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Diving beetles of the Sakaerat Biosphere Reserve, Nakhon Ratchasima Province, with four new records for Thailand

(Coleoptera, Dytiscidae)

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A recent survey of the Dytiscidae of Sakaerat Biosphere Reserve, Nakhon Ratchasima Province in Northeast Thailand revealed 9 genera and 22 species, mainly collected in lentic habitats. Most identified species are widespread in the Indo-Malayan region. *Copelatus oblitus* Sharp, 1882, *Cybister convexus* Sharp, 1882, *Hydrovatus sinister* Sharp, 1890 and *Laccophilus latipennis* Brancucci, 1983 are recorded for the first time in Thailand. The distributional range and ecology are discussed for each species. Photos of remarkable species and habitats in the dry and during the rainy season and a map are provided.

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Introduction

This present work is based on the results of the “Sakaerat Biosphere Reserve Expedition, 2013–2015” carried out by the senior author. This Biosphere Reserve is situated on the edge of the Khorat Plateau in Thailand’s north-eastern province of Nakhon Ratchasima. Despite the fact that Thailand has been investigated previously for dytiscid beetles and the results were published in several recent revisions (e.g. Wewalka 1979, 2015, 2016, Brancucci 1983, Biström 1996, Hendrich & Balke 1997, Št’astný 2003), the present study provided a number of new records for the country. The objective of this paper is to present a checklist of the recorded species in the reserve and to give some notes on the general distribution and habitat preferences of each remarkable species.

Descriptions and photographs of the localities, showing the different seasonality in many habitats, are provided. The publication will be another step forwards to an annotated checklist of the Dytiscidae of Thailand (Atthakor et al. in prep.).

Study area

Sakaerat Biosphere Reserve (SBR) is situated on the edge of the Khorat Plateau in Thailand’s north-eastern province of Nakhon Ratchasima, covering the area between coordinates 14°26' to 14°32' N and 101°50' to 101°57' E, and spanning 821 km² (82 100 hectares) in area. Designated as a biosphere reserve in 1977 around the Sakaerat Environmental Research Station (SERS), it is the oldest of four biosphere reserves in Thailand. Managed by the Thailand

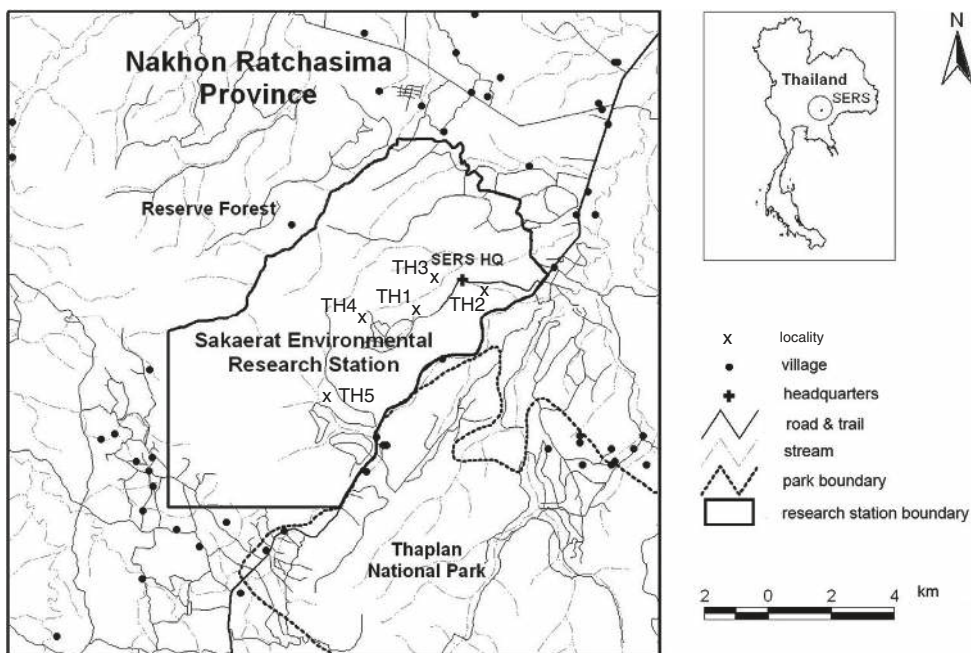


Fig. 1. Map of Sakaerat Biosphere Reserve, modified from Trisurat (2010).

Institute of Scientific and Technological Research (TISTR), the station is running as a facility for ecological and environmental studies, with researchers and school children as the main interest groups, but is also open to the general public.

Major ecosystem types of the SBR consist of tropical dry or deciduous forest, with dry dipterocarp and evergreen forests making up less than 80 % of the total area. Dominant vegetation in the dipterocarp forests consists of *Shorea obtusa* and *S. siamensis*, and *Hopea* trees, namely *H. ferrea* and *H. odorata* (Ishizuka et al. 1998, Kamo et al. 2002).

The climate type is classed as equatorial savannah with dry winter (Kottek et al. 2006), with annual rainfall between 1100–1300 mm (Lamotte et al. 1998). The rainy season is usually from May to October. The coolest periods are between November and February, with a daily mean temperature of the coldest month of around 18.5 °C. The hottest time of year is during the months of March to May, with a daily mean temperature of around 29.0 °C. Annual mean temperature is reportedly about 26.0 °C (Lamotte et al. 1998). However, during the study period 2013–2015, raw meteorological data recorded by the SERS showed minimum temperatures as low as around 10.0 °C in December and maximum temperatures of around 40.0 °C or more in March and April. Although the annual average relative humidity from 2013–2015 remained at around 80 %, 2014 experienced below

average precipitation of less than 1000 mm, making it an unusually dry year (SERS 2017).

Since the establishment of the SERS, numerous studies of the flora and fauna have been carried out (Heyer & Sukhum 1970, Ishizuka et al. 1998, Kamo et al. 2002, Yasunaga 2012, Sukteeka & Thane 2015). However, none has included studies on water beetles in the area. Therefore, the purpose of this paper is to report on the predaceous diving beetles from Sakaerat Biosphere Reserve.

Material and methods

Beetles were collected from five localities within the Sakaerat Biosphere Reserve (SBR) and the adjacent Sakaerat Silvicultural Research Station (SSRS), herein treated as part of the Sakaerat Biosphere Reserve due to its close proximity and geographical continuity.

At each of the localities, depending on the habitat, one or more of the following methods were used to collect the beetles: 1) Inverted traps made out of plastic water bottles containing tinned tuna as bait were placed at each locality and left overnight, 2) vigorous sweeping using a 500 µm mesh-size heavy duty D-frame aquatic kick net, 3) hand collection using a tea strainer. All specimens were preserved in 95 % ethanol.

Laccophilus species identification was done by using Brancucci (1983). All *Hydrovatus* were identified with the revision of Biström (1996). The identification of the



Figs 2-7. Habitats. **2.** Upper Dam (TH1), August 2013 – during the 2013 rainy season; **3.** Upper Dam (TH1), December 2013 – after the 2013 wet season; **4.** Lower Dam (TH2), December 2013; **5.** Lower Dam (TH2), June 2015; **6.** King Cobra Cave (TH3), October 2013; **7.** King Cobra Cave (TH3), March 2014.

Cybister and *Hydaticus* was based on Vazirani (1969), Hendrich and Brancucci (2013) and Wewalka (1979, 2015, 2016). For *Sandracottus* the manuscript version of the revision by Hendrich & Brancucci was used. The single *Copelatus* species was identified using specimens compared with type material.

Depositories

All species and most specimens are deposited in the collection of Wisrutta Atthakor, Srinakharinwirot University, Department of Biology, Bangkok, Thailand.

A larger series of *Cybister limbatus* (Fabricius, 1775) is deposited in the Zoologische Staatssammlung München, Germany.

Localities sampled

Locality 1 (TH1). Upper Dam (14°29.8' N 101°54.9' E) about 485 m a.s.l. Three visits: 1) 3 Aug 2013, 2) 13-14 Dec 2013, and 3) 21-22 Mar 2014; all Atthakor leg. During the first visit, the reservoir was all but dry, with a small pond in the middle, thus hand collection was carried out using a tea strainer. During the second and

third visits, bottle traps containing tinned tuna as bait were placed at several points around the edges of the pond and left overnight.

Locality 2 (TH2). Lower Dam (14°30.5'N 101°55.8'E) About 316 m a.s.l. Six visits: 1) 27–28 Oct 2013, 2) 13–14 Dec 2013, 3) 21–22 Mar 2014, 4) 27–28 Apr 2015, 5) 18–19 May 2015, and 6) 23–24 Jun 2015; all Atthakor leg. A combination of bottle traps left overnight at the edges of the pond and vigorous sweeping from the quite heavily vegetated water's edge using an aquatic kick net was used to collect beetles. Water levels had decreased with each visit but had not become completely dry as a result of the unusually dry rainy season of 2014.

Locality 3 (TH3). King Cobra Cave (14°30.3'N 101°55.2'E) About 400 m a.s.l. Six visits: 1) 27–28 Oct 2013, 2) 13–14 Dec 2013, 3) 21–22 Mar 2014, 4) 27–28 Apr 2015, 5) 18–19 May 2015, and 6) 23–24 Jun 2015; all Atthakor leg. A combination of traps and sweeping was used to collect beetles, either from the edge of the pond or by standing in the pond during the final two visits when the water level was very low. Water levels at this locality were variable. In October 2013, just at the end of the 2013 rainy season, there was a small waterfall running down into the pond in front of the cave, causing it to overflow onto the bedrocks opposite. In December 2013, there was no longer a waterfall but there was still an inlet stream from the side of the pond, creating a small overflow stream. Pond water was clear. During

the start of the dry season in March 2014, there was no water input into the pond and it was no longer full and overflowing. Pond water was dark and starting to accumulate leaf litter. From April to June 2015 pond water appeared black, with water level greatly reduced by June 2015, though not completely dry, and filled with rotting leaf litter. Although this locality was not revisited during or just after the rainy season in 2014, we were informed by staff at the research station that it had been unusually dry, and there was no waterfall running into the pond as in the previous year.

Locality 4 (TH4). Huay Tor Kad (14°28.6'N 101°53.3'E), about 440 m a.s.l. Three visits: 1) 28–29 Apr 2015, 2) 18–19 May 2015, and 3) 23–24 Jun 2015; all Atthakor leg. A combination of inverted traps and hand collection using a tea strainer was used. At the dates those specimens were collected, the locality was almost dried up “pond” with soft muddy substrate covered with leaf litter. Water depth was no more than a few centimetres, 10 cm at most. However, an earlier survey of the area (in which no specimens were collected) revealed a much fuller pond, with a water depth of about 2 metres. Like in the Upper Dam (TH1), the water level was quite variable, depending on the season and severity of preceding wet seasons.

Locality 5 (TH5). Twin Ponds (14°30.3'N 101°54.1'E), about 560 m a.s.l. Three visits: 1) 28–29 Apr 2015, 2) 18–19 May 2015, and 3) 23–24 Jun 2015; all

Table 1. Species list.

Species	Localities				
	1	2	3	4	5
<i>Hyphydrus lyratus lyratus</i> Swartz, 1808		1♂ 1♀			
<i>H. sumatrae</i> Régimbart, 1880				2♂	
<i>Hydrovatus acuminatus</i> Motschulsky, 1859		1♂			
<i>H. rufoniger rufoniger</i> (Clark, 1863)		2♂			
<i>H. sinister</i> Sharp, 1890*		3♂			
<i>H. stridulus</i> Biström, 1997		1♂			
<i>Hydroglyphus cf. orientalis</i> (Clark, 1863)	1♂				
<i>Leidytes nicobaricus</i> (Redtenbacher, 1867)		1♂			
<i>Laccophilus ellipticus</i> Régimbart, 1889		1♂			
<i>L. latipennis</i> Brancucci, 1983*		9♂		2♂	
<i>L. parvulus obtusus</i> Sharp, 1882		2♂			
<i>L. siamensis siamensis</i> Sharp, 1882	1♂				
<i>L. transversalis leptogonus</i> Brancucci, 1983		1♂		5♂	
<i>Hydaticus fabricii</i> (W.S. Macleay, 1825)		1♂ 1♀	1♂		
<i>H. luczonicus</i> Aubé, 1838		1♂ 1♀			
<i>H. pacificus pacificus</i> Aubé, 1838			1♂		
<i>H. ricinus</i> Wewalka, 1979		1♂			
<i>Sandracottus maculatus</i> (Wehncke, 1876)		1♂	4♂ 9♀		
<i>S. mixtus</i> (Blanchard, 1843)			7♂ 17♀		
<i>Copelatus oblitus</i> Sharp, 1882*		1♂			
<i>Cybister convexus</i> Sharp, 1882*		1♂ 1♀			
<i>C. limbatus</i> (Fabricius, 1775)	71♂ 65♀				97♂ 83♀



Figs 8–11. Habitats. **8.** Huay Tor Kad (TH4), August 2013, preliminary expedition survey trip; **9.** Huay Tor Kad (TH4), May 2015; **10.** Twin Ponds (TH5) (north side), April 2015; **11.** Twin Ponds (TH5) (south side), April 2015.

Atthakor leg. Samples were collected using inverted traps left overnight. Neither hand collection nor vigorous sweeping was done due to the soft substrate at the edges of the water making it difficult and unstable to stand at the edge for long enough to carry out sweeps.

Results

In total, 348 specimens of adult Dytiscidae were obtained and examined as a result of the Sakaerat Biosphere Reserve survey carried out by the senior author during the period from August 2013 to June 2015, representing 9 genera and 22 species. Of these, four species are recorded for the first time for Thailand.

Table 1 lists the species and number of each species from each locality. Not all female specimens could be identified to species level; they have been kept together with the male specimens from the same locality. Asterisks (*) following the species names denote first records for Thailand.

Remarkable faunistic records

Copelatus oblitus Sharp, 1882 Fig. 12

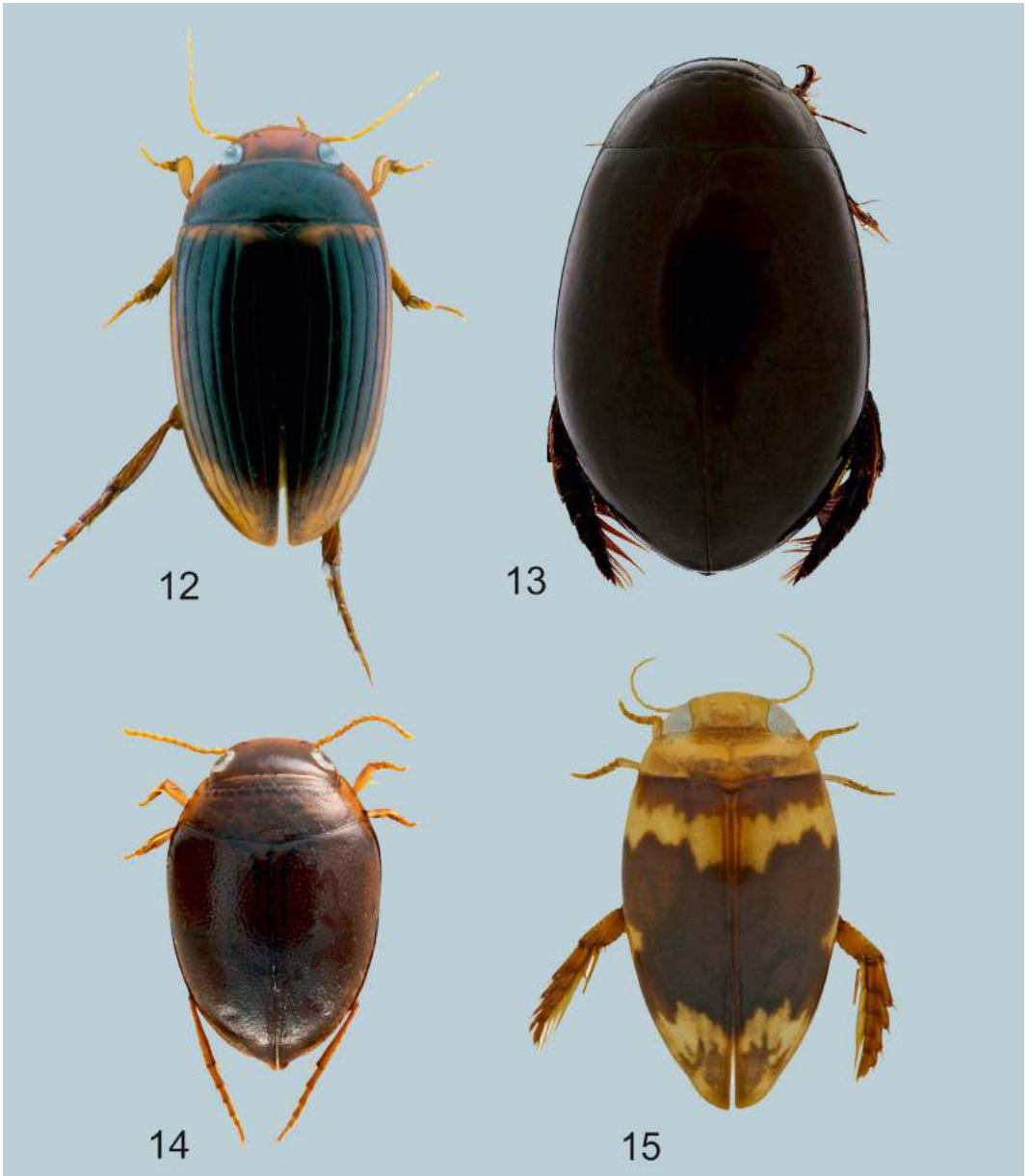
Sharp 1882: 582; Régimbart 1899: 298; Hendrich et al. 2004: 118; Nilsson & Hájek 2017: 58.

Distribution. India [Andaman Islands], Japan [Yaku-shima and Ryukus Islands], Malaysia [Sarawak], Taiwan (Satô 1985, 1990) and Singapore (Vazirani 1977, Hendrich et al. 2004). The record for Indonesia: Sulawesi (Balfour-Browne 1939) needs to be confirmed (Hendrich et al. 2004). First record for Thailand.

Ecology. The species is found among leaf litter, roots and submerged plants of very small, temporary, shallow puddles in or near forested areas (Hendrich et al. 2004).

Cybister convexus Sharp, 1882 Fig. 13

Sharp 1882: 718; Vazirani 1969: 284; Nilson & Hájek 2017: 78.



Figs 12–15. Habitus of 12. *Copelatus oblitus* (2.6 mm); 13. *Cybister convexus* (3.3 mm); 14. *Hydrovatus sinister* (4.7 mm); 15. *Laccophilus latipennis* (28.5 mm).

Additional material studied. 1 female, “Thailand, Nakhon Ratchasima, Khao Yai, Pak Chong village, 19th May 1991, Adam Cotton collection” (Australian National Insect Collection, Canberra, Australia).

Distribution. India: West Bengal (Vazirani 1969), China (Yunnan), Myanmar (Régimbart 1899, Hendrich 2008). First record for Thailand.

Ecology. Not much is known about the habitat preferences of the species. It can be found from hilly (350 m, Thailand) to high mountain regions (2200 m, Yunnan). In China (Yunnan) it was collected in a water-filled rut on a forest track (Hendrich 2008). Most probably the occurrence is associated with forested areas, as observed in other completely black

Cybister. *Cybister convexus* is less frequently attracted to light than other species of the genus. It is quite rare in museum collections.

***Hydrovatus sinister* Sharp, 1890**

Fig. 14

Sharp 1890: 343; Biström 1996: 521; Balke et al. 1997: 325; Hendrich et al. 2004: 115; Nilsson & Hájek 2017: 171.

Distribution. Sri Lanka, India, Myanmar, Laos, West Malaysia, Indonesia [Sumatra, Kalimantan] (Biström 1996) and Singapore (Balke et al. 1997, Hendrich et al. 2004). First record for Thailand.

Ecology. *Hydrovatus sinister* is an inhabitant of shallow, muddy water of open swamps, artificial ponds (garden and park ponds, quarry ponds), and slowly flowing irrigation ditches. The habitat is rich in rotten leaves, sedges and submerged plants (Hendrich et al. 2004).

***Laccophilus latipennis* Brancucci, 1983**

Fig. 15

Brancucci 1983: 294; Nilsson & Hájek 2017: 219.

Distribution. India, Bhutan, Myanmar, Laos, Vietnam, West Malaysia, Singapore, Indonesia [Java, Sumbawa, Timor] (Brancucci 1983). First record for Thailand.

Ecology. A lentic species restricted to forested areas. The species can be found in shallow and shaded, more permanent forest pools in primary and secondary growth (older rubber plantations) lowland forest. The bottom of the pools consists mostly of mats of floating grasses, mud and a layer of rotten leaves or twigs.

Discussion

The majority of species found during this study were collected from the Lower Dam (TH2) locality, including all of the four species new to Thailand. The surrounding area at this location was quite forested and the pond itself was heavily vegetated. It also had quite large populations of tadpoles and small fishes. The thick vegetation, which provided ample hiding place for the beetles, and the availability of diverse sources of prey would explain the beetles' preference for this location and hence their relative diversity in terms of species number compared to the other localities.

Both the Upper Dam (TH1) and the Twin Ponds (TH5) were dominated by *Cybister limbatus*, the largest diving beetle in Southeast Asia (Hendrich & Brancucci 2013). They were especially abundant at the Twin Ponds locality in April 2015. Despite the abundance of *Cybister* at the Upper Dam and Twin Ponds, however, only one species was collected from these two localities. Both specimens of the other species, *C. convexus*, were collected from the Lower Dam (TH2).

Both the Upper Dam reservoir and the Twin Ponds locality were quite large and open bodies of water, without vegetation cover for the beetles to hide amongst, which could explain the lack of dytiscid diversity at these localities.

Numerous *Sandracottus mixtus* (Blanchard, 1843) and several *Hydaticus pacificus* Aubé, 1838 were found at King Cobra Cave (TH3), where the highly conspicuous *Sandracottus* could be seen resting just under the surface of the water, or swimming around. The *Hydaticus* were more difficult to spot and were rather more elusive than *Sandracottus mixtus* and *S. maculatus* (Wehncke, 1876) at the same location, but several specimens would make appearances upon agitation of bottom leaf litter. *Sandracottus mixtus* appeared to be the dominant species of the genus at this location, with only a few modern records of *S. maculatus* from Thailand (Hendrich & Brancucci, in prep.).

Huay Tor Kad (TH4) was teeming with *Laccophilus* and *Allocotocerus* hydrophilids. The habitat appeared to be quite rich in prey, with tadpoles, small fishes and mayfly larvae also populating it similarly to the Lower Dam. When the water levels were high, the edges of the pond would be heavily vegetated; at low levels, however, the water edge was left with a muddy substrate. Like the Lower Dam, the surrounding area was quite forested. These factors could account for the apparent species richness of Huay Tor Kad.

Acknowledgements

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