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Bioecology and behaviour of *Coenosia attenuata* in greenhouse vegetable crops in the Oeste region, Portugal

Célia MATEUS
Instituto Nacional de Investigação Agrária e Veterinária, IP, Oeiras, Portugal

Abstract

Spatial distribution and flight and predation activities of *Coenosia attenuata* Stein (Diptera Muscidae) adults were studied in greenhouse vegetable crops in the Oeste region, Portugal. During spring and summer, fewer flies were seen in the crops in the middle of the day in relation to the morning and afternoon periods. Males/ females ratio was 1:4, independently of the season. Flies were significantly more abundant in the sunny areas of crops in relation to the shadowed ones, and were found landed on cucumber and sweet pepper plants (especially on leaves), in opposition to tomato plants; in this crop, flies preferred the tutors and other greenhouse structures. Adults were also abundant next to the soil, on the plastic covering it and on irrigation pipes. Outside greenhouses, adults were landed everywhere. Most flies, when landed in the pending cucumber leaves, were next to their borders and oriented downwards. Some flights were trigged by insects flying inside a range of about 30 cm distance (here called "provoked flights"), and also by other movements made by the observer nearby. Insects landed on the same leaf as the predator, moving closely (but not flying), were not attacked. The majority of flights registered had no visible cause ("non-provoked flights"), some of them looking more like jumps. In 72% of provoked flights, flies returned to the leaf they had just left, and in almost half of them, they adopted both the location and the orientation they had before in the leaf. The percentage of preys captured was very low: many flights were probably the result of a territorial behaviour and not of a predation activity. Cannibalism was not detected in the field. Predation in the field occurred on whiteflies, small hymenopterans, leafhoppers, leafminers, sciarids, psocopterans, and also on thrips. Most preys were attacked in the cervix area.

Key words: Tiger-fly, spatial distribution, predation, flight, biological control.

Introduction

Both larvae and adults of *Coenosia attenuata* Stein (Diptera Muscidae) are polyphagous predators and some of the preys are common greenhouse pests. Larvae are soil-dwelling and feed on small soft bodied soil invertebrates like the larvae of sciarids (Diptera Sciaridae) and shore flies (Diptera Ephydridae), and adults, on the other hand, live above the soil, for example, on the canopy of crops, and feed on flying insects, like sciarids, whiteflies (Rhynchota Aleyrodidae), leafminers (Diptera Agromyzidae) and winged aphids (Rhynchota Aphididae) (Moreschi and Colombo, 1999; Kühne, 2000; Martinez and Cocquempot, 2000; Sensenback *et al*., 2005; Sutherland, 2005; Prieto *et al*., 2005; Pinho *et al*., 2009; Ugine *et al*., 2010; Pohl *et al*., 2012). Adults wait for the prey, landed on the plants or on other surfaces, and attack insects flying nearby, in an ambush hunting behavior (Künhe, 2000). An interesting feature of this predator is that it attacks and kills preys even when not hungry (Martinez and Cocquempot, 2000). It is also known as "tiger-fly".

C. attenuata is distributed worldwide, but its capacity to tolerate high temperatures maintaining the predation activity (Moreschi, 1999; Martinez and Cocquempot, 2000, Gilioli *et al*., 2005) makes it very interesting for pests' biological control in the greenhouses of the Mediterranean basin, during the summer. In this region, it has already been detected in Portugal (Prieto, 2002, Prieto *et al*., 2005), Spain (Rodriguez *et al*., 2004), France (Martinez and Cocquempot, 2000), Italy (Colombo and Eördegh, 1991), Malta (Ebejer and Gatt, 1999), Greece (Suvák, 2008), Cyprus (Witters *et al.*, 2009), Turkey (Pohl *et al*., 2003), Syria (Hennig, 1964), Israel (Pont and Grach, 2008), Egypt (Hennig, 1964), Libya (Hennig, 1964), Algeria (Hennig, 1964), Morocco (Pont, 1986), Lebanon and Tunisia (A. C. Pont, personal communication).

In this study, the spatial distribution of *C. attenuata* adults in greenhouse vegetable crops is analyzed, as well as their flight and predation activities.

Materials and methods

Field observations took place in four unheated greenhouses: two with cucumber plants (cucumber 1 and cucumber 2), one with sweet pepper, and another with tomato, about 75 km north Lisbon, in the "Oeste region" of Portugal. Observations occurred during the autumn 2007/ winter 2008, and spring/ summer 2009: six sampling dates in the first period, in cucumber 1 and in sweet pepper, and five sampling dates in the second period in cucumber 2 and in tomato, in what concerns spatial distribution. Behaviour observations began, previously, in the summer 2007, in a total of five observation dates in 2007 and six in 2009.

Greenhouses were all plastic ones with lateral windows, and crops were grown in rows (simple ones in sweet pepper and tomato, and double ones in cucumber), with approximately 40 cm between plants, which were conducted vertically. Border rows were not considered for observations. No insecticides sprays occurred during the observation periods in those greenhouses.

Spatial distribution

Along cucumber 1, cucumber 2 and sweet pepper crop rows, in approximately every four meters, a section of one meter of the crop was inspected (specifically stems, upper page of leaves, flowers and fruits, in the upper, middle and lower height level of the plants present in that section), in a total of six or seven sections per row, depending on the greenhouses. The presence of *C. attenuata* adults was registered. Crop rows had a north-south direction, meaning that in the morning, when walking along the inter-rows inspecting the plants, in one side, the part of the plants facing the inter-row was in the shadow (here called shadowed row) and, in the opposite side, the part of the plants facing the inter-row was receiving the sunlight directly (here called sunny row). In the afternoon, the same occurred, but with an opposite orientation. The number of *C. attenuata* adults observed in the morning, in each sunny row and in the opposite shadowed one, was registered and compared by the paired t-test, in a total of 53 pairs of rows in cucumber and 25 pairs in sweet pepper. Observations were also conducted in the afternoon in the cucumber crop (21 pairs of rows), and rows were also compared by the paired t-test.

The spatial distribution of potential preys was evaluated in cucumber 2 greenhouse, following the same methodology described above for the predator, with the additional observation of the lower page of three leaves per height level, in each section. Potential preys of *C. attenuata* adults were those insects not bigger than this predator adults and with capability of flying, and their presence in sunny and shadowed crop rows (31 pairs of rows) was compared using the Wilcoxon matched pairs test.

In tomato, the distribution of *C. attenuata* adults was registered in two different crop development stages: (1) when there were fruits in the 1st and 2nd clusters, the 3rd ones were still flowering, and the top of plants were 50 to 70 cm distant from the horizontal tutor (which was at about 1.80 m height); (2) and later, when most fruits were ripened and many plants already reached the horizontal tutor. Along tomato crop rows, the presence of *C. attenuata* adults was registered, in every four meters, in one meter sectors constituted by: (1) a tomato plant; (2) the respective vertical tutor (above the top of the plant and along the stem); (3) the horizontal tutor where the vertical ones were tied at the top (50 cm each side of the plant were observed); (4) the bended irrigation pipe in the floor, next to plant; and (5) the plastic covering the floor along the rows (50 cm each side of the plant were observed). The items 4 and 5 were considered only in the second development stage set of observations, since old leaves had already been eliminated, leaving those items visible. Plants observed in that crop development stage were those that still had not reached the horizontal tutor (i.e. the top part of the vertical tutor was still not covered by the plant). Sectors (N = 25 for the first development stage, and N = 40 for the second one) were analysed and locations of the predator compared with the Friedman test, followed by the nonparametric Tukey-type multiple comparisons test (Zar, 1984).

The location of *C. attenuata* adults landed in cucumber leaves, selected at random, was registered, considering three parts of the leaf with approximately equal area: next to the petiole, middle area, and border of the leaf. The orientation of adult flies landed on cucumber leaves and on tomato greenhouse structures, all selected at random, was also registered, that is if flies' head was facing upwards or downwards in pending leaves or in other non-horizontal surfaces. Additionally, for a smaller number of flies, their orientation was registered taking into account if flies were located in sunny rows or in shadowed ones. These two parameters (location and orientation in the leaves or other structures) were registered only after about 5 seconds observing the fly, with no change occurring during that period. Predators holding preys were not considered for this analysis.

C. attenuata adults were also searched for outside the crop greenhouses.

Statistical analysis was performed with the programs Minitab (4.0) and Statistica (7), for a significance level of 0.05.

Flight activity

The behaviour of *C. attenuata* adults landed in cucumber leaves was registered, during the morning. Adults were selected at random and observed individually, during 30 minutes or until they left the leaf where they were landed. Distance between the fly and the observer was about 0.8 to 1 meter, with the observer seated and doing minimum movements during the observation period. Flights were classified as "provoked flights" and "non-provoked flights", whether their cause was identified or not by the observer; seldom flights occurred with no visible cause. Parameters registered were: (1) the location and orientation of the fly in the leaf, in the beginning of the observation period, and after each flight (registration occurred about 5 seconds after landing); (2) the time flights occurred; (3) their cause; and (4) the capture of preys during the flight. For adults' location, the criterion was the same indicated above (next to the petiole, middle area and border of the leaf). For adults' orientation, each cucumber leaf was divided in sectors as if it was a clock, the petiole indicating 0h/12h and the leaf apical part indicating 6h; flies were registered as oriented towards the hours.

Temperature at the beginning and at the end of each observation period was registered with a maximum-minimum thermometer (XH-202).

Predation activity

In relation to predators holding preys, detected during the observations of spatial distribution, flight activity and other random observations, the time taken in the feeding process was registered until the prey was abandoned. Consumed preys were collected after being abandoned by the predator and were identified in the laboratory. The location of attack/ predation vestiges in their bodies was registered.

The behaviour associated to predation consumption was also registered.

Results

Spatial distribution

Significantly more *C. attenuata* adults were detected in the sunny rows than in the shadowed ones in the cucumber greenhouses, in the morning ($t = 10.78$, $df = 52$, $p = 0.000$) and in the afternoon ($t = 7.95$, $df = 20$, $p = 0.000$). The same occurred in the sweet pepper greenhouse, analysed during the morning period ($t = 8.93$, $df = 24$, $p = 0.000$). In relation to the presence of potential preys in cucumber, no significant differences were detected between the two types of rows ($N = 31$, $Z = 0.87$, $p = 0.38$). Analyzing whiteflies, separately, the most abundant potential preys (88%), the same result was reached ($N = 28$, $Z = 0.71$, $p = 0.48$). Predators and potential preys mean number (± SE) are presented in table 1.

Predators' sex-ratio (male/female) was 0.26 (± 0.08) in cucumber and 0.25 (± 0.06) in sweet pepper, during the autumn, and 0.25 (± 0.05) in cucumber during spring/summer.

In tomato, in the first crop development stage analyzed, all *C. attenuata* adults detected (N = 26) were landed in the vertical tutors above the top of the plant. In the second development stage there were significant differences between the items compared ($\chi^2_r = 135.26$, $N = 40$, $df = 7$, $p = 0.000$), being the predators' presence significantly higher in the part of the vertical tutor above the top of the plant, in the horizontal tutor (located above the plant), and also on the bended irrigation pipes placed in the soil (table 2).

Predators observed landed on cucumber leaves (N = 268 adults) were: 57% in the border of the leaves, 33%, in the middle area, and 10% in the interior, next to the petiole. In relation to predators orientation on cucumber leaves (N = 787 adults), 98% were oriented downwards, that is with the head and front legs in a lower height level in relation to the rest of the body. Because most observed leaves were pending towards the inter-rows, flies were than mostly directed towards them. When predators location in sunny and shadowed rows was taken into consideration (N = 97 adults and N = 43 adults, respectively), 97% in sunny rows and 95% in shadowed ones had a downwards orientation. In the tomato crop, on plants and on structures associated to them, 97% (out of 185 adults observed) were facing downwards: as an example, 114 out of 116 individuals detected in vertical tutors were in that position, as well as 59 out of 60 seen on the irrigation pipes.

During spring and summer, at the middle of the day, when temperatures were high, few predator adults were detected in the crops in relation to the morning; they were seen again landed on the plants and other greenhouse structures at the end of the afternoon, when temperatures had already dropped.

Outside the greenhouses, *C. attenuata* adults could be found everywhere: they were landed in the surrounding natural vegetation and on a variety of structures (on the greenhouses plastic, warehouses walls and agricultural machinery).

Flight activity

A total of 1159 minutes and 48 seconds were spent observing the behaviour of 69 *C. attenuata* adults (53 females and 16 males) landed on cucumber leaves, a mean of about 17 minutes per fly. When landed, most of the time, predators did not move (as it is possible to evaluate by an observer 0.8 to 1 meter distance): adults

Table 1. Mean number (± SE) of *C. attenuata* adults (predator) and potential preys (total and whiteflies) registered in sunny rows and in shadowed ones in greenhouse crops.

	Cucumber				Sweet pepper	
	Morning		Afternoon		Morning	
	Sunny	Shadow	Sunny	Shadow	Sunny	Shadow
Predator	23.9a (± 2.1)	2.0b (± 0.3)	19.3a (± 2.1)	2.8b (± 0.7)	8.0a (± 0.9)	0.7b (± 0.2)
Preys (total)	15.3a (± 4.4)	14.7a (± 3.2)	-	-	-	-
Preys (whiteflies)	14.6a (± 4.8)	13.8a (± 3.4)	-	-	-	-

In each crop/period, predator and preys values followed by different letters are statistically different at a 0.05 level of significance.

Table 2. Mean number (± SE) of *C. attenuata* adults in the tomato crop and greenhouse structures, and respective sum of ranks used in statistical analysis.

	Mean (± SE)	Sum of ranks
Horizontal tutor	1.13 (± 0.15)	242.5 a
Vertical tutor- top	1.35 (± 0.18)	255.0 a
Vertical tutor –along stem	0.03 (± 0.03)	132.5 b
Plant (fruits)	0.03 (± 0.03)	132.0 b
Plant (leaves)	0.08 (± 0.06)	137.0 b
Vertical tutor- next soil	0.23 (± 0.09)	153.5 b
Irrigation pipe- next soil	1.73 (± 0.28)	239.5 a
Plastic- cover soil	1.18 (± 0.07)	148.0 b

Values followed by the same letter are not significantly different at a 0.05 level of significance.

Table 3. Maintenance/ change of location and/ or orientation of *C. attenuata* adults in cucumber leaves after a flight in relation to the situation before that flight; abandonment of the leaf.

	Provoked flights (N = 72)	Non-provoked flights (N = 222)
Location and orientation maintained	34	109
Only location maintained	7	24
Only orientation maintained	4	37
Location and orientation altered	7	18
Leaf abandoned	20	34

were rarely seen walking on a leaf and, when that happened, the proboscis was touching it, as if they were probing; more frequently, they rotated slightly, changing orientation. Most predator movements were quick flights, whether "provoked" or "non-provoked" ones.

Fifteen out of 69 adults (22%) remained in the same leaf after the 30 min observation period. Of those flies that abandoned the leaf during the observation period, 63% did so by a non-provoked flight and 37% by provoked flights.

A total of 72 provoked flights and 222 non-provoked flights were registered (table 3). 85% of provoked flights were caused by an insect flying nearby; the others were also caused by movements but not of potential preys. Most non-provoked flights were smaller ones, generally inside the perimeter of the cucumber leaves, some looking almost like jumps. Minimum and maximum period of time between two consecutive non-provoked flights were of 2 seconds, and of 11 minutes and 22 seconds, respectively.

In 47% of provoked flights and in 49% of non-provoked ones, at the end of them, flies adopted the same location and orientation in the leaf that they had before the flight, and in only 10% and 8%, respectively, the result was a change in both location and orientation (table 3).

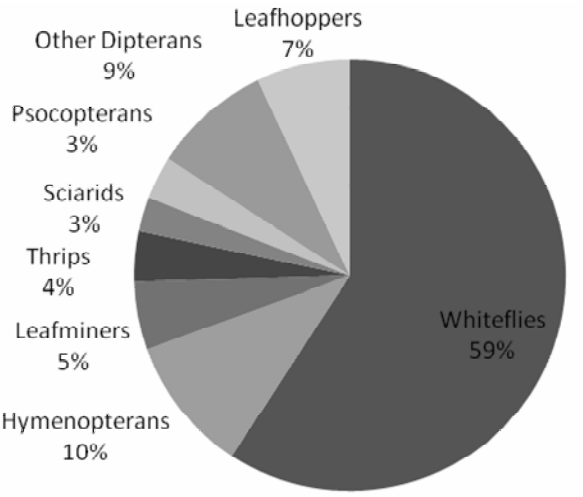

Figure 1. Preys (N = 157) captured by *C. attenuata* adults (143 females and 14 males) during the observations conducted in greenhouse crops in the Oeste region, Portugal.

In relation to the flies' orientation in cucumber leaves, when landed there, 96% of the orientations adopted by the flies during the observation period were between 4h and 8h (seeing the leaf as a clock, as indicated above), which corresponds to downwards orientation, since leaves were pending by the petiole.

In 52 out of 72 provoked flights (72%), the predator returned to the leaf from where it had left, allowing to verify if a prey had been captured: only three of those flights resulted in the capture and consumption of a prey, and in four of them, the predator returned to the leaf holding a small hymenopteran that was not consumed and, in fact, flew away. Fourteen of those 52 flights had been trigged by other *C. attenuata* adults flying near by, which were never captured. Cannibalism was only observed when two female flies were being transported to the laboratory in the same vial.

Never a *C. attenuata* fly was seen attacking an insect landed in the same leaf, even when that insect was walking in front of the predator, 1 cm distant. Insects caused the predators flights/ attack movements only when flying nearby (inside a range of about 30 cm distance), or when landing or taking off from the same leaf or neighbourhood ones.

Flight activity observations occurred in a range of temperatures between 20 to 28 °C.

Predation activity

Insects captured by *C. attenuata* (N = 157) are presented in figure 1, being whiteflies the majority of them (59%). Some predation data were already presented above, associated to flight activity observations. In the sweet pepper greenhouse, in spite of the high abundance of released *Orius* sp., never a *C. attenuata* adult was observed attacking those adults.

Predation was identified by the existence of a hole in the preys' tegument (N = 56), caused by the predator's proboscid for sucking the preys' content. In most preys (N = 23) that predation hole was localized in the cervix or "neck" (the membranous area between the occipital region of the head and the prothorax), but it could also be found in the head (N = 16), thorax (N = 8) and abdomen (N = 9) of the prey. Sometimes preys ended decapitated or partially decapitated, with the head in a twisted position.

The time spent sucking the preys began to be counted, in most cases, when the feeding process was already in course, not from its beginning, which was the case of a sciarid sucked during 5 minutes and 14 seconds (5'14"), a small hymenopteran (8'58") and a leaf-

miner *Liriomyza* sp. (9'50"). A whitefly was seen being captured and the feeding process occurred during 2'20" as well as an unidentified dipteran sucked during 16'05".

When a predator stopped sucking the prey, it released it, and generally walked slightly forward over the dead prey, leaving it behind. The release of the prey was followed by scraping the front legs one against the other.

Discussion and conclusions

C. attenuata adults were significantly more abundant in the sunny areas of crops in relation to the shadowed ones, both in the morning and in the afternoon. This cannot be directly attributed to the distribution of potential preys, since they were equally abundant in sunny and shadowed areas of the crop. According to Gonzalez-Bellido *et al*. (2011), adaptations in the form and function of *C. attenuata*'s photoreceptors favor resolution over sensitivity, reflecting this species' lifestyle and the need to recognize and target preys with precision; a well illuminated environment offers then better predation conditions to this predator.

Pinho *et al*. (2009) observed a clear preference of *C. attenuata* adults for the cucumber and sweet pepper leaves, in relation to the other parts of those plants, which was also observed during this study, even though not registered. Contrarily, in tomato, flies were rarely seen in contact with the plants or structures closely associated to them, as for example the part of the vertical tutor interlaced along the stem, as if something in the tomato plant repels this species. On the other hand, the part of the vertical tutor above the tomato plant was one of the preferred locations, being the large majority of flies oriented downwards, facing the plant below them, in what could be interpreted as a vigilant attitude towards insects flying around. When tomato plants were high, almost reaching the top horizontal tutor, many flies were also landed there. Adults were also detected next to the floor, on the bended irrigation pipes, reflecting this species' biology, as adults emerge from the soil, and may predate adult insects present there, as for example sciarids. The number of flies present on the plastic covering the soil along the rows may have been underestimated owing to the difficulty to detect the flies on a black plastic with dust and soil particles. In crops that for any reason do not attract *C. attenuata*, like tomato, vertical tutors or any other vertical structures should always be present, regularly spaced in the crop, for promoting this predator presence and activity.

Outside the greenhouses, *C. attenuata* adults could be found landed everywhere; *Coenosia* sp. can colonize greenhouses from the outside (Kühne, 2000).

C. attenuata adults were located preferably near the borders of cucumber pending leaves and oriented downwards, which probably allows a broader visualization of insects flying nearby, as well as an easier and quicker take-off. Their front legs are the shorter pair and the hind one the longest (Pérez, 2006), and so the downwards position accentuates this morphological feature. A positive geotropism may also be considered: although not counted in this study, most flies during the feeding process (holding and sucking the prey) had also a downwards orientation. This orientation occurred both in pending leaves located in sunny rows and in the opposite shadowed ones and so flies were not oriented towards the sun. Flies orientation was registered only after waiting five seconds because, seldom, immediately after landing, flies changed their position for a new one, which lasted for a longer time (a more "stabilized position").

During spring and summer, fewer predator adults were detected in the crops in the middle of the day in relation to the morning and afternoon periods, as also referred by Moreschi and Süss (1998), probably due to high temperature values, that make them search for cooler places, e.g. near vents and windows (Moreschi and Süss, 1998; Moreschi, 1999). In this study, flight and predation observations occurred at temperatures ranging 20 to 28 °C, at which flight and predation activities are high, according to Moreschi and Süss (1998) and Gilioli *et al*. (2005).

Four times more *C. attenuata* females than males were found in the greenhouses, independently of the season. When evaluating sex ratio in the field, other sex dimorfism features besides body size must be considered, because *C. attenuata* females, bigger than males, varied considerably in their size; other morphological differences, easily detected without a magnifying lens, are the colour of the head, antennae, abdomen and front legs, and also the general shape of the body (Moreschi and Süss, 1998; Rodriguez and Aguilera, 2002; Aguilera *et al*., 2004; Pérez, 2006). It was also noticed that males were more difficult to capture than females; they were more agile in escaping, and in fact Gilioli *et al*. (2005) concluded that males' activity is slightly higher than females one.

C. attenuata adults' provoked flights were trigged by insects flying nearby, inside a range of about 30 cm distances, half the distance indicated by Evans (1930) for *Coenosia humilis* Meigen. Other movements could also have the same effect: sometimes flies landed on the observer's hand or on the paper being handled, if movement occurred too closely. The 0.8 to 1 meter distance between the observer and the observed fly was defined in order to avoid interference situations. No insect walking nearby the predator, in the same leaf, was seen to be attacked, although movements of the predator's body indicated that it was pairing attention to it; when the insect was forced to take-off (by gently approaching the tip of a pencil), the predator generally followed it. References recognize that *Coenosia* spp. flight is trigged by insects flying close by (Evans, 1930; Moreschi and Süss, 1998; Kühne, 2000), and by small air borne objects (Morris and Cloutier, 1987), like sand particles thrown in their vicinity (Prieto *et al*., 2005).

The majority of flights registered had no identified cause (here called non-provoked flights). Sometimes they were frequent (separated by few seconds), but a fly could be landed, without significant movements, during more than 11 minutes. Non-provoked flights were generally small ones, mostly occurring in the leaf perimeter, some looking like jumps, which is in accordance with the already referred length of hind legs in relation to the

others. However, some flies abandoned the leaf where they were landed through a non-provoked flight.

In 72% of provoked flights, flies returned to leaf they had just left. According to Kuhne (1998; 2000) and Moreschi and Süss (1998), *Coenosia* spp. generally return to the original place to suck the prey, but in the present study the return occurred even when the predator had not captured a prey, and in almost half of the flights, it adopted both the location and the orientation in the leaf that they had just before taking-off from it.

At the end of the 30 minutes observation period, 22% of the observed predators were still in the same leaf, but since they had been chosen at random, already landed, it is not possible to evaluate for how long they stayed there. *C. humilis* was seen using the same perch for at least half an hour in sucession (Evans, 1930).

The percentage of provoked flights that resulted in the capture of a prey was low, as also seen by Evans (1930) for *C. humilis*, reflecting a low predation success or more probably a territorial behaviour, in which *C. attenuata* adults repel other insects flying nearby, by flying towards them. Sutherland (2005) identified a territorial behaviour in this species, and Morris and Cloutier (1987) referred to a "conspecific buzzing behaviour" in *Coenosia tigrina* F., with apparent attacks between conspecific adults with no killing occurring.

Cannibalism was never observed in the field during this study, but occurred when transporting adults together in small plastic vials, as expected from a predator species. Cannibalism is described for *Coenosia* spp. adults, in hunger situations, when alternative preys are lacking (Moreshi and Süss, 1998) or in laboratory conditions (Morris and Cloutier, 1987), specially by females over males (Rodriguez and Aguillera, 2002).

Most preys captured were whiteflies, which were also the most abundant ones in the greenhouses studied; it has yet to be clarified whether the cause was their abundance or a preference. Other preys captured were sciarids, leafminers, other small diperans not identified, psocopterans, leafhoppers and small hymenopterans. Thrips were also predated. All preys captured were relatively small and, in fact, according to Moreschi and Süss (1998), *Coenosia* sp. adults predate insects of equal size or slightly bigger than the predator. The prey spectrum presented here, except for psocopterans, is also indicated by other authors, whether from field observations or laboratory predation tests (Künhe, 1998; Téllez and Tapia, 2006; Pinho *et al*., 2009). Being a generalist predator, the relative abundance of each arthropod taxa present when observations are made affects the percentage of preyed arthropods of each type.

The cervix was the preferred location for the insertion of the proboscis for sucking the preys, as also referred by Colombo and Eördegh (1991) and Moreschi and Süss (1998). Time spent sucking each type of prey varies between authors (Evans, 1930; Moreschi and Süss, 1998) and in fact depends on the preys' body content and on the rate of hunger of the predator. Additionally, preys are not always completely consumed, as a result of a so called "predation instinct" (Morris and Cloutier, 1987; Moreschi and Süss, 1998), which makes this fly a very interesting agent of biological control, since a higher number of preys are killed.

Small hymenopteran are in the list of preys in this study, but four small specimens (and just in this *taxa*) flew away short while having arrived to the leaf held by the predator, abandoned/ rejected or being able to escape. No attacks were observed over *Orius* sp.; they were especially abundant in the sweet pepper greenhouse, where they had been released, but were very rarely seen flying. Téllez and Tapia (2006), in laboratory conditions, observed predation over some parasitoids, especially in the absence of alternative preys, and also refer that mirid and anthocorid predators were able to defend themselves from the attacks.

In literature, *C. attenuata* is considered a very promising agent of biological control, however, being a non-specific predator, its impact on other beneficials present in agricultural ecosystems has to be assessed; it is the challenge right now, and the results of the studies under course will dictate if, in relation to *C. attenuata*, releases or open rearing systems are desirable or just only conservation measures should be advised.

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Author's address: Célia MATEUS (celia.mateus@iniav.pt), Instituto Nacional de Investigação Agrária e Veterinária, IP, Av. da República, 2784-505 Oeiras, Portugal.

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