alonia_nigronervosa_Coquerel_on_various_Zingiberaceous_crops.pdf

by Suparman Suparman

Submission date: 08-Feb-2023 09:12PM (UTC+0700)
Submission ID: 2009296256
File name: alonia_nigronervosa_Coquerel_on_various_Zingiberaceous_crops.pdf (1.03M)
Word count: 6591
Character count: 30979

BIOVALENTIA: BIOLOGICAL RESEARCH JOURNAL
e-ISSN: 2477-1392
Vol. 8 No. 2, Nov 2022

Biology of *Pentalonia nigronervosa* Coquerel on various Zingiberaceous crops

Riski Anwar Efendi[1]*, Suparman SHK[2], Harman Hamidson[2]

[1] *Ilmu Tanaman, Faculty of Agriculture, Sriwijaya University, Palembang, Sumatera Selatan 30139, Indonesia*
[2] *Departemen Hama dan Penyakit Tumbuhan, Faculty of Agriculture, Sriwijaya University, Indralaya, Sumatera Selatan 30662, Indonesia Road Palembang-Prabumulih KM 32 Indralaya, Ogan Ilir, Sumatera Selatan, Indonesia Fax.0711-580663*

*Corresponding author

E-mail address: riskiefendi44@gmail.com (Riski Anwar Efendi)
Peer review under responsibility of Biology Department Sriwijaya University

Abstract

Pentalonia nigronervosa *Coquerel (Hemiptera; Aphididae) is the main vector of banana bunchy top disease caused by Banana Bunchy Top Virus (BBTV). The disease is an important and most damaging disease to the crop because infected bananas fail to produce fruits. As the vector of BBTV, P. nigronervosa is able to lives not only on banana plants but also on others plants, especially those belong to Family Zingiberaceae. The objective of this research was to reveal the biology of* P. nigronervosa *on banana and other plant species belong to Family Zingiberaceae commonly found around banana cultivation areas. The research was conducted in the Laboratory of Entomology, Department of Plant Protection, Faculty of Agriculture, Sriwijaya University from June to December 2021. The research was an experimental research arranged in a Completely Randomized Design using plant species as treatment and was replicated 10 times of replications. Young suckers of banana and zingiberaceous plants were used to rear the banana aphid where all biological aspects of the aphid were observed.* P. nigronervosa *and the young suckers were placed in a transparent pot covered with transparent plastic with a window made from cheese cloth to facilitate air movement. Room temperature was set to approximately 25oC since the aphid grow and reproduce well under such temperature. The results showed that* P. nigronervosa *are able to live and reproduce not only on banana but also on seven species of Zingiberaceous plants with little variation of some morphological and biological parameters. The significant different was found between biological characteristics of the aphid lived on torch ginger and cardamom which had longer life cycle but smaller fecundity compared to other experimental hosts used in the research.*

Keywords: P. nigronervosa*, bunchy top virus, zingiberaceous plant*

Received: May 21, 2022, Accepted: July 7, 2022

1. Introduction

Pentalonia nigronervosa Coquerel (Hemiptera; Aphididae) is the only vector of banana bunchy top disease (BBTD) caused by *Banana Bunchy Top Virus* (BBTV) [1]. The disease is reported to be the most damaging to banana crops since the infected banana produces no fruit and the disease spreads very quickly from plant to another. The disease has been reported to infect banana almost in all banana producing countries, both in tropical and sub-tropical areas [2]. The aphid likes to stay in difficult places of their host such as lower parts of the host or underneath of leaf sheath. They prefer to occupy safe places where they can build mutualistic association with ants. The ants feed on honey dew exerted by the aphid and the aphid get protection from the ant especially from predatory insects [3]. Instead of living on banana, *P. nigronervosa* are also frequently found living on various plant species belong to Family Zingiberaceae [4].

P. nigronervosa living on tropical areas reproduce parthenogenetically, all adult are female and nymphs produced by those female are also female [4] Instead of reproduce parthenogenetically, the aphid living under subtropical climate reproduced sexually for which male and female copulate to produce eggs. The eggs are ready to dormant during winter and hatched in spring to continue their life cycle.

Life cycle of *P. nigronervosa* on its main host consist of four nymphal instars and adult phase. The period of each instar of their nymph spend 2 to 3 days before molting to their next instar. Each instar also has different colors. All nymphal instars and adult were reported to be able to transmit BBTV from infected to healthy banana plants.

Banana bunchy top virus is transmitted by *P. nigronervosa* in persistent manner. The virus is sucked and circulated in the vector through digestion organs and hemo-

coel before finally the virus particles reach saliva gland from which the virus particles are released to healthy plant when the vector visit healthy banana and suck plant liquid from its phloem. Saliva containing virus particles is used by the vector to lubricate their stylet before piercing the host tissue with which the vector bring the virus particles into the host [5].

The fast spread of BBTV and the ability of the virus to present in the vector for long time [6] has made the virus very dangerous to banana plantation. The optimal temperature for the virus to spread and infect banana is approximately 25°C [7]. Banana infected by BBTV shows very specific and obvious symptoms. The plant is stunted with narrow and erect leaves making the plant look bunchy and the disease called banana bunchy top. Under advanced infection, the leaves margins turn to yellow necrotic lesions appear along the margins [8]. The existence of plants on which *P. nigronervosa* can alternatively live and reproduce would make the control of the aphid even more difficult since such plants have similar growing condition to those of banana and grow well surrounding banana cultivation.

Even though there are reports on the ability of *P. nigronervosa* to live and reproduce on zingiberaceous plants, there has been no report on the biology of the aphid on various species of zingiberaceous plants, especially on those grow surrounding banana such as torch ginger, cardamom, galangal, ginger, turmeric, Javanese turmeric, and Chinese ginger.

2. Materials and Methods

The research was an experiment conducted in Laboratory of Entomology, Department of Plant Protection, Faculty of Agriculture, Sriwijaya University, Indonesia from June to December 2021. The experiment was arranged in a Completely Randomized Design with 8 treatments and 10 replications. The treatment was host plant species consisted of 1 banana species and 7 Zingiberaceous plant species.

The zingiberaceous species were: torch ginger (*Etlingera elatior* (Jack) R.M.Sm), cardamom (*Amomum compactum* Sol. Ex Mato), galangal (*Alpinia galanga* L, Swart), Javanese turmeric (*Curcuma xanthor-rhiza* Roxb), ginger (*Zingiber officinale* var. Rubrum), turmeric (*Curcuma domestica* Val) and Chinese turmeric (*Boesenbergia rotunda* (Linn) Mansf).

All plants used in the experiment were collected from farmer field from which only healthy plants were selected. Banana aphids used in the experiment were also collected from farmer field and taken only from infested healthy banana to make sure that all aphid reared for the experiment were not viruliverous.

2.1 Preparation of alternative host plant species

Putri cultivar of banana and 7 Zingiberaceous plant species were planted in 30 cm diameter polybag filled with soil and organic manure at 1:1 composition. All polybags were placed in shaded house until produced enough uniform suckers for bio-assay experiment of *P. nigronervosa* in various host plant species

Number of suckers of each host plant species was 10 as to facilitate 10 replications.

2.2 Preparation of Banana aphids

Banana aphid *P. nigronervosa* was derived from healthy banana plant belong to farmer in Ogan Ilir Regency. The aphid was then reared using healthy banana suckers in a room set to have 25°C temperature. The banana suckers were covered with clear plastic cylinder with cheese cloth at the top to facilitate air movement.

After reaching enough number of aphids, the next rearing was conducted using Zingiberaceous plant species used in the experiment. The aphid rearing in Zingiberaceous plants was continued until enough imagoes were produced in each plant species. Ten imagoes were then picked from each plant and moved to the same plant species to produce their first progeny. One of first instar progeny was placed in a sucker of the same plant species for biological assay and this work was repeated 10 times.

2.3 Biological assay of *Pentalonia nigronervosa* on various alternative host

Each of 8 suckers of alternative host plants, one banana cultivar and 7 Zingiberacous species, was planted in a pot covered with plastic cylinder with cheesecloth on the top for aeration. Ten pots were prepared for each plant species as replications.

The newly borne first instar of *P. nigronervosa* was transferred to the appropriate sucker by using the tip of wetted small paint brush to avoid the damage of its stylet. After being transferred, attention was given to guarantee that the young aphid was alive before the pot being covered using plastic cylinder.

Observations of morphological and biological characteristics of the aphid were conducted daily since the transfer day until the death of the aphid. Observation was made to characterize each nymph instar of *P. nigronervosa* lived on each experimental plants. Morphological data collected included color, shape and size of the aphid nymphs, while biological included longevity of each nymph instar, life cycle, reproductive period, fecundity and lifespan of the aphid.

The measurement of body size of the aphid was conducted using application of Millimeter-Screen Ruler Version 2.3.0 after being calibrated. The longevity of each in-

star was measured as the period between moltings, except for first instar which was measured as the period from nymph delivery until the first molting [4].

Each observation and measurement were conducted carefully to prevent the aphids from being stressed and to guarantee that the aphid could grow normally and naturally. In case an aphid died for whatever reason, the dead aphid was replaced with newly born aphid and the observation was repeated from the beginning.

To count the number of aphid progenies, each newly born aphid was transferred to other sucker of the same plant species to support the observation and measurement of the aphid morphology and biology, and for photographic necessity.

2.4 Data Analysis

All collected data was analyzed by using program application named RStudio.

3. Results and Discussion

The results of morphological and biological characteristics of banana aphid *P. nigronervosa* on 8 alternative host plant species showed that the aphid could live and reproduced on all of experimental plants. The growth and development of the aphid population were different among the host plant species. *P. nigronervosa* might be interested in Zingiberaceous plants because of flower's color since Zingiberaceous plant tend to have yellow, red or purple color which are attractive to insect. According to [9], aphid were interested to plant color since plant color reflects the nutritional value of the plant. Furthermore, the interest of aphid to specific color of plants might be manipulated to prevent aphid infestation to cultivated crop by using colorful plant as barriers or trap crop for the aphid [10].

The color of *P. nigronervosa* lived on several different host plants were relatively similar i.e. greenish brown, except those lived on cardamom which showed slightly transparent yellowish color, and those living on Putri banana which showed yellow color of their second instar (Table 1; Figure 1-8). Different color of aphid lived on different host plants has been reported by [11] who observe the aphid on Araceous and Zingiberaceous plants. However, the transparent greenish color of the first instar of the aphid lived on banana sucker was different from the report of [12] who reported that the color of the first instar of *P. nigronervosa* lived on banana sucker was reddish brown. The color difference occurred might be due to different content of phloem liquids from where the liquids was sucked by the aphid. According to [13], the biological different amongst *P. nigronervosa* could be caused by different host and agro ecological conditions. In this research, the environ-mental condition in the place where the research conducted was set to have room temperature of 25°C to facilitate the optimum growth of the aphid since the aphid needs such temperature for its optimal growth [14]. Different results could also be caused by different temperature and humidity between this research and previous researches conducted in other areas.

Number of instar of *P. nigronervosa* living on different host species was not significantly different, 4 instars of nymph and 1 stadia of imago. This result was same as those reported by previous researchers who found 4 instars of nymph and 1 phase of imago [1][12][15]. Furthermore, even though the number of nymph instars was similar, the longevity of each nymph instar and imago were different from those reported by previous researchers who conducted researches on alternative host without banana.

Rajan [12] reported that *P. nigronervosa* living on cardamom had 4 instars with longevity of instar period ranged from 10 to 15 days without specification of the longevity of each instar, and the life span of its imagoes ranged from 8 to 26 days. He also reported that the average fecundity of the imago living on cardamom was 14 per imago. On the other hand, Padmalatha and Ranjit Singh [16] reported that nymph period of *P. nigronervosa* on banana leaf cuttings ranged from 8 to 11 days and imago lifespan was 11-12 days with fecundity 22 progenies per female imago.

The life of *P. nigronervosa* on various species of Zingiberaceous plants was different shown by different morphology such as body size and color and biology such as life cycle, reproductive period and fecundity. This findings was in accordance to the report by [17] that host plant quality could manipulate aphid biology which finally affected the efficiency of virus transmission, both for persistent and non-persistent virus.

Result of observation of *P. nigronervosa* morphology on Javanese turmeric showed that the color of the first nymph instar was transparent green, pear-shaped body with 0.64 mm length (Table 2) and 0.31 mm width (Table 3) and had 4 segments of antennae with an average length of 0.41 mm (Table 4), second instar was brown, pear-shaped with 0.76 mm length and 0.42 mm width and had 4 segments of antennae with an average length of 0.70 mm. The third nymph instar was reddish brown in color, pear-shaped body at 1.03 mm length and 0.73 mm width and had 5 segments antennae at 1.05 mm length. Fourth instar was dark brown in color, pear-shaped body with average body length of 1.19 mm (Table 2), and 0.84 mm of average body width (Table 3), had 6 segment of antennae with length of 1.25 mm on average, and had black color in their tibia (Table 4) (Figurer 1).

P. nigronervosa was able to live and develop on Javanese turmeric since the aphid was reported to have preference to Zingiberaceous plants, even though no report has been published on the preference of the aphid to Javanese turmeric [1]. However, the aphid was found naturally infest Javanese turmeric, especially on the cigar leaf of the plant.

Table 1. Colors of *Pentalonia nigronervosa* instars living on 8 different host plant species

Plant common name	Instar color			
	1	2	3	4
Torch ginger	green	Dark brown	Reddish brown	Dark brown
Javanese turmeric	Transparent green	brown	Reddish brown	Dark brown
galangal	green	Reddish brown	Dark brown	Dark brown
Chinese turmeric	green	Dark brown	Reddish brown	Dark brown
cardamom	Transparent yellow	Reddish brown	Reddish brown	Dark brown
turmeric	green	Reddish brown	Reddish brown	Reddish brown
Ginger	green	Reddish brown	Reddish brown	Reddish brown
Banana	green,	Pale yellow	Reddish brown	Reddish brown

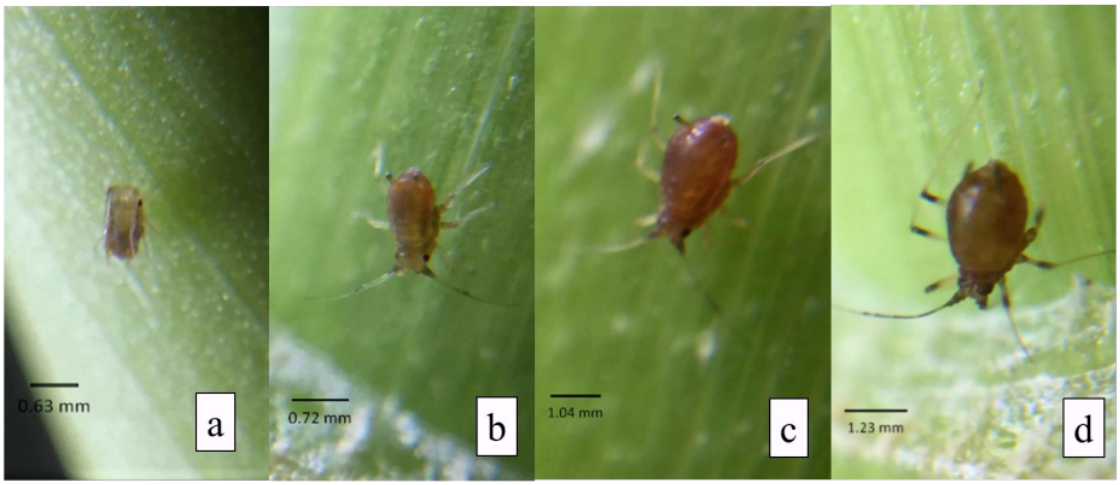

Figure 1. *Pentalonia nigronervosa lived on* Javanese turmeric: a. instar 1, b. instar 2, c. instar 3, d. instar 4

The first instar of *P. nigronervosa* lived on galangal was greenish in color, pear-shaped body with average length 0.75 mm and width 0.59 mm and had 4 segments of antennae with average length of 0.68 mm. The second instar was reddish brown in color, pear-shaped body with average length 0.99 mm and width 0.68 mm and had 4 segment antennae of 0.98 mm length. The third instar was dark brown in color, pear-shaped body with average length 1.10 mm and width 0.72 mm and had 5 segment antennae with average length 1.05 mm. The fourth instar was dark brown in color, pear-shaped body with average length 1.40 mm and width 0.80 mm and had 6 segment antennae with average length 1.47 mm and had black color on their tibia (Table 2, 3 and 4) (Figure 2).

P. nigronervosa could successfully live on galangal with morphometric similar to the morphometric of those lived on banana. This was in accordance with the finding by [18] who reported that the aphid was frequently found infesting *Alpinia* spp. as its alternative host.

First instar nymph of *P. nigronervosa* lived on Chinese turmeric was greenish in color, pear-shaped body with length 0.61 mm and width 0.38 mm and had 4 segment antennae at 0.57 mm length on average. Second instar was dark brown in color, pear-shaped body with average length 0.87 mm and width 0.44 mm, and had 4 segment antennae at 0.90 mm length on average. Third instar was reddish brown in color, average body length 1.06 mm and width 0.61 mm, and had 5 segment antennae at 1.11 mm length on average. Fourth instar was dark brown in color, average body length 1.23 mm and width 0.75 mm, and had 6 segment antennae at 1.33 mm length on average. Specific black color appeared on tibia (Table 3, 3, 4) (Figure 3).

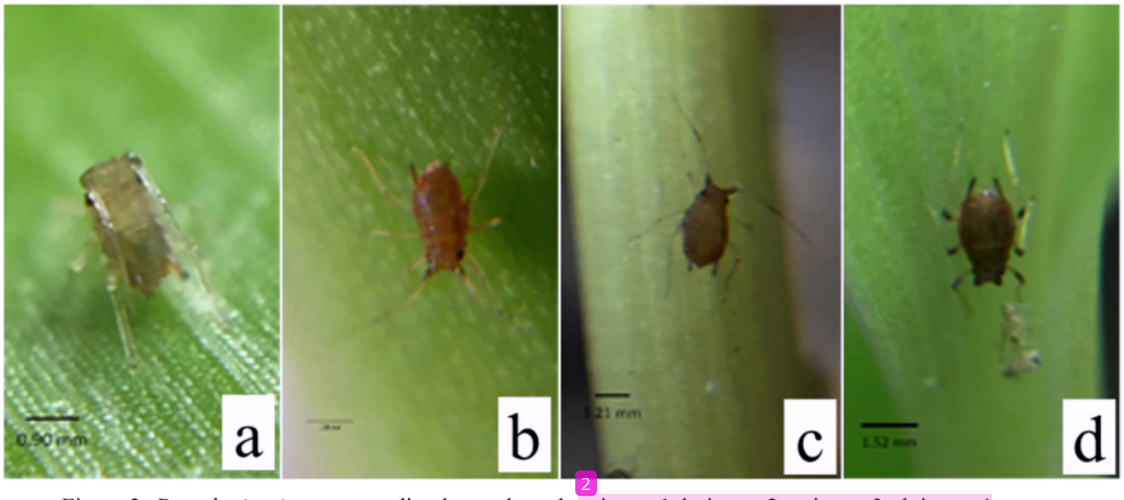

Figure 2. *Pentalonia nigronervosa* lived on galangal: a. instar 1, b. instar 2, c. instar 3, d. instar 4

Chinese turmeric has never been reported as one of alternative host of *P. nigronervosa*. In this research, the banana aphid could live and breed on it with morphology and biology similar to those lived on other Zingiberaceous plants. It seems that all plant of the family suitable for the aphid. According to [19], the host plants of *P. nigronervosa* are Araceae, Musaceae, Zingiberaceae.

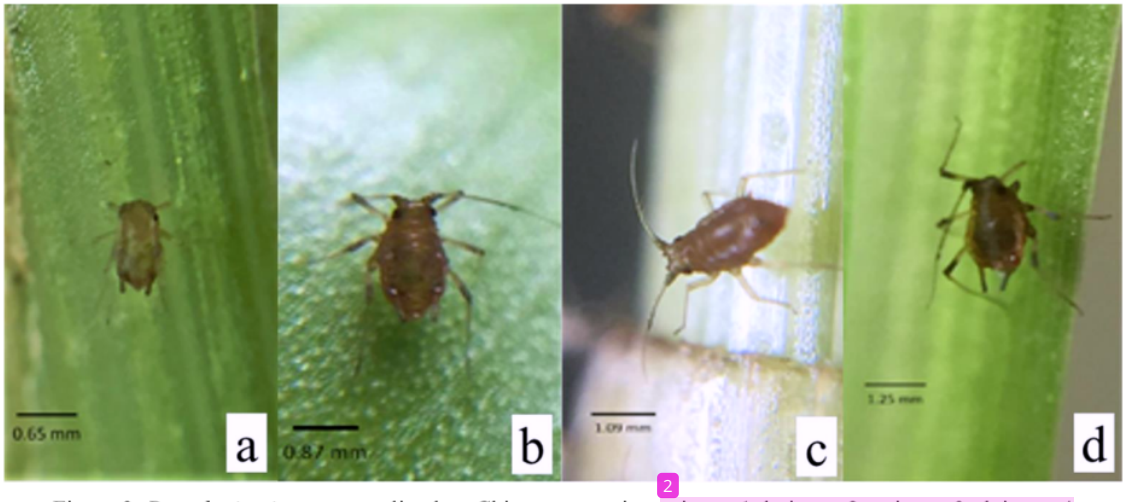

Figure 3. *Pentalonia nigronervosa* lived on Chinese turmeric: a. instar 1, b. instar 2, c. instar 3, d. instar 4

First instar nymph of *P. nigronervosa* lived on cardamom was transparent yellow in color, pear-shaped body with average length 0.65 mm and width 0.30 mm, and had 4 segment antennae at 0.63 mm length on average. Second instar was reddish brown in color, pear-shaped body with average body length 0.81 mm and body width 0.46 mm, and had 4 segment antennae at 0.83 mm length on average. Third instar was reddish brown in color, pear-shaped body with average length 1.00 mm and width 0.56 mm, and had 5 segment antennae at 1.05 mm on average. Fourth instar was dark brown in color, oval shape with average body length 1.23 mm body width 0.72 mm. The nymphs had 6 segment antennae at 1.32 mm on averageand black color appeared on tibia (Table 2, 3, 4) (Figure 4).

Cardamom has been reported as an alternative host of *P. nigronervosa* and the aphid naturally lived on the plant and transmitted viral disease called Katte and mosaic disease to the plant [20].

First instar nymphs of *P. nigronervosa* lived on

torch ginger was greenish in color, pear-shaped body with average length 0.67 mm and width 0.36 mm. The nymphs had had 4 segment antennae at 0.63 mm length on average. Second instar was brown in color, pear-shaped body with average length 0.88 mm and width 0.46 mm, and had 4 segment antennae at 0.88 mm on average. Third instar was reddish brown in color, pear-shaped body with average length 1.07 mm and width 0.57 mm, and had 5 segment antennae at 1.10 mm on average. Fourth instar was dark brown in color, pear-shaped body with average length 1.23 mm and width 0.77 mm. The nymphs had 6 segment antennae at 1.31 mm length on average and specific black color appeared on their tibia (Table 2, 3, 4) (Figure 5).

Figure 4. *Pentalonia nigronervosa* live on cardamom: a. instar 1, b. instar 2, c. instar 3, d. instar 4

Torch ginger is one of Zingiberaceous plant species physically harder and taller than other species of the same family. However, young shoots and flowers are quite soft and suitable for aphid to suck liquid sap from the plant. In this research, we found that *P. nigronervosa* was able to live and develop but with slightly different morphological and biological characteristics compared to those lived on banana and other plants. The variation in morphology and biology among aphid lived on different host was common since different plant species might contain different nutritional value which might result in different life quality for the insects live on them, as reported by [21] who studied morphometric of *P. nigronervosa* on various host plant species.

Figure 5. *Pentalonia nigronervosa* lived on torch ginger: a. instar 1, b. instar 2, c. instar 3, d. instar 4

First instar nymph of *P. nigronervosa* lived on turmeric was greenish in color, pear-shaped body with average length 0.65 mm and width 0.33 mm, and had 4 segment antennae at 0.61 mm length on average. Second instar was reddish brown in color, pear-shaped body with average length 0.86 mm and width 0.49 mm, and had 4 segment antennae at 0.87 mm length on average. Third instar was reddish brown in color, pear-shaped body with average length 1.07 mm and width 0.64 mm, and had 5 segment antennae at 1.12 mm length on average. Fourth instar was reddish brown in color, pear-shaped body with average length 1.25 mm and width 0.88 mm. The nymphs at this stage had 6 segment antennae at 1.32 mm length on average and specific black color appeared on tibia (Table 2, 3, 4) (Figure 6).

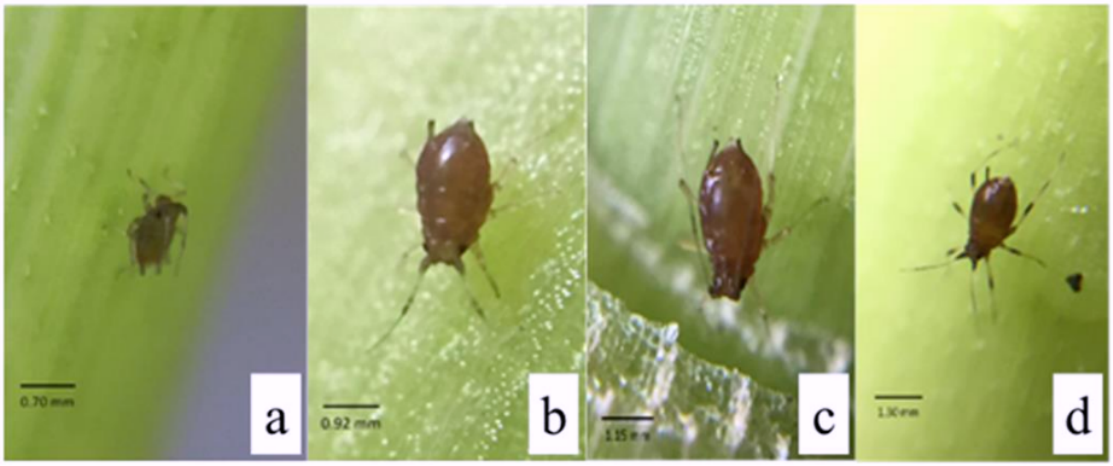

Figure 6. *Pentalonia nigronervosa* lived on turmeric: a. instar 1, b. instar 2, c. instar 3, d. instar 4

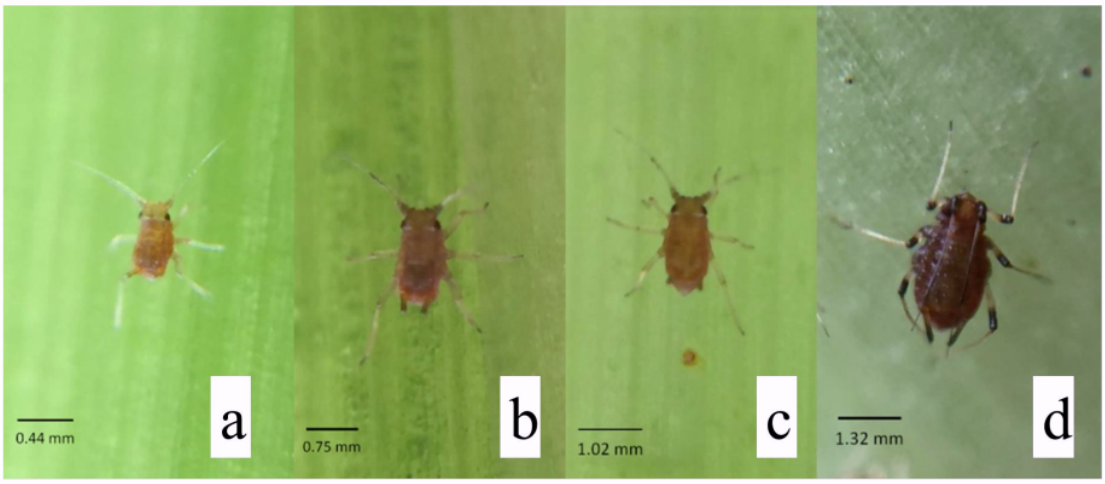

Figure 7. *Pentalonia nigronervosa* lived on ginger: a. instar 1, b. instar 2, c. instar 3, d. instar 4

Pentalonia spp has been reported to infest turmeric even though *P. caladii* was common to be found in turmeric than *P. nigronervosa* [21]. In this, research, banana aphid *P. nigronervosa* could live and develop on turmeric but under isolated place where there was no other plants as alternative hosts. Under natural condition, the aphid was rarely found on turmeric.

First instar nymph of *P. nigronervosa* lived on ginger was greenish in color, oval body with average length 0.48 mm and width 0.32 mm, and had 4 segment antennae at 0.45 mm length on average. Second instar was reddish brown in color, pear-shaped body with average length 0.74 mm and width 0.51 mm and had 4 segment antennae at 0.76 mm length on average. Third instar was reddish brown in color, pear-shaped body with average length 0.94 mm and width 0.66 mm, and had 5 segment antennae at 0.99 mm length on average. Fourth instar was reddish brown in color, pear-shaped body with average length 1.22 mm and width 0.78 mm. The nymphs had 6 segment antennae at 1.29 mm on average and black color appeared on tibia (Table 2, 3, 4) (Figure 7).

P. nigronervosa was also reported to be able to infest ginger in a research conducted by [22] who reported that banana aphid primarily colonized banana (*Musa* spp.) and taro (*Colocasia esculenta*) plants, whereas *P. caladii* more frequently found to colonizes ginger (*Zingiber officinale*, *Alpinia purpu-rata*, *Hedychium coronarium*), heliconia (*Heliconia* spp.) and taro plants.

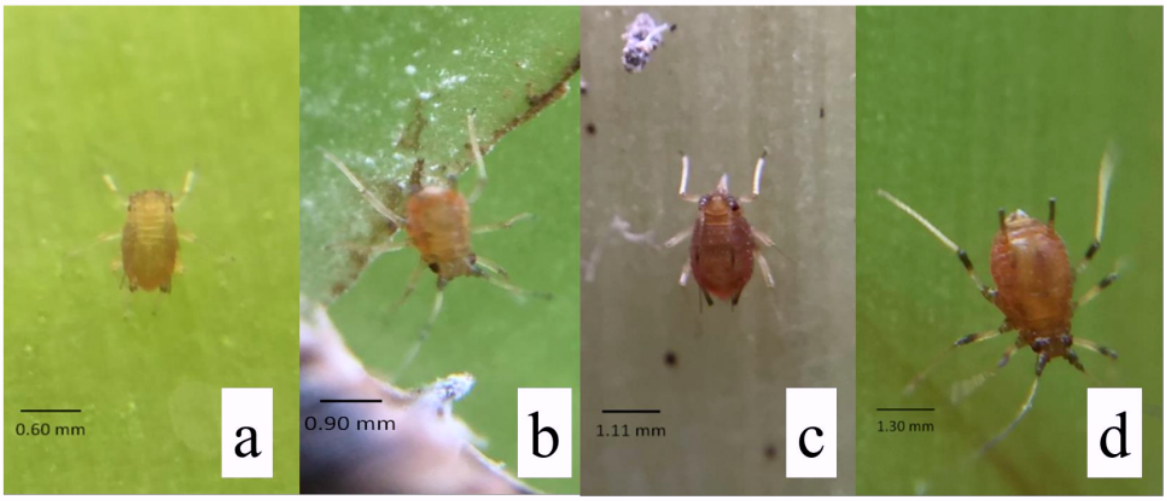

Figure 8. *Pentalonia nigronervosa* lived on banana: a. instar 1, b. instar 2, c. instar 3, d. instar 4

First instar nymph of *P. nigronervosa* lived on banana was transparent greenish in color, pear-shaped body with average length 0.58 mm and width 0.36 mm, and had 4 segment antennae with average length 0.55 mm. Second instar was light yellow in color, pear-shaped body with average length 0.85 mm and width 0.51 mm and had 4 segment antennae at 0.85 mm length on average. Third instar was reddish brown in color, pear-shaped body with average length 1.05 mm and width 0.62 mm, and had 5 segment antennae at 1.08 mm length on average. Fourth instar was reddish brown in color, pear-shaped body with average length 1.24 mm and width 0.85 mm. The antennae of this nymph stage had reached 6 segment at 1.29 mm length and specific black color appeared on tibia (Table 2, 3, 4) (Figure 8).

In general, as can be seen in Table 2, instar period of *P. nigronervosa* was not significantly different between those lived on Zingiberaceous plants and on banana. The different was only noticed on the aphid lived on torch ginger which had longer second larval period an shorter third larval period. The nymphal periods in all experimental plants were similar to those reported by [16] who reported that nymphal stage of *P. nigronervosa* under laboratory conditions ranged from 8 to 11 days.

The instar length of *P. nigronervosa* lived on different host was relatively similar, the smallest was recorded on the first and second instars of the aphid lived on ginger (0.48 and 0.74 mm respectively). However, the body length of first instar of the aphid was different from those mentioned by [23] that the average size of the first instar of *P. nigronervosa* was 0.12 mm.

Table 2. Instar period of *Pentalonia nigronervosa* lived on Zingiberaceous plants

Plant common name	Instar period			
	1	2	3	4
Torch ginger	2.90 ± 0.09 a	3.80 ± 0.13 a	2.00 ± 0.14 c	2.10 ± 0.26 a
Javanese turmeric	1.90 ± 0.09 a	3.10 ± 0.26 abc	2.90 ± 0.17 ab	2.00 ± 0.20 a
Galangal	2.20 ± 0.13 a	2.10 ± 0.09 e	2.60 ± 0.15 abc	2.30 ± 0.14 a
Chinese turmeric	1.90 ± 0.09 a	2.90 ± 0.09 bcd	2.80 ± 0.13 ab	2.10 ± 0.09 a
Cardamom	2.00 ± 0.00 a	2.80 ± 0.13 bcd	3.10 ± 0.09 a	2.10 ± 0.09 a
Turmeric	2.00 ± 0.00 a	3.20 ± 0.13 ab	2.50 ± 0.16 abc	2.00 ± 0.00 a
Ginger	2.00 ± 0.00 a	2.30 ± 0.14 de	2.70 ± 0.14 ab	1.90 ± 0.09 a
Banana	2.00 ± 0.00 a	2.40 ± 0.15 cde	2.40 ± 0.15 abc	2.00 ± 0.00 a

Note : Figures followed by the same letter are not significantly different according to LSD5%

Table 3. Instar nymph length of *Pentalonia nigronervosa* lived on Zingiberaceous plants

Plant common name	Instar nymph length (mm)			
	1	2	3	4
Torch ginger	0.67 ± 0.02 ab	0.88 ± 0.03 ab	1.07 ± 0.03 a	1.23 ± 0.04 ab
Javanese turmeric	0.64 ± 0.01 ab	0.76 ± 0.01 b	1.03 ± 0.04 a	1.19 ± 0.03 b
Galangal	0.75 ± 0.05 a	0.99 ± 0.08 a	1.10 ± 0.08 a	1.40 ± 0.08 a
Chinese turmeric	0.61 ± 0.01 b	0.87 ± 0.02 ab	1.06 ± 0.02 a	1.23 ± 0.02 ab
Cardamom	0.65 ± 0.02 ab	0.81 ± 0.02 ab	1.00 ± 0.02 a	1.23 ±0.04 ab
Turmeric	0.65 ± 0.03 ab	0.86 ± 0.02 ab	1.07 ± 0.02 a	1.25 ± 0.03 ab
Ginger	0.48 ± 0.02 c	0.74 ± 0.03 b	0.95 ± 0.03 a	1.22 ± 0.04 ab
Banana	0.58 ± 0.01 bc	0.85 ± 0.03 ab	1.05 ± 0.01 a	1.24 ± 0.01 ab

Note : Figures followed by the same letter are not significantly different according to LSD5%

Table 4. Instar nymph width of *Pentalonia nigronervosa* lived on Zingiberaceous plants

Plant common name	Instar nymph width (mm)			
	1	2	3	4
Torch ginger	0.36 ± 0.02 b	0.46 ± 0.02 b	0.57 ± 0.01 ab	0.77 ± 0.02 ab
Javanese turmeric	0.31 ± 0.02 b	0.42 ± 0.01 b	0.73 ± 0.05 a	0.84 ± 0.04 ab
Galangal	0.59 ± 0.07 a	0.68 ± 0.07 a	0.72 ± 0.06 ab	0.80 ± 0.06 ab
Chinese turmeric	0.38 ± 0.01 b	0.44 ± 0.01 b	0.61 ± 0.02 ab	0.75 ± 0.02 ab
Cardamom	0.30 ± 0.02 b	0.46 ± 0.02 b	0.56 ± 0.01 b	0.72 ± 0.01 b
Turmeric	0.33 ± 0.01 b	0.49 ± 0.02 b	0.64 ± 0.02 ab	0.88 ± 0.02 a
Ginger	0.32 ± 0.01 b	0.51 ± 0.03 b	0.66 ± 0.04 ab	0.78 ± 0.02 ab
Banana	0.36 ± 0.01 b	0.51 ± 0.01 b	0.62 ± 0.01 ab	0.85 ± 0.02 ab

Note : Figures followed by the same letter are not significantly different according to LSD5%

Table 5.Length of *Pentalonia nigronervosa antennae* lived on Zingiberaceous plants

Plant common name	Length of antennae (mm)			
	1	2	3	4
Torch ginger	0.63 ± 0.01 a	0.88 ± 0.03 ab	1.10 ± 0.03 a	1.31 ± 0.04 ab
Javanese turmeric	0.41 ± 0.06 c	0.70 ± 0.01 c	1.05 ± 0.04 a	1.25 ± 0.03 b
Galangal	0.68 ± 0.04 a	0.98 ± 0.08 a	1.05 ± 0.11 a	1.47 ± 0.08 a
Chinese turmeric	0.57 ± 0.01 ab	0.90 ± 0.02 ab	1.11 ± 0.02 a	1.33 ± 0.04 ab
Cardamom	0.63 ± 0.02 a	0.83 ± 0.02 abc	1.05 ± 0.03 a	1.32 ± 0.04 ab
Turmeric	0.61 ± 0.03 a	0.87 ± 0.02 ab	1.12 ± 0.02 a	1.32 ± 0.02 ab
Ginger	0.45 ± 0.02 bc	0.76 ± 0.03 bc	0.99 ± 0.04 a	1.29 ± 0.04 ab
Banana	0.55 ± 0.01 abc	0.85 ± 0.02 abc	1.08 ± 0.02 a	1.29 ± 0.02 ab

Note : Figures followed by the same letter are not significantly different according to LSD5%

Table 6. Life cycle of *Pentalonia nigronervosa* lived on Zingiberaceous plants

Plant common name	Life cycle (day)
Torch ginger	10.80 ± 0.31 a
Javanese turmeric	9.90 ± 0.30 abc
Galangal	9.20 ± 0.19 bcd
Chinese turmeric	9.70 ± 0.20 bcd
Cardamom	10.00 ± 0.20 ab
Turmeric	9.70 ± 0.25 bcd
Ginger	8.90 ± 0.09 cd
Banana	8.80 ± 0.19 d

Note : Figures followed by the same letter are not significantly different according to LSD5%

Table 7. Reproductive period and fecundity of *Pentalonia nigronervosa* lived on Zingiberaceous plants

Plant common name	Reproductive period	Fecundity
Torch ginger	7.20 ± 0.28 c	10.10 ± 0.64 de
Javanese turmeric	10.50 ± 0.32 b	14.50 ± 0.89 bc
Galangal	13.40 ± 0.84 a	18.40 ± 1.12 b
Chinese turmeric	12.80 ± 0.39 a	16.30 ± 1.01 b
Cardamom	8.10 ± 0.41 c	8.70 ± 0.25 e
Turmeric	12.30 ± 0.53 ab	15.90 ± 1.38 bc
Ginger	12.70 ± 0.53 ab	12.20 ± 0.51 cd
Banana	14.60 ± 0.29 a	23.20 ± 0.73 a

Note: Figures followed by the same letter are not significantly different according to LSD5%

Body width of first and second instar nymphs of *P. nigronervosa* lived on galangal was significantly different from those lived on other hosts. At third instar, only the width of those lived on cardamom significantly different from those of aphids lived on turmeric, and for the fourth instar, significant different was only between those lived on cardamom and turmeric (Table 4). Nymph width is a species characteristic of aphid which normally measured as head width across the eyes of the imagoes [4].

Number of antenna segment was no difference for the same instar of *P. nigronervosa* even though they lived on different hosts. However, the length of the antennae of the aphid lived on Javanese turmeric and ginger were significantly shorter than those of the aphid lived on other hosts. According to [24], the length of antennae of *P. nigronervosa* is almost the same as the length of its body, and in this research we also found that the average length of antennae of each instar of *P. nigronervosa* nymph was almost the same as the average length of each instar body (Table 3, 5).

The longest life cycle of *P. nigronervosa* was found when the aphid live on torch ginger and cardamom, and the shortest was when the aphid lived on ginger and banana (Table 6). Life cycle of *P. nigronervosa* on cardamom and torch ginger almost the same as life cycle of the aphid reported by [12] that life cycle of *P. nigronervosa* ranged from 8 to 11 days but life cycle of the aphid lived on other hosts were shorter, ranged from 8,6 to 9.9 days.

P. nigronervosa not only had shorter life cycle on torch ginger and cardamom, but also had shorter reproductive period with smaller fecundity which were significantly different from those of other hosts. The fecundity of *P. nigronervosa* lived on Zingiberaceous plants were smaller than that of the aphid lived on banana (Table 7). Fecundity of *P. nigronervosa* lived on banana cuttings under laboratory condition was 23.20 nymphs per adult which was almost the same as the fecundity of the aphid on banana reported by [16] that average offspring of banana aphid *P. nigronervosa* per female was 22.

4. Conclusion

Banana aphid *P. nigronervosa* was able to live on all Zingiberaceous plant species with morphological and biological characteristic almost the sama as those lived on banana as the main host of the aphid. The difference was noticed only on those lived on torch ginger and cardamom which showed longer life cycle but smaller fecundity.

5. Acknowledgement

This research was funded by Sriwijaya University through Excellent Competitive Research Funding Scheme year 2021.

References

[1] J. D. Robson, M. G. Wright, And R. P. P. Almeida, "Biology Of Pentalonia Nigronervosa (Hemiptera, Aphididae) On Banana Using Different Rearing Methods," Environ. Entomol., Vol. 36, No. 1, Pp. 46–52, 2007.

[2] D. H. Stechmann, "Ant-Attendance As A Critical Factor In The Biological Control Of The Banana Aphid Pentalonia Nigronervosa Coq. (Horn. Aphididae) In Oceania," J. Appl. Entomol., Vol. 120, No. 2, Pp. 119–123, 1996.

[3] J. D. Robson, M. G. Wright, And R. P. P. Almeida, "Within-Plant Distribution And Binomial Sampling Of Pentalonia Nigronervosa (Hemiptera: Aphididae) On Banana," J. Econ. Entomol., Vol. 99, No. 6, Pp. 2185–2190, 2006.

[4] R. G. Foottit, H. E. L. Maw, K. S. Pike, And R. H. Miller, "The Identity Of Pentalonia Nigronervosa Coquerel And P. Caladii Van Der Goot (Hemiptera: Aphididae) Based On Molecular And Morphometric Analysis," Nature, Vol. 115, No. 2884, P. 208, 2010.

[5] S. Mokolintad, R. Maramis, And H. Makal, "Insidensi Penyakit Kerdil (Bunchy Top Virus) Pada Tanaman Pisang (Musa Paradisiaca L) Di Kecamatan Aer Tembaga Kota Bitung (Incidence," No. 1981, 2003.

[6] D. Widyastuti And S. Hendrastuti Hidayat, "Pengaruh Waktu Infeksi Virus Kerdil Pisang Terhadap Kerentanan Tiga Kultivar," J. Hama Dan Penyakit Tumbuh. Trop., Vol. 5, No. 1, Pp. 42–49, 2005.

[7] S. Watanabe, D. Borthakur, And And A. Bressan, "Localization Of Banana Bunchy Top Virus And Cellular Compartments In Gut And Salivary Gland Tissues Of The Aphid Vector Pentalonia Nigronervosa," J. Juzen Med. Soc., Vol. 57, No. 1, Pp. 46–74, 2015.

[8] I. Irwansyah, S. Sofian, And N. Akhsan, "Identifikasi Karakteristik Gejala Serangan Banana Bunchy Top Virus (BBTV) Dan Intensitasnya Pada Tanaman Pisang Di Beberapa Kecamatan Di Kabupaten Kutai Kartanegara," J. Agroekoteknologi Trop. Lembab, Vol. 2, No. 1, P. 55, 2019.

[9] T.F. Döring, "How aphids find their plant hosts and how they don't". Ann. Appl. Biol. Vol.16, Pp. 3–26

[10] C. Hooks and A. Fereres. "Protecting crops from non-persistently aphid-transmitted viruses: A review on the use of barrier plants as a management tool". Virus Research Vol.1, No. 20, Pp.1–16,2006.

[11] S Rahmah, N Maryana, and P Hidayat. "Host preference of Pentalonia nigronervosa Coquerel and P. caladii van der Goot (Hemiptera: Aphididae) on various host plants". OP Conf. Series: Earth and Environmental Science, Vol. 694, Pp. 1-8, 2021.

[12] P. Rajan, P. 1981. "Biology of Penatalonia nigronervosa f. caladii van der Goot, vector of Katte disease of cardamom. J. Plantation Crops, Vol. 1, Pp. 34 -41, 1981.

[14] B.P. McCornack, D. W. Ragsdale, and R. C. Venette. "Demography of soybean aphid (Homoptera: Aphididae) at summer temperatures," J. Econ. Entomol.,Vol 97, Pp. 854 – 861, 2004.

[15] G. Basak, A. Banerjee, and B. Bandyopadhyay. "Studies on some bio-ecological aspects and varietal preference of banana aphid, Pentalonia nigronervosa Coquerel (Hemiptera: Aphididae)," J. Crop Weed. Vol.11, No. 2, Pp. 181-186, 2015.

[16] C. Padmalatha C and A.J.A. Ranjit Singh, "Life table and survivorship curve of Pentalonia nigronervosa Coq. (Homoptera: Aphididae)," J. Appl. Zool. Vol. 13, Pp. 156-159, 2002.

[17] K. Gadhave, B. Dutta, TCoolong, and Srinivasan, "A non-persistent aphid-transmitted Potyvirus differentially alters the vector and non-vector biology through host plant quality manipulation," Nature Scientific Reports, Vol. 9, Pp. 2503, 2019.

[18] R.L.Blackman and V. F. Eastop. 1984. Aphids on the world's crops: an identification and information guide. Wiley, Chichester, UK, 1984.

[19] S. Sugimooto and K. Kitagawa, "Keys to the species of Aphidinae (Homoptera) intercepted at import inspection in Japan," Res. Bull. Plant. Prot. Japan, Vol. 31: 57-66, 1995.

[20] Rao, "Katte disease of small cardamom and its control. Indian journal of Horticulture, Vol. 34, No. 2, Pp. 183-187, 1977

[21] W. Bagariang, P. Hidayat, and S.H. Hidayat, "Morphometric Analysis and Host Range of the Genus Pentalonia Coquerel (Hemiptera: Aphididae) Infesting Banana in Java," Jurnal Perlindungan Tanaman Indonesia, Vol. 23, No. 2, 171–178, 2019.

[22] S. Watanabe, A.M. Greenwell, and A. Bressan. "Localization, Concentration, and Transmission Efficiency of Banana bunchy top virus in Four Asexual Lineages of Pentalonia aphids," Viruses. Vol. 5, No. 2, Pp. 758–776, 2013.

[23] Suparman, Nurhayati and A. Setyawati. "Preferensi dan Kecocokan Inang Pentalonia nigronervosa Coquerel (Hemiptera: Aphididae) terhadap Berbagai Varietas Pisang," J. Entomol. Indon. Vol. 8, No.2, Pp. 73-84, 2011.

[24] R.L. Blackman RL and V.F. Eastop, "Aphids on the World's Herbaceous Plants and Shrubs," Eurppean Journal of Entomology , Vol. 105, No. 1, Pp. 164-164, 2006.

alonia_nigronervosa_Coquerel_on_various_Zingiberaceous_c...

ORIGINALITY REPORT

6%	4%	6%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	T. Jonung, A. Ramzy, P. Herlin, J.H. James, L. Edwards, J.E. Fischer. "Indole Amines and Amino Acids in Various Brain Regions after Infusion of Branched Chain Amino Acids into Hepatectomized Rats", European Surgical Research, 1985 Publication	1%
2	orca.cf.ac.uk Internet Source	1%
3	Escalona, V.H.. "Metabolic activity and quality changes of whole and fresh-cut kohlrabi (Brassica oleracea L. gongylodes group) stored under controlled atmospheres", Postharvest Biology and Technology, 200608 Publication	1%
4	Max Beier. "The pseudoscorpions of New Zealand, Norfolk, and Lord Howe", New Zealand Journal of Zoology, 1976 Publication	1%
5	THOS L. CASEY. "VI.?Coleopterological Notices.", Annals of the New York Academy of	1%

Sciences, 12/1896
Publication

6	www.jstage.jst.go.jp Internet Source	1 %
7	edepot.wur.nl Internet Source	1 %

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		