

Repeated predation of Odonata by the hornet *Vespa crabro* (Hymenoptera: Vespidae)

Klaas-Douwe B. Dijkstra¹, Adolfo Cordero Rivera² & José A. Andrés³

¹Gortestraat 11, NL-2311 MS Leiden, The Netherlands. <dijkstra@naturalis.nnm.nl>

²Departamento de Ecología e Bioloxía Animal, Universidade de Vigo, E.U.E.T. Forestal, Campus Universitario, 36005 Pontevedra, Spain. <acordero@uvigo.es>

³Animal Ecology, Department of Ecology and Environmental Science, Umeå University, SE-90187 Umeå, Sweden. <jose.andres@eg.umu.se>

Received 05 January 2000; revised 06 April 2000, accepted 01 June 2000.

Key words: Odonata, dragonfly, *Calopteryx haemorrhoidalis*, *Sympetrum* spp., *Vespa crabro*, Hymenoptera, predation, oviposition, courtship.

Abstract

Predation of aggregated, ovipositing tandems of *Sympetrum sanguineum* and *S. vulgatum* by the hornet *Vespa crabro* was observed in Belarus. The same species of hornet was seen killing territorial males and copulating females of *Calopteryx haemorrhoidalis* in Italy. Numerous remains of these odonates at the oviposition sites suggest that attacks occur frequently. A short review of vespid predation of Odonata is given. Species of the genera *Vespa* and *Vespula* have often been reported as predators of single, emerging and ovipositing odonates, taking prey as big as large *Aeshna* species. Odonata may form an important source of protein for *V. crabro* in parts of its range. Such predation may contribute strongly to odonate mortality locally. The disturbing effect may also disrupt opportunity for reproductive behaviour.

Observations

In the late morning of 6 September 1999 KDBD was observing an aggregation of ovipositing tandems of *Sympetrum vulgatum* (Linnaeus) at an oxbow near Hlupin, Zhitkovichskij Rayon, Gomelskaya Oblast, southern Belarus (52°04'N, 28°09'E). The size of the cluster ranged from four to ten tandems. Suddenly a hornet *Vespa crabro* Linnaeus invaded the group and began attacking tandems. After several unsuccessful attacks a tandem was brought down and the hornet began gnawing on the female. The male managed to free himself and his mate and recommenced oviposition movements, dragging the dead female along. After a brief rest in the vegetation and a second bout of dipping movements, he abandoned oviposition attempts. Almost directly thereafter a hornet, possibly the same individual, seized a second tandem and began consuming the male. The female escaped and continued oviposition alone. A search of the oviposition site - a surface no greater than 2 m² - for the remains of earlier victims

yielded a handful of dismembered heads, wings and abdomens, amounting to at least nine individuals of *S. vulgatum*, including the before-mentioned male. The retrieved abdomens belonged to five males and two females. In the early afternoon oviposition had ceased at this particular spot, but two meters away a group of up to six tandems of *S. sanguineum* (Müller) was found ovipositing. After a few minutes of observation a hornet appeared, but its attacks merely chased off all the pairs. Here the wings of two individuals were found.

During fieldwork on the reproductive behaviour of *Calopteryx haemorrhoidalis* (Vander Linden) near Pontecorvo, Frosinone Province, Lazio, Central Italy (41°27'N, 13°39'E), ACR and JAA observed repeated attacks by *V. crabro* on the study species. During a total of 75 hours of observation from 6 to 24 August 1999, hornets were seen attacking 13 males (three of which were courting) and seven copulating pairs. Of these, four males and two females were captured and eaten (Fig. 1). One of the captured males was courting. Although patrolling males were attacked, none were captured.



Figure 1. Predation of a *Calopteryx haemorrhoidalis* male by *Vespa crabro* in Central Italy, August 1999. The length of the victim's hindwing is 29.9 mm (Photo: A. Cordero Rivera).

In several cases adults were able to escape even after initial capture. The wings of at least 14 additional males and four females were found among floating *Potamogeton* leaves, suggesting that many more individuals had been captured (all remains were removed daily, to avoid double counting). These must have been killed recently, because most of the remains belonged to specimens marked individually for our experiments. To illustrate the predation intensity, visits by at least 60 hornets were noted during six

hours of observation along a section of eight meters of riverbank on 8 August 1999; the same individuals probably returned frequently. As many as four hornets were seen at a time. During this period three adults were captured. The attacks were so persistent that they caused the disappearance of all the territorial males from the water during short periods, and courtship behaviour was often interrupted.

In both cases the hornets behaved similarly. The prey was grasped with the legs and, although the hornets were seen to curve the abdomen towards the victim, it was not clear whether they stung it. The prey was generally brought down to the floating vegetation, where it was devoured in one or two minutes, after which only the wings and sometimes the head and abdomen were left. It appeared that the hornets only salvaged the thorax. On two occasions the captured zygopterans were transported to nearby trees, where they were dismembered. It was therefore likely that individuals were killed without their remains being found.

In Italy the hornets frequently visited the river to drink, where they perched on floating *Potamogeton* leaves, remaining there for two or three minutes. Apparently, some individuals visited the river not only to drink, but also to attack Zygoptera. The hornets' behaviour in Italy suggested that they had a search image for *C. haemorrhoidalis*. On repeated occasions hornets ignored perched *Platynemis pennipes* (Pallas) but attacked *C. haemorrhoidalis*. The floating wing of a male *C. haemorrhoidalis* elicited attacks by at least three hornets during one morning and a dead male was removed by a hornet from a spider's web. Dark objects, such as leaves, were also attacked frequently.

Discussion

Predation by *Vespa crabro* appears to occur quite frequently among Odonata (Paine 1992; Papazian 1997; Garbutt 1998). Members of the related genus *Vespula* are equally ferocious (Robins 1938; Clark 1942; Hutchinson 1979; Burton 1991; Majaerus 1993; Taylor 1994) and have been reported to prey on emerging individuals (Schmidt 1964; Thickett 1994; Waring 1994; Gasse & Kröger 1996; Fliedner & Fliedner 2000). Cordero (1988) noted frequent inspection of ovipositing sites of *Lestes viridis* (Vander Linden) by *Vespula vulgaris* (Linnaeus) but observed only one killing. Vespids can take prey much larger than themselves. Both *V. vulgaris* and *V. crabro* are known to prey on mature individuals of *Aeshna cyanea* (Müller) (Majaerus 1993; Garbutt 1998). In Belarus remains of *A. juncea* (Linnaeus) and *A. subarctica elisabethae* Djakonov were found that were indicative of hornet predation (K.-D. Dijkstra unpubl.). In Japan *V. crabro* is known to have taken the formidable gomphid *Sieboldius albardae* Selys, whereas it specialises on cicadas (Cicadidae) considerably larger than itself (Matsuura & Yamane 1990).

Whereas most reports of attacks on mature odonates have involved single occurrences, our observations suggest that many individuals can be preyed on within a short time. At the end of the summer in 1999 hornets were extremely abundant in both areas, as were reproductively active Odonata. Hornets may contribute importantly to mortality during that time of year. Additionally, the disturbing effect of their presence may also significantly reduce the time and opportunity for reproductive behaviour.

Surprisingly, no hornet predation was observed at the same locality in Italy in August 1997 (Cordero 1999), although hornets nested near the site. Perhaps the hornets had not yet developed the appropriate search image. Vespids have a habit of visiting the same food source repeatedly until it is exhausted, in the case of *V. crabro* generally operating within a radius of up to 2.4 km from the nest (Matsuura & Yamane 1990). Many *Vespa* species are opportunistic predators of large insects. Libellulids, especially *Sympetrum frequens* (Selys), are known to be one of the most important protein sources of the Japanese species *V. analis* Fabricius and *V. simillima* Smith (Matsuura & Yamane 1990). It seems that Odonata may form an important food item for *V. crabro* in parts of its range.

Rehfeldt (1992, 1995) discusses aggregation behaviour of ovipositing *S. vulgatum* in relation to predation by Green Frogs (*Rana esculenta* Linnaeus). Arriving tandems generally select sites where other tandems are already present, unless vegetation is dense, in which case solitary oviposition is preferred. A tandem has a lower risk of being preyed on in a group, than when it is alone. Besides diluting predation probability, groups may also indicate sites with favourable conditions for the eggs and larvae or where the frequency of attacks is low. On the other hand, aggregated tandems also form extremely visible and attractive concentrations of prey. Vespids are swift and sharp-sighted predators, which can attack such sites repeatedly.

Hilfert-Rüppell (1999) studied the effects of the predation pressure by the spider *Dolomedes* sp. on territorial males of *C. haemorrhoidalis* and by Green Frogs on *Calopteryx splendens* (Harris). Despite repeated attacks, Green Frogs were unable to catch patrolling or fighting *C. splendens* males. Similarly, we only recorded the capture of perching, courting or copulating males. We counted more killed males than females (23 vs 8). This can be expected, as males were much more numerous at the riverbank than females. Courting males also fly more slowly and are therefore more easily captured than females. Furthermore, hornets mainly searched the shore vegetation where territorial males perched, and avoided the floating leaves of *Potamogeton*, where females oviposited. Although these observations would imply that males are relatively more vulnerable to attacks than females, our data are unsuitable to test this. The fact that *P. pennipes* was not attacked suggests that hornets had a search image for *C. haemorrhoidalis*. This could be due to the greater abundance of the latter species, which clearly dominated the odonate fauna of the river.

Acknowledgements

ACR was supported by a travel grant from Xunta de Galicia. KDBD was sponsored by the Uyttenboogaart-Eliassen Stichting and Institute for Inland Water Management and Waste Water Treatment (RIZA). We wish to thank Philip Corbet and an anonymous referee for reviewing the manuscript.

References

- Burton, J.E., 1991. Social wasps *Vespula* spp. attacking *Aeshna* hawk dragonflies and silver Y moth *Autographa gamma* L. (Lep.: Noctuidae). *Entomologist's Record and Journal of Variation* 103: 199-200.
- Clark, W.A., 1942. Dragonfly attacked by wasp. *The Entomologist* 75: 263.
- Cordero, A., 1988. Estudio ecológico de una población de *Lestes viridis* Vander Linden, 1925 (Zygoptera, Lestidae). *Limnética* 4: 1-8.
- Cordero, A., 1999. Forced copulations and female contact guarding at a high male density in a calopterygid damselfly. *Journal of Insect Behavior* 12: 27-37.
- Fliedner, T. & H. Fliedner, 2000. *Aeshna cyanea* als Beute von *Vespula vulgaris*: ergänzende Beobachtungen zu Angriffen sozialer Faltenwespen auf schlüpfende Libellen (Odonata: Aeshnidae; Hymenoptera: Vespidae). *Libellula* 19: 71-77.
- Garbutt, A., 1998. Hornet predation on a dragonfly. *Journal of the British Dragonfly Society* 14: 30-31.
- Gasse, M. & C. Kröger, 1996. Schlüpfende Grofibellen (Anisoptera: Aeshnidae) als Beute der sozialen Faltenwespe *Vespula vulgaris* L. (Hymenoptera: Vespidae). *Libellula* 15: 45-55.
- Hilfert-Rüppell, D., 1999. To stay or not to stay: decision-making during territorial behaviour of *Calopteryx haemorrhoidalis* and *Calopteryx splendens splendens* (Zygoptera: Calopterygidae). *International Journal of Odonatology* 2: 167-175.
- Hutchinson, R., 1979. A *Vespula* wasp (Hymenoptera: Vespidae) with a male *Enallagma boreale* Selys (Zygoptera: Coenagrionidae) in its mouth. *Cordulia* 5: 84.
- Majaerus, M.E.N., 1993. Predation of *Aeshna cyanea* by *Vespula vulgaris*. *Bulletin of the Amateur Entomologist's Society* 52: 67.
- Matsuura, M. & S. Yamane, 1990. *Biology of the vespine wasps*. Springer, Berlin.
- Paine, A., 1992. Notes and observation. *Journal of the British Dragonfly Society* 8: 14-18.
- Papazian, M., 1997. *Onychogomphus forcipatus unguiculatus* (Vander Linden, 1820) victime du frelon (*Vespa crabro* L., 1758) (Odonata, Anisoptera, Gomphidae; Hymenoptera, Apocrita, Vespidae). *Martinia* 13:123-125.
- Rehfeldt, G.E., 1992. Aggregation during oviposition and predation risk in *Sympetrum vulgatum* L. (Odonata: Libellulidae). *Behavioral Ecology and Sociobiology* 30: 317-322.
- Rehfeldt, G.E., 1995. *Natürliche Feinde, Parasiten und Fortpflanzung von Libellen*. Odonatological Monographs 1, Braunschweig.
- Robins, J.M., 1938. Wasp versus dragonfly. *The Irish Naturalist's Journal* 7: 10-11.
- Schmidt, E., 1964. Biologische-ökologische Untersuchungen an Hochmoorlibellen (Odonata). *Zeitschrift für Wissenschaftliche Zoologie, Abteilung A* 169: 313-386.
- Taylor, M.R., 1994. The predation of *Sympetrum sanguineum* (Müller) by *Vespula germanica* (Fabricius) (Hymenoptera, Vespidae). *Journal of the British Dragonfly Society* 10: 39.
- Thickett, L.A., 1994. Predation of a freshly-emerged zygopteran by a social wasp. *Journal of the British Dragonfly Society* 10: 44-45.
- Waring, P., 1994. Predation of emerging dragonfly by wasps. *Lancashire Wildlife Journal* 2-3: 62-63.