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Original article

The occurrence of *Varroa underwoodi* (Acarina: Varroidae) in Papua New Guinea and Indonesia

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Summary — The findings reported here contribute to what is currently known about the geographical distribution, host range and reproduction of the ectoparasitic mite, *Varroa underwoodi*. Female *V underwoodi* and their nymphal offspring were collected from sealed drone cells in *Apis cerana* colonies in Papua New Guinea (PNG), the Indonesian provinces of Java, Sulawesi and Irian Jaya, and the Indonesian islands of Biak and Yapen. Gravid female *V underwoodi* were also collected from newly capped drone cells in *A nigrocincta* colonies in Sulawesi. Adult female *V underwoodi*, showing no signs of reproduction, were collected from capped worker cells in *A mellifera* colonies in PNG. On the basis of morphological structures, the adult female *V underwoodi* specimens from PNG and Indonesia were indistinguishable from *V underwoodi* specimens described from other localities.

***Apis mellifera* / *Apis cerana* / *Apis nigrocincta* / *Varroa underwoodi* / geographical distribution**

INTRODUCTION

When surveying mites associated with honey bees in Papua New Guinea (PNG) and Indonesia, we collected mites that appeared to be extremely small specimens of *Varroa jacobsoni* Oudemans. On closer examination they proved to be specimens of *V underwoodi* Delfinado-Baker and Aggarwal. This species was first described from *Apis cerana* Fabricius from Nepal (Delfinado-Baker and Aggarwal, 1987), but it has subsequently been detected on the same host in South Korea (Woo, 1992). Until now, the known distribution of *V underwoodi* has been limited to these two

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localities and its host range has only included *A cerana*, although a single *V underwoodi*-like specimen was detected by de Guzman et al (1996) on an adult *A nuluensis* Tingek, Koeniger and Koeniger worker bee that had been removed from a mixed colony of *A nuluensis* and *A cerana* in Malaysian Borneo. In this paper we report on additional localities and a possible extended host range for *V underwoodi*. Lee (1995) presented a preliminary report on the initial detection by one of us (DA) of *V underwoodi* in PNG. That report is now confirmed and validated in this paper.

MATERIALS AND METHODS

Specimens of *V underwoodi* adults and nymphs were detected in and collected from capped drone brood cells of single *A cerana* colonies located at Goroka (on 6 June 1994), Telefomin (on 14 May 1994) and Lae (on 15 April 1995) in PNG. Non-gravid adult *V underwoodi* without offspring were also detected in and collected from capped worker brood cells in single *A mellifera* Linnaeus colonies located at Telefomin (on 14 May 1994) and Mount Hagen (on 12 April 1995) in PNG. Adult females and nymphs of *V underwoodi* were also detected in and collected from capped drone brood cells in single *A cerana* colonies located in the Indonesian province of Irian Jaya (at Koya Timur on 24 August 1995 and 12 March 1996) and its offshore islands of Biak (at Biak on 23 March 1995) and Yapen (at Serui on 13 March 1997), and on the Indonesian islands of Java (at Pati on 30 July 1994 and at Bogor on 20 June 1996) and Sulawesi (at Kamarora, 90 km south-east of Palu on 24 June 1996 and 4 October 1996). Gravid adult female *V underwoodi* without offspring were also collected from newly capped drone brood cells in single *A nigrocincta* colonies at Kamarora, Sulawesi (on 23 June 1996 and 4 October 1996).

Adults or adults and nymphal stages of *V underwoodi* were located in brood cells of single bee colonies at the localities given above after removing the wax cell cappings and developing brood from usually more than 100 sealed worker brood cells and from every sealed drone brood cell present. Usually, more than 100 bee larvae were also removed from uncapped worker brood cells and all uncapped drone brood cells, and the larvae and cells examined for mites; the exception was with *A nigrocincta* colonies examined in Sulawesi during October 1996 when only capped drone brood cells were examined. Once located, *V underwoodi* adults and nymphs were placed in small plastic or glass vials containing 70% alcohol and transported to the laboratory in Canberra, Australia, for examination using dissecting and light microscopes fitted with ocular micrometers. Body length and width measurements were conducted on unmounted adult female specimens. For comparative studies, published morphological descriptions of *V underwoodi* were used in conjunction with a female *V underwoodi* specimen from the Australian National Insect Collection, Canberra, that was collected and identified by KS Woo on 13 May 1991 from *A cerana* at Chonnam Yamyang, South Korea.

RESULTS

In the *A cerana* colonies, small numbers of adult female *V underwoodi* were detected at the various sampling localities listed above (see below). They were also only detected in capped drone brood cells despite the fact that usually more worker cells than drone cells and uncapped as well as capped cells were examined. These females were almost always reproducing as they were usually accompanied by nymphal stages. Some cells that contained reproducing *V underwoodi* were simultaneously infested with reproducing female *V jacobsoni*. Of six adult female *V underwoodi* detected in *A mellifera* worker cells in PNG that contained red-eyed pupae or older, none were gravid or accompanied by nymphal offspring. Nevertheless, gravid adult female *V underwoodi* without offspring were collected from recently capped *A nigrocincta* drone brood cells in Sulawesi. Voucher specimens of *V underwoodi* from *A nigrocincta* have been deposited in the Australian National Insect Collection.

The specimens of adult female *V underwoodi* we examined from *A cerana* in PNG

measured 700-752 µm long and 1 089-1 157 µm wide (mean 720 × 1 105 µm, n = 15); from *A mellifera* in PNG, 700-735 µm long and 1 090-1 120 µm wide (mean 713 × 1 103 µm, n = 6); from *A cerana* in Irian Jaya, 690-730 µm long and 1 050-1 130 µm wide (mean 716 × 1 096 µm, n = 5); while single adult female specimens from *A cerana* in Sulawesi and Java measured 780 x 1 050 µm and 720 × 1 080 µm respectively. Our adult female specimens from *A nigrocincta* from Sulawesi measured 740-760 µm long and 1 120-1 220 µm wide (mean 744 × 1 160 µm, n = 5). These body sizes compare with the type specimens from Nepal (741-780 × 1 151-1 168 µm) (Delfinado-Baker and Aggarwal, 1987), with the single adult female specimen we examined from South Korea (757 × 1 286 µm) and with specimens from Korea examined by Woo (1992) (703-784 × 1 135-1 324 µm). In contrast, specimens of adult female *V jacobsoni* we collected from the same *A cerana* colonies at Lae in PNG as our specimens of *V underwoodi* measured 952-1064 µm long × 1 372-1 512 µm wide (mean: 1 023 × 1 473 µm, n = 50). Hence, our PNG *V jacobsoni* specimens were approximately 30% longer and 25% wider than our PNG *V underwoodi* specimens.

On the basis of examinations of the gnathosoma, leg and body sclerotisation and chaetotaxy, peritreme and other structures, our adult female specimens of *V underwoodi* were morphologically indistinguishable from those described from Nepal by Delfinado-Baker and Aggarwal (1987) and with an adult female specimen of *V underwoodi* from Korea in the Australian National Insect Collection. *V underwoodi* may be readily distinguished from *V jacobsoni* on the basis of its smaller size and the greater length of the lateral marginal setae on the idiosoma. In *V underwoodi*, these setae gradually increase in length posteriorly, with the longest setae, at position number 10-11, 132-153 µm, and the last 3-5 pairs decreasing in length. This may be contrasted with the lateral marginal setae of *V jacobsoni* which are uniform in length (about 90 µm). This absolute difference in setal length is emphasized by the difference in body size of the two species. The ratio of body length to length of the longest lateral marginal seta is 4.8-5.2 for *V underwoodi* and 11.5-12.1 for *V jacobsoni*.

DISCUSSION

Our findings clearly show that the geographical distribution of *V underwoodi* is much wider than previously thought. Our findings also indicate that adult female *V underwoodi* in PNG and Indonesia exhibit a well defined penchant for *A cerana* drone brood cells in which they reproduce following cell-capping. Nevertheless, further studies are needed to confirm whether or not female *V underwoodi* can reproduce on *A mellifera* and *A nigrocincta* brood. Although the female *V underwoodi* we collected from *A nigrocincta* drone cells could have recently spread from neighbouring *A cerana* colonies, the fact that these were gravid suggests that they were preparing for oviposition. It is yet not clear whether they might reproduce in worker cells. Of the six adult female *V underwoodi* we detected in sealed *A mellifera* worker brood cells in PNG, none were gravid or showing signs of reproduction. If future studies show *V underwoodi* to be unable to reproduce on *A mellifera* worker and drone brood in PNG, this would indicate that *V underwoodi* could have first entered New Guinea in *A cerana* colonies introduced from Java to Irian Jaya during the 1970's (Anderson, 1994), also suggesting that *V underwoodi* has been present in Java for at least the past 20 years. Obviously, further studies will help clarify aspects of the spread, reproduction and host range of *V underwoodi*.

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Résumé — La présence de *Varroa underwoodi* (Acarina : Varroidae) en Papouasie Nouvelle Guinée et en Indonésie. Les résultats présentés ici élargissent notre connaissance de la répartition géographique, du spectre d'hôtes et du comportement reproducteur de l'acarien ectoparasite *Varroa underwoodi* Delfinado-Baker et Aggarwal. Des adultes et des nymphes de *V underwoodi* ont été trouvés dans des cellules de couvain mâle operculé de colonies d'*Apis cerana* Fabricius en Papouasie Nouvelle Guinée (PNG, 1994 et 1995) dans les provinces indonésiennes de Java (1994 et 1996), de Sulawesi (1996) et d'Irian Jaya (1995 et 1996) et sur les îles indonésiennes de Biak et Yapen (1995 et 1997 respectivement). En outre, on a trouvé des femelles gravides de *V underwoodi,* dans des cellules de mâles récemment operculées de colonies d'*A nigrocincta* Smith à Sulawesi en 1996, alors que des femelles de *V underwoodi* ne présentant pas de signe de reproduction, ont été trouvées dans des cellules d'ouvrières operculées de colonies d'*A mellifera* L en PNG en 1994 et 1995. Les adultes et les nymphes de *V underwoodi* trouvés ont été mis dans de l'alcool à 70 % et transportés au laboratoire à Canberra, Australie, pour examen. Les dimensions des spécimens adultes femelles sont les suivantes : 700-752 µm de long et 1 089-1 157 µm de large ($\bar{x}$: 720 × 1 105 µm, n = 15) pour celles issues d'*A cerana* en PNG; 700-735 µm de long et 1 090-1 120 µm de large ($\bar{x}$: 713 × 1 103 µm, n = 6) pour celles issues d'*A mellifera* en PNG ; 690-730 µm de long et 1 050-1 130 µm de large ($\bar{x}$: 716 × 1 096 µm, n = 5) pour celles issues d'*A cerana* à Irian Jaya ; 780 × 1 050 µm et 720 × 1 080 µm pour les deux specimesn issus d'*A cerana* respectivement à Sulawesi et Java ; et 740 × 760 µm de long et 1 120 × 1 220 µm de large ($\bar{x}$: 744 × 1 160 µm, n = 5) pour celles issues d'*A nigrocincta* à Sulawesi. D'après l'examen des gnathosomes, de la sclérotisation et de la répartition des soies de la patte et du corps, du péritrème et d'autres structures, les spécimens femelles de *V underwoodi* trouvés en PNG et en Indonésie ne peuvent être distingués morphologiquement de ceux décrits dans d'autres localités. Les résultats montrent que la répartition géographique de *V underwoodi* est bien plus grande qu'on ne le pensait et que les femelles ont un net penchant pour le couvain mâle d'*A cerana*, sur lequel elles se reproduisent. Ils indiquent aussi que *V underwoodi* pourrait se reproduire sur le couvain mâle d'*A nigrocincta*, mais pas sur le couvain d'ouvrières d'*Apis mellifera*. Néanmoins le comportement reproducteur de *V underwoodi* nécessite de plus amples recherches.

Varroa underwoodi* / répartition géographique / *Apis nigrocincta* / *Apis cerana* / *Apis mellifera

Zusammenfassung — Vorkommen von *Varroa underwoodi* (Acarina: Varroidae) in Papua New Guinea und Indonesien. Die hier vorgestellten Befunde erweitern den Kenntnisstand über geographische Verbreitung, Wirtsspektrum und Reproduktionsverhalten der außenparasitischen Milbe *Varroa underwoodi* Delfinado-Baker & Aggarwal. Adulte *V underwoodi* und Nymphen wurden in verdeckelter Drohnenbrut einzelner Völker von *A cerana* Fabricius in Papua New Guinea (PNG, 1994 und 1995), in den indonesischen Provinzen Java (1994 und 1996), Sulawesi (1996), Irian Jaya (1995 und 1996), und auf den indonesischen Inseln Biak and Yapen (1995 bzw 1997) gefunden. Weiterhin wurden weibliche *V underwoodi* mit Eientwicklung 1996 in frischverdeckelten Drohnenzellen aus Völkern von *A nigrocincta* Smith in Sulawesi

gefunden. In verdeckelten Arbeiteinnenzellen aus Völkern von *A mellifera* Linnaeus in PNG wurden dagegen 1994 and 1995 weibliche *V underwoodi* ohne jedes Anzeichen von Reproduktion gefunden. Die gefundenen Adulten und Nymphen von *V underwoodi* wurden in 70% Alkohol zur genaueren Untersuchung in das Labor in Canberra, Australien gebracht. Die auf *A cerana* aus PNG gefundenen adulten weiblichen Milben waren 700-752 µm lang und 1 089-1 157 µm breit (Mittel: 720 × 1 105 µm, $n = 15$); die auf *A mellifera* aus PNG gefundenen waren 700-735 µm lang und 1 090-1 120 µm breit (Mittel: 713 × 1 103 µm, $n = 6$); die auf *A cerana* aus Irian Jaya gefundenen waren 690-730 µm lang und 1 050-1 130 µm breit (Mittel: 716 × 1 096 µm, $n = 5$); die von *A cerana* aus Sulawesi und Java maßen 780 x 1050 µm bzw 720 × 1 080 µm. Die von *A nigrocincta* von Sulawesi stammenden adulten weiblichen Milben maßen 740-760 µm in der Länge und 1 120-1 220 µm in der Breite (Mittel: 744 × 1 160 µm, $n = 5$). Die auf PNG und Indonesien gefundenen weiblichen *V underwoodi* waren auf Grundlage der Untersuchung von Gnathosoma, der Sclerotisierung der Beine und des Körpers sowie der Beborstung, den Peritremata und anderen Strukturen morphologisch nicht von den aus anderen Orten beschriebenen unterscheidbar. Die Ergebnisse zeigen, daß die geographische Verbreitung von *V underwoodi* wesentlich größer ist als zuvor bekannt und zeigen weiter eine ausgeprägte Neigung des Parasiten zur Drohnenbrut von *A cerana*, in der diese auch reproduzieren. Die Ergebnisse deuten weiter darauf hin, daß *V underwoodi* sich in Drohnenbrut von *A nigrocincta* vermehren kann, dagegen nicht in Arbeiterinnenbrut von *A mellifera*, allerdings bedarf das Vermehrungsverhalten dieser Art weiterer Klärung.

Apis mellifera / Apis cerana / Apis nigrocincta / Varroa underwoodi / Varroa jacobsoni

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