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Effectiveness of Controling Brontispa Using Parasitoids *Acecodes hispinarum* in Kampot Province, Cambodia

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Abstract

The coconut leaf beetles (Brontispa spp.) are the subject of a new contaminant that has recently appeared on the territory of Cambodia since 2003. This study has two objectives: (a) to analyze the situation of damage to coconut plants by Brontispa in Kampot province; and (b) to understand the parasite breeding in the laboratory and its release in the field and its effectiveness in controlling Brontispa. This study was conducted in Kampot province because the coconut crops in this province, like in other provinces, have been suffering from the damage caused by Brontispa. According to the report of the GDA, which was researched by the Priority Expression Project on the Study of the Prevalence of Coconut Pests in 2006–2007, it shows that there are 79 villages and 11 communes in Angkor Chey district, Kampot province, of which 80,080 were damaged, equivalent to 70% of the total of 114,400 coconut trees.Based on the results of this study, it can be concluded that the coconut crop in Kampot province is currently being seriously destroyed by Brontispa. The results of the survey showed that there were 2,476 coconut trees, of which only 838 were not damaged, while 1,638 other trees were damaged, such as: destroyed from 1–15% of 261 trees; destroyed from 16–30% of 260 trees; destroyed from 31–50% of 252 trees; destroyed from 1–50% of 252 trees; destroyed from 51–70% of 365 trees; and destroyed from 70–100% of 500 trees. To conclude, the negative effects of Brontispa can be effectively eliminated by using this acetaminophen parasite, but it will take a bit longer. This measure's application is extensive, long-lasting, and labor-efficient; it particularly has no impact on biodiversity, health, or environmental preservation.

Keywords

Brontispa, parasitoids, asecodeshispinarum, plant protection, pest controls.

1. INTRODUCTION

The coconut leaf beetles (Brontispa spp.) are the subject of a new contaminant that has recently appeared on the territory of Cambodia since 2003, first in Mondulkiri province. The epidemic was reported by a previous technician from the Plant Protection Officeof the Department of Plant Protection, Sanitary, and Phyto-Sanitary, which severely affected 27 types of palm trees and other crops. The destruction from Brontispa will suffer in the future if we do not take timely measures to eradicate it. Coconut is a secondary crop for farmers and the entire Cambodian population after food crops, and it also plays an important role in increasing household income, especially for some local farmers in Takeo and Kampot provinces. Statistics from the General Department of Agriculture (GDA) in 2012 show that even in these two provinces, there are about 550,000 coconut trees that are bearing fruit, excluding small coconuts and palm trees that are about to bear fruit and planted in old villages, schools, pagodas, in the new villages, and almost all the nearby rice fields (GDA, 2012).

Although the Plant ProtectionOffice has currently tested and achieved good results in controlling Brontispa, the measures taken by the office are all chemical measures, including the use of pesticides in the control. There is suspicion that there will be toxic residues in coconut water, although there is no scientific evidence. Therefore, biological measures are the only ones that can ensure the quality of products, both coconut water and coconut meat, and they are also measures that will stabilize the sustainability of biological fertilization in nature. In particular, although the Plant ProtectionOffice published a technical article and disseminated information to farmers about Brontispa and control measures, as well as a notification to the Department of Agriculture, Forestry, and Fisheries (DAFF) in all provinces on April 9, 2003, Already, the measures have not yet been fully implemented, even though the epidemic and the extent of the damage have not been reported by those departments. Therefore, a comprehensive national survey should be carried out in the affected areas, which is also a requirement of phyto-sanitary work to eradicate the presence of this Brontispa (pest eradication). At the same time, this survey is also a contribution to the Pest Surveillance Program, which is a member of the International Plant Protection Convention (IPPC) and, in particular, member countries of the Southeast Asia regional community (Plant Quarantine Pest) (Plant ProtectionOffice, 2007). Therefore, biological measures are the only ones that can ensure the quality of products, both coconut water and coconut meat, as well as measures that will stabilize the sustainability of biological scales in nature and also contribute to reducing the use of pesticides and improving organic production strategies.

This study has two objectives: (a) to analyze the situation of damage to coconut plants by Brontispa in Kampot province; and (b) to understand the parasite breeding in the laboratory and its release in the field and its effectiveness in controlling Brontispa.

2. METHODOLOGY

2.1. Location of study

This study was conducted in Kampot province because the coconut crops in this province, like in other provinces, have been suffering from the damage caused by Brontispa. According to the report of the GDA, which was researched by the Priority Expression Project on the Study of the Prevalence of Coconut Pests in 2006–2007, it shows that there are 79 villages and 11 communes in Angkor Chey district, Kampot province, of which 80,080 were damaged, equivalent to 70% of the total of 114,400 coconut trees.

Three districts in Kampot province were selected to be the location of study such as Angkor Chey, Kampong Trach and Banteay Meas district. In Angkor Chey district we chose DambokKpous commune, in Kampong Trach we chose Srok Khang Lech commune, and in Banteay Meas we chose

Touk Meas commune to be the location of study. Two villages of each commune were selected to calculate the sample size.

2.2. Sampling method and sample size

Sample selection was made and the survey method was used by using a questionnaire based on the total household size of 48,992 of the total population in the three communes with an error of 10%. The sample size is calculated following the formula ofYamane Taro (1967) and it is about 120 samples. This study surveyed every household who was spoken with to find out how many coconut trees they had, how much damage the pests had done, and whether they intended to use the coconut trees to test for *Acecodes hispinarum* parasites. Samples will be selected for the purpose of determining the selection of damaged coconut trees under 5 years of age in the research area to conduct parasite testing in this study. The sample was selected from 10 plants per village (60 treatments and control), and 1 mummy was released per tree, including 70–160 *Acecodes hispinarum* parasites.

2.3. Data collection and data analysis

The survey will be conducted in accordance with the FAO Pest Surveillance Method and Identification.

Determining the level of destruction of the coconut trees in each target village will be determined by a score of 0 to 5 according to the destruction rate as follows:

0- No destruction

1-1-15% of the original tree number observed

2- 16-30 of the original tree number observed

3- 31-50% of the original tree number observed

4- 51-70% of the original tree number observed

5- 71-100 of the original tree number observed

The level of damage to each coconut tree will be determined by a score of 0 to 5, depending on the number of coconut-palm leaf destroyed:

0- No destruction

1- Damage on a single top leaf

2- Damage on the top leaves and the first stem

3- Damage on the top leaves, first stem and second stem

4- Damage on the top leaves, first stem, second stem and the third stem

5- Damage on the top leaves, first stem, second stem, third stem and the fourth stem

The above method must be done before releasing the parasite. Thirty coconut trees of 5-year-old and destroyed by Brontispa have been selected to be experimented by releasing *Acecodes hispinarum* parasites (10 trees/village) and investigated how these parasites destroyed the coconut trees.

The following is the picture of *Acecodes hispinarum* parasite:

Fig. 1: Picture of Acecodes hispinarum parasite

Fig. 2: Picture of Brontispa

The method of experiment is to select coconut trees which damaged by Brontispa under 5 years of age. There is no replication and have tree treatments (T_1, T_2, T_3 = Release the Asecodes hispinarum), and $T_{1\text{-}1}$, $T_{2\text{-}1}$, $T_{3\text{-}1}$ are the control treatments).

There were four post-release data collection as follows:

1. First collection in 7 days after releasing parasites
2. Second collection in 26 days after releasing parasites
3. Third collection in 45 days after releasing parasites
4. The fourth collection took place 64 days after releasing parasites.

All data have been analyzed by Microsoft Excel, SPSS and t-test and interpreted into graphs, tables, and figures.

3. RESULTS AND DISCUSSION

3.1. Results from the survey on the degree of damage to coconut trees by Brontispa

- Number of coconut trees of each household

According to the responses from 120 farmers, there are 61 families with 7 to 19 coconut trees (50.80%), 38 familieswith 20 to 29 coconut trees (31.60%), and 21 familieswith 30 to 45 coconut trees (17.60%). In general, there are no farmers who grow coconuts on plantations; they plant coconuts only around their house area.

- Number of coconut trees in average

According to the responses from 120 farmers, there are 2,476 coconut trees in total, and there are 20.63 coconut trees in average per family. The minimum of having coconut trees is 7, and the maximum of having coconut trees is 45.

- Quantity of coconut trees and level of damage

According to the responses from 120 farmers, the total number of coconut trees is 2,476, of which 838 trees (33.84%) are not damaged by the Brontispa, 261 trees (10.54%) are damaged one blade, 260 trees (10.50%) are damaged two blades, 252 trees (10.18%) are damaged three blades, 365 trees (14.74%) are damaged four blades, and 500 trees (20.20%) are damaged five blades. This result was obtained by using the pest surveillance method from FAO.

- The awareness of farmers on Brontispa

According to the responses from 120 farmers, there are only10 farmers (8.3%) who did not have awareness on the pest damaged the coconut trees. However, 110 farmers (91.7%)know clearly about the damage on coconut trees caused by Brontispa. It can be concluded that most farmers pay close attention to their coconut crop, and few farmers pay little attention to their coconut crop.

- The source of awareness on harmful pests

According to the responses from 120 farmers, 14 farmers (11.7%) know the source of damage by Brontispa from the agricultural officers, 80 farmers (66.7%)know the source of damage by Brontispa by self-observation, and 26 farmers (21.7%) has no attention and do not know the source of damage on the coconut trees.

- Quantity of coconut yield decreased in percentage

According to the responses from 120 farmers, most of them have not observed on the increasing or decreasing of coconut yield, however, the result of estimation from farmers has shown in the table below:

Table 1. Quantity of coconut yield decreased in percentage

Quantity of coconut yield decreased	Number of households	Percentage
Decreasing by 5 percent	76	63.40
Decreasing by 10 percent	36	30.00
Decreasing by 20 percent	8	06.70
Total	120	100

- Protection method and maintenance technique

According to the responses from 120 farmers, most of them have maintained the coconut tree by fertilizing them while they were young and small, however, 70 farmers (58.3%) have no protection method and maintenance method on coconut planting and 50 farmers (41.7%) have used chemical on coconut tree while they are growing from young. The coconut trees are easy to grow and not difficult in maintenance. The result found that most of farmers did not take care on maintenance or irrigating water on coconut trees.

- The use of *Acecodes hispinarum* parasite to protect Brontispa

According to the responses from 120 farmers, all of them are unaware of the parasites and did not even use them, especially the *Acecodes hispinarum* parasite, to protect the Brontispa from damage.

- The number of coconut trees that yield well per household

According to the responses from 120 farmers, there are four categories of the number of coconut trees that yield well per household. The table below describes the number of trees, the number of households and the percentage of household:

Table 2. The number of coconut trees that yield well per household

Number of coconut trees that yield well	Number of households	Percentage
7 to 10 trees	27	22.50
11 to 20 trees	40	33.30
21 to 30 trees	44	36.70
31 to 37 trees	09	7.50

- The amount of coconut sales per household per year

Studies indicate that, while not being considered a major crop, coconuts are among the most important fruits for a family's daily income. Farmers can sell coconuts to make a living quickly and on schedule because theyare in low supply. However, research indicates that farmers already have a steady income because they can afford to sell coconuts nearly every month.According to the responses from 120 farmers, there are four categories of the amount of coconut sales per household per year. The table below describes the number of trees, the number of households and the percentage of household:

Table 3. The amount of coconut sales per household per year

Amount of coconut sales per year	Number of households	Percentage
168 to 600 coconuts	64	53.40
601 to 900 coconuts	24	20.00
901 to 1000 coconuts	13	10.80
1001 to 1380coconuts	19	15.80

3.2. Results on the number of Brontispa before releasing parasites

- Number of Brontispa before releasing parasites in SbovAndet village, DambokKpous commune

According to the on-site observation, the number of Brontispa before releasing parasites on 10 coconut trees in SbovAndet village, DambokKhpous commune, Angkor Chey district, Kampot province, are shown by each life cycleas follows:

- worms of Brontispa in lava 1-2 phase, a total of 578 heads
- worms of Brontispa in lava 3-4 phase, a total of 587 heads
- worms of Brontispa in pupa phase, a total of 202 heads
- worms of Brontispa in adult phase, a total of 1,064 heads

In particular, there is no mummy, which is the parasite nest. Therefore, we can use the 10 coconut trees that were surveyed to release the parasites to control the Brontispa, especially the worms in phases 3–4, which have about 587 heads, which can allow the parasites to nest and kill the Brontispa.

- Number of Brontispa before releasing parasites in Takor village, DambokKpous commune

According to the on-site observation, the number of Brontispa before releasing parasites on 10 coconut trees in Takor village, DambokKhpous commune, Angkor Chey district, Kampot province, are shown by each life cycle as follows:

- worms of Brontispa in lava 1-2 phase, a total of 537 heads
- worms of Brontispa in lava 3-4 phase, a total of 503 heads
- worms of Brontispa in pupa phase, a total of 233 heads
- worms of Brontispa in adult phase, a total of 979 heads

In particular, there is no mummy, which is the parasite nest. Therefore, we can use the 10 coconut trees that were surveyed to release the parasites to control the Brontispa, especially the worms in phases 3–4, which have about 503 heads, which can allow the parasites to nest and kill the Brontispa.

- Number of Brontispa before releasing parasites in Prey Thom village, Samrong Leu commune

According to the on-site observation, the number of Brontispa before releasing parasites on 10 coconut trees in Prey Thom village, Samrong Leu commune, Banteay Meas district, Kampot province, are shown by each life cycle as follows:

- worms of Brontispa in lava 1-2 phase, a total of 490 heads
- worms of Brontispa in lava 3-4 phase, a total of 653 heads
- worms of Brontispa in pupa phase, a total of 291 heads
- worms of Brontispa in adult phase, a total of 1,127 heads

In particular, there is no mummy, which is the parasite nest. Therefore, we can use the 10 coconut trees that were surveyed to release the parasites to control the Brontispa, especially the worms in phases 3–4, which have about 653 heads, which can allow the parasites to nest and kill the Brontispa.

- Number of Brontispa before releasing parasites in Prey Chek village, Samrong Leu commune

According to the on-site observation, the number of Brontispa before releasing parasites on 10 coconut trees in Prey Chek village, Samrong Leu commune, Banteay Meas district, Kampot province, are shown by each life cycle as follows:

- worms of Brontispa in lava 1-2 phase, a total of 638 heads
- worms of Brontispa in lava 3-4 phase, a total of 576 heads
- worms of Brontispa in pupa phase, a total of 274 heads
- worms of Brontispa in adult phase, a total of 1,099 heads

In particular, there is no mummy, which is the parasite nest. Therefore, we can use the 10 coconut trees that were surveyed to release the parasites to control the Brontispa, especially the worms in phases 3–4, which have about 576 heads, which can allow the parasites to nest and kill the Brontispa.

- Number of Brontispa before releasing parasites in Kampoul Meas village, ReuseySrok commune

According to the on-site observation, the number of Brontispa before releasing parasites on 10 coconut trees in Kampoul Meas village, ReuseySrok commune, Kampong Trach district, Kampot province, are shown by each life cycle as follows:

- worms of Brontispa in lava 1-2 phase, a total of 755 heads
- worms of Brontispa in lava 3-4 phase, a total of 799 heads
- worms of Brontispa in pupa phase, a total of 317 heads
- worms of Brontispa in adult phase, a total of 1,254 heads

In particular, there is no mummy, which is the parasite nest. Therefore, we can use the 10 coconut trees that were surveyed to release the parasites to control the Brontispa, especially the worms in phases 3–4, which have about 799 heads, which can allow the parasites to nest and kill the Brontispa.

- Number of Brontispa before releasing parasites in Thnung village, ReuseySrok commune

According to the on-site observation, the number of Brontispa before releasing parasites on 10 coconut trees in Thnung village, ReuseySrok commune, Kampong Trach district, Kampot province, are shown by each life cycle as follows:

- worms of Brontispa in lava 1-2 phase, a total of 545 heads
- worms of Brontispa in lava 3-4 phase, a total of 638 heads
- worms of Brontispa in pupa phase, a total of 233 heads
- worms of Brontispa in adult phase, a total of 780 heads

In particular, there is no mummy, which is the parasite nest. Therefore, we can use the 10 coconut trees that were surveyed to release the parasites to control the Brontispa, especially the worms in phases 3–4, which have about 638 heads, which can allow the parasites to nest and kill the Brontispa.

3.3. Results of using parasites

3.3.1 Results from villages that releasing parasites

- Equation of declining trend of the lava 1-2 phase population

According to the experimental data collected four times by the life cycle of mummyshowed that the average population of the lava 1-2 phase of the mummy life cycle are 55,767 heads. There is a decrease after the release of mummiesper coconut treeby 0.7967 head.In the case of the lava 1-2 phase population equation, there was a strongly correlated (R^2 = 0.9792) to the effect of the mummy life cycle.

- Equation of declining trend of the lava 3-4 phase population

According to the experimental data collected four times by the life cycle of mummyshowed that the average population of the lava 3-4 phase of the mummy life cycle are 67,117 heads. There is a decrease after the release of mummiesper coconut treeby 2.21 heads.In the case of the lava 3-4 phase population equation, there was a strongly correlated (R^2 = 0.9897) to the effect of the mummy life cycle.

- Equation of declining trend of the pupa phase population

According to the experimental data collected four times by the life cycle of mummyshowed that the average population of the pupa phase of the mummy life cycle are 23,317 heads. There is a decrease after the release of mummiesper coconut treeby 0.7033 head.In the case of the pupa phase population equation, there was a strongly correlated (R^2 = 0.9795) to the effect of the mummy life cycle.

- Equation of the decrease trend of the adult phase population

According to the experimental data collected four times by the life cycle of mummyshowed that the average population of the adult phase of the mummy life cycle are 108,43heads. There is a decrease after the release of mummiesper coconut treeby 1.8867 head.In the case of the adult phase population equation, there was a strongly correlated (R^2 = 0.999) to the effect of the mummy life cycle.

- The increase in the number of mummies

According to the result of collecting data four times after releasing the parasites (mummies), the life cycle of the mummies showed that after 7 days of the release of parasites, there were an average of 2.6 heads per tree for the first collection, 3.7 heads per tree for the second collection, 5.9 heads per tree for the third collection, and 8.5 heads per tree for the fourth collection.

- Equation of the growth of mummies by the life cycle

According to the experimental data collected four times through the life cycle of mummies, from the release to the last collection, the growth of mummies increased in the form of an exponential function, which is a rapid increase at a growth rate of 30.8% with each life cycle. This relationship is very strong (R^2 = 0.9247) to the relative growth of the mummy life cycle.

- Comparison of the growth of mummies and the declining of lava 3-4 phase population

According to the results of the regression analysis for the growth of mummies (R^2 = 0.9247) and the decrease of the lava 3-4 phase (R^2 = 0.9897), these equations can be used to predict the number of mummy births and the decline of the lava 3-4 phase through the mummy life cycle up to the 12^{th} phase. The results show that the number of lava in the 3–4 phase will decrease by the same amount as the number of mummies in the 10^{th} life cycle. Therefore, the control of Brontispa must take at least 10 life cycles of mummies to balance the number of mummies and the Brontispa.

3.3.2 Results from villages that not releasing parasites (follow-up)

- Equation of declining trend of the lava 1-2 phase population

According to the experimental data collected four times by the life cycle of mummyshowed that the average population of the lava 1-2 phase of the mummy life cycle are 54.567 heads. There is a decrease after the release of mummiesper coconut treeby 1.3067 head.In the case of the lava 1-2 phase population equation, there was a strongly correlated (R^2 = 0.9483) to the effect of the mummy life cycle.

- The decrease in the number of Brontispa

According to the result of collecting data four times after releasing the parasites (mummies), after 7 days of the release of parasites, there was a decrease of 54.96 heads per tree of the lava 3-4 phase,

and still decreases to53.5 heads for the second collection, 51 heads per tree for the third collection, and 49.43 heads per tree for the fourth collection.

- Equation of declining trend of the lava 3-4 phase population

According to the experimental data collected four times by the life cycle of mummyshowed that the average population of the lava 3-4 phase of the mummy life cycle are 55heads. There is a decrease after the release of mummiesper coconut treeby 1.91 heads.In the case of the lava 3-4 phase population equation, there was a strongly correlated (R^2 = 0.9894) to the effect of the mummy life cycle.

- Equation of declining trend of the pupa phase population

According to the experimental data collected four times by the life cycle of mummyshowed that the average population of the pupa phase of the mummy life cycle are 22.317 heads. There is a decrease after the release of mummiesper coconut treeby 0.65 head.In the case of the pupa phase population equation, there was a strongly correlated (R^2 = 0.956) to the effect of the mummy life cycle.

- Equation of the decrease trend of the adult phase population

According to the experimental data collected four times by the life cycle of mummyshowed that the average population of the adult phase of the mummy life cycle are 92.083heads. There is a decrease after the release of mummiesper coconut treeby 1.8033 head.In the case of the adult phase population equation, there was a strongly correlated (R^2 = 0.999) to the effect of the mummy life cycle.

- The increase in the number of mummies

According to the result of collecting data four times after releasing the parasites (mummies), the life cycle of the mummies showed that after 7 days of the release of parasites, there were an average of 1.7 heads per tree for the first collection, 2 heads per tree for the second collection, 3.5 heads per tree for the third collection, and 5.6 heads per tree for the fourth collection.

- Equation of the growth of mummies by the life cycle

According to the experimental data collected four times through the life cycle of mummies, from the release to the last collection, the growth of mummies increased in the form of an exponential function, which is a rapid increase at a growth rate of 40.85% with each life cycle. This relationship is very strong (R^2 = 0.97) to the relative growth of the mummy life cycle.

- Comparison of the growth of mummies and the declining of lava 3-4 phase population

According to the results of the regression analysis for the growth of mummies (R^2 = 1) and the decrease of the lava 3-4 phase (R^2 = 1), these equations can be used to predict the number of mummy births and the decline of the lava 3-4 phase through the mummy life cycle up to the 12^{th} phase. The results show that the number of lava in the 3–4 phase will decrease by the same amount as the number of mummies in the 9^{th} life cycle. Therefore, the control of Brontispa must take at least 9 life cycles of mummies to balance the number of mummies and the Brontispa.

4. CONCLUSIONS

Based on the results of this study, it can be concluded that the coconut crop in Kampot province is currently being seriously destroyed by Brontispa. The results of the survey showed that there were 2,476 coconut trees, of which only 838 were not damaged, while 1,638 other trees were damaged, such as: destroyed from 1–15% of 261 trees; destroyed from 16–30% of 260 trees; destroyed from 31–50% of 252 trees; destroyed from 1–50% of 252 trees; destroyed from 51–70% of 365 trees; and destroyed from 70–100% of 500 trees. Research indicates that, while not being a big crop, coconuts are among the most important fruits for a family's daily income. Farmers can sell coconuts to make a living quickly and on schedule because there is in low supply. However, research indicates that farmers already have a steady income because they can afford to sell coconuts every month. Due to the parasites' ability to spread to other regions, using them to lessen the negative effects of Brontispa has proven effective. Overall, the negative effects of Brontispa can be effectively eliminated by using this acetaminophen parasite, but it will take a bit longer. This measure's application is extensive, long-lasting, and labor-efficient; it particularly has no impact on biodiversity, health, or environmental preservation.

REFERENCES

Anon, B. (1981). *New records*. Quarterly Newsletter, FAO Plant protection Committee for South East Asia and Pacific Region, 24:4-11

APPC (1987). *Insect pest of economic significance affecting major crops of the countries in Asia and the Pacific region*. Technical Document No. 135 Bangkok, Thailand: Regional FAO Office for Asia and the Pacific (RAPA).

Bourke, Tv. (1981). *Quarterly report for quarter ending 31 October 1981*. Apia, Western Samoa: FAO Plant Protection Advisor.

British American Tobacco Cambodia (2003). *Methods of reducing the risk and storage of pesticides*. Phnom Penh, Cambodia.

Brown, E.S., Green, A.H. (1958). The control by insecticides of Brontispalongissima (Gestro) (Coleopt., Chrysomelidae-Hispinae) on young coconut palms in the British Solomon Island. *Bulletin of Entomological Research, 49*:239-272.

Chiu, S.C., Lai, P.Y., Chen, B.H., Chen, Z.C., Shiau, J.F. (1985). Introduction, propagation and liberation of a pupal parasitoid, Tetrastichusbrontispae, for the control of coconut leaf beetle in Taiwan. *Journal of Agricultural Research of China, 34*(2):213-222.

Cochereau, P. (1965). Notes on and attempt to acclimatize Tetrastichusbrontispae Ferriere (Hym. Chalc. Eulophiae) on the host BrontispalongissimaGestro var froggatti Sharp (Col. Chrysom. Hispinae) in New Caledonia. *Comptes Rendus Hebdomadaire des Seances de 1'Academie d'Agriculture de France, 51*:661-667.

Cochereau, P. (1969). Installation of Terastichusbrontispae Ferr. (Hymenoptera, Eulophidae) parasite of Brontispa logissima Gestro var froggatti Sarp (Cot. Chrysomelidae. Hispinae) in the peninsula of Noumea. *Cahiers ORSTROM, Serie BIioligie, 7*:139-14.

Department of Agriculture Thailand (2001). *A guide book for field crops production in Thailand*. Bangkok, Thailand.

Environmental Foundation (2002). *Death in small Doses-Cambodia's pesticide Problems and Solution*. Phnom Penh, Cambodia.

FAO (1981). *The coconut hispine, Brontispalongissima*. Quarterly Newsletter, FAO plant Protection Committee for the South Asia and Pacific Region, 24:910.

FAO/WHO (2002). *European Conference on Food Safety and Quality 25-28 Feb.2002*. Budapest, Hungary.

Yamane, T. (1967). *Statistics: An Introductory Analysis, 2nd Edition*. New York: Harper and Row.