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A survey of Odonata of Mondulkiri, the elevated eastern province of Cambodia, for ten days in June 2014.

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Abstract

Results of an odonatological survey of Mondulkiri Province of Cambodia, at the foothills and Central Plateau of the Annamese Mts. in June 8 – June 17, 2014 are presented. Of 106 Odonata species met (46 zygopterans, 60 anisopterans), 97 were identified to previously known named species, of which 15 are reported for the first time for Cambodia, namely *Mnais mneme* Ris, 1916, *Rhinocypha seducta* Hämäläinen et Karube, 2001, *Philoganga loringae* Fraser, 1927, *Rhinagrion hainanense* Wilson et Reels, 2001, *Amphiallagma parvum* (Selys, 1876), *Ceriagrion chaoi* Asahina, 1967, *Paracercion malayanum* (Selys, 1876), *Prodasineura doisuthepensis* Hoess, 2007, *Protosticta grandis* Asahina, 1985, *Tetracanthagyna waterhousei* McLachlan, 1898, *Gomphidia kruegeri* Martin, 1904, *Heliogomphus chaoi* Karube, 2004, *Leptogomphus baolocensis* Karube, 2001, *Microgomphus jurzitzi* Karube, 2000, *Onychothemis culminicola* Förster, 1904, and two species for which the specimens collected on this trip were described as new subspecies: *Indolestes gracilis expressior* Kosterin, 2015, *Coelliccia poungyi dasha* Kosterin, 2016. Five species collected on this trip have been described elsewhere as new to science, namely *Onychargia priyadak* Kosterin, 2015, *Prodasineura hoffmanni* Kosterin, 2015, *Asiagomphus reinhardti* Kosterin et Yokoi, 2016, *Euthygomphus schorri* Kosterin, 2016 and *Risiophlebia guentheri* Kosterin, 2015. So the total number of the first country records of named species made on this trip is 22. Still four species found may be undescribed. The number of named species recorded in Cambodia has reached 178. Remarks on taxonomy and variation of *Euphaea masoni* Selys, 1879, *E. ochracea* Selys, 1859, *Aciagrion approximans* (Selys, 1876), and *Lamelligomphus castor* Lieftinck, 1941 are provided. Characters of mature males of *R. seducta* are updated. Notes on habitats and habits of some species are provided. *Onychothemis culminicola* and *O. testacea* Laidlaw, 1902 seem to exclude each other at rivers, the former occupying smaller and more elevated ones; a putative hybrid male was observed. General notes on the area and field impressions are briefly outlined.

Key words: Odonata, dragonflies, damselflies, fauna, the first country record, Cambodia, Mondulkiri Province, Annamense Mountains, Indochina, *Vestalis gracilis* (Rambur, 1842) (wing enfumation), *Euphaea masoni inouei* Asahina, 1977 (wing lustre, new

combination), *Euphaea ochracea* Selys, 1859 (geographical variation, habitat), *Rhincocypha seducta* Hämäläinen et Karube, 2001 (the second published finding, additional specific characters, habitat), *Aciagrion approximans* (Selys, 1876) and *Aciagrion migratum* (Selys, 1876) (relationship, differences, occurrence in Cambodia), *Onychargia priydak* Kosterin, 2015 (records in Thailand), *Prodasineura hoffmanni* Kosterin, 2015 (resemblance to a specimen from North Vietnam); Cambodian records of *Merogomphus parvus* Krüger, 1899 reidentified as *Euthygomphus yunnanensis* Zhou et Wu, 1992. *Heliogomphus* sp.; *Heliogomphus svihleri* Asahina, 1970 (possible synonymy, a closely related species); *Lamelligomphus castor* Lieftinck, 1941 compared to *Lamelligomphus vietnamensis* Karube 2015; *Onychothemis culminicola* Förster, 1904 and *O. testacea* Laidlaw, 1902 (mutual displacement, putative hybrid),

Introduction

In spite of a recent progress, the Odonata fauna of Cambodia remains insufficiently studied. In 2010, 2011, 2013, 2015 and 2016 I made five trips to the coastal regions of the country aimed to reveal the nearly unknown Odonata fauna of the Cardamom Mt. foothills and Bokor Plateau (Kosterin 2010; 2011; 2012a, b; Kosterin et al. 2012b; Kosterin 2015f; 2016a and unpublished). These data were updated by observations and photos by Gerard Chartier, who makes permanent observations in the Tatai Commune, Hans-Jürgen Roland with colleagues, Jeremy Holden, Francois Mey and Leslie Day (Roland & Roland 2010; Roland et al. 2011; Day 2011; Kosterin et al. 2012a; Kosterin & Chartier 2014). In 2013 I visited for the same purpose Ratanakiri Province in the north-eastern Cambodia but failed to examine its elevated areas at the Lao border (Kosterin 2014a, b). As a result of these and earlier studies (Asahina 1967; Kosterin & Vihrev 2006; Benstead 2006), 156 named species have been reported for Cambodia, including a newly described one (Kosterin et al. 2012a), as well as a number of still unnamed and unidentified species (checklisted by Kosterin et al., 2012b with updates by Kosterin 2014a; 2015f; Kosterin & Chartier 2014; Seehausen et al. 2016). On my trip to Cambodia in June 2014 I revisited the coastal Cardamom foothills for several days (Kosterin, in prep.) but my main target was Mondulakiri Province. It is situated in eastern Cambodia and borders southern Vietnam. It embraces western foothills and the western part of the Central Plateau of the Annamense (or Annamite) Mts. Earlier only H.J. Roland with colleagues (Roland & Roland 2010; 2011; Roland et al. 2014) provided some photographic data on Odonata from this province, namely from the Seima Forest and Buu Sraa Waterfalls. I spent in Mondulakiri Province ten days from 08.06.2014 to 17.06.2014, mostly on the plateau, and revealed a fauna much richer than elsewhere in Cambodia, including species and subspecies new to science (Kosterin 2015a,b,c,e; 2016b-c; Kosterin & Yokoi 2016). The results are presented below. A separate section deals with results of shortly revisiting the Buu Sraa Waterfalls area on 03-04.08.2016. More photos are soon to be available at <http://www.allodonata.com> and at my own site at <http://pisum.bionet.nsc.ru/kosterin/odonata/cambodia.htm>.

Methods

The localities examined were accessed riding a four-gear Honda motorbike. Odonata were sought while walking along brooks, rivers and pond banks. Well recognisable common species were recorded by sight, some individuals were captured, examined in hand and released, some voucher specimens or small series of other species were collected and preserved on cotton layers with paper covers. Odonata were photographed in purely natural conditions, in some cases also in hand to register living colours. Totally 1,953 photos of Odonata and landscapes were taken with Olympus Camedia C8080 camera and 229 landscape photos were taken by Pentax WG10 camera. Coordinates were recorded by Garmin eTrex H personal GPS navigator but the provided ranges for the areas actually examined, as well as elevations above sea level, were revised using GoogleEarth. 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. Dates are provided according to the British system: dd.mm.year.

The region

Mondulkiri Province (literally 'the Mountain of Mandala'), the largest in Cambodia (14,288 km²), occupies the western part and slopes of the Central Plateau of the Annamense Mts.

The western outskirts of the Annamese Mts. are still covered with a large (ca 35 x 20 km) and still nearly undisturbed evergreen Seima Protected Forest (Fig. 1) (in fact pro-



Figure 1. A river in Seima forest 22.5 km SW of Sen Monorom (Loc. 2). A habitat of *Neurobasis chinensis*, *Euphaea masoni inouei*, *Heliocypha biforata*, *H. perforata limbata*, *Rhinagrion hainanense*, *Coeliccia* sp. cf. *kazukoae*, *Copera marginipes*, *C. vittata*, *Cratilla lineata calverti*, *Diplacodes trivialis*, *Neurothemis fluctuans*, *N. fulvia*, *Orthetrum chrysis*, *O. glaucum*, *Pantala flavescens*, *Tetra-themis platyptera*, *Trithemis aurora*.

tected only from logging) occupying gentle ridges at 150-600 m a.s.l. The latter elevation seems to be a limit of dense evergreen forest in this area.

The plateau, where the Province capitol Sen Monorom is situated, with main elevations of 600-850 m a.s.l., is covered with grassy savannah with open tree stand, which densens into evergreen forest in valleys of numerous brooks and rivulets (Fig. 2). It enjoys a pleasant montane climate, warm but not hot, round the year. The area is still thinly populated (4.3 persons/km² over the province) and scarcely disturbed. Perhaps the most conspicuous disturbance there is presence of large pine plantations. There is a forested Phnom Nimlyr Mt., 935 (or 982) m a.s.l., at the Vietnamese border, with no good roads and a strict regime of access, which I did not explore, yet it is only about 100 m higher than the plateau at Dak Dam village which I studied in quite detail. In Google Earth one can see that in the Mt. Nimlyr area, any forest disappear behind the Vietnamese border, hence the Cambodian territory is still (but how long for?) a refuge of the peculiar nature of this area.



Figure 2. Savannah of the Central Plateau of the Annamense Mts. at Sen Monorom.

The area to the north-east of Sen Monorom, where the highest in Cambodia (with two tiers, 10 and 15 m high) Buu Sraa Waterfalls (Fig. 3-4) are situated, is somewhat less elevated (400-600 m above sea level) and more flat, although still resting on volcanic plates. Although situated at the same elevations as Seima Forest, they are naturally covered with deciduous dry dipterocarp forests (Fig. 5), obviously being in the rain shadow of the Plateau and getting less precipitation. However, the river valley below the mentioned waterfall is clad with evergreen forest. This area is more populated than the above considered and largely converted to farmland. It is crossed by three relatively large rivers, here conventionally called 'Kruegeri', 'Testacea' and 'Buu Sraa' Rivers, while their actual local names remained unknown to me. A huge, supposedly similar but scarcely populated, area situated north of Sen Monorom, towards Koh Nhek village, remains unvisited and unexplored odonatologically. However, a new good road is being constructed from Sen Monorom to Ban Lung, Ratanakiri, which makes this area, on one hand, well accessible and, on the other hand, sacrificed to exploitation.



Figure 3. The lower tier of the Buu Sraa Waterfalls and a downstream view from it.



Figure 4. The upper tier of the Buu Sraa Waterfalls.

Localities visited

Some nameless localities were given with conventional nicknames (in singular quotations), mostly after Odonata. All localities are numerated throughout and so shown as dots on a general map of Fig 6. Time intervals of examination of localities are given very approximately.

Loc. 1. Seima forest 34 km SW of Sen Monorom, $12^{\circ}12'15\text{--}30''$ N $107^{\circ}00'58\text{--}01'12''$ E, 302-310 m a.s.l., 17.06.2014: 13:10-15:30. Evergreen forest with many seepages; a small rivulet with turbid water crossing the road and inundating a considerable area of forest, rapidous upstream; two shady pools (large and small) at roadside secondary forest; a roadside grassy area, partly inundated.

Loc. 2. Seima forest 22.5 km SW of Sen Monorom, $12^{\circ}17'16\text{--}46''$ N $107^{\circ}04'17\text{--}55''$ E, 373-397 m a.s.l., 17.06.2014: 9:15-13:00. A deep valley of quite a large rapidous river with rather cold water; a dark banana grove at a bank, evergreen forest in the valley and on slopes (Fig. 1) large and rather intact but some individual trees cut



Figure 5. Deciduous dipterocarp forest at the road from Sen Monorom to Buu Sraa Waterfalls.

and a number of temporary forest roads; a shaded small forest brook. Wet, many pools remained from a recent rain when examined.

Loc. 3. 'Chaoi Brook', 3.5 km SSE of Sen Monorom, 12°25'36-44" N 107°11'01-06" E, 690-700 m a.s.l., 11.06.2014: 10:25-11:00. Upper reaches of a small brook hidden in hardly permeable bush thickets, with some trees in otherwise grassy slope (Fig. 7); downstream turns to a wider valley with water flowing through tall *Cyperus* sp. grass with some *Allocasia*.

Loc. 4. Monorom Waterfall area:

Loc. 4a. Monorom Waterfall area, the left tributary 'Ochracea rivulet' of the main river, 3.5 km WSW of Sen Monorom, 12°26'17-31" N 107°09'37-53" E, 628-645 m a.s.l., 13.06.2014: 9:30-15:00. A fast rivulet 2-3 m wide, with some rapids, surrounded partly by forest patches, partly by bamboo thickets; one reach faces a large grassy slope.



Figure 6. Disposition of the localities visited in the view SE Cambodia adopted from Google Earth. For the explanation of the numbers see the text.



Figure 7. 'Chaoi Brook' (Loc. 3) 3.5 km SSE of Sen Monorom. A habitat of *Helio gomphus chaoi*, *Onychothemis culminicola*, *Orthetrum chrysis*, *O. luzonicum*, *Trithemis festiva*, *Zygonyx iris malayana*.



Figure 8. Monorom Waterfall and its main river (Loc. 4b) 3.5 km SSE of Sen Monorom. A habitat of *Neurobasis chinensis*, *Vestalis gracilis*, *Dysphaea gloriosa*, *Euphaea masoni inouei*, *E. ochracea*, *Aristocypha fulgipennis*, *Heliocypha perforata limbata*, *Protosticta* sp.1 and sp. 2, *Gomphidictinus perakensis*, *Tetrathemis platyptera*.



Figure 9. The lower pond in Sen Monorom (Loc. 5). A habitat of *Lestes praemorsus decipiens*, *Amphiallagma parvum*, *Agriocnemis femina*, *Ceragrion auranticum*, *Ischnura senegalensis*, *Paracercion malayanum*, *Pseudagrion microcephalum*, *Prodasineura autumnalis*, *Anax guttatus*, *Ictinogomphus decoratus*, *Epophthalmia frontalis*, *Aethriamanta brevipennis*, *A. gracilis*, *Brachydiplax chalybea*, *Crocothemis servilia*, *Neurothemis fluctuans*, *Orthetrum sabina*, *Pseudothemis jorina*, *Rhyothemis phyllis*, *R. triangulare*, *Trithemis aurora*, *Urothemis signata*.



Loc. 4b. Monorom Waterfall, the main river (Fig. 8), 12°26'31-39" N 107°09'32-38" E, 614-622 m a.s.l., 13 and 14.06.2014: 15:30-15:40; 15.06.2014: 9:00-10:30. A relatively large rapidous river with the forested left bank and partly a stripe of forest and a road at the right bank; examined downstream of a large reservoir and upstream of the hydropower station using the enegy of water flowing from the reservoir through a collateral channel.

Loc. 4c. Water reservoir upstream Monorom Waterfall, 12°26'37" N 107°09'39" E, 622 m a.s.l., 13 and 14.06.2014: 15:10-15:30. Large, with turbid water and partly forested, partly open banks.

Loc. 5. Lower pond in Sen Monorom (Fig. 9), 12°27'37-40" N 107°10'52-56" E, 675 m a.s.l., 8.06.2014: 15:20-17:30. A large (300 x 140 m) and deep pond, water filled with hydrophytes and some floating (*Salvinia*) and emergent (*Ludwigia* and *Commelina*) plants, rimmed with a narrow floating bog formed by *Poaceae*, banks with small allotments with planted banana, pineapple etc.

Loc. 6. 'Onychargia swamp' (illustrated in Kosterin 2015c: fig. 5a-b), 2 km SE Sen Monorom, 12°26'56-58" N 107°12'15-17" E, 683 m a.s.l., 8.06.2014: 13:00-13:30. A broad quaking (floating) bog, formed partly by low *Poaceae*, partly by tall *Cyperus* sp.,



Figure 10. 'Culminicola Rivulet' (Loc. 7) 3.5-3.8 km ESE of Sen Monorom. A habitat of *Vestalis gracilis*, *Euphaea masoni inouei*, *Heliocypha biforata*, *H. perforata limbata*, *Agriocnemis femina*, *Mortonagrion aborense*, *Pseudagrion pruinatum*, *P. rubriceps*, *Prodasineura autumnalis*, *P. doisuthepensis*, *Pseudocoptera ciliata*, *Euthygomphus schorri* (its type locality here), *Burmagomphus asahinai*, *Brachydiplax farinosa*, *Neurothemis fluctuans*, *N. fuvia*, *Onychothemis culminicola*, *Orthetrum chrysis*, *O. luzonicum*, *Rhyothemis plutonia*, *R. triangularis*, *Tetrathemis platyptera*, *Tholymis tillarga*, *Trithemis aurora*, *T. festiva*, *Zygonyx iris malayanum*.

with *Allocasia* at their border; with laminar water flow above vegetation. Set in a small shallow valley with rice and maize fields. The type locality of *Onychargia priydak* Kosterin, 2015 (Kosterin 2015c).

Loc. 7. 'Culminicola Rivulet' (Fig. 10), 3.5-3.8 km ESE of Sen Monorom, 12°26'43-53" N 107°13'00-20" E, 689-691 m a.s.l., 8.06.2014, 9:30- 12:30. A rivulet 2-3 m wide, with the following reaches: a slow reach with a clay bottom, partly shady, partly with open grassy places; a medium fast reach with a gravel/silt bottom; sunny riffles; a small adjacent sunny swamplet with inundated fine grass. The type locality of *Euthygomphus schorri* (Kosterin 2016b).

Loc. 8. Dak Dam env., 12°24'58"-25'07" N 107°19'02-14" E, 762-774 m a.s.l., 16.06.2014: 10:00-13:40. A medium-sized river with bamboo and tree stand at banks; bamboo thickets with a small brook, a tall-grass (*Cyperus* sp.) forest swamp with sparse trees with some sluggish pools (illustrated in Kosterin 2015b: fig. 3), a damp short-grass buffalo pasture with some small pools and *Melastoma* bushes (obviously in place of the tall-grass swamp) (illustrated in Kosterin 2015e: fig. 5c-d). The type locality of *Risioptlebia guentheri* Kosterin, 2015 (Kosterin 2015b).



Figure 11. 'Kruegeri River' (Loc. 11) 12 km NE of Sen Monorom. A habitat of *Neurobasis chinensis*, *Vestalis gracilis*, *Dysphaea gloriosa*, *Euphaea masoni inouei*, *Helio-cypha perforata limbata*, *Copera marginipes*, *C. vittata*, *Prodasineura autumnalis*, *Burmagomphus divaricatus*, *Gomphidia kruegeri*, *Brachythemis contaminata*, *Onychothemis culminicola*, *Orthetrum glaucum*, *Tetrathemis platyptera*, *Tholymis tillarga*, *Trithemis aurora*, *T. festiva*, *Zygonyx iris malayanum*.

Loc. 9. Dak Dam Waterfall, 12°24'29-37" N 107°18'40-46" E, 810-815 m a.s.l., 16.06.2014: 14:05-15:50. A medium-sized river upstream the waterfall, with a stripe of forest at banks, and a damp short-grass pasture (as at Loc. 8) nearby.

Loc. 10. 'Seducta brook' (illustrated in Kosterin 2015e: fig. 5), 4.2 km SE of Dak Dam village, 12°23'10-18" N 107°19'22-30" E, 877-878 m a.s.l., 14.06.2014: 12:40-14:50. A brook in a deep and narrow forest dell, small, shallow, with dark bottom and smooth moderate current, difficult to follow because crossed by many (ca each 20 m) fallen trees of different age, sparse *Cyathea* sp. at banks in understorey. The type locality of *Prodasineura hoffmanni* Kosterin, 2015 (Kosterin 2015e).

Loc. 11. 'Kruegeri River' (Fig. 11), 12 km NE of Sen Monorom, between Srae Empum and Buu Sraa, 12°30'58"-31'16" N 107°17'10-32" E, 530-570 m a.s.l., 10.06.2014: 9:00-11:30. Quite a large river, water slightly turbid, bed mostly rocky but there was an arm with slow current, banks with open dipterocarp stand with tall grass and traces of fire, with some small shady pools. A grassy open area with a small brook nearby.

Loc. 12. 'Testacea River' (Fig. 12), 23 km NE of Sen Monorom, 12°33'31-49" N 107°22'06-14" E, 427-434 m a.s.l., 10.08.2014. 11:55-13:17. A very large river, very fast and rapidous, knee to neck deep, with a slow and much deeper reach.



Figure 12. 'Testacea River' (Loc. 12) 23 km NE of Sen Monorom. A habitat of *Neurobasis chinensis*, *Vestalis gracilis*, *Dysphaea gloriosa*, *Euphaea masoni inouei*, *Heliocypha perforata limbata*, *Pseudagrion pruinosum*, *Prodasineura autumnalis*, *Onychotemis testacea*, *Tramea transmarina euryale*, *Zygonyx iris malayanum*.

Loc. 13. Buu Sraa Waterfalls area:

Loc. 13a. 'Loringae brook', the left tributary of the main river downstream the waterfall, upstream its own waterfall (Fig. 13), 12°33'58"-34°01" N 107°24'43"-25°02" E, 432-515 m a.s.l., 9.06.2014: 13:30-15:00; 10.06.2014: 13:40-15:15; 15.06.2014: 8:30-9:50. A shallow inundated muddy swamp with water hyacinth upstream the road, some shady sluggish black pools piled with entangled branches, then a moderately fast stream, partly shaded by tall forest, partly openly flowing above sandstone rocks until it falls from a high rock.

Loc. 13b. 'Loringae brook', downstream its waterfall (Fig. 14-15), 12°34'01"-19" N, 107°24'50"-25°03" E, 416-490 m a.s.l., 12.06.2014: 9:20-13:30; 15.06.2014: 10:00-15:15. A meandering brook with partly silty and partly stony bed with rapidous sections and pools, shaded by tall forest (with traces of old fire) and/or tall bamboo thickets, often crossed with fallen trees; there is a tiny and very shady left tributary spring (Fig. 16). The type locality of *Coelliccia poungyi* dasha Kosterin, 2016 (Kosterin 2016c) and *Asiagomphus reinhardti* Kosterin et Yokoi, 2016 (Kosterin & Yokoi 2016).



Figure 13. 'Loringae brook', the left tributary of the main river of Buu Sraa Waterfalls, upstream its own waterfall (Loc. 13a). A habitat of *Vestalis gracilis*, *Euphaea masoni inouei*, *Aristocypha fulgipennis*, *Heliocypha biforata*, *Philoganga loringae*, *Copera marginipes*, *C. vittata*, *Prodasi-neura autumnalis*, *Euthygomphus schorri*, *E. yunnanensis*, *Lamelligomphus castor*, *Leptogomphus baolocensis*, *Neurothemis fluctuans*, *N. fuvia*, *N. intermedia atalanta*, *Orthetrum chrysis*, *O. glaucum*, *Tetrathemis platyptera*, *Trithemis aurora*, *Zygonyx iris malayanum*.



Figure 14. 'Loringae brook', the left tributary of the main river of Buu Sraa Waterfalls, just below its own waterfall (Loc. 13b). A habitat of *Euphaea masoni inouei*, *Aristocypha fulgipennis*, *Heliocypha biforata*, *Philoganga loringae*, *Prodasineura autumnalis*, *Protosticta grandis*, *P. sp1. cf. caroli*, *Teracanthagyna waterhousei*, *Euthygomphus schorri*, *Gompidictinus perakensis*, *Lamelligompgus castor*, *Leptogomphus baolocensis*, *Macromia septima*, *Zygonyx iris malayanum*.



Figure 15. 'Loringae brook', the left tributary of the main river of Buu Sraa Waterfalls, downstream its own waterfall (Loc. 13b). A habitat of *Vestalis gracilis*, *Euphaea masoni inouei*, *Aristocypha fulgipennis*, *Heliocypha biforata*, *H. perforata limbata*, *Rhinagrion hainanense*, *Coeliccia poungyi dasha* (its type locality here), *Prodasi-neura autumnalis*, *P. doisuthepensis*, *Protosticta grandis*, *P. sp1. cf. caroli*, *Gynacantha sub-interrupta*, *Teracanthagyna waterhousei*, *Asiogomphus reinhardti* (its type locality here), *Lamelligomphus castor*, *Idionyx thailandica*, *Macromidia genialis ssp.*, *Cratilla lineata calverti*, *Lathrecista asiatica*, *Zygonyx iris malayanum*.

Loc. 13c. Buu Sra floodplain, 12°34'16" N 107°25'07" E, 440 m a.s.l., 9.06.2014: 14:20-15:20; 12.06.2014: 14:00-15:00. A broad grassy floodplain, with open tree stand, grass and traces of fire, below the waterfalls, with a large and shallow shady pool with scarce emergent vegetation at shallower ends, partly hidden under entangled branches; and some smaller pools, bordered by a slope covered with tall bamboo thickets, also with traces of fire.

Loc. 13d. Main river below Buu Sra Waterfalls (Fig. 3 above, Fig. 17), 12°34'16" N 107°25'07" E, 440 m a.s.l., 12.06.2014: 13:30-13:50, 15:00-15:30; 15.06.2014: 15:20-15:50. A large shallow and rapidous river with the banks half open, half forested. Immediately below the waterfalls there are small pools on rock outcrops.

Loc. 13e. The main river between the two tiers of Buu Sraa waterfalls (Fig. 18), 12°34'00-19" N 107°25'03-09" E, 442-476 m a.s.l., 9.06.2014: 10:20-11:20. A powerful river reach, partly deep, partly rapidous, partly, hidden in forest, on the right bank with wet cliffs.



Figure 16. A tiny and very shady left tributary spring of the 'Loringae brook' (Loc. 13b). A habitat of *Protosticta* sp.1, *Macrogomphus kerri*.



Figure 17. The main river downstream Buu Sraa Waterfalls (Loc. 13d). A habitat of *Dysphaea gloriosa*, *Heliocypha perforata limbata*, *Pseudagrion pruinosum*, *Onychothemis* sp.



Figure 18. The main river between the two tiers of Buu Sraa Waterfalls (Loc. 13e). A habitat of *Euphaea masoni inouei*, *Aristocypha fulgipennis*, *Heliocypha perforata limbata*, *Prodasineura autumnalis*, *P. doisuthepensis*, *Burmagomphus divaricatus*, *Lathrecista asiatica*, *Zygonyx iris malayanum*.

Loc. 13f. Main river upstream Buu Sraa waterfalls (Fig. 19), 12°33'50-59" N 107°25'03-09" E, 488-504 m a.s.l., 9.06.2014: 11:20-11:40, 12:50-13:10. Mostly slow and man height deep, partly rapidous, banks bordered by tree stand but the banks covered by very open secondary tree and bush stand; immediately upstream the waterfall the banks are open and rocky and the river rich shallow. Water slightly whitish turbid. The type locality of *Indolestes gracilis expressior* Kosterin, 2015 (Kosterin 2015a).

Loc. 13g. 'Plutonia pool' at the right bank of the main river upsteram Buu Sraa Waterfalls (Fig. 20), 12°33'55" N 107°25'10" E, 500 m a.s.l., 9.06.2014: 11:40-12:30; 10.08.2014: 16:00-16:15, 12.06.2014: 8:15-8:40. Quite a large, sunlit, very shallow grassy pool with abundant emergent vegetation, muddy bottom, and bushes at one side.

Loc. 13h. Small pools at the former (Fig. 21), 10.08.201: 16:15-16:30; 12.06.2014: 8:40-9:00. Very small and shallow muddy pools on a sunlit narrow grassy floodplain.



Figure 19. The main river upstream Buu Sraa Waterfalls (Loc. 13f). A habitat of *Dysphaea gloriosa*, *Euphaea masoni inouei*, *Prodasineura autumnalis*, *P. doisuthependis*, *Burmagomphus asahinai*, *B. divaricatus*, *Ictinogomphus decoratus melaenops*, *Neurothemis fluctuans*, *Onychothemis testacea*, *Orthetrum glaucum*, *Zygonyx iris malayanum*.

Figure 20. 'Plutonia pool' at the right bank of the main river upstream Buu Sraa Waterfalls (Loc. 13f). A habitat of *Aciagrion approximans*, *A. hisopa*, *Argiocnemis femina*, *Argiocnemis rubescens rubeola*, *Ceriagrion chaoi*, *Ischnura senegalensis*, *Pseudagrion australasiae*, *Onychargia atrocyana*, *Pseudocoptera ciliata*, *Anax guttatus*, *Acisoma panorpoides*, *Brachydiplox farinosa*, *Hydrobasileus croceus*, *Lathrecista asiatica*, *Neurothemis fluctuans*, *N. fulvia*, *N. intermedia atalanta*, *Orthertrum chrysis*, *O. neglectum*, *Potamarcha congener*, *Rhyothemis plutonia*, *R. triangulare*, *Treama transmarina euryale*.



Figure 21. Small grassy pools near 'Plutonia pool' (Loc. 13h) (see Fig. 20). A habitat of *Aciagrion approximans*, *Argiocnemis rubescens rubeola*, *Ceriagrion indochinense*.



Annotated list of species

Asterisks indicate first records for Cambodia made on the trip considered (some already mentioned in my other publications devoted to particular groups and based on its results). Observations as to habitats and behaviour and taxonomic remarks are provided where necessary but most common and well known species are not commented. The specimens are kept partly in Naturalis Biodiversity Center, Leiden (RMNH) and partly with the author, the latter are available for investigation upon request.

Idionyx and Macromidia are considered within the family Synthemisidae sensu lato: molecular data showed unequivocally that these and some other genera form a monophyletic group with Synthemis, the so-called 'GSE clade'. However, the recent joint paper (Dijkstra et al. 2013), reconsidering Odonata families according to molecular data, left these genera as 'Libelluloidea incertae sedis' beyond any family, while so many other families were reshuffled. The molecular evidence is more than sufficient to accept Synthemisidae in the broad sense, as it has been already done by M. Schorr and D. Paulson in their World Odonata Species List (Schorr & Paulson 2015). Zygopteran genera were attributed to families according to the recent revision by Dijkstra et al. (2014).

Zygoptera

Calopterygidae

**Mnais mneme* Ris, 1916

Loc. 9: 1 ♂, 1 ♀ (with hyaline wings) collected; Loc. 10: 8 ♂ collected (2 with orange, 6 with hyaline wings), several ♀ (of both types) seen and photographed (Fig. 22-23).

Remarks. Identification thanks to Matti Hämäläinen (pers. comm.) based on the male penis structure, the only reliable character to distinguish this species from the very close *M. andersoni* McLachlan in Selys, 1873 (Asahina 1974).

Observations. Found quite in abundance at the most elevated (877-878 m a.s.l.) of the studied localities - the very narrow, shady and piled with fallen trees dell of the 'Seducta brook', and scarce at the third elevated locality, the Dak Dam environs (762-774 m a.s.l.). Perhaps in this area, the species is at its lowest limit of the range of inhabited elevations and so is too local.

Neurobasis chinensis (Linnaeus, 1758)

Loc. 1 (river): many ♀, ♂ seen; Loc. 2: several ♀ seen; Loc. 4a: numerous; Loc. 4b: 12-13.06.2014: many ♀, ♂ seen; Loc. 11: many ♀, ♂ seen; Loc. 12: many ♀, ♂ seen.



Figure 22. *Mnais mnome*, androchromatic (with orange wings) males at the 'Seducta brook' (Loc. 10).

Vestalis gracilis (Rambur, 1842)

Loc. 1 (swamp, rivulet): many ind. seen; Loc. 3: several seen; Loc. 4a: many seen, including teneral; Loc. 4b: 12-13.06.2014: many seen; Loc. 7: 1 collected, several seen; Loc. 8: many ind. seen; Loc. 10: several seen; Loc. 11: 1 ind. seen; Loc. 12: 1 collected; Loc. 13a: 09-10.06.2014: 1 photographed, many seen; 10.06.2014: 1 collected; Loc. 13b: 12.06.2014: many seen.

Remarks. All individuals had the wingtips smoked. This is in line with the supposition that this enfumation results from development at higher temperatures at the end



Figure 23. *Mnais mneme*, gynochromatic (with hyaline wings) males at the 'Seducta brook' (Loc. 10).

of dry season (Kosterin 2011; 2014a). A male collected on 10.08.2014 at 'Loringae brook' was surprisingly small: hind wing 35 mm, abdomen without appendages 44 mm - compare 39 and 51 mm, respectively, in a male collected in the same day at 'Testacea River', that is normal for the species.

Euphaeidae

Dysphaea gloriosa Fraser, 1938

Loc. 4b: 13.06.2014: 2 seen; Loc. 11: 2 seen; Loc. 12: 1 collected, many more seen; Loc. 13d: 15.06.2014: 1 seen; Loc. 13f: 1 seen.

Observations. Found only at large rivers preferred by this species, although in Ratanakiri Province in June 2013 it was found also at smaller ones (Kosterin 2014a).

Euphaea masoni inouei Asahina, 1977, comb. nov.

Loc. 1 (river): many seen; Loc. 2: several seen; Loc. 4a: 1, 1 collected into alcohol, 1 collected, 1 photographed (Fig. 24), numerous seen; Loc. 4b: 12-13.06.2014: many several seen; Loc. 7: 3, 1 collected, several more, seen; Loc. 8: very many, seen; Loc. 10: many, seen; Loc. 11: several seen; Loc. 12: several seen; Loc. 13a: 09-10.06.2014: many, seen; Loc. 13b: 12 and 15.06.2014: 1 and 1 photographed, many, seen; Loc. 13e: 09-10.06.2014: several seen; Loc. 13f: several, seen.

Remarks. All males had a dark deep-blue lustre (leaving a broad black border) on the hind wing underside and a very strong coppery lustre in the wing upperside, which I at last managed to illustrate with a photograph (Fig. 24) having encountered at Loc. 4a a male which had an unusual habit to rest with the wings half-opened. The same characters were observed in males in Ratanakiri Province in NE Cambodia (Kosterin 2014a). A photo of a male of *Euphaea masoni* Selys, 1879 published by Von Ellenrieder et al. (2015: fig. 20) shows the same deep blue lustre on the hind wing underside. According to a personal communication by Matti Hämäläinen, the same lustres are seen in *Euphea hirta* Hämäläinen & Karube, 2001, described from Bão Lộc in South Vietnam (Hämäläinen & Karube 2001) which is some 100-130 km SE of the studied area, where it is sympatric to *E. masoni* showing at least the same blue lustre of the hind wing underside. The exactly similar appearance of two close sympatric species of demoiselles is something not to expect theoretically, since a disruptive selection against occasional hybridisation should operate in this situation. I checked with a lens many males of this demoiselle in the field but all they had structural characters of *E. masoni* (no such dense and conspicuous setae at the end of abdomen, the paraprocts well seen in lateral view) but not *E. hirta*.

Males of *E. masoni* from East Thailand and the Cardamom Mts. in SW Cambodia are quite different: with a slight deep-purple lustre on the wing upperside and no or very scarce lustre on the wing underside (Kosterin 2014a). This is enough to conclude that Thailand+Cardamoms versus East Cambodia+Vietnam are respectively inhabited by two different subspecies, *Euphaea masoni masoni* Selys, 1879 and *E.*



Figure 24. *Euphaea masoni inouei*, a male resting with open wings at 'Ochracea rivulet' (Loc. 4a).

masoni inouei Asahina, 1977. *E. masoni* was described from Tenasserim, the area in Lower Myanmar close to Thailand, while *Euphaea guerini inouei* Asahina, 1977 was described from "Thao Bolba near Dalat, S. Vietnam", in fact from Bo Bla waterfall (Thac Bo Bla), ca 25 km E of B o Lóc (pers. comm. by M. Hämäläinen; à Lat is the capitol of Lâm òng Province), that is very close to Mondulkiri Province. "E. g. inouei" was described as differing from "E. guerini masoni" by a smaller size (hw 27 vs 29 mm) and larger not-coloured areas of wings (Asahina 1977; 1986a).

These characters are variable (e.g. in Cambodia, see Kosterin 2010; 2011) and have no taxonomical value. However, the above considered differences in the upperside and hind wing underside lustres are stable and vote for the reality of the eastern, East Cambodian and Vietnamese, taxon. In Cambodia, *E. masoni masoni* and *E. masoni inouei* are well separated by the vast Cambodian Lowland, however they should contact each other in the mountainous north of Indochina, in Laos or nearby. The area where they meet and what happens there - syntopy, sympatry with habitat displacement, a transgressive hybrid zone etc. – is still to be found.

The treatment of the taxa *masoni* and *inouei* as subspecies of *E. guerini* Rambur, 1842 by Asahina (1977; 1986a) did not hold water (van Tol & Rosendaal 1995; Hämäläinen & Karube 2001) since substantial differences of males of *masoni+inouei* from *guerini* were underestimated, namely strongly foliate vs moderately foliate cerci, absence vs presence of a ventral tuft of bristles on S9 (Asahina 1977; 1986a) non-sharp vs sharp edges of the vesicle lateral corners, and absence vs presence of a strong green lustre on the hind wing upperside (Hämäläinen & Karube 2001). So the specific status of *E. masoni* was restored (van Tol & Rosendaal 1995; Hämäläinen & Karube 2001).

Meanwhile *E. guerini* is also present in South Vietnam, including in a sympatry with *E. masoni* and *E. hirta* in Lâm óng Province. Beyond structural features, *E. guerini* can easily be recognised by a strong green lustre of the hind wing upperside, quite strong blue lustre of the hind wing underside and the hind wing coloured to tips (Hämäläinen & Karube 2001; Phan et al. 2011; Karjalainen & Hämäläinen 2013). It was reported for Cambodia by Martin (1904; note he reported both *E. guerini* and *E. masoni* for Tonkin and Annam, that is he distinguished them well) and was very expected from so nearby Mondulkirí Province. However, I failed to find it there, in spite of a focused search.

Euphaea ochracea Selys, 1859 ?ssp.

Loc. 4a: 7 5 collected (of them 1 1 in alcohol), several photographed (Fig. 25), many, mostly teneral, seen; Loc. 4b: 12-13.06.2014: several teneral , seen; Loc. 8: 2 collected, many , seen.

Remarks. The females differ from that depicted by Asahina (1986a) from Thailand (with the locality not specified) in having the anteclypeus completely black (light with a broad black stripe, with four processes, at the upper margin in the Thai female) and the light stripe on the postclypeus interrupted for the width of anteclypeus, even in teneral specimens (continuous in the Thai female). Fraser (1934) also mentioned “a broad stripe across frons” (interrupted in our females).

This species has been reported from Cambodia by a photograph of a specimen from Kbal Chhay Waterfall at Kampongsaom Peninsula (Kosterin et al. 2012b), but identity of this specimen is to be confirmed: the cercus shape, the degree of wing coloration and the thoracic patterns seem to differ from *E. ochracea* collected in Mondulkirí Province.



Figure 25. *Euphaea ochracea*, males at 'Ochracea rivulet' (Loc. 4a).

Observations. Found at small to medium rivers only on the Central Plateau, at elevations not less than 630 m a.s.l., although not reported from elsewhere as a species confined to highlands.

Both sexes preferred to perch on conspicuous stems, seemingly aggregated up to a dozen of individuals within several metres, but in shade of tree or bamboo canopy. They rarely flew, in contrast to active males of *E. masoni*.

Chlorocyphidae

Aristocypha fulgipennis (Guerin, 1871)

Loc. 1 (river): 1 collected; Loc. 4a: several seen; Loc. 4b: 13.06.2014: several (1 teneral) seen; Loc. 8: 1 collected; Loc. 13a: 1 collected; Loc. 13b: 12.06.2014: 2 collected, many seen below the waterfall; 15.06.2014: several seen along the brook; Loc. 13e: 1 collected.

Observations. Only at rocky, rapidous reaches of brooks and small rivers, at all elevations.

Heliocypha biforata (Selys, 1859)

Loc. 1 (river): several seen; Loc. 2: 1 seen; Loc. 4a: 1 collected; Loc. 7: 1 collected, several, seen; Loc. 8: several, seen; Loc. 10: several seen; Loc. 13a: 09.06.2014: several, seen; Loc. 13b: 12.06.2014: many, seen.

Heliocypha perforata limbata (Selys, 1879)

Loc. 2: several seen; Loc. 4b: 13.06.2014: several 1 seen; Loc. 7: 1 1 collected; Loc. 11: several, seen; Loc. 12: many, seen; Loc. 13a: 12 and 15.06.2014: several at the mouth; Loc. 13b: 12 and 15.06.2014: several at the mouth (as penetrated from the main river); Loc. 13d: several seen; Loc. 13e: 9-10.06.2014: several seen.

Observations. The well known inclination of this species to rocks and rapids at larger streams and of the previous species, *H. biforata*, to vegetation at smaller streams, was well observed in this area as well. These two species of *Heliocypha* quite can co-occur in the same localities, but in this area the co-occurrence was observed only at the medium streams of 'Culminicola Rivulet' (Loc. 7) and 'Loringae brook' (Loc. 13b).

Libellago lineata (Burmeister, 1839)

Loc. 13a (inundated part): 10.06.2014: 1 collected, 1 seen.

**Rhinocypha seducta* Hämäläinen et Karube, 2001

Loc. 8: 1 collected; Loc. 10: 5 collected, 1 photographed (Fig. 26).

Remarks. This is the second reported finding of this species after its description (Hämäläinen & Karube 2001). The body pattern coincided with the original description

in detail. On the other hand, the hind wing offered two characters not mentioned there (most probably because the males of the type series were subteneral):

- a strong coppery lustre of the upperside;
- the anteriodistal ca one fourth of the coloured apical wing area of the underside has a spot with a strong violet-blue-green lustre with indistinct borders (nothing like a vitreous spot). It can be seen even on the poor natural photos provided here (Fig. 26). While flying, males of *R. seducta* at first glance resembled *A. fulgipennis* by a similar strong coppery shining of their hind wings but were well recognisable by the very bright shining area added to the wing apical part.

Observations. Quite a number of males were encountered, together with *H. biforata*, in a closed, shady, overgrown with trees and bushes valley of 'Seducta brook', and only one male in a larger river (but also at a shady reach) in Dak Dam environs, where it co-occurred with *A. fulgipennis*. These localities were close to each other, both among the most elevated (762-868 m a.s.l.) of examined, and at both *R. seducta* co-occurred with *M. mneme* and *Prodasineura hofmanni* Kosterin, 2015



Figure 26. *Rhinocypha seducta*, males at 'Seducta brook' (Loc. 8).

(described by specimens from this trip), curiously in the same quantities: quite a few at Seducta brook and one individual in the Dak Dam environs (*M. mneme* was found nowhere else while *P. hoffmanni* also at Dak Dam Waterfall). No doubt, these species belong to the same eco-faunal complex.

Philogangidae

Piloganga loringae Fraser, 1927

Loc. 13a: 9.06.2014: 1 collected (Fig. 27 above); 15.06.2014: 1 collected; Loc. 13b: 12.06.2014: 1 photographed (Fig. 27 below) and collected.

Observations. Males perched on tall sticks above pools at the stony section of the brook; they were not at all cautious.



Figure 27. *Philoganga loringae*, a captured female (above) and perching male (below) at the 'Loringae brook' (Loc. 13a-b).



Philosinidae

**Rhinagrion hainanense* Wilson et Reels, 2001

Loc. 2 (a forest brook): 1 collected;
Loc. 13b: 12.06.2014: 1 1 collected;
15.06.2014: 1 2 collected, several
, 1 photographed (Fig. 28), many
seen.

Remarks. It is noteworthy that this species was abundant at the 'Loringae brook', and also found at Seima forest, while *Rhinagrion viridatum* Fraser, 1938, abundant in the Cardamoms (Kosterin 2011, 2012a) and also found at Virachey National Park (Kosterin 2014a), was not found at all. Perhaps these species tend to exclude each other.

Observations. As common for representatives of the genus, these damselflies are very motile, rarely perch for long and often change a perch, males being more active. Having sat on a twig, a male several times curves abdomen up to raise its end and obviously to demonstrate its scarlet underside.



Figure 28. *Rhinagrion hainanense*, a female (above) and male (other) at the Loringae brook (Loc. 13a).

Lestidae

Lestes praemorsus decipiens Kirby, 1893

Loc. 5: 1 photographed.

**Indolestes gracilis expressior* Kosterin, 2015

Loc. 13g: 9.06.2014: 1 collected – the holotype of the subspecies.

Remarks. The mentioned male is the holotype of this recently described subspecies (Kosterin 2015a) of a species known to range in Ceylon and western Hindustan. Taking into account the remoteness of the main range of *I. gracilis* (Hagen in Selys, 1862), most probably *expressior* is in fact a separate Indochinese species, but data are too insufficient to claim this at present. Note this is the first and only specimen from this genus collected in Cambodia, implying its representatives to be very rare there.

Coenagrionidae

Aciagrion approximans (Selys, 1876)

Loc. 9 (pasture): 2, 1 collected, several more seen; Loc. 13g: 12.06.2014: 2 collected; Loc. 13h: 10.06.2014: 2 collected; 12.06.2014: 2 collected.

Remarks. These damselflies had a violet ground colour, a narrow transversal postocular stripe and S10 black dorsally, that is were identical to those reported by Kosterin (2014a) for Ratanakiri Province (conventionally the ‘Violet Aciagrion’).

In the cited paper, Kosterin (2014a) reported existence in Cambodia of two very similar *Aciagrion* damselflies differing only in the ground colour: the blue one on Bokor Plateau, identified as *A. tillyardi* Laidlaw, 1919 (Kosterin 2011; 2012a, b), and the violet one (‘Violet Aciagrion’) in Ratanakiri Province, also found in Hong Kong and Thailand, with the valid name unclear. (Note an error in Kosterin (2014a) who claimed, with reference to Laidlaw (1919) “large postocular spots just connected by a narrow streak” to be a feature of *A. tillyardi* while in fact Laidlaw (1919: 187) wrote “a linear gray-blue post-ocular mark on either side, connected by a fine, transverse line of the same colour across the occiput”.) However, the postocular markings probably varies in this group of *Aciagrion* from a transversal stripe broadening to the ends to two well-defined spots connected with a streak, depending on the environmental conditions, so is at least in *Aciagrion migratum* (Selys, 1876) in Japan (Kosterin et al. 2014).

Later Kosterin et al. (2014) designated the neotype of *Pseudagrion approximans* Selys, 1876 from Khasi Hills, NE India, that made *Aciagrion approximans* (Selys, 1876) the valid name for the taxon from Khasi Hills and *A. tillyardi* its junior synonym. Moreover, they found out that this taxon from Khasi Hills has a violet ground colour, hence being that ‘Violet Aciagrion’. This shifted the nomenclatorial problem to the valid name for the blue damselflies from Bokor (Kosterin 2011; 2012a, b). In fact, *Aciagrion migratum* (Selys, 1876) described from Japan and also ranging in China and Korea, differs from *A. approximans* only in its blue ground colour (Kosterin 2014a). There seem

to be two more probable options: either *A. approximans* and *A. migratum* are synonyms (with the valid name still to be chosen by the First Reviser since they were described in the same work), or the Bokor damselflies are *A. migratum*. This is a matter of further, perhaps molecular, studies. For the time being I tentatively assume the Bokor damselflies to be *A. migratum* (Kosterin 2015f).

Observations. These damselflies were found at the Buu Sraa and Dak Dam Waterfalls but in the same habitat having no relation to waterfalls: medium-sized to tiny, very shallow muddy pools with sedgy banks on sunlit open areas. This is exactly the same habitat where they were found in Ratanakiri Province (Kosterin 2014a) but differing from peat-moss mires where the presumed *A. migratum* occurs on Bokor Plateau (Kosterin 2011; 2012a, b).

Aciagrion hisopa (Selys, 1876)

Loc. 13g: 12.06.2014: 5 collected.

Remarks. The characters and variation of this species were discussed earlier (Kosterin 2012a; 2014a). The specimens collected in June in Mondulkiri Province had a coppery, not black, pattern, as in spring rather than late summer specimens (Kosterin 2012a).

Observations. Found at a sunlit, small, shallow grassy pool, that is typical for the species (Kosterin 2012a; 2014f), together with one more, above considered species of this genus.

Argiocnemis femina (Brauer, 1868)

Loc. 5: 8 1 juv. collected, many seen; Loc. 6: 1 , 1 collected; Loc. 7: 2 , 2 collected; Loc. 13g: 10.06.2014: 1 collected.

Observations. Surprisingly, no other representatives of the genus were found in the area, e.g. *A. pygmaea* (Rambur, 1842), which is the most common one at least in E. Thailand and SW Cambodia. Oppositely, *A. femina* is very common more northerly, in China and Japan, but surprisingly rare in SW Cambodia (Kosterin 2011).



Figure 29. *Argiocnemis rubescens rubeola*, a male at an oxbow pool of the main river downstream Buu Sraa Waterfalls (Loc. 13c).

Argiocnemis rubescens rubeola Selys, 1877

Loc. 13c: 9.06.2014: 1 ♂, 2 ♀ (1 red abdomen, 1 mature) collected, 1 ♂ photographed (Fig. 29), several ♀ seen; 12.06.2014: 1 ♀ mature collected, several seen; Loc. 13g: 10.06.2014: 1 ♂ collected; Loc. 13h: 10.06.2014: 3 ♀ seen.

Observations. Summarising my experience with this species in Thailand and Cambodia I may conclude that it prefers medium-sized lentic habitats at least with some clear water.

**Amphiallagma parvum* (Selys, 1876)

Loc. 5: 1 ♂ collected, 1 more seen.

Observations. I noticed two males simultaneously and very closely to each other hovering in the air in the shade of a banana growing near the pond bank, and managed to capture one. In spite of a long search I failed to meet more individuals. I have no idea why those two were found so close.

Ceriagrion auranticum Fraser, 1922

Loc. 5: 4 ♂, 1 ♀ collected, several more seen.

Observations. Found at the banks of a large pond inside a town, that is in exactly the same situation as my previous (and only) finding of this species in Cambodia – in Ban Lung Town, Ratanakiri Province (Kosterin 2014a). The males occurred in grass under bananas and sparse trees at some distance from the bank while several females were found in grass of the water margin: a situation opposite to the usual for Odonata.

Ceriagrion azureum (Selys, 1891)

Loc. 8 (pasture): 2 ♂, 2 ♀ collected; Loc. 9 (pasture): many ♀, seen.

Observations. Found abundant in two overgrazed buffalo pastures with very short fine grass near Dak Dam village, where these damselflies occurred at very small, round pools with grassy margins scattered over. Curiously, my previous finding of this species in Cambodia was at a similar habitat on the flat top of Kong Kreav Veal Hill, which was, however, a pasture of wild buffaloes in Virachey National Park, also overgrazed around the only shallow, grassy, but somewhat larger pool available for those animals for drinking and providing a habitat for *C. azureum* (Kosterin 2014a). So the species demonstrates fidelity to some habitat type, be it natural or anthropic, and seems to be connected with large ungulates which support this habitat by preventing its being overgrown by taller vegetation.

Ceriagrion cerinorubellum (Brauer, 1865)

Loc. 13c: 12.06.2014: 1 ♀ seen.

**Ceriagrion chaoi* Asahina, 1967

Loc. 13g: 9.06.2014: 1 ♂ collected; 10.06.2014: 1 ♂ collected, 1 tandem seen.

Observations. Found only in sparse emerging grass on the surface of a shallow grassy pool, together with *A. hisopa* and *A. approximans*.

Ceriagrion indochinense Asahina, 1967

Loc. 13h: 10.06.2014: 2 collected.

Observations. Found only at tiny sunlit muddy pools with scarce grass (much smaller than the above mentioned one, although nearby), together with *A. approximans*.

Ischnura senegalensis Rambur, 1842

Loc. 5: 1 teneral, 2 collected; Loc. 13g: 10.06.2014: 1 seen.

Observations. This elsewhere common species was quite rare in this area, and far from being abundant where present.

Mortonagrion aborensense (Laidlaw, 1914)

Loc. 7: 1 collected; Loc. 8 (swamp): 1 collected; Loc. 10: 1 collected.

Remarks. The specimens collected were remarkably large: hw 16 mm, abd+apps 25 mm.

Observations. Occurred in deep shade at dense and tall vegetation of banks of two brooks ('Culminicola' and 'Seducta') hidden under tree canopy, and in a similar habitat but at a shallow pool hidden in tall *Cyperus* sedge at a small forest swamp at Dak Dam.

**Paracercion malayanum* (Selys, 1876)

Loc. 5: 6 collected, several photographed (Fig. 30), many seen.

Observations. Males of these damselflies were quite abundant over the surface of the large pond in Sen Monorom, where they perched on emerging grass stems just above the water surface, but some effort was needed to recognise them among

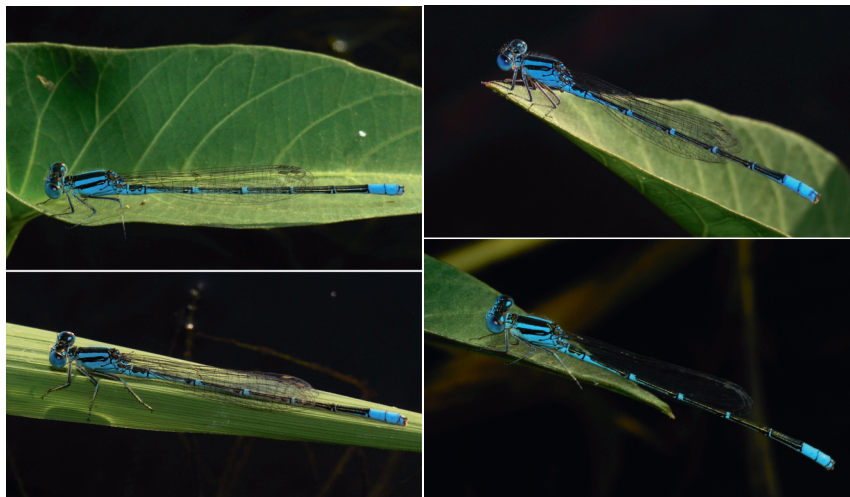


Figure 30. *Paracercion malayanum*, males over the surface of the lower pond in Sen Monorom (Loc. 5).

extremely more abundant individuals of *Pseudagrion microcephalum* (Rambur, 1842). Compared to them, males of *P. malayanum* were less motile, perched more steadily and generally kept closer to the grassy bank, where they were also found among grass.

Pseudagrion australasiae Selys, 1876

Loc. 13g: 10.06.2014: 2 , 1 collected; 12.06.2014: several seen.

Pseudagrion microcephalum (Rambur, 1842)

Loc. 5: 4 2 (1 green, 1 blue) collected, several tandems and copulae photographed (Fig. 31), very numerous , seen, many in tandem or copula.

Remarks. Blue and green female morphs were seen in comparable frequencies.

Observations. Extremely abundant at the pond in Sen Monorom, almost swarming over the water surface, but not found elsewhere.

Usually this and the previous species are not found syntopically in the same localities. They seem to avoid each other to exclude interspecies mating because of their very similar appearance. However in Cambodia, I found them together at least once in Ream National Park (Kosterin 2015f).



Figure 31. *Pseudagrion microcephalum*, a copula (left) and tandem (right) at the lower pond in Sen Monorom (Loc. 5).

Pseudagrion pruinosum (Burmeister, 1839)

Loc. 1 (river): 1 seen; Loc. 7: 1 collected, several , 1 seen; Loc. 12: several seen; Loc. 13a: 10.06.2014: 1 seen.

Observations. In contrast to its congeners found in Cambodia, this is a purely lotic species. It is not so selective in a stream type as found from brooks to major river; prefers moderately shaded habitats.

Pseudagrion rubriceps Selys, 1876

Loc. 7: 1 seen.

Platycnemididae

Coeliccia sp. cf. *kazukoae* Asahina, 1984

Loc. 2: 1 collected; Loc. 8 (in shade of bamboo thickets): 1 collected; Loc. 13c: 12.06.2014: 1 collected (1 was also collected at Loc. 13b on 03.08.2016, see below).

Remarks. The male resembles that photographed in at the same Buu Sraa Waterfall (loc. 13) and reported as *Coeliccia* sp. by Roland et al. (2011) and that depicted from South Vietnam and identified as *C. kazukoae* by Steinhoff & Do (2013). Specimens from E Cambodia and Vietnam deserve further study.

**Coeliccia poungyi* dasha Kosterin, 2016

Loc. 13b: 15.06.2014: 2 collected, 1 more photographed. (More specimens collected at this locality on 03.08.2016, see below)

Remarks. These specimens were described as ssp. *dasha* (Kosterin 2016c) because of the black colour extending to occupy the entire S9 tergite and the yellowish-white rather than chrome yellow S10 and appendages, less area of the mesepisternum blue spots and 1/3 shorter terminal lobe of the ligula. Such differences could be equivocally considered as being of a specific level but I abstained from claiming *dasha* as a distinct species in the situation of possible allopatry (occurrence in the Annamense Mts. versus the mountains of Thailand and northern parts of Laos and Vietnam). Maybe further studies will assure the specific rank of this taxon.

Observations. The two males were found close to each other in the shade of bamboo thickets near a winding 'Loringae' brook with partly silty and partly stony bed, with rapidous sections and pools, shaded by tall forest. Much more individuals of both sexes were observed in the same area on 03.08.2016 (see below).

After publication of the description of *C. poungyi* dasha (Kosterin 2016c), Matti Hämäläinen and Phan Quốc Toàn kindly informed me (independently) that this taxon also occurs in the neighbouring Lâm Đồng Province in southern Vietnam.

Copera marginipes (Rambur, 1842)

Loc. 1 (larger pool): many seen; Loc. 2: several seen; Loc. 7: 2 collected; Loc. 10: 1 mature , 2 immature seen; Loc. 11: 2 seen; Loc. 13a: 09-10.06.2014: several , seen.

Copera vittata (Selys, 1863)

Loc. 1: several (larger pool) to many (swamp) seen; Loc. 2: several seen; Loc. 4a: several teneral ('ghost stage') ind. seen (identification tentative); Loc. 8: 1 seen; Loc. 11: 1 collected (at a shady pool); Loc. 13a: 15.06.2014: 1 seen at a swamp. Observations. Invariably found in overshadowed moist habitats near seepages and small pools with black littery bottom, often at river banks.

Onychargia atrocyana Selys, 1865

Loc. 13g: 9.06.2014: 1, 1 collected in tandem.

Remarks. The structures of the male specimen are depicted and the differences of this well known species from the next one, described from this trip, are discussed in (Kosterin 2015c).

Observations. A tandem was collected in grass at a bank of a shallow muddy pool, although this species prefers tall herbs at swamps with scarce water.

**Onychargia priydak* Kosterin, 2015

Loc. 6: 3 (1 holotype, 2 paratypes, 1 of these 3 males photographed, see Fig. 32), 1 collected (paratype); Loc. 8: 3, 2 (paratypes) collected, several more and tandems seen and photographed.



Figure 32. *Onychargia priydak*, a male from the type series photographed in nature in the type locality, 'Onychargia Swamp' (Loc. 6) at Sen Monorom.

Remarks. This species has been recently described by the mentioned specimens (Kosterin 2015c). The males strikingly differ from the above species by thick and bright white pruinescence on the thorax, femora, and base of abdomen, and by some structural differences in the appendages; no distinguished characters were found in females.

When the description paper was circulated it appeared that for the last four years the unmistakable white males of this species have been at least three times photographed by Thai naturalists in North Thailand: Reinthong Ruangrong, at Chiang Mai, Chang Mai Province (see [http://www.siamensis.org/species_index#40122--Species : Onychargia priydak](http://www.siamensis.org/species_index#40122--Species%3A%20Onychargia%20priydak)), by Dennis Farrell at Nam Nao National Park, Petchabun Province on 30.07.2011 (see <http://thaiodonata.blogspot.ru/2015/07/180-onychargia-priydak-kosterin-2015.html>), and by Bem Cola elsewhere. These specimens were discussed (but not identified) in the Facebook group 'Dragonflies of Thailand' (<https://www.facebook.com/groups/DragonfliesOfThailand/>). Most recently, on 13.11.2015 a male was photographed by Len Worthington at Mae Hong Son, North Thailand.

In 2016, *O. priydak* has been found also in South Vietnam: on 17.05.2016, Tom Kompier (pers. comm.) collected a male at a swamp near Bao Loc, Lâm Đồng Province, and on 12.06.2016 a putative female at the same location.

According to the paper by Asahina (1987) which I, unfortunately, overlooked while describing the species, specimens of '*Onychargia atrocyana*' from Hong Kong have some stripy, not continuous, white pruinescence at the synthorax, the appendages similar to those of *O. priydak* (the paraprocts longer than cerci, one rounded swelling rather than two pointed knobs on their lateral lamina) and a peculiar structure of the penis with processed lateral lobes (in the paratype of *O. priydak*, the penis was indistinguishable from that of *O. atrocyana*). They can be a still undescribed species.

Prodasineura autumnalis (Fraser, 1922)

Loc. 4a: several seen; Loc. 5: 1 teneral, 1 teneral collected; Loc. 7: 1 collected, many seen; Loc. 11: many seen, including teneral; Loc. 12: very many, seen, many teneral; Loc. 13a: 09.06.2014: several seen; Loc. 13b: 12.06.2014: several seen at middle and lower reaches; 15.06.2014 – several ovipositing tandems seen (1 of them photographed) at the mouth; Loc. 13e: several seen; Loc. 13f: numerous, several and tandems seen.

**Prodasineura doisuthepensis* Hoess, 2007

Loc. 4a: 1 seen; Loc. 7: 4 collected, 1 photographed (Fig. 33), several more seen; Loc. 8: very many seen; Loc. 9 (river): many seen; Loc. 13b: 12.06.2014: 1 collected; 15.06.2014: 2 collected, several ovipositing tandems photographed and seen at the mouth; Loc. 13e: many seen; Loc. 13f: 1, 1 collected, 1 photographed, numerous, several and tandems seen.

Remarks. Males of *P. doisuthepensis* from Mondulkiri Province of Cambodia differ from the original description of the species from North Thailand in having the S9 blue spot diamond-shaped or roundish rather than triangular and the paraproct attenuated apical part entirely chrome yellow instead of black outside and chrome

yellow only inside (Fig. 34) (Kosterin 2015e); the female of this species is described in the cited reference.

Observations. At the river upstream the Buu Sraa Waterfalls, this and preceding species were equally numerous, but *P. autumnalis* avoided shady places while *P. doisuthepensis* seemed to be indifferent to sunshine or shade. At the 'Culminicola Rivulet' these species

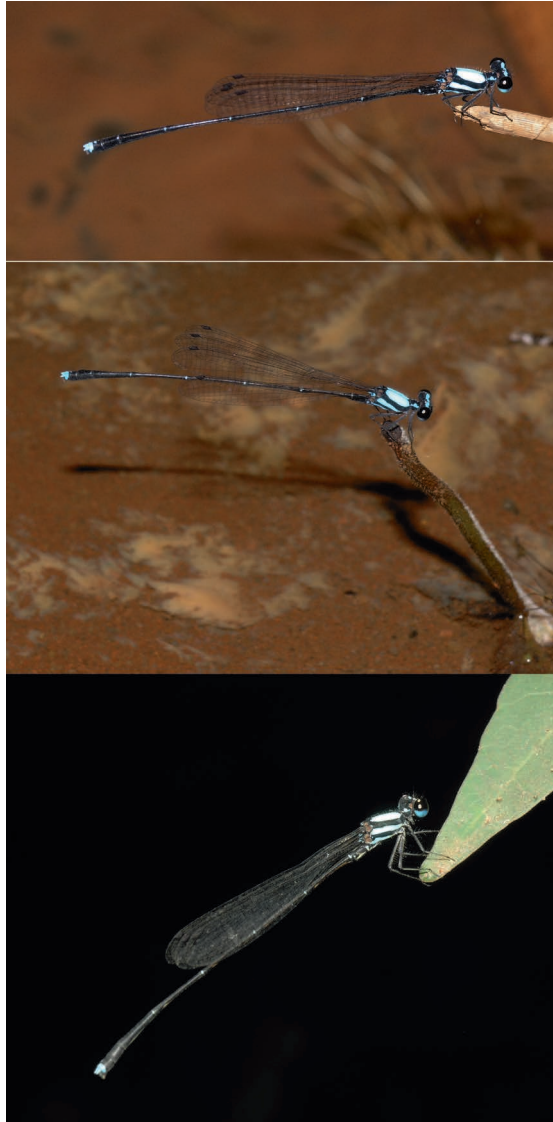


Figure 33. *Prodasineura doisuthepensis*, a male at 'Culminicola rivulet' (Loc. 7) at Sen Monorom.



Figure 34. *Prodasineura doisuthepensis*, end of abdomen of a male from 'Loringae brook' downstream of Buu Sraa Waterfalls (Loc. 13b).

seemed to segregate with respect to that factor: *P. doisuthepensis* was found only at a very shady shallow reach while *P. autumnalis* at an open reach. The bright blue light thorax of *P. doisuthepensis* is very conspicuous in shade. However, on 15.06.2015 I observed several tandems of both species ovipositing side-by-side at the 'Loringae brook' mouth.

**Prodasineura hoffmanni* Kosterin, 2015

Loc. 8 (river): photographed; Loc. 9 (river): 1 collected (a paratype of *P. hoffmanni*); Loc. 10: 5, 1 (in tandem), collected (the holotype, and paratypes of *P. hoffmanni*) 1, 1 tandem photographed, several more seen.

Remarks. The species was described by the above mentioned specimens (Kosterin 2015f), for its live photos see the cited paper.

As soon as in 2016, *P. hoffmanni* was thrice found at small forested streams in Lâm Đồng Province of South Vietnam (pers. comm. by Tom Kompier): on 16.02.2016 Tom Kompier and James Holden found about 20 specimens of *P. hoffmanni* in Ca Tien National Park, on 16-17.04.2016 Tom collected three males at a Lạt, and on 17.05.2016 he collected a male at Bảo Lộc.

In one of his latest papers, Asahina (1997) reported and depicted a blue-patterned *Prodasineura* male from Xuan Nha, Moc Chau, Son La Province, North Vietnam under

an uncertain yet misleading identification "*Prodasineura* sp. (*verticalis* Selys?)", which is impossible since *P. verticalis* has a red pattern. The figures provided allow to assume relatedness of that specimen to *P. hoffmanni*, although it differs in having shorter antehumeral blue stripes occupying only 2/3 of the mesepisternum length (throughout its length in *P. hoffmanni*) and larger dorsal blue spot on S9 (tiny in *P. hoffmanni*).

Prodasineura verticalis sensu Asahina, 1983 nec Selys (1860)

Loc. 10: 3 collected, several more seen.

Remarks. Hopefully, the long anticipated description of this species will appear soon.

Observations. Co-occurred with the preceding species at a small brook hidden in dense vegetation and piled with fallen trees in a shady narrow valley, most elevated among investigated (877-878 m a.s.l.).

Pseudocoperca ciliata (Selys, 1863)

Loc. 5: many seen; Loc. 7: 1 seen, 1 collected; Loc.13a (inundated part): 15.06.2014: 1 seen at a swamp; Loc. 13g: 09.06.2014: 1 seen.

Platystictidae

**Protosticta grandis* Asahina, 1985

Loc. 13b: 12.06.2014: 5 , 1 collected, 1 photographed (Fig. 35); 15.06.2014: 1 seen.

Observations. Occurred, together with the next species, at deep shade at moist banks of 'Loringae brook' downstream the waterfall.

Protosticta sp1. cf. *caroli* van Tol, 2008

Loc. 4b: 13.06.2014: 1 , 1 collected, 1 photographed, several more ind. seen; Loc. 13b: 12.06.2014: 6 (2 in RMNH) 2 (1 without end of abdomen) collected, 1 photographed; 15.06.2014: 3 seen.

Remarks. Earlier (Kosterin 2014a) I reported *P. caroli* from Cha Ong Waterfall in Ratanakiri Province of Cambodia and described its female for the first time (the



Figure 35. *Protosticta grandis*, a male at 'Loringae brook' downstream of Buu Sraa Waterfalls (Loc. 13b).

fact overlooked by Phan & Kompier (2016) who later claimed they did the same). Those males somewhat differed from the type series from S Vietnam (van Tol 2008) as follows:

- 1) Prothorax in both sexes mostly creamy white with posterior lobe black and some darkening at posterior margins of the lateral lobes, while in the type series "black markings as follows: anterior lobe with median trapezoid spot, posterior side ca one-third of posterior width of anterior lobe, median lobe with variegated brownish-black markings, but latero-anterior corner pale coloured; lateral lobes yellowish-white with narrow black stripe along dorsal and posterior margin; posterior lobe black" (van Tol 2008: 227).
- 2) Dorsum of S9 dark anteriorly for 1/3 or slightly less of its length versus for 3/5 in the type series, and with the posterior dark border a very narrow versus 1/6 of the segment in the type series.

The here reported males from Mondulkiri have morphological diagnostic characters as in *P. caroli* (van Tol 2008) and are even closer to the type series as being more melanised with respect to both above characters:

- 1) Prothorax in both sexes mostly creamy white, posterior lobe black but brown at its dorsolateral parts separated by a fine suture; median lobe with a characteristic pair of dark brown or blackish strokes with indistinct margins directed ahead from posterior lobe along inner margin of its paired dorsal sclerites; lateral lobes with brownish or blackish shades at their posterior margin.
- 2) In 8 measured males, dorsum of S9 is dark anteriorly for 15, 20, 21, 41, 44 and 46 % of its length.

The here reported complete female specimen from Mondulkiri Province is similar to that described from Ratanakiri Province (Kosterin 2014a) but is somewhat more melanised: the prothorax median lobe with a blackish pattern (see above), S8 blackish with only anterioventral corners of tergite whitish; S9 blackish with only a whitish spot occupying ca posterior 1/3 of its dorsum; ovipositor apex blackish (but its dorsal tooth still whitish).

This greater resemblance of the Mondulkiri series to the type series of *P. caroli* would not be surprising since Cha Ong Waterfall is situated 200-210 km NW of the type locality being Chu Yang Sin National Park, Da Lak Province, South Vietnam (van Tol 2008), while Monorom and Buu Sraa Waterfalls are situated almost twice as close to the type locality, 127 and 105 km NWW, respectively. However, preliminary molecular analysis (pers. comm. by Rory Dow and our still unpublished data) showed that the Mondulkiri series differs substantially from the topotypical *P. caroli* and *P. linnaei* and the Ratanakiri series of *P. caroli*, the three latter series being much more similar to each other. Perhaps the here reported Mondulkiri series represents an undescribed species and will be treated in detail elsewhere.

Observations. At 'Loringae brook' and its tiny tributary these damselflies occurred in deepest shade and kept mostly to small bluffs of damp black soil; and the river downstream Monorom Waterfall their habitat were similar ground bluffs of its right bank which were somewhat less shaded, so that some damselflies were found perching on rather exposed leaves.

**Protosticta* sp.2 cf. *pseudocuriosa* Phan et Kompier, 2016

Loc. 4b: 13.06.2014: 1

Remarks. This male most resembles *Protosticta pseudocuriosa* Phan et Kompier, 2016 recently described from Central Vietnam (Phan & Kompier 2016) but lacks the light spot at the dorsal end of the mesopleural suture. Its identity deserves further study.

Observations. A male was unexpectedly found in a series of the previous species from downstream of Monorom Waterfalls.

Anisoptera

Aeshnidae

Anax guttatus (Burmeister, 1839)

Loc. 5: many seen (not checked in hands); Loc. 13g: 09.06.2014: 1 seen; 10.06.2014: 1 checked and released.

Gynacantha subinterrupta Rambur, 1842

Loc. 1 (smaller pool): 1, 1 collected, 2 more seen; Loc. 13b: 15.06.2014: 1 immature collected; Loc. 13c: 12.06.2014: 2 ind. (1 teneral) observed (identification tentative).

Observations: Meeting this species at Loc.13 was as most usual: dragonflies (some teneral, with still glittering wings) were startled from shady understory, they did not fly more than for a dozen metres and sat again on a branch but were hard to follow by sight; they were still greyish, without green and blue markings of mature males. Contrary at Loc. 1., mature dragonflies were observed at a breeding place being a shallow roadside ditch with a wet ground hidden under bushes near a larger pool. There at 13:10 I startled from bushes two individuals which immediately sat again; at 15:40 they were active and I caught a male chasing a female and saw more males flying by. Oviposition of females of this species into wet ground at some distance from a larger roadside pool and males patrolling barren ground around the pool was reported for Mondulkiri Province by Kosterin (2014a).

**Tetracanthagyna waterhousei* McLachlan, 1898

Loc. 8 (tall-grass swamp): 1 photographed (Fig. 36); Loc. 13b: 12.06.2014: 1 photographed (Fig. 37 above); 15.06.2014: 1 collected (Fig. 37 below), 1 more seen.

Observations: At 'Loringae brook', females were startled from branches at bamboo thickets under the forest canopy (Fig. 37). On 15.06.2014 a female was observed to land on a sunlit log lying across the brook, rather high above water, very close to its waterfall, and started to oviposit but escaped soon. A male was startled at bush thickets at Dak Dam (Fig. 36). It was not at all cautious and I captured it by hand and released. Only on a photo I recognised it was a male. Males of *Tetracanthagyna* are rarely observed and few in collections.



Figure 36. *Tetracanthagyna waterhousei*, a male at a margin of a tall grass (*Cyperus* sp.) swamp in the Dak Dam village environs. (Loc. 8).



Figure 37. *Tetracanthagyna waterhousei*, a female in nature (above) and held (below) at 'Loringae brook' downstream of Buu Sraa Waterfalls (Loc. 13b).

Gomphidae

Euthygomphus yunnanensis Zhou et Wu, 1992

Loc. 13a: 10.06.2014: 1 ♂; 1 ♀ collected.

Remarks. The male perfectly fits the original description (Zhou & Wu 1992) but the antehumeral stripes are missing, perhaps with maturity.

It was this species which was earlier erroneously reported from Thailand (Asahina 1986b; Hämäläinen & Pinratana 1999; Day et al. 2012) and Cambodia (Kosterin 2012b; 2015f; Kosterin et al. 2012) as *Merogomphus parvus* (Krüger, 1899), as discussed in detail elsewhere (Kosterin 2016b). The genus *Euthygomphus* Kosterin, 2016 was described in the same paper (Kosterin 2016b) to receive a handful of similar species with simple, straight, light-colored cerci hitherto included to either *Merogomphus* Martin, 1904 or *Anisogomphus* Selys, 1857.

**Euthygomphus schorri* Kosterin, 2016

Loc. 7: 1 ♂; 1 ♀ collected; Loc. 13a: 10.06.2014: 1 ♂ photographed; Loc. 13b: 15.06.2014: 1 ♂ collected. Either this or the previous species were recorded visually at Loc. 11: 2 ♂ seen.

Remarks. The above listed specimens comprised the type series of this species which was described very recently (Kosterin 2016b). Occiput black in males, with two long spines and a yellow spot behind it in females, dorsal stripes not fused to collar stripes, antehumeral absent in male, present in females; male cerci curving outside each other in dorsal view and furnished with a strong apical upright tooth (Kosterin 2016b).



Figure 38. *Asiyomphus reinhardti*, the holotype male immediately after captivity at its type locality, 'Loringae brook' downstream of Buu Sraa Waterfalls (Loc. 13b).

**Asiagomphus reinhardti* Kosterin et Yokoi, 2016

Loc. 13b: 15.06.2014: 1 photographed (Kosterin & Yokoi 2016: fig. 1) and collected (Fig. 38).

Remarks. The species has recently been described by two males, this one (the holotype) and the paratype from southern Laos (Kosterin & Yokoi 2016).

When preparing the description I sadly forgot that I made a good photo of the general habitus of the holotype in lateral view immediately after captivity, which of course should have been included into the paper (Kosterin & Yokoi 2016). For later is better than never I publish it herewith (Fig. 38).

Two years later *A. reinhardti* has been collected in South Vietnam by Tom Kompier (pers. comm.): 3 males and 1 (still undescribed) female of near Bảo Lộc, Lâm Đồng Province on 17.05.2016, at a medium-sized stream with large boulders and sandy patches, and 2 males and 1 female (with some 15 individuals seen) in Gia Lai Province on 19.06.2016.

Observations. This old and worn out male perched on a sunlit stone at the 'Loringae brook' and was not too cautious.

Burmagomphus asahinai Kosterin, Makbun et Davrueng, 2012

Loc. 7: 4 collected, several photographed (Fig. 39 below), many seen; Loc. 13f: 2 collected, 1 of them photographed (Fig. 39 above).

Remarks. The collected males differed from the type series from SW Cambodia and E Thailand (Kosterin et al. 2012a) but were similar to specimens from Ratanakiri Province in NE Cambodia (Kosterin 2014b) in the following characters:

- a yellow spot present on the occiput;
- the antear yellow spot large, triangular and the antehumeral yellow stripe produced towards it and even fused to it in two specimens;
- The S10 posterior margin was produced into a spine in one specimen but slightly pointed not forming a spine in five specimens. Presence of the S10 spine is variable in the species (Kosterin et al. 2012a; Kosterin 2014b).

This species has been recently reported for à Lạt in southern Vietnam (Karube 2015), which is just 145 km SE of Sen Monorom.

Observations. In Koh Kong Province, where its type locality is situated, *B. asahinai* was found at two relatively large rivers while *B. divaricatus* (also found at that river) was very abundant at a smaller 'Mircogomphus River' (Kosterin et al. 2012a, b). Contrary to this, here in Mondulkiri Province *B. asahinai* was the only, and very abundant, species of *Burmagomphus* at a small 'Culminicola Brook' but occurred also at a large Buu Sraa main river upstream the waterfall. In Ratanakiri Province, *B. asahinai* was also very abundant at a small 'Asahinai brook' (Kosterin 2014a, b). It seems that in SW Cambodia *B. asahinai* prefers larger rivers but in E Cambodia it prefers small brooks.

Burmagomphus divaricatus Lieftink, 1964

Loc. 4a: 1 photographed (Fig. 40c) and collected; Loc. 11: 3 collected, 2 more (Fig. 40b, d), 1 (Fig. 40a) photographed; Loc. 13e: 9.06.2014: 1 collected. Besides, 2 were collected at Loc. 13d on 04.08.2016 (see below).



Figure 39. Males of *Burmagomphus asahinai* at the right bank of the main river between the tiers of the Buu Sraa Waterfalls (Loc. 13e) (above) and the 'Culminicula Rivulet' (Loc. 7) (below).

Remarks. Kosterin (2014b) reported two males of *B. divaricatus* from Ratanakiri Province in NE Cambodia, one of which had denticles at the posterior angle of the posterior hamulus (in addition to the robust tooth at the anterior angle), one at the left hamulus and two at the right hamulus (Kosterin 2014b: fig. 3). This male was, however, *B. divaricatus* according to other diagnostic characters. Such denticles are among diagnostic characters of *B. arboreus* (Lieftinck 1964) but were not earlier reported for *B. divaricatus* from elsewhere, including SW Cambodia (Kosterin 2014b).



Figure 40. *Burmagomphus divaricatus*: a – female, b-d – males, a-f,d - at the Kruegeri River (Loc. 11), c – at the ‘Ochracea Rivulet’, the left tributary of the main river of Monorom Waterfalls (Loc. 4a).

All the nine males of *B. divaricatus* now collected in Mondulkiri Province also had these denticles. Their number is as follows (left/right hamulus): 1/1 in two males, 2/1 (Fig. 41a-b) in three males, 2/2 in two males, 1/4 (!) in one male and 2/4 in one male. All these males displayed important diagnostic characters of *B. divaricatus*, namely conspicuous long hairs at the anterior margin of the posterior hamulus (Fig. 41a-b) and very long and slender, divaricate arms of the epiproct (Fig. 41c-d). They have no posterior spine on S9, claimed diagnostic at the original description from Malay Peninsula (Lieftinck 1964) but appeared variably expressed and usually absent in Indochina (Asahina 1977; Kosterin 2014b). Their cerci were not sinuous in dorsal view, as well as elsewhere in Indochina (Kosterin 2014b).

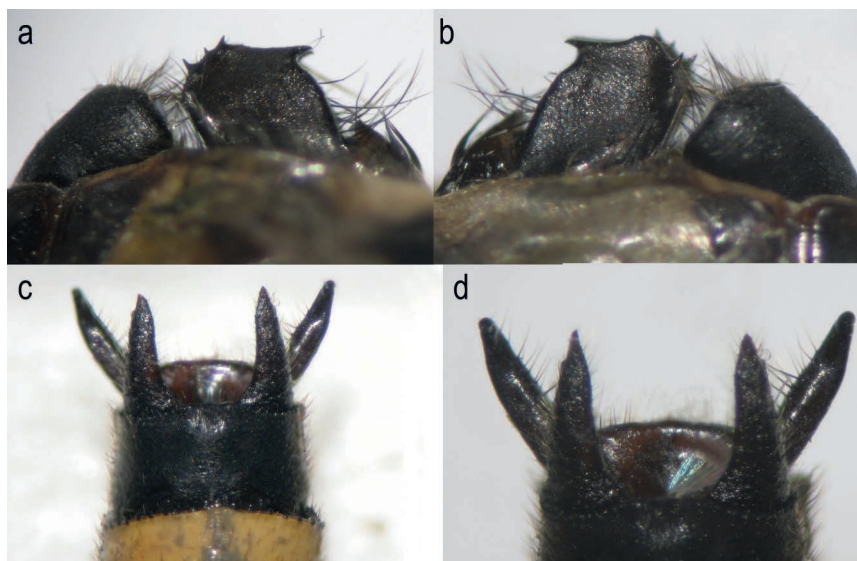


Figure 41. Abdominal details of a male of *Burmagomphus divaricatus* from the Kruegeri River (Loc. 11); a – secondary genitalia, right lateral view; b – ditto, left lateral view; c-d - anal appendages, dorsal view. Not to scale.

We may conclude that presence of such additional denticles at the posterior hamulus posterior angle is a trait predominating in *B. divaricatus* males in E Cambodia and expect the same in S Vietnam. This character has not been reported from this species from elsewhere, however we cannot exclude the possibility that some earlier reports of *B. arboreus* from Thailand and Vietnam in fact referred to such specimens of *B. divaricatus* rather than to the actual *B. arboreus*.

No more *Burmagomphus* males with the combination of characters as in the lectotype and paralectotypes of *B. arboreus* as respectively described and depicted by Williamson (1908) and Lieftinck (1964), including lack of long hairs on the posterior hamulus and the cerci broad in dorsal view, were reported after Lieftinck (1964). This rises some

doubts about actual identity of *B. arboreus*. More specimens from Myanmar (the type locality) are necessary to clarify the issue.

Most of the specimens collected did not display reduction of the lower portion of the antehumeral light stripe at the mesepisternum, as was observed in males from SW Cambodia (Kosterin 2014b). Only one specimen had this portion separated with a gap of the black ground colour.

Observations. As the previous species, this one was found both at a small rivulet (Loc. 4e) and moderately fast (Loc. 11) and rapidous (loc. 13e) rivers. But very remarkably, *B. divaricatus* was never found together with *B. asahinai*; they were registered at the same Buu Sraa main river but the former at a rapidous reach between the two waterfall tiers while the latter at a slow reach upstream the waterfall. Note that 'Culminicola rivulet', where *B. asahinai* was abundant, was rather similar to 'Ochracea Rivulet', where



Figure 42. A male of *Gomphidia kruegeri* at Kruegeri River (Loc. 11).

B. divaricatus occurred. *B. divaricatus* was found most frequent at the moderately fast 'Kruegeri River': five males were found at main river as well as its two arms, one fast and one partly slow; they perched on riparian bushes, herbs growing at muddy bank patches and the mud itself, both in sunny places and deep shade.

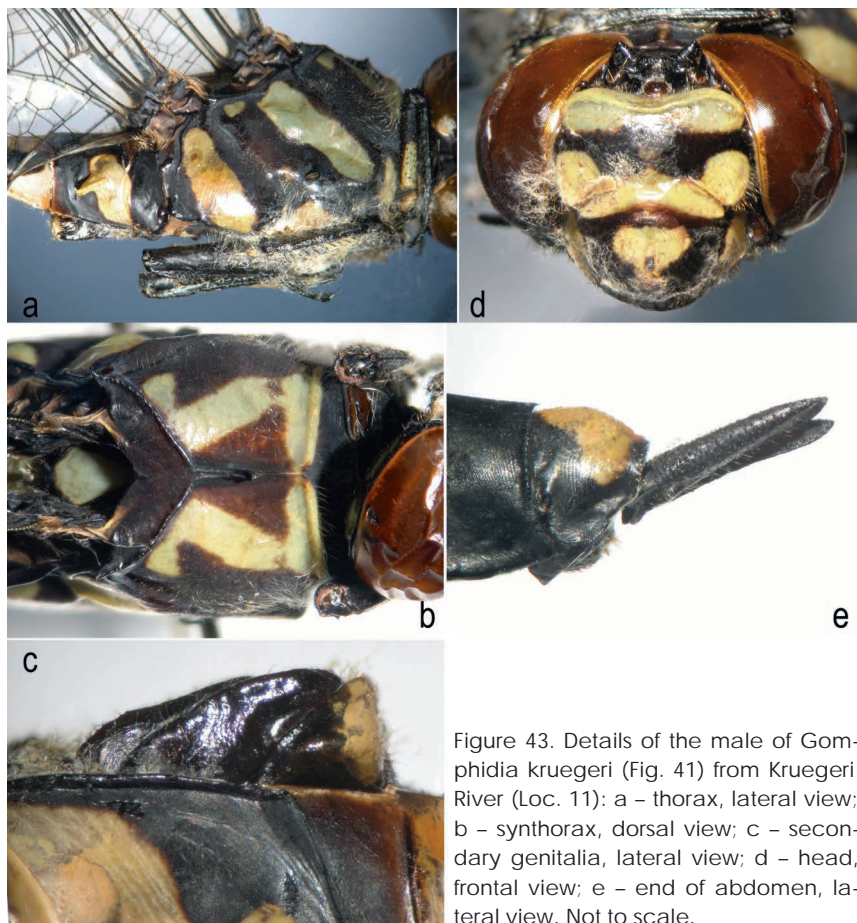


Figure 43. Details of the male of *Gomphidia kruegeri* (Fig. 41) from Kruegeri River (Loc. 11): a – thorax, lateral view; b – synthorax, dorsal view; c – secondary genitalia, lateral view; d – head, frontal view; e – end of abdomen, lateral view. Not to scale.

**Gomphidia kruegeri* Martin, 1904

Loc. 11: 1 photographed (Fig. 42) and collected (Fig. 43).

Remarks. The only male found has the morphological characters of *G. kruegeri*, most important of which is the vestigial epiproct not seen from sides (Martin 1904) (Fig. 43e). Let us note slender straight cerci as if turned along their axes apically to subdorsally reveal flattened inner side (Fig. 43e); the secondary genitalia with the hamuli apices not seen from sides (Fig. 43c). The body pattern principally refers to *G.*

kruegeri as well, including a mostly yellow labrum, a continuous frontal yellow stripe (Fig. 43d), a well developed dorsal stripe at the mesepisternum (Fig. 43b), costal veins densely spotted with light dots. But the combination of specific characters of the body pattern differs from those published for more black *G. kruegeri kruegeri* and more yellow *G. kruegeri fukiensis* Chao, 1955 (Wilson & Reels 2001). The head, mesepisterna, legs and abdomen show substantial extension of the yellow pattern:

- Head (Fig. 43d): labrum yellow with a small dark spot in centre; anteclypeus yellow, postclypeus brownish with very large lateral yellow spots, united to the yellow of anteclypeus, and an indistinct central yellow spot; yellow stripe along frons broad and continuous.
- Mesepisterna (Fig. 43b): anterior yellow collar not interrupted; dorsal stripes almost contacting it and broadly contacting antealar spots, but no trace of antehumeral (second) stripes.
- Legs (Fig. 43a): basal halves of fore femora yellow.

Abdomen (Fig. 42): yellow present on all abdominal segments: large vertical oval-shaped lateral spots on S2 entering posterior margins of S1 and extending to auricles; a tennis racket shaped dorsal spot on S2; large triangular anteriolateral spots and a subtriangular anteriodorsal spot occupying 1/3 of segment length on S3; rather large, apically forked anteriodorsal spots on S4-6; a large anterior spot on S7 extending dorsally to 40% of segment length; a semicircular anterior spot at S8 occupying ca ¼ of segment length; a pair of vertically elongate anterior spots on S9; S10 with a large dorsoposterior spot occupying entire segment dorsally.

The yellow spots at the postclypeus are the character of *G. kruegeri fukiensis* (Wilson & Reels 2001); the black central spot on the labrum (Fig. 43d) was not reported from literature.

At the same time, the lateral yellow pattern of the synthorax is strongly restricted (Fig. 43a): just two (a small upper and very small lower) yellow spots at the metepisternum between the two main yellow lateral stripes (this is the character of *G. kruegeri kruegeri*); and the second lateral stripe is narrower than in any subspecies reported in literature, so that the anterior black border of the metepimeron is about twice as narrow as its width and there is a large black area at the metepimeron ventro-posterior corner.

Antenodals 16-17 in fw, 11-12 on hw; postnodals 10-11 on fw, 10 on hw. Fw: triangle 4 celled, subtriangle of the right fore wing entire, that of the left fore wing consists of 3 cells; hw: triangles 2-3 celled, subtriangles entire. Wings brownish enfumed distally and posteriorly.

Measurements: hw 40 mm, abd without cerci 47 mm, total length with apps 69 mm, pt 5.5 (fw) – 6 (hw) mm. This specimen is remarkably small: the type, from 'Tonkin', was reported to be ca 25% larger: abdomen 63 mm, hind wing 50 mm, antenodals: 24 on fw, 16 on hw; postnodals 13-14 on fw, 13 on hw.

This insect seems to correspond to *Gomphidia* sp1. reported by Yokoi & Souphanthong (2014) for two localities in Attapu Province in South Laos, at the very border of Cambodia. It hardly represents an undescribed species but quite likely would worth de-

scription as one more subspecies of *G. kruegeri* with accumulation of specimens. A caution is, however, needed because the variation seems to be strong. Earlier on the same trip, on 2.06.2014, I collected a male of seemingly the same species at 'Microgomphus River' in Thma Bang environs, Koh Kong Province, the Cardamom Mts. in SW Cambodia (Fig. 44). It has principally the same characters but no central vague light spot at the postclypeus (the lateral spots are exactly the same) (Fig. 44a), the anterior collar interrupted, the dorsal spots at the mesepisternum isolated both from it and the antealar spots (Fig. 44b), the second lateral stripe of synthorax somewhat broader, the yellow on the fore femora restricted to the very base (Fig. 44c). Besides, it is larger: hw 43 mm, abd 51 mm, total length 74 mm; antenodals

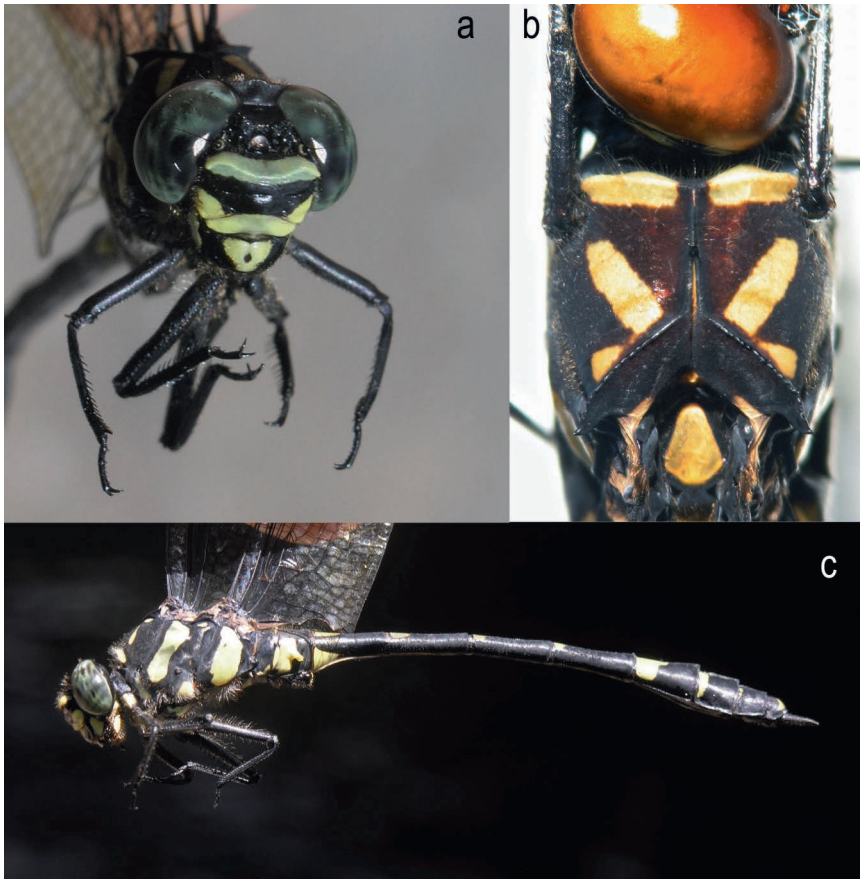


Figure 44. Details of the male of *Gomphidia kruegeri* (Fig. 41) from at 'Microgomphus River' in Thma Bang environs, Koh Kong Province, the Cardamom Mts. in SW Cambodia collected on 2.06.2014: a – head, frontal view; b – synthorax, dorsal view; c – general habitus, lateral view. Not to scale.



Figure 45. Males of *Gomphidictinus perakensis* at 'Ochracea Rivulet', the left tributary of the main river of Monorom Waterfall (Loc. 4a).

20 on hw, 13 on fw, postnodals 12-13 on fw, 13 on hw; triangles 3-4-celled on fw, 3-celled on hw, subtriangles entire or 1-celled on fw, entire on hw. That is, by size and the mesepisternum pattern (but not by the head and lateral synthorax pattern) it approaches *G. kruegeri kruegeri*. Unfortunately, no detail of the specimens recorded from Laos (Yokoi & Souphanthong 2014) and Thailand (Hämäläinen & Pinratana 1999) have been published.

Observations. This male was found perching on a stick over a strong 'Kruegeri' River (Fig. 42) and was not cautious, as other species of *Gomphidia* and *Gomphidictinus* I so far observed.

Gomphidictinus perakensis (Laidlaw, 1902)

Loc. 4a: 3 collected, several photographed (Fig. 45), several more seen; Loc. 4b: 13.06.2014: 2 seen; Loc. 8: 1 photographed; Loc. 13b: 15.06.2014: 1 photographed, 1 more seen under the waterfall.

Remarks. One of the males at Loc. 4a had well-expressed longitudinal yellow dorsal strokes on S3-S5 (Fig. 45, middle and bottom). It is noteworthy that absence of any yellow markings versus presence of transversal yellow rings was mentioned by Karube (2016) among diagnostic characters distinguishing *Gomphidictinus perakensis* and *G. kompieri* Karube, 2016 described from North Vietman. Our specimens fit *G. perakensis* with respect to all other characters, including structural ones, size and yellow maculation of the face; besides the markings in the specimens of Fig. 45 are lengthwise strokes rather than rings. It may be concluded that presence of markings in S3-S5 would better be excluded from the diagnostic characters of these two species.

Observations. Males perch always above spraying rapids of brooks and rivulets, e.g. just under the waterfall at the 'Loringae brook', at sticks from low to 1-1.5 m (Fig. 45) and are remarkable for being not at all cautious, surprisingly for such a big dragonfly.

**Hellogomphus chaoi* Karube, 2004

Loc. 3: 1 teneral collected, 1 teneral photographed (Fig. 46 above) and collected; Loc. 4a: 1 teneral photographed (Fig. 46 below) and collected, 1 collected.

Remarks. This is the second known locality of the species which was hitherto collected (in 1996, 1997 and 2002) only in its type locality: Vietnam, Lâm Đồng Province, 15 km from B o Lộc to Hồ Chí Minh (Karube 2004). The here published Cambodian locality is just 127 km NNW apart from the type locality. All specimens were collected teneral, still weakly coloured, left for several hours in captivity to advance with maturation; all were preserved in alcohol, some dried later. All the characters well match the original description.

Observations. These teneral individuals were found at vegetation at a small 'Ochracea rivulet' and a very small 'Chaoi brook'; the former had open water while the water of the latter was completely hidden under entangled bushes and herbs (Fig. 8).

Ictinogomphus decoratus melaenops (Selys, 1858)

Loc. 5: many seen, 1 checked and released; Loc.13a (inundated part): 15.06.2014: several seen at a swamp; Loc. 13f: 09.06.2014: 1 seen.



Figure 46. Teneral *Heliogomphus chaoi*: a male at 'Chaoi Rivulet', Loc. 4a (below) and female at 'Ochracea brook', Loc. 3 (below).

Lamelligomphus castor (Lieftink, 1941)

Loc. 13a: 10.06.2014: 1 collected, 1 more seen; 15.06.2014 – 1 seen; Loc. 13b: 12.06.2014: 1, 1 collected, 1, 1 photographed (Fig. 47 above); 15.06.2014: 1 collected, several photographed (Fig. 47 below, 48), many, seen.

Remarks. Kosterin (2014b) reported minor differences of the *L. castor* males from Ratanakiri Province of Cambodia from the characters of a Thai male reported and depicted by Asahina (1986c). The males now collected in Mondulakiri Province correspond to those from Ratanakiri Province in every detail. There is a notable difference of the two females available from Ratanakiri Province (overlooked by Kosterin 2014b) and Mondulakiri Province on one hand from the Thai one depicted and described



Figure 47. A female (above) and male (below) of *Lamelligomphus castor* hovering over 'Loringae brook' downstream of Buu Sraa Waterfalls (Loc. 13b).

by Asahina (1986c) on the other hand: the occiput bears a pair of horns in both Cambodian females (Fig. 49a) but no horns in the Thai female.

Lamelligomphus vietnamensis Karube, 2015 was recently described from North Vietnam as compared with *L. hainaneisis* but not to *L. castor*. Its description (Karube 2015) shows no difference from the original description of *L. castor* (Lieftinck 1941), except that the illustration in the latter does not show the basal part of the anterior hamulus which is hidden behind the sternite margin. It would be a reason of synonymy if the illustrated penis structure of *L. vietnamensis* were not differ so much from that of the Cambodian specimens (Fig. 49b-d): in the former the flagellum is shorter, there is no space between the proximal lobe and the distal segment, the median segment has a broad base without a 'neck' at the stem. As illustrated, the penis of *L. vietnamensis* resembles those of *L. motuoensis* (Chao, 1983) or *L. formosanus* (Matsumura



Figure 48. Males of *Lamelligomphus castor* hovering over 'Loringae brook' downstream of Buu Sraa Waterfalls (Loc. 13b).

in Oguma, 1926) (Chao 1990) but is even more peculiar. It is not excluded that it was just deformed (dorso-ventrally compressed) in the holotype of *L. vietnamensis*. Unfortunately, no topotypic Malaysian specimen of *L. castor* is available to me for comparison at present.

Observations. Both sexes are notable for their habit to hover over water for quite a long time without changing position, allowing to easily photograph them (Fig. 47-48).

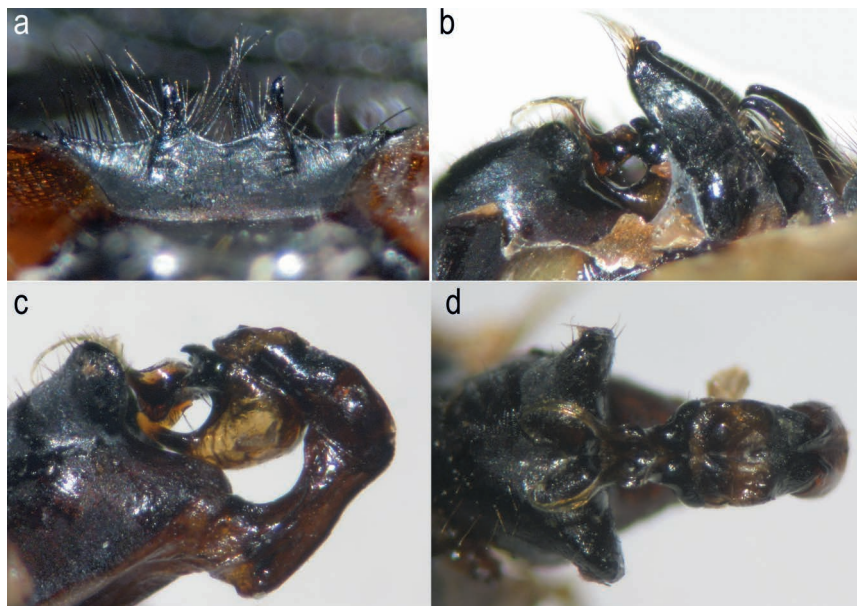


Figure 49. Details of *Lamelligomphus castor*: a – female from ‘Loringae brook’ downstream of Buu Sraa Waterfalls (Loc. 13b); b-d – male from Cambodia, Ratanakiri Province, Kachan Waterfall (Kosterin 2014a); a– female occiput, frontal view; b – male secondary genitalia, c – vesica spermalis, lateral view; d – ditto, ventral view Not to scale.

They are active at moderately fast or fast brook sections but not at rapids. Although their activity takes place mostly in shade of the forest canopy, it seems that it demands a sunny weather, for these dragonflies are rarely seen in overcast weather, e.g. in afternoons.

**Leptogomphus baolocensis* Karube, 2001

Loc. 13a: 9.06.2014: 1 collected, 1 more seen; Loc. 13b: 12.06.2014: 1 collected.

Remarks. This is the fifth report and third known locality of the species which was described from the same place as the above considered *H. chaoi*: Vietnam, Lâm Đồng Province, 15 km from Bảo Lộc to Hochimín (Karube 2001) and was collected there in the same 1996-1997 and 2002 years (Karube 2001; 2014) and then in two localities in Champasak Province in southern Laos (Yokoi & Souphanthing 2005). The here published Cambodian locality is different from that of *H. chaoi*, but is situated the same 127 km apart from the type locality. The two males collected well corresponded to the description.

Observations. Males were found perched on branches (or small palm fronds) both below the waterfall at ‘Loringae brook’ and at a forest road at distance of the calm upper reach of the same brook.

Macrogomphus kerri Fraser, 1922

Loc. 4a: 1 photographed (Fig. 50 above); Loc. 13b: 12.06.2014: 1 collected, 1 more photographed (Fig. 50 below); 15.06.2014: 1 seen.

Observations. At 'Loringae brook', males perched at very low sticks (Fig. 50 below) at a spring flowing in a very shady dell with a tiny brook (a tributary of the 'Loringae brook', Fig. 16). They were not very cautious; when disturbed, they often hovered at the same point over the water but for less time than those of *L. castor*. They were registered in the first half of the day and were absent in overcast afternoons. At 'Ochracea rivulet', a male perched quite differently on a sunny branch of a tree over the river at the height of ca 2 m, and also was not cautious (note that identification of that male was based only on a photo of Fig. 50, above).



Figure 50. Males of *Macrogomphus kerri* at 'Ochracea Rivulet', the left tributary of the main river of Monorom Waterfall (Loc. 4a) (above) and a small shady dell (Fig. 15) at 'Loringae brook' downstream of Buu Sraa Waterfalls (Loc. 13b).

**Microgomphus juritzai* Karube, 2000

Loc. 4a: 1 collected.

Remarks. This species was described from the same locality as *H. chaoi* and *L. baolocensis*: Vietnam, Lâm Đồng Province, 15 km from Bảo Lộc to Hochimín (Karube 2000; 2014).

Later it was reported for Sam Nua in central Laos (Yokoi 2003). This is the third known locality of the species. The male collected well corresponded to the description.

Observations. Found in grass on a large grassy slope facing the rivulet valley.

Synthemisidae s. l.

Idionyx thailandica Hämäläinen, 1985

Loc. 13b: 12.06.2014 – 1 collected; 15.06.2014: 2, 2 collected, several more seen.

Remarks. A male specimen depicted under this name on Plate 23 in Yokoi & Souphanthong (2014) was mididentified: it has a long dorsal spine on S10 while males of *I. thailandica* lack any spine there (Hämäläinen 1985).

Observations. At 'Loringae brook', males fluttered at openings among bamboo thickets at the height of 1.5-2 m under overcast weather.

Many times, at Buu Sraa waterfall, 'Ochracea rivulet' and 'Chaoi brook', it happened that a small, dark, hard to follow by sight dragonfly started to fly, very fastly, erratically and low above the ground or vegetation, around me for some time, always in shade of the forest or bamboo canopy or in overcast weather. Obviously it was rested and startled by me but preferred to hunt for insects possibly following or being startled by me, thus exhibiting the so-called accompanying behaviour (Corbet & Miller 1991). All times I missed to catch it. Judging from their general image and flying mode, they most probably were *Idionyx* sp.

Macromidia rapida Martin, 1907

Loc. 4a: 1 collected, tentatively 2 more seen.

Observations. At 'Ochracea rivulet', these dragonflies rested on bamboo twigs at ca 2 m above the ground or water, in shade of bamboo thickets, but were quite cautious throughout the day.

Macromidia genialis Laidlaw, 1923, ssp.

Loc. 13b: 15.06.2014: 1, 1 (abdomen starting from S7 missing) collected, several more seen.

Remarks. The male is similar to Thai (Asahina 1987) and Cambodian (Kosterin 2014a) specimens of *M. genialis shanensis* Fraeser, 1927 but a very important difference: there is an additional, and the most broad and conspicuous dorsal yellow shield-shaped spot on S7, while in *shanensis* the most conspicuous spot is disposed on S6 while S7 is devoid of spots or has only faint weak dorsal streak. More specimens from this place are necessary to clarify the taxonomic status of this male. Attribution of the taxon *shanensis* to species *M. genialis*, described by one specimen from highlands of peninsular Malaysia missing the light dorsal pattern (Laidlaw 1923), is also questionable.

Observations. At 'Loringae brook', males ranged fastly and straight-forwardly and about 1-1.5 m high over territories of several metres (faster and lower than those of

Idionyx in the same place) at openings among bamboo thickets during overcast weather. (One of such males was attracted by an ovipositing male of *Idionyx*). A female oviposited at tiny shady pools at the brook, after a missing net stroke it re-appeared at the same place after ca 5 min.

Macromiidae

Epopthalmia frontalis Selys, 1871

Loc. 4c: several seen (identification tentative); Loc. 5: 1 collected, several seen.

Observations. Males ranged over the water along the bank of the large pond in Sen Monorom.

Macromia septima Martin, 1904

Loc. 13b: 12.06.2014: 1 collected.

Remarks. This female specimen was depicted and discussed in Kosterin (2015d). It has an extended abdominal yellow pattern as compared to those from the Cardamoms, and with additional anteriolateral yellow spots on S3, as in the specimen depicted by Karube (2011: fig. 20-21) from northern Vietnam.

Observations. The only female was collected, at deep forest shade, at the 'Loringae brook' downstream its waterfall, where it flows through a series of alternating slower pools and faster sections (Fig. 14). Unlike this, in Koh Kong Province this species was repeatedly found at exposed banks of larger (but still small) rivers (Kosterin 2012; 2014a; 2015d).



Figure 51. A male of *Aethriamanta gracilis* at the lower pond in Sen Monorom (Loc. 5).

Libellulidae

Aethriamanta brevipennis (Rambur, 1842)

Loc. 5: 1 collected, many seen.

Aethriamanta gracilis (Brauer, 1878)

Loc. 5: 1 collected, 1 photographed (Fig. 51), numerous seen; Loc. 13g: 9.06.2014: 1 collected.

Observations. This and the previous species were abundant at floating grassy mats along the bank of the large pond in Sen Morom, This species was more abundant than the previous one; the latter is somewhat larger and so perched higher on grasses and was more active.

Amphithemis curvistyla

Loc. 8 (tall-grass swamp): 1 collected.

Observations. The only male was collected at a small forest swamp with tall *Cyperus* grass at Dak Dam village (together with *Risiopebia guentheri*, see below).

Acisoma panorpoides Rambur, 1842

Loc. 13g: 09.06.2014: 1 seen.

Brachydiplax chalybea chalybea Brauer, 1868

Loc. 5: 1 seen.

Brachydiplax farinosa (Krüger, 1899)

Loc. 1 (swamp): 1 collected; Loc. 7: 1 seen; Loc. 13a: 9-10.06.2014: 1 collected, several seen; Loc. 13g: 09-10.06.2014: many seen; 10.06.2014: 1 collected.

Brachythemis contaminata (Fabricius, 1793)

Loc. 4c: several seen at stones and low water under the dam; Loc. 11: 1 seen.

Cratilla lineata calverti Förster, 1903

Loc. 1: several seen at a large pool; Loc. 2: 1 collected, several ind. seen; Loc. 8 (at the village): 1 seen; Loc. 13b: 15.06.2014: 1 collected; Loc. 13c: 12.06.2014: 1 collected.

Observations. Confined to shade, as obligatorily for this species.

Crocothemis servilia (Drury, 1770)

Loc. 5: 1 seen; Loc. 13a (the inundated part): 10.06.2014: 1 seen.

Diplacodes trivialis (Rambur, 1842)

Loc. 1 (in inundated grass): 1 seen; Loc. 2: 1 ind. seen; Loc. 9 (at a pasture): several seen.

Hydrobasileus croceus (Brauer 1867)

Loc. 13a (the inundated part): 10.06.2014: 2 collected, 1 more seen; Loc. 13g:
09.06.2014: 1, 1 tandem seen; 10.06.2014: 1 seen.

Lathrecista asiatica (Fabricius, 1798)

Loc. 1 (large pool): 1 collected, 1 more seen; Loc. 13b: 15.06.2014: 1 teneral



Figure 52. A male of *Onychothemis culminicola* at the 'Culminicola Rivulet' near Sen Monorom (Loc. 7).

collected; Loc. 13c: 12.06.2014: 1 teneral released; Loc. 13e: 09.06.2014: 1 fully mature seen; Loc. 13g: 09.06.2014: 3 not fully mature seen.

Neurothemis fluctuans (Fabricius, 1793)

Loc. 1 (swamp): many , several seen; Loc. 2: several seen; Loc. 4a: 1 seen (at a valley swamp); Loc. 5: several seen; Loc. 7: several , seen; Loc. 8 (swamp, pasture): many , seen; Loc. 13a: 09-10.06.2014: several seen; Loc. 13f: 09.06.2014: several seen; Loc. 13g: 09-10,12.06.2014: several seen; 10.06.2014: 1 coloured wings collected.

Neurothemis fulvia (Drury, 1773)

Loc. 1 (swamp): 1 seen; Loc. 2: 1 seen; Loc. 7: 2 seen; Loc. 8 (tall-grass swamp): 1 seen; Loc. 13a: 09-10.06.2014: several seen; Loc. 13g: 9-10.06.2014: several seen.

Neurothemis intermedia atalanta Ris, 1919

Loc. 13a: 09.06.2014: 1 seen; Loc. 13g: 9.06.2014: 1 collected.

**Onychothemis culminicola* Förster, 1904

Loc. 3: 1 seen; Loc. 4a: several seen; Loc. 7: 2 collected, 2 more photographed (Fig. 52); Loc. 8: many seen (at the river, penetrated to the swamp); Loc. 11: 1 collected.

Onychothemis testacea Laidlaw, 1902

Loc. 12: 1 collected, several seen; Loc. 13d: 15.06.2014: 1 unusual seen (see 'Remarks'), Loc. 13f: 1 seen.

Remarks. A male observed on 15.06.2014, but unfortunately not collected, at the river below Buu Sraa Waterfalls, had a dark reddish-brown ground colour with yellow spots and looked intermediate between *O. culminicola* and *O. testacea*, perhaps a hybrid (it could hardly be an immature male since it was obviously territorial at a breeding place).

Observations. Males of both *Onychothemis* species perch and range over troubled water at rapids. The two species of *Onychothemis*, males of which differ so drastically as red and black, were observed at different rivers and seemed to exclude each other. All localities of *O. culminicola* were located west of 107°20' E, above 510 m a.s.l. and at smaller rivers, while all localities of *O. testacea* were east and below the mentioned values and at larger rivers, with the seeming border situating between the 'Kruegeri' and 'Testacea' Rivers. However it is unclear if these values are in fact geographical (hardly existing), hypsomerical or river-size-related (more likely) thresholds dividing the niches of these species or just a matter of chance. The above mentioned observations of a putative hybrid between the two species may show that crossing between them is possible. Perhaps it is associated with some negative effect on fertility and so is undesirable and drives disruptive selection of these species as to their habitat preferences. Both species were reported as common for Xiangshuang-banna Dai Autonomous Prefecture, Yunnan Province (Zhang 2010). Haomiao Zhang

kindly informed me that the two species co-occurred at the same streams but *O. culminicola* avoided large rivers and preferred more forested habitats. The ecological preferences and possible mutual displacement of them worth specially studying.

Orthetrum chrysis (Selys, 1891)

Loc. 1 (larger pool, swamp): several , 1 seen; Loc. 2: several seen; Loc. 3: 1 seen; Loc. 7: 1 seen; Loc. 8 (swamp, pasture): several seen; Loc. 13a: 09 and 15.06.2014: 1 seen at pools; Loc. 13g: 09.06.2014: 1 seen.

Observations. At a small open section of 'Chaoi brook', a male of this species and a male of *O. culminicola*, both bright red, were in permanent conflict, mostly chasing each other and rarely perching.

Orthetrum glaucum (Brauer, 1865)

Loc. 1 (inundated grass): 2 seen (1 immature); Loc. 2: 1 collected; Loc. 4a: 1 immature collected; Loc. 4b: 13.06.2014: 3 seen at a nearby road; Loc. 11: 2 seen; Loc. 13a: 09-10.06.2014: 2 seen, 1 of them photographed; 10.06.2014: 1 collected; Loc. 13d (pools on rocks): 12.06.2014: several seen; Loc. 13f: 1 seen.

Orthetrum luzonicum (Brauer, 1868)

Loc. 3: several seen; Loc. 4a: 1 collected, 1 immature seen; Loc. 6: several seen; Loc. 7: several , 1 tandem seen; Loc. 8 (swamp, pasture): many , seen; Loc. 9 (pasture): many , seen; Loc. 13a (inundated part): 10.06.2014: 1 seen.

Observations. A tandem oviposited at a small swamplet with a shot inundated Poaceae grass at the 'Culminicola rivulet'. This species prefers sunlit places with grass and herbs hiding the water of small brooks. Its occurrence often correlates with the presence of large leaves of *Allocasia* spp. ('elephant ear').

Orthetrum neglectum (Rambur, 1842)

Loc. 8 (at a pond in the village): 2 seen; Loc. 13g: 12.06.2014: 1 photographed.

Remarks. A substantial molecular analysis by Yong et al. (2015, with the paper title containing an oxymoron "cryptic species of *Orthetrum pruinosum*") showed clearly that two presumed subspecies of *Orthetrum pruinosum* (Burmeister, 1839), *neglectum* Rambur, 1842 from ranging in the continental Asia and *schneideri* Förster, 1903 from Peninsular Malaysia and Borneo, are not conspecific: the former is related to *O. testaceum* (Burmeister, 1839) while the latter to *O. chrysis*. Unfortunately, the nominotypical *O. neglectum neglectum*, described from Indonesia, was not involved into that study. However, biogeographically it is very unlikely that the continental taxon *neglectum* is conspecific to *O. neglectum neglectum* while the Malaysian taxon *schneideri* is not. The latter may be either conspecific to *neglectum* s. str. or another bona species. Hence, *O. neglectum* can safely be treated as bona species.

Orthetrum sabina (Drury, 1770)

Loc. 5: 1 ind. seen.

Observations. This elsewhere common species appeared surprisingly rare in this area.

Orthetrum triangulare (Selys, 1878)

Loc. 13a (pools): 10.06.2014: 1 photographed (Fig. 53), 1 more seen, 15.06.2014: 1 collected.

Observations. Two males were invariably found at two close to each other, very small, forest-shaded pools with rust-coloured rotten water and muddy bottom, piled



Figure 53. A male of *Orthetrum triangulare* at small muddy pools piled with dead tree branches at 'Loringae brook' downstream of Buu Sraa Waterfalls (Loc. 13b).

with fallen tree branches and dead bamboo, situated near the 'Loringae brook' at a distance upstream of its waterfall. They, and a male of *O. chrysis*, perched on branches (Fig. 53) and were very hard to photograph or catch because of scarcely permeable environments. Being disturbed, they changed a perch, with more disturbance disappeared behind low trees and bushes but returned after a while.

Palpopleura sexmaculata (Fabricius, 1787)

Loc. 4a: 1 collected (at a valley swamp with *Typha* and *Allocaasia*); Loc. 8: 2 collected, many more seen; Loc. 9 (pasture): several seen.

Remarks. The three females collected have no dark-brown patches on the hind wings as described for some females from Ratanakiri Province (Kosterin 2014a).

Observations. This species appeared to be surprisingly numerous at small pools at a short-grass buffalo pasture at Dak Dam village and, in fewer quantities, at a similar pasture at Dak Dam Waterfall.

Pantala flavescens (Linnaeus, 1758)

Loc. 2 (above road): many ind. seen.

Potamarcha congener (Rambur, 1842)

Loc. 8 (a pasture): 1 seen; Loc. 13g: 9.06.2014: 2 seen; 10.06.2014: 1 seen.

Pseudothemis jorina Förster, 1904

Loc. 4c: several seen; Loc. 5: several seen.

Observations. Found at large water reserves; males perch and range over shaded water of deeper banks but often fly to sunny surface as well.



Figure 54. A male of *Rhyothemis plutonia* at an oxbow pool on the left floodplain of the main river downstream Buu Sraa Waterfalls (Loc. 13c).



Rhyothemis phyllis
(Sulzer, 1776)

Loc. 5: 2 seen.

Rhyothemis plutonia
Selys, 1883

Loc. 7: 1 collected, 2 more seen; Loc.13a (inundated part): 15.06.2014: several seen; Loc.13c: 12.06.2014: 1 photographed (Fig. 54), several seen; Loc. 13g: 9-10.06.2014: 1 photographed (Fig. 55), several seen, 9.06.2014: 1 collected.

Observations. Males perch on branches and stems not lower than 1.5-2 m and spend quite a lot of time to chase each other. They often notice and start to descend to males of *R. triangularis* which have wingspots of the same colour but perch low in emerging grass, but usually do not chase them and proceed flying high. Curiously, at a flood-



Figure 55. A male of *Rhyothemis plutonia* at 'Plutonia pool' (Loc. 13g) at the right bank of the main river downstream Buu Sraa Waterfalls.

land pool at Buu Sraa, three males of *R. plutonia* paid little attention to an ovipositing female of their own species: only once a male descended to it but very soon returned to its rival males.

Rhythemis triangularis Kirby, 1889

Loc. 5: many seen; Loc. 7: 1 seen; Loc. 13a (inundated part): 09.06.2014: 1 seen; 15.06.2014: several seen at a swamp; Loc. 13g: 9-10.06.2014: several, 1 seen.

Observations. Males perch low above the water, on emerging Poaceae grass.

**Risiophlebia guentheri* Kosterin, 2015

Loc. 8 (tall-grass swamp): 3, 1 collected – the holotype and paratypes of the species (see Kosterin 2015b), 1 (Fig. 56), 1 photographed.

Remarks. A species described (Kosterin 2015b) by the above mentioned specimens obtained on this trip; three males of this species were probably collected still in 1962 in a locality in S Vietnam (Asahina 1969), that is 102 km NE of the type locality (Loc. 8).

Observations. Both sexes were observed perching high on tall *Cyperus* sp. of a small forest swamplet (almost waterless) formed by that plant.



Figure 56. A male of *Risiophlebia guentheri* at the type locality at a tall grass (*Cyperus* sp.) swamp in the Dak Dam village environs (Loc. 8).

Tetrathemis platyptera Selys, 1878

Loc. 1 (swamp, larger pool): 1 photographed (Fig. 57 below), several seen; Loc. 2: 1 collected; Loc. 4b: 13.06.2014: 1 teneral photographed (Fig. 57 above); Loc. 7: 1 collected, 1 more seen; Loc. 8: 1 collected; Loc. 11: 1 collected; Loc. 13a: 15.06.2014: 1 seen. Loc. 13c: 12.06.2014: 1 seen.

Observations. These dragonflies prefer to perch on sticks at small forest pools, however in this area, where it was rather frequent, it was found in quite a variety of habitats. These were: a small round pool with clear water in deep shade of trees at a major river, as most typical for the species (Locs. 2, 4b, 8 and 11); in shade of dense bamboo thickets overhanging over a bay of a large oxbow at the Buu Sraa River left floodplain with clear water (Loc. 13c); in shaded shallow pools with rotten rust-coloured water (Loc. 13a); at the middle of a larger roadside pool with muddy water at a forest edge (Loc. 1). Surprisingly, at Loc. 7, two males were found perched under direct sun on dry branches of bushes bordering a small, shallow, sunlit swamp with fine grass.



Fig. 57. Males of *Tetrathemis platyptera*: above – a teneral one at the main river downstream Monorom Waterfalls (Loc. 4b); below – a mature one at a riverside swamp in Seima Forest 34 km SW of Sen Monorom (Loc. 1).

Tholymis tillarga (Fabricius, 1798)

Loc. 7: 1 seen; Loc. 11: 1 seen.

Tramea transmarina euryale Selys, 1878

Loc. 12: 1 seen; Loc. 13g: 09.06.2014: 1 seen; 1 tandem collected.

Trithemis aurora (Burmeister, 1839)

Loc. 1 (swamp, inundated grass, river): several seen; Loc. 2: 1 seen; Loc. 5: many seen; Loc. 6: several seen; Loc. 7: many seen; Loc. 11: several seen; Loc. 13a: 09-10.06.2014: several, 1 seen; Loc. 13d (pools on rocks): 12.06.2014: several seen.

Trithemis festiva (Rambur, 1842)

Loc. 1 (river): several seen; Loc. 3: several seen; Loc. 7: several seen; Loc. 11: 1 collected, many seen; Loc. 13a (inundated part): 15.06.2014: several seen at a swamp.

Observations. For some reason, at 'Kruegeri River' on 10.06.2014, males were found perching not on stones at water, as typical for the species, but on large grasses or sticks at a grassy opening dozens of metres off, near a small brook. Perhaps this behaviour was due to a strong rain lasting until 6:00 a.m.

Urothemis signata (Rambur, 1842)

Loc. 5: several seen;

Observations. This species inhabits large, non-eutrophic lentic water bodies, such as the pond in Sen Monorom.

Zygonyx iris malayana Laidlaw, 1902

Loc. 1 (river): several seen; Loc. 3: 1 seen; Loc. 4a: many seen; Loc. 7: 1 collected, several seen; Loc. 8: many seen; Loc. 11: several seen; Loc. 12: many seen; Loc. 13a: 10.06.2014: several seen, Loc. 13b: 12.06.2014: many seen; Loc. 13c: 12.06.2014: several seen; Loc. 13e: 9-10.06.2014: several, 1 tandem seen; Loc. 13f: several seen.

Zyxomma petiolatum Rambur, 1842

Loc. 1 (swamp): several ind. seen; Loc. 13c: 09.06.2014: 1 seen; 12.06.2014: 1 collected, 1 more seen.

Observations. At a floodplain lake below Buu Sraa Waterfalls, males ranged (in mid-day and the afternoon) very low above the water surface of a large shady floodland pool, examining also small bays hidden in entangled branches. Their trajectories were unstable and their return to the same place aperiodic. They were too fast to catch, and I succeeded only when two males started to fight with each other in front of me. In an inundated forest at Seima forest, these dragonflies appeared at ca 15:50.

Appendix: results of revisiting Buu Sraa Waterfall area on August 3-4, 2016

The Buu Sraa Waterfall area (loc. 13a-d) was revisited for two days in 2016 as an attempt to update type series of some taxa to be described, which appeared successful with *C. poungyi dasha*. August 3 started with a rain and was overcast; the sun only twice appeared for a little while, and this was the only time when anisopterans were seen. August 4 started sunny but there was a strong downpour in the afternoon.

Most time was devoted to the 'Loringae brook' downstream its waterfall (Loc. 13b). There were many *V. gracilis*, *E. masoni inouei*, *H. biforata*, *C. marginipes*, *P. autumnalis* (but the latter only on the second day), few *A. fulgipennis*, *L. castor*, *Z. iris malayana*, singular males of *R. hainanense* and a teneral of *T. festiva*, female of *A. rubescens rubeola*, an individual of *Macrogomphus* sp. (most probably *M. kerri*, sex uncertain). Surprisingly, in the central and upper reaches, closer to the waterfall, there were quite many *C. poungyi dasha*. They perched mostly on ginger leaves and palm fronds and were quite active in spite of moist overcast weather, easy to get into the air and often changing perches. On 03.08.2016, I collected 3 tandems and 7 more males. Besides, in the central reach I collected one male of *C. cf. kazukoae*. The following odonates recorded here in 2014 were not found: *Phyloganga*, *Gynacantha*, *Tetracanthagyna*, *Asiagomphus*, *Euthygomphus*, *Macromia*, *Macromidia*, *Idionyx* and, surprisingly, the formerly (in June 2014) abundant *Protosticta* and *P. doisuthensis*. Some of those losses could be attributed to unprecedented drought in spring 2016 in Cambodia, although the gross amount of Odonata in August 2016 did not seem less than in 2014.

A short visit to the brook upstream its waterfall (Loc. 13a) provided only few *V. gracilis*, *N. fluctuans*, *O. glaucum*.

The main river left bank just downstream the Buu Sraa waterfall (Loc. 13d) provided on 04.08.2016 many *V. gracilis*, *E. masoni inouei*, *H. biforata*, *C. marginipes*, *P. autumnalis*, few *O. glaucum*, *T. platyptera*, *T. aurora*, two males of *B. divaricatus*, singular *E. yunnanensis* (a female), *O. chrysis*, *O. neglectum* (males).

At the right floodplain (Loc. 13c) mostly open grassy areas were examined. There were a few *N. fulvia*, *N. intermedia atalanta*, *T. aurora*, *T. platyptera* at shallow pools, a male of *O. chrysis*, a male of *L. asiatica*, and young, still uncoloured, male and female of *O. glaucum*. Besides, in grass near the mouth of 'Loringae brook' I collected a species new for the Cambodian fauna:

**Heliogomphus* sp. cf. *svihleri* Asahina, 1970

Loc. 13c (near Loc. 13b): 03.08.2016: 1 collected (Fig. 58).

Remarks. The specimen fits the original description of *H. svihleri* (Asahina 1970), including such important characters as the pair of strong horns behind the lateral ocelli, the pair of long narrow spines on the occiput (Fig. 58e), the genital plate shape (Fig. 58f); the face maculation with a pair of rounded spots on the labrum (Fig. 58d), the pattern of the thorax (Fig. 58b) and abdomen, including broad yellow lateral stripes on S2, two large yellow spots, the proximal triangular and the distal elongate; on either side of S3-S6, and an unpaired dorsoproximal spot on S7 (Fig. 58a). However, one important difference made me to abstain from identifying this specimen as *H.*

svihleri – the presence of a high conical centra projection between the horns of the occiput (Fig. 58e). There are 6 crossveins above Rs between Arc and R1-R4 junction on the fore wing (Fig. 58c), and no basal subcostal antenode, that also fits the characters of *Heliogomphus* Laidlaw, 1922 according to Fraser (1934). The head has a peculiar, subprognathe shape (Fig. 58b).

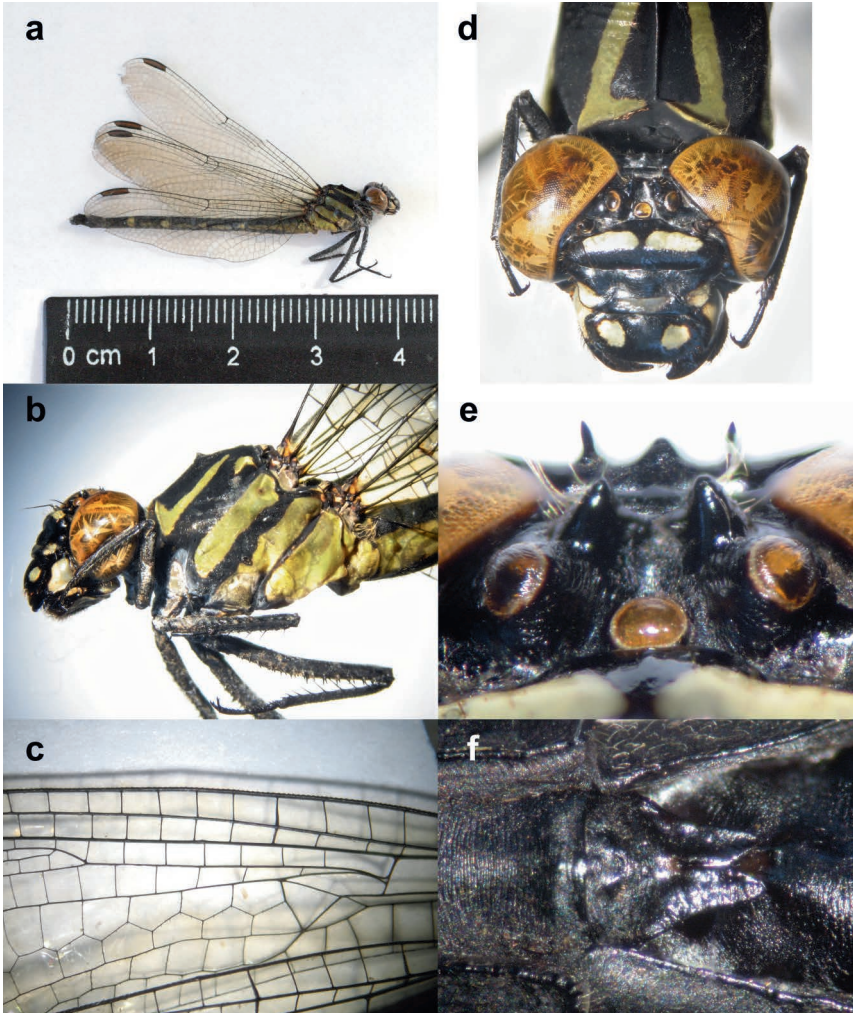


Fig. 58. A female of *Heliogomphus* sp. cf. *svihleri*: a – general habitus; b – head and thorax, lateral view; c – venation of the fore wing basal part; d – head, frontal view; e – vertex and occiput, frontal view; f – genital plate. Not to scale.

However *H. svihleri* itself remains an enigmatic species until present known for science only by the two females of the type series from Myanmar and Central Thailand (Asahina 1970; 1986c), an additional female from North Thailand (Hämäläinen & Pinratana 1999), plus another putative teneral female from North Thailand (Kosterin et al. 2011). At the same time the genus *Heliogomphus* is very speciose and many species are still known by males only, so there is a probability that *H. svihleri* has senior or junior synonym(s).

Update to the country fauna.

A checklist of Odonata of Cambodia at the state of to the end of 2012 was published in Kosterin et al. (2012b) and counted 135 named species. Later publications (Kosterin et al., 2014a; Kosterin & Chartier 2014; Kosterin 2015f – there *A. migratum* was added for a species collected still in 2010; Kosterin 2016a; Seehausen et al. 2016 – they reported *Sinictinogomphus clavatus* (Fabricius, 1775) by a female from Siem Reap Province) raised this number to 156. During this ten days long trip to Mondulkiri Province, 106 Odonata species were met with, 97 of which were identified to previously known named species, five species were described as new to science (Kosterin 2015b,c,e; 2016b; Kosterin & Yokoi 2016) and for two species new subspecies were described (Kosterin 2015a; 2016). The named species found for the first time in Cambodia on this trip were as follows: *Mnais mneme* Ris, 1916, *Rhinocypha seducta* Hämäläinen et Karube, 2001, *Philoganga loringae* Fraser, 1927, *Rhinagrion hainanense* Wilson et Reels, 2001, *Indolestes gracilis expressior* Kosterin 2015, *Amphiallagma parvum* (Selys, 1876), *Ceriagrion chaoi* Asahina, 1967, *Paracercion malayanum* (Selys, 1876), *Coeliccia poungyi dasha* Kosterin, 2016, *Onychargia priydak* Kosterin, 2015, *Prodasineura doisuthepensis* Hoess, 2007, *Prodasineura hoffmanni* Kosterin, 2015, *Protosticta grandis* Asahina, 1985, *Tetracanthagyna waterhousei* McLachlan, 1898, *Asiagomphus reinhardti* Kosterin et Yokoi, 2016, *Euthygomphus schorri* Kosterin, 2016, *Gomphidia kruegeri* Martin, 1904, *Heliogomphus chaoi* Karube, 2004, *Leptogomphus baolocensis* Karube, 2001, *Microgomphus jurzitzi* Karube, 2000, *Onychothemis culminicola* Förster, 1904, *Risiophlebia guentheri* Kosterin, 2015. So the total number of first country records made during this trip was as many as 22 species. The number of named species recorded in Cambodia is now 178. Five herewith reported species without reliable identifications (one added in 2016) most probably are undescribed but demand further analysis. Note that previous Cambodian (and Thai) records of *Mergomphus parvus* (Krüger, 1899) were reidentified as *Euthygomphus yunnanensis* Zhou et Wu, 1992 (Kosterin 2014b).

Four species, *R. seducta*, *Heliogomphus chaoi*, *L. baolocensis* and *M. jurzitzi* were expectable in Cambodia as described in 2000s by or with participation of Haruki Karube from the neighbouring Lâm Đồng Province of Vietnam. On the other hand, five new taxa described by specimens collected on this trip to Mondulkiri Province have been found in that province of Vietnam, before my trip: *C. poungyi dasha* (pers. comm. by Matti Hämäläinen and Phan Quốc Ton), *R. guentheri* (Asahina 1969), or after it: *O. priydak*, *P. hoffmanni* and *A. reinhradti* (pers. comm. by Tom Kompier). This is of

course not surprising since Mondulkiri and Lăm ồng Provinces are adjacent to each other over the Cambodian/Vietnamese border.

According to my rough estimates, 38 species are still expectable for Cambodia as present in East Thailand, 18 species are expectable as present in South Vietnam and 9 species are expected from South Laos. I am sorry for the oxymoron but from my previous experience I also expect from Cambodia finding of not less than 10-15 unexpected species. Hence my estimate of the richness of the entire Cambodian fauna of Odonata is some 260 species.

Notes on the areas visited and Odonata observed.

Weather, seasonal conditions, threats and larger creatures

I found the Annamense Central Plateau amidst the rainy season to have a very comfortable climate: moderately warm (maybe 25°C) round the day, with sunny days and mostly with strong thunderstorms at sunset.

No mosquitoes in the field; in rooms, slow and noisy *Aedes* sp. were active at sunset, while elsewhere in Cambodia I was pestered by *Anopheles* sp. active at night. Leaches were encountered, in abundance, only in Seima forest at low elevations of 300-400 m a.s.l. Two snakes were seen at the Kruegeri River after a strong rain: one among emerging grass and another, a green *Trimeresurus* sp., on a tree branch overhanging the river. Macaques were noticed in tree crowns at Seima Forest and Buu Sra Waterfall. At a roadside fresh logged area close to Buu Sra Waterfall there was a warning sign indicating presence of explosive war remnants (Fig. 59).



Fig. 59. A warning sign of explosive war remnants at the road to Buu Sra Waterfalls.

I left Mondulkiri Province on 18.06.2014 and since 8.07.2014 to 13.07.2014 suffered from several waves of high temperature and headache without any other symptoms, resembling the supposed Katayama fever due to infestation of *Schistosoma mekongi*, which I suffered after visiting the neighbouring Ratanakiri Province in 2013 (Kosterin 2014a). The shorter period of the illness in 2014 could be explained by an earlier intake of prasiquantel.

Seima Forest

The road to Mondulkiri left the Central Cambodian depression and entered once forested hilly area at Snuol, Kratie Province. However, all the way through 'Snuol Wildlife Sanctuary' it crossed a revolting, just recently and completely cleared and burnt out area with still smoking stumps and very few dipterocarp trees left. It seems that the environment changed when the road entered the so-called Seima Forest in Mondulkiri Province. It was an asphalted road of ideal quality going through rolling hills clad with infinite and seemingly virgin evergreen forest (Fig. 1) without any noticeable population. Most probably, that road was constructed in advance of development of the area through trade with Vietnam, hence the future of the Seima Forest looks rather doomed and it may soon look like the area at Snuol. The forest changed to savannah only when the road rose to about 600 m a.s.l.

I had an opportunity to explore Seima Forest in detail on the last day of my trip, June 17. Thick, even forest was not a good place to look for Odonata. In fact, the road crossed only two rivers with promising valleys, which I examined in detail. This experience supported my earlier conclusion that a vibrant evergreen lowland and low-hill forests is poor in odonatological respect. I registered 23 species (no gomphids!), of which 21 were most common and widespread elsewhere in the Cambodian areas I studied before, and only two were more or less 'something special': *A. fulgipennis* occurring only in the eastern Cambodia and *R. hainanense* recorded in Cambodia for the first time on this trip. I found the forest very dark. At Loc. 1 the river inundated quite an area of forest, most probably because of the road embankment. Odonata were more abundant and diverse at the inundated area, and even more abundant and diverse at a small half-shaded muddy roadside pool, so it is human activity that favours Odonata in the forest. Loc. 2 was examined in the morning after a strong night rain, everything was wet and the rain loving *Cratilla lineata* were active. The river at Loc. 2 was rapidous and quite cold.

Deciduous dipterocarp forest at moderate elevations

This area was examined only briefly by the way to the most fruitful Buu Sraa Waterfalls. The road went along long and gentle hill ridges clad with lovely open dipterocarp stand with fresh, bright-green and very large foliage (somewhat resembling Mongolian Oak parklands of the Russian Far East) (Fig. 5) but offering no water for Odonata but two large 'Kruegeri' (Fig. 11) and 'Testacea' (Fig. 12) Rivers, Loc. 11 and 12, respectively, both surrounded by those dipterocarp forests with traces of fire. The former was examined after a considerable rain but yielded as many as 19 species for 2.5 hours, including four species of gomphids, of which *G. kruegeri* was not recorded elsewhere.

The 'Testacea River' (Fig. 12) once more proved the statement that large and powerful rivers in Cambodian mountains are poor in Odonata. It was extremely beautiful and its flow was powerful enough to make walking in water along the banks very hard and impossible without repeated falling in water. Odonata were scarce and limited to few species tolerating larger rapidous rivers: quite many *N. chinensis*, *D. gloriosa*, *H. perforata*, *P. autumnalis*, *Onychothemis testacea*, *Z. iris*, few *V. gracilis* (in shade of the banks), *E. masoni*, *O. pruinosa*, accounted for 1.5 hours spent. Of those species, only *D. gloriosa* could be considered as preferring larger rivers, but it was not too numerous as well. Because of unstable positions in the fast river, I missed the only two Burmagomphus-size gomphids encountered.

This area could be a battlefield of two related species seemingly competing for habitats and mutually excluding each other: *Onychothemis culminicola* and *O. testacea*. The former occupies all more elevated habitats on the plateau and found at the 'Kruegeri River' (ca 550 m a.s.l.), the former found at 'Testacea' (ca 430 m a.s.l.) and 'Buu Sraa' Rivers (440-500 m a.s.l.). At the latter I observed an individual which seemed to be transitory between these species as to the body colour, probably a hybrid. If the species are able of some but undesirable hybridisation, this could reinforce their competition for habitat aimed to reduce it.

Buu Sra Waterfalls

These popular and impressive waterfalls (Fig. 3-4) appeared as well the most fruitful area among those examined in Mondulkiri Province: 71 species in total, including two new species (*Euthygomphus schorri* and *Asiagomphus reinhardti*) and two new subspecies (*Indolestes gracilis expressor* and *Coeliccia poungyi dasha*)! Although so touristically popular, Buu Sraa Waterfall appeared a real 'Lost World' in odonatological respect. However, most of this diversity was contributed not by the large main river (Loc. 13d-f). As noted above, major rivers in Cambodia are rather poor in Odonata, and the "Buu Sraa River" was one of the richest: 15 species (compare to 10 at the 'Testacea River'). However, the main and enormously rich yield was offered by the 'Loringae brook' (Loc. 13a-b) (Fig. 13-14): 47 species (as many as 8 of them gomphids), of which five, *P. loringae*, *C. poungyi*, *P. grandis*, *A. reinhardti* and *L. baolocensis*, so far have not been found elsewhere in Cambodia and three, *R. hainanense*, *T. waterhousei* and *Euthygomphus schorri* were found each in one more locality on the same trip. The first reason for this richness is the optimum size of the stream, which may be called either a large brook or a small rivulet. My experience in Thailand, Cambodia and Indonesia suggests that this is the size which leaves streams of all other size class far behind as to the diversity of Odonata. The second reason is that the brook crosses a complicated relief and hence provides a chain of contrasted habitats: a pond-like inundation upstream of the road embankment, an open reach flowing over basalt plates (Fig. 13) (of interesting species, it provided *P. loringae*) and crossing a shady cutting (provided *L. baolocensis* and *Euthygomphus schorri*), a muddy area with small pools piled with fallen trees (provided *O. triangulare*), a high waterfall below which the brook flew amongst large wet rocks (Fig. 14) (provided more *P. loringae*, *T. waterhousei*, more *L. baolocensis*,

E. yunnanensis, *M. septima*), a long shady reach winding amongst forest and bamboo thickets (Fig. 15) (provided *R. hainanense*, *C. poungyi dasha*, *P. grandis*, *Protosticta* sp.1, more *T. waterhousei*, *A. reinhardti*, *I. thailandica*, *M. genialis*), a tiny and very shady tributary spring (Fig. 16) (provided *Protosticta* sp.1, *M. kerri*), a half-open estuary (provided *H. perforata limbata*, *G. subinterrupta* and numerous tandems of both *P. autumnalis* and *P. doisuthensis* ovipositing side-by-side). There is no surprise that I examined this brook three times, spending there 13.5 hours in total and each time finding more and more interesting species.

Another very fruitful habitat was a shallow 'Plutonia pool' (Fig. 20) (Loc. 13g) on the right floodplain upstream the waterfall. It offered 23 species (for two hours in total for three visits), including the first country record of *C. chaoi* and such interesting species as *A. approximans*, *A. hisopa*, *O. atrocyana* and *A. gracilis*. It is noteworthy that only there I found the common in Cambodia *P. australasiae* (replaced by *P. microcephalum* at a large pond in Sen Monorom, Loc. 5). Tiny pools nearby (Fig. 21) provided more *A. approximans* and some *C. indochinense* (not found elsewhere in the area) and seemed to be their preferred habitat.



Fig. 60. A road from Sen Monorom to the Vietnamese border.

Savannah of Central Plateau

The Lonley Planet Guide to Cambodia characterises the plateau as follows: "In the dry season it is a little like Wales with sunshine, in the wet season, like Tasmania with more rain" and "The Switzerland of Cambodia" (Ray & Robinson 2008: 298-299). That all did not ring bells to me, not preventing from enjoying a pleasant climate of the place which would be nice to live (maybe too cloudy) and, most of all, riding motorbike by excellent and absolutely empty road winding through rolling hills to the Vietnamese border (Fig. 60). This riding was not only far too pleasant but also fruitful as it revealed 'Seducta brook' and environs of Dak Dam village (Loc. 8), the capitol of Pnong (Bunong) minority, with their peculiar fauna. However, the immediate suburbs of Sen Monorom, that is three randomly chosen streams, 'Culminicola' and 'Chaoi' brooks and 'Ochracea rivulet', and also 'Onychargia swamp', appeared not much less interesting.

First of all, the plateau offered three species new to science: *O. priydak*, *P. hoffmanni* and *R. guentheri*. The type locality of the first of them, 'Onychargia swamp' (Loc. 6), is situated in the Sen Monorom suburbs (but this species appeared even more numerous at Dak Dam, Loc. 8), of the second at Dak Dam, and of the third at 'Seducta brook' (Loc. 10) (but it was also found at Dak Dam Waterfall, Loc. 9). Second, there were species found for the first time in Cambodia and only on the plateau: *H. chaoi* was found only at two brooks at Sen Monorom, 'Chaoi brook' (Loc. 3) and 'Ochracea rivulet' (Loc. 4a), *M. juritzai* only at 'Ochracea rivulet', *M. mneme* and *R. seducta* only at 'Seducta brook' and Dak Dam environs, *E. ochracea* at 'Ochracea rivulet and Dak Dam environs. Four of these species were found only at the most elevated – 760-880 m a.s.l. – among the studied localities. *R. guentheri* was confined to peculiar habitat, a small tall grass (*Cyperus* sp.) forest swamp, not found elsewhere, so it may not in fact be restricted by elevation. However, three noteworthy species, *M. mneme*, *R. seducta* and *P. hoffmanni*, were rather abundant at 'Seducta brook' (877 m a.s.l.), solitary at Dak Dam village at 762-774 m a.s.l. (the first and second) or Dak Dam waterfall at 810-815 m a.s.l. (the third), and not found at seemingly similar streams at lower elevations. It seems that the top of the plateau just exceeds the lower elevational limit, supposedly at 750 m a.s.l., of these species, perhaps to be found in abundance at greater elevations available nearby in S Vietnam or more distantly in S Laos. Unfortunately, the very mountain of Phnom Nimlyr, with its top at 935 m a.s.l. according to Google Earth and 982 m a.s.l. according to the map, looking like a considerable forested hill, remained unexplored. But it was situated just in 12 km E of the 'Seducta brook' and was only some 50-100 m higher.

The plateau also offered second Cambodian findings of some species, first found in Ratanakiri Province (Kosterin 2014a), namely of *A. approximans*, *C. azureum*, *P. sexmaculata*.

The 'Culminicola brook' (Loc. 7) situated in the Sen Monorom suburbs, was another example of a stream of the right size, small but not the smallest, to reveal the most diverse fauna: for three hours of examination I found 27 species there.

The large pond in Sen Monorom (Loc. 5) revealed a rich fauna (21 species for two hours) including two first country records, *P. malayanum* (in great abundance) and

A. parvum (just two males) and such an interesting species as *A. gracilis*, only recently found on the continent. I, however, found no large ponds at other elevations so there was nothing to compare with but the neighboring and very similar upper pond, visited only briefly.

General

Note that so far, the number of first records of named Odonata species in Cambodia made on four my earlier 2-3 week long trips in 2010-2013 grew steadily (instead of decreasing) as 13, 14, 15 and 17. For the time being, this is the most fruitful odonatalogical expedition in my life, providing 22 country records (of named species), because of the very interesting, species rich and hitherto not explored area. During this trip I was lucky to collect as many as five species and two subspecies new to science, which I described in separate papers (Kosterin 2015a-c, e; 2016b-c; Kosterin & Yokoi 2016): *Indolestes gracilis expressior*, *Coeliccia poungyi dasha*, *Onychargia priydak*, *Prodasineura hoffmanni*, *Asiagomphus reinhardti*, *Euthygomphus schorri* and *Risiophlebia guentheri*; not counting four species needing further studies, including *P. verticalis* sensu Asahina, 1984, which is known as undescribed for about 16 years, so literally not being new to science. It is noteworthy that I collected two of new species (*O. priydak* and *E. schorri*) on my first day in the region and three of those (*O. priydak*, *P. hoffmanni* and *R. guentheri*) on my 51th birthday, June 16, spent in complete solitude at Dak Dam village (but two of them were collected also in other days). (Earlier I spent my 50th birthday also in solitude but in a hospital, suffering from Katayama fever after my earlier trip to Ratanakiri Province.) No doubt, Mondulkiri Province deserves more study, especially along the road under construction to Ratanakiri Province, which will cross the elevated savannah area of the eastern Cambodia further north.

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