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## On Odonata of Phnom Tumpor (Cambodia) in the late dry season (March 2019)

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### Abstract

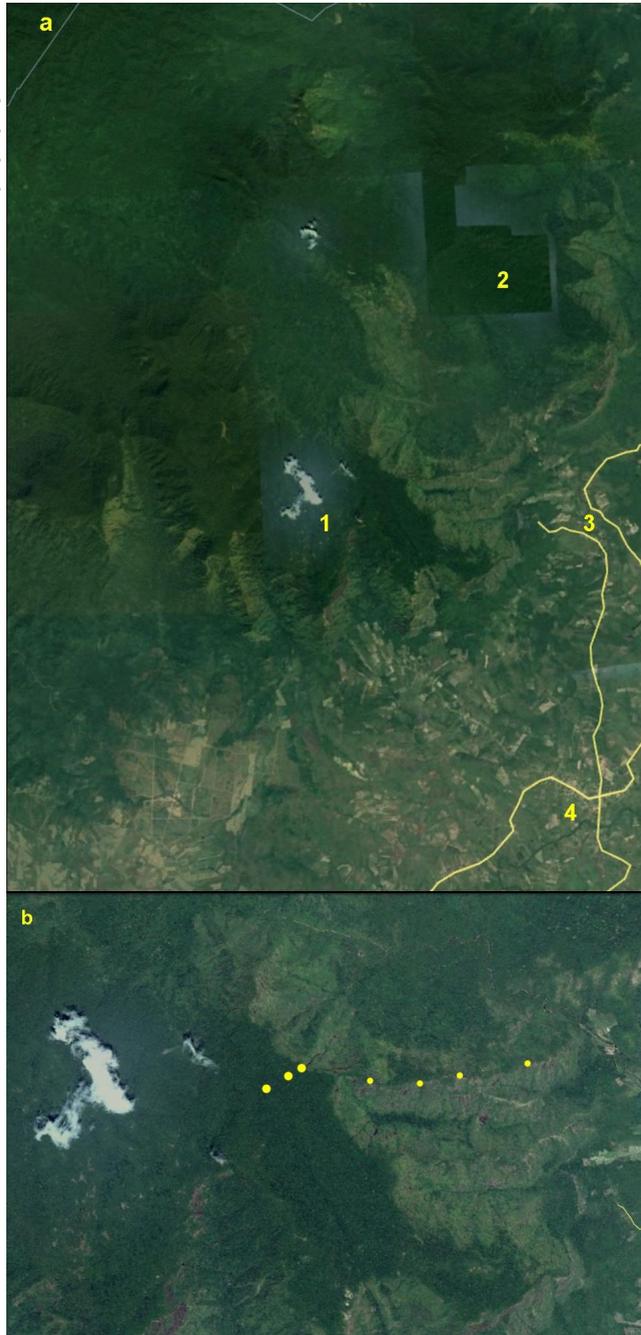
Phnom Tumpor is a scarcely accessible basalt table mountain in the Cardamom Mts. in Pursat Province of Cambodia. On top surface it bears tall evergreen forest (ca 1100 m a.s.l.), concealing a slow rivulet, O'Gran, being a chain of deep pools. It was examined odonatologically on March 14-18th, 2019. Six common species were recorded in dry and burnt scrub on the Phnom Tumpor slopes and ten on the forested upper surface at O'Gran, among them *Polycanthagyna erythromelas* (Selys, 1891) and *Macromia* sp. cf. *pinratani* Asahina, 1987 for the first time in Cambodia. The peculiarities of the males of *Coeliccia kazukoae* Asahina, 1984 from Phnom Tumpor and the problem of distinguishing females of *M. pinratani* and *M. moorei* are discussed.

**Key words:** Cambodia, Pursat Province, Cardamom Mountains, Phnom Tumpor, Phnom Dalai, Odonata, dragonflies, damselflies, *Coeliccia kazukoae*, *Anax immaculifrons*, *Polycanthagyna erythromelas*, *Macromia pinratani*, *Macromia moorei*.

### Introduction

The Cardamom Mountains stretch along the Gulf of Siam coast from E Thailand through SW Cambodia to the Vietnamese Phu Quoc Island. Most of the range is formed by sandstone but there is a massif of two twin, partly joined mountains, Phnom Tumpor (or Phnom Kran; 1557 m a.s.l.) and Phnom Dalai in Veal Veang District of Pursat Province of Cambodia, formed by intrusion of the basalt through sandstone. Both are small basalt plateaux, almost table mountains, rising to 1100-1300 m a.s.l. over a gentle terrain of ca 300 m a.s.l. where Pramoui and Tumpor villages are situated (Figs 1a, 2). Their upper surfaces are also more or less gentle and covered by a peculiar tall and humid "basalt evergreen forest characterised by very tall trees including giant *Ficus*, the genera *Irvingia*, *Syzygium* and *Garcinia*, and various representatives of the Lauraceae" (Monastyrsky et al., 2011: 123), which until now is pristine and untouched on Phnom Tumpor, rarely visited by people, and only slightly disturbed on Phnom Dalai. At the same time, their steep rocky slopes, formed mostly by sandstone, are covered with quite different plant associations: dry low forest or open tree stands, scrub, bamboo thickets and, in their middle zone, by a Tennaserim pine (*Pinus latteri* Mason) zone on sandstone rocks. In the pine stand on the slopes of both mountains an en-

**Figure 1. Phnom Tumpor (a, b) and Phnom Dalai (a) as seen in Google Earth: 1 – Phnom Tumpor; 2 – Phnom Dalai; 3 – Tumpor village; 4 – Pramoui village; b, the dots from left to right: the upstream end of the studied stretch of O’Gran, the camp position, the downstream end of the studied stretch at the waterfalls; the four smaller dots to the right denote the four humps of the lateral spur along the crest of which Phnom Tumpor is reached. Not to scale.**



demical pitcher plant species occurs, *Nepenthes holdeni* Mey (Mey 2010). All types of the slope vegetation are regularly subject to low-level fires. Thus the upper forested surfaces of both mountains offer a kind of isolated, 'island' habitat, a 'lost world'. In 2000, there still were elephants and tigers on both mountains but both had disappeared from Tumpor by 2006; now the tigers have disappeared



**Figure 2. Phnom Tumpor as viewed from the villages of Tumpor (a) and Pramoui (b).**

from the whole of Cambodia while elephants might still be present on Phnom Dalai (J. Holden pers. comm.).

Both mountains are parts of the Phnom Samkos Wildlife Sanctuary. In 2006-2010 they were investigated by a complex expedition arranged by Fauna & Flora International NGO. As a result, they became one of the best studied place in Cambodia with respect to butterflies, specifically studied on Phnom Tumpor during 21-27.02.2006 (Monastyrsky et al. 2011), but no regular study of their Odonata fauna has been carried

out. Nevertheless, in 2010 Jeremy Holden took occasional photos of damselflies and dragonflies, mostly on Phnom Dalai, which were identified and published (Kosterin & Holden 2011; Kosterin et al. 2012). In particular, such species as *Lestes nodalis* Selys, 1891, *Tetrathemis platyptera* Selys, 1878, and *Orthetrum triangulare* (Selys, 1878) were reported for Cambodia for the first time based on the photos taken on Phnom Dalai (Kosterin & Holden 2011; Kosterin et al. 2012). Jeremy also kindly informed me that in ca February-March 2006 he repeatedly witnessed some large salmon-coloured aeshnids at the O'Gran (O'Kran) Rivulet on Phnom Tumpor. This motivated me to attempt visiting the rivulet and mountain in the same late dry season, although less favourable than the early rainy season for lotic Odonata imagines.

Me and the local guide Chhun Chhum from Tumpor village ascended to Phnom Tumpor on 14-15.03.2019, spent the second half of 15.03.2019 and throughout 16-17.03.2019 at the O'Gran and descended on 18.03.2019. This study would better be repeated in the early rainy season, but since it is unclear if and when that will be possible, I here publish the data obtained so far.

### The area

At the time of my visit the deciduous dipterocarp forests on the low terrain, e.g. at Pramoui village, were burning, making the sky smoky and the sun red in the daytime. This habitat is pyrophylic and has been formed in adaptation to such fires. Most of these forests have been already burnt before, after which the dipterocarps and their saplings had produced large fresh leaves, in spite of the dry season (Fig. 3). The slopes of Phnom Tumpor were completely dry and largely burnt out without fresh leaves – almost totally at lower elevations, moderately at medium elevations and scarcely at the top. We ascended Phnom Tumpor along the crest of its short eastern spur (so steep that sometimes it was hardly possible to stand), a ridge bearing a chain of four local humps, each over-topped by the next (Fig. 1b). Its lower part was covered by tall bamboo thickets alternating with open stands of low trees (Fig. 4), profoundly affected by low-level fires. The second and third humps were in the pine belt, with the pine growing on sandstone rocky terrain as an admixture to low trees (Fig. 5) or forming pure stands; this zone was also almost completely affected by low-level fires. In all these zones the insect life was very scarce (some rare butterflies) but we saw some birds (many swallows, a group of parrots) and repeatedly heard the call of *Gekko gekko* (Linnaeus, 1758) (in spite of it being daytime). The fourth hump bore fragments of taller forest, some scrub and tall Poaceae; burnt areas were infrequent; there were more insects and birds. In the morning the calls of the Red Junglefowl (*Gallus gallus* (Linnaeus, 1758)) and gibbons were heard.

Passing by a small cliff at the margin of the top surface we immediately entered a different world of humid, tall and lush forest on a thick soil and slightly undulating terrain, which continued without any gap throughout our journey. The trees were of various sizes and included several species of palms (Fig. 6).

At the time of our visit, the O'Gran Rivulet had a very weak current – in shallow places like a small brook. However, it mostly comprised a chain of the so-called 'anlung' – deep and broad reaches (Figs 7-8), connected by short stretches of brook seeping



**Fig 3. Regenerating deciduous dipterocarp forest with fresh foliage after a low-level fire near Pramoui village, 13.3.2019.**



**Figure 4.** Open stand of low trees at the lower part of the crest of the eastern spur of Phnom Tumpor (top and middle) and a patch of tall deciduous forest at its foot (bottom).



**Figure 5. The crest of the eastern spur of Phnom Tumpor at the pine zone (at the second and third hump); the Tenneserim pine (*Pinus latteri*) seen on the right.**

through small stones (Fig. 9). These anlungs were rather cold, few metres wide, up to hip deep, had a dark-brown silty bottom; they were full of amazingly dense shoals of tadpoles, inhabited by frogs but apparently lacked fish. The banks were up to 1-1.5 m high; flat bank sections were in many places churned up by wild boars. There was no special riparian vegetation but some stretches of *Allocasia* sp. with tall leaves; otherwise there was an ordinary forest on the banks, enriched by some *Cyathea* tree ferns. There were several narrow tributaries; all but two temporarily had no water but sucking muddy ground instead. The course of O'Gran was studied over a distance of ca 500 m where it was mostly represented by anlungs, upstream to the point (12.3832 N, 103.0507 E, 1192 m a.s.l.) further of which the flowing water disappeared; there was only a wet stony bottom with few pools. Downstream the O'Gran approached the mountain slope; there it flowed over a 'staircase' of large rocks and formed two small waterfalls with deep pools beneath (Fig. 10) (but in the lower on the water did not fall into the pool but seeped around over a rock). Finally it fell to the abyss (12.3857 N, 103.0542 E, 1163 m a.s.l.). This rocky part was the only small open area we saw. The camp was at the middle of the studied O'Gran section, at 12.3841 N, 103.0533 E, 1190 m. (The coordinates were retrieved by the Garmin E-trex navigator, the elevations from Google Earth.)

There is a larger stream on the opposite side of Phnom Tumpor (J. Holden pers. comm.) which was not visited.

The weather was pleasant, by no means hot in the daytime and evening, but before dawn it got really cold. In the evening at least two species of tree frog called, mostly *Rhaco-*



**Figure 6. Tall evergreen forest on basalt on the top surface of Phnom Tumpor near the O'Gran brook.**



**Figure 7. Examples of deeper 'anlungs' (very slow reaches) of the O'Gran brook on Phnom Tumpor.**



**Figure 8. Examples of shallower 'anlungs' of the O'Gran brook.**

*phorus rhodopus* Liu et Hu, 1960 (identified from a photo by Alexandre Teynié), and some cicadas or cadydids sang but all they generally ceased by midnight. Birds were numerous and diverse while I saw only one skink lizard and one cast snake skin in 2.5 days.

The butterflies (Fig. 11) were rather scarce. Remarkably there were no Hepseriidae or Pieridae, and only two Lycaenidae individuals (*Udara* sp. and *Pithecops corvus correctus* Cowan, 1966 (Fig. 11f); no hairstreaks), few *Papilio* sp. ('Helens') and few Nymphalidae s.l. were seen (one individual of each *Kallima inachus siamensis* Fruhstorfer, 1912, *Chersonesia* sp., *Cyrestis thyodamas thyodamas* Doyère, 1840, *Lexias pardalis jadeitina* (Fruhstorfer, 1913), *Lethe confusa confusa* Aurvillius, 1898 (Fig. 11d), *Lethe chandica suvarna* Fruhstorfer, 1908, *Melanitis* sp., two *Melanocyma faunula faunula* (Westwood, 1850) (Fig. 11c); and only three representatives of the latter family were



**Figure 9. An example of a shallow reach, at the time of examination just water seeping through shingle, at the O'Gran brook.**

common, two Amathusinae – *Stichophthalma cambodia cambodia* (Hewiston, 1862) (Fig. 11a) and *Thaumantis diores splendens* Tytler, 1939 (Fig. 11b), and one Satyrinae – *Ragadia crisilda critolus* de Nicéville, 1892 (Fig. 11e). (*K. inachus*, *L. confusa*, *L. chandica*, *T. diores*, *L. pardalis* and *P. corvus* have not been reported by Monastyrsky et al. (2011) specifically for Phnom Tumpor.)

Eight days after I left O'Gran I measured a slight rise of body temperature and for a few days felt very strong fatigue, with some head and muscle ache. The symptoms looked like a very mild version of those I suffered three times after visiting eastern



**Figure 10. The O'Gran brook in its rocky section before its falls from the Phnom Tumpor steep slope.**

Cambodia in 2013, 2014 and 2018, self-diagnosed as acute schistosomiasis (Katayama fever) and self-medicated with praziquantel. Walking all day in water courses incurs a high risk of schistosomiasis. Unlike eastern Cambodia, this area is beyond the endemic range of *Schistosoma mekongi* Voge, Bruckner et Bruce, 1978 but *S. japonica* (Katsurada, 1904) is a possibility. That parasite has a broad range of mammalian hosts and can persist at Phnom Tumpor at least in the wild boar population. They can also support a population of terrestrial leeches, common on the O'Gran banks.

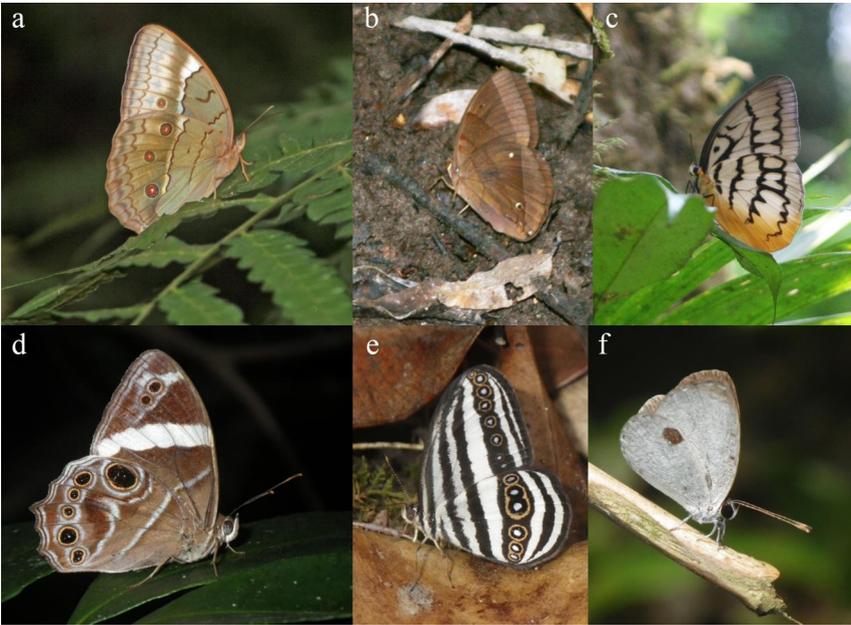


Figure 11. Butterflies at the O'Gran brook on Phnom Tumpor slope (15-17.03.2019): a – *Stichophthalma cambodia cambodia*; b – *Thaumantis diores splendens*; c – *Melanocyma faunula faunula* (Nymphalidae, Amathusinae); d – *Lethe confusa confusa*; e – *Ragadia crisilda critolus* (Nymphalidae, Satyrinae); f – *Pithecopus correctus* (Lycaenidae).



Figure 12. *Aciagrion pallidum*, a male, in tall grass in open tree stand at the uppermost (fourth) hump of the eastern spur of Phnom Thumpor, 15.03.2019.

## Results

### Odonata seen on slopes

These were scarce. A female of *Potamarcha congener* (Rambur, 1842) perched on a stick in the bamboo thickets at the very base of the mountain on 18.03.2019. Several individuals of *Diplacodes trivialis* (Rambur, 1842) and *Neurothemis intermedia atalanta* Ris, 1913 and a male of *Neurothemis tullia* (Drury, 1773) were noticed on the burnt out low levels. A little swarm of *Pantala flavescens* (Fabricius, 1798) kept to a crest just below the second hump, both on our way there and back. At the same hump a female of *Orthetrum* sp. was sighted with a brown and black pattern. A male of *Aciagrion pallidum* Selys, 1891 (Fig. 12) was found in sunny tall grass on the fourth hump on 15.03.2019. These were the commonest species, including those more or less associated with the dry season (*A. pallidum*, *N. intermedia*), but the *Orthetrum* female remained unidentified.

### Odonata of O'Gran

#### 1. *Aristocypha fenestrella* (Rambur, 1842)

Males (Fig. 13) occurred along O'Gran on the banks of both anlungs and at a rocky/waterfall section. They appeared only in sunshine and mostly perched on leaves and fronds of riparian bushes, gingers or small palms. Four males (far more seen) and one female (the only seen) were collected.



**Figure 13. *Aristocypha fenestrella*, a male on the O'Gran brook bank on Phnom Thumpor, 16.03.2019.**

#### 2. *Mortonagrion aborense* (Laidlaw, 1914)

A single male was collected on a shady anlung bank at ca 10:00 on 17.03.2019. Remark. The specimen size (hw 14, ab 21.5, mm) corresponds to that of specimens from Thailand (Asahina 1982; as *M. binocellata*; hw 13, ab 22-23) and Koh Kong Province of Cambodia (Kosterin 2011) while specimens from Mondulkiri Province in E Cambodia are larger (hw 15-16, ab 23.5-25) (Kosterin 2016 and further specimens of 2018).

#### 3. *Coeliccia kazukoae* Asahina, 1984 (Fig. 14)

Common on the banks of O'Gran both in sunny and overcast weather; rested mostly on leaves. Thirteen males, one female collected, more seen.



Figure 14. *Coeliccia kazukoae*, males on the O'Gran brook bank, 16 (above) - 17 (below). 03.2019.

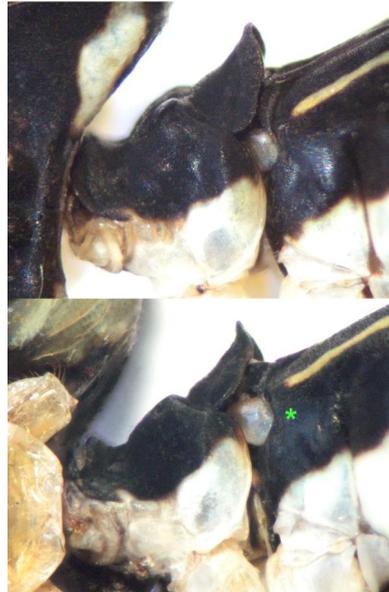


Figure 15. The prothorax and fore part of the synthorax of two males of *Coeliccia kazukoae* from O'Gran. The green asterisk indicates the lateral sclerites of the mesostigmal plate. Scale bar 0.5 mm.

Remarks. The males of the Tumpor series have some peculiarities as compared with those collected at low levels in the coastal Cardamonean foothills in Thailand and Cambodia (Kosterin & Kompier, 2017). First of all, the latter are characterised by curiously large and long lateral sclerites of the mesostigmal plate, almost as in females (Kosterin & Kompier 2017: fig. 5i,j). The Tumpor males have these sclerites much shorter (Fig. 15), as in the closely related species *Coelliccia rolandorum* Kosterin & Kompier, 2017 (Kosterin & Kompier 2017: fig. 5d,e) (some variability of the sclerite size in both the foothill and Tumpor *kazukoae* is negligible as compared with the difference mentioned). The colour of the metepisternum and antehumeral stripes varies from greenish (more often) (Fig. 14 above) to blue, while always blue in the foothill specimens. All males of the Tumpor series correspond to the fully melanised (fully mature) foothill males, as having the mesothorax saturated black with a pair of distinct streaks along the mesepisterna and with neither additional diffuse lighter stripes (as in immature foothill males) nor distinct pale streaks along the mesopleural sutures (as in most males of *C. rolandorum*). The small pale spots at the posterior ends of the mesopleural sutures were present in only 5 of 13 Tumpor males, but in all all the examined foothill males. The only collected Tumpor female corresponds to the fully mature *kazukoae* females from foothills with respect to the prothorax shape (Kosterin & Kompier 2017) and in having two pairs of brownish indistinct streaks, on both sides of the middorsal suture and along the mesopleural sutures. It would be interesting to see immature males from this site to check whether they have the indistinctly striped mesothorax as typical for the



**Figure 16.** *Coelliccia yamasakii*, males at the open rocky section of the O'Gran brook, 17.03.2019.

lowland *kazukoae*. The above mentioned peculiarities of the Tumpor males are, however, not sufficient enough to recognise them as a taxon other than *C. kazukoae*.

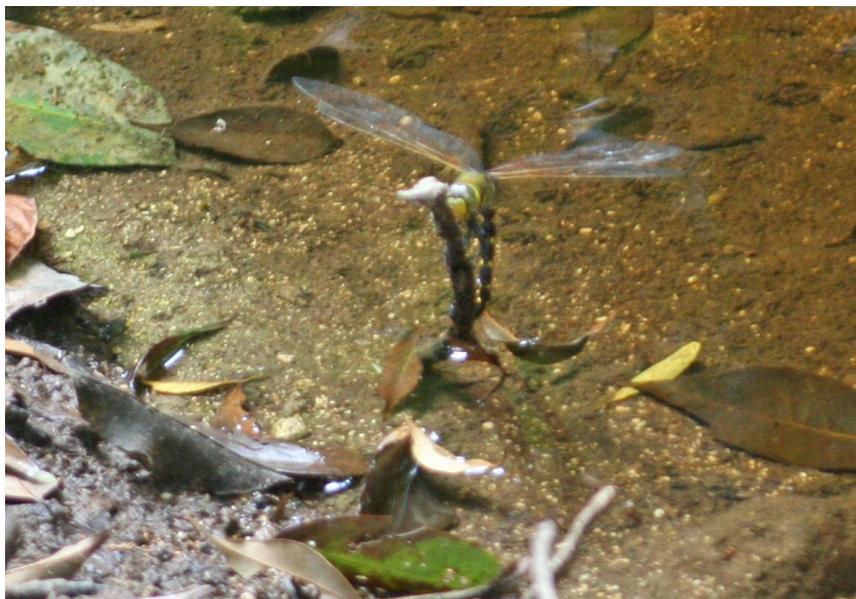
4. *Coeliccia yamasakii* Asahina, 1984 (Fig. 16)

Occurred only in the rocky/waterfall section, for some reason found only on 17.03.2019. Four males, two females collected, more seen.

5. *Anax immaculifrons* Rambur, 1842

For two and half days I made eight sightings of these dragonflies (three of them ovipositing) in both overcast and sunny weather, and rather evenly distributed through the day: early in the morning (16.03); at 9:30 ovipositing (17.03.2019), at sunny midday – twice on 16.03.2019 and three times (one of them ovipositing) on 17.03, at 14:30 ovipositing (15.03.2019) (Fig. 17). The females oviposited on very small twigs at the water edge of muddy banks (Fig. 17), spending very little time at each and alternating oviposition with hovering over the water, or passing by very fast over the water without returning. Nothing resembling territorial male behaviour was observed, and most probably all these individuals were females. Twice I was able to make good net strokes but missed. The photo of Fig. 17 is poor and taken from a bad angle, yet I saw the hovering dragonflies from above and side very well and have no doubt about the identification.

As many as ten exuviae were found, all on dead bush branches emerging from black anlung water (Fig. 18), usually in groups by 3-4.



**Figure 17. A female of *Anax immaculifrons* ovipositing on a twig on a muddy branch of an lung of the O'Gran brook, 15.03.2019.**



**Figure 18.** Exuviae of *Anax immaculifrons* on dead stems over anlungs of the O'Gran brook, 15.03.2019.

6. *Polycanthagyna erythromelas* (Selys, 1891)

At 11:15 on 16.03.2019, before the sun appeared from the clouds, at the rocky/waterfall section, a female hovered and oviposited into moss covering rocks, bark at the base of bushes and the ground littered with leaves, all dry and not adjacent to water (Fig. 19). It was not at all cautious but disappeared after an unsuccessful net stroke. Next day on 13:20 perhaps the same female oviposited on mossy rocks near the pool beneath a dry waterfall and was collected.



**Figure 19. A female of *Polycanthagyna erythromelas* ovipositing into bark, mossy stone and ground at the rocky section of the O'Gran brook, 16.03.2019.**

#### 7. *Macromia* sp. cf. *pinratani* Asahina, 1987

Two females were collected (Fig. 20). Both rapidly ranged for a short distance low over small narrow pools through which O'Gran flows in its rocky section (before 15:00 on 16.03.19, Fig. 20a. and at 14:03 on 17.03.19, Fig. 20b). Two more, presumably females, were observed on 16.03.19 to similarly range (i) over a similar pool at ca 11:00 and (ii) over a short shaded between anlungns where O'Gran was seeping through small stones in its shallowest parts section, at 8:30. Two more sightings of a passing individual were made on the same day at places like the last described. Only twice I observed individuals passing over the surface of anlungns; at 9:30 and 16:03 on 17.03.2019. Only once, at midday on 17.03.2019 I observed a presumed *Macromia* male (missed), which passed three times (upstream, downstream and again upstream) over a chain of shallow seepages and deeper pools of O'Gran, obviously patrolling its long course.

In sum there were 9 sightings of *Macromia* individuals with female behaviour (which looked like preparation for oviposition) or passing by, and one with a male be-

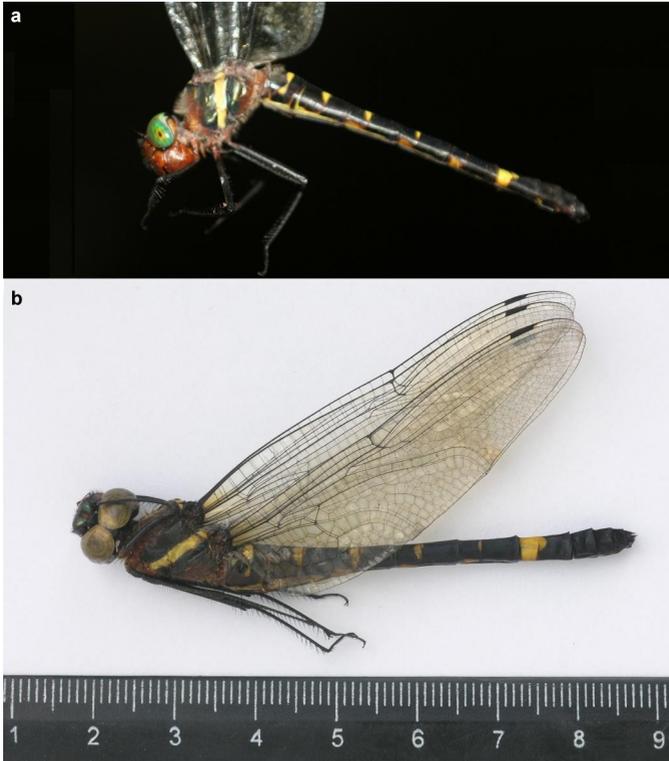


Figure 20. Females of *Macromia* cf. *pinratani* collected at the rocky section of the O'Gran brook on 16 (a) and 17 (b). 17.03.2019. Not to scale.

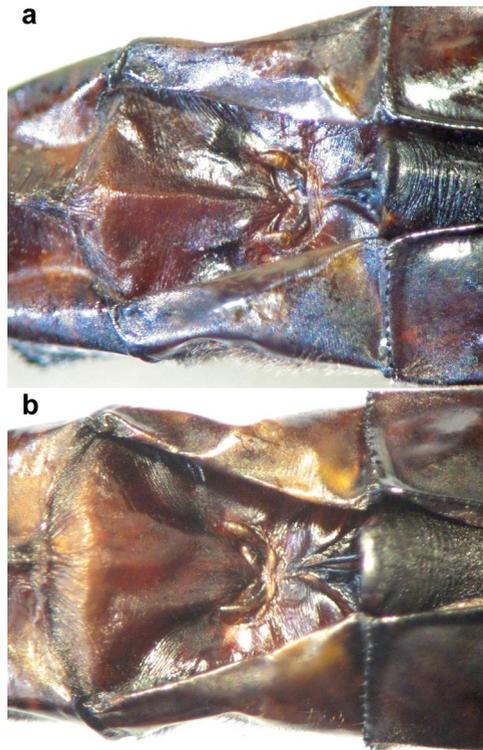


Figure 21. A *Macromia* exuvia beneath a large dead tree trunk hanging over a deep anlung of the O'Gran brook, 16.03.2019.

haviour. Seven of these sightings were over shallow water and only two of passing over anlungs. At the same time I collected 7 exuviae from deep anlungs, 6 of which were clinging to the lower surface of two huge mossy trunks of trees fallen across the anlungs (3 and 4 exuviae at each) (Fig. 21). Such a location does not fit the presumed oviposition sites observed. So either females oviposit in very shallow, seeping water while the larvae later migrate to deep anlungs, or the exuviae belonged to another species associated with deeper water.

Remarks. The reddish-brown face with no yellow marking and the metallic green present only on the frons upper surface (clearly in one specimen, but only traces in the other), flattened protrusions of the frons and the absence of antehumeral stripes restrict the choice of candidate species to *M. moorei* Selys, 1874 ssp. and *M. pinratani* Asahina, 1987. However, identifying the females is a challenge.

The vulvar lamina of *M. pinratani* was twice illustrated by the species' author (Asahina 1987: fig. 7; 1996: fig. 17) and later by Seehausen (2018: fig. 7), although in the latter case the identification is still questionable. All these illustrations show the lamina as in our females (Fig. 22). Surprisingly for an old and widespread species *M. moorei*, represented by three presumed subspecies, there exists only one



**Figure 22.** The vulvar laminae of the females of *Macromia cf. pinratani* collected at the rocky section of the O'Gran brook on 16 (a) and 17 (b). 17.03.2019 (see Fig. 20). Scale bar 1 mm.

drawing of the vulvar lamina of a specimen from Assam by Asahina (1987: fig. 31). This drawing is puzzling as showing the vulvar lamina extremely short, almost reduced, with a very broad shallow incision. This plainly contradicts the verbal description of this structure by Fraser (1936: 166): "Vulvar scale short, narrowly and deeply emarginate". This statement by Fraser exactly fits the vulvar lamina shape illustrated for *M. pinratani*, while that in Asahina's drawing of *M. moorei* from Assam could be described in contrast as "shallowly and broadly emarginate". Taking into account the obvious close relatedness *M. moorei* and *M. pinratani*, one can suppose that the vulvar scale is similar in these species while Asahina's Assamese female specimen of *M. moorei* was anomalous or misidentified.

The S2 yellow marking needs to be considered, since Kompier (2019) proposed that in Vietnam *M. moorei* has a broad and usually uninterrupted S2 pale pattern while *M. pinratani* has a narrower and always interrupted pattern. This character works for males (but the males from Quảng Nam Province, Central Vietnam, have the S2 stripe interrupted), which are also easily distinguished by the secondary genitalia, while its validity for females is questionable. Indeed, the photos of *M. moorei* females from Yên Bái and Tam Dao Provinces of northern Vietnam in Kompier (2019), from Sapa in northern Vietnam shown in Karube (2011: fig. 11), and the Thai female in Muraki (2014: fig. 47), unequivocally show S2 with a broad yellow stripe expanding and extending towards the anterioventral corner of the tergite, its ventral margins not outlined with yellow.

In the original description of *M. pinratani*, only a narrow transverse streak and an isolated small lateral spot are shown (Asahina, 1987: fig. 6). In that of *M. pinratani vietnamensis* Asahina, 1996 a broad but short transverse stripe and broad pale ventral tergite margins are shown (Asahina 1996: fig. 14); the broad but short transverse stripe is also seen in a photo of a female from Tam Dao of the same taxon in Karube (2011: fig. 15). In the photo of a female from Tam Dao by Kompier (2019) one can see a broad dorsal stripe, an isolated large lateral spot (as shown in the male but not for the female of *M. pinratani vietnamensis* by Asahina (1996: compare figs 13 and 14) and a narrow ventral pale margin. The photo of a Thai female of *M. pinratani* by Muraki (2014: fig. 92) shows a rather continuous but narrow bracket-like transverse stripe and a pale ventral margin, as in our specimens (Fig. 20). The photo of a Lao female supposedly of *M. pinratani* by Seehausen (2018: fig. 6) obscurely shows a narrow transverse stripe seemingly fused to the large anteriolateral spots.

In the available illustrations of females, the pale pattern of S3-S5 is as follows:

- broad square-bracket-like transverse stripes extended anteriorly along the tergite ventral margins (shortly interrupted before this extension or not) - in both *M. moorei* and *M. pinratani* from Thailand shown by Muraki (2014: figs 47, 92) and from northern Vietnam shown by Kompier (2019) but only in *M. moorei* from northern Vietnam shown by Karube (Karube 2011: fig. 11); the same in the Tumpor specimens (Fig. 20);
- very narrow transversal streaks without pale areas ventrally - in the original description of *M. pinratani pinratani* (Asahina 1987: fig. 6), and

- broad irregular stripes not extended ventrally in *M. pinratani vietnamensis* - in the original description (Asahina 1996: fig. 14) and in the female from Tam Dao shown by Karube (2011: fig. 15).

Thus either the S3-S5 pattern is not diagnostic, or not all the illustrated females were correctly identified.

Gene Bank contains sequences of the 451 base pair long 5'-fragment ('Folmer fragment') of the mitochondrial COI gene, uploaded by Ryo Futahashi, from two specimens of *M. moorei* originating from Thailand and Hainan, but none for *M. pinratani*. These two sequences (LC366841.1 and LC366840.1) differ in 16 synonymous nucleotide substitutions that means a 3.5% uncorrected p-distance. This value seems too large for intra-species variation and may hint at, although is not evidence for, a probable non-conspecificity of those specimens (misidentified, representing cryptic species, or presumed subspecies which are actually species). For the time being, without a proven sequence of *M. pinratani*, it is impossible to positively identify our females by molecular means.

In general, the body pattern of our females, especially that on S2, best fits that shown in *M. pinratani* in Muraki (2014: 92) while the vulvar lamina as well is as shown for *M. pinratani* (Asahina 1987: fig. 7; 1996: fig. 17) and later by Seehausen (2018: fig. 7). Hence for the time being I tentatively identify the collected females as *M. pinratani* but for decisive identification the males are needed.

#### 8. *Orthetrum triangulare* (Selys, 1878)

On all three days a male was invariably observed, but in sunshine only, at a rather open place where O'Gran was shallow and flowing through mud and some pebbles at the mouth of a small tributary brook with some water and a muddy bed (Fig. 23). There was a preferred perch, a low twig by a muddy part. A male was very cautious and ranged fast along both water courses. At ca 10:50 on 17.03.2019 it was captured but another one appeared in the same place in a few minutes (seemingly two males competed for this place). In the overcast afternoon of the same day a female was observed ovipositing in the same place, with my footprints on the mud filled with water. In the sunny part of the same day males were twice observed elsewhere, at an anlung and rocky section of the O'Gran. It is interesting that males were active only in sunshine while the female oviposited in overcast weather, perhaps to avoid their interfering harassment.

#### 9. *Tholymis tillarga* (Fabricius, 1798)

During overcast periods of 16-17.03.2019, I made six sightings of females of this species (one collected) during their characteristic very fast and erratic flight with frequent touching of the water surface – four at pools in the open rocky area and two at anlungs. No males were observed. I have little doubt that these females dispersed to Phnom Tumpor from lower down, since this species has a strong dispersal ability.

#### 10. *Zygonyx iris malayana* (Laidlaw, 1902)

A male appeared hovering above the rocky/waterfall section (a typical habitat of the species) soon after the sun appeared at 11:20 on 16.03.2019 (collected).



**Figure 23. A preferred habitat of *Orthetrum triangulare* at the O' Gran brook.**

## Discussion

*P. erythromelas* and *M. sp. cf. pinratani* have been recorded in the already quite studied Cambodia for the first time, and that alone makes the known Odonata species richness of O'Gran notable. It is nevertheless even more peculiar by virtue of the species missing as compared with lower elevations in the Cardamoms (Kosterin 2010; 2011; 2012b; 2014; 2015; Kosterin & Chartier 2018), rather than by what was found there. For instance, all forest streams in Cambodia seen by me before abounded in *Vestalis gracilis* (Rambur, 1842), and O'Gran is the first one found without this species. Almost the same can be said of *Heliocypha biforata* (Selys, 1858) and at least one *Prodasineura* species. It could be speculated that the Tumpor environment is

too cold for these species. But they were found at about the same elevation and cool climate on the Bokor Plateau of the same Cardamom Mts. (Kosterin 2012a). The shaded, black forest pools of and near O'Gran seemed the best habitat for *Gynacantha* spp., at least for the elsewhere common and seemingly seasonally indifferent *G. subinterrupta* Rambur, 1842, but no *Gynacantha* was observed. Elsewhere in Cambodia, as well as almost everywhere in the world, most species found in a habitat are from the families Coenagrionidae and Libellulidae. In the handful of species found at O'Gran in March, the former was represented by only one species (and one individual found), *M. aborense*, and the latter by three, *O. triangulare*, *T. tillarga* and *Z. iris*. One or two species were found there from other families: Chlorocyphidae (1), Platycnemididae (2), Aeshnidae (2) and Macromiidae (1).

Of the ten species recorded, six were rather numerous (if exuviae are also taken into account) and seem to find a favourable habitat in O'Gran: *A. fenestrella*, *C. kazukoae*, *C. yamasakii*, *A. immaculifrons*, *M. cf. pinratani* and, perhaps, *O. triangulare*.

In Cambodia, *A. fenestrella* was earlier recorded from two localities in the Cardamoms, at ca 920 and 320 m a.s.l. (Kosterin 2011; 2012a; 2014). *A. immaculifrons* was found once at ca 430 m a.s.l., in a locality 60 km directly to the south from O'Gran, at a brook flowing through flat sandstone rocks in half-open habitat on a moderately elevated plateau (Kosterin 2012b). At O'Gran this species surely finds a more favourable habitat and is numerous. It can be speculated that both of the last mentioned species avoid lower elevations in the Cardamoms.

All odonate species found at O'Gran except for *A. immaculifrons* also occur in Chanthaburi Province of Thailand (Hämäläinen & Pinratana 1999), which is in the western part of the Cardamoms. According to my observations, the mountains at Khao Khitchakut National Park in this province (Kosterin & Vikhev 2008) are also formed by igneous rocks rather than sandstone but at lower elevations and closer to the sea than in Phnom Tumpor.

The three largest dragonfly species observed, *A. immaculifrons*, *P. erythromelas* and *M. cf. pinratani*, were represented by only or mostly (in the case of *M. cf. pinratani*) females. Such a situation is usually observed at the end of the flight period, so the territorial males could be expected to occur around January-February.

No doubt O'Gran should be re-examined in the early part of a rainy season when most lotic odonate species emerge, especially Gomphidae. In that family, even the existence of narrowly local endemics cannot be excluded.

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**Figure 24.** The local guide Mr Chhun Chhum collecting Odonata at the O'Gran brook, 17.03.2019.

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