OF TIGER BEETLES AND UBIQUITOUS ANTS: HAZARDOUS LIVING AMONGST TENACIOUS PREY

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ABSTRACT. Ants represent a significant source of food for both larval and adult tiger beetles. However, adults must sometimes endure the consequences of defensive and aggressive encounters with ants, resulting in the attachment of ant heads to their appendages. This consequence is the focus of the present study, reporting 15 new accounts and commenting on the ecological implications.

INTRODUCTION

Ant colonies are complex societies often consisting of thousands of individuals (Wilson 1971). They are ubiquitous in the terrestrial environment, and their ecological impacts remain unsurpassed in the insect world (see Hölldobler and Wilson 1990). Worker ants search their surroundings for food resources (Carroll and Janzen 1973) and in the case of predaceous species often effectively regulate the abundance of other arthropods in their foraging territory (Finnegan 1971, Laine and Niemelä 1980).

In light of the abundance of ant colonies in the terrestrial environment, it is no surprise that tiger beetles often inhabit areas where ants are common. This co-occurrence may be both an advantage and disadvantage for the tiger beetle. On the one hand, tiger beetle larvae and adults utilize ants as an important food resource (Larochelle 1974a, Wilson 1978, Hori 1982, Kaulbars and Freitag 1993). On the other, ants can potentially prey on tiger beetles if circumstances allow (Larochelle 1972, Rogers 1974). At least in some cases, victimized ants fight back with tenacity as evidenced by the occasional tiger beetle specimen with an ant head attached to an appendage (Kippenhan 1990). In this paper, we provide fifteen additional accounts of ant attachments to tiger beetle body appendages and discuss the ecological consequences of these inevitable interactions.

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DISCUSSION

Larvae

Tiger beetle larvae are generally sedentary, remaining in their postnatal burrows through pupation. There are a few exceptions in which larvae abandon their burrows during periods of extreme conditions such as lack of moisture or flooding (Shelford 1908, Hamilton 1925, Willis 1967). However, burrow relocation is not known as a common occurrence. Undisturbed larvae wait at the tops of their burrows for prey to come within striking distance and then react quickly to seize their prey with sickle-shaped mandibles. Larvae anchor themselves to the walls of their burrows at three points—the legs, a pair of hooks on the venter of the fifth abdominal segment, and the pygopod—making it difficult for struggling prey to dislodge them. Nearly all small arthropods, including ants, are acceptable as food to larvae and adults (Willis 1967, Pearson 1988).

Subterranean burrows often 50 cm or more in depth protect larvae against most potential above-ground enemies. Commonly noted exceptions are bombyliid flies and tiphiid wasps, two groups of parasitoids frequently encountered attacking larvae (Wilson and Farish 1973, Palmer 1982, Knisley and Pearson 1984, Knisley 1987). In one reported instance, ants were observed digging out and consuming first instars of *Cicindela haemorrhagica* LeConte (Knisley 1987). Cantharid larvae have also been observed feeding on larvae of *Pseudoxycheila tarsalis* Bates (Schultz 1994). Overall, though, inhabiting a fixed burrow has advantages when compared to the active adult stage, i.e., considerable reduction in the number of potential natural enemies.

Tiger beetle larvae appear to benefit from a close association with ants, although Willis (1967) suggested that ants may represent a significant threat as predators . For an individual larva, close proximity to an ant nest increases the probability of coming into contact with foraging ants. Studies indicate that increased larval fitness and survival are directly correlated with increased food availability (Palmer 1978, Pearson and Knisley 1985, Knisley and Juliano 1988). However, there is danger in being too close to a nest entrance.

Adults

Adult tiger beetles are highly mobile, especially the diurnal species which have long cursorial legs and the ability to move quickly by running or taking flight. Speed alone does not always deter predation, however. Adults are known to use chemical defenses, structural coloration, testaceous abdomens, and/or gregarious behavior to serve as effective antipredatory mechanisms (Pearson 1985, Schultz 1986).

Adult tiger beetles have many natural enemies, although the ecological impacts of their interactions are not well understood. A number of vertebrates (Larochelle 1974b, 1975a, 1975b, 1978) and invertebrates, including asilid flies (Lavigne 1972, 1977, Shelly and Pearson 1978), spiders (Valenti 1994), a dragonfly (Graves 1962), and a mantid (Hori 1982), have been reported as predators of adult tiger beetles. Many species of ants attack and consume other arthropods, but reports of attacks on tiger beetles are scarce in the literature. Larochelle (1972) and Rogers (1974) reported that ants were able to kill adult tiger beetles, but these observations were made in a confined area where adult tiger beetles were unable to flee.

Ants apparently respond to tiger beetle attacks by using their mandibles to grasp appendages. This act of self defense may lead to escape, but often results in consumption of the ant by the tiger beetle leaving the ant head and other portions remaining attached to the grasped appendage (Rogers 1974). Alternatively, many ants may aggressively defend their nest areas. Willis (1967) reported ant heads attached to tiger beetle appendages. Larochelle (1974a) listed the following species with unidentified ant heads attached to either the antenna (an) or hind leg (hl): *Cicindela circumpicta johnsoni* Fitch (an), *C. formosa gibsoni* W. Brown (an), *C. marutha* Dow (hl), *C. obsoleta santaclarae* Bates (hl), *C. repanda* Dejean (an), *C. scutellaris lecontei* Haldeman (an), *C. sexguttata* F. (an), *C. viridisticta arizonensis* Bates (hl), and *C. willistoni* LeConte (an). Fifteen new accounts of ant attachments to tiger beetle appendages are presented in Table 1 in addition to the incidences reported by Kippenhan (1990). See Figs. 1–4 for representative ant attachments. There does not appear to be a sexual bias in ant head attachments. In our small sample, the ratio of male:female tiger beetles with ant attachments was nearly 1:1.

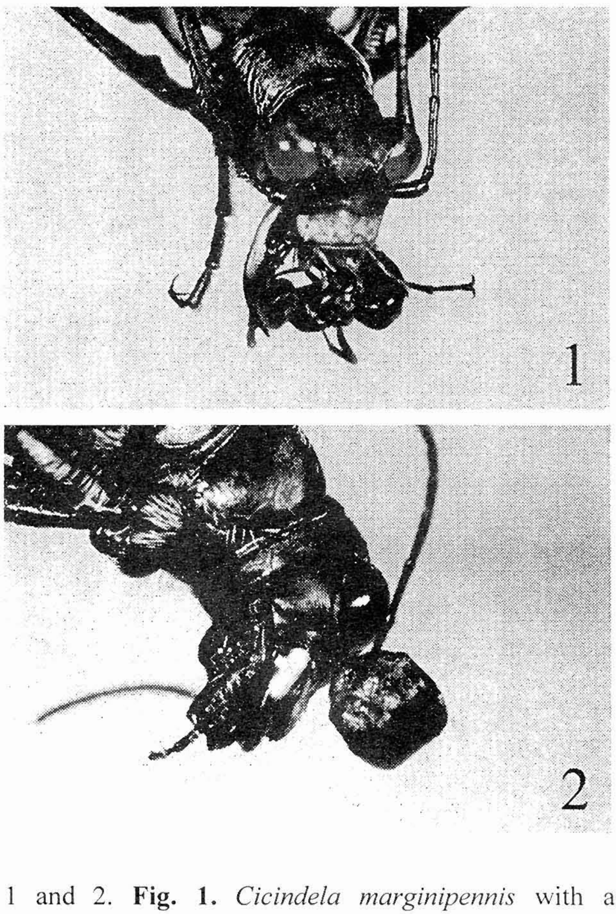
Table 1. Tiger beetle specimens with ant attachments.

Tiger beetle species (sex, state)	Ant species (portion present); attachment site on tiger beetle	Source*
Cicindela bellissima Leng (♀, WA)	*Formica nitideventris* Latreille (head to partial gaster); right fore tarsus	WSUC
C. formosa gibsoni W. Brown (♀, CO)	*Pogonomyrmex barbatus* Smith (head only); right antenna	MGKC
C. formosa gibsoni W. Brown (♂, CO)	*Pogonomyrmex barbatus* Smith (head to mesothorax); right antenna	MGKC
C. formosa gibsoni W. Brown[†] (♂, CO)	*Pogonomyrmex barbatus* Smith (head only); left antenna	MGKC
C. formosa gibsoni W. Brown (♀, CO)	*Pogonomyrmex barbatus* Smith (head only); right antenna	MGKC
C. formosa gibsoni W. Brown[†] (♂, CO)	*Pogonomyrmex barbatus* Smith (head only); right hind tarsus	MGKC
C. limbalis Klug[†] (♀, CO)	*Camponotus* sp. (head only); right antenna	MGKC
C. marginipennis LeConte (♂, NH)	*Formica* sp. (entire); right maxillary palpus (Fig. 1)	MAVC
C. obsoleta Say (♀, CO)	*Pogonomyrmex rugosa* Emery (head only); right scape (Fig. 2)	MGKC
C. pugetana Casey (♀, WA)	*Pogonomyrmex barbatus* Smith (head only); right antenna	MAVC
C. pulchra Say (♂, CO)	*Pogonomyrmex barbatus* Smith (head and thorax); left scape (Fig. 3)	INHS
C. pulchra Say (♂, CO)	*Pogonomyrmex barbatus* Smith (head only); right antenna	INHS
C. punctulata Olivier (♂, NM)	*Lasius* sp. (head only); right scape	MAVC
C. punctulata chihuahuae Bates (♂, UT)	undet. sp. (head only); left hind tarsus	WSUC
C. scutellaris Say (♀, CO)	*Pogonomyrmex barbatus* Smith (head only); left hind tarsus	MGKC
C. scutellaris lecontei Haldeman (♀, NY)	*Camponotus* sp. (head only); right antenna	MAVC
C. tranquebarica Herbst (♀, CO)	*Formica* sp. (two heads only); right antenna and right hind tarsus	INHS
C. tranquebarica kirbyi LeConte[†‡] (♀, CO)	*Pogonomyrmex barbatus* Smith (head and prothorax); right scape	MGKC
Megacephala virginica L. (♂, FL)	*Solenopsis molesta* (Say) (entire + 2nd head); left hind tarsus (Fig. 4)	WSUC

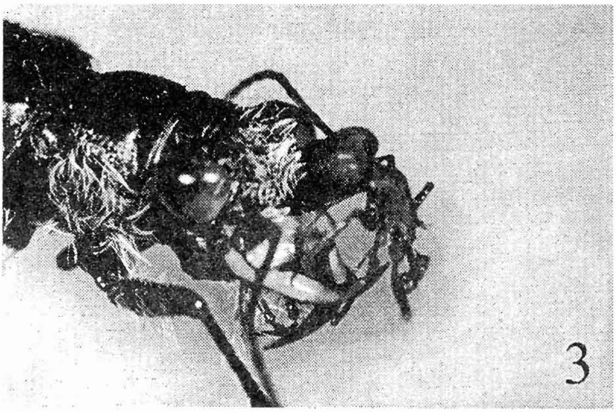
* INHS–Illinois Natural History Survey Collection   MAVC–Michael A. Valenti Collection
MGKC–Michael G. Kippenhan Collection   WSUC–Maurice T. James Collection, Washington State University

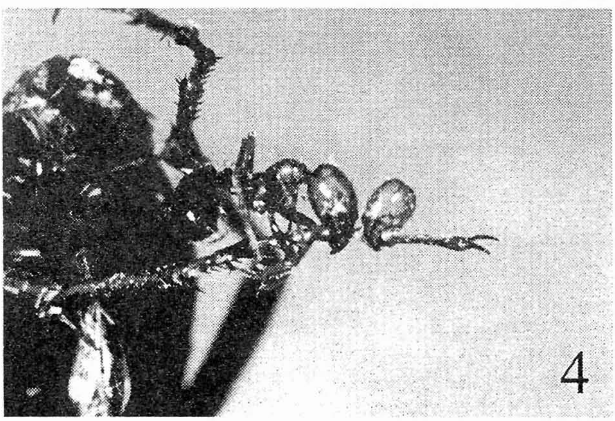
† see Kippenhan (1990) for photograph illustrating ant attachment site

‡ female specimen of a mating pair mounted on a single pin



Figures 1 and 2. **Fig. 1.** *Cicindela marginipennis* with an entire specimen of a *Formica* sp. attached to its right maxillary palpus. **Fig. 2.** *Cicindela obsoleta* with the head of a *Pogonomyrmex rugosa* attached to its right scape.





Figures 3 and 4. **Fig. 3.** *Cicindela pulchra* with the head and thorax of *Pogonomyrmex barbatus* attached to its left scape.
Fig. 4. *Megacephala virginica* with an entire specimen and a second head of *Solenopsis molesta* attached to its left hind tarsus.

It would be interesting to determine whether adult female tiger beetles oviposit randomly in areas of suitable substrate or show a preference for areas where prey are more plentiful (e.g., near an ant nest). There would be tradeoffs involved when seeking out areas in close proximity to an ant nest. Encounters with workers and soldiers might discourage female tiger beetles from taking the time needed to deposit eggs into the soil.

Some ants such as *Pogonomyrmex barbatus* Smith aggressively defend the area around their subterranean nest openings. Such behavior has been characterized as patrolling by some myrmecologists (Gordon 1986). In our sample of 19 tiger beetle specimens, 11 of the attachments were by *P. barbatus* (Table 1). It should be noted that this ant species clears all vegetation from the nest entrance, providing an ideal bare spot on which flying tiger beetles can land. Owing to the aggressive nature of *P. barbatus* and other ants, the attachments could conceivably represent unsuccessful ant attacks on tiger beetles resulting from nest defense behavior. Of the 21 total ants listed in Table 1, seven were attached to legs, 13 to antennae, and only one directly to the mouthparts. It seems plausible that leg and antennal attachments resulted from ants attacking tiger beetles rather than the reverse. Perhaps the potential prey is also a tenacious foe. It is feasible that ants play a significant role in tiger beetle ecology as an enemy rather than merely prey.

SUMMARY

From our current understanding of the biology and ecology of tiger beetles, it appears that larvae benefit greatly from a close association with ants. Although adults also benefit from ants as a food source, the presence of ants creates a somewhat hazardous above-ground environment. Adult tiger beetles are vulnerable to attack by patrolling and foraging ants but are not without their own defensive mechanisms—namely the ability to move swiftly either by running or taking flight. Studies involving detailed field observations are needed to elucidate the true nature of the relationship between the voracious tiger beetle and the tenacious ant.

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