much more intensive and continued until early May when the rainy season usually starts.

This unusual weather resulted from overheating of the Indian Ocean surface providing "below average sea level pressure and above average sea surface temperature in the western tropical Pacific and eastern Indian Ocean", in association with a "significant La Niña episode". This episode started in June/July 2010 and was "characterized by unusually cool ocean surface temperatures in the central and eastern tropical Pacific", which "disrupts the large-scale ocean-atmosphere circulation patterns in the tropics". This association "led to much above average rainfall in parts of Australia, Indonesia and southeast Asia" (World Meteorological Organisation, Press release no. 907; http://www.wmo.int/pages/mediacentre/press_releases/pr_907_en.html).

The rainy season itself was evaluated by Jason Webb (pers. comm.) as rather normal, and particularly this August – as normally heavy rainy (with a reservation that the norm is hard to outline since weather varies strongly from year to year). However, from my point of view, the weather did not look too rainy and hardly differed from that in the same month in Siberia. Only two too heavy downpours, at 4 a. m. on 16th August at Koh Kong and in the afternoon of 25th August at Thma Bang, were something rarely seen in Siberia. I observed all possible kinds of rains: fog-like drizzle, short sunny showers from small clouds, strong and long rainy storms, heavy downpours and a kind which rarely occurs in the North: large but very rare raindrops for a long time falling from an overcast sky. Yet the most frequent were afternoon thunderstorms, with impressive heavy clouds arriving from North-East, towering and thundering for several hours but producing very weak and short rains. For 17 days of my stay in Cambodia, only one day, 12th August, was completely rainless. On the other hand, just one day, 28th August, was lost for work due to a continuous rain throughout while most days having only short rains.

As compared to November/December, there were more water in all large and medium-sized rivers and about the same amount of water in brooks and small rivulets. This may be interpreted through more rains higher in the mountains.

I did not measure temperature but it was felt invariably very comfortable and hardly exceeded 30°C. The running waters seemed pleasantly cool allowing walking along the beds of brooks and rivulets throughout the day. There were no mosquitoes outdoors (very few indoors), of other potentially dangerous animals I saw just three different snakes and a number of huge wasps. Leeches were locally either numerous (especially at Rainbow Lodge and the Thma Bang River) or scarce to absent, without noticeable regularity except for a paradoxical impression that they preferred sunny weather.

As expected, the *veals* (a local term for natural open areas, see Kosterin 2011: 2-6) were full of water but did not at all looked as swamps, as I could imagine in November. Their sandy soils prevented water from accumulation at the ground surface, at

the same time flat sandstone rocks lying at small depth, being the main factor responsible for existence of *veals*, prevented it from draining down. Most of the *veals* occupied ridge tops and had gently slanting surfaces. As a result of all these circumstances, *veals* were seeping in running water throughout. Flat and intricately encarved rocks appearing on day surface were glittering due to numerous shallow pools or, more frequently, water flowing laminarily over broad rock surfaces (Fig. 1).

Figure 1. Sandstone rocks, mostly flat and glistening with water, at the *veals* (open savannah-like areas) in the Cardamom foothills, ascribed with conventional names in the 'Localities visited' section: a) 'Doritis *veal*', 13.08.2011; b, c) 'Viola *veal*', 12.08.2011; d) 'Delphiniondes *veal*', 13.08.2011.

On such well watered rocks, pioneering plants were abundant represented by an annual sundew species *Drosera indica* L. and some unidentified monocot (Fig. 2); a lithophilic orchid *Doritis* (*Phalaenoides*) *pulcherrima* Lindl. was also flowering among them (Fig. 3 a-c). Streams of various size, from tiny to considerable brooks, crossed grassy areas here and there in seemingly chaotic directions; but water often flew laminarily over the entire gentle surface of grassy areas as well. A tiny white terrest-

rial orchid flowering in these grassy areas was a remarkable of the season (Fig. 3d). I should note, however, that the small 'Lispe *veal*' examined in the previous trip (Kosterin 2011: 20-21, 79) was flat and lacked rocks, so it had no running water and looked as in November, just with the shallow pools expanded.

Figure 2. *Drosera indica* L. and an unidentified monocotyledonous plant (with geen spirally directed leaves) growing on flat sandstone rocks seeping with water, on 'Doritis *veal*', 13.08.2011.

Three days spent in Kampot and Kep (August 17 and 20-21) were sunny, with a short thunderstorm each. Rice paddy fields were green everywhere but the rice was still being planted on some.

Two days (August 18-19) atop the Bokor Plateau were gloomy and foggy, with periods of quite heavy rains and short sunshine. General differences from December consisted in all leaves being green (not young reddish foliage), curious sounds (series of 2-3 'dry strokes') produced from dusk to down from coppice by numerous frogs or

Figure 3. Most common orchids flowering in August in the Cardamom foothills: a-c) *Doritis* (*Phalaenoides*) *pulcherrima* Lindl. growing on flat sandstone rocks ('Doritis *veal*', 13.08.2011); d) an unidentified species flowering in grassy temporal bogs in *veals* ('Lispe *veal*', 13.08.2011); e) *Arundina* sp. ('Bokorensis mire', Bokor Plateau, 17.08.2011).

crickets, and quite a lot of moths arriving to light at night. Old sandy roads and shallow pits were covered with extremely shallow, stagnant or flowing water, with several *Utricularia* sp. flowering, of which *U. odorata* Pellegr. was the most abundant and produced yellow carpets above pools (Fig. 58 a, b). The orchid *Arundina* sp. flowered more abundantly than in December (Fig. 3e).

Figure 4. A view on the Koh Kong suburbs and the Koh Kong Estuary from the road to Pursat crossing low outposts of the Cardamoms in the east, 14 (below) and 15 (above).08.2011.

The 'Platystylus brook' on the Kep hill (see Kosterin 2010) had the same amount of water as in December. Superficially the Kep hill differed from April and November in being very rich in diverse butterflies, of which most numerous and noticeable were *Tanaecia julii* (Lesson, 1837), *Lebadea martha* (Fabricius, 1787) (Nymphalidae) and, surprisingly, *Lamproptera meges* (Zinken, 1831) (Papilionidae).

While returning from Cambodia on 29th August through Chanthabury and Rayong Provinces of Thailand I saw rivers risen up to bridges and some flooded land, suggesting there were more rains in those regions of Thailand than in the Cambodian coast. In early September, a disastrous downpour occurred in both, in October the central regions of Thailand and Cambodia got flooded, with so many casualties. The Koh Kong area, however, were not flooded in spite of quite heavy rains (Jason D. Webb pers. comm.). I noticed that although all traditional Cambodian wooden houses are built on piles, nothing was constructed in Koh Kong and Kampot against high water and the floors in stone houses were just continuation of the streets while the streets in turn were continuation of the bank. The well-drained gentle mountainous coast of Koh Kong Province (Fig. 4) lacking both narrow gorges, apt to sudden floods, and broad flatlands, slowly discharging water, seem to be well naturally protected from floods.

Toponymy problems

"Cambodia is divided into twenty-three provinces (*khaet*) and the capital Phnom Penh. Provinces are further subdivided into districts (*srŏk*) and municipalities (*krong*). Districts are divided into communes (*khum*) and quarters (*sangkat*), then further divided into villages (*phum*). The municipalities are divided into quarters (*sangkat*), which are divided into villages (*phum*), and further divided into groups (*krom*). The capital is divided into sections (*khan*), which are divided into quarters (*sangkat*), and further divided into villages (*phum*)." (http://en.wikipedia.org/wiki/Administrative_divisions_of_Cambodia). I wish this elegant system were better corresponded to what people say and maps show. For instance, everybody seems to know the settlement Thma Bang, mentioned in the two previous reports (Kosterin 2010, 2011). There is Thma Bang District, and in Wikipedia (http://en.wikipedia.org/wiki/Thma_Bang_District) one founds a table showing it to contain 7 communes divided into 18 villages in total, neither of which is called Thma Bang. On the Periplus Travel Map four villages are shown in this area: Trapaeng Khnor, Ta Tey Leu, Puoch and Ruessei Chryum, but no Thma Bang. Curiously, Ta Tey Leu and Russei Chrym are the names of communes while Trapaeng Khnar of a village within the former. There is a cross of three roads where the district centre Thma Bang should be, but no name is associated with this. In GoogleEarth, two nearby villages are indicated as Phumi Triev and Phumi Cherav

(perhaps the same name corresponding to Phum Trapaeng Chheu Trav), while the main settlement at the crossroad, obviously Thma Bang itself, remains unindicated again. I suppose that 1) the capital of Thma Bang District is called Thma Bang but is a quarter (and then village) beyond communes, and hence 2) it remained unnoticed by map makers.

There is Tatai Commune, which is said in Wikipedia to consist of two villages, Kaoh Andaet and Anlong Vak. Since a commune cannot contain quarters, we must conclude that there is no Tatai village. So it remains unclear what is the actual name of the village at the Phnom Doung Bridge which everybody calls Tatai.

Needless to remind that the Latin spelling of all Khmer toponyms is strongly variable and no official spelling seems to exist.

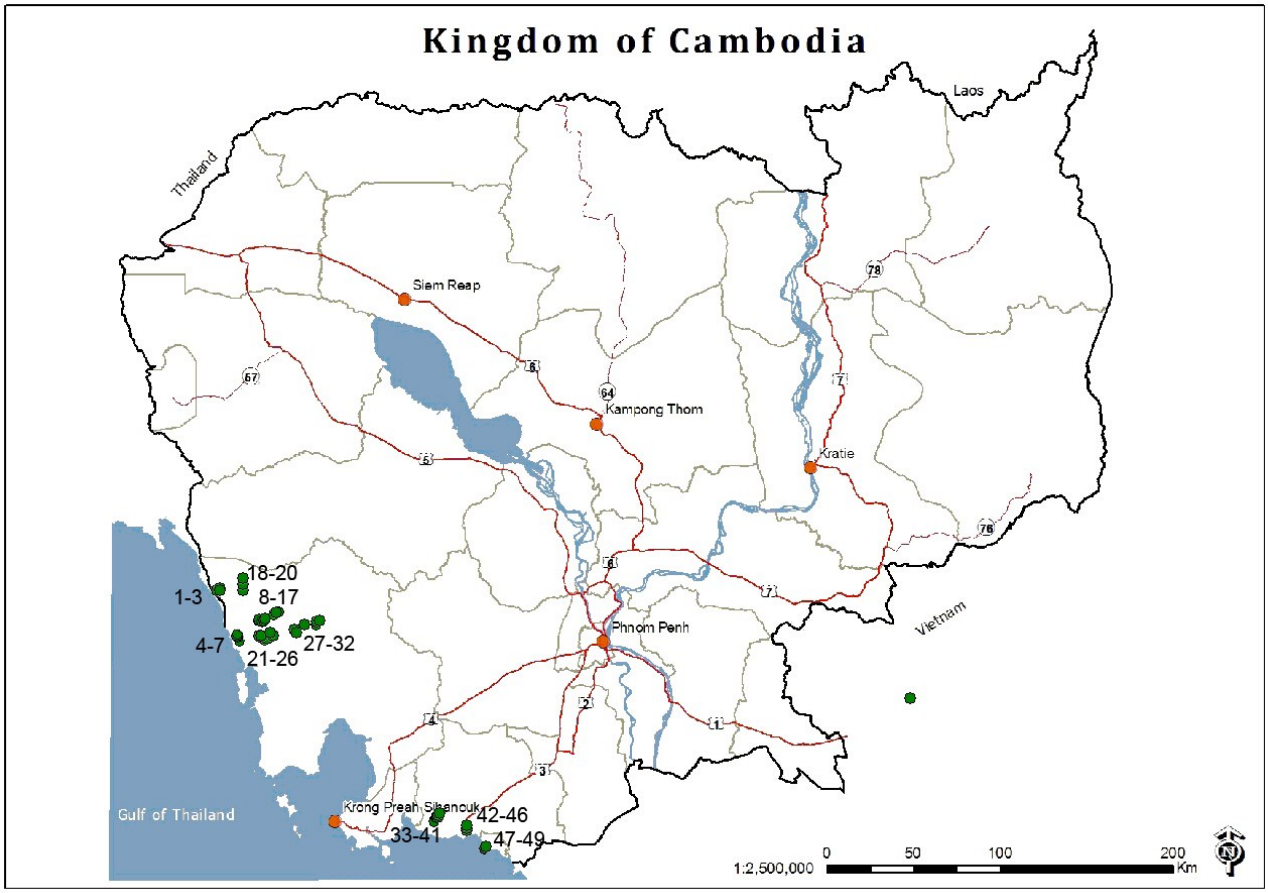

Figure 5. Disposition of localities examined in August 12-28, 2011. For explanation of locality numeration see the 'By locality list of Odonata recorded during the trip' section of the text.

Localities visited

In my previous reports (Kosterin 2010, 2011) I described in details many localities (cf "Field notes" sections). In Kosterin (2011) I also assigned conventional names to

some rivulets, brooks and ponds, either nameless or with local names not available. Here I will use these names for the localities revisited during the present study and introduce some more (including detailed description) for the sites not visited before. Coordinates of all localities are provided in the 'List of Odonata Recorded' section and their rough situations are shown on Fig. 5 (for explanation of their numeration see 'By locality list of Odonata recorded during the trip' below).

Koh Kong Province

This time I did not visit the Koh Por waterfalls but instead visited a locality called Thma Dar at the right major river called Koh Bopw (pers. comm. by Jason Webb.) of the two forming the Koh Kong Estuary (Koh Por being the left one). Koh Bopw flows from north-west in parallel to the coast and the Thailand border. The latter goes along the top of a low ridge separating the Koh Bopw River from the coast. This was my westernmost locality in the area. Alike the Koh Por Waterfalls, the Thma Dar locality (Fig. 6) was a place where the powerful rapidous mountain Koh Bopw River

Figure 6. The lowermost waterfall of the Koh Bopw River at its transition to an estuary at Thma Dar Locality, 27.08.2011.

passed the last waterfall and entered its very long estuary, mangroves with aerial roots and nypa palms appearing very soon among the jungles hanging over the banks. In fact it was situated just 6 km north of the coastal Thai town Khlong Yai and 5 km W of the Thai coastal village Ban Khlong Khut, separated from them by the border ridge. The banks and bottom were composed of rocks and huge boulders of sandstone, with admixture of few limestone boulders. The right board of the valley formed by the mentioned ridge was said to be mined, however there was a small frontier military base nearby. The left board was formed by considerable forest-clad SW foothills of the Ben Bun Mt. (723 m a.s.l.), with partly quite steep SW slope. The lowermost slopes were gentle and affected by human activity, which included:

Figure 7. Signs of human activity at Thma Dar terrain: top left, slash-and-burn upland rice 'culture'; bottom left, a peasant's tent in coppice; top right, a marrow growing among rice; bottom right, a rusted mortar bomb remnant; 27.08.2011.

- a grassy pasture with some sparse long huts and a small herd of cattle but seemingly temporarily abandoned by people (another military station?),

- very old rough roads overgrown with vigorously flowering *Osbeckia* sp. (Melastomacea) bushes and other secondary vegetation (there I found a rusted mortar bomb remnant, Fig. 7, bottom right),

- areas recently cleared for a primitive slash-and-burn agriculture, with the forest cut and burnt out and upland rice planted (Fig. 7, top left).

At Thma Dar locality, a considerable rapidous rivulet joined the Koh Bopw from its left side; further I will call it 'Prodasineura rivulet'. It had a spectacular valley of huge sandstone rocks, some of the flat ones being so encarved by water that are often perforated by curious holes (the nature obviously hinted the Angkor Wat creators what was to be done with sandstone), and some forming vertical layered walls seeping with water (Fig. 54). I examined the valley of the main river for 500 m upstream of the mouth. Some distance downstream the 'Prodasineura River' mouth along the main river, the latter accepted a brook which descended from the steep forested slope where was seen to have a very impressive high waterfall. The pools formed by the brook had unusually developed green submerged algal slime, in spite of the water current. Soon upstream the mouth the brook forked into two very steep valleys crossed by several fallen huge trees. I will call it 'Gynacantha brook'. I examined the Thma Dar area in an overcast and partly rainy day ended with heavy rain lasting overnight and continued on the following day. Maybe for this reason there were not a single leech and odonates were rather scarce.

In the close vicinity of Koh Kong I revisited the mangrove and swampy area includeing' Cora marsh' (Fig. 35), the beach at the estuary bank, the Peam Krasaop Natural Sanctuary (Kosterin 2010: 10-12, 52; Kosterin, 2011: 12-13, 77) and investigated two shallow freshwater ponds adjacent from the east to the road to Peam Krasaop, further called 'Calamorum ponds'. They were separated from the mangrove marsh by the road embankment, rimmed by ditches with running brackish water, but the ponds were not connected to them. They were surrounded by sparse, perhaps planted trees and a buffalo pasture retaining some quasi-natural vegetation with bushes and *Ligodium* ferns. Large areas of the lowland SW suburbs of Koh Kong appeared to be freshwater swamps with *Melaleuca cajuputi* open stand, a very peculiar biocoenosis connecting mangroves and forests, but I failed to examine them due to the non-stopping rain during my last day in Cambodia.

Along the road to Pursat I revisited the localities with the following conventional names given in Kosterin (2011): 'Femina Swamp' (Ibid.: 19-20, 78) (but too briefly), 'Lispe *Veal*' (Ibid.: 20-21, 79), 'Aciagrion Rivulet' headwater (Ibid.: 21-23, 79), 'Hemi-

cordulia brook' (Ibid.: 24-26, 79), 'Nannophya rivulet' (Ibid.: 24-32, 80), 'Nepenthes brook' (Ibid.: 32-34, 80) and 'Capricornis rivulet' (Fig. 59a) (Ibid.: 34-39) but omitted 'Archibasis brook' and 'Glaucum brook'. Three new localities were added here:

- From the margin of 'Lispe *Veal*' several hundred metres W of 'the Aciagrion Rivulet' I entered the forest, which was dense but not so tall there (with some *Sphagnum* cushions occurring on the ground), and wandered for 1.5 hours via some system of paths and even old roads overgrown with coppice. I crossed two rapidous rivulets with beds made of broad sandstone blocks, a very shallow and slow brook with black bottom formed by leaf litter, and two small *veals*. I will call this place 'Callidula low forest'.

- Behind the 'Nannophya rivulet' the road crossed another rivulet somewhat larger than the latter, with a small village on its right side downstream the road (Fig. 59b). Upstream the road it formed a long and a man-height deep shady reach with slow current and silty bottom. It has to accept the name 'Macromia rivulet', after my main prey there.

- Between this rivulet and the 'Nepenthes brook' I found a road leading to the Righ Tatai River right bank where it had an open rocky bank with very sparse bushes, followed by a tiny, shallow (a knee-deep) and very warm oxbow with grassy bank and a *Batrachium*-like submerged plant. Nearby downstream there was a kind of a very large bay. This locality will be called 'Chrysis bay'.

Between the 'Macromia rivulet' and 'Chrysis bay' the new wide road to Pursat, constructed by Chinese, leaved the old one (leading to 'Capricornis rivulet' and on) and turned left. There was a checkpoint with guards who ban foreigners passing by motorbike. However, our mentioned temporal international team had no problem to pass it in a rented car for a day-long excursion reaching three localities situated in the Central Cardamonian Protected Forest and quite distant from those examined by me in 2010. The road was good but completely isolated from the surrounding vibrant nature by hardly permeable mounds of bulldozered ground and dead trees. Via brand-new steel bridges we crossed five large rivers with either clear or turbid water, three very close to each other, which must be the Koh Por and its tributaries, and witnessed dams and power-producing tunnel being constructed. Only at one single point the road came close to a river bank allowing its examination but we could not afford this to ourselves due to the lack of time. After crossing the fifth river, the road ascended quite high uphill and then proceeded along a kind of a long plateau with a chain of *veals*. Because of two of us were interested in carnivorous plants, we stopped and examined three of these *veals*. All of them were characterized by the presence of nearly flat sandstone surfaces seeping with water. I denote these *veals* by the following conventional names:

- 'Doritis *veal*' (after *Doritis* (*Phalaenoides*) *pulcherrima*). This was a very small treeless *veal* (Fig. 1a) outlined from the south by a considerable brook, mostly hidden in thickets including *Pandanus*, *Calamus* and various trees and at last disappearing under the rocks and re-appearing quite apart and below quite a steep forested slope. Close to where it entered an open area there were some shallow pools with submerged vegetation and nearly hot water.

- 'Anax *veal*'. This was a large *veal* producing several 'bays' surrounded by forest. It was a true savannah with sparse stand of trees among which most impressive were Tenasserim pines (*Pinus latteri* Mason); that is I at last reached the notorious pine parklands being a feature of central Cardamom uplands (Fig. 8). The wind roared in the pine crowns, quite picturesque against gloomy clouds, and one could imagine he got somewhere in the North, but 'nests' of the deer-horn epiphytic ferns (*Platyceros* sp.) growing on pine trunks returned the observer back to tropics (Fig 8, right). The road went across the *veal* and was accompanied by a chain of huts, with some roadside pools next to them. The *veal* was crossed by two brooks. One of them had a sandy bed, soon it entered the forest and then outlined its margin but under the forest canopy; there I for the first time saw several tree ferns (*Cyathea* sp.?) (Fig. 9). The other, let it be the 'Anax brook', appeared from coppice, flowed through an open area over a flat sandstone bed, then narrowed as enclosed in grassy banks with several cushions of *Sphagnum* (Fig. 29b) and then fell down some cliffs in a steep forested gorge and disappeared from sight.

- 'Delphiniodes *veal*' (named after *Utricularia delphinioides* Torel ex Pellegr., which we found there). This was the most remote and the largest *veal* I saw. It was flat and drier than two previous ones but still was an open savannah with pines, although having large treeless areas. Some of them were boggy and grassy (mostly Juncaceae), crossed by a tiny brook with a ground bed, some were patches of open white sand, large area was occupied by sandstone flat rocks (Fig. 1d). From NW the *veal* was fringed by a steep escarpment sinking into the ocean of forest, from where an impressive view opened on the Phnom Samkos Mt. (1717 m a.s.l.), the second high peak of Cambodia, that time partly hidden by a downpour (Fig. 10).

In the vicinity of Tatai village I revisited the 'Oculata brook' and Andy's pond (Kosterin 2010: 27-30: 54; Kosterin 2011: 43-44, 81), the Tatai waterfall (Kosterin 2010: 21-22; 53-54; Kosterin 2011: 39-40, 80-81) and the nearby 'Rhinagrion brook' (Kosterin 2011: 40-41, 81) but not the 'Masoni brook'. Besides, through the courtesy of Gee Chartier, I examined two more sites:

Figure 8. 'Anax *veal*', with an open stand of Tennaserim pines (*Pinus latteri* Mason), with epiphytic fern *Platyceros* sp. growing on them (right), 13.08.2011.

- the surroundings of Rainbow Lodge on the right bank of the Left Tatai River estuary 1.7 km N of the Phnom Doung bridge at Tatai village. This was a hill slope clad with dense bamboo forest, most probably secondary since it hid some very old roads. Bamboo came close to the river bank with usual semi-mangrove arboreal vegetation and some patches of grassy swamps (tall sedge with a characteristic *Ligodium* fern). Tiny brooks descending from the hill had water smelling of iron, and Gee said the compass hand indicated at the hill rather than at the North.

- a bank of the Right Tatai River where it forms a large bay with slow reverse current along a rocky bank; and also the adjacent western slope of the above mentioned hill, covered with 'normal' primary forest and crossed by two small shady brooks. This locality is called 'Lake area' by the Rainbow Lodge keepers.

Another new locality was a large and quite elevated (340-380 m a.s.l.) savannah-like *veal* (Fig. 11) crossed by the road to Thma Bang soon after it sprouts the national

highway N48. It was slanting to the south and along the road was marked by a lonely pine but it appeared that open stand of pines (*Pinus latteri* Mason, mostly young trees), *Dipterocarpus obtusifolius* Teijsm. ex Miq., *Melaleuca cajuputi* and some other

Figure 9. Tree ferns (*Cyathea* sp.?) at a rivulet margining 'Anax *veal*', 13.08.2011.

Figure 10. Phnom Samkos Mt., the second high peak of the Cardamoms, as viewed from an escarpment of 'Delphinioides *veal*'. 13.08.2011.

Figure 11. A savannah-like open tree stand typical for *veals* at 'Viola *veal*', 12.08.2011.

trees proceeds down the gentle slope. There were many flat sandstone rocks and some tiny brooks, sometimes with *Sphagnum* cushions, crossing grassy areas. From the west the *veal* was bordered by a considerable rapidous rivulet, the east and south margins were outlined by smaller rivulets. All this quite a large area is considered here as one locality which accepts the conventional name 'Viola *veal*'.

At quite a distance down the slope of 'the Viola *veal*' I shortly examined a nice small river with alternating up-to-the-neck deep reaches with a sandy bed and rapidous rocky reaches and forested banks, the left one being steep. I name it the 'Neurobasis River', for the lack of more peculiar findings.

In Thma Bang District I revisited the localities examined before; the 'Microgomphus River', deep upstream (Fig. 25) and shallow downstream the bridge (Kosterin 2010: 32-35, 54-55; Kosterin 2011: 44-46, 81-82) and rapids on the Thma Bang River. In my previous report (Kosterin, 2011: 46-47, 82) I wrongly considered the later as 'the Thma Bang waterfall' but in fact the actual waterfall, which I did not manage to visit, was situated much downstream. I added a large shallow pond within outskirts of Thma Bang village. It had an extremely warm water from where some *Eleocharis*-like

spikerush emerged; at one bank there were thickets of *Scirpus*-like bulrush, at another a curious stand of tall Fabaceae bushes also emerging from water (Fig. 31). I'll call it 'Triangularis pond'.

Kampot Province

On the Bokor Plateau I revisited 'Praemorsus pond' (now destroyed) (Kosterin 2011: 53, 82-83), 'Bokorensis mire' (Ibid: 53, 83; I have to correct its size which was in fact 0.4 x 0.5 km), and the Popokvil River at the upper bridge and at the waterfall (Ibid.: 61-63, 83-84); now I also examined dense bracken thickets over large boulders at its right bank near the waterfall. I also investigated the following new localities:

- very shallow pools over a sandy bulldozered ground near 'Praemorsus pond', to be called 'Minutissima pit' (after a tiny lilac-flowered *Utricularia minutissima* Wahl. which was very abundant, see Fig. 58c);

- an old sandy road between 'Bokorensis mire' and 'Limbata ponds', seeping with shallow water; it was overgrown with flowering *Utricularia odorata* Pellegr.- 'Odorata road' (Fig. 58a, b);

- the Popokvil river at the end of this road (upstream of the upper bridge) and the adjacent rather tall forest but still with some *Dacrydium elatum* (Roxb.) Wahl. ex Hook. The river had a sandy bottom, the depth varied from several cm to about a knee-deep (Fig. 57). The river carried flocks of a thick 'light-brownish' foam. In the nearby forest, there were a chain of shallow 'black' stagnant pools (Fig. 37a) and a natural tiny knee-deep swamp, densely overgrown with a tussock sedge (*Carex* sp.) (Fig. 37b); both connected to some small brooks. Let us call this area 'Idionyx reach' of the Popokvil River;

- the Popokvil River at an open area at the upper bridge;

- the Popokvil River between the upper and lower (near the waterfall) bridges and the adjacent newly bulldozered ground roads.

North of Kampot I examined a locally popular recreation site, the Tek Chhou Rapids at the major River of Kampot (does it has an own name?). Upstream of them at the place where this river leaf the eastern slopes of the Bokor Plateau, another dam is being constructed by a Chinese company. The rapids at that site were mighty and impressive (Fig. 12) but people said (exaggeratingly, I suppose) that the torrent was just a remnant of what they have been seeing before the dam construction. The right bank was cliffy in its lower part and gentle, with groups of *Pandanus* sp. at the

Figure 12. Tek Chhou Rapids at the River of Kampot, 21.08.2011.

water edge, on its upper part, where numerous wooden picnic platforms were constructed. The left bank was flat and occupied by a vast floodplain, close to the river being a shingle and boulder field almost devoid of vegetation and becoming sandy with secondary tree groves at distance.

Behind that floodplain, at the valley border, there was a large oxbow lake more than human-height deep at middle, with partly firm grassy and partly bushy banks. I'll call it 'Decoratus oxbow'.

At some distance from Tek Chhou towards Kampot, a medium-sized rivulet (Fig. 13) descended from the southeasternmost foothills of the Bokor to the main river. It had a rocky bed, was moderately rapidous and ran mostly through rather open countryside with secondary vegetation (*Mimosa* bushes and tree groups) and some plantations. Some patches of its banks were shaded and had large rocks. It accepts the conventional name 'Gracilis rivulet'.

Within the town of Kamot I examined, unfortunately just for an hour in the evening, a very large (150 m in diametre) round pond not far from the river, with very shallow water completely hidden by dense vegetation composed of tall grasses (Poaceae) and bulrush (*Scirpus* sp.), lotus (*Nelumbo nucifera* Gaertn.), water hyacinth (*Eichhornia crassipes* (Mart.) Solms), *Salvinia* sp. and water clover (*Marsilea* sp.). This pond will be called 'Aethriamanta pond'.

I also examined patches of bushy mangroves on sandy or muddy ground and one spikerush (*Eleocharis* sp.) marsh, obviously a former rice field, in the southern suburbs of Kampot.

Kep Province

I visited the 'Ludwigia pond' within lowland Kep, 'Zyxomma pond' and 'Platystylus brook on the Kep Hill (Kosterin 2010: 44-51, 56-57 [still no conventional names in that paper]; Kosterin 2011: 69-76, 84-85). The 'Platystylus brook' valley was cleared from coppice for some distance from the pond, to facilitate water supplying of the lower lying households through pipes coming from tiny reservoirs, obviously renewed recently. On the contrary, the valley upper parts became impermeable (Fig. 14) since the path was overgrown with thorny wining herbs.

Figure 13. 'Gracilis Rivulet' flowing from the foot of Bokor Plateau through countryside, 6.2 km NNW of Kampot, 21.08.2011.

Figure 14. Dense thickets in 'Platystylus brook' valley on Kep Hill, 20.08.2011.

The end of Bokor

I am sure this was my last visit to the Bokor Hill Station since nothing left to explore there. They finished the road, both ascending the plateau slope and going above its surface, and it looked pretty as surrounded by neat short cut lawns. A huge tasteless building of the new casino was towering in fogs, surrounded by miserable huts of its constructors and their families, hardly believable to be human dwellings (Fig. 15a). First customers were expected in 2012 already. Something huge was being constructed from concrete immediately above the Popokvil Waterfall, most probably for customers to watch it from a 'convenient' platform. Adjacent to the pagoda, a huge pavilion appeared showing a model of what they are going to construct (Fig. 16): a town with three thousand houses not counting tall building (I have no idea who is going to rent a house in a fog). Noteworthy, the town will cover all open areas, and the open area free of houses will be occupied by artificial ponds. No room will be left for the peculiar and rich boggy communities of the plateau, which harbour all known, and so far quite rich, populations of the endemic pitcher plant species *Nepenthes bokorensis* Mey. (and also of other carnivorous plant species: two of *Drosera* and five of *Utricularia*, F.S. Mey pers. comm.). Needless to say there will be no room for the natural community of lentic Odonata as well. During our two-day long trip, the 'Prae-

Figure 15. Devastating human activity on Bokor Hill, within the limits of Preah Monivong National Park: a) a new casino being constructed; b) expanding the road to Popokwil Waterfall; c) draining 'Bokorensis mire'; d) dumping ground onto 'Limbata ponds'; 18.08.2011.

Figure 16. A model of the town to be constructed on Bokor Hill in a pavilion adjacent to the pagoda.

morsus pond' still existed but its banks were bulldozered and almost lacked grass. I was just a couple of days late to investigate the 'Limbata ponds' where I had found rich fauna in December (Kosterin 2011): this time I witnessed a chain of heavy goods vehicles dumping ground onto these ponds (Fig. 15d). I could still examine the huge 'Bokorensis mire' but an excavator was simultaneously digging a ditch to dry it out (Fig. 15c). On the model, one could see some coppice left, but the developers seemed to have never heard that wetlands might be of some value as well, and were going to leave no tiny shelter for them to retain. Prolongation of the Preah Monivong National Park jurisdiction over this territory looks now a cynic grim of the world of money.

The Bokor Plateau is huge and still contains places where no road leads to, but it is covered with continuous forest except for the area between Bokor Hill Station and Popokvil River where large open wetlands once existed but are being exterminated right now, even before they have been studied odonatologically.

By-locality list of Odonata recorded during the trip.

Coordinates were retrieved from GoogleEarth® unless otherwise stated. The 59 localities visited are numerated throughout and shown on a general map of Fig 5. Time of beginning and end of observation/collecting was inferred from field notes and accessory data of digital photographs (in total 2,108 taken) and rounded to 5-10 minutes. In total, neat field work for 16 days took 79 hours 50 minutes. 'Released' means captured, examined and released. Generic names in full and species authors are given upon the first mentions of species in this section. Asterisks indicate the very first findings of new species for Cambodia. Any specimens are available for investigation upon request but sending from Russia is difficult.

Koh-Kong Province

I. Thma Dar locality (Fig. 6-7) at the lowermost waterfall on the Koh Bopw River, 27 km NNW of Koh Kong, ~6 km N of Khlong Yai.

1. The main river at the waterfall. 11°49'58'' N, 102°53'20'' E, 10 m, 27.08.2010: 10:20-11:10 a.m. *Euphaea masoni* Selys, 1859 - 1 ♂ seen; *Prodasineura autumnalis* (Fraser, 1922) – 1 ♂ seen; *Pantala flavescens* (Fabricius, 1798) – many seen; *Orthetrum sabina* (Drury, 1770) – several seen.

2. Its tributary 'Prodasineura rivulet' (Fig. 54), a medium-sized rapidous left tributary of the Koh Bopw. 11°49'55''-50'03'' N, 102°53'27-38'' E, 10-72 m, 27.08.2010: 9:10-10:20 a.m. and 11:10 a.m. – 1:15 p.m. *Neurobasis chinensis*

(Linnaeus, 1758) – 1 ♀ seen; *E. masoni* – several ♂♂ seen; *Dysphaea gloriosa* Fraser, 1938 – 2 ♂♂ seen; *Heliocypha perforata limbata* (Selys, 1879) – many ♂♂ seen; *P. autumnalis* – many seen; *Prodasineura verticalis* sensu Asahina, 1983 –4 ♂♂, 3 ♀♀ collected, some more ind. and several tandems seen; *Neurothemis fulvia* (Drury, 1773) – 1 ♂ seen at a road pool nearby; *P. flavescens* – many seen; *Trithemis aurora* (Burmeister, 1839) – 1 ♂ seen; *Zygonyx iris malayana* Laidlaw, 1902 – many ♂♂ seen, 1 ♂ photographed.

3. Its tributary 'Gynacantha' brook, with a high waterfall seen uphill. 11°49'47-48'' N, 102°53'38-41'' E, 27.08.2010: 10-25 m (coordinates very uncertain), 2:40-3:45 p.m. *Vestalis gracilis* (Rambur, 1842) – several seen; *H. biforata* – several ♀♀ seen; *Coeliccia kazukoae* Asahina, 1984 – 1 ♂ collected, 1 tandem photographed (Fig. 47), 1 more ♂ seen; *Copera vittata* (Selys, 1863) – 1 ♂, 1 immature (ghost) ind. seen; *P. verticalis* sensu Asahina, 1983– several ♂♂ seen; *Gynacantha subinterrupta* Rambur, 1842 – 1 ♀ collected, 1 more ind. seen; *T. aurora* – 1 ♂ seen; *Trithemis festiva* (Rambur, 1842) – 1 ♂ seen; *Orthetrum chrysis* (Selys, 1891) – several ♂♂ seen.

II. Koh Kong to Peam Krasaop Wildlife Sanctuary (coordinates uncertain).

4. A road near the Peam Krasaop Wildlife Sanctuary 'market'. 11°33'30'' N, 102°59'30'' E, 2 m, 26.08.2011: ca 5 p.m. This time no Odonata found.

5. 'Calamorum ponds' E of the road to Peam Krasaop. Coordinates not available. 26.08.2011: 3:50-4:30 p.m. *Lestes praemorsus decipiens* Kirby, 1893 – 1 ♂ collected; *Agriocnemis minima* Selys, 1877 – 1 ♀ collected; *Aciagrion borneense* Ris, 1911 – 3 teneral ♂♂ collected; *Paracercion calamorum dyeri* (Fraser, 1919) – 4 ♂♂ collected, 1 ♂ photographed (Fig. 34), many seen; *Pseudagrion microcephalum* (Rambur, 1842) – 1 ♂collected, several ♂♂ seen; *Crocothemis servilia* (Drury, 1770) – 1 ♂ seen; *Neurothemis fluctuans* (Fabricius, 1793) – several seen; *Rhyothemis phyllis* (Sulzer, 1776) or *variegata* (Linnaeus, 1763) – 1 ind. seen.

6. Near beach on the Koh-Kong estuary left bank. 11°34'54'' N, 102°58'34'' E, 2 m, 26.08.2011: 3:20-3:45 p.m. *Ischnura senegalensis* (Rambur, 1842) – 1 ♂ seen; *C. servilia* – 1 ♂, 1 ♀ seen.

7. 'Cora marsh' (Fig. 35), at an old cemetery, W of the road to Peam Krasaop just behind it leaves Koh-Kong at the school. 11°35'27'' N, 102°58'53'' E, 2 m, 26.08. 2011. 2:20-3:15 and 5:20-5:40 p.m. *Agriocnemis minima* Selys, 1877 – 1 ♂, 1 immature red ♀, 1 mature ♀ collected; *Ceriagrion cerinorubellum* (Brauer, 1865) – 1 ♀ collected; *Ceriagrion calamineum* Lieftinck, 1951 – 1 ♂ collected; *I. senegalensis* – several ♂♂, ♀♀ seen; *P. calamorum dyeri* – 1 ♂ collected; *P. microcepha-*

lum – 2 ♂♂ collected; *Brachythemis contaminata* (Fabricius, 1793) – 1 ♂ seen; *N. fluctuans* - several ♂♂, ♀♀ seen; *Neurothemis tullia* (Drury, 1773) – several ♂♂, ♀♀ seen; *O. sabina* (Drury, 1770) – many seen; *Tholymis tillarga* (Fabricius, 1798) – many ♂♂, ♀♀ seen; *Trithemis pallidinervis* (Kirby, 1889) – 1 ind. seen.

III. Road towards Pursat

8. Forest 'Femina swamp', Koh-Kong E suburbs. 11°37'11'' N, 103°01'25'' E (GPS), 16 m, 13.08.2011: ca 8 a.m.; 14.08.2011: 4:20-4:30 p.m. *N. fluctuans* – many ♂♂, several ♀♀ seen: *R. phyllis* – 1 ♂ collected 14.08.

9. 'Lispe *veal*', 13 km ENE Koh-Kong, shallow roadside pools. 11°39'34'' N, 103°05'45'' E (GPS) 286-316 m, 13.08.2011: ca: 9 a.m. 16.08.2011: 2:50-3:30 p.m. *C. calamineum* – 1 ♂ collected 16.08; *B. contaminata* – 1 ♀ seen 16.08; *T. festiva* – 1 ♂ seen; *T. pallidinervis* - 1 ind. seen on both days.

10. A grassy swamplet at the 'Aciagrion rivulet' source at the 'Lispe *veal*' margin, 13 km ENE Koh-Kong. 11°39'35'' N, 103°05'44'' E, 316 m, 13.08.2011: 9:07-9:37 a.m., 15.08.2011: 12:00-12:30 a.m., 16.08.2011: 2:50-3:30 p.m. *L. praemorsus decipiens*- 5 ♂♂ collected, 2 ♂♂ photographed (Fig. 30 a, b), immense ♂♂ seen; **Aciagrion hisopa* (Selys, 1876) – 7 ♂♂, 3 ♀♀ collected (Fig. 45 a-c, e, g, j, l), several ♂♂, ♀♀ seen on 13.08, 1 teneral ♂ photographed (Fig. 44b) 16.08, numerous teneral ind. seen all three days; *A. borneense* – many teneral ind. seen, 1 ♂, 1 ♀ collected 15.08; *C. calamineum* - 1 ♂ seen 13.08 and 16.08; *C. cerinorubellum* - 1 ind. seen 13.08 and 15.08; *Brachydiplax* sp. – 1 ♂ seen 16.08; *Diplacodes nebulosa* (Fabricius, 1793) – several ♂♂ seen; *Diplacodes trivialis* (Rambur, 1842) - 1 immature ♂ seen 15.08; *Indothemis limbata* (Selys, 1891) – 1 ♂ collected, many ♂♂ seen 13.08, none 15.08, several 16.08; *Nannophya pygmaea* Rambur, 1842 – 1 ♀ collected, 1 ♀ seen 13.08, several ♂♂, 1 ♀ seen 15.08; *N. fluctuans* – 1 ♀ collected 13.08; *Neurothemis intermedia atalanta* Ris, 1919 - 1 mature ♂, 1 immature ♀ collected 13.08, 1 mature ♂ seen 15.08; *N. t. tullia* - 1 ♀ seen 13.08; *O. chrysis* – 1 ♂ seen 16.08; *P. flavescens* - several ind. seen 13.08, 1 ♂ released 16.08; *R. phyllis* – 1 ♀ collected 16.08; *Tramea transmarina euryale* Selys, 1878 – 2 ♂♂ seen 16.08.

11. 'Callidula low forest' crossed by two rapidous rivulets, and two small *veals*, all N of 'Lispe *veal*', 11°39'35''-40'16'' N, 103°05'20-44'' E, 280-330 m (data very uncertain), 15.08.2011: 8:40-10:10 a.m. *V. gracilis* - many ind. seen; *N. chinensis* - 1 teneral ♀ photographed (Fig. 21); *E. masoni* - 1 ♂, 1 ♀ collected, 1 ♂ seen; *H. biforata* - 2 ♀♀ collected; 1 ♂ seen; *C. vittata* - 1 ind seen; *Gynacantha* sp. - 1 ind seen; *N. fluctuans* – 1 teneral ♂ seen. Small *veals*: *I. limbata*: 1 ♂; *T. aurora* - 1 ♂ seen; *O. sabin*a - 1 individual seen.

12. 'Hemicordulia brook', 13 km ENE Koh-Kong. 11°39'55'' N, 103°05'34'' E, 315 m, 15.08.2011: 10:25-11:40 a.m. *V. gracilis* – several ind. seen; *N. chinensis* - 1 ♂ seen; *H. biforata* - 1 ♂ seen; *Pseudagrion pruinosum* (Burmeister, 1839) - 1 ♂ collected; *P. verticalis* sensu Asahina, 1983 - 3 ♂♂ collected; *Hemicordulia* sp. – 1 ♂ collected (Fig. 22), 1 more ♂ seen; *Nannophya pygmaea* - several ♂ seen; *N. fluctuans* - 1 mature ♂ seen; *O. chrysis* - 2 ♂♂ seen; *Rhyothemis obsolescens* Kirby, 1889 - 4 ♂♂ seen, of them 1 ♂ collected, 1 ♂ photographed (Fig. 27 above); *T. aurora* - several ♂♂ seen.

13. 'Nannophya rivulet', 16 km ENE Koh-Kong. 11°40'14-22'' N, 103°07'32-38'' E, 296 m, 14.08.2011: 3-3:20 p.m., 16.08.2011: 9 a.m. – 1 p.m. *N. chinensis* - 1 ♂, 1 ♀ seen on both days; *V. gracilis* – many seen on both days; *E. masoni* – 1 ♂ (Fig. 43a), 1 ♀ collected, 1 more ♂ seen 16.08; *Aristocypha fenestrella* (Rambur, 1842) – 1 ♂ collected 16.08; *H. biforata* - 4 ♂♂ (1 teneral) seen, 7 ♀♀ collected 16.08; *Archibasis viola* Lieftinck, 1949 – 1 ♂ collected, several ♂ seen 16.08; *P. pruinosum* – 1 ♂ collected, several ♂ seen; 16.08; *Pseudagrion williamsoni* Selys, 1836 – 1 tandem collected, 1 ♂ seen 16.08; *C. vittata* – 1 tandem collected 16.08; *P. verticalis* sensu Asahina, 1983 – 8 ♂♂, 3 ♀♀ collected 16.08; **Nepogomphus walli* (Fraser, 1924) – 1 ♀ collected (Fig. 24c) 16.08; *Hemicordulia* sp. – 6 ♂♂ collected, many ♂, 1 copula seen 16.08; *Agrionoptera insignis insignis* (Rambur, 1842) – 1 ♂ collected, 1 more ♂ seen 16.08; *N. fluctuans* - 2 ♂♂, 1 ♀ seen 14.08; *Orchithemis pulcherrima* Brauer, 1878 – 1 ♂ collected, many ♂♂, ?1 ♀ seen (a black individual with a partly pruinosed abdomen, could be also a gynochromic male morph), several ♂♂ photographed (Fig. 28) 16.08; *O. chrysis* – 2 ♂♂ seen 16.08; *O. sabina* - 1 ind. seen 14.08; *Potamarcha congener* (Rambur, 1842) – 1 ♂ photographed 16.08 (at a muddy roadside pool nearby, Fig. 19); *R. obsolescens* – 1 ♂ collected, many ♂♂ seen, some photographed (Fig. 27 below) 16.08; *T. aurora* – several ♂♂ seen on both days; *T. festiva* – several ♂♂ seen 16.08; *T. pallidinervis* – 1 ind. seen at the road 16.08.

14. 'Macromia rivulet' (Fig. 59b), 16 km ENE Koh-Kong. 11°40'51'' N, 103°07'38'' E, 305 m, 16.08.2011: 1:15-2:30 p.m. *N. chinensis* – 1 ♂, 1 ♀ seen; *V. gracilis* – several seen; *Libellago hyalina* (Selys, 1859) – 2 ♂♂ seen; *P. pruinosum* – several ♂♂ seen; *Hemicordulia* sp. – 3 ♂♂ seen; **Macromia cupricincta* Fraser, 1924 – 1 ♀ collected (Fig. 50 c-d); *N. pygmaea* – several ♂♂ seen; *O. chrysis* – 2 ♂♂ seen; *R. obsolescens* – several ♂♂ seen.

15. 'Chrysis bay' at the Right Tatai River right bank, 22? km ENE Koh-Kong. 11°41'04'' N, 103°08'53'' E (coordinates very uncertain), ~217 m, 14.08.2011: 1:50-2:15 p.m. *V. gracilis* - 1 ind seen; *A. viola* - 1 ♂ photographed (Fig. 20); *O. chrysis* – 6 ♂♂ , 1 ♀ seen; *N. pygmaea* - 3 ♂♂ seen; *T. aurora* - 1 ♂ seen.

16. 'Nepenthes brook', 22.5 km ENE Koh-Kong. 11°41'43'' N, 103°10'21'' E (GPS), 286 m, 14.08.2011: 1:15-1:35 p.m. *V. gracilis* - several seen (1 immature ind.*); P. pruinosum* - 1 immature ♂ seen; *P. verticalis* sensu Asahina, 1983 - 1 ♂ seen; *Rhinagrion viridatum* Fraser, 1938 - 1 ind. seen; *I. limbata* – 1 ♂ seen; *T. aurora* - 1 ♂ seen, *Z. iris malayana* - 1 ♂ seen.

17. 'Capricornis rivulet' (Fig. 59a), 25.5 km ENE Koh-Kong. 11°42'31'' N, 103°11'55'' E (GPS), 306 m, 14.08.2011: 9:30 a.m. – 1 p.m. *V. gracilis* - 1 ♂ collected, 2 ind. seen; *N. chinensis* – many ♂♂, several ♀♀ seen; *E. masoni* - very many ♂♂ and 2 tandems seen, of which 1 ♀ collected, 1 ♂ photographed; *H. perforata limbata* - 2 ♂♂ seen, wings of 1 ♂ collected; *P. autumnalis* – 1 ♂ collected, *P. verticalis* sensu Asahina, 1983 - 1 tandem collected, 1 tandem seen; 4 more ♂♂ seen; *R. viridatum* - 1 ♂ photographed, 1 more ♂ seen; **Burmagomphus divaricatus* Lieftinck, 1964 - 1 ♂ photographed and collected; **Macromia septima* Martin, 1904 - 1 ♀ collected; *N. fluctuans* - 2 ♂♂, 1 ♀ seen; *Z. iris malayana* - many ♂♂ seen.

18. 'Doritis *veal*' (Fig. 1a), 11°49'34'' N, 103°04'14'' E (retrieved from LANDSAT, nasa.usgs.gov), 398 m, 13.08.2011: 11:40-12:40 a.m. *V. gracilis* - many seen: *N. pygmaea* - several ♂♂ seen; *N. fluctuans* – 1 ♂ seen; *O. chrysis* - several ♂♂ seen; *Orthetrum glaucum* (Brauer, 1865) - 2 ♂♂ seen, *O. sabina* - 1 ind seen; *T. aurora* - 2 ♂♂ seen; *P. flavescens* - several seen; *Z. iris malayana* – 1 ♂ collected, 3 more ♂♂ seen.

19. 'Anax *veal*' (Fig. 8) with 'Anax brook' (Fig. 29c), 11°49'34-50'' N, 103°04'8-33'' E (LANDSAT, nasa.usgs.gov), 13.08.2011: 1-2:50 p.m. *C. cerinorubellum* – 1 ind. seen; **Anax immaculifrons* Rambur, 1842 – 1 ♂ (Fig. 29a, b), 1 exuvia (Fig. 29d) collected; *Paragomphus capricornis* (Förster, 1914) – 1 ♂ photographed (Fig. 23) and collected; **A. insignis* – 1 ♂, 1 ♀ collected; *D. trivialis* – 1 immature ♂ seen; *N. pygmaea* – 1 ♂ seen by F. Mey; *P. flavescens* – several ind. seen; *T. festiva* – 1 ♂ seen. Roadside pools: *T. transmarina euryale* – 1 mature ♂ collected; *T. aurora* – 2 ♂♂ seen.

20. 'Delphinioides *veal*' (Fig. 1d), 11°53'17-25'' N, 103°04'0-16'' E (LANDSAT, nasa.usgs.gov), 13.08.2011: 3:10-4:10 p.m. *N. pygmaea* - several ♂♂ seen; *N. intermedia atalanta* - 1 ♂ collected (body not bright red, wings bright); *P. flavescens* - several ind. seen.

IV. Tatai village and Phnom Doung Bridge environs.

21. 'Rhinagrion brook', 0.8 km S Tatai Waterfall, 11°34'52'' N, 103°05'37'' E, 80 m, 22.08.2011: 12 a.m. – 3 p.m. *V. gracilis* - 1 tandem photographed (Fig. 17), many

ind. seen; *H. biforata* - many ♂♂ seen, 2 ♂♂ photographed, 3 ♀♀ collected; *R. viridatum* - 1 ♂ photographed, 2 ♂♂ seen; *A. viola* – 1 ♂ seen; *P. pruinosum* - 1 ♂ collected; *P. verticalis* sensu Asahina, 1983 - 1 ♂, 1 ♀ collected; *N. fluctuans* – several ♂♂, 1 ♀ seen.

Figure 17. A copula of *Vestalis gracilis* at 'Rhinagrion brook' near the Tatai Waterfall, 22.08.2011.

22. Tatai Waterfall on the Right Tatai River, 11°35'13'' N, 103°05'45'' E, 18-26 m, 22.08.2011: 3-6 p.m. *V. gracilis* - 1 ind. seen; *N. chinensis* - 1 ♂ seen; *H. perforata limbata* - 1 ♂ seen; *P. pruinosum* - 1 teneral ♂ collected; *P. autumnalis* - 3 ♂ seen; *N. fluctuans* - 2 ♂♂, 1 ♀ seen; *Z. iris malayana* - ca 15 ind. seen; *T. tillarga* - several ind. seen.

23. 'Lake area' on the Right Tatai River, 11°35'46-58'' N, 103°07'12-22'' E, 58-100 m, 24.08.2011, 24.08.2011: 10 a.m – 2 p.m. *N. chinensis* - several ♂♂, ♀♀ seen; *V. gracilis* - several seen; *E. masoni* – 1 ♀ seen; *P. pruinosum* - 1 ♂ seen; *C. kazukoae* – 1 ♂ photographed, 1 ♂ seen; *P. autumnalis* - many ♂, 1 copula, several teneral ind. seen; Gomphidae Gen. sp. - 1 ♀ photographed by Gee Chartier, *Gomphidia* sp.? - 1 ♂ seen; *Cratilla lineata calverti* Förster, 1903 – 1 ♂ photographed

(Fig. 26); *N. intermedia atalanta* - 2 immature ♂♂ seen; *N. fluctuans* - several ♂♂, 2 ♀♀ seen; *O. chrysis* - 1 ♂ seen; *O. sabina* - several seen.

24. Rainbow Lodge on the Left Tatai estuary right bank, 11°35'48-56'' N, 103°07'33-43'' E, 5-70 m, 24.08.2011: 9-10 a.m., 2-3 p.m. *Aciagrion hisopa* - 1 ♂ photographed, 1 more ♂ seen; *N. fluctuans* – several ♂♂, ♀♀ seen; *T. tillarga* – several seen.

25. The stony 'Oculata brook' valley (Fig. 52), 11°33'46-50'' N, 103°07'23-29'' E, 30-100 m, 26.08.2011: 7:15-11 a.m. *V. gracilis* – 2 immature ind. seen; *N. chinensis* – 1 ♀ seen; *H. biforata* – many mature, some immature and teneral ♂♂, ♀♀ seen, 1♂, 14 ♀♀ collected; *R. viridatum* – 1 ovipositing ♀ photographed (Fig. 53); *A. hisopa* – 2 mature ♂♂ seen in the lower part; *C kazukoae* – 2 mature ♂♂ collected, 1 mature ♂ photographed, 5 more mature ♂♂ seen; *C. vittata* – several mature ♂♂, 1 immature (ghost) ind. seen; *Idionyx* sp. – 1 teneral ind. seen; *N. fluctuans* – many (more immature, less mature) ind. seen.

26. Andy's pond on the floodplain where the 'Oculata brook' falls, 11°33'50'' N, 103°07'29'' E, 30 m, 24.08.2011: ca 7 p.m., 25.08.2011: 5:30-5:40 p.m., 26.08.2011: 7:00-7:15 a.m., 11-11:30 a.m. *A. hisopa* – immense teneral and mature ind., many tandems in copula seen, 2 teneral ♂♂, 1 teneral ♀ collected 25.08, 8 ♂♂, 2 ♀♀ collected (Fig. 45 d, f, g, i, k; Fig. 46 a, c), 1 copula photographed (Fig. 44a) 26.08; *Argiocnemis rubescens rubeola* Selys, 1877 – 1 ♂, 1 ♀ (Fig. 33), both immature at the red state, collected, ♀ also photographed 26.08; *I. senegalensis* – 1 ♀ collected 24.08, several seen 26.08; *P. microcephalum* – 2 ♂♂ collected 14 and 25.08; *Anax* ?*guttatus* (Burmeister, 1839) – 1 ♂ seen; *Ictinogomphus decoratus melaenops* (Selys, 1858) – 1 ♂ collected 26.08; **Macromidia rapida* Martin, 1907 – 2 ♂♂ collected at the shallow mouth of the 'Oculata brook' (Fig. 51) 25.08; *C. servilia* – several ♂♂ seen 25.08; *N. fluctuans* – many ♂♂ seen; *T. tillarga* – 1 ind. seen 25.08; *T. aurora* – several ♂♂ seen 26.08; *O. chrysis* – 2 ♂♂ seen at the brook mouth 28.08; *O. glaucum* – 1 ♂ seen at the brook mouth 28.08; *O. sabina* – several seen 28.08; *R. phyllis* – 1 ♀ collected, 1 ovipositing ♀ seen 26.08; *Zyxomma petiolatum* Rambur, 1842 – 1 immature ♂ collected 24.08.

V. The road to and environs of Thma Bang.

27. 'Viola *veal*' (Fig. 1 b, c, 11), 11°35'00-31'' N, 103°13'39-14'17'' E, 339-380 m, 12.08.2011: 9 a.m. – 2 p.m., 3-3:40 p.m.

27a. The *veal* itself: *D. nebulosa* – 1 ♀ seen; *N. t. tullia* – 1 ♂ seen; *O. sabina* – 2 ind. seen; *P. flavescens* – several ind. seen; *T. aurora* – several ♂♂ seen, 1 ♀ collected, 1 ♀ released; *T. festiva* – 1 ♂ released.

Figure 18. *Heliocypha biforata* at a rivulet margining 'Viola *veal*': above, female; below, male, 12.08.2011.

27b. Brooks and rivulets: *N. chinensis* – 1 ♂ seen; *V. gracilis* – 2 ♂♂, 1 ♀ collected (all mature), 1 immature ♂ released, many ind. seen; *E. masoni* – 1 ♂ seen; *H. biforata* – 1 ♂, 1 ♀ photographed (Fig. 18), 1 ♀ collected; *A. viola* – 2 ♂♂ collected, 2 ♂♂ (1 teneral) released; *C. kazukoae* – 1 ♂ photographed and collected; *P. verticalis* sensu Asahina, 1983 – 2 ♂♂ collected; *T. aurora* – 1 ♂ seen; *T. festiva* – 1 ♂ released.

28. 'Neurobasis river'11°34' N, 103°14'' E (coordinates uncertain), ca 280 m, 12.08.2011: 2:20-2:40 p.m. *N. chinensis* – 1 ♂ seen; *V. gracilis* – 1 ♀ photographed, several ind. seen; *Heliocypha* sp. – 1 ♀ seen; *P. verticalis* sensu Asahina, 1983 – 1 ♂ collected.

29. Uncertain locality halfway from National Road 48 to Thma-Bang, 25.08.2011, ca 2:30 p.m. *C. lineata* – 1 ♂, 1 ♀ collected, 1 more ind. seen; *P. flavescens* – 1 ovipositing ♀ seen.

30. '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.

30a. The rapidous reach downstream the bridge (Fig. 25), 23.08.2011: 8:50 – 10:40 a.m. *V. gracilis* - several seen; *N. chinensis* - many ♂♂, ♀♀ seen; *D. gloriosa* - 1 ♂ collected, 1 tandem photographed, several ♂♂ seen; *E. masoni* - many ♂♂, 1 ♀ seen, 2 mature ♂♂ (Fig. 43 b, c), 1 mature ♀, 2 teneral ♂♂, 1 teneral ♀ collected; *H. perforata* - many ♂♂, ♀♀ seen, 9 ♀♀ collected; *B. divaricatus* - many ♂♂ seen, 6 ♂♂collected, 3 ♂♂ photographed (Fig. 48a; Fig. 55 a-b, d); **Gomphidictinus perakensis* (Laidlaw, 1902) - 1 ♂ collected (Fig. 24a); **Onychothemis testacea* Laidlaw, 1902 - 1 ♂ collected; *O. chrysis* - 2 ♂♂ seen; *Orthetrum glaucum* – 1 ♀ collected; *T. festiva* - 2 ♂♂ seen; *Z. iris malayana* - many ♂♂, several tandems seen, 1 ♂ collected.

30b. The slow and deep reach upstream the bridge and a transitory rather slow and shallow section at the bridge, 23.08.2011: 10:40 a.m. – 1:10 p.m., 25.08. 2011: 8:55-10 a.m. *V. gracilis* – several seen; *N. chinensis* – several ♂♂, ♀♀ seen; *D. gloriosa* – 1 ♂ photographed 23.08, 1 tandem seen 25.08; *E. masoni* – several ♂♂ seen on both days, 1 ♀ seen 23.08; *H. perforata* - several ♂♂, ♀♀ seen; *P. pruinosum* - several ♂♂ seen; *Pseudagrion rubriceps* Selys, 1836 - 1 ♂ seen 23.08; *A. viola* - 1 ♂ seen 23.08; *P. autumnalis* - many ♂♂ seen; *B. divaricatus* – 1 ♂ photographed 25.08; *N. walli* - 3 ♂♂, 1 ♀ collected, 1 ♂ photographed (Fig. 56), 1 more ♂ and 1 ♀ seen 23.04, 3 ♂♂, 2 ♀♀ collected, several ind. seen 25.08; *P. capricornis* - 1 ♂ photographed 23.08; *Merogomphus parvus* (Krüger, 1899) - 1 ♀ collected (Fig. 24b) 23.08; *M. septima* - 1

ind. seen 23.08, 2 ♀♀ collected (Fig. 50 a-b), 2 ind. (the same?) seen 25.08; *T. aurora* – several ♂♂, 1 ♀ seen; *T. transmarina euryale* - 1 mature ♂ seen 23.08; *Onychothemis testacea* - 1 or 2 ♂♂ photographed (Fig. 60) 23.08, also seen 25.08.

31. Thma Bang River rapids 6 km SW Thma Bang village [considered as 'waterfall' in (Kosterin, 2011: 46-47, 82)]. 11°39'40'' N, 103°23'46' E, 337 m, 23.08.2011: 1:30-3:30 p.m., 25.08.2011: 10:20-12:40 a.m. *V. gracilis* – very many seen; *N. chinensis* – several ♂♂ seen; *E. masoni* – several ♂♂ seen, 1 teneral ♂ collected 25.08; *H. perforata limbata* - several ♂♂ seen; *P. autumnalis* – several ♂♂, 1 teneral ♀ photographed 23.08, many ♂♂, several tandems seen 25.08; *B. divaricatus* – 1 ♂ collected, 1 ♂ photographed (Fig. 48b; 55c) 25.08; *Burmagomphus* sp. n. – 1 ♂ collected 25.08; *Z. iris malayana* - ca 50 ind. seen in a swarm, many ♂♂ seen, 1 ♂ collected 23.08; several seen in a swarm, several ovipositing tandems photographed (Fig. 61) 25.08.

32. 'Triangularis pond' (Fig. 30) within Thma Bang village, 11°40'13'' N, 103°24'31' E, 372 m (coordinates uncertain), 25.08.2011: 1:20-1:50 p.m. *L. praemorsus decipiens* – 2 ♂♂ collected, 1 ♂ photographed, many ♂♂ seen; *A. rubescens rubeola* – 1 mature ♂ collected; *Ceriagrion malaisei* - 3 ♂♂ collected, 1 ♂ photographed, several ♂♂ seen; *Pseudagrion australasiae* Selys, 1876 – 1 tandem collected, ♂ seen; *P. williamsoni* – 1 ♂ seen; *Anax* ? *guttatus* – several ♂♂ seen; *B. chalybaea* Brauer, 1868– 2 ♂♂ seen; *B. farinosa* Krüger, 1902 – 3 ♂♂ collected, 1 ♂ seen; *D. nebulosa* – 1 ♂ seen; *I. limbata* – 1 ♂ collected; *O. sabina* – 1 ind. seen; *R. phyllis* or *variegata* – 1 ind. seen; *Rhyothemis triangularis* Kirby, 1889 – 1 ♂ photographed (Fig. 32); *T. transmarina euryale* – 1 ♂ seen; *T. aurora* – 1 ♂ seen.

Kampot Province

VI. Bokor Plateau

33. Bokor Hill Station. 10°37'19-55'' N, 104°01'18-38'' E, 1030-1037 m, 18.08.2011: 10-10:30 a.m. *P. flavescens* – many immature seen.

34. 'Praemorsus pond', 2.9 km NE Bokor Palace. 10°38'44'' N, 104°02'21' E, 926 m, 18.08.2011: ca 11:30 a.m. *A. tillyardi* Laidlaw, 1919 – 3 ♂♂ seen.

35. A sandy pit at the *Sphagnum* 'Bokorensis mire', 2.9-3.5 km NE Bokor Palace; coordinates of the mire to be corrected as compared to (Kosterin 2011) as follows: 10°38'47''-39'02'' N, 104°02'11-24'' E, 923 m, 19.08.2011: 15:30-15:45. *A. tillyardi* – several ♂♂ seen; *L. praemorsus decipiens* – 2 ♂♂ seen; *N. pygmaea* – several ♂♂ seen; *O. sabina* – 1 ind. seen; *T. aurora* – several ♂♂ seen.

36. 'Minutissima pit' (Fig. 58c, a bulldozered sandy ground with very shallow pools), 2.9 km NE Bokor Palace, 10°38'46'' N, 104°02'24' E, 923 m, 18.08.2011: 11:00-11:30 a.m.; 19.08.2010: 3:30-3:50 p.m. *L. praemorsus decipiens* – 1 ♂ seen; *A. tillyardi*– 4 ♂♂ collected 18.08, several seen; *C. cerinorubellum* – 1 ♂ seen; *N. pygmaea* – 1 ♂ collected, 2 more ♂♂; *N. fluctuans* – 1 ♂ seen.

37. 'Odorata road' (Fig. 58) very shallow lotic pools over an old sandy road going across a *veal*, 3.6 km NE Bokor Palace, 3.6 km NE Bokor Palace, 10°39'03-13'' N, 104°02'14-26' E, 921-927 m, 18.08.2011: 11:50-12:10 a.m., 1–1:20 p.m.; 19.08. 2011: ca 8:48, 11:00 a.m. and 3:30 p.m. *A. borneense* – 1 ♀ collected; *A. tillyardi* – several ♂♂ seen; *Agriocnemis nana* (Laidlaw, 1914) – 1 red immature ♀ collected 18.08; *A. guttatus* – a ranging ♂ observed at 11 a.m. on 19.08; *Hemicordulia* sp. – 2 ♂♂ collected, 3 more ♂♂ seen 18.08; *D. trivialis* – 1 mature ♂ seen 18.08; *T. aurora* – several ♂♂ seen.

38. 'Idionyx reach' of the Popokvil River (Fig. 57) and the adjacent forest brooks, 3.6-3.9 km NE Bokor Palace 10°39'12-19'' N, 104°02'12-21' E, 925-932 m, 18.08. 2011: 12:10 a.m. – 1.p.m., 19.08.2011: 8:50 - 11:00 a.m., including:

38a. The river itself. 10°39'12-19'' N, 104°02'12-21' E, 925-932 m, 18.08.2011: 12:30 a.m. – 1.p.m., 19.08.2011: 8:50 - 11:00 a.m., 19.08.2011: 9:10 - 10:30 a.m. *A. viola* – 1 ♂ seen 19.08; *P. pruinosum* –1 ♂ collected, 1 tandem seen 18.08; *Hemicordulia* sp. – 1 ♂ seen 19.08; **Idionyx* ? *thailandica* Hämäläinen, 1985 - 1 teneral ♀ photographed (Fig.39) and collected 19.08.

38b. Shady forest pools with black bottom connected with a tiny brook (Fig. 37a), 10°39'14'' N, 104°02'15'' E, 928 m, 18.08.2011: 12:10-12:30 a.m., 19.08. 2011: 8:50 - 9:10 a.m. *H. biforata* – 1 immature ♂ collected 19.08; *A. viola* – 1 ♂ seen 18.08; *C. vittata* – 1 tandem, 1 immature ♂ collected 18.08, 1 ♂ seen 19.08, several immature ind. seen in both days; **Lyriothemis elegantissima* Selys, 1883 - 1 ♂ collected, another ♂ and an ovipositing ♀ seen 18.08; *O. chrysis* – 1 ♂ seen at a forest edge 18.08.

38c. A tiny sedgy swamp (Fig. 37b) near the river, 10°39'17'' N, 104°02'13'' E, 922 m. 19.08.2011: 10:30 - 11:00 a.m. *A. tillyardi* – several copulae, tandems and ♂♂ seen, 1 tandem photographed; *A. viola* – 1 ♂ seen; *Hemicordulia* sp. – 1 ♂ seen; *L. elegantissima* - 1 ♂ photographed (Fig. 38), another ♂ seen.

39. The Popokvil River at the upper bridge, 3.9 km NE Bokor Palace. 10°39'06'' N, 104°02'43'' E, 920 m, 19.08.2011: 11:40-12:10 a.m. *I. senegalensis* – 1 ♂ seen; *P.*

australasiae – 1 ♂ collected, 1 tandem seen 19.08; *P. pruinosum* –many ♂♂, several tandems seen; *A. guttatus* – 1 ovipositing ♀ photographed (Fig. 36); *O. chrysis* – several ♂♂ seen; *T aurora* – many ♂♂ seen; ?*T. festiva* – 1 ♂ seen.

40. The Popokvil River between the upper and lower bridges and at the former, also adjacent new ground roads, 3.9-4.9 km NE Bokor Palace, 10°39'06-30'' N, 104°02'43''-03’09’’ E, 916-926 m, 18.08.2011: 3:10-3:30 p.m.; 19.08.2011: 12:00 a.m. - 1:10 p.m. *V. gracilis* – many (some teneral) seen, 1 ♂ photographed 19.08; *L. praemorsus decipiens* – 1 teneral ♀ photographed and collected (Fig. 30c) 18.08; *A. tillyardi* – 2 ♂♂ seen 18.08; *P. autumnalis* – 1 ♂ collected 19.08; *Hemicordulia* sp. 1 ♂ seen 19.08; *N. fulvia* – 1 ♀ photographed; *O. chrysis* – several ♂♂ seen 19.08; *P. flavescens* - several seen; *T. aurora* – 1 ♀ seen 18.08.

41. Popokvil River at and just upstream of the waterfalls (including bracken thikets over large boulders at the right bank), 4.9 km NE Bokor Palace. 10°39'30-33'' N, 104°03'04-06'' E, 912-918 m, 18.08.2011: 2-3 p.m. 19.08.2011: 1:20-2:40 p.m. *V. gracilis* – 2 ♂♂, 1 ♀ collected 18.08, many seen, 1 teneral ♀ photographed, another teneral ind. seen; *E. masoni* – 1 ♂, 1 ♀ collected, 1 more ♂ seen; *A. tillyardi* – 1 teneral ♂, 1 teneral ♀ collected 19.08; *C. vittata* – 1 ♂, 1 immature ind. seen 18.08; *A guttatus* – 1 ♂ seen above a road 19.08.

VII. Kampot and environs.

42. Tek Chhou Rapids (Fig. 12) on the right major river forming the River of Kampot, 10°40'13-19'' N, 104°07'47’’-08’15'' E, 6-12 m (data uncertain), 21.08.2011: 9:00-10:40 and 12:00-12:40 a. m. *V. gracilis* – 1 ind. seen; *Copera marginipes* (Rambur, 1842) – 2 ♂♂ seen; *P. autumnalis* – 1 ♂ seen, 1 teneral ind. collected; *D. trivialis* – 1 mature ♂ seen; *N. fulvia* - 1 ♀ collected, several ind seen; *O. chrysis* - several ♂♂ seen, several ind. seen; *R. phyllis* or *variegata* – 1 ind. seen.

43. ‘Decoratus oxbow’ at the left slope of that river valley, 10°40'19'' N, 104°08'12’ E, 6 m (data very uncertain), 21.08.2011: 10:40-12:00 a.m. *P. autumnalis* – several ♂♂ seen; *P. australasiae* - several ♂♂, several tandems 1 ♀ seen; *P. rubriceps* – 2 tandems seen; *A. guttatus* – 1 ♂ seen; *I. decoratus melaenops* – 1 ♂ collected, 2 more ♂♂ seen; *B. chalybea* – 1 ♂ seen; *C. servilia* – 1 ♂ seen; *Lathrecista asiatica* (Fabricius, 1798) – 1 ♂ photographed nearby; *N. fluctuans* – several ♂♂ seen; *N. fulvia* - several ind., seen; *O. chrysis* – 1 ♂ seen (in a shallow part); *O. sabina* – 1 ind. seen nearby; *R. phyllis* – 1 ♀ collected; *R. phyllis* or *variegata* – 1 ♀ collected (alike *phyllis* and dark spots at triangles absent, but basal black bands long and wavy, apical dark spots large, wing membrane yellowish); *T. aurora* – many ♂♂ seen.

44. 'Gracilis rivulet' (Fig. 13), 10°38'49'' N, 104°08'27''' E, 43 m, 6.2 km NNW of Kampot (data uncertain), 21.08.2011: 1:30-2:30 p.m. *V. gracilis* – 1 ♂, 1 ♀ collected, numerous seen; *N. chinensis* – 2 ♂♂, 2 ♀♀ seen; *C. marginipes* - 1 ♂ collected; *P. autumnalis* – 1 ♂ seen; *T. aurora* - many ♂♂, 1 ♀ seen; *O. sabina* – 1 ind. seen; *O. chrysis* – 2 ♂♂ seen; *P. congener* – 1 ♀ collected.

45. 'Aethriamanta pond' within Kampot, 10°36'10-15'' N, 104°10'54-59'' E, 21.08.2011: 5:10-6:00 p.m. *Agriocnemis* f. *femina* (Brauer, 1868) – 1 ♀ collected; *Ceriagrion praetermissum* Lieftinck, 1929 – 2 ♀♀ collected; *Onychargia atrocyana* Selys, 1865 – 1 ♀ seen; *Acisoma panorpoides panorpoides* Rambur, 1842 – numerous ♂♂, ♀♀ seen; *Aethriamanta brevipennis* (Rambur, 1842) – 1 ♂ collected; *B. chalybaea* – 1 ♂ seen; *C. servilia* – 1 ♀ seen, *O. sabina* – 1 ind. seen.

46. Mangrove and spikerush marshes in Kampot S suburbs, 10°35'30-38'' N, 104°11'28-46'' E, 2 m, 4:30-5:00 p.m. *Agriocnemis pygmaea* (Rambur, 1842) – 2 ♀♀ collected; *I. senegalensis* - 2 ♂♂, 1 ♀ seen; *P. flavescens* – several seen.

Kep Province

VIII. Kep environs.

47. Lowland 'Ludwigia pond'. 10°29'10'' N, 104°17'36'' E, 27 m, 17.08.2011: 4-5 p.m., 20.08.2011: 2-3 p.m. *Agriocnemis pygmaea* – 2 ♂♂, 2 ♀♀ collected 17.08, several ♂♂, ♀♀ seen; *Ceriagrion malaisei* Schmidt, 1974 – 1 ♂ collected, 2 ♂♂ seen 17.08, 1 ♂ seen 20.08; *I. senegalensis* –1 ♂, 1 ♀ collected 17.08, many ♂♂, ♀♀ seen; *P. australasiae* – 1 ♂, 1 ♀ collected 17.08, several ♂♂, ♀♀ seen; *Copera ciliata* – 1 ♂ photographed (Fig. 40), 1 ♀ collected 17.08, several ind. seen; *I. decoratus melaenops* – 1 ♂ photographed (Fig. 41) 17.08 and 20.08; *A. guttatus* – 1 ovipositing ♀ released, 1 ♂, 1 more ovipositing ♀ seen 20.08; *B. c. chalybea* – many ♂ seen; *C. servilia* – several ♂♂, ♀♀ seen; *D. trivialis* – 2 immature ♂♂ seen 20.08; *N. fluctuans* – 1 ♂ seen 20.08; *P. flavescens* – several seen.

48. Kep Hill, 'Zyxomma pond'. 10°29'25'' N, 104°18'13'' E, 91 m, 20.08.2011: 12 a.m. – 1 p.m. and 4-6 p.m. ?*Ictinogomphus* sp. – 1 ind. seen; ?*C. servilia* – 1 ♂ seen; *Pseudothemis jorina* Förster, 1904 – not less than 2 ♂♂ seen.

49. Kep Hill, 'Platistylus brook' (Fig. 14). 10°29'25'' N, 104°18'09-13'' E, 90-110 m, 20.08.2011: 9:30-12:00 a.m. *P. verticalis* sensu Asahina, 1983 – 1 ♂ collected, 1 more ♂ seen; *I. thailandica* – 1 teneral ♂ collected; *O. chrysis* – 1 ♂ seen; **Orthetrum testaceum* (Burmeister, 1839) – 1 ♂ photographed (Fig. 42) and collected; **Orthetrum luzonicum* (Brauer, 1868) – 1 ♀ collected; *R. variegata* – 1 ♂ collected.

General notes of the August Odonata aspect in the areas visited.

I-V. Koh Kong Province: coastal SW foothills of the Cardamoms.

Here and below in this section, a reference to trip of April 13-23, 2010 (Kosterin 2010) is implied when April is mentioned and that to November 28-December 11, 2010 (Kosterin 2011) when November/December or 'autumn' is mentioned.

The main impression from Cambodian Odonata in August was paradoxical. With a lot of water everywhere, Odonata seemed generally less abundant and much more confined to the permanent water than in November/December. Several circumstances contributed to this impression. The first was the near absence of the characteristic abundant early dry season species on dispersal. Of those, not a single individual of *Aciagrion pallidum* was encountered. *Aciagrion borneense* was found at two breeding sites only, and exclusively in the immature stage: the 'Aciagrion rivulet' source (many) and the 'Calamorum ponds' (three). *Neurothemis intermedia atalanta* was represented, oppositely, by very few mostly mature individuals but also at a breeding place (the 'Aciagrion rivulet' source). The three mentioned species were abundant in November/December. Not a single individual of *Lathrecista asiatica*, a less abundant dry season species frequent in April, was found in Koh Kong Province during this trip, as well as in November/December. Interestingly, a species of the same category as to my experience in Kep and SE Thailand, *Potamarcha congener*, was not observed in Koh Kong Province in April and November/December but this time a mature male was found at a dirty roadside pool at 'Nannophya rivulet' (Fig. 19).

Species of this readily dispersal category, but not usually confined to the dry season, *Pantala flavescens* and *Tramea transmarina euryale*, were less common in August than in November/December. The former was moderately abundant while the latter was represented by few but now full-mature brownish-purple males patrolling potential breeding sites: the grassy boglet of the 'Aciagrion rivulet' source, a clear roadside pool at the 'Anax *veal*', a shallow 'Triangularis pond' and, surprisingly, a deep and slow reach of the 'Microgomphus River'. Single immature males of *Diplacodes trivialis* were observed in the first two localities. *Trithemis pallidinervis* was less frequent than in April and autumn. Very few *Tholymis tillarga* were observed beyond the Koh Kong mangrove area, although in autumn females of this crepuscular species was frequently seen active even at daytime in shade throughout the area. *Orthetrum sabina* was rather scarce, as in both previous trips.

Damselflies were common at slow and open rivulet patches in November/December (but not in April) and appeared quite depleted in August, except for *Pseudagrion pruinosum*. Only one male of *P. rubriceps* was observed at the slow reach of the 'Microgomphus river' upstream the bridge; one male and one tandem of *P. williams-*

Figure 19. A male of *Potamarcha congener*, also that of *Trithemis aurora* (top), at a muddy roadside pool at 'Nannophya rivulet', 16.08. 2011.

oni at the 'Nannophya rivulet' (both common in respective rivers in November/December); neither the latter nor *P. australasiae* at the 'Hemicordulia brook' (both present in December). Contrary, *Archibasis viola* (Fig. 20) increased in number and oddly appeared the most common damselfly at brooks and rivulets, but only in shaded places (often seen hovering at 1-1.2 m above the water, being disturbed by an observer). *P. pruinosum* was observed in nearly the same number as *A. viola* and preferred the same shaded but somewhat larger streams, such as 'Nannophya rivulet' and 'Microgomphus river'. *Copera vittata* became scarce; other species of this genus were not found in Koh Kong Province during this trip.

Figure 20. A male of *Archibasis viola* at a shallow warm pool on the Right Tatai River right bank at 'Chrysis bay', 14.08.2011.

Some widespread and more or less riverine species were nearly at the same abundance as in April and November/December or slightly increased in number. *Neurothemis fluctuans* was as common as in November and was represented by both immature and mature individuals (immature ones prevailed in November). *Orthetrum chrysis* invariably appeared in quite a number once you see some small and warm pools with black bottom near rivers and brooks, either in sandstone holes or as tiny ground oxbows (the same in April and autumn). Noteworthy, its less abundant companion in November, *Orthetrum glaucum*, which was absent in December, this time was seen only at the 'Doritis *veal*' (2 males) and the rapidous part of the "Microgomphus River' (a young female). *Trithemis aurora* was common at any brooks, such as crossing *veals*, and this time *Trithemis festiva* accompanied it more fre-

quently than in April (one encountered at 'Masoni brook') and November/December (several seen at 'Capricornis rivulet'). These two species were equal in number at the 'Nannophya rivulet', however in other localities *T. festiva* was less abundant. The two *Prodasineura* species occurred in about the same numbers as in November/December: *Prodasineura autumnalis* at 'Microgomphus River' and Tatai River, while *P. verticalis* sensu Asahina, 1983 sporadically at brooks. Both species were found at the 'Prodasineura River' but in different habitats (see 'Notes on habitats and habits ...' below). *Vestalis gracilis* seemed to be less abundant than during the previous trips. The same refers to *Dysphaea gloriosa*, observed only at 'Microgomphus River' and 'Prodasineura rivulet'.

Figure 21. A still soft teneral female of *Neurobasis chinensis* at a rapidous stream crossing 'Callidula low forest', 15.08.2011.

Other demoiselles, however, increased in number. *Euphaea masoni* became extremely abundant at any rapidous stream or river. Judging from the face coloration in females, most of them were quite mature now (see the 'Comments on specimens' section), at the same time teneral individuals were quite frequent at the 'Microgomphus' and Thma Bang Rivers. *Neurobasis chinensis* (Fig. 21) appeared at those brooks

and rivers where I did not see it before: at the 'Nannophya rivulet', Right Tatai River at the waterfall, and one female was even encountered at a small and mostly shaded and rapidous 'Oculata brook'. The latter did not look as a suitable habitat of this species, so that female had probably migrated from elsewhere. Numerous *Heliocypha biforata*, including immature individuals, were observed in the same 'Oculata brook', which now had quite a lot of water. The species has not been recorded from there in both previous trips. Curiously, *H. biforata* disappeared from the 'Microgomphus River' where *Helicoypha perforata limbata* was now abundant in both rapidous and nearly stagnant parts. The presence and abundance of *H. biforata* at other rivulets seemingly did not change. Two males of *Libellago hyalina* were observed at a slow flowing and deep reach of the 'Macromia rivulet'. I saw this species before only once in April, at a completely dry stream bed. There was a new provincial record in the same family: a male of *Aristocypha fenestrella* was found perching on a sunny rock in a rapidous part of the 'Nannophya rivulet', among abundant *H. biforata* and *E. masoni*.

Zygonyx iris malayana was another lotic species which considerably increased in number. Males hovered in numbers above small rapidous streams while at large rivers, such as Right Tatai and Thma-Bang, foraging swarms were observed (see the 'Notes on habitat and habits ...' section below).

Hemicordulia undescr. spec. (see Kosterin 2011) was at its place on the 'Hemicordulia brook' but appeared also surprisingly numerous at somewhat similar to each other nearby rivulets: the 'Nannophya rivulet' (where the species was absent in December) and 'Macromia rivulet' (not examined before).

Other differences between August and November/December at lotic habitats consisted in seemingly chaotic appearance of some species at some brooks and rivulets and their disappearance from others. For instance, *Coeliccia kazukoae* was abundant at 'Oculata brook' in August, scarce in April and absent in December. At the same time it occurred at 'Rhinagrion brook' in December but absent in April and August. In November/December, four individuals of *Rhinagrion viridatum* were observed at the 'Microgomphus River' and two at the Thma Bang River but none in August, when (but not before) this species was found at the 'Oculata brook' and 'Capricornis rivulet'; and only at 'Rhinagrion brook' it was found both in December and August. Most impressive was situation with *Nannophya pygmaea*, which in August appeared much more common at *veals* at elevations above 250 m a.s.l. but just one male was seen at the 'Nannophya rivulet' where it was most abundant in autumn (but there were quite a number of males at the next and quite close 'Macromia rivulet'). Most probably, these anecdotal observations suggest that some species have seasonal cycles specific to a given stream or river, probably established by chance and so not synchronised with those at other steams or rivers.

Veals, much better examined this time than in autumn, appeared to be poor in Odonata, in spite of a lot of surface water. One could often see several *P. flavescens* flying above, scarce individuals of *D. trivialis*, *Diplacodes nebulosa*, *Neurothemis t. tullia* or *O. sabina*. could be disturbed from ground or grass. Frequent *T. aurora* and much less frequent *T. festiva* occurred at tiny brooks, at the 'Doritis *veal*' and at 'Anax *veal*' *N. pygmaea* joined them, while on the 'Delphiniodes *veal*', the largest and most elevated among examined, we only saw three species: *P. flavescens* (several), *D. trivialis* (one male) and *N. pygmaea* (many). The latter species seemed to prefer *veals*, occurring at grassy banks of very small, sunny and warm water bodies, such as tiny brook oxbows with abundant submerged vegetation (e.g. at the 'Chrysis bay', 'Doritis *veal*'), grassy swamplets ('Aciagrion rivulet') tiny slow brooks crossing grassy patches ('Anax *veal*', 'Delphinioides *veal*'). However, it was found also at the banks of the half-shaded forest 'Nannophya and Macromia rivulets' which only neighboured small *veals*.

In spite of the general impression of Odonata being depleted in number in August as compared to November/December, both river/rivulets and shallow lentic ponds in fact gained in Odonata diversity, although hardly so in their abundance (needless to say that in April Odonata were inferior to both November/December and August in both diversity and abundance).

The increment of lotic species was naturally contributed by predominantly rheophylic families, Gomphidae and Corduliidae. I have to accept Corduliidae in the broad sense, including *Macromia*, since it was recently shown that phylogenetic placement of *Macromidia* and *Idionyx*, the genera I concern here, is uncertain and the problem should be more thoroughly studied (Dumont et al., 2010.) Representatives of both families appeared in good numbers in the only medium-size river examined, the 'Microgomphus River' being the left tributary of the Thma Bang River and were very scarce in either smaller rivulets or at major rivers. At rivulets and brooks, I encountered the following Gomphidae and Corduliidae:

- many patrolling males of *Hemicordulia* sp. (Fig. 22) above the 'Nannophya' and 'Macromia' Rivulets, two above 'Hemicordulia brook';

- a characteristic long-legged Macromia larva which clanged for a second to a flat rock and disappeared in a swiftly rapidous (almost a chain of small waterfalls) rivulet bordering the 'Viola *veal*' from the west (I would not expect *Macromia* in such a stream);

- a male of *Paragomphus capricornis* perching on a tree trunk at the 'Anax brook' (Fig 23);

Figure 22. A captured male of *Hemicordulia* undescr. spec. at 'Hemicordulia brook', 15.08.2011.

- a female of *Nepogomphus walli* flying above the surface of 'Nannophya rivulet' (Fig. 24c);

- a male of *Burmagomphus divaricatus* perching on a log and a female of *Macromia septima* swiftly patrolling a shallow sandy section (Fig. 59a) of a shaded bank of the 'Capricornis rvuet';

- a female of *Macromia cupricincta* (Fig. 59b) patrolling a partly shaded, slow and deep reach of the 'Macromia rivulet';

- two Corduliidae species found at the 'Oculata brook'. From one shaded reach, I disturbed but failed to catch a teneral *Idionyx* sp. which slowly flew up to tree canopies making round by round in its characteristic fluttering flight. In deep dusk and in a view of a thunderstorm coming on August 25th, at the brook mouth, I unexpectedly collected two males *Macromidia rapida* (Fig. 49) which swiftly flew extremely low above very shallow water with dense submerged grass just behind the last tiny waterfall of the brook (in fact its 'estuary' at Andy's pond).

Figure 23. A male of *Paragomphus capricornis* perching on a log lying across a brook at 'Anax *veal*', 13.08.2011.

The major Right Tatai River (at the Tatai Waterfall) provided no species of both Gomphidae and Corduliidae families, while at its 'Lake area' (nothing in common with a lake, just a widening with countercurrent) I observed a flying male most probably of *Gomphidictinus perakensis* and Gee Chartier photographed a teneral gomphid which could be a male of *Merogomphus parvus*.

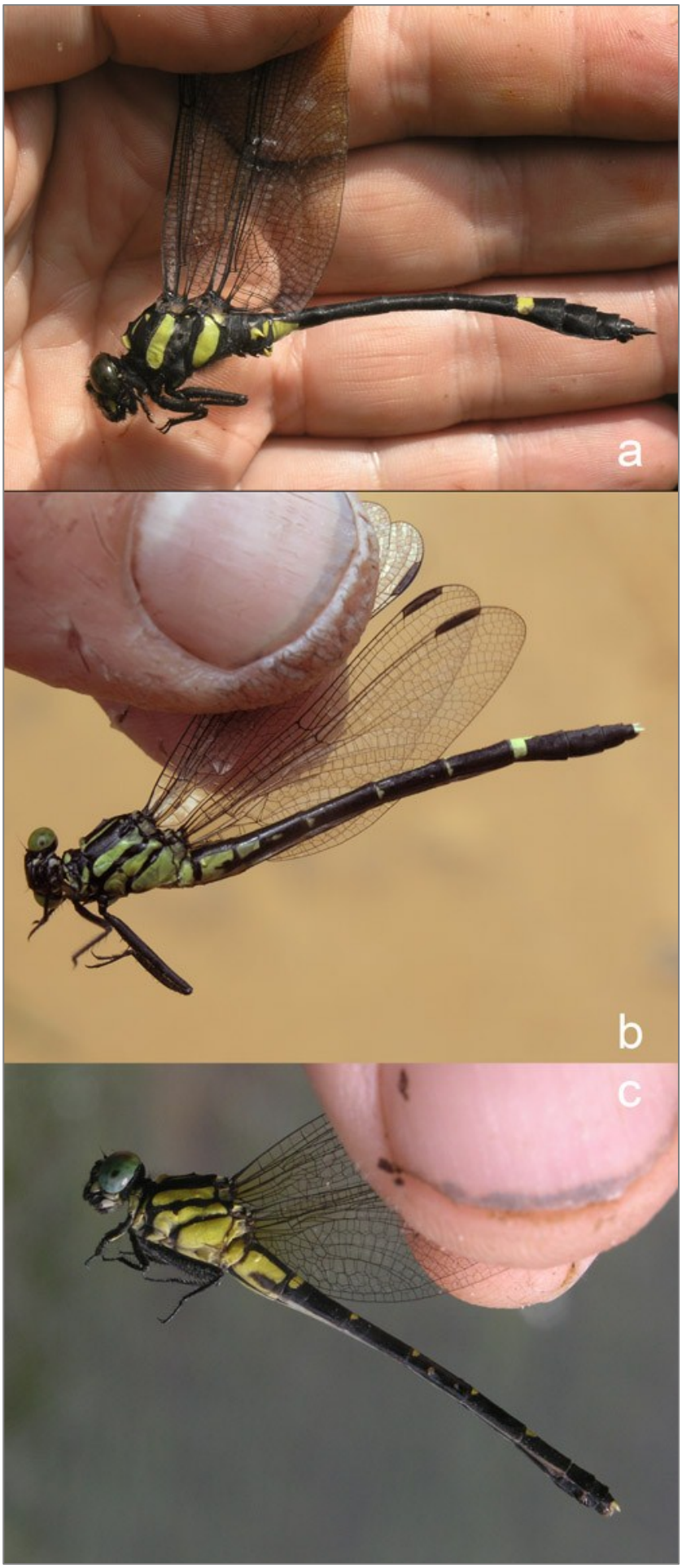

Figure 24. Some captured gomphids: a) a male of *Gomphidictinus perakensis*, 'Microgomphus River', 23.08.2011; b) a female of *Merogomphus parvus*, the same data; c) a female of *Nepogomphus walli*, 'Nannophya rivulet', 16.08.2011.

Figure 25. 'Microgomphus River' near Thma Bang in rainy season, its rapidous part downstream the bridge, 23.08.2011.

The Thma Bang and its tributary 'Microgomphus River' deserve special consideration. The 'Microgomphus River', this season full of water (Fig. 25), was most rich in Gomphidae and Corduliidae, perhaps due to its intermediate size which fitted them best. Males of *B. divaricatus* (Fig.55 a-b, d) perching on rocks were numerous along its rapidous part downstream the bridge (no females were found). There I also discovered a male of *G. perakensis* (Fig. 24a) perching on a conspicuous tree branch. Both sexes of *N. walli* perched on vegetation (Fig. 56) or flew swiftly low over the water surface at the short, still slow but rather shallow reach just upstream the bridge. At the transitional shallow part, a male *P. capricornis* landed on sandy bank at the very water margin. At the same part I collected two and missed two more females of *M. septima* (Fig. 50 a-b). At the deep reach I collected the only female of **M. parvus* (Fig. 24c) which landed onto a shady tree branch ca 1.5 m above the water surface.

At the larger and rapidous Thma Bang River, I found just 2 males of *B. divaricatus* (Fig. 55c), 1 male of *Burmagomphus* sp., and no *Macromia*. The 'Microgomphus River' seems to fit best to *B. divaricatus, N. walli* and *M. septima* as supporting their large populations, which appeared very scarce elsewhere in the localities studied (just 1 female of *N. walli* at 'Nannophya Rivulet'; 1 male of *B. divaricatus* at 'Capricornis Rivulet' and 2 at the Thma Bang River).

Figure 26. A male of *Cratilla lineata calverti* perching on a bamboo stem in shade at a tiny brook near 'Lake area' at the Right Tatai River 3.3 km NNW of Tatai village, 24.08.2011.

There were species new for the country or province at lotic habitats also from an eurytopic family Libellulidae. A male of *Cratilla lineata calverti* (Fig. 26) (a species not seen in the previous trips) perched 1.5-2 m high in shade of bamboo jungle at a swampy forest brook with dark water near the 'Lake area' of the Right Tatai River (on observation of several individuals of this species at the road to Thma Bang see below

in the ‘Notes on Habitats and Habits...’ section). At least two males of *Onychothemis testacea* (Fig. 60) perched at banks of the transitory part of the ‘Microgomphus River’. Quite many obviously congregated males of *Rhyothemis obsolescens* perched on branches at banks of the ‘Hemicordulia brook’ and ‘Nannophya rivulet’ (Fig. 27)

Figure 27. Males of *Rhyothemis obsolescens* at ‘Hemicordulia brook', 15.08.2011 (above) and ‘Nannophya rivulet', 16.08.2011 (below).

(localities quite close to each other), or altogether got to flutter above. I saw this species before only in the Ream National Park near Sihanoukville, also at a brook (Kosterin 2010). Quite numerous, but only at the shaded, mostly with swampy banks, reaches of the ‘Nannophya rivulet’, crimson-red males of *Orchithemis pulcherrima* (Fig. 28) appeared; I saw also a black/blue individual which most probably was a female but could be a male gynochromic morphs well. (Hitherto in Cambodia, this species was only once photographed at the Left Tatai River, see Day 2011). At the same hardly accessible reaches of the ‘Nannophya Rivulet’ with banks of deep mud interspersed with stolones of some thorny Araceae I found two males of *Agriono-*

ptera insignis insignis perching on branches at moderate height. I also collected a male and a female of this species near a very deep and dark crevice in cliffs with a pool (perhaps their breeding place) at the point where the 'Anax brook' fell from the bluff of the 'Anax *veal*'. The last four mentioned four libellulid species seem to be rare or very stenotopic as found just in one or two localities.

Figure 28. Male of *Orchithemis pulcherrima* at 'Nannophya rivulet, 16.08.2011.

Surprisingly, an orange-coloured male of *Anax immaculifrons* (Fig. 29 a, c) was encountered to circle widely above the same 'Anax brook' where it left coppice and started to flow over flat rocks. On a tiny grassy 'island' at the brook (Fig. 29b) several dozen metres downstream I found an exuvia of this species (Fig. 29d). The larva must have developed in this quite a fast and shallow brook.

All shallow ponds appeared rather unique and have to be considered separately. Generally, a strong decrease in number should be noted of such otherwise common species as *Ischnura senegalensis* and *Agriocnemis* spp.; the latter found only in the mangrove area near Koh Kong and represented only by *A. minima*, which was not observed in Koh Kong Province before. At the same time, not a single individual of the expectedly commonest *A. pygmaea* was observed in the Province in August. Another notable replacement was appearance of *Pseudagrion microcephalum*, also not yet seen in Koh Kong Province, compensated by a depletion of the common in dry season *P. australasiae*. Do these species tend to exclude each other in Cambodia temporally when on the wing, rather than spatially as Fraser (1933) suggested for India? I also did not find any *Lestes concinnus* Hagen in Selys, 1862, while *Lestes praemorsus decipiens*, hitherto not seen in Koh Kong Province, appeared numerous and widespread.

Figure 29. A male of *Anax immaculifrons* captured at 'Anax *veal*' (a, c) and scrutinised by one of our team, François Mey (a); a supposed exuvia of that male (d) and a tiny grassy island on a stream where it was found (b), 13.08.2011.

Maybe the most interesting of lentic habitat was the grassy boglet at the 'Aciagrion rivulet' source, which I visited thrice and summarize the results below. In November/ December huge numbers of *Aciagrion hisopa* emerged from it, while some mature *A. borneense* were found further along the 'Aciagrion rivulet' and I supposed they may breed at the same boglet as well (Kosterin 2011). This was proved in August when the situation appeared nearly opposite: there were mature *A. hisopa* of both sexes, including copulae, in grass emerging from water, and about equal numbers of teneral individuals of both *A. hisopa* (Fig. 44b) and *A. borneense*. Mature males of *L. praemorsus decipiens* (Fig. 30a, c), not seen here in autumn, appeared very numerous in the same emerging grass. Each sweep of the net unintentionally provided 1-2 of them. In Autumn I found this species only on the Bokor Plateau, as well as other

Figure 30. ***Lestes praemorsus decipiens*****: a, c) males at 'Acaigrion rivulet source', Koh Kong Province, 13.08.2011; b) a teneral female at the upper bridge on Popokvil River, Bokor Plateau. Kampot Province, 18.08.2011.**

odonates, which now appeared numerous at the same 'Aciagrion boglet' side by side with the above mentioned lestid: this was *Indothemis limbata*. In the rainy morning of 13th August, many bright-black males scattered over the boglet surface and banks were conspicuous in fresh-green grass. These two species, together with *Ceriagrion calamineum* (now scarce) and a blue medium-sized *Aciagrion* (although different species), made the boglet looking in August very much like the 'Limbata ponds' on the Bokor Plateau in December (noteworthy both areas in general abounded in *Hemicordulia* sp. in August). This was another example of de-synchronicity of odonate life cycles in different localities of in the Cardamoms. (*I. limbata* seemed to be widely dispersed in Koh Kong Province in April, as I discovered a lonely male at a small nearby *veal* in 'Callidula low forest', another one at the 'Nepenthes brook' further along the road to Pursat, and another one at the 'Triangularis pond'; fig. 31). At sunny weather, the boglet was patrolled by few (I observed two) mature *T. transmarina eu-*

Figure 31. 'Triangularis pond' in Thma Bang settlement, Koh Kong Province, 25.08.2011.

ryale, and by *P. flavescens* at any weather except for strong rain. Other species found, as well as in November/December, were *Ceriagrion cerinorubellum* (one male),

Rhyothemis phyllis (one female), *N. pygmaea* (several, of both sexes), *N. intermedia atalanta* (just two mature males and one immature female, perhaps among the first individuals emerged in this year) and generally very common but now not numerous *D. nebulosa* and *Neurothemis t. tullia*. Besides, on 16th August I encountered a bright-white male of *Brachydiplax* sp. which I failed to catch and identify. Other species like *Brachythemis contaminata*, *T. festiva*, *T. pallidinervis* were added during brief exploring of close shallow roadside pools at the 'Lispe *veal*' (one individual each, but the latter on two of the three visits).

Figure 32. A male of *Rhyothemis triangularis* at 'Triangularis pond' in Thma Bang settlement (Fig. 31), 25.08.2011.

Andy's pond appeared very rich at this visit. There were immense *A. hisopa*, just emerged tenerals as well as mature and mating individuals (Fig. 44a), in spikerush thickets at banks. (Two mature males were found under the dense forest canopy at a steep valley of the 'Oculata brook' several dozen metres above the pond; and two males were found under bamboo jungle canopy nearly at the same distance above

Rainbow Lodge). There were *I. senegalensis*, but not many, and some males of *P. microcephalum*. On 26th August, a male and a female (Fig. 33) of *A. rubescens rubeola* at the red premature stage were also found in spikerush. Of dragonflies, there were a perching male of *Ictinogomphus decoratus melaenops*, a ranging male of *A. guttatus* (not checked against the above mentioned close species), several *O. sabina*, a fluttering male and a female (ovipositing at a shallow place near the brook mouth) of *R. phyllis*, many *N. fluctuans*, an immature male of *Zyxomma petiolatum* Rambur, 1842 collected in deep twilight of 24th August and several individuals of *T. tillarga* seen in twilight of 25th August. The two above mentioned males of M. *rapida* can be reported for this pond as well, as flying above the very shallow bay at the mouth of the 'Oculata brook'. At daytime, a male of *Orthetrum glaucum* and two of *O. chrysys* were found there. No *Diplacode*s spp., *Brachydiplax contaminata*. For comparison, in

December I found only *A. borneense* and immense *N. fluctuans* at this pond (although for shorter examination).

Noteworthy, not a single *Agriocnemis* individual was found at the three above reported localities.

Figure 33. A female of *Argiocnemis rubescens rubeola*, at the 'red immature' stage, at Andy's pond at Tatai village, 26.08.2011.

Figure 34. A male of *Paracercion calamorum dyeri* at 'Calamorum ponds' in Koh Kong S suburbs, 26.08.2011.

The mangrove area SE of Koh Kong this time was much richer in Odonata than in April and November/December, that was expectable at the end of the rainy season at waters with fluctuated salinity. There appeared *Paracercion calamorum dyeri*, abundant at the 'Calamorum ponds' (Fig. 34), scarce at 'Cora Marsh' and so far not found elsewhere in the entire studied area, and *P. microcephalum*, present but not abundant at both these sites. *Agriocnemis* were also present but now represented only by *A. minima*, collected both in sparce fine grass inundated by high tide at the 'Cora Marsh' and at the banks of the 'Calamorum ponds'. At the two latter localities (unfortunately not examined earlier), a male of *L. praemorsus decipiens*, and three teneral males of *A. borneense* were found. The 'Cora marsh' (Fig. 35) was lifeless in April and presented 12 species in November/December; the same number being recorded in August. In addition to the mentioned species I found a female of *Ceriagrion cerinorubellum* in surrounding bushes, a male of *C. calamineum* at the emerging grass (a noteworthy finding in a mangrove area of a species recorded up to 1000 m a.s.l. on the Bokor Plateau, see Kosterin 2011) and *B. contaminata* and *T. tillarga* (but not *Macrodiplax cora* this time) at firm banks and in the bushes. These observations showed that the swamps and marshes behind mangroves support an interesting fauna that must be investigated more thoroughly during the rainy season.

Figure 35. 'Cora marsh' adjacent to mangroves in Koh Kong southern suburbs, 26.08.2011.

VI. Bokor Plateau

As soon as I missed, right before my eyes, such rich habitats as 'Limbata ponds' and 'Praemorsus pond' and had no time to examine the artificial pond at the rangers' station but added the 'Idionyx reach' and the between-bridge reach of the Popokvil River, the results are not strictly comparable with December. In general, little has changed. *P. flavescens* appeared but were represented by small swarms of immature, yellowish individuals. There were no dispersal *Ceriagrion olivaceum* Laidlaw, 1914, *P. congener*, *T. tillarga*, *T. transmarina euryale* found in December (the three former as extremely numerous), while *D. trivialis*, *O. sabina* were observed by one individual each. *A. borneense*, *I. senegalensis* and *P. australasiae* appeared quite scarce (as well as in Koh Kong Province): I recorded just one female of the first at the 'Odorata road', a male of the second and a male and a tandem of the third at the Popokvil River. Not a single individual of *Agriocnemis pygmaea* was detected, instead an immature, at the red stage, female of *Agriocnemis nana* was found at the 'Odorata road'. At the same time, among large generalists, *A. guttatus* appeared (also recorded in April), of which I twice observed males ranging at sunny weather (one above a

Figure 36. A female of *Anax guttatus* ovipositing into floating vegetation in the middle of the Popokvil River at the lower bridge, 19.08.2011. In the upper left isert, a male of *Pseudagrion pruinosum* is seen perching on its abdomen.

dry road, the other above the 'Odorata road' with a small shallow brook flowing above) and a female which oviposited in long submerged vegetation winding in the shallow and rather fast reach of the Popokvil River at the upper bridge (Fig. 36). *T. aurora* were found at modest numbers at ponds and rivers, as well as in April and December, a male of *N. fluctuans* was found at the 'Minutissima pit' and an immature female of *Neurothemis fulvia* was discovered at a new-made ground road.

Figure 37. Habitats of *Lyriothemis elegantissima* in the forest at 'Idionyx reach' of the Popokvil River on the Bokor Plateau: a) a chain of dark shallow pools united with a tiny brook; b) a small sedge tussock swamplet. 19.08.2011.

There were two tiny brooks being a chain of black-bottomed muddy pools under the forest canopy (Fig. 37a) near the 'Idionyx reach' of the Popokvil River, one flowing from the above mentioned sedgy swamplet (Fig. 37b). Both at the brook and at the swamplet, I found two males of *Lyriothemis elegantissima* (Fig. 38) perching and chasing each other, and at a pool also a female ovipositing into the water edge of a shallow black pool. Other Odonata at that area of black pools and brook were *C. vittata* (mostly at the 'ghost' immature stage), and I encountered one *A. viola*, both species being expected. Unexpected was an immature male of *H. biforata*, obviously migrated there from the Popokvil River (where recorded in December).

Figure 38. A male of *Lyriothemis elegantissima* at the small sedge tussock swamplet in the forest at the Popokvil River, see Fig. 37b. 19.08. 2011.

The Popokvil River surface at open reaches (Fig. 57) was now occupied by many *P. pruinosum*, with just one *P. australasiae* seen (common in December). Several *P. pruinosum* and one male of *A. viola* were also detected at the shady 'Idionyx reach'. Elsewhere, *P. pruinosum* prefers places shaded by tree canopy, but here it extended to open places as well, perhaps because the foggy weather predominating on Bokor prevents them from getting much sunshine. *A. viola*, however, did not extend to open places. At the between-bridge reach I also observed a mature male of *P. autumnalis* hovering over the water. *Orthetrum chrysis* was at its place as in December, but neither O*. pruinosum neglectum* nor *O. glaucum* were noticed this time. *V. gracilis* were abundant, but now were young, some individuals being teneral. Two males and a female of *E. masoni* were registered at a rocky and rapidous reach of the Popokvil River just upstream the waterfall. From a ground bank of a shady patch of the 'Idionyx reach', I disturbed a teneral female of *Idionyx ?thailandica* which landed on bushes and palm fronds (Fig. 39) and was then collected.

The abundance and ubiquity of *Hemicordulia* undescr. spec. on the plateau appeared most striking for me. Its males patrolled water half-shaded table of any Popokvil River reach, and five ones appeared to patrol a brook and a shallow pool over the 'Odorata road' (See 'Habitats and habits below and Fig. 58a).

Note that so far only two species of those recorded on the Bokor Plateau, *A. tillyardi* and *L. elegantissima*, were not found also at much lower elevations and seemingly different natural conditions in Koh Kong Province.

VII. Kampot environs

Tek Chhou Rapids, like the major rivers in Koh Kong Province, appeared poor in Odonata. Of lotic species I recorded at the river bank only two individuals and both beyond the rapidous part: a male of *V. gracilis* in a village upstream the rapids and a teneral *P. autumnalis* above the water downstream the rapids. Nearby there was a male *D. trivialis* on a shingle bank. At the very rapids, I found only common species at small shady black pools at the river bank: *Copera marginipes*, *O. chrysis*, *N. fulvia*, *R. phyllis* or R. *variegata*. Sunlit black pools found in a vast shingle left bank downstream the rapids provided only one *O. sabina* and one *O. chrysis*. A large, deep and clear 'Decoratus oxbow' appeared fruitful: there were several *I. decoratus melaenops* perching on high sticks at its banks, a male *A. guttatus* ranging along, a handful of common libellulids: *Crocothemis servilia*, *B. chalybea*, *O. chrysis* (in a silty shallow part), *T. aurora*. There were *P. autumnalis* in grass at banks alongside *P. rubriceps* and *P. australasiae* at sparse emerging vegetation above the water. Apart from the oxbow, on lower branch of a tree growing on a pasture I found, rather unexpectedly

Figure 39. A teneral female of *Idionyx ?thailandica* at the bank of 'Idionyx reach' of the Popokvil River, Bokor Plateau, 19.08.2011.

in this season, a full-mature male of *Lathrecista asiatica*, and among groups of such trees recorded two fluttering females of *Rhyothemis phyllis* (one suspectable of being an unusual androchromic *R. variegata* missing dark spots at the fore wing triangles).

The 'Gracilis rivulet' (Fig. 13) exhibited few common lotic species: many *T. festiva*, some *T. aurora*, few *O. chrysis*, *C. marginipes*, *P. autumnalis*, a lot of *V. gracilis* and several *N. chinense* of both sexes (I observed courtship resulted in mating). The two demoiselle species would fit more a forest than an open countryside with tree groves, where they were encountered here; maybe this countryside was young and the forest had been cleared quite recently. At a small stagnant ditch there was an individual of *O. sabina* and at ruderal vegetation at a distance from the river a female of *P. congener* was found.

The 'Aethriamanta' former pond, now grown up with rich vegetation, appeared very interesting and deserved more than an hour long examination. Along with expected species common in such an environment, as *Agriocnemis femina* (one female, the only for the trip and the second individual known from Cambodia, see Kosterin 2011), *Acisoma p. panorpoides* (extremely numerous), *B. chalybaea*, *C. servilia*, *O. sabina* (few), I unexpectedly spotted a male of *Aethriamanta brevipennis* perching not far from the pond bank; a female of *Onychargia atrocyana* was seen on a bush ca 2 m above the ground, and in grass beyond the concrete pond banks I collected two females of *Ceriagrion praetermissum*.

The mangrove area in the southern suburbs of Kampot, near Cham villages, appeared very poor. Some *P. flavescens* flew above sandy bank patches; an abandoned paddy field turned into spikerush swamp provided scarce *A. pygmaea* and *I. senegalensis*.

VIII. Kep environs

The main differences from December was, again, absence of some common species which occurred in large quantities dispersed away from water bodies in that month: *Ceriagrion olivaceum*, *T. tillarga*, *T. transmatina euryale*, *P. congener*. However, there were moderately large swarms of *P. flavescens* at low places, e.g. above the 'Ludwigia pond'. Only two individuals of *D. trivialis* were met.

The 'Ludwigia pond' was rich in common Odonata, none being numerous. There were *A. pygmaea*, *I. senegalensis* (most abundant), *Copera ciliata* (Fig. 40, new for the pond), *Ceriagrion malaisei* (several males and females), *A. guttatus* (at least 1 ovipositing female checked from hand, and 1 male), *I. decoratus melaenops* (Fig. 41), new

Figure 40. A male of *Copera ciliata* at 'Ludwigia pond' in Kep, 17.08.2011.

Figure 41. A male of *Ictinogomphus decoratus melaenops* at 'Ludwigia pond' in Kep, 20.08.2011.

for the pond, at least one perching male (another male found at a nearly dried out small pond, overgrown with grass, at the tourist information centre), *A. panorpoides, C. servilia*, *B. c. chalybea*. At last at Kep, I encountered a male of *N. fluctuans*, a species common elsewhere but not seen in Kep in April and December.

The 'Zyxomma pond' on the Kep Hill was poor in odonates: there were at least two territorial males of *Pseudothemis jorina* (found in April) and at least one of either *C. servilia* or *Rhodothemis rufa* (the latter found in April and December) but nothing else (not a single damselfly!). For an hour of observation at midday I saw a large dragonfly which descended from the crown of a huge tree towering above the pond, made several rounds above the water surface and touched it twice and then returned into the crown. Judging from its size, shape and behaviour, it should have been a male of *Ictinogomphus* (see the 'Notes on Habitats and Habits...' section). Observation during an hour in twilight, in view of an approaching slight rain from impressive clouds, brought nothing.

Figure 42. A male of *Orthetrum testaceum* at 'Platystylus brook' on Kep Hill, 20.08.2011.

The pools at the lower 'Platystylus brook' for some reason had no odonates. At the lower section, now partly cleared from coppice, I found a large bright-red male dragonfly (Fig. 42) which perched on a low stick and was confined to a guarding area too small (ca 5 m) for its size. I collected it and was surprised to find a male **Orthetrum testaceum*, a species more common in the south. Besides, nearby I surprisingly collected a female **Orthetrum luzonicum*. In the valley I neither found *Lestes platystylus* Rambur, 1842, quite common in December, nor observed swarms of *Rhyothemis* sp. and *P. jorina*, as in April. Damselflies were very scarce and represented by *P. verticalis* sensu Asahina, 1983. From a tiny recently restored reserve with grassless banks I nevertheless scared away a just emerged male of *I. thailandica* which matured in captivity.

Absence of common dispersal species, the presence of *C. malaisei* and absence of *C. ?indochinense*, *Brachydiplax farinosa* Krüger, 1902 at the 'Ludwigia pond', and damselflies at the 'Platystylus brook' other than *P. verticalis* sensu Asahina, 1983, made the odonate aspect observed at Kep in August resembling that of April rather than December. Generally, Kep seems to have a scarcely expressed seasonality. At the same time, noteworthy that a short section of the 'Platystilus brook' examined for quite a short time, again provided new country records, now three species, two of which in the *Orthetrum* genus, represented by one individual each.

Notes on specimens

In the notes below, the photos or specimen details were prepared from serial photographs obtained via lens Zeiss Stemi 2000-C with digital camera Canon PowerShot A640. Images with broad focus zones were obtained from serial photos with shifted focus using the software Helicon Focus 5.1 (http://www.photo-soft.ru/heliconfocus.html). The genital ligula of *A. hisopa* was examined with luminescence microscope Olympus BX50 in a phase contrast mode and photographed with digital camera Olympus CCD Olympus DP50.

1. *Vestalis gracilis* (Rambur, 1842)
Earlier (Kosterin 2011) I supposed that the fumy wingtips in *V. gracilis* are connected with neither geography nor age but a demoiselle gets its fumy wingtips if develops at higher temperatures at the end of the dry season, that would explain the fact that all had the fumy wingtips in April but none in November/December (Kosterin 2010, 2011). In August, the adult population could be represented by mixture of individuals survived from before the onset of rainy season and those emerged during its first half, so I expected a mixture of individuals with fumy and without wingtips fumy, now correlated with age (fumy old and non-fumy young). This was nearly the case, although correlation with age was weak as not all old individuals had fumy wingtips. In

Koh Kong Province I observed both fumy and not fumy mature individuals, as well as some subteneral, of course with clear wingtips. All the three types were encountered at the 'Viola *veal*'; noteworthy both fumy and not fumy individuals were obviously old: with blackened seams of the pterothorax and some pruinescense on the abdomen tip. At the 'Capricornis Rivulet' I collected an old fumy male, while at the nearby 'Nepenthes brook' I saw one teneral individual. At the 'Rhinagrion brook', all observed individuals were old and had fumy wingtips while both individuals seen at the nearby 'Oculata brook' were immature, not fumy. In Kampot Province, *V. gracilis* were young with clear wingtips on the Bokor Plateau, where teneral ones occurred, while at the 'Gracilis Rivulet' at its base (that is ca 800 m lower), all were old, with slightly pruinosed two last abdominal segments and invariably fumy wingtips.

2. *Euphea masoni* Selys, 1859

I tried to examine all males I encountered for the characters differentiating *E. masoni* from *E. guerini* Rambur, 1842 (Hämäläinen & Karube 2001), namely a transparent tip of the hind wing and absence of a greenish lustre (I'd say the males of *E. masoni* have a very slight purple lustre). For instance, on 14 August at the 'Capricornis rivulet' I examined about 20 males. None probable *E. guereni* was seen. A male collected at the 'Nannophya rivulet' on 16 August has hardly noticeable tiny lightenings at the hind wing tips but no trace of a green lustre (Fig. 43a). Among males found at the 'Microgomphus River', I collected two aberrant ones as to the dark colour on the fore wing, much restricted in one (Fig. 43b) and absent in the other (Fig. 43c). As I wrote earlier (Kosterin 2011), two teneral males collected from this river on 23 August, acquired vague wingspots of normal size for 4-5 hours in captivity.

Figure 43. Male specimens of *Euphaea masoni* from Koh Kong Province with anomalous wing coloration: a) with a nearly disappeared transparent area of the hind wing tip, 'Nannophya rivulet', 16.08.2011; b) with shrunken wing dark spots, especially on the fore wing, 'Microgomphus River', 23.08.2011; with the fore wing dark spot missing, the same locality and date.

Two males encountered at the Popokvil River had a normal wing coloration, while the only one got in December had discoloured wings (Kosterin 2011).

In Kosterin (2010: 59-60, Fig. 40) I provided photos of faces of two *Euphaea* females differing in the lower part of the frons being either brownish, with a distinct dentate border of the black colour (a female from the environs of Tatai, obviously *E. masoni*, fig. 40 above), or entirely black (a female from Kbal Chhay, Fig. 40 below). Although looking so distinct, these patterns most probably refer to young and mature females, respectively, since in August I collected females which either:

- had the frons entirely black, as the above mentioned Kbal Chhay female (Kosterin 2010: Fig. 40 below), which hence must be *E. masoni* as well: three females, from the Miscogomphus River' of 23 August, from the 'Nannophya Rivulet' of 16 August, and from the Popokvil River above the waterfall of 19 August, respectively;

- had the frons bicoloured, as the Tatai female in (Kosterin 2010: Fig. 40 above): that from a brook in the 'Callidula low forest' of 15 August;

- had the lower part of the frons very dark brown but without a distinct border of the black colour (probably an intermediate age): that from the 'Capricornis Rivulet" of 14 August.

3. *Aciagrion tillyardi* Laidlaw, 1919.
This species was described from Assam (type locality: Cheeraunji; Laidlaw, 1919), as well as its eight months junior synonym *Enallagma assamica* Fraser, 1919 (type locality: Shillong; Fraser, 1919; for synonymy see Fraser, 1933 and Kimmins, 1966). Later Laidlaw (1924) supposed and Fraser (1933) claimed that *A. tillyardi* was a junior synonyms of *Aciagrion approximans* (Selys, 1876) (first described as *Pseudagrion microcephalum ?race approximans* Selys, 1876), that was declined by Wilson (2000). Until this nomenclatural problem is finally solved, for the time being I follow the predominant usage and denote the species in question as *A. tillyardi* Laidlaw, 1919. After the first descriptions by Laidlaw (1919) and Fraser (1919), Laildaw (1924) gave a short characterisation of the species while Fraser (1933) provided a species key and another detailed description of this species (under the name *Aciagrion approximans*). Both authors considered it to be confined to Assam, so their descriptions (Laidlaw, 1919; 1924; Fraser, 1919; 1933) concerned only the types and approximate topotypes. Specimens from Bokor, of both sexes, fit them very well, with the following minor reservations.

- "Upper lip dark brown, fading to black at base" according to Laildaw (1919: 187); "labrum blue, narrowly black at base" according to Fraser, 1933: 342). The Bokor specimens have the labrum dark brown, sometimes with a blue tint, in its distal half and black in proximal half;

- Fraser (1933) did not mention the pale anterior lobe of the prothorax;

- according to Fraser (1933: 333 and 342), “black markings on dorsum of segments 2 and 10 very broad” in the key and “segment 10 black” in the description; “[segment] 10 metallic black” in (Laidlaw, 1919: 187) and “black on dorsum” in Laidlaw (1924: 3). In males from Bokor, S10 is blue at sides, with black stripes at the anterior and posterior margins connected on dorsum, that at the posterior margin may expand laterally (see Fig. 72 in Kosterin 2011);

- in the Bokor specimens, in side view, the hook on the inferior male anal appendages is either seen (rarely), as in Fig. 148 in Fraser (1933), or not seen, as in Wilson (2000);

- anal appendages black (Laidlaw 1919; 1924; Fraser 1933), but in Fraser (1919) the inferior appendages are said to be whitish; in the Bokor specimens they are black but in one male the inferior appendages are brown;

- in the Bokor females, the ground colour is rather greenish blue (see fig. 45 in Kosterin 2011), that corresponds to “colouring as in the male” by Laidlaw (1919: 187). Fraser described it as more differing from male: “similar to the male but paler in colour” (Fraser 1919: 878) and “pale bluish-green” (Fraser, 1933: 343); the antehumeral stripes in the Bokor female and the postocular marking of the same ground colour, not “pale greenish-yellow” as stated in the last cited source;

- Fraser (1933) did not mention, but Laidlaw (1924) did, that in females, the black colour on S9 does not reach its end, the same in our females;

- the size of the Bokor specimens is slightly larger: abdomen 26-28 mm in males, 25-26 mm in females (24.5 mm in males and 22.5 mm in females according to Laidlaw (1919; 1924); 22-24 mm in both sexes according to Fraser (1933)).

Noteworthy, the ground colour in males is expressed as varying at different body parts from “gray blue” to “gray olive” and “greenish-white” (Laidlaw 1919: 187-188) (perhaps faded in dead specimens); “bright blue” (Laidlaw 1924: 3); from “blue” to “deep sky blue” and “pale greenish blue” (Fraser 1919: 877-878); “blue” to “pale blue” and “bluish green” (Fraser 1933: 342); the males from Bokor having it either saturated blue or greenish blue. When reporting *A. tillyardi* for Hong Kong, Wilson (2000) described it with some notable difference as to the ground colour, several times stating it to be “violaceous”, also “fading to pale bluish green on the metepimeron” in males, predominantly yellow in females. Wilson even proposed a vernacular name ‘Violet Aciagrion’ for this species.

According to Wilson (2000), males have a "pale distal mark at the base of the inferior appendage" (shown on the figure at its lower prominence). (Besides, on Fig. 2 in (Wilson 2000), the black humeral stripes are shown not entering the infra-mesepisternum, but it is not so even on Wilson's own photos from Hong Kong; e.g. at http://www.asia-dragonfly.net.)

All authors mentioned quite an expressed pruinescence on the lower parts of the thorax and abdomen, which well presents in the Bokor specimens as well.

Noteworthy that at Asia Dragonfly Home Page (http://www.asia-dragonfly.net) there are 18 photos identified as *A. tillyardi* and uploaded by Dennis Farrell (aka Faz) from North Thailand (Chiang Mai, Phetchabun and Loei Provinces) which show insects of both sexes coloured exactly as described by Wilson (2000), violet males and brownish females. Dennis kindly sent me his close up photos of the appendages of a male from Nam Nao National Park, Phetchabun Province, which show them as typical for *A. tillayrdi* and even with the light spot on the inferior one, as described and shown by Wilson (2000). One should note that North Thailand is situated halfway between Assam and Cambodia, where *A. tillyardi* was found by no means violet. The 'Violet Aciagrion' of North Thailand and South China could be an environmental modification of *A. tillyardi* or have some genetic specificity.

4. *Aciagrion hisopa* (Selys, 1876)

Taxonomy of the Asian representatives of *Aciagrion* is thought to be confusing (Hämäläinen 2001). The two summarising overviews of most of them (Laidlaw 1924; Fraser 1933) were published almost a century ago and a new revision is of an imperative need (Asahina 1990). In August, I collected two species of this genus: *A. tillyardi* on the Bokor Plateau and another species in Koh Kong Province: quite good series of identical specimens from the 'Nannophya Rivulet source' and Andy's pond, in which both sexes generally had a saturated blue ground colour. Males had S8-10 blue and unmarked and the upper appendages black and non-bifurcated in profile view (Figs. 44, 45). The most probable candidate for this species was *Aciagrion hisopa* (Selys, 1876), described from "Pulo Besoar en Malaise" (Selys Longchamps 1876: 507). It was recently supposed that even in records from Thailand, at least three distinct species were lumped under this name (Hämäläinen 2001), while the true *A. hisopa* may be confined to Peninsular Malaysia (Orr 2005). To identify my Koh Kong specimens, I compared them:

- with photos of the two syntypes of *A. hisopa* still preserved in Royal Belgian Institute of natural Sciences, Bruxelles (IRSNB), kindly taken and provided by Jérôme Constant, the Curator of Selys collection.

- with photos of several recent *A. hisopa* specimens from Peninsular Malaysia (Kuala Lumpur and Tasek Bera) preserved in NCB Naturalis, Leiden (RNMH), kindly taken and provided by Rory Dow;

- with a drawing of the male genital ligula of a specimen of *A. hisopa* from Singapore made by Laidlaw (1924); this drawing obviously does not show fine membraneous lateral lobes of the ligula, instead it shows its more sclerotised fore and hind parts only, which looked as two pairs of narrow processes.

Figure 44. *Aciagrion hisopa* in Koh Kong Province: a) copula at Andy's pond, 26.08.2011; b) teneral male at 'Aciagrion rivulet source', 16.08.2011.

I found no any structural difference of my Koh Kong specimens from the above listed illustrations of *A. hisopa*. Recent specimens, as well as a figure in Orr (2005) and a photo in Tang et al. (2010) show a somewhat restricted black pattern on the head and thorax, with the humeral streak very narrow and incomplete in its fore part, but in the better preserved mature syntype of *A. hisopa* the black humeral streak is evenly broad, as in my Koh Kong specimens (Fig. 44). So I confidently identify my specimens as *A. hisopa*. The morphological and pattern details are shown in Fig. 45, the structure of the genital ligula in Fig. 46. A lot should be discussed as to the literature published concerning this and related species, and some lectotypes are to be designated. This will be done in a special detailed paper elsewhere.

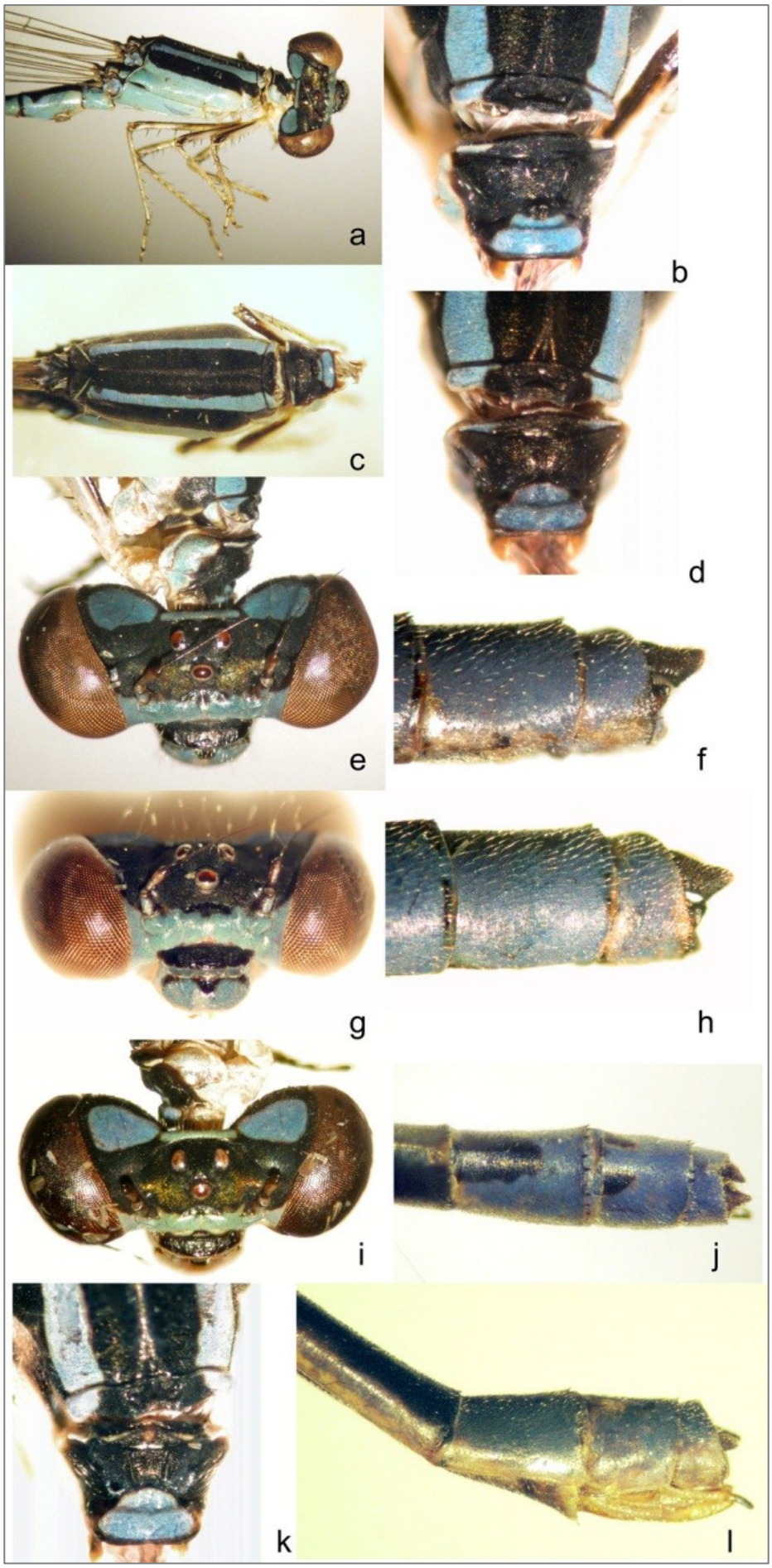

Figure 45. Details of pattern and morphology of *Aciagrion hisopa* from Koh Kong Province (not to scale): a-h) males; i-l) females; a-c, e, g) a male from 'Aciagrion rivulet source', 13.08. 2011; d, f, g) three different males from Andy's pond, 26.08. 2011; j, l) two different females from 'Aciagrion rivulet source, 13.08. 2011; i, k) a female from Andy's pond, 26.08. 2011; a) head and thorax; b-d, k) thorax, dorsal view; e, i) head, dorsal view; g) frontal view; f, h, l) end of abdomen, lateral view; j) end of abdomen, dorsal view.

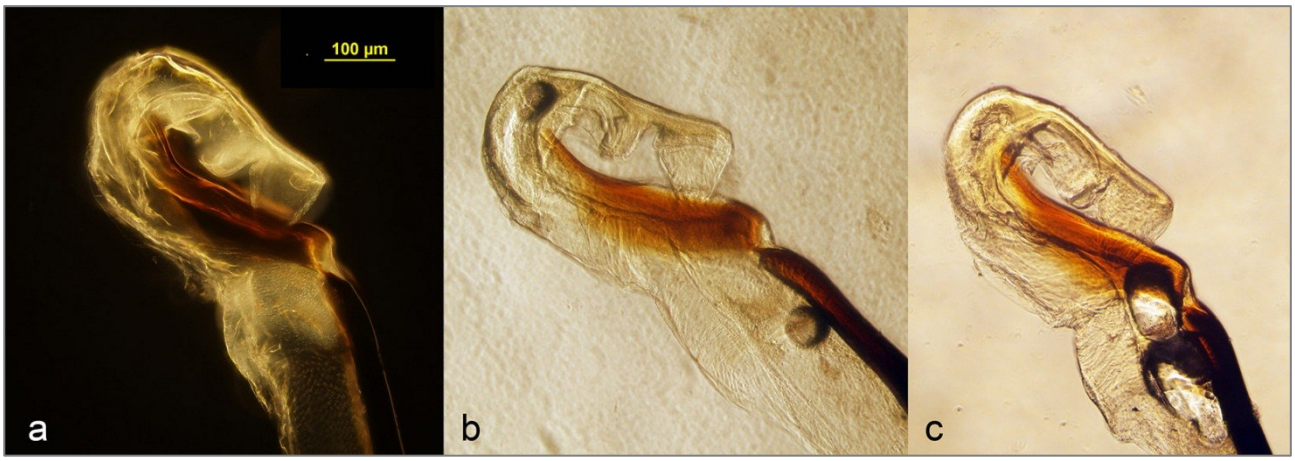

Figure 46. Proximal part of genital ligula of *Aciagrion hisopa* males from Andy's pond in Koh Kong Province: a, c) two males of 26.08.2011; b) a tan-and-blue male collected on 18.04.2010 and erroneously identified as *Aciagrion* sp. cf. *pallidum* in (Kosterin 2010: 60-62 and fig. 41)

In the previous report (Kosterin 2011: 92), I mentioned numerous teneral specimens I encountered in November/December at the boglet at the 'Aciagrion Rivulet source' as "*Aciagrion* sp." and provided photograph of the male anal appendages. No doubt they were *A. hisopa*, now found there in a mature state as well. In those teneral specimens, the upper appendages had a somewhat different appearance since were inclined down (Kosterin 2011: fig. 73), while in mature individuals they were directed more behind; the actual shape being the same.

In Kosterin (2010: 27, 54, 60-62, fig. 41) I discussed two male specimens, referred to as "*Aciagrion cf. pallidum* Selys, 1891", collected on 18.04.2010 in a deep forested slope right above the Andy's pond, that is above the site where *A. hisopa* were found in August (curiously, on 26 August I collected two mature males of *A. hisopa* in exactly the same place). They seem to be *A. hisopa* as well: they have the identical anal appendages (compare Fig. 44 f, h here and Fig. 41 in Kosterin 2010); all other characters except for coloration and abdomen length coincide as well. The morphology of the appendages and S10 suggest that those two males had nothing in common to *A. pallidum* (in fact this was claimed already in Kosterin 2010). In the cited paper, I considered them as close to that species, that was obviously a blunder, because they had no any black pattern at all, which seemed to be replaced by a vague tan pattern with a bronze lustre. The legs, pterostigmas, appendages etc. were of lighter colours than in the August *A. hisopa* specimens. Since the two April males had a saturated blue ground colour, I considered them to be mature, although they could be still immature. However, on 16 August at the 'Aciagrion rivulet source' I photographed a teneral specimen of *A. hisopa* which still was not blue but already had the pattern very dark (Fig. 44b).

I may suggest another interpretation of these facts: April was an extremely hot time of the year while in August the temperature was much lower, the weather resembl-

ing a Siberian summer. Maybe in *Aciagrion*, the colour of the pattern, black versus tan, depends not on individual age but on some conditions, most probably temperature, during some critical stage of development, so that it developed tan in specimens emerged in April but black in those emerged in August. (The invariably black pattern in the *Aciagrion* northern relatives, *Enallagma* and *Ischnura*, would be explainable in this respect as well).

Figure 47. A tandem of *Coeliccia kazukoae* (= *C. megumii*), 'Gynacantha brook' valley near Thma Dar locality, 27.08.2011.

What I cannot explain is ca 7% longer abdomen in those two April males (30 and 30.5 mm) than in the August mature males (27.5-28 mm ; measurements by caliper in the lab to within 0.5), all other parts being of the same size. The teneral specimens collected in November/December had the abdomen as long as mature ones found in August. In April males, elongation was especially noticeable in S10, which was about as long at the ventral side as high (see Kosterin 2010: Fig. 41). Yet I doubt that two species are involved here. Could there be some environmental variation as to the abdominal length as well? There is information in Internet about existence of seasonal variation in the general size in *Aciagrion migratum* (Selys, 1876) in Korea: "in summer, 24-26 mm at the abdomen and 15-17 mm at the rear wings. In winter, 28-31 mm at the abdomen and 18-22 mm at the rear wings." (http://www.naris.go.kr/v2_en/naris_search/search_result_detail.jsp?inst_id=33931). More collections should be done at Andy's pond in different seasons to solve the enigma.

5. *Coeliccia kazukoae* Asahina, 1984
All specimens of *C. kazukoae* I observed in August were fully mature, with a full developed black pattern, which corresponded to the description of *C. megumii* (for their synonymy see Kosterin 2011). At the 'Gynacantha brook' I managed to photograph a tandem (Fig. 47).

6. *Burmagomphus divaricatus* Lieftinck, 1964
Males exhibit all the morphological characters of the species, including the characteristic broad posterior hamulus with one strong backward-directed spine and a fringe of long hairs on its posterior margin, the S9 hind margin protruding and pointed at middle (not so in one out of the eight collected males), and very slender and strongly projecting lateral branches of the inferior appendage (Lieftinck 1964; Asahina 1986). However, the antehumeral light stripe had strongly reduced lower part which was either absent (in 3 males) or represented by a tiny isolated spot (in 5 males, shown by white arrowheads in Fig. 48); the light spot on the mesepisternum at the wing base was absent in 5 males (alike in both in Fig. 48) and presented in 3 males (combination of both present was found in 2 males and of both absent in 2 males as well). The lateral thoracic pattern corresponded to Fig. 29 in Lieftinck (1964) rather than to Fig. 8 in Asahina (1986), that is the black anastomosis in the metepisternum upper part complete and indistinctly (with a diffuse brownish connection) fused with the black stripe along the mesepimeron/metepisternum seam, but all the lateral stripes are broader. I do not think the melanisation of mesepisternum to be of some taxonomical value.

Burmagomphus undescr. spec. from the Thma Bang River represented by a male collected on 25.12.2011 (see above) and four teneral females collected on 15.04.2011 (Kosterin 2010: 65-66) will be described from Cambodia and Thailand elsewhere jointly with Noppadon Makbun.

Figure 48. Close-up view at perching males of *Burmagomphus divaricatus* at 'Microgomphus River', 23.08.2011 (above) and 'Thma Bang River', 25.08. 2011 (below). White arrowheads indicate the spots being remnants of the antehumeral stripe lower part.

7. *Merogomphus parvus* (Krüger, 1899)
The female from the 'Microgomphus River' lacked paired spines on its occiput, which is very slightly serrate, alike females of this species from Thailand examined by Asahina (1986), and entirely black, as his female from Saraburi Province. I must note that two teneral females photographed at the Thma Bang River on 15.04.2010 appeared in fact to be not *Burmagomphus* sp. (Kosterin 1910: 36, 55) but *Merogomphus parvus* (Fig. 49), while the four collected teneral females were the above mentioned *Burmagomphus* sp.n. indeed.

Figure 49. A teneral female of *Merogomphus parvus*, photographed at Thma Bang River bank on 15.04.2011 and erroneously counted among *Burmagomphus* sp. in (Kosterin 2010: 36, 65-66).

8. *Hemicordulia* undescr. spec.
In three males obtained in December at the 'Hemicordulia brook', no spots were seen in the abdomen, while a male from Phu Ruea, Loei, Thailand, courtesy sent by Brother Amnuay Pinratana, had dark-yellowish lateral spots (Kosterin 2011). Now I collected seven males from Koh Kong Province and two males from Bokor Plateau. Two of the specimens from Koh Kong Province had no spots while the others had more or less obscure dark yellowish to brown spots. Most probably, the spots darken and disappear with age.

9. *Macromia septima* Martin, 1902

Macromia species are either hard or impossible to identify by females; however, I am quite sure in my identifications. The two females collected at 'Microgomphus River' are obviously conspecific, belong to the *calliope*-group and fit the descriptions of *Macromia septima* both by Martin (1904) and, more importantly, Lieftinck (1929, 1950) and photos in Karube (2011). The main identification characters were uniform-

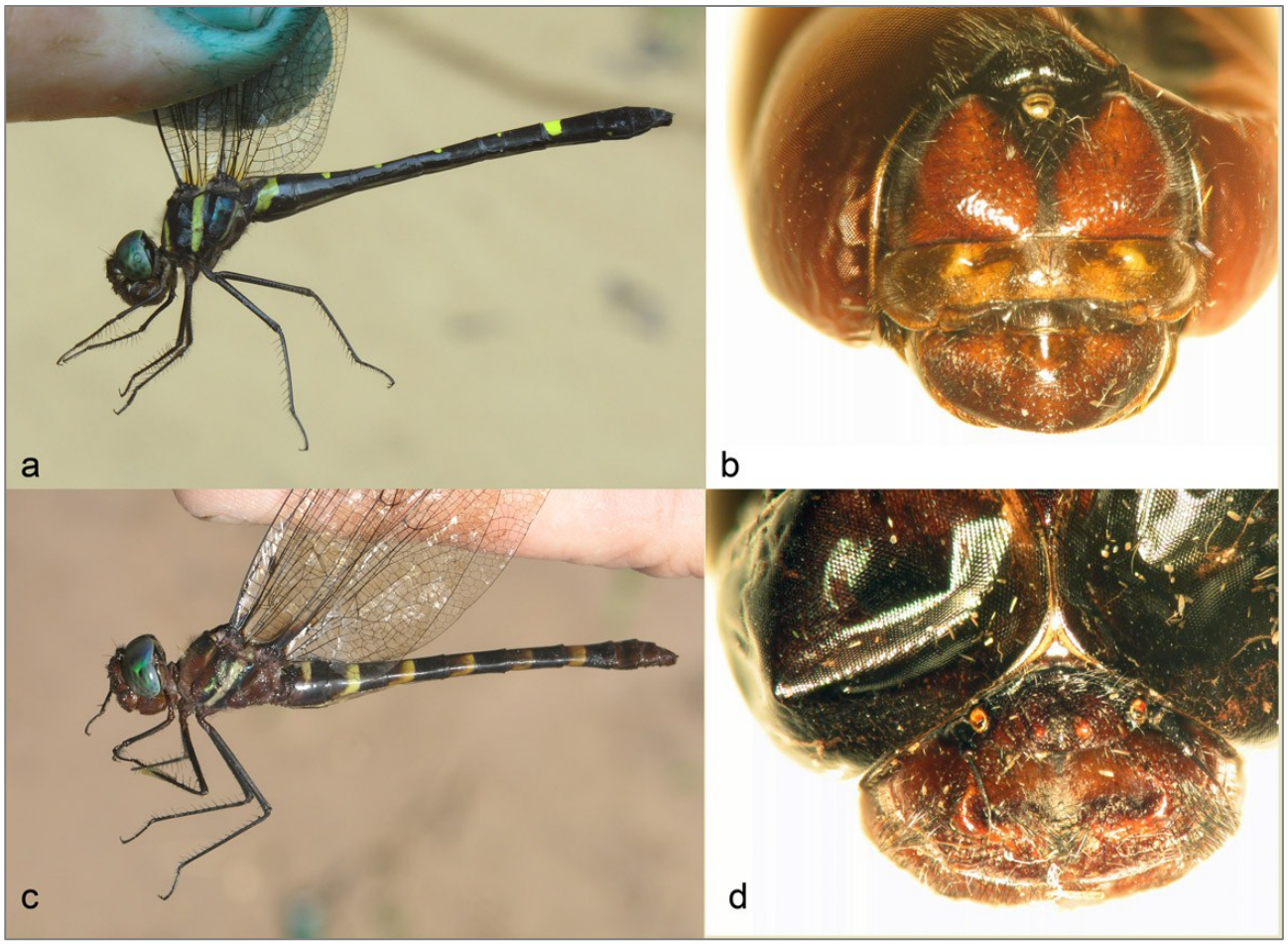

Figure 50. Females of *Macromia* spp. from Koh Kong Province (not to scale): a-b) *Macromia septima*, 'Microgomphus River' near Thma Bang settlement, 25.08.2011; c-d) *Macromia cupricincta*, 'Macromia rivulet, 16.08.2011; a, c) live colour habiti; b, d) heads; b) frontal view; d) dorsal view. Green colour on fingers is *viridis nitentis*, an antiseptic medicine for small wounds popular in Russia.

ly reddish-brown face (the key character, see fig. 21 in Karube 2011) with pointed pyramidal processes and very dark brownish vertex with two pointed tubercles (Fig. 50b), a brown pterothorax with obscure metallic-blue lustre in its dorsal part and humeral stripes extending to the middle of the metepisternum, a black, non-metallic abdomen with a broad contiguous transversal yellow band across S2, small paired dorsal brownish-yellow spots at the middle of segments S3-6, a large, slightly pointed brownish-yellow spot at the base of S7, extending for 1/3 of its length, also traces of ventrobasal streaks on S3 and ventrobasal spots on S8 (Fig. 50a), extremely short

and hardly visible vulvar scale, a pair of small, appressed, divergent and pointed leaf-like tubercles on the free sternite margin of S8. Measurements: length of abdomen with appendages 38-41 mm, hind wing 36-37 mm. No other species of the *calliope*-group so far reported for the neighbouring Thailand (Hämäläinen & Pinratana 1999) and Vietnam (Do & Dang 2006; Karube 2011), namely *Macromia calliope* Ris, 1916, *M. callisto* Laidlaw, 1902, *M. chayaphumensis* Hämäläinen, 1985 (the female still not described), *M. flavocolorata* Fraser, 1922, *M. urania* Ris, 1916, has an uniformly brown face. I hope my identification will be confirmed in future by male specimens.

The female from the 'Capricornis Rivulet' missed the two last abdominal segments already when taken off the net. Most probably it is also *M. septima*, in spite of the following differences. It is slightly larger: the hind wing 39 mm (the abdomen length unknown); however, the antenodal number is the same: 15 and 16 on the fore wing and 11 on the hind wing, versus 15, 16, 17 and 18 on the fore wing and 10 (one wing) - 11 (3 wings) on the hind wing in the 'Microgomphus River' specimens. In the 'Capricornis Rivulet' female, the entire wing membrane is slightly fumy with yellowish-brown, while in the 'Microgomphus River' specimens this fume appears gradually only in distal wing halves. Most important, the 'Capricornis Rivulet' specimen looks as having a flat vertex without tubercles. However, it seems as if pressed against a horizontal surface; moreover, the very tips of the antefrontal pyramidal processes seem to be pressed against the same surface. Most probably, the head top of this specimen was just somewhat deformed, perhaps before maturity. Anyway, getting male specimens from both rivers is much desirable.

10. *Macromia cupricincta* Fraser, 1924

Because identification of *Macromia* females is usually problematic, I have to enumerate the basis of my identification which I consider as quite reliable. The female from 'Macromia rivulet' exhibited such characters mentioned by Asahina (1987) as reddish dark-brown face with moderate paired antefrontal prominences, each bearing a semicircular ridge surrounding a shallow dimple (Fig. 50d), ferruginous-brown ground colour of the most part of the pterothorax (expect for metallic greenish-black upper 1/3 of the metepisternum, the hind part of the mesepimeron, and the metepisternum), S1, the basal part of S2, and entire S8-10, absence of humeral stripes, broad dull yellow abdominal markings (Fig. 50c).

11. *Macromidia rapida* Martin, 1906

I should note some discrepancies in the characters of this species existing in literature. They concern:

(i) The number of cell rows in the hind wing discoidal field: (i) "... in the discoidal field ... with 3 single cells followed by two rows ... on the hind wing" (Lieftinck,

1935: 195) versus “the discoidal field in both fore and hind wings commencing with two rows of cells” (Lieftinck 1971: 18). The former seems more correct, the hind wing discoidal field is one-rowed for the first 3 cells in one of my males and for the first 2 and 5 cells in two hind wings of the other male.

(ii) The body ground colour: “Thorax vert métallique entièrement en dessus”, “Abdomen vert métallique sur les deux premiers segments, noir, ensuite, taché de jaune comme suit” (Martin 1906: 79); “body metallic green” (Lieftinck 1935: 195); “body is metallic black” (Lieftinck 1971: 18). In my specimens, the thorax ground colour is metallic green, that of abdomen is brownish black at S1-3 (both males looked rather young that may be the reason of the brown tint), with metallic green on dorsum of S1-2, and glossy black at the rest of the abdomen, that fully corresponds to the original description.

(iii) The abdominal yellow marking in male. According to the original description, “un triangle dorsal ayant la pointe en haut sur tout le milieu du 1er segment; le 2e court, sans tache, saut un petit point dorsal terminal chez les ♂... avec un peu de jaune aux cõtés; le 3e avec une raie dorsale d’un bout á l’autre, plus large á la base; les 4-5es avec une fine raie dorsale d’un bout á l’autre; le 6s également avec la raie dorsale s’largissant seulement au milieu; les 7-8es de méme; les 9-10es noirs” (Martin 1906: 79). However, on the colour table, the male is depicted as if having rather broad yellow spots at middle of segments 5-7, instead of fine dorsal band throughout the segment length, as in the description, and shows just a small dot or reflex on segment 8 (Martin 1906: Planche III, fig. 18). Taken into account the difficulties with providing coloured illustration existed in those old times, it is the detailed verbal description which would be trusted. However, there are different reports concerning dorsal yellow marking on segments 2 and 8: According to Lieftinck, “abdomen with sharply defined, yellow mid-dorsal longitudinal spots on segm. 3-7, and a few yellow points on 2 and 8” (Lieftinck 1935: 195), “well defined middorsal yellow spots on segm. 3-7" (Lieftinck 1971: 18). On photos of males of *M. rapida* from Hong Kong by Keith Wilson in (Agriculture, Fisheries and Conservation Department, HKSAR Government. 2002: 61) and by Pangkin Bergman at http://www.flickr.com/photos/m6n66/4722400799/, we see a narrow yellow dorsal line on S3-6, somewhat broadening on S6, a broader spot on S7 and none on S8. In my males, the dorsal abdominal yellow marking is as follows: a small dorsal dot and a fine and short transversal line at the distal margin of S2, finest dorsal lines along S3-6, which rather form a contiguous line but are hardly traceable at distal ends of the segment (a fine correspondence to Martin 1906), S7 with only a slightly broader narrowly lanceolate spot extending for its proximal half in one specimen and, as the finest line, to its distal end in the other specimen; S8-10 unmarked (a good correspondence to Lieftinck 1935, 1971 and the mentioned photos): see Fig. 51a.

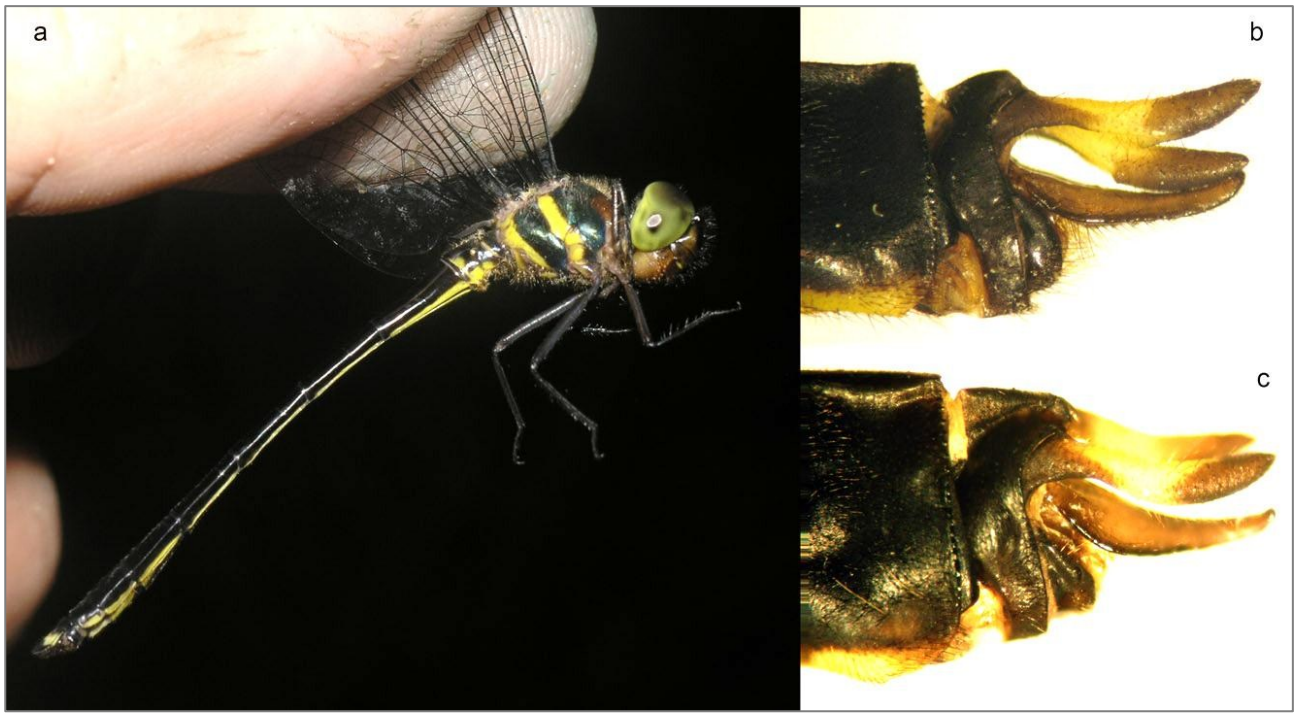

Figure 51. Males of *Macromidia rapida* collected at the mouth of 'Oculata brook' at Andy's pond in Tatai village on twilight 25.08.2011: a) general habitus, b-c) appendages of the two males collected.

In spite of the above, I consider identification of my males as *M. rapida* doubtless, also basing on peculiar bicoloured upper appendages (as in Martin 1906) and two rows of cells from the very beginning of the fore wing discoidal field, the character mentioned by all the above cited authors (Martin 1906; Lieftinck 1935; 1971). Curiously, the length of the lower appendage differs substantially in my males: shorter than the upper appendages (Fig. 51b), although somewhat less than in the figure by Martin (1906: fig. 91) in one male, and almost equal to the upper appendages in the other male (Fig. 51c). This must be a matter of individual variation, because of absence of any other sound difference between the two males, collected simultaneously in the same point. Other characters in the two males as should be in the species: 15 (in 3 wings) – 16 (in 1 wing) antenodals on the fore wings (16-20 according to Lieftinck 1935), 10 antenodal in the hind wings (9-10 ibid.), three rows of cells between the anal loop and the wing margin (ibid); hind wing 30 and 31 mm (31-32 mm ibid.).

12. *Idionyx thailandica* Hämäläinen, 1985

Both male (in Kep) and female (on Bokor) of *Idionyx* belonging to the *yolanda*-group were collected teneral. The male was still soft and discoloured but a day later in captivity it acquired coloration and rather hardened. Its identification as *I. thailandica* is based on a substantial lateral expansion of the abdomen distal part, with the ratio of widths of the apical parts of S8 and S6 being about 1.62 (said to be ~2 in the holotype of *I. thailandica* and less than 1.5 in *I. victor* Hämäläinen, 1991), the yellow stripe on the metepimeron not turned forward at the alar sinus (unlike in *I. victor*),

dorsally expanded S2-3, almost not hooked down lateral processes of the lower appendage (unlike in *I. yolanda*), dense hairs above its terminal lobe (Hämäläinen 1985; 1991; Asahina 1987). Hind wing 28 mm, abdomen with appendages 27 mm. Identification of the female (Fig. 39) is based on the even in width and straight yellow lateral thoracic band going through spiracle (Hämäläinen 1985), but is still conventional; however, no related species are expected in this area. Its hind wing is 32 mm, abdomen 28 mm (the abdomens in both specimens collected teneral may be not fully expanded). Species of the *yolanda*-group do not occur sympatrically and seem to replace each other geographically (that weakens confidence in their species status, see Wilson & Reels 2001), with *I. yolanda* ranging in Sundaland including the Malay Peninsula (Hämäläinen 1991; Orr 2005), an undescribed species found in the Malay Isthmus within Thailand (Hämäläinen 2002), *I. thailandica* in the continental Thailand (Hämäläinen & Pinratana 1999), *I. victor* in South China (Wilson & Reels 2001) and *I. philippa* Ris, 1912 in the Philippines (Hämäläinen 1991). Recently Karube (2011) reported *I. victor* for South Vietnam, that is close to the Cambodian limits and Kep in particular; unfortunately, his specimen was not discussed with respect to *I. thailandica*.

13. *Brachydiplax farinosa* Krüger, 1902
Fraser (1936) and later Asahina (1988) suggested that *B. farinosa* has 8-9 antenodals on the fore wing and by this may be distinguished from *B. sobrina* (Rambur, 1842) which has seven antenodals. This character expectedly appeared not so reliable: of six fore wings of the three males of *B. farinosa* collected at the 'Triangularis pond' and identified by the accessory genitalia, seven had eight antenodals and one had seven antenodals.

14. *Neurothemis fluctuans* (Fabricius, 1793)
In Koh Kong Province this time, numerous *N. fluctuans* were represented by a mixture of mature and immature individuals, judging from the intensity of the male wing coloration.

Notes on habitats and habits of some species

1. *Vestalis gracilis* individuals almost invariably occurred in shade at river and brook banks, as a rule loosely aggregating in some places. At the Popokvil River I observed a male who perched on a branch of a *Dacridium* sapling growing from the middle of the river, and several times returned to the same patch. However, on 21 August at the 'Gracilis Rivulet' near Kampot (Fig. 13), numerous mature (with a slight pruines-

cence at two last abdominal segments) individuals of *V. gracilis* were for some yet unclear reasons observed at its long open reach flowing across countryside, at exposed banks with stones and short grass, at partly cloudy weather about an hour after a small shower. They did not seek shade and behaved exactly as if were some *Calopteryx splendens* in North Eurasia. Noteworthy, at the same river, some *Neurobasis chinensis* occurred only at reaches bordered by dense trees at least from one side.

2. *Euphaea masoni* prefers half-shaded places at rapidous streams (brooks to medium-sized rivers). Males perch either on branch tips 1-3 m above the water, or, less frequently, on stones; females perch invariably on branch tips and are not elusive, as seen almost as frequently as males (the same by the way concerns *Heliocypha* spp., but their males more tend to perch on rocks). Matching males may form small swarms (up to 4 individuals, as seen at the 'Capricornis rivulet'). Some males were observed as if playing by swiftly descended closely to the small waterfalls almost touching the foam and spray.

3. Oviposition of *Rhinagrion viridatum* observed at 9:05-9:16 a. m. on 26th August at the 'Oculata brook' (Fig. 52, 53) well corresponded to that described by Kalkman & Villanueva (2011) as follows: "... used mossy vegetation some 1.5 metres above the stream surface". The female oviposited into moss at a vertical surface of a boulder ca 1 m above the brook (Fig. 52). When disturbed, it flew and set on a nearby branch but in several minutes returned to the same place and proceeded oviposition. After second disturbance while photographing it descended to another boulder and oviposited for some minutes, then returned to the previous oviposition place, then to a third place. While ovipositing, it slowly went round the very ovipositing place so that changed orientation from vertical with the head up to upside down (Fig. 53).

4. Occurrence of *Prodasineura autumnalis* and *P. verticalis* sensu Asahina, 1983 confirmed their segregation at the preferred habitats: considerable rivers and rivulets for the former and small brooks and seepages for the latter (Kosterin 2011). I, however, managed to spot a place where they occur side-by-side. It was the 'Prodasineura river' at some distance upstream the mouth at Thma Dar terrain. On its right bank there was a several metres high layered vertical sandstone wall seeping with water, which formed pools at its small ledges (Fig. 54a). At these ledges and above the pools I observed many hovering males and some tandems of *P. verticalis* sensu Asahina, 1983 while in several metres, at the main powerful stream (Fig. 54b), some *P. autumnalis* occurred.

5. At the 'Microgomphus River', *Burmagomphus divaricatus* preferred the rapidous part with sandstone rocks and scarcely entered the shallow transitory part at the bridge. Males perched invariably on rocks, mostly horizontal, less frequently slanting. They kept their abdomen parallel to the substrate of just slightly raising up (Fig. 55). (The only male of this species at the 'Capricornis rivulet' landed on a rock and as

Figure 52. Ovipositing site of *Rhinagrion viridatum*, a shady and mossy boulderly above the 'Oculata brook' valley at Tatai village, 26.08.2011.

Figure 53. An ovipositing female of *Rhinagrion viridatum*, a shady and mossy boulderly above the 'Oculata brook' valley at Tatai village, 26.08. 2011.

Figure 54. A locality where two species of *Prodasineura* occur side by side, 'Prodasineura rivulet', the Koh Bopw River left tributary at Thma Dar terrain, 27.08.2011: a) shaded water seepages at layered sandstone rocks inhabited by *Prodasineura verticalis* sensu Asahina, 1983; b) surface of the rivulet above which howering males of *Prodasineura autumnalis* occurred.

Figure 55. Males of *Burmagomphus divaricatus* perching on rocks near rivers: a-b, d) 'Microgomphus River' troubled part below the bridge, 23.08.2011; c) Thma Bang River, 25.08.2011; a) a male of *Trithemis festiva* is also seen nearby.

large log.) This completely contradicts the first phrase of the following Lieftinck's note on the genus in general: "Adults are easily overlooked creatures with arboricolous habits, usually found resting on bright green foliage beside a stream. So far known all species breed in running water, but the larvae seem capable only to burrow in silt or fine tracts and avoid the tracts of streams with fast flowing water" (Lieftinck, 1964: 14). The habitat characterisation by Fraser (1926: 408) fits more: "... jungle habitats, frequenting mountain streams in ravines ... Males are found resting on stones in midstream or on rocks and foliage beside these waters". First males appeared in the morning, still overcast at ca 9 a.m. on 23th August and at first sunbeams at 8:30 a.m. on 25th August, they permanently made very short movements while perching and were cautious. Later in sunny day they sat immovable, sometimes near each other, and were much less cautious. No male ranging behaviour and no females were observed. At the Thma Bang River, the male (or two males) of *Burmagomphus* n. sp., as well as several males of *B. divaricatus*, observed on 25 August, had exactly the same behaviour (the morning behaviour was not observed). Noteworthy, at this more powerful river, *Burmagomphus* spp. were much more scarce.

6. *Nepogomphus walli* occupied mainly its transitory part at the bridge, shallow but calm, with sandy bottom with some flat sandstone plates. Contrary to *B. divaricatus*, males of *N. walli* were five times observed perching always on low bank vegetation (Fig. 56). Besides, individuals of this species were frequently observed very fastly flying, very low above the river surface, mostly to and fro across the river, but only at direct sun. Several times I observed them to rise up to the tree crowns and land there at 3-5 m above the water. To my surprise, these ranging individuals were represented by both sexes: for both days I captured 3 males and 3 females. Perhaps *N. walli* invariably perches on vegetation, mostly in tree crowns but some males also at bank herbage. The only individual of *N. walli* found elsewhere was a female at the 'Nannophya Rivulet', which again flew swiftly just over the surface of a small, not more than 0.5x0.5 m patch of the river where it was shallow, shaded, had a considerable current and filled with long leaves of some submerged plant which were winding in the current and extend above the surface. That is, behavior of this female was alike of those at the 'Microgomphus River' but the suitable flight sight was very restricted in area.

7. At the 'Ictonogomphus oxbow' in Kamot environs, I twice observed as a male of *Ictinogomphus decoratus melaenops* left its perch at the bank, flew to open water, several times touched ('picked') water and returned to the perch. The same did a presumable *Ictinogomphus* male who descended from a crown of a huge tree hanging over the 'Zyxomma Pond' on Kep Hill: picked water twice and flew up back. I have no idea if they 'drink' (but why other dragonfly rarely do so?), are able to collect some prey from water surface (hardly so), or this was some other behaviour.

8. Being so many during this visit, the males of *Hemicordulia* undescr. spec. extended beyond their seemingly preferred habitats: clear and rather deep pools and reaches with sandy beds, slow current and banks with arboreal vegetation (see Figs 14 and 18 in Kosterin 2011, although not found in the second locality in 2010), but patrolled even sunny and fast reaches of the 'Nannophya rivulet' crossing an open pasture, where they ranged side-by side with perching *Trithemis aurora* and *festiva*; as well as at silty reaches in deep shade (observations of 16th August). However, they did not enter the rapidous part of the rivulet, in spite of presence of calm pools and reaches but with rocky rather than sandy bottoms. It seems that they were confined to sandy and tolerated silty beds.

On the Bokor Plateau, two males of *Hemicordulia* were observed on 19th August (after 10 a.m.) patrolling half-shaded reaches with slow to moderate current and sandy bed of the Popokvil River (Fig. 57), which surely suited them best. However, on Bokor these males were also observed in some seemingly atypical habitats. At 1:00-1:20 p.m. 18th August, at an overcast weather between rains, about five patrolling males appeared over shallowest pools with sandy bottom and the water flowing over the

Figure 56. A male of *Nepogomphus walli* perching on riparian herbaceous vegetation at the transitory part of 'Microgomphus River' at the bridge, 23.08.2011.

old ground 'Odorata road' crossing a large *veal* (Fig. 58a), and a sedgy small brook nearby. This looked like some unusual outburst, for they were absent at this point both before, at 11:50-12:10 a.m., and after, at 3:30 p.m., as well as next day at 8:48, 11:00 a.m. and 3:30 p.m., in spite of the weather varying greatly from short sun through overcast to drizzling rain. Because on 18th August, with several rains, no males were observed on the Popokvil River itself, this appearance of males over the flooded road could be some temporal abnormal activity. At 10:20 a.m. 19th August, a patrolling male appeared above a forest tiny knee-deep swamp close to the River, filled with tussock sedge (*Carex* sp.) which left no open water.

At the 'Nannophya rivulet', I noticed a copula which flew for several seconds over an open and rather fast reach and then landed on a bush. When seated, they performed short 'convulsive' movements about once a second; then were disturbed by me approaching.

9. Adult *Macromia* encountered during this trip were represented by females of two species, with quite contrasted behaviour. Smaller females of *M. septima* were observed as swiftly ranging low along the water edge of short (just 2-3 m) sections of sandy banks (open or with grass) of rather slow reaches of medium-sized rivers in con-

Figure 57. 'Idionyx reach' of the Popokvil River, the most suitable habitat, intensively patrolled by males, of *Hemicordulia* undescr. spec. on the Bokor Plateau, 19.08.2011.

dition of absence of direct sunbeams, mostly in the morning: 1 case at ca 9:30 a.m. on 14th August at the 'Capricornis Rivulet' not far from its mouth (in shade at sunny weather) (Fig. 59a); 4 cases at 9-10 a.m. on 25th August (at both banks at ca 9 a.m. at still overcast skies, at the shaded right bank at ca 10 a.m. at already sunny weather); but once also in midday: ca 1 p.m. on 23th August at the 'Microgomphus River' transitional section at the bridge (in shade at sunny weather). It is unknown if the five mentioned 'cases' represented different or same individuals. Two of them were collected on 25th August but I made an unsuccessful net sweep on 23th August and three such sweeps on 25th August, which made a dragonfly to disappear. On the contrary, a larger *M. cupricincta* female ranged at sunny midday on 16th August not so low over open surface along a several dozen metre long, half-shaded, knee-to-throat deep stretch of the 'Macromia Rivulet' with a sandy/silty/litter bottom (Fig. 59b). A 5-10 min long interval between its two appearances suggested that maybe it also entered for an unknown distance a shallower and faster upstream reach hidden in the coppice. Judging from the habitats, both species should have sand-dwelling larvae. Hence the *Macromia* larva once seen cling to a rock in a fast and rapidous stream at the 'Viola *veal*' must belong to some third species.

Figure 58. Ground roads and pits on Bokor Plateau: a) 'Odorata road', a sandy road covered with shallow lotic pools crossing the *veal* not far from Popokvil waterfall on Bokor Plateau; a spot of occasional (atypical?) activity of males of *Hemicordulia* undescr. spec. on 18.08.2011; François Sockhom Mey, an expert in carnivorous plants, is seen at his work; he has described *Nepenthes bokorensis* Mey, the plateau endemic which grow in abundance nearby; b) *Utricularia odorata* Pellegr. in vigorous blossom on this road; c) *Utricularia minutissima* Wahl. at 'Minutisima pit' nearby, identifications by François (a).

10. On 26th August at the 'Cora Marsh' situated in the mangrove area in the SE suburbs of Koh Kong, I twice observed common libellulids to follow me. First they were two males of *Tholymis tillarga*, who fluttered around me after I had disturbed them from tall *Juncus* rush at ca 2:30 p.m. Second it was a male of *Brachythemis contaminata* who closely followed my feet for ca 5 min and 15 m when I walked over a trampled bank with a low scarce grass. Obviously it was an adaptive *accompanying behaviour* (Corbet & Miller 1991) of following large animals who disturb potential prey, but it was strange that I did not see it nowhere else in Cambodia. This may be explained by frequent appearing of cattle at the town margin; then we have to assume that dragonfly may learn to follow cattle.

11. *Cratilla lineata* is said to inhabit "closed forest and forested swamps" (Orr 2005: 96). It was exactly so with a male perching on bamboo branches (Fig. 26) at 2-2.5 m over a shaded swampy brook overgrown with a dense bamboo near the left bank of the 'Lake area' (the Right Tatai River swelling) on 24th August. At the same time, on 25th August I observed three individuals (a male, a female and an unknown sex) at open conditions: as ranging, with hovering and chasing each other, over the road along a dense forest margin or perching on exposed sticks. It was no surprise for this tenebrous libellulid that this activity at the open area took place under quite a strong

Figure 59. Places patrolled by *Macromia* females in localities at the road from Koh Kong to Pursat: a) a 2-3 m long shady sandy bank stretch of 'Capricornis rivulet' near its mouth patrolled by a female of *Macromia septima*, 14.08. 2011; b) a half-shaded deep reach of 'Macromia rivulet' patrolled by that of *Macromia cupricincta*, 16. 08.2011.

rain. That time I rode a motorbike from under a severe downpour in Thma Bang to still dry Tatai, so I cannot say if it was after the heavy downpour passed that place away or it was just a strong rain from the margin of the same cloud. Before I made this way thrice for two days at good weather and did not observed these dragonflies. Anyway, ability of this species to expand to open places under rainy conditions is noteworthy.

12. Territorial *Lyriothemis elegantissima* males switched hovering and agonistic contacts with each other with perching on dry branches, usually at 2.5-3 m above the ground, exhibiting quite a fidelity to the preferred perch. It appeared easy to pull a branch to lower the perching male to ca. 1.5 above the ground for photographing without disturbing it (Fig. 38). I did it several times.

13. Males of *Onychothemis testacea* at the bridge through the 'Microgomphus River' perched either on an iron rod or naked sticks at the very bank or on a thin liana hanging from the bridge almost to the spraying and foaming fast water, almost a waterfall (Fig. 60); or ranged over the river.

14. It sounds a commonplace to say that males of *Zygonyx iris malayana* typically slowly soar over fastest places of rapidous medium-sized streams or nearby. At the same time they obviously avoid larger rivers. It is another commonplace that dragonfly males guard the breeding places. However, I once found about ten exuviae of this species on a ceiling of a niche of one of the Koh Por Waterfalls, that is at the middle of a mighty river (Kosterin 2010). And on this trip I observed oviposition of this species at sites not so habitual for ranging males as being calm and shady. At 10:38-10:40 a.m. on 25th August, two tandems oviposited onto a very short shaded bank stretch, with shallow slow water and bottom filled with black leaf litter, of a right arm of the elsewhere rapidous Thma Bang River (Fig. 61). The suitable patch seemed so tiny that the two tandems oviposited just in several centimetres from each other. Another male was attracted to them and flew nearby, then one tandem disjoined but the female proceeded oviposition alone. About an hour later I observed exactly the same situation at exactly similar patch of the opposite bank of the same Tham Bang arm: again two tandems oviposited very closely to each other and again one of them disjoined.

Besides, *Z. iris* appeared to aggregate to feed, alike *P. flavescens*, *Rhyothemis phyllis / variegata* or some our northern *Aeshna* species. Thus, the same day as above and closely, at ca 10 a.m., several individuals of *Z. iris* and *P. flavescens* soared together 3-6 m above the ground in a very loose swarm in open banana plantation near the Thma Bang River left bank. I managed to catch a *Zygonyx* male after about ten unsuccessful net sweeps; curiously, he did not react to them. Twice I observed much more impressive *Zygonyx* swarms, both at a major river and under slow rain. One

Figure 60. Male(?s) of *Onychothemis testacea* perching over the water of 'Microgomphus River' near Thma Bang, 23.08.2011.

was above the same Thma Bang River rapids on 23th August. I arrived there at 14:40 p.m. when a very slow rain had just started from an impresssive thunderstorm cloud. Above the wide river bed upstream a kind of small waterfall, there was a swarm formed by ca 50 *Zygonyx* individuals. They flew from 3 m above the river and flat rocks, that is hardly at a net reach, to much higher, but I failed to evaluate the upper limit. I managed to collect one individual; it was a male but I cannot judge about sex representation in the swarm. When the rain ceased, the lower limit of flight raised considerably, so that the dragonflies flew not below the level of tree crowns on the bank. A day before I observed a swarm of ca 15 individuals at the Tatai River, which kept to the woody valley right margin at the traverse of and in a couple of dozens of metres from the Tatai Waterfall. Again, I arrived there, at ca 15 p.m. at the very beginning of a slow rain from a thunderstorm cloud which had approached for a long time. The dragonflies flew under that rain not less than 5 m above the flat rocks of the valley bed, near the forest margin. In an hour the rain ceased and, again, the swarm raised so that all dragonflies flew above the tree crowns. At ca 17 p.m. the swarm proceeded existence but the participants became fewer. At ca 17:30 p.m. only five dragonflies left, the last was observed at 17:58 p.m., still before sunset, with first bats appeared few minutes later. Such a behaviour was noted by Fraser (1936: 393), although without a direct mention of congregation, as follows: “whilst, after first emergence, they soar above the forest at great heights and may be observed with field-glasses in vast numbers at heights of several hundred feet”.

15. Reaction of some lentic Odonata to rain was not so clear for me. *Lestes praemorsus decipiens* were perching on emerging grass over the water in any weather when I visited their habitats: in sun, under medium-strong rain, under downpour, and in gloomy weather after a night downpour. Noteworthy that in rainy weather, they kept their wings folded while at good weather they keep them open. Three of these five observations of them remaining at their breeding places under rain were done at the boglet at the ‘Aciagrion rivulet’ source. At the same place, males of *Indothemis limbata* and both sexes of *Aciagrion hisopa* were on their place in the emerging grass at the medium-strong rain (13th August). However, *I. limbata* were scarce at sunny weather after a night downpour (16th August) but absent in overcast weather between night and afternoon downpours (15th August), while mature *A. hisopa* were absent in both these days. (Emerging of *Aciagrion hisopa* and *A. borneense* went on in tensively in all these days but only in shaded grass in the sunny midday.) So, *I. limbata* and *A. borneense* remained in place at moderate rains but downpours made them to disappear, if not kill them. Perching individuals of *Trithemis pallidinervis* were seen on 13th and 15th August but disappeared on 16th August, after the second downpour. At the ‘Triangularis pond’ I observed both sexes of *Diplacodes nebulosa* at their breeding places in sparse emergent grass during extremely strong downpour, their (not large) number at the ‘Aciagrion rivulet source’ also seemingly did not depend on weather. However, these anecdotal observations do not allow any definite conclusions.

Figure 61. Ovipositing tandems of *Zygonyx iris malayana* (below accompanied by a male from a just disjoint tandem) at a small shady bank stretch with a slow current and litter bottom, Thma Bang river near Thma Bang, 25.08.2011.

Update to the country fauna.

The previous count in Kosterin (2011) provided 106 named species recorded in Cambodia. Since then, four more species were added: *Agriocnemis lacteola* Selys, 1877, *Coeliccia yamasakii* Asahina, 1984 (Kosterin & Holden 2011), *Heliaeschna crassa* Krüger, 1899 and *Orchithemis pulcherrima* (Day 2011). In the present trip, 87 named species were recorded, of which 15 appeared new records for Cambodia, namely *Aciagrion hisopa*, *Anax immaculifrons*, *Burmagomphus divaricatus*, *Gomphidictinus perakensis*, *Merogomphus parvus*, *Nepogomphus walli*, *Idionyx thailandica*, *Macromia cupricincta*, *Macromia septima*, *Macromidia rapida*, *Agrionoptera insignis*, *Lyriothemis elegantissima*, *Onychothemis testacea*, *Orthetrum luzonicum* and *Orthetrum testaceum*. This rised the number of named species known to Cambodia to 125, that is still below half of the number of species expected for this country. Note a relatively large number of Gomphidae and Corduliidae species and scantity of damselflies (just one species) among the update. The area studied worth revisited in the early rainy season, that is in May-June, to get more lotic species; after this the coastal Cardamonian foothills could be considered as preliminarily examined, the core of the Cardamom Mts. being the next target.

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CORRIGENDA TO:

a) **Kosterin, O.E. 2010. A glance at the Odonata of the Cambodian coastal regions: end of dry season in 2010. International Dragonfly Fund Report 29: 1-75.**

- → Page 38, line 8: “6 teneral *Burmagomphus* females” – in fact 4 teneral *Burmagomphus* females and 2 teneral *Merogomphus parvus* females (see Fig. 49).
- → Page 48, line 4: “*P. australasiae*” – in fact it was *P. microcephalum*, see (Kosterin 2011).
- → Page 55: Thma Bang River upstream waterfall ..., Photos: .. "*Burmagomphus* sp. 2 more ♀” – should be *Merogomphus parvus*, see above.
- → Page 57: A nearby shallow pool, collections: "*Pseudagrion australasiae* – 1♂ (21.04)" – should be *P. microcephalum*, see above.
- → Page 64, Fig. 43: the legend says "males" while the *Burmagomphus* specimen is a female, as also stated in the text.
- → Page 74, the reference Asahina, 1986: the volume must be XIII instead of XI as printed.

b) **Kosterin, O.E. 2011. Odonata of the Cambodian coastal regions revisited: beginning of dry season in 2010. International Dragonfly Fund Report 40: 1-108.**

- → Page 65, Fig 55: both individuals were claimed to be females while the lower photo shows an immature male.
- → Page 81 ‘Masoni brook’: “*P. verticalis* sensu Asahina, 1983 – 1 tandem photographed” - in fact this tandem was photographed at ‘Rhinagrion brook’.
- → Page 87, line 10: “19.09.2011” – should be “19.08.2011”.