# AAR NEWSLETTER

March 2016

## Message from the Editorial Team

Happy New Year and welcome to 2016! While the New Year is often the time of the year that all of us pledge to commit ourselves to fulfill a resolution, many a time those resolutions tend to change. Over the years, AAR has continued unwaveringly to strive to meet the changing tides faced by the Agricultural Industry. Through scientific research and its applications, we strive to better our services to benefit our Principals and clients. On behalf of our Director of Research, Mr Goh Kah Joo, we extend our wishes of success to all our clients and may our seedlings, clones and consultancy services aid your fruits of labour in reaping all rewards in 2016 and years to come.

In this issue, we have selected two articles covering Pests & Diseases. The first, written by Goh Yit Kheng, provides an overview of his research in search of biological control agents against *Ganoderma boninense*. His efforts have reaped success with the discovery of a new mycoparasitic fungus with promising results, and we can only look forward to what is to come in the near future. Our second article by Dr Teo Tze Min (Entomologist) presents her research on the extent of damages inflicted by *Metisa plana*, one of the most common leaf eating pests found in oil palm plantations in Peninsular Malaysia. Estates prone to bagworm outbreaks would benefit from this paper as it highlights the increasing damage inflicted on the oil palm canopy as the insect matures, and hence stressing on the importance of early detection and timely treatment. Happy reading!

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## In This Issue

Technical papers:

# *Ganoderma boninense* – A rich source of its own enemies

**Goh Yit Kheng***, *Goh You Keng, Nurul Fadhilah Marzuki, Tan Swee Sian, Tung Hun Jiat, and Goh Kah Joo*

**Fungi growing on *Ganoderma* species…**

*Ganoderma*, like many other fungi may harbour a wide range of mycophilic and mycoparasitic fungi. The term 'mycophilic' was coined to describe consistent inter-fungal or fungus-fungus associations, but the biology and mechanisms of these interspecific relationships are still unknown (Jeffries and Young 1994). These fungi can be categorized into a few common groups, namely neutralism (the relations between two interacting species that do not affect each other), mutualism (the relations between two or more interacting species in which each individual benefits from others mutually), antagonism (one species benefits at the cost of another interacting species), competition (equally detrimental interaction between different individuals or species), and mycoparasitism (non-mutual relationship between two fungal species, the parasite and the host, where the former benefits at the expense of the latter). Most of the fruiting body-inhabiting fungi reported in the literatures are from the order of Hypocreales (Ascomycetes) and followed by Tremellales (Basidiomycetes) (Gams *et al*. 2004).

Examples of fungi found on some *Ganoderma* species listed below:-

* *Ganoderma lingzhi* or *G. lucidum* (LingZhi) – *Cladobotryum semicirculare* (Kirschner et al. 2007) and *Xylogone ganodermophthora* (Kang et al. 2010) were reported to be pathogenic toward medicinal Lingzhi mushroom.
* *Ganoderma philippii* (Root-rot disease in *Eucalyptus pellita*) – Mycoparasitic *Phlebiopsis* sp. (Agustini et al. 2014) reported as potential biocontrol agent for root-rot disease.
* *Ganoderma applanatum* and *G. carnosum* – *Albertiniella polyporicola, Hypocrea lacteal, Verticillium incruvum,* and *Trichoderma polyporum* (Helfer 1991), were found living the two Ganoderma species although the relations and functions of these fungi toward the *Ganoderma* species are not known.

*In Taiwan and Korea, fungicolous or mycophilic fungi were reported to reduce Lingzhi production (suppress formation of fruiting bodies).*

*In Eucalyptus pellita plantation, mycoparasitic Phlebiopsis species was found to suppress the growth of G. philippii.*
*We are thinking… is that possible for us to use the parasites or pathogens of G. boninense to suppress or control basal stem rot (BSR) disease?*

**At AAR, we are working on fungi isolated from *Ganoderma boninense* (causal agent of basal stem rot in oil palms) and we believe these fungi can be potential biocontrol agents for controlling *G. boninense* in the future…**

A few potential fungi for biocontrol have been isolated from various substrates colonized by *G. boninense* starting from year 2013 (Table 1), and much efforts are still being channelled into isolating more fungi associated with *G. boninense*.

In year 2013, an unknown fungus was isolated from *G. boninense* pure culture (obtained from *Ganoderma* screening experiment done by Kok *et al*. 2013) and later this fungus was found to be a new species and was described and named as *Scytalidium parasiticum* (Figure 1A) (Goh *et al.* 2015). This was the first report of mycoparasitic *Scytalidium* species on *G. boninense* in Malaysia. *Scytalidium parasiticum* was observed to suppress the growth of *G. boninense* in the lab and also reduced both *Ganoderma* incidence as well as severity in nursery trials (T4 *G. boninense* G8 isolate only vs T5 with both *Ganoderma* + *S. parasiticum* and T6 *G. boninense* G10 isolate only vs T7 with both *Ganoderma* + *S. parasiticum*) (Table 2). *S. parasiticum* could be a potential biocontrol agent for *G. boninense* in oil palms. AAR has filed two patents, namely Malaysian and Indonesian Patents, on the use of *S. parasiticum* and its metabolites in controlling plant diseases. Field trials will be conducted in the near future to establish the efficacy of *S. parasiticum* in the oil palm ecosystem.

In year 2014, *Cladobotryum semicirculare* was found to proliferate on *G. boninense* fruiting bodies (Figure 1B) (Marzuki et al. 2015). It, however, showed greater inhibition towards the growth of *Rigidoporus* sp. (rubber white root disease) than *G. boninense* (oil palm white rot disease). Results from laboratory studies showed that mycoparasitic *S. parasiticum* inhibited the growth of *G. boninense* better than *C. semicirculare*; hence, the decision to focus on developing *S. parasiticum* as biocontrol agent against basal stems rot disease.

In year 2015, *Bionectria* and *Ceraceomyces* species were isolated from the substrates infected with *G. boni-*

*nense* (collected from oil palm plantation), and *Talaromyces* and *Penicillium* species were obtained from rubber wood block (RWB) colonized with *G. boninense* (Table 1). Based on our preliminary observations, *Bionectria* appeared to be antagonistic toward *G. boninense* with capabilities of producing fungistatic compounds at the contact zones, whereas, *Talaromyces* observed to be mycoparasitic with formation of contact structures on *G. boninense* mycelia. Further studies on determining the antifungal metabolites or compounds produced by both of these fungi will be useful to have better understanding on their mechanisms in suppressing *G. boninense.* Cultures of both *Bionectria* and *Talaromyces* species are shown in Figure 1C and 1D, respectively. Both *Bionectria* and *Talaromyces* species are still at the early stages of laboratory and nursery testing as potential biocontrol agents.

Based on molecular, phylogenetic, and morphological approaches, the existing mycophilic fungal isolates can be identified and characterized. More in-depth studies are ongoing to determine the relationships between these fungi and *G. boninense.* More nursery and field trials will be carried out to evaluate the efficacy and stability of these mycoparasitic or mycophilic fungi in controlling BSR due to *G. boninense.* Prior to field experiments, mass production of the microbial inoculants will need to be optimised. We do hope with this and the expanding collection of promising candidates at AAR, we will be able to introduce this group of beneficial fungi into the oil palm plantations as an environmental-friendly control measure against BSR disease.


***Figure 1.*** *(A) Pure culture of Scytalidium parasiticum; (B) Cladobotryum semicirculare on G. boninense fruiting bodies; (C) Colony of Talaromyces sp. on Petri plate; and (D) Bionectria sp. on medium.*

| Source | Origin | Tentative ID | Ref |
|---|---|---|---|
| A | Selangor | *Cladobotryum semicirculare* | 1 |
| A | Selangor | *Trichoderma* sp. | 2 |
| B | Johor | *Scytalidium parasiticum* | 3* |
| C | Selangor | *Bionectria* sp. | 2 |
| C | Kedah | *Ceraceomyces* sp. | 2 |
| D | Selangor | *Talaromyces* sp. | 2 |
| D | Selangor | *Penicillium* sp. | 2 |

***Table 1:*** *Source and origin of the fungicolous fungal isolates associated with G. boninense*

*Source: [A] G. boninense* fruiting bodies, [*B*] *G. boninense* pure culture, [*C*] Substrates infected with *G. boninense, [D]* RWB inoculated with *G. boninense.*
*References:* [*1*] Marzuki *et al*. (2015), [2] Unpublished Data. [*3*] Goh *et al*., (2015)* *(Filed for Malaysian (PI 2014702803) and Indonesian (P-00201505847) Patents in 2015 (Patents Pending)*

***Table 2.*** *Influence of Scytalidium parasiticum on Ganoderma disease incidence and severity in nursery experiment.*

| Treatment* | Disease Census or Scoring | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Disease incidence (%) | | | Disease severity index (%) | | | AUDPC‡‡ | DR† |
| | 1 MAT‡ | 3 MAT | 5 MAT | 1 MAT | 3 MAT | 5 MAT | (%) | (%)∞ |
| T1 | 0 | 0 | 0 | 0 a | 0 a | 0 a | 0 | - |
| T2 | 0 | 0 | 0 | 0 a | 0 a | 0 a | 0 | - |
| T3 | 0 | 0 | 0 | 0 a | 0 a | 0 a | 0 | - |
| T4 | 10 | 30 | 50 | 6.7 a | 26.7 bc | 41.7 b | 102.5 | - |
| T5 | 0 | 30 | 40 | 0 a | 15.0 ab | 20.0 ab | 45.0 | 56.1 |
| T6 | 30 | 70 | 90 | 21.7 b | 45.0 c | 75.0 c | 188.3 | - |
| T7 | 0 | 10 | 50 | 0 a | 5.0 a | 41.7 b | 44.2 | 76.6 |

*Treatments: T1 – control; T2 – with non-inoculated rubber wood block (RWB) only; T3 – with non-inoculated RWB and *S. parasiticum* (Sp) inocula; T4 – with RWB inoculated with *G. boninense* G8 only; T5 – with RWB inoculated with *G. boninense* G8 and Sp inocula; T6 – with RWB inoculated with *G. boninense* G10 only; and T7 – with RWB inoculated with *G. boninense* G10 and Sp inocula. MAT refers to Months-after-treatment.‡‡AUDPC refers to Area under disease progression curve.

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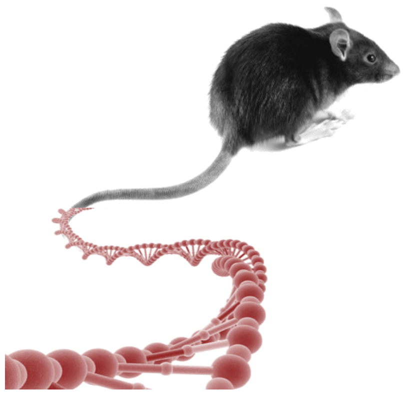

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# Feeding Behaviour of *Metisa plana* Walker (Lepidoptera: Psychidae) in Lab Condition and size estimation at each life stages of wild population in an estate in Johor.

***Kevin Fernandez* and Teo Tze Min.**

*Metisa plana* Walker (Lepidoptera: Psychidae) is commonly known as a pest especially in the oil palm (*Elaeis guineensis*) estates of Malaysia. Basri, 1993 found that light defoliation (about 3.2%) by *M. plana* did not affect the yield but a moderate defoliation (about 10%-13%) can cause crop loss of 33%-40%. In a serious outbreak of *M. plana* damages of up to 50% will lead to losses of about 40%-47% or 10t/ha over two years (Norman and Othman, 2006).

The characteristic of *M. plana* is it feeds on the oil palm leaf and attaches the pieces of leaflets as the outer casing for the caterpillar. The larva develops into a pupa and finally into an adult. Female adult *M. plana* remains within its pupal bag attached to the lower surface of the oil palm leaves. The male *M. plana* develops into flying moths. The female will attract the flying adult by emission of pheromone (Norman *et al*., 2010) and lays eggs within her pupal bag. When hatched, the offsprings will emerge from its mother's pupal bag.

Parasitoids and predators are a group of natural enemies towards bagworms and play an important role in reducing the number bagworms (Norman and Basri, 2010). *Dolichogenidea metesae* is the most common larval parasitoid of *M. plana*. Hyperparasitoids particularly *Pediobius anomalus* and *Pediobius imbrues* commonly are known to attack *Dolichogenidea metesae* (Norman *et al*., 1995).

Information of a full life cycle of *M. plana* larva based on its feeding behaviour is important for a sound management on this species. The weakness in the life cycle of *M. plana* can be determined and exploited for the control of this species. This information can be used to compare current practises against the life cycle of *M. plana*. It would allow for better understanding of the biology of *M. plana* for the purpose of pest management in the oil palm estates (Basri and Kevan, 1995).

## Methodology

This study was carried out under lab conditions for 60 days from May 2015 to June 2015 in the Entomology Lab of AAR. Bagworms were collected from an estate in Johor where bagworm outbreak was reported during that time. Bagworms were randomly collected from the field and transferred into a cage (30cm X 30cm X 75cm) and kept under lab conditions (25$^{o}$c).Identification of the different types of bagworms was done. Larvae of *M. plana* collected were randomly measured for its case size to predict instar sizes. Larvae of living *Metisa plana* were randomly picked and placed singly in modified cylindrical petri dishes. Daily measurements of the *M. plana* outer casing length were recorded. Fresh pinnae measuring about 8 cm X 3 cm was supplied to each bagworm daily. Observation of the eating behaviour of each *M. plana* on the pinnae was recorded.

Parasitoids and predators emerging from the cage were collected and recorded. Identification of parasitoids and predators was done using keys from Norman *et al*., 1996.

## Results:

### Population of bagworms in an estate in Johor

A total of 3124 *Metisa plana* were sampled and it dominates the bagworm community from our sampling estate. There were other bagworms also collected: *Pteroma pendula*, *Mahasena corbetti*, and *Clania sp*.. Figure 1 shows the percentage of bagworm species in our sampling. Image 1-4 shows the different types of bagworm collected.

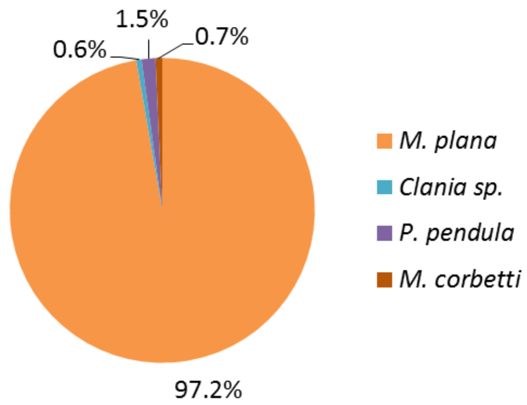
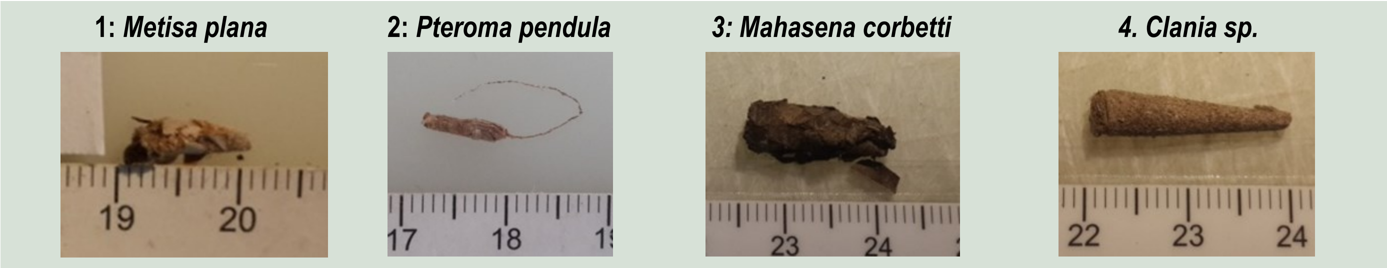



***Figure 1:*** *Percentage of different types of bagworms from an estate in Johor*

The larvae collected from the estate can be categorised according to the different instar stages. Table 1 shows the




| Instars | Length of M. plana | No of Larvae |
|---|---|---|
| 1st | 0.1 – 0.2 | 7 |
| 2nd | 0.3 – 0.5 | 601 |
| 3rd | 0.6 – 0.8 | 789 |
| 4th | 0.9 – 1.2 | 1222 |
| 5th | 1.3 – 1.5 | 473 |
| 6th | 1.6 – 1.9 | 32 |

***Table 1**: Larvae collected from the estate categorized into predicted instar*

larvae collected categorized into the predicted instars. The 4th instar is the majority in our sampling.

### Area of defoliation caused by *Metisa plana*

There are two types of defoliation which can be observed: minor defoliation (Image 5) which skeletonizes the surface of the pinnae, and major defoliation (Image 6) which excises a hole on the pinnae.

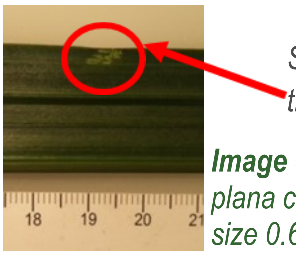



***Image 5**: Minor defoliation by M. plana caused by larva of case size 0.6cm*

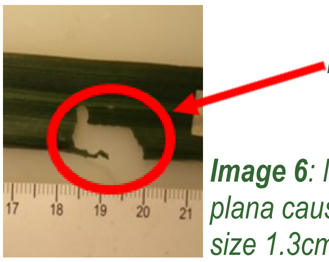



***Image 6**: Major defoliation by M. plana caused by larva of case size 1.3cm*

A total of 178 of bagworms ranging from different lengths were used. The highest recorded defoliated area is 0.61 $cm^2$ for the *M. plana* at the length of 1.6 cm per day (Fig. 2).

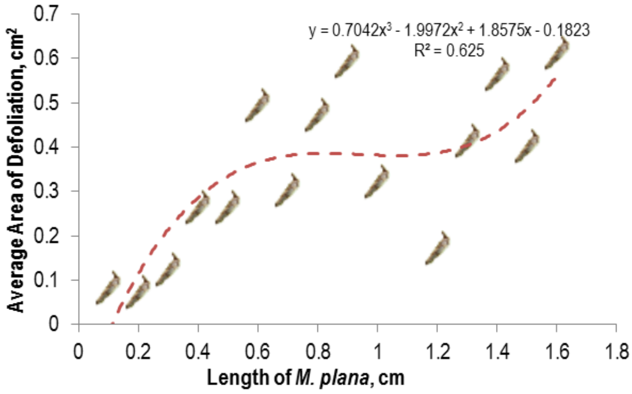



***Figure 2**: Average defoliation area per day caused by different sizes of Metisa plana*

Minor defoliation of *M. plana* was recorded ranging from 0.1 cm to 0.8 cm. The highest area of minor defoliation (0.54$cm^2$) was caused by larvae of 0.8 cm in case size (Fig. 3). Major defoliation occurs from 0.2 cm to 1.6 cm sized *M. plana*. Highest recorded major defoliation (0.61$cm^2$) is caused by larvae from the largest case size of 1.6 cm (Fig. 3).

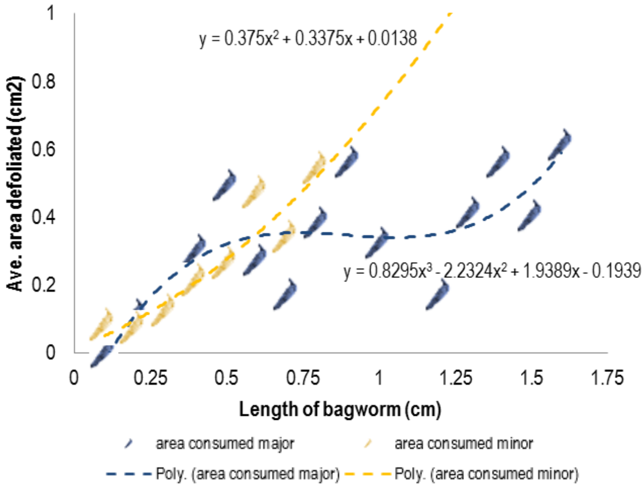



***Figure 3**: Average area of defoliation per day caused by different sizes of Metisa plana*

### Size predication of *Metisa plana* instars

Figure 4 shows the predicted instar stages for a *M. plana* larva. The instars are determined by the feeding behaviour of *M. plana* larvae. The average area of defoliation increases from the 1st instar to the 3rd instar. However, there was a decrease in the 4th instar. Increasing defoliation is again seen at 5th and 6th instar.

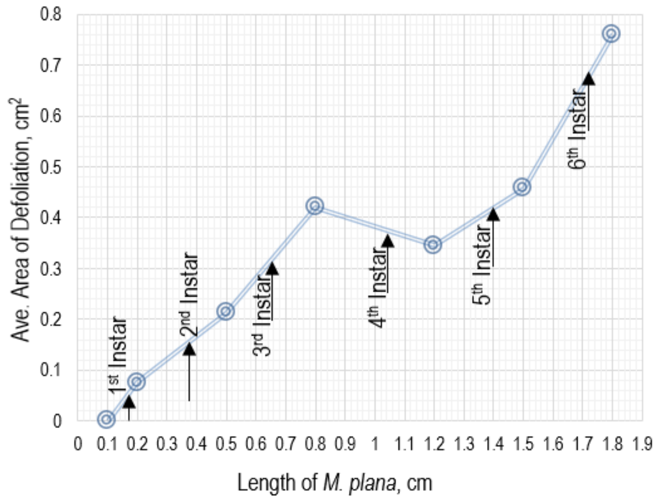



***Figure 4**: Predicted Different Instar Stages according to Average Area of Defoliation*

**Community of beneficial insects found associated with bagworms**

A total of 32 predators and parasitoids have emerged from our *M. plana* sampling. Figure 5 shows the different types of predators and parasitoids identified in percentages.

**Discussion**

The highest area of leaf defoliation was seen when the larvae was about 1.6 cm in length. This is as *M. plana* was preparing for pupation; in a stage where it will become dormant before emerging as an adult.

The average time required for each instar to moult into the next instar as studied by Chua et al., 2011 is summarised in part of Table 2. From our study, we have concluded the sizes of *M. plana* instars and its relation to its ability to defoliate (see table 2). Only 1st instar larvae cause minor defoliation. Major defoliation starts when larvae enter into the 2nd instar as it begin to elongate its case by leaf attachment. The 6th instar shows the highest defoliation area before pupating. This study has similar findings with Chua *et al.*, 2011 in which there were six different instar stages identified. However, the range of each instar differs compared to Chua *et al.*, 2011. It was observed that only *M. plana* with a case size of smaller than 0.8 cm causes minor defoliation. Major defoliation can occur from case sizes 0.2 cm - 1.6 cm as larvae of *M. plana* uses about 66.8% of the leaf tissue for growth and development, while 33.2% is used for case construction (Basri & Kevan, 1995). Using the equation $y = 0.7042x^3 - 1.9972x^2 + 1.8575x - 0.1823$, the area of defoliation can be predicted for *M. plana* larvae at different life stages.

Predators of *M. plana* collected were both larvae and adult *Callimerus arcufer*, which is a beetle used in biocontrol of bagworms and nettle caterpillars in oil palm estates. Cheong *et al.*, 2010, reported that predation of *P. pendula* was 24.6% and 40.2% by *C. arcufer* in their study. Parasitoids emerged from our *M. plana* samples were identified as *Dolichogenidea sp.*, *Tetrastichus sp.*, and *Eurytoma sp. Dolichogenidae sp.* (9.2%). *Dolichogenidae metesae* are known to attack the 3rd instar to 6th instar of its host (Wahid *et al.*, 1995). *Tetrastichus sp.* (31.8%) are parasitoids of *M. plana* and *M. corbetti* (Hanysyam *et al.*, 2013) and are mostly gregarious larval-pupal endoparasitoid and koinobiont, in which the species allows the host to continue its development while feeding on it (Yang *et al.*, 2013). *Eurytoma sp.* found in *M. plana* (13.6%) are also known to be a parasitoid for *M. corbetti* (Hanysyam *et al.*, 2013). However, most *Eurytoma sp.* prefers to attack gall wasps Cynipidae (Hymenoptera) and Diptera families Tephritisae and Cecidomyidae (Mena-Correa *et al.*, 2010). Hyperparasitoids which are found from *M. plana* are *Eupelmus catoxanthae* (31.8%) and *Pediobius sp.* (13.6%).

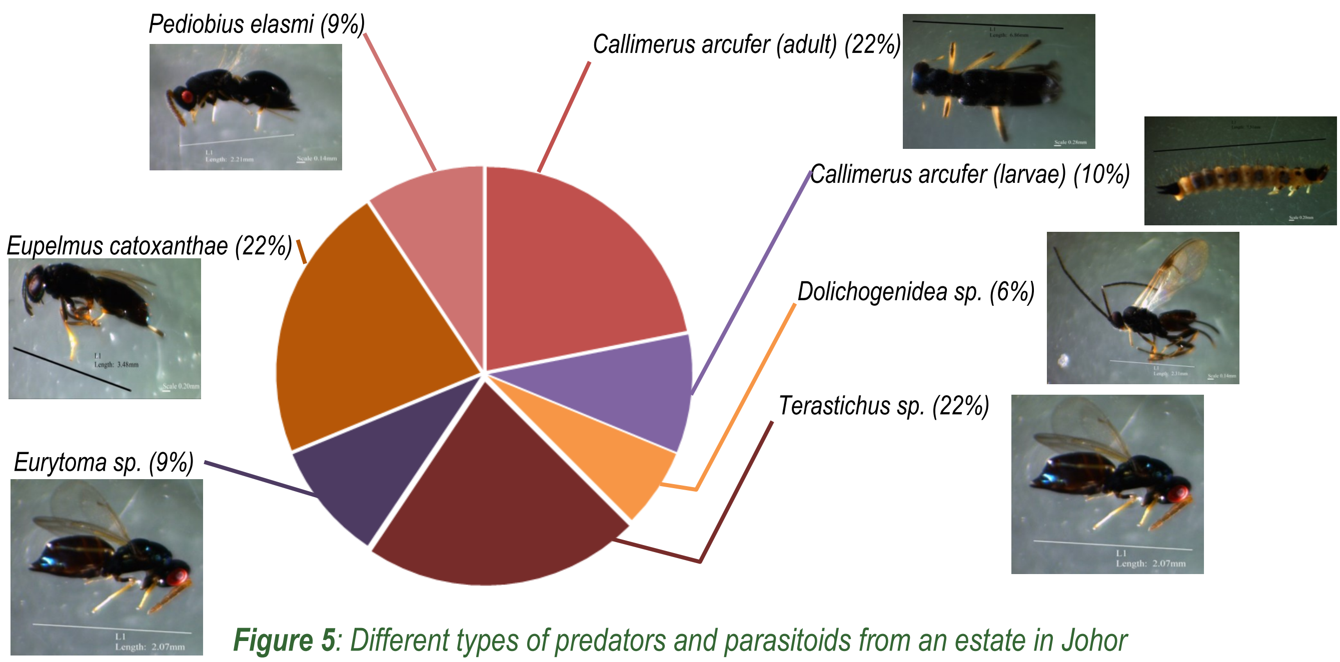



***Figure 5**: Different types of predators and parasitoids from an estate in Johor*

| Instars | Average Area Defoliated, cm$^2$ | Development into Next Instar, days (Chua *et al.*, 2011) | Casing length, cm | Average Area Defoliated for Each Instar cm$^2$ |
|---|---|---|---|---|
| 1st | 0.075 | 12.5 | 0.1 – 0.2 | 0.94 |
| 2nd | 0.213 | 15.5 | 0.3 – 0.5 | 3.30 |
| 3rd | 0.420 | 17.0 | 0.6 – 0.8 | 7.14 |
| 4th | 0.345 | 12.5 | 0.9 – 1.2 | 4.31 |
| 5th | 0.457 | 14.0 | 1.3 – 1.5 | 6.40 |
| 6th | 0.760 | 10.0 | 1.6 – 1.9 | 7.60 |
| Total defoliated area | | | | 29.69 |

***Table 2**: Predicted area of defoliation for each instar stage*

## Conclusion

The total area which is predicted to be defoliated by one larva of *M. plana* throughout its lifetime is 29.69 cm$^2$. The 3rd and 6th instar stages are reflected as the highest defoliating activity. Treatment for outbreak of *M. plana* therefore should be registered before the growth of the larva reaches 3rd instar (i.e 5 mm or less in size). Predators and parasitoids may control the number of *M. plana* and other bagworms outbreaks and is present in the study site. Our study supports our current policy guidelines to treat bagworms, and the importance of treating bagworms that are 0.5 cm or smaller for a more effective control.

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# PT AARi SOCIAL NEWS

**PT. AARI Annual Dinner 2015**

Our 2015 Annual Dinner was held in conjunction with our Sports Day. This year's annual gathering featured several sport tournaments which included futsal and table tennis competitions where we tested our mettle and teamwork through friendly matches. The night itself added to a string of memorable events which took place during the day—our Annual Dinner was overflowing with food, joy and reflections of how far we have come to and achieved as a Company which thrives on teamwork. Giving in to the sentiments, the committee decided to go with the theme that connects with everybody: "Colourful". In appreciation, numerous awards and door gifts were given away. One of them went to the "best performer" from our OPLS team, a stand-up comedian of rare talent! We were also honored by the presence of representatives from KLK, Mr. Trevor Chong and Pak Syed Zainal. Overall, we have to say that this year's Annual Dinner was a success.

AARISC President 2015


# AARSC SOCIAL NEWS

## AAR Annual Trip 2015

AAR's Annual Company Trip this year to The Lost World of Tambun, Gua Tempurung and Kellie's Castle was a success, with many loving the waterpark and rides, struggling through the dark wet caveS (but made it through) and enjoying the views of the historic ruins. Overall, it has been a fun year of bonding for all.

## ANNUAL COMPANY TRIP


## Main Office

The AAR Kota Damansara office was a flurry of enjoyable 'extracurricular' activities for all employees, mainly participating in our favourite Malaysian pastime; eating! Starting with a Hari Raya lunch in July, this was followed by the fruit festival in August (held in conjunction with the Staff Seminar), Annual Dinner, which is always the highlight of the year, and finally a triple combo of Deepavali, Christmas and farewell celebration for our dear Kak Fazi. To compensate for the heavy eating, a futsal tournament was held to burn off some of the calories gained (we hope).

## Paloh

The substantially large team at Paloh under the guidance of Mr Chin Shenyang organised a whole list of activities this year. The sports events held included netball and futsal in March, football, volleyball and takraw in April, badminton in June, bowling as well as football again in November. A durian festival was held in July and Family Day in October, whereby ten lucky winners won prizes from the lucky draw.


# AARSC SOCIAL NEWS

## Biotech

The 'compact' team in Biotech certainly did not miss out by having their own activities which included a Hari Raya lunch in August, Interactive Day at KLCC in November and Christmas celebration in December.

## Sabah

Sabah substation has also been very energetic under the leadership of Mr Lee Kok Yew, with many sports events held in 2015, which included camping in Taman Bukit Tawau, futsal, takraw and volleyball matches, as well as other fun and games during the family day and trip to Kota Kinabalu. To sharpen their minds, a carom match was also held. As usual, the highlight of the year was Annual Dinner where everybody filled themselves up with goodies and participated in karaoke and dances.


## TC Lab

TC Lab organized a string of events in 2015. Their first "Raya makan-makan" celebration was organized on August 11th together with their fruit festival. Their annual Family Day/ Sports Day took place on 31st October of 2015. Many games were played with intense competitive spirits mixed with loud pure laughters. Deepavali / Christmas. For Deepavali/Christmas Celebration over at TC Lab on December 16th, the TC Lab family worked together to make the event a success. Some of the staff worked together to cook a delicious pot of Nasi Briyani for everyone to feast on at our canteen.

## Annual Dinner

AAR's company annual dinner, which is always the highlight of the year, was held at Rahman Putra Golf & Country Club. Over 500 employees from all sub-stations congregated for the night. Performances by staff and lucky draws wooed the crowd throughout the night.

# OUR FAMILY CONTINUES TO GROW!

**Dr. Wee Sin Ling (AAR)**
Tissue Culturist / Assistant Research Officer II,
Ph.D Biosciences, University of Nottingham (Malaysia)

**Pak Bayu Meta Anggoro (PT.AARI)**
Agronomist / Assistant Research Officer
M. Sc. Food Engineering,
Izmir Inst. Technology (Turkey)

**Ms. Goh Mean See (AAR)**
Chemist / Assistant Research Officer I,
M.Sc. Applied Sciences (Organic Chemistry), Queensland University of Technology (Australia)

**Pak Dziyad Dzulfansyah (PT.AARI)**
Agronomist / Assistant Research Officer
M. Sc. Agri Engineering, IPB (Indonesia)

**Pak Alex Hermanto (PT.AARI)**
Agronomist / Assistant Research Officer
B. Sc. Biotechnology, Monash University (Malaysia)

# STRENGTH LIES IN THE ROOTS

## Congratulations to all our 2015 Employee Recognition Award and Long Service Award Winners!

On Friday, November 27th AAR recognized the men and women who make a difference at the company. The Employee Recognition Awards, given to staff members who showed outstanding performance, dedication and positive attitude, went to:

**DEDICATION AWARDS**

Puan Zaidah bt. Idris (Paloh SP)
Puan Norizah bt Mohamad (Paloh SP)
En. Ahmad Zulkarnaen b Hamdin (EM)
En. Sharul Nizam b Mansor (Paloh)

**INITIATIVE AWARD**

En. Samsudin b Saleh (GPS/GIS)

**INNOVATION AWARD**

Cik Nurul Fadhilah bt Marzuki (P&D)

**EMPLOYEE OF THE YEAR AWARD**

Mr. Lim Tuan Dim (Telok Sengat sub-station)