The Red Palm Weevil, *Rhynchophorus ferrugineus* (Olivier, 1790) in Malta (Coleoptera: Curculionoidea)

Steve MIZZI[1], David DANDRIA[2], David MIFSUD[3] & Santi LONGO[4]

ABSTRACT. *Rhynchophorus ferrugineus* is a weevil native to southern Asia and Melanesia which was accidentally introduced and established in Malta since 2007. This insect has been causing extensive damage to Canary Island palms (*Phoenix canariensis*) in the majority of towns around Malta. Morphometric measurements are provided and variation in the spots present on the pronotum of adult weevils in Malta is reported and compared with that found in Sicily. Suggested measures for the management of red palm weevil in Malta are also included.

KEY WORDS. Malta, Red Palm Weevil, morphology, control measures.

INTRODUCTION

The Red Palm Weevil (RPW), *Rhynchophorus ferrugineus* (Olivier, 1790) is a large curculionid beetle belonging to the sub-family Rhynchophorinae. Males can be easily identified by the presence of thick, erect dorsal setae on rostrum (Fig. 1) whereas in females, rostrum is longer, slender, more cylindrical and lacks setae (Fig. 2). This weevil was recently accidentally introduced in Malta where it has adapted well to the Maltese climate and has caused severe damage to its host plants.

R. ferrugineus which is native to southern Asia and Melanesia entered the Arabian Gulf countries in the mid-1980s (Abraham *et al.,* 1998; Murphy & Briscoe, 1999; Bozbuga & Hazir, 2008). Since then, it has rapidly expanded its geographical range westwards (Murphy & Briscoe, 1999; Ferry & Gomez, 2002; Malumphy & Moran, 2007). It reached Eastern Saudi Arabia in 1985 and from there it spread to many other countries (Ferry & Gomez, 2002). The pest was first recorded in the Northern United Arab Emirates in 1985, whence it spread to Oman (Ferry & Gomez, 2002). In Iran it was first detected in the Savaran region in 1990 and two years later it was discovered in Egypt (Cox, 1993). It was then found in southern Spain in 1994 and in Israel, Jordan and the Palestinian Authority Territories in 1999 (Kehat, 1999; Soroker *et al.*, 2005; Malumphy & Moran, 2007). There is ample evidence that the first red palm weevils were introduced into Spain from thousands of *Phoenix* palm trees imported from Egypt (Barranco *et al.*, 1996). It has since spread to Italy in 2004, Canary Islands in 2005, Balearic Islands, Cyprus, France and Greece in 2006 and Turkey in 2007 (Malumphy & Moran, 2007). In Malta, the RPW was detected for the first time in 2007.

[1] Starlight, 7, Marsaxlokk Road, Żejtun ZTN 2603, Malta. E-mail: mizzisteve@msn.com
[2] 75/1, High Street, Sliema SLM 1540, Malta. E-mail: robdand@maltanet.net
[3] Department of Biology, Junior College, University of Malta, Msida MSD 1251, Malta. E-mail: david.a.mifsud@um.edu.mt
[4] Dipartimento di Scienze e Tecnologie Fitosanitarie (Di. S. Te. F.), University of Catania, Via S. Sofia 100, 95123 Catania, Italy. E-mail: longosan@unict.it

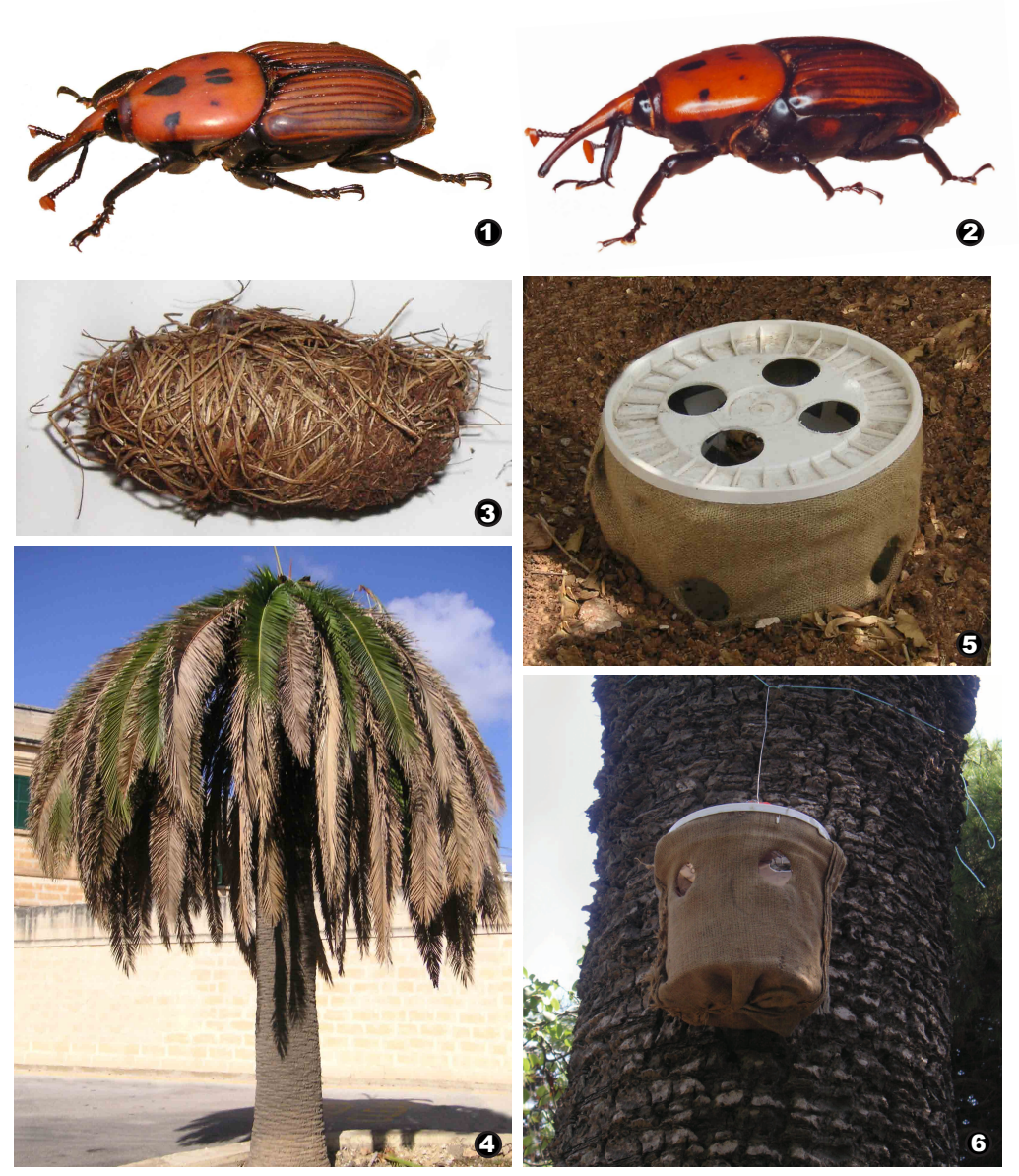
In most countries, where RPW was established, *Phoenix canariensis* palms were the first hosts to become infested. *P. canariensis* represents the preferred host of the RPW, however when its population increases other species of palms such as *P. dactylifera* and *Washingtonia* spp. start to become infested (Longo, 2008a). So far, the only affected palm trees in Malta were all *P. canariensis* and since its introduction until March 2009, around 310 infested palm trees have been destroyed; 121 palms were removed from public lands and 189 were removed from private property (PQ, 2009).

The female palm weevils lay eggs in the axils and petioles of new leaves or more commonly in wounds caused by pruning or wind damage. Larvae burrow into the petioles and reach terminal bud of palms where they complete their life cycle. Tunnelling and feeding by the larvae debilitate the infected trees, which eventurally die. RPW larvae construct cocoons (Fig. 3) from dried palm fibres. Pupation takes place inside the cocoon whence the adult will eventually emerge. Common symptoms of weevil infestation on palms include leaf chlorosis, collapse of green leaves that are no longer supported by the bored axils and eventual collapse of the canopy (Fig. 4). Males of RPW produce an aggregation pheromone which can be used both for mass trapping and monitoring purposes (Murphy & Briscoe, 1999). Black spots on the adults' pronotum are due to the presence of melanin in the cuticle while the rusty colour of the weevils is due to the presence of carotenoids in the epidermal cells (Longo, 2006).

MATERIAL AND METHODS

RPW collection by various methods was carried out between August 2008 and April 2009. *Phoenix canariensis*, *P. dactylifera* and *Washingtonia* spp. palm trees from different localities in the Maltese Islands were inspected for the presence of *R. ferrugineus*. RPW adults which were caught alive were killed by freezing and later were dry mounted by direct pinning. Adult weevils which were collected dead from the field were relaxed by placing on a piece of plastozote which was then floated on a mixture of water, ethanol and detergent within a sealed plastic container. After three days, the beetles were sufficiently relaxed for mounting. Cocoons collected from infested palms were placed in small plastic containers. The cocoons were checked from time to time for emergence of adults. When adults emerged, the date of emergence was noted. Emerged adults were left alive for 3 days in another container so that their exoskeleton would harden prior to killing and mounting. Eleven pheromone traps containing aggregation pheromone dispensers were also used in order to collect RPW adults from different localities in Malta between September 2008 and December 2008. The aggregation pheromone (Rhylure LAT-400) contained 4-methyl-5-nonanol and 4-methyl-5-nonanone. The traps were made from a 10 litre plastic bucket with four circular holes laterally and from above. Most of the bucket was then wrapped by a brown cloth so that the weevils could easily attach themselves and eventually enter the holes and become entrapped. The traps were either put near soil level (Fig. 5) or hung up on palms (Fig. 6) or other trees.

Larvae collected from infected palms were reared on fresh banana stems (*Musa* sp.) which were cut into small logs and placed in large plastic containers. The plastic containers were covered with cloth to prevent flies from entering the container and allowed ventilation. The larvae within the containers were kept at room temperature. The food source was periodically changed to ensure that the larvae had fresh food available. Great care was taken to search for the larvae within the old logs before placing new banana logs. When cocoons were found they were extracted carefully and placed in small plastic containers. The cocoons were checked as frequently as possible for adult emergence. The date of emergence of adults from cocoons was noted.



Figures 1-2. Adult RPW (**1**, male; **2**, female); **Figure 3**: Cocoon of RPW; **Figure 4**: Palm damaged by RPW; **Figures 5-6**: Pheromone traps (5, on the ground; 6, hung on a palm tree).

Adult weevils collected through various techniques as described above were used for measuring different body parts using a binocular stereo microscope. The measurements included the following body parts: whole body length (L); abdomen length (al); abdomen width (aw); pronotum length (pl); pronotum width (pw); head size (hs); length from tip of rostrum to antennal insertion (ta) (Fig. 7). All measurements were made from the dorsal surface except for the head size and distance from tip of rostrum to the antennal insertion which were made from a lateral

view. The variation in position of the prothoracic spots often present in *R. ferrugineus* adults was also studied. Each adult weevil in the collection was analysed and the different typologies encountered were drawn.

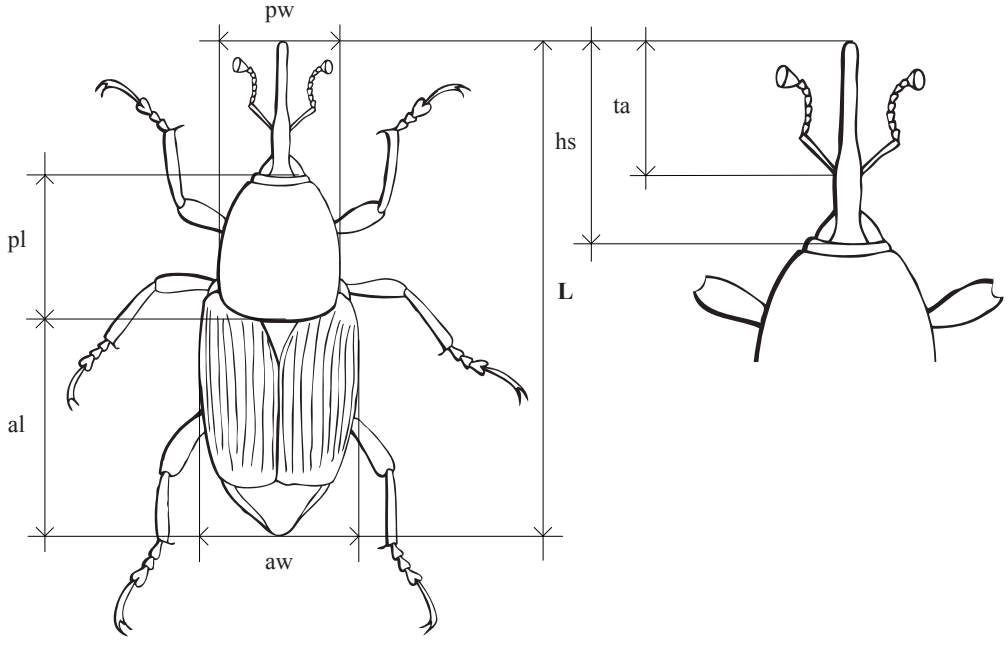


Figure 7. Different measurements taken from body parts of RPW. **L**, whole body length; **pl**, pronotum length; **al**, abdomen length; **pw**; pronotum width; **aw**; abdomen width; **hs**, head size; **ta**, distance from tip of rostrum to the antennal insertion.

RESULTS

In total, 523 adult RPW comprising 254 males and 269 females were available for the present study. These were obtained by various methods as explained earlier from the following localities: Floriana, Ħamrun, Kappara, Lija, Baħar iċ-Ċagħaq, Madliena, Mġarr, Mrieħel, Msida, Mtarfa, Naxxar, Pietà, Rabat, Salini, Santa Venera, Sliema, Żejtun and Żurrieq (Table 1).

Table 1. The numbers of *R. ferrugineus* adults obtained using different methods.

	Males	Females	Total number of adult weevils
Captured alive or found dead in trees	140	94	234
Emerged from cocoons collected from palms	46	62	108
Emerged from cocoons formed by reared larvae	21	26	47
Captured by pheromone traps	47	87	134
Total	**254**	**269**	**523**

234 live and dead specimens were collected from *P. canariensis* palm trees. None of the *P. dactylifera* and *Washingtonia* spp. inspected were found to be infested with *R. ferrugineus*. Out of a total of 182 inspected palms from different localities, 51 (28%) were found to be infected with the RPW. From 293 cocoons collected from infested palms, only 108 adult weevils emerged. A total of 191 larvae were reared on banana stem but only 77 of them (40%) formed cocoons. Fully grown adults emerged from 47 (61%) of the 77 cocoons formed. The total number of adults captured from pheromone traps was 134 with a sex ratio of 1.85:1. Table 2 provides details of adults captured in different localities using different placement of pheromone traps. The fluctuation of adult RPW captured by pheromone traps between September and December of 2008 is indicated in figure 8.

Table 2. The number of adult RPW captured by the pheromone traps in the different localities.

Locality	Position of trap	Total number of adults captured
Mtarfa	Hung on a *P. canariensis* trunk	32
Rabat	Hung on a *P. canariensis* trunk	30
Pieta	Hung on a *P. canariensis* trunk	15
Salini	Hung on a *P. canariensis* trunk	15
Żejtun	At soil level	14
Naxxar	At soil level	11
Msida	At soil level	9
Mġarr	Hung on a tree (not palm)	4
Żurrieq	Hung on a tree (not palm)	3
Mrieħel	Hung on a tree (not palm)	1
Qormi	Hung on a tree (not palm)	0

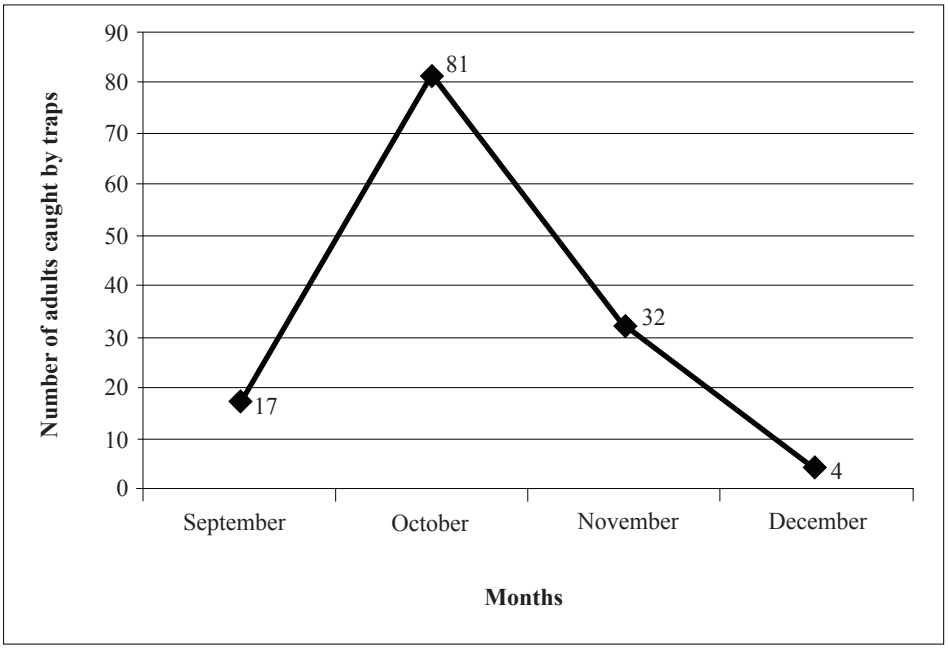


Figure 8. Graph showing the numbers of adult RPW caught by pheromone traps between September and December of 2008.

The dimensions of the different body parts measured in the adult weevils are shown in Table 3.

Table 3. Mean dimensions in mm of different body parts of *R. ferrugineus* adult males and females

Males (n = 254)							
	L	**al**	**aw**	**pl**	**pw**	**hs**	**ta**
Min	23.05	9.33	7.67	7.33	6.17	5.54	4.56
Max	36.88	15.33	12.67	14.17	10.83	9.71	6.79
Average	30.82	12.56	10.45	10.39	8.59	7.88	5.77
Females (n = 269)							
	L	**al**	**aw**	**pl**	**pw**	**hs**	**ta**
Min	23.99	9.17	8.33	7.50	6.67	6.70	5.33
Max	37.92	17.33	12.83	12.50	10.67	10.59	8.00
Average	32.63	13.45	10.82	10.63	8,87	8.56	6.84

Of the 523 adult weevils which were studied, 14 different typologies of pronotal markings were encountered (Fig. 9). Nine typologies were encountered in both males and females, 4 typologies only in females and one typology only in males. A total of 10 typologies were encountered in males while a total of 13 typologies were encountered in females.

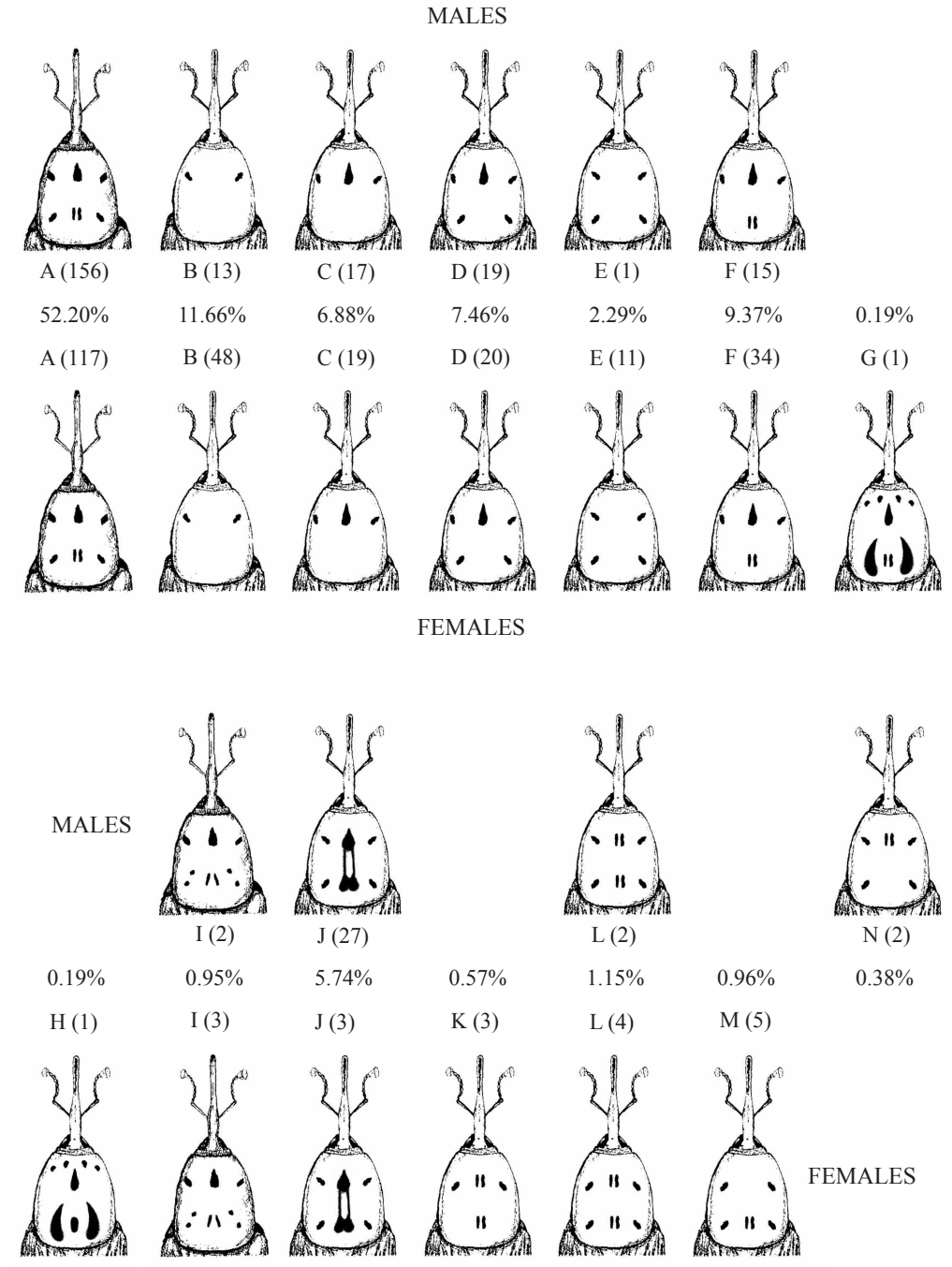


Figure 9. The different typologies of pronotal markings encountered on red palm weevils in Malta with percentage incidence.

DISCUSSION

R. ferrugineus is a polyphagous species with several host plants but with a marked preference for palms. The species was first noted in Malta in 2007 (Cole, 2009). The species is a serious pest of palms with 28% of palms inspected during the present study being found infected by RPW. So far, in Malta only *P. canariensis* was found to host RPW. *P. canariensis* is normally the most affected palm species during the first years after the introduction and establishment of the weevil in a new territory (Longo, 2008a). Infestation of other species of palms such as on *P. dactylifera* and *Washingtonia* spp. is expected to occur in future if the population of the RPW continues to increase. In the Maltese Islands, it was shown that adults, in search of new breeding grounds, peak during October (Fig. 8) and then decrease significantly in December. These results are similar to those obtained in studies carried out in Eastern Sicily between 2005 and 2006 (Conti *et al.*, 2008). These studies have also shown that the red palm weevil reaches damaging levels at the end of summer (September-October) followed by a strong reduction in adult activity in winter and spring as a consequence of low temperatures.

Only 40% of RPW larvae reared under laboratory conditions on banana managed to reach adult stage. This suggests that many larvae did not survive possibly due to a change in food source which is to be expected since the banana plant is not one of the preferred host plants for the RPW. However, it shows that the RPW is highly adaptable to different diets. It appears that initially larvae find it difficult to survive on the new food source, but those which adapt to it reach the adult stage successfully. A high mortality rate was also observed when cocoons were reared. Adult weevils managed to emerge from only 37% of cocoons collected in the present study. Longo (2006) also recorded a high mortality from the larval to the adult stage since only 77 adults (17.87%) emerged from the 431 cocoons collected during that study.

More females of RPW were captured using pheromone traps, which is not the case with most insect pheromones which usually attract males. A sex ratio dominated by females from pheromone trap captures was also shown in other studies (e.g. Longo, 2006) where the sex ratio was 2.05:1. Furthermore, it was also noted that the traps with the highest catch were those hung above the ground on *P. canariensis* trunks. The *P. canariensis* palm trees themselves might have served as an additional attractant for the weevils.

From various measurements of body parts (Table 3) of RPW taken in the present study the following conclusions were made. As with most insects, body size of females (especially total body length and abdominal length) was significantly larger than that of males. The total length of rostrum and length of rostrum from its apex to antennal insertion was much higher in females than in males. In fact, such measurements may be used effectively to discriminate between males and females of RPW. In terms of pronotal marking, the most common typology found in RPW in Malta was the one exhibiting seven markings (Fig. 9A) with a 52.20% occurrence. The two spots typology (Fig. 9B) was the second most common (11.66%). The typology shown in figure 9N was found only in males while typologies as shown in figures 9G, 9H, 9K and 9M were found only in females. Six typologies found in the present study are very similar to six out of eight different typologies encountered in Sicily (Longo, 2006). Typologies as shown in figures 9A, 9B, 9C, 9D, 9E and 9F, correspond respectively to Longo's typologies as shown in figures 10A, 10B, 10E, 10D, 10G, and 10C. Furthermore, the two most common typologies in the Sicilian study were those shown in figure 10A and 10B, as was found in the current study. The smaller sample

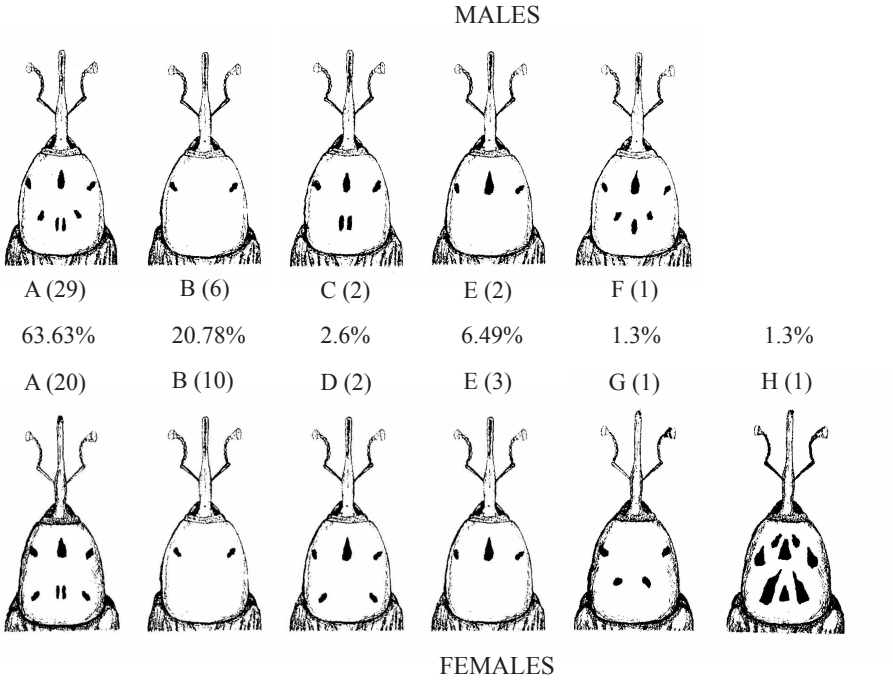


Figure 10. The different typologies of pronotal markings recorded in Sicily (after Longo, 2006).

of 77 adults used by Longo (2006) might explain why only eight typologies were encountered in Sicily as opposed to the 14 different typologies encountered here in Malta. But one must note that although a larger sample was used in Malta, two typologies encountered in Sicily were not found in Malta which might indicate a degree of diversity between the Sicilian RPW population and that of Malta.

Control measures. Various techniques have been used to try to control RPW such as pheromone traps and chemical control. Despite good results of these techniques in the laboratory, they are not efficient enough in the field to succeed in eliminating red palm weevil. The reason for this is probably the great difficulty in reaching all life stages of the weevil inside an adult palm tree (Longo, 2008b).

Since the adult population of the RPW in Malta peaks in October it is important that certain measures are taken during this time. Pruning of palm trees (through removal of fronds) should be stopped altogether between September and November. This is due to the fact that pruning creates wounds which attract females to oviposit in them. In August, Maltese fishermen cut hundreds of palm fronds which are used as sheltering grounds for the dolphin fish "*lampuki*". It is important that such an activity, even though not in the peak period when adults are around, is done under supervision and that all pruning cuts are immediately covered by suitable sealant substances. This is rarely done in Malta. Furthermore pruning should be followed by at least three consecutive insecticide sprays. Excessive pruning must be avoided since loss of mature leaves leads to loss of nutrients for the developing fronds, slower growth and stress to the palm tree. Stressed palm trees are more susceptible to attack by the weevil. The common practice for pruning palms in Malta is

to cut leaves from their base. Ideally this should not be done when pruning green fronds. Green fronds have to be cut some distance away from the trunk so that if weevil eggs are deposited on the wounds, the larvae would be unable to reach the trunk before the leaf dries out. The problem with such pruning is a cosmetic one, since trees pruned in this way are visually less attractive. Cutting of fronds should be carried out in winter time, from January till March.

With regards to insecticide treatment of infected trees, Conti *et al.* (2008) have found that spraying in winter and in spring gives positive results on infected palms since new leaves emerge, but in autumn the same trees start to show symptoms again. This indicates that the insecticide might suppress insect populations to undetectable levels. Therefore frequent spraying is important for effective control of RPW, but one must take into account that this might present a health risk to people and animals in the vicinity. One strategy that should be implemented to manage the pest would be to treat those trees which show symptoms during winter and early spring so that damage to palms at the end of summer would be decreased. In order to reduce the health risk of insecticide spraying, injection methods are being used which are giving positive results in the Mediterranean Region. A hole is drilled in the trunk, just below the region of infection and then the insecticide is injected directly in the palm tree. Such method reduces the release of insecticide in the environment which can end up contaminating water tables. The palm transports water from its roots to the higher regions and this causes the insecticide to be transported to the infected regions.

The implementation of rigorous phytosanitary measures is the most promising approach to manage this pest. Under the environmental conditions of Malta, extensive surveys and the immediate elimination of the newly infested trees at the first insect detection, after the period of decreased activity of the pest in winter and early spring, can suppress drastically the insect populations and the damage to the palm in the summer season. Extensive surveys and insect monitoring are crucial for the success of this phytosanitary strategy.

ACKNOWLEDGMENTS

We would like to thank the Plant Health Department in Malta for all their assistance during this study. We would like to also thank Dr Shakir Al-Zaidi from Russell IPM Ltd. for sending us pheromone dispensers for use during the present study.

REFERENCES

Abraham, V. A., AL-Shuaibi, M.A., Faleiro, J. R., Abuzuhairah, R. A. & Vidyasagar, P.S.P.V. (1998) An integrated management approach for red date palm weevil, *Rhynchophorus ferrugineus* Oliv., a key pest of date palm in Middle East. *Sultan Qabus University J. for Sci. Res., Agricultural Sciences*, **3**: 77-84.

Barranco, P., De La Pena, J. & Cabello, T. (1996) El picudo rojo de las palmeras *Rhynchophorus ferrugineus* (Olivier) neuva plaga en Europa (Col.:Curculionidae). *Phytoma-Espana*, **76**: 36-40.

Bozbuga, R. & Hazir, A. (2008) Pests of the palm (*Palmae* sp.) and date palm (*Phoenix dactylifera*) determined in Turkey and evaluation of red palm weevil (*Rhynchophorus ferrugineus* Olivier) (Coleoptera: Curculionidae). *EPPO Bulletin*, **38** (1): 127-130.

Cole, S. (2009) Insects in Malta, Summer 2007. *Bulletin of the Amateur Entomologists' Society*, **68** (484): 108-112.

Conti, F., Sesto, F., Raciti, E., Tamburino, V. & Longo, S. (2008) Ecological Factors Affecting the Spread of *Rhynchophorus ferrugineus* (Red Palm Weevil) in Eastern Sicily. *Palms*, **52** (3): 127-132.

Cox, M.L. (1993) Red palm weevil, *Rhynchophorus ferrugineus* in Egypt. *FAO Plant Protection Bulletin*, **41** (1): 30-31.

Ferry, M. & Gomez, S. (2002) The Red Palm Weevil in the Mediterranean Area. *Palms*, **46** (4): 172-178.

Kehat, M. (1999) Threat to Date Palms in Israel, Jordan and the Palestinian Authority by the Red Palm Weevil, *Rhynchophorus ferrugineus*. *Phytoparasitica*, **27**: 107-108.

Longo, S. (2006) Ulteriori acquisizioni sul Punteruolo rosso asiatico, dannoso alla Palma delle Canarie in Sicilia. *Informatore Fitopatologico*, **10**: 40-44.

Longo, S. (2008a) Infestazioni del Punteruolo Rosso delle Palme (*Rhynchophorus ferrugineus*) in Italia. Bozza relazione Sanremo (12.03.08) (unpublished report).

Longo, S. (2008b) Il Punteruolo Rosso delle Palme in Italia: morfologia, bio-etologia e protezione integrata. Meeting at Tavola Rotonda: Istituto Agronomico Mediterraneo di Bari (14.05.08) (unpublished report).

Malumphy, C. & Moran, H. (2007) Plant Pest Notice: Red palm weevil – *Rhynchophorus ferrugineus*. No. 50. *Central Science Laboratory*, DEFRA, UK.

Murphy, S.T. & Briscoe, B. R. (1999) The red palm weevil as an alien invasive: biology and the prospects for biological control as a component of IPM. *Biocontrol News and Information*, **20** (1): 35-46.

PQ (Parliamentary Question) (2009) No. 97, Legislature XI, Sitting 97 of 25/03/2009, Malta.

Soroker, V., Blumberg, D., Reneh, S., Talebaev, S., Anshelevich, L., Harari, A.R., Haberman, A. & Hamburger-Rishard, M. (2005) Current Status of red palm weevil palm plantations in Israel. *Phytoparasitica*, **33**: 97-106.

ISSN : 2070-4526
Date of Publication : 30th September 2009

Received: July 30, 2009
Accepted: Sept 10, 2009