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RESEARCH ARTICLE

WHITEFLY DIVERSITY (HEMIPTERA: ALEYRODIDAE) AND ITS PARASITOIDS IN LOWLAND IN WEST SUMATERA

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Abstract

Whitefly is an important pest in various fruit plants. This study aimed to study the diversity of whitefly in fruit plants in the lowlands of West Sumatra. Fruit plants samplings were guava, sweet orange and lime. Sampling locations were at Padang Timur District, Padang, Pauh 1 District, Padang, Pauh 2 District Padang. The method used is methode survey and sample determination is done by Purposive Random Sampling method. The taking of nymph was conducted by searching the parasitic nymphs on each plant found throughout the location determined as the location of the study. Based on the identification results, there were 2 whitefly species found in fruit plants in the lowland, *Aleurocanthus woglumi* and *Bemisia tabaci*. The diversity of whitefly in the lowlands was 1, 065 and the uniformity index was 0, 969.

Introduction:-

Fruit is one of the plants that is useful as a fulfillment of nutrients for the human body and is generally consumed directly. In terms of nutrition, fruit is associated with its role as a source of vitamins, macro and micro minerals and high sources of fiber [1]. Since long ago many people have known the benefits contained in fruits that are very important in fulfilling nutrients that are good for the body and affect health. In the fulfillment of nutrients derived from fruits experiencing problems so that production decreases. The problems faced in fruit cultivation are whitefly [2].

Whitefly is the order of Hemiptera which has a piercing-sucking mouth type that lives below the leaf surface, white and its wings covered by a layer of wax [3]. Whitefly has been widespread in the tropics and subtropics, in Asia, Africa, Europe, Oceania, Caribbean, North America and Central America [4]. Whitefly is a polyphag insect, generally these insects are known as viral vectors that cause disease in plants by sucking phloem fluid on the leaves and producing honey dew which becomes a growing medium of sooty fungus which blocks photosynthesis and affects production [5]. This pest resulted in 20-100% of yield loss [6]. Whitefly can live from lowland, temperate plains to highlands. The height of the place is very influential on the development of this pest. Study reports that

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whitefly can live in the lowland, temperate plains and highland. The number of whitefly species is found more in the lowland (32 species) than in the highland (9 species) [7].

Whitefly pest control still uses insecticides. There is no single control method that gives optimal results in controlling whitefly both using chemical insecticides, biology, and technical culture. The use of pesticides can have a negative impact on the environment including causing pest resistance, resurgence of pests, leaving residues on products and hazards for consumers [8]. One effort to overcome the negative impact of the use of pesticides is by environmentally friendly controls by utilizing parasitoid. Information on whitefly on fruit trees at site altitude ie lowlands needs to be reported as basic information about the diversity of whitefly. The study of diversity in fruit trees in the lowlands of West Sumatra has not been reported yet. The objectives of this study are: (1) Determining the type of whitefly, (2) Determining the type of parasitoid, (3) diversity analyse.

Materials and Methods:-

Implementation of Research

The survey methode was used in this reserach and the determination of the sample was conducted by Purposive Random Sampling method. The geographical position and height of the sampling location was done using GPS (*Global Positioning System*). The sampling method was carried out by taking plant leaves directly with two parasitic nymphs in one plant. Sampling was carried out in three locations, Padang Timur District, Padang (7 m asl), Pauh 1 District, Padang (119 m asl), Pauh 2 District, Padang (140 m asl). Samples that taken from the field were carried out to the laboratory and the parasitic whitefly nymphs were separated according to the type of whitefly. The whitefly that after separated was put in petridish and then closed and labeled. Adult of whitefly was identified based on Martin's identification key (1987) [9] and parasitoid was identified using the identification book Goult and Huber (1993) [10].

Observations

a. Type Whitefly

Observation of whitefly species was carried out by identifying based on Martin's identification key (1987) and by matching previous research drawings [9] [7].

b. Number of Whitefly

Whitefly nymphs were counted by the number of nymphs in the leaves in each type of whitefly. Each type of whitefly was separated by one nymph on one petridish. This observation was conducted to determine the number of individual nymphs on guava, sweet orange and lime.

c. Parasitoid type

The parasitoid that came out of the parasitic nymphs in the petridish was collected by taking a parasitoid from the petridish using a brush and inserted into the testub which contained 96% alcohol. This observation aimed to determine the type of parasitoid that parasites whitefly.

Data Analysis

a. Diversity Index

The whitefly diversity index was determined using the Shannon-Wienner diversity index formula [11]. The criteria for species diversity index according to Fachrul (2007) [12] are 3, namely: H '<1.5 means that diversity was classified as low, if H' = 1.5 - 3.5 meant that it is moderate and if H '> 3.5 it was high. The Shannon-Wienner diversity index equation is as follows:

$$H = - \sum Pi \sum_{i=1}^{5} (\log e.\ Pi)$$

$$Pi = n/N$$

Information:

H = Shannon-Wienner diversity index
Pi = Proportion of individual species to the community
n = abundance of individual species i
N = total number of individuals of all species

b. Evenness Index

Species evenness was the proportion of each species in a community. The evenness index of whitefly was determined using the Simpsons Equity Index formula [11]. The criteria for species evenness index according (Krebs, 2000) were 3, namely: if E < 0.4 meant evenness is low, if E = 0.4 - 0.6 classified as moderate and if E > 0.6 then classified as high [11]. Evenness of whitefly species could be calculated using Simpson's evenness index [11]. The Simpson's evenness index equation is as follows:

$$D = 1 - \sum_{i=1}^{s} pi^2$$

Information:

D = Simpson's evenness index
Pi = Proportion of individual species

Results and Discussion:-

3.1 Types of Whitefly

The results showed there were 2 species found in fruit plants in the lowlands of West Sumatra. The species were *Aleurocanthus woglumi* and *Bemisia tabaci*. Morphologically, white fleas were found to have the following characteristics. Adult of *A. woglumi* found in lime plants had a body size o1 mm with an orange body and mottled black wings (Figure 1a). Adult of *A. woglumi* was found in lime. Another study also found *A. woglumi* on citrus leaves with the same characteristics in this study [7] [13]. *B. tabaci* had a body size of 0.8 mm and white wings (Figure 2b). The *B. tabaci* adult had a characteristic yellowish white adult which in the anterior was a red eye pattern with yellowish cream colored body and white wings (Figure 2b). Adult of *B. tabaci* was found in guava, sweet orange and lime. This result was correlated to another study which found *B. tabaci* with morphological character of the *B. tabaci* white adult colours with the size of the rear wing was not wide and white, rather yellowish thorax in cucumber, cassava, soybean, winged, curly red chili, tomato and eggplant plants [7] [14].

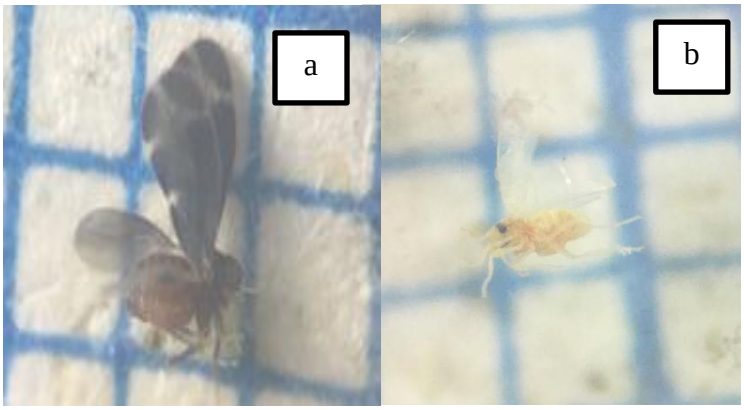

Figure 1:-*Aleurocanthus woglumi* imago (a), *Bemisia tabaci* imago (b)

According to the morphology, the nymphs of whitefly *A. woglumi* and *B. tabaci* had the following characteristics (Figure 2). Nymph *A. woglumi* had the characteristics by having a shiny black body color with stiff black shiny thorns. There were 11 pairs of taper spines on the dorsal, a pair of spines in the posterior size longer than the other spines that resemble a tail [9] [5] (Figure 2a). Other studies also found nymph of *A. woglumi* in citrus plants with the same characteristics in this study [7]. *B. tabaci* nymph had the characteristics of a pear-shaped body and red eyes. The *B. tabaci* nymph had characteristics such as an elliptical puparium, one pair of *caudal setae*r which was located at the same size of puparium, there was a *vasiform orifice* on the triangular posterior puparium area with a size longer than a round groove (*cudal furrow*). Another feature was the operculum (*operculum*) which covered the *vasiform orifice* [9] (Figure 2b). Another study also found *B. tabaci* nymph on cassava leaves, cotton leaves, potato leaves and tobacco with the same characteristics in this study. Based on morphological observations, whitefly nymphs found in different host plants did not affect the morphology [7] [16].

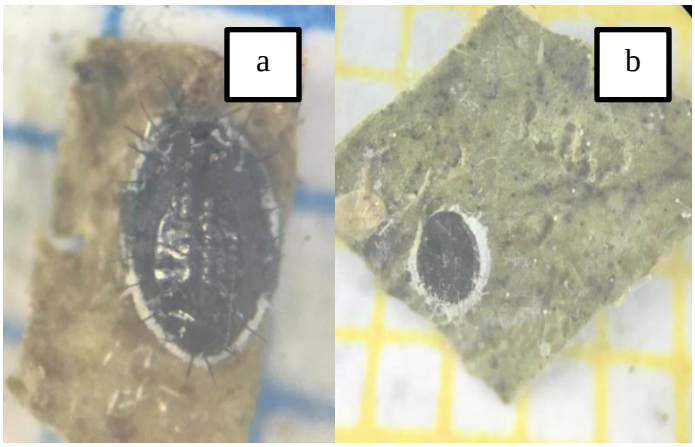

Figure 2:-The parasitic nymph *Aleurocanthus woglumi* (a), the parasitic *Bemisia tabaci* nymph (b)

3.2 Number of nymphs Whitefly

The number of whitefly nymphs in each species found in leaves varied. The number of *A. woglumi* in lime plants were 799 individuals. *A. woglumi* was only found in lime.It due to the citrus sp. was the main host of *A.woglumi* [17] [18] [19] [20] [21]. Other studies also found that *A. woglumi* could not infect hosts other than oranges [22]. The number of *B. tabaci* individuals in guava plants was 616 individuals, in sweet orange plants there were 361 individuals and in lime plants there were 464 individuals. *B. tabaci* attacked more than one type of plant. It due to *B. tabaci* was polyphag. Another study found that *B. tabaci* attacked tomato, chili, soybean, tobacco, eggplant, okra and several ornamental plants [23] [24] [25].

3.3 Types of parasitoids

The results of identification of whitefly parasitoid found in fruit plants in the lowlands of West Sumatra were 4 species, namely Encarsia (Aphelinidae), Encyrtidae, Platygastridae 01 and Platygastridae 02. The morphology of the parasitoid species has the following characteristics.

Encarsia (Aphelinidae)

Body 2 mm in length or less, relatively lightly sclerotized, often dark but at most with obscure metalic luster; antenna usually with at most 6 distinct flagellomeres (rarely with 7-9 flagellomeres including obscure ring-like basal flagellomeres); females with at most 4 distinct flagellomeres between pedicel and club; males without distinct club; pronotum usually distinctly shorter than half length of mesoscutum and often linear in dorsal view; mesoscutum with notauli more or less straight, complete and widely separated at transscutal articulation near anteromedial angels of axillae; axillae relatively small, with anteromedial angels widely separated, usually partly advanced anterior to scutellum; prepectus flat posterior to pronotum, with anterodorsal point of articulation anterior to (E) or posterior to (some A) insertion of pl_2 -t_2 c muscle, sometimes also with internal prepectal strut between ventral angle of prepectus and mesoscutum (some A); individual usually fully winged but some females subapterous; fore wing with marginal vein relatively long; stigmal vein short and postmarginal vein either absent or not extending beyond point in line with apex of stigmal vein (A), oe stigmal and postmarginal veins both long but then parastigma (curved apical part of submarginal vein) usually extending spike-like onto membrane behind submarginal vein and with 1 or 2 conspicuously long bristles (E); mesopleuron usually with distinct mesepisternum and mesepimeron separated by fine groove and than with or without small subalar acropleuron, but acropleuron sometimes enlarged and very rarely comprising entire mesopleuron; mesothorax in ventral view without membranous area anterior to mesocoxa (except *Coccobius*); mesotrochantinal plate and metasternum abutting (requires removal of mesocoxae to observe) and either with metasternum extending anteriorly and ventrally to mesotrochantinal plate (then metasternal pit widely separated from anterior margin of metasternum) (A) or mesotrochantinal plate extending dorsally to transverse margin of metasternum (then metasternal pit very near anterior margin of metasternum) (E); protibia with relatively long, curved apical spur; mesotibia dorsoapically, and mesotarsus ventrally, without pegs (except some *Eutrichosomella*); mesotibial spur relatively long, often robust; metatibia sometimes with long and conspicuous bristles (most E); tarsi usually with 5, less commonly with 4, tarsomeres; propodeum almost always conspicuously transverse, with metasoma widely attached to mesosoma; cercus not conspicuously advanced anteriorly.

Species are primary endoparasitoids or ectoparasitoids, or hyperparasitoids, mostly of Aleyrodoidae, Aphidoidae, Auchenorrhyncha, Psylloidae and especially Coccoidae (Homoptera), but also of the eggs of Lepidoptera amd Orthoptera, the eggs, larvae, and pupae of Diptera and the larvae of other Chalcidoids and Dryinidae. The family is renowed for its often complicated modes of differential development and parasitism of the sexes. In some species the females are endoparasitoids and the males ectoparasitoids of the same host species, whereas in others the males are hyperparasitoids of females of their own species (obligate adelphoparasitism or autoparasitism), of other aphelinid species (facultative adelphoparasitism), or of other primary parasitoid [10] [26] [27] [28] [29] [30] [31] [32] [33] [34].

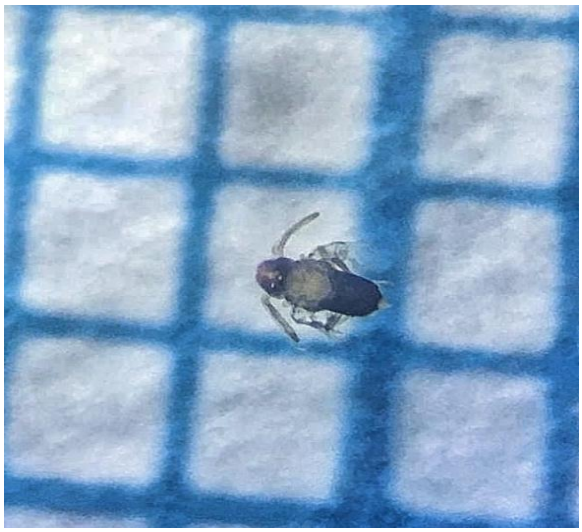

Figure 3. Encarsia (Aphelididae): has a body size of 0, 8 mm, has a red head, antenna type *stratioys*, transparant thorax and a black abdomen

Encyrtidae

Body with pronotum usually visible and most often transverse in dorsal view; mesoscutum usually without notauli but if present then linear and more or less sinuately V-shaped; mesocutum articulated to scutellar-axillar complex only laterally, with very slender membranous area and/or depressed anterior margin of scutellar-axillar complex visible between sclerites if mesonotum arched; axillae almost always transverse-triangular, usually with contiguous anteromedial angels (sometimes appearing separate because of overhanging posteromedial curvature of mesoscutum); prepectus flat posterior to pronotum but internally with prepectal strut between ventral angel of prepectus and mesocutum; individuals fully winged to wingless; fully winged specimens with marginal, stigmal, and postmarginal veins relatively short, the marginal vein usually very short to punctiform; acropleuron convexly enlarged to metapleuron; mesothorax in ventral view with or without membranous area anterior to each mesocoxa but mesocoxa unable to rotate completely out of fossa; mesocoxa inserted at or anterior to midline of acropleuron; mesosternum transverse; protibia without dorsoapical spicules, with relatively long, curved tibial spur; mesotibia with row of pegs along anteroapical margin, with robust, usually elongate spur; tarsi usually with 5, less commonly with 4, tarsomeres; mesotarsus usually with pegs in various patterns along ventral or anteroventral surfaces of tarsomeres; metasoma with cercus advanced anteriorly, usually distinctly so, and then apical tergum large, triangular or U-shaped and/or with one or more terga M-like between and around cerci.

Encyrtidae is one of the most important Chalcidoid families for biological control. Species are endoparasitoids, mostly of Coccoidae (Homoptera), but also of the eggs or larvae of Coleoptera, Diptera, Lepidoptera, Hymenoptera, Neuroptera, Orthoptera, Hemiptera and Arachnida. One tribe, Copidosomatini, whose members are primary parasitoids of Lepidoptera, has an unusual process of multiplication of specimens from one egg within the host larva. The egg in this polyembryonic type of development divides into an irregularly branched chain of cells, each of which becomes a separate embryo. The resulting endoparasitic larvae consume the host larva and pupate within its swollen and distorted skin, with the emerging adults being all of one sex, unless more than one egg was deposited initially [10] [35] [36] [37] [38] [39] [40] [41].

Figure 4. Encyrtidae; has a body size of 2 mm, yellow, has two pairs of wings, antenna type *Agre*

Platygastridae

The body length is generally 1-2 mm to 4 mm, usually slender, usually black, rarely yellowish, without metallic colors. Antenna strongly elbowed, usually with 8 flagellomeres, rarely with fewer (5-7); male flagellomere 2 (rarely 1) modified; fore wing usually veinless or if submarginal vein developed then only very rarely reaching anterior margin of wing, the stigmal and postmarginal veins absent; hind wing at most with short stub of submarginal vein; metasomal segment 2 always the longest and widest; female almost always with only 6 apparent tergits, exceptionally fewer; metasomal tergum 7 (apical tergum) internal, considerably reduced and depigmented, without cerci or sensory plates, hidden under tergum 6 and not extruded with ovipositor.

Some Platygastidae are primarily solitary parasitoids in eggs of various insects (Coleoptera, Homoptera) or they parasitize egg-like hosts such as young larvae of Coccoidae or Aleyrodidae (Homoptera); the entire development is completed in one stage of the hosts (idiobionts). However, most Platygastridae are koinobionts, parasitizing the host egg (usually gall-forming Cecidomyiidae) but developing only after the host is nearly full grown (prepupa or pupa). Some of these species are polyembryonic with two or more individuals developing from one fertilized egg [10] [42] [43] [44] [45].

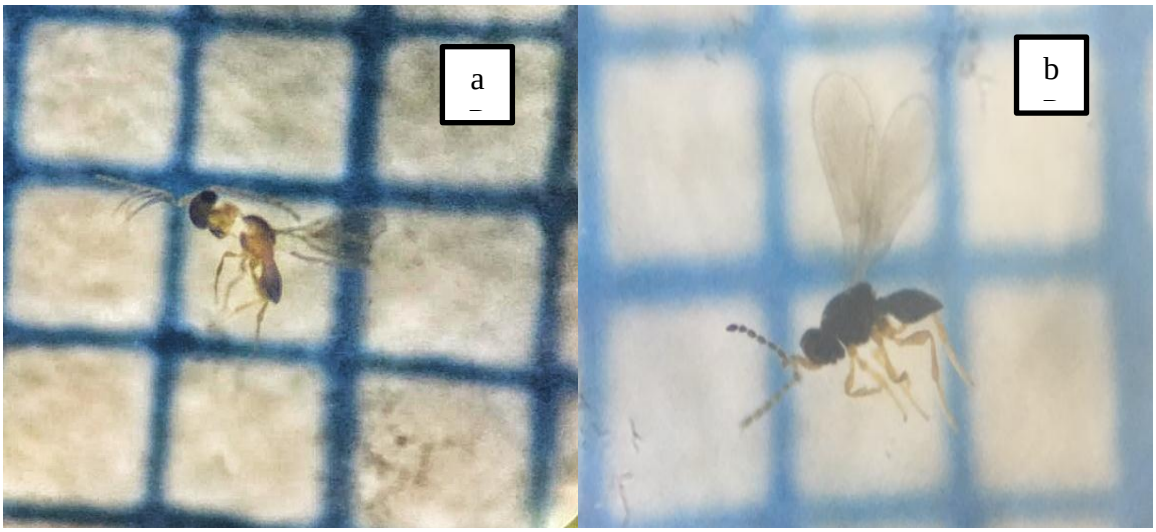

Figure 5. Platygastridae; Platygastridae 01: two pairs of wings, beige body, body size 1 mm, black abdomen (a), Platygastridae 02: have 1 mm body size, black, have two pairs of wings, abdomen bouncy (b)

3.4 Diversity Index

The results of the analysis of the diversity index of whitefly in the lowlands of West Sumatra according to Shannon Winner were classified as low, ie 1, 065 in the lowlands. It due to by the small number of whitefly species (2 species) found. The height of the place at a location affected the temperature that was suitable for the development of certain whitefly. Another study reported that the diversity of insects at an altitude of 1100 m above sea level was lower than the diversity of insects on plains less than 1000 m asl [46]. The evenness index of whitefly species in the lowlands of West Sumatra was relatively high (0, 969, close to 1) which was thought to have relatively more stable environmental conditions, meaning that no species dominated at each location. It due to each location had a different environmental condition that affected the stability of the environment and population. Another study reported that high and low evenness was correlated to the stability of environmental and population factors. There was an association between diversity index and evenness of whitefly in each location, where if diversity was high then evenness was high [47].

Parameter	Lowland
Number of Species (S)	2
Number of individuals (N)	3697
Species diversity (H')	1, 065
Species evenness (E)	0, 969

Table 1:-Index of whitefly infestation in the lowlands of West Sumatra

Conclusions and Suggestions:-

The results showed that there were 2 species *Aluerocanthus woglumi* and *Bemisia tabaci* found in fruit plants in the lowlands of West Sumatra. (2) There were 4 species of whitefly parasitoid found in the lowlands of West Sumatra, Encarsi (Aphelinidae), Encyrtidae, Platygastridae. (3) Diversity index of whitefly in the lowlands of West Sumatra was 1, 065 and its evenness index 0, 969. Further research is reqiured to analyse thr effectiveness the parasitoid biology as a biological agent as an environmentally friendly control in West Sumatra.

References:-

1. Wills, R.B.H., W.B. Wc Glasson. D. Graham, T.H. Lee, E.G. Hall. 1989. Postharvest An Introduction to the Physiology and Handling of Fruits and Vegetables. A VI Publ., Connecticut.
2. Aked, J. 2000. Fruits and Vegetables, in Kilcast. K and Subramaniam, P (Eds.): The Stability and Shelf - life of Food, CRC Press.
3. Watson GW. 2007. Identification of whiteflies (Hemiptera: Aleyrodidae). APEC Re-entry Workshop on Whiteflies and Mealybugs, Kuala Lumpur, Malaysia, 2007 Apr 16-26. Institute of Biological Sciences, University Malaya.
4. Hill DS. 1987. Agricultural Insect Pest of the Tropics and their Control Cambridge (UK): Cambridge University Press.
5. Nurtjahyani SD, Yusriadi & Murtini I. 2015. Karakteristik Tanaman Cabai yang Terserang Hama Kutu Kebul (*Bemisia tabaci*). Universitas PGRI Ronggolawe. Tuban.
6. Setiawati, W. & B. K. Udiarto. 2005. Pengelolaan Tanaman Terpadu pada Tanaman Cabai Merah dalam Upaya Mengatasi Serangan Penyakit Virus Kuning. Makalah disampaikan pada Pertemuan Apresiasi Penerapan Penganggulangan Virus Cabai, Yogyakarta, 14-15 April 2005. 16 Hl.
7. Nurulaila L. 2012. Keanekaragaman Spesies dan Kunci Identifikasi Kutu Kebul (Hemiptera : Aleyrodidae) pada Tanaman Pertanian di Jawa Barat. Sekolah Pascasarjana Institut Pertanian Bogor. [Tesis].
8. Ramlan, Nurjanani, Sjafaruddin, M. 2010. Kajian teknologi pengelolaan hama kopi arabika Ramah lingkungan. Balai Pengkajian Teknologi Pertanian Sulawesi Selatan. Prosiding Seminar Ilmiah dan Pertemuan Tahunan PEI dan PFI XX Komisariat Daerah Sulawesi Selatan, 27 Mei 2010.
9. Martin, J.H. 1987. An identification guide to common whitefly pest species of the world (Homoptera, Aleyrodidae). Tropical Pest Management, 33 (4): 298-322.
10. Goult H & Huber JT. 1993. Hymenoptera of the world: An identification guide to families. Crntre for Land and Biological Resources Research Ottawa, Ontario. Research Branch Agriculture Canada Publication 1894/E.
11. Krebs, C.J. 2000. Program for ecological methodology (Software). Second Edition. New York: An imprint of Addison Wesley Longman, Icn.
12. Fachrul, M.F. 2007. Metode sampling bioekologi. Jakarta: Bumi Aksara.

13. Simala M & Masten Milek T. 2013. First record of the orange spiny whitefly, Aleurocanthus spiniferus Quaintance, 1903 (Hymenoptera : Aleyrodidae) in Crotaria. Abstract Volume of 11. Slovenian Conference on Plant Protection with International Participation (And the round table of risks reduction in Phyto-Pharmaceutical Products use in the frame of Crosustain Project), Bled, Slovenia, 5-6,3.2013, 354-358.
14. Sudiono & Yasin. 2006. Karakterisasi Kutu Kebul (*Bemisia tabaci*) sebagai Vektor Virus Gemini dengan Teknik PCR-RAPD. Jurnal HPT Tropika. 6(2):13-119.
15. Tayyib, M. M. M. Jawwad Yousuf, M Akbar, M Mukhtar and Ahmad Saeed Khan. 2014. Genus *Aleurocanthus* (HOMOPTERA : ALEYRODIDAE) with two new records from Pakistan. Di dalam APEC Reentry Workshop on Whiteflies and Mealybugs (Kuala Lumpur, December 2007). Kuala Lumpur: Institute of Biological Sciences, University Malaya.
16. Howard B, Howard Bell, Maureen Wakefield, Roy Macarthur, Jonathan Stein, Debbie Collins, Andy Hart, Alain Roques, Sylvie Augustin, Annie Yart, Christelle Pere, Gritta Schrader, Claudia Wendt, Andrea Battisti, Massimo Faccoli, Lorenzo Marini, Edoardo Petrucco Toffolo. 2013. A Review of the Literature Relevant to the Monitoring of Regulated Plant Health Pests in Europe. Di dalam APEC Reentry Workshop on Whiteflies and Mealybugs (Kuala Lumpur, December 2007). Kuala Lumpur: Institute of Biological Sciences, University Malaya.
17. Martin, J.H. 1996. Neotropical whiteflies of the subfamily Aleurodicinae established in the western Palaearctic (Homoptera: Aleyrodidae). Journal of Natural History, 30: 1849-1859.
18. [18] EPPO ((European and Mediterranean Plant Protection Organization)/CABI 1997. *Aleurocanthus spiniferus.* In Quarantine Pests for Europe, 2nd ed., CAB International, Wallingford: 21-24.
19. [19] Kanmiya K, Ueda S, Kasai A, Yamashita K, Sato Y and Yoshiyasu Y, 2011. Proposal of new specific status for teainfesting populations of the nominal citrus spiny whitefly Aleurocanthus spiniferus (Homoptera: Aleyrodiadae). Zootaxa, 2797, 25–44.
20. David BV, 2012. The Whitefly or Mealywing bugs. Biology, Host Specificity and Management. Lambert Academic Publishing.
21. EPPO (European and Mediterranean Plant Protection Organization), 2017. PQR database. Paris, France: European and Mediterranean Plant Protection Organization.
22. Steinberg B & Dowell RV, 1980. Suitability of native or naturalized plants as long-term hosts of the citrus blackfly. Annals of the Entomological Society of America, 73, 662–664.
23. Oliveira, M.R.V., T.J. Henneberry, & P. Anderson. 2001. History, current status, and collaborative research project for *Bemisia tabaci*. J. Crop Protection 20 (9) : 709-723.
24. Sharma SS and Batra GR. "Whitefly outbreak and failure of insecticides in its control in Haryana state: a note". Haryana Journal of Horticultural Sciences 24.2 (1995): 160-161.
25. Palaniswami MS., et al. "Sweet potato whitefly Bemisia stabaci: ecobiology, host interaction and natural enemies". Entomon 26 (2001): 256-262.
26. Compere, H. 1947. A new genus and species, *Eurymyiocnema aphelinidae* (Hymenoptera, Aphelinidae) and a history of the genera *Euryischia* Riley and *Myiocnema* Ashmead. Bulletin of Entomological Research 38(3):381-388.
27. Hayat, M. 1983. The genera of Aphelinidae (Hymenoptera) of the world. Systematic Entomology 8(1):63-102.
28. Hayat, M., and M. Verma. 1980. The aphelinid subfamily Eriaporinae (Hym: Chalcidoidae). Oriental Insects 14(1):29-40.
29. Jasnosh, VA. 1976. Classification of parasitic Hymenoptera of the family Aphelinidae (Chalcidoidae). Entomologicheskoe Obozrenie 55(1):159-168. [In Russian] [English translation: Entomological Review 55(1):114-120.
30. Jasnosh, VA. 1979. Host-parasite relations in the family Aphelinidae (Hymenoptera, Chalcidoidae). Entomologicheskoe Obozrenie 58(4):751-761. [In Russian] [English translation: Entomological Review (1980) 58(4):61-70].
31. Jasnosh, VA. 1983. A review of the aphelinid genera (Hymenoptera, Aphelinidae) of the world. I. A key to the genera. Entomologichesskoe Obozrenie 62(1):157-171. [In Russian] [English translation: Entomological Review 62(1):145-159].
32. Rosen, D., and P.Debach. 1979. Species of *Aphytis* of the world (Hymenoptera: Aphelinidae). Junk, The Hague, The Netherlands. Ix + 801 pp.
33. Shafee, S.A. 1975. A new family of Chalcidoidae (Insecta: Hymenoptera). Records of the Zoological Survey of India 68:21-31.
34. Ferriere, Ch. 1965. Hymenoptera: Aphelinidae d'Europe et du Bassin Mediterraneen. Masson. Paris, France. 206 pp.

35. Noyes, J.S. 1988. Encyrtidae (Insecta: Hymenoptera). Fauna of New Zeland No. 13. 188 pp.
36. Prinsloo, G.L., and D.P. Annecke. 1979. A key to the genera of Encyrtidae from the Eithopian region, with descriptions of three new genera (Hymenoptera: Chalcidoidae). Journal of the Entomological Society of Southern Africa 42(2):349-382.
37. Tachikawa, T. 1963. Revisional studies on the Encyrtidae of Japan (Hymenoptera: Calcidoidae). Memoirs of the Ehime University, Section VI (Agriculture) 9(1):1-264.
38. Tachikawa, T. 1981. Hosts of Encyrtid genera in the world (Hymenoptera: Chalcidoidae). Memoirs of the College of Agriculture, Ehime University 25(2):85-110.
39. Trjapitzin, V.A. 1971. Review of genera of Palaearctic encyrtids (Hymenoptera, Encyrtidae). Akademiia Nauk SSSR, Parasiticheskie Nasekomye-entomofagi, Trudy Vsesoyuznogo entomologicheskogo Obshchestva, Izdatel'stvo "Nauka", Leningradskoe Otdelenie, Leningrad 54:68-155. [In Russian].
40. Trjapitzin, V.A. 1977. The characteristics features of the morfhology of adult encyrtids (Hymenoptera, Chalcidoidae, Encyrtidae) and their systematic significance. Akademiia Nauk SSSR, Paraziticheskie Nasekomye-entomofagi, Trudy Vsesoyuznogo entomologicheskogo Obshchestva, Izdatel'stvo "Nauka", Leningradskoe Otdelenie, Leningrad 58:145-199.[In Russian].
41. Trjapitzin, V.A. 1989. Parasitic Hymenoptera of the Family Encyrtidae of the Palaearctics. Akademiia Nauk SSSR, Leningrad, USSR. 487 pp. [In Russian].
42. Goult H & Huber JT. 1993. Hymenoptera of the world: An identification guide to families. Crntre for Land and Biological Resources Research Ottawa, Ontario. Research Branch Agriculture Canada Publication 1894/E.
43. Masner, L & L. Huggert. 1989. Word review and keys to genera of the subfamily Inostemmatinae with reassignment of the taxa to the Platygastridae and Sceliotrachelinae (Hymenoptera: Platygastridae). Memoirs of the Entomological Society of Canada No. 147. 214 pp.
44. Vlug, HJ.1985. The types of Platygastridae (Hymenoptera, Scelionoidae) described by Haliday and Walker and preserved in the National Museum of Ireland and in the British Museum (Natural History). 2. Keys to species, redescriptions, synonymy. Tijdschrift voor Entomologie 127: 179-224.
45. Kozlov, MA. 1987. Superfamily Proctotrupoidae (Proctotrupoids). Pages 983-1212 in Medvedev, G.S., ed. Keys to the insects of the European part of the USSR, Volume III, Part 2. Amerind, New Delhi, India. 1341 pp.
46. Idris AB, Nor SM, Rohaida R. 2002. Study on diversity of insect communities at different altitudes of Gunung Nuang in Selangor, Malaysia. *J of Biological Sciences* [internet], [diunduh 2018 Apr 20]; 2(7):505-507. Tersedia pada: http://docsdrive.com/pdfs/ansinet/jbs/2002/505-507.pdf.
47. Jamili, A & Hayanto, H. 2014. Keanekaragaman dan parasitisasi parasitoid telur Leptocorisa acuta pada berbagai pola tanam padi. J. Agrotrop 4(2): 112-118.