

Odonata of Phnom Kulen Mts, Cambodia: a preliminary checklist

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Abstract

Phnom Kulen is a small and low plateau in the northern Cambodia still partly covered with evergreen forests and isolated from similar habitats by the Cambodian Lowland at least for 60 km. A preliminary checklist of its Odonata is provided, including 97 species. *Burmagomphus* sp. cf. *willamsoni* and *Macromia callisto* are for the first time reported for Cambodia.

Key words: Odonata, dragonflies, damselflies, fauna, Cambodia, Phnom Kulen Mountains, evergreen forest, androchromatic females in *Neurothemis fluctuans*

Introduction

Phnom Kulen are twin small (in sum ca 46 km long) and low (ca 200-487 m a.s.l.) bipartite plateaux which appear to be an island of evergreen rainforests amidst the Cambodian Lowland (Fig. 1), which is scarcely elevated above the sea level and almost totally converted to arable land. It was interesting to investigate the fauna of Odonata of Phnom Kulen, both as providing promising habitats, including nearly pristine ones, and as an isolate from similar habitats elsewhere. The closest similar forests are found at the same low Dangrek Mountains some 60 km to the north. Of odonatologists, only Haruki Karube visited Phnom Kulen in 2000 but his data were not published. Here we provide a preliminary checklist of Odonata of Phnom Kulen based on data of different kind contributed by the authors: photographic data by Eddie Smith (E.S.) for 2012-2020 and focused odonatological research, including observing and some collecting, by Oleg Kosterin (O.K.) in 2017-2019. More studies were planned to complete the goal, but since the work in 2020 unexpectedly appeared impossible it worth publishing the existing data at least as a starting point for further research.

Methods

E.S. has been photographically recording Odonata of Phnom Kulen Mts, among other wildlife, since 2014, using cameras SONY DSLR-A100, SONY DSLR-A850, SONY

DSC-RX100M2 and before 2016 and SONY SLT-A99V since 2016. Being a microlight pilot he made preliminary scouting for promising habitats (streams and reservoirs) from the air. His photos are considered and identified by O.K. O.K. has visited Phnom Kulen specially for searching Odonata on 23.02.2017; 11-12.06.2018, 14.06.2018, 17.06.2018, 30.06.2018, 1.07.2018, 3-4.11.2018, 6.11.2018, 10-11.03.2019, 28-30.03.2019; 2.12.2019, 11.12.2019 (dates are provided in dd.mm.year format), 17 days in total. He registered common species by sight or photography and collected few specimens with a hand net when necessary; these are stored in the author's collection and Naturalis Biodiversity Center, Leiden, the Netherlands. The photos of Odonata by E.S. were mostly presented in the Facebook group 'Natural Cambodia' and partly in iNaturalist.org (see the user @hondapcx), all photos by O.K. are presented in iNaturalist.org (see the user @oleg_kosterin); both photo sets are easy to find in iNaturalist under the project 'Odonata of Cambodia'. Coordinates, in the decimal degree format, were recorded by O.K. with Garmin eTrex H personal GPS navigator but their ranges for the areas actually examined were revised using Google Earth; E.S. recorded them automatically since 2016 by GPS navigator embedded in the camera SONY SLT-A99V. Since the data by O.K. and E.S. so differ in their nature and approach, in the annotated list below they are provided separately for each species, after the headers O.K. and E.S. For the data by O.K. their nature are indicated as follows: collected specimens - "collected"; natural photographs (taken with Canon EOS 350D camera with a Sigma AF 24-70 mm F2.8 EX DG MACRO lens) - "photo"; visual observations - "seen"; all data by E.S. are photographs by default. Before 2016, he used cameras without embedded GPS navigator and marked photos as taken generally in Phnom Kulen. Their more precise provenance cannot be traced, so they are provided under the header 'Not located'. All such photos were made in the eastern plateau. (However, some of E.S.'s photos for that period were located in his annotations in Facebook posts). The authorship of the photographs below is indicated as O.K. (Oleg Kosterin) and E.S. (Eddie Smith).

The area

The Phnom Kulen Mts are situated in the northern part of Siem Reap Province and are two twin pear-shaped sandstone plateaux extended from NW to SE and directed by their narrow ends towards each other, with a 1.5 km wide gap between them (Fig. 1), through which National Road 67 goes from Siem Reap to Anlong Veng. The NW plateau has the dimensions of 20×11 km, the SE plateau 28×15 km. They have nearly flat, moderately elevated (from ca 200 to 487 m a.s.l.) surfaces (Figs 2-3) but quite steep slopes (Fig. 4), however the NW plateau has a branchy, lower but rocky western spur. Since the plateaux get at least rare small rains even in the dry season, the natural vegetation of the top surface is evergreen rainforest (Fig. 5) and that of the slopes is sparse deciduous forest (Fig. 4). Both in general appearance and in biogeographical sense Phnom Kulen is a forest island among vast open landscapes – deforested farmland to the south and open low deciduous forests of *Dipterocarpus intricatus* Dyer to the north. (There is no surprise that Phnom Kulen served among the last Khmer Rouge strongholds.) The SE Plateau is drained by a considerable river known under the names O'Dar, Prey Thom, 1000 Linga River, Chup Preah and Siem Reap (these

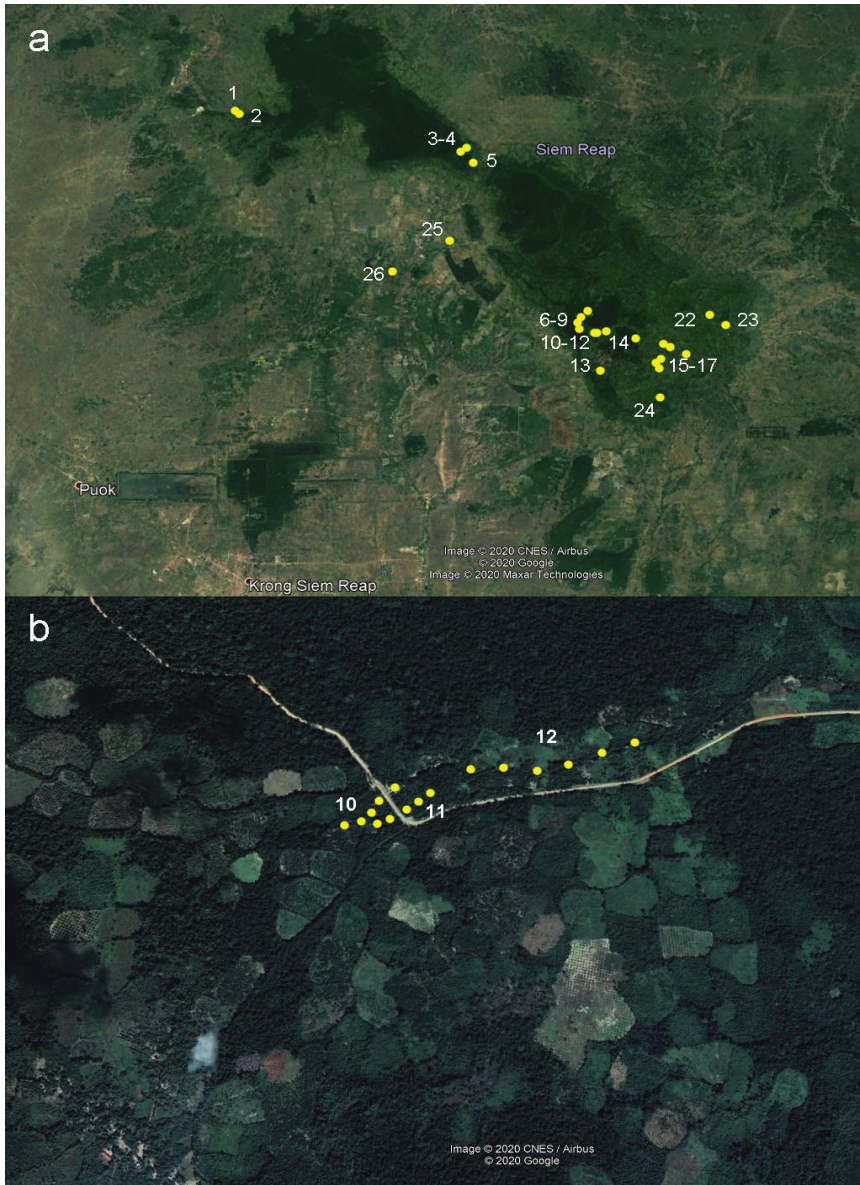


Figure 1. Disposition of localities studied (Loc. 1– Loc. 26), shown as dots, in the Phnom Kulen Mountains and of Loc. 10 – Loc. 12, shown as series of dots, in a larger scale image. Locality numerals are indicated, for explanation see the text. The images are adopted from Google Earth.



Figure 2. A view on the Phnom Kulen eastern plateau from the south, 25.09.2019. E.S.



Figure 3. A view on the Phnom Kulen eastern plateau from the east; see the new road being constructed. February 2019. E.S.

names more or less change from the sources towards downstream). For simplicity further in the text this river will be mostly referred to as the Siem Reap River. It has a famous tall waterfall (Fig. 6) being a good dragonfly place. Both plateaux have many smaller rivers and brooks. In the SE part of the SE plateau there are some areas of flat sandstone outcrops with sparse savannah-like vegetation (Khmer 'veal'), the largest (1.7×1 km) situated to the east of Thmei village. There is a remarkable 'floating forest' at Tnal Mareh terrain, where a branchy stream flows through a swamped forest with trees producing numerous pointed pneumatophores, strongly resembling mangroves (Fig. 7). Such floating forest was said to exist also at Tmar Truonh village. A



Figure 4. Western foothills of the Phnom Kulen eastern plateau:
16.12.2019, E.S. (top), 10.03.2019, O.K. (middle), 11.06.2018, O.K. (bottom).

similar habitat was examined by O.K. in 2019 in Prey Long Forest in Stung Treng Province (Kosterin 2020a). However, it is unclear if these habitats are fully natural or formed in the bottoms of the former big water reservoirs after them being destroyed (at least a thousand years ago Tnal Mareh served as a clay quarry for a ceramic factory).

The SE plateau has been densely inhabited for not less than a thousand years and always was a sacred place. There in 802 Jayavarman II proclaimed the independent Khmer Empire (Kambujadesa) with the capital of Mahendraparvata (the same name being applied to the mountains). In later decades he left it in favour of the new capital Hariharalaya at Lake Tonle Sap. Later Phnom Kulen served a source of stone blocks for construction of the famous temples of the Angkorian complex, which were transport-



Figure 5. Evergreen forest on the upper part of the western slope of the Phnom Kulen eastern plateau, 11.06.2018, O.K.

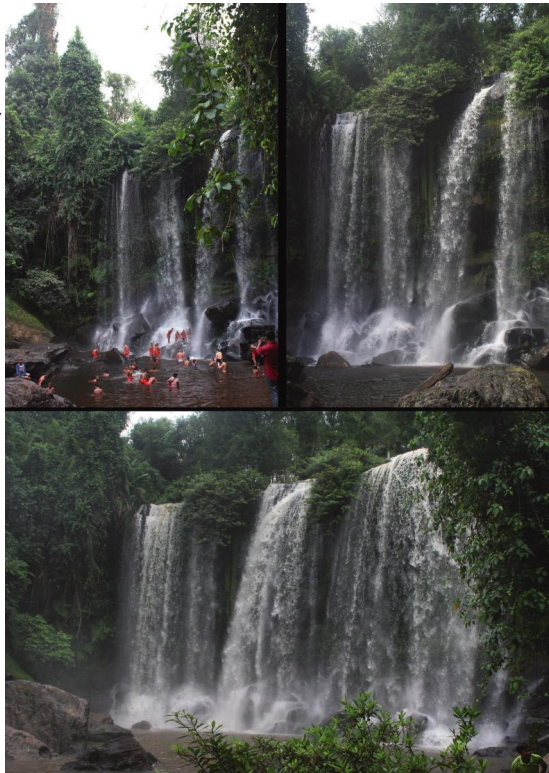


Figure 6. The Phnom Kulen Waterfall (Loc. 8) with varying amount of water: 23.02.2017 (top left), 12.06.2018 (top right) and 17.05.2018, O.K.



Figure 7. 'Floating forest' at Tnal Mareh terrain (Loc. 17). Numerous pneumatophores are seen in the left and right bottom photos. 28.11.2019, O.K. A habitat of *A. viola*, *C. cerinorubellum*, *P. williamsoni*, *C. vittata*, *P. ciliata*, *B. oculata*, *Nannophya pygmaea*, *N. fluctuans* etc.

ed from there to the Lake Tonle Sap vicinities via impressive artificial channels. Phnom Kulen harbours remarkable monuments of the pre-Angkorian period: thousands of lingas carved (to provide fertility downstream) in the bottom of the Siem Reap River (Fig. 8), the biggest in Cambodia Buddah statue called Preah Ang Thom, two ancient elephants carved from rocks, Damrei Krab (Fig. 9a) and Damrei Sras (Fig. 9b), and quite a number of pre-Angkorian temple ruins of different state of preservation. At the Rong Chen Archaeological Protected Area a ceramic factory was founded at the same time when the Empire was proclaimed and have been existing for half a century, so that the ground under the forest is presently full of broken ornamental ceramics (Fig. 10). There were not less than four big artificial water reservoirs (Khmer 'baray'): Ta Penh, Tnal Dach (the present name, 'broken dam' in Khmer), Srae Tbong and Tnal Mareh. However, the dams were destroyed by American bombing in the course of the so-called Operation Menu in 1969-1970 so that three of them have no more water and only the dam and reservoir of Tnal Dach (Fig. 11) was restored in 2012. The traditional land use on the SE Phnom Kulen plateau is 'circle agriculture' (a kind of slash-and-burn agriculture): the forest is cleared and burnt in a rounded territory some 150-200 m in diameter, crops are grown, then the circle is abandoned and re-used each 6-7 years. At present most of the plateau surface, as viewed from above (Fig. 1b), is a mosaic of adjacent cleared circles separated with narrow bor-



Figure 8. Numerous 'lingas' carved in the sandstone bottom of the main river of the eastern plateau of Phnom Kulen (the Siem Reap River) (Loc. 7): 23.02.2017, O.K. A habitat of *V. gracilis*, *N. chinensis*, *Euphaea* sp., *B. contaminata*, *O. chrysis*, *O. glaucum*, *O. neglectum*, *O. sabina*, *T. aurora*, *T. festiva* etc.



Figure 9. Elephants carved from sandstone rocks on the eastern Phnom Kulen Plateau, Damrei Krab (a) and Damrei Sras (b), 30.06.2018, O.K.

ders of remaining forest trees. In 2003, cashew was introduced and since 2008–2009 the cashew growing appeared the predominant land use. Only some areas of pristine forest are still protected, like Preah Thom (Khmer 'big forest') Community Protected Area (ca 5×3 km) at the Preah Ang Thom and the waterfall. Presently a good paved road is being constructed through the SE plateau (Fig. 3), said to serve for construction of a town of luxuriant villas, naturally for Chinese money.



Figure 10. Shards of the Kambujadesha time ceramics piled at Rong Chen Archaeological Protected Area, near Tnal Mareh terrain (Loc. 17), 28.11.2019, O.K.



Figure 11. Tnal Dach Reservoir (Loc. 20) as viewed from the air, 15.06.2019, E.S.





Figure 12. Carvings in the sandstone bottom of the Kbal Spean River on the western Phnom Kulen Plateau (Loc. 4), 14.06.2018, O.K.



Figure 13. The river (Loc. 1) 12 km NNE of Phnom Peung Tanon Resort at the lowering western spur of the western Phnom Kulen Plateau, 25.12.2019, E.S. Habitat of *I. senegalensis*, *P. australasiae*, *P. rubriceps*, *B. contaminata*, *C. servilia*, *O. luzonicum*, *O. sabina*, *T. aurora*, *T. festiva*, *T. pallidinervis* etc.

For some reason the NW plateau remains unexplored and undisturbed, still being covered with vibrant pristine rainforest. However, the Kbal Spean (Khmer 'head bridge') River in its SE part is famous for the linga carvings in its bottom, even more impressive than those on the SE Plateau (Fig. 12). The lowering wester spur of this plateau has high rocks but is scarce in water.

Localities examined

The localities are numbered and given short nicknames (provided in the list in brackets), both are alternatively mentioned in the text below. Their disposition is shown in Fig. 1. Dates of examination by O.K. (if any) are provided; and of examination by E.S. for localities not examined by O.K. In the captions to photographs illustrating habitats, either the most common (but not obviously immigrated from elsewhere) or most interesting dragonfly and damselfly species occurring therein are mentioned.

Western plateau

Loc. 1 (Peung Tanon River): a small river 900 m downstream (NW) of its leaving the low and rocky W spur of the western plateau of Phnom Kulen Mts. It flows through an open area with fields and plantations (Fig. 13). It is shallow, fast and clear, the bottom clayey, red, mostly firm but at some places sticky. The river bed is converted into a rice field so that rice grows immediately from shallow branching streams. Upstream of the road the river becomes deeper and narrow, further upstream there is a small dam and a pond. 12 km NEE of Phnom Peung Tanon Resort, 13.724–727°N, 103.849–850°E, 106–108 m a.s.l. Examined by O.K. on 11.12.2019.

Loc. 2 (Peung Tanon brook): an overgrown brook among cassava fields at the foothill of the western spur of the western plateau in the Phnom Peung Tanon Resort environs. The water is hidden under bushes woven by winding plants including ferns, with few tiny open pools. The downstream end of the examined part is more open, approached by forest remnants at the high right bank. 13.717–719°N, 105.853–855°E, 117–122 m a.s.l. Examined by O.K. on 11.12.2019.

Loc. 3 (Kbal Spean River valley): the Kbal Apean River valley downstream of the linga carvings, flowing (sometimes disappearing) through a natural staircase of large sandstone rocks in lush evergreen forest. There is a small waterfall just downstream of the carvings. 13.6846–6860°N, 104.016–017°E, 185–192 m a.s.l. Examined by O.K. on 14.06.2018; 6.11.2018.

Loc. 4 (upstream of Kbal Spean): the Kbal Spean River valley upstream of (Fig. 14) and at (Fig. 12) the carvings, flowing calm and flat half-shaded by pristine evergreen forest (rather open at the carvings). The water is clear, the depth varies from very small on sandy and flat stone bottom to knee deep, in such deep places with much litter and sucking silt. The course is frequently crossed by fallen trees and rattans. Some small patches of *Colocasias* indet. and *Lasia spinosa* (L.) Thwaites at banks. 13.686–692°N, 104.013–017°E, 192–212 m a.s.l. Examined by O.K. on 14.06.2018; 6.11.2018.

Loc. 5 (Kbal Spean headquarters): the same rivulet as above flowing along the eastern plateau foothills, at the national park entrance, having just left the mountains;



Figure 14. The Kbal Spean River on the western Phnom Kulen Plateau upstream of the carvings (Loc. 4), 14.06.2018, O.K. Habitat of *V. gracilis*, *Euphaea* sp., *H. biforata*, *R. viridatum*, *C. vittata*, *P. verticalis* sensu Asahina, *Gomphidia* sp., *M. rapida*, *R. obsolescens* etc.

hidden in tall grass including *Colocasiae* indet. 13.679–680°N, 104.023–026°E, 78–80 m a.s.l. Examined by O.K. on 14.06.2018; 6.11.2018.

Eastern plateau

Loc. 6 (upstream of carvings): the shady reaches (Fig. 15) of the Prey Thom (O'Dar, Siem Reap) River reaches upstream its reach with linga carvings, evergreen forest (seemingly secondary), 750–1400 m SW the waterfall, 650–1000 m W-SW Preah Ang Thom. A medium-sized, moderately fast shallow river, most of the day shaded, with a sandy bottom and low earthy bluffs at banks. Some open places at the left bank. There is a spring being a small deep roundish pool, devoid of any vegetation, with ice-cold water visibly going from the pale-grey bottom (Fig. 16). 13.560–567°N, 104.100–102°E, 290–295 m a.s.l. Examined by O.K. on 23.02.2017; 11-12.06.2018; 4.11.2018.

Loc. 7 (carvings): the Prey Thom (O'Dar, Siem Reap) River reach ('the River of 1000 Linga') with linga carved in the bottom (Fig. 8), surrounded by evergreen forest, 500–750 m SW the waterfall, 350–650 m W-SW Preah Ang Thom. The river bed mostly open and sunlit. Just downstream the bridge the right bank outlines an open area 270×100 m of flat sandstone rocks. There the river is very shallow and slow; then it passes rapids and a considerable ledge (Fig. 17) and then flows fast over rocks, in shade. There is a tiny but not so shallow roadside pool with *Nymphaea* sp. on the open flat rocks. Behind the rocky area there are secondary thickets with thorny bushes, small glades and ancient ruins. 13.565–567°N, 104.102–105°E, 280–290 m a.s.l. Examined by O.K. on 23.02.2017; 11-12.06.2018; 17.06.2018; 4.11.2018.

Loc. 8 (Kulen Waterfall): the well-known waterfall on the Prey Thom (O'Dar, Siem Reap) River, 500 m N of Preah Ang Thom (Fig. 6). Two tiers, the higher some 5 and the lower some 30 m high, a big pool under the latter, with big boulders at its banks; evergreen forest on the valley slope; small glades and an open trading area above, 13.568–569°N, 104.106–108°E, 270–290 m a.s.l. Examined by O.K. on 23.02.2017; 11-12.06.2018; 17.06.2018; 30.06.2018; 4.11.2018.

Loc. 9 (downstream of Kulen Waterfall): the rapidous Prey Thom (O'Dar, Siem Reap) River flowing in evergreen forest downstream the waterfall; moderately fast to fast, depth variable, large solitary rocks, an open place with a high ledge. 500–800 m N–NNE of Preah Ang Thom, 13.569–572°N, 104.108–109°E, 250–270 m a.s.l. Examined by O.K. on 11.06.2018; 17.06.2018; 30.06.2018.

Loc. 10 (2nd bridge): the right bank of the Prey Thom (O'Dar, Siem Reap) River flowing in evergreen forest remnants between the second bridge and the brook mouth at its left bank; shady downstream of the bridge and open for some distance upstreams (Fig. 18). Rather shallow, speed moderate. 1.2 km SE of Preah Ang Thom, 13.5532–5548°N, 104.1167–1181°E, 298–300 m a.s.l. Examined by O.K. on 12.06.2018; 17.06.2018; 30.06.2018; 4.11.2018.

Loc. 11 (Kulen brook): an overgrown brook, the left Siem Reap River tributary, flowing through evergreen forest remnants and small cashew plantations, with clear, slightly brownish water. Mostly overgrown with walls of thick and tall vegetation (in more open places at the lowermost reach represented mostly by forked fern). There is an open pool at the road to village Thmei, through which the brook flows through three



Figure 15. A shady reach of of the main river of the eastern plateau of Phnom Kulen (the Siem Reap River) upstream of the linga carvings, flowing through secondary forest (part of Loc. 6), 12.06.2018, O.K. Habitat of *D. gloriosa*, *H. biforata*, *L. hyalina*, *R. viridatum*, *L. nodalis*, *A. rubescens*, *P. pruinatum*, *P. williamsoni*, *C. marginipes*, *M. alani*, *Onychothemis testacea*, *O. chrysis*, *R. obsolescens*, *Z. iris* etc.



Figure 16. A cold spring at the shady bank of the Siem Reap River upstream of the linga carvings (part of Loc. 6), 4.11.2018, O.K. At this spring single males of *Brachygonia oculata* were twice registered by E.S., on 24.07.2015 (Fig. 55b) and 6.10.2015.



Figure 17. The ledge at the Siem Reap River downstream of the linga carvings (part of Loc. 7), 11.06.2018, O.K. Habitat of *N. chinensis*, *V. gracilis*, *D. gloriosa*, *Euphaea* sp., *H. biforata*, *P. verticalis* sensu Asahina, *T. aurora*, *Z. iris* etc.

pipes ca 1.5 km in diameter, from which the water is seeping over algae-clad concrete plate. The upper reaches crossed by many fallen trees and rattans, with sandy bottom but silty deep places (Fig. 19). The lowest reach downstream of the road



Figure 18. The shady reach of the Siem Reap River downstream of the 2nd bridge (Loc. 10), 4.11.2018, O.K. Habitat of *N. chinensis*, *V. gracilis*, *D. gloriosa*, *Euphaea* sp., *H. biforata*, *C. marginipes*, *Gomphidia* sp., *B. contaminata*, *Onychothemis testacea*, *O. chrysis* etc.

Figure 19. The brook of Loc. 11 hidden in evergreen forest remnants, 4.11.2018, O.K. Habitat of *V. gracilis*, *L. hyalina*, *A. pallidum*, *A. viola*, *M. aborense*, *C. marginipes*, *C. vittata*, *P. verticalis* sensu Asahina, *M. alani*, *Nannophya pygmaea*, *N. fluctuans*, *O. pulcherrima*, *O. chrysis*, *R. obsolescens* etc.





Figure 20. The lowermost reach of the brook of Loc. 11 with round holes in its sandstone bottom, in the dry season, 10.03.2019 (left) and the rainy season, 12.06.2018 (right); O.K. A possible breeding site of *Gynacantha subinterrupta*, *Idionyx thailandica* and *Macromidia rapida*.

over flat sandstone rock with big (up to a metre in diameter) and deep round holes (such holes are made by harder stones lying on sandstone and moved by the current) (Fig. 20). At the end of the dry season, in March 2019, the brook was completely dried out, with some water left only in the round holes. Among the best places. 1.2–1.9 km SE of Preah Ang Thom, 13.553–554°N, 104.117–120°E, 301–330 m a.s.l. Examined by O.K. on 12.06.2018; 17.06.2018; 30.06.2018; 4.11.2018, 30.11.2019.

Loc. 12 (upstream of 2nd bridge): the Prey Thom River (O'Dar River, Siem Reap River) ~2 km SE of Preah Ang Thom. Most open and sunny, partly shaded river with a slow to fast but smooth current (Fig. 21), from knee-deep to waist deep, in some places man height deep. The bottom is formed by flat sandstone rocks, with sandy patches, the banks are overgrown with Poaceae grass and some Colocasiae. Near the upstream part of the studied section there is a ledge with a low 'waterfall', at which a brook enters from the left side. Upstream of this place the river flows broadly and very slowly. Some cashew plantation at the left bank and a recently cleared area at the right bank. One of the richest dragonfly places. 13.5547–5560°N, 104.1211–1266°E, ~300 m a.s.l. Examined by O.K. on 4.11.2018, 30.11.2019.

Figure 21. The half-shaded calm reach of the Siem Reap River upstream of the second bridge (Loc. 12), 11.03.2019 (top), 4.11.2018 (middle), 30.11.2019 (bottom), O.K. Habitat of *N. chinensis*, *V. gracilis*, *H. biforata*, *L. hyalina*, *L. lineata*, *R. viridatum*, *A. rubescens*, *P. australasiae*, *P. rubriceps*, *P. pruinatum*, *P. williamsoni*, *C. vittata*, *P. verticalis sensu Asahina*, *P. ciliata*, *P. capricornis*, *M. cupricincta*, *A. panorpoides*, *B. contaminata*, *D. nebulosa*, *N. fluctuans*, *Onychothemis testacea*, *R. rufa*, *R. phyllis*, *R. triangularis*, *R. variegata*, *T. aurora*, *Zygonyx iris* etc.





Figure 22. A brook flowing over an open area of flat sandstone rocks (loc. 'veal') on the eastern Phnom Kulen plateau 1.5 km SE of Thmei village (Loc. 13). 30.06.2018, O.K. Habitat of *V. gracilis*, *P. verticalis sensu Asahina*, *N. fluctuans*, *O. chrysis*, *Z. iris* etc.



Figure 23. The bottom of the Srae Tbong former reservoir, with a river flowing through swampy grassland (part of Loc. 15). 28.11.2019, O.K. Habitat of *A. minima*, *D. nebulosa*, *O. luzonicum*, *P. sexmaculata* etc.

Loc. 13 (veal brook): an overgrown brook on a savannah clad, nearly barren sandstone plateau ('veal') 1.7 × 1 km, 1.5 km SE of Thmei village. A chain of pools, up to knee-deep, over sandstone. Downstream of the road the brook flows shallowly over flat sandstone rocks, with some deeper pools; hidden in low and thick forest patch (Fig. 22). Upstream of the road there is at first a long waist-deep shady reach, further upstream

it flows in a 'channel' of thick low bushes and low trees, knee-deep, mostly filled with a fine *Poaceae* grass. Curiously, although this brook flows amidst dry barren rock plates, it had hardly less amount of water in the late dry season (March 2019) than in the rainy season (June 2018). 13.523–524°N, 104.119–121°E, 320–326 m a.s.l. Examined by O.K. on 30.06.2018, 11.03.2019.

Loc. 14 (forest border): the valley of the stream flowing from the three next localities, to join the Siem Reap River in 150 m, along the border of the protected Prey Thom Forest and a cashew plantation area; here crossed by the road from Preah Ang Thom to Anlong Thom; 13.548–549°N, 104.147–148°E, 313–325 m a.s.l.. No water in the dry season. Examined only by E.S. on 3.12.2018 and 7.12.2018.

Loc. 15 (Srae Tbong): 1.9 km SW of Anlong Thom village, the E margin of a former large (700×600 m) reservoir called Srae Tbong, now filled with open grassy floating bog, with hanging grass mats soaked with water of numerous river arms flowing through (Fig. 23). Some trees and a rice field at margins. 13.5234–5240°N, 104.1574–1582°E, 332–335 m a.s.l. Examined by O.K. on 28.11.2019.

Loc. 16 (Srae Tbong River): the medium-sized river flowing from the previous place (Loc. 15) to the next place (Loc. 17), from ankle- to neck-deep, with partly firm and partly sucking bottom, bordered by trees. Examined by O.K. on 28.11.2019 downstream (north) of the bridge and the broken dam of Srae Tbong, 13.5258–5269°N, 104.1558–1564°E, 333–335 m a.s.l. E.S. examined a nearby patch of the swamped forest, similar to that of the next locality (Loc. 17) at the dam (13.5256–5259°N, 104.1558–1564°E) on 28.07.2019, 27.10.2019 and 7.11.2019.

Loc. 17 (Tnal Mareh): 1.3 km SW of Anlong Thom village, Rong Chen Archaeological Protected Area, Tnal Mareh terrain, the place of the ancient ceramic factory founded in the first years of IX century. A broad (240×150 m) depression (perhaps the former source of clay for the factory) filled with a shady, low 'floating forest' swamped with a branching rivulet, presumably dominated with *Rhizophora* sp., with numerous pointed pneumatophores as at seaside mangroves (Fig. 7). The rivulet arms up to waist-deep, some nearly stagnant, some with a fast current. A more open shallower channel, bordered with bushes, 100 m long, goes at right angle to the river course. A narrow (145×15 m) boggy pasture (a former rice field) with spikerush nearby. The slightly elevated right bank occupied with evergreen forest, with the soil filled with numerous ceramic shards, often finely ornamented (Fig. 10). A bushy pasture at the left bank. 13.528–530°N, 104.157–160°E, 333–336 m a.s.l. Examined by O.K. on 28–30.11.2019.

Loc. 18 (cashew): 600 m NW of Anlong Thom village, the O'Dar River smoothly flowing among remnants of forest trees through cashew plantations over even flat sandy bottom, half-shaded by forest trees. 13.5412–5417°N, 104.1628–1638°E, 325–328 m a.s.l. Examined by O.K. on 10.03.2019.

Loc. 19 (Anlong Thom): 500 m NE of Anlong Thom village. The O'Dar River flowing shallowly over a sandstone bed by a big open savannah-like glade, evergreen forest remnants and a cashew plantation. The following reaches change from one to another from downstream to upstream: (i) a riffly part by cashew plantation, used by locals for washing, (ii) a waist-deep long pool, (iii) a long curious reach with water seeping over very smooth slanting rock covered with wet water moss, (iv) a very shallow reach flowing over flat sandstone plate, with a tall 'wall' of forked fern at the



Figure 24. The dam of the Tnal Dach Reservoir (Loc. 20). (The bottom photo shows *Nepenthes mirabilis* floating in water along with the aquatic carnivorous plant *Utricularia aurea*). 29.11.2019, O.K.

right bank and forest remnants at the left bank, (v) a shaded deep reach under tree canopy, (vi) a small rather dirty pond (again used by locals for washing) behind a small low dam (vii) further upstream the river. hidden in scrub, narrowly flows through a chain of pools. Among the best places. 13.541–542°N, 71 104. 168–170°E, 336–340 m a.s.l. Examined by O.K. on 10.03.2019, 28–29.11.2019.

Loc. 20 (Tnal Dach): 800 m NE of Anlong Thom village, Tnal Dach Reservoir (320 × 300 m) (Fig. 11). Its dam was destroyed by American bombing and restored in 2012. A long and high dam with tall trees (Fig. 24), a cashew plantation below it. At the dam the depth varies from chest to man height; the banks are steep, densely overgrown with Poaceae, *Cyperus* and *Lygodium*; there are some small islands of the same vegetation (Fig. 25b). The lateral banks are shal-



Figure 25. The Tnal Dach Reservoir (Loc. 20): the river outlet (a), the steep grassy bank at the dam (b) and a shallow S bank (c). 29.11.2019, O.K. Habitat of *A. borneense*, *C. cerinorubellum*, *P. calamorum*, *P. australasiae*, *P. williamsoni*, *O. atrocyana*, *P. ciliata*, *I. decoratus*, *A. panorpoides*, *A. gracilis*, *B. chalybea*, *B. farinosa*, *B. sobrina*, *C. servilia*, *D. nebulosa*, *H. croceus*, *I. limbata*, *Nannophya pygmaea*, *N. fluctuans*, *O. sabina*, *T. pallidinervis*, *R. phyllis*, *R. triangularis*, *U. signata* etc.

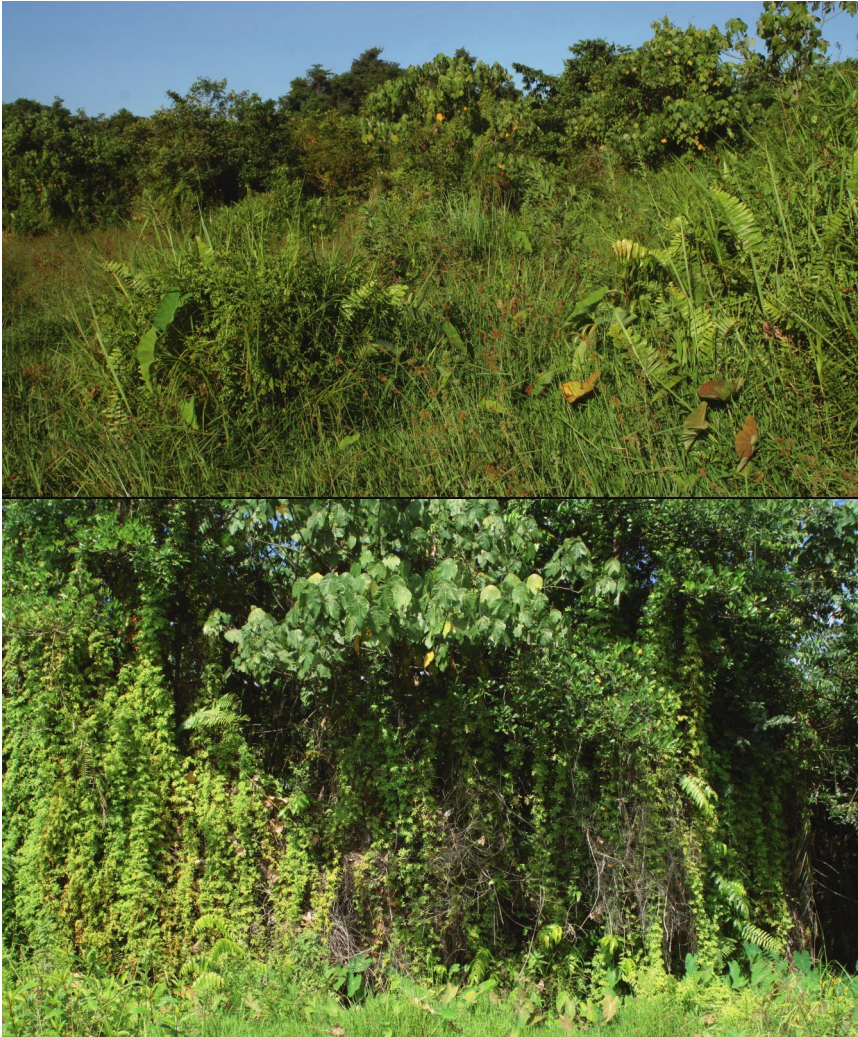


Figure 26. Grass and bushes over shallow running water at the Tmar Truonh terrain (Loc. 21). 29.11.2019, O.K. Habitat of *V. gracilis*, *A. femina*, *A. minima*, *C. cerinorubellum*, *P. williamsoni*, *P. ciliata*, *D. nebulosa*, *Nannophya pygmaea*, *N. fluctuans*, *O. luzonicum* etc.

low, with quite a lot of dead trees standing in the water (which grew there before the dam was restored). At the northern end of the dam a concrete outlet (Fig. 25a) is constructed of the Prey Thom, O'Dar River, or Siem Reap River (Locs 6-10, 12, 18-19), here rather a small rivulet flowing in a deep shady valley. At this place the reservoir is shallow and its bottom sandy and firm. There is a very shallow bay at the

S dam corner, with emerging Poaceae and Cyperaceae grass (Fig. 25c) and then *Nepenthes mirabilis* (Lour.) Rafarin floating in water side-by-side with *Utricularia aurea* Lour. (Fig. 24, bottom). At the dam northern end there is an isolated shallow pool with golden fishes. The northern bank is densely overgrown with tall grass and somewhat swampy. Among the best places. 13.5395–5423°N, 104.1730–1758°E, 344–348 m a.s.l. Examined by O.K. on 28–29.11.2019.

Loc. 21 (Tmar Truonh): 1.5 km W of Tmar Thruonh village, Srae Tmar Truonh terrain. A big (320×160 m) open area occupied with rice fields. The above mentioned O'Dar (Prey Thom or Siem Reap) River outlines its northern margin. It is hidden by trees, braided with winding ferns, and forms a grassy floating bog like at Loc. 15, with hanging grassy mats soaking with water (Fig. 26) and alternating with narrow courses of fast flowing clear water. 13.5383–5385°N, 104.1808–1820°E, 351–353 m a.s.l. Examined by O.K. on 29.11.2019.

Loc. 22 (Sangkae Leak village environs); a small stream with cold and very clean water and solid bottom of small stones and sand, the valley shaded by trees. 13.5642–5646 N, 104.1955–1956 E, 352 m a.s.l. Examined only by E.S. on 25.11.2019.



Figure 27. The Siem Reap River at the first bridge after its leaving the eastern plateau of Phnom Kulen for the lowland, 2.5 km SE of Khum village (Loc. 25). 2.12.2019, O.K. Habitat of *D. gloriosa*, *L. lineata*, *P. australasiae*, *P. rubriceps*, *P. williamsoni*, *P. autumnalis*, *P. coerulescens*, *Burmagomphus* sp. cf. *williamsoni*, *M. kerri*, *C. servilia*, *O. chrysis*, *O. neglectum*, *T. aurora*, *T. festiva* etc.



Figure 28. The Siem Reap River upstream of (a), at (b) and downstream of (c) the bridge in Banteay Srei village (Loc. 26); a – 1.07.2018; b-c - 2.12.2019, O.K. Habitats of *N. chinensis*, *V. gracilis*, *D. gloriosa*, *L. lineata*, *P. williamsoni*, *C. malaisei*, *P. autumnalis*, *P. coerulea*, *P. ciliata*, *E. yunnanensis*, *I. decoratus*, *M. kerri*, *P. capricornis*, *M. aculeata*, *B. contaminata*, *D. trivialis*, *C. servilia*, *N. fluctuans*, *N. fulvia*, *Onychotemis testacea*, *O. chrysis*, *O. neglectum*, *O. sabina*, *T. aurora* etc.

Loc. 23 (Ta Penh): 500–600 m N of Ta Penh village. A brook passing, under trees, a gap in an ancient dam, crossing a big pasture and then running along a scrub with trees and forked fern, then entering it. Mostly shallow, at some places boggy, amidst a pasture there is a big grassy widening. 13.5555–5571°N, 104.2115–2139°E, 365–367 m a.s.l. Examined by O.K. on 10.03.2019.

Loc. 24 (Thma Dab Temple): 150 m E of the Thma Dab Temple ruins, a small and very clean stream in a very thick, hardly penetrable forest. There is some water even in the dry season. Soil sandy with just a bit of mud and no rocks. 13.5016°N, 104.1609–1610°E, 344 m a.s.l. Examined by E.S. on 14.03.2020.

Additional localities at the Siem River reaches shortly downstream of its descend from the mountains to the lowland:

Loc. 25 (closest bridge): the Siem Reap River at the first bridge 5.5 km downstream of its leaving the mountains (Fig. 27). A long sunny reach, ankle to waist deep, surrounded by 'walls' of thick bushes and trees; some logs in water. Arable land, plantation and forest remnants around. 2.5 km SE of Khum village, 13.619–620°N, 104.006–007°E, 60 m a.s.l. Examined by O.K.: 2.12.2019.

Loc. 26 (Banteay Srei): the considerable Siem Reap River at the bridge in Banteay Srei village (Fig. 28). The bottom is sandy with some stones (under the bridge they are piled deliberately); the current is fast (at narrower parts hard to go against it) but smooth. Upstream of the bridge the river is open, mostly shallow but with some man-height deep places (Fig. 28a); downstream of the bridge from knee- to waist-deep and mostly shady (Fig. 28c). The sandy banks are overgrown with giant spiny bamboo and other thickets; the right bank with a shallow bay with a patch of fine inundated grass and *Marsilea* sp.. 2.3 km W of Phnom Diy Hill, 13.5950–5965°N, 103.9613–9623°E, 51–52 m a.s.l. Examined by O.K.: 11–12.06.2018; 14.06.2018; 1.07.2018; 3.11.2018; 2.12.2019.

Annotated checklist of Odonata of Phnom Kulen

Calopterygidae

1. *Neurobasis chinensis* (Linnaeus, 1758)

O.K.: **Loc. 7**: 23.02.2017: several ♂♂ seen; 11.06.2018: several ♂♂, ♀♀ seen. **Loc. 8**: 12.06.2018: many ♂♂, ♀♀ seen; 17.06.2018: many ♂♂, ♀♀ seen. **Loc. 10**: 12.06.2018: many ♂♂, ♀♀ seen; 17.06.2018: many ♂♂, ♀♀ seen. **Loc. 12**: 4.11.2018: several ♂, 1 ♀ seen; 11.03.2019: several ♂♂, ♀♀ seen below the small waterfall; 30.11.2019: several ♂♂, ♀♀ seen. **Loc. 26**: 14.06.2018: many ♂♂, several ♀♀ seen; 1.07.2018: several ♂♂ seen; 3.11.2018: 1 ♂ seen; 6.11.2018: 1 ♂ seen.

E.S.: **Loc. 12**: 22.12.2019: ♂. Not located: 4.12.2018: ♂.

Observations. Occurs at half-shaded rivers with fast or slightly turbulent current. Common but not numerous. So far registered only along the main river of the eastern plateau (O'Dar, Prey Thom, or Siem Reap), including its course after leaving the plateau for the plain but still close to it. Active until dusk.

2. *Vestalis gracilis* (Rambur, 1842)

O.K.: **Loc. 3:** 14.06.2018: many seen. **Loc. 4:** 14.06.2018: several seen ; 6.11.2018: many seen. **Loc. 5:** 14.06.2018: several seen. Locs 6-7: 23.02.2017: many ♂♂, ♀♀ seen (wingtips clear); 11.06.2018: very many ♂♂, ♀♀ seen (wingtips darkened). **Loc. 7:** 4.11.2018: several seen. **Loc. 8:** 12.06.2018: many seen; 17.06.2018: many seen; 30.06.2018: many seen; 4.11.2018: many seen; 10.03.2019: many seen. **Loc. 10:** 17.06.2018: many seen; 30.06.2018: many seen; 4.11.2018: many seen. **Loc. 11:** 12.06.2018: many ♂♂, ♀♀ seen (wingtips dark); 17.06.2018: very many ♂♂, ♀♀ seen; 30.06.2018: very many seen; 4.11.2018: many seen; 10-11.03.2019: very many seen; 30.11.2019: several seen. **Loc. 12:** 4.11.2018: many seen; 11.03.2019: very many seen; 30.22.2019: several seen. **Loc. 13:** 30.06.2018: several seen; 11.03.2019: many seen. **Loc. 17:** 29.11.2019: several seen. **Loc. 18:** 10.03.2019: many seen. **Loc. 19:** 10.03.2019: many seen; 28.11.2019: several seen; 29.11.2019: many seen. **Loc. 21:** 29.11.2019: several ♂♂ seen. **Loc. 23:** 10.03.2019: several seen. **Loc. 26:** 14.06.2018: several seen; 1.07.2018: several seen; 3.11.2018: 2 ind. seen.

E.S.: **Loc. 6:** 23.02.2017: ♂, ♀; 16.03.2018: ♀; 4.11.2018: ♂. **Loc. 10:** 20.03.2018: ♂; 4.12.2018: sex uncertain. **Loc. 12:** 13.12.2018: ♂♂; 16.12.2018: ♂. **Loc. 13:** 22.07.2019: ♂. **Loc. 14:** 7.12.2018: sex uncertain. **Loc. 15:** 27.10.2019: ♂; 7.11.2019: ♂♂. **Loc. 18:** 10.03.2019: ♂. **Loc. 19:** 5.03.2019: ♀; 14.05.2019: ♀. Not located: ♂; 6.10.2015: ♂; 15.06.2017: ♂; 18.05.2018: ♀; 28.07.2018: ♂; 4.12.2018: ♂; 22.12.2018: ♂; 7.03.2019: ♂; 12.04.2019: teneral ♂; 24.04.2019: ♂.

Remarks. At Locs 6-7 these demoiselles had clear wingtips in February 2017 but dark wingtips in June 2018 (in other cases this character was not recorded). This is in line with a supposition that imagines with dark wingtips result from larvae developed in late dry season (February/April) which is the hottest time of the year (Kosterin 2011).

Observations. One of the commonest and most abundant Odonata. Imagines congregate at tree-shaded shrubs by banks of small and medium forest rivers.

Euphaeidae

3. *Dysphaea gloriosa* Fraser, 1938 (Fig. 29)

O.K.: **Loc. 6:** 11.06.2018: 1 ♂ seen; 12.06.2018: 2 ♂♂ seen. **Loc. 7:** 11.06.2018: 1 ♂ photo. **Loc. 8:** 12.06.2018: very many ♂♂ seen; 17.06.2018: 2 ♂♂ collected, many ♂♂ seen; 30.06.2018: 1 ♂ collected, very many ♂♂ seen. **Loc. 10:** 12.06.2018: 1 ♂ collected, 2 more ♂♂ seen; 30.06.2018: several ♂♂ seen. **Loc. 25:** 2.12.2019: 1 ♂ photo. **Loc. 26:** 1.07.2018: several ♂♂ seen.

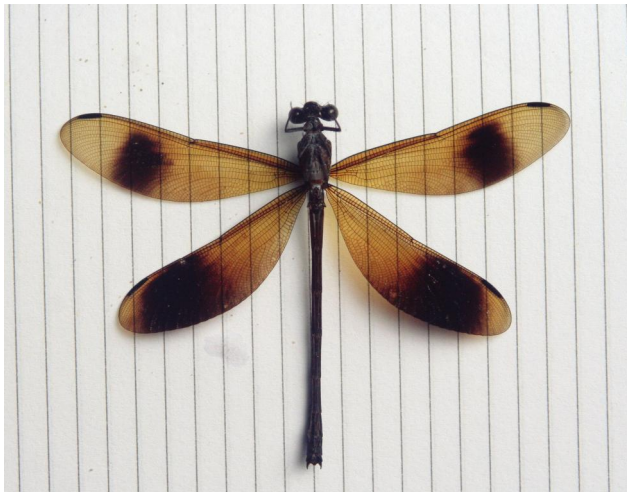
E.S.: **Loc. 10:** 18.05.2018: ♂. **Loc. 25:** 30.05.2019: ♂. Not located: ♂; 15.06.2017: ♂.

Observations. At Loc. 8 on 12.06.2018, at 8:45 a.m. O.K. saw only two males at the rocks below the waterfall, but many of those appeared between 9:30 and 10 a.m.; they perched on rocks or, less frequently, on branches, fought with each other and became not too cautious. They remained active until twilight ca 5:30 p.m. In non-rocky river reaches the males invariably occupy dry branches (either thick or thin) of fallen trees in or near the river (Fig. 29).

Figure 29. A male of *Dysphaea gloriosa* perching on a log at the first bridge of the Siem Reap River after its leaving the Phnom Kulen eastern plateau (Loc. 25), 2.12.2019, O.K.



Figure 30. A male of *Euphaea* sp. from the Siem Reap River at its ledge downstream of the carvings (Loc.7). Line space 5 mm. 11.06.2018, O.K.



4. *Euphaea* sp. (Figs 30-33)

O.K.: **Loc. 3:** 14.06.2018: 8 ♂♂, 2 ♀♀ collected, 1 ♂ photo (Fig. 32b), very many ♂♂ seen. **Loc. 4:** 14.06.2018: very many ♂♂ seen; 6.11.2018: 1 ♀ collected, several ♂♂ seen. **Loc. 7:** 23.02.2017: 1 ♂ collected (Fig. 30); 11.06.2018: 4 ♂♂ collected, 1 ♂ photo (Fig. 31a), 1 ♀ photographed (Fig. 33b) and collected, many ♂♂ seen. **Loc. 8:** 12.06.2018: 4 ♂♂, 1 ♀ collected, 1 ♂ photo (Fig. 31b), many ♂♂ seen; 17.06.2018: many ♂♂ seen; 30.06.2018: several ♂♂ seen; 4.11.2018: several ♂♂ seen. **Loc. 10:** 12.06.2018: many ♂♂ seen; 17.06.2018: many ♂♂ seen; 30.06.2018: many ♂♂ seen; 4.11.2018: many seen. **Loc. 11:** 12.06.2018: several ♂♂ seen; 17.06.2018: several ♂♂ seen; 30.06.2018: several ♂♂ seen; 10.03.2019; 11.03.2019: 1 ♂ seen; 1 ♂ seen. **Loc. 12:** 4.11.2018: 1 ♂ collected, several ♂♂ seen; 11.03.2018: 1 ♂ seen at the small waterfall; 30.11.2018: several ♂♂ seen at the same place.

E.S.: **Loc. 10:** 20.03.2018: ♂ (Fig. 31c); 4.11.2018: ♂; 18.05.2018: ♂. **Loc. 12:** 22.12.2018: ♂ (Fig. 32a); 14.05.2019: ♀ (Fig. 33a). Not located: 30.04.2015: ♂; 19.04.2017: ♂.

Remarks. The *Euphaea* species inhabiting Phnom Kulen is similar to *E. masoni* Selys, 1859 but the males of *E. masoni* have the distinct borders of the black areas in their wings (see e.g. Kosterin 2012: fig. 43) while in all Phnom Kulen males the dark (blackish-brown) coloration, with seemingly the same total amount of melanin, is 'dissolved' over the wing area (Figs 30-31). Both sides of their wings also show a mixture of bluish-green and purple reflections (Fig. 32), versus a dull purple reflex on the upperside only in males of *E. masoni*. Such 'dissolved' males (Kosterin 2017: figs 21, 22a-b) also occur in Stung Treng Province (east of Phnom Kulen, along the Mekong River) at a frequency comparable with that of males with the distinct wing pattern typical for *E. masoni* (Kosterin 2017: fig. 22c). This can be interpreted as either two distinct morphs of the same species, perhaps monogenically controlled, with the 'dissolved' allele fixed in the Phnom Kulen population, or as two sympatric species, with Phnom Kulen as the core area for the undescribed 'dissolved' one. The issue is complicated by rare occurrence of 'discoloured' males, with the wings not only missing distinct spots but also much less melanised on average, across the range of *E. masoni* (Hämäläinen et al. 2019), see an example in Kosterin (2011: fig. 69).

Mature males of *E. masoni* have the face entirely glossy-brownish-black. Those of the related species *Euphaea cyanopogon* Hämäläinen, Kosterin et Kompier, 2019, recently described from Kampongsaom Peninsula and Phu Quoc Island, with discoloured wings, have two indistinct pale spots on the labrum (Hämäläinen et al. 2019). The males from Phnom Kulen exhibit a range of variation between these versions of the labrum coloration: from entirely glossy brownish-black (in about half of male specimens) through having two brownish lightening at the labrum upper margin to the labrum with a pair large yellowish triangular spots. It is unclear if this variation is age-related (there is no noticeable difference in the otherwise phenotype), and if the same variation exists in 'true' *E. masoni*.

Molecular studies, hopefully focused on more than one sequence, could shed light on the taxonomic status of the Phnom Kulen population.



Figure 31. Males of *Euphaea* sp.: a - from the Siem Reap River at its ledge downstream of the carvings (Loc.7), 11.06.2018, O.K.; b - from below the waterfall on the same river (Loc. 8), 12.06.2018, O.K.; c - at the second bridge of the same river (Loc. 10), 20.03.2018, E.S.



Figure 32. Males of *Euphaea* sp. with half-open wings: a - from the Siem Reap River upstream of the 2nd bridge (Loc. 12), 22.12.2018, E.S.; b - from the Kbal Spean River downstream of the carvings (Loc. 3), 14.06.2018, O.K.

Observations. Occurs only at streams with rocky bed and at least somewhat turbulent water. Prefers to perch on branches (Figs 31a,c, 32), especially females (Fig. 33) but can also occupy stones (Fig. 31b), although less readily than the previous species.



Figure 33. Females of *Euphaea* sp.: a – upstream of the second bridge the Siem Reap River (Loc. 12), 14.05.2019, E.S; b - from the ledge of the same river downstream of the carvings (Loc.7), 11.06.2018, O.K.

Chlorocyphidae

5. *Heliocypha biforata* (Selys, 1859)

O.K.: **Loc. 3:** 14.06.2018: 1 ♂, many ♂♂, ♀♀ seen; 6.11.2018: 1 ♂ photo, several more ♂♂ seen. **Loc. 4:** 14.06.2018: 1 ♂ photo, very many ♂♂, ♀♀ seen; 6.11.2018: 1 very many ♂♂, ♀♀ seen. **Loc. 5:** 14.06.2018: several ♂♂ seen; 6.06.2018: many ♂♂, ♀♀

seen. **Loc. 6:** 23.02.2017: several ♂♂, ♀♀ seen. **Loc. 7:** 23.02.2017: 1 teneral ♂ collected, several ♂♂, ♀♀ seen; 11.06.2018: 5 ♂♂ collected, many ♂♂, ♀♀ seen; 4.11.2018: several seen. **Loc. 8:** 12.06.2018: 1 ♂ photo; many ♂♂, several ♀♀ seen; 17.06.2018: 2 ♂♂ collected, many ♂♂ seen; 30.06.2018: very many ♂♂ seen; 4.11.2018: many seen. **Loc. 10:** 12.06.2018: very many ♂♂, ♀♀ seen; 30.06.2018: many seen; 4.11.2018: many seen; 10.03.2019: many seen. **Loc. 11:** 12.06.2018: many ♂♂, ♀♀ seen; 17.06.2018: many seen; 4.11.2018: many seen; 10-11.03.2019: several seen; 30.11.2019: several immature ♂♂ seen. **Loc. 12:** 4.11.2018: many seen; 11.03.2019: very many seen; 30.11.2019: 1 ♀ collected, many ♂♂, ♀♀ seen. **Loc. 18:** 10.03.2019: 1 ♂ seen.

E.S.: **Loc. 6:** 23.02.2017: ♂, ♀; 4.11.2018: ♂; 3.12.2018: ♀; 13.12.2018: ♂, ♀; 15.05.2019: ♀. **Loc. 10:** 20.03.2018: ♂, ♀; 11.04.2018: ♂♂; 19.04.2018: ♂; 18.05.2018: ♂, tandem; 4.11.2018: ♂♂; 3.12.2018: ♀. **Loc. 12:** 13.12.2018: ♂; 16.12.2018: ♂; 22.12.2018: ♀. **Loc. 19:** 14.05.2019: ♀. **Loc. 25:** 29.04.2019: ♂; 27.11.2019: ♂, ♀. E.S.: **Loc. 24:** 14.03.2020: ♂. Not located: 23.02.2015: ♂; 15.05.2015: ♂; 11.04.2017: ♂♂; 27.04.2017: ♀; 7.03.2019: ♂ and teneral ♂; 12.04.2019: teneral ♂.

Observations. Very common round the year at banks of forest rivers and brooks. Elsewhere males of this species prefer to perch on vegetation and avoid stones, which are preferred by a congener *H. perforata* (Percheron in Guérin-Méneville & Percheron, 1835), hence demonstrating behavioural segregation with it (Kosterin 2011). However *H. perforata*, common elsewhere in Cambodia, is for some reason absent from Phnom Kulen. As a result, males of *H. biforata* can be equally often observed perching on stones (if any) at water course banks and so can be mistaken for *H. perforata* from distance. Hence in the situation of absence of the matching species the disruptive selection for behavioural differences is relaxed allowing it to be more flexible.

6. *Libellago hyalina* (Sely, 1959) (Figs 34)

O.K.: **Loc. 6:** 12.06.2018: 2 ♂♂ seen. **Loc. 11:** 12.06.2018: 3 ♂♂ collected; 17.06.2018: 2 ♂♂ collected, many seen; 30.06.2018: many seen; 4.11.2018: many ♂♂, ♀♀ seen. **Loc. 12:** 11.03.2019: 2 ♂♂ seen. **Loc. 18:** 10.03.2019: several ♂♂ seen. **Loc. 19** (shady area): 10.03.2019: 1 ♂, 2 ♀♀ collected, several ♂♂ seen.

E.S.: **Loc. 10:** 4.11.2018: ♀. **Loc. 11:** 4.11.2018: ♂. **Loc. 12** (at a small brook, the left tributary of the main river): 16.07.2019: ♀ (Fig. 34a); **Loc. 20** (at the outlet): 7.11.2019: ♂ (Fig. 34b-c), ♀; **Loc. 25:** 29.04.2019: ♂; 15.05.2019: ♀. Not located: 4.11.2018: ♂.

Observations. Rather a small, obscure and elusive species preferring shaded streams from brooks to medium rivers. However, of 8 localities where it was found in Phnom Kulen, all at the eastern plateau, 7 were at the main river (known as Siem Reap River and other names), including Loc. 25 where it has already left the plateau for lowland, and only one (Loc. 11) at its smaller tributary. The preferred micro-habitats of this species are patches of flowing litter and foam accumulated at trunks or branches of trees fallen across rivers or brooks, as shown in Fig. 15.



Figure 34. *Libellago hyalina*: a – female, upstream of the second bridge the Siem Reap River (Loc. 12), 16.07.2019, E.S; b-c – male, Tnal Dach Reservoir at the river outlet (Loc.20), 7.11.2019, E.S.

7. *Libellago lineata* (Burmeister, 1839)

O.K.: **Loc. 5:** 6.11.2018: 1 ♂ seen. **Loc. 12:** 4.1.2018: 2 ♂♂ seen; 30.11.2019: several ♂♂ seen. **Loc. 19:** 28.11.2019: 1 ♂ seen; 29.11.2019: 1 ♂, 1 ♀ seen. **Loc. 25:** 2.12.2019: many ♂♂, ♀♀ seen. **Loc. 26:** 12.06.2018: 1 ♂ seen; 14.06.2018: 1 ♂, 2 ♀♀ collected, many ♂♂, ♀♀ seen; 1.07.2018: 1 ♂ photo, many ♂♂, ♀♀ seen; 3.11.2018: 1 ♂ seen; 6.11.2018: 1 ♂ seen; 2.12.2019: several ♂♂ seen.

E.S.: **Loc. 7:** 28.07.2018: ♂♂, **Loc. 25:** 27.04.2019: ♂♂, ♀♀; 30.05.2019: ♂♂, ♀; Not located: 14.12.2018: ♂.

Photos by Peter Gartner in Facebook group 'Natural Cambodia': **Loc. 5:** 04-06.2013: ♂, ♀.

Observations. In contrast to its above congener, this species prefers lowland, sunny reaches of rivers, and avoids brooks and small rivulets. Its very motile bright yellow-and-black males are quite conspicuous in sunlit places they prefer. Females prefer to sit on thin branches, usually of bamboo, quite high over the water. Readily found in plenties at the Siem River or Kbal Spean Rivulet when they have left the mountains (Locs 5, 25-26) but is quite rarely met uphill (at the same Siem Reap River; locs 7, 12, 19).

Philosinidae

8. *Rhinagrion viridatum* Fraser, 1938 (Figs 35)

O.K.: **Loc. 4:** 14.06.2018: 2 ♂♂ seen; 6.11.2018: 3 ♂♂ collected, 3 ♂♂ photo (Fig. 35), very many ♂♂ seen. **Loc. 6:** 4.11.2018: 1 ♂ seen. **Loc. 12:** 4.11.2018: 1 ♂ collected. **Loc. 19:** 29.11.2019: 1 ♂ photo.



Figure 35. A male of *Rhinagrion viridatum* at the Kbal Spean River upstream of the carvings (Loc. 4), 6.11.2018, O.K.

Observations. Occurs at small rivers and in evergreen forest. On 6.11.2018 all along the Kbal Spean River upstream of the carvings (Loc. 6) O.K. observed an unprecedented abundance of males (Fig. 35) of this species: up to 2-3 on each sunlit bush at the banks. Twice he observed as two males matched with an agonistic behaviour like in chlorocyphids: they were hovering face-to-face over the river surface and swaying simultaneously.

Lestidae

9. *Lestes praemorsus decipiens* Kirby, 1893

E.S.: Not located: 15.05.2015: ♂.

Remarks. Although rather a common species elsewhere in Cambodia, recorded only once and only by photo without exact location.

10. *Lestes nodalis* Selys, 1891 (Fig. 36)

E.S.: Loc. 6: 22.12.2018: ♀ (Fig. 36).

Remarks. As the previous species, this one has been recorded only once and only by a photo (Fig. 36). There seem to exist two related species, *L. nodalis* and *L. garoensis* Lahiri, 1987, differing only in the shape of the male cerci, blunt versus pointed tips of the main cercus body as well as its inner inflation (Lieftinck 1960; Kosterin 2019a). *L. nodalis* was described from Lower Myanmar and its doubtless males have been twice reported for Thailand (Lieftinck 1960; Asahina 1983) while *L. garoensis* (= *L. nodalis* sensu Fraser, 1933 nec Selys), described from Meghalaya and Manipur States of India, is so far known only from India (Fraser 1933; Lahiri 1987; Kosterin 2019a). Since Myanmar and Thailand are much closer to Cambodia than India, we preliminarily identify the female photo from Phnom Kulen as *L. nodalis* rather than *L. garoensis*. Hopefully this record will later be confirmed by male specimen(s). *L. nodalis* has already been reported for Cambodia but, again, based on a (male) photo only (Kosterin et al. 2012), which would not allow distinguishing between *L. nodalis* and *L. garoensis*.



Figure 36. A female of *Lestes nodalis* at the Siem Reap River upstream of the carvings (Loc. 6), 22.12.2018, E.S.



Figure 37. Males of *Aciagrion borneense*: a – at the shallow S bank of the Tnal Dach Reservoir (Loc. 20), 29.12.2019, O.K.; b – (see the black mark on S9) at the Siem Reap River upstream of the 2nd bridge (Loc. 12), 15.12.2018, E.S.

Coenagrionidae

11. *Aciagrion borneense* Ris, 1911 (Fig. 37)

O.K.: **Loc. 20** (at a shallow bay): 29.11.2019: 1 ♂ collected; 1 ♂ photo (Fig. 37a).

E.S.: **Loc. 12:** 15.12.2018: ♂ (with a black mark on S9). **Loc. 14:** 3.12.2018: ♀.

Remarks. Some males have a black dorsal streak on S9. The same was observed at the Lake Tonle Sap N bank in the same province but not yet elsewhere in Cambodia. Laidlaw (1924) admitted possibility of presence of a dorsal black marking on S9 in males this species.

Observations. This mostly a dry season species was registered only in November and December and seems to be rather scarce in Phnom Kulen.

12. *Aciagrion pallidum* Selys, 1891

O.K.: **Loc. 4:** 6.11.2018: 1 ♀ collected, 1 more ind. seen. **Loc. 11** (a dry cashew plantation nearby): 4.11.2018: 1 ♂, 1 ♀ collected, 1 more ind. seen. **Loc. 17:** 28.11.2019: 1 immature ♂ released.

E.S.: **Loc. 12:** 14.12.2018: ♀; 16.12.2018: ♂, ♀; 22.12.2018: ♂.

Observations. This is also a dry season species (Fraser 1933) and it was also infrequently registered only in November and December, at different environments.

13. *Agriocnemis femina* (Brauer, 1868)

O.K.: **Loc. 21:** 29.11.2019: 4 ♂♂ collected, 1 ♂ photo, very many ♂♂, ♀♀ seen.

Observations. This species, so common elsewhere in E and SE Asia, for some reason is rarely met in Cambodia and was found only once in Phnom Kulen, although in big quantities and in the most fit habitat: fine emerging grass soaking with half-running water.

14. *Agriocnemis minima* Selys, 1877

O.K.: **Loc. 12:** 30.11.2019: 1 ♀ collected. **Loc. 15:** 28.11.2019: 1 ♂, 1 ♀ collected. **Loc. 17** (a grassy swamp): 28.11.2019: 1 ♀ collected. **Loc. 20:** 28.11.2019: 1 ♀ collected. **Loc. 21:** 29.11.2019: 5 ♂♂, 1 ♀ collected, very many ♂♂, ♀♀ seen. **Loc. 25:** 3.11.2018: 1 ♂ collected.

E.S.: **Loc. 20:** 5.11.2019: ♂, immature (red) ♀, 25.11.2019: ♀.

Observations. The most common and widespread *Agriocnemis* species in Siem Reap Province in general and in Phnom Kulen in particular; found in emerging fine grass at different water bodies.

15. *Agriocnemis nana* (Laidlaw, 1914)

O.K.: **Loc. 16:** 28.11.2019: 1 ♀ collected. **Loc. 17** (a grassy swamp): 28.11.2019: 1 ♂, 2 ♀♀ collected. **Loc. 23:** 10.03.2019: 1 ♀ collected. **Loc. 26:** 1.07.2018: 2 teneral ♀♀ collected.

E.S.: Not located: 12.14.2019: ♂ and a teneral ♂.

Observations. Occurs less frequently than *A. minima* and *A. pygmaea*, mostly at moist grassy places.

16. *Agriocnemis pygmaea* (Rambur, 1842)

O.K.: **Loc. 2:** 11.12.2019: 2 ♂♂ collected. **Loc. 23:** 10.03.2019: 1 ♂, 1 ♀ collected, several ♂♂ and copulae seen. **Loc. 26:** 3.11.2018: 1 ♂ collected.

E.S.: **Loc. 18:** 10.03.2019: 1 ♂. Not located: 7.03.2019: ♂.

Observations. Rather common in emerging fine grass, like *A. minima*. Curiously, while *A. pygmaea* was found in 4 localities and *A. minima* in 6 ones, there was no locality where both were found together. However we several time found them together in the below lower areas of Siem Reap Province.

17. *Agriocnemis rubescens rubeola* Selys, 1877

O.K.: **Loc. 12:** 11.03.2019: 1 ♂ collected. **Loc. 19:** 10.03.2019: 1 ♂ seen.

E.S.: **Loc. 6:** 11.04.2018: ♂.

Observations. Rather a rare species.



Figure 38. A male of *Archibasis viola* at the Siem Reap River upstream of the 2nd bridge (Loc. 12), 11.03.2019, O.K.

18. *Archibasis viola* Lieftinck, 1949 (Fig. 38)

O.K.: **Loc. 11:** 17.06.2018: 1 ♂ collected; 4.11.2018: 1 ♂, 1 tandem collected, several ♂♂ seen; 30.11.2019: 1 ♂ seen. **Loc. 12:** 11.03.2019: 1 ♂ photo (Fig. 38). **Loc. 17:** 29.11.2019: 1 ♂ collected. **Loc. 19** (shady area): 10.03.2019: 1 ♂ collected, several ♂♂ seen; 29.11.2019: 1 ♂ collected.

E.S.: **Loc. 24:** 14.03.2020: ♂.

Observations. Always occurs in shade at small water courses in evergreen forest: at a tiny brook (Loc. 11), rarely at shady banks of the larger O'Dar (Siem Reap) River (Fig. 38) (Locs 12 and 19), and in swamped 'floating forest' of Thnal Mareh (Loc. 17).

19. *Ceragrion cerinorubellum* (Brauer, 1865)

O.K.: **Loc. 13:** 11.03.2019: 1 ♂ seen. **Loc. 17:** 28.11.2019: 1 ♂, 1 ♀ seen, 29.11.2019: 2 ♂♂ seen. **Loc. 20:** 28.11.2019: several ♂♂ seen. **Loc. 21:** 29.11.2019: several ♂♂ seen.

E.S.: **Loc. 16:** 27.10.2019: ♂, ♀. **Loc. 19:** 10.03.2019: 1 ♂ seen; 29.11.2019: 1 ♂ seen at the small pond. **Loc. 20:** 23.10.2019: ♂; 27.10.2019: ♂. **Loc. 25:** 27.04.2019: ♀. Not located: 7.03.2019: ♂ and tandem; **Loc 18:** 14.05.2019: ♂ and tandem; 10.03.2019: 1 ♂.

Observations. A conspicuous and more or less common species occurring at sunlit vegetation at small or medium streams, often on forked fern 'walls'.

20. *Ceragrion indochinense* Asahina, 1967

O.K.: **Loc. 4** (at an adjacent grassy glade): 6.11.2018: 1 teneral ♂ photographed and collected.

Photo by Peter Gartner in Facebook group 'Natural Cambodia': **Loc. 5:** May 2013: ♂

Observations. Found only twice and for some reason only at the Kbal Spean Rivulet, on the western plateau and at its E foot.

21. *Ceriagrion malaisei* Schmidt, 1964

O.K.: **Loc. 26:** 1.07.2018: 1 mature ♂ collected.

Observations. Found only once at the lowland reach of the Siem Reap River in Banteay Srei village, at a small patch of Marsilea sp. at a shallow right bank.

22. *Ceriagrion olivaceum* Laidlaw, 1914

O.K.: **Loc. 7:** 23.02.2017: 1 ♂, 1 ♀ collected, 1 more ♂ seen. **Loc. 12:** 30.11.2019: 1 ♂ collected. **Loc. 13:** 11.03.2019: 1 ♀ collected.

E.S.: **Loc. 6:** 22.12.2018: ♂. **Loc. 12:** 13.12.2018: ♂. At Peung Tbal 1.5 km SW of Anlung Thom village (13.535 N, 104.154 E): 22.12.2018: ♂.

Observations. Another dry season species, met from November to March.

23. *Ischnura aurora* (Brauer, 1865) (Fig. 39)

E.S.: **Loc. 19:** 7.10.2019: ♂ (Fig. 39).

Remarks. A rare species recorded once (Fig. 39); also once recorded in the lowland in the same Siem Reap province at lake Tonle Sap (Kosterin 2020b).



Figure 39. A male of *Ischnura aurora* at the O'Dar River near Anlung Thom village (Loc. 19), 7.10.2019, E.S.

24. *Ischnura senegalensis* (Rambur, 1842)

E.S.: **Loc. 1:** 11.12.2019: several ♂♂, ♀♀ seen. **Loc. 20:** 23.10.2019: ♂;

Remarks. This is maybe the commonest elsewhere in the Oriental Ecoregion damselfly, but for some reason it appeared extremely rare in Phnom Kulen. Recorded only two times (one of which, at Loc. 1, at the foot rather than in the mountains).

25. *Mortonagrion aborense* Laidlaw, 1914

O.K.: **Loc. 11:** 30.11.2019: 1 ♀ collected.

Observations. A female was found hovering amidst bush vegetation in a small brook valley densely overgrown with evergreen forest, that is a typical habitat of the species.



Figure 40. A male of *Paracercion calamorum dyeri* at the shallow S bank of the Tnal Dach Reservoir (Loc. 20), 29.12.2019, O.K.

26. *Paracercion calamorum dyeri* Fraser, 1919 (Fig. 40)

O.K.: **Loc. 20:** 28-29.11.2019: many ♂♂ seen; 29.11.2019: 1 ♂ photo (Fig. 40).

Observations. Found only in the largest lentic habitat on the Phnom Kulen, the Tnal Dach Reservoir. Males perch on sparse vegetation floating on the water surface (Fig. 40).

27. *Pseudagrion australasiae* Selys, 1876

O.K.: **Loc. 1:** 11.12.2019: several ♂♂ seen, some captured and released. **Loc. 12:** 11.03.2019: 3 ♂♂ collected, many ♂♂ seen. **Loc. 16:** 28.11.2019: 4 ♂♂ collected, several more ♂♂ seen. **Loc. 17:** 28.11.2019: 1 ♂ released; 29.11.2019: 1 ♂ collected, at the small pond many ♂♂ seen. **Loc. 20:** 28-29.11.2019: 2 ♂♂ collected, many ♂♂ seen. **Loc. 25:** 2.12.2019: several ♂♂ seen. **Loc. 26:** 2.12.2019: several ♂♂ seen.

E.S.: **Loc. 20:** 23.10.2019: ♂.

Photos by Peter Gartner in Facebook group 'Natural Cambodia': **Loc. 5:** 05.2013: ♂.

Observations. Common at lentic habitats but occurs at calm reaches at streams as well. The males of this species seem to be the most active fliers among congeners, they perch on floating vegetation without perch fidelity and also patrol the water surface by fast flying low above it.

28. *Pseudagrion pruinatum* (Burmeister, 1839)

O.K.: **Loc. 6:** 11.06.2018: several ♂♂ seen. **Loc. 7:** 11.06.2018: 2 ♂♂ collected, 1 ♂ photo, 1 tandem seen. **Loc. 10:** 12.06.2018: 1 ♂ seen. **Loc. 12:** 4.11.2018: 3 ♂♂, 1 ♀ collected, 1 more ♂ seen' 11.03.2019: several ♂♂ seen; 30.11.2019: several ♂♂ seen. **Loc. 18:** 10.03.2019: several ♂♂ seen. **Loc. 19:** 10.03.2019: 1 ♂ collected; 29.11.2019: 1 ♂ photo. **Loc. 21:** 29.11.2019: 1 ♂ seen.

E.S.: **Loc. 6:** 3.12.2018: ♂. **Loc. 12:** 16.12.2018: ♂. **Loc. 19:** 14.05.2019: ♂; 25.11.2019: ♂. Not located: 23.03.2014: ♂; 30.04.2015: ♂; 12.04.2019: ♂.

Observations. Inhabits streams and small rivers with slow to medium current flowing through evergreen forest; in Siem Reap Province not found at the lowland. This species is almost invariably found in places where the large-leaved plants from the tribe Colocasieae grow at banks (*Colocasia* or *Allocasia*, taro or elephant ear). Of course no direct ecological interactions is implied, both plants and damselflies just prefer the same habitats.

29. *Pseudagrion rubriceps* Selys, 1876

O.K.: **Loc. 1:** 11.12.2019: several ♂♂ seen. **Loc. 6:** 23.02.2017: 1 ♂ seen. **Loc. 12:** 11.03.2019: many ♂♂ seen; 30.11.2019: very many ♂♂ seen. **Loc. 19:** 29.11.2019: 1 ♂ seen. **Loc. 23:** 10.03.2019: 1 ♂ seen. **Loc. 25:** 2.12.2019: very many ♂♂ seen. **Loc. 26:** 3.11.2018: many ♂♂, several tandems seen; 2.12.2019: several ♂♂ seen.

E.S.: **Loc. 7:** 23.02.2017: ♂. **Loc. 19:** 10.03.2019: ♂ and copula; 25.11.2019: ♂♂. **Loc. 20:** 23.10.2019: ♂. **Loc. 22:** 25.11.2019: ♂. **Loc. 23:** 10.03.2019: ♂. Not located: 7.03.2019: ♂; 12.04.2019: ♂; 7.10.2019: ♂;

Observations. A common Oriental species which can be found even at lentic anthropogenic habitats. However, among 10 its known habitats in Phnom Kulen 9 are riverine, of which 6 were at the same Siem Reap River 'in the broad sense'. The males of this species keep to the grass at the banks and fly over the water surface among those of *P. williamsoni*, *P. australasiae* and *P. pruinosum*.



Figure 41. A tandem of *Pseudagrion williamsoni* at the Siem Reap River at the bridge in Banteay Srey village (Loc. 26), 1.07.2018, O.K.

30. *Pseudagrion williamsoni* Fraser, 1922 (Fig. 41)

O.K.: **Loc. 6:** 23.02.2017: 2 ♂♂ seen; **Loc. 12:** 4.11.2018: 1 ♂ collected, many ♂♂ seen; 11.03.2019: very many ♂♂ seen; 30.11.2019: very many ♂♂ seen. **Loc. 16:** 28.11.2019: many ♂♂ seen. **Loc. 17:** 28-30.11.2019: many ♂♂ seen. **Loc. 18:** 10.03.2019: several ♂♂ seen. **Loc. 19:** 10.03.2019: several ♂♂ seen; 29.11.2019: many ♂♂ seen at the small pond. **Loc. 20:** 28-29.11.2019: very many ♂♂ seen. **Loc. 21:** 29.11.2019: several ♂♂ seen. **Loc. 25:** 2.12.2019: many ♂♂ seen. **Loc. 26:** 1.07.2018: 1 tandem photographed (Fig. 41) and collected, many ♂♂, ♀♀ and tandems seen; 3.11.2018: 2 ♂♂ seen; 2.12.2019: several ♂♂ seen.

E.S.: **Loc. 19:** 25.11.2019: ♂. **Loc. 25:** 29.04.2019: ♀. Not located: 7.12.2018: ♂; 12.04.2019: ♂.

Observations. One of the most common damselfly at sunny places with slow or moderate current at small and medium rivers. Nevertheless, it was found surprisingly numerous at the grassy banks of the large Tnal Dach Reservoir (Loc. 20), which is drained by a small river but still has a still water.

Platycnemididae31. *Copera marginipes* (Rambur, 1842)

O.K.: **Loc. 4:** 6.11.2018: 1 ♂ collected. **Loc. 5:** 6.06.2018: many ♂♂, ♀♀ seen. **Loc. 6:** 23.02.2017: 1 ♀ collected, many ♂♂, ♀♀ seen. **Loc. 7:** 23.02.2017: many ♂♂, ♀♀ seen. **Loc. 9:** 4.11.2018: ♂ seen. **Loc. 11:** 17.06.2018: 1 ♀ collected; 30.11.2019: several ♂♂ seen. **Loc. 12:** 30.11.2019: several ♂♂ seen. **Loc. 19:** 10.03.2019: 1 ♂ collected, several ♂♂ seen; 28.11.2019: 1 ♂ collected, several ♂♂, ♀♀ seen.

E.S.: **Loc. 6:** 11.04.2018: ♂; 19.04.2018: immature ♂; 4.11.2018: ♂, ♀. **Loc. 10:** 11.04.2018: ♂♂; immature ♀; 4.11.2018: ♂; 3.12.2018: ♂. **Loc. 12:** 13.12.2018: ♂, ♀; 14.12.2018: ♂, ♀, copula; 22.12.2018: ♀. **Loc. 19:** 10.03.2019: ♂; 25.11.2019: ♂. **Loc. 20:** 23.10.2019: tandem; **Loc. 22:** 25.11.2019: tandem. **Loc. 25:** 27.11.2019: ♂. Not located: 20.03.2017: ♂; 27.04.2017: ♂; 4.12.2018: ♂.

Observations. Very common at sunny places at streams and rivers on the plateaux but only once found at the Siem Reap River in the lowland below.

32. *Copera vittata* (Selys, 1863)

O.K.: **Loc. 3:** 14.06.2018: 1 teneral ♂ collected. **Loc. 4:** 6.11.2018: very many ♂♂, several tandems seen. **Loc. 7:** 23.02.2017: 1 ♂, 1 ♀ collected, many ♂♂, ♀♀ seen. **Loc. 11:** 4.11.2018: many ♂♂, ♀♀, tandems seen; 30.11.2019: 2 ♂♂ collected, several ♂♂, 1 tandem seen. **Loc. 12:** 4.11.2018: 1 ♂ collected. **Loc. 17:** 28.11.2019: 1 ♀ collected; 29.11.2019: 1 ♂ collected, 1 ♂ seen. **Loc. 19:** 29.11.2019: 1 ♂ seen.

E.S.: **Loc. 6:** 3.12.2018: tandem.

Observations. Prefers shaded pools with a lot of litter, avoids stream banks.

33. *Onychargia atrocyana* Selys, 1865 (Fig. 42)

O.K.: **Loc. 20:** 28.11.2019: 1 ♂ collected, 1 more ♂ seen.

E.S.: **Loc. 12** (at a small brook, the left tributary of the main river): 14.05.2019: ♂; 16.06.2019: ♂. **Loc. 16:** 28.07.2019: ♂ (Fig. 42a); 7.11.2019: ♂; 14.03.2020: ♂. **Loc. 20:**



Figure 42. Males of *Onychargia atrocyana* at the Srae Tbong River (Loc.16), 28.07.2019 (a) and at the dam of the Tnal Dach Reservoir (Loc. 20), 7.11.2019 (b), E.S.

4.05.2019: ♂; 6.06.2019: ♂; 12.06.2019: ♂; 7.10.2019: ♂; 23.10.2019: ♂; 27.10.2019: ♂; 7.11.2019: ♂ (Fig. 42b).

Observations. Can be found (Fig. 42a) at margin of the trees growing at the dam of the Dnal Dach Reservoir (Loc. 20) seemingly at any season. The reservoir bank at the dam, steep but densely overgrown with grass and herbs, seems to provide the most suitable habitat of the species. Only two records elsewhere.

34. *Onychargia priyadak* Kosterin, 2015 (Fig. 43)

O.K.: **Loc. 2:** 11.12.2019: 1 ♂ photo (Fig. 43).

Observations. The only male (Fig. 43) was found at the foot of the south-western spur of the western plateau in rather a specific habitat: in a tiny glade in bush thickets several metres apart from a brook hidden under winding plants, in a gentle bushy valley, the slope of which were converted into cassava fields. For some reason that male was so calm that remained still even when slightly touched and it was necessary to push it to make it to get into the air and to fly for several centimetres.



Figure 43. A male of *Onychargia priydak* in a small glade in buch thickets near a brook at the western low spur of the western Phnom Kulen plateau (Loc. 2), 11.12.2019, O.K.

35. *Prodasineura autumnalis* (Fraser, 1922) (Figs 44-45)

O.K.: **Loc. 4:** 14.06.2018: 1 ♂ collected; 6.11.2018: 1 ♂ collected. **Loc. 5:** 6.11.2018: 1 ♂ seen. **Loc. 8:** 12.06.2018: 1 ♂ seen; 17.06.2018: 1 ♂ collected; 30.06.2018: several ♂♂ seen. **Loc. 12:** 30.11.2019: several ♂♂ seen. **Loc. 19:** 29.11.2019: several ♂♂ seen. **Loc. 25:** 2.12.2019: many ♂♂ and tandems seen. **Loc. 26:** 14.06.2018: 3 ♂♂ collected (Fig. 44); 3.11.2018: 1 ♂ collected; 1.07.2018: very many ♂♂, ♀♀ seen; 2.11.2018: very many ♂♂ and tandems seen.

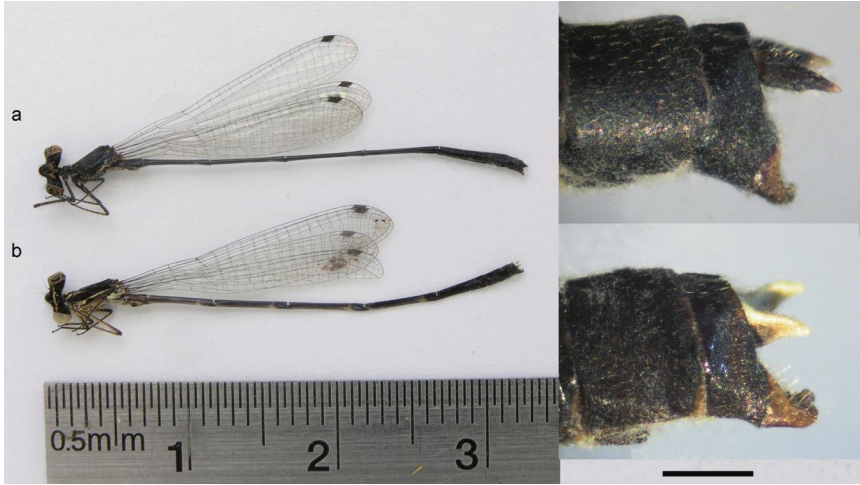


Figure 44. A mature (a) and immature (b) males of *Prodasineura autumnalis* from the Siem Reap River at the bridge in Banteay Srei village (Loc. 26), 14.06.2018. Scale bar 0.5 mm. O.K. Note mostly pale dorsolateral surfaces of the cerci in the young male. The seemingly different shape of the cerci in the two males shown resulted the position of the left cercus in the mature one (a), slightly turned along its axes so that its basoventral projections is hidden.



Figure 45. Mature males of *Prodasineura autumnalis* with pale above (a) and entirely dark (b) cerci photographed on 30. 05.2019 from the Siem Reap River at the first bridge after its leaving the mountains (Loc. 25), E.S.

E.S.: **Loc. 10:** 5.11.2019: ♂. **Loc. 19:** 5.11.2019: ♂, copula; 25.11.2019: ♂. **Loc. 25:** 29.04.2019: ♂; 15.05.2019: ♂; 30.05.2019: 2 ♂♂, with white above (Fig. 45a) and dark (Fig. 45b) cerci, tandems; 3.11.2019: immature ♂; 27.11.2019: ♂, 2 ovipositing tandems.

Observations. Common over the surface of small (Kbal Spean, Srae Tbong) or, mostly, medium (namely Siem Reap, all along its course) rivers.

Remarks. In *Prodasineura* males, the coloration of the last abdominal segments and appendages are as a rule species-specific and provide useful identification cues. In this respect the issue of the cercus colour in males of *P. autumnalis* can be confusing. In the Phnom Kulen collection, the mature males, with the thorax black with only a dull yellowish stripe on the metepimeron and a yellowish area on the poststernum left, have the cerci characteristically brownish-black with paler extreme bases and tips (Figs 44a, 45a), as is common for mature males of this species. However, in a young male of 14.06.2018 from Loc.26 (Fig. 44b) collected along with two mature males (Fig. 44a), which still retained the full pattern of cream-white stripes, namely the antehumeral stripes at the mesepisternum and broad lateral stripes along the mesothoracic suture and on the metepimeron, the dorso-lateral surfaces of the cerci are mostly clear creamy-white while their ventro-axial surfaces are mostly brownish (Fig. 44b). This seemingly an ageing/maturation-related change is nevertheless striking. Moreover, E.S. managed to photograph (at the same river part but somewhat upstreams, Loc. 25) a mature male, with the pale thoracic stripes already disappeared and the lower part of the synthorax pruinose, in which the cerci were still pale above (Fig. 44a, compare a similar male from the same place and date with dark cerci in Fig. 44b). The issue of the coloration of the cerci in *P. autumnalis* deserves further attention.

36. *Prodasineura coerulescens* (Fraser, 1932) (Figs 46)

O.K.: ?**Loc. 7:** 23.02.2017: 1 teneral ♀ collected, identification tentative. **Loc. 25:** 2.12.2019: 1 ♂ collected. **Loc. 26:** 12.06.2018: 1 ♂ photo, several ♂♂, ♀♀ seen; 14.06.2018: 3 ♂♂, 2 ♀♀ collected, many ♂♂ seen; 1.07.2018: 1 ♀ collected, several ♂♂ photo (Fig. 46c), many ♂♂, ♀♀ seen; 3.11.2018: 1 ♂ collected, several ♂♂ seen. E.S.: **Loc. 25:** 29.04.2019: ♂; 15.05.2019: tandem (Fig. 46a); 30.05.2019: ♂, ♀ and a tandem; 27.11.2019: tandem. **Loc. 26:** 30.05.2019: ♀.

Observations. These damselflies are abundant at the Siem Reap River where it already left the mountains but still is rather fast and clear, at Locs 25 and 26 (the latter in the famous Banteay Srei village). There they fly together with *P. autumnalis* but rather outnumber them. The males and tandems spend a lot of time hovering at the same place over the surface of fast, sunny river reaches and are very conspicuous (Fig. 46a,c). At the same time, unlike *P. autumnalis*, *P. coerulescens* seems to be confined to that river section near foothills and hardly expands upstream or downstream of it. There are only two observations by E.S. downstream of Banteay Srei (Loc. 26), 12.5 km SSW of it, where the river is already broad, deep and very calm: 13.490 N, 103.921 E; 13.09.2018 (♀); the same place, 17.09.2018 (♂; Fig. 46b) (at the same time *P. autumnalis* is still rather common at that point round the year). In the mountains, only one teneral female was collected at the same



river at the carvings but its identification is based on the horns of prothorax directed forward and is not so reliable.

Figure 46. A tandem (a) and males (b-c) of *Prodasi-neura coerulescens* over the Siem Reap River after its leaving the mountains: a – Loc. 25, 15.05. 2019, E.S.; b - 13.490 N, 103. 921 E, 17.09. 2018, E.S.; c – Loc. 26, 1.07. 2018, O.K.

37. *Prodasineura verticalis* sensu Asahina, 1983 nec Selys (1860)

O.K.: **Loc. 3:** 14.06.2018: 1 teneral ♂ collected. **Loc. 4:** 14.06.2018: 2 ♂♂, 1 tandem seen; 6.11.2018: 1 ♂, 1 tandem seen. **Loc. 7:** 11.06.2018: 5 ♂♂, 3 ♀♀ collected, 1 ♂, 1 ♀ photo, many ♂♂, ♀♀ seen. **Loc. 8:** 12.06.2018: 1 ♂ seen; 17.06.2018: 1 ♂ seen. **Loc. 9:** 17.06.2018: 3 ♂♂, 3 ♀♀ collected in tandems, several ♂♂, ♀♀ seen; 30.06.2018: several seen. **Loc. 10:** 12.06.2018: several ♂♂ seen; **Loc. 11:** 12.06.2018: several ♂♂, ♀♀ seen; 4.11.2018: 1 ♀ seen. **Loc. 12:** 4.11.2018: 2 ♂♂ seen; 11.03.2019: several ♂♂, ♀♀ seen; 30.11.2019: 1 ♂ seen. **Loc. 13:** 30.06.2018: several seen; 11.03.2019: 1 tandem seen. **Loc. 18:** 10.03.2019: several ♂♂ seen. **Loc. 19:** 10.03.2019: 1 ♂ collected, several ♂♂, ♀♀ seen; 29.11.2019: 1 ♂ seen.

E.S.: ♂. **Loc. 12:** 14.05.2019: tandem; 16.07.2019: ♀ (at a small brook, the left tributary of the main river). **Loc. 19:** 14.05.2019: ♂; 20.07.2019: ♂; 25.11.2019: ♀. **Loc. 14:** 3.12.2018: teneral ♂. **Loc. 22:** 25.11.2019: ♀. **Loc. 24:** 13.03.2020: ♂. Not located: 28.06.2015: ♂; 25.07.2018: ♂; 12.04.2019: ♂; 24.04.2019: ♂, tandem.

Photo by Phann Sithan in Facebook group 'Natural Cambodia': **Loc. 4:** 6.08.2014: ♂.

Remarks. Since publication of the Thai Odonata Atlas by Hämäläinen & Pinratana (1999) this well known species is recognised as yet undescribed. Hopefully it will be eventually described in near future.

Observations. Common at rivers or brook, preferring the latter, but, unlike the two previous species, keep to shady places where are mostly seen hovering in gaps among vegetation at the height of 1-1.5 m. In such shady conditions, the saturated orange thoracic stripes of hovering males are very conspicuous, unlike the rest of the body. A tandem ovipositing onto slime algae in a tiny stream between stones was observed at Loc. 7.

38. *Pseudocopera ciliata* (Selys, 1863)

O.K.: **Loc. 12:** 11.03.2019: 1 ♂, 1 ♀ seen; 30.11.2019: many seen. **Loc. 17:** 28-30.11.2019: very many seen. **Loc. 19:** 10.03.2019: 1 ♂ seen. **Loc. 20:** 28-29.11.2019: very many seen (mostly at a shallow grassy bay). **Loc. 21:** 29.11.2019: several ♂♂, ♀♀ seen. **Loc. 26:** 14.06.2018: 1 ♂ collected; 1.07.2018: many ♂♂, ♀♀ seen; 6.11.2018: 1 ♂ collected, many ♂♂ seen.

E.S.: **Loc. 19:** 14.05.2019: ♂; 5.11.2019: ♂. **Loc. 20:** 6.06.2019: ♂. 0.07.2019: ♀; 7.10.2019: ♂♂, ♀♀; 23.10.2019: ♂, ♀; 27.10.2019: ♂, ♀; 5.11.2019: ♂, ♀.

Observations. Common. Keeps to fine low Poaceae grass at shallow water of streams or lakes/ponds with clear water. On Phnom Kulen finds best habitats at the river branches flowing through grassy mats at Srae Tmar Truonh (Loc. 21), at shallow grassy bays of Tnal Dach Reservoir (Loc. 20) and at the shallower banks of the Siem Reap River in Banteay Srei (Loc. 26).

Aeshnidae39. *Gynacantha subinterrupta* Rambur, 1842 (Figs 47)

O.K.: **Loc. 11:** 10.03.2019: 1 ♂ photo, maybe 1 more seen. **Loc. 17:** 29.11.2019: 1 ♀ photographed (Figs 47) and collected.



Figure 47. A female of *Gynacantha subinterrupta* in evergreen forest in the Rong Chen Archaeological Protected Area (Fig. 10) near Tnal Mareh terrain (Loc. 17). 29.11.2019, O.K.

Observations. Surprisingly there were only two findings of this species, common elsewhere in forested areas of Cambodia. On March 10, 2019, at the end of dry season, one or two males were startled from shaded earthy bluffs, with hanging roots, at two adjacent dried out pools of the temporary forest brook of Loc. 11 downstream of the road. This male (or these males) obviously returned to that place and were startled again. Just downstream from these former pools, another male flew at deep round holes in the sandstone brook bed, and even penetrated inside for a while. These pools, where dark water still left (Fig. 20, left), could serve a good larval habitat for this species, so that male was most probably searching for ovipositing females. However they are probably not so good a habitat in the rainy season when the brook is flowing (Fig. 20, right). Maybe for this reason these dragonflies were not seen there at other visits. Pools at the Tnal Mareh swamped forest (Loc. 17), near which a female was found in evergreen forest (Figs 47), could serve for breeding as well.

40. *Tetracanthagyna waterhousei* McLachlan, 1898

O.K.: **Loc. 11:** 12.06.2018: 1 ♀ collected.

Observations. The only female met was startled from a big half-open pool at the brook, bordered on one side with a forked fern thicket.

Gomphidae

41. *Euthygomphus yunnanensis* (Zhou et Wu, 1992)

O.K.: **Loc. 26:** 14.06.2018: 1 ♂ collected.

Remarks. For the correct naming of this species, formerly known as *Merogomphus parvus* sensu Asahina, 1986 nec Krüger, 1899 see Kosterin (2016a). The occiput colour is variable in both sexes of this species (Ibid.); in the male from Loc. 26 it is black.

Observations. The only male found was startled from a bamboo branch hanging over the Siem Reap River just upstream of the bridge in Banteay Srei and sat on a tree branch hanging nearby. Remarkably this happened almost in twilight, at 5:50 p.m. Earlier O.K. observed this species only in daytime at herbs and bushes growing on the bank rather than hanging over the water (Kosterin 2011; 2015a; 2016a,b; 2017).

42. *Burmagomphus* sp. cf. *williamsoni* Förster, 1914 (Fig. 48)

O.K.: **Loc. 8:** 12.06.2018: 1 ♂ collected and missed; 17.06.2018: 1 ♂, 1 ♀ collected; 1 ♂, 1 ♀ photo (Fig. 48a-b); 30.06.2018: 2 ♂♂ collected, 1 more ♂ seen.

E.S.: **Loc. 19:** 15.05.2019: ♂; **Loc. 25:** 15.05.2019: ♂ (Fig. 48c).

Remarks. The following male characters are shared with *B. williamsoni* as described and illustrated by Lieftinck (1953; 1964): the antehumeral and dorsal stripes fused into a broad kinked stripe, the posterior hamulus very broad with an anteriorly directed hook and without additional denticles or long hairs, the epiproct arms in line with the cerci when viewed above, the tooth of the cercus occupying a subapical position. The following male character differ from *B. williamsoni*: the antehumeral pale stripe is narrowly separated from that on the inframesepisternum with black (not so in female); the subapical cercal tooth very prominent, forming almost a right angle in dorsal view and well seen in lateral view; the paraproct arms as long as (rather than shorter than) the cerci and with their inner margins distinctly convex, as in *Burmagomphus vermicularis* (Martin, 1904) (Do 2011: figs 2g-h, 3d), but the incision between them is not U-shaped as in both mentioned species but trapezoid-shaped, with a straight central section. S9 has no dorsoapical tooth (a character variable in some other species of the genus). The female occiput has a prominent yellow conical projection, as in *B. williamsoni* but, unlike that species (Lieftinck 1953: fig. 40; 1964: fig. 20-22), misses the pair of bi- or tridental tubercles at its sides (the occiput of *B. vermicularis* is simple, straight, see Lieftinck 1953: fig. 41). The teneral *Burmagomphus* female collected at Pramoll Phdom village in Preah Vihear Province (Kosterin 2020a) is similar. The above mentioned characters nearly justify a separate species but further study is necessary.

Observations. Found in May-June. Most sightings were made at a big and deep river broadening under the Kulen Waterfall (Loc. 8). There these dragonflies appeared at around 9:30 a.m., rest on big boulders by the water (but far beyond the reach of the waterfall spray) (Fig 48a-b), rarely on shrubs growing on rocks, or fly low over the water surface, sometimes chasing matches. Two other localities were the same river upstreams (Loc. 19) and downstreams, already after its having left the mountains (Loc. 25) (Fig. 48c).



Figure 48. Female (a) and males (b-c) of *Burmagomphus* sp. cf. *williamsoni*: a-b – at the Phnom Kulen waterfall (Loc. 8), 17.06.2018, O.K.; c – at the Siem Reap River at the first bridge after its leaving the mountains (Loc. 25), 15.05.2019, E.S.

43. *Gomphidia* sp. ♂ (Fig. 49)

O.K.: **Loc. 4:** 14.06.2018: 1 ♂ seen (identification tentative). **Loc. 9:** 30.06.2018: 1 ♂ seen (identification tentative). **Loc. 10:** 30.06.2018: 1 ♂ collected. **Loc. 11:** 17.06.2018: 1 ♂ seen; 30.06.2018: 1 ♂ collected, 1 more ♂ photo (Fig. 49).

Remarks. The same species as reported from Thma Bang environs of Kog Kong Province (but not that from Mondulhiri Province in the same paper) as *Gomphidia kruegeri*, nec Martin, 1904. (Kosterin 2016b). They showed a combination of maculation characters of the taxa *kruegeri* s. str. and *fukiensis* Chao, 1955 (the latter considered by Kosterin (2016b) as subspecies of *G. kruegeri*), but had a black spot in the centre of the labrum reported for neither of those two species. However, *G. fukien-*



Figure 49. Males of *Gomphidia* sp. (above) and *Zygonyx iris malayana* (below) perching on the same stick at the lowermost reaches of the forest brook of Loc. 11, 30.06.2018, O.K.

sis has been shown to be bona species (Zhang 2019), while the Cambodian specimens most probably represent a different species to be described elsewhere.

Observations. Found only in June, in the lowest reaches of a brook (Loc. 11) and the Siem Reap/Prey Thom River at their junction point (Loc. 10). The dragonflies observed downstream of the Kulen Waterfall on the same river (Loc. 9) and at the Kbal Spean River on the western plateau (Loc. 4) had the same size, habitus and behaviour but were not caught. At both Loc. 4 (the brook) and Loc. 11 (Kbal

Spean River), males perched on dry sticks at long calm reaches with a sandy (in the former case) or litter (in the latter case) bottom, ranged along the reach and were cautious. Curiously, at loc. 11 the same dry stick was occupied by a male on 17.06.2018 and 30.06.2018. In the first case when the male was startled from that stick it rose to the tree crowns and sat on a dry branch at ca 4 m above the ground, then disappeared. In the second case the male tried to chase out a male of *Zygonyx iris malayana* but at last they perched on the same stick very closely to each other (Fig. 49). At the larger river of Loc. 10 the male landed on a green branch hanging lower above the water.

44. *Ictinogomphus decoratus melaenops* (Selys, 1858)

O.K.: **Loc. 19:** 10.03.2019: 1 ♂, 1 ♀ seen. **Loc. 20:** 29.11.2019: 1 ♂ photo, several ♂♂ seen. **Loc. 23:** 10.03.2019: 1 ♂ seen. **Loc. 26:** 1.06.2018: 1 ♂ photo, quite many ♂♂ seen; 3.11.2018: 2 ♂♂ seen.

E.S.: **Loc. 19:** 14.05.2019: ♂. **Loc. 20:** 6.06.2019: ♂. Not located: 12.04.2019: ♂; 24.04.2019: ♂♂.

Observations. A lentic non-seasonal species, found in Phnom Kulen at the big water reserve Tnal Dach (Loc., 20) which looked the most fit habitat, on broad and slow pools at a brook (Loc. 23) and the main river of the eastern plateau (Locs 19, 26), including downstream of it at Banteay Srei (Loc. 26). Males perch on sticks and range broadly over the water surface, being rather incautious.

45. *Macrogomphus kerri* Fraser, 1922

O.K.: **Loc. 8** (shady reach just below the waterfall): 12.06.2018: 1 ♂ collected. **Loc. 11:** 17.06.2018: 1 ♂ collected. **Loc. 26:** 1.07.2018: 2 ♂♂ photo.

E.S.: **Loc. 26:** 27.04.2019: ♂.

Observations. Observed in April-July. On the plateau both males were met while very fast ranging at the height of 1-2 m in forest shade, along the forked fern thickets in the lowermost reaches of the brook tributary of the same river (Loc. 11) or along the bank and damp rocks just below the Kulen Waterfall (Loc. 8). On the same Siem Reap River just downstream of the bridge in Banteay Srei (Loc. 26) O.K. unexpectedly noticed a male ranging over a fast shady reach which then rose and sat on a dry branch in a tree crown ca 4 m above the river, very closely to another male of that species which appeared already sitting there.

46. *Microgomphus alani* Kosterin, 2016

O.K.: **Loc. 6:** 11.06.2018: 1 ♀ collected. **Loc. 9:** 17.06.2018: 1 ♂ collected. **Loc. 11:** 30.06.201: 1 ♀ collected.

Remarks. For morphological and ecological details of this species, including its above enumerated Phnom Kulen findings, see Kosterin (2019b).

Observations. Found at the banks of the main river (locs 6, 9) and its tributary brook (loc. 11) half-shaded by evergreen forest.

47. *Paragomphus capricornis* (Förster, 1914) (Fig. 50)

O.K.: **Loc. 12:** 4.11.2018: 1 ♀ photo (Fig. 50). **Loc. 26:** 3.11.2018: 1 ♂, 1 ♀ collected.

E.S.: **Loc. 25:** 27.11.2019: ♂.

Observations. For some reason observed in November only, two sightings below the plateau versus one on it. In the first case both sexes perched on bushes by a relatively high river bank, in the second case a female sat on a dry stick (Fig. 50) on a dry glade separated from a river by a tree strip.



Figure 50. A female of *Paragomphus capricornis* perching on a stick on a dry glade by the Siem Reap River upstream of the second bridge (Loc. 12), 4.11.2018, O.K.

Synthemistidae

48. *Idionyx thailandica* Hämäläinen, 1985

O.K.: **Loc. 8:** 12.06.2018: 1 ♂, 8 ♀♀ collected, dozens of ♀♀ seen. **Loc. 11:** 12.06.2018: 3 ♀♀ collected, 1 ♀ released; 17.06.2018: 4 ♀♀ released.

Remarks. Perhaps the same species as *Idionyx victor* Hämäläinen, 1991, the claimed diagnostic differences being variable and not convincing (Karube 2011). The current (mal)practice is a country based identification: specimens from China and Vietnam are traditionally identified as *I. victor* while those from Thailand and Cambodia as *I. thailandica*.

For some reason in some populations females are much more common than males: at least in Ratanakiri Province (Kosterin 2014) and Phnom Kulen (this paper). Among 17 individuals checked in hand in Phnom Kulen, only one male was found.

Observations. In June found common/numerous in two specific places, active either in shade at daytime (Loc. 11) or in dusk (Loc. 8).

At the lowermost brook of Loc. 11, females (at least three on 12.06.2018 and two on 17.06.2018) oviposited at daytime but in deep shade while fast flying immediately above the water seeping between the big round holes in sandstone filled with water (Fig. 20, left). Another female was caught on 12.06.2018 while fast flying (among males of *Macromidia rapida*, see below) very low above the water seeping over a concrete plate from the pipes through which the brook crosses the road. On 17.06.2018, two females fluttered over the road crossing this brook when the sun was hidden by an approaching thunderstorm cloud. At ca 5:30 p.m. of 12.06.2018, O.K. witnessed as numerous individuals of *I. thailandica* appeared below the Kulen Waterfall (Loc. 8), starting to flutter low and erratically near a narrow bay (from 2-3 m apart from water to the water edge) of the pool below the waterfall – not less than 20 in view at once – and many also above rocks on the banks (here again together with males of *M. rapida*). Six of them checked in hand were females. Few individuals also flew above a trading 'street' above the waterfall; of the two checked one appeared to be a male, the only one obtained from Phnom Kulen.

There were also two uncertain sightings on 14.06.2018 of females probably of this species ovipositing in shaded shallow bays of the Kbal Spean River upstream of the carvings (Loc. 4).

49. *Macromidia rapida* Martin, 1907

O.K.: **Loc. 4:** 14.06.2018: 1 ♂ collected, 1 more ♂ seen. **Loc. 8:** 12.06.2018: very many ♂♂ seen, 1 ♂ collected. **Loc. 10:** 17.06.2018: 1 ♂ released. **Loc. 11:** 12.06.2018: 6 ♂♂ collected, 1 ♂ released; 17.06.2018: 1 ♂ released; 30.06.2018: 1 ♂ released, 1 ♂ seen.

Observations. Found in the same places and as a rule together with *I. thailandicus* from the same family (the latter not confirmed from Loc. 4) in either shade or dusk, although on 30.06.2018 only *M. rapida* was observed. But while *M. thailandicus* was represented mostly by females, only males of *M. rapida* were met.

On 12.06.2018 O.K. managed to catch one by one for a very short time 6 males of *M. rapida* (along with a female of *I. thailandica*) ranging very low above the aforementioned water seeping over concrete basement from the pipes through which the brook of Loc. 11 crosses the road; one more male was caught over the shady lowermost brook reach with round holes (Fig. 20, left), also along with females of *I. thailandica*. In the evening of the same day, at ca 5:30 p.m., males of *M. rapida* were found ranging over small pools between boulders and rocks at the pool below the Kulen Waterfall (Loc. 8). They were flying very low and rather slowly as compared to females of *I. thailandica* flying above them, erratically, faster and at a greater height. On both 17.06.2018 and 30.08.2018 only one male was observed flying over the water seeping from that pipe bridge of Loc. 11. Also on 17.06.2018 a male ranged over the shady bank of the main river (Loc. 10) near the brook mouth, and on 30.08.2018 a male was caught at the brook reach with the round holes, which ranged over the height of 1 m (rather than very low over the water as usual). At the Kbal Spean River (Loc. 4), two males were seen while elusively ranging over shady shallow reaches as well.

Macromiidae

50. *Epophthalmia frontalis* Selys, 1871

O.K.: **Loc. 16:** 28.11.2019: 1 ♂, 1 ovipositing ♀ seen; **Loc. 20** (near the outlet): 28.11.2019: 1 ♂ seen. **Loc. 26:** 1.07.2018: 1 ind. seen.

Remarks. Sightings only, identification tentative.

Observations. At loc. 16 examined between 3 and 3:30 p.m., a female appeared each time soon after the sun appeared from clouds and several times flew along the considerable river. Twice it started ovipositing at the border of a shallow place with emerging vegetation and a deep place, flying fast to and fro and hitting the surface with its abdomen with such a strength that spray reached O.K.'s face. Two times a male was also seen flying by for a little while. The two other sightings were of a dragonfly ranging quite high and fast along the Siem Reap River, on the plateau where it left the Tnal Dach Reservoir (Loc. 20) and on the lowland at Banteay Srei (Loc. 26).

51. *Macromia aculeata* Fraser, 1927 (Fig. 51)

O.K.: **Loc. 26:** 1.07.2018: 1 ♂ collected (Fig. 51).

Remarks. For clarification of the identity and distribution of this species see Kosterin (2015b).

Observations. On a sunny midday at a half-shaded fast reach the Siem Reap River downstream of the bridge in Banteay Srey, a male (Fig. 51) floated spread upside down but still alive on the river surface. Most probably its ruined position resulted from an attack of a male of *Onychothemis testacea*, several of which patrolled the water surface.

52. *Macromia callisto* Laidlaw, 1922 (Fig. 52)

O.K.: **Loc. 11:** 17.06.2018: 1 ♀ collected (Fig. 52).

Remarks. Illustrations in Muraki (2014) were helpful for identification of this female, which is small (hind wing 33 mm, abdomen 38 mm, total length 51 mm) and has a broad yellow stripe across the frons, S2 broadly yellow anteriorly, S3-S5 with very small yellow spots, S7 with a yellow ring and S8 with traces of yellow spot at base (Fig. 52).

Observations. Captured in flight over a sandy open reach not far from the mouth (downstream from the road) of the Loc. 11 brook.

53. *Macromia cupricincta* Fraser, 1924 (Fig. 53)

O.K.: **Loc. 12:** 11.03.2019: 1 ♂ collected (Fig. 53).

Observations. A male ranged fast and low above the surface along a long, relatively deep but still fast, sunny reach of the main river of the eastern plateau.

Libellulidae

54. *Aethriamanta brevipennis* (Rambur, 1842)

O.K.: **Loc. 7:** 11.06.2018: 1 ♀ collected.

E.S.: **Loc. 26:** 30.05.2019: ♀.

Observations. This species, quite common at lowland ponds of Siem Reap Province, was only once found on the eastern plateau: a female perched ~2 m



Figure 51. A male of *Macromia aculeata* collected from the Siem Reap River surface downstream of the bridge in Banteay Srei village (Loc. 26, 1.07.2018, O.K.

above the ground on a long branch of a dead bush in a small glade separated by trees from the 1000 Linga (Siem Reap) River at carvings. No pond nearby, so this finding was unexpected and strange.

55. *Aethriamanta gracilis* (Brauer, 1878) (Fig. 54)

E.S.: **Loc. 20:** 6.06.2019: copula (Fig. 54).

Observations. Found only at the Tnal Dach Reservoir, the overgrown banks of which is a habitat very suitable for the species, which for some reason has not been found in the lowlands of Siem Reap Province.



Figure 52. A female of *Macromia callisto* collected at the forest brook of Loc. 11, 17.06.2018, O.K.



Figure 53. A male of *Macromia cupricincta* collected at the Siem Reap River upstream of the 2nd bridge (Loc. 12). 17.06.2018, O.K.



Figure 54. A copula of *Aethriamanta gracilis* at the Tnal Dach Reservoir (Loc. 20). 6.06.2019, E.S.

56. *Acisoma panorpoides* Rambur, 1842

O.K.: **Loc. 12:** 11.03.2019: several ♂♂ seen; 30.11.2019: several ♂♂ seen. **Loc. 20:** 28-29.11.2019: very many seen. **Loc. 23:** 10.03.2019: many ♂♂ seen.

E.S.: **Loc. 20:** 6.06.2019: ♂; 5.11.2019: ♀. Not located: 7.03.2019: ♀; 24.04.2019: ♂, ♀.

Observations. Generally a common species but rather uncommon in Phnom Kulen. Occurs at herbs and grass emerging from water. Prefers lentic habitats (as Loc. 20) but occurs also at slow river reaches (Locs 12, 23).

57. *Brachydiplax chalybea chalybea* Brauer, 1868

O.K.: **Loc. 18:** 10.03.2019: several ♂♂ seen. **Loc. 19:** 10.03.2019: several ♂♂ seen. **Loc. 20:** 28.11.2019: 1 ♂ seen; 29.11.2019: 1 ♂ photo, many ♂♂ seen.

E.S.: **Loc. 19:** 14.05.2019: ♂.

Observations. A lentic species not so common in Phnom Kulen. It however is thriving at the shallow N bank of Tnal Dach Reservoir overgrown with tall *Cyperus* sp.

58. *Brachydiplax farinosa* (Krüger, 1899)

O.K.: **Loc. 7** (a small pool on rocks): 12.06.2018: 1 ♂ collected, 1 more ♂ seen. **Loc. 20**: 29.11.2019 (among trees on the dam): 1 ♂ photo.

E.S.: **Loc. 7** (the same small pool on rocks): 18.05.2018: ♂; **Loc. 20**: 7.10.2019: ♂; 7.11.2019: ♂.

Photo by Timo Hartmann in Facebook group 'Natural Cambodia': Loc. 4: 21.09.2008: ♂.

Observations. The species prefers small overgrown ponds, so it is invariably found at a tiny but deep pool with *Nymphaea* on sandstone rocks at the linga carvings on the Siem Reap River (Loc. 7). Solitary males were also met at the Tnal Dach Reservoir (Loc. 20), e.g. a male perching on bushes in small sunlit spots under trees growing on the dam (29.11.2019).

59. *Brachydiplax sobrina* (Rambur, 1842)

O.K.: **Loc. 20**: 29.11.2019: 1 ♂ collected.

E.S.: Not located: 28.07.2018: ♂.

Remarks. The species is characterised as having 7 forewing antenodals (Asahina 1988), however the specimen collected has 6 ones on the left forewing and 7 in the right forewing.

Observations. A male was collected at the margin of grove near the dam of Thal Dach Reservoir.



Figure 55. Males of *Brachygonia oculata*: a – in the Tnal Mareh floating forest (Fig. 7, Loc. 17), 28.11.2019, O.K., b – at a cold spring (Fig. 16) of the Siem Reap River right bank upstream of the carvings (Loc. 6), 24.07.2015, E.S.; c – in the floating forest at Loc. 17, 27.10.2019, E.S.

60. *Brachygonia oculata* (Brauer, 1878) (Fig. 55)

O.K.: **Loc. 17**: 28-30.11.2019: very many ♂♂, many ♀♀ seen; 28.11.2019: 1 ♂ photo (Fig. 55a); 29.11.2019: 2 ♀♀ collected, 1 ♀ photo; 30.11.2019: 2 ♂♂ collected:

E.S.: **Loc. 6** (at a cold spring): 24.07.2015 (Fig. 55b): ♂; 6.10.2015: ♂; **Loc. 16**: 27.10.2019: ♂ (Fig. 55c).

Observations. A species usually confined to shady swampy forests (often behind mangroves). There is no surprise that it occurs plentifully in the 'floating forest' of Tnal Mareh (Fig. 55a) (Loc. 17, Fig. 7) and a similar habitat at the nearby (Fig. 55c) (Loc. 16), which so much resembles mangroves in appearance (including numerous pneumatophorata protruding from water) and conditions. The singular males (Fig. 55b) were also found twice, in different years, at a small, round, deep pool with a clear water formed by a sacred cold spring (Fig. 16) near the 1000 Linga (Siem Reap) River right bank. Not found elsewhere.

61. *Brachythemis contaminata* (Fabricius, 1793)

O.K.: **Loc. 1**: 11.12.2019: very many ♂♂, ♀♀ seen. **Loc. 5**: 14.06.2018: several ♂♂ seen. **Loc. 7**: 23.02.2017: 1 ♂, 1 ♀ seen; 11.06.2018: 1 ♂, 1 ♀ seen. **Loc. 8**: 12.06.2018: 1 ♂, 1 ♀ (maybe more) seen; 10.03.2019: several seen. **Loc. 10**: 10.03.2019: several seen. **Loc. 12**: 11.03.2019: many ♂♂, ♀♀ seen. **Loc. 18**: 10.03.2019: several seen. **Loc. 19**: 10.03.2019: many ♂♂, ♀♀ seen; 29.11.2019: 1 ♀ seen at the small pond. **Loc. 23**: 10.03.2019: very many ♂♂, ♀♀ seen. **Loc. 26**: 14.06.2018: quite many seen; 1.07.2018: many seen; 3.11.2018: 1 ♂ seen.

E.S.: **Loc. 16**: 28.07.2019: ♂. **Loc. 19**: 12.06.2019: ♂. **Loc. 23**: 10.03.2019: ♂. Not located: 7.03.2019: ♂, ♀.

Observations. An omnipresent and eurytopic species tolerating pollution but still preferring slow current water, so on Phnom Kulen occurring mostly at rivers. Curiously, several individuals were found in the spray zone, with moist rocks, just below the high Kulen Waterfall, that looked far from a typical habitat of this species.

62. *Cratilla lineata calverti* Förster, 1903

O.K.: **Loc. 13** (shady road in a forest patch nearby): 30.06.2018: uncertain sighting of several individuals at dusk.

E.S.: **Loc. 20**: 23.10.2019: ♂. Not located: 22.12.2018: ♀.

Photo by Caleb Jones (in Facebook group 'Natural Cambodia'): **Loc. 3**: ♀.

Observations. The species active always in deep forest shade, also while raining or in dusk. Surprisingly rare in Phnom Kulen, in spite of widespread suitable habitats.

63. *Crocothemis servilia* (Drury, 1770)

O.K.: **Loc. 1**: 11.12.2019: many ♂♂, several ♀♀ seen. **Loc. 2**: 11.12.2019: 1 ♂ collected. **Loc. 19** (at the small pond): 29.11.2019: many ♂♂ seen. **Loc. 20** (at a shallow grassy bay): 29.11.2019: many ♂♂ seen. **Loc. 21**: 10.03.2019: many ♂♂ seen. **Loc. 25**: 2.12.2019: several ♂♂ seen. **Loc. 26**: 1.07.2018: several 1 ♂♂, 1 ♀, 1 ovipositing tandem seen; 1 ♂ seen; 2.12.2019: many ♂♂ seen.

E.S.: **Loc. 7**: 23.02.2017: ♂. **Loc. 19**: 10.03.2019: ♂.

Observations. A common lentic species occurring where it finds suitable habitats, hence not so frequent in Phnom Kulen.

64. *Diplacodes nebulosa* (Fabricius, 1794)

O.K.: **Loc. 7:** 12.06.2018: 1 ♂ collected. **Loc. 12:** 11.03.2019: 1 ♂ collected, several ♂♂ seen; 30.11.2019: several ♂♂ seen. **Loc. 15:** 28.11.2019: many ♂♂, ♀♀ seen. **Loc. 16:** 28.11.2019: many ♂♂, ♀♀ seen. **Loc. 17:** 28-30.11.2019: several ♂♂, 1 ♀ seen. **Loc. 19** (at the small pond): many seen. **Loc. 20:** 28-29.11.2019: very many ♂♂, ♀♀ seen. **Loc. 21:** 29.11.2019: many ♂♂, ♀♀ seen. **Loc. 23:** 10.03.2019: 1 ♂ seen.

E.S.: **Loc. 20:** 5.11.2019: ♂, ♀.

Observations. A common lentic species confined to emerging vegetation, occurs also in similar conditions at river slow reaches.

65. *Diplacodes trivialis* (Rambur, 1842)

O.K.: **Loc. 1:** 11.12.2019: several ♂♂ seen. **Loc. 7:** 23.02.2017: 1 ♂ seen; 11.06.2018: 1 ♂ seen. **Loc. 8** (rocks above the waterfall): 11.06.2018: 1 ♂ photo. **Loc. 12** (at lotic pools on a road): 4.11.2018: 1 immature ♂ seen. **Loc. 15:** 28.11.2019: 1 ♂ seen. **Loc. 17:** 28.11.2019: 1 ♂ seen; 29.11.2019: 1 ♂ seen. **Loc. 20:** 29.11.2019: 1 ♂ seen. **Loc. 23:** 10.03.2019: many ind., 1 copula seen. **Loc. 26:** 3.11.2018: 1 immature ♂ seen; 2.12.2019: several ♂♂, 1 ♀ seen.

E.S.: **Loc. 10:** 20.03.2018: ♂. **Loc. 22:** 25.11.2019: ♂, ♀.

Observations. A common species more often seen at open places beyond water.

66. *Hydrobasileus croceus* (Brauer, 1867)

O.K.: **Loc. 4:** 14.06.2018: 1 ♂ seen. **Loc. 10** (an open reach upstream of the bridge): 30.06.2018: 1 ♂ seen. **Loc. 11** (above an open pool at the road): 17.06.2018: 1 ♂ collected; 30.06.2018: 1 ♂ seen. **Loc. 20:** 28.11.2019: 1 ♂ seen; 29.11.2019: 1 ♂ collected, many ♂♂ seen.

Observations. Males can be seen soaring high above open pools (Locs 4, 11) and reaches (Loc. 10) of streams. On 29.11.2019 they appeared unusually numerous at the Thal Dach Reservoir dam (Loc. 20), soaring above the water and the dam itself.

67. *Indothemis limbata* (Selys, 1891)

O.K.: **Loc. 20:** 29.11.2019: 3 ♂♂ collected, several more seen. **Loc. 23:** 10.03.2019: 1 ♂ collected, 1 more ♂ seen.

Observations. Found at Thal Dach Reservoir (Loc. 20), with the overgrown banks and surface or relatively deep water seeming to be the typical habitat of the species, and at a grassy and boggy broadening of a brook crossing an open pasture (Loc. 23). Males perch on sticks and fly much over the water.

68. *Lathrecista asiatica* (Fabricius, 1798)

O.K.: **Loc. 7:** 4.11.2018: 1 ♀ photo.

E.S.: **Loc. 20:** 5.11.2019: ♂; 7.11.2019: ♀.

Photo by Timo Hartmann in Facebook group 'Natural Cambodia': **Loc. 4:** 21.09.2008: ♂.

Observations. A species common elsewhere in Cambodia, especially in the dry season, but for some reason rare in Phnom Kulen.

69. *Nannophya pygmaea* (Rambur, 1842) (Fig. 56)

O.K.: **Loc. 11:** 4.11.2018: 1 ♂ collected, 1 ♂ photo (Fig. 56, top). **Loc. 12:** 11.03.2019: many ♂♂, 1 copula seen. **Loc. 13:** 11.03.2019: very many seen. **Loc. 17:** 28-30.11.2019: several ♂♂, ♀♀ seen; 29.11.2019: 1 ♂ collected. **Loc. 19:** 10.03.2019: 1 ♂ collected, several ♂♂ seen; 29.11.2019: several ♂♂ seen at the small pond. **Loc. 20:** 28-29.11.2019: several ♂♂ seen; 29.11.2019: 1 ♂ photo (Fig. 56, bottom). **Loc. 21:** 29.11.2019: 1 ♂ photo, many mature and immature ♂♂ seen.



E.S.: **Loc. 12:** 22.07.2019: ♀. **Loc. 18:** 10.03.2019: ♂; 25.11.2019: ♂. Not located: 24.04.2019: ♂; 5.11.2019: ♀; 25.11.2019: ♂.

Observations. Confined to fine moist grass with thin leaves near shallow water, as a rule of slow sunny reaches of small streams or brooks. Remarkably common in Phnom Kulen, although absent from most visited broad river reaches with sandstone beds such as Locs 6-8. For some reason not yet found on the western plateau.

Figure 56. Males of *Nannophya pygmaea*: a – in the forest brook valley of Loc. 11, 4.11.2018, , b – at the Tnal Dach Reservoir (Loc. 20), 29.11.2019. O.K.



Figure 57. A female of *Neurothemis fluctuans* with a light yellowing wing coloration at the Srae Tbong River (Loc. 16), 27.10.2019, E.S.

70. *Neurothemis fluctuans* (Fabricius, 1793) (Figs 57-59)

O.K.: **Locs 6-7:** 23.02.2017: many ♂♂ (all with the wing colour not yet saturated), ♀♀ seen. **Loc. 7:** 4.11.2018: several seen; **Loc. 11:** 4.11.2018: 1 ♀ collected; several ♂♂, ♀♀ seen; 10-11.03.2019: very many seen; 30.11.2019: several seen. **Loc. 12:** 11.03.2019: very many seen; 30.11.2019: many ♂♂, ♀♀ seen. **Loc. 13:** 11.03.2019: many seen. **Loc. 16:** 28.11.2019: many seen. **Loc. 17:** 28-30.11.2019: many seen. **Loc. 18:** 10.03.2019: several seen. **Loc. 19:** 10.03.2019: many seen; 28.11.2019: many seen; 29.11.2019: 1 ♂ photo. **Loc. 20:** 28-29.03.2019: very many ♂♂, ♀♀ seen, including teneral. **Loc. 21:** 29.11.2019: many seen. **Loc. 23:** 10.03.2019: very many ♂♂, ♀♀ seen, including teneral. **Loc. 26:** 1.07.2018: 1 ♂ seen; 2.12.2019: several seen.

E.S.: **Loc. 6:** 20.03.2018: 2 ♂♂; 11.04.2018: ♂; 13.12.2018: ♀. **Loc. 13:** 11.04.2018: androchromatic ♀. **Loc. 14:** 13.12.2018: androchromatic ♀. **Loc. 16:** 27.10.2019: ♂, 2 androchromatic ♀♀ (Fig. 58a,c), ♀ with wings slightly coloured (Fig. 57). **Loc. 20:** 7.11.2019: ♂, androchromatic ♀ (Fig. 58d); 27.10.2019: androchromatic ♀. **Loc. 23:** 10.03.2019: ♂. By the forest road between **Loc. 6** and **Loc. 9** (13.5605 N, 104.1805 E): 19.04.2018: ♂ (with a straight border of the wing colour) (Fig. 59); 20.02.2016: androchromatic ♀; 3.03.2016: ♀ with wings slightly coloured. Not located: 19.04.2018: ♂; 3.07.2018: androchromatic ♀ (Fig. 58b); 7.12.2018: ♀ (wings slightly coloured);



Figure 58. Androchromatic females of *Neurothemis fluctuans*: a, c – at the Srae Tbong River (Loc. 16), 27.10.2019 (the same place and date as the female with pale wing colour in Fig. 57); b – Phnom Kulen, not located, 3.07.2018; d – at Tnal Dach Reservoir (Loc. 20), 7.11.2019. E.S.

3.12.2018: androchromatic ♀; 22.12.2018: ♀; 7.03.2019: androchromatic ♀, ♀ with wings slightly coloured; 11.04.2019: androchromatic ♀; 12.04.2019: ♀.

Remarks. In Phnom Kulen there is an unusually high proportion of androchromatic females of this species. Among 17 females photographed by E.S. almost at random 3 had clear wings, 4 had wings slightly coloured (Fig. 57) and 10 were distinctly androchromatic (Fig. 58). So, the proportion of females with coloured wings appears to be ca 82%, while they are usually a minority elsewhere. The coloured wing part in androchromatic females is shorter than in males and does not reach the pterostigma. Its colour in mature individuals is usually darker, blackish-brown rather than reddish-brown as in males, yet the abdomen is dark-reddish contrasting in its colour to the wings (similarly coloured in males). Such females were illustrated by Roland et al. (2011: fig. 9) from Banteay Srei. Those reported by Kosterin (2014: fig. 15) from Ratanakiri Province had a much more restricted coloured wing areas.



Figure 59. A male of *Neurothemis fluctuans*: with an unusual, straight border of wing coloration from between Locs 6 and 9, 19.04.2018. E.S.

The females with slightly coloured wings has a yellowish tint of this coloration (Fig. 57) while in the androchromatic females the tint is rather blackish-brown (Fig. 58), even in rather young individuals where the colour is rather slight (Fig. 58b). Those yellowish-winged females may be interpreted as the youngest ones, in which the wing coloration just started to form, as a distinct morph or even as heterozygotes for alleles of some gene responsible for the wing coloration. This issue is to be clarified experimentally.

The male photographed by E.S. on 19.04.2018 between Locs 6 and 9 had the unusual, straight wing colour border (Fig 59).

Observations. One of the most common and widespread dragonfly.

71. *Neurothemis fulvia* (Drury, 1773)

O.K.: **Loc. 1:** 11.12.2019: 1 ♂ seen. **Loc. 2:** 11.12.2019: 1 ♂ seen. **Loc. 4:** 6.11.2018: 1 ♂ seen. **Loc. 5:** 6.11.2018: 1 ♂ seen. **Loc. 6:** 1 ♂ collected (found dead, still soft). **Loc. 7** (a small pool on rocks): 12.06.2018: 2 ♂♂ seen; 4.11.2018: 1 ♂ seen. **Loc. 10:** 4.11.2018: 1 ♀ seen. **Loc. 12:** 11.03.2019: 2 ♂♂ seen. **Loc. 26:** 14.06.2018: 1 ♂ seen; 1.07.2018: 1 ♂ seen; 3.11.2018: 1 ♂ seen; 2.12.2019: 2 ♂♂ seen.

E.S.: **Loc. 7** (a small pool on rocks): 18.05.2018: ♂. **Loc. 8** (at the trade area above the waterfall): 16.03.2018: ♂. **Loc. 21** (S of the road, 13.5316 N, 104.183 E): 12.06.2019: ♀. Not located: 24.01.2015: ♂; 14.12.2015: ♂.

Observations. Common; the habitat preference is hardly traceable.

72. *Neurothemis intermedia atalanta* Ris, 1919

O.K.: **Loc. 4:** 6.11.2018: several seen at the river, many at a glade behind trees. **Loc. 5:** 14.06.2018: 1 mature ♂ photo; 6.11.2018: several seen.. **Loc. 7:** 23.02.2017:

1 ♀ seen; 11.06.2018: 1 mature ♂, 1 immature ♂ collected; 1 immature ♂, 1 mature ♀ photo. **Loc. 9** (a small glade above the waterfall): 12.06.2018: 1 ♂ seen. **Loc. 10:** 4.11.2018: 1 ♀ seen. **Loc. 11** (a dry cashew plantation nearby): 30.06.2018: 1 ♂ seen; 4.11.2018: quite many ♂♂, ♀♀ seen; 10.03.2019: 1 immature ♂ seen; 20.11.2019: many immature ind. seen. **Loc. 12** (a dry glades behind trees): 4.11.2018: several seen; 30.11.2019: several seen. **Loc. 17:** 29.11.2019: 1 ♀ seen. **Loc. 19:** 28.11.2019: 1 ind. seen. **Loc. 23:** 10.03.2019: 1 ♂ seen. **Loc. 26:** several immature ♂♂, ♀♀ seen. E.S.: **Loc. 8:** 16.03.2018: ♀. By the road 1.5 km NW of **Loc. 6** (13.5743 N, 104.0892 E): 18.05.2018: ♂, ♀. Not located: 16.12.2018: immature ♂; 22.12.2018: ♂.

Observations. A common species, especially in the dry season, seen mostly in dry places beyond the water, e.g. in grassy glades or at cashew plantations.

73. *Neurothemis tullia* (Drury, 1773)

O.K.: **Loc. 1** (on the rice field): 11.12.2019: 1 ♂♂ seen. **Loc. 7:** 23.02.2017: several ♂♂, ♀♀ seen; 17.06.2018: 1 ♂ seen. **Loc. 19** (at a pond): 10.03.2019: several ♂♂, ♀♀ seen. **Loc. 20:** 29.11.2019: 1 ♀ seen. **Loc. 23:** 10.03.2019: several ♂♂, ♀♀ seen.

E.S.: **Loc. 6:** 20.03.2018: 1 ♀.

Photos by Peter Gartner in Facebook group 'Natural Cambodia': **Loc. 5:** 04-06.2013: ♂.

Observations. A lentic species common elsewhere in Cambodia but not so frequent in Phnom Kulen where it was repeatedly found also at the main river of the eastern plateau.

74. *Onychothemis testacea* Laidlaw, 1902

O.K.: Locs 6-7: 11.06.2018: several ♂♂ seen. **Loc. 8:** 12.06.2018: 1 ♀ collected; 1 ♂ seen. **Loc. 9:** 17.06.2018: 1 ♂ seen; 1 ♂ photo; 30.06.2018: several ♂♂, 1 ♀ seen. **Loc. 10:** 12.06.2018: 1 ♂ collected, 1 more ♂ seen; 17.06.2018: several ♂♂ seen. **Loc. 12:** 4.11.2018: several ♂♂ seen. **Loc. 19:** 29.11.2019: 1 ♂ seen. **Loc. 26:** 14.06.2018: 1 ♂ collected, 2 more ♂♂ seen; 1.07.2019: 1 ♂ photo, many ♂♂, 1 ovipositing ♀ seen.

E.S.: **Loc. 19:** 14.05.2019: ♂; 25.11.2019: ♂. **Loc. 25:** 30.05.2019: ♂.

Observations. Occurs at rapids or at least fast river reaches, which may be quite shady, which the males patrol by perching on dry tree branches or thin lianas or bamboo branches above the water, fast flying over the surface and chasing other dragonflies. A female was observed (at Loc. 26) which oviposited over a root bunch on a branch emerging from water at a rapid.

75. *Orchithemis pulcherrima* Brauer, 1878 (Fig. 60)

O.K.: **Loc. 11:** 17.06.2018: 2 ♂♂ collected, 1 immature ♂ photo, many ♂♂ seen; 30.06.2018: 1 mature ♂ photo (Fig. 60b), many ♂♂, 1 ♀ (red form) seen. **Loc. 19:** (shady area): several ♂♂ seen. **Loc. 23:** 10.03.2019: 1 ♂ collected; 1 ♂ photo-graphed (Fig. 60c).

E.S.: **Loc. 16:** 28.07.2019: ♂; 27.10.2019: ♂, ♀ (red form, Fig. 60a). **Loc. 19:** 10.03.2019: ♂.

Observations. Occurs, usually together with *A. viola*, at shady overgrown brooks (Loc. 11, 23) or small rivers (Locs 16, 19) in evergreen forest or secondary dense shrubbery at its patches, where the bright-red abdomen of males is conspicuous even in dark conditions (Fig. 60b-c).



Figure 60. A female (a) and males (b-c) of *Orchithemis pulcherrima*: a – at the Srae Tbong River (Loc. 16), 27.10.2019, E.S.; b – in the brook valley of Loc. 11, 30.06.2018, O.K.; c – shrubs at Ta Penh village (Loc. 23), 10.03.2019, O.K.

76. *Orthetrum chrysis* (Selys, 1891)

O.K.: **Loc. 1:** 11.12.2019: several ♂♂ seen. **Loc. 2:** 11.12.2019: many ♂♂ seen. **Loc. 3:** 6.11.2018: 1 ♂ seen. **Loc. 4:** 6.11.2018: several ♂♂ seen. **Loc. 5:** 6.11.2018: several ♂♂ seen. **Loc. 6:** 23.02.2017: several ♂♂ seen; **Loc. 7:** 23.02.2017: several ♂♂ seen; 17.06.2018: 1 ♂ seen. **Loc. 10:** 30.06.2018: 1 ♂ seen; 4.11.2018: several ♂♂ seen. **Loc. 11:** 30.06.2018: 1 ♂ seen; 17.06.2018: 1 ♂ seen; 4.11.2018: many ♂♂ seen; 30.11.2019: several ♂♂ seen. **Loc. 12:** 4.11.2018: several ♂♂ seen at lotic pools on a road; 11.03.2019: many ♂♂ seen; 30.11.2019: 1 ♂ seen at the small waterfall. **Loc. 13:** 11.03.2019: several ♂♂ seen. **Loc. 16:** 28.11.2019: several ♂♂ seen. **Loc. 18:** 10.03.2019: several ♂♂ seen. **Loc. 19:** 10.03.2019: many ♂♂ seen; 28.11.2019: several ♂♂ seen; 29.11.2019: 1 ♂, 1 ♀ photo, many ♂♂ seen. **Loc. 20** (at the outlet stream): 28-29.11.2019: 1 ♂ seen. **Loc. 21:** 29.11.2019: several ♂♂ seen. **Loc. 23:** 10.03.2019: very many ♂♂, several copulae seen. **Loc. 25:** 2.12.2019: many ♂♂ seen. **Loc. 26:** 3.11.2018: 1 ♂ seen; 2.12.2019: many ♂♂ seen.

E.S.: **Loc. 6:** 16.03.2018: ♂. **Loc. 19:** 4.11.2018: ♂. **Loc. 22:** 25.11.2019: ♂. Not located: 15.05.2015: copula; 7.12.2018: ♂.

Observations. Very common at any river and rivulet but actually associated with shallow pools nearby, usually with black litter-covered bottom, rather than with main streams.

77. *Orthetrum glaucum* (Brauer, 1865) (Fig. 61a,d)

O.K.: **Loc. 2:** 11.12.2019: 1 ♂ photo (Fig. 61d). **Loc. 3:** 6.11.2018: 1 ♂ photo. **Loc. 7:** 23.02.2017: 1 ♂ seen; 4.11.2018: many ♂♂ seen. **Loc. 8:** 12.06.2018: 1 ♂ photo; 4.11.2018: many ♂♂ seen. **Loc. 11** (at an open roadside pool): 4.11.2018: 1 ♀ collected, 1 ♂ photo, few more ♂♂ seen. **Loc. 12:** 4.11.2018: 1 ♂ seen at lotic pools on a road; 30.11.2019: 1 ♂ seen at the small waterfall. **Loc. 20** (at the outlet stream): 28.11.2019: 1 immature ♂ photo.

E.S.: **Loc. 19:** 25.11.2019: ♂. **Loc. 22:** 25.11.2019: ♂, copula. Not located: 13.11.2012: ♂ (Fig. 61a); 16.11.2014: ♂.



Figure 61. Males of *Orthetrum* spp.: a, d – *O. glaucum*; b – *O. sabina*; c – *O. neglectum*; a-b – Phnom Kulen, not located, 13.11.2012, E.S.; c-d – at the brook near the low western spur of the western plateau (Loc. 2), 11.12.2019, O.K.

Observations. Occurs at open places at rivers, brooks, or seepages on roads. Less common than the previous species and associated with flowing water rather than pools, e.g. with shallow river arms or brooks. Males usually perch on stones or flat rocks.

78. *Orthetrum luzonicum* (Brauer, 1868)

O.K.: **Loc. 1** (on the rice field): 11.12.2019: several ♂♂ seen. **Loc. 2**: 11.12.2019: 1 ♂ collected, 1 ♂ photo, very many ♂♂ seen. **Loc. 13**: 11.03.2019: 2 ♂♂ seen. **Loc. 15**: 28.11.2019: several ♂♂ seen. **Loc. 19**: 10.03.2019: several ♂♂ seen; 29.11.2019: 1 ♂ seen at the river, many ♂♂ at the small pond. **Loc. 21**: 29.11.2019: many ♂♂ seen. **Loc. 23**: 10.03.2019: 1 subfederal ♂ collected; 1 subfederal ♂ photo, several more such ♂♂ seen.

E.S.: **Loc. 19**: 5.11.2019: ♂; 25.11.2019: ♂. **Loc. 20**: 23.10.2019: ♂. **Loc. 22**: 25.11.2019: ♂. **Loc. 23**: 10.03.2019: subfederal ♂.

Observations. Occurs at small open streams overgrown with grass, e.g. brooks, river arms, especially of rivers flowing through flat grassy areas. There is some ecological correlation with the occurrence of taro/elephant ear plants (*Colocasiasae*).

79. *Orthetrum neglectum* (Rambur, 1842) (Fig. 61c, 62)

O.K.: **Loc. 1**: 11.12.2019: many ♂♂ seen. **Loc. 2**: 11.12.2019: 1 ♂ photo (Fig. 61c), many ♂♂ seen. **Loc. 6**: 23.02.2017: several ♂♂ seen; **Loc. 7**: 23.02.2017: several ♂♂ seen; 4.11.2018: 1 ♂ seen. **Loc. 8**: 4.11.2018: 1 ♂ seen. **Loc. 16**: 28.11.2019: 1 ♂ seen. **Loc. 19**: 29.11.2019: 1 ♂ photo, several ♂♂ seen. **Loc. 23**: 10.03.2019: many ♂♂, several copulae seen. **Loc. 25**: 2.12.2019: several ♂♂ seen. **Loc. 26**: 3.11.2018: 1 ♂ seen; 2.12.2019: 1 ♂ seen..

E.S.: **Loc. 7**: 23.02.2017: ♂. **Loc. 19**: ♂; 5.11.2019: copula (Fig. 62). **Loc. 22**: 25.11.2019: ♂. **Loc. 24**: 14.03.2020: ♂. Not located: 12.04.2019: ♂; 7.10.2019: ♂.

Observations. This species is common at open reaches of rivers; not observed at small brook except for that of Ta Penh (Loc. 23) where was numerous. Less numerous than *O. chrysis* and showing no connection to pools.

80. *Orthetrum sabina* (Drury, 1770) (Fig. 61b, 63)

O.K.: **Loc. 1**: 11.12.2019: very many ♂♂ seen. **Loc. 2**: 11.12.2019: many ♂♂ seen. **Loc. 4**: 6.11.2018: 1 ind. seen. **Loc. 7**: 23.02.2017: several ♂♂ seen; 4.11.2018: several seen. **Loc. 11** (the dry cashew plantation nearby): 30.11.2019: 1 ind. seen. **Loc. 12**: 4.11.2018: several ♂♂ seen at lotic pools on a road; 30.11.2019: several seen. **Loc. 16**: 28.11.2019: several seen. **Loc. 18**: 10.03.2019: several seen. **Loc. 19**: 10.03.2019: many seen (mostly at the pond); 28.11.2019: 1 ind. seen; 29.11.2019: many seen. **Loc. 20**: 29.11.2019: 1 ♂ photo (Fig. 63), many seen. **Loc. 23**: 10.03.2019: many seen. **Loc. 25**: 2.12.2019: 1 ♂ seen. **Loc. 26**: 3.11.2018: very many ♂♂ seen; 2.12.2019: very many seen.

E.S.: Not located: 13.11.2012: ♂ (Fig. 61b); 7.12.2018: ♀.

Observations. Occurs at open places, on the plateaux less common than on the lowlands. Usually associated with big open lentic water bodies or seepages at the sandstone banks of mountain rivers, but territorial males were observed patrolling the surface of rather a fast lowland river of Loc. 1 and perching on its



Figure 62. A copula of *Orthetrum neglectum* at the O'Dar River near An-lung Thom village (Loc. 19), 5.11.2019, E.S.

banks. At the Tnal Dach Reservoir, a male was found in tandem with a female of *Trithemis pallidinervis* (Fig. 63).

81. *Orthetrum testaceum* (Burmeister, 1839) (Fig. 64)

E.S.: Not located: 30.04. 2015: copula (Fig. 64).

Remarks. Identified by one photo (Fig. 64), by the male abdomen rather evenly broad and warm scarlet red and the red thorax, while in the similar *O. chrysis* the abdomen is tapering and colder crimson red and the thorax is dark brown. Unfortunately, there is no specimen to check

in hand. From Cambodia, the species has been reported by one male collected in Kep (Kosterin 2011); in Thailand is more common in the south of the country (Hämäläinen & Pinratana 1999).

82. *Palpopleura sexmaculata* (Fabricius, 1787) (Fig. 65)

O.K.: **Loc. 15:** 28.11.2019: 1 ♂ collected.

E.S.: **Loc. 19:** 25.11.2019: 2 ♂♂, 1 ♀ (Fig. 65).

Observations. Occurs at small grassy pools, in our area formed by water streaming through grass. Rare in the territory considered.

83. *Pantala flavescens* (Linnaeus, 1758).

O.K.: **Loc. 1:** 11.12.2019: many seen. **Loc. 7** (over flat sandstone rocky area): 11-12.06.2018: many seen; 17.06.2018: many seen. **Loc. 8:** 30.06.2018: 2 ovipositing ♀♀ seen. **Loc. 12** (above a road): 4.11.2018: 1 ind. seen. **Loc. 15:** 28.11.2019: several seen **Loc. 19:** 29.11.2019: several seen. **Loc. 20** (above a shallow bay): 29.11.2019: several seen. Over the road on the NW plateau slope: 17.06.2018: many seen after a downpour.



Figure 63. An anomalous tandem of a male of *Orthetrum sabina* and a female of *Trithemis pallidinervis* at the shallow SW corner of the Tnal Dach Reservoir (Loc. 20), 29.11.2019, O.K.



Figure 64. A copula of *Orthetrum testaceum* from somewhere in the Phnom Kulen eastern plateau, 30.04.2015, E.S.

E.S.: By the road from Anlong Thom to Sangkae Leak (13.5497 N, 104.1810 E): 27.10.2019: ♀.

Observations. These dragonflies as a rule soar above open areas, usually forming loose swarms; they remain active under weak rains. Although the species is known to breed mostly in small temporary pools, two supposedly ovipositing females were observed (the only oviposition sighting) at the big and deep pool under the Kulen Waterfall. Unlike other libellulids making long ovipositing series, they soared 2-3 m above, descended to water to make touch it briefly with their abdomen and rose again.

84. *Potamarcha congener* (Rambur, 1842)

O.K.: **Loc. 20** (an isolated shallow pool at bank at the NW corner): 29.11.2019: 1 teneral ♀ collected.



Figure 65. A female (a) and male (b) of *Palpopleura sexmaculata* at the O'Dar River near Anlung Thom village (Loc. 19), 25.11.2019, E.S.

E.S.: **Loc. 7** (at a small pool on rocks): 18.05.2018: ♂. By the road from Anlong Thom to Sangkae Leak (13.5498 N, 104.1813 E): 27.10.2019: ♂

Photos by Peter Gartner in Facebook group 'Natural Cambodia': **Loc. 5**: 04-06.2013: ♂, ♀.

Observations. Prefers small stagnant pools with open banks, often dirty. The pool at Loc. 20 approached this preferred habitats, although had grassy banks. Rare in the area.

85. *Rhodothermis rufa* (Rambur, 1842)

O.K.: **Loc. 7**: 23.02.2017: 1 ♀ seen. **Loc. 12**: 11.03.2019: 1 ♂ collected, very many ♂♂ seen; 30.11.2019: several ♂♂, many ♀♀ seen.

Observations. In two different times of the year this species was found remarkably numerous at the open reach with a flat bottom and medium current of the main river of the eastern plateau (Loc. 12), where kept to grassy mats with abundant *Colocasiae* plants along the banks. More common in the lowlands of Siem Reap Province (Kosterin 2020b).

86. *Rhyothemis obsolescens* Kirby, 1889 (Fig. 66)

O.K.: **Loc. 4**: 14.06.2018: 2 ♂♂ collected, 1 more ♂ seen. **Loc. 6**: 11.06.2018: 1 ♂ photo (Fig. 66c), several ♂♂ seen; 12.06.2018: several ♂♂ seen. **Loc. 9**: 11.06.2018: 1 ♂ seen. **Loc. 11**: 17.06.2018: 2 ♂♂ seen; 30.06.2018: many ♂♂ seen. **Loc. 12**: 11.03.2019: several ♂♂ seen. **Loc. 23**: 10.03.2019: several ♂♂ seen.

E.S.: **Loc. 6**: 2.06.2019: ♂; 15.05.2019: ♂ (Fig. 66b). **Loc. 19**: 10.03.2019: ♂ (Fig. 66d); 14.05.2019: ♂. **Loc. 20**: 6.06.2019: ♂. Not located: 21.05.2014: ♂ (Fig. 66b); 30.04.2015: ♀; 15.05.2015: ♂; 24.04.2019: ♂♂; 27.07.2019: ♂ (Fig. 66e)

Observations. Quite common at slow reaches of small forest rivers and brooks with abundant evergreen forest vegetation at banks, where taro/elephant ear (*Colocasiae* indet.) is usually present. Not found in the lowland. Spends overcast weather at high tree branches and descends to streams in sunshine.

87. *Rhyothemis phyllis* (Sulzer, 1776)

O.K.: **Loc. 7**: 11.06.2018: 1 ind. seen. **Loc. 8**: 12.06.2018: many seen in a swarm over open trading area. **Loc. 12**: 11.03.2019: many seen. **Loc. 19**: 10.03.2019: many seen. **Loc. 20**: 29.11.2019: 1 ♂ released. **Loc. 21**: 29.11.2019: 1 ind. seen. **Loc. 23**: 10.03.2019: very many seen.

Observations. Usually observed fluttering together with *R. variegata*, often in loose swarms, at glades and larger open places near rivers, usually at forest margins.

88. *Rhyothemis plutonia* Selys, 1883 (Fig. 67)

O.K.: **Loc. 7**: 11.06.2018: 1 ind. seen. **Loc. 11** (at the open pool at the road embankment): 30.06.2018: 1 worn out ♂ seen.

E.S.: **Loc. 20**: 6.06.2019: ♂ (Fig. 67 left). Not located: 26.07.2015: ♂; 15.06.2017: ♀ (Fig. 67 right); 24.04.2019: ♂♂.

Observations. Rarely occurs at small open places; usually perch high on tall bushes. Tends to occur together with much more widespread *R. phyllis* and *R. variegata*. So, at Loc. 7 met together with them in gaps of secondary tree growth apart from the river.

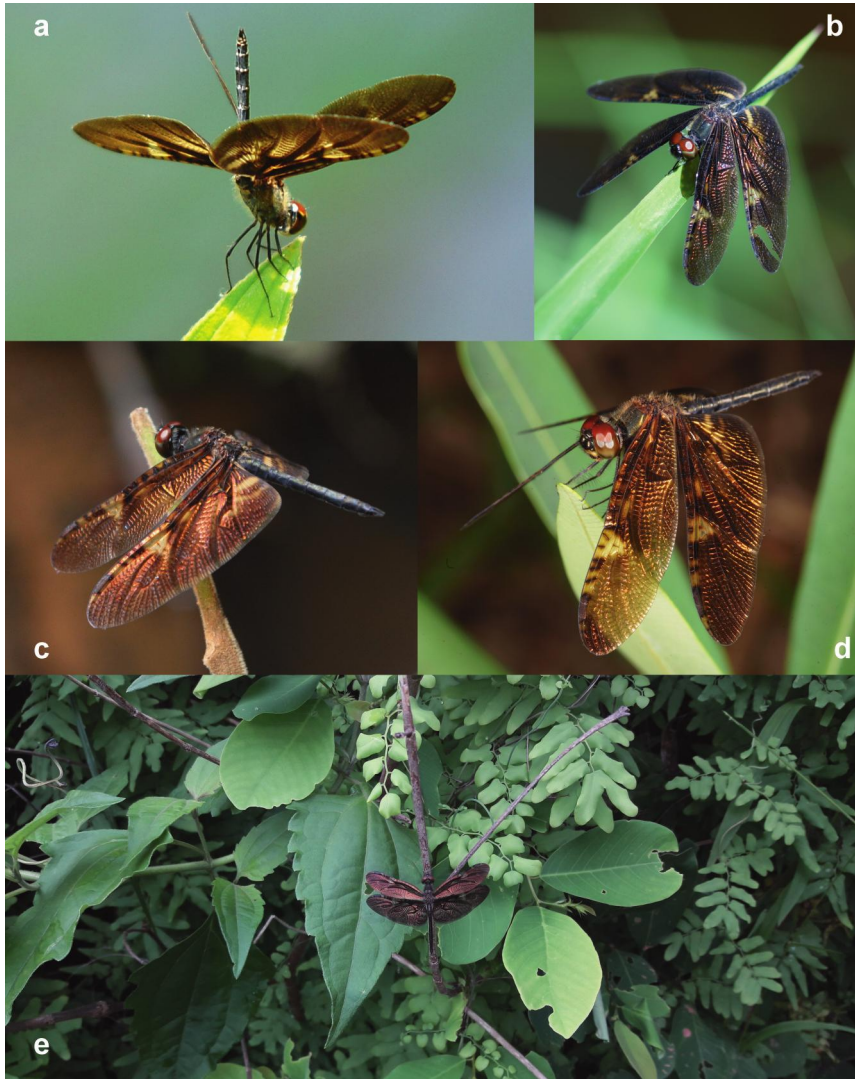


Figure 66. Males of *Rhyothemis obsolescens*: a – the eastern plateau of Phnom Kulen, not located, 21.05.2014, E.S.; b – at the Siem Reap River upstream of the carvings (Loc. 6), 15.05.2019, E.S.; c – at the same place, 11.06.2018, O.K.; d – at the same river at Anlung Thom village (Loc. 19), 10.03.2019, E.S.; e – the eastern plateau, not located, 27.07.2019, E.S.

89. *Rhyothemis triangularis* Kirby, 1889 (Fig. 68)

O.K.: Loc. 12: 11.03.2019: 1 ♂ seen.

E.S.: **Loc. 20:** 6.06.2019: ♂; 20.06.2019: ♂; 28.04.2020: teneral ♀ (Fig. 68). Not located: 24.04.2019: ♂♂.

Observations. Rare, prefers stagnant or slowly flowing water with abundant emergent, so met at the Tnal Dach Reservoir (Loc. 20) and an open reach of the Siem Riep River where it flows flat with grassy mats with taro/elephant ear along the bank (Loc. 11).

90. *Rhyothemis variegata* (Linnaeus, 1763)

O.K.: **Loc. 2:** 11.12.2019: 1 ♀ seen. **Loc. 7:** 11.06.2018: 1 ♀ seen; **Loc. 8:** 12.06.2018: many ♀♀ seen in a swarm over the open trading area; 30.06.2018: 1 ♀ seen under the waterfall. **Loc. 12:** 11.03.2019: many ♀♀ seen. **Loc. 19:** 10.03.2019: many ♀♀ seen. **Loc. 23:** 10.03.2019: very many ♀♀ seen.

Remarks. Females only; most probably just a female morph of the species known as *R. phyllis* (Kosterin 2010), which then would be a junior subjective synonym of *R. variegata*.

Observations. Observed fluttering usually together with *R. variegata* (of 8 localities were either of these species were found both were observed at 5).



Figure 67. *Rhyothemis plutonia*: left – a male at the Tnal Dach Reservoir (Loc. 20), 6.06.2019, E.S.; b – a female, the Phnom Kulen eastern plateau, not located, 15.06.2017; E.S.

91. *Tetrathemis platyptera* Selys, 1878

O.K.: **Loc. 3:** 14.06.2018: 1 ♂ collected. **Loc. 4:** 6.11.2018: 1 ♂ photo, 1 ♂ seen at the same point.

Observations. Found at both visits by O.K. to the Kbal Spean River on the western plateau, but for some reason not elsewhere. In June a male was met at a round hole filled with water in one of big rocks through which the river descended from the carving area. In November two males were met resting closely to each other on dry branches at a deep pool in the calm river section upstreams of the carvings. In both cases those males were very cautious and immediately flew high to tree crowns (in the first case after some 10 min the male was found at his water hole again).



Figure 68. A teneral female of *Rhyothemis triangularis* at the Tnal Dach Reservoir (Loc. 20), 28.04.2020; E.S.

92. *Tholymis tillarga* (Fabricius, 1798)

O.K.: **Loc. 17:** 28.11.2019: 1 ♀ seen. **Loc. 19:** 28.11.2019: very many ♂♂, ♀♀ seen in twilight. **Loc. 12:** 30.11.2019: several ind. seen. **Loc. 26:** 2.12.2019: 1 ♂ seen.

Observations. A common lowland species breeding in lentic, often polluted habitats from where it disperses broadly. Active mostly in twilight, at daytime resting in bushes remaining quite active and cautious. Not so often seen in Phnom Kulen, but found very numerous at Loc. 19 in November.

93. *Trithemis aurora* (Burmeister, 1839) (Fig. 69a)

O.K.: **Loc. 1:** 11.12.2019: many ♂♂ seen, 1 ♂ photo (Fig. 69a). **Loc. 4:** 6.11.2018: several ♂♂ seen. **Loc. 7:** 23.02.2017: several ♂♂ seen; 11.06.2018: 1 ♂ seen. **Loc. 8** (rock above the waterfall): 17.06.2018: 1 ♂ seen; 4.11.2018: several ♂♂ seen. **Loc. 10:** 4.11.2018: 1 ♀ seen. **Loc. 12:** 11.03.2019: several ♂♂ seen; 30.11.2019: many ♂♂, 1 ♀ seen. **Loc. 13:** 11.03.2019: 1 ♂ seen. **Loc. 19:** 10.03.2019: several ♂♂ seen; 28.11.2019: several ♂♂ seen; 29.11.2019: many ♂♂ seen. **Loc. 20** (at the outlet): 28-29.11.2019: several ♂♂ seen. **Loc. 21:** 29.11.2019: 1 ♀ seen. **Loc. 25:** 2.12.2019: many ♂♂ seen. **Loc. 26:** 14.06.2018: 2 ♂♂ seen; 1.07.2018: many ♂♂ seen; 3.11.2018: several ♂♂ seen; 2.12.2019: many ♂♂ seen.

E.S.: **Loc. 6:** 18.05.2018: ♂. **Loc. 8:** 23.05.2016: ♂. **Loc. 10:** 25.11.2019: ♂, ♀. **Loc. 19:** 5.11.2019: ♂. **Loc. 22:** 25.11.2019: ♂, ♀. **Loc. 25:** 27.11.2019: ♂. Not located: 7.11.2018: ♂♂; 23.10.2019: ♂.

Observations. Common at open reaches of rivers and brooks with open stony or sandy banks, both in the mountains and near their foothills.

94. *Trithemis festiva* (Rambur, 1842)

O.K.: **Loc. 1:** 11.12.2019: many ♂♂ seen. **Loc. 7:** 23.02.2017: many ♂♂ seen; 4.11.2018: many ♂♂ seen. **Loc. 8:** 4.11.2018: many ♂♂ seen. **Loc. 11** (at an open roadside pool):

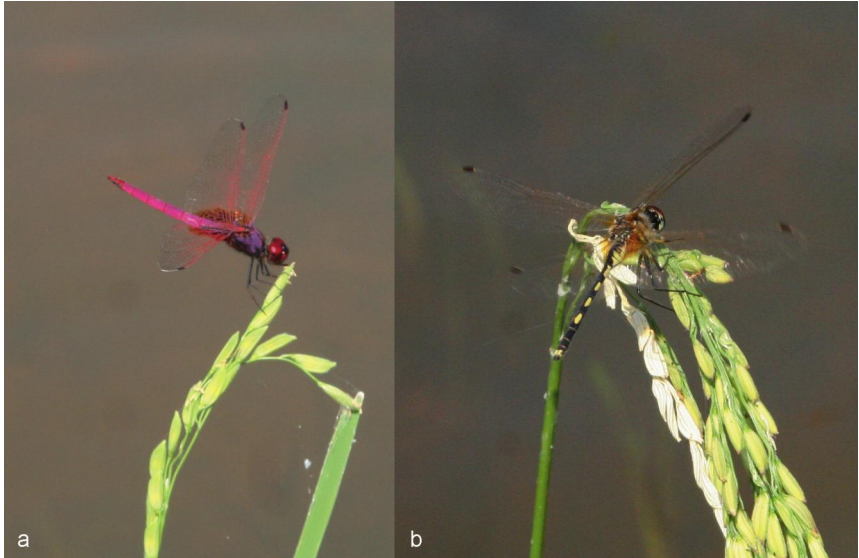


Figure 69. Males of *Trithemis aurora* (a) and *T. pallidinervis* (b) perching on rice panicles at a field made in a flat bad of a river at the western spur of the western Phnom Kulen plateau (Loc. 1), 11.12.2019, O.K.

4.11.2018: 1 ♂ photo, 1 more ♂ seen. **Loc. 12** (downstream of the small waterfall): 11.03.2019: 1 ♂ seen; 30.11.2019: several ♂♂ seen.. **Loc. 19**: 10.03.2019: 1 ♂ seen. **Loc. 25**: 2.12.2019: many ♂♂ seen.

E.S.: **Loc. 6**: 23.02.2017: ♂. **Loc. 19**: 10.03.2019: ♂; 5.11.2019: ♂; 25.11.2019: ♂. **Loc. 22**: 25.11.2019: ♂. Not located: 23.03.2014: ♂; 16.11.2014: ♂; 21.12.2014: ♂; 4.11.2018: ♂; 7.12.2018: ♂♂; 14.12.2018: ♂; 12.04.2019: ♂; 23.10.2019: ♂; 5.11.2019: ♂.

Observations. Less common than the previous species, prefers rapids at small streams; usually observed together with *O. glaucum*.

95. *Trithemis pallidinervis* (Kirby, 1889) (Figs 62, 69b)

O.K.: **Loc. 1**: 11.12.2019: 1 ♂ photo (Fig. 69b), many ♂♂ ♀♀ seen. **Loc. 7**: 4.11.2018: 1 ♂ photo. **Loc. 19** (at the small pond): several seen. **Loc. 20**: 28-29.11.2019: many seen; 29.11.2019: 1 ♀ photo (Fig. 62).

E.S.: **Loc. 19**: 25.11.2019: ♂. **Loc. 20**: 5.11.2019: ♂. Not located: 25.11.2019: ♂.

Observations. Prefers big, usually stagnant water in open landscapes, usually in lowlands. Hence in Phnom Kulen this species is common at the large reservoir of Tnal Dach (Loc. 20) and nearby but rare elsewhere. Surprisingly it was found common at the flat but still fast river just leaving the SW spur of the western plateau (Loc. 1). Curiously, males of all three species of *Trithemis* could be observed there perching at the panicles of rice planted right into the flat river bed (Fig. 70).

96. *Urothemis signata* (Rambur, 1842)

O.K.: **Loc. 10** (the open reach upstream of the bridge): 17.06.2018: 1 ♂ photo; 30.06.2018: 2 ♂♂ seen. **Loc. 17**: 28.11.2019: 1 ♂ seen. **Loc. 19** (at a pond): 10.03.2019: 1 ♂ seen. **Loc. 20**: 29.11.2019: several ♂♂ seen.

Observations. The species prefers big and deep ponds so is generally rare in Phnom Kulen; expectedly rather common at the banks of the big reservoir of Dnal Dach (Locl 20).

97. *Zygonyx iris malayana* Laidlaw, 1902 (Fig. 70)

O.K.: **Loc. 3**: 14.06.2018: 4 ♂♂ collected, several more seen; 6.11.2018: 1 ♂ seen. **Loc. 4**: 6.11.2018: several ♂♂ seen. **Loc. 6**: 11.06.2018: 1 ♂ collected; 12.06.2018: several ♂♂ seen. **Loc. 7**: 23.02.2017: several ♂♂ seen; 11.06.2017: several ♂♂ seen. **Loc. 8**: 12.06.2017: several ♂♂ seen; 17.06.2017: several ♂♂ seen. **Loc. 10**: 4.11.2018: ♂ seen. **Loc. 11**: 17.06.2018: several ♂♂ seen; 30.06.2018: 2 ♂♂ photo (Fig. 70d). **Loc. 12**: 4.11.2018: several ♂♂ seen; 11.03.2019: several ♂♂ seen. **Loc. 19**: 10.03.2019: 2 ♂♂ seen.

E.S.: **Loc. 13**: 11.04.2018: ♂ (Fig. 70b). **Loc. 19**: 10.03.2019: ♂; 5.11.2019: ♂ (Fig. 70a); 20.07.2019: ♂ (Fig. 70c); 6.06.2019: ♂. Not located: 23.03.2014: ♂; 7.10.2019: ♂.

Remarks. Some mature males (e.g. two of the four collected at Loc. 3, that photographed at Loc. 13) are very dark, so that the brownish stripes on the thorax and base of abdomen are obscured and scarcely seen, while the fine yellow middorsal line is not noticeable by a naked eye (Fig. 70).

Observations. Common at rivers with stony beds and fast current, over which the males soar and hover, occurs at brooks with the same conditions.

Discussion

In spite of shortage of interesting findings, the revealed Odonata fauna of Phnom Kulen Mts appeared surprisingly rich, as counting 97 species, and in general well representative of Cambodia overall. This is because Phnom Kulen offers a variety of both lotic and lentic habitats. Not many gomphids were registered (7 species, of which one is lentic), mostly because a number of stream habitats most promising for them, namely Locs. 2, 15-18, 19 (the outlet), were found only in 2019 and were not examined in June. Such examination was planned for 2020 but failed due to the too well known reasons.

Of the 97 species revealed, only 17 have been hitherto reported for Phnom Kulen. Roland et al. (2011) recorded *V. gracilis*, *H. biforata*, *L. lineata* (the first report of this species for Cambodia), *C. marginipes*, *P. rubriceps*, *B. contaminata*, *D. trivialis*, *N. fulvia*, *O. chrysis*, *O. neglectum* (as *O. pruinatum neglectum*), *T. aurora* and *T. festiva* on 15.11.2010 at their locality 4 ("13°40,7412 N, 104°01,533 E") corresponding to our Loc. 5, the Kbal Spean River at the national park entrance, although this species assemblage would be expected more upstreams. Seehausen et al. (2016) reported *Nannophya pygmaea*, *N. fulvia*, *N. intermedia atalanta*, *O. luzonicum*, *O. sabina* and *R. obsolescens*, for Phnom Kulen without further verbal detail, while the coordinates provided ("13.7000° N, 104.0522° E") project to arable flatland at the northern foot of the eastern plateau, where *N. pygmaea* and *R. obsolescens* could hardly occur.



Figure 70. Darkened mature males of *Zygonyx iris malayana*: a – at the O'Dar River near Anlung Thom village (Loc. 19), 5.11.2019, E.S.; b – at a brook flowing through open flat sandstone rocks (Loc. 13), 11.04.2018, E.S.; c - Loc. 19, 20.07.2019, E.S.; d - (Loc. 11), 30.06.2018, O.K.

It was very interesting to find a complex of species confined to sluggish brooks shaded by evergreen rainforest, with slow current and dark silty bottom, such as *Archibasis viola*, *Brachygonia oculata*, *Orchithemis pulcherima* (usually also accompanied by *Nannophya pygmaea*). These three species have generally Sondaic ranges (Kosterin & Kompier 2018), were first found in coastal areas in SW Cambodia (Kosterin 2010; 2011; Day 2011) and are usually seen in coastal, often swamped lowland and foothill rainforests. Their presence contributes to an impression of Phnom Kulen as virtually an island, which it certainly was in the past when the Cambodian lowland still did not rise from the sea.

Macromia callisto is here reported for Cambodia for the first time. *Burmagomphus* sp. cf. *williamsoni* was also first found in this country in Phnom Kulen, and soon also in Preah Vihear Province (Kosterin 2020a), but needs further study. A very interesting record, the second in Cambodia after that on Phnom Dalai in the Cardamoms (Kosterin et al. 2012) is *Lestes nodalis* (unfortunately both Cambodian records of this species are still photographic only). The only photo of a mating pair of *Orthetrum testaceum* without precise location remains the only evidence of presence of this species, rare in Cambodia, in Phnom Kulen.

Phnom Kulen is a home of a recently described species *Microgomphus alani*, an undescribed species *Gomphidia* sp. and at least two unusual forms of uncertain taxonomical status, *Euphaea* sp. cf. *masoni* and *Burmagomphus* sp. cf. *williamsoni*, but all has been also recorded elsewhere, e.g. the two latter mentioned ones at less elevations more easterly, in Stung Treng (Kosterin 2017) and Preah Vihear Provinces (Kosterin 2020a), respectively.

In the context of its general richness the Phnom Kulen fauna of dragonflies and damselflies is even more remarkable for its omissions. No single representative of the genus *Coeliccia* and of the entire family Platystictidae were found, in spite of examination of many suitable habitats. All blue and blue-faced *Pseudagrion* males found on the Phnom Kulen appeared to be *P. australasiae* and checking many males from different localities in hand O.K. failed to find a single male of *P. microcephalum* Rambur, 1842, although both were found in the adjacent lowland. There *P. microcephalum* was found at the very banks of the great Lake Tonle Sap while *A. australasiae* at small lotic habitats elsewhere (Kosterin 2020b). These two very similar species tend to exclude each other from micro-habitats, although still can be not so rarely found together, e.g. in Ream Peninsula (Kosterin 2019c).

Remarkable was the absence of *Heliocypha perforata*, common on rocky streams elsewhere in Cambodia. Curiously, in absence of this species, males the related *H. biforata* did not show their usual preference of perching on vegetation but equally readily perch on streamside rocks, that is a common habit of *H. perforata*. Thus, in absence of a competitor the behavioural segregation of these two species is released. These species absences can be ascribed to the island position of the Phnom Kulen rainforest, so that some species or higher taxa failed to colonise or recolonise a remote habitat separated from their main ranges by exploited flatland.

Zyxomma petiolatum Rambur, 1842 could be overlooked for its crepuscular activity, since we managed to spend only three nights on Phnom Kulen. Absence of *Pseudorthemis jorina* Förster, 1904, preferring calm, half-shaded deep lake or river reaches, which are common in Phnom Kulen, looks strange, especially in view that the species

was found at seemingly not so fitting habitat at the mouth of the Roluos Channel going from Phnom Kulen to Lake Tonle Sap (Kosterin 2020a). At the same time we do not think that absence in Phnom Kulen of records of *Anax* spp. means actual absence of these excellent flyers, so that *A. guttatus* is expected to be found there sooner or later. However an obvious general scarcity of aesnids on Phnom Kulen should be admitted (but hardly explained).

Interestingly, Phnom Kulen appeared to be inhabited by *Burmagomphus* sp. cf. *willamsoni* while both south-eastern (Kosterin 2010; 2011; 2012; 2014) and eastern (Kosterin 2014; 2016b) Cambodia are inhabited by two other species of this genus, *divaricatus* Lieftinck, 1964 and *B. asahinai* Kosterin, Makbun & Davrueng, 2012. It is unclear why *T. platyptera* has never been found on the eastern plateau while observed on both visits, made in the contrasting seasons, to the Kbal Spean River (Locs 3-4) on the western plateau.

Expectedly, most of the odonate life on the eastern plateau as well as on the foot-hill below is concentrated along its main river of so many names (O'Dar, Phay Thom, the River of 1000 Linga, Chup Preah, Siem Reap) and of reaches so different with respect of their natural conditions.

With exception of lotic dragonflies of the families Gomphidae and Synthemistidae confined to the rainy season, odonate assemblage of Phnom Kulen exhibits little or no seasonality so that most species can be found there in any time. This is understandable in that, standing amidst a perfect flatland, these plateaux receive some rains even in dry season.

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