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Phoretic mite *Neocypholaelaps indica* Evans infests inflorescences of *Pachysandra axillari* Franch. and its pollinators, *Apis cerana* Fabricius

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Parasitic *Varroa* mites are serious pests in beekeeping, which can destroy *Apis cerana* and *A. mellifera* hives in many countries in the world (Zemene *et al*. 2015). As a result, these mites have been studied in detailed in recent decades (Anderson and Trueman 2000; Novym *et al*. 2012). However, flower mites, such as pollenophagous and phoretic mites, have been overlooked by researchers, because these mites may not cause directed damage to hives. However, these phoretic mites can attach to the thorax, abdomen and legs of bees, and could theoretically influence the carrying capacity of the foragers (Ramanan and Ghai 1984; Eickwort 1990). Actually, previous studies also indicated that flower mites might indirectly affect the fitness of flowering plants in the long term (Lara and Ornelas 2001; Velázquez and Ornelas 2010). In this study, we report that the phoretic flower mite *Neocypholaelaps indica* can infest flowers of *Pachysandra axillaris* and *Apis cerana* in Yunnan, China. We suggest that beekeepers, researchers and regulators should be aware of this species to regulate its potential harm to beekeeping and output of crops in China.

To evaluate the occurrence of *N. indica* on different hosts, mature individuals of *N. indica* were collected from different flowers and foraging bees in Kunming Botanical Garden (KBG), Yunnan, China (25º8'48.9" N and 102º44'41.2" E, 1788 masl). The mites from *P. axillaris* were investigated in detail because we found the pollinators of *P. axillaris*, Eastern honey bee *A. cerana*, were heavily infested by *N. indica* when they visited inflorescences of *P. axillaris* (Fig. 1A–E). The number of individuals of *N. indica* in inflorescences of *P. axillaris* and on bodies of *A. cerana* was recorded in November in 2006 and 2008. The work was carried out between 12:00 noon and 3:00 pm on sunny days. To count mites on the body of *A. cerana* and in flowers of *P. axillaris*, at least fifteen bees and ten inflorescences were collected without conscious bias on each day and washed with 70% ethanol. We also recorded the individuals of *N. indica* in flowers of other flowering plants (fifteen bees and ten flowers/inflorescences), which had same anthesis as *P. axillaris*. In total, 57 families, 92 genera, and 123 species of plants were investigated during the flowering period of *P. axillaris* in 2006 and 2008.

The results show that the mean number of mature *N. indica* on *A. cerana* individual which visited flower of *P. axillaris* was much higher than on other flowering plants. The average number of mites on each *A. cerana* individual varied from 16.2 to 44.4 in 2006 and from 13.6 to 38.2 in 2008 (Table 1). The average number of mites in 10 inflorescences of *P. axillaris* varied from 32.9 to 83.8 in 2006 and from 26.7 to 66.2 in 2008 (Table 1). In all the 123 flowering plants that were visited by *A. cerana*, only three species were visited by bees carrying *N. indica*. The species are *Polygonum cuspidatum* (0.47 ± 0.22 individual), *Tropaeolum majus* (1.87 ± 0.61) and *Musella lasiocarpa* (2.53 ± 0.86). Bees that visited *P. axillaris* were more heavily infested than bees that visited other flowers.

More details were presented in Table 1. This study revealed that *N. indica* preferred inflorescences of *P. axillaris*. Actually, mites will be abundant in flowers that are nutritionally suitable for them and have plenty of floral visitors, preferably *Apis* bees (which purportedly provide a safe haven of the nest should there be no flowers available). The two factors probably overlap, but it is possible the mites would do just as well in flowers that are not preferred by bees (other aspects, like floral morphology, affect bee foraging, etc.). Our field observation revealed that all life stages of *N. indica* can be found in inflorescences of *P. axillaris*. We also found a highly female-biased field sex ratio, with more than 98% of mature mites being female. Like the other flower-inhabiting ameroseiid mites, *N. indica* uses *P. axillaris* inflorescences as its breeding ground and bees as its dispersal agents (Kar *et al*. 2015).

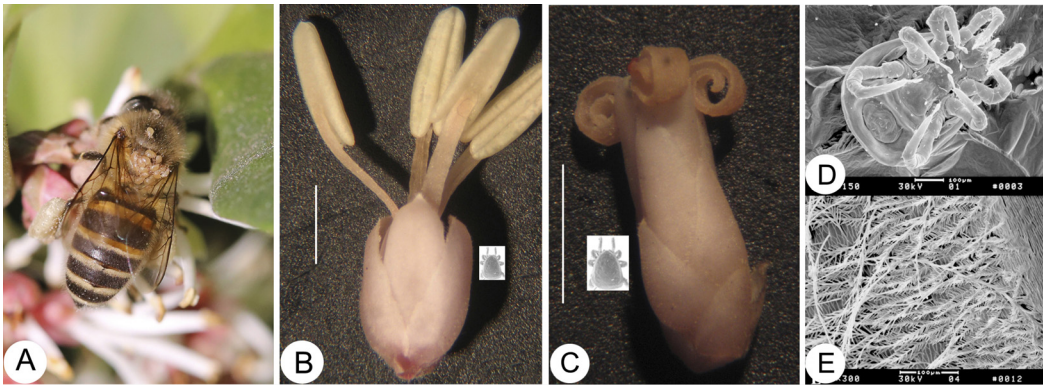

FIGURE 1. *Neocypholaelaps indica* occurred on inflorescences of *Pachysandra axillaris* and *Apis cerana*. A, mites of *N. indica* on body of *A. cerana*; B & C, the size of mite, male and female flower of *P. axillaris* (scale bar = 2mm); D & E, observation of female mite and hairs on lamosina of *A. cerana* under scanning electron microscope.

TABLE 1. Average number (± S.E.) and range (in parentheses) of *Neocypholaelaps indica* on *Apis cerana* and inflorescences of *Pachysandra axillaris*.

Date	Average mites on bee (*n* = 15)	Average mites on inflorescence (*n* = 10)	Date	Average mites on bee (*n* = 15)	Average mites on inflorescence (*n* = 10)
20.11.06	16.8 ± 1.93 (12–26)	55.6 ± 3.73 (41–66)	18.11.08	27.4 ± 2.32 (22–34)	41.2 ± 3.53 (34–50)
21.11.06	23.0 ± 1.72 (16–29)	32.9 ± 2.56 (24–42)	20.11.08	13.6 ± 1.24 (9–18)	26.7 ± 1.87 (20–33)
22.11.06	37.2 ± 2.16 (26–47)	76.3 ± 6.71 (63–91)	21.11.08	19.0 ± 1.63 (12–26)	36.3 ± 2.66 (30–46)
24.11.06	21.4 ± 2.01 (14–30)	83.8 ± 6.45 (68–103)	22.11.08	21.4 ± 1.87 (17–26)	43.8 ± 3.42 (36–53)
25.11.06	32.0 ± 2.13 (26–41)	45.1 ± 3.28 (35–56)	23.11.08	38.2 ± 2.86 (31–44)	59.6 ± 3.87 (46–69)
27.11.06	44.4 ± 3.28 (31–57)	49.0 ± 3.88 (40–64)	24.11.08	18.4 ± 1.12 (13–24)	34.4 ± 2.72 (28–42)
28.11.06	16.2 ± 1.14 (12–22)	35.4 ± 3.12 (26–42)	26.11.08	20.6 ± 1.76 (16–27)	66.2 ± 5.49 (45–81)
29.11.06	27.6 ± 1.32 (23–31)	40.7 ± 5.11 (29–48)	27.11.08	33.4 ± 2.13 (21–46)	38.1 ± 2.73 (32–47)

Previous studies showed that the phoretic *N. indica* used different carriers, such as flowers, bees, flies, and butterflies in different countries (Mo 1972; Eickwort 1990). Adult mites and immature mites have been observed in the bottom board of the colonies of *A. cerana* and *A. mellifera* and in flowers visited by bees (Percy *et al*. 1968; Verma 1995; Jyothi and Reddy 1996). The mite *N. indica* can reduce the food or pollen carrying capacity of the *A. cerana* foragers, which also feeds mainly on pollen and honey (Ramanan and Ghai 1984; Verma 1995; Jyothi and Reddy 1996). In this study, we report that *N. indica* prefers inflorescences of *P. axillaris* and its *A. cerana* pollinators. We infer

that olfactory, visual, and/or gustatory cues from flowers may mediate the interactions among *N. indica*, *P. axillaris* and *A. cerana*. The cues may be used to decrease the negative impacts of *N. indica* in beekeeping and output of crops in future.

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