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RECORDS OF THE BLACK AND GOLDEN CICADA, *HUECHYS FUSCA* DISTANT, 1892 IN SINGAPORE, WITH NATURAL HISTORY OBSERVATIONS (HOMOPTERA: CICADIDAE: CICADETTINAE)

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INTRODUCTION

In Singapore, the cicada genus *Huechys* Amyot & Audinet-Serville, 1843 is represented by two species, namely: (i) *Huechys sanguinea* (de Geer, 1773) — the black and scarlet cicada — and (ii) *Huechys fusca* Distant, 1892 — the black and golden cicada (Moulton, 1923; Zaidi & Ruslan, 1997; Ali & Leong, 2009). The black and golden cicada has a typical Sundaic distribution and has been recorded from Sumatra (type locality), the Malay Peninsula (including Singapore), and Borneo (Moulton, 1923). At the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research (RMBR), National University of Singapore, representative specimens of *Huechys fusca* from Peninsular Malaysia and Singapore have been deposited (see: Material Examined, Table 1). In addition, we report our field observations on various aspects of its natural history, including emergence, bioacoustics, mating, and oviposition.

Fig. 1. Lateral view of the larval exuvia (body length: 20 mm) of *Huechys fusca*, perched under a leaf at eye-level at the Bukit Timah Nature Reserve. It was found on 28 Sep.2009 at 1735 hours. (Photograph by: Tzi Ming Leong).

Fig. 2. Dorsal view of larval exuvia (as in Fig. 1). It was collected as a voucher specimen (ZRC.6.21671, female, body length: 20 mm). Note prominent black rings circling its thoracic and abdominal segments. (Photograph by: Tzi Ming Leong).

EMERGENCE

In late Sep.2009, the characteristic buzzing calls and initial sightings of adult *Huechys fusca* were observed by MS along the Senapang Trail at the Bukit Timah Nature Reserve (BTNR), who had previously encountered them at the same site in earlier years. Repeat visits were made to this site to document the behaviour and ecology of this poorly studied species. While scanning the vegetation for vacated exuviae, a small number was found and preserved (see: Material Examined, Table 2). The first exuvia was located at eye-level on the underside of a leaf on 28 Sep.2009 at 1735 hours (Figs. 1, 2). Upon careful inspection, it was determined to be a female (ZRC.6.21671, body length: 20 mm). The exuvia was a translucent, light brown, with the posterior margins of its thoracic and abdominal segments encircled with black.

On the morning of 29 Sep.2009 (ca. 1110 hours), a recently emerged male was encountered at BTNR (Fig. 3). Its wings had been fully extended and were folded roof-wise over its body. From the anterior perspective, its eyes and frons were an attractive, golden yellow colour (Fig. 4). In time, the frons would retain its rich yellow hue, whereas its eyes would become entirely black. This adult specimen was left undisturbed, but its corresponding exuvia was retrieved as a voucher specimen (ZRC.6.21673, body length: 18 mm).

At the Upper Peirce forest, the sequence of emergence was previously documented by LYKL during the daytime, in the early 1990s, and photographed using slide film (Fig. 5). The brownish orange nymphoid larva was already perched beneath a leaf (Fig. 5a), just as in Figs. 1, 2. When most of its body had emerged from the exuvia, only the distal portion of its abdomen remained lodged within (Fig. 5b). Once the limbs had sufficiently stiffened, it arched itself upwards and forwards to grasp firmly onto its exuvia, liberating its abdomen (Fig. 5c). Its wings then quickly unraveled themselves as they raced downwards (Fig. 5d). Upon attaining their full extent, the straightened wings then adopted a roof-wise, resting angle over its body (Fig. 5e). At this point, the wings were still a pale, ghostly white.

For small species of cicadas, there appears to be a tendency for this process of emergence to occur in the morning, or daylight hours (Boulard, 2007; Ali & Leong, 2009), as opposed to the night time for larger cicada species. Based on available records from museum specimens and personal field encounters, there does not appear to be any particular time of year when this cicada species may appear predictably. Long-term monitoring of known, localised populations would help us determine the periodic intervals between the emergences of adjacent broods.

Fig. 3. A recently eclosed male cicada, perched at knee-level, encountered on the late morning of 29 Sep.2009 (ca. 1110 hours) at the Bukit Timah Nature Reserve. Its wings had achieved full extension and turned smoky gray. The wings would eventually become matt, greyish-black. The exuvia was collected as a voucher specimen (ZRC.6.21673, body length: 18 mm). (Photograph by: Tzi Ming Leong).

Fig. 4. Anterior close-up of emergent male (as in Fig. 3), viewed from the top. Note golden yellow frons and eyes. The frons would retain its yellow colour, while the eyes eventually become jet black. (Photograph by: Tzi Ming Leong).

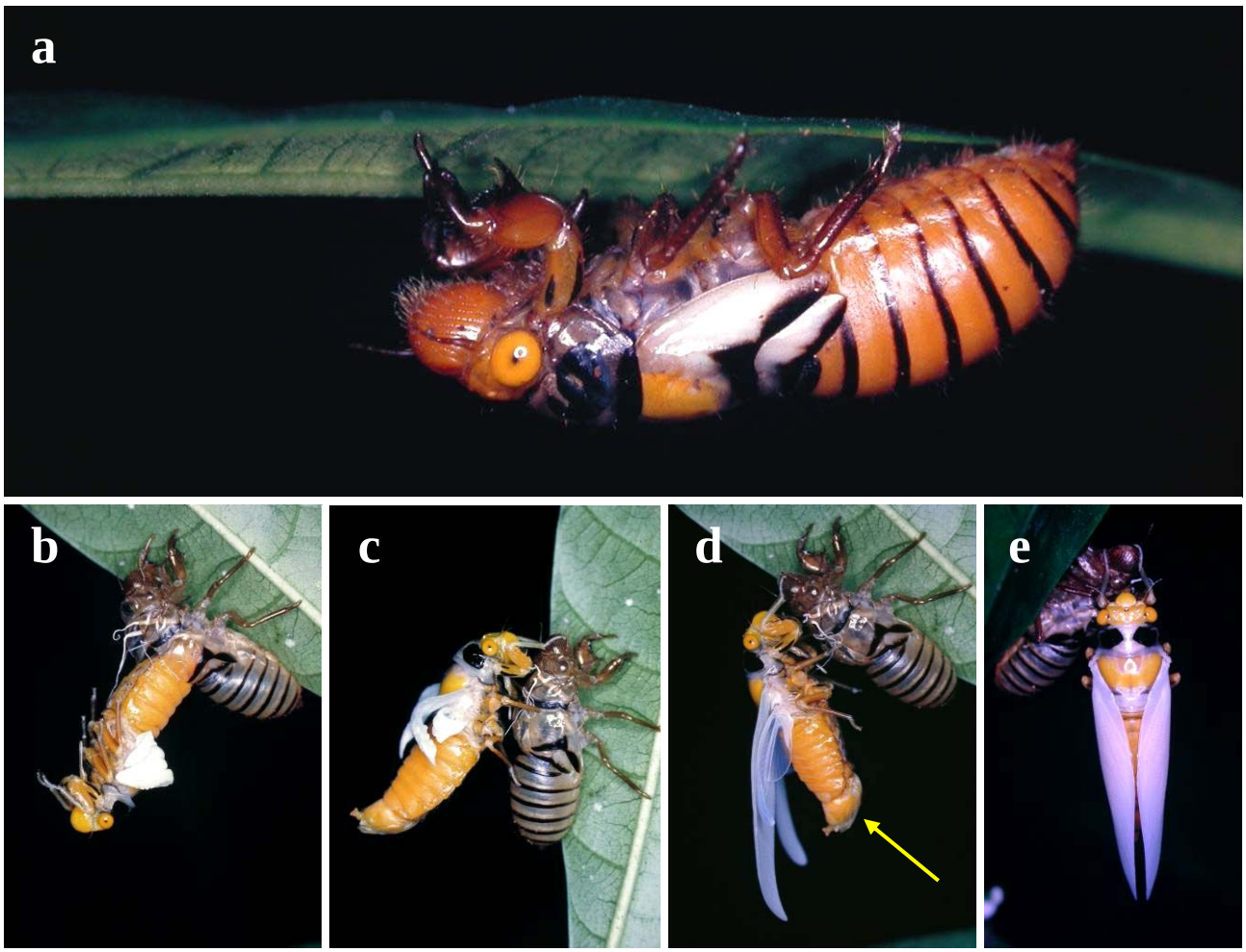

Fig. 5. In the early 1990s, an emergence sequence was witnessed at the Upper Peirce forest: (a) nymphoid larva prior to eclosion, (b) dangling by the abdomen, (c) grasping onto exuvia after liberation of entire body, (d) extension of wings, (e) folding of fully extended wings over body. The ovipositor (arrowed) confirms the cicada to be a female. (Photographs by: Laurence Y. K. Leong).

BIOACOUSTICS

Male cicadas were observed to be relatively mobile during their tymbalisation activity, rather than calling from a stationary position on a tree trunk (as witnessed in many other cicada species). They crawled around steadily along branches, over and under leaves, while emitting a continuous, high pitched buzzing song. Its typical calling posture was with wings parted and almost parallel, boldly revealing the rich yellow colour of its arched abdomen (Fig. 6). Such flamboyant behaviour is probably employed to maximise the efficiency of its visual and audio cues, intended for receptive females in the vicinity.

A number of audio recordings of its tymbalisation were made at BTNR on the 28 and 29 Sep.2009. These recordings were acquired as wav sound files with a stereo microphone (Canon S5 IS) at a sample rate of 44.1 kHz. Acoustic analysis was performed on a 15-s segment recorded on 29 Sep.2010 at ca. 1310 hours. From the spectrogram generated (Fig. 7), it could be determined that its frequency band of emission ranged between 7.8–11.9 kHz, with an intensity peak at 9.8 kHz. The call is essentially composed of constant, rapid pulses (46.7 pulses s^{-1}), but may experience transitional periods during which the pulse rate progressively declines (to 19.0 pulses s^{-1}), accompanied by a lightening of the intensity. Such 'intermission' periods typically last ca. 3 s, after which it accelerates back to the original plateau pulse rates. For *Huechys fusca*, this is possibly a first attempt to record and describe its tymbalisation for the species. The corresponding sound file (MP3 format) of this brief segment is available for download.

Comparatively, the calls of the more widespread species, *Huechys sanguinea*, have received greater attention. For example, its call has been recorded for the Taiwan populations (Chen, 2004: 174, audio CD, Track 35: 11 s). In Peninsular Malaysia, calls were recorded and analysed (with voucher specimens) from the Endau Rompin National Park in Mar.1999 (Gogala & Trilar, 2004: 70, 81; Fig. 9). In the Malaysian examples of *Huechys sanguinea*, the frequency band of emission spanned 4.5–8.5 kHz, with an intensity peak approaching 6 kHz. This proves to be relatively lower pitched than the Singapore examples of *Huechys fusca*. Nevertheless, both species of *Huechys* display a monotonous buzz that is probably consistent with the genus.

Fig. 6. An actively calling male (body length: 19 mm) observed at the Bukit Timah Nature Reserve on 29 Sep.2009 (ca. 1215 hours). As the male produces its tymbalisation, it would crawl about branches and leaves in a slow, yet deliberate fashion, adopting a characteristic posture with wings held apart to expose its pulsating, golden yellow abdomen. (Photograph by: Tzi Ming Leong).

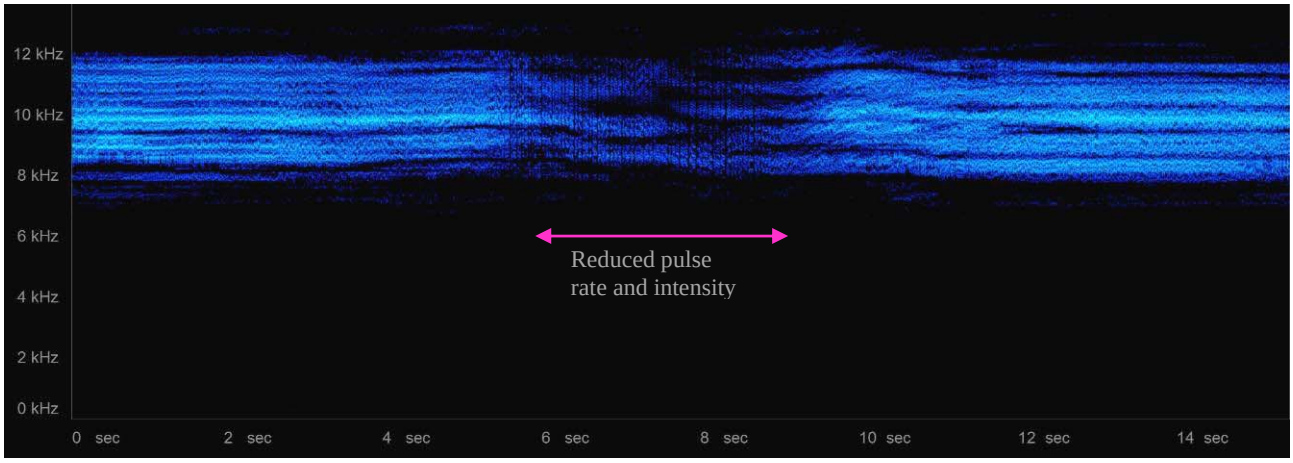

Fig. 7. Representative spectrogram of a 15-s segment of a male cicada's tymbalisation, recorded at Bukit Timah Nature Reserve on 29 Sep.2009 (ca. 1310 hours). The call is predominantly a continuous, buzzing sound composed of rapid pulses (46.7 pulses s^{-1}), but occasionally reduces its pulse rate (down to 19.0 pulses s^{-1}) and intensity for brief moments (ca. 3 s) before resuming its constant buzz. The frequency band of emission was between 7.8–11.9 kHz, with an intensity peak at 9.8 kHz. Corresponding sound file (MP3, 15 s) is available for download.

MATING

Despite intensive searching, encounters with mating pairs were few and far between. Only two sightings of such activity were witnessed (in 2009 and 2010). On 17 Oct.2009 (ca. 1715 hours), a mating pair was spotted just above head level and photographed by MS at the BTNR (Fig. 8). Their abdomens were united at the apices and their heads were facing opposite directions. Occasionally, they would crawl around on the thin stems of the young *Rhodamnia cinerea* tree they were perched upon. The pair remained joined for at least an hour. On 10 Jun.2010 (ca. 2030 hours), a mating pair was encountered at waist-level at the BTNR and photographed by SKF (Fig. 9). Upon closer inspection, it could be seen that the male genitalia was clearly everted and engaged onto that of the female. While males and females of *Huechys fusca* are mostly similar, in terms of colour patterns and general shape, there are observable differences in size, with the females tending to be marginally larger by 1–2 mm (see: Material Examined, Table 1). A similar size difference between the sexes is also recognised in *Huechys sanguinea* (Chen, 2004).

Fig. 8. On the late afternoon of 17 Oct.2009 (ca. 1715 hours), a mating pair (male: left, body length: 19 mm) was sighted at the Bukit Timah Nature Reserve. (Photograph by: Mishak Shunari).

Fig. 9. On the night of 10 Jun.2010 (ca. 2030 hours), a mating pair (male: right, body length: 18 mm) was encountered at the Bukit Timah Nature Reserve. The male genitalia was fully everted and intimately engaged onto the rear end of the female abdomen. (Photograph by: Sai Khoon Foo).

OVIPOSITION

On the afternoon of 29 Sep.2009, we were privileged to observe, at close range, the egg-laying efforts by a number of females at BTNR (Figs. 10, 11). At ca. 1225 hours, a single female had just begun its attempts to make incisions in the underside of a branch of *Syzygium polyanthum*, perched at chest-level (Fig. 10). The needle-like terebra had emerged from within the ovipositor sheath, and was employed to pierce deep into the branch, which was followed by muscular contractions of its abdomen as a portion of its fertilised eggs were transferred therein. The female then retracted its terebra and crawled a few steps forward. This routine would then be repeated along the branch for a length of ca. 6 cm. However, the entire process was laborious and painstaking, requiring many hours. This particular female only completed its oviposition after 1700 hours, whereupon it crawled up onto a leaf, noticeably exhausted. It was then retained as a voucher specimen (ZRC.6.21674, body length: 20 mm, forewing length: 23 mm).

At the same locality, two other females were observed to be sharing the same plant to deposit their eggs (ca. 1245 hours). They were perched on an inclined main stem of *Clidemia hirta* at knee-level (Fig. 11). The upper female had just begun its terebral insertion, while the lower female must have been actively ovipositing for the past hour at least. Fresh signs of terebral penetration into the stem were obvious, in the form of evenly spaced scars left in the wake of its advancement along the stem.

With further observations of the vegetation in the vicinity of this cicada population, similar looking scars could be detected in the stems and branches of other plant species. Some of these scars had already healed over and may have been more than a year old. In total, such scarring marks were found on five species of plants, including: *Rhodamnia cinerea*, *Syzygium polyanthum* (Myrtaceae), *Clidemia hirta* and *Pternandra* species (Melastomataceae), and *Cinnamomum iners* (Lauraceae).

Fig. 10. A female cicada ovipositing into the branch of a salam tree (*Syzygium polyanthum*; Myrtaceae) at chest-level at the Bukit Timah Nature Reserve on the afternoon of 29 Sep.2009 (ca. 1225 hours). Note insertion of needle-like terebra (arrowed). When the entire process of oviposition was complete after 1700 hours, the cicada was collected as a voucher specimen (ZRC.6.21674, body length: 20 mm, forewing length: 23 mm). (Photograph by: Tzi Ming Leong).

Fig. 11. Simultaneous oviposition by two female cicadas (body lengths: 20 mm) at the Bukit Timah Nature Reserve on the afternoon of 29 Sep.2009 (ca. 1245 hours). They were inserting their eggs into the main stem of Koster's curse (*Clidemia hirta*; Melastomataceae) at knee-level. Note evenly spaced scars (arrowed), freshly created by the lower female. (Photograph by: Tzi Ming Leong).

MATERIAL EXAMINED

Table 1. Specimens of adult *Huechys fusca* at the ZRC, RMBR. [PM = Peninsular Malaysia, SG = Singapore, BTNR = Bukit Timah Nature Reserve, M = male, F = female, BL = body length (mm), FW = forewing length (mm)].

Catalogue No.	Sex	BL	FW	Locality	Collector(s)	Date
ZRC.6.21662	M	18	20	PM: Pahang; Taman Negara.	B. Leonard	28 Jul.1975
ZRC.6.21663	M	19	21	PM: Pahang-Selangor; Fraser's Hill town centre.	K. Lim	4 Jun.1990
ZRC.6.21664	F	20	21	PM: Johore: Gunong 'Kulai' (probably Pulai).	unknown	17 Oct.1965
ZRC.6.21665	M	18	20	SG: Mandai Reservoir, tree felling.	D. H. Murphy	20 Nov.1967
ZRC.6.21666	F	19	21	SG: 'at house lights'.	C. P. C.	1 Jun.1970
ZRC.6.21670	M	19	18	SG: BTNR; Senapang Link, on bamboo leaves, calling at eye-level.	M. Shunari	27 Sep.2009 (1600 hours)
ZRC.6.21672	M	18	18	SG: BTNR; Senapang Link, on shrubs at groin-level.	T. M. Leong & M. Shunari	28 Sep.2009 (1615 hours)
ZRC.6.21674	F	20	23	SG: BTNR; Senapang Link, ovipositing on thin branch of *Syzygium polyanthum* at chest-level.	T. M. Leong & M. Shunari	29 Sep.2009 (1705 hours)
ZRC.6.21676	M	18	18	SG: BTNR; Senapang Link, on shrub of *Dillenia suffruticosa*, calling at eye-level.	M. Shunari	7 Oct.2009 (1115 hours)

Table 2. Specimens of *Huechys fusca* exuviae at the ZRC, RMBR. [BTNR = Bukit Timah Nature Reserve, M = male, F = female, BL = body length (mm)].

Catalogue No.	Sex	BL	Locality	Collector(s)	Date
ZRC.6.21671	F	20	BTNR: Senapang Link, under fig leaf, at eye-level.	T. M. Leong & M. Shunari	28 Sep.2009 (1735 hours)
ZRC.6.21673	M	18	BTNR: Senapang Link, beside trail, belonging to freshly emerged male, at calf-level. Adult not collected.	T. M. Leong & M. Shunari	29 Sep.2009 (1130 hours)
ZRC.6.21675	M	18	BTNR: Senapang Link, beside trail, at calf-level.	M. Shunari	3 Oct.2009 (1530 hours)

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