Paysandisia archon (Burmeister, 1880) parasitized in laboratory by Trichogramma: First success

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Palm Borer moth (PBM), *Paysandisia archon* (Lepidoptera: Castniidae), was accidentally introduced in Mediterranean area from Argentina and it has been adaptated to the climate and the palm species in place. The most PBM attacked palm species in France, Italy and Spain are *Chamaeros humilis*, *Trachycarpus fortune* and *Phoenix canariensis* (André & Tixier-Malicorne, 2013; Chapin, 2006; Riolo & al., 2004; Sarto i Monteys, 2013; Tiradon & al, 2013). In this context, it is required to find an efficient and practical strategy susceptible to reduce PBM population, respecting the environment and human health.

Principal damages (pictures a, b, c, d): gallery holes, deformation, twisting of palm trunks, drying up of the palms (Riolo & al., 2004; EPPO/OEPP, 2008b) and also economic impacts with more than 100M€ to control this pest and the Red Palm Weevil (Rochat & al., 2013).

Control methods

Main alternatives of control: mechanical with application of glue, biological with a fungi, *Beauveria bassiana* (Millet & al., 2007), or a nematode, *Steinernema carpocapse* (Nardi & al., 2009; Tiradon & al., 2013). BUT these alternative methods of control are expansive and the process is complex (Tabone & al., 2013).

Our interest is focused on the **Egg Stage** because it is the most accessible, in the crown, and it is before phytophagous stages (Tabone & al., 2013; Tiradon & al., 2013).

First oophagous parasitoids tested are *Trichogramma* that are known as biological control on different crops. Selection criteria for different strains of *Trichogramma* tested are the host, geographical origins, biological characteristics (Tabone & al., 2013; Tiradon & al., 2013).

As part of the European project Palm Protect (2012-2014), the objective of the study was to find an egg parasitoid of PBM.
The goal of the project is to rapidly consolidate the lastest advances, clarify controversial points and permit the evaluation of additional possibilities to make reliable advice which are based on community expertise in Europe (Rochat & al., 2013). Some of *Trichogramma* have successfully parasitized *P. argon* eggs in laboratory.
The global efficiency was also taken into account by the number of eggs aborted and parasited.

Experimental Process

PBM eggs came from CIRAD in Montpellier (France) and the University of Ancôna (Italy) rearings. They were packaged in specific envelopes and kept at 24°C±2. Eggs came from either a rearing on palm or a production on artificial field.
The collection of ***Trichogramma*** used were reared on *Ephestia kuhniella* (Zeller) eggs previously irradiated with UV. Rearing conditions were 18°C±1, RH 80%±10, LD 16:8. Strains were continually reared in the Laboratory of Biocontrôle, UEFM, INRA PACA, at Antibes (France) (Tiradon & al., 2013). For this experiment, we used 13 strains of *Trichogramma* which are reared on transparent plastic tubes (length 7cm, diameter 1cm). They are fed with droplet of honey.

Conditions of tests: 25°C±1, RH 70%±10, LD 16:8.
Tests with several modalities:
- The age of *Trichogramma* females.
- The ratio between the number of *trichogramma* females and the number of PBM eggs.

Combinations of tests:

Number of Trichogramma females	Number of PBM eggs: 1	2	3	4	5	6
1	x	x	x	x	x	x
2	x	x	x	x	x	x
3	x	x	x	x	x	x
...	x	x	x	x	x	x
20	x	x	x	x	x	x

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Observations & **Counting**:
Daily observations about the colour alteration of eggs, the number of abortion, the caterpillars hatching or the *Trichogramma* emergence.
Counting of parasitism, aborting and the global efficiency of the different strains of *Trichogramma* tested.

Trichogramma female on PBM egg

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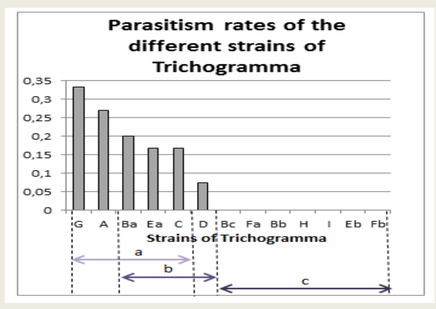
Analyses are performed with the software R (version 2,15,3,). To determine rates of parasitism and abortion and the effectiveness of parasitoid species, binomial logistic linear regressions were produced. When the effect of these factors is significant, comparisons between the average values were made by the function glht (General Linear HypoThesis). Otherwise, in order to assess trends of the effects of parasitism and abortion rates, we used Fisher's test in order to classify the strains according to their efficiency.

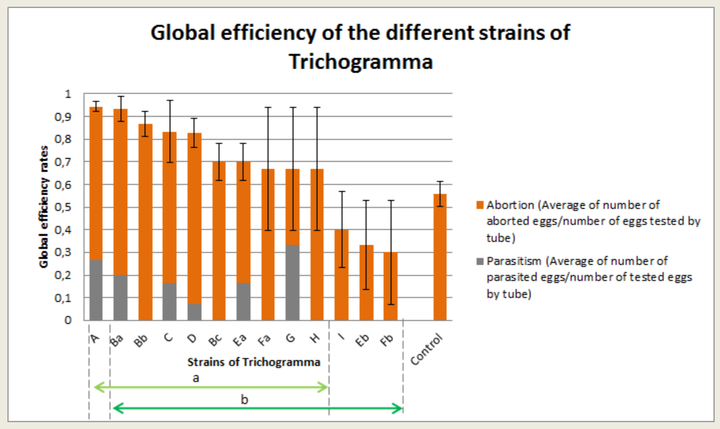
Promising Results

Parasitism: Analysis of parasitism rates of *Trichogramma* strains allowed to split into three groups a, b and c, with significant differences. Class "a" corresponds to the strains with the highest rates of parasitism: G, A, Ba, Ea and C. In this group, two strains, A and G show parasitism rates greater than 25% and are significantly different to group "b".
In addition, 7 strains have no parasitized egg *P. archon*. In all tests, we do not observe the emergence of *Trichogramma* in parasitized eggs.



Aborting: The rate of aborting observed for each strain of *Trichogramma* are more homogeneous than the rate of parasitism. With a threshold of 10% (P <0.1), the group where the abortion rate is significantly higher consists of strains Bb, D and A.

Efficiency: The efficiency is significantly different according to the strains of *Trichogramma*. The strain A is significantly more effective than all the others. Nine strains (Ba, Bb, C, D, Bc, Ea, F, G and H) are significantly more effective than I, Eb and Fb. These last three strains have no parasitized egg *P. archon*. Their lower rates of abortion witness is probably an artifact due to the low number of repetitions.



Conclusion & Perspectives

These preliminary results are very promising in area of research. Indeed, the contact of different strains of *Trichogramma* with eggs of PBM shows us that some eggs are parasitized and we observed an increase in the abortion rate compared to the natural abortion rate. Also among different strains of *Trichogramma* testing, 5 of them (A, Ba, Bb, C and D) testing show efficiency rates greater than 80%. Thus, *Trichogramma* behaviour studies which have provided good results which will allow us to improve their efficiency and to set up a release strategy. The choice of the most effective oophagous parasitoid against PBM could then be improved.

Furthermore, it would be interesting to explore the efficiency of others oophagous parasitoid species than *Trichogramma*. The objective focuses firstly on gathering, identifying and testing native oophagous parasitoid species from the Mediterranean area. If the results are not convincing, we should study species from Argentina to consider acclimatization.

Acknowledge
We thank Laurence Ollivier (CIRAD Montpellier), Nunzio Isidoro and Paola Riolo (University of Ancona) for the supply of eggs of P. archon needed to study ; Claire Charlton (Fera Society, England) for her corrections of english ; Didier Rochat for the scientific coordination of Palm Protect program.
The research that led to these results was funded by the 7th Framework Programme of the European Community in the No. FP7 KBBE 2011-5-289566 (PALM PROTECT) program.

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