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A short survey of Odonata in Stung Treng Province in northern Cambodia in mid-summer 2016

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Abstract

Results are presented of an odonatological survey of 23 localities in Thala Barivat District of Stung Treng Province, northern Cambodia, on July 26 – August 1, 2016. Most localities were situated in areas of open low deciduous dipterocarp forests on gravel soils, some at hillside areas of tall evergreen dipterocarp forest. The great Mekong River right bank was studied within 7 km downstream of its Nimith (Nimet, Khon Thai, Labak Koun, Khone Pha Pheng) Waterfall. In total, 55 species were found, of which 52 identified to species and three to genus. Two species, *Gynacantha saltatrix* Martin, 1909 and *Macrogomphus matsukii* Asahina, 1986, were recorded in Cambodia for the first time. Five obligatory lotic species were found at the Mekong River, namely *Dysphaea gloriosa*, *Prodasineura coerulescens*, *Burmagomphus asahinai*, *Nychogomphus duaricus* and *Onychothemis testacea*, including teneral of *P. coerulescens* and *B. asahinai*. Most probably these species breed in the Mekong reach which is enriched with oxygen downstream of the great waterfall cascade.

Key words: Odonata, dragonflies, damselflies, fauna, the first country record, Indochina, Cambodia, Stung Treng Province, Thala Barivat District, low deciduous dipterocarp forest, tall evergreen dipterocarp forest, lotic species in the Mekong River, Khone Pha Pheng Falls, water oxygen level, *Euphaea masoni* ssp., *Aciagrion* sp., drought of 2016.

Introduction

My previous seven trips to Cambodia focused on its scarcely known fauna of Odonata; hilly and mountainous regions in south-west and east of Cambodia were studied. On July 26 – August 1, 2016, I examined the plain areas of Thala Barivat District in the north-west of Stung Treng Province of this country, west of the great Mekong River, and at the Mekong itself. Expectedly, the fauna revealed was not too diverse compared with that of the mountains. Besides, the time of my visit was inferior to that of the early June when lotic species are best found upon emergence. However, this year early June happened not to be the early rainy season as usual but the end of an unprecedented drought at the end of the dry season which shifted

the onset of rains in the Cambodian plain for five weeks. This drought could deplete Odonata severely, however I would not say I had the impression that odonates were fewer in number than usual. The results of this short but first historical assessment of dragonflies and damselflies of Stung Treng Province are delivered below. Some more photos will soon be available at <http://www.alloodonata.com> and <http://pisum.bionet.nsc.ru/kosterin/odonata/cambodia.htm>.

Methods

Odonata were sought while walking along the water courses. Well recognisable common species were recorded by sight, some voucher specimens or small series of other species were collected, treated overnight with nailpolish remover, being a mixture of acetone and water in an unknown proportion, and preserved on cotton layers with paper covers. Odonata were photographed either free in natural conditions or in hand (never posed), using Olympus Camedia C8080 and Canon EOS 350D cameras, the latter with Sigma lens. Coordinates were retrieved by Garmin eTrex H personal GPS navigator but the provided spans of coordinates for the areas actually examined, as well as elevations above sea level, were revised using Google-Earth. 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.

The region

The region studied was mostly a flatland west of the Mekong River, with some sharp hills of tropical karst and a hilly ridge along the Mekong River at the magnificent waterfall of this river, known as Nimith (Nimet) or Labak Koun in Cambodia (at its left bank) and Khon Thai or Khone Pha Pheng (or, separately, Khone Falls and Pha Pheng Falls) in Laos (occupying the right bank and islands) (Fig. 1). This is the largest waterfall in South-East Asia, formed of a succession of rapids 9.7 km long and 10 km wide.



Figure 1. A panorama of the Nimith (or Nimet, Khon Thai, Labak Koun, Khone Pha Pheng) Waterfall on the Mekong River. 31.07.2016.

The land is mostly formed by soils of reddish-brown gravel and occupied by open low deciduous dipterocarp forest (Fig. 2a). This forest still covers most of the area of Thala Barivat and Srae Ruessei Communes, the eastern part of Sam'ang Commune and southern part of Preah Rumkel Commune; alternating with cashew plantations

and sporadic rice fields that predominate in the rest of the area. The strip of several hundred metres along new excellent roads is devoid of old trees but abounds in saplings implying fast forest recovery. There are quite a lot of pools in this strip occupying gravel pits dug during road construction. However, everywhere in this type



Figure 2. Open low deciduous dipterocarp forest, with the grassy level formed by *Vietnamosasa* sp. bamboo, a typical community of the area studied (above) and some of its spectacular plants: *Cycas revoluta* (below left), *Decaschistia* sp. (below middle), *Curcuma alismatifolia* (below right), as photographed at Srae Ruessei village (Loc. 7), 28.07.2016.

of forest, numerous charred stumps and logs are scattered indicating regular low fires have occurred. This forest is a very picturesque parkland landscape with sparse low but stout trees with very large dark foliage (Fig. 2). From a distance it seems that the ground is covered with a fresh-green lawn which in fact is waist to double human height high, scarcely permeable bamboo *Vietnamosasa* sp. ('prech' in Khmer) with very branched, thin but woody stems and small narrow leaves. (It is noteworthy that superficially similar forest in Mondulkiri Province has a 'normal' grass of Poaceae indet.) Some small areas have sandy soils and approach savannah-like 'veals' (in Khmer), with lower trees, short and sparse grass, quite a diversity of flowers (of Zingiberaceae and Malvaceae, Gesneriaceae) and scattered cycads (*Cycas revoluta* Thunb.) (Fig. 2 below left). These forests are crossed by many brooks flowing in corridors between 'walls' of the grassy bamboo, with mostly gravel and sometimes rocky beds and slightly turbid, opalescent water. Larger rivulets and rivers are usually hidden in thickets of giant thorny bamboo, also have gravel beds and slightly turbid water; for some reason they appeared rather poor in Odonata.

Smaller areas of tall evergreen or semi-evergreen forest, are associated mostly with hill slopes. For instance, large forested area at the road towards Preah Rumkel village was represented with tall evergreen forest south of a small hill but with low deciduous forest north of this hill. As a rule, margins of any patch of evergreen forest is hard to enter because of piles of felled and partly burnt, charred trees. Only the above mentioned forest was accessible from a new high ground road to Preah Rumkel; however, it appeared interspersed with roads for selective logging.

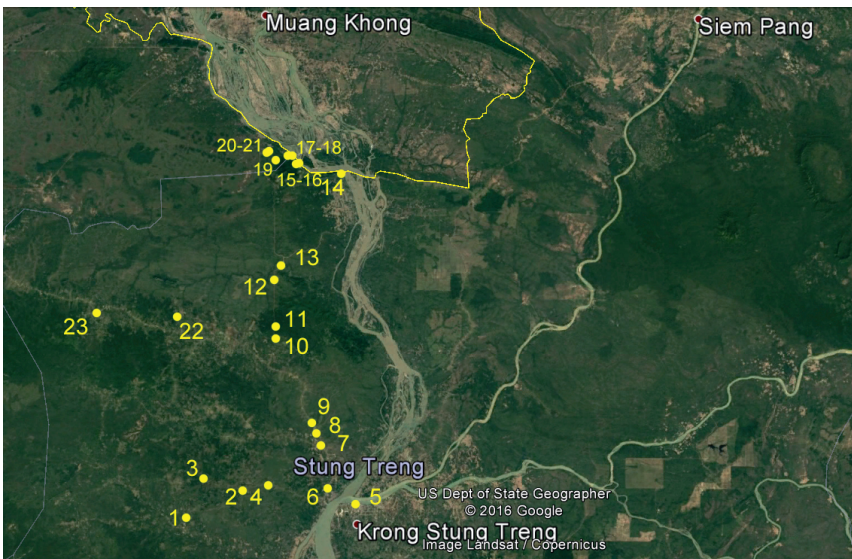


Figure 3. Geographical disposition of the localities studied in Thala Barivat District of Stung Treng Province of Cambodia. For explanation of the locality numbers see the text. The base image is taken from Google Earth.

The studied segment of the Mekong right bank is variable, mostly with a medium-high ground bluff and bed of clayey, but also with rock outcrops and sandy patches; at the time of my visit there were inundated trees and bushes in water. The current is considerable downstream of the waterfall but soon the river becomes very calm and expands to the so-called Veun Nyang/Anlong Cheuteal pool inhabited by a subpopulation of Irrawaddy dolphins (*Orcaella brevirostris* Owen in Gray, 1866) (which I failed to see, although guided in this by locals). In spite of this, there is an active project of Don Sahong Dam across Mekong to be constructed at the Nimeth/Hon Tai Waterfall.

Localities visited

All localities are numerated throughout and shown as dots on a general map of Fig 3. Times of examination of localities are given very approximately. The sampling dates are provided in the dd.mm.year format. Altitude is given in m a.s.l. The time of visit is given in local time of day.

Loc. 1. A small clear rivulet with gravel bottom and remnants of tall forest along its banks; the water course at the road crossing piled with cut felled large trees; surrounded by grassy areas with low deciduous dipterocarp stand; 16 km W of Stung Treng, 8 km ENE of Rumdeng village, 13°31'44-49" N 105°48'43-46" E, 82-85 m, 30.07.2016: 14:00-15:00.

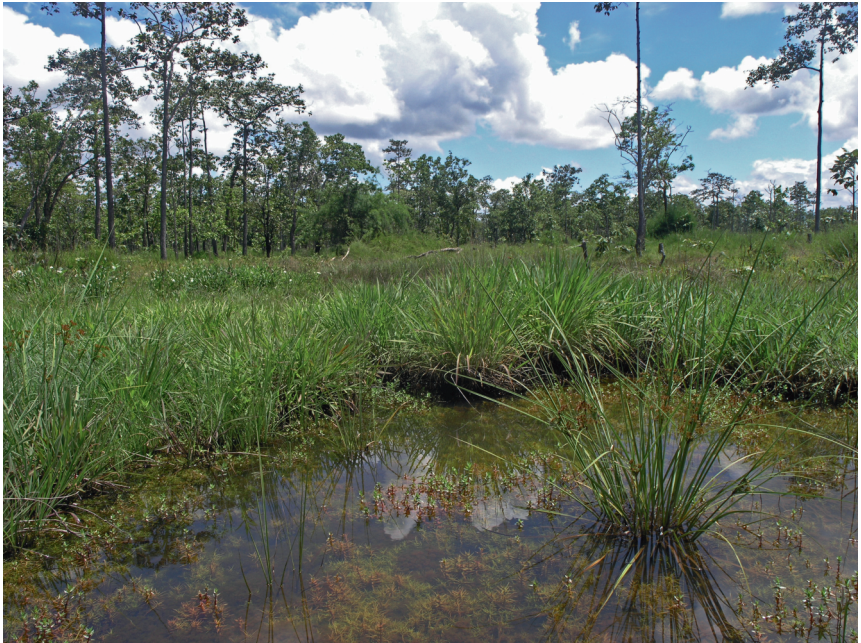


Figure 4. A grassy swamplot among open low deciduous dipterocarp forest 11 km ENE of Rumdeng village (Loc. 2). Habitat of *Aciagrion approximans*, *Ceriagrion indochinense*, *C. calamineum*, *Diplacodes nebulosa*, *Neurothemis fluctuans*, *N. intermedia*, *Orthetrum luzonicum*, *O. sabina*, *Trithemis aurora*. 30.07.2016.

Loc. 2. A wet area amidst grassy open low deciduous dipterocarp forest, with grassy seepages, several very small (2-3 m) shallow muddy pools with almost hot water (Fig. 4), and a tiny brook; 14.5 km W of Stung Treng, 11 km ENE of Rumdeng village, 13°32'26-31" N 105°50'06-12" E, 90-95 m, 30.07.2016: 13:00-13:35.

Loc. 3. A hilly area at a limestone pit; 20 km WNW of Stung Treng, 8 km NE of Chamkar Leu village, 13°33'31-45" N 105°47'12-32" E, 93-95 m, 30.07.2016: 10:07-12:20.

Loc. 3a. A small slightly turbid river with a gravel bed, spiny bamboo thickets and remnants of tall forest (Fig. 5), 13°33'31-33" N 105°47'14-32" E, 93-95 m.

Loc. 3b. A cut and burnt forest area shallowly inundated by the above river. 13°33'31-32" N 105°47'12-17" E, 94 m.



Figure 5. A river at a limestone pit 8 km NE of Chamkar Leu village (Loc. 3a). Habitat of *Vestalis gracilis*, *Libellago lineata*, *Pseudagrion rubriceps*, *Copera marginipes*, *Ictinogomphus decoratus*, *Paragomphus capricornis*, *Epophthalmia* sp., *Trithemis aurora*, *T. festiva*. 30.07.2016.

Loc. 4. A small brook with slighty turbid water crossing a small-leaved bamboo ('prech') (*Vietmanosasa* sp.) area with open low deciduous dipterocarp stand (Fig. 6); 9.5 km WNW of Stung Treng, 6.5 km W of Phumi Thala Barivat, 13°32'49-52" N 105°53'01-03" E, 84-86 m, 29.07.2016: 15:50-16:30.

Loc. 5. The Se Kong River left bank at Stung Treng, a huge high river bank within the town, with a concrete pavement and, below it, small patches of reed and spiny leguminous bushes (Fig. 7), 13°31'56" N 105°58'15" E, 47 m. 29.07.2016: 17:50-18:20.



Figure 6. A small brook crossing open low dipterocarp stand 6.5 km W of Thala Barivat village (Loc. 4). Habitat of *Libellago lineata*, *Pseudagrion rubriceps*, *Prodasineura autumnalis*, *Brachythemis contaminata*, *Tholymis tillarga*, *Trithemis aurora*. 29.07.2016.

Figure 7. The Se Kong River left bank at Stung Treng (Loc. 5), just before its junction with the Mekong. Habitat of *Brachythemis contaminata* and *Pantala flavescens*. 29.07.2016.

Loc. 6. Quite a big river crossing a populated area, with muddy water, clayey bed and high slippery bluffs, surrounded by tall spiny bamboo thickets (Fig. 8); 9 km NNW of Stung Treng, 5 km NNW of Phumi Thala Barivat, 13°33'03-04" N 105°55'56-58" E, 62-63 m. 29.07.2016: 15:00-15:20.



Figure 8. A river 5 km NNW of Thala Barivat village (Loc. 6). Habitat of *Brachythemis contaminata*, *Diplacodes trivialis*, *Orthetrum sabina*, *Pantala flavescens*, *Rhyothemis variegata*. 29.07.2016.

Loc. 7. A rivulet at Srae Ruessei village: a small rivulet, overgrown with 'prech' forming 'walls' about the height of a man (Fig. 9), winding among a sparse low deciduous dipterocarp stand with the grassy layer formed by the same low bamboo or, on areas with more sandy soil, of sparser and lower herbage of the 'veal' type, with many flowering gingers (mostly *Curcuma alismatifolia* Gagnep.), crepe ginger (*Cheilocostus speciosus* (J. Konig) C. Specht) *Decaschistia* sp., and cycads (Fig. 2, below left); there are several tributary brooks and large shallow pools in place of former ground peats, with clayey/gravel ground; 0-0.5 km NE of Srae Ruessei village, Thala Barivat Commune, 9 km NNW of Stung Treng. 13°35'41"-36'13" N 105°55'47-52" E, 64-67 m. 28.07.2016: 8:07-12:30

Loc. 8. A small river with a slightly turbid water, gravel bottom, tall spiny bamboo thickets at banks, and a deep open reach upstream of the bridge; Srae Ruessei Commune, 11 km NW of Stung Treng, 1.5 km N of Srae Ruessei village, 13°36'43-48" N 105°55'19-22" E, 63 m, 29.07.2016: 14:05-14:40.



Figure 9. A rivulet at Srae Ruessei village (Loc. 7) crossing open low deciduous dipterocarp forest. Habitat of *Vestalis gracilis*, *Libellago lineata*, *Ceriatrion indochinense*, *Pseudagrion rubriceps*, *Copeera marginipes*, *Prodasineura autumnalis*, *Gynacantha bayadera*, *G. saltatrix*, *G. subinterrupta*, *Euthygomphus yunnanensis*, *Brachythemis contaminata*, *Orthetrum sabinia*, *Pantala flavescens*, *Tholymis fillarga*, *Trithemis aurora*, *T. festiva*, *Zyxomma petiolatum*. 28.07.2016.

Loc. 9. A river 13 km NW of Stung Treng, 3 km NNW of Srae Ruessei village, 13°37'24-35" N 105°54'46-53" E, 68-71 m, 28.07.2016: 16:20-17:07; 29.07.2016: 12:44-13:55.

Loc. 9a. A medium-sized river with slightly turbid water, gravel bottom, tall spiny bamboo thickets with admixture of a few trees at the banks (Fig. 10) and a very deep lake-like reach upstream of the bridge.

Loc. 9b. Several small stagnant pools at a ruderal open area at the bridge.

Loc. 9c. Large medium-sized former gravel pits with hot clear water and cyanobacterial mats amidst 'prech' thickets at the road.

Loc. 10. A rivulet with very slightly turbid water, ankle to knee deep and on average 2-4 m wide but more as a chain of pools connected by a small stream, having a sandy to gravel bottom, winding in a man-height valley under the shade of tall evergreen dipterocarp forest (Fig. 11) looking intact except a nearby area where the trees were recently logged at a small village. There is a neck-deep open pool where the rivulet crosses the road. A remarkable feature of this rivulet were giant ant lions *Dendroleon* sp., resting on lianas or small tree trunks in very dense groups of about a dozen of individuals which simultaneously rose into the air when startled; 25.5 km NNW of Stung Treng, 4.7 km E of Sam'ang village, 13°43'51"-44'06" N 105°51'56"-52'15" E; 93-95 m, 28.07.2016: 15:00-15:35; 29.07.2016: 10:07-12:27.



Figure 10. A river 3 km NNW of Srae Ruessei village (Loc. 9a) crossing spiny bamboo thickets and forest remnants. Habitat of *Libellago lineata*, *Pseudagrion rubriceps*, *Copera marginipes*, *Prodasineura autumnalis*, *Brachythemis contaminata*, *Tholymis tillarga*, *Trithemis aurora*. 28.07.2016.



Figure 11. A rivulet in tall evergreen dipterocarp forest 4.7 km E of Sam'ang village (Loc. 10). Habitat of *Euphaea masoni*, *Heliocypha biforata*, *Libellago lineata*, *Rhinagrion hainanense*, *Ceragrion indochinense*, *Pseudagrion rubriceps*, *Copera marginipes*, *Prodasineura autumnalis*, *Gynacantha subinterrupta*, *Pseudothemis jorina*, *Trithemis aurora*, *Zyxomma petiolatum*. 29.07.2016.

Loc. 11. A brook 26.5 km NNW of Stung Treng, 5 km ENE of Sam'ang village, 13°44'30-46" N 105°51'14-56" E, 108-118 m, 28.07.2016: 13:30-14:45.

Loc. 11a. A brook crossing an evergreen dipterocarp forest forming a small pond of variable (up to neck) depth, partly overshadowed by tall 'prech'.

Loc. 11b. A very shallow round muddy pool in tall evergreen forest (Fig. 12) at the above brook.

Loc. 11c. A shady and muddy road for selective logging in a tall evergreen forest, with small pools with green water.



Figure 12. A very shallow muddy pool near a brook in tall evergreen forest (Loc. 11b) 5 km NNE of Sam'ang village. Habitat of *Orolestes octomaculatus*, *Ceriagrion indochinense*, *Lathrecista asiatica*, *Potamacha congener*. 28.07.2016.

Loc. 12. A rivulet with slightly turbid water flowing between 'walls' of 'prech' through open stand of low deciduous dipterocarps, mostly with a gravel bottom but a section flows through sandstone rocks (Fig. 13); a small roadside pool up to chest deep; 32.5 km NNW of Stung Treng, 9.5 km NE of Sam'ang village, 13°47'51"-48'01" N 105°51'36-57" E, 81-85 m, 27.07.2016: 12:30-14:35.

Loc. 13. The O Ta Lao River: a big river flowing at a high level, inundating bushes and trees on the banks and islands (Fig. 14), with muddy water and a powerful current; banks shaded with bamboo thickets and trees, further inland open low deciduous dipterocarp forest; there is a shady narrow bay with calm water at a temporary brook mouth; 34 km NNW of Stung Treng, 12 km SW of Preah Rumkel village, 13°49'01-09" N 105°52'32-46" E, 72-82 m, 27.07.2016: 10:40-12:20.



Figure 13. A rivulet crossing low deciduous dipterocarp savannah 9.5 km NE of Sam'ang village (Loc. 12). Habitat of *Vestalis gracilis*, *Heliocypha biforata*, *Libellago lineata*, *Pseudagrion rubriceps*, *Copera marginipes*, *Prodasineura autumnalis*, *Euthygomphus yunnanensis*, *Brachythemis contaminata*, *Tholymis tillarga*, *Trithemis aurora*. 27.07.2016.

Figure 14. The O Ta Lao River 12 km SW of Preah Rumkel village (Loc. 13). Habitat of *Libellago lineata*, *Prodasineura autumnalis*, *Brachythemis contaminata*, *Pantala flavescens*, *Trithemis aurora*, *T. festiva*. 27.07.2016.



Loc. 14. Dolphin Viewpoint in Anlung Chheuted (or Anlong Svay) village: the right bank of a broadening of the Mekong serving as a habitat for a subpopulation of Irrawaddy dolphins (not seen at all). The river is calm with a very slow current, although the far-off noise of the Nimith Waterfall situated 7 km upstream is permanently heard. The banks (Fig. 15) are very shallow, clayey, with sparse partly inundated spiny legume bushes, then there are moderately high but quite steep, clayey bluffs, then a terrace with a band of open shrubbery, mostly with the same legume bushes, partly replaced by ruderal grassland and households, then a high bamboo and tree stand, with glades

with fresh grass, ferns and winding plants. 13°55'35-44" N 105°56'57"-57'02" E, 58-61 m, 31.07.2016: 17:50-18:20; 1.08.2016: 9:00-10:20, 17:30-18:20.



Figure 15. The Mekong River right bank at Dolphin Viewpoint in Anlung Chheuteal village, 7 km downstream of the Nimeth waterfall (Loc. 14). The hill seen is an island in Laos. Habitat of *Dysphaea gloriosa*, *Prodasineura coerulescens*, *Gynacantha ?subinterrupta*, *Burmagomphus asahinai*, *Nychogomphus duaricus*, *Brachythemis contaminata*, *Diplacodes trivialis*, *Orthetrum testaceum*, *Potamarcha congener*, *Rhyothemis variegata*, *Tholymis fillarga*. 1.08.2016.

Loc. 15. The Mekong rocky bank 1.3 km downstream (SE) of Nimith Waterfall: banks with an open, medium-high bluff with rough rock outcrops supporting scanty low bushes, with some sandy beaches margined with forest (Fig. 16); the river current moderate but the waterfall is seen far upstream. 13°56'28-41" N 105°53'40-45" E, 70-73 m, 1.08.2016: 11:40-12:30.



Figure 16. The Mekong River right 1.3 km downstream of the Nimith waterfall (Loc. 15). Habitat of *Burmagomphus asahinai*, *Brachythemis contaminata*, *Onychothemis testacea*, *Pantala flavescens*, *Trithemis aurora*. 1.08.2016.

Loc. 16. A pond 1 km SE of Nimith Waterfall, near a huge Buddha statue under construction: a large and more than man height deep pond formed by a small but overflowing brook dammed by the high road, with many dead trees and inundated *Mimosa pudica* L. bushes in slightly turbid water; surrounded by remnants of evergreen forest. 13°56'32-33" N 105°53'31-32" E, 111 m, 1.08.2016: 10:50-11:30.

Loc. 17. A tiny brook 0.5 km SW of Nimith Waterfall, flowing through secondary semi-evergreen forest with tall dipterocarps, a lot of spiny bamboo and a small pool at a high road. 13°56'47-51" N 105°53'08-11" E, 103-120 m, 31.07.2016: 11:30-12:10.

Loc. 18. The open Mekong right bank at Nimith Waterfall (Figs. 1, 17): some tiny pools both on rocks in the waterfall spray and on the grassy bank, 13°57'04-08" N 105°53'06-15" E, 78-82 m, 31.07.2016: 10:40-11:10.

Loc. 19. A brook at Phnom Preahkonha village: 1-2 m wide, with clear water, shaded in a very rich, tall primary evergreen forest (Fig. 18) on a slope of an acute hill at the



Figure 17. The open Mekong right bank at Nimith Waterfall (Loc. 18). Habitat of *Libellago lineata*, *Brachythemis contaminata*, *Diplacodes trivialis*, *Pantala flavescens*, *Potamarcha congener*, *Rhyothemis variegata*. 31.07.2016.



Figure 18. A brook crossing tall evergreen forest at Phnom Preahkonha village (Loc. 19). Habitat of *Vestalis gracilis*, *Euphaea masoni*, *Heliocypha biforata*, *Copepla marginipes*, *Prodasineura autumnalis*. 31.07.2016.



Figure 19. A brook at the crossroad 2 km SW of Kampong Preah village (Loc. 20) crossing open low deciduous dipterocarp forest. Habitat of *Euphaea masoni*, *Libellago lineata*, *Aciagrion* sp., *Ceriagrion indochinense*, *Pseudagrion rubriceps*, *Copera marginipes*, *Prodasineura autumnalis*, *Macrogomphus matsukii*, *Brachythemis contaminata*, *Tholymis tillarga*, *Trithemis aurora*. 1.08.2016.

Mekong right bank; 2 km WSW of Nimith Waterfall, 13°56'27-29" N 105°52'04-14" E, 140-165 m, 31.07.2016: 12:40-13:30.

Loc. 20. A brook at a crossroad where the road to Nimith Waterfall branches from the road Stung Treng - Kampong Sralau, 2 km SW of Kampong Preah village (Fig. 19): ca 2 m wide, with almost non-turbid water, partly flowing in a roadside ditch, half-hidden by bushes, half open; then entering an open low deciduous dipterocarp parkland, with either 'prech', not so tall as elsewhere, or short 'veal' vegetation with many flowers, like at Loc. 7; no traces of fire; 14 km NW of Preah Rumkel village, 13°57'06-19" N 105°50'38-50" E, 92-97 m, 31.07.2016: 14:50-15:50; 1.08.2016: 13:00-14:00; 15:15-16:30.

Loc. 21. A rivulet at Kampong Preah village: 2-3 m wide, with a gravel bed and very slightly turbid water, surrounded by pure thickets of tall spiny bamboo, with a roadside small wet grassy area; 1.8 km SW of Kampong Preah village 13°57'17-20" N 105°50'51-55" E, 93-95 m, 31.07.2016: 14:20-14:40.

Loc. 22. A tiny brook with gravel or muddy bottom flowing within small remnants of tall evergreen forest currently being logged and replaced by cashew plantations

at a northern foot of picturesque limestone karst outcrops (Fig. 20); Sam'ang Commune, 9 km WNW of Sam'ang village, 13°44'37-54" N 105°44'27-41" E, 120-127 m, 26.07.2016: 15:00-15:50.

Loc. 23. A medium-sized river with a high level, fast current and remnants of a recent higher inundation such as a layer of fresh silt at the lower banks; the banks partly covered by ruderal *Mimosa pudica*, partly by small banana plantations, partly by forest remnants; partly by open grassy area with open dipterocarp saplings; Anlung Chhrey Commune, 10 km NNE of Anlung Chhrey village, 13°45'20-43" N 105°38'19-42" E, 119-150 m, 26.07.2016: 17:00-18:00.



Figure 20. Young plantations replacing tall evergreen forest at limestone outcrops 9 km WNW of Sam'ang village (Loc. 22). 26.07.2016.

Weather.

The 2015/2016 El Niño episode appeared to be the most powerful occurrence since the beginning of observations in 1950: the Oceanic Niño Index (ONI) showed the record high values for the history of observations, 2.1-2.3, in the period September 2016 – March 2016 suggesting the record heating of the Equatorial Pacific and effects on the global climate (http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml; retrieved on May 1, 2016). Accordingly, spring 2016 brought an unprecedented heat wave in Cambodia setting a new all-time temperature record of 42.6°C in Preah Vihear on April 15 and the second highest record of 42.2°C in Oddar Meanchey on April 14 (Kossov 2016). This wave resulted in a severe drought and local environmental disasters never seen before. On 20-30 of April, hundreds of bats died at Phnom Bok Temple at Siem Reap because of daytime overheating (Sengkong & Kossov 2016) and ca 65 tons of fish

died for the same reason in Lake Tonle Chhmar in Kampong Thom Province (Chheng & David 2016). Enormous areas of 'flooded forest' were burning for a month in Battambang Province and were hard to control because of the lack of water (Dara & Seangly 2016). In late April, the drought resulted in the disappearance of the last water sources and hence the death of 60 monkeys in Battambang Province (Dara & Seangly 2016) and no less than 200 wild buffaloes and cows in Stung Treng Province (Crothers 2016). Since January to mid-May 2016, nearly 250,000 ha, that is about a third of the total area of the floodable forests around the great Lake Tonle Sap have been burnt out, because of the combination of a natural factor (the unprecedented drought) and indirect (deforestation in the upstream water catchment) and direct (forest clearing for fields by burning) human impacts (Sassoon 2016). The West Baray water reserve at Siem Reap dropped to its lowest level in living memory.

In the Koh Kong area (SW of Cambodia), the first significant rain was during the last night of April but May was characterised by an enormous amount of rain, as normally expected in September/October (G. Chartier, pers. comm.). In Central Cambodia, the rains were delayed for ca five weeks, and started around June 15 instead of May 10-15, the amount of rain being normal for late June (S. De Greef, pers. comm.).

On my trip to Cambodia in late July/early August I did not see any signs of the aforementioned drought but one: for 12 days spent in Koh Kong and Stung Treng Province I did not see a single terrestrial leach, which should have been numerous in the rainy season at least in Koh Kong Province. No doubt the depletion of those delicate moist-loving creatures was a consequence of the drought.

During the seven days of my visit to Stung Treng Province on 26.07-1.08.2016 there was only one long and strong downpour in the afternoon of 27.07.2016 (also a short downpour in the morning) and short showers in the evening of 28 and 29.07.2016, in the afternoon of 31.07.2016, and in the early morning and in the afternoon of 1.08.2016. Usually the sky was overcast with heavy clouds in the morning, the sun appearing at 10-11 am bringing heat and making the clouds became sparser and thinner, but some heavy clouds bringing sudden showers were wandering around. While staying at the Mekong River at Anlung Cheuteal village I was surprised by hot and humid evenings, absolutely windless even at the huge river.

Results

Annotated list of species

Asterisks (*) indicate the first records for Cambodia. The specimens are kept partly in Naturalis Biodiversity Center, Leiden (RMNH), partly in the author's collection.

Calopterygidae

Vestalis gracilis (Rambur, 1842)

Loc. 3a: 1 ind. seen; **Loc. 7:** 2 ind. seen; **Loc. 12:** 2 ♀♀ seen; **Loc. 14:** 1 ♀ seen; **Loc. 16:** several ♂♂ seen and photographed; **Loc. 17:** 1 ♂ collected, very many immature ind. seen (in forest at a tributary brook); **Loc. 19:** many seen.

Observations. In the Preah Rumkel community, at small brooks in hillside patches of evergreen dipterocarp forest, there were numerous, obviously young individuals with clear wingtips, some of them teneral, while in a more southerly area of open short deciduous dipterocarp forests in Sam'ang, Srae Ruessel and Thala Barivat communities, only very few mature individuals occurred, with dark smoked wingtips, obviously evidence for development at high temperatures of the dry season (Kosterin 2011; 2012).

Euphaeidae

Dysphaea gloriosa Fraser, 1938

Loc. 14: 31.07.2016: 1 ♀ seen (identification tentative).

Observation. A female was seen at dusk, perching at ca 4 m above the ground on top of a tall leguminous bush growing in a spiny shrubbery on a terrace of the Mekong right bank near its edge. The silhouette of *Dysphaea* was unmistakable, and it was *D. gloriosa* which breeds in a major Se Kong River in the north-eastern Ratanakiri Province (Kosterin 2014). Rather weak wing pigmentation, more in basal part, as could be seen from quite a distance, suggested a female. There was no possibility to collect that individual, and no more were found next day.

Euphaea masoni Selys, 1879 ssp.

Loc. 1: 1 ♂ photographed (Fig. 21) and collected (Fig. 22a); **Loc. 10:** 28.07.2016: 2 ♂♂ seen (29.07.2016: none); **Loc. 17:** 3 ♂♂ collected, several more seen; **Loc. 19:** 5 ♂♂ collected, very many seen; **Loc. 20:** 1.08.2016: 1 ♀ collected.

Remarks. The specimens cannot be attributed to either of the two known subspecies: males of *E. masoni masoni* have a moderate purple lustre of the wing upper side of the wings while those of *E. masoni inouei* Asahina, 1977 have a very strong coppery lustre of the wing upperside and a deep blue lustre of the hind wing underside, leaving the apical area non-iridescent (Kosterin 2016b). Based on unpublished molecular data, Hämäläinen (2017) recently claimed that *E. inouei* is bona species. All the specimens reported here had a slight but obvious mixed pink and blue-green lustre of both wing sides. Such a colouration was reported for a related species *Euphaea hirta* Hämäläinen & Karube, 2001, described from South Vietnam, but our specimens did not show any structural diagnostic characters (see Hämäläinen & Karube, 2001) of that species. In half of the male specimens (the 'diffuse type'), the dark band was narrowed and as if the pigment was diluted and spread over the entire wing, with the bands being dark-brown rather than black and the transparent areas strongly smoked with yellowish-brown (Figs 21, 22a-b). In others (the 'distinct type') the bands were wider and darker while the transparent parts almost colourless (Fig. 22c). The pigmentation character was individually variable but it is possible to attribute each male to one of the two mentioned morphs. Interestingly, in Phnom Kulen Mts. (a small isolated massif up to 487 m a.s.l. in Siem Reap Province, situated 190 km SWW of the here considered area at the Mekong), only 'diffuse type' males were found: 4 ♂♂ of 4.09.2000, Haruke Karube leg., in the collection of Matti Hämäläinen (pers. comm); 2 ♂♂, 23.02.2017, my own data.

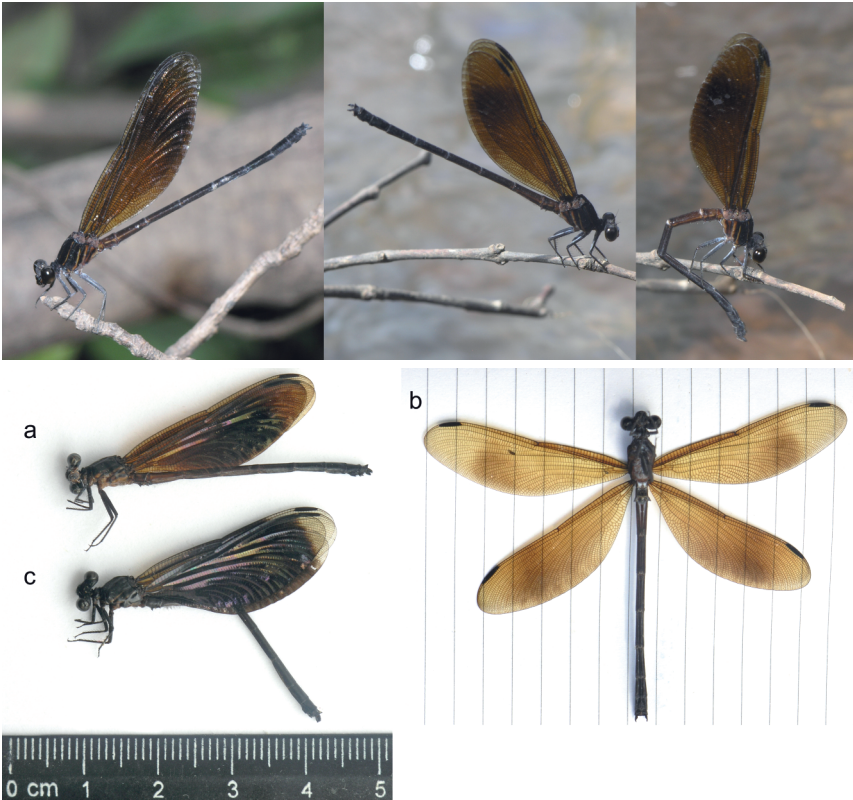


Figure 21. A male of *Euphaea masoni* ssp. of the 'diffuse type' at Loc. 1. 30.07.2016.

Figure 22. Males of *Euphaea masoni* ssp. of the 'diffuse' (a-b) and 'distinct' (c) types, collected at Loc. 1 (b, the same specimen as in Fig. 21) and 19 (a, c).

Observations. Common in remnants of tall evergreen forest on hills near Mekong in Preah Rumkel commune, especially in a virgin forest patch at Phnom Preahkonha, while in the flatter area SW and NW of Stung Treng only three individuals were found in two localities: two in a large evergreen forest and one at a very small patch of this among open low dipterocarp forest.

Chlorocyphidae

Heliocypha biforata (Selys, 1859)

Loc. 10: 28.07.2016: 1 ♂, 1 ♀ collected, many ♂♂, ♀♀ seen; **Loc. 12:** 1 ♂, 2 ♀♀ seen;

Loc. 17: several ♂♂, ♀♀ seen; **Loc. 19:** many ♂♂, ♀♀ seen.

Observations. Three of the four localities where this species, common elsewhere in Cambodia, was found were in tall dipterocarp forest. There it was rather abundant.

The fourth, **Loc. 12**, was a brook in an open low deciduous dipterocarp forest and the species was scarce there.

Libellago lineata (Burmeister, 1839)

Loc. 1: several ♂♂ seen; **Loc. 3a:** many ♂♂, ♀♀ seen; **Loc. 4:** several ♂♂, ♀♀ seen; **Loc. 7:** very many ♂♂, ♀♀ seen; **Loc. 8:** many ♂♂, ♀♀ seen; **Loc. 9a:** very many ♂♂, ♀♀ seen; **Loc. 10:** many ♂♂, ♀♀ seen; **Loc. 11a:** very many ♂♂, many ♀♀ seen; **Loc. 12:** 1 ♂, 1 ♀ collected, many ♂♂, ♀♀ seen; **Loc. 13:** many ♂♂, ♀♀ seen; **Loc. 16:** several ♂♂, ♀♀ seen; **Loc. 18:** several ♂♂, ♀♀ seen; **Loc. 20:** very many ♂♂, ♀♀ seen; **Loc. 21:** several ♂♂ seen;

Observations: One of the commonest and most abundant odonates on brooks and small rivulets in the area examined; also found at tiny pools at the Nimith Waterfall, in the spray zone.

Philosinidae

Rhinagrion hainanense Wilson & Reels, 2001

Loc. 10: 28.07.2016: 1 ♂ collected.

Observations: Found at a small rivulet shaded by tall evergreen forest (looking quite undisturbed in that specific locality. Fig. 11), that is in the same environment as in Monduliri Province of Cambodia (Kosterin 2016b).

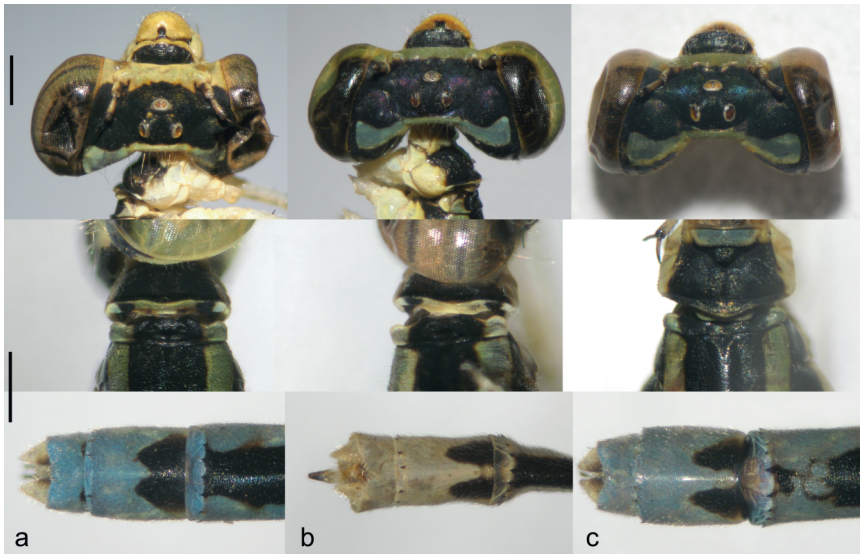


Figure 23. Head (above), prothorax (middle) and end of abdomen (below), dorsal view, of three female specimens of *Aciagrion* sp. collected at Loc. 11a (a), Loc. 9b (b) and Loc. 20 (c). Scale bars 0.5 mm.

Lestidae

Lestes praemorsus decipiens Kirby, 1893

Loc. 12: 1 ♂ collected, several seen.

Orolestes octomaculatus Martin, 1904

Loc. 11b: 1 ♂ collected, 1 more ♂ seen.

Observation: Two males were startled from low tree branches at the margin of a round and very shallow muddy pool in a tall evergreen forest (Loc. 11b, Fig. 12). Of the two records of this species in Ratanakiri (Kosterin 2014), one was also at a muddy roadside pool with a forest remnant at its side.

Coenagrionidae

Aciagrion approximans (Selys, 1876)

Loc. 2: 3 ♂♂ collected, 1 more seen.

Observation: Four males were found among short grass growing over a small lotic seepage with shallow nearly stagnant pools in a low dipterocarp open forest. The species habitats in Ratanakiri (Kosterin 2014) and Mondulkiri (Kosterin 2016b) Provinces were also tiny and shallow pools with short grass in open places, but without running water.

Aciagrion sp.

Loc. 9b: 28.07.2016: 1 ♀ collected (Fig. 23b); **Loc. 11a:** 1 ♀ collected (Fig. 23a); **Loc. 20:** 1.08.2016: 1 ♂ collected but lost, 1 ♀ collected (Fig. 23c).

Remarks. Both sexes had a greenish-blue ground colour. The male, briefly seen in hands, had S8 and S9 unmarked. Two of the females collected had a large dorsal black spot on S8 not reaching its apex and a pair of dorsobasal elongate spots on S9 (Fig. 23b-c); in a female from Loc. 11a these paired spots were fused into a united bifid spot (Fig. 23a), somewhat like in *Aciagrion migratum* (Selys, 1876) from Bokor Plateau, and the black spot on S8 reached its apex. The same pattern of the end of abdomen, with clear S8-S9 in males and a pair of spots in S9 in females, is found in *Aciagrion hisopa* (Selys, 1876) occurring in Cambodia and in some other species from elsewhere (e.g. *A. olympicum* Laidlaw, 1919). However, my specimens are substantially smaller than *A. hisopa*, which has a relatively longer abdomen, and than *A. migratum*, which has disproportionately more antenodals: compare the measurements of female specimens of Cambodian species at my disposal in Table 1 (note that I have many more males of both species which have similar measurements). Besides, these female have a duller and more greenish ground colour than both mentioned species. In size they more or less correspond to *A. borneense* Ris, 1911 and *A. approximans*, females of which, however, have dorsum of S8 and S9 almost completely occupied by the black patch; besides, females of the latter species have a dull brownish ground colour. It is not excluded that the Stung Treng specimens represent an undescribed species, so losing the only male collected was very unfortunate.

Observations: Three females were collected at three different localities; at one of them, at a rivulet flowing through open low deciduous dipterocarp forest (Loc. 20), a male was also noticed in grass near the rivulet and captured. Unfortunately, later he escaped from a jar, leaving the species identity an enigma.

Table 1. Some measurements of Cambodian female specimens of *Aciagrion* spp. in my collection.

Species	Number of ♀♀ examined	Province	hind wing length (mm)	abdomen length (mm)	forewing postnodals
<i>Aciagrion</i> sp.	3	Stung Treng	16-17	24-25	9-11
<i>A. borneense</i>	6	Koh Kong, Preah Sihanouk, Kampot, Siem Reap	14.5-16	21.5-24	8-10 (mostly 9)
<i>A. approximans</i>	1	Mondulkiri	16	22	10-11
<i>A. migratum</i>	2	Kampot (Bokor)	18-18.5	23.5-26	13-14
<i>A. hisopa</i>	2	Koh Kong	18.5-19	26-27	11
<i>A. pallidum</i>	1	Koh Kong	19	29	11

Ceriagrion indochinense Asahina, 1967

Loc. 2: 1 copula photographed (Fig. 24b), from which ♂ collected, 1 more ♀ seen; **Loc. 3b:** several ♂ seen; **Loc. 7:** 1 ♀ collected; **Loc. 11a:** 2 ♂♂ collected, several seen; **Loc. 11b:** 1 ♂ collected; **Loc. 12:** 1 ♂, 2 ♀♀ collected, several ♂♂ and tandems seen, a tandem photographed (Fig. 24a); **Loc. 20:** 1.08.2014: 1 ♂ seen.

Observations: A common *Ceriagrion* species in the area studied, found in inundated grass at roadside pools of a considerable depth, less frequently at rivulets.



Figure 24. An ovipositing tandem (a, at Loc. 12) and copula (b, at Loc. 2) of *Ceriagrion indochinense*.

Ceragrion calamineum Lieftinck, 1951

Loc. 2: 2 ♂♂ collected; **Loc. 3b:** 1 ♂ collected; **Loc. 12:** 1 ♂ collected;

Observations: Males were found at three localities as an admixture to those of *C. indochinense*, well differing from them by their chrome-yellow (rather than lemon-yellow in *C. indochinense*) abdomen and synthorax (greenish in *C. indochinense*) and a slightly smaller size. At coastal marshes of the south-western Koh Kong Province visited before Stung Treng Province, *C. calamineum* was the most common and numerous species (Kosterin & Chartier 2017).

Pseudagrion australasiae Selys, 1876

Loc. 9a: 28.07.2016: 1 ♂ collected, 1 more seen.

Observation: Although being a common and omnipresent species elsewhere in Cambodia, here it was found only once, at a large and deep pond on a medium-size rivulet.

Pseudagrion rubriceps Selys, 1876

Loc. 3a: many ♂♂, ♀♀ seen; **Loc. 4:** several ♂♂ seen; **Loc. 7:** many ♂♂, ♀♀ seen; **Loc. 8:** several ♂♂ seen; **Loc. 9a:** very many ♂♂, ♀♀ seen; **Loc. 9b:** 29.07.2016: 1 teneral ♂ collected; **Loc. 10:** several ♂♂ seen; **Loc. 11a:** very many ♂♂, many ♀♀ seen; **Loc. 12:** very many ♂♂, several tandems seen, 1 ♂ collected; **Loc. 16:** many seen, 1 ♂ collected; **Loc. 20:** many ♂♂, ♀♀ seen.

Observations: An absolute dominant among Zygoptera at small pools, brooks and small rivulets in the region studied.

Platycnemididae

Copera marginipes (Rambur, 1842)

Loc. 1: several ♂♂ seen; **Loc. 3a:** several ♂♂ seen; **Loc. 7:** several ♂♂ and immature ind. seen; **Loc. 8:** several ♂♂, ♀♀ seen; **Loc. 9a:** several ♂♂ seen; **Loc. 10:** several ♂♂ seen; **Loc. 11a:** several ♂♂ seen; **Loc. 12:** several ♂♂; **Loc. 17:** many ♂♂ seen; **Loc. 19:** several ♂♂, ♀♀ seen; **Loc. 20:** 31.07.2016: several ♂♂ seen; 1 ♀ collected; **Loc. 22:** 2 ♂♂ seen; **Loc. 23:** several ♂♂ and immature ind. seen.

Observations: Common at a variety of localities, more than elsewhere in SW, E and NE Cambodia which I had visited before.

Prodasineura autumnalis (Fraser, 1922)

Loc. 4: several ♂♂ seen; **Loc. 7:** many ♂♂, ♀♀ seen; **Loc. 8:** many ♂♂ seen; **Loc. 9a:** several ♂♂ seen; **Loc. 9b:** 1 ♂ seen; **Loc. 10:** many ♂♂ seen; **Loc. 11a:** several seen; **Loc. 12:** 1 ♂ collected, several seen; **Loc. 13:** many ♂♂, 1 ♀ seen; **Loc. 16:** several ♂♂ seen; **Loc. 17:** several ♂♂ seen; **Loc. 19:** many ♂♂ seen; **Loc. 20:** many ♂♂ seen; **Loc. 21:** 1 ♂ seen.

Observations: A common and locally abundant species at brooks and small rivulets, and sometimes also at pools.

Prodasineura coerulescens (Fraser, 1932)

Loc. 14: 1.08.2016: 1 ♂ photographed and collected.

Remarks. The collected male was not fully mature, with the light pattern bluish-white rather than saturated blue as it is in a fully mature state.

Observations: The only male was found at a shrubbery edge above a bluff of the Mekong River right bank. In Cambodia, this species has been registered in the more easterly situated Ratanakiri Province, at a medium-sized river (a Se San right tributary) (Kosterin 2014), while three other congeners found in Cambodia inhabit smaller streams: small rivers, brooks (*P. autumnalis*, *P. doisuthepensis* Hoess, 2000, *P. verticalis* sensu Asahina, 1984) or even seepages (the last mentioned species) (Kosterin 2012; 2015; 2016b). This finding indicates that *P. coerulescens* inhabits medium-sized to major rivers.

Aeshnidae

Anax ?guttatus (Burmeister, 1839)

Loc. 16: 1 ♂ seen (identification tentative).

Remarks: The coloration corresponded to *A. guttatus* but checking in hand would be necessary to rule out similar species expected.

Observations: Only one male was noticed flying over a large roadside pond (not far from the Mekong River right bank just downstream of the Nimith Waterfall).

Gynacantha bayadera Selys, 1891

Loc. 7: 1 ♀ collected (Fig. 25a).

Remarks. This species has been found for the first time in Cambodia, also a female, just six days before in Koh Kong Province (Kosterin & Chartier 2017).

**Gynacantha saltatrix* Martin, 1909

Loc. 7: 2 ♂♂, 1 ♀ collected (Fig. 25b-c).

Remarks. The female is very similar to that of the simultaneously collected preceding species but well differs significantly with a well defined and contrasted T-mark on the top of the frons, versus completely absent in *G. bayadera*. An additional difference of the collected females is the entirely olive-green eyes in *G. saltatrix*, while blue in the upper part in *O. bayadera*. The wing membrane is clear in *G. saltatrix* specimens while slightly brownish-darkened in the *G. bayadera* female, but in *Gynacantha* spp. this coloration is probably age-related.

Observations: Two specimens of this and one of the preceding species were collected in the sunny morning being startled from 'walls' of *Vietnamosasa* sp. (Fig. 9) bordering a rivulet at Srae Ruessey village, among grassy low deciduous dipterocarp forest (or savannah); one male was also startled from grass at several dozens metres from the rivulet. All them flew for a short distance and landed again, as typical for *Gynacantha*. One more individual of this or previous species was also startled at the river but escaped.

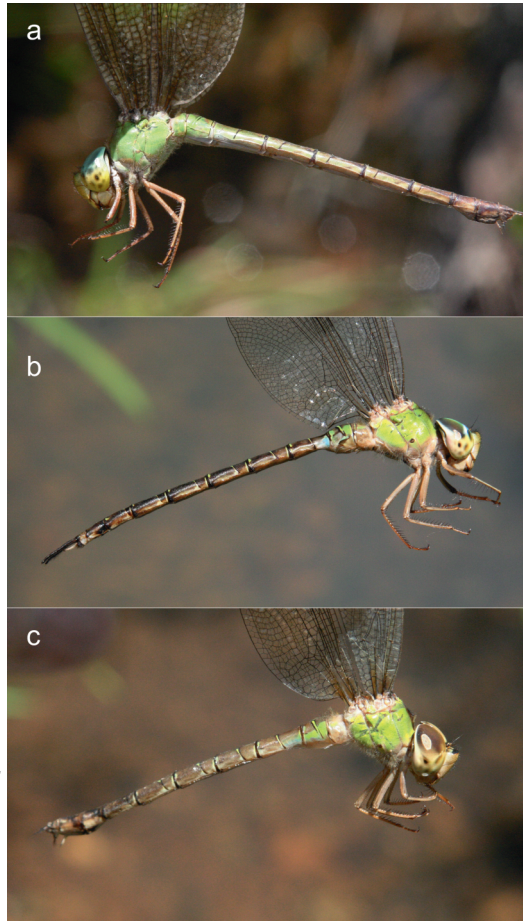


Figure 25. Specimens of *Gynacantha* sp. collected at a rivulet at Srae Ruessei village (Loc. 7, Fig. 9): *G. bayadera* female (a) and *G. saltatrix* male (b) and female (c). 27.07.2016.

Gynacantha subinterrupta Rambur, 1842

Loc. 7: 1 ♂ collected; **Loc. 10:** 28.07.2016: 1 ♀ collected, 29.07.2016 -3 ♀♀ (2 teneral) released, 3 more seen; **Loc. 14:** 1 ♂ seen (identification tentative but highly probable); **Loc. 23:** 1 ♂, 2 ♀♀ collected, one of them photographed (Fig. 26).

Observations: Unlike the two above listed congeners found only once, this species was registered at as many as four localities with different environments: a rivulet in grassy dipterocarp savannah at Srae Ruessei village (Loc. 7, Fig. 9; collected together with the two above species), at a river and pool in a patch of undisturbed, shady tall evergreen forest (Loc. 10, Fig. 11), and at secondary groves in strongly disturbed terrain at a medium-sized river (Loc. 23) and the Mekong River (Loc. 14). A male was captured when patrolling in dusk at a very shady bank of a medium-sized



Figure 26. Female of *Gynacantha subinterrupta* sitting under a banana leaf at Loc. 23. 26.07.2016.

river at Loc. 23, flying just above the mud left from its recent overflow, beneath trees. Nearby two females were startled from ruderal vegetation under a more open tree stand with a banana plantation. At Loc. 10, I startled five teneral individuals, with still glittering wings, from a shallow pool with a litter bottom shaded with tall evergreen forest, obviously a breeding place. A more open, larger and muddy roadside pool was observed to be a breeding place of this species in Ratanakiri Province (Kosterin 2014), and a small, shady shallow roadside pool in Mondulakiri Province (Kosterin 2016b).

Gomphidae

Burmagomphus asahinai Kosterin, Makbun et Davrueng, 2012

Loc. 14: 1 ♀ collected, 1 more ♀ photographed (Fig. 27), 1 more ♀ seen; **Loc. 15:** 1 teneral ♀ collected.

Observations: In Koh Kong Province, from where this species was described, it inhabits medium to larger rivers (Kosterin et al., 2012); in the eastern Ratanakiri (Kosterin 2014) and Mondulakiri (Kosterin 2016b) Provinces it inhabits small rivers and brooks. Therefore it was surprising to find out that it also inhabits the great river of Mekong. Only females were recorded at its right bank (four in total), three at shrubs and tree

edges at its slow reach with a clayey bottom at the Dolphin Viewpoint (Fig. 27), and one at the rocky bank just 1.3 km downstream of the Nimith Waterfall. The latter had just emerged and was still discoloured (left to harden and gain in colour overnight in captivity), hence proving breeding of the species in that great river.



Figure 27. Female of *Burmagomphus asahinai* at the Mekong River right bank at Anlung Chheuteal village (Loc. 14, Fig.15). 1.08.2016.

Ictinogomphus decoratus melaenops (Selys, 1858)

Loc. 3a: 2 ♂♂ seen; **Loc. 3b:** several ♂♂ seen, 1 photographed; **Loc. 8:** 1 ♂ seen; **Loc. 9b:** 29.07.2016: 1 ♂ collected, 1 ♂ seen; **Loc. 9c:** 29.07.2016: 1 ♂♂ collected, many ♂♂ seen; **Loc. 11a:** 1 ♂ seen.

Observations: In the area studied, the best habitats for this species were offered by roadside former gravel pits made during road construction and now filled with shadow and nearly hot water, devoid from vegetation except cyanobacterial mats. For instance, these dragonflies were abundant at such habitats at Loc. 9c; but also at a broad inundated area over an area of logged and burnt forest at Loc. 3b. Singular males were observed also at smaller and deep roadside pools at dammed brooks.

Euthygomphus yunnanensis (Zhou & Wu, 1992)

Loc. 7: 1 ♀ collected; **Loc. 12:** 1 ♂ photographed (Kosterin 2016a: fig. 6a) and collected.

Remarks. This species is common in Indochina and Thailand but used to be misidentified as *Merogomphus parvus* (Krüger, 1899) (Kosterin 2016b).

Observations: The male and female were encountered at different localities but in exactly the same conditions: they perched on leaves of the *Vietnamosasa* 'walls' bordering brooks with gravel bottom and slightly turbid water, flowing through open low deciduous dipterocarp forests.

**Macrogomphus matsukii* Asahina, 1986

Loc. 20: 31.07.2016: 1 ♀ collected (Fig. 28).

Observations. A female was startled from a low tree at a brook flowing in a ditch beside the road crossing in open low deciduous dipterocarp forest. It was amazingly incautious, having twice landed (ca 1.5 m high) on a similar branch of the same tree immediately after I had twice missed with net strokes trying to capture her.



Figure 28. Female of *Macrogomphus matsukii* collected at Loc. 20 (Fig. 19). 31.07.2016.

Nychogomphus duaricus (Fraser, 1924)

Loc. 1: 1 ♂ collected; **Loc. 10:** 28.07.2016: 1 ♀ collected (Fig. 29b); **Loc. 14:** 1 ♂ photographed and collected (Fig. 29a).

Observations. Both males and the female were perching on stems in grass vegetation: above the Mekong River right bank bluff (Loc. 14), among a low *Vietnamosasa* grassy area not far from a medium-sized river (Loc. 1), and at a roadside pool at a brook in tall evergreen forest (Loc. 10).

Paragomphus capricornis (Förster, 1914)

Loc. 3a: 1 teneral ♀ collected.

Observations. A just emerged, still soft, female was collected in a habitat typical for the species: a small river with a gravel bottom (Fig. 5). I also saw a gomphid male of a comparable size at small trees of that river but failed to capture it.

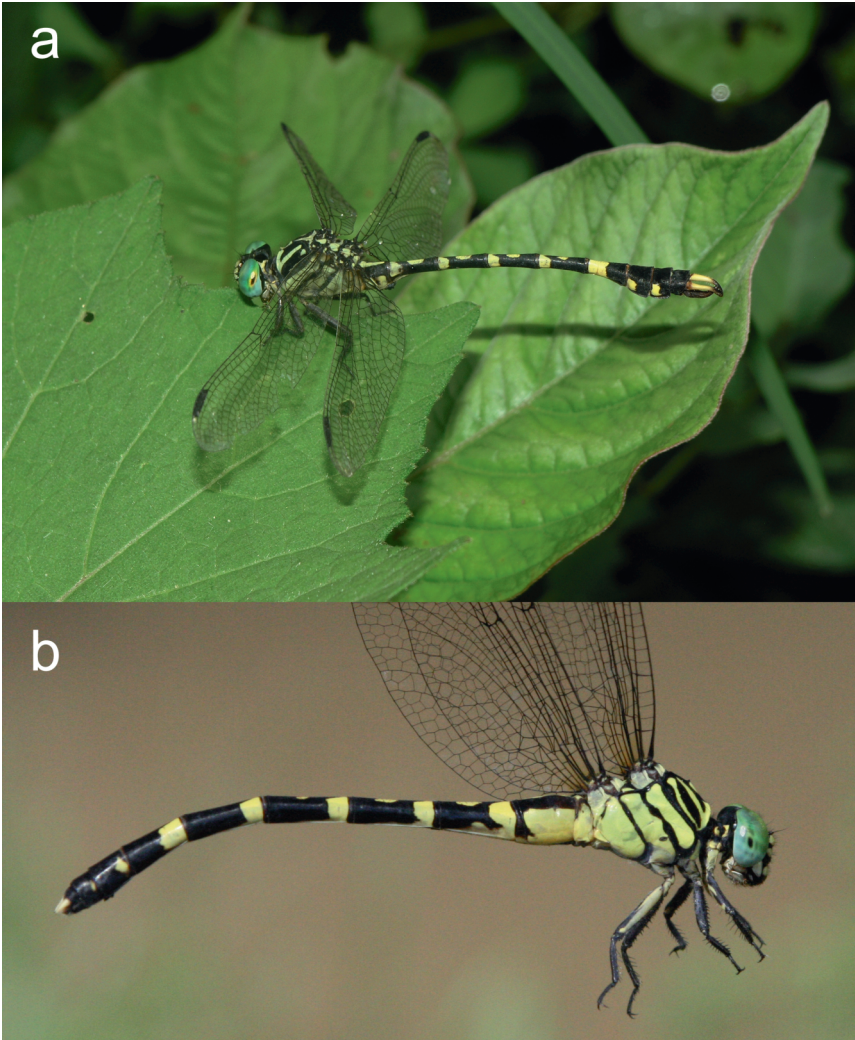


Figure 29. *Nychogomphus duaricus*: a male at the Mekong River right bank at An-lung Chheuteal village (Loc. 14, Fig.15) (a) and a female collected at Loc. 10 (b).

Macromiidae

Ephthalia sp.

Loc. 3a: 1 ♂ seen; **Loc. 8:** 1 ♂ seen; **Loc. 9a:** 1 ♂ seen;

Observations. Males patrolled large and broad river reaches and had such large territories that they re-appeared at the same place only after quite a while and

did not follow similar trajectories. I failed to capture any; in coloration they looked like the common *E. frontalis* Selys, 1871.

Libellulidae

Aethriamanta sp.

Loc. 23: 1 ♀ collected (Fig. 30) but lost.

Remarks. The female belonged to either *Aethriamanta gracilis* (Brauer, 1878) or *A. aethra* Ris, 1912, both recorded in Cambodia (Roland & Roland 2010), but I failed to identify to which of the similar species, it belonged.

Observations. The female perched on a dead stick at a margin of a forest remnant at a medium-sized river in quite a populated area, not far from small grassy swamplets where it could breed.



Figure 30. Female of *Aethriamanta gracilis* or *A. aethra* collected at Loc. 23. 26.07.2016.

Brachydiplax chalybea chalybea Brauer, 1868

Loc. 11a: 1 ♂ seen.

Brachydiplax farinosa (Krüger, 1899)

Loc. 11a: 3 ♂♂ collected, several more seen.

Observations. Both *Brachydiplax* species were found only once, at rather a small but very deep roadside pool, partly shaded by tall grass, in a tall evergreen forest area.

Brachythemis contaminata (Fabricius, 1793)

Loc. 3b: many ♂♂, ♀♀ seen; **Loc. 4:** several ♂♂, ♀♀ seen; **Loc. 5:** many ♂♂, ♀♀ seen; **Loc. 6:** many ♂♂, ♀♀ seen; **Loc. 7:** very many ♂♂, ♀♀ seen; **Loc. 8:** many ♂♂, ♀♀ seen; **Loc. 9a:** very many ♂♂, ♀♀ seen; **Loc. 9b:** many ♂♂, ♀♀ seen; **Loc. 9c:** many ♂♂, ♀♀ seen; **Loc. 12:** several ♂♂, ♀♀ seen; **Loc. 13:** several ♂♂, ♀♀ seen; **Loc. 14:** many ♂♂, ♀♀ seen; **Loc. 15:** several ♂♂, ♀♀ seen; **Loc. 16:** many ♂♂, ♀♀ seen; **Loc. 17:** several ♂♂, ♀♀ seen; **Loc. 18:** many ♂♂, ♀♀ seen; **Loc. 20:** very many ♂♂, ♀♀ seen.

Observations: A dominant species among Anisoptera in a variety of habitats, especially numerous at medium-sized rivers with gravel beds flowing through areas affected by human activity, mostly at open reaches. Individuals of both sexes were found following a human, or other large animal, passing through their habitats.

Cratilla lineata calverti Förster, 1903

Loc. 11c: many ♂♂, several ♀♀ seen, 2 ♂♂ photographed, 1 ♂, 1 ♀ collected.

Observations. Found only once but in quite numbers in a typical habitat: at numerous small dirty pools, some with green water, on a shady muddy logging road in tall evergreen dipterocarp forest. Males and females perched at sticks and low bushes, from immediately to ca 1.5m above the ground or hovered over the road and pools. They were remarkably non-cautious and were not frightened even by net strokes.

Crocothemis servilia (Drury, 1770)

Loc. 3b: 1 ♀ photographed, 1 more ♀ seen, 1; **Loc. 9b:** several ♂♂, ♀♀ seen; **Loc. 12:** 1 ♂ released; **Loc. 14:** 1.08.2016: 1 ♀ seen; **Loc. 18:** 1 ♂, several ♀♀ seen.

Diplacodes trivialis (Rambur, 1842)

Loc. 6: several immature, 1 mature ♂♂ seen; **Loc. 8:** 1 immature ♂ seen; **Loc. 14:** 1.08.2016: 1 immature ♂ seen; **Loc. 18:** several ♂♂ seen; **Loc. 20:** 1.08.2014: 1 ♂ seen.

Observations. Occurs at barren ground in populated areas most affected by human activity.

Diplacodes nebulosa (Fabricius, 1793)

Loc. 2: 2 ♂♂ seen.

Observations. This species, usually common at ponds with rich vegetation, was found once at an open area of grassy seepages and tiny pools among open deciduous dipterocarp forest (Fig. 4).

Lathrecista asiatica (Fabricius, 1798)

Loc. 3a: 1 ♂ seen; **Loc. 10:** 29.07.2016: 1 ♀ collected, several ♂♂, ♀♀, seen; **Loc. 11a:** many ♂♂, several ♀♀, seen, including teneralis; **Loc. 11b:** several ♂♂ seen; **Loc. 17:** several seen; **Loc. 22:** several ♂♂ seen; **Loc. 23:** 2 ♂♂ seen.

Observations. Occurred mostly at open places in tall evergreen forest or its remnants, especially at small pools including muddy ones; not found in the habitat most widespread in the area, namely the open low deciduous dipterocarp forest.

Neurothemis fluctuans (Fabricius, 1793)

Loc. 2: 1 ♂ seen.

Observations. Amazingly, only one individual of this species, one of the most common and numerous elsewhere in Cambodia.

Neurothemis fulvia (Drury, 1773)

Loc. 11a: several seen, including teneral; **Loc. 14:** 1.08.2016: 2 ♂♂ seen, 1 of them photographed; **Loc. 23:** many seen;

Neurothemis intermedia atalanta Ris, 1919

Loc. 2: 1 teneral ♂, 1 teneral ♀ seen; **Loc. 9b:** 28.07.2016: 1 ♂ collected; **Loc. 11a:** 1 ♀ collected; **Loc. 14:** 1.08.2016: 1 ♂ photographed; 1 ♀ collected; **Loc. 21:** 1 ♂ seen; **Loc. 23:** 1 ♀ seen;

Observations. This species is considered as flying mostly in dry season, yet it appeared rather common, although not numerous, in the studied area in July, including quite mature individuals judging by their coloration.

Onychothemis testacea Laidlaw, 1902

Loc. 15: 1 ♀ photographed and collected, 1 more ind. seen.

Observations. The species prefers rough water at rapids in medium-sized rivers; here found at a rocky bank of the Mekong 1.3 km downstream of the great Nimith Waterfall (Fig. 16), but not at the waterfall itself. The dragonflies perched on prominent branches at a riverside forest margin and were cautious. A female captured a butterfly *Hypolympnas bolina* (Linnaeus, 1758); this was the second time I had seen these dragonflies catching large butterflies (for the first time see Kosterin 2014).

Orthetrum luzonicum (Brauer, 1868)

Loc. 2: 1 ♂ collected, 1 more seen.

Observations. Found at grassy seepages and a small brook in an open area (Fig. 4), together with *A. approximans*, *D. nebulosa* and *N. fluctuans* also found only there.

Orthetrum sabina (Drury, 1770)

Loc. 2: several ♂♂ seen; **Loc. 3b:** several ind. seen; **Loc. 6:** 1 ♂ seen; **Loc. 7:** 1 ♂ seen; **Loc. 9b:** 1 ♂ seen; **Loc. 14:** 1.08.2016: several ♂♂ seen.

Observations. Common everywhere in SE Cambodia but rather not so in the area studied, more frequent in populated area, at pools among ruderal vegetation.

Orthetrum neglectum (Rambur, 1842)

Loc. 22: several ♂♂ seen, 1 photographed.

Observations. Males patrolled a small brook flowing at the last patch of the tall evergreen forest being logged and replaced by plantations.

Orthetrum testaceum (Burmeister, 1839)

Loc. 12: 2 ♂♂ seen (identification tentative by size and tint of the red colour); **Loc.**

20: 1.08.2016: 1 immature ♀ collected.

Observations. A species rare in Cambodia.

Pantala flavescens (Linnaeus, 1758).

Loc. 3: several seen; **Loc. 5:** very many seen; **Loc. 6:** several seen; **Loc. 7:** several seen; **Loc. 9:** several seen; **Loc. 10:** several seen; **Loc. 11:** several seen; **Loc. 13:** many seen; **Loc. 14:** extremely numerous; **Loc. 15:** several seen; **Loc. 17:** several seen; **Loc. 18:** many seen; **Loc. 22:** many seen.

Observations. Common and quite numerous everywhere, mostly flying over the roads in small loose swarms; however at the banks of major rivers of Se San and Mekong, e.g. in Stung Treng Centre and at the Dolphin Viewpoint, large swarms of dozens to hundreds individuals were often observed, especially in the evening.

Potamarcha congener (Rambur, 1842)

Loc. 10: several ♂♂ seen; **Loc. 11a:** many ♂♂ seen; **Loc. 11b:** several ♂♂ seen; **Loc. 17:** several ♂♂ seen; **Loc. 18:** 1 ♂ seen; **Loc. 20:** 1.08.2016: 1 ♀ photographed and collected.

Observations. The species prefers open muddy pools, including those in villages and cities, but in this area occurred mostly at pools in tall evergreen forest areas, in three of the five localities together with *L. asiatica*.

Pseudothemis jorina Förster, 1904

Loc. 3b: several ♂♂, 1 ♀ seen; **Loc. 8:** 2 ♂♂ seen; **Loc. 10:** 1 ♂ seen; **Loc. 11a:** 1 ♂ seen; **Loc. 12:** 1 ♂ collected, several seen; **Loc. 13:** 1 ♂ seen.

Observations. Each deep clear pool, even a quite small roadside one, were invariably patrolled by a male, rarely several males, of this species. At a burnt and inundated logged area of Log. 3b, a female oviposited over shallow stagnant water among burnt stumps, with a male hovered immediately above her.

Rhyothemis obsolescens Kirby, 1889

Loc. 11a: 1 ♂ seen; **Loc. 12:** several ♂♂ seen.

Rhyothemis phyllis (Sulzer, 1776)

Loc. 3b: 1 ♂ seen; **Loc. 9b:** 1 ind. seen.

Rhyothemis plutonia Selys, 1883

Loc. 3b: 1 ♂ collected, several seen; **Loc. 16:** several ♂♂ seen.

Observations. Found twice in the same habitat: remnants of logged and burnt forest inundated by large ponds on a brook or rivulet.

Rhyothemis triangularis Kirby, 1889

Loc. 12: several ♂♂ seen.

Rhyothemis variegata (Linnaeus, 1763)

Loc. 6: 2 ♀♀ seen; **Loc. 9b:** 1 ♀ seen; **Loc. 18:** 1 ♀ seen; **Loc. 20:** 1.08.2014: 1 ♀ seen.

Observations. Occurred in open areas, singular individuals only.

Tholymis tillarga (Fabricius, 1798)

Loc. 3a: several ♂♂, ♀♀ seen; **Loc. 4:** several seen; **Loc. 7:** many ♂♂, ♀♀ seen; **Loc. 9a:** several seen; **Loc. 9b:** several seen; **Loc. 10:** several seen; **Loc. 12:** 1 ♀ seen; **Loc. 14:** 1.08.2016: several; **Loc. 20:** several ♂♂, ♀♀ seen; **Loc. 23:** many seen.

Observations. Observed frequently in many different habitats; at daytime on short flights or as startled from bushes or tall grass. Should be in fact very numerous as could be seen during the twilight activity characteristic for the species, which I had an opportunity to observe only once, at Loc. 23.

Trithemis aurora (Burmeister, 1839)

Loc. 1: several ♂♂ seen; **Loc. 2:** several ♂♂ seen; **Loc. 3a:** several ♂♂ seen; **Loc. 3b:** many ♂♂, several ♀♀ seen; **Loc. 4:** several ♂♂ seen; **Loc. 7:** very many ♂♂ seen; **Loc. 8:** several ♂♂, ♀♀ seen; **Loc. 9a:** several ♂♂, ♀♀ seen; **Loc. 9c:** many ♂♂, ♀♀ seen; **Loc. 10:** several ♂♂ seen; **Loc. 11a:** many ♂♂ seen; **Loc. 11b:** several ♂♂ seen; **Loc. 12:** many ♂♂, several ♀♀ seen; **Loc. 13:** many ♂♂, several ♀♀ seen; **Loc. 15:** several ♂♂ seen; **Loc. 17:** several ♂♂ seen; **Loc. 20:** very many ♂♂, several ♀♀ seen; **Loc. 22:** many ♂♂, several ♀♀ seen; **Loc. 23:** many ♂♂, several ♀♀ seen, 1 ♀ photographed.

Observations. Along with *B. contaminata*, this is the most common anisopteran in the area, but preferring smaller brooks, rivulets and pools with grassy banks in less disturbed areas.

Trithemis festiva (Rambur, 1842)

Loc. 3a: 1 ♂ seen; **Loc. 7:** 1 ♂ photographed; **Loc. 13:** 1 ♂ photographed.

Observations. Much rarer than the previous species; at the mighty O Ta Lao River the male was observed perched on a railing at the middle of the bridge.

Urothemis signata (Rambur, 1842)

Loc. 9b: 1 ♂ seen.

Zygomma petiolatum Rambur, 1842

Loc. 7: 1 ind. seen; **Loc. 10:** 29.07.2016: 1 ♂, 1 ♀ collected, 1 more ♂ seen; **Loc. 11a:** 1 ♂ collected, 1 more ♂ and 1 ovipositing ♀ seen.

Observations. This species is normally seen during its twilight activity but all the above records were made during the day. At Loc. 10, three individuals were startled from branches at ca 2 m above the ground at a shady brook in the tall evergreen forest, while at Loc. 11 three specimens, including an ovipositing female, were observed at hot noon at a more exposed roadside pool in the same area, where the surface was shaded by tall emergent grass.

Update to the country fauna.

During this eight day trip I found and identified 52 species of Odonata. Of them two species, *Gynacantha saltatrix* and *Macrogomphus matsukii*, were found in Cambodia for the first time. Of the three unidentified species, *Aciagrion* sp., *Epo-phthalmia* sp. and *Aethriamanta* either *aethra* or *gracilis*. The former should be a new country record as well.

General notes

Low deciduous dipterocarp forest

The studied area, mostly a 10 km wide strip west of the Mekong River, in Thala Barivat District of Stung Treng Province, is basically a gravel flatland covered with open and low, deciduous dipterocarp forest with a tall grass level formed by the narrow-leafed bamboo *Vietnamosasa* sp. (Fig. 2), rarely with a short-grass sandy 'veals'. It is crossed by numerous brooks and rivulets with gravel, very locally sandstone, beds and slightly turbid water. At roads and near settlements they usually form ponds which may be small but usually deep. All these water courses invariably offered the same standard set of common species: the most numerous *L. lineata*, *P. rubriceps*, *B. contaminata* and *T. aurora*, and less numerous but not less common *V. gracilis*, *C. indochinense*, *C. marginipes*, *P. autumnalis*, *P. jorina*, *T. tillarga*. It was strange to see in most localities only one *Pseudagrion* species of the four common elsewhere in Cambodia. Another species, *P. australasiae* was only found at the lake-like river widening at Loc. 9. Some species occurred rather randomly in several of the localities: *G. subinterrupta*, *E. yunnanensis*, *I. decoratus*, *N. duaricus*, *N. intermedia*, *O. sabina*, *T. festiva*, *Z. petiolatum*. Other species can be considered as scarce. Of those, it was interesting to find three species of *Gynacantha* altogether, *G. saltatrix* (more abundant), *G. bayadera* and *G. subinterrupta*, at a rivulet near Srae Ruessei village (Loc. 7, Fig. 9). At Loc. 2, 3b and 12, *C. calamineum* was found side-by side with the common *C. indochinense* but much less in number.

Larger rivers provided almost nothing but few individuals of the commonest species, although some of them, with slow reaches over gravel bottom, looked extremely promising, at least for gomphids, while the two largest, at Loc. 6 (Fig. 8) and Loc. 13 (O Ta Lao River, Fig. 14), had a very high level, speed and turbidity. All these larger rivers were surrounded by obviously secondary thickets of tall thorny bamboo, which I did not see in other regions of Cambodia; this most probably indicated a prolonged and considerable human impact on their banks.

A grassy seepage, with a tiny brook and very small ponds with almost hot water, amid a low deciduous dipterocarp savannah (Loc. 2, Fig. 4), offered some rather expected species not found elsewhere on this trip: *A. approximans*, *Agriocnemis* sp., *D. nebulosa*, *O. luzonicum*. A habitat in some sense opposite to the above mentioned, namely large roadside ponds in place of former gravel pits, with clear very hot water and no aquatic vegetation but cyanobacterial mats, was a preferred habitat for *I. decoratus* but inhabited by very few other odonates, like *B. contaminata* or *T. aurora*.

Tall evergreen forest

Dense and shady, tall evergreen (or semi-evergreen) dipterocarp forests were associated with hills. They strongly suffer from human activity and as a rule are very hard to enter because of entangled branches of many freshly felled trees surrounding them. The best condition I saw at an obviously virgin primary forest at Phnom Preahkonha Hill at the Mekong Bank (Loc. 19, Fig. 18), although it also contained some in-forest banana plantation. However, at a nice shady brook in that forest I found only four odonate species: *V. gracilis*, *E. masoni* (very numerous), *H. biforata* and *C. marginipes*. More species were found at a larger rivulet of Loc. 10 flowing in rather intact forest but near a logged area (Fig. 11), of which most interesting was *R. hainanense*. The forest at Loc. 11 was being selectively logged and hence had a system of half-shady, muddy logging roads, which expectedly offered numerous *C. lineata calverti*, while males of *O. sexmaculata* were found at a shallow forest pool (Loc. 11b, Fig. 12). An analogous but larger pool at Loc. 10 appeared a place of an active emergence of *G. subinterrupta* (five teneral individuals with glittering wings recorded).

The Mekong River

My experience of six trips to SW, NE and E Cambodia in 2010-2015 suggested that the richest fauna of lotic odonate species is to be found in small rivers (some 5 m wide on average); smaller rivulets (ca 2 m wide) have less rich fauna, while both small, mostly temporal brooks and medium rivers support poor (and different) faunas, and only very scanty dragonflies and very few damselflies, the most common and widespread species, can be found at major rivers. For this reason I did not expect to find anything at the great river of Mekong. The Se San (Se Kong) River at Stung Treng, near its junction with Mekong and nearly as huge (Loc. 5, Fig. 7) supported that expectation, as I found only two species of omnipresent libellulids, *P. flavescens* (lentic but of great dispersal ability) and *B. contaminata* (eurybiont preferring slow flowing water), although quite abundant.

However, the Mekong reach downstream of its Nimith Waterfall or Khone Pha Pheng Falls, 9.7 km long and ca 10 km wide, offered a number of obligatory lotic species. The breeding in Mekong was proved for *B. asahinai*, since a just hatched female was collected, and for *P. coerulescens*, recorded by an immature male with still slightly bluish rather than saturated sky blue light pattern. There is little doubt, however, that the three more lotic species found, *D. gloriosa*, *N. duaricus* and *O. testacea*, breed in the Mekong as well. At least *D. gloriosa* was among few odonate species found to inhabit the major Se San River in its middle flow at Ta Veng village in Ratanakiri Province (Kosterin 2014), while *O. testacea* was found at rocky banks preferred by this species elsewhere. Of these five lotic species, *B. asahinai* and *O. testacea* were recorded 1.3 km downstream from the waterfall, with the Mekong current already laminar but the banks still rocky, with small sandy patches (Loc. 15, Fig. 16), while *D. gloriosa*, *P. coerulescens*, *N. duaricus* and the same *B. asahinai* were found at a very calm and broad, lake-like 'Dolphin pool' at Anlung Cheuteal

village (Loc. 14, Fig. 15). However, the latter locality was still just 6.5-7 km downstream of the waterfall, the noise of which being permanently heard there. The surprising occurrence of a number of lotic Odonata species at that calm reach, contrasted to nearly absence of those at major Cambodian rivers elsewhere, may be explained by water obviously saturated with oxygen downstream of the huge, 9.7 km long waterfall, although already calm. In both localities, a non-obligatory but preferably lotic *B. contaminata* was found; another such species, *L. lineata*, was found at small pools on the rocks situated in the reach of the waterfall itself most probably breeding in them (Loc. 18, Fig. 17). It is not excluded that a number of eurybiotic species found at Mekong (Loc. 14-15, 18), namely *G. subinterrupta*, *C. servilia*, *D. trivialis*, *O. sabina*, *P. congener*, *T. tillarga*, *T. aurora* could have bred from shallows of the Mekong at its clayey banks as well.

Possible effects of the preceding drought

The most striking circumstance was a complete absence of any *Agriocnemis* spp. and of *Copera vittata* (Selys, 1863). The former prefers grassy wet places, with no or very shallow open water, the latter is a common forest species elsewhere in Cambodia, inhabiting shady, small and very shallow, black pools with rotten litter in forests. Perhaps their absence was the only observed consequence of the unprecedented drought in spring, as those shallow places could have dried out completely.

Perspectives

I suppose that the odonate species assemblage observed in low deciduous and tall evergreen dipterocarp forests was typical for the whole flat area of north-eastern Cambodia.

I examined the Mekong within 7 km downstream of the waterfall for in total of 4 hours 20 minutes in two days and I wish I had one more day for this, since all obligatory lotic species were far from abundant and without doubt more of them could still be found. It should be noted that at the time of my visit, the Mekong waters were high and inundated some trees at the banks, while the best time to reveal the rheophylic odonate species at the moment of their extensive emergence would be May, that is at the very beginning of the rainy season.

Prey Long, the last huge, still virgin rainforest in Indochina, containing areas of several square kilometres of swamp forest (McDonald 2004), is the next target of Odonata assessment. It is situated in 35-40 km of SW of Stung Treng. Its fauna of Odonata is expected to be similar to that of the neighbouring area considered here, but perhaps richer because of undisturbed conditions of the evergreen rainforest and totally unexplored, scarcely accessible swamped areas. However, that area has sandy soils different from the gravel soils of the area near the Mekong, and there exist 'veals' with *Melaleuca cajuputi* Powell, as in the coastal areas of Cambodia (McDonald 2004). The edaphic conditions can exert some, although unknown, influence on the Odonata species assemblage.

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