

## Insect Pests of Red Cabbage (*Brassica oleracea* L.) and Life Cycle of the Cabbage Worm, *Crocidolomia pavonana* (Fabricius), in Lanao del Sur Province, Philippines

Desiree Lee L. Vasquez<sup>1</sup>, Emma M. Sabado<sup>2\*</sup> and Juliet C. Bangi<sup>2</sup>

<sup>1</sup> Office of the Provincial Agriculturist, Bureau of Agricultural Extension (BAEX), Telaje, Tandag City, Cagwait, Surigao del Sur, Philippines

<sup>2</sup> Department of Plant Science, College of Agriculture, Mindanao State University (MSU), Marawi City, Lanao del Sur, ARMM, Philippines

\* corresponding author: e-mail: emcsab53@yahoo.com.sg

### ABSTRACT

A study was conducted in Mindanao State University, Marawi City, Lanao del Sur Province, Autonomous Region of Muslim Mindanao (ARMM) in Southern Philippines from October, 2014 to February, 2015 to identify insect pests associated with red cabbage (*Brassica oleracea* L. var. *capitata* L. f. *rubra* L.) and to study the life cycle of the particular pest that causes the greatest damage to it. Insects on red cabbage belong to 12 families under seven orders. Red cabbage pests belong to orders Lepidoptera, Coleoptera, Hemiptera and Orthoptera. Among these, the cabbage worm, *Crocidolomia pavonana* (Fabricius), was the major insect pest that caused 100% harvest loss to red cabbage grown under Lanao del Sur conditions. The minor pests were identified as the diamondback moth *Plutella xylostella* (L.), aphids (*Myzus* sp.), curculionid beetle (*Metapocyrtus* sp.), cabbage white moth (*Euproctis* sp.) and grasshoppers [*Ailopus thalassinus* (Fabricius), *Heteroptermis* sp. and *Atractomorpha psittacina* (Haan)]. Beneficial insects belong to Diptera, Hymenoptera and Neuroptera, which include a syrphid fly, a vespid wasp and a green lacewing, respectively. Under laboratory conditions, the mean life cycle of *C. pavonana* lasted 25.96 days (22-31); the mean egg incubation period was 4.42 days (4-5) while percentage of egg hatchability ranged from 22 to 100 with a mean of 73.90. There are four larval instars with a mean larval duration of 13.84 days (12-26) while the pupal stage lasted 7.70 days (6-9). Adult males lived up to 17.20 days (14-22) while females lived longer, up to 19.80 days (13-25). Female moths laid an average of 8.50 egg clusters (5-15) containing an average of 208.80 eggs (40-424) throughout their lifetime.

**Key words:** cabbage worm, *Crocidolomia pavonana*, insect pests, life cycle, red cabbage

### INTRODUCTION

Cabbage is the most widely grown crop among crucifers, particularly in mid- and high elevation areas in the Philippines. The Bureau of Agricultural Statistics reported in 2009 that it is planted in more than 7662 ha (BAS, 2009) with the volume of production estimated at 124,712 metric tons. The more commonly available and grown variety is the green or almost white cabbage. The red cabbage (*Brassica oleracea* L. var. *capitata* L. f. *rubra* L.) is a close relative - actually a form - of the more common cultivars. It belongs to a group of called "Cole Crops", grown for their firm, compact, round to flat heads. In 2006, cabbage contributed around PHP1.08B to the Philippine

economy. Recognizing its importance to the industry, the Philippine Council for Agriculture, Aquatic, Forestry and Natural Resources Research and Development, Department of Science and Technology (PCAARRD-DOST) identified cabbage as a priority crop under the National Vegetable Research & Development Program (PCAARD, 2010). The red cabbage, more expensive than the green one, is recognized by its purple or deep red color which is due to its high level of flavonoid content (Hansen et al., 2010). The latter is also regarded as one of the healthiest foods in the world. The anthocyanin present in its leaves serves as protection against cardiovascular diseases and certain cancers such as bladder, colon and prostate cancers (Hansen et al., 2010; Dias 2012).

Gabriel (1997) listed 38 insect pest species attacking the cabbage or mustard family (cabbage, cauliflower, mustard, pechay and radish) in the Philippines, 24 of them chewing and 14, sucking herbivores. About 10 insect species and some mites are considered as economically important pests. Thus, growing cabbage requires intensive care to protect it from pests and attain its optimum yield. One of the most destructive insect pests is the cabbage worm, *Crocidolomia pavonana* (Fabricius). Together with the diamondback moth, *Plutella xylostella* (L.), as its major pests, production is greatly reduced due to damages caused by these pests. Studies of cabbage pests have focused mainly on the green variety and primarily in Luzon (e.g. Cayabyab et al., 1998; Javier et al., 2004; Morallo-Rejesus et al., 1995) except for a general arthropod diversity assessment conducted in cabbage-growing areas in Mount Malindang, Misamis Occidental (Sabado et al., 2004). Little or none has been conducted on red cabbage, although it is generally perceived that all types of red cabbage are tolerant to the diamondback moth. This leaves the cabbage worm as the sole pest of red cabbage, causing very serious damage to it from pre-heading to post-heading stages, thus consuming the whole plant. The damage caused by cabbage worm feeding makes the product unsalable (ACIAR, 2010).

Because red cabbage is not commonly grown in Lanao del Sur despite its favorable climate, information about the insect pests associated with this crop is non-existent. Hence, this study was conducted to identify the different insect pests attacking red cabbage, as well as to study the life history of the pest that causes the greatest damage to it. Data from this study will be useful in the future management of the pests when farmers finally engage in large-scale production of red cabbage.

## MATERIALS AND METHODS

### Site and Duration of the Study

Red Jewel F1 Hybrid red cabbage seeds were sown in a seedling tray with growing medium of mixed vermicast, carbonized rice hull and egg shells. Three weeks after seed sowing, 60 seedlings were transplanted in two plots inside the Botanical Garden of Mindanao State University (MSU), Marawi City, Lanao del Sur, Autonomous Region of Muslim Mindanao (ARMM). Prior to transplanting, basal application of two grams of urea (45-0-0) and 13 grams of complete fertilizer (14-14-14) was done. Watering and weeding were likewise done regularly to promote proper cabbage growth and development.

### **Insect Collection and Identification**

Visual counting of insects in 10 red cabbage plants per plot was done for five consecutive weeks. Net sweeping was done for mobile insects. Representative specimens were collected and preserved in vials for correct identification. Specimens were identified by Dr. Myrna G. Ballentes, an insect taxonomist of the Department of Entomology, College of Agriculture, Central Mindanao University, Musuan, Bukidnon.

### **Life Cycle Study**

Cabbage leaves with egg clusters of *C. pavonana* were collected and brought to the laboratory and the eggs were allowed to hatch. Fifty newly-hatched larvae were individually transferred to fresh cabbage leaves and reared in plastic cups until they reached the adult stage. The duration of the different larval instars and their morphological features were observed and recorded. Fifteen males and 15 females were paired, and each pair was allowed to mate inside a single cup. They were provided with cotton soaked in sugar solution as food source. The life cycle study was conducted in two trials.

The following data were observed and recorded:

- a. Pre-oviposition period– the total number of days from emergence to just before the female moth laid eggs
- b. Oviposition period – the total number of days during which the female moth laid eggs
- c. Post-oviposition – the total number of days from the time the female moth stopped laying eggs to the time of its death
- d. Longevity – the total life span of male and female moths (represented by 12 males and 15 females)
- e. Fecundity – the total number of eggs laid by each female moth
- f. Body measurements – based on body length and width, length of antennae and wing expanse of 10 adult males and 10 adult females

The total number of days of incubation period and percentage of egg hatchability were recorded. The number of eggs per cluster was counted using a digital microscope.

## **RESULTS AND DISCUSSION**

### **Insects Associated with Red Cabbage**

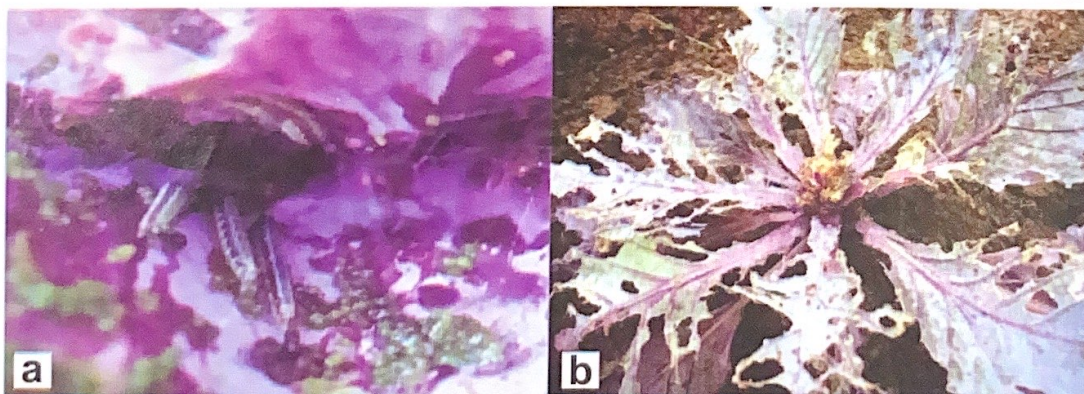
The identified insects associated with red cabbage belong to 12 families under seven orders (Table 1). The pest species were classified under the orders Coleoptera (beetles), Hemiptera (aphids), Lepidoptera (moths) and Orthoptera (grasshoppers). Beneficial insects belong to the orders Diptera (syrphid fly), Hymenoptera (vespid wasp) and Neuroptera (chrysopid or green lacewing).

Based on observed damage or crop loss during the study period, the cabbage worm, *C. pavonana*, is here considered the major insect pest of red cabbage. The larvae consumed the crop, resulting to 100% loss of potential harvest (Figure 1). Visual

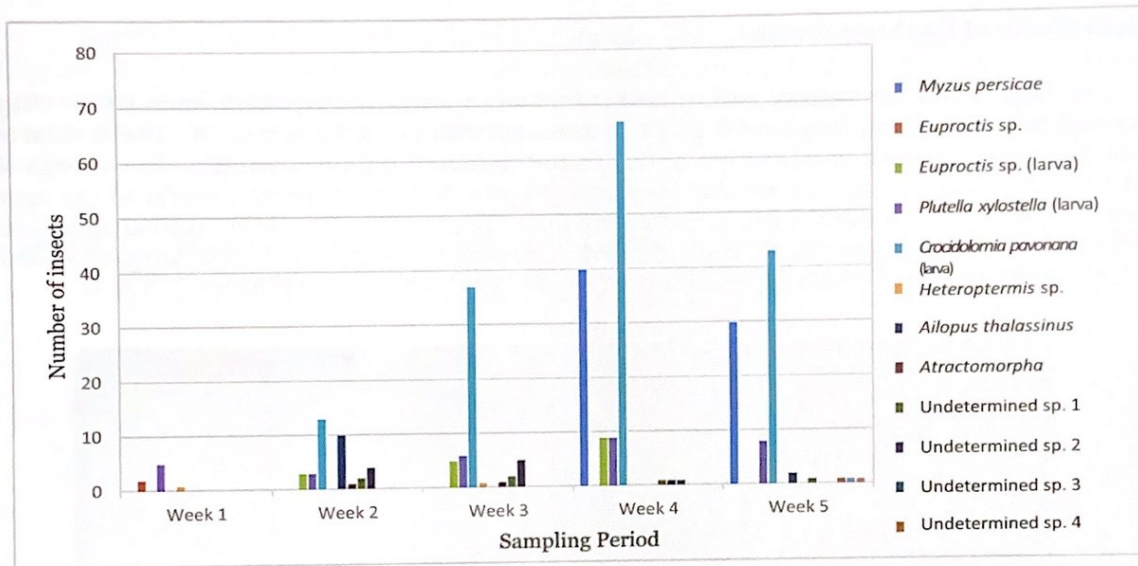
counts consistently showed high larval population of the pest throughout the sampling period. Some started to feed on cabbage during the second week after planting, reaching the peak of abundance in the fourth week (Figure 2). The larvae left sticky, wet fecal material on the leaves.

**Table 1.** List of insects associated with red cabbage in MSU Campus, Marawi City, Lanao del Sur, Autonomous Region of Muslim Mindanao, Philippines. October-December 2014.

Order/Family	Species	Common Name	Role
Coleoptera			
Curculionidae	<i>Metapocyrtus</i> sp.	Easter egg weevil	Pest
Scarabaeidae	Undetermined	Scarab beetle	Pest
Diptera			
Phoridae	Undetermined (larva)	Phorid (maggot)	Scavenger (?)
Syrphidae	<i>Ischiodon</i> (?)	Syrphid fly, Hover fly	Predator
Hemiptera			
Aphididae	<i>Myzus persicae</i> (Sulzer)	Green peach aphid	Pest
Hymenoptera			
Vespidae	<i>Vespa</i> (?)	Vespid wasp	Predator
Lepidoptera			
Crambidae	<i>Crocidolomia pavonana</i> (Fabricius)	Cabbage worm	Pest
Lymantriidae	<i>Euproctis</i> sp.	Cabbage white moth	Pest
Plutellidae	<i>Plutella xylostella</i> (L.)	Diamondback moth	Pest
Neuroptera			
Chrysopidae	Undetermined	Green lacewing	Predator
Orthoptera			
Acrididae	<i>Ailopus thalassinus</i> (Fabricius)	Grasshopper	Pest
Pyrgomorphidae	<i>Atractomorpha psittacina</i> (Haan)	Slant-faced grasshopper	Pest
	<i>Heteroptermis</i> sp.	Grasshopper	Pest

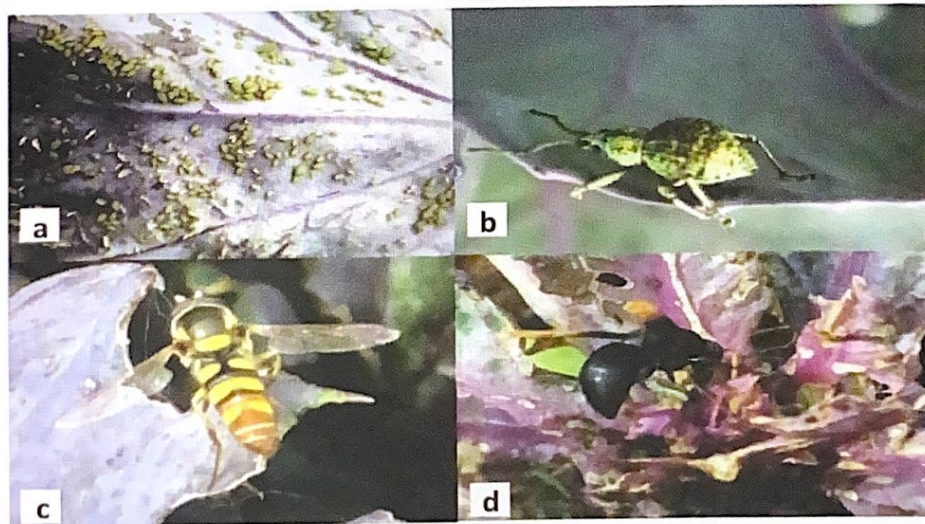


**Figure 1.** Cabbage worm, *Crocidolomia pavonana*. **a.** Larvae. **b.** severe damage on red cabbage.



**Figure 2.** Abundance of insects on red cabbage, MSU, Marawi City, Lanao del Sur, Autonomous Region of Muslim Mindanao. October-December, 2014.

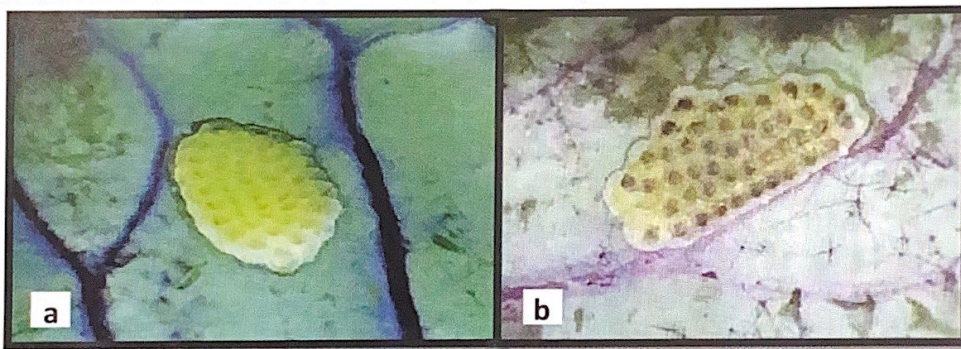
The green peach aphid, *Myzus persicae* (Sulzer) (Figure 3a), is considered a minor pest of red cabbage. Nymphs and adults suck sap from the leaves, resulting to an unsightly appearance due to spoiled honeydew. Other minor pests include the diamondback moth (*P. xylostella*), cabbage moth (*Euproctis* sp.), the short-horned grasshopper [*Ailopus thalassinus* (Fabricius)] and slant-faced grasshopper [*Atractomorpha psittacina* (Haan)]. Likewise, important predators include the vespid wasp, syrphid fly and green lacewing (Figure 3)



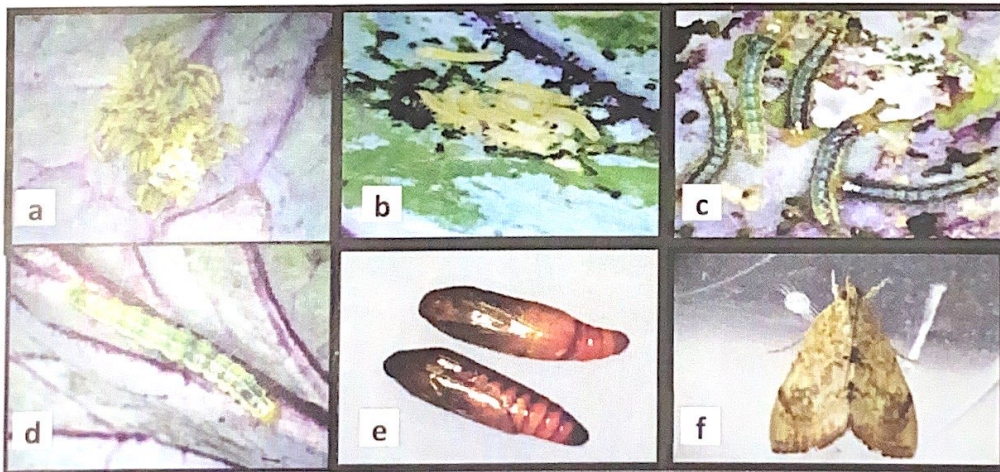
**Figure 3.** Some insects associated with red cabbage. **a.** Aphids, *Myzus persicae*. **b.** curculionid beetle, *Metaphocytus* sp. **c.** syrphid fly. **d.** vespid wasp.

### Life Cycle of Cabbage Worm

**Egg.** Eggs are yellow green, laid in clusters, and overlap with each other. Egg clusters have a mean length of 4.10 (3-5) mm and width of 3.00 mm (2-4). These turn to dark brown (“blackheads”) when about to hatch. Each cluster contains an average of 47.90 eggs (33-77), which are flat and oval (Figure 4). Female moths prefer to lay eggs on underside of leaves with smooth surface. Some eggs are laid individually but hatchability was higher when eggs are laid in clusters. The mean incubation period was 4.42 days (4-5) with mean hatchability of 86.66 (22-100) percent (Tables 2, 3 & 4).



**Figure 4.** Eggs of *Crocidolomia pavonana* on red cabbage. **a.** Newly laid cluster. **b.** Blackheads (about to hatch).



**Figure 5.** Developmental stages of *Crocidolomia pavonana* on red cabbage. **a-d.** Larvae: **a.** First instar. **b.** Second instar. **c.** Third instar. **d.** Fourth instar. **e.** Pupae. **f.** Adult female.

**Larva.** First Instar. Newly-hatched larvae are yellow with dark brown heads (Figure 5). They scatter throughout the leaf surface immediately after hatching and consume the leaf epidermis, leaving the leaves a thin, papery appearance. The mean length of the first instar larva is 1.00 mm, and width, 0.50 mm, while mean larval instar duration is 2.20 days (2-3) (Tables 2 & 4).

**Table 2.** Duration of the different stages of *Crocidolomia pavonana* on red cabbage in MSU Campus, Marawi City, Lanao del Sur, Autonomous Region of Muslim Mindanao, Philippines. October 2014- February 2015.

Life Stages	Duration (days)	
	Range	Mean
Egg		
Incubation Period	4-5	4.42 ± 0.49
Hatchability (%)	22-100	86.66 ± 16.33
Larva		
First Instar	2-3	2.20 ± 0.40
Second Instar	3-4	3.20 ± 0.40
Third Instar	2-3	2.66 ± 0.47
Fourth Instar	5-7	5.78 ± 0.65
Pupa	6-9	7.70 ± 0.95
Total Development <sup>a</sup>	22-31	25.96 ± 8.25
Post-Development		
Pre-oviposition <sup>b</sup>	5-8	5.80 ± 1.10
Oviposition <sup>b</sup>	6-12	9.70 ± 2.02
Post-oviposition <sup>b</sup>	2-6	4.40 ± 1.33
Longevity		
Female <sup>b</sup>	13-25	19.80 ± 2.89
Male <sup>c</sup>	14-22	17.20 ± 2.70

<sup>a</sup> based on 50 samples; <sup>b</sup> based on 12 females; <sup>c</sup> based on 10 males

**Table 3.** Fecundity of adult female *Crocidolomia pavonana* on red cabbage in MSU Campus, Marawi City, Lanao del Sur, Autonomous Region of Muslim Mindanao, Philippines. October 2014-February 2015.

Fecundity	Number of Eggs/Cluster	
	Range	Mean
a. No. of egg clusters/day <sup>a</sup>	0-4	2.10 ± 1.00
b. No. of eggs/cluster <sup>a</sup>	33-77	50.60 ± 15.71
c. No. of egg clusters laid/female <sup>b</sup>	5-15	8.50 ± 2.88
d. Total no. of eggs laid/day <sup>b</sup>	16-133	80.20 ± 24.66
e. Total no. of eggs laid/female	40-424	231.80 ± 88.16

<sup>a</sup> based on 10 egg clusters; <sup>b</sup> based on 10 females

**Table 4.** Measurements (mm) of egg clusters and individual insects in the different life stages of *Crocidolomia pavonana* on red cabbage in MSU Campus, Marawi City, Lanao del Sur, Autonomous Region of Muslim Mindanao, Philippines. October 2014-February 2015.

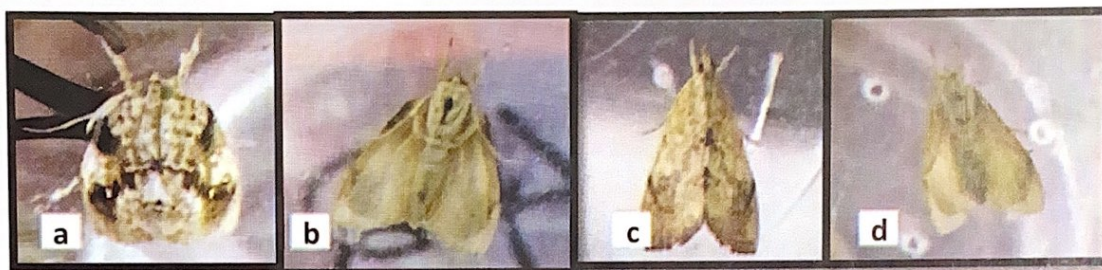
Developmental Stage*	Duration (days)	
	Range	Mean
Egg (cluster)		
Cluster length	3-5	4.10 ± 0.74
Cluster width	2-4	3.00 ± 0.67
First Instar		
Body length	1	1.00 ± 0.00
Body width	0.5	0.50 ± 0.00
Second Instar		
Body length	2-3	2.70 ± 0.48
Body width	1	1.00 ± 0.00
Third Instar		
Body length	8-10	9.10 ± 0.88
Body width	1	1.00 ± 0.00
Fourth Instar		
Body length	20-22	21.50 ± 0.71
Body width	2	2.00 ± 0.00
Adult female		
Body length	8-10	9.10 ± 0.57
Body width	2	2.00 ± 0.00
Antennal length	5-7	6.00 ± 0.47
Wing expanse	18-23	19.90 ± 1.70
Adult male		
Body length	10-11	10.20 ± 0.32
Body width	2	2.00 ± 0.00
Antennal length	6-7	6.60 ± 0.52
Wing expanse	19-22	20.30 ± 1.06

\* based on 10 samples for each stage

**Pupa.** The mature larva began to contract as it approached the pupal stage (Figure 5). The pupa has a mean length of 7.70 mm and its width is 2.9 mm. The mean pupal duration is 7.70 days (6-9 days). The newly-formed pupa is yellow-green, then turned to yellow-brown and finally to dark brown when about to emerge as an adult. Under field conditions, mature larvae burrow into the soil near the base of the host plant to pupate (Sastrosiswojo and Setiawati, 1992).

**Adult.** Adults of *C. pavonana* are sexually dimorphic, i.e., the adult male is very distinct from the female. Ventrally, the male has a distinct dark spot on its thorax whereas the female has none (Figure 6). Likewise, the male has darker marks on the wings while the female has pale, creamy white marks. The male is about 10.20 mm long and 2.0 mm wide, while the female is about 9.10 mm long and 2.0 mm wide. Generally, the antennae of the males are slightly longer (6.60 mm) than those of the females (6.00 mm). The male wingspan (20.30 mm) is wider than that of the female (18-.60 mm). Adults are generally nocturnal but the female usually lays eggs early in the morning.





**Figure 6.** Adults (moths) of *Crocidolomia pavonana* **a-b.** Males: **a.** dorsal view. **b.** ventral view showing dark spot on thorax. **c-d.** Females: **c.** dorsal view. **d.** ventral view, showing absence of dark spot on thorax.

### Longevity and Fecundity of *C. pavonana*

Female adults of *C. pavonana* live longer than the males. The mean life span of females is 19.80 days (13-25) while that of males is 17.20 days (14-22). The mean pre-oviposition period of the female adult is 5.80 (5-8 days), oviposition period is 9.70 days (6-12) and post-oviposition period is 4.40 days (2-6). The mean number of egg clusters laid by females throughout their lifetime is 8.50 (5-15). Egg clusters laid per day vary from 0 to 4 with a mean of 1.60. Each cluster contains a mean of 47.90 eggs (33-77). The total number of eggs produced by *C. pavonana* during its oviposition period ranged from 40 to 424 with a mean of 208.80 eggs (Table 3).

### SUMMARY, CONCLUSION AND RECOMMENDATION

A study was conducted in Mindanao State University, Marawi City, Lanao del Sur, ARMM from October, 2014 to February, 2015 to identify insect pests of red cabbage and to study the life history of the pest causing greatest damage to the crop. Red cabbage insects belong to seven orders and 12 families. The insect species belong to orders Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Neuroptera and Orthoptera. The cabbage worm or cabbage head caterpillar, *C. pavonana*, was the most damaging insect pest to red cabbage during the study. The minor insect pests include the diamondback moth *P. xylostella*, curculionid beetle *Metapocyrtus* sp., cabbage white moth *Euproctis* sp., green peach aphid *M. persicae*, grasshoppers *Ai. thalassinus*, *At. psittacina* and *Heteroptermis* sp.

The mean life cycle of cabbage worm or cabbage head caterpillar is 25.96 days (22-31). The eggs laid in clusters hatched in 4.42 days (4-5) with hatchability of 73.90 (22-100) percent. There are four larval instars with a mean duration of 13.84 days (12-26) while the pupal stage is 7.70 days (6-9 days). The fourth larval instar is the most destructive stage during which the larvae bore into and completely skeletonize the leaves, ultimately damaging the red cabbage head and resulting to 100% yield loss. Adult males lived up to 17.20 days (14-22) while females lived longer, i.e., up to 19.80 days (13-25). The female moths laid an average of 8.50 egg clusters (5-15) containing 208.80 eggs (40-424) throughout their lifetime. It is recommended that similar studies be further conducted in other locations in Lanao provinces and in other areas in

Mindanao that are similar in climate with Marawi City to see whether there would be variations in arthropod community composition as well as in life history traits of pests from those gathered in this study.

#### LITERATURE CITED

- [ACIAR] Australian Center for International Agricultural Research. 2010. Cabbage head caterpillar (*Crocidolomia pavonana*). Department of Agriculture and Food. Australia. 2 p.
- [BAS] Bureau of Agricultural Statistics. 2009. Performance of Philippine Agriculture. Vegetables. <http://www.bas.gov.ph>.
- CAYABYAB BF, NAVASERO MV, SANTIAGO DR, CASTILLO AG, LIGAT BS & RECAIDO N. Cabbage insect fauna in the Mountain Province and Ilocos Sur (Philippines). 14. Annual Scientific Conference of the Federation of Crop Science Societies of the Philippines, Cebu City (Philippines), 19-24 Apr 1998. Crop Science Society of the Philippines. Philippine Journal of Crop Science 23 (Supplement no. 1): 90.
- DIAS JS. 2012. Nutritional quality and health benefits of vegetables: A review. Food and Nutrition Sciences 3: 1354-1374.
- GABRIEL BP. 1997. Insects and Mites Injurious to Philippine Crop Plants. College, Laguna, Philippines. National Crop Protection Center and the Department of Entomology, College of Agriculture, University of the Philippines Los Baños. 172 p.
- HANSEN M, BENGTTSSON G.B, BORGE GI, BERGE L & WOLD AB. 2010. Red cabbage, a vegetable rich in health-related glucosinolates. Acta Horticulturae 867(5): 61-65.
- JAVIER PA, MORALLO-REJESUS B & BARILE VR. 2004. Occurrence and seasonal abundance of cabbage webworm, *Hellula undalis* (Fab.). Philippine Entomologist 18: 164-173.
- MORALLO-REJESUS B, JAVIER PA & BARILE VA. 1995. Assessment of the occurrence and abundance of *Hellula undalis* in the Philippines. AVRDC Proceedings of the AVNET-II Midterm Workshop. Asian Vegetable Research and Development Center, Shanhua, Tainan, Taiwan, 1995, 95-438314-320.
- [PCARRD] Philippine Council for Agriculture, Forestry and Natural Resources Research and Development. 2010. PCARRD-DOST annual report 2009. Los Baños, Laguna: PCARRD-DOST. 78 p.
- SABADO EM, REYES SG & PADOGDOG ET JR. 2004. Assessing the diversity of selected arthropods in cabbage-growing areas in Mt. Malindang, Misamis Occidental. Biodiversity Research Programme (BRP) for Development in Mindanao: Focus on Mt. Malindang and Environs. SEAMEO SEARCA, College, Laguna. NJP Printmakers Incorporated, Quezon City, Philippines. 58 p.
- SASTROSISWOJO S & SETIAWATI W. 1992. Biology and control of *Crocidolomia binotalis* in Indonesia. pp. 81-87, In N. S. Talekar (ed.), Diamondback Moth and Other Crucifer Pests. Proceedings of the Second International Workshop, Tainan, Taiwan, 10-14 December 1990, AVRDC Publication No. 92-368. Asian Vegetable Research and Development Center, Taipei, Taiwan.
- VAN DEN OEVER R. 1973. A study on the life history of *Crocidolomia binotalis* Zell. and the population dynamics of *Crocidolomia binotalis* and *Plutella maculipennis* Curt. on cabbage in Indonesia. Report on a six-month practical stage at L.P. Hort. Pasarminggu, Jakarta. 52 p.