

A review of the cockroach genus *Catara* Walker, 1868 from Borneo (Insecta: Blattodea: Blattidae: Blattinae)

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Abstract. The cockroach genus *Catara* Walker, 1868, contains two species, both occur in Borneo. The type species, *Catara rugosicollis* (Brunner 1865), has previously been recorded from 24 localities in Borneo, and also from Peninsular Malaysia, Singapore, Java and Sumatra. Published records for *Catara minor* Krauss, 1902 are limited to Java, and one record from Mt Murud in Sarawak. The existing records are reviewed and new records are presented for *C. minor* from 23 new localities in Sabah, and for *C. rugosicollis* from 17 new localities in Sabah, Sarawak, Brunei & Kalimantan. *Catara rugosicollis* occurs throughout Borneo but *C. minor* appears to have a distribution that is restricted to North East Borneo. The identity of *C. minor* males and females has been confirmed by captive breeding and notes are included on conditions needed for successful rearing.

Keywords: Blattodea, Borneo, *Catara minor*, *Catara rugosicollis*, cockroach, distribution, rearing

INTRODUCTION

The current study is part of an on-going project by P.E. Bragg to investigate the distribution of cockroaches, mantids and phasmids in Borneo. The distribution of cockroaches in Borneo is a particularly under-studied area: for most species, the only records were published before 1950; for many they are known only from the type locality. This paper deals with the genus *Catara* Walker, 1868, comprising only two species. As members of the genus are perhaps easily recognised, *Catara rugosicollis* (Brunner 1865) is one of the most commonly recorded cockroaches in Borneo: there are published records from 24 localities. Examination of the specimens of *Catara* collected by Bragg over a period of 30 years, and breeding of some of these specimens by J.M. Loach, raised some questions about the existing records. Breeding was a critical part of the study because it enabled males and females of *C. minor* Krauss, 1902 to be associated with no doubt that they were the same species.

MATERIALS & METHODS

Type specimens are abbreviated as follows: HT = Holotype; LT = Lectotype; PLT = Paralectotype; ST = Syntype.

Museum collections are abbreviated by the standard codens established by Arnett *et al.* (1993) with additional abbreviations for unlisted collections:

BORN – Universiti Malaysia Sabah, Kota Kinabalu, Sabah, Malaysia.
 BMNH – Natural History Museum, London, U.K.
 FRCS – Forest Research Centre, Sepilok, Sabah, Malaysia.
 ISNB – Royal Belgian Institute of Natural Sciences, Brussels, Belgium.
 OXUM – Oxford University Natural History Museum, Oxford, U.K.
 PEB – P.E. Bragg's collection, Lower Pilsley, Chesterfield, U.K.
 PIMJ – Phyletisches Museum, Jena, Germany.
 SMSM – Sarawak Museum, Kuching, Sarawak, Malaysia.
 SP/EDC – Sabah Parks Entomology Department Collection, Kinabalu Park HQ, Sabah, Malaysia.

The author Carl Brunner de Wattenwyl is abbreviated to Brunner.

In data tables: ♂n = a male nymph, ♀n = a female nymph, n = nymph of unspecified sex.

Data have been converted to a standard format: Locality, sex (Museum) Collector, Date [day.month.year – with the month in Roman numerals].

Specimens collected by Bragg were found at night by searching vegetation by torch-light. Prior to 2022, the specimens collected were chance finds while looking for phasmids; in 2022, more emphasis was placed on cockroaches resulting in more specimens being collected. Most specimens were preserved, by drying, soon after capture. Specimens of *C. minor* collected at Kawag Gibong Forest Reserve in Sabah were reared in captivity. The three specimens in FRCS cockroach collection were examined to determine the species and the data were recorded. Some specimens collected, or reared, by Bragg have since been deposited in FRCS and at Kinabalu Park.

All published records for *Catara* have been examined and the specimen numbers and localities recorded (Table 1). Localities for historical specimens collected on Borneo island can pose problems due to changed spellings, changes of name and the use of different languages (Bragg 2001: 42-47). In addition, there are the problems that may have been caused by misreading hand-written labels, and misspelling when transcribing data. The issue is particularly complex in Kalimantan where many of the names used by Dutch collectors have changed. The seemingly indiscriminate and interchangeable use of ü, u, and ue is commonly encountered. A variety of maps, and internet searches, were used to try to find localities recorded by various authors. For specimens examined, the latitude and longitude are taken from a hand-held GPS unit when one was available or from maps; these are recorded in Table 1 as degrees, minutes and seconds or just as degrees and minutes depending on the precision of the locality data.

Table 1. Specimen records of *Catara* spp. in Borneo. *C. minor* in red, *C. rugosicollis* in black.

Locality	Latitude & Longitude	Source	Specimens
BRUNEI			
Trusan	N04° 47' E115° 16'	Hebard, 1929	1♂
Terajah Waterfall	N04° 17' E114° 25'	PEB	1♂
KALIMANTAN			
Kelembenkari (near Palangkaraya)	S02° 19' E113° 54'	PEB	1♀n
Kenepai	N00° 43' E111° 43'	Bruijning, 1948	1♀
Ketapan, East Kalimantan	[not found]	Princis, 1950	2♂♂

Ketingau	[not found]	Bruijning, 1948	1♀
Lohaban (= Lohabang)	N00° 48' E109° 02'	Hebard, 1929	1♀
Long Blu-u (= Bloe-oe = Labuk Bluu)	N00° 43' E114° 27'	Bruijning, 1948	3♂, 18♀ +11n
Long Navang	N01° 48' E114° 43'	Hanitsch, 1933a	2♂♂
Mt. Bawang (near Madi village)	N00° 55' E109° 26'	PEB	1♀
Mt. Tibang	N01° 32' E114° 36'	Hanitsch, 1933a	3♂♂, 4♀♀
Mt. Tilung (= Mt. Tilung)	N00° 39' E113° 07'	Bruijning, 1948	1n
Pajau River	N01° 40' E114° 45'	Hanitsch, 1933a	2♂♂, 1♀
Pontianak	S00° 02' E109° 20'	Hebard, 1929	1♂, 1♀
Sambas	N01° 22' E109° 18'	Bruijning, 1948	1n
Upper Mahakkam river	[vague – omitted from map]	Bruijning, 1948	3♂, 13♀ +4n
SABAH			
Crocker Range: Inobong	N05° 50' E116° 09'	PEB, SP/EDC	4♂, 1♀
Crocker Range: KK-Tambunan road.	N05° 52' 53" E116° 14' 19"	PEB	1♂
KK-Tambunan, km 59, Rafflesia C.	N05° 47' E116° 21'	FRCS, BORN	1♂, 1♂n
Crocker Range. [Centre of Park]	N05° 35' E116° 05'	FRCS, SP/EDC, BORN	4♂, 2♀, 3♂, 1♀, 1♂n
Danum Valley	N04° 55' E117° 40'	BORN	1♀, ♀n.
Gunung Maria [Kawasan]	N04° 26' E117° 57'	SP/EDC	1♂, 1♀
Imbak, Telupid District	N05° 03' E117° 07'	SP/EDC	1♂
Kawag Forest Reserve	N05° 03' 02" E117° 59' 00"	PEB	4♀♀, 1♀
Kalumpang, Kunak	N04° 25' E118° 10'	FRCS	2♂♂
Labuan Island	N05° 20' E115° 13'	Hebard, 1929	3♀♀
Lobong-Lobong	N06° 04' E116° 28'	SP/EDC	1♀
Mahua	N05° 47' E116° 26'	SP/EDC	1♂n, 1♂, 2♀, 2♂n
Mamut, Ranau	N06° 02' E116° 39'	SP/EDC	1♂, 1♀n
Mt. Kinabalu: Kamborangah 7000ft	N06° 02' E116° 33'	Hanitsch, 1933b	
Mt. Kinabalu: Kiau, 3000ft	N06° 02' E116° 30'	Hanitsch, 1933b	5♂♂
Mt. Kinabalu: Lumu Lumu 5500ft	N06° 01' E116° 32'	Hanitsch, 1933b	10♀♀
Mt. Kinabalu: Marei Parei 5000ft	N06° 05' E116° 31'	Hanitsch, 1933b	
Mt. Kinabalu: Park HQ area	N06° 00' E116° 33'	PEB, SP/EDC	5♂♂, 2, 1n.
Mt. Kinabalu: Mesilau substation	N06° 03' E116° 36'	SP/EDC	2♂♂, 1♂n, 7♀
Mt. Kinabalu: Monggis substation	N06° 12' E116° 46'	*SP/EDC	1♂
Mt. Kinabalu: Sayap substation	N06° 10' E116° 34'	SP/EDC	1♂n
Mt. Kinabalu: Serinsim (Marak Parak)	N06° 19' E116° 44'	SP/EDC, BORN	1♂ 1♀
Mt. Silam	N04° 58' E118° 10'	PEB	1♂ 1♀
Nalumad, Ranau District	N06° 06' E116° 45'	SP/EDC	1♂
Papar, Ulu Kimanis	N05° 34' E115° 57'	BORN	1♂, ♀n,
Poring Hot Springs	N06° 02' 46" E116° 42' 10"	PEB, SP/EDC	1♂, 1♂, 2♀, 1♂n
Sepilok	N05° 52' 37" E117° 56' 55"	PEB, FRCS	3♂ 2♀ 3♂n 1♀n
Simpangan, Tuaran (batu 24)	N06° 13' E116° 13'	BORN	1(sex unrecorded)
Sipitang, Mendolong (= Mendulong)	N04° 55' E115° 46'	Roth, 1999	1♂
Tabin Wildlife Reserve	N05° 16' E118° 39'	BORN	1♂, 1♂,
Tawau Hills Park	N04° 28' E117° 55'	SP/EDC	1♂, 1n, 1♂, 4♀
Trus Madi	N05° 33' E116° 31'	SP/EDC, BORN	1♂n, 1♂, 2♀, ♀n
SARAWAK			
Bako National Park	N01° 43' E110° 27'	Roth, 1999	1♂
Banting	N01° 17' E111° 12'	Hanitsch, 1915	?♂♂, ?♀♀
Kelabit country [Bario =Bareo]	N03° 44' E115° 28'	Hanitsch, 1925	1♂
Kuching	N01° 33' E110° 21'	Hebard, 1929, SMSM	1♂, 4♀♀
Limbang	N04° 45' E115° 00'	SMSM	1♀
Matang	N01° 35' E110° 13'	SMSM	1n
Mt. Dulit	N03° 22' E114° 10'	Hanitsch, 1925	3♂♂
Mt. Murud	N03° 54' E115° 29'	Hanitsch, 1925	1♂, 3♂♂ 5♀♀
Mt. Poe (=Poi = Pueh)	N01° 48' E109° 41'	Hanitsch, 1915	1♂, 1♀
Mt. Santubong	N01° 44' E110° 20'	PEB	1♂n
Terusan	N01° 28' E111° 25'	SMSM	1♀
Tutau River (= Sungai Tutah)	N03° 59' E114° 40'	Hanitsch, 1925	1♂, 1♀

The male genitalia were removed by a method similar to that outlined by Roth (1969) for the genitalia of *Blaberus* spp. Although *Catara* is much smaller than *Blaberus*, Roth's method proved suitable. Specimens had the abdomen soaked in water for several hours. The abdomen was slit along the lateral membranes on each side using a scalpel, and the genitalia carefully removed with a pair of fine forceps. The abdominal tergites were then replaced in their original positions and the specimen left to dry; this method leaves the insect externally intact and is preferable to the alternative method of removing the end of the abdomen and mounting the subgenital and supra anal plates on a slide. After removal, the genitalia were cleared in 10% Potassium hydroxide (KOH), washed in water (1 hour), and washed twice in 100% ethanol (1 hour each). The genitalia were then spread on a 25 mm square cover slip, mounted in Euparal, and covered with a 19 mm diameter circular cover slip. When dried, the glass was sandwiched between two pieces of thin card with a 20 mm diameter hole in them; the card was then pinned below the data label on the specimen.

After preparing several slides, it became clear that dissection and removal of the genitalia was not necessary. The apex of the left phallomere can often be examined *in situ* just by soaking the abdomen in water, then placing the specimen on its back and lifting the subgenital plate with fine forceps or a pin (Figures 3A & 3B). It was also found that the apex of the left phallomere can be seen dorsally in a dried specimen which has both wings open.

The website iNaturalist was searched for photographic records of *Catara* from Borneo. Records without precise localities, or with photographs that did not allow species identification with a reasonable degree of confidence, were discounted. The data from iNaturalist is presented as decimal degrees in Table 2 (as used in iNaturalist). Distribution maps were plotted using the online program Simplemapp (Shorthouse 2010). Photographs were taken using a Canon EOS 350D digital camera with a 60 mm macro lens, and a cheap (unbranded) microscope camera.

Table 2. Photographic records from iNaturalist; *C. minor* in red, *C. rugosicollis* in black.

Locality		Latitude & Longitude	iNaturalist user name	Sex
BRUNEI	Liang	N04.665859 E114.493117	jungle_johnny	1♂
KALIMANTAN	Kapuas, Kabupaten	S02.148552 E114.447391	isabetabug	1♂
	Kapuas R., Mantangai, Katunjung	S02.153444 E114.442617	andrew_aldercotte	1♀
SABAH	Kapuas R., Batuah	S02.992149 E114.308697	roktaviani	1♀
	Crocker Range, near Keningau	N05.404522 E116.103403	mihail_omelko	1♂
	Crocker Range, near Papar	N05.489375 E116.018251	botalex	1♂
	Kinabalu Park	N06.008142 E116.537956	jessat	1♀
		N06.007836 E116.542604	galois	1♂
		N06.012693 E116.540326	yah_japan	2♀, 1♂
		N06.050088 E116.701852	slowwakey	1♀
	Lahad Datu District	N04.961547 E117.801667	twan3253	1♀
	Lahad Datu	N04.968452 E117.801468	ottob-c	1♂
	Danum Valley	N04.96184 E117.689217	bentsai	1♀
SARAWAK	Kota Belud	N06.256214 E116.53138	albertkang	1♂
	Tawau	N04.398934 E117.886803	jamesmifan	1♀
	Tawau Hills Park	N04.399093 E117.889196	hobatahalmahera	1♀
	Bako NP	N01.724593 E110.470276	huang-shin-chun	1♂
		N01.714291 E110.445487	nakarb	1♀
	Bintangor	N02.070316 E111.631058	dedywijaya_abdullah	1♀

Kuching, Petra Jaya	N01.605317 E110.189705	cclborneo	1♀
	N01.752856 E110.320372	sullivanribbit	1♂
Lundu, Gunung Gading	N01.692659 E109.843946	kinmatsu	1♂, 1♀
	N01.692283 E109.844153	sullivanribbit	2♀
Mulu NP	N04.04328 E114.81732	stanimiradeleva	1♀
Lorong Kota Padawan	N01.127976 E110.218402	nickybay	1♀

After analysis of the initial data outlined above, a further collection was made by Bragg & Loach in November and December 2023 at several sites in Sabah; the collections at Kinabalu Park (SP/EDC) and Universiti Malaysia Sabah (BORN) were examined and data recorded. In January 2024, Bragg visited the Sarawak Museum and examined the specimens recorded by Hanitsch (1925) and some previously unrecorded specimens.

RESULTS

Members of this genus are quite easy to distinguish from most other cockroaches that occur in Borneo. Both sexes have distinctive wide black & white stripes on the antennae. Males have long, black, slender wings that lie very flat on the body, the wings are exceptionally long: about one and a half times the body length. The wings can fade to brown in preserved specimens (Figure 2C), this may be due to bleaching by sunlight, or perhaps just degradation of pigments with time. Females are completely wingless with a relatively short, fat body, which may appear to be almost hemispherical. The ease of identification is reflected in the 56 observations recorded on the iNaturalist website (iNaturalist 2023), many of which are for Borneo. The identification of the specimens on iNaturalist cannot be verified but observations which appear to be identifiable to species from the photographs are listed in Table 2 and are plotted on the distribution maps in yellow.

Although the females of the two species are fairly easy to distinguish, the males are difficult to distinguish. Females have large tubercles on the dorsal surface of the abdomen in *rugosicollis*; the abdomen of *minor* is almost smooth. Males of *minor* have a punctulate pronotum with a relatively smooth posterior margin, those of *rugosicollis* have some raised tubercles on the posterior of the pronotum (Figure 4); however, it can be difficult to identify the males without close examination and preferably confirmation by examination of the genitalia. Nymphs of the two species can be distinguished by the presence or absence of tubercles on the dorsal surface of the abdomen as in the case of females.

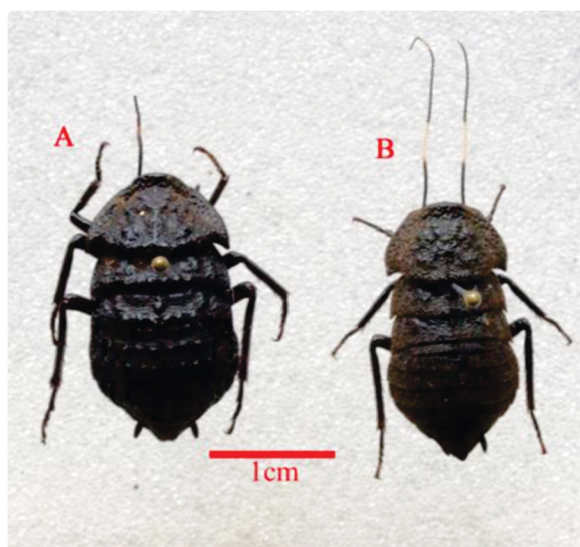


Figure 1. *Catara* females: A. *C. rugosicollis*, B. *C. minor*.

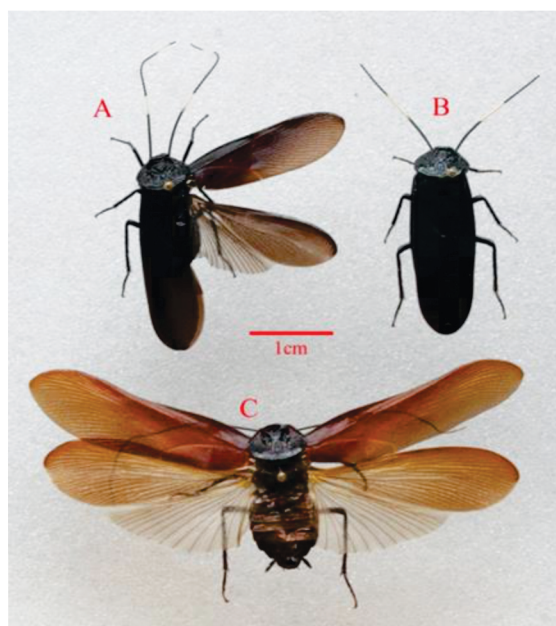


Figure 2. *Catara minor* males – A. Mt. Silam, B. Sepilok, C. Mt Kinabalu (faded to brown).

Taxonomy

Until very recently, the genus *Catara* and two other Bornean genera: *Protagonista* Shelford, 1908 and *Eroblatta* Shelford, 1910 were placed in the subfamily Archiblattinae within the family Blattidae. Wang *et al.* (2016: 58) discussed the taxonomy of Archiblattinae saying “The subfamily Archiblattinae has a controversial taxonomic history since it was established” but concluding “we propose to retain the validity of the subfamily Archiblattinae”. However, recently Archiblattinae was synonymised with Blattinae based on a phylogenetic study by Deng *et al.* (2023).

Regardless of the phylogenetic position of these genera, these three remain morphologically distinct from the rest of the Blattinae which occur in Borneo. They are characterised by having a pronotum which is hardened and rugose or deeply punctate, with sides that are thickened, and by the tibiae which are notably cylindrical with very few spines. There are currently only five Bornean species in this group: two *Catara*, one *Eroblatta* and two *Protagonista*.

Key to “Archiblattinae” of Borneo

1. Posterior metatarsus about equal in length to the remaining joints; wings of the male protrude beyond the end of the abdomen by at least one third of their length..... *Catara*
Walker, 1868.
- Posterior metatarsus considerably longer than the remaining joints..... 2

2. Spines on outer surface of hind tibia arranged in 2 rows..... *Protagonista* Shelford, 1908.
 - Spines on outer surface of hind tibia arranged in 3 rows.....*Eroblatta* Shelford, 1910.

***Catara* Walker, 1868**

Catara Walker, 1868: 52. Type species: *Catara rugicollis* Walker, 1868 by monotypy [= *Catara rugosicollis* (Brunner, 1865)].

Shelford (1910: 21) gives the following description of the genus: Male with tegmina & wings fully developed. Female completely aperiodous. Antennae slightly incrassated. Pronotum rugose; sub-discoïdal anteriorly truncate in the male; subcucullate, posteriorly truncate, and with the posterior angles produced in the female. Supra-anal lamina of male sub-transverse; genital styles small. Cerci short and obtuse. Femora almost entirely unarmed. Tibial spines small and few in number, biserially arranged on the outer aspect of the tibiae. Tarsi unarmed beneath; posterior metatarsus equal in length to the remaining joints, its pulvillus apical, the remaining pulvilli large. Areolia small.

Key to species of *Catara*

- Female with large tubercles on the hind margin of the abdominal tergites. Male with tubercles on the hind margin of the pronotum; Left phallomere with a broad, flattened (dagger-shaped) appendage near the apical hook..... *C. rugosicollis*
- Female with dorsal surface of abdomen more or less smooth. Male with the pronotum more or less uniformly punctate, without obvious tubercles on the hind margin. Left phallomere with a narrow, cylindrical (stiletto-shaped) appendage near the apical hook..... *C. minor*

The male genitalia can be used to distinguish the males of the two species. Princis (1950: 166, Figures 9 & 10) illustrated the apex of the left phallomere of both species. However, he did not explain the three dimensional nature of the apices and his illustrations are consequently difficult to interpret. The left phallomere is strongly sclerotised and has an apical hook, it is almost uniformly dark brown; the hook points towards the dorsal surface of the insect. The apex of the phallomere also has an appendage which is more or less a straight continuation of the phallomere where the apical hook begins; the appendage is less heavily sclerotised and is paler in colour. The shape of the appendage is characteristic of the species. *Catara minor* has an appendage that is uniformly slender (Figures 3A & 3C); that of *rugosicollis* is dorsoventrally flattened, forming a dagger shape (Figures 3B & 3D).

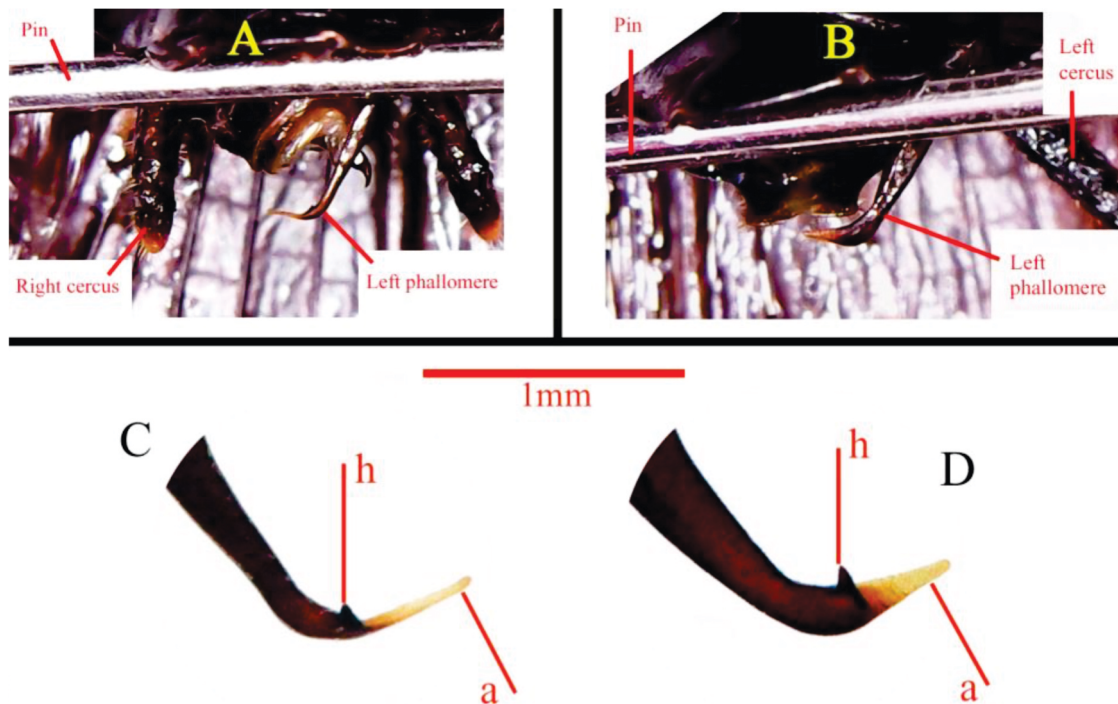


Figure 3. *Catara* males: **A&B.** Ventral view of apex of abdomen with subgenital plate lifted; **C&D.** Dorsal view of apex of left phallomere. **A&C.** *Catara minor*; **B&D.** *Catara rugosicollis*.

The apex of the phallomere can be examined without the need to dissect the genitalia. All that is necessary is to soften a dried specimen, or examine a fresh specimen, place the insect on its back and lift the sub-anal plate. The appendage of the phallomere should then be visible pointing to the right side of the insect; the apical hook is hidden as it points towards the dorsal surface (Figures 3A & 3B).

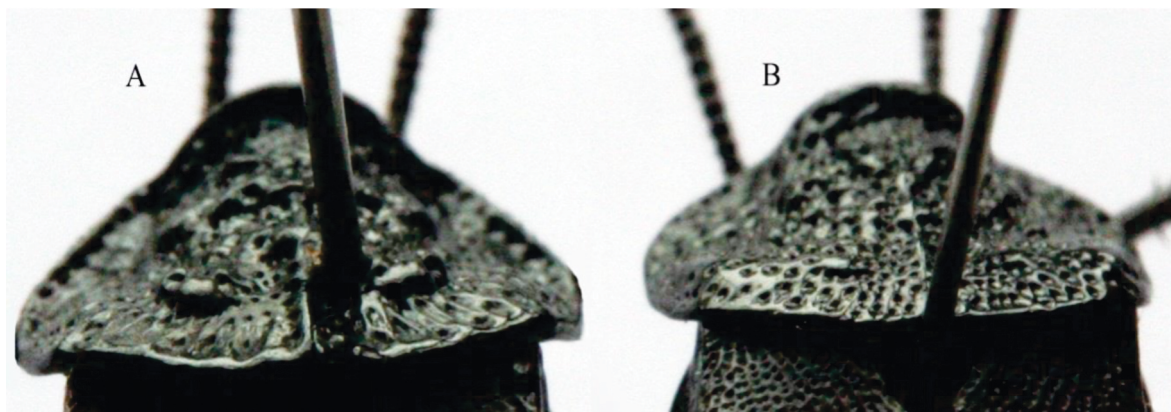


Figure 4. A. *Catara rugosicollis* pronotum of male. B. *Catara minor* pronotum of male.

***Catara minor* Krauss, 1902**

Catara minor Krauss, 1902: 753 (111), pl. 67.3 67.3A, 67.3B. STs: ♂♂♀♀ & nymphs (PIMJ) Tjibodas, Java.; Kirby, 1910: 564; Hanitsch, 1915: 118; Koningsberger, 1915: 605; Hanitsch, 1923: 466; Hanitsch, 1925: 97; Caudell, 1927: 4; Hebard, 1929: 85; Princis, 1950: 168, fig. 10 (♂ genitalia); Princis, 1965: 388.

There are only five published records of specimens of this species; four of these are for Java, and one for Borneo. The Javan records are all for Tjibodas (= Cibodas) on Mt. Gede by Krauss (1902), Caudell (1927), Hebard (1929), and Princis (1950); Caudell's record also includes specimens from Buitenzorg (= Bogor). Only Krauss recorded adult males. The source of the genitalia illustrated by Princis (1950, Figure 10) in his paper on specimens in the Lund Museum is not stated, presumably he used material from another museum without recording the data.

The only published record for Borneo is by Hanitsch (1925) who recorded a single male from 6,500 ft on Mt. Murud, Sarawak. Examination of this specimen in SMSM by Bragg confirmed Hanitsch had identified the specimen correctly.

Specimen data:

SABAH, Kinabalu Park, between Park HQ and Power station. 1♂ (PEB) P.E. Bragg, 21.viii.2001, 1♂ (PEB) 26.viii.2001.
 SABAH, Crocker Range, Kota Kinabalu-Tambunan road. N05° 52' 53" E116° 14' 19". 436m. 1♂ (PEB) P.E. Bragg, 30.ix.2022.
 SABAH, Crocker Range, Inobong Sub-station. N05° 50' E116° 09'. 2♂♂ (PEB), 1♂ (KNP) P.E. Bragg, 17.x.2022.
 SABAH, Poring Hot Springs. N06° 02' 46" E116° 42' 10". 500m. 1♂ (PEB) P.E. Bragg, 04.x.2022.
 SABAH, Mt. Silam. N04° 58' E118° 10'. 1♂ (PEB) P.E. Bragg, 09.x.2022.
 SABAH, Mt. Silam. N04° 57' 55" E118° 10' 30", Summit path, 700-912m. 1♀ (PEB) P.E. Bragg & J.M. Loach, 27.xi.2023.
 SABAH, Sepilok, Rainforest Discovery Centre. N05° 52' 37" E117° 56' 55". 1♂, 1♀ (PEB) P.E. Bragg, 14.x.2022; 1♂n (PEB) P.E. Bragg, 15.x.2022; 1♂n, 1♀n (PEB) P.E. Bragg & J.M. Loach, 25.xi.2023; 1♂, 1♂n (PEB) P.E. Bragg & J.M. Loach, 30.xi.2023.
 SABAH, Kawag F.R. N05° 03' 02" E117° 59' 00". 1♀ (PEB) P.E. Bragg, 11.x.2022; 2♀♀ (PEB), 1♀ (FRCS) P.E. Bragg, 12.x.2022.
 SABAH, Kawag F.R. 1♂ (FRCS), 1♂ (PEB) Captive reared in UK by P.E. Bragg, 2023.
 SABAH, Kawag F.R. 1♀n (PEB) Captive reared in UK by J.M. Loach, 2023.
 SABAH, Kalumpang, Kunak. 1♂ (FRCS) Louis, 23.vii.1970. 1♂ (FRCS) Louis, 24.vii.1970.
 SABAH, Sepilok Lout ♂, ♀ (FRCS) Ento Staff, viii.1994.
 SABAH, Tambunan, VJR Rafflesia. ♀ (FRCS) Arthur C., iv.1994.
 SABAH, Crocker Range. ♂ (FRCS) Forestry Entomology Staff, vii.1993.
 SABAH, Crocker Range Park. ♂ (SP/EDC/00147) E'logi Unit TS, Light trap, 29.iii.1996.
 SABAH, Crocker Range N.P. ♀ (BORN, BLAT-00400) ITO Gen., 14-16.x.1999.
 SABAH, Crocker Range Park. 2♂♂ (SP/EDC/00149 & SP/EDC/00150) Sinail D., 02-12.iv.2004.
 SABAH, Crocker Range Park. ♀ (SP/EDC/00375) Johny Lapidin, 03.ix.2005.
 SABAH, Expedisi Mamut Ranau, Alt. 1500m. ♂ (SP/EDC/00671) Jennifer S., 19-30.ix.2022.
 SABAH, Expedisi Mamut Ranau, Alt. 1500m. ♀n (SP/EDC/00669) Johny Lapidin, 19-30.ix.2022.
 SABAH, KNP PHQ 1450m. ♂ (SP/EDC/00145) David S., 22.iv.2003.
 SABAH, PHQ Kinabalu. ♂ (SP/EDC/00161) Ferdinan, 06.iii.1998.
 SABAH, KNP HQ, 1500m. ♂ (SP/EDC/00155) T. Kikuta, 25.viii.1993.
 SABAH, Head Quarters, 1500m. 1n (SP/EDC/00339) Toru Kikuta, 06.i.1993.
 SABAH, Eksplorasi PHQ, Silau Silau trail, 1600m. ♀ (SP/EDC/00549) Staff Entomologi, 05.iii.2009.
 SABAH, Eksplorasi PHQ, 1400-1600m. ♀ (SP/EDC/00353) Yusilie Kumin, 21-22.ix.2004.
 SABAH, Inobong Substation, 500m. ♂ (SP/EDC/00470) Yusilie Kumin, 12-13.vii.2007.
 SABAH, Tawau Hills Park, 300m. ♂ (SP/EDC/00547) Yusilie Kumin, 12-17.i.2006.

SABAH, Tawau, T.N. Bukit Tawau. 1n (BORN, BLAT-00226) Nordin Wahid Kg, 01.xii.1989.
 SABAH, XPDC Imbak Telupid. ♂ (SP/EDC/00148) Sinail Dunsil, 09-17.v.2004.
 SABAH, Tuaran, Kampung Simpangan, batu 24. (BORN, BLAT00227) Saming Hussin, 02.iv.1988.
 SABAH, YS-ITM. ♂n (BORN, BLAT-00212) Fathia H., 21.ix.1987.
 SABAH, Danum Valley. ♀ (BORN, BLAT00560) K. Maekawa, 03.x.1996. “*Catara rugosicollis* (Brunner)”.
 SABAH, DVFC. ♀n (BORN, BLAT00821) K. Mamuai, Hamin, 22.viii.[19]94. [data difficult to read].
 SABAH, Lahad Datu, Tabin, Km21. ♂ (BORN, BLAT00720) W. Nordin, 16.iii.1998.
 SABAH, Kinabalu Park, Serinsim Substation, Ulu Marudu. ♀ (BORN) Ricky Shearer Richard, 01.x.2023.
 SABAH, Serinsim K.M. ♂ (SP/EDC/00154) Patrick G., 11.v.1995.
 SABAH, Kinabalu Park, Denai Serinsim – Monggis. ♂ (SP/EDC/00555) Sinail Dunsul, 22.iv.2010.
 SABAH, Kotal’s Route Trail, Kinabalu Park, 2100m. ♀ (SP/EDC/00350) Johny Lapidin, iv.2005.
 SABAH, Eksplorasi Mesilau, 1936m. ♂n (SP/EDC/00476), ♀ (SP/EDC/00475) Yusilie Kumin, 07-08.ix.2007.
 SABAH, Eksplorasi Mesilau. ♀ (SP/EDC/00467) Yusilie Kumin, 11-12.v.2007.
 SABAH, Eksplorasi Mesilau. ♀ (SP/EDC/00465) Wahimah S., 11-12.iv.2007.
 SABAH, Eksplorasi Mesilau. ♀ (SP/EDC/00479) Wahimah S., 19-20.iii.2008.
 SABAH, Mesilau Nature Park, 1800m. ♀ (SP/EDC/00346), ♀ (SP/EDC/00349) Johny Lapidin, 01-04.iv.2005.
 SABAH, Kinabalu Park, Mesilau Nature Park, 1800m. ♂ (SP/EDC/00151) Johnny Lapidin, 01-04.iv.2005.
 SABAH, Kinabalu Park, Mesilau Sub-Station. ♂ (SP/EDC/00473) Johnny Lapidin, 30.xi.2007.
 SABAH, Lobong-Lobong. ♀ (SP/EDC/00356) Yuslie K. 22.vii.1995.
 SABAH, Ekspedisi Pck Mahua, 1730-2032. ♂n (SP/EDC/00354) Wahimah S., 25-30.viii.2003.
 SABAH, Sayap, 1000m. ♂n (SP/EDC/00340) T. Kikuta, 21.x.1992.
 SABAH, Ekspidisi Trus Madi. 1n (SP/EDC/00342) Yusilie K., 31.x.2001.

The male specimens collected by Bragg in 2022 were all found resting on vegetation, either leaves or branches, at heights between about 30 cm and 2 m above the ground. This is likely to be a product of the collecting method rather than a reliable assessment of where the males occur. The females at Kawag were all found within 20 m of the resthouse, one was found on the wall of the resthouse about 40 cm above the ground, the remainder were found on low growing vegetation, less than 30 cm tall, under trees growing on a slope at the side of the resthouse. One female was preserved immediately, several others were kept alive to attempt rearing and three of these were subsequently preserved; two or three specimens died and rotted before they could be preserved. The female from Sepilok was found at ground level.

An ootheca was produced by one female within about a week of capture. Fifteen nymphs hatched on 04.xii.2022 from an ootheca but it is not known if this hatching was from the first ootheca to be laid.



Figure 5. *Catara minor*, female.



Figure 6. *Catara minor*, male.

***Catara rugosicollis* (Brunner 1865)**

Deropeltis rugosicollis Brunner, 1865: 245. HT ♂ (ISNB) Java(?).

Catara rugosicollis (Brunner, 1865); Kirby, 1904: 148; Shelford, 1910: 22, pl. 2.19(♀); Hanitsch, 1915: 117, pl. 5.26(♂) & 5.27(♀); Hanitsch, 1923a: 210; Hanitsch, 1923b: 442; Hanitsch, 1925: 97; Karny, 1925: 189, fig. 4 (♀); Hebard, 1929: 85; Hanitsch, 1932: 76; Hanitsch, 1933a: 234; Hanitsch, 1933b: 327; Bruijning, 1948: 118; Princis, 1950: 168, fig. 9 (♂ genitalia); Princis, 1957: 94; Princis, 1965: 387; Roth, 1999: 177. = *Catara rugicollis* Walker, 1868: 53. LT ♂ (BMNH, 57-36) Sarawak. Wallace. "PLT ♂ "Borneo"; 1 ♂ "?" [no locality], 2 ♀♀ Sarawak. [LT selection by Princis, 1957: 94 – he labelled the LT in BMNH although did not give the data in his publication].

Synonymised with *rugosicollis* by Kirby, 1904: 148.

= *Archiblatta valvularia* Saussure, 1873: 118, fig. 40(♀). HT ♀ (ISNB) Java; Brunner, 1898: 200. Synonymised with *rugosicollis* by Kirby, 1904: 148.

Specimen data:

BRUNEI, Teraja, Waterfall trail. 1 ♂ (PEB) P.E. Bragg, 05.xi.1994.

KALIMANTAN, Kelembekari, Setia Alam Jaya Logging camp, in the camp. 1 ♀n (PEB) P. Jenkins, viii.1994.

KALIMANTAN, Mt. Bawang, near Madi village. 1 ♀ (PEB) Local collector, vii.2018. [purchased 2023].

SABAH, Kawag F.R. N05° 03' 02" E117° 59' 00". 1 ♀ (FRCS) P.E. Bragg, 11.x.2022.

SABAH, Crocker Range. ♂ (FRCS) Forestry Entomology Staff, vii.1993.

SABAH, Poring Springs. N06° 02' 52" E116° 42' 09". 2 ♀♀, 1 ♀n (PEB) P.E. Bragg & J.M. Loach, 12.xi.2023.

SABAH, Tawau Hills Park, 300m. ♂ (SP/EDC/00153) David S. 02.ix.2002.

SABAH, Tawau, 100m. ♀ (SP/EDC/00347) T. Kikuta, 04.ii.1993.

SABAH, Tawau Hill Park. ♀ (SP/EDC/00343) Wahimah S., 27.viii.2000; ♀ (SP/EDC/00344) Wahimah S., 28.viii.2000.

SABAH, Ekspedisi Taman Bukit Tawau, Km 0.5, 867m. ♀ (SP/EDC/00433) Yusilie Kumin, 19.ii.2007.

SABAH, Crocker Range Park. ♂ (SP/EDC/00394) 07-12.ix.2006.

SABAH, Crocker Range Park. ♂ (SP/EDC/00146) Sinail D. 02-12.iv.2004.

SABAH, Crocker Range Park, 900m. ♂n (SP/EDC/00355) Yusilie Kumin, 26.v.2005.

SABAH, Crocker Range Park. ♀ (SP/EDC/00395) Yusilie Kumin, 07-12.ix.2006.

SABAH, Trus Madi, Base Camp, 1500m. ♀ (BORN, BLAT-0000036), ♀n (BORN, BLAT-0000034) ITO Gen., 30.x-07.xi.2001.
 SABAH, Trus Madi, Base Camp, 1500m. ♀ (BORN, BLAT00711) Azrie Alliamat, 23.x-07.xi.2001.
 SABAH, Trus Madi. ♂ (BORN, BLAT00448) Light trap, 09-15.ix.1996.
 SABAH, Lahad Datu, Tabin W.R. Km21. ♂ (BORN, BLAT00399) Nordin Wahid, 10-23.ii.1998.
 SABAH, Tambunan, K.K-Tambunan, Km 59, 1350m. ♂n (BORN, BLAT00916) Nordin Wahid, 28.i.1996.
 SABAH, Papar, Ulu Kimanis, Utan Paradise, Trail, 722m. N05° 29.3581' E116° 01.106'. ♂ (BORN, BLAT01122) Norizzah, 26.ii.2010.
 SABAH, Papar, Ulu Kimanis, Utan Paradise, Trail, 718m. N05° 29.358' E116° 01,117'. ♀n (BORN, BLAT01143) Shazarah, 27.ii.2010. [collector's name difficult to read].
 SABAH, Pos Kawalan Lakang, Nalumad, Ranau Taman Kinabalu, 458m. ♂ (SP/EDC00627) Yusilie Kumin, 09-14.iii.2015.
 SABAH, Ekspedisi Pck Mahua, 1730-2032m. ♂ (SP/EDC/00156), ♀ (SP/EDC/00345), ♀ (SP/EDC/00351), ♂n (SP/EDC/00352), ♂n (SP/EDC/00348) Wahimah S., 25-30.viii.2003.
 SABAH, Poring. ♂ (SP/EDC/00542) IBOY: MYPO-LTG3 Light trap, ground. 08.v.2002.
 SABAH, Eksplorasi Gunung Maria, Kawasan, 264m. ♂ (SP/EDC/00622), ♀ (SP/EDC/00624) Johny Lapidin, 07-14.iv.2014.
 SABAH, Inobong Substation, 500m. ♀ (SP/EDC/00466) Yusilie Kumin, 12-13.vii.2007.
 SABAH. ♂n (SP/EDC/00348) [no other data]
 SARAWAK, Mt Santubong, 50-300m. 1♂n (PEB) P.E. Bragg, 21.x.1994.
 SARAWAK, Terusan. ♀ (SMSM) viii.1900.
 SARAWAK, Kuching. ♀ (SMSM) viii.1898; ♀ (SMSM) 16.iii.1899.
 SARAWAK, Matang, 440ft. 1 nymph [sex not recorded] (SMSM) 11.xii.1909.
 SARAWAK, Limbang. ♀ (SMSM) 10.iv.1910.

Brunner was uncertain about the locality for the holotype and recorded it as “Java(?)”. Saussure’s type specimen of *Archiblatta valvularia* was also from Java. Hanitsch (1923a) and Hebard (1929) both state their belief that Brunner’s locality data was correct. Hanitsch (1923a) says it has “repeatedly been recorded from Java, and also from the Malay Peninsula, Singapore, Sumatra, and Borneo”. However, published specimen records from outside Borneo are limited: it is recorded from Java by Hanitsch (1923a) and by Bruijning (1948); from Malay Peninsula by Bruijning (1948); from Sumatra by Hanitsch (1932), Bruijning (1948), and Princis (1950). Singapore was listed as a locality by Kirby (1904) but without giving specimen data; presumably this was based on material in BMNH. Although not stated in his paper, the specimens of *Catara* recorded by Hanitsch (1925) are in SMSM.

The earliest record of *Catara* in Borneo is Walker’s type specimens of *Catara rugicollis* which were just recorded as from Sarawak, with no specific locality. Subsequent records for Borneo are numerous, with 24 distinct localities being recorded (Table 3), plus the “Upper Mahakkam river”: an area which contains several of the 24 more precise localities. The material recorded here adds 17 new localities.

Table 3. Comparison of historical records, and new specimens recorded prior to November 2023.

	Specimen numbers		Distinct localities	
	<i>rugosicollis</i>	<i>minor</i>	<i>rugosicollis</i>	<i>minor</i>
Historical records	115+	1	24	1
PEB & 3 FRCS records	6	19+	6	8

The female from Kawag (Figure 7) was collected on a low-growing plant on a track-side about 200 m from the area where the specimens of *C. minor* were collected. The male nymph from Santubong was found about 40 cm above ground level on the top of a low growing plant, in a wooded area. The male nymph produced a very strong smell which persisted on the hand for more than 24 hours, despite washing in soap and water. The female from Kawag produced a similar smell but it was not so long lasting, perhaps because it was washed off sooner.



Figure 7. *Catara rugosicollis*, female.

Distribution

Some of the Bornean localities recorded in the literature are rather vague and some assumptions have been necessary to plot the distribution maps. For “Kelabit country” (Hanitish 1925: 97) Bario, Sarawak has been selected as the most likely area. Princis (1950: 168) recorded two males of *rugosicollis* from “Ostborneo, Ketapan (150ft)”, attempts to locate this have been unsuccessful: the use of “Ostborneo” [East Borneo] rules out the possibility of Ketapang on the west coast (S01°51' E109°59') which is the closest name we have found. Hebard (1929) recorded “Trusan, Brunei, Borneo” as the data on a specimen from 1915; this is somewhat puzzling as the last transfer of land to Sarawak was completed in 1905 (Turnbull 1980: 167), and the transfer of Trusan valley from Brunei to Sarawak had taken place in 1884. Although it is possible that the data label may refer to the Trusan river which runs quite close to Brunei, Trusan village (in Sarawak) has been treated as the locality for the purposes of mapping the species. Bruijning (1948) recorded specimens from a rather vague “Upper Mahakkam river” based on material collected on the first Nieuwenhuis expedition in 1894; the subsequent expedition in 1898 gave specific localities on the Mahakkam river,

so those from 1894 have been disregarded when plotting the distribution map. Hebard (1929: 85) recorded a specimen of *rugosicollis* from “Lohaban, Borneo”, this is assumed to refer to Lohabang in West Kalimantan; the specimen was in Oberthur’s collection which also contained a specimen from Pontianak, West Kalimantan. Several specimens have a rather vague locality of “Crocker Range”, these records have been plotted south-east of Papar, at about the centre of the Crocker Range National Park. A female *C. minor* from “Kotal’s route trail” has grouped with those from the Mesilau substation which is the start of the trail. The locality “YS-ITM” for a *C. minor* male nymph in BORN remains unknown. The specimen of *C. minor* from “Denai Serinsim – Monggis” has been plotted mid-way between Serinsim and Monggis.

Specimens of *rugosicollis* were recorded from four sites on Mt. Kinabalu, Sabah by Hanitsch (1933b), all four localities are in close proximity to the modern day Kinabalu Park HQ. Kiau and Marei Parei are both well-known and were easily located; Lumu-Lumu and Kamborangah required some research. Lumu-Lumu is on the route between the Park HQ and the Power Station at the Timpohon Gate; it is probably derived from Lumu-nunu which is a Dusun name which means peeling bark for a tree (*Tristanopsis* sp.) which grew at what was a regular camping site for climbers in the past. Kamborangah is also on the route from the Park HQ to the summit, it is the ridge beyond the Timpohon Gate. To complicate matters, at least six different spellings have been used for this location: Kamburangau (Gibbs 1914: 36), Kamborangah (Hanitsch 1933b: 327), Kamborangoh (Lee 1996: 19), Kemburongoh (Lee 1996: map on page 20; Beaman *et al.* 1996: 495), Kemburengoh (Beaman *et al.* 1996: 495), and Kambarangoh (Wikipedia 2006). The Wikipedia spelling gave no source, so may be a modern error; we have added the alternative spellings to the Wikipedia page. Some alternative spellings for other localities are included in Table 1.

Examination of data available in early 2023 showed a striking contrast between the number of specimens of each species in the collections of FRCS and P.E. Bragg, and those in the historical records (Table 3). *Catara minor* was clearly the most common in these collections but there was only a single historical record of the species. The number of *rugosicollis* in the historical records is greater than 115; Hanitsch (1915: 118) only says “several specimens, ♂ and ♀ at Banting, Sarawak”, so only one of each sex has been included in Table 3. Bragg preserved four female *minor* from Kawag in 2022 although two or three more were collected but not preserved. Hanitsch (1933b) records 15 specimens from four areas of Mt Kinabalu (Table 3) but did not specify how many from each area; all are within a fairly small region near to the current Park HQ.

Initially, this analysis was surprising because in the historical records, only one of more than 116 specimens were *minor*, whereas the in the new records 76% were *minor* found in eight different localities. This caused some speculation about the reliability of the historical records. Various possible explanations for the differences in the data were considered.

1. Misidentification of specimens. The differences in male genitalia were only described by Princis in 1950. All other historical records pre-date the description of the genitalia so there was no known way to check males if the identification was doubtful.

2. Different collection methods. All specimens collected by Bragg were collected at night by searching vegetation by torchlight. It is very likely that the historical specimens were collected in daylight as electric torches would have been unavailable or impracticable due to the weight of batteries; all those recorded by Bruijning (1948) were collected in 1893-1898 on expeditions that lasted many months.
3. Geographical differences. Most of the historical specimens are from Sarawak or Kalimantan and are *rugosicollis*; most of the specimens examined initially were from Sabah and are *minor*. The historical records of *rugosicollis* from Sabah are 15 specimens from four sites on Mt. Kinabalu (Hanitsch 1933b). They were collected by H.M. Pendlebury in April 1929 and, although Hanitsch says “the types of the new species described [in his paper].... will be preserved in [OXUM]”, there is no mention of where the specimens of known species may be. These specimens in particular would warrant re-examination.

Misidentification is unlikely as the authors were experienced taxonomists and many of the historical specimens were female. Furthermore, three of the four authors involved: Hanitsch, Hebard, and Princis, were familiar with *minor*, having recorded specimens from outside Borneo. Differences in collecting methods is a plausible explanation but considered unlikely as both species are nocturnal. When distribution maps were plotted it became clear that *C. minor* is the dominant species in, and appears to be restricted to, North East Borneo i.e. Sabah and part of Eastern Sarawak; *C. rugosicollis* has been found throughout Borneo.

After the initial assessment, Bragg and Loach visited Sabah in 2023 to look for more evidence, both in the wild, and in museum collections; Bragg visited the Sarawak Museum in January 2024. Four more specimens of *C. minor* were found in FRCS, having been previously overlooked because they were in an incorrectly labelled drawer; numerous specimens were found in the Sabah Parks collection (SP/EDC), and numerous specimens in University Malaysia Sabah (BORN); five previously unrecorded specimens were found in SMSM.

Catara rugosicollis has been found to occur in the same vicinity as *C. minor* in nine localities: Mt. Murud, Kawag, Tabin, Tawau, Poring Hot Springs, Tambunan, Trus Madi, Mahua, and Mt Kinabalu HQ area (including Lumu-Lumu); the rather vague “Crocker Range” records are potentially a tenth locality with both species. The restricted distribution of *C. minor* is supported by the records on iNaturalist (Table 2).

The photographic records on iNaturalist are not always correctly identified, and in some cases the species cannot be identified from the photographs; in some cases only the country is given as the locality. The records are from 2017-2023; those which are clear enough to be identified with a reasonable degree of reliability, and a specific locality are in Table 2. These results clearly agree with the specimen-based distribution.

The distribution maps (Figure 8) are plotted with priority given to published records (in blue), then new specimen records (in red) and finally iNaturalist records (in yellow).

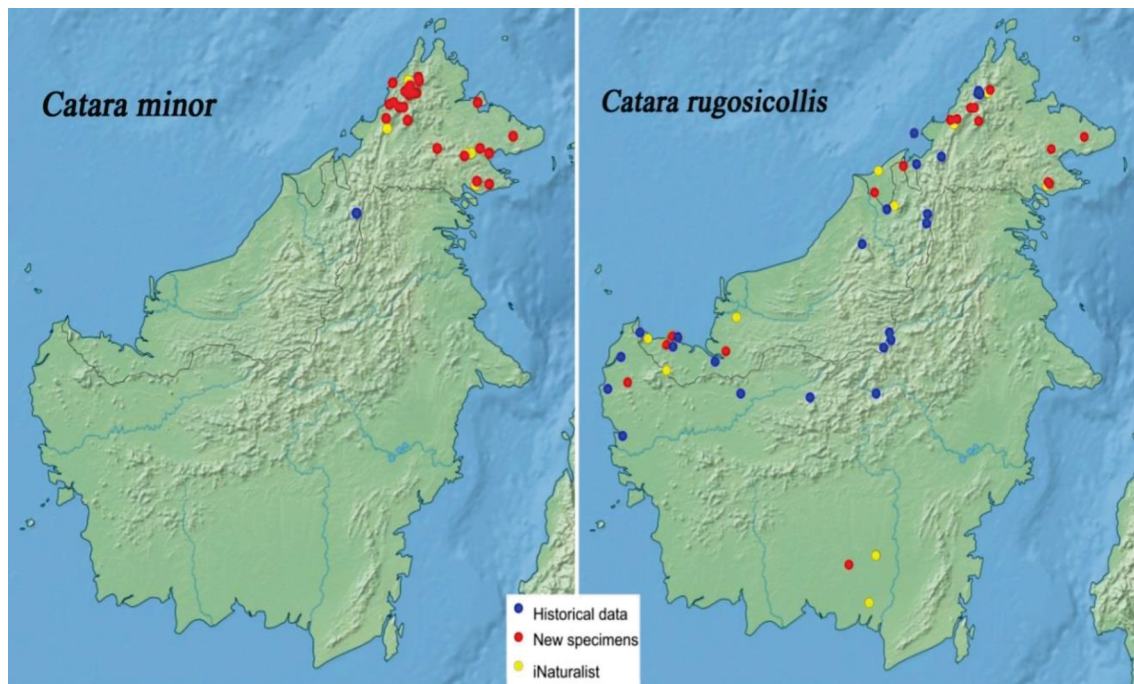


Figure 8. Distribution maps.

One male from Sarawak, Kapit (photographed by sandylingchoo) is possibly *Catara minor* but it is not possible to be certain based on the photographs of the specimen. Two photographs by albertkang, one male, one female taken on Palawan Island, Philippines are probably *C. minor*; *Catara* has not previously been recorded from the Philippines.

Rearing

Females of *C. minor* from Kawag were reared in a glass aquarium with a layer of commercial potting compost and dried leaves. A container of wet Vermiculite was placed in one corner of the cage. The lid of the cage was wooden with a large number of 25 mm diameter ventilation holes covered by mesh, the ventilation eventually proved excessive resulting in dehydration of the substrate and rearing was not very successful. Apple (*Malus domestica*), banana (*Musa acuminata*) and Kiwi fruit (*Actinidia deliciosa*) was provided as food and the cage was left more or less undisturbed. The adults survived several months and some nymphs hatched but did not thrive. After about five months, the surviving nymphs were transferred to a small plastic box with little ventilation, and mushroom (*Agaricus bisporus*) was added to their diet, thereafter a male nymph became adult and others are continuing to develop.

One of the first oothecae to be laid was given to John Loach to rear. This hatched on 04.xii.2022, a maximum of 54 days after being laid: the date of laying is not known; it was incubated at various temperatures while being transported, then kept at about 26-28°C. Fifteen nymphs hatched from the ootheca and were reared successfully as detailed below.



Figure 9. Enclosure used for rearing *Catara minor*.

The newly hatched nymphs were housed in a three litre clear plastic box with dimensions of 180 mm x 180 mm x 90 mm high; this was used throughout their development to adult. Ventilation amounting to 4.4% of the surface area was provided by two vents 45 mm in diameter, one in the top and one in the side. The ventilation holes were covered with plastic mesh with 0.4mm holes; this kept ingress of fruit flies (*Drosophila melanogaster*) and fungus gnats (*Bradysia* spp.) to a minimum. A substrate of moss peat, top soil, sphagnum moss (*Sphagnum* sp.) was used for absorption and retention of moisture. Oak (*Quercus robur*) bark, and leaves of Beech (*Fagus sylvatica*), Oak, and Sweet Chestnut (*Castanea sativa*) were provided as daytime hiding places for the insects. Humidity was maintained at 80+% by spraying with water each evening. A photo-period of 12 hours light and 12 hours dark was also provided by an LED, and a corresponding daytime temperature of 26°C, and night-time 20°C was maintained.

Shop-bought button mushrooms were the preferred diet, along with small amounts of banana, apple and fish-food flakes. Some of the sweet chestnut leaves provided as cover were also consumed. Two proprietary brands of fish-food flakes were offered to the colony. The first was made up of the following main ingredients: wheat flour, vegetable protein concentrate and dried brewer's yeast, with food values of 15% protein, 1.5% fat and 2.5% fibre. This was preferred to the second which contained less protein at 7.8% and additional Spirulina alga (*Arthrospira platensis*). This suggests that *C. minor* have, like many other Blattodea, an opportunistic approach to protein availability; this was further evidenced when they were found to consume a small piece of defrosted newborn mouse (*Mus musculus*) which was provided.

The 15 *C. minor* nymphs which hatched on 04.xii.2022 grew rapidly. At 1st instar the nymphs are 3 mm in length and a rusty red colour with distinctive white and black

banded antennae. It is not until 5th instar that they gain their full adult black colouration. No problems were experienced due to bad moulting although cannibalism during moulting was observed from the 5th instar, probably due to the increased proximity. At this stage, the animals were split into colonies of five individuals.

The first female became adult after 169 days, followed by first male adult after 181 days. Mating was first observed 16 days after the first male became adult and the first ootheca was laid four days later. Females produced an ootheca at a rate of one every 10-14 days, the oothecae have a height of about 4 mm, a width of 3 mm and a length of 7-10 mm. All oothecae were removed and incubated on vermiculate at a humidity of 80+%. The first ootheca of this generation had an incubation period of 60 days at 26°C. Twenty offsprings emerged from this ootheca.

When carrying oothecae, females roam around the enclosure searching for a suitable place to deposit their oothecae and are seen at this time to be very active during daytime. Oothecae deposition sites were often basic: most were placed underneath a leaf at ground level, or attached to the underside of the bark pieces provided. Females added various materials found in their enclosure to the outside of the ootheca.

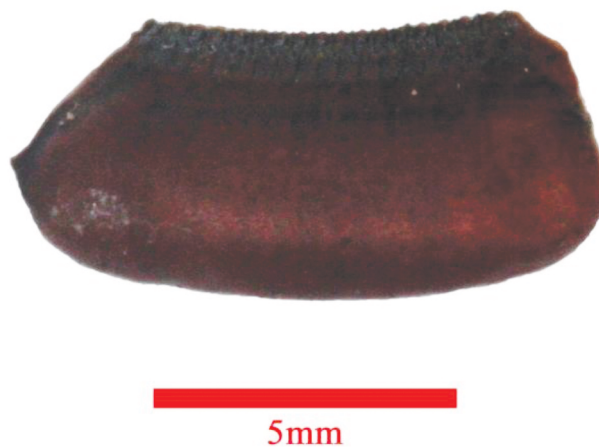


Figure 10. Ootheca of *Catara minor*.

Behaviour

In common with most cockroaches, *Catara* are predominantly nocturnal and when disturbed during night-time periods, all stages of *C. minor* will readily dart for cover. Males and females will both climb in captivity but stay under cover in daytime. Adult males are commonly found in the highest cover available in the cage both at night, and during the day. The males collected in the wild by Bragg were all found from about 0.3-2.0 m above ground level; females were all found close to ground level, with the exception of the female *C. rugosicollis* at Kawag which was about 0.5 m above the

ground. When disturbed in captivity, both males and females of *C. minor* prefer to freeze and wait for danger to move away. With any greater level of disturbance, males will readily fly, and are quite proficient at doing so.

A very strong odour was produced by *C. rugosicollis* nymphs which were handled on Mt Santubong in Sarawak; the offensive smell persisted for several days despite frequent hand washing. At Kawag in Sabah, *C. minor* was found to produce a similar smell but it was not as strong and did not last more than about 12 hours. An inoffensive odour is produced by *C. minor* in captivity which seems to be more pronounced when fed a diet containing fungi. It seems likely that the strength of the odour produced is, at least in part, dependant on diet.

CONCLUSION

Locality data from 222 specimens and 29 photographs have been examined. There is clear evidence that *Catara rugosicollis* is widespread in Borneo. *Catara minor* appears to be confined to Sabah and the East end of Sarawak. Although there is only one historical record of *C. minor* from Borneo, it is common and widespread in Sabah. Photographs posted on the website iNaturalist suggest the genus is present in the Philippines. Distinguishing the two species is easy in the females; although males can usually be distinguished by the hind margin of the pronotum, examination of the genitalia may be necessary in some cases. In captivity, mushrooms seem to be a preferred food. The defensive smell produced by *Catara* seems to be, at least partly, dependant on diet.

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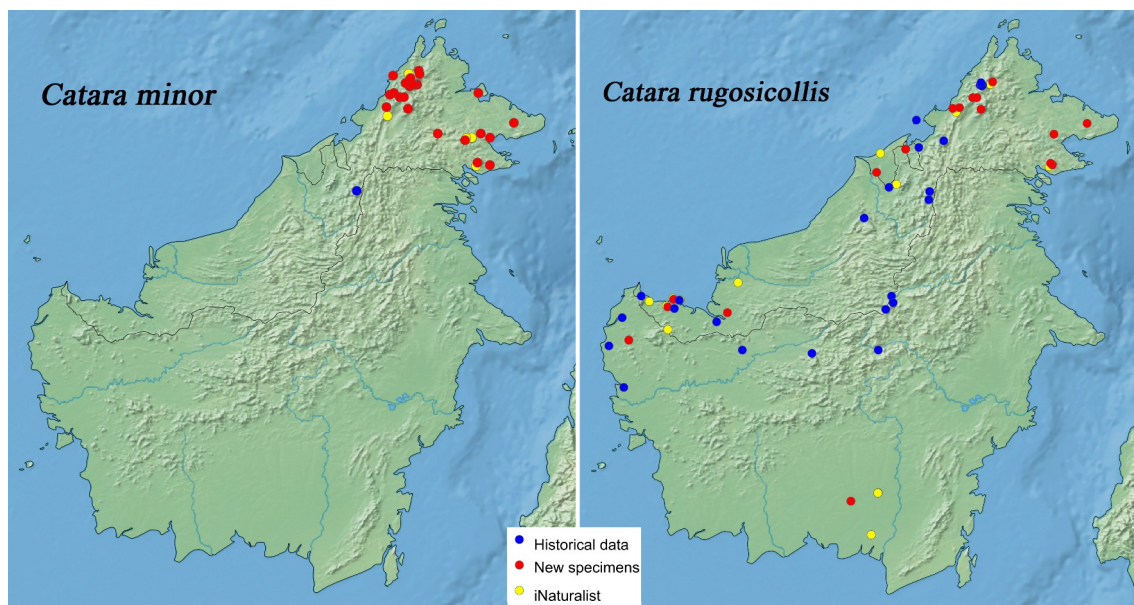
A review of the cockroach genus *Catara* Walker, 1868 from Borneo (Insecta: Blattodea: Blattidae: Blattinae).

P.E. Bragg, J.M. Loach, A.Y.C. Chung & R. Japir (2024)

Sepilok Bulletin, 33: 30-51.

Page 37. The second sentence of the paragraph below figure 3 should read: “All that is necessary is to soften a dried ~~the~~ specimen, or examine a fresh specimen, place the insect on its back and lift the sub-anal plate.”

Page 45. Due to an editing error, figure 8 was distorted. The correct figure is here.



Page 48. Due to an oversight, Dr Nazirah was omitted from the acknowledgements, add “We thank Dr Nazirah Bt. Mustaffa (UMS) for arranging access to the BORN collection.”