INTRAPOPULATION VARIATION IN AN AUSTRALIAN POPULATION OF THE NORTH AMERICAN THRIPS, *BAGNALLIELLA YUCCAE* (THYSANOPTERA: PHLAEOTHRIPIDAE), A NEW RECORD FROM AUSTRALIA

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ABSTRACT

The genus *Bagnalliella* Karny is an endemic North American genus of Phlaeothripidae with 7 species associated with the New World plant genus *Yucca*; 2 Old World species currently placed in the genus are probably not congeneric. The number of sensoria on antennal segments III and IV has been used to distinguish the *Bagnalliella* species on *Yucca*, but an invasive population of *Bagnalliella yuccae* (Hinds) is reported here from Australia, at Brisbane, Queensland, in which the number of sensoria varied between individuals and even between left and right antennae of single individuals. These observations cast considerable doubt on the validity of some of the North American species of *Bagnalliella*. The Australian population was damaging young leaves of *Yucca elephantipes*, and indicates the ease with which thrips can be distributed by the horticultural trade.

Key Words: *Bagnalliella yuccae*, *Yucca elephantipes*, thrips, Thysanoptera

RESUMEN

El género *Bagnalliella* Karny es un género de la familia Phlaeothripidae endémico de Norteamérica con 7 especies associadas con plantas del género *Yucca* en el Nuevo Mundo; 2 especies del Mundo Antiguo actualmente puestos en el mismo género pero probablemente no son congéneres. Se ha usado el número de sensoria sobre los segmentos III y IV de la antena para distinguir las especies de *Bagnalliella* sobre *Yucca*, pero una población invasora de *Bagnalliella yuccae* (Hinds) de Brisbane, Queensland, Australia que es reportada aqui varía en el número de sensoria entre individuos y aún entre la antenna izquierda y derecha del mismo individuo. Estas observaciones ponen una duda considerable sobre la validez de algunos de las especies de *Bagnalliella* en Norteamérica. La población australiana estuvo dañando hojas tiernas de *Yucca elephantipes*, e indica la facilidad en que los trips pueden ser distribuidos por medio del comercio de productos horticolas.

Seven of the 9 thrips species listed in the genus *Bagnalliella* Karny are known from *Yucca* plants in North America (*B. arizonae*, *B. australis*, *B. desertae*, *B. glaucae*, *B. huachucae*, *B. mojave*, and *B. yuccae*). These species have been described from various *Yucca* spp. covering large areas from east coast North America, Central America, and across to west coast North America (Table 3). In contrast, 2 species, *B. flavipes* from New Guinea and *B. robusta* from Africa, possibly belong in other genera (Hoddle et al. 2009).

Bagnalliella yuccae (Hinds) was first described in 1902 from Amherst, Massachusetts and Washington District of Columbia on the East coast of North America on *Yucca filamentosa* and *Solidago* spp. flowers (goldenrod) as *Cephalothrips yuccae* Hinds (see Mound 2009). Cott (1956) reported that *B. yuccae* was known from several *Yucca* spp. including *Yucca filamentosa*, and *Solidago* spp., and was also only known to occur east of the Mississippi River, USA. Only one female specimen was recorded from *Solidago* (Cott 1956), raising considerable doubt of this being a true host record. Currently *B. yuccae* is known from Japan, Korea, the Mediterranean region of Europe, Russia, North America (Okajima 2006), and now Australia. The genus *Yucca* contains approximately 47 species and their natural distributions cover North and Central America, extending into the West Indies (Mabberley 2008). *Bagnalliella. yuccae* has undoubtedly been transported around the world by the horticultural trade on cultivated *Yucca* species (Mound & Marullo 1996; Okajima 2006).

No key to distinguish between the 7 species of *Bagnalliella* from *Yucca* has ever been produced, although Cott (1956) produced a key distinguishing 3 of these species. That key relies heavily on the number of sensoria on antennal segments III and IV. According to their original descriptions, the American species differ from the type species, *B. yuccae* (Figs. 1B and C) as follows; *B. arizonae*—body color and size of tenth abdominal segment (Hood 1927a), *B. australis*—color of head and antennae, size of antennal segments (Hood 1939), *B. desertae*—1 minute sensorium on anten-

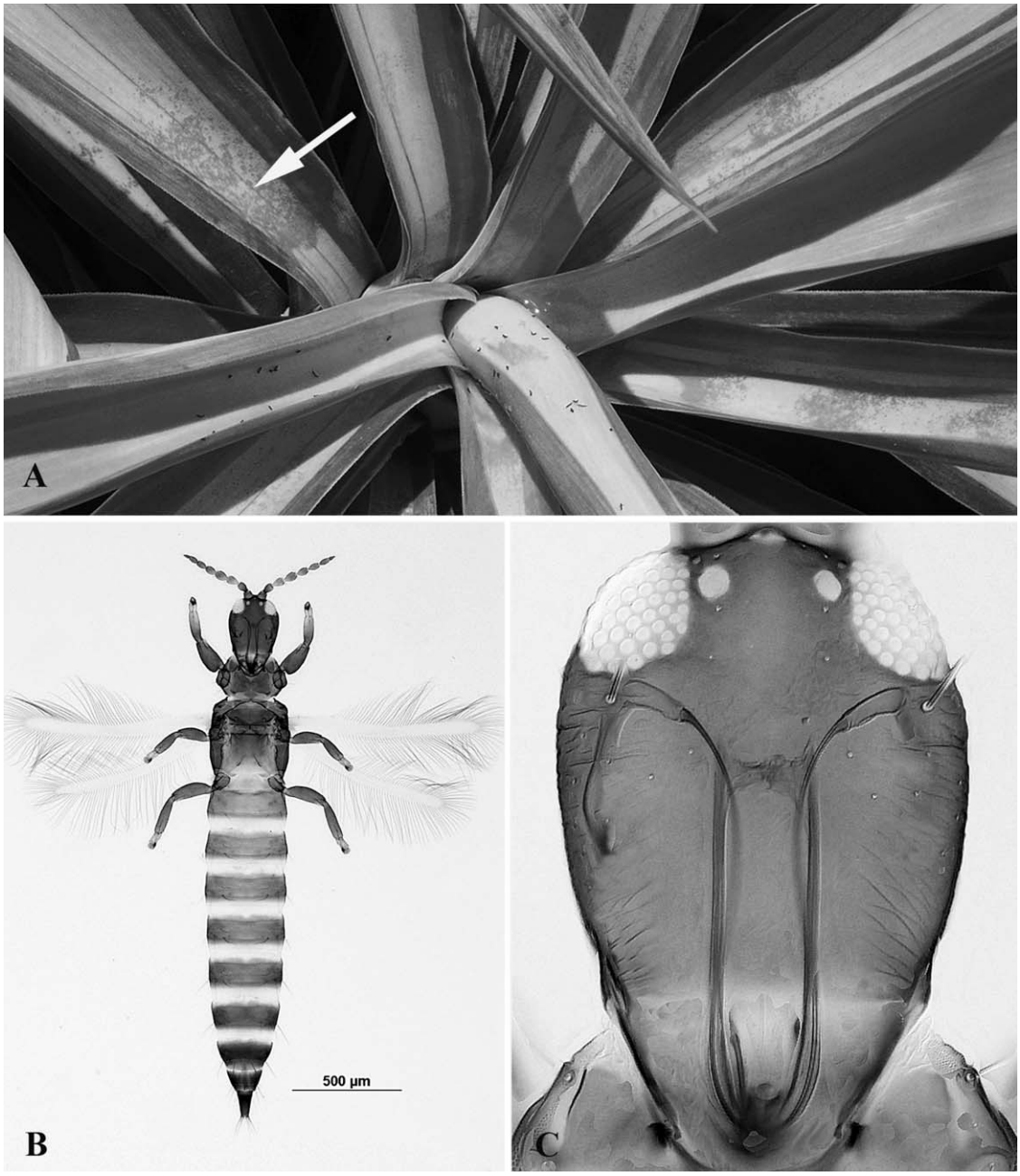

Fig. 1. A—*Bagnalliella yuccae* feeding at the bases of young leaves of *Y. elephantipes* 'Silver Star' (variegated variety), in Brisbane, Australia (feeding damage marked by white arrow); B—Adult female *Bagnalliella yuccae*; C - Head of adult female *Bagnalliella yuccae.*

nal segment III (Hood 1927a), *B. glaucae* - color of subhypodermal pigmention (Hood 1927b), *B. huachucae*—size of antennal segment II and tenth abdominal segment (Hood 1927a), *B. mojave*—color of antennae and 1 minute sensorium on antennal segment III (Hood 1927a).

In Sep 2009, a routine inspection at a wholesale nursery in Brisbane, Queensland, Australia found cultivated plants of *Yucca elephantipes* (Agavaceae) with established populations of large, dark thrips feeding at the bases of the young leaves (Fig. 1A). Although confirmed as a

TABLE 1. NUMBER OF SENSORIA ON ANTENNAL SEGMENTS III AND IV ON *BAGNALLIELLA YUCCAE* FROM ORIGINAL DESCRIPTION IN 4 MAJOR PUBLICATIONS AND VARIATION ACROSS AUSTRALIAN SPECIMENS.

	Number of sensoria on antennal segment III	Number of sensoria on antennal segment IV
Hinds (1902)	Not included	Not included
Cott (1956)	2	4
Stannard (1968)	Not included	4
Okajima (2006)	2	3
Hoddle et al. (2009)	2	4
Interception, Melbourne	2, 3 or 4	3 or 4
Brisbane, Australia		
Population 1	2 or 3	2, 3 or 4
Population 2	2 or 3	2, 3 or 4
Population 3	2 or 3	3 or 4

TABLE 2. NUMBER OF SENSORIA ON LEFT AND RIGHT ANTENNAL SEGMENTS III AND IV ON INDIVIDUALS OF INTERCEPTED AND AUSTRALIAN SPECIMENS.

	Left antenna		Right antenna	
Specimens	III	IV	III	IV
Melbourne, Interception				
Female	3	4	3	4
Female	3	4	4	4
Female	3	4	3	4
Female	3	4	3	4
Female	3	4	3	4
Female	3	4	2	4
Female	3	4	3	4
Female	3	4	3	4
Male	2	3	2	3
Brisbane Population 1				
Female	3	3	3	4
Female	3	3	3	4
Female	2	4	3	4
Female	3	4	3	4
Male	3	4	3	3
Male	2	3	2	2
Brisbane Population 2				
Female	3	3	3	4
Female	3	4	3	4
Female	3	4	3	4
Female	3	2	2	3
Female	3	4	2	4
Male	2	3	3	3
Male	3	3	2	3
Brisbane Population 3				
Female	3	4	3	4
Female	3	3	3	4
Female	3	4	3	4
Female	3	4	3	4
Male	2	3	2	3
Male	2	3	2	3
Male	2	3	2	3

species of *Bagnalliella* Hinds (Laurence A. Mound, Australian National Insect Collection, Canberra), further study indicated that these specimens failed to match precisely the available descriptions of *B. yuccae* (Cott 1956; Stannard 1968; Okajima 2006; Hoddle et al. 2009) because of variation in the number of sensoria on the third and fourth antennal segments. Several thrips identified as *Bagnalliella* sp. (LAM, ANIC) were intercepted by the Australian Quarantine and Inspection Service (AQIS), Melbourne, Australia during 2005 and 2006 (B. Crowe, AQIS, personal communication). These thrips were found on stems of *Yucca elephantipes* imported from Costa Rica and Guatemala and were consequently fumigated. In order to help with identifying this invasive species, a study was made of the variation in the number of antennal sensoria.

Material and Methods

Three collections of *B. yuccae* were taken from new leaf bases of *Y. elephantipes* (non-variegated variety) and *Y. elephantipes* 'Silver Star' (variegated variety), in Brisbane, Australia, and the number of sensoria on antennal segments III and IV were counted. The first collection taken in late Sep 2009 was from *Y. elephantipes* 'Silver Star' and 2 weeks later the second collection was taken again from *Y. elephantipes* 'Silver Star' (Fig. 1A), together with the third collection from *Y. elephantipes*. Specimens of intercepted thrips from Melbourne, Australia (origin, Costa Rica; May and Sep 2005, Jan 2006) were borrowed and included for analysis in this study.

In total, 20 *B. yuccae* specimens (13 females and 7 males) from the 3 Brisbane collections were mounted onto glass microscope slides in Canada balsam (see Hoddle et al. 2009 for mounting protocol) (Figs. 1B and C). These specimens, together with 9 slide-mounted specimens from the interception in Melbourne were studied under a Nikon 90i compound microscope with Differential Interference Contrast objectives. The number of sensoria on antennal segments III and IV was counted and recorded for left and right antennae. All slide-mounted specimens of *B. yuccae* have been lodged as voucher specimens in the Queensland Primary Industries and Fisheries Entomology Collection and ANIC.

Results

Variation in Antennal Sensoria

Table 1 indicates the number of sensoria on antennal segments III and IV of *B. yuccae* as indicated in the original description and 4 major publications on this species, together with the range of variation found within the intercepted material and established populations from Australia. It should be noted that 3 authors claim that there are 4 sensoria on segment four (Cott 1956; Stannard 1968; Hoddle et al. 2009) but 1 author states that there are only 3 sensoria on this segment (Okajima 2006) (Table 1). All authors agree there

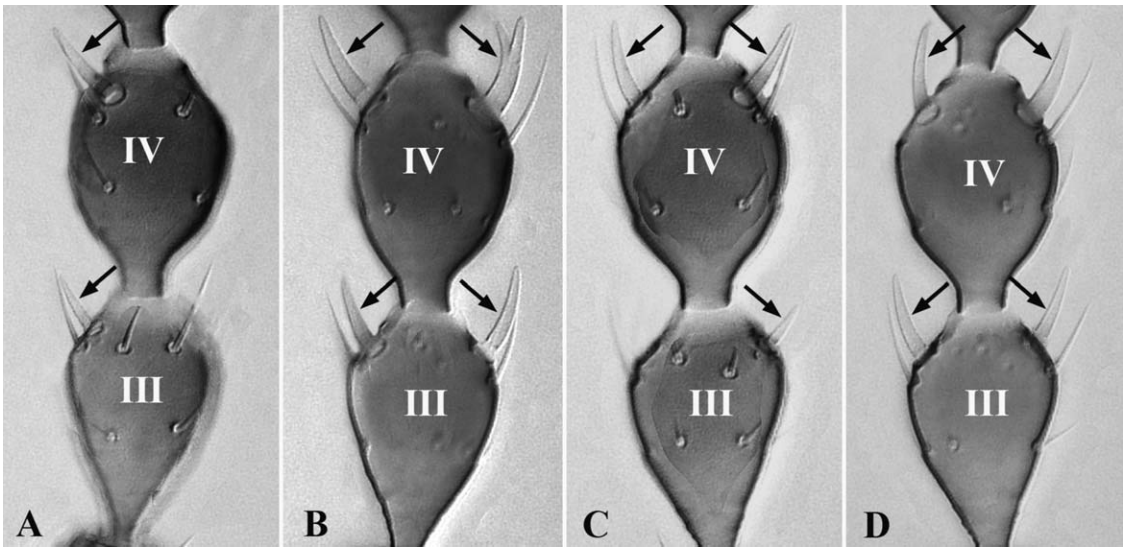

Fig. 2. Dorsal and ventral views of a *Bagnalliella yuccae* individual's antennal segments III and IV showing variation of sensorial (arrows). A—Left antennae dorsal view, III has 1 sensorium, IV has 1 sensorium; B—Left antennae ventral view, III has 2 sensoria, IV has 2 sensoria (1 split); C—Right antennae dorsal view, III has 1 sensorium, IV has 2 sensoria; D—Right antennae ventral view, III has 2 sensoria, IV has 2 sensoria.

are 2 sensoria on the third segment (Table 1). In contrast, within the Australian population, the number of sensoria varied between individuals as well as between the left and right antennae of individuals (Table 2). The numbers of sensoria found on the left and right antennal segment III varied among individuals between 2, 3, or 4 in varying combinations (Fig. 2). Sensoria on the left and right antennal segment IV numbered 2, 3, or 4, again in varying combinations. Remarkably, 1 sensorium was unusually split (Fig. 2B). Within the 29 specimens included in this study, the most common combination of sensoria on antennal segments III and IV was as follows: 3 on III and 4 on IV in 12 females, and 2 on III and 3 on IV in 4 males. The 9 specimens intercepted in Melbourne, that originated from Costa Rica, showed little variation in the number of sensoria on antennal segments III and IV, with 7 specimens possessing the most common combination (3 on III and 4 on IV in females).

Discussion

Within Thysanoptera, variation in numbers of sensoria on antennal segments III and IV is relatively uncommon (LAM, ANIC, personal communication). The tribe Haplothripini, of which *Bagnalliella* is a member, is reported to have 5 species that show variation in the number of sensoria on either antennal segment three or four; *Karynothrips flavipes* and *K. melaleucus* have either 3 or 4 sensoria on antennal segment IV (Goldarazena et al. 2008), *Haplothrips bituberculatus* has 3 or 4 sensoria on antennal segment IV, *Haplothrips dicksoniae* has 2 or 3 sensoria on antennal segment IV and *Haplothrips frici* 1 or 2 sensoria on antennal segment III (Mound & Minaei 2007). In Haplothripini species, the possession of 3 sensoria on antennal segment III is a plesiomorphic character state, which is retained by only a few genera (Mound & Minaei 2007).

The Australian specimens most closely match the descriptions of *B. yuccae* from the 4 major publications by Cott (1956), Stannard (1968), Okajima (2006), and Hoddle et al. (2009), except for the number of sensoria number on antennal segments III & IV. The possibility of the Australian populations being a mixture of different species seems unlikely. The lack of any consistency in the number of sensoria on antennal segments III & IV is most likely due to intra-specific variation. *Bagnalliella yuccae* specimens held in the Ewart Thrips Collection, University of California, Riverside, also exhibit similar variation in sensoria numbers on antennal segments III and IV as seen in the Australian material (M. Hoddle, UC, Riverside, California, personal communication).

The most recent publication concerning differences in *Bagnalliella* species was published over 50 years ago, and a re-examination of the genus is

TABLE 3. HOSTS AND DISTRIBUTIONS OF *BAGNALLIELLA* SPECIES, NORTH AMERICA, AS PUBLISHED IN THEIR ORIGINAL DESCRIPTIONS.

Bagnalliella spp.	Publication	Hosts	Distribution
B. arizonae	Hood (1927b)	*Yucca* spp.	West coast and central North America—Arizona, Texas, New Mexico.
B. australis	Hood (1939)	*Yucca* sp.	East coast North America—San Antonio, Missouri, Texas.
B. desertae	Hood (1927b)	*Yucca* sp.	West coast North America—California.
B. glaucae	Hood (1927a)	*Yucca glauca*	Central North America—Colorado.
B. huachucae	Hood (1927b)	*Yucca* sp.	Western North America—Arizona.
B. mojave	Hood (1927b)	*Yucca* sp.	West coast North America—California.
B. yuccae	Hinds (1902)	*Yucca filamentosa* and *Solidago* spp. (goldenrod)	East coast North America—Massachusetts, District of Columbia

well overdue. Such a study should include not only the morphological differences between specimens from different species of *Yucca*, but also molecular analyses of DNA to help with species designations.

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References Cited

Cott, H. E. 1956. Systematics of the Suborder Tubulifera (Thysanoptera) in California. Publications in Entomology, University of California 13: 1-216.

Goldarazena, A., Mound, L. A., and Zur Strassen, R. 2008. Nomenclatural problems among Thysanoptera (Insecta) of Costa Rica. Revista Biologia Tropical 56: 961-968

Hinds, W. E. 1902. Contribution to a Monograph of the insects of the order Thysanoptera inhabiting North America. Proc. United States Natl. Museum 23: 79-242.

Hoddle, M. S., Mound, L. A., and Paris, D. L. 2009. Thrips of California. Cd-rom published by CBIT Publishing, Queensland. http://www.lucidcentral.org/keys/v3/thrips_of_california/Thrips_of_California.html

Hood, J. D. 1927a. New western Thysanoptera. Proc. Biol. Soc. Washington 40: 197-204.

Hood, J. D. 1927b. New Thysanoptera from the United States. J. New York Entomol. Soc. 35: 123-142.

Hood, J. D. 1939. New North American Thysanoptera, principally from Texas. Revista de Entomologia 10: 550-619.

Mabberley, D. J. 2008. Mabberley's Plant Book, A Portable Dictionary of Plants, Their Classification and Uses. Cambridge University Press, Cambridge, UK.

Mound, L. A. 1997. Biological Diversity, pp. 197-215 *In* T. Lewis [ed.], Thrips as Crop Pests. CAB International, UK. 740 pp.

Mound, L. A. 2009. Thysanoptera (Thrips) of the World - a checklist http://www.ento.csiro.au/thysanoptera/worldthrips.html

Mound, L. A., and Marullo, R. 1996. The Thrips of Central and South America: An Introduction (Insecta: Thysanoptera). Associated Publishers, Florida USA.

Mound, L. A., and Minaei, K. 2007. Australian thrips of the *Haplothrips* lineage (Insecta: Thysanoptera). J. Natural History 41: 2919-2978.

Okajima, S. 2006. The Insects of Japan Vol. 2. The Suborder Tubulifera (Thysanoptera). Touka Shobo Co. Ltd., Fukuoka, Japan.

Stannard, L. J. 1968. The Thrips, Thysanoptera, of Illinois. Bull. Illinois Natural History Survey 29: 213-552.