
Mass rearing and dispersal of biological control agents (BCAs) as interventions in Coconut Scale Insect (CSI) calamity areas in Basilan, Philippines

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Abstract Predatory beetles and Parasitoids were mass-reared using the squash medium and coconut seedling media, respectively, in Basilan, Mindanao and Southern Philippines. The methods were used to mass-produce BCAs to control the infestations of Coconut Scale Insects (CSI). The CSIs taken from infested coconut leaves were inoculated on squash fruits. When 80% of the fruits were coated by CSI, the adult predators of genus *Telsimia* and *Cybocephalus* and parasitoids *Comperiella calauanica* were separately placed in rearing boxes that contained the CSI-coated fruits. On these CSI-coated fruits, the adult female predators were allowed to lay their eggs. Five methods were used to rear the parasitoids. These were the squash medium exposed in different laboratory temperatures and light exposures, the CSI-infested coconut seedlings in open backyard and CSI-infested seedlings in net cage. The squash medium method was used to rear the predatory beetles. The CSI-infested coconut seedlings in net cages were the best protocol to mass-rear the parasitoids. These parasitoids grew only in external net cages and selectively on one CSI species, *Aspidiotus rigidus*. that initially had also preference for coconut plants. The predators grew best in squash medium where 2 CSI species, *Aspidiotus destructor* and *Aspidiotus excisus*, favored transferred infestation of the BCAs, the predatory beetles were the first to grow large population and were the first ones released to the coconut farmers. A total of 234,000 predators and 379,500 parasitoids were harvested and dispersed in 6 Municipalities of Basilan within the year of project.

Keywords: Biological intervention, Infestation, Parasitoid, Predator

Introduction

In the urgency to combat the Coconut Scale Insect (CSI) infestation reported in Basilan, Mindanao Island, Southern Philippines in 2014 and reaching outbreak levels in 2016, various IPM measures were employed by the Philippine Coconut Authority technical men that included leaf pruning, spraying with botanicals and chemicals and to the extent of injecting coconut trunks with chemicals. S&T interventions using biological control protocols

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had just been developed by partners in the academe during the later part of the year 2016 in anticipation of a possible recurrence of an earlier similar experience in the Southern Tagalog Region, Luzon, Northern Philippines between the years 2010 to 2014. From 2017 to 2018, particularly for the Basilan CSI calamity, several methods of mass-rearing and dispersal of both predators and parasitoids as biological control agents (BCAs) were tried, modified and well-documented. One method was optimized and worked best for the mass-rearing and dispersal of the predators while another one was best for the parasitoids. Generally, this study of the Mindanao State University – Maguindanao aimed to provide biological control measures to intervene with the CSI infestation in Basilan. Specifically, it aimed to: 1) to identify the CSI species infesting the coconut plants in Basilan; 2) to modify the protocols of mass-rearing the BCAs to suit the Basilan condition; 2) mass-produce the biological control agents (BCAs) and disperse them to the 6 CSI-infested municipalities in Basilan; and, 3) to verify the effectiveness of the protocols in addressing the CSI problem. The modification of the earlier reported biological control protocols to be able to produce greater number of BCAs and to apply to wider CSI-calamity areas, was an emergency and a relatively new management system to address the CSI infestation problem. With the project's expected outputs to attain the rehabilitation of the 6 target CSI-infested municipalities, in the long run, the impacts of the project would be the revival of the coconut industry in Basilan and the regain of the income of the coconut farmers.

Materials and Methods

The mass-rearing and dispersal of biological control agents (BCAs) were conducted from April 1, 2017 to March 31, 2018. Mass-rearing was done at the laboratories which were established in Basilan State College, Sta. Clara, Lamitan City, Basilan and dispersals were done in the 6 target out of the 12 municipalities in Basilan, Autonomous Region in Muslim Mindanao (ARMM).

First, the species of Coconut Scale Insects (CSIs) were identified. Leaflet samples were gathered randomly from 100 coconut trees in the target municipalities. Right on site, samples were examined for the presence of the CSIs. Immediately, samples were taken to the laboratory for closer examination under the magnifying lens, microscope, and with photoshots that were transferred on computers to be enlarged for easier identification of the CSI species and for counting each species population.

Second, the CSIs were grown in the laboratory. CSI-infested coconut leaves from the plantations were brought to the laboratory to allow the CSIs to transfer infestation on earlier obtained squash fruits. By means of 2 methods -

Sandwich Method and Wrapping Method (by PCA-XIV-ARMM), the CSIs were allowed to coat the squash fruits.

Third, the Biocontrol Agents (BCAs) – both Parasitoids and Predators were mass-reared separately in rearing boxes that contained the 80% CSI-coated squash fruits. There were 1000 boxes allotted for the BCAs- 500 boxes for the predators and 500 for the parasitoids. In there, the BCAs were allowed to undergo reproduction – their eggs laid, life cycles completed and monitored regularly for the mass production of their offsprings. Five methods for the mass-rearing of the parasitoids were tried based on the IEC material of Amalin *et al.* (2017). One after another, the method of mass rearing was modified to find the best one that suited the prevailing condition in Basilan. Three of the methods used well-selected fruits of the squash *Suprema* variety due to its more abundance than other varieties among the farms in Basilan. Two of the methods used CSI-infested coconut seedlings as media due to their ready availability.

Results

Three CSI species in the Basilan coconut plantations were identified as *Aspidiotus rigidus*, *Aspidiotus destructor* and *Aspidiotus excisus* (Figure 1). *Comperiella calauanica* parasitized only *Aspidiotus rigidus* (Figure 2). The 3 species of CSI transferred infestation from one coconut leaf to another. However, *Aspidiotus rigidus* did not transfer infestation to squash medium. Only *Aspidiotus destructor* and *A. excisus rigidus* transferred infestation from coconut leaf to *Suprema* squash variety (Figure 3). *Aspidiotus rigidus* does not, but *Aspidiotus destructor* and *A. excisus rigidus* do transfer infestation from coconut leaf to squash medium. The five methods that were used to rear the parasitoids differed in performance to produce a considerable population (Table 1) that would be dispersable in the CSI-infested areas. The best method for the mass-rearing and dispersal of the parasitoids *Comperiella calauanica* consisted of five steps (Table 2). The best method for the mass-rearing and dispersal of the predatory beetles *Telsimia ephippiger*, *Telsimia nitida* and *Cybocephalus* sp. consisted of six steps (Table 3).

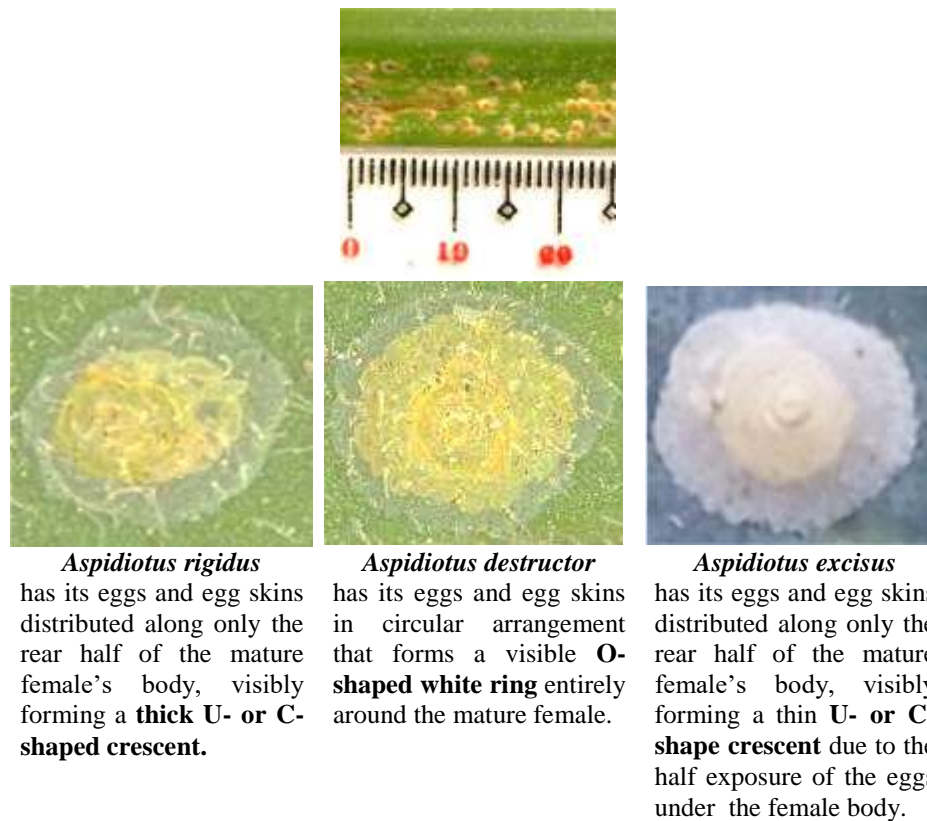


Figure 1. The 3 species of Coconut Scale Insect (CSI) that were identified among the coconut plantations in Basilan, ARMM, Southern Philippines



Figure 2. *Comperiella calauanica* specifically parasitizes on CSI *Aspidiotus rigidus* (↙) as shown in this sample photograph

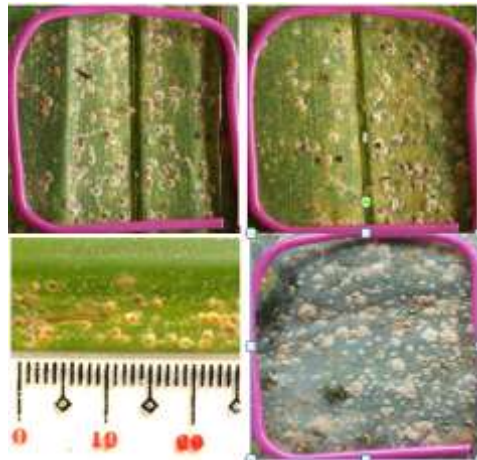


Figure 3. The 3 species of CSI transfer infestation from one coconut leaf to another.

Table 1. Results obtained from the 5 methods used for the mass-rearing of the parasitoid *Comperiella calauanica* in Basilan, ARMM

Methods for Mass-Rearing <i>Comperiella calauanica</i>				
1 Squash* Medium	2 Squash* Medium	3 Squash* Medium	4 CSI-Infested Coconut Seedling in Open Backyard	5 CSI-Infested Coconut Seedling in Net Cage
Squash fruit was pre-infested with CSI.	Squash fruit was pre-infested with CSI.	Squash fruit was pre-infested with CSI.	<i>Comperiella</i> sp. adults & pupae parasitizing CSI on coconut leaflets were clipped on CSI-free coconut seedling	<i>Comperiella</i> sp. adults & pupae parasitizing CSI on coconut leaf-lets were clipped on CSI-infested coconut seedlings inside net cages
No new <i>Comperiella</i> adults and pupae that emerged	No new <i>Comperiella</i> adults and pupae that emerged	No new <i>Comperiella</i> adults and pupae that emerged	0-2 new <i>Comperiella</i> adults but no new pupae that emerged	Too many to count new <i>Comperiella</i> adults and pupae that emerged
The introduced adults died	The introduced adults died	The introduced adults died	The introduced adults were lost	

*Suprema variety of squash.

Table 2. Steps of the best method for the the mass-rearing and dispersal of the parasitoids *Comperiella calauanica*

Steps	Description
1	CSI-infested coconut seedlings were sourced from nurseries and farms and were planted inside net cages outside the laboratory room.
2	Coconut leaflets containing <i>C. calauanica</i> pupae were sourced from seedlings or trees around. Inside net cages, 15-cm portions of the leaflets with a total of at least 15 pupae were clipped on each of the CSI-infested coconut seedlings.
3	<i>C. calauanica</i> were reared inside net cage with temperature of 25- 26 °C and partial shading from natural light for 8 hours.
4	New <i>Comperiella</i> adults were collected in sterile containers and dispersed among CSI-infested coconut trees at a recommended rate of 150 insects/ha.
5	Host seedlings with <i>Comperiella</i> pupae and adults were released to farmers for planting among CSI-infested coconut trees at a rate of 1 host seedling/ha.

Table 3. Steps of the best method for the the mass-rearing and dispersal of the predatory beetles *Telsimia ephippiger*, *Telsimia nitida* and *Cybocephalus* sp

Steps	Description
1	Identification and field collection of predatory beetles.
2	Preparation of squash media for the separate mass-rearing of the species of beetles inside the laboratory.
3	Infestation of the squash fruits with Coconut Scale Insects (CSI) was done by one of two ways: Wrapping Method and Sandwich Method.
4	When infestation has reached 20% coating on the squash fruits, CSI-infested fruits were transferred to incubation boxes
5	80% CSI-coated squash fruits were transferred to rearing boxes. Separately, each of the 3 predatory beetles - both adults and larvae, were introduced at a rate of 20 insects/box. Rearing boxes were arranged in chambers inside the laboratory.
6	Predators <i>Telsimia ephippiger</i> and <i>Telsimia nitida</i> were collected after 25-30 days and <i>Cybocephalus</i> sp. after 42-45 days. Dispersal is done among the coconut trees at a rate of 200 predators per hectare.

Discussion

The 3 CSI species that prevailed in the Basilan coconut plantations were identified and confirmed as *Aspidiotus rigidus*, *Aspidiotus destructor* and *Aspidiotus excisus* (Almarinez *et al.*, 2014; Amalin *et al.*, 2017; Medina, 2017). *Comperiella calauanica* parasitized only *A. rigidus* that were infesting the

coconut seedlings in Basilan. The same *C. calauanica* had been known as the endoparasitoid of the invasive coconut scale, *Aspidiotus rigidus* Reyne (Barrion *et al.*, 2016). Earlier, *Aspidiotus rigidus* Reyne (Hemiptera: Diaspididae) was reported as a devastating pest of coconut in the Philippines (Watson *et al.*, 2014). Close examination of the CSI-infested leaves found a large number of *C. calauanica* adults, their pupae in the bodies of the *A. rigidus*, and exit holes in the bodies of dead *A. rigidus* from which *C. calauanica* had parasitized and emerged. Closer examination confirmed the CSIs parasitized by *C. calauanica* were *A. rigidus*, while some of the CSIs were not parasitized and they were found as *A. destructor* and *A. excisus*. Around 200-500 *C. calauanica* adults and pupae were produced per life cycle in each coconut seedling.

For the mass-rearing and dispersal of the parasitoid *Comperiella calauanica* out of the 5 methods modified and tried, the best method was the fifth consisting of CSI-infested coconut seedlings grown in external net cages, introduced with the adult *C. calauanica*, and allowed to mass-produce to meet the target production and dispersal of 180,000 parasitoids in a year (Josue, 2018a). On *Suprema* squash with transferred CSI-infestation, only the populations of the 2 CSIs *A. destructor* and *A. excisus* were found. The 3 introduced beetles in the rearing boxes showed effective predation on these 2 CSIs. Around 300-500 predatory beetle adults and larvae were produced per life cycle in each squash in a rearing box. For the mass-rearing and dispersal of the predatory beetles *Telsimia ephippiger*, *Telsimia nitida* and *Cybocephalus* sp., the best method consisted of CSI-transfer infestation from coconut leaves to squash fruits contained in rearing boxes inside the laboratory, introduced with the adult beetles and allowed to mass-produce to meet the target production and dispersal of 200,000 predatory beetles in a year (Josue, 2018b). Dispersals of the BCAs in the respective communities were best helped by the farmers themselves.

The actual produce for the year were 117% over the target or a total of 244,000 predators, 234,000 of which were dispersed and 239% over the target or a total of 429,500 parasitoids, 379,500 of which were dispersed in the target municipalities (Josue, 2018c). Actual observations that were photo-documented showed high recovery of previously CSI-infested coconut trees from being “severe” characterized by “almost all leaves are yellowing to browning” to “all green.” with the growth of new leaves, recovery of the plants by replacing yellowing leaves, and showing “no infestation” (Josue, 2018c). The parasitoids *C. calauanica* showed more advantages over the predatory beetles if mass-production and dispersal are considered, which must be due to their shorter life cycles compared to those of the predators. However, *C. calauanica* is very specific for the CSI *A. rigidus*. Inevitably, the predators must also be mass-

produced and dispersed because of their proven predation on the other 2 CSIs *A. destructor* and *A. excisus*. Thus, the 2 groups of BCAs must be mass-produced for complete biological interventions in the CSI calamity areas in Basilan, Mindanao, Southern Philippines.

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References

- Almarinez, B. J. M., Amalin, D. M., Carandang, J. S. R., Navasero, M. V. and Navasero, M. M. (2014). First Philippine record of the parasitoid, *Comperiella* sp. (Hymenoptera: Encyrtidae): a potential biological control agent against *Aspidiotus rigidus* (Hemiptera: Diaspididae). *Journal of Applied Entomology*. DOI: 10, 1111/jen. 12173.
- Amalin D. M., Almarinez, B. J. M., Navasero, M. V. and Navasero, M. M. (2018). Meeting at the Zamboanga Research Center, February 2, 2018, PCA IX, San Ramon, Zamboanga City.
- Amalin, D. M., Almarinez, B. J. M., Ormenita, L. A. C., Serrana, J. M., Carandang, J. S. R. and Barrion, A. T. (2017). *Comperiella calauanica*: A Native Endoparasitoid for the management of the coconut scale insect, *Aspidiotus rigidus*. IEC Material.
- Barrion, A. T., Almarinez, B. J. M., Amalin, D. M. and Carandang, J. S. R. (2016). *Comperiella calauanica* sp. (Hymenoptera: Encyrtidae), an endoparasitoid of the invasive coconut scale, *Aspidiotus rigidus* Reyne (Hemiptera: Diaspididae) on Luzon Island, Philippines. *Asia Life Sciences*. 25:1-15.
- Josue, R. dR. (2018a). Best practice for mass rearing and dispersal of parasitoid *Comperiella calauanica* as biocontrol for the coconut scale insect (CSI) *Aspidiotus rigidus* in Basilan. Philippine Copyright 2018.
- Josue, R. dR. (2018b). Best practice for mass rearing and dispersal of 3 predatory beetles as biocontrol for the coconut scale insect (CSIs) *Aspidiotus destructor* and *Aspidiotus excisus* in Basilan. Philippine Copyright 2018.
- Josue, R. dR. (2018c). Terminal Report: Biological interventions in coconut scale insect (CSI) Calamity areas in Basilan, ARMM. DOST-PCAARRD (SAFE) funded Project. 154 pp.
- Medina, C. dR. (2017). National symposium on the coconut scale insect, Zamboanga City. April 2017.
- Watson, G. W., Adalla, C. B., Shepard, B. M. and Carner, G. R. (2014). *Aspidiotus rigidus* Reyne (Hemiptera: Diaspididae): a devastating pest of coconut in the Philippines. *Agricultural and Forest Entomology*. DOI: 10.1111/afe.12074.

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