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MENTHA SPICATA VAR. SPICATA (L. 1753) AND RAPHANUS SATIVUS VAR. SATIVUS (L. 1753): SURVIVAL MEAL FOR MEDAUROIDEA EXTRADENTATA (BRUNNER VON WATTENWYL 1907) (PHASMATODEA: PHASMATIDAE)

GABRIEL OLIVE*, JEAN-YVES ZIMMER, GILLES OLIVE***

*Ecole Industrielle et Commerciale de la Ville de Namur, Laboratoire C2A, Rue Pépin, 2B, 5000 Namur, Belgium, email: gilles.olive@eicvn.be

**Hexapoda - Insectarium "Jean Leclercq", Rue de Grand-Axhe 45E, 4300 Waremme, Belgium

INTRODUCTION

Medauroidea extradentata (Brunner von Wattenwyl 1907) (Phasmatodea: Phasmatidae), which was also called *Cuniculina annamensis*, *Clitumnus extradentatus*, *Clitumnus extradentata* and *Baculum extradentatum* (CatalogueOfLife, 2014) but remains named *Cuniculina imbriga* (Tedtenbacher 1908) on Internet (Biron, 2006; OPIE, 2015; Wikimini, 2015) and at Office Pour les Insectes et leur Environnement (OPIE) (Guyot, 2012), is commonly known as the Vietnamese or Annam Walking Stick. Note that some authors consider *Cuniculina impigra* (Lelong, 1995; Busshardt et al., 2011; Theunissen et al., 2014) as a synonym, whereas it is in fact the species *Ramulus impigrus* (Brunner von Wattenwyl 1907) (CatalogueOfLife, 2015).

Medauroidea extradentata is widely bred and considered as very easy to maintain in captivity (Lelong, 1995). Although its natural food plant in Vietnam is unknown, this species is able to feed on a large variety of plants in captivity such as brambles and raspberries (*Rubus* spp. (L. 1753)), rose bushes (*Rosa* sp. (L. 1753)), mountain ash and nannyberry (*Sorbus* spp. (L. 1753)), cultivated strawberries (*Fragaria* × *ananassa* (Duch. 1788)), cotoneasters (*Cotoneaster* sp. (Medik. 1789)), firethorn or pyracantha (*Pyracantha coccinea* (M. Roem. 1847)), dropwort (*Filipendula* sp.), dogwoods (*Cornus* sp. (L. 1758)), oaks (*Quercus* sp. (L. 1753)), eucalyptus (*Eucalyptus* spp. (L'Hér. 1789)), birches (*Betula* sp. (L. 1753)), alders (*Alnus* sp. (Mill. 1754)), red and white currant (*Ribes rubrum* (L. 1753)), organic lettuce (*Lactuca sativa* (L. 1753)) (Boucher & Varady-Szabo, 2005), common wild rose (*Rosa canina* (L. 1753)) (Lau, 1987), beeches (*Fagus* sp. (L. 1753)), hawthorn (*Crataegus* sp. (L. 1753)), cherry trees, wild cherry trees and blackthorn (*Prunus* sp. (L. 1753)), apple trees (*Malus* spp. (Mill. 1754)), hibiscus (*Hibiscus* spp. (L. 1753)), orange tree (*Citrus sinensis* ((L.) Osbeck 1765)) (Biron, 2006), hazel (*Corylus maxima* (Mill. 1768)), linden (*Tilia* sp. (L. 1753)), chestnuts (*Castanea* spp. (Mill. 1754)), spindle tree (*Euonymus europaeus* (L. 1753)), citrus (*Citrus* spp. (L. 1753)), photinia (*Photinia fraseri* (Lindl. 1821)) (Guyot, 2012) and ficus (*Ficus benjamina* (L. 1767)) (Calvin & Lange, 2010) but not ivy (*Hedera helix* (L. 1753)) unlike other common stick insects as *Carausius morosus* (Sinéty 1901) (Guyot, 2012).

In the current management of a stick insect breeding of the species *M. extradentata* authors have made some experimental observations. First, escapes of about ten young specimens (between 1-1.5 cm) among 200 young and adult insects were regularly observed. Despite the presence of succulent plants *Graptopetalum paraguayense* (Walther 1938) and *Aptenia cordifolia* (Schwantes 1928) located at a distance of about fifty centimeters, no escaped stick insect was found there; some of them have however been observed on spearmint plants (*Mentha spicata* var. *spicata* (L. 1753)) located more than 80 cm from the terrarium as well as on radish leaves (*Raphanus sativus* var. *sativus* (L. 1753)) located about 230 cm. Moreover, four live specimens at first instar (between 1.1-1.5 cm in length) were found on *R. sativus* var. *sativus* plants shortly after mid-August 2014. How to explain this survival for fifteen days without water or conventional food with an average temperature of 16.4 °C (AccuWeather, 2014) ?

The second observation was made during periods of current food plants shortage such as *Rubus idaeus* (L. 1753) and *Rubus fruticosus* (L. 1753) (Boucher & Varady-Szabo, 2005). When *M. spicata* var. *spicata* branches were presented, this is the stem that appeared to have been eaten ; leaves were sometimes not even eaten. This case was observed three times and it was impossible to know the sex and the development stage of the specimens.

All these "field" observations prompted the authors to conduct experiments in controlled conditions to reproduce observations made in situ ; other experiments will be conducted later over a longer period in

order to check their size compared to controls, the capacity to perform a complete cycle, ... These first experiments are described in this extended abstract. Despite all our research it seems not known to our knowledge that the species *M. extradentata* is able to survive on spearmint or radish plants, or related species such as basil or sage for the first one and cabbage or mustard for the latter.

MATERIAL AND METHODS

Experiments were conducted in Gembloux (Belgium) [50°34'N 4°41'E] in a perforated polypropylene box of 1180 cm³ (15 cm (l) × 10.5 cm (w) × 7.5 cm (h)), carefully washed with green Dreft® (brand Procter & Gamble) and thoroughly rinsed with warm water between each experiment. The stick insects were kept at room temperature (22 ± 3 °C), the lighting corresponding to the natural light cycle and the relative humidity was approximately 70 %. The number of specimens used in each experiment was randomly selected by the module Study on Random of the software Gabriel Data Analysis (Olive, 2013). Stick insects were measured from the tip of the abdomen to the base of antennae with a ruler of the Stanley brand. *Medauroidea extradentata* insects came from the Hexapoda breeding located in Belgium (Insectarium "Jean Leclercq", Rue de Grand-Axhe 45E, B-4300 Waremme). Radish seeds belong to the Excelsiorgran brand (La Hulpe, Belgium) "Rond rouge écarlate N° 0505 Saxa".

Verification if species *Medauroidea extradentata* eats stems of *Mentha spicata* var. *spicata* (September 3-8, 2014)

Three specimens (2.6, 3.8 and 4.2 cm) were placed in the presence of two *M. spicata* var. *spicata* branches growing in interior pot, the first plant dating from 2001. Each day the two spearmint branches were replaced by two new ones, one in the morning and the other in the evening. Some water (0.2 ml) was added in the morning of the third experiment day, directly on the bottom of the box in order to ensure the stick insects survival. This complete experiment lasted five days.

Survival on leaves of *Raphanus sativus* var. *sativus* (September 20 to October 18, 2014)

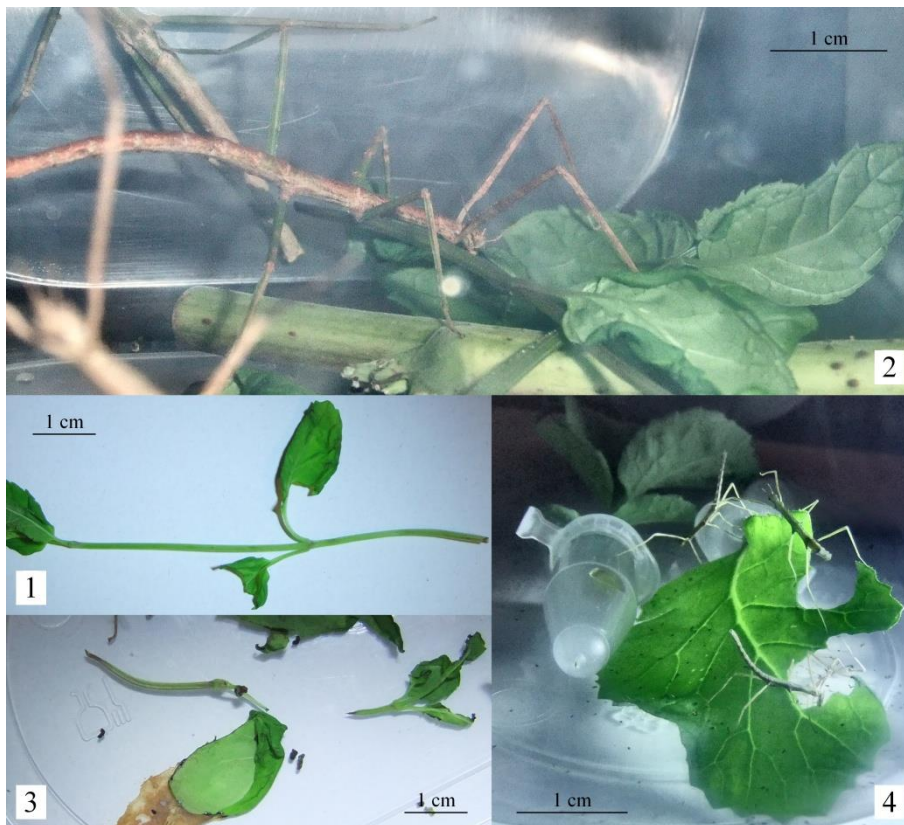
Eleven specimens - between 1.1 and 1.5 cm in size - were placed in a box containing two leaves of *R. sativus* var. *sativus*, of which the petiole is kept in water by a safelock microtube (2 cm³ in capacity); the cap of this microtube was perforated in order to supply water to leaves, without allowing access to stick insects (fig. 4). Seeds of *R. sativus* var. *sativus* were planted 4 months before the beginning of the experiment. The two leaves of radish were changed at the 5th, 8th and 12th day. The 15th day, *R. sativus* var. *sativus* leaves were replaced by two leaves of *Rubus idaeus* that were changed the 5th, 8th and 12th following days. A wet sponge was also introduced in the box during the second phase of the experiment which also lasted 15 days.

RESULTS AND DISCUSSION

It is well known that in captivity *Medauroidea extradentata* species mainly feeds on bramble (*Rubus fruticosus*), raspberry (*Rubus idaeus*) (Rowley & Ratcliffe, 1980; Lelong, 1995; Boucher & Varady-Szabo, 2005) or hazel (*Corylus maxima*) (Guyot, 2012). During a winter while it was difficult to find *R. idaeus* and *C. maxima* leaves, feeding trials were conducted with spearmint (*M. spicata* var. *spicata*). It was observed that insects had eaten spearmint stem instead of leaves. To confirm this observation a controlled experiment was conducted consisting to put three stick insects (between 2.6-4.2 cm in length in order to be big enough to eat stems) in a box with two branches of *M. spicata* var. *spicata*. Each day the two spearmint branches were replaced by two new ones, one in the morning and the other in the evening. The fourth day eaten spearmint leaves were observed (fig. 1) and the 4.2 cm specimen was photographed while eating leaves (fig. 2). The next day the proof that *M. extradentata* stick insects are able to feed on spearmint stems (without consuming the leaves) could be observed (fig. 3). To date no plausible explanation has however been found to explain the fact that in some cases stick insects prefer the stems to the leaves. To our knowledge no studies on the chemical composition of the leaves and stems have been performed on *M. spicata* (Baser et al., 1999; Chauhan et al., 2009; Orio et al., 2012) unlike *Mentha pulegium* (L. 1753) (Cook et al., 2007). Despite their chemical proximity, these results cannot be extrapolated because the major compound for *M. pulegium* is pulegone (Cook et al., 2007), while it is carvone for *M. spicata* (Chauhan et al., 2009). In the case of *M. pulegium*, the stem contains 20 % less pulegone than the leaves (Cook et al., 2007); this may be an explanation that the stems of *M. spicata* contain less carvone than the leaves. But the most likely

hypothesis is that the *M. spicata* stem contains little essential oil, as in the case of *M. pulegium* (less than 0.1 % on dried stems (Cook et al., 2007)) ; the first hydrodistillation trials (for a gas chromatography analysis) tend to confirm this hypothesis. Note that in the presence of bramble, raspberry or hazel foliage, stick insects are not interested in spearmint branches.

In August 2014, after fifteen days without current food (bramble, raspberry and hazel) and water, four specimens of approximately 1.5 cm in length were found on radish plants (*R. sativus* var. *sativus*). No plausible explanation has been found except the fact that the four insects had probably survived by eating radish. For this, eleven specimens - between 1.1-1.5 cm in length in order to be closer to the four survivors - were only placed in the presence of radish leaves, without access to water, to test as closely as possible the hypothesis. The third day one specimen ate a small piece of leaf, the missing piece being only visible with a magnifying glass. Figure 4 shows the 11th day of the experiment, stick insects eating the leaves that have been attacked from the 9th day. The first death was recorded on the seventh day and from there, there was almost one death per day for a total of 7 on the fifteenth day, the last day of the first experiment phase. The remaining four specimens were then replaced in normal living conditions, that's to say in presence of water and only fed on wild raspberry for a period of fifteen days, with changes of leaves based on the same frequency that the first phase. From the beginning, the surviving specimens drank and ate raspberry. At the 6th day of the second phase, a new death was confirmed. After fifteen days, there were so three survivors measuring respectively 1.5, 1.5 and 1.8 cm. Although no moult has been observed, the three specimens had probably to moult during the second phase of the experiment (in the presence of raspberry). It seems that the tested hypothesis is confirmed, that's to say that a small number of *M. extradentata* are able to survive on *R. sativus* var. *sativus* plants, even if radish leaves are not eaten in the presence of raspberry.



Figures 1-4. Results of experiments. 1, eaten spearmint leaves (*Mentha spicata* var. *spicata*) ; 2, female stick insect eating a spearmint leaf ; 3, eaten spearmint stem ; 4, young stick insects eating a radish leaf (*Raphanus sativus* var. *sativus*). Photos 2 and 4 were treated with a filter of color revitalization (Altalux/Irfanview) to increase sharpness

CONCLUSION

In case of usual food shortages (bramble, raspberry and hazel), it has been demonstrated that some specimens of the species *M. extradentata* are able to survive on other food resources. *Mentha spicata*

var. *spicata* does not seem to pose adaptation problem (ongoing experiment), but survival on *R. sativus* var. *sativus* is obviously accessible to a limited number of specimens (3 out of 11 in this experiment). This is the first time that it is observed that *M. extradentata* is able to feed on spearmint and radish. These experiments will be repeated over longer periods in order to study if specimens living on one of the cited plants have the capacity to perform a complete cycle, if their eggs are viable, and also to check their size compared to controls. In addition other plants will be tested.

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