Akta Agrosia

Identification of Mulberry Pests and Its Natural Enemies at "Rumah Sutera Alam" Ciapus, West Java

Adrian Triandi*, **Nadzirum Mubin, Lia Nurulalia**
Department of Plant Protection, Faculty of Agriculture, IPB University Wing 7 Level 5 Kamper St. Dramaga Babakan Bogor 16680. INDONESIA

ARTICLE INFO

Keywords:
IPM
Morus alba
natural enemies
pest
trapping

Article history:
Received: Dec 03, 2020
Accepted: Jun 04, 2021

*Corresponding author:
E-mail: adrian_98@apps.ipb.ac.id

ABSTRACT

Mulberry plant (*Morus alba*) has an important social and economic contribution, which grown mainly for feeding silk worm (*Bombyx mori*), whose silk is used for crafting Indonesia traditional clothes. Cultivation of mulberry crops, harveste dfor its leaves and fruit, ideally by Integrated Pest Management (IPM) is necessary so that mulberry plants grow ideally and leaves have high quality and quantity without becoming a source of inoculum for pests and diseases of silkworm maintenance. Mulberry cultivation is generally carried out without using pesticide input so it is interesting in monitoring pests and natural enemies in the mulberry ecosystem. The research was conducted on two varieties of mulberry plants, namely *Morus alba* var. Kanva-2 and *Morus cathayana* in the same agroecosystem. Observation of pests and natural enemies was carried out using yellow sticky traps (YST) and pitfall traps (PFT). The orders and families found in the two varieties showed acroceridae family of 37.81% in the YST and hypogastruridae family with a value of 83.76% in the PFT observation

INTRODUCTION

Mulberry (*Morus* spp.) is a plant that has important socio-economic value in Asia, especially Central and East Asia. Mulberry cultivation practices are related to many industries, including food (fruit), medicine (polyphenol and antioxidative flavonoid compounds), and the use of leaves as silkworm feed-in sericulture practices. However, mulberry crop is grown mainly for feeding the silkworm, *Bombyx mori*, to produce silk yarn. The silk worm, eating the mulberry leaves, converts the leaf protein to silk protein (Ghosh *et. al*. 2017).

The varieties played important values in the *Morus* spp. including economic value because they produce large amounts of high-quality leaves, namely *M. alba*, *M. multicaulis* (good quality without fertilization but with coarse leaves), and *M. nigra* (black mulberry). The development of a new type of mulberry that is often cultivated by farmers are *M. cathayana*, *M. alba* var. *Kanva 2*, and *M. lembang*. Regarding those varieties, several varieties have economically importance namely cathayana and Kanva-2.

The challenges faced by silkworm farmers are the lack of availability to good mulberry leaves or the decreased productivity of mulberry due to pests and disease (Prayudyaningsih 2006). There are at least 6

ISSN: 1410-3354 / e-ISSN:2615-7136

Cited this as: Triandi, A., N. Mubin and L. Nurulalia. 2021. Identification of mulberry pests and its natural enemies at "Rumah Sutera Alam" Ciapus, West Java. Akta Agrosia 24(1):9-18 .

types of pests that are of concern in the cultivation of mulberry plants in Indonesia. In general, pests attack all parts of the plant, including leaves, stems, and roots. The negative impact of pest attacks is a decrease in the production and quality of mulberry leaves, in this case, water and protein content, so it is not good for use as caterpillar feed (Prayudyaningsih 2006). Mulberry is vulnerable to attack by a variety of pests which causes an abrupt decline in leaf yield and a degradation of its appearance. Feeding certain leaves to silkworm results in detrimental effects on the yield of coconut and the consistency of the silk. While mulberry is home to hundreds of insect species, including Pyralidae, mulberry thrips, Thripidae, pink mealybug, Pseudococcidae, Pseudoccidae on papaya, and Aleyrodidae cause significant disruption and crop damages, while the majority of them live in mild or secondary pest status below the level of economic harm.

The loss of yield due to pest attacks on mulberry cultivation is definitely high, considering the low use of pesticides (insecticides) in the crop, since the leaves can still be used (harvested 2-3 times a day as feed for silkworms (*Bombyx mori*). Yield losses (leaves) from pests ranged from 20.05 % (41.36 grams per plant) to 94.34 % (each plant leaf was invaded by pests) (Prayudyaningsih 2006). Pest management is required in a proper manner so that mulberry pests can be properly managed. Mulberry pest control options are required to apply the Integrated Pest Control (IPM) concept and to make pesticides the last control choice so that mulberry leaves are not harmful when offered as feed to silkworm (*B.mori*).

The objective of this experiment were to observe and to classify the pest incidence on two species of mulberry *Morus alba* var. *Kanva-2* and *Morus cathayana* and their natrural enemies.

MATERIALS AND METHODS

Time and Location

The experiment was done from September 5th to October 20th, 2020, at Rumah Sutera Alam Ciapus, Bogor, West Java, from where the leaf sample were taken for the experiment.

Sampling Techniques

Sample was taken weekly for a month by a survey, using the Yellow Sticky Trap (YST) and Pitfall Trap (PFT), done in 2 different mulberry plant varieties (*Morus cathayana* and *M. alba* Var. *Kanva-2*). The author determines sample plants or samples by making a diagonal map of the observation area. For each plant that is passed by a diagonal point, YST and PFTs are performed. The YST size used is 20 cm x 25 cm. The PFT used was a 90 mL volume cup filled with soapy water.Both of these sampling techniques are aimed at obtaining insects that have flying characteristics and are around the canopy of the plantations (YST), while the PFT is aimed at getting insects that cross and are active in the roots and soil around the mulberry plantations.

The author uses the yellow sticky trap (YST) because in general arthropods and other flying insects are attracted to yellow. Yellow sticky traps were effective in attracting and trapping a large number of adult whiteflies (Bandyopadhyay *et al*. 2004) as the main pest of mulberry plants. In a comparative efficacy study, the yellow sticky traps alone could suppress 32% of the populations within 28 days of installation.

Some literature noted that YST is not substantially different in the monitoring process for other essential mulberry pests. Monitoring and controlling of *Cotarina* sp. or generally referred to as mulberry fruit gal-midge, did not have a major impact using YST, but Green sticky traps had an exceptionally excellent adult trapping effect followed by blue sticky traps, whereas turquoise and purple sticky traps had the worse trapping effects (Jiequn *et al*. 2018). Due to its general existence, the authors have preferred to use YST as a monitoring tool.

The use of PFT instruments is used to track arthropods that have the roles of pests and natural enemies. Pitfall trapping, the easiest and cheapest method, is useful in catching certain arthropod that are nocturnally active on the surface but are inefficient in capturing either the bottom dwellers or those that scatter by flight. Pitfall trapping is most effective in open environments, such as grasslands and scrub woodland, as the capture values can be influenced by vegetation complexity.

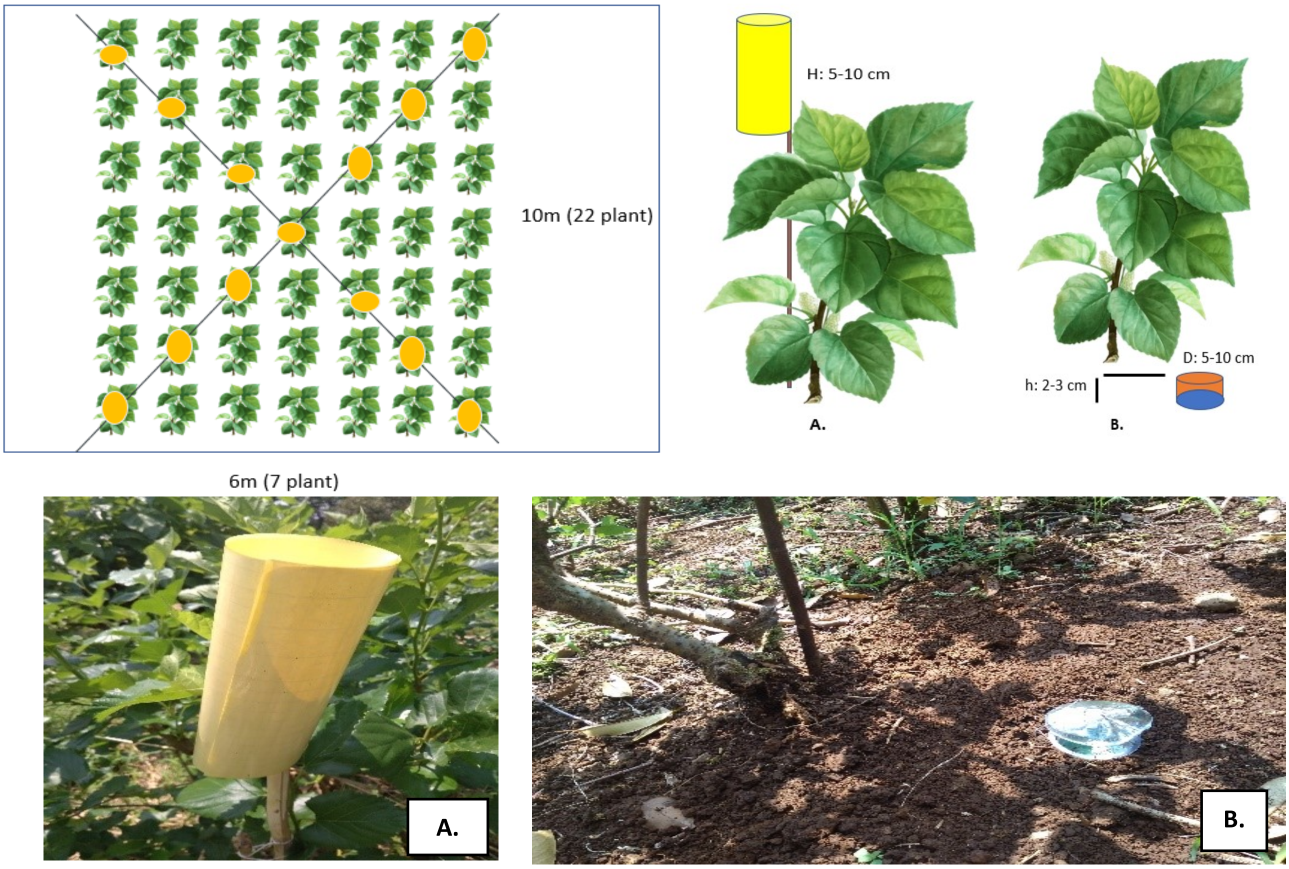

Fig 1 Sampling location and placement of YST (A) and PFT (B) on mulberry plants

Determination of sample space, varies between species, but for mulberry plants, the author is related by Jiequn's research (2018), putting mulberry sticky traps at a distance of 1,5 m from the ground using a wooden stick. There is no standardization of the size and depth of the PFT when monitoring using PFT, because the PFT application is a modification depending on the commodity. Even if researchers are unable to use the suggested uniform template, pitfall trap data obtained in future studies will be more useful if investigators listed all of the pitfall trap approaches used including specifics of the above characteristics of pitfall traps, positioning, and maintenance strategies (Hohbein 2018). The author positions the PFT at a depth of 2-5cm such that the observation plate is level with the land, the plate has a diameter of 8cm and the plate depth is 5cm. The author adds a solution to kill insects or arthropods, a mixture of water and dishwashing liquid soap. The history of this solution is resistance (does not evaporate quickly), is efficient in killing insects, and is inexpensive. The placement of the PFT is in a distance of +-10cm from the stem of the plant.

Identification of Insects and Other Arthropods on The Trap

Insects and arthropods caught in both traps (YST and PFT) were identified to the family level using the reference source Hymenoptera of the world: an identification guides to families by Goulet and Huber (1993), Australasian Chalcidoidea (Hymenoptera): a Biosystematic Revision of Genera of Fourteen Families, with a reclassification of Species, Borror and Delong's Introduction to the study of insects (2005), Insects of Australia Volumes 1A & 2A (1991), as well as specific national and international scientific journals. Observation of insects and arthropods was carried out using a stereo-microscope and a binocular microscope. In some limitation conditions, the authors also observed with a dinolite magnification tool (potable digital microscope).

Relative Abundance of Insects and Arthropods in the Sampling Area

The relative abundances of each other insect and arthropod were calculated by the Krebs equation (1989).

$$Relative\ Abundance = \frac{Number\ of\ species\ found}{Total\ number\ of\ species}\ x\ 100\%$$

Relative abundance data were then analyzed on the role of each arthropod in the agroecosystem. The data were presented in the form of tables and graphs as well as comparisons through other related scientific journals.

RESULTS AND DISCUSSION

Arthropods Weekly Diversity on Both Trap and Mulberry Varieties

Observations on each mulberry variety were carried out using PFT and YST periodically for 4 consecutive weeks. In Figures 2 and 4, data shows that collembola as the most caught soil arthropod in the PFT method, while Figures 3 and 5 show the Acroceridae family which is the most caught in the YST method. Each insect caught every week shows insects diversity on mulberry plantations. Details can be seen in Figures 2,3,4, and 5.

Relative Abundance of Arthopods

Based on the relative abundance analysis proposed by Krebs (1989), family Hypogastruridae (collembola) has an abundance percentage of up to 83.27% of the total population of soil arthropods trapped in the PFT of the Cathayana (Fig. 2) mulberry field. Meanwhile, in the canva variety, the Hypogastruridae family had a relative population abundance of up to 83.76%. Several other soil arthropods found in traps then filled the percentage gap, consisted of carabidae and scarabidae. The second-highest relative population on PFT was found in the family Formicidae, on Cathayana and Kanva (Fig.4) varieties being 7.73% and 7.12%, respectively.

Analysis of the relative abundance of the YST (Fig. 3 and Fig. 5) straps was found to be more diverse with several representative families. YST in the Kanva variety, namely the Acroceridae family, has an abundance of up to 28%, with the second and third highest being Pompilidssae and Dolichopodidae, with relative abundances of up to 12% and 11.33%, respectively. Observations on the relative abundance of the arthropod family were found at YST Cathayana. The highest was found at 37.81% in the family Acroceridae. The second and third largest relative abundance of the YST Cathayana trap was 9.24% in Dolichopodidae and 6.72% in the two families Cicadellidae and Pompilidae.

Each biological behavior of each arthropod caught in the two traps with different mulberry varieties for 4 weeks. Collembola with the Hypogastruridae family is the largest number of arthropods that the authors get. According to Eisenhauer *et al*. (2011), at a plant root depth

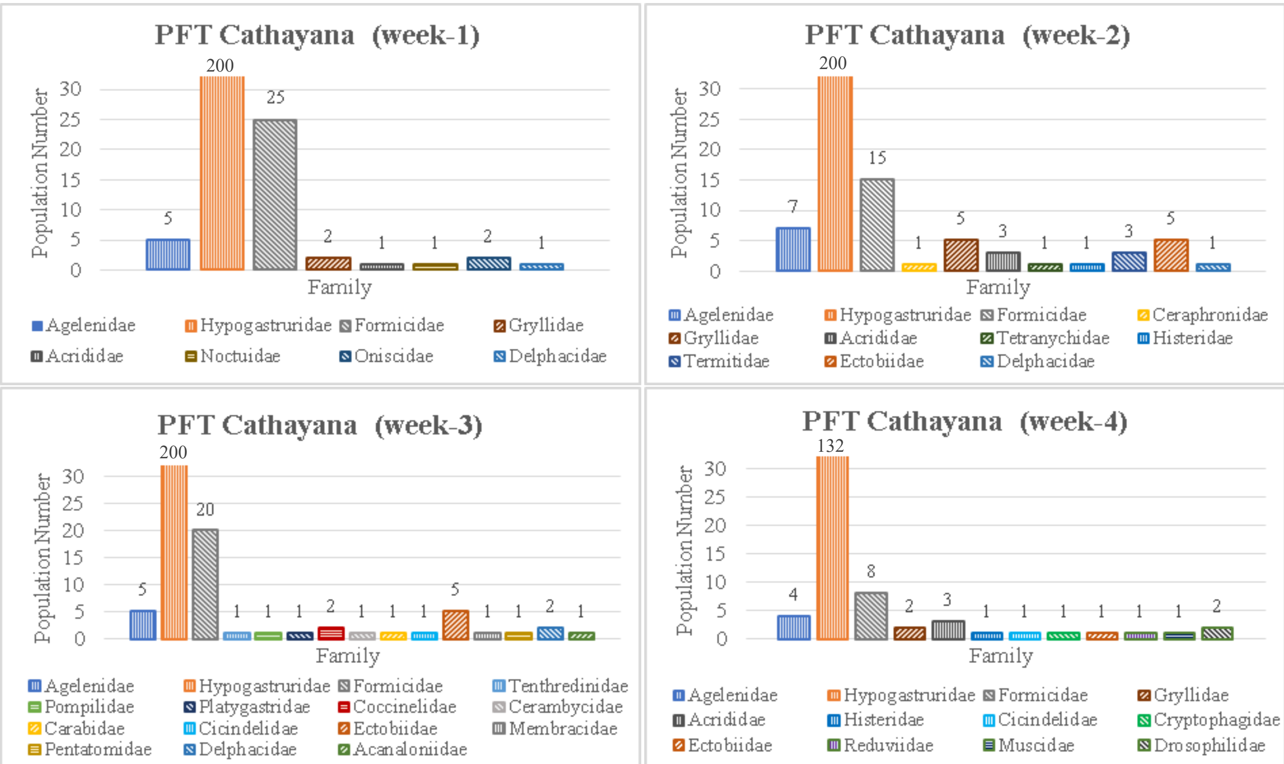

Fig 2. The diversity of arthhopod families found in PFT trap on *Morus alba. Var. Cathayana* observed

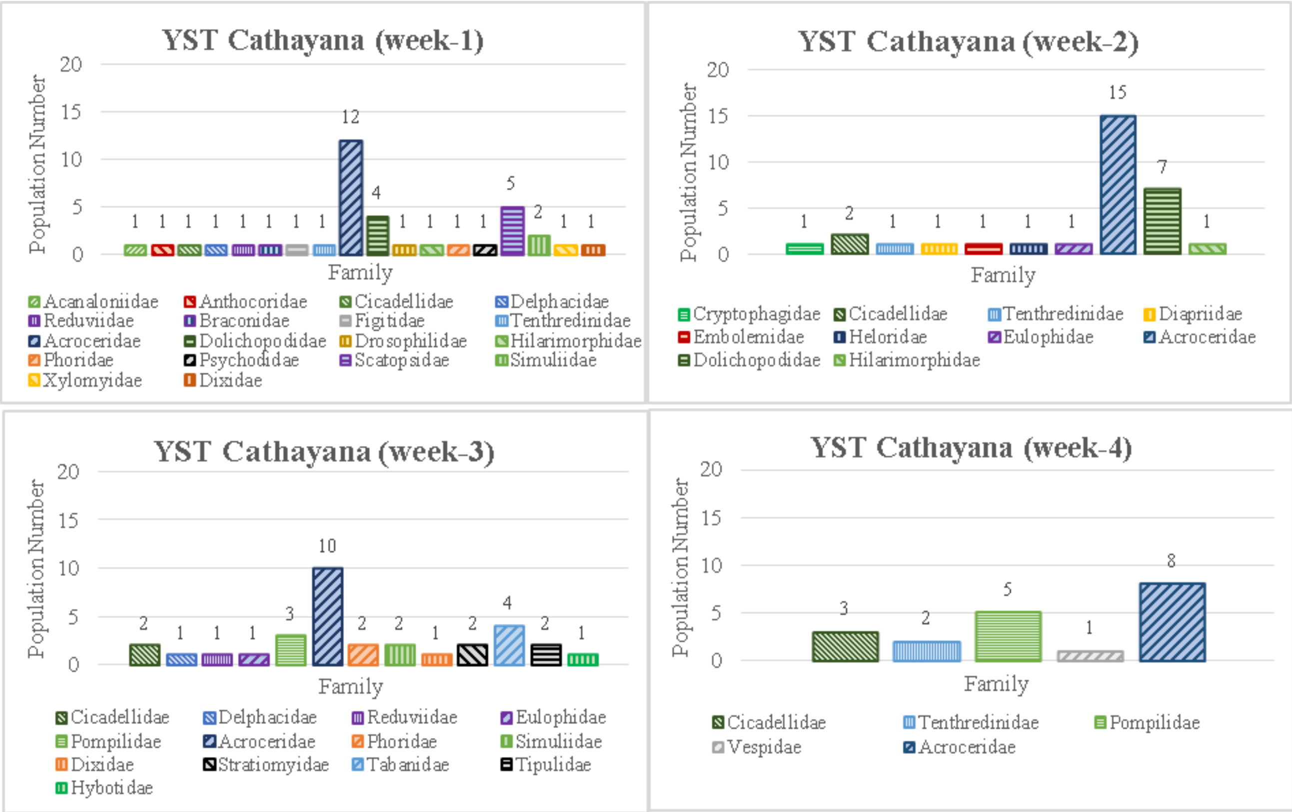

Fig 3. The diversity of arthhopod families found in YST trap on *Morus alba. Var. Cathayana* observed

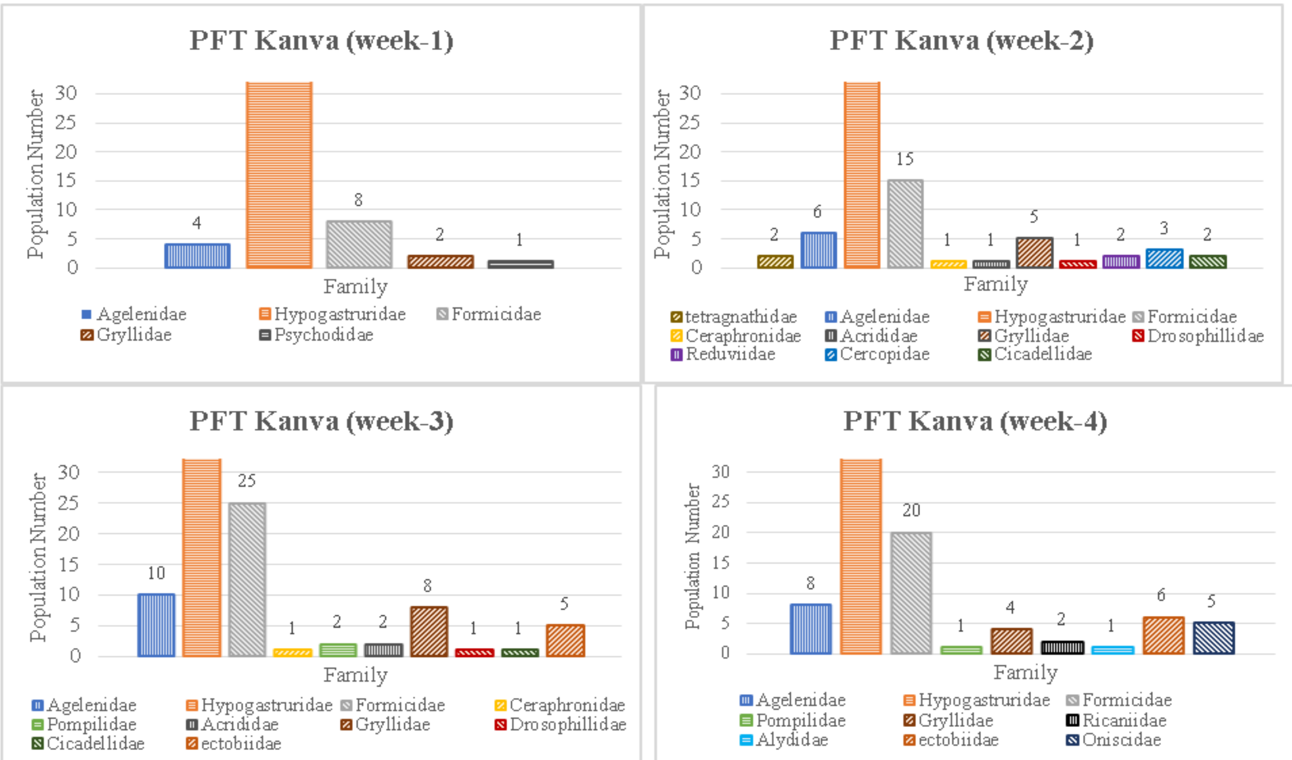

Fig 4. The diversity of arthhopod families found in PFT trap on *Morus alba. Var. Kanva* observed weekly.

of 5-10cm, Collembola has a density of up to 60,000 ind. m-2 in grasslands. The lack of pesticide treatment in mulberry cultivation is a form of conservation in soil arthropods. There is a negative relationship between the routine application of herbicides to the diversity and population of collembola, especially in the species *Friesea truncata*. Based on the potential for diversity, high population size, and high density are the reasons why PFT gets

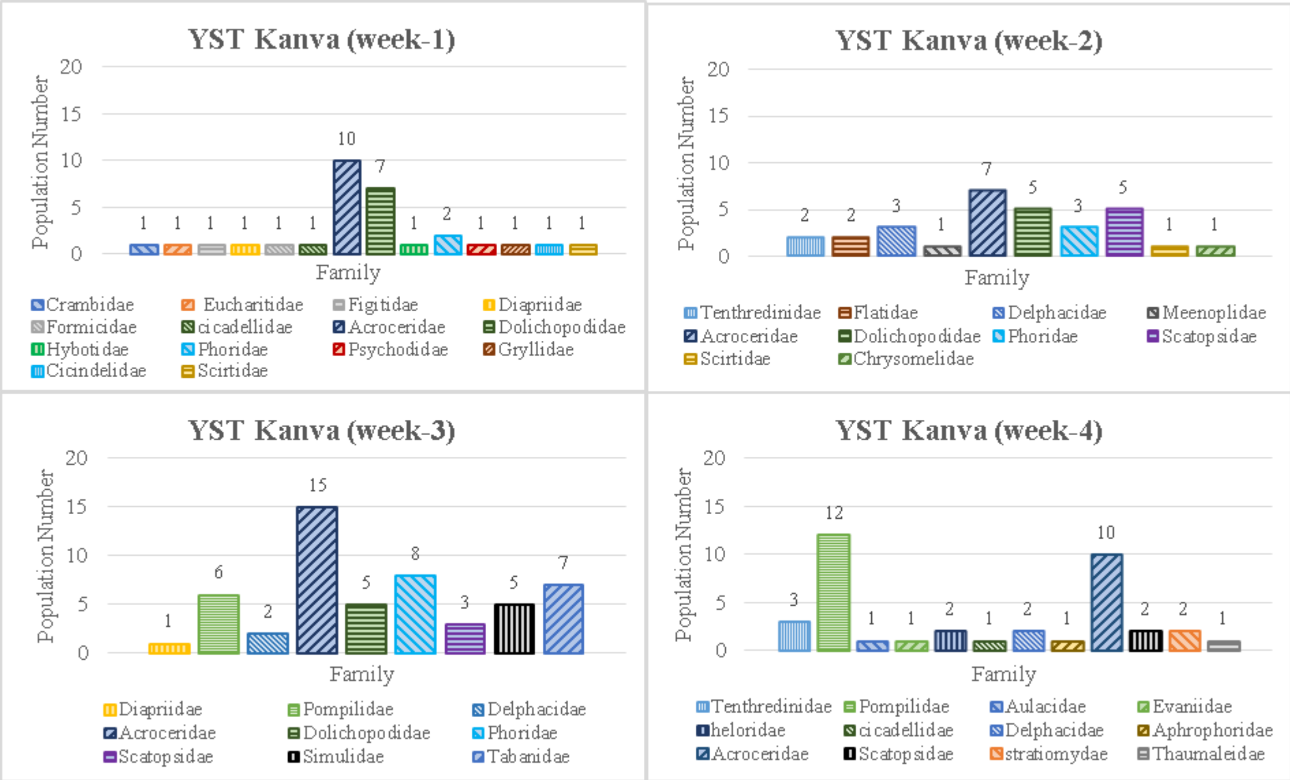

Fig 5. The diversity of arthhopod families found in YST trap on *Morus alba. Var. Kanva* observed weekly.

a lot of collembolas. This is also an indication that the observation area is still very fertile and rich in beneficial soil arthropods.

Formicidae is the second largest family found on PFT in the two mulberry varieties. Formicidae roles as a predator of small and weak insect or animal, also roles as a decomposer of organic matter. Naturally, ants could be preferred for indicators of environmental condition changes, it also roles to maintain the nutrition cycle and structure of soils. Soil temperatures have an average of about 32.1^{0}C. Ants can be used for habitat indicator status (Zayadi *et al.* 2013). A large amount of litter and mulberry harvested in the land, as well as fallen fruit that is not harvested, are the main food sources for the Formicidae.

Observation of family abundance in YST traps found the family Acroceridae (Order Diptera) as the largest family found in the two mulberry varieties. Three acrocerid genera have been recorded visiting the flowers of several plant species in Chile. An undescribed Brazilian species of the genus *Philopota* Wiedemann feeds and mates at the flowers of *Stachytarpheta cayennensis* and also exhibits territorial behavior over flower resources. This was possible because the planted mulberry began to have flowers and the acroceridae family pollinated around the plant canopy.

Dolichopodidae were the second and third largest insects that were obtained during 1 month of observation. Best known for their long legs and the bright metallic green, blue, and yellow hues of the most conspicuous species, most are small, 5 to 10 mm long, although the family also contains "microdolichopodids"measuring approximately 1 mm. Adults are predaceous. List of all known published records of predation by adult dolichopodids includes approximately 200 records representing at least 168 predatory species in 47 genera. The prey species are mostly Diptera, and more than half belong to the families Chironomidae and Culicidae. However, various Condylostylus species (Diptera: Dolichopodidae) have been recorded to prey on dark-winged fungus gnats, leaf-miner flies, aphids, leafhoppers, thrips, whiteflies, and mites. Many Dolichopodidae that were caught gave the conclusion that the conservation of natural enemies occurred.

Pompilids are found mostly in PFT and YST traps with a role in the environment as predators. Pompilidae exist at the expense of spiders, an ancient group of terrestrial invertebrates predators

(Day 2012). Many Pompilidae caught have concluded that natural enemies are conserved. The high population of Cicadellidae is consistent with research on the mulberry plantation, Morus alba L., from Phulambri, Khultabad, and Gangapur mulberry fields, Aurangabad district, Maharashtra, India. Occurrence most likely occurs in July to October.

Agelenidae are found to be widespread soil predators and canopy arthropods, with prey hunting usually occurring at night (nocturnal) (Suana *et al.* 2013). Popular spiders are categorized as general predators and have an important role to play in reducing and preventing the incidence of natural pest explosions in agricultural crops and contribute to biodiversity. The spider is found in arbors with three-dimensional funnel-shaped nests. This is consistent with Platnick (2003)'s observation that the cobwebs of the Agelenidae family are founded on low vegetation and shrubs, although certain species can be found in tree-branched holes and rocky caves.

Pests and Natural Enemies on PFT Traps at Two Mulberry Varieties

In PFT, predators, and parasitoids as natural enemies are generally found in the order Araneae and Hymenoptera, pests are generally found in many orders, namely Hemiptera, Coleoptera, Isoptera, and Diptera (Fig.2&4).sss The Hemiptera order families found were Delphacidae, Acanaloniidae, Reduviidae (predators), Cercopidae, Cicadellidae, Ricaniidae, and Alydidae. The families found in the order Coleoptera are Tetranychidae, Histeridae, Coccinellidae, Cerambycidae, Carabidae, Cicindelidae, and Cryptophagidae. The families obtained in the Isoptera order are Termitidae, while the Diptera orders are Muscidae, Drosophilidae, and Psychodidae. Delphacidae has the characteristics of attack as a pest by sucking sap from healthy plants, especially on young leaves and stems, causing a decrease in the quality and quantity of harvested mulberry leaves. (Nelly *et al.* 2017). Stated that acanaloniidae are known as polyphagous insect pests with a wide host range, including mulberry plants. Acanaloniidae is known for its behavior that sucks plant sap but does not cause significant yield losses in the affected plants. Reduviidae are found in solitary and non-group plantations. Predators in this case Reduviidae are very potential to prey on pests of the caterpillars Lepidoptera, Leafhoppers, Aphids,

A B C

Fig 6. Hypogastruridae (A), Formicidae (B), and Agelenidae (C).

A B C D

Fig 7. Acroceridae (A), Pompilidae (B), Dolichopodidae (C), and Cicadellidae (D).

and Thrips. Several types of Reduviidae such as *Rhinocornis* spp., *Coranus* spp. Assessed as having a high level of predation (Bach 1975). Cercopidae or generally referred to as spittlebugs. Usually, the spittlebug population in the pasture is dry and increases with the early rainy season by the time crop is sown.

Cicadellidae, Ricaniidae, and Alydidae are common in many plants because they are cosmopolitan pests with a wide host. The presence of these three families will certainly reduce the quality of the mulberry leaves that are produced for silkworm feed. . They reduce the leaf yield and quality which reflects adversely on the quantum of silkworm rearing and cocoon productivity. Empoasca flavescens F. (Hemiptera: Cicadellidae) is the major sucking pest of mulberry in the tropical zones (Sakthivel *et al*. 2012). Ricaniidae family species are generally widespread over the tropical zones. This pest is also found in the Morus sp. Mulberry plant. by sucking the leaves of the mulberry plant and there may be an increase in population from June to late August (Özgen *et al.* 2011). Alydidae sucks on mulberry leaves and fruit until the leaves and fruit are disformed. Alydidae generally has a range of hosts to survive, namely mango, coffee, conifers, and mulberry.

The Coleoptera family was found to have various roles in the agroecosystem, namely pests and predators. The families found were Histeridae (predator), Coccinellidae (predator), Cerambycidae (stem pest), Carabidae, and Cicindelidae (predator), also Cryptophagidae (fungi associated and pollen eating). Histeridae are often found as predators, especially in Musca sp. often found to be predators for the egg and larval phases of Musca sp. In natural areas, these beetles have been found in various types of moist organic detritus (wet and decaying plant matter, animal carrion, and animal / human feces) where they can find their immature fly prey (Borowski and Mazur 2015).

Coccinellidae is also an effective predator, especially on pests of the order Hemiptera. The main prey of predatory Coccinellidae is aphids (Aphididae spp.), Scale insects, and insect eggs. Most of the aphids that are eaten are the main pests in various crops. On the other hand, Cerambycidae are the main pests of mulberry plants. The main species that attack is Epepectes plarator which is a mulberry stem borer. At first, the larvae will eat the underside of the bark along with the cambium layer irregularly. Then the larvae will enter into the xylem layer, by making a hole and developing here. As a result, plant resistance becomes weak, and stems break (Andadari *et al.* 2013). Carabidae and Cicindelidae are generally classified into the same family, namely carabids with the main role as predators in the agroecosystem. Carabids usually live in the soil or near the ground. Carabids are usually active at night (nocturnal), during the day these insects hide under leaves or rocks or underplant stems.

Pests and Natural Enemies on YST Traps at Two Mulberry Varieties

At least two important orders in the observation of YST traps on the two varieties of mulberry plants with cultivation without pesticides in the management of plant pests in the mulberry agroecosystems. Both orders had the largest number of captured populations of each family compared to other orders. The Hymenoptera and Dipteraorders are the two main orders on this discussion. This is because the families found in other orders (Coleoptera, Hemiptera, and Orthoptera) are a family known as generalist pests and predators which are also found in other plant agroecosystems, as well as some predators found in the order Coleoptera have similar families to predators found in PFT trap. The Hymenoptera orders found in YST traps consist of several families, namely Braconidae, Figitidae, Tenthredinidae, Diapriidae, Eulophidae, Pompilidae, Vespidae, and Evaniidae. All of the families found were of importance as predators and parasitoids. Braconidae itself is a parasitoid commonly found in parasites of aphids (Aphididae) which is an important pest of mulberry, especially when its leaves are harvested. Braconidae is a solitary endoparasitoid of aphids with cosmopolitan distribution (Barahoei *et al.* 2013). Figitidae are parasitoids commonly found in parasites of fruit flies. Blattodea is obtained from the Termitidae family (Andadari *et al.* 2013).

CONCLUSION

There were variety of pests as well as their natural enemies on mulberry crops grown at Rumah Sutera Alam Ciapus, West Java, found in different level of population, distribution, families, or varietes. The population of Hypogastruridae (Collembola) was the highest arthropods trapped in PFT with the highest relative abundance (83.76%) in both mulberry varieties. The highest relative abundance of YST traps was found in the Acroceridae family (Dipteran) with 37.81%.

ACKNOWLEDGMENT

We thank Mr. Dudut Prasetyo, the lecturer at Prasetya Mulya University and the mulberry plantation owner, for valuable opportunities for doing research at his plantation.

REFERENCES

Andadari. L., S. Pudjiono, Suwandi and T. Rahmawati. 2013. Budidaya Murbei dan Ulat Sutera. Pusat Penelitian dan Pengembangan Peningkatan Produktivitas Hutan: Forda Press.

Bach, D.P. 1975. Biological Control by Natural Enemies. Cambridge Univ. Press Ca. Riverside.

Bandyopadhyay, U.K., M.V. Santhakumar, N.K. Das, P.K. Mukherjee and S.R. Urs. 2004. Efficacy of yellow sticky traps in monitoring the mulberry whitefly, Dialeuropora decempuncta. Pest Management in Horticultural Ecosystem. 10 (1): 49-54.

Barahoei, H., E. Rahksani, S.M. Madjdzadeh, A. Alipour, S. Taheri, E. Nader, A.M. Bogdanovic, O.P. Obradovic, et al. 2013. Aphid parasitoid species (Hymenoptera: Braconidae: Aphidiinae) of central submountains of Iran. North-Western Journal Of Zoology.9(1):70-93.

Borowski, J. and S. Mazur. 2015. Beetles (Coleoptera) of the Rogów region. Part IV – clown beetles (Histeridae) and false clown beetles (Sphaeritidae). International Letters of Natural Sciences 37(1): 10–17.

Borror, D.J., C.A. Triplehorn and N.F. Johnson. 2005. Borror and Delong's Introduction to the Study of Insects 7 th Edition. Canada (CA): Belmont.

Day, M.C. 2012. Spider Wasps Hymenoptera: Pompilidae. Handbooks for the Identification of British Insects: Royal Entomological Society.

Eisenhauer, N., A.C.W. Sabais and S. Scheu. 2011. Collembola species composition and diversity effects on ecosystem functioning vary with plant functional group identity. Soil Biology and Biochemistry. 43(8): 1697-1704.

Ghosh, A., D. Gangopadhyay and T. Chowdhury. 2017. Economical and environmental importance of mulberry: a review. International Journal of Plant and Environment 3(2):67-72.

Goulet, H. and J.T. Huber. 1993. Hymenoptera of The World: An Identification Guide to Families. Canada (CA): Agriculture Canada Publication.

Hohbein, R. and C. Conway. 2018. Pitfall traps: a review of methods for estimating arthropod abundance: pitfall traps: estimating arthropod abundance. Wildlife Society Bulletin.42(4):597-606.

Jiequn, R., C.Li, L. Zhinan, Z. Minghai, Y. Yi and Z. Zhangyun. 2018. Attractive effect of different colored sticky traps on Cotarina sp. in mulberry field. Advances in Engineering Research.170(7):1658-1661.

Krebs, C.J. 1989. Ecological Methodology. New York (US): Harper and Row inc.

Nelly, N., M.Y. Syahrawati and H. Hamid. 2017. Abundance of corn planthopper (Stenocranus pacificus) (Hemiptera: Delphacidae) and the potential natural enemies in West Sumatra, Indonesia. Biodiversitas.18(2):696-700.

Özgen, I., C. Gözüaçık and M. KaravinM. 2011. Host plant preferences of *Ricania hedenborgi* stal, 1868 (hemiptera: ricaniidae). Mun. Ent. Zool.6 (2):983-986.

Platnick NI.2003.The World Spider Catalog. New York: American Museum of Natural History.

Prayudyaningsih, R., H. Tikupadang dan B. Santoso. 2006. Hama dan penyakit jenis murbei eksot dan tingkat kehilangan daunnya pada akhir musim kemarau.Jurnal

Penelitian Hutan dan Konservasi Alam.3(4): 429-435.

Sakthivel, N., R. Balakrishna, J. Ravikumar, P. Samuthiravelu, L. Isaiarasu and S.M.H. Qadri. 2012. Efficacy of botanicals against jassid Empoasca flavescens F. (Hemiptera: Cicadellidae) on mulberry and their biosafety to natural enemies. J.biopest. 5 (1):246 – 249.

Suana, I.W. and H. Haryanto. 2013. Diversity of spiders and their potentials as natural enemies of cashew pests. Indonesian Journal of Entomology.10(1):24-30.

Zayadi, H., L. Hakim and Setyoleksono. 2013. Composition and diversity of soil arthropods of Rajegwesi Meru Betiri National Park. Journal of Tropical Life Science.3(33):166-171.