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## Update of 2014 and 2016 to Odonata found at the marshy coast of SW Cambodia including three species added for the country

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### Abstract

The Odonata fauna of flat marshy areas of the Gulf of Siam coast in Koh Kong Province of Cambodia, containing 55 species, is considered. The published data of 2010-2013 and new data of 2014 and 2016 on the surroundings of Koh Kong town are compiled and the first data on the area of large swampy *Melaleuca* forests at Andoung Tuek village are presented as well as some occasional photographic records. *Gynacantha bayadera*, *Lyriothemis mortoni* and *Pornothemis serrata* were for the first time recorded for Cambodia. *Mortonagrion falcatum* was found unexpectedly abundant at Andoung Tuek.

**Key words:** Odonata, dragonflies, damselflies, fauna, the first country record, Cambodia, Koh Kong Province, coastal marshes, mangroves, *Melaleuca* forest.

### Introduction

Cambodia faces the Siamese Gulf of the South Chinese Sea in its south-western part. The coast is bordered by the gentle range of the Cardamoms and is mostly flat and marshy, with long and broad brackish estuaries and extensive mangroves followed by marshy forests of *Melaleuca cajuputi* Powell, with protruding Botum Sokor and Kampong Saom Peninsulas having steeper coasts rimmed with sandy beaches. The north-western part of the Cambodian coast is in Koh Kong Province (Fig. 1). Its capitol Koh Kong resides on the left bank of a large estuary and is a convenient base for exploring its vast marshy surroundings still moderately affected by human activity. They were repeatedly but very briefly examined by the first author (O.K.) since 2010, with the results being published soon after their obtaining, specifically on 12 and 14.04.2010 (Kosterin 2010), 28.11.2010, 4 and 11.12.2010 (Kosterin 2011), 26.08.2011 (Kosterin 2012) and 22 and 25.05.2013 (Kosterin 2014). In the publication mentioned, the data from the flat marshy coastal areas were provided along with those from foot-

hills of a very different environment, as clad with evergreen forest and rich in streaming water, and in a chronological rather than a systematical order, that made it inconvenient to subtract data referring to different habitat types. Since those publications, two more short odonatological examinations of that coastal area by O.K. were added, on 2.06.2014 and 21-23.07.2016, the results of which are presented here. This motivated us to provide a summarising table of Odonata species so far found in that marshy area (Table 1).

Besides, the second author (G.C.), being a resident of Rainbow Lodge situated at foothills near Koh Kong, made frequent visits to the marshy areas and registered some interesting Odonata photographically.

Also on 24.07.2016, O.K. at last fulfilled his long intention to examine remarkable vast swampy Melaleuca forests at the coastal area at the village of Andoung Tuek in the SE part of Koh Kong Province, situated over the Botum Sokor Peninsula from Koh Kong.

All these data comprised the four parts of this communication.

## Methods

Odonata were sought while walking along marshes, swamps, ponds and ditches. Well recognisable common species were recorded by sight, voucher specimens



Fig. 1. Disposition of localities at coastal flatlands of Koh Kong Province of Cambodia at Koh Kong Town, Tatai River and Andoung Tuek village referred to in this paper (the basis taken from Google Earth).

or small series of some were collected. Odonata were photographed free in purely natural conditions, in one cases also in hand, using Olympus Camedia C8080 and Canon EOS 350D (with Sigma lens) cameras by O.K. and Olympus TG4 camera by G.C. Disposition of the localities in Koh Kong Province considered in this paper is shown in small scale in Fig. 1; for a more precise information their coordinates are provided in the text. The coordinates were recorded by O.K. with Garmin eTrex H personal GPS navigator and by G.C. with Olympus TG4 camera, but the provided ranges for the areas actually examined, as well as elevations above sea level, were revised using GoogleEarth. The sampling dates are provided in the dd.mm.year format. The photos by G.C. are subscribed as such, others are by O.K. Species added in this report to particular localities also studied before are marked below with '\*'.

The species new for Cambodia

1. *Gynacantha bayadera* Selys, 1891

Koh Kong Province, Tatai Commune, under the Phum Doung Brigde (at the right bank), 11°33'55" N 103°07'33" E, 9 m a.s.l. 22.07.2016: 1 collected (Fig. 2) (O.K. & G.C.).

Found at the bank of a brackish estuary with semi-mangrove ripararian vegetation but surrounded with hills clad with evergreen forest, hence at the border of the marshy area considered there. Most probably the species breed in forest rather than in marshes. Earlier as many as four species of *Gynacantha* (*G. basiguttata* Selys, 1882, *G. demeter* Ris, 1911; *G. phaeomeria* Lieftinck, 1960 *G. subinterrupta* Rambur, 1842) have been reported, by photos by G.C., from the foothill forests at Rainbow Lodge situated at the foothills 1.7 km upstream, while *G. bayadera* remained a very expected species (Kosterin et al. 2012).



Fig. 2. *Gynacantha bayadera*, female, collected in twilight under Andoung Tuek Bridge, Tatai Commune, Koh Kong Province, Cambodia on 22.07.2016.



Fig. 3. *Lyriothemis mortoni*, males, at swampy *Melaleuca* forest edges at Andoung Tuek (a) and Koh Andet village (b), 24.07.2016. *Forcipomyia* (*Pterobosca*) sp. midges parasitise on the wings of the species (see also Kosterin et al. 2012).

The female was noticed in late dusk twilight (at the time when numerous *Tholymis tillarga* (Fabricius, 1798) appeared), one and a half hours after a strong downpour,

as flying very low examining the wet barren ground and concrete under the large bridge. Having approached us, it rose up along our bodies seemingly searching for accompanying insects, that is showing the so-called accompanying behaviour (Corbet & Miller 1991) – never observed by us in *Gynacantha* before. It disappeared after a missed net stroke but re-appeared at the same spot after some 10 minutes and exhibited the same behaviour.

The species is widespread in tropical Asia (Orr 2005).

## 2. *Lyriothemis mortoni* Ris, 1919

Koh Kong Province, Andoung Tuek District, a half-inundated open *Melaleuca* forest, 11°11'52-56" N 103°28'43-46" E, 6 m a.s.l., 24.07.2016: 1 collected, 1 more photographed, 1 more seen (Fig. 3a) (O.K.). Koh Kong Province and District, Koh Andet village environs, 11°32'16" N 103°08'07" E, 8 m a.s.l., a similar habitat, 24.07.2016: 1 photographed (Fig. 3b) (G.C.).

This species was curiously found on the same day independently by both authors, approximately 53 km apart but in exactly the same habitat: near (from inside, Fig. 4a) or at a margin (Fig. 4b) of a light, open, swampy *Melaleuca* forest with a dense spikerush (?*Eleocharis*) grass layer. Asahina (1988: p.11) noted about the habitat of this species the following: "In Thailand this species was unexpectedly found in a jungle marsh near the town Chanthaburi. Though this species is taxonomically near the Japanese species [*L. pachygastra* (Selys, 1878)], its habitat was jungle swamp instead of open marsh as in the case of Japanese species." The here reported habitats look intermediate between the options mentioned.

The species has been described from "Lower Burma" and was only known also from Thailand: Chanthaburi, Chumphon and Trang Provinces (Asahina 1988; Hämäläinen & Pinratana 1999; Day et al. 2011).

According to observations at Andoung Tuek, these dragonflies perched on bush branches ca 1-2 m above the ground, were rather cautious and somewhat resembled males of *Brachydiplax chalybea* Brauer, 1868, being slightly more frequent in that area. The males of *L. mortoni* could be distinguished from them by a darker colour and missing a habit of raising their abdomen to the obelisk position.

## 3. *Pornothemis serrata* Krüger, 1902

Koh Kong Province and District, the right bank of a lower course of an unnamed small river, the right tributary of the Tatai River estuary, 11°30'48" N 103°07'37" E, 6 m a.s.l., 17.07.2016: 1 photographed (Fig. 5) (G.C.).

This rare species was photographed in a marshy area at a bank of a small stream off the main estuary, in a thickets of *Pandanus odorifer* (Forssk.) Kunze (for an analogous habitat see Fig. 18c). The exact habitat was not revisited since that, but the area 300-600 m northerly was searched for this species repeatedly in 2016–early 2017 without success.

The species was known before from Malay Peninsula, Sumatra, Java, Borneo and adjacent islands (Liefinck 1954), but was not reported even from Thailand (Hämäläinen & Pinratana 1999). So this is another Malesian element in the Cambodian fauna of Odonata added to those eight species listed by Kosterin (2014).



Fig. 4. Habitats of *Lyriothemis mortoni*: edges of swampy coastal *Melaleuca cajuputi* forests with a spikerush grass layer at Andoung Tuek (a) and Koh Andet village (b), 24.07.2016.





Fig. 5. *Panothemis serrata*, male, at the marshy right bank of an unnamed small river off Tatai River estuary, with Pandanus, 17.07.2016.

#### Swamped Melaleuca forests at Andoung Tuek

Having passed Andoung Tuek while from Koh Kong to Sihanoukville or Phnom Penh via National Road 48, one can see for 2-3 km and be impressed by vast and even forests formed by the only tree species with whitish twisted trunks, somewhat resembling birch (Fig. 6). This is cajuput or white samet, *Melaleuca cajuputi*, Powell a close relative of the paperbark tree (the same genus) and eucalypts. It forms pure stands behind mangroves serving a transition to species-rich evergreen forest on more elevated lands. These forests are swampy and temporarily inundated. O.K. managed to examine them for a whole day of 24.07.2016, for 1.4 km along the road to Srae Ambel between the village of Andoung Tuek and the border of Andoung Tuek and Kandal Districts, within 11°11'48"-12°28" N 103°28'30"-29°00" E, 2-6 m a.s.l.

First of all, O.K. found that most of the forests were actually planted, with trees forming regular rows. Most probably this was restoration of once existing natural forests, as the land is best fit to them and can hardly be used for something else. There occurred, however, quite natural forest areas with irregularly grown trees.

The forests at the NE, opposite to the coast side of the road, which obviously arrests water flow from the foothills, were inundated by shallow and very warm, almost hot water filled with freshly green emergent grass of Juncaceae or Cyperaceae, most probably spikerush (*Eleocharis* sp.). The trees at that side of the road looked younger



Fig. 6. Swampy coastal *Melaleuca cajuputi* forests at Andoung Tuek, Koh Kong Province, Cambodia, 24.07.2016.

and showed obvious signs of a large, quite recent fire which killed some trees (Fig. 7). Along the road there was a chain of open knee-deep (or somewhat deeper) pools with only scarce *Melaleuca* trees, variable amount of emergent grass and scarce flowering *Barclaya* sp. Scarce buffaloes were seen grazing. This looked a



Fig. 7. Burnt and inundated swampy *Melaleuca cajuputi* forests at the NE side of the National Highway 48 at Andoung Tuek, Koh Kong Province, Cambodia, 24.07.2016. Habitat of *Aciagrion hisopa*, *Ceriagrion cerinorubellum*, *Mortonagrion falcatum*, *Pseudagrion australasiae*, *P. microcephalum*, *P. williamsoni*.

damselfly paradise, but damselflies were rather scarce (all males, collected): O.K. managed to spot two *Ceriagrion cerinorubellum* (Brauer, 1865), one *Aciagrion hisopa* (Selys, 1876), one *Pseudagrion williamsoni* Fraser, 1922, one *P. australasiae* Selys, 1876 and one *P. microcephalum* (Rambur, 1842). The two latter were found just several metres apart at the same ditch of deeper open water; a rare case when these superficially very similar species, seemingly tending to exclude each other (Kosterin 2015a), occurred together. The habitat fitted best for *Agriocnemis* spp., but net sweeping provided quite a few *Mortonagrion falcatum* Lieftinck, 1934 of both sexes (4, 4 collected), a species so far reported for Cambodia by only one male collected at Tatai village (Kosterin 2011), but no formally *Agriocnemis* species (the separation of *Mortonagrion* from *Agriocnemis* is artificial for a formal venation character and the former, with some exceptions, seems to be just a clade inside the hence paraphyletic *Agriocnemis*, see Dow 2011).

The forests between the road and coast were partly not inundated, with the ground layer of vegetation formed with dense spikerush and rather sparse understory (Fig. 8), and partly inundated with a very shallow water, but hidden bays of brackish sea water with black bottom, large *Acrostichum* ferns and some mangrove bushes (Fig. 9). Dragonflies were not abundant; the most frequent were *Neurothemis fluctuans* (Fabricius, 1793) and *T. tillarga* (both resting and flying were observed, in spite of the hot sun), while *Orthetrum sabina* (Drury, 1770) and *B. chalybea* were rather scarce. Among the latter, the above mentioned 2 (Fig. 3a), 1 of *L. mortoni* were found.

Damselflies were also scarce and represented by rather frequent *Ceriatagrion calamineum* Lieftinck, 1951 (6 , 1 collected), scarce *C. cerinorubellum* (1 collected), and, again, not abundant but persistent *M. falcatum* of both sexes. O.K. followed for quite a distance a ditch with black bottom and brackish water, crossing the forest from the coast, and found at its banks several *B. chalybea* (1 collected), one *O. sabina* and one *C. calamineum* (all males), most probably dispersed from the nearby freshwater swamps.

At the village margin there was a very large area of open shallow, almost hot water with rich emergent vegetation. There were several *Neurothemis tullia* (Drury, 1773) and *N. fluctuans*; sweeping provided another male of *M. falcatum*; several *Pantala flavescens* (Fabricius, 1798) soared above the pool and a swarm of not less than twenty *Rhyothemis phyllis* (Sulzer, 1776) and *R. variegata* (Linnaeus, 1763) (less in number) kept to a line of trees at the bordering road embankment.

Near the village and the border of Kandal District there were open pastures trumped out with buffaloes, with some very muddy pools. There were *Diplacodes nebulosa* (Fabricius, 1793) of both sexes (1 , 1 collected), scarce *N. fluctuans*, *N. tullia*, *R. phyllis*, a female of *Nannophya pygmaea* Rambur, 1842 (at the district border), at pools, *M. falcatum* and *C. calamineum* (one of each).

In general O.K. registered 18 species of Odonata (7 Zygoptera, 11 Anisoptera), of which *L. mortoni* was new for Cambodia and abundance of *M. falcatum*, contrasted to absence of *Agriocnemis* s. str. was surprising.

#### Koh Kong suburbs

The natural condition of the marshy Koh Kong suburbs is described by Kosterin (2010, 2011, 2012, 2014). In general this is alteration of mangrove bays and estuaries and open flat area barely above the sea level with sparse trees (mostly *Melaleuca*) and bushes (mostly *Melastoma*), temporary grassy freshwater swamps and ditches and pools, mostly along roads. In this section, we report the still unpublished results of examination by O.K. of the southern suburbs on 2.06.2014 (shortly) and 21 and 23.07.2016 (thoroughly) and of the eastern suburbs on 21.07.2016. June 2014 was unusually dry, with low water level in estuaries and grassy swamps dried out.

1. In the southern Koh Kong suburbs most attention was paid to the two twin roadside 'Calamorum ponds', 11°35'00-06" N 102°59'05-10" E, 4 m a.s.l. (Kosterin 2012, 2014), of which the northern one already disappeared in 2016 being filled with earth (it was still in place in April 2015). The remaining pond is more than a human height deep, with rather steep sandy banks partly overgrown by *Ligodium* fern thickets and *Ficus* sp. trees (Fig. 10). Also the adjacent swamp was examined, being a large area of fine grass inundated by shallow fresh water and bordered by bushes.

A remarkable finding at the ponds was a population of *Ictinogomphus decoratus* (Selys, 1854) (3 collected in 2014, 9 collected, about a dozen more (some apart from water) and 1 ovipositing seen in 2016) showing a striking trimorphism for male coloration. One morph corresponds to the *I. d. melaenops* (Selys, 1857) phenotype. In the second yellow colour occupies about half of the face area, the outer



Fig. 8. Partly inundated swampy *Melaleuca cajuputi* forests at the SW side of the National Highway 48 at Andoung Tuek, Koh Kong Province, Cambodia, 24.07.2016. Habitat of *Ceriagrion calamineum*, *Mortonagrion falcatum*, *Brachydiplax chalybea*, *Lyriothemis mortoni*, *Neurothemis fluctuans*, *Orthetrum sabina*, *Tholymis tillarga*.



Fig. 9. Bays of brackish water with mangrove vegetation inside swampy *Melaleuca cajuputi* forests at the SW side of the National Highway 48 at Andoung Tuek, Koh Kong Province, Cambodia, 24.07.2016. There occur *Ceriagrion calamineum*, *Brachydiplax chalybea*, *Orthetrum sabina*, most probably migrated from freshwater swamps.

surface of femora are yellow and a yellow antehumeral streak appears on the metepisternum. In the third the face and femora are predominantly yellow, the femora



Fig. 10. The remaining 'Calamorum pond' at the southern suburbs of Koh Kong, Cambodia, 21.07.2016. Habitat of (registered in August 2011 and July 2016) *Lestes platystylus*, *L. praemorsus*, *Aciagrion borneense*, *Agriocnemis minima*, *A. pygmaea*, *Ischnura senegalense*, *Paracercion calamorum*, *Pseudagrion microcephalum*, *P. rubriceps*, *Ictinogomphus decoratus*, *Epophthalmia* sp., *Crocothemis servilia*, *Brachythemis contaminata*, *Neurothemis fluctuans*, *N. tullia*, *Orthetrum sabina*, *Pseudothemis jorina*, *Rhyothemis phyllis*, *R. variegata*, *Tholymis tillarga*.

outer side is also yellow, while a yellow streak is also added on the metepisternum. There is no structural difference between the morphs. This case will be considered in detail elsewhere.

Also in both years, \**Epophthalmia* sp. was observed: males for a little while widely ranged over the water surface (their individual territories most probably covered several water bodies at once) on 21 and 23.07.2016, and a female ovipositing near a sandy bank was noticed both on 2.07.2014 and 21.07.2016. O.K. failed to catch any for identification. From the Tatai River 12-16 km E of this site, *Epophthalmia vittigera bellicosa* Lieftinck, 1948 has been obtained (Kosterin & Chartier 2014 and this paper).

On 1.06.2014 at the larger (now nonexisting) of the 'Calamorum ponds', an addition was made for the studied area in general: a ranging male of \**Hydrobasileus croceus* (Brauer, 1867), and for the ponds: \**Tamea transmarina euryale* Selys, 1878 (1 ♂) and \**Diplacodes trivialis* (Rambur, 1842) (1 ♂). Other species: *Agriocnemis pygmaea*

(Rambur, 1842) (1 juvenile ), *Ceriatagrion malaisei* Schmidt, 1964 (1 ), *C. cerinorubellum* (1 ), *Ischnura senegalensis* (Rambur, 1842) (1 ), *B. contaminata* (Fabricius, 1793) (many , 1 ), *C. servilia* (Drury, 1770) (1 ), *N. fluctuans* (several ), *O. sabina* (several), *R. variegata* (1 , Fig. 11); *T. pallidinervis* (Kirby, 1889) (1 ).

Observations at the remaining pond on 21 and 23.07.2016 provided two novelties for the area in general: \**Pseudagrion rubriceps* Selys, 1876 (2 ), \**Pseudothemis jorina* Förster, 1904 (several territorial , 1 , Fig. 12). Other species: many: *Agriocnemis pygmaea* (mostly at a shallow ditch nearby), *B. contaminata*, *N. fluctuans* (2 collected), *T. tillarga*; several: \**Lestes platystylus* Rambur, 1842 (2 , 1 collected), *P. microcephalum* ( , 1 collected), *O. sabina*, *P. flavescens* (above the nearby road), *Potamarcha congener* (Rambur, 1842) ( at pools and bushes nearby), *R. phyllis*,



Fig. 11. *Rhyothemis variegata*, female, at 'Calamorum ponds' at the southern suburbs of Koh Kong, Cambodia, 1.06.2014.

*R. variegata*; solitary: *I. senegalensis* (1 ), *N. tullia* (1 ).

At a nearby smaller and shallower satellite pond and a shallow grassy swamp (11°34'56"-35°00" N 102°59'07"-10" E, 4 m a.s.l.; Fig. 13): many: *A. pygmaea* (mostly immature red individuals), *N. fluctuans*, *N. tullia*, *B. chalybea* ( ), *O. sabina*, *R. phyllis*; several: *A. hisopa* (2 collected, dark pattern black, as should be in mid-summer), *C. calamineum* ( , less ), *I. senegalensis*, *R. variegata*; solitary: *L. platystylus* (1 collected), *Nannophya pygmaea* ( ), *Anax ? guttatus* Burmeister, 1839 ( ).

Nearby at 19:30h on 23.07.2016, a curious dense congregation of not less than 30 low flying individuals (both sexes) of *T. tillarga* was observed at a protrusion, as a blunt angle, of a very low ground bluff over a white sandy beach of the estuary





Fig. 12. *Pseudothemis jorina*, a female resting on a branch under a *Ficus* sp. canopy at the 'Calamorum pond' in the evening of 21.07.2016 at 'Calamorum ponds' at the southern suburbs of Koh Kong.



Fig. 13. A shallow grassy freshwater swamp in the southern Koh Kong suburbs, 23.07.2016. Habitat of *Lestes platystylus*, *Aciagrion hisopa*, *A. pygmaea*, *Ceriagrion calamineum*, *Ischnura senegalensis*, *Brachydiplax chalybea*, *Nannophya pygmaea*, *Neurothemis fluctuans*, *N. tullia*, *Orthetrum sabina*, *Rhyothemis phyllis*, *R. variegata*.

left bank.

2. The eastern Koh Kong suburbs were examined between the town and an estuary of a small river, behind which the National Highway NH48 rises to the foothills, within 11°36'06-53" N 102°59'36" - 103°01'01" E, 4-6 m a.s.l. Earlier this area was briefly examined on 14.04.2010, that is at the end of the dry season, when only 12 odonate species were registered (Kosterin 2010). On 21.07.2016 three particular localities were examined:

- (i) An inundated area between NH48 and the airport: a lake-like part with muddy bottom, almost hot water, bordered by *Cyperaceae* indet. with 'pussey' ears, then *Scirpus* sp., then dense thickets of *Poaceae* indet.; a vast veal (a Khmer word for savannah-like community on poor acid soils) inundated with a shallow to medium-deep cool to warm water with firm bottom, scarce emergent *Scirpus* sp. and *Cyperus* sp. grass and *Melaleuca* trees (Fig. 14): 11°36'33-50" N 102°59'36-55" E (12 a.m. – 3 p.m.). Very numerous: *N. fluctuans*, *N. tullia*; many \**C. calamineum* (in sparse inundated grass at the inundated veal; 8 , 3 collected), \**P. australasiae* (1 collected), \**B. contaminata*, *O. sabina*; *T. pallidinervis*, \**R. phyllis*; several: *I. senegalensis*, \**Paracercion calamorum* (Ris, 1916) (a copula, collected, and 1 in sparse emergent grass at the inundated veal), *P. microcephalum* (a copula and several ), \**Epopthalmia* sp. (over the inundated



Fig. 14. An inundated veal (savannah-like community on poor sandy soils) between National Highway 48 and the airport in the eastern Koh Kong suburbs, 21.07.2016. Habitat of *Agriocnemis pygmaea*, *Ceriagrion calamineum*, *Ischnura senegalensis*, *Paracercion calamorum*, *Pseudagrion australasiae*, *P. microcephalum*, *Epophthalmia* sp., *Brachythemis contaminata*, *Diplacodes nebulosa*, *Nannophya pygmaea*, *Neurothemis fluctuans*, *N. intermedia atalanta*, *N. tullia*, *Orthetrum sabina*, *Rhyothemis phyllis*, *R. variegata*, *Tholymis tillarga*, *Trithemis pallidinervis*, *Urothemis signata*.



Fig. 15. *Urothemis signata*, male, at the inundated veal of Fig. 13, 21.07.2016.

veal); *D. nebulosa*, \**N. pygmaea* (a copula and at the inundated veal), \**Neurothemis intermedia atalanta* Ris, 1913 (1 immature, 1, collected), \**R. variegata*, *T. tillarga*; solitary: *Agriocnemis pygmaea* (1), \**Lathrecista asiatica* (Fabricius, 1798) (1 immature), \**Urothemis signata* (Rambur, 1842) (1 perching on a stem over the water of the inundated veal, Fig. 15).

- (ii) A large and deep roadside pool with compact thickets of spikerush, bordered with *Melaleuca* and more shady trees at the opposite side, with a shaded bay with black bottom and cold water, surrounded with *Ligodium* thickets, penetrating under the trees; ca 11°36'19" N 103°00'16" E (ca 4 p.m., dense cloudy weather after a small rain). Very numerous *T. tillarga*, many *B. contaminata*, *N. fluctuans*, *N. tullia*; solitary: \**Zyxomma petiolatum* Rambur, 1842 (ranging over the shaded bay, quite early for this species).
- (iii) A narrow roadside pool with fine emergent grass and quaking bog at banks, ca 11°36'13" N 103°01'07" E (ca 3:30 p.m.). Several males of \**Acisoma panorpoides* Rambur, 1842 and \**B. chalybea*.

No *I. decoratus*, although expected. Species found on 14.04.2010 but not on 21.07.2016: *Aciaagrion borneense* (Selys, 1886), *C. cerinorubellum*, *D. trivialis*.

Again there was a case of co-occurring of *P. australasiae* and *P. microcephalum*, but the former occurred in sparse grass emerging from cool water of the inundated veal while the latter was found only at a small pool with dense grass and very warm water. Males of *Epophthalmia* sp. ranged widely over the inundated veal without

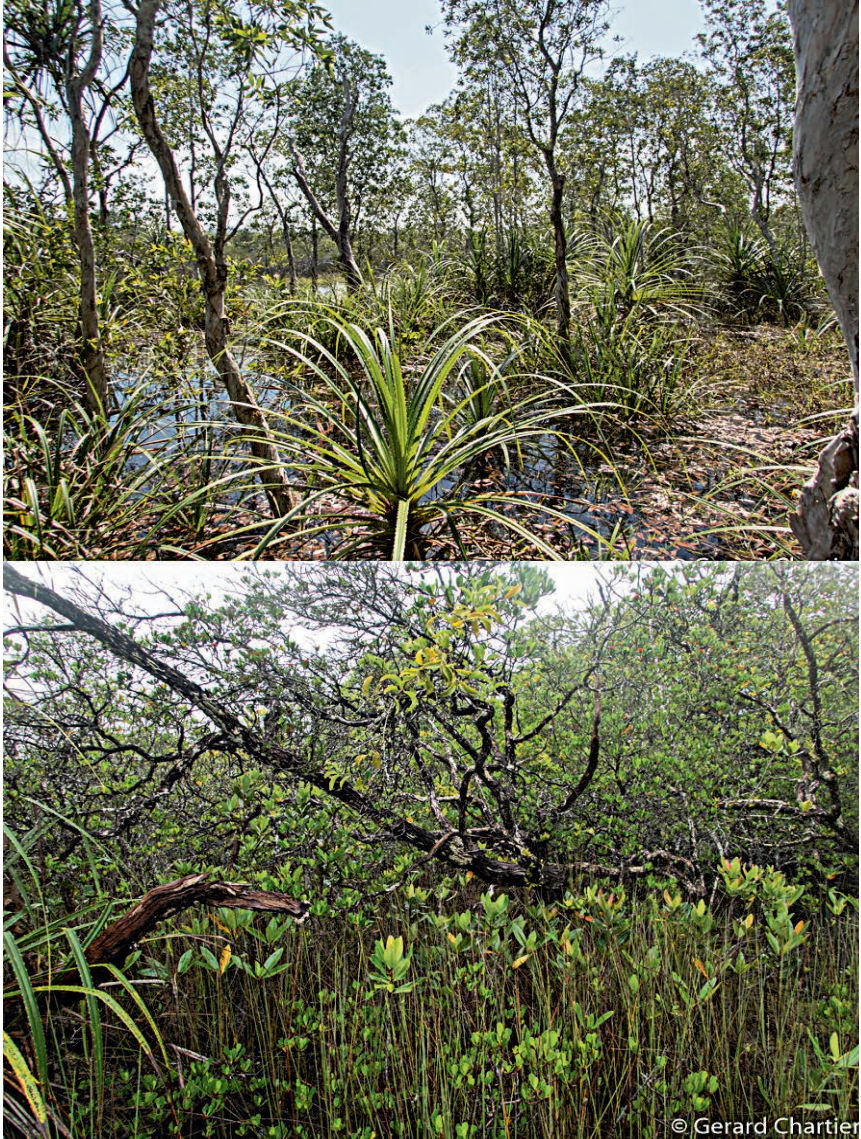


Fig. 16. flat and marshy, half-open area with open stand of *Melaleuca cajuputi* and *Pandanus odorifer*, at the lowermost Tatai Estuary.

steady trajectories and over huge territories, very rarely two of those were seen chasing each other, and once a female with hanging abdomen was noticed.  
Area at the lowermost Tatai River estuary



(c) Gerard Chartier

Fig. 17. A small overgrown river at the right (western) Tatai tributary, with black water, affected by tide and brackish at dry season. Habitat of *Libellago hyalina*, *Epophthalmia vittigera*, *Macromia cincta*, *Brachydiplax chalybea*, *Trithemis aurora*.

Since mid-2016, G.C. had to quite often visited the area at the right bank of the lowermost estuary of the large Tatai River, at ca 11°30'31"-35'00" N 103°07'08" E, 4



Fig. 18. marshy area with *Pandanus odorifer* at the lowermost Tatai Estuary: a - at low tide, b - at high tide, habitat of *Lestes concinnus* and *Nannophia pygmaea*; c - thickets analogous to those where *Pornothemis serrata* was found.

m a.s.l.. Unfortunately he had no opportunity to conduct regular observation and registry of Odonata, yet some occasional observations and photographic registry worth to be presented. This area is flat and marshy, at the sea level, grassy with open stand of *M. cajuputi* and *P. odorifer* (Fig. 16) but, as different to the Kog Kong suburbs, the foothills are near, in some 1-1.5 km. Most of the observations were done at the estuary of a small river being the right (i.e. western) Tatai tributary, with black water (Fig. 17), affected by tide and brackish at dry season, 300-500 m north of the site at the same river where *P. serrata* was found (see above). Most interesting was presence of some lotic species associated with fresh current water: *Vestalis gracilis* (Rambur, 1842) (1 seen at the bank vegetation on 28.01.2017), *Libellago hyalina* (Selys, 1859) (many times seen landing on a moving kayak throughout the year, with the latest in January 2017), *Macromia cincta* Rambur, 1842 (1 collected 06.08.2016, also several uncertain sightings; for the record of this species, thought to be Malesian, in Cambodia see Kosterin 2015b), *Rhyothemis obsolescens* Kirby, 1889 (1 seen at the bank vegetation on 28.01.2017), *Trithemis aurora* (Burmeister, 1839) (seen on twigs over the water). These species most probably immigrated from the nearby permanently fresh streams in the nearby foothills but could also establish temporal populations in rainy season when the river becomes fresh. Also *A. guttatus* (occasional sightings), *E. vittigera bellicosa* (1 dead collected from water surface 06.08.2016, 1 collected on 31.01.2017, several sightings), *B. chalybea* (several sightings), *P. jorina* (1 seen on 31.01.2017), *R. phyllis* and *R. variegata* (frequent), *U. signata* (several seen on 28-31.01.2017) were observed at the same small river. On a nearby marsh (Fig. 18) the following species were recorded: *Lestes concinnus* Hagen in Selys, 1862 (1 ), *A. borneense* (1 ), *Aciagrion pallidum* Selys, 1891 (1 ) on 8.01.2017, *C. cerinorubellum* (many times, Fig. 19), *M. falcatum* (1 subterminal photographed on 3.02.2017), *Pseudagrion* spp. (frequent, 1 of *P. microcephalum* photographed on 3.02.2017), *D. trivialis* (few sightings), *Nannophya pygmaea* (1 , 2 on 17 and 30.07.2016), *N. intermedia atalanta* (several sightings), *N. fluctuans* (always numerous), *N. fulvia* (Drury, 1773) (one sighting in December 2016), *P. flavescens* (several seen on 28.01.2017). This interesting, ecologically complex site deserves special study, to be continued by G.C.



Fig. 19. A male of *Ceriagrion cerinorubellum* with a prey of a teneral male of the same species, 27.08.2016.



### Synopsis of Odonata recorded at marshy coasts of Koh Kong Province

Table 1 summarises Odonata found in the marshy coastal flatlands of Koh Kong Province of Cambodia: seven visits by O.K. in the vicinity of Koh Kong in 2010-2016 (Kosterin 2010, 2011, 2012, 2014, this communication), by G.C. at the lowermost Tatai estuary in July 2016-February 2017, and by O.K. at Andoung Tuek in July 2016 (this communication). The data from specific small localities around Koh Kong, including nicknamed in the above cited earlier publications as 'Calamorum ponds' (one of the two no longer existing), 'Cora marsh' (no longer existing), 'Hisopa swamp'. 'Pygmaea swamp', also the northern and eastern marshy suburbs of Koh Kong, a ditch inside the town, the environs of Peam Krasaop Natural Sanctuary and a beach at the nearby marshes and estuary right bank, are piled together. They are presented according to the sequence of months rather than years, to provide a picture of seasonality. *G. bayadera* is added to that of the lowermost Tatai estuary, as collected somewhat upstream at the same estuary. The authorities and years of description and subspecies are omitted.

The fauna revealed in the flat, marshy coastal areas in total contains 55 species, 27 (55%) of which are libellulids. Most of them are common and widespread lentic species, to which the core of invariably registered (or nearly so) species belong: *Agriocnemis pygmaea*, *I. senegalensis*, *C. servilia*, *B. contaminata*, *D. nebulosa*, *N. fluctuans*, *N. tullia*, *O. sabina*, *T. tillarga*, *T. pallidinervis*, of which *N. fluctuans* and *T. tillarga* were permanently abundant. Some species were rare, and some were rather unexpected: *L. platystylus*, *A. hisopa*, *I. decoratus*, *H. croceus*, *Nannophya pygmaea*, *P. jorina*, *Z. petiolatum*. Presence of at least some of these species indicates that the area is enriched with purely fresh waters obtained from abundant rains and perhaps descending from the nearby foothills. Some expected species were not found at all, e.g. *Pseudocopera ciliata* (Selys, 1863). At the same time, the species specific to brackish water (*Macrodiplax cora* (Brauer, 1867), met only once in one locality) or surely (*T. tillarga*) or possibly (*I. senegalensis*, *P. microcephalum*, see Kosterin 2014) tolerating it were rather few in number. The species assemblage at the Andoung Tuek environs appeared of some difference from that at Koh Kong, because of the abundance of *M. falcatum*, only once found at the Tatai estuary, and not detected *A. pygmaea*, *I. senegalensis*, *B. contaminata*, *C. servilia* and *T. pallidinervis* (no doubt they should be present there but not met). The lowermost Tatai estuary area revealed some lotic species, most probably immigrated from freshwater streams of the closely situated foothills: *V. gracilis*, *L. hyalina*, *M. cincta*, *R. obsolescens*, *T. aurora*.

Table 1. Checklist of Odonata found in the flat marshy environs of Koh Kong and in the area of swampy *Melaleuca* forests at Andoung Tuek. Codes of abundance: 1 – single individual found, 2 – few (2 to 5 individuals); 3 – moderately abundant (5-20), 4 – abundant (~20-100), 5 – very abundant (>>100); for the lowermost Tatai estuary only presence of species is indicated by "+", as abundance of common species was not evaluated.

Species	Koh Kong suburbs						Lowermost Tatai estuary vii 2016 – ii 2017	Andoung Tuek env. vii 2016
	xi-xii 2010	iv 2010	v 2013	vi 2014	vii 2016	viii 2011		
<b>Calopterygidae</b>								
1. <i>Vestalis gracilis</i>	-	-	-	-	-	-	+	-
<b>Chlorocyphidae</b>								
2. <i>Libellago hyalina</i>	-	-	-	-	-	-	+	-
<b>Lestidae</b>								
3. <i>Lestes concinnus</i>	1	-	-	-	-	-	+	-
4. <i>Lestes platystylus</i>	-	-	2	-	2	-	-	-
5. <i>Lestes praemorsus</i>	-	-	-	-	-	1	-	-
<b>Ceonagrionidae</b>								
6. <i>Agriocnemis minima</i>	-	-	1	-	-	3	-	-
7. <i>Agriocnemis pygmaea</i>	3	1	5	1	5	-	-	-
8. <i>Aciagrion borneense</i>	2	1	2	-	-	2	+	-
9. <i>Aciagrion hisopa</i>	-	-	2	-	2	-	-	1
10. <i>Aciagrion pallidum</i>	1	-	-	-	-	-	+	-
11. <i>Ceriagrion calamineum</i>	-	-	-	-	4	1	-	4
12. <i>Ceriagrion cerinorubellum</i>	-	3	-	1	-	1	+	2
13. <i>Ceriagrion malaisei</i>	-	-	5	1	-	-	-	-
14. <i>Ischnura senegalensis</i>	4	2	5	1	3	3	-	-
15. <i>Mortonagrion falcatum</i>	-	-	-	-	-	-	+	4
16. <i>Paracercion calamorum</i>	-	-	-	-	2	4	-	-
17. <i>Pseudagrion australasiae</i>	1	-	2	-	3	-	-	1
18. <i>Pseudagrion microcephalum</i>	-	-	2	-	3	-	+	1
19. <i>Pseudagrion rubriceps</i>	-	-	-	-	2	-	-	-
20. <i>Pseudagrion williamsoni</i>	-	-	-	-	-	-	-	1
<b>Aeshnidae</b>								
21. <i>Anax guttatus</i>	-	-	2	1	1	-	+	-
22. <i>Gynacantha bayadera</i>	-	+	-	-	-	-	-	-
<b>Gomphidae</b>								
23. <i>Ictinogomphus decoratus</i>	-	-	-	2	3	-	-	-
<b>Macromiidae</b>								
24. <i>Epophthalmia vittigera</i> ( <i>Epophthalmia</i> sp.)	-	-	-	-	-	-	+	-
25. <i>Macromia cincta</i>	-	-	-	1	2	-	+	-
25. <i>Macromia cincta</i>	-	-	-	-	-	-	+	-
<b>Libellulidae</b>								
26. <i>Acisoma panorpoides</i>	-	1	2	-	2	-	-	-
27. <i>Brachydiplax chalybea</i>	-	2	2	-	3	-	+	3
28. <i>Brachythemis contaminata</i>	2	-	5	3	5	1	-	-
29. <i>Crocothemis servilia</i>	2	3	1	1	-	2	-	-
30. <i>Diplacodes nebulosa</i>	4	3	2	-	3	-	-	2
31. <i>Diplacodes trivialis</i>	4	3	-	1	-	-	+	-
32. <i>Hydrobasileus croceus</i>	-	-	-	1	-	-	-	-
33. <i>Lathrecista asiatica</i>	-	-	-	-	1	-	-	-
34. <i>Lyriothemis mortoni</i>	-	-	-	-	-	-	+	2
35. <i>Macrodiplax cora</i>	2	-	-	-	-	-	-	-
36. <i>Nannophya pygmaea</i>	-	-	2	-	2	-	+	1
37. <i>Neurothemis fluctuans</i>	2	3	3	3	5	3	+	5
38. <i>Neurothemis fulvia</i>	-	-	-	-	-	-	+	-
39. <i>Neurothemis intermedia</i>	-	-	-	-	2	-	+	-
40. <i>Neurothemis tullia</i>	2	3	3	-	5	2	-	3
41. <i>Orthetrum sabina</i>	2	1	2	2	4	3	-	3
42. <i>Pantala flavescens</i>	-	-	1	-	4	-	+	3
43. <i>Pomothemis serrata</i>	-	-	-	-	-	-	+	-
44. <i>Potamarcha congener</i>	-	-	-	-	2	-	-	-
45. <i>Pseudothemis jorina</i>	-	-	-	-	2	-	+	-
46. <i>Rhyothemis obsolescens</i>	-	-	-	-	-	-	+	-
47. <i>Rhyothemis phyllis</i>	-	1	3	-	4	1	+	4
48. <i>Rhyothemis triangularis</i>	-	-	1	-	-	-	-	-
49. <i>Rhyothemis variegata</i>	-	-	3	-	3	-	+	-
50. <i>Tholymis tillarga</i>	2	2	3	-	5	4	-	4
51. <i>Tramea transmarina</i>	1	2	-	1	-	-	-	-
52. <i>Trithemis aurora</i>	-	-	-	-	-	-	+	-
53. <i>Trithemis pallidinervis</i>	1	1	2	1	4	1	-	-
54. <i>Urothemis signata</i>	-	-	-	-	1	-	+	-
55. <i>Zyxomma petiolatum</i>	-	-	-	-	1	-	-	-

Seasonality is not well expressed. Of the two allegedly dry season species of *Aciagrion*, *A. pallidum* was found only twice while *A. borneense* was also met in summer. The following circumstances at Koh Kong look curious:

- unstable presence of *A. minima* (November 2011 and May 2013, rather numerous in the first case) and
- seemingly alternating presence of three species of *Ceriagrion*: *C. calamineum* (numerous in July, scarce in August), *C. malaisei* (numerous in May, scarce in June, no overlap with the former) and *C. cerinorubellum* (numerous in April, scarce in June and August), although it remains unclear if they reflected seasonality or peculiarities of certain years.

We found ourselves unable to provide a comparative analysis of the Odonata assemblage revealed as we failed to find any published information of a similar odonatological assessment of some coastal marshy area in the Oriental ecoregion. This may be explained by the fact that most of similar coastal flatlands elsewhere are densely populated and exploited and have lost most of their natural ecosystems, hence our data could be unique in this respect.

Although each visit to this area was short, in sum they reveal the local Odonata well and although O.K. loves the Koh Kong suburbs so much, he can't help but claim cessation of his activity there until all other regions of Cambodia are at least preliminary examined odonatologically. At the same time G.C. continues his study of the Tatai River estuary. No doubt, the area deserves a targeted stationary ecological investigation, until its nature is lost because of increasing human impact.

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