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Odonata from logged and unlogged forest in the Ulu Balui and Ulu Baleh, Kapit Division, Sarawak, in June and September 2013

Rory A. Dow[1] & Robin W.J. Ngiam[2]

[1]Naturalis Biodiversity Centre, P.O. Box 9517, 2300 RA Leiden, The Netherlands
Email: rory.dow230@yahoo.co.uk

[2]National Biodiversity Centre, National Parks Board, Singapore
Email: ngiam_wen_jiang@nparks.gov.sg, yanrobin@hotmail.com

Abstract

The results of two expeditions into the Ulu Baleh and Ulu Balui areas of the interior of Sarawak are presented, including data from forest that was pristine at the time of sampling but that was subsequently logged. A total of 74 species are recorded, notably including *Coeliccia campioni*, *Coeliccia* new species *borneensis*-group, *Pericnemis* spp., *Heliogomphus blandulus*, *Leptogomphus pendleburyi*, *Chlorogomphus* ?*manau* and *Procordulia* ?new species. A discussion of the results and potential differences in the odonate fauna of comparable logged and unlogged forest sites is given.

Key words

Odonata; Sarawak; Borneo; Malaysia; logging effects; virgin forests

Introduction

Despite all the work that we have done in Sarawak, there are still large blank areas on the odonatological map of the state. The biggest of these blank spaces are in vast Kapit division, which is not much smaller than the Netherlands, and mostly difficult or very difficult to access. In an attempt to reduce the size of the Kapit blank area, in late 2012 we asked our friend Somoh anak Nyapong, 'our man in Kapit', to investigate the possibilities for making a survey somewhere in a large arc along the border with Indonesia. Our good friend Luke Southwell assisted by coordinating with Somoh. Many factors have to be considered when planning such a survey, not least the existence of usable logging roads (the only access) and the likely degree of hostility of the timber company that holds the licences for the target area. Our request resulted in the two small expeditions reported here and partly funded by the IDF.

Somoh and his brother Lion (Malaysian spelling of Leon) came up with a plan for the first expedition, held in June 2013 with both authors present, but due to the difficulties of communicating with them from a distance, we had little idea where we were actually going until we met up with them in Kapit town the day before we were due to leave. In Kapit we were able to look at a map and determine, more-or-less, that we were heading into an area south and east of the Hose mountains near the Indonesian border and including parts of the headwaters of both the Baleh and Balui rivers, the two major tributaries that converge near Kapit town to form the Rajang River (the largest in Sarawak). Fig. 1 shows the position of the target area, and the sampling points. This area is almost as close to the geometric centre of Borneo as it is possible to be while remaining in Malaysia. Within the area we would have various options, and would have to make decisions about exactly where to go as we obtained more detailed information from the timber workers in the area. One piece of welcome news was that most of the area was under Rimbunan Hijau Sendirian Berhad, a timber company that we have dealt with before and found unusually helpful and friendly. However we

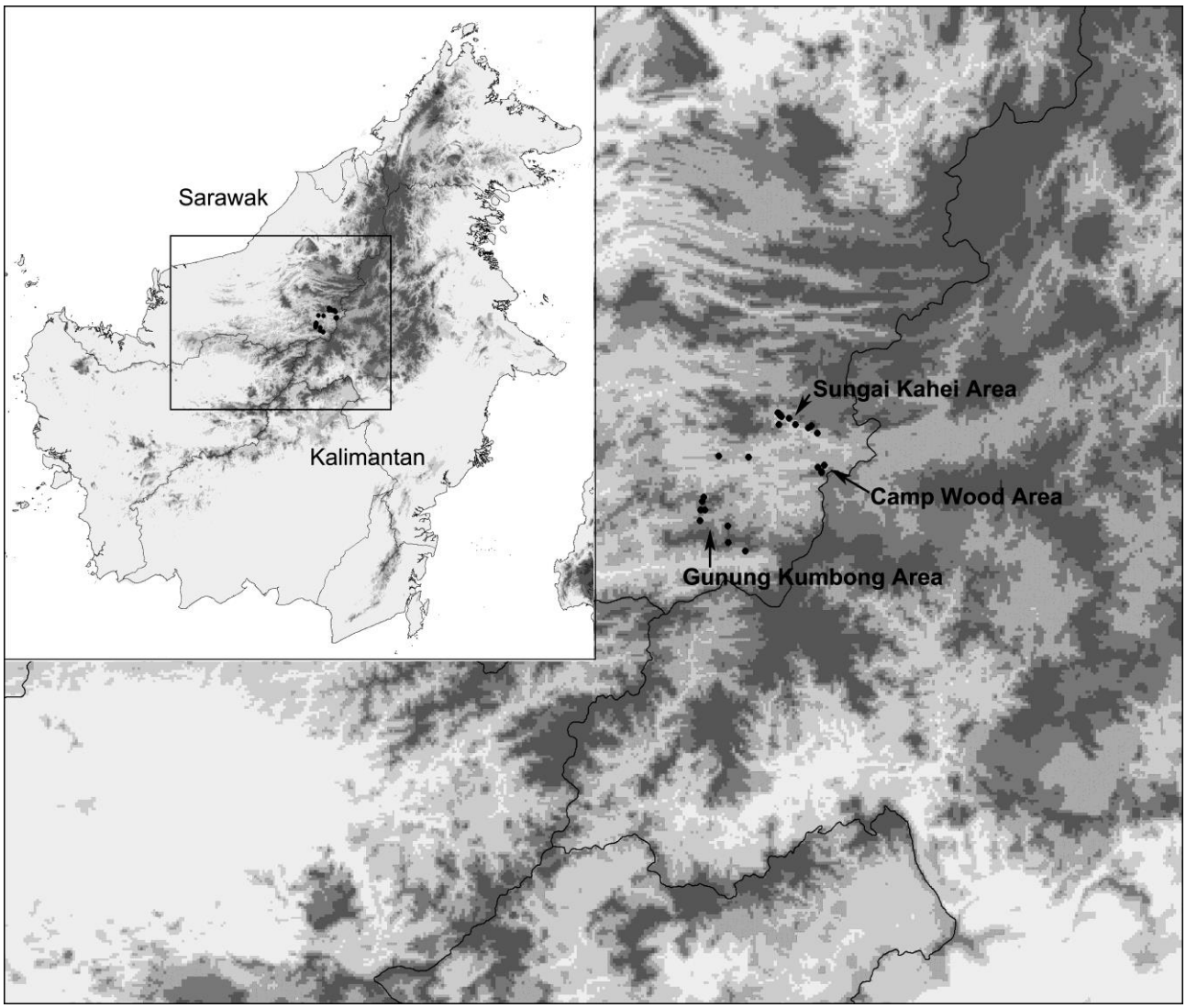

Figure 1. Map of Borneo indicating the area of the expeditions, and more detailed view of same area. Image made with the aid of DIVA GIS.

would be at the mercy of the attitudes of individual camp managers and security personnel, so that there was still plenty of scope for problems. During the first expedition we located an accessible area of soon-to-be-logged completely virgin forest.

The discovery of the virgin forest area prompted RD to approach the IDF for further funding to make another trip to the area before cutting. These uncut areas offer not just a window into what the fauna of the area was like before logging activities, but an invaluable (and soon to be lost) opportunity to gather before and after logging data from precisely known sites – something that has been lacking until now and which is needed to really gauge the effects of logging on forest odonate communities. Study of imagery on Google Earth revealed some other potentially unlogged areas in the Ulu Balui area; the intention was to also investigate some of these areas if possible. The second expedition was made in late August and early September 2013; of the authors, only RD was present.

No trips which we have made into the interior of Sarawak have better exemplified the difficulties and dangers of working in the logging areas of the state than the two expeditions reported here. The roads are hazardous, landslides are frequent (between the two expeditions reported here a logging hut in the Sungai Kahei area was struck by a land slide in the night, resulting in the death of one man and another man losing both of his legs), operating costs are high, and one is working far from medical assistance in steep, difficult terrain with many dangers. But the biggest difficulty is in getting reliable and accurate information. There is no tourist information or other publically available official information about these areas, and few or no tourists ever even attempt to visit them so nothing useful is available from blogs etc. Freely available satellite imagery (e.g. Google Earth) is useful but the maps are always years out of date (even though the current year is displayed on the screen), so that areas that look pristine on the map turn out to be heavily logged when one gets there. Also, with the quality of imagery available for most timber areas in Sarawak, it is often not possible to distinguish between a virgin area and an area that has been logged long enough ago that the network of logging tracks has become obscured. We have to rely entirely on the knowledge of people who have worked in the areas, or come from them (but very few people live in the area of concern here) to get us to those areas. Once in the area one has to find the right person to ask, then ask exactly the right questions, in the right way, and sometimes it seems they have to be asked at the right time (e.g. only after the person you are asking have seen enough of you to get used to you, or when they are in the right mood); this is a task that, in practice, is so difficult and time consuming that we have rarely achieved it. With good contacts in the higher layers of timber company management good information could be obtained before visiting an area, but contacts of this sort are very difficult to make.

Note on operating costs

Because of the need to use a good 4WD with a very good driver, the costs of operating in the interior of Kapit division are very high. We give a rough break down of the basic operating costs here, to demonstrate how IDF money is being used (RM – Malaysian Ringgit).

4WD plus Lion Nyapong wages plus fuel = 750 RM/day.

Other wages = 330 RM/day (average figure for three persons employed, varies slightly according to who is employed).

Rations at 20 RM/day per person = 100 RM/day based on 5 persons (June trip was 6 people, August/September 5 people).

Total = 1180 RM/day, or approximately 268 Euro/day at a rate of 4.4 RM to 1 Euro (the exchange rate has been around this value for some time now). So 1000 Euro of funding does not quite cover 4 days work in this area.

Figure 2. Annotated GoogleEarth image of the area of the expeditions with some of the sampling sites labelled, plus timber camps. See under September 4 in the diary section for an explanation of "End road new area".

Locations

An overview of many of the sampling locations can be seen in Fig. 2. Latitude and longitude are given in decimal degrees below, to 3 d.p. accuracy.

* indicates virgin forest.

Mantan Camp/Gunung Kumbong area

Locations in Ulu Baleh unless otherwise noted.

- M1 In Mantan timber camp, and beside logging roads and other open habitats.
- M2 Stream A in disturbed forest near Mantan Camp, sampled on 9/6, ca 800m at road (1.744N, 114.318E).
- M3 Stream B in disturbed forest near Mantan Camp sampled on 9/6, ca 810m at road (1.743N, 114.331E).
- M4 Stream in disturbed forest, on road leading from Mantan camp toward border, sampled on 10/6, 620-680m (1.612N, 114.460E).
- M5 Streams in disturbed forest near camp of nights of 9-10/6, sampled on 10/6 (1.638N, 114.443E).
- M6 Stream in disturbed forest with head at ca 1170m, sampled on 11/6 (1.1.640N, 114.406E).
- M7 Streams in in disturbed forest near to M6 but lower down, sampled on 11/6, ca 985-995m at road (1.692N, 114.404E).
- M8 Stream system in disturbed forest below camp of nights of 11-13/6, sampled on 12/6, ca 600-650m (1.710N, 114.315E).
- M9 Stream in disturbed forest at ca 920m, sampled on 13/6 (Ulu Balui) (1.771N, 114.323E).
- M10 Stream in disturbed forest at ca 790m, sampled on 13/6 (Ulu Balui) (1.785N, 114.328E).

Tapak Mageh area

All in Ulu Balui.

Camp Wood (ca 660m) area:

- W1 In timber camp, and besides logging roads and other open habitats.
- W2 Low gradient stream and tributaries in disturbed forest on road to border, sampled 30/8 and on morning of 1/9, ca 560m (1.888N, 114.714E).
- W3 Stream system at 830-900m between Camp Wood and border, edge of virgin forest (mosaic virgin and disturbed), sampled 1/9 and in passing on 2-3/9 (1.866N, 114.706E).
- W4* Same stream system at 900-1030m in virgin forest, sampled 2-3/9 (1.863N, 114.706E).
- W5 Stream system in disturbed forest, sampled on 1/9, ca 510m at road (1.880N, 114.693E).

Figure 3. Annotated GoogleEarth image of the Sungai Kahei area. Note that the satellite image, although downloaded in May 2014, is out-of-date; even at the time of sampling the sites marked KD had been logged and the logging roads would be visible in any satellite image captured after timber extraction.

Sungai Kahei area (Fig. 3; although the satellite image was downloaded from Google Earth on 18th May 2014, it is so out-of-date that it shows most of the locations that were already logged when we visited them as undisturbed):

Disturbed habitats:

- KD1 By logging roads, open pools etc.
- KD2 Stream, in disturbed forest, at camp of 14/6, sampled late afternoon/dusk of 14/6, ca 560m (2.208N, 114.662E).
- KD3 Stream, in disturbed forest, at camp of nights of 15-16/6 and 6-11/9, sampled incidentally whilst bathing, ca 490m (2.017N, 114.622E).
- KD4 Streams in disturbed forest at ca 850-910m, sampled 16/6 (2.012N, 114.672E).
- KD5 Shaded pool by old logging track in area of KD4, sampled 16/6 (2.013N, 114.674E).
- KD6 Stream A in disturbed forest sampled 7/9, exact altitude unknown but ca 600-800m.
- KD7 Stream B in disturbed forest sampled 7/9, exact altitude unknown, but ca 600-800m.
- KD8 Pond at edge virgin forest at KV8, sampled 8-9/9, ca 530m.
- KD9 Large, low gradient stream and tributaries in very disturbed forest, sampled 11/9, ca 430m (1.989N, 114.693E).
- KD10 Marshy, semi-open pond adjacent to KD9, sampled 11/9.

Undisturbed habitats:

- KV1* Stream in virgin forest, ca 500-640m, sampled 15/6 (2.046N, 114.573E).
- KV2* Streams in virgin forest, ca 510-550m sampled 15/6 (2.046N, 114.572E).
- KV3* Streams in virgin forest, ca 565-630m sampled 16/6 (2.049N, 114.571E).
- KV4* Stream in virgin forest, ca 500-640m, sampled 6-7/9 (2.042N, 114.577E).
- KV5* Stream in virgin forest, ca 510m at road, sampled 6/9, possibly overlaps with KV3 in upper part (2.048N, 114.570E).
- KV6* Stream in virgin forest, ca 490m at road, sampled 7/9 (2.051N, 114.570E).
- KV7* Stream in virgin forest, ca 500-695m sampled 8-9/9 (2.054N, 114.566E).
- KV8* Streams in virgin forest, ca 530m at road, sampled 8-9/9 (2.052N, 114.568E).
- KV9* Stream in virgin forest, ca 600-685m sampled 10/9* (2.038N, 114.602E).
- KV10* In virgin forest, not associated with stream, including at small forest pools, ca 530-800m.

Other

- O1 Streams and pools between Camp Rose and Camp Maxi Wealth, sampled in transit 14/6 (ca 730m, 1.913N, 114.471E) and 17/6 (ca 785m, 1.917N, 114.375E).
- O2 By logging road in Camp Rose area on 4/9 (altitude and coordinates unknown) and 5/9 (ca 940m, 2.017N, 114.568E).

Expedition diary

To give more context to the locations listed above, and to illustrate the difficulties involved, we give a rough diary of both expeditions. Names are abbreviated below as MB (Manau anak Budi), RD (Rory Dow), RN (Robin Ngiam), LN (Lion anak Nyapong), SN (Somoh anak Nyapong) and LS (Luke Southwell).

First expedition

June 7. RD and RN arrive in Kapit by express boat from Sibu; LS already in town to facilitate buying of supplies with LN and SN.

June 8. Departure from Kapit, involving mini bus from town with supplies, to a log pond (an area where logs are collected for processing) by the Baleh river (Fig. 4), long boat over the river to another log pond and small village where SN has a house and where LN had his 4WD. Due to difficulties en-route only managed to start the real journey after noon. Hose mountains to the east of us for most of the late afternoon (Fig. 5 shows most of the party with the Hose Mountains in the background). Drove into the night, stopping after dark at a huge plywood factory in the middle of nowhere to eat

in one of the canteens. Finally stopped to sleep, using an abandoned shack outside a timber camp (the gates had been shut for the night for security reasons). LS, RD and RN struck by food poisoning in the night (the others had all worked in timber camps in the area and were presumably already immune to whatever got us). Rained on and off in afternoon and into the night.

Figure 4. The Baleh river near our crossing point. Photograph by Robin Ngiam.

Figure 5. Members of the first expedition, minus Robin Ngiam (holding the camera). From left to right: Lion anak Nyapong, Rory Dow, Somoh anak Nyapong, Luke Southwell and Manau anak Budi.

June 9. Moved on, LS and RN recovered quickly, RD still very weak. Fortunately we had made good progress the day before and were not far from our target area. Arrived at Mantan timber camp, those who could ate breakfast, LN and SN got some information about which roads in the area were usable. Headed on a road going approximately

Figure 6. A stream near Mantan Camp. Photograph by Robin Ngiam.

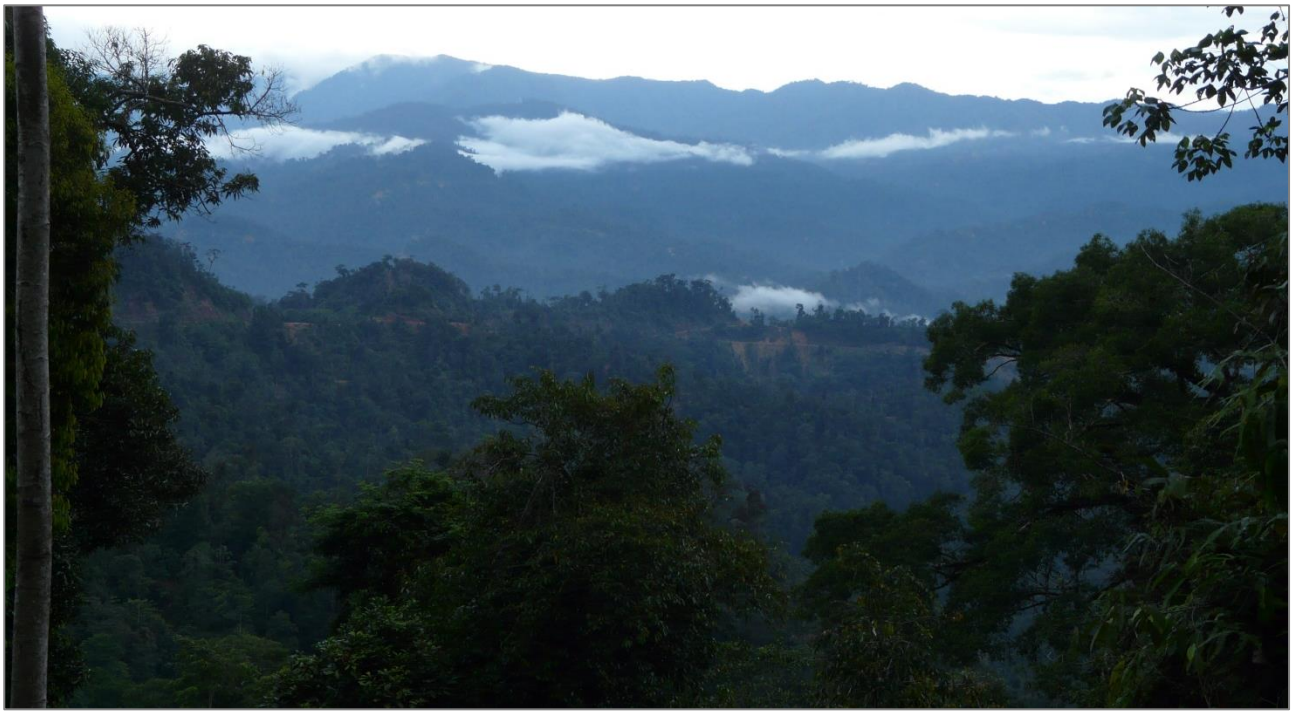

Figure 7. A view from the road near our camp of June 9. Photograph by Robin Ngiam.

south-east towards the border. Stopped to sample in some streams (locations M2, M3, Fig. 6). Located an empty logging hut that we could use to stay in; main drawback – no reliable water supply at the hut, had to drive some distance for water. Weather mostly good. Fig. 7 shows a view in this area.

June 10. MB and RN sampled the streams we were using for bathing (M5), RD was dropped off at a stream (M4) further down the road towards the border, LN and SN sent to see how far down the road we would be able to go (Fig. 8 shows a typical section of in use logging road in the area). When they returned to pick RD up, they and the vehicle were almost entirely covered in reddish mud. They had only managed to go a short distance before the 4WD sank to almost above the wheels in mud that had looked like solid road and they had spent most of the day getting it out again; this road was not going to take us anywhere else. Weather good.

Figure 8. A typical section of in-use (e.g. good condition) logging road in the mountains. Photograph by Robin Ngiam.

June 11. Having breakfast when a bulldozer and its crew passed by, they stopped and told us that they were going to get a logging hut further down the road (Fig. 9 shows this hut being moved) and take it somewhere else, after that they would be back for our hut which was also needed elsewhere, so we would have to move. Hurried pack-

Figure 9. A logging hut on the move. Photograph by Robin Ngiam.

ing. Headed back towards Mantan camp, on route at a high point on the road (ca 1200m) inferred the presence of a stream (M6) a little further down and LS, MB and RD found it after a difficult climb down. SN and RN worked streams (M7) further down the road, LN located a new camp place at another deserted logging hut on a side road not far from Mantan camp. Fieldwork badly affected by rain after 12, cleared up after field work ended. On way to new camp saw, on the road, in quick succession – a Binturong, a large Leaf Monkey and some type of Mongoose. Fig. 10 shows a view from the road. New camp (Fig. 11) had large drums that collected rain water, but insufficient for bathing if not much rain. Alternative bathing site a clear stream reached by fording a much larger, very turbid stream about 10 minutes drive further down the road.

June 12. MB, RD, RN sampled in bathing stream system (M8, Fig. 12). LN and SN sent to a larger timber camp before Mantan Camp, to get information on roads taking us firmly into the Uu Balui area to the north east. Many heavy rain showers after 11 am, heavy rain latter in the afternoon. Had a social visit around dusk by a Kenyah (one of the Orang Ulu races) guy who worked security at Mantan Camp gate, he was from one of the few longhouses in this remote area, apparently a very large one with

Figure 10. View over logged forest. Photograph by Robin Ngiam.

Figure 11. Our camp of June 11-13. Photograph by Robin Ngiam.

"200 doors", e.g. 200 families living there. Had a meeting in the evening and decided that the next day would be the last in the Mantan camp area, after that we would make a one day journey north and east to an area called Tapak Mageh in the Ulu Balui. Fig. 13 shows an early morning view from near the camp.

Figure 12. Stream sampled June 12. Photograph by Robin Ngiam.

Figure 13. Morning view from our camp of June 11-13. Photograph by Robin Ngiam.

June 13. Attempted to work streams on another road near Mantan Camp. First problem: on reaching the junction found a number of logging trucks parked up, waiting for the road to dry enough to be usable. LN checked the road and decided that we would have to wait as well. MB, RD, RN proceeded on foot, found a suitable looking stream system at ca 920m (M9, Fig. 14). After stopping here for a while RD carried on and found another, lower, stream (M10), after being picked up by LN and SN when they brought the 4WD up. Weather heavily overcast all day with some light rain.

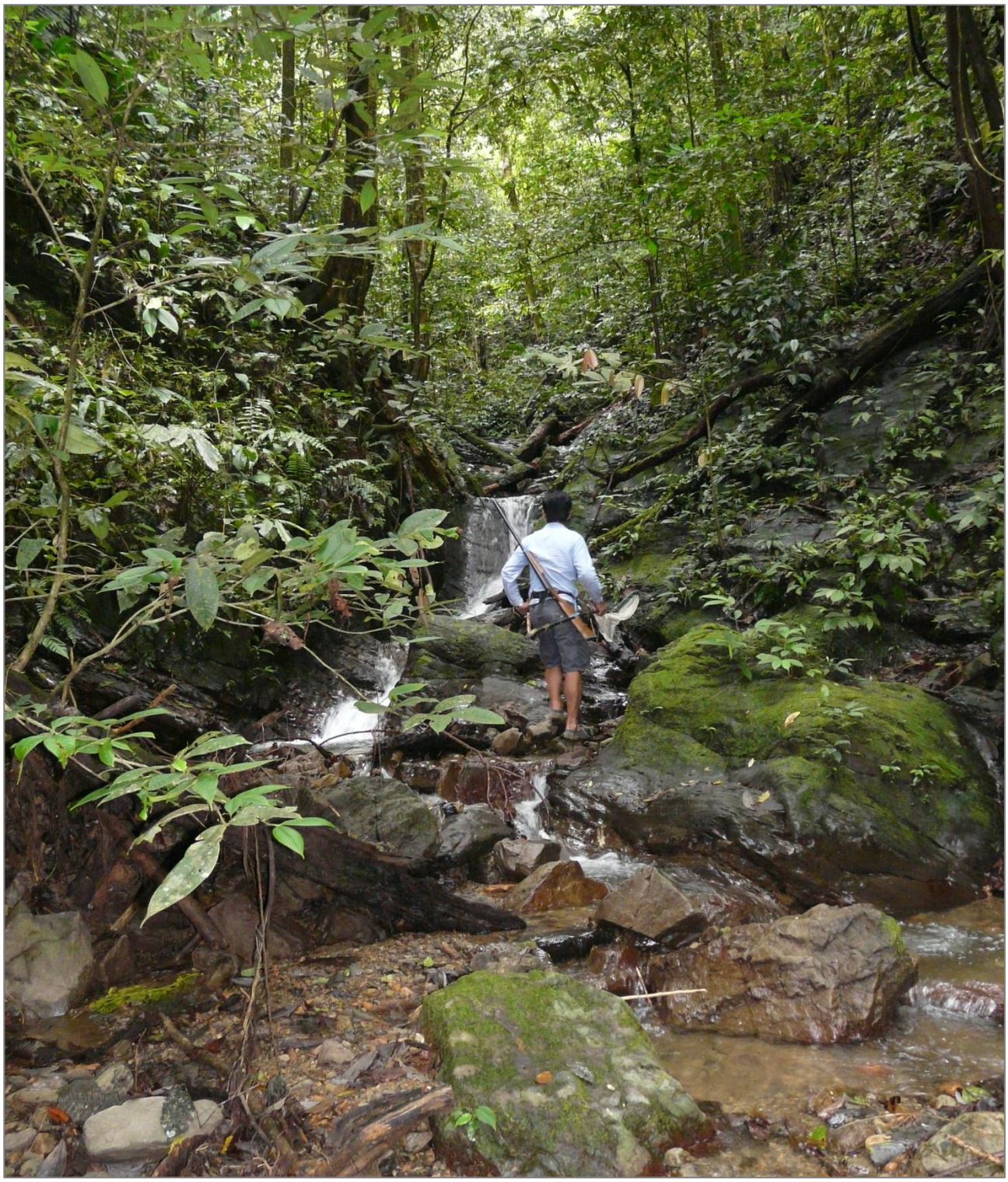

Figure 14. Manau ascending stream at ca 920m, sampled June 13. Photograph by Robin Ngiam.

June 14. Travel to Tapak Mageh area, with very brief stops, including brief field work (O1) and a stop at a large timber camp, Camp Rose. Reached the timber camp in the Tapak Mageh area, Camp Wood, in early afternoon. Located the camp manager and the towkay who ran the camp shop (Fig. 15), a very important man in this camp, got their permission to work in the area and some information. Headed off on a road at their direction that took us to the Sungai Kahei area. Had to stop and make camp at the first suitable site because it was getting late. Twice encountered groups of Penan (until recently nomadic hunter gatherers, now mostly settled but still retaining many of their old habits), one of the groups appeared not to have ever seen a westerner before. It later turned out that these Penan were from Long Nai, the only Long House in the Tapak Mageh / Sungai Kahei area.

Figure 15. The shop at Camp Wood. Photograph by Robin Ngiam.

June 15. MB, RD, LN, SN and RN carried on along the road where our camp was, which slowly converged with a tributary of Sungai Kahei, a large, very turbid and violent stream. After some distance we realised that, apart from the damage caused by the road itself, we were in virgin forest (Fig. 16). At about this point we gave a lift to some guys who were walking along the road. It turned out that they were Garu (Gaharu or Agarwood – a very valuable resinous heartwood that forms in certain trees because of a mould infection) collectors from Indonesia (they had apparently simply walked over

the border) who were using the new road to gain access to the virgin forest before the trees were cut. It turned out that there were many of these guys in the area, living off the land. This added an extra hazard to working in the forest, as they could easily shoot someone by mistake while hunting, and would then simply disappear back over the border, so suffering no consequences. Eventually reached the head of the road, where a small group of guys (plus at least one of their young wives) were staying, and making the road. Found out from them that their job was simply to make the road, then they would go elsewhere. The timber licence for the area where the new section of road was had not been released by the Forest Department yet, so the company would wait until it was (predicted to be around September 2013), then repair the road and start logging. We immediately realised that this represented an invaluable opportunity, but we only had one more day after this to make use of it. We also got some information that there was a higher road (the second tier) into the virgin forest (which later proved to be a misunderstanding). Got ahead of the road works and sampled in the virgin forest, sending LN, SN and the 4WD back to find a closer place to camp. RD worked in one stream system (KV1), MB and RN went further in and found another system (KV2, Fig. 17). Getting out of the good forest later in the day was rendered hazardous by falling trees brought down by the bulldozers making the road. Weather excellent.

Figure 16. New logging road, Sungai Kahei area. Photograph by Robin Ngiam.

Figure 17. Small stream in virgin forest, Sungai Kahei area. Photograph by Robin Ngiam.

June 16. MB, RN went back to the known virgin forest area at head of new road and went further in (KV3, Fig. 18). Half way up a stream, RN was surprised by a Garu collector who sneaked up very quietly from behind. Luckily the person was friendly and there was a short exchange of pleasantries. The episode highlighted the dangers of working in remote forests where Indonesians had entered illegally. RN would not have been able to defend himself if the Garu collector was hostile. On a lighter note, towards the end of the day a beautiful Giant Ground Squirrel crossed a stream about 5m in front of RN, apparently unaware of his presence. RN observed a female *Vestalis beryllae* apparently ovipositing into muddy leaf litter about 5 metres distance from the stream (Fig. 19). This fascinating behaviour was observed for about three minutes. To the best of our knowledge, this is the first account of this ovipositing method for the genus. RD and LS went in search of the second tier, but instead ended up on an old road higher up on the hills, but not near the virgin area. Rather than potentially lose all of the last day in the area searching, decided to cut their losses and sample at streams and other habitats in the highest part of the old road (KD4, KD5); with hind sight this was a good decision as valuable material was collected, and the second tier did not actually exist. Weather excellent.

Figure 18. Stream in virgin forest, Sungai Kahei area. Photograph by Robin Ngiam.

Figure 19. *Vestalis beryllae* oviposition behaviour. Photograph by Robin Ngiam.

June 17. First part of return journey to Kapit town (Fig. 20 shows something seen on the way). Decided to head to MB's house at the foot of the Hose mountains for the night, rather than make camp or have to search for an empty hut along the way. Stopped briefly for fieldwork at a site near Camp Rose (O1). Reached MB's house after dark, last part of journey in torrential rain storm on appalling road.

Figure 20. Hornbills are a common site in Kapit division. This pair was seen on our journey from Sungai Kahei to Manau's house on June 17. Photograph by Robin Ngiam.

June 18. Left MB's house, sampled at a stream on the way back, about one hour out from SN's house (results will be reported elsewhere, as not in the area being covered in this report). Arrived back in Kapit town late afternoon.

Second expedition

August 29. Departed Kapit for second trip to Tapak Mageh area. A great effort by LN enabled us to reach Camp Rose somewhere around 11 pm the same day, where we had to sleep at a shelter in a log pond because the camp gate was shut.

August 30. Moved early, had breakfast in the Camp Rose canteen and a quick conversation with the camp manager there – he told us about another new (eg not logged before) area about 90 km along a road from Camp Rose that we had not tried before, going in the approximate direction of Bukit Tiban (a high mountain on the border), very useful information. Then went on to Camp Wood and had a conversation with our friend the canteen towkay. This revealed a serious problem – to get to the unlogged area we had visited before we had to use a road that had a gate at the start of the Sungai Kahei area, before this the gate had been open, but this time we had arrived just before the public holiday for Malaysia's independence day, most operations in the Sungai Kahei area had already stopped for the holiday, and the gate keepers had already gone on leave, leaving the gates locked in all areas where no operations were on-going during the holiday period, and apparently taking the keys with them! Since it seemed there was no prospect of getting into the Sungai Kahei area before September 9 when the gate keepers were due back, we had to try an alternative. We attemptted to drive down the road to the border, which apparently ran a rather indirect route (Camp Wood is only about 4 km from the border in a straight line), reaching a border checkpoint after approximately 24 km. Small areas of uncut forest appeared to be present along the border in satellite images and our plan was to set up a camp close to one of these areas. However we soon hit a problem, which revealed a more serious problem. A few km down the road we came to a section so bad we could not get our 4WD through, although a local vehicle was making the journey very regularly. At first RD thought that this was because of the huge load of provisions etc. that we had on the back of our vehicle, but discussion with LN revealed the true problem – we did not have the correct type of off-road tyres for the really bad sections! In fact this had also been the case during our first trip, but conditions had been better then; LN had been too polite to ask for the extra money to pay for the right type of tyres; this problem returned to haunt us later on. We decided that it was futile to try going further along this route, and that RD would sample a low gradient, rather open stream (W2) we had just passed while the rest checked some of the logging roads nearby to see if they led to suitable areas for sampling. After that we would head back to Camp Wood and see if there was somewhere there that we could stay. A promising looking area was located on a road running at about 800m on a steep mountain side between Camp Wood and the border. On returning to Camp Wood the towkay told us that there was a building they sometimes used for visitors, next to the camp managers house, that was empty at the time, but we would have to wait for the manager to return from one of the blocks where felling was still going on to get permission to use it. After about one hours wait the manager returned and gave us permission. That night we decided to

use Camp Wood as our base for a few days and explore the area between the camp and the border from there. A bright, sunny day.

September 1. After an early stop at the stream where RD had sampled the day before, in case of early flying *Macromia* (unfortunately there were none), RD and MB went to the steep area located the day before (W3), LS tried some other streams (W5) a bit lower down in the same area and LN tried some of the other roads in the area. RD worked a stream that fell in a small waterfall just above the road while MB went further on. RDs stream was very difficult at first, with many sections where climbing was necessary. Finally, after a long detour away from the stream and a difficult climb, RD discovered a small trail with a water pipe running close by (not leading from his stream). Following the path back, it crossed RDs stream, and also, sections of the forest above the path were clearly virgin. Following the stream up led into virgin forest, but it was not possible to go far before progress was blocked by a waterfall. A route around, using a ridge line, was available, but it was getting late and the sun was only shining occasionally, and RD felt that this was better attempted with MB's assistance, so he decided to explore the path. Carrying on, the path descended a bit, ran through mostly more disturbed forest, crossing one small stream, and then the dry head of another almost at the top of a broad ridge. At this point RD found the head of another small stream on the other face of the ridge, and a short way down this stream a female *Chlorogomphus* was caught while apparently ovipositing in a seepage. Close by here, while RD waited for the sun at the absolute head of the same seepage, a loud knocking was heard coming from inside a tree trunk a few metres away. After several repetitions of this odd event, and a total lack of sunshine, a mystified and slightly nervous RD found his way back to the path. Not knowing exactly where the path was going, he decided to retrace his steps, and climb back down the way he had come. Once on the road, the water pipe was located and the trail started at the point where the pipe diverged from the road, but was very far from obvious here. MB had found even steeper and more difficult streams than RD, and had not come across the pipe path. Only occasional sunshine after 11 AM. Discussion with MB and LS yielded the suggestion that the knocking that RD had heard coming from inside the tree trunk was a Porcupine that had burrowed in and become trapped; however neither MB nor LS seemed fully convinced by their explanation.

September 2. MB and RD used the water pipe path (the pipe seemed to run to Camp Wood) to access the virgin forest area (W4), LN and LS explored more of the road system in the area. On the pipe path, the first order of business was to see where the source of the pipe was – this was located a couple of hundred metres past the point where RD had first found the path, at a small stream in extremely steep terrain; it was too hazardous to work here. Returning to RD's first stream of the day before, a way up the ridge was found. Moving well into the virgin forest area, the stream was relocated and RD worked this while MB crossed the next ridge in search of another stream.

Working upstream, RD was forced back up onto the ridge by a large tree fall, and followed the ridge until it joined another, almost level ridge which brought him to a point where he could enter the absolute head of the stream. It was also apparent that there was another stream system on the other side of the top ridge (in fact this was part of the sources of the stream feeding the water pipe). On their way back to the road RD and MB checked the *Chlorogomphus* seepage area again; RD found that the knocking from inside the tree trunk could be provoked by tapping on it. MB seemed extremely reluctant to come into this area, and never came to the part where this tree was. Only occasional sunshine after 11 AM. That night, after discussing what LN and LS had found, it was decided that the virgin forest area was the best available option near Camp Wood and that we would explore that area further the next day, then move on to the area that the manager at Camp Rose had told us about the following day.

September 3. Headed back into the virgin forest area, and by following the top ridge found another boundary to the area, formed by a logging track. RD headed back into the stream that had been spotted the day before, LS and MB followed the logging track with the aim of cutting back down into the virgin forest further along. The top part of RD's stream was dry but, with some difficulty, he was able to get to the part where there was water and follow it down until it joined a larger stream. Going downstream from here revealed a series of waterfalls in increasingly steep terrain and it soon became clear that this was the upper part of the stream feeding the water pipe. Going upstream RD finally encountered LS and MB coming downstream in the same system. MB had come almost face-to-face with a large King Cobra. Weather mostly sunny.

September 4. Set off early, stopping briefly at Camp Rose for a check on our information, then took the turning to the new area. Followed the long windy road for approximately 90 km, spotting one large but surprisingly clear running stream (a possible indication that there are unlogged areas further upstream) along the way, a possible site for future investigation. Eventually got to the new area around 2 pm; the timber camp here was just a small collection of logging huts crammed together on a small ridge, with no nearby water source. There was a junction here, both roads leading into new areas. Following one of the roads we came to a section that needed repairing before we got to virgin forest (this point is indicated as "End road new area" in Fig. 2, however the caption is not really accurate, as it was not the end of the road), while attempting to follow the other a heavy down pour started and we started sliding all over the place and had to stop. Our tires were completely useless on the roads in this section when they were wet, and we had extreme difficulty in getting the vehicle back to a point where we could drive relatively safely. Had to conclude that we would not be able to work in this area with the current tires and returned to Camp Wood. At camp wood the towkay gave us good and bad news; the bad news was that we could only use the accommodation there for a couple more days, after that it was needed for

a contingent of police coming to the area (presumably for a border patrol). The good news was that a key to the gate leading into the Sungai Kahei area had been located and would be available on the 6th, although if we choose to use it, the gate would have to be locked behind us and would not be opened again until the 9th, meaning that we would not be able to use the 4WD to get anyone to medical treatment in case of injury.

September 5. Since we could not go to Sungai Kahei until the following day, decided to check another area that RD had spotted on the satellite maps. This area was reached by another junction near Camp Rose, and looked as though it might be unlogged in places, but the image quality was not good enough to be sure. It turned out that in fact at least the area accessible by our road had been logged once a long time ago and was now being opened up for a second round. However the road did not penetrate far into the area that had looked interesting on the satellite images. Drove a long way along the road, locating potential places to camp and work, but access into the higher parts was blocked by a broken bridge; apparently the area on the other side was under a different timber company, one with a reputation of extreme hostility to researchers and outsiders generally. Attempted sampling in a recently re-logged section (O2) near the end of the usable road in the late afternoon, with very little result. RD came across the most spectacular Strangler Fig he had ever seen in this area, not especially tall but almost unbelievably massive at the base, and in the stage where the original host tree had died and completely rotted away but the Strangler Fig had not yet filled in the gap. From his GPS RD could see that at this point we were not far from, but on the opposite side of the Sungai Kahei, the virgin area discovered back in June. Since the forest in this area was not virgin, decided to proceed to the virgin forest in the Sungai Kahei area on the 6th as planned. Brief spells of sunshine, some rain, but mostly just overcast.

September 6. Left Camp Wood early, with another vehicle with us, containing the key to the Sungai Kahei gate. Got through the gate, which was locked behind us, and proceeded towards our June campsite. We found the logging hut we had used in June, still empty and still usable. Followed the road into the virgin area. A problem for the timber company in making the road and then leaving it unused for a few months soon became apparent; its condition had deteriorated and numerous small landslides had occurred. The company was in the process of beginning operations in the virgin area, but had only got so far and still had a lot to do in repairing the road. The reason they were so keen to keep the gate locked when none of their staff were there was that there was a fortune in heavy machinery parked beside the road. Around the area of the stream sampled by RD on June 15 the road became impassable by 4WD because of land slides. RD and MB continued on foot, the others went back to the logging hut to unload and set up camp. RD found a stream system (KV4) before that he had sampled in June, MB went further on and checked another system (KV5). RD's stream system very promising, but no sun before 1 pm.

September 7. RD and MB went back to the virgin area, after dropping them off LS and LN went in search of the second tier. RD returned to the same stream system as on the 6th, MB explored further on (KV6). No sun before 1 pm again, but over the two days RD got a decent sample at his stream system. LN and LS found that the road that we had thought would lead to the second tier diverged from our area before becoming unusable, with no sign of virgin forest or a new road; it seemed that the second tier was a myth. LS sampled in some streams he found on the way (KD6, KD7), with decent results. Heavy rain in the night.

September 8. RD, MB and LS went further down the road into the virgin area. Just after the furthest point reached by MB on the previous day found the road completely blocked by a fresh land slip. The mud had the consistency of wet concrete and the hill side on either side of the slip still looked unstable. Took a lengthy detour below the road to get past the land slide. By the time we returned in the afternoon the land slide had hardened and we were able to climb over it. Found two more stream systems, at the first (KV8) several streams converged at the point the road crossed them, the road had made a dam so that a large forest edge pond (KD8) had formed. At the second system (KV7) there were also several streams, but they converged below the road. RD worked the second system, LS and MB went further but soon found the end of the road and went back to the first system. Sun after 12.

September 9. RD, MB and LS returned to the same stream systems for more extensive exploration as on the previous day. On our return to the pick-up point for the 4WD found that the timber workers had returned and had already cleared some of the obstacles on the road. Intermittent sunshine.

September 10. We had noticed a junction, not present in June, on the road, just before the virgin area, that appeared to lead into virgin forest higher up. On the 10th RD, MB and LS explored this area. The road was not very long, and was unusable for our 4WD after the halfway point, but did indeed reach into the virgin area before abruptly ending at a stream (KV9); the road was not long enough to be the fabled second tier. Proceeding up the road end stream we soon hit a waterfall that could only be passed by a very steep climb up the side that was at the very limit of RDs abilities. Rather than follow MB and LS on a similar climb to get back down to the stream above the waterfall, RD headed up onto a ridge above in the hope of finding an easier route down into the stream further up. This was eventually accomplished. Later on LS slipped in the upper part of the stream, bashing his hip. At the time he seemed ok, but that night the deep bruising from the fall caused him considerable pain, and everyone else considerable alarm. Late in the afternoon the whole party returned to the ridge and used it to trek to the top of the hill, finding some small (and largely unproductive) forest pools on the way. The habitat explored on this day looked extremely promising, and the weather was the best of any day during the trip, but relatively few odonate species were found.

September 11. Last full day in the Sungai Kahei area. In order to achieve some variety in the type of habitat surveyed and because everyone was exhausted from so much work in steep terrain, RD, MB and LS went to a larger, low gradient but rocky stream (KD9) on the way back to the gate, in logged forest. RD went upstream, mostly staying on the main stream, but also exploring a swampy pond area (KD10) at the side, LS and MB went downstream and explored tributaries. Weather mostly cloudy, some rain.

September 12. Start of journey back to Kapit. Whilst driving around a tight bend on a narrow part of the road almost collided head on with a 4WD from Camp Wood; saved from collision or swerving off the cliff to one side by LNs cool head and skill. Decided to overnight at Manau's house again. Took a lengthy detour to explore a road running close to the eastern end of the House Mountains.

September 13. Returned to Kapit, fieldwork on the way ruled out by weather conditions.

Odonata collected

Classification used here follows Dijkstra *et al.* (2013) for Anisoptera and Dijkstra *et al.* (2013) for Zygoptera, including the treatment of some genera formerly placed in Megapodagrionidae and Corduliidae as *incertae sedis*. Pairs collected in tandem are indicated by ♂+♀.

Zygoptera

Lestidae

1. *Orolestes wallacei* (Kirby, 1889)
This has generally been regarded as a lowland, low gradient species, but we have found it in mountainous terrain at altitudes from 700-900m in both Kapit and Miri divisions now. Its habitat in this terrain is typically marshy areas and small ponds beside old logging tracks in disturbed forest. KD5 – 2 ♂♂, 16.vi.2013, RD.

Platystictidae

2. *Drepanosticta actaeon* Laidlaw, 1934
This species was moderately common in both the Mantan Camp and Tapak Mageh areas. M6 – ♂, ♀, 11.vi.2013, RD; ♂, ♀, 11.vi.2013, LS. M9 – ♂, 13.vi.2013, MB; ♂, ♂+♀, 13.vi.2013, RN. W4 – ♂, 2.ix.2013, RD. KD4 – ♂, 16.vi.2013, RD. KD7 – ♀, 7.ix.2013, LS. KV7 – ♂, 8.ix.2013, RD; 4 ♂♂, ♀, 9.ix.2013, RD. KV8 – ♂, 9.ix.2013, MB.

3. *Drepanosticta attala* Lieftinck, 1934
One female was caught at the side of the largest stream surveyed, broad and low gradient but rocky and fast flowing, with an open canopy. KD9 – ♀, 11.ix.2013, RD.

4. *Drepanosticta* species cf *crenitis* Lieftinck, 1933
For both this and the next species, as-yet unpublished molecular data suggests that they may in fact be complexes consisting of many distinct species, probably each with a small range. However there is little morphological difference between these possibly distinct species.
M4 – ♂, ♀, 10.vi.2013, RD. M8 – ♀, 12.vi.2013, MB; 2 ♀♀, 12.vi.2013, RD. W3 – ♂, 2 ♀♀, 1.ix.2013, RD. W4 – ♂ (teneral), 2.ix.2013, MB; ♂, 2.ix.2013, RD. KV1 – 2 ♀♀, 15.vi.2013, RD. KV4 – 2 ♀♀, 7.ix.2013, RD. KV7 – ♂, 9.ix.2013, RD.

5. *Drepanosticta* species cf *dentifera* Kimmins, 1936
KV7 – ♂, 9.ix.2013, RD. KV8 – ♂, 8.ix.2013, MB.

6. *Drepanosticta dulitensis* Kimmins, 1936
Moderately common in the Mantan Camp area and very common in the Sungai Kahei area. M4 – 6 ♂♂, 10.vi.2013, RD. M8 – ♂, 12.vi.2013, RD. W3 – 5 ♂♂, 1.ix.2013, RD. KV1 – 2 ♂♂, 15.vi.2013, RD. KV2 – ♂, 15.vi.2015, RN. KV3 – ♂, 16.vi.2013, MB. KV4 – ♂, 6.ix.2013, RD. KV6 – 3 ♂♂, 7.ix.2013, MB. KV7 – 2 ♂♂, 8.ix.2013, RD. KV9 – ♂, 10.ix.2013, MB.

7. *Drepanosticta rufostigma* (Selys, 1886)
M4 – 2 ♂♂, 10.vi.2013, RD. M5 – ♂, 10.vi.2013, RN. M8 – 2 ♂♂, 12.vi.2013, RD. M10 – 2 ♂♂, 13.vi.2013, RD. W3 – ♂, 1.ix.2013, RD. W4 – ♂, 3.ix.2013, RD. KD4 – ♂, 16.vi.2013, RD. KD9 – ♂ (teneral), 11.ix.2013, MB; 2 ♂♂, 11.ix.2013, LS. KV1 – 2♂♂, 13.vi.2013, RD. KV2 – 2 ♂♂, 15.vi.2013, MB; 4 ♂♂, 15.vi.2013, RN. KV3 – ♂, 16.vi.2013, MB; ♂, ♀, 16.vi.2013, RN. KV4 – 2 ♂♂, 6.ix.2013, RD; 3 ♂♂, ♀, 7.ix.2013, RD. KV5 – 2 ♂♂, 6.ix.2013, MB. KV6 – ♂, 7.ix.2013, MB. KV7 – 3 ♂♂, 8.ix.2013, RD. KV8 – 2 ♂♂, 8.ix.2013, MB; 2 ♂♂, 9.ix.2013, LS.

8. *Drepanosticta versicolor* (Laidlaw, 1913)
KD6 – ♂, 7.ix.2013, LS. KD7 – 3 ♂♂, 7.ix.2013, LS. KD9 – ♂, 11.ix.2013, RD. KV1 – ♂, 15.vi.2013, RD. KV4 – ♂, ♀, 7.ix.2013, RD. KV5 – ♀, 6.ix.2013, MB. KV7 – 3 ♂♂, 9.ix.2013, RD. KV8 – ♀, 9.ix.2013, MB; 3 ♂♂, 9.ix.2013, LS.

9. *Protosticta* species
This unnamed species is allied to *P. kinabaluensis* Laidlaw, and is also known from Mount Kinabalu, as well as the Crocker Range in Sabah, and the Tama Abu Range and Gunung Kalulong in Sarawak's Miri Division. This is the first confirmed record from Kapit division, although teneral females that might be this species have been found at other locations in the division. M9 – ♀ (teneral), 13.vi.13, RN. W3 – ♂, ♀, 1.ix.2013, RD. W4 – ♂, ♀ (teneral), 2.ix.2013, RD.

10. *Telosticta longigaster* Dow & Orr, 2012
Two of the females collected have the posterior pronotal lobe with corners produced into short rearwards directed horns rather than the typical hanging lobes,

see Dow & Orr (2012) for a discussion of this variation. Fig. 21 shows a female. M4 – 2 ♂♂, 10.vi.2013, RD. M6 – ♂, 11.vi.2013, RD; 2 ♀♀, 11.vi.2013, LS. M8 – 3 ♂♂, 12.vi.2013, MB; 6 ♂♂, 12.vi.2013, RD. M10 – ♀, 13.vi.2013, RD. W3 – ♂, 1.ix.2013, RD. W4 – 2 ♂♂, ♀, 2.ix.2013, MB; 5 ♂♂, 2.ix.2013, RD; ♂, 3.ix.2013, MB; 2 ♂♂, 3.ix.2013, RD. KD4 – 4 ♂♂, 16.vi.2013, RD; ♂, 16.vi.2013, LS. KD9 – ?♀, 11.ix.2013, LS. KV1 – 3 ♂♂, ♀, 15.vi.2013, RD. KV2 – ♀ (teneral), 15.vi.2013, MB; ♂, ♂+♀, 15.vi.2013, RN. KV4 – 6 ♂♂, 7.ix.2013, RD. KV6 – ♂, 7.ix.2013, MB. KV7 – 4 ♂♂, ♀, 9.ix.2013, RD. KV8 – 2 ♂♂, 8.ix.2013, MB; 2 ♂♂, ♀, 9.ix.2013, MB; ♂, 9.ix.2013, LS. O1 – ♂, 17.vi.2013, RD; ♂, 17.vi.2013, LS.

Figure 21. *Telosticta longigaster* female. Photographs by Robin Ngiam.

11. *Telosticta* species
One female collected at a small stream at ca 790m in disturbed forest differs from *T. longigaster* in the shape and colour (red) of its pterostigma and in having atypically long cerci; it almost certainly represents a different, undescribed, species. M10 – ♀, 13.vi.2013, RD.

Calopterygidae

12. *Neurobasis longipes* Hagen, 1887
W2 – ♂, 30.viii.2013, RD; ♂, 1.ix.2013, MB. KD9 – ♂, 11.ix.2013, MB.

13. *Vestalis amnicola* Lieftinck, 1965
M2 – ♂, 9.vi.2013, RD; 4 ♂♂, 9.vi.2013, RN. M3 – 6 ♂♂, 9.vi.2013, LS. M4 – 3 ♂♂, 10.vi.2913, RD. M5 – 9 ♂♂, 10.vi.2013, MB; 3 ♂♂, 10.vi.2013, RN. M7 – 4 ♂♂, 12.vi.2013, MB; ♂, 12.vi.2013, RD; 2 ♂♂, 12.vi.2013, RN. W2 – 2 ♂♂, 30.viii.2013, RD. W3 – ♂, 1.ix.2013, MB. W5 – 3 ♂♂, ♀, 1.ix.2013, LS. KD2 – ♂, 15.vi.2013, LS. KD3 – ♂, 16.vi.2013, SN; 3 ♂♂, 16.vi.2013, LS. KD7 – 2 ♂♂, 7.ix.2013, LS. KD9 – 6 ♂♂, 11.ix.2013, MB; ♂, 11.ix.2013, LS. KV2 – ♂, 15.vi.2013, MB. KV3 – ♂, 16.vi.2013, RN. O1 – ♂, 17.vi.2013, RN.

14. *Vestalis atropha* Lieftinck, 1965
KD9 – ♂, 11.ix.2013, LS. KV1 – ♂, 15.vi.2013, RD.

15. *Vestalis beryllae* Laidlaw, 1915
Quite common in the steep terrain of the Ulu Baleh and Ulu Balui. Figs. 19 and 22. M5 – ♂+♀, 10.vi.2013, MB. W4 – ♂, 2.ix.2013, RD; ♂, 3.ix.2013, RD; ♂, 3.ix.2013, LS. KD4 – ♂, 16.vi.2013, LS. KV1 – 3 ♂♂, 15.vi.2013, RD. KV2 – 2 ♂♂, 15.vi.2013, MB. KV4 – 2 ♂♂, 7.ix.2013, RD. KV6 – 2 ♂♂, ♀, 7.ix.2013, MB. KV8 – ♂, 9.ix.2013, MB; ♂, 9.ix.2013, LS. KV9 – ♂, 10.ix.2013, MB; ♂, ♀, 10.ix.2013, RD; ♂, 10.ix.2013, LS.

Figure 22. *Vestalis beryllae* male. Photograph by Robin Ngiam.

Chlorocyphidae

16. *Heliocypha biseriata* (Selys, 1859)
KD9 – ♂, 11.ix.2013, RD.

17. *Rhinocypha aurofulgens* Laidlaw, 1931
M8 – 2 ♂♂, 12.vi.2013, MB; 3 ♂♂, ♀, 12.vi.2013, RD. W2 – 4 ♂, 30.viii.2013, RD; ♀, 1.ix.2013, MB; 2 ♂♂, ♀, 1.ix.2013, LS. KD3 – ♂, 9.ix.2013, RD. KD9 – ♂, 2 ♀♀, 11.ix.2013, MB; 3 ♂♂, ♀, 11.ix.2013, RD.

18. *Rhinocypha* cf *spinifer* Laidlaw, 1931
Problematic female *Rhinocypha*, closely allied to *R. spinifer* but possibly not that species. M9 – ♀, 13.vi.2013, MB. W3 – ♀, 1.ix.2013, RD. W4 – ♀, 3.ix.2013, RD. KV7 – ♀, 9.ix.2013, RD.

Devadattidae

As yet un-described species of *Devadatta* are referred to as species A, B and C. A combined morphological and molecular analysis of the Bornean Devadattidae will be published in the near future (Dow, Hämäläinen & Stokvis in preparation). Specimens will be listed in that publication, only the locations where each species were found are listed here.

19. *Devadatta* species A
W3, KD9, KV1, KV4, KV5, KV9.

20. *Devadatta* species B
M2, M4, M5, M7, M8, W3, W4, KD4, KD6, KD7, KV2, KV3, KV4, KV5, KV6, KV7, KV8, KV 9.

21. *Devadatta* species C
M6, M9.

Euphaeidae

22. *Euphaea subcostalis* Selys, 1873
W2 – ♂, 30.viii.2013, RD. W5 – ♂, 1.ix.2013, LS. KD3 – ♂, 16.vi.2013, LS. KD6 – ♂, 7.ix.2013, LS. KD9 – 2 ♀♀, 11.ix.2013, MB; ♂, 11.ix.2013, LS. KV1 – 2 ♂♂, 15.vi.2013, RD. KV2 – ♂, 15.vi.2013, MB; ♂, 15.vi.2013, RN. KV3 – 2 ♂♂, 16.vi.2013, MB; 3 ♂♂, 16.vi.2013, RN. KV6 – ♂, 7.ix.2013, MB. KV7 – 2 ♂♂, 8.ix.2013, RD; ♂, 8.ix.2013, RD. KV8 – ♂, 9.ix.2013, MB.

23. *Euphaea subnodalis* (Laidlaw, 1915)
W5 – ♂, 1.ix.2013, LS. KD9 – ♂, 11.ix.2013, RD.

24. *Euphaea tricolor* Selys, 1859
KD9 – 2 ♂♂, 11.ix.2013, RD; ♂, 11.ix.2013, LS.

Platycnemididae

25. *Coeliccia* species cf *borneensis* (Selys, 1866)
As already noted in Dow & Reels (2011), the distinction between a typical form and a 'western' form of *C. borneensis* no longer seems tenable, although all of the specimens listed here would fall within the 'western form' as defined by Dow (2010). The true situation with *C. borneensis* is unclear at present, unpublished molecular results show several distinct clades, but these do not correlate well with morphological features etc. Very common in the area surveyed. M1 – ♂ (teneral), 11.vi.2013, RD. M4 – 4 ♂♂, 10.vi.2013, RD. M6 – 2 ♂♂, 11.vi.2013, RD; 2 ♂♂, 11.vi.2013, LS. M7 – ♂, 11.vi.2013, RN; ♂, 11.vi.2013, SN. M9 – ♂, 13.vi.2013, MB; 2 ♂♂, 13.vi.2013, RN. M10 – ♂, 13.vi.2013, RD. W3 – ♂, 1.ix.2013, MB; ♂, 1.ix.2013, RD. W4 – 4 ♂♂, ♀, 2.ix.2013, MB; 3 ♂♂, 2.ix.2013, RD; ♀, 3.ix.2013, LS. W5 – ♂, 1.ix.2013, LS. KD4 – 2 ♂♂, 16.vi.2013, RD; 2 ♂♂, ♀, 16.vi.2013, LS. KV1 – 3 ♂♂, ♀, 15.vi.2013, RD. KV2 – ♀, 15.vi.2013, RN. KV3 – 3 ♂♂, 16.vi.2013, RN. KV4 – ♂, 2 ♀♀, 7.ix.2013, RD. KV5 – 4 ♂♂, 2 ♀♀, 6.ix.2013, MB. KV6 – ♂, 7.ix.2013, MB. KV7 – ♂, ♀, 8.ix.2013, RD; 6 ♂♂, 9.ix.2013, RD. KV8 – 4 ♂♂, ♀, 9.ix.2013, MB; ♂, 9.ix.2013, LS. KV9 – 6 ♂♂, 10.ix.2013, MB; 6 ♂♂, ♀, 10.ix.2013, RD; 2 ♂♂, 10.ix.2013, LS. O1 – ♀, 17.vi.2013, RN.

26. *Coeliccia campioni* Laidlaw, 1918
Much more local than the last species, and only found in the Tapak Mageh section of the area surveyed. It could be distinguished from the other two *borneensis*-group species found in the area by the colour of the structures between the wing bases (see Dow 2010): yellow in *C. campioni* but with at least some blue in the others. KD7 – 3 ♂♂, 7.ix.2013, LS. KV1 – ♂, 15.vi.2013, RD. KV4 – 2 ♂♂, 7.ix.2013, RD. KV5 – 5 ♂♂, 6.ix.2013, MB.

27. *Coeliccia* new species *borneensis*-group
This species is almost indistinguishable from *C.* species cf *borneensis* in the field, except that the blue between the wing bases is reduced compared to that species, but it differs clearly in the structure of the cerci. W4 – ♂, 2.ix.2013, RD. KD6 – ♂, 7.ix.2013, LS. KV4 – ♂, 6.ix.2013, RD.

28. *Coeliccia cyaneothorax* Kimmins, 1936
M4 – 3 ♂♂, 10.vi.2013, RD. M5 – ♂, 10.vi.2013, MB' ♂, 10.vi.2013, RD. M8 – ♂, 12.vi.2013, RD. M10 – ♂, 13.vi.2013, RD. KV3 – ♂, 16.vi.2013, MB. KV6 – 3 ♂♂, 7.ix.2013, MB. KV9 – ♂, 10.ix.2013, MB.

29. *Coeliccia* species cf *nemoricola* Laidlaw, 1912
M6 – 2 ♂♂, 11.vi.2013, RD; ♂, 11.vi.2013, LS. W3 – ♂, 1.ix.2013, RD. W4 – ♂, 2.ix.2013, RD; ♂, 3.ix.2013, MB; 3 ♂♂, 3.ix.2013, RD. KD9 – ♀, 11.ix.2013, MB. KV4 – ♂, 6.ix.2013, RD; 4 ♂♂, ♀, 7.ix.2013, RD. KV6 – ♂+♀, 7.ix.2013 MB. KV9 – ♂, 10.ix.2013, RD. O1 – ♂, 17.vi.2013, RD; ♂, 17.vi.2013, LS.

30. *Coeliccia nigrohamata* Laidlaw, 1918 Fig. 23
M6 – ♂, 10.vi.2013, MB; 2 ♂♂, 10.vi.2013, RN. M6 – ♂, 11.vi.2013, RD; ♂, 11.vi.2013, LS. W2 – ♀, 30.viii.2013, RD. W3 – ♂, 1.ix.2013, RD; W4 – 6 ♂♂, 2.ix.2013, MB; 2 ♂♂, 6.ix.2013, RD. KD4 – ♂, 16.vi.2013, RD. KD7 – 5 ♂♂, 7.ix.2013, LS. KD9 – 7 ♂♂ ♀, 11.ix.2013, MB; ♂, 11.ix.2013, RD; ♂, 11.ix.2013, LS. KV1 – 2 ♂♂, 15.vi.2013, RD.KV3 – ♂, 16.vi.2013, MB' ♂, 16.vi.2013, RN. KV4 – 4 ♂♂, 6.ix.2013, RD; ♂, 7.ix.2013, RD. KV5 – ♂, 6.vi.2013, MB. KV6 – 8 ♂♂, 7.ix.2013, MB. KV7 – 2 ♂♂, 8.ix.2013, RD; 5 ♂♂, ♂+♀, 9.ix.2013, RD. KV8 – 2 ♂♂, ♀, ♂+♀, 9.ix.2013, LS. KV9 – 2 ♂♂, 10.ix.2013, RD. O1 – ♂, 17.vi.2013, RN.

Figure 23. *Coeliccia nigrohamata* male. Photograph by Robin Ngiam.

31. *Copera vittata* (Selys, 1863)
W2 – ♂, 30.viii.2013, RD. KD1 – ♂, 16.vi.2013, LS. KD10 – ♂, 11.ix.2013, RD.

32. *Prodasineura hyperythra* (Selys, 1886)
Notably this was the only member of the Disparoneurinae found in the area surveyed, although habitat apparently suitable for other species of the subfamily was found. KD9 – ♂, 11.ix.2013, MB.

Coenagrionidae

33. *Agriocnemis femina* (Brauer, 1868)
KD10 – ♂, 11.ix.2013, RD.

34. *Argiocnemis* species
W1 – ♂, 2.ix.2013, RD. KD10 – 2 ♂♂, ♂+♀, 11.ix.2013, RD.

35. *Ceriagrion bellona* Laidlaw, 1915
W1 – ♂, ♀, 1.ix.2013, MB. KD5 – ♂+♀, 16.vi.2013, RD; ♂, ♀, 16.vi.2013, LS. O1 – ♂+♀, 14.vi.2013, RD; ♂, ♂+♀, 17.vi.2013, RN.

36. *Pericnemis dowi* Orr & Hämäläinen, 2013
One female apparently ovipositing into a buttress root hole beside a stream (KV1) in virgin forest in the Sungai Kahei area. In describing this species, Orr & Hämäläinen (2013: 339) noted that "a number of bred specimens and wild caught females are in the collections of Naturalis Biodiversity Centre, Leiden but cannot at present be located". These specimens were located in early 2014 and consist of 2 males and 3 females collected at the Kuala Belalong Field Studies Centre in Brunei in August 1992 (one male) and September 1993 (the rest), of these the male from 1992 and one of the females were caught as adults, the rest are indicated as bred from larvae on the labels. KV1 – ♀, 15.vi.2013, RD.

37. *Pericnemis* ?*kiautarum* Orr & Hämäläinen, 2013
One female taken on or near the top of a ridge in virgin forest near KV6 in the Sungai Kahei area and agreeing with the description of male *P. kiautarum* in prothorax structure, wing venation and colouration. A male *P. kiautarum* from the Kuala Belalong Field Studies Centre in Brunei was found amongst the previously missing material of *P. dowi* listed under that species above. KV10 – ♀, 17.ix.2013, MB.

38. *Stenagrion dubium* (Laidlaw, 1912) Fig. 24.
M2 – 3 ♂♂, 9.vi.2013, RN. M3 – 5 ♂♂, ♀, 9.vi.2013, LS. M4 – 4 ♂♂, 10.vi.2013, RD. M5 – ♂, 10.vi.2013, MB; ♂, 10.vi.2013, RN. M6 – 2 ♂♂, 11.vi.2013, RD; 7 ♂♂, ♀,

Figure 24. *Stenagrion dubium* male. Photograph by Robin Ngiam.

11.vi.2013, LS. M7 – ♂, 11.vi.2013, RN. M8 – ♂, ♂+♀, 12.vi.2013, MB; 2 ♂♂, 12.vi.2013, RD. M9 – 3 ♂♂, 13.vi.2013, MB; ♂, 13.vi.2013, RN. W2 – ♀, 30.viii.2013, RD. W3 – 6 ♂♂, 1.ix.2013, MB; 3 ♂♂, 1.ix.2013, RD. W4 – 3 ♂♂, 2.ix.2013, MB; ♂, 2.ix.2013, RD; 2 ♂♂, 3.ix.2013, RD; ♂+♀, 3.ix.2013, LLS. KD4 – ♂, 16.vi.2013, LS. KD7 – ♂, 7.ix.2013, LS. KD9 – ♂, 11.ix.2013, RD; ♂, 11.ix.2013, LS. KV1 – ♂, 15.vi.2013, RD. KV2 – ♂, 15.vi.2013, MB; 4 ♂♂, 15.vi.2013, RN. KV3 – ♂, 16.vi.2013, MB; 2 ♂♂, ♀, 6.vi.2013, RN. KV4 – 3 ♂♂, 6.ix.2013, RD; 2 ♂♂, 6.ix.2013, RD. KV7 – 2 ♂♂, 8.ix.2013, RD; 3 ♂♂, 9.ix.2013, RD. KV8 – ♂, ♀, 8.ix.2013, MB; ♂+♀, 8.ix.2013, LS; 9 ♂♂, 9.ix.2013, MB; 3 ♂♂, 9.ix.2013, LS. KV9 – 4 ♂♂, 10.ix.2013, MB; 2 ♂♂, 10.ix.2013, RD. O1 – ♂, 17.vi.2013, RD.

39. *Xiphiagrion cyanomelas* (Selys, 1876)
M1 – ♂, 13.vi.2013, RD. KD1 – 2 ♂♂, 16.vi.2013, RD. O2 – ♂, 4.ix.2013, RD.

Anisoptera

Aeshnidae

40. *Anax panybeus* Hagen, 1867
This species seems common in logging areas in the interior of Sarawak. A male was caught in a timber camp in the Ulu Baleh, and large *Anax* that are likely to be this species were seen apparently foraging at Camp Wood in the Tapak Mageh area as well as in log ponds at various locations. M1 – ♂, 9.vi.2013, RN. KD8 – ♀, 9.ix.2013, MB.

41. *Indaeschna grubaueri* (Förster, 1904)
W1 – ♀, 5.ix.2013, RD. W4 – ♀, 3.ix.2013, MB. KD8 – ♀, 8.ix.2013, MB; ♂, 9.ix.2013, MB.

Figure 25. *Tetracanthagyna degorsi* female apparently ovipoisiting into a mossy log. Photograph by Robin Ngiam.

42. *Tetracanthagyna degorsi* Martin, 1896
An apparently ovipositing female is shown in Fig. 25.
KV8 – ♀, 8.ix.2013, MB.

Gomphidae

43. *Acrogomphus* species
Only *A. jubilaris* Lieftinck has been recorded from Borneo, but as most records of the genus from the island are of females or larvae, the possibility of other species cannot be ruled out. KD4 – ♀, 16.vi.2013, LS.

44. *Heliogomphus blandulus* Lieftinck, 1929
A very poorly known species, the only previously published records definitely of it are of the holotype from western Kalimantan (Lieftinck 1929) and a record from the Hose Mountains in Sarawak (Dow & Ngiam 2012). However a record that might be of this species can be found in Orr (2001, 2003). Fig. 26. KD4 – ♂, 16.vi.2013, RD. KV5 – ♀, 6.ix.2013, RD.

Figure 26. *Heliogomphus blandulus* male. Photographs by Robin Ngiam.

45. *Leptogomphus pendleburyi* Laidlaw, 1934
This is another very poorly known species. The only published records are of the holotype from Mount Kinabalu in Sabah (Laidlaw 1934), a teneral male from Brunei (Kalkman 2005) and a teneral male probably belonging to this species from Mount Dulit in Sarawak (Dow, Reels, Butler 2013). However a few other records are now

available and will be published elsewhere. The female has not been described but the female listed here agrees very well with the male in size and markings. Since van Tol (1990) made his revision of the genus, significant new material has become available; a fresh revision of the genus in Borneo will be undertaken in the not-too-distant future. Fig. 27. KD1 – ♂, 16.vi.2013, RD; ♀, 8.ix.2013, RD.

Figure 27. *Leptogomphus pendleburyi* male. Photographs by Robin Ngiam.

46. *Leptogomphus williamsoni* Laidlaw, 1912

A larva collected during the first expedition was used as the basis of the first larval description for this species in Ngiam & Dow (2013). Fig. 28.

M7 - One larva (♀), 11.vi.2013, RN, emerged on 3.vii.2013. KD4 – ♂, 16.vi.2913, LS. KV2 – ♀, 15.vi.2013, MB. KV9 – ♂ (teneral), 10.ix.2013, LS.

Figure 28. *Leptogomphus williamsoni* male. Photographs by Robin Ngiam.

Chlorogomphidae

47. *Chlorogomphus* ?*manau* Dow & Ngiam, 2011
A female *Chlorogomphus* was caught while apparently ovipositing in a seepage in disturbed forest (but within tens of metres of undisturbed forest). It agrees in size, proportions and markings with *C. manau* (see Dow & Ngiam 2011) and is very likely to be that species. W3 – ♀, 1.ix.2013, RD.

Macromiidae

48. *Macromia westwoodi* Selys, 1874
W4 – ♀, 2.ix.2013, MB; ♂, 3.ix.2013, RN.

Corduliidae

49. *Procordulia fusiformis* Lieftinck, 1977 Fig. 29.
M1 – ♂, 13.vi.2013, RD.

Figure 29. *Procordulia fusiformis* male. Photograph by Robin Ngiam.

50. *Procordulia* ?new species
One male was collected at a forest edge pond where the new logging road had dammed a stream. It is very similar to *P. fusiformis* but has an only slightly fusiform abdomen and subtle differences in the accessory genitalia. The altitude at this location is only ca 530m, far lower than *P. fusiformis* has ever been recorded. KD8 – ♂, 9.ix.2013, MB.

Libellulidae

51. *Cratilla lineata* (Brauer, 1878)
M1 – ♂, 10.vi.2013, MB. KD1 – ♂, 10.ix.2013, RD. KD5 – 2 ♂♂, 16.vi.2013, RD.

52. *Cratilla metallica* (Brauer, 1878)
M2 – ♂, 9.vi.2013, RD. W1 – ♂, 1.ix.2013, RD; 2 ♂, ♀, 3.ix.2013, MB. KD5 – ♂, 16.vi.2013, RD. KV10 – ♂, 10.ix.2013, RD.

53. *Diplacodes trivialis* (Rambur, 1842)
KD1 – ♂, 16.vi.2013, RD.

54. *Hylaeothemis clementia* Ris, 1909 Fig. 30.
KD1 – ♂ (teneral), 16.vi.2013, RD. KD4 – ♀, 16.vi.2013, RD. O1 – ♂, 17.vi.2013, RN.

Figure 30. *Hylaeothemis clementia* male. Photograph by Robin Ngiam.

55. *Lyriothemis biappendiculata* (Selys, 1878)
KD4 – ♂, 16.vi.2013, RD. KD9 – 11.ix.2013, RD.

56. *Lyriothemis cleis* Brauer, 1868
M1 – ♂ (teneral), 9.vi.2013, LN. KD1 – 2 ♀♀, 16.vi.2013, RD.

57. *Neurothemis fluctuans* (Fabricius, 1793)
W1 – 2 ♂♂, ♀, 16.vi.2013, LS. KD10 – ♂, 11.ix.2013, RD.

58. *Neurothemis ramburii* (Brauer, 1866)
W1 – ♂, 16.vi.2013, RD.

59. *Onychothemis coccinea* Lieftinck, 1953
W2 – ♂, 30.viii.2013, RD.

60. *Orthetrum chrysis* (Selys, 1891)
M5 – ♂, 10.vi.2013, RN. KV3 – ♂+♀, 16.vi.2013, MB; ♂, 16.vi.2013, RN.

61. *Orthetrum glaucum* (Brauer, 1865)
M1 – ♂, 13.vi.2013, SN. M3 – ♂, 9.vi.2013, LS. M5 – ♂, ♀, 10.vi.2013, RN. M7 – ♂, 11.vi.2013, RN; ♀, 11.vi.2013, SN. W1 – ♂, 1.ix.2013, MB; ♂,1.ix.2013, RD. W5 – 2 ♀♀, 1.ix.2013, LS. KD2 – ♀, 15.vi.2013, LS. KD7 – ♂, 7.ix.2013, LS. O1 – ♀, 17.vi.2013, LS. O2 – ♂, 5.ix.2013, LS.

62. *Orthetrum pruinosum schneideri* Förster, 1903
This species has sometimes been regarded as a denizen of pristine forest but we have frequently found it in very disturbed mixed dipterocarp forest. In the Sungai Kahei area it appeared, along with *O. glaucum*, *O. testaceum* and *Pantala flavescens*, to actually be following the progress of the new road, appearing at barren muddy pools beside, and created by, the road a day or two after they first filled. M1 – ♂, 13.vi.2013, RD; ♀, 13.vi.2013, SN. M2 – ♂, 9.vi.2013, RN. M3 – ♂, 9.vi.2013, LS. M7 – ♂, 11.vi.2013, SN. KD8 – ♂, 8.ix.2013, RD; ♀, 8.ix.2013, LS.

63. *Orthetrum testaceum* (Burmeister, 1839)
W1 – ♂, 1.ix.2013, LS. KD1 – ♂, 16.vi.2013, RD.

64. *Pantala flavescens* (Fabricius, 1798)
KD1 – ♂, 15.vi.2013, SN.

65. *Tetrathemis hyalina* Kirby, 1889
KD10 – ♂, ♀, 11.ix.2013, RD.

66. *Tetrathemis* species
KD5 – ♂, 16.vi.2013, RD.

67. *Tramea transmarina euryale* Selys, 1878

W1 – ♂, 30.ix.2013, RD.

68. *Trithemis aurora* (Burmeister, 1839)
KD1 – ♀, 15.vi.2013, SN; ♂, 16.vi.2013, RD. KD8 – ♀, 8.ix.2013, MB.

69. *Trithemis festiva* (Burmeister, 1839)
M5 – 2 ♂♂, 10.vi.2013, RN. M8 – ♂, 12.vi.2013, MB. W1 – ♂, 1.ix.2013, RD.

70. *Tyriobapta torrida* Kirby, 1889
KD10 – ♂, 11.ix.2013, RD.

71. *Zygonyx iris errans* Lieftinck, 1953
W2 – 30.viii.2013, RD.

72. *Zyxomma petiolatum* Rambur, 1842
KD8 – 2 ♂♂, 9.ix.2013, MB.

Incertae sedis

73. *Idionyx* species
KD4 – 2 ♀♀, 16.vi.2013, RD. O1 – ♀, 17.vi.2013, RN. W4 – ♀, 2.ix.2013, RD. KV5 – ♀, 6.ix.2013, MB.

74. *Macromidia fulva* Laidlaw, 1915
KD2 – 2 ♂♂, 3 ♀♀, 14.vi.2013, RN. KD3 – ♂, 16.vi.2013, RD; ♀, 16.vi.2013, RN.

Discussion

The two small expeditions reported here generated a wealth of data from an area where there was no data before, and in that regard alone can be treated as successful. Two entirely new or potentially entirely new species were found (*Coeliccia* new species *borneensis*-group and *Procordulia* ?new species) as well as a number of poorly known species (e.g. *Coeliccia campioni*, *Pericnemis* spp., *Heliogomphus blandulus*, *Leptogomphus pendleburyi* and *Chlorogomphus* ?*manau*).

But perhaps most importantly, we were able to gather data from precisely known sites before they were logged at all; this has not been achieved for Odonata in Borneo before. Such data, and the questions it can be used to answer, are of more than academic interest. Although it is probably too late to apply any knowledge gained in Sarawak, there are very large areas of unlogged forest remaining in the mountainous heart of Borneo on the Kalimantan side of the border. Although it is clearly highly desirable that large parts of the Kalimantan forests be given protected status, it is probably unrealistic to believe that other large areas will not be subjected to commercial logging in the future; lessons learnt in Sarawak could have a beneficial effect on conservation in this event. However, as useful as this data is, a caveat has to be added: the authors lacked the expertise in experimental design, and the equipment necessary to make proper measurements of stream characteristics, to allow for a really significant statistical comparison between the sites before and after logging, and the amount of sampling at each site was simply not great enough. All that we could do with the time and fund-

ing available was to seize the opportunity to get some data before logging. It is sobering to think of how much more could have been achieved if more funding was available (so that more time could have been spent in the area, and additional expertise could have been brought in) and better information was available before actually reaching the areas concerned. However, although the sites we sampled in the Sungai Kahei area will have all been logged now, there are still opportunities for meaningful before and after logging comparisons as at present there are still a few other as-yet unlogged but non-protected areas close to the Indonesian border in both Kapit and Miri divisions. But these opportunities will all be gone within the next few years. Virgin forest sites such as W4 may survive for longer, and provide an opportunity for comparison with comparable logged forest very close by; however the size of the virgin areas may be too small to allow truly significant studies to be carried out.

It is worthwhile to discuss what we mean by virgin or unlogged forest before going further. Essentially we are referring to areas of old growth forest, dominated by climax rather than pioneer tree species. It should be noted that in Sarawak, and probably throughout most of Borneo, almost all lowland and mid altitude forest that is not in the steepest and most inaccessible terrain is very likely to have undergone some form of human disturbance in the past, whether it be silviculture, small scale shifting agriculture or local use timber extraction. Even areas that are uninhabited today were probably inhabited during the height of the headhunting period when many groups of people would attempt to hide themselves away (this was pointed out to the first author by the Earl of Cranbrook, an authority on Borneo in general, and one who has been intimately involved in many aspects of both natural history and anthropology on the island since the 1950s). However this historical disturbance was gradual (e.g. only a small area at a time) and incomplete (e.g. in a given area some forest would be cleared for agriculture, but much would never be clear cut, especially on steep slopes, just subjected to selective removal of trees for building etc., and even this disturbance would become less further away from navigable rivers because of transportation difficulties. So what we now regard as virgin forest is likely to be a mosaic, with some patches maybe only 100-200 years old, others older but with some history of timber removal, or an unnaturally high proportion of trees producing human edible fruit, and other areas approaching the almost mythical untouched by human hands state, but of course even these are subject to natural disturbance from large tree falls etc. In contrast, commercial selective logging affects rather large areas almost entirely and over a relatively short time scale. Commercial logging in Sarawak has almost always been selective in the past, with clear cutting only when land is converted for plantation (typically oil palm or acacia).

It is obvious that even the most selective logging will have at least a short term, local, negative effect on stenotopic forest odonates, because of sudden changes in temperature and humidity through opening up of the canopy, increased sediment in streams, and even alterations to stream beds and stream courses. These alterations to the ori-

ginal habitat persist, in some cases for many years. However similar alterations do occur naturally, albeit usually on a much smaller scale and over a much longer period of time, even in forest undisturbed by human activities (e.g. as a result of events such as tree falls and, in hilly country, natural land slips after heavy rain). What is less obvious is how great the negative effects of logging are on Odonata and how long lasting; any study of this is further complicated by the fact that logging is carried out in different ways at different places and times. For instance, in Sarawak minimum cutting diameters for valuable timber species during the first harvest have fallen over the years that large scale commercial logging has been taking place, so that the first harvest in an area now is potentially much more damaging than that which would have taken place 15 years ago. However, with sufficient data is should be possible to answer questions such as: do many species become locally extinct (e.g. in a particular stream system) as a result of a single selective harvest of timber? How long do species that have become locally extinct take to recolonize? How long does it take a population of a species to fully recover?

The data generated in the Sungai Kahei area provides a good illustration of why one cannot simply compare the fauna of disturbed forest in one area with undisturbed or less disturbed forest in similar terrain in another area. We have data from some streams at 500-700m on Gunung Mulu in the national park of the same name, in very similar terrain and with a comparable quality of forest. We recorded a total of 26 species from the stream habitats in virgin forest in the Sungai Kahei area (KV1-9), and 23 species from the streams on Gunung Mulu (with some man days less collecting effort). At most 16 of these species were found in both areas (*Drepanosticta* cf *crenitis* and *D.* cf *dentifera* are recorded from both, but it is possible that the species at Sungai Kahei are not actually the same as those from Gunung Mulu, see comments under *D.* cf *crenitis* above). Of course it is possible that with more sampling in both areas more species will be found in common (especially from the Anisoptera), but the differences in the available data seem too large to be ignored.

Some simple analysis is possible with the logged versus virgin forest data we have from the two expeditions. However we note a number of potential problems with this analysis as we go. One immediate problem is that although we know which sites were unlogged and which sites had been logged already, we do not know how long ago logging finished at the logged sites. Google Earth imagery now comes with an imagery date once one zooms in far enough; that for many of the disturbed sites in the Sungai Kahei area is currently shown as 10th April 2013, e.g. just over two months before our first visit to the area; these sites appear unlogged in the images, but this does not tally with what we saw at the sites, e.g. state of smaller logging tracks (the so-called jalan lipan – centipede road, named because of the make of some of the machinery used to make them), size of second growth trees beside logging roads and so on which suggest a longer period since logging; pioneer tree species are fast growing but they do not reach heights over 4m in two months. So it appears that the imagery date with

freely available satellite data is not a reliable way of judging how long ago a site was logged.

Overall, excluding site W3 (mosaic of virgin and logged forest), 38 species were collected in virgin forest and 65 were collected in disturbed forest and open habitats. The greater number of species in disturbed and open habitats merely reflects the greater variety of such habitats sampled (e.g. almost all standing water sites sampled fall into this category) and the larger number of individual sites in this category (25 compared to 11 for virgin forest).

A more meaningful comparison between logged and unlogged forest in the area of the expeditions is provided when only forest species (e.g. those known or usually believed to be dependent on forest for their survival; 58 of the species collected during the two expeditions fall into this category) and stream sites are considered. Additionally, some of the streams in disturbed forest differ substantially in size and/or gradient in at least a part of the section sampled from any of those sampled in virgin forest (M8, W2 and KD9), so these are excluded as well as W3. Moreover the sites O1 and O2 are composite stream and standing water sites (lumped together for convenience) and only sampled incidentally whilst travelling or exploring; these sites are excluded as well. With these restrictions, 28 forest species were found at streams in virgin forest (10 sites), and 31 at comparable streams in logged forest (14 sites). Once the number

Table 1: Percentage (rounded to nearest whole number) of virgin and logged forest stream sites at which species common in the area of the expeditions were found.

Species (total number sites)	% virgin forest sites	% logged forest sites
Devadatta species B (17)	100	50
Euphaea subcostalis (9)	60	21
Vestalis amnicola (11)	20	64
Vestalis beryllae (9)	70	14
Drepanosticta actaeon (7)	30	29
Drepanosticta sp. cf *crenitis* (5)	40	7
Drepanosticta dulitensis (8)	70	7
Drepanosticta rufostigma (13)	90	29
Drepanosticta versicolor (7)	50	14
Telosticta longigaster (11)	70	29
Stenagrion dubium (17)	80	64
Coeliccia sp. cf *borneensis* (17)	100	50
Coeliccia cyaneothorax (6)	30	21
Coeliccia sp. cf *nemoricola* (5)	40	7
Coeliccia nigrohamata (14)	100	29

of sites is taken into consideration the difference in these figures does not seem significant. However far more data is required, and a more sophisticated analysis taking into account smaller differences between streams, for any real conclusion about relative numbers of forest stream species between virgin and logged habitats can be made. What is potentially more informative is to compare the percentage of sites in the two types of forest at which a given species was found. Species which were only found at one or a few sites can be excluded from consideration as the low number of sites is likely to indicate difficulty of capture, or general scarcity in the area so that differences between logged and unlogged might be more apparent than real for these species with the size of the current data set.

Table 1 shows the percentage of sites in each forest category at which the 15 species (all Zygoptera) found at five or more sites overall (from the 24 sites under consideration) were found. Although these species, moderately to very common in the area and relatively easy to collect, are likely to be present at more sites than they were recorded from, their apparent absence from a site suggests that they were less abundant at that site, at least when sampled, than at those at which they were found.

It is striking that of the 15 species recorded at five or more sites, although none were only found at virgin forest sites, 12 were found at a significantly greater percentage of virgin forest sites than logged sites and only one (*Vestalis amnicola*) was found at a greater percentage of logged sites than unlogged sites. Two species found at far more unlogged than logged sites, *Drepanosticta* species cf *crenitis* and *Drepanosticta versicolor*, are likely to be under-recorded due to small size, cryptic colouration and habitat preferences, however this applies equally to unlogged and logged habitats, so that any possible under-recording is unlikely to change the impression that they are more common in unlogged forest. Two species (*Drepanosticta actaeon* and *Stenagrion dubium*) were found at only a slightly greater percentage of unlogged than logged sites, of these *Stenagrion dubium* is an extremely common species in steep terrain and we have frequently found it in logged forest so there is no surprise that it was found frequently in logged forest during these expeditions. What is perhaps surprising is that species such as *Euphaea subcostalis*, *Drepanosticta rufostigma* and *Coeliccia nigrohamata*, which are common across Sarawak and that we have frequently found in logged forest in other areas (where there has been no option of comparing logged and unlogged) appear to be so much less common in logged forest than unlogged forest in the area of our expeditions.

However, as all the virgin forest sites were in the Tapek Mageh area in the Ulu Balui, but many of the disturbed forest sites are in the Ulu Baleh, it might be that the apparent differences between unlogged and logged forest for the 15 species listed in Table 1 actually merely reflect pre-logging differences between the two areas; e.g. possibly the 12 species that seem clearly more common in unlogged forest than logged forest are simply more common in the Ulu Balui than the Ulu Baleh and this accounts for the difference, rather than logging. Unfortunately our data is biased to the Ulu Balui where

far more time was spent than in Ulu Baleh; overall only 25 species were recorded in the Baleh drainage, against 73 in the Balui drainage, not only was collecting effort in the Balui drainage much greater, but also a greater variety of habitats were sampled in the Balui drainage. Only sites M1-M8 are in the watershed of the Baleh river while M9-10, W1-5, KD1-10 and KV1-10 are in the watershed of the Balui river. Leaving out the sites excluded above leaves eight logged sites in the Ulu Balui and six in the Ulu Baleh. When the analysis above is performed only considering the Ulu Balui (and of course the argument about original abundances might also apply on a smaller scale, e.g. perhaps we are really seeing differences between the Sungai Kahei area and the rest of our study area, but we do not have sufficient data to properly address this) there are 12 species that were found at five or more sites; Table 2 shows the percentage of sites in each forest category (out of 18 sites overall) for these 12 species.

Table 2: Percentage (rounded to nearest whole number) of virgin and logged forest stream sites in the Ulu Balui at which species common in that area were found.

Species (total number sites)	% virgin forest sites	% logged forest sites
Devadatta species B (13)	100	38
Euphaea subcostalis (9)	60	38
Vestalis amnicola (6)	20	50
Vestalis beryllae (8)	70	13
Drepanosticta actaeon (6)	30	38
Drepanosticta dulitensis (7)	70	0
Drepanosticta rufostigma (11)	90	25
Drepanosticta versicolor (7)	50	25
Telosticta longigaster (9)	70	25
Stenagrion dubium (11)	80	38
Coeliccia sp. cf *borneensis* (14)	100	50
Coeliccia nigrohamata (12)	100	25

Table 2Table 2 reveals a similar story, the main differences are that *Drepanosticta actaeon* now appears slightly more common in logged forest and *Stenagrion dubium* appears substantially more common in unlogged forest. *Vestalis amnicola* still appears more common in logged forest. The other nine species still appear more common in unlogged than logged forest; in six cases the difference between the percentages has increased slightly, and in three it has fallen. Of the three species that have dropped out of the analysis (*Drepanosticta* species cf *crenitis*, *Coeliccia cyaneothorax* and *C.* species cf *nemoricola*) because they were recorded at less than five sites in the Ulu Balui (four sites for each of them), only *C. cyaneothorax* was found in logged forest at all in the Ulu Balui. The apparent preference for logged forest seen in *Vestalis amnicola* in the area

of the expeditions might reflect a preference for more and larger sunspots than are typical in the small streams in virgin forest that we sampled.

One further deficiency of the comparison between logged and unlogged forest in the Ulu Balui should be mentioned (refer to the appendix): only (approximately) 7 man days of sampling effort were made in the logged forest sites included from the area, against approximately 23 man days in the unlogged forest sites. However the species in Table 2, if common at a given site, are typically collected within half a day of sampling effort by one collector in workable weather conditions, so that the imbalance is not considered to undermine the results. Moreover the message from Table 2 is essentially the same as from Table 1 where more logged forest sites are considered, with approximately 10.5 man days more sampling effort in the logged sites but the same amount of effort in the unlogged sites. It is also worth noting that this imbalance can still be corrected further with more collecting at suitable disturbed sites in the same areas.

Another factor not addressed above might be seasonal differences in abundances of some species, e.g. possibly some species were more abundant in September when there was more sampling in unlogged forest sites than in June when there was more sampling in logged forest sites.

To summarise, with the data we have, although there is a strong suggestion of real differences in the abundance of some forest stream odonate species between logged and unlogged forest; with a reduced number of sites in logged forest in most species with sufficient data, but with at least one case of apparent preference for logged forest. However, these differences could actually be due to factors unrelated to logging (e.g. differences in abundance between different areas prior to logging or more finely grained differences in micro habitat preference than can be dealt with the amount of data available and in the simplistic analysis presented here). Also, since we do not know how long ago disturbance occurred at the logged sites, possibly we are only seeing the difference between very recently logged sites and unlogged sites and that returning to the logged sites in another year would reveal much less difference. Thus our data cannot discriminate between a situation where logging leads to rather short-term (one or two years) effects on populations of forest stream species, and that where effects are much more long term. However it would still be of great interest to see if the same pattern is revealed in other areas where such a comparison is still possible, and of course longer and, if possible, more sophisticated studies are highly desirable, but rendered difficult because of lack of funding. With funding, we ourselves would like to make the following further investigations in the Ulu Baleh and Ulu Balui:

- Searches for and sampling in other unlogged forest patches remaining in the area.
- More sampling in logged sites for comparison, preferably in conjunction with greater cooperation from the timber company, enabling us to know the time since logging finished at individual sites with some accuracy.

- Resampling in the areas that were unlogged when first sampled, at regular intervals, now that they have been logged.

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References

Dijkstra, K.-D.B., G. Bechly, S.M. Bybee, R.A. Dow, H.J. Dumont, G. Fleck, R.W. Garrison, M. Hämäläinen, V.J. Kalkman, H. Karube, M.L. May, A.G. Orr, D.R. Paulson, A.C. Rehn, G. Theischinger, J.W.H. Trueman, J. van Tol, N. von Ellenrieder & J. Ware, 2013. The classification and diversity of dragonflies and damselflies (Odonata). In: Zhang, Z.-Q. (Ed.) Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness (Addenda 2013). Zootaxa 3703: 1–82.

Dijkstra, K.-D.B., V.J. Kalkman, R.A. Dow, F.R. Stokvis & J. van Tol, 2013. Redefining the damselfly families: the first comprehensive molecular phylogeny of Zygoptera (Odonata). Systematic Entomology doi: 10.1111/syen.12035.

Dow, R.A., 2010c. Revision of the genus *Coeliccia* (Zygoptera: Platycnemididae) in Borneo. Part I: The *borneensis*–group of species. Zoologische Mededelingen Leiden 84(7): 117–157.

Dow, R.A. & R.W.J. Ngiam, 2011. *Chlorogomphus manau* sp. nov. from Sarawak, Malaysia (Odonata: Chlorogomphidae). International Journal of Odonatology 14(3): 269–274.

Dow, R.A. & R.W.J. Ngiam, 2012. Odonata collected in the Hose Mountains, Kapit Division, Sarawak, Malaysia in April 2011. International Dragonfly Fund Report 44: 1–18.

Dow, R.A. & A.G. Orr, 2012. *Telosticta*, a new damselfly genus from Borneo and Palawan (Odonata: Zygoptera: Platystictidae). The Raffles Bulletin of Zoology 60(2): 361–397.

Dow, R.A. & G.T. Reels, 2011. *Coeliccia southwelli* sp. nov. (Odonata: Zygoptera: Platycnemididae) from Mount Dulit, Sarawak. Zootaxa 2832: 63–68.

Dow, R.A., G.T. Reels & S.G. Butler, 2013. Odonata of the Dulit Range in Sarawak, Malaysian Borneo. Notulae odonatologicae 8(1): 1–16.

Kalkman, V.J. 2005. Some notes on dragonflies observed at the KBFSC, Brunei. Agrion 9(1): 13-14.

Laidlaw, F.F., 1934. A Note on the dragonfly fauna (Odonata) of Mount Kinabalu and of some other mountain areas of Malaysia, with a description of some new or little known species. Journal of the Federated Malay States Museums 17(3): 549–561.

Lieftinck, M.A. 1929. Contributions to the Dragonfly fauna of the Sondaic Area. Tijdschrift voor Entomologie 72: 109–147.

Orr, A. G. & M. Hämäläinen, 2013. Two new species of *Pericnemis* from Borneo, with comparative notes on related species (Zygoptera: Coenagrionidae). Odonatologica 42(4): 335-345.

Ngiam, R. W. J. & R. A. Dow, 2013. The larva of *Leptogomphus risi* Laidlaw from Singapore with a comparison to *Leptogomphus williamsoni* Laidlaw from Sarawak and congeners (Odonata: Anisoptera: Gomphidae). Nature in Singapore. 6: 307-312.

Van Tol, J., 1990. Key to the Malesian species of *Leptogomphus* Selys, with the description of a new species from Sabah (Odonata, Gomphidae). Tijdschrift voor Entomologie 133: 97–105.

Appendix

Table 3 summarises numbers of species (and families) recorded at each location. For stream sites, except those merely sampled in passing, while bathing or for very brief periods, the collectors active at the sites and the number of man days of effort are given as well.

Table 3: Summary of numbers of species and families for each sampled location. Collectors and approximate days of man effort are given for stream sites not sampled incidentally.

Location	Number of species	Number of families	Sampled by	Number of man days collecting effort
M1	8	5		
M2	6	4	MB, RD, RN	1.5
M3	4	3	LS	0.5
M4	9	5	RD	1
M5	9	6	MB, RN	2
M6	7	4	MB, RD, RN	1.5
M7	7	6	RN, SN	1
M8	9	6	MB, RD, RN	3
M9	6	5	MB, RN (RD)	2
M10	5	2	RD	1
W1	11	3		
W2	9	6	RD (MB, LS)	1.5
W3	14	7	RD	1
W4	16	9	MB, RD, LS	5
W5	5	4	LS	1
KD1	10	3		
KD2	2	2		
KD3	4	4		
KD4	14	8	RD, LS	2
KD5	5	3		
KD6	5	4	LS	0.5
KD7	7	6	LS	0.5
KD8	6	3		
KD9	16	8	MB, RD, LS	3
KD10	6	3		
KV1	15	7	RD	1
KV2	11	6	MB, RN	2
KV3	9	7	MB, RN	2
KV4	14	5	RD	2
KV5	9	5	MB	1
KV6	10	5	MB	1
KV7	13	6	RD	2
KV8	12	7	MB, LS	4
KV9	10	6	MB, RD, LS	3
KV10	3	2		
O1	9	6		
O2	2	2		

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79	2010	Villanueva, Reagan, Philippinen	Odonata of the Diomabok-Lake region south of Davao, The Philippines Follow-up
80	2011	Villanueva, Reagan, Philippinen	Odonata of the Catanduanes-Island, The Philippines
81	2012	Villanueva, Reagan, Philippinen	Odonata of Dinapique, The Philippines
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84		Marinov, Milen, Christchurch	Odonata of Solomon Islands
85	2012	Villanueva, Reagan, Philippinen	Odonata from Talaingod, Davao del Norte, Mindanao Island, Philippines
86	2012	Do Manh, Cuong, Hanoi, Vietnam	Mau Son Mountain Odonata, Vietnam
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