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Short Communication

Concurrence of the *Acarapis* Species Complex (Acari: Tarsonemidae) in a Commercial Honey-Bee Apiary in the Pacific Northwest

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ABSTRACT

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An examination of a commercial honey-bee apiary for the *Acarapis* species complex revealed the following: queens were essentially free from *Acarapis* parasitism; colonies were more frequently infested with *A. dorsalis* and *A. woodi* than *A. externus*; individual worker-bee hosts were rarely parasitized by more than one *Acarapis* species. Observed sex ratios for all three mite species, under the conditions of the relatively low infestation rate observed in this study, favored females over males.

INTRODUCTION

The identification and description in 1921 of the honey bee tracheal mite, *Acarapis woodi* (Rennie), as the putative cause of Isle of Wight disease (Rennie et al., 1921; Bailey, 1964) was followed slightly more than a decade later by the description of two additional *Acarapis* species, *A. externus* Morgenthaler and *A. dorsalis* Morgenthaler (Morgenthaler, 1934). Both are ectoparasites and are believed to be host-specific to the western honey bee, *Apis mellifera* L.

Due to the suspected pathogenicity of *A. woodi*, the vast majority of research concerning the genus *Acarapis* both in Europe and in North America has been devoted to the tracheal mite. The two external *Acarapis* species have been virtually ignored as regards their life-histories and pest status. Furthermore, only rarely have all three species been considered in the aggregate as an impingement in honey-bee colonies. We report here our observations on the concurrence of the *Acarapis* species complex at the colony and individual host levels, and compare worker and queen infestation rates in an apiary of commercially managed honey bees in the U.S. Pacific Northwest.

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MATERIALS AND METHODS

Colonies from an infested apiary in White Salmon, Washington, were sampled on 31 May 1987. A total of 41 queens of unknown age were removed from 39 colonies during the course of requeening. Four of the queens were mother/daughter pairs resulting from supersedure conditions. Companion samples of several hundred worker bees were taken from each colony directly following queen removal. All samples were immediately anaesthetized with CO_2 and held on dry ice until being returned to the laboratory where they were kept at $-17°C$ until examination. Subsamples of 30 bees per colony, for a total of 1170 workers, were examined for all mite life-stages. Individual worker bees were visually scanned at magnifications of 20–50× to detect external *Acarapis*. *Acarapis woodi* were detected by excising and examining the two major thoracic tracheal trunks. All *Acarapis* life stages found associated with the wing axillaries were mounted on slides for additional taxonomic characterization under phase contrast.

RESULTS AND DISCUSSION:

Acarapis infestation of queens

None of the 41 examined queens was infested with *A. dorsalis*. A single queen was found to harbor *A. externus*, and this infestation consisted of a single adult female. These observations closely agree with those of Eckert (1961) who found no external mites in a sample of 69 queens of varying age. Observations to date would suggest that queens infrequently serve as hosts for the external *Acarapis* species.

We discovered *A. woodi* in only one of the 41 queens sampled. This queen harbored a bilateral infestation that exceeded 50 mites/trachea. Our low queen infestation rate (2.5%) contrasts with several published reports. For example, Pettis et al. (1989) reported an infestation rate of 30.6% in a sample of 83 queens from commercial colonies in Mexico, while Giordani (1977) found an infestation rate of 51.3% in a sample of 39 queens. Pettis et al. (1989) reported, as have others, that queens rapidly decline in susceptibility to *A. woodi* parasitism with increasing age. Therefore, a critical time for queen infestation is during the mating period when they are ca. 10–14 days old. We suspect that the queen cohort we examined came from mating nuclei free of *A. woodi*. The single infested queen may have been a recent supersedure or may represent an uncommon situation of mites infesting an older host.

The single infested queen in our sample had a gross weight (an indirect measure of ovary size and thus egg production) that was within one standard deviation of the 41-queen sample (infested queen wt = 281.7 mg; $\bar{x}$ queen

wt = 256.2, SD = 35.6 mg). Thus, gross-weight data provide no obvious indication of reduced reproductive potential in this individual.

Acarapis infestation of colonies

Tables 1 and 2 summarize our observations concerning *Acarapis* infestations at the colony level. *Acarapis dorsalis* and *A. woodi* achieved nearly equal infestation levels (87.2 and 82.0%, respectively), whereas *A. externus* was present in only six of the 39 sampled colonies (15.4%). Infestation levels, as measured by the average % of workers infested/colony, also were similar for *A. dorsalis* and *A. woodi* (8.6 and 8.1%, respectively). We consider the overall infestation level of these colonies as being low.

Acarapis infestation of workers

Of the 1170 worker bees examined, *Acarapis* species infested 217 individuals or 18.6% (20.8% if *A. dorsalis* immature forms observed on wing veins are

TABLE 1

Colony distribution of *Acarapis* species

	A. dorsalis	*A. externus*	*A. woodi*
No. colonies infested (and %)	34/39 (87.2)	6/39 (15.4)	32/39 (82.0)
Workers infested per colony (%)	0–37	0–37	0–60
Avg. infested workers per colony (%; ±SD)	8.6 ± 9.4	2.0 ± 7.4	8.1 ± 11.9

TABLE 2

Acarapis occurrence at the colony[1] and individual[2] host levels

Single-species infestation	
A. woodi only	5 colonies/93 workers
A dorsalis only	6 colonies/95 workers
A. externus only	0 colonies/18 workers
Multiple-species infestation	
All three species	5 colonies/0 workers
A. dorsalis + *A. woodi*	22 colonies/5 workers
A. dorsalis + *A. externus*	1 colony/5 workers
A. externus + *A. woodi*	0 colonies/1 worker

[1]39 infested colonies.
[2]217 infested workers.

TABLE 3

Total *Acarapis* population from all worker samples.[1]

Species	Hosts (no.)	Eggs	Immatures (larvae/nymphs)	Adults		Total	Mites/host
				Females	Males		
A. woodi:	99	484	389	470	164	1,507	15.2
A dorsalis:	103	137	89	74	34	334	3.2
A. externus:	24	23	23	19	11	76	3.2

[1]1170 sampled workers, with 217 infested.

included). Only 5% of these infested bees had more than one species of mite (Table 2). It is apparent from Table 3 that *A. woodi* is capable of generating much higher populations per bee than either of the external *Acarapis* species. The mean number of *A. externus* and *A. dorsalis* per infested host is equal and may indicate an optimum per host level.

The sex ratio (female:male) of ca. 3:1 for *A. woodi* and *A. dorsalis* and ca. 2:1 for *A. externus* (Table 3) is not unusual for mites in the family Tarsonemidae (Lindquist, 1986). A range of sex ratios (f:m) has been reported for *Acarapis–A. woodi*, 3:1 or 4:1 (Morison, 1932); *A. externus*, 1:1 (Brügger, 1936); *A. externus* and *A. dorsalis* 2:1 through 1:1 to 2:3 (Lindquist, 1986). It is difficult to know if these observed sex ratios are typical of a primary sex ratio or are functional ratios engendered by the life-history and behavior of the mites: for example, males may be shorter-lived or migratory patterns may vary between the sexes. If these ratios are representative of a primary sex ratio, they would suggest amphitokous or arrhenotokous parthenogenesis with a haplo-diploid sex-determining mechanism. Amphitoky and arrhenotoky have been demonstrated in several other species of Tarsonemidae (Lindquist, 1986).

SUMMARY

1. External *Acarapis* infrequently infest queens;

2. Colony infestations by *A. woodi* and *A. dorsalis* were far more common than those of *A. externus* in our observed apiary;

3. *A. woodi* generates much higher populations at both colony and individual host levels than do the external *Acarapis* species;

4. All three *Acarapis* species displayed a sex ratio that favors females and is thus suggestive of a haplo-diploid mode of sex determination; and

5. Individual worker bees are most commonly infested by a single *Acarapis* species, under the conditions of the low overall infestation rates that we observed.

REFERENCES

Bailey, L., 1964. The 'Isle of Wight disease': the origin and significance of the myth. Bee World, 45: 18, 32–37.

Brügger, A., 1936. Zur Kenntnis der ausserlichen *Acarapis*-Milben. Arch. Bienenkd., Leipzig, 17: 113–142.

Eckert, J.E., 1961. *Acarapis* mites of the honey bee. *Apis mellifera* Linnaeus. J. Insect Pathol., 3: 409–425.

Giordani, G., 1977. Course of acarine disease in the field. In: C. Meletinov (Editor). Proc. 26th Int. Apiculture Congress, Adelaide, Australia, 1977. Apimondia Publishing, Bucharest, pp. 459–467.

Lindquist, E., 1986. The world genera of Tarsonemidae (Acari:Heterostigmata): a morphological, phylogenetic, and systematic revision, with a reclassification of family group taxa in the Heterostigmata. Mem. Entomol. Soc. Can., 136: 517 pp.

Morgenthaler, O., 1934. Krankheitserregende und harmlose Arten der Bienenmilbe *Acarapis*, zugleich ein Beitrag zum Species-Problem. Rev. Suisse Zool., 41: 429–446.

Morison, G.D., 1932. A mite (*Acarapis*) that dwells on the back of the honey-bee. Bee Kingdom, 3: 6–11.

Pettis, J.S., Dietz, A. and Eischcen, F.A., 1989. Infestation levels of *Acarapis woodi* (Rennie) in queen honey bees of various ages. Apidologie, 20: 69–75.

Rennie, J., White, P.B. and Harvey, E.J., 1921. Isle of Wight disease in Hive bees. The etiology of the disease. Trans. R. Soc. Edinburgh, 52: 737–755.