

SHORT REPORT

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A video clip of the biting midge *Culicoides anophelis* ingesting blood from an engorged *Anopheles* mosquito in Hainan, China

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Abstract

Background: Biting midges are hematophagous ectoparasites of insects, humans and other animals. *Culicoides (Trithicoides) anophelis* Edwards 1922 is a predator of engorged mosquitoes.

Findings: In a field trip of wild mosquito collections, *C. anophelis* was found on two *Anopheles* mosquitoes. One mosquito with a midge clinging onto its abdomen was caught on video demonstrating the act of the midge taking blood from the engorged mosquito *Anopheles vagus*. The midge *C. anophelis* has a broad host range. Documented in the literature, the midge has been found in various mosquito species in the genera *Anopheles*, *Culex*, *Aedes* and *Armigeres*.

Conclusions: A video clip was presented demonstrating a midge taking blood from an engorged mosquito. The host promiscuity of *C. anophelis* raises a concern about its potential as a mechanical or biological vector to spread viruses among mosquito populations.

Keywords: *Culicoides anophelis*, *Anopheles* mosquito, Biting midge, Video

Findings

The biting midge *Culicoides (Trithicoides) anophelis* Edwards is a predator of engorged mosquitoes, which was first described by Edwards in 1922 [1]. Later in 1947, Liard reported a *C. anophelis* sucking engorged blood from the abdomen of a flying mosquito *Armigeres lacuum* [2]. In the 1950s, *C. anophelis* was found on the mosquitoes in the genera *Aedes*, *Anopheles*, *Armigeres* and *Culex* mosquitoes in Hainan, China [3]. There are several reports of the midge in India [4,5]. Here we report two anopheline mosquitoes that were attacked by *C. anophelis*, and one scene was caught on video demonstrating the act of a midge taking blood from an engorged mosquito.

The observation was made in the course of a mosquito collection on the evening of August 10, 2013 in Yanfeng, Haikou, Hainan Province, China. Mosquitoes were attracted and trapped in a net trap inside which a cow was placed. The trapped mosquitoes were caught by an electronic aspirator and released into a cage and brought back to the laboratory for further processing. When sorting out mosquitoes, one mosquito was found to have a midge clinging to its abdomen (Figure 1). The mosquito was identified as *Anopheles sinensis* and the midge was identified as *C. anophelis*. The next day, another mosquito collection was carried out using the same baited trap. Among the mosquitoes collected, another mosquito was found carrying a midge. The mosquito and midge were chloroformed lightly, the mosquito was immobilised and the midge was active and hanging onto the mosquito abdomen. The mosquito and midge were placed under a stereo microscope (Nikon SMZ745T). A video was recorded with a camera (Additional file 1). On the video footage, the midge firmly attached itself to the mosquito via the mouthparts that had penetrated the

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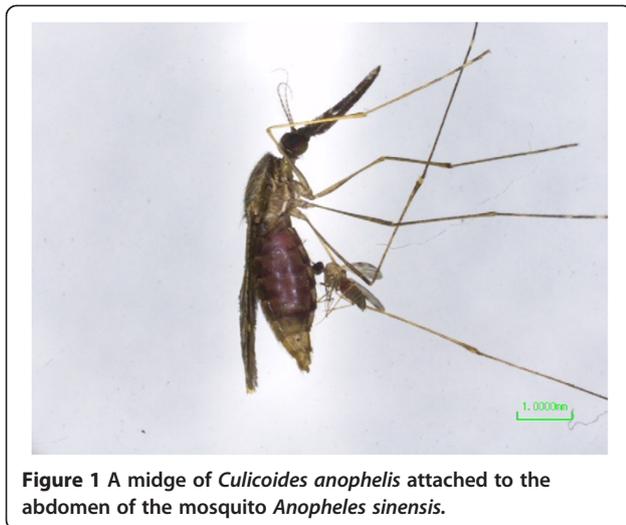


Figure 1 A midge of *Culicoides anophelis* attached to the abdomen of the mosquito *Anopheles sinensis*.

lateral part of the fourth segment of the engorged abdomen. The midge abdomen distended with blood in it. Periodically the legs were moving agitatedly. About 3 minutes later, the midge was trying to remove its mouthparts from the mosquito. It appeared difficult to unplug the proboscis, the midge rotated 180° with the mouthparts inside the abdomen and finally detached from the mosquito. The steady attachment may be attributed to the structure of the mouthparts [6,7], which ensures that midges can hang onto flying mosquitoes while ingesting blood. Documented by Edwards (1922) and Chhila and Chaudhry (2010), the midge could remain attached to its host mosquito for 48–56 hr [1,4]. The mosquito was identified as *An. vagus*, and the midge was identified as *C. anophelis* by morphology [1].

At least 19 mosquito species in the genera *Anopheles*, *Culex*, *Aedes* and *Armigeres* have been documented as hosts of *C. anophelis* (Table 1). These data indicate that *C. anophelis* has a broad host range. Furthermore, the infestation is commonly seen in the mosquito specimens in field collections [1-3]. In a recent report the midges were found on 8 of 11 (72.7%) *An. stephensi* collected in cattle sheds in India [4]. In another report from India, the prevalence of *C. anophelis* was 6.7% (87/1297) in five midge collections from April to August in 2004 [5]. Interestingly, in the same report, some of *C. anophelis* were caught directly on cattle and buffaloes, which indicates that *C. anophelis* can feed on animals other than mosquitoes [5]. Certain mosquitoes and *Culicoides* midges are vectors for arboviruses that cause human and/or animal diseases, such as mosquito-borne Dengue virus, West Nile virus, Japanese encephalitis virus, and midge-borne bluetongue virus, Oropouche virus and Schmallenberg virus [8-10]. The fact that *C. anophelis* takes blood from a broad range of mosquitoes raised a concern that the midge may serve as a mechanism for biological vectors to spread viruses among

Table 1 Mosquito species known to be infested by *C. anophelis*

Mosquito species	Reference
<i>Aedes vexans</i>	3
<i>Anopheles aconitus</i>	1
<i>Anopheles annularis</i>	2
<i>Anopheles fuliginosus</i>	1
<i>Anopheles hyrcanus</i>	1
<i>Anopheles karwari</i>	1,2
<i>Anopheles maculatus</i>	2
<i>Anopheles maculipennis</i>	2
<i>Anopheles nigerrimus</i>	2
<i>Anopheles sinensis</i>	2, 3, current
<i>Anopheles stephensi</i>	4
<i>Anopheles umbrosus</i>	1
<i>Anopheles vagus</i>	1,2,3, current
<i>Armigeres lacuum</i>	2
<i>Armigere sobturbans</i>	3
<i>Culex bitaeniorhynchus</i>	3
<i>Culex fatigans</i>	3
<i>Culex tritaeniorhynchus</i>	3
<i>Culex whitmorei</i>	3

mosquito populations. However, to the best of our knowledge, except the mosquito infestation reports, little is known about the behavior, ecology and genetics of *C. anophelis*. No data are available regarding the vector potentials for *C. anophelis*. Additionally, host preference of midges is one of the critical determinants of vector competence of midge-borne diseases [11,12]. The host preference is largely determined by blood source identification [12-17]. It might be a potential issue for midge blood meal analysis in the circumstances when *C. anophelis* specimens are present in a midge collection if specimens are not carefully identified, because the blood source of *C. anophelis* would be derived from the animals that mosquitoes feed on. The significant lack of knowledge about *C. anophelis* definitely warrants further investigations to increase the understanding of the midge.

Ethical approval

The study was carried out with the full approval of cow keepers and sampling was undertaken with approval of Yanfeng County, Haikou City, Hainan Province, China.

Additional file

Additional file 1: A midge *Culicoides anophelis* is ingesting blood from an engorged mosquito *Anopheles vagus*.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

All authors made contribution to the collection of insects. YM, JX and ZY discussed the paper structure, and JX and YM wrote the manuscript. HS edited the video. All authors read and approved the final version of the manuscript.

Acknowledgments

We thank Professor Yixin Yu in Center for Disease Control and Prevention of PLA for his confirmation of identification of the midge *Culicoides anophelis*. YM was supported by a grant of National Natural Science Foundation of China-Yunnan Joint Fund (U0932604), JX was supported by a NIH grant (1SC2GM092789-01A1).

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Received: 23 October 2013 Accepted: 11 November 2013

Published: 13 November 2013

References

1. Edwards FW: On some Malayan and other species of *Culicoides*, with a note on the genus *Lasiohelea*. *Bull Entomol Res* 1922, **13**:161–167.
2. Laird M: A ceratopogonine midge (*Culicoides anophelis* Edwards, 1922) sucking engorged blood from a mosquito (*Armigeres lacuum* Edwards, 1922) at Palmalmal, New Britain. *Trans & Proc R Soc N Z* 1947, **76**(2):158–161.
3. Chu FL: Four species of the genus *Culicoides* (Diptera: Heleidae) from Hainan island, south China. *Acta Entomol Sin* 1959, **9**(2):161–165.
4. Chhilar JS, Chaudhry S: First report of a biting midge *Culicoides anophelis* parasitizing mosquito *Anopheles stephensi* from North-western India. *J Exp Sci* 2010, **1**(12):3–6.
5. Reddy CVS, Hafeez M: Studies on certain aspects of prevalence of *Culicoides* species. *Indian J Anim Sci* 2008, **78**(2):138–142.
6. McKeever S, Wright MD, Hagan DV: Mouthparts of females of four *Culicoides* species (Diptera: ceratopogonidae). *Ann Entomol Soc Am* 1988, **81**(2):332–341.
7. Sutcliffe JF, Deepan PD: Anatomy and function of the mouthparts of the biting midge, *Culicoides sanguisuga* (Diptera: ceratopogonidae). *J Morphol* 1988, **198**(3):353–365.
8. Carpenter S, Groschup MH, Garros C, Felipe-Bauer ML, Purse BV: *Culicoides* biting midges, arboviruses and public health in Europe. *Antiviral Res* 2013, **100**(1):102–113.
9. Mellor PS, Boorman J, Baylis M: *Culicoides* biting midges: their role as arbovirus vectors. *Annu Rev Entomol* 2000, **45**:307–340.
10. Weaver SC, Reisen WK: Present and future arboviral threats. *Antiviral Res* 2010, **85**(2):328–345.
11. Ninio C, Augot D, Delecolle JC, Dufour B, Depaquit J: Contribution to the knowledge of *Culicoides* (Diptera: ceratopogonidae) host preferences in France. *Parasitol Res* 2011, **108**(3):657–663.
12. Viennet E, Garros C, Gardes L, Rakotoarivony I, Allene X, Lancelot R, Crochet D, Moullia C, Baldet T, Balenghien T: Host preferences of Palaearctic *Culicoides* biting midges: implications for transmission of orbiviruses. *Med Vet Entomol* 2013, **27**(3):255–266.
13. Calvo JH, Berzal B, Calvete C, Miranda MA, Estrada R, Lucientes J: Host feeding patterns of *Culicoides* species (Diptera: Ceratopogonidae) within the Picos de Europa National Park in northern Spain. *Bull Entomol Res* 2012, **102**(6):692–697.
14. Lassen SB, Nielsen SA, Kristensen M: Identity and diversity of blood meal hosts of biting midges (Diptera: ceratopogonidae: *Culicoides latreille*) in Denmark. *Parasite Vector* 2012, **5**:143.

15. Lassen SB, Nielsen SA, Skovgard H, Kristensen M: Molecular identification of bloodmeals from biting midges (Diptera: ceratopogonidae: *Culicoides latreille*) in Denmark. *Parasitol Res* 2011, **108**(4):823–829.
16. Pettersson E, Bensch S, Ander M, Chirico J, Sigvald R, Ignell R: Molecular identification of bloodmeals and species composition in *Culicoides* biting midges. *Med Vet Entomol* 2013, **27**(1):104–112.
17. Braverman Y, Frish K, Reis M, Mumcuoglu KY: Host Preference of *Culicoides* spp from Israel based on sensory organs and morphometry (Diptera: ceratopogonidae). *Entomol Gen* 2012, **34**(1–2):97–110.

doi:10.1186/1756-3305-6-326

Cite this article as: Ma et al.: A video clip of the biting midge *Culicoides anophelis* ingesting blood from an engorged *Anopheles* mosquito in Hainan, China. *Parasites & Vectors* 2013 **6**:326.

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