

Reactions Of *Brachyponera luteipes* to Contacts with Different Social Insects

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Abstract. *Brachyponera chinensis*, known as the Asian needle ants, is an ant species with complex behaviors. The main focus of this paper is if *Brachyponera chinensis* has the ability to sense the volatile chemical of termites and hunt them easily, does its close cousin, *Brachyponera luteipes*, react toward termites the same as them, and what will *Brachyponera luteipes* responses when it contacts with other social insects that live in the same habitat as them. This lecture will show the result of *Brachyponera luteipes*'s reactions when contact with *Brachyponera chinensis*, *Brachyponera luteipes*, *Reticulitermes qingdaoensis*, and *Pheidole nodus*. *Brachyponera luteipes* also have techniques to hunt termites. *Brachyponera luteipes* do not have many techniques toward *P. nodus*, they avoid *P. nodus* soldiers. In conflicts with *Brachyponera chinensis*, *Brachyponera luteipes* shows a more aggressive attitude and takes a great advantage against *Brachyponera chinensis*. Information for this paper was gathered from Myrmecology and Ethology, to determine how *Brachyponera luteipes* is different from *Brachyponera chinensis* and how will it reacts toward different species that share the same habitat with it.

Keywords: *Brachyponera luteipes*, termite, animal interactions, Ethology, bigheaded ants, Myrmecology.

1. Introduction

Brachyponera luteipes is a member of *Ponerinae* that is small but very predatory. Its colony is usually not very large, like many small *Ponerinae* spp., they prefer to live in humid areas like rotten wood and bathrooms in human buildings. It is not as well-known as its close cousin, *Brachyponera chinensis*, but it also shows great adaptive ability toward exotic land, not only in Asia, it's also founded in New Zealand as an alien species [1]. It has also been suspected introduced in Southeastern North America because there are only have slight differences in workers of *Brachyponera luteipes* and *Brachyponera chinensis* (mainly in size, body fur, and funiculus, their males is easier to distinguish), people sometimes regard *Brachyponera luteipes* as *Brachyponera chinensis*, but even they are different species sharing similar niches. *Brachyponera chinensis*, known as the Asian needle ant, is a species of ant with great interest in termites; it is also an invasive species in Oceania and North America [2-4]. Like its close cousin, it builds nests in rotten wood and humid soil nearby, and sometimes it lives in human buildings, usually in bathrooms, the living conditions provide the Asian needle ant a better opportunity for hunting termites. The Asian needle ants have special technics in hunting termites, as a member of *Ponerinae*, the Asian needle ant has a stinger that can inject venom [5]. For humans, its nasty venom can cause redness and swelling, and for Asian needle ants themselves, it is a very effective tool to hunt small invertebrates [5]. Its exoskeleton is light but hard; provides them good protection and high nobility, very helpful when dealing with termites' sharp mandibles and their large soldiers. Most importantly, there's evidence showing that this species can sense the volatile chemical of termites during the hunt [6]. When they find the channel of termites for transportation, they'll make destruction on it. The termite workers will sense the injury and call for soldiers; the volatile chemical will be detected by Asian needle ants. After termite soldier comes and repels these Asian needle ants; it'll leave, then workers will come and fix the injury. And when those workers come back again, Asian needle ants will attack and kill them as quickly as possible. When they sense the presence of termite soldier, they'll retreat to avoid fighting [7].

Rotten wood is also the place where many other ant species are active, like *Pheidole* sp., *Camponotus* sp., and *Tetramorium* sp.. They are all dangerous competitors to *Brachyponera* sp., plus the population of *Brachyponera luteipes* and *Brachyponera chinensis* is not very large [8]. Among those ants, members of *Pheidole* are very aggressive and deadly, because they have soldier caste, they can pose a great threat toward larger arthropods than themselves, during the fight, their workers can pin down their victim by biting its antennae and legs, and simultaneously they call for soldiers. The soldier will dismember their victim in high efficiency. No doubt if the worker of *Brachyponera* gets held by *Pheidole* workers, the chance of escape is slim. The concern is what is the reaction of workers of *Brachyponera* to prevent this from happening in the first place?

Reticulitermes qingdaoensis is a native termite species in Eastern China, mainly distributed in Shandong province [9]. It is usually found in wood that is not very arid. Like other members in *Reticulitermes*, they have the caste of the soldier and those *Reticulitermes* soldiers can defend the colony from invaders like *Brachyponera* sp. [7]. *Brachyponera luteipes* sometimes have its channels near the channels of *Reticulitermes qingdaoensis*, it might be the predator of *Reticulitermes qingdaoensis* since there are records of them hunting other termites [10].

The main goal is to understand the reactions of *Brachyponera luteipes* toward those species that have overlap distribution with it when they meet by experiment. It can also serve as a measurement of the competitive ability of *Brachyponera luteipes* to some social animals in habitats like rotten wood etc.

2. Methodology

2.1. Experiment species

4 different species are involved namely *Brachyponera luteipes*, *Reticulitermes qingdaoensis*, *Pheidole nodus*, and *Brachyponera chinensis* which are divided into 8 groups for different experiments.

The content of the control group is two different *Brachyponera luteipes* workers. Both of them have three individuals.

The content of the experimental group for the first experiment is *Brachyponera luteipes* versus *Reticulitermes qingdaoensis* workers. Both of them have three individuals. The experiment will repeat three times, this can ensure the precision of conclusions is enough.

The content of the experimental group for the second experiment is *Brachyponera luteipes* versus *Reticulitermes qingdaoensis* workers & soldier. Both of them have three individuals, for *Reticulitermes qingdaoensis* they have two workers and one soldier. The experiment will repeat three times, this can ensure the precision of conclusions is enough.

The content of the experimental group for the third experiment is *Brachyponera luteipes* versus *Reticulitermes qingdaoensis* soldiers. Both of them have three individuals. The experiment will repeat three times, this can ensure the precision of conclusions is enough.

The content of the experimental group for the fourth experiment is *Brachyponera luteipes* versus *Pheidole nodus* workers. Both of them have three individuals. The experiment will repeat three times, this can ensure the precision of conclusions is enough.

The content of the experimental group for the fifth experiment is *Brachyponera luteipes* versus *Pheidole nodus* workers & soldier. Both of them have three individuals, for *Pheidole nodus*, they have two workers and one soldier. The experiment will repeat three times, this can ensure the precision of conclusions is enough.

The content of the experimental group for the sixth experiment is *Brachyponera luteipes* versus *Pheidole nodus* soldiers. Both of them have three individuals. The experiment will repeat three times, this can ensure the precision of conclusions is enough.

For the seventh experiment, the experiment groups were *Brachyponera luteipes* versus *Brachyponera chinensis*. Both of them have three individuals. The experiment will repeat three times, this can ensure the precision of conclusions is enough.

2.2. Experiment apparatuses

In the experiment, the experimenter uses three glass petri dishes with diameters of 60mm and 17mm high as the experiment vessel to contain ants and termites. For ants and termites to enter the experiment vessel safely and have enough time to adapt to the new environment, there's also a 58mm length and 16mm high partition made of paper shall, these partitions have a 5mm wide entrance in the middle. Also, two layers of tissue mimic the ground, providing them with packing to hold. To prevent dehydration from happening, the experimenter drops two drops of water on the tissue.

2.3. Experiment method

After preparing these experiment apparatuses, the experimenter began to put ants and termites in the environment; the sequence is putting other ants and termites before the testing species, *Brachyponera luteipes*. Then the experimenter will wait for about 3 minutes for these insects to adapt to the environment, and the experimenter will open the entrance and start recording behaviors of *Brachyponera luteipes* and other ants/termites by taking photos and short videos. The experiment terminates when one group is exterminated by another group, or they show no interest/can't do effective damage toward others after 20mins.

For evaluation, the experimenter uses tabulation to record results. The rows show the reaction of three groups of *Brachyponera luteipes*, the columns show the reactions of other ants and termites.

3. Results and discussions

3.1. Results

The full meaning of the abbreviations in the table is given below.

Brachyponera luteipes= *B. luteipes*

Reticulitermes qingdaoensis= *R. qingdaoensis*

Pheidole nodus= *P. nodus*

Brachyponera chinensis= *B. chinensis*

Only workers= OW

Only Soldiers= OS

2 workers & 1 soldier= 2W1S

Accept=AC

Minor conflict (bite, sting, cause injury, but not lethal) =MC

Heavily conflict (bite, sting, cause injury, but lethal) =HC

Exterminate=EX

Cause partly damaged=CPD

Got damaged (for *B. luteipes*) =GD

Been exterminated (for *B. luteipes*) =BEX

Table 1. *B. luteipes* reactions toward three different species.

	<i>B. luteipes</i> (control)	<i>R. qingdaoensis</i> (OW)	<i>R. qingdaoensis</i> (2W1S)	<i>R. qingdaoensis</i> (OS)	<i>P. nodus</i> (OW)	<i>P. nodus</i> (2W1S)	<i>P. nodus</i> (OS)	<i>B. chinensis</i>
<i>B. luteipes</i> G1	MC/AC (14mins)	HC/EX (1min)	HC/EX (3mins)	HC/GD/EX (13mins)	HC/EX (11mins)	HC/CP D (20mins)	MC (20mins)	HC/EX (20mins)
<i>B. luteipes</i> G2	-	HC/EX (2mins)	HC/EX (4mins)	HC/GD/EX (10mins)	HC/EX (8mins)	HC/CP D (20mins)	HC/GD (20mins)	HC/EX (15mins)
<i>B. luteipes</i> G3	-	HC/EX (1min)	HC/GD/EX (3mins)	HC/EX (10mins)	HC/EX (9mins)	HC/CP D (20mins)	HC/GD (20mins)	HC/CP D (20mins)

In the control experiment, two groups of *B. luteipes* have minor conflicts, after that they accept each other.

In three groups of experiment toward termites, all of the *B. luteipes* groups exterminate termites and have no injuries during all conflicts with no soldiers. The *R. qingdaoensis* groups with soldiers take longer period for *B. luteipes* groups to exterminate them.

In three groups of experiment toward big-headed ants, all of the workers, except one worker in the experiment with *B. luteipes* Group 1, were all killed by *B. luteipes*. There are no death of *P. nodus* soldiers during all experiments they are involved, three individuals (two from 2W1S, one from OS to *B. luteipes* Group 2 and *B. luteipes* Group 3) got injured and died after experiments.

In three groups of experiment toward *B. chinensis*, all of the *B. luteipes* groups exterminate termites and have only one injury during all experiments and the wound does not causes death of the injured worker (See in Table 1).

3.2. Discussions

3.2.1 Interspecific comparison (*B. luteipes* & *B. luteipes*)

As a very aggressive species, *B. luteipes* does not show the trend to fight to death with workers from another *B. luteipes* colony. Instead, during the entire control experiment, there were only two conflicts that caused harm to workers. When workers of two different colonies meet, they have four reactions; they might run away, and more often they start to contact with each other. But in some situations, one worker will open its mandibles and chase another one, or even worse, both of them are aggressive and have a fight (A.). At the end of the fight, one worker got stung by another one, but surprisingly, even though the venom of *B. luteipes* is lethal to many small invertebrates, it seems that this venom is not so deadly to *B. luteipes* itself, two workers that been stung got recovered in an hour, and during the process, other workers do not show the trend of attack, they lick the wounded and tap them with antennas (C.). In 14mins, the conflicts disappear. They might have the ability to accept workers of the same species (B.), for the assumption, that their colony is not huge, to save the limited colony members, they try to avoid conflicts among the same species as much as possible (See Fig.1).

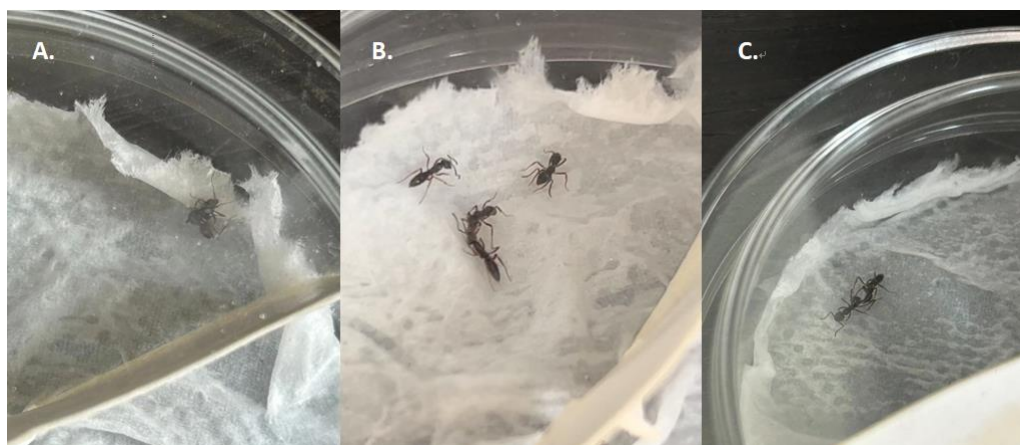


Fig.1 A. Two *B. luteipes* workers fight each other; B. Four *B. luteipes* workers get together without fighting; C. A *B. luteipes* worker is licking another *B. luteipes* worker that been stung.

3.2.2 *B. luteipes* & *R. qingdaoensis* (workers, workers& soldier, soldiers)

In the experiment, *B. luteipes* proves itself as a specialized termite hunter. They show a very aggressive attitude toward *R. qingdaoensis*, especially to workers. Termite worker individuals cannot build sufficient defense lines against *B. luteipes*, when they meet a *B. luteipes* worker, they do not fight back, and instead, they panic and try to run away. As for *B. luteipes*, it does not let the chance escape; it often quickly grabs the termite's antennas or thorax and stings it precisely (D.). The termite worker will convulsion and die in seconds, after that *B. luteipes* worker will lick them and carry them around, they also put the corpse on the ground and strayed around, making sure there were no other termites still survive.

When a *R. qingdaoensis* soldier encounters a *B. luteipes* worker, it usually bites immediately (E.). As for *B. luteipes*, it has two different options; one is retreating temporarily and waiting for opportunities to sneak attack, and the other one is when *R. qingdaoensis* soldier misses the chance to bite on *B. luteipes* worker body parts, *B. luteipes* worker will dash on to its head, try to bite its antenna, thorax, and abdomen. The termite soldier will struggle hard and bite when it notices *B. luteipes* is above, but this action is in vain, after controlling the termite soldier *B. luteipes* quickly stings on its victim, the venom is highly effective toward termites, quickly kills the termite soldier (F.). When other soldiers nearby find another termite soldier is being attacked, they will also try to bite and drive *B. luteipes* away, this method sometimes works and *B. luteipes* even get injured (G.), but most of the time it is too late for them to do this, the victim soldier was already down and *B. luteipes* will return and picks its corpse away.

On some special occasions, *R. qingdaoensis* workers will also show an aggressive attitude toward *B. luteipes*. When *R. qingdaoensis* soldier is having a battle with *B. luteipes*, they might release some chemical signals to notice *R. qingdaoensis* workers, these chemical signals sometimes irritate *R. qingdaoensis* workers and make them aggressive, and they will also try to bite *B. luteipes*. But this situation is kind of rare, in three experiments with *B. luteipes* and *R. qingdaoensis* workers& soldier, there's only one example where workers become aggressive and bite *B. luteipes* (F.). This might be because in the other two experiments, termite soldiers got killed too quickly, and these workers were not nearby.

Something also interesting is that when *B. luteipes* gets injured, it becomes very aggressive. In three experiments about *B. luteipes* and *R. qingdaoensis* workers& soldier and soldiers, the termite soldier bites *B. luteipes*'s antenna and legs off its body, but the *B. luteipes* becomes aggressive even crazy toward termites, it does not care about injuries, dashes on *R. qingdaoensis*'s body and sting them to death, though this reaction causes more injuries (G.). This is very effective, causing less loss to *B. luteipes*'s colony. In one experiment, a *B. luteipes* worker killed three *R. qingdaoensis* soldiers one by one on its own, but it also got damaged badly and died after returning to its colony (See Fig. 2).



Fig. 2 D. A *B. luteipes* worker is stinging a *R. qingdaoensis* worker, E. A *R. qingdaoensis* soldier is confronting two *B. luteipes* workers; they open their mandibles and biting enemies; F. A *B. luteipes* worker grabs the opportunity to kill the *R. qingdaoensis* soldier, but a *R. qingdaoensis* worker next to it bite on its leg, G. An injured *B. luteipes* worker is killing a *R. qingdaoensis* soldier; another *R. qingdaoensis* soldier next to it is trying to bite its leg.

3.2.3 *B. luteipes* & *P. nodus* (workers, workers& soldier, soldiers)

In the battle with *P. nodus*, *B. luteipes* does not show many advantages, medium-sized big-headed ants are dangerous enemies to *B. luteipes*. When three *B. luteipes* face three workers of *P. nodus*, they just simply bite and sting them to death. The experimenter does not think *B. luteipes* has many special technics for fighting with big-headed ant workers; it just uses its size advantage and stingers to kill them (H.). In all experiments with *B. luteipes* facing three *P. nodus* workers, all of these big-headed ant workers got killed when they first encountered them.

As for *P. nodus* soldiers, *B. luteipes* also does not have many special techniques. Most of the time when they encounter, *P. nodus* soldiers will bite with *B. luteipes* or start to chase it, *B. luteipes* will fight back and run away, and sometimes another *B. luteipes* nearby will try to cooperate with it, it might attack the big-headed ant soldier in another side, but this attack is more like threatening, not as deadly as when they are facing *R. qingdaoensis*. *P. nodus* soldier's powerful mandibles can let them easily damage *B. luteipes*, plus their thick and tight exoskeleton, especially its head, does not give *B. luteipes* chances to sting. During the experiment, these were still some *P. nodus* soldiers got stung and died (I.).

During the experiment, the cooperation of *P. nodus* workers and soldiers is not very obvious, this might be because the number of workers and soldiers is too small, and this is one limitation of the experiment. But what experiments show interesting is *B. luteipes* will not attack *P. nodus* workers if there's a soldier closely nearby, this might be because it is afraid that *P. nodus* soldier will bite it during the killing process (J.) (Fig. 3).



Fig. 3 H A *B. luteipes* worker is killing a *P. nodus* worker, I. A *P. nodus* soldier is fighting with a *B. luteipes* worker. Both of them got injured and dead after the experiment, J. A *B. luteipes* worker is passing by a *P. nodus* worker with a *P. nodus* soldier; the former leaves after they meet.

3.2.4 *B. luteipes* & *B. chinensis*

B. chinensis, known as Asian needle ants, are bigger and stronger than its close cousin, *B. luteipes*. The experimenter first thought *B. luteipes* did not have any chance against *B. chinensis*, but the fact is the opposite, *B. chinensis* is frightened and tries to escape or escape after a few bites when it meets *B. luteipes*, and *B. luteipes* chases after it fiercely, bite its leg and sting it to death (K.). When these two ants are fighting, they both try to hold the opponent and sting it, but *B. luteipes* usually gets to a closer position by its small size and have more opportunities to sting (L.). Both of their mandibles are not as powerful as *Camponotus* and *Pheidole*, so the slight size advantage might become a short point, *B. chinensis* is usually the negative one (M.).

B. chinensis's is beneficial for them to hunt larger termite species and fight with carpenter ants in the southern part of China, that might be the reason why there're more common in the southern, but the fighting with *B. luteipes*, they have done a bad work during these three experiments (Fig. 4).

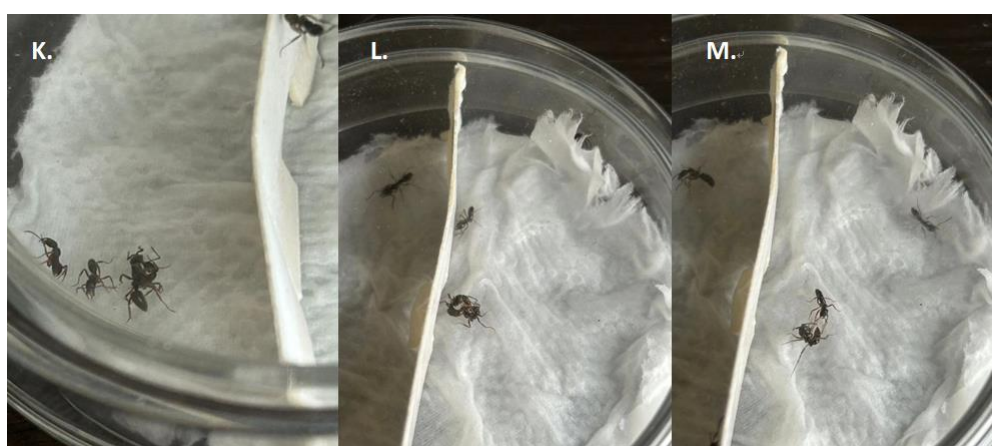


Fig. 4 K. A *B. chinensis* worker is trying to escape from a *B. luteipes* worker that is stinging it; L. A *B. chinensis* worker is fighting with a *B. luteipes* worker; M. A *B. luteipes* worker just killed the *B. chinensis* worker that fought with it.

4. Conclusion

During the experiment, the experimenter found some limitations in it. First, in some experiments, the partition has a crevice, which creates the chance for small insects like *P. nodus* workers to enter another half of the experiment ground and start the fight before the experimenter can take photos, because of that, the experiment restarted many times. Second, some termites like to hide in the curve

of tissues, causing problems with taking photos, some fights might miss, and the experimenter only can see half of the *B. luteipes* worker clearly above the tissue. Thirdly, because of the limitation of resources and time, the experiment cannot conclude all situations. *B. chinensis* might have an advantage over *B. luteipes* in some places, but *P. nodus* workers and soldiers' cooperation might have a better chance of damaging or even exterminating *B. luteipes*. The experiment only has three individuals in each group, and most of them came from the same area, this is a great limitation, but the experimenter cannot fix it in this short period, it requires too many resources and too much time. Like *B. chinensis*, *B. luteipes* is also becoming an alien invasive species in many places around the globe. People usually ignore it and see it as *B. chinensis*. But in the experiment, what we can see is *B. luteipes* can be a fiercer hunter toward many native social insects, it can remain aggressive when other ants feel afraid. It is likely to have the same technique as *B. chinensis* like decoding pheromones of termites; they also have fighting skills toward other social insects. It has strategies to save its colony's power by avoiding unnecessary fights and dedicating wounded to risk hunting. People should be aware of this species, though it does not have great differences with *B. chinensis*, it is still a different species, a more adaptive species to a variety of environments and it has its risks of species invasion.

References

- [1] Taylor, R. W. (1961). *Notes and New Records of Exotic Ants Introduced Into New Zealand*. *New Zealand Entomologist*, 2(6), 28–37.
- [2] Bednar, D. M., & Silverman, J. (2011). *Use of termites, Reticulitermes virginicus, as a springboard in the invasive success of a predatory ant, Pachycondyla (=Brachyponera) chinensis*. *Insectes Sociaux*, 58(4), 459–467.
- [3] Bolton, B. (1995). *A taxonomic and zoogeographical census of the extant ant taxa (Hymenoptera: Formicidae)*. *Journal of Natural History*, 29(4), 1037–1056.
- [4] Gue'nard B. and Dunn R.R. 2010. A new (old), invasive ant in the hardwood forests of Eastern North America and its potentially widespread impacts. *PLoS ONE* 5: e11614. doi:10.1371/journal.pone.0011614
- [5] Buczkowski, G. (2015). *The Trojan horse approach for managing invasive ants: a study with Asian needle ants, Pachycondyla chinensis*. *Biological Invasions*, 18(2), 507–515
- [6] Benoit Guénard, James K. Wetterer, and Joe A. MacGown "Global and Temporal Spread of a Taxonomically Challenging Invasive ant, Brachyponera chinensis (Hymenoptera: Formicidae)," *Florida Entomologist* 101(4), 649-656, (1 December 2018).
- [7] Matsuura, K. (2002). *Colony-level stabilization of soldier head width for head-plug defense in the termite Reticulitermes speratus (Isoptera: Rhinotermitidae)*. *Behavioral Ecology and Sociobiology*, 51(2), 172–179. doi:10.1007/s00265-001-0426-2
- [8] Allen, Hamilton Ross. (2017). *Biology and Behavior of the Asian Needle Ant, Brachyponera chinensis (Emery)*, Clemson University ProQuest Dissertations Publishing, 10685417
- [9] Ping Zuan, Lin Zou, Xiaodong Zhou, Preliminary investigation of termites in Linyi and Rizhao areas of Shandong Province. *Urban pest Control* 2003 Phase II 34.
- [10] Kikuchi, T., Miyazaki, S., Ohnishi, H., Takahashi, J., Nakajima, Y., & Tsuji, K. (2008). *Small queens and big-headed workers in a monomorphic ponerine ant*. *Naturwissenschaften*, 95(10), 963–968.