BIBLIOGRAPHY

SAKIWAT, CHONA B. April 2013. Effectiveness of Different Fermented Fruit Extracts and Vinegar Juice in Attracting Fruit Fly *(Bactrocera sp*.). Benguet State University La Trinidad Benguet.

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ABSTRACT

The study was conducted at Balili Experimental Station, La Trinidad Benguet from December 2012 to March 2013 to determine the best formulation that attract adult fruit fly; identify the species of fruit fly trapped in the attractant; determine the duration of the efficacy of the attractant; to determine the population and families of the other arthropods trapped in the attractant; and know the cost of production in preparing fruit extract and vinegar juice.

Muscovado extract (2 kg muscovado + 2 liters tap water +100ml vinegar juice) trapped the most number of fruit flies. Majority of the trapped fruit flies were females.

There were nine fruit fly species trapped from the different treatments, namely: *Neoceratitis cyanescens* (Bezzi), *Bactrocera invadens* (Tsuruta and White), *Bactrocera trayoni* (Froggatt), *Bactrocera occipitalis* (Bezzi), *Bactrocera Philippinensis* (Drew and Hancock), *Bactrocera cucurbitidae* (Coquillet), *Bactrocera dorsalis* Hendel and two unidentified species.

The duration of efficacy of formulated natural attractant lasted for 26 days with increasing attractancy up to third week and gradually decreased.

The arthropods trapped in the attractant belonged to 8 orders under class Insecta and two Suborders of class Arachnida. Further, the orders trapped were Diptera with 15 families; Lepidoptera with 9 families; Coleoptera with 11 families; Hymenoptera with 5 families; Hemiptera with 5 families; Blattodea with 1 family; Neuroptera with 2 families and Dermaptera with 1 family. The two Suborders under class Arachnida that was trapped belong to Aranae and Acari.

The total cost of production for the whole experiment was Php. 3,978.75.

RESULTS AND DISCUSSION

Population of Fruit fly Trapped in the Different Extracts

The mean population of fruit fly trapped in the different treatment is presented in Table 1. The result implies that treatment 1-9 is effective in trapping adult fruit fly, on the other hand treatment T_9 (muscovadoextract) attracted the most number of fruit fly. This result signify that muscovado with water has equal sugar and water amount content of ripen fruits, as Mau and Matin in 2005 mentioned, ripe fruits are preferred by fruit fly for oviposition. The statistical analysis shows that treatments 1-9 has no significant difference with each other and treatments2, 3, 4, 10, 11 and 12 respectively are not significantly different in trapping adult fruit fly.

There were total of 224 population of fruit fly trapped on the different treatments. It indicates that the treatments has the ability to attract adult fruit fly except for treatment 10 (vinegar juice) that does not able to trap fruit fly differedfrom the study of McNew (2009) in which mixture of muscovado sugar and vinegar can catch flies insects, and treatment 11 (crudevinegar) which disagree with what Dekker and Messing (n.d) mentioned that mixes of vinegar and water and yeast have attracted both male and females of Dipteran species. Numerically the highest population of fruit fly was observed in T_9 (muscovadoextract) with a total of 37 and a mean of 9.25, and T_5(guavaextract) as corroborated by Manuel(2011) that natural guava trap was proven to be effective since it was able to trap adult fruit fly. This was followed by treatment 8 (bananaextract), treatment 7 (mangoextract), treatment 1 (banana and strawberry extract), treatment 6 (bananaextract), treatment 3 (banana and mango extract), treatment 2 (banana and guavaextract), and treatment 4 (strawberry extract).

Table 1. Mean total of trapped fruit fly in the different extracts

TREATMENTS	TOTAL	MEAN
T_1 (banana and strawberry extract)	25	6.25[a]
T_2 (banana and guava extract)	19	4.75[ab]
T_3 (banana and mango extract)	19	4.75[ab]
T_4 (strawberry extract)	18	4.50[ab]
T_5 (guava extract)	30	7.50[a]
T_6 (banana extract)	25	6.25[a]
T_7 (mango extract)	25	6.25[a]
T_8 (fruit muscovado extract)	26	6.50[a]
T_9 (muscovado extract)	37	9.25[a]
T_{10} (vinegar juice)	0	0.00[b]
T_{11} (crude vinegar)	0	0.00[b]
T_{12} (water)	0	0.00[b]
TOTAL	224	56

Means with the same letter is not significantly different at 5% level of significance (DMRT)

The result also shows that the presence of methyl eugenol that attracts fruit flies is still present even after fermentation of fruits.

The mean number of female fruit fly trapped in the different treatments is presented in Table 2. The result shows that there was a highly significant difference on the different treatment. The data shows that from T_1 (banana and strawberry extract) to T_9 (muscovadoextract) can attract female fruit fly.

The femalerequire more food after being mated to support its egg development and female usually search for oviposition site on ripen fruits. Female fruit flies preferred ripen fruits as corroboratedby Matin and Mau (2005) that ripen fruit are preferred for oviposition.

Number of female fruit fly trapped in the attractant per day was presented in Figure 11. The Figure shows that the rate of the attractant in trapping female fruit fly per day is one to 33. The figure also shows that during the 3rd day, 33 female fruit flies was trapped.

Table 2. The mean total of adult female fruit fly trapped on the different treatments

TREATMENTS	TOTAL	MEAN
T_1 (banana and strawberry extract)	21	6.25[a]
T_2 (banana and guava extract)	16	4.00[ab]
T_3 (banana and mango extract)	16	3.50[ab]
T_4 (strawberry extract)	14	3.50[ab]
T_5 (guava extract)	25	6.25[a]
T_6 (banana extract)	14	3.50[ab]
T_7 (mango extract)	24	6.00[a]
T_8 (fruit muscovado extract)	19	4.75[ab]
T_9 (muscovado extract)	30	7.00[a]
T_{10} (vinegar juice)	0	0.00[b]
T_{11} (crude vinegar)	0	0.00[b]
T_{12} (water)	0	0.00[b]
TOTAL	179	44.75

Means with the same letter is not significantly different at 5% level of significance (DMRT)

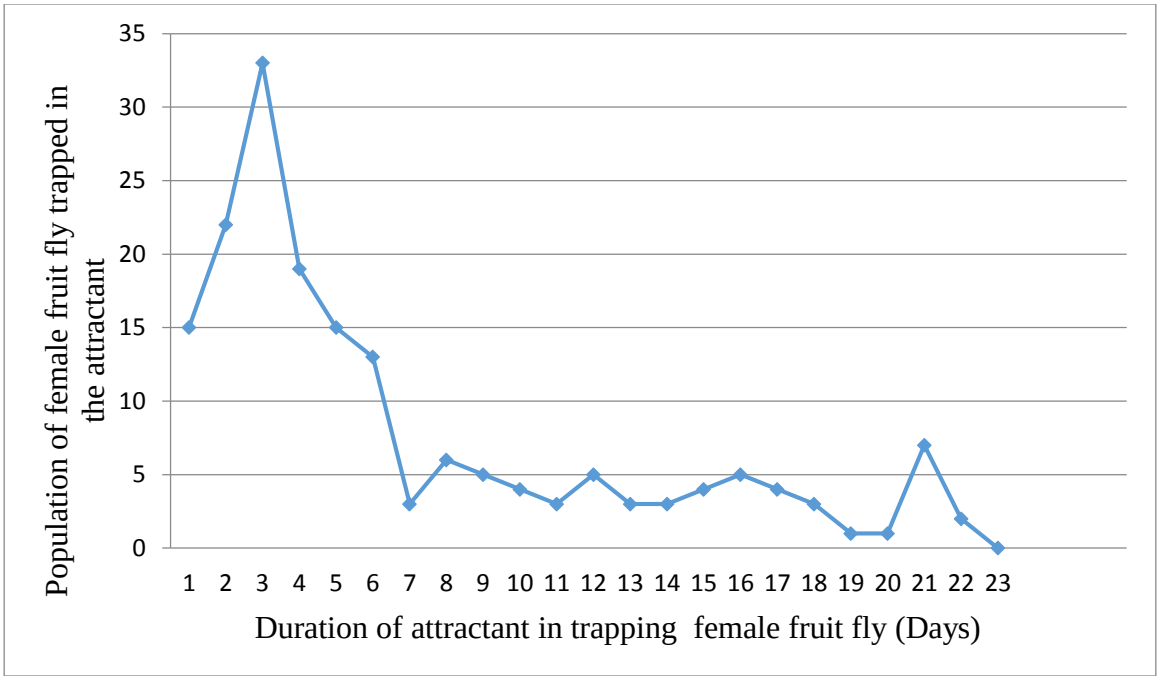

Figure 11. Number of female fruit fly trapped in the attractant per day

The Table 3 shows the mean of adult male fruit fly trapped on the different treatments. The statistical analysis shows that there was a high significant difference on the different treatments.

Treatment T_1 (banana and muscovadoextract) to T_9 (muscovadoextract) was effective in trapping adult male fruit fly however statistical analysis shows that the treatments effective in attracting male fruit fly was T_6(bananaextract) and T_9 (muscovadoextract). Male are attracted to the methyl eugenol but not for egg laying but for mating.

Number of male fruit flies trapped in the attractant per day is presented in Figure 12. The figure shows that the rate of the attractant in trapping male fruit fly per day was one to six. The figure shows that on the 3rd day the attractant was able to trap six male fruit flies.

Table 3.The mean total ofadult male fruit fly trapped on the different treatments

TREATMENTS	TOTAL	MEAN
T_1 (banana and strawberry extract)	4	1.00^{bc}
T_2 (banana and guava extract)	3	1.00^{bc}
T_3 (banana and mango extract)	3	0.75^{bc}
T_4 (strawberry extract)	4	1.00^{bc}
T_5 (guava extract)	5	1.25^{abc}
T_6 (banana extract)	11	2.75^{a}
T_7 (mango extract)	1	0.25^{c}
T_8 (fruit muscovado extract)	7	1.75^{abc}
T_9 (muscovado extract)	7	2.25^{ab}
T_{10} (vinegar juice)	0	0.00^{c}
T_{11} (crude vinegar)	0	0.00^{c}
T_{12} (water)	0	0.00^{c}
TOTAL	45	11.25

Means with the same letter is not significantly different at 5% level of significance (DMRT)

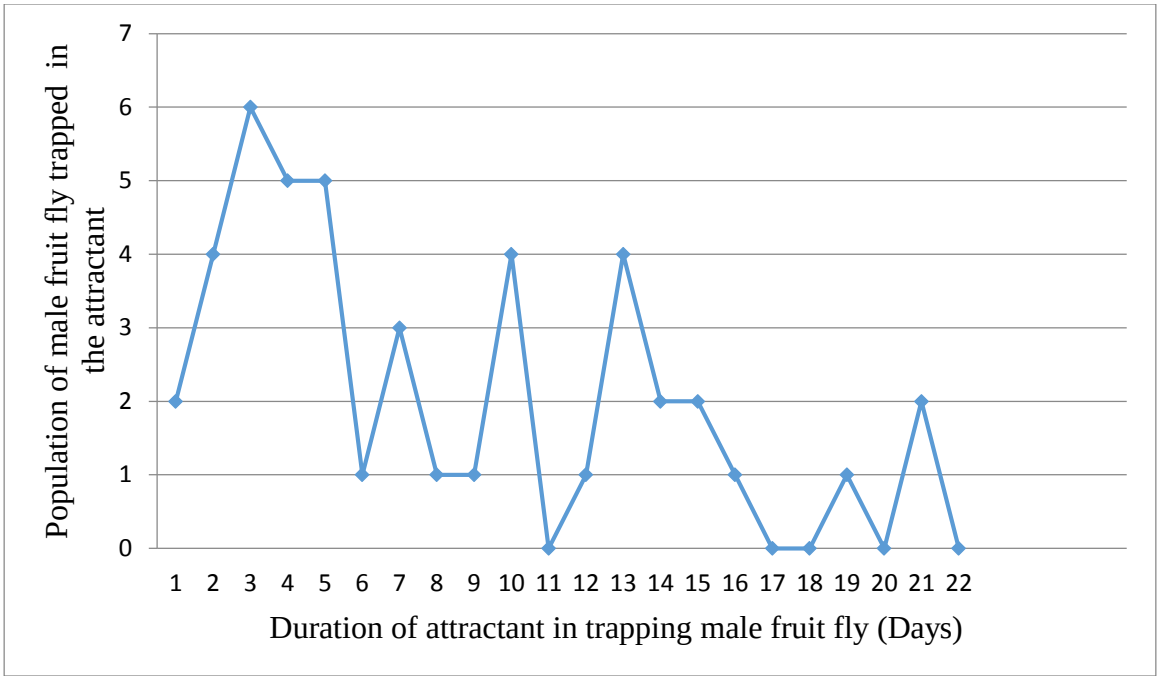

Figure 12.Number of male fruit fly trapped in the attractant per day

Species of Fruit Fly Trapped

The total number of female and male fruit fly species in the different treatment is presented in Table 4. There were nine species of fruit fly trapped in the different attractant. These were *Neoceratitiscyanescens* (Bezzi), *Bactrocerainvadens* (Tsuruta and White), *Bactroceratrayoni* (Froggatt), *Bactroceraoccipitalis* (Bezzi), *BactroceraPhilippinensis* (Drew and Hancock), *Bactroceracucurbitidae* (Coquillet), *Bactroceradorsalis* Hendel and two unidentified species. The fruit fly species were found on figure 13-20.

The result shows that trapped female is higher in number compared to male. The Table 4 also shows that tomato fruit fly (*Neoceratitiscyanescens)* was thehighest numberof fruit fly trapped. This indicates that the formulated attractant is effective in trapping *N.cyanescens.* During the data gathering it was observed that tomatoes were planted near the trapping site.

The result implies that the treatments are effective for pest control since most adult female fruit flies lay up to 500 eggs in their life span as mentioned byRussel (n.d).Thus by using muscovado extract can be used to decrease fruit fly population.

Table 4.The total number of trapped fruit flies species on the different treatments

SPECIES OF FRUIT FLY	SEX OF FRUIT FLY		TOTAL	MEAN
	F	M		
*Neoceratitiscyanescens*Bezzi	143	41	184	92.00[a]
Bactrocera invadens(Tsuruta and White)	10	0	10	5.00[b]
Bactrocera trayoni (Froggatt)	1	0	1	0.50[b]
Bactrocera occipitalis(Bezzi)	2	0	2	1.00[b]
Bactrocera philippinises (Drew and Hancock)	5	0	5	2.50[b]
Bactrocera cucurbitae(Coquillet)	3	0	3	1.50[b]
*Bactrocera dorsalis*Hendel	4	3	7	3.50[b]
Bactrocera sp. 1.	7	2	9	4.50[b]
Bactrocera sp. 2.	2	1	3	1.50[b]

Means with the same letter is not significantly different at 5% level of significance (DMRT)

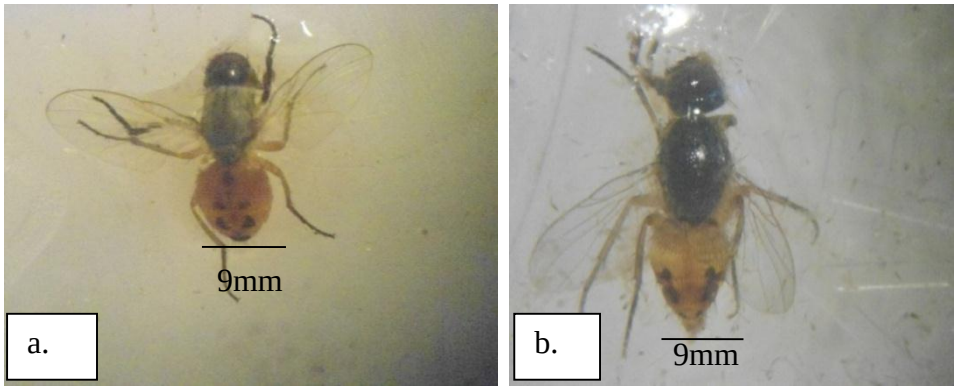

Figure 13. a) Adult male *Neoceratitiscyanescens*Bezzi; b) Adult female*Neoceratitiscyanescens*Bezzi (10x)

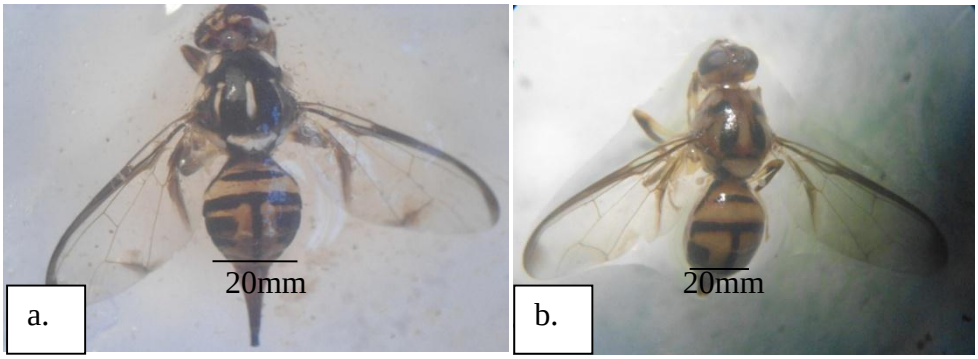

Figure 14. a) Adult female *Bactrocerainvadens*(Tsuruta and White);b)aAdult female *Bactrocerainva*dens (Tsuruta and White) (10x)

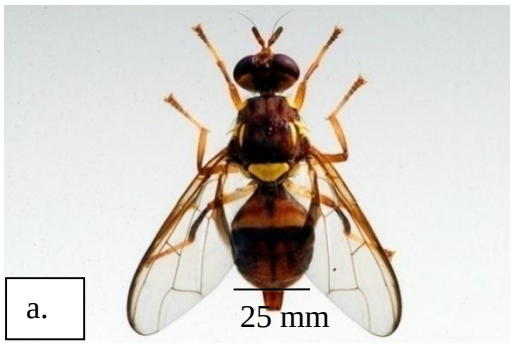

Figure 15. Adult female *Bactroceratrayoni* (Froggatt)

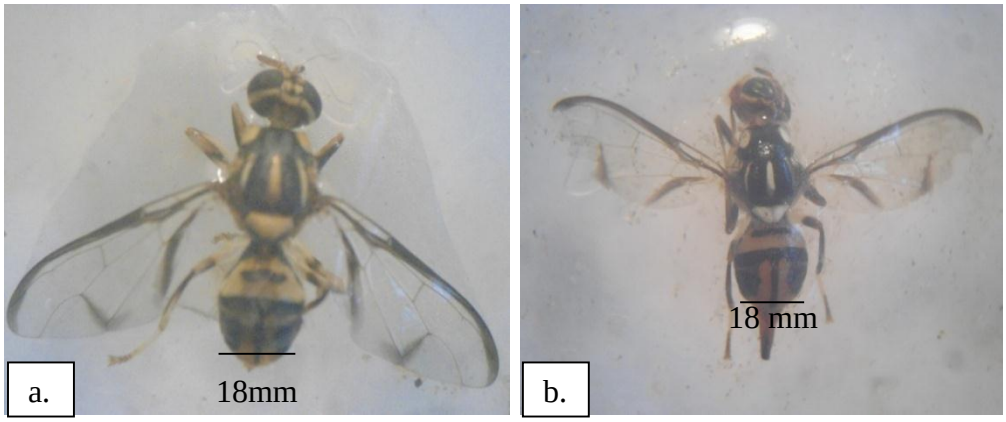

Figure 16. Adult male*Bactroceraoccipitalis*(Bezzi);b) Adult female*Bactrocera occipitalis* (Bezzi) (10x)

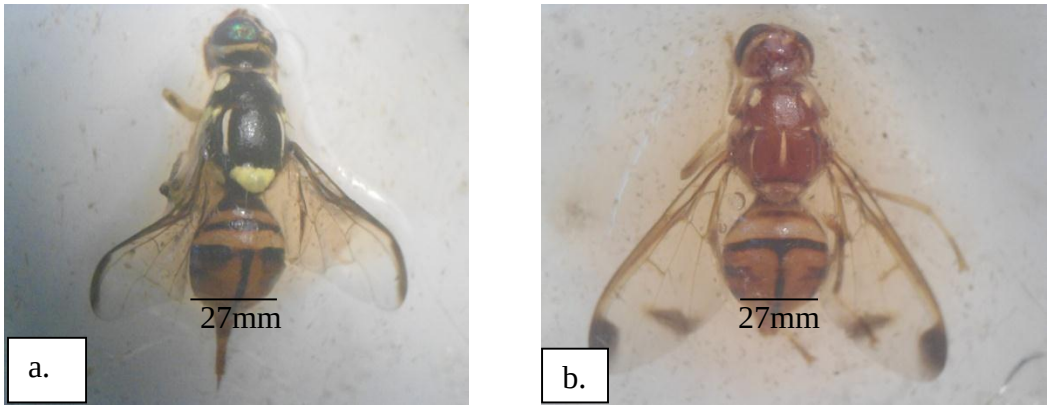

Figure 17. a)Adult female*Bactrocera Philippinensis*(Drew and Hancock)(10x)

Figure18. Adult female *Bactrocera cucurbitae*(Coquillet) (10x)

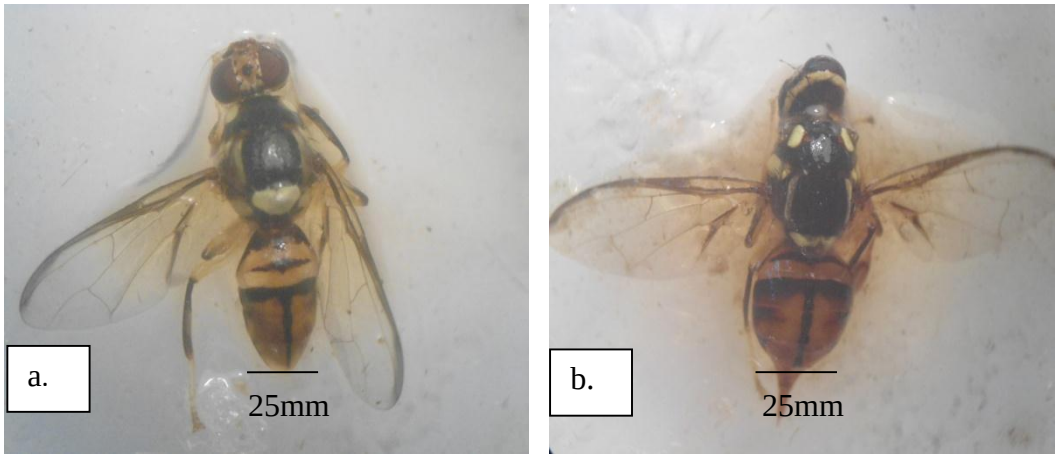

Figure 19.a) Adult male *Bactroceradorsalis*Hendel; b) adult female *Bactrocera dorsalis*Hendel (10x)

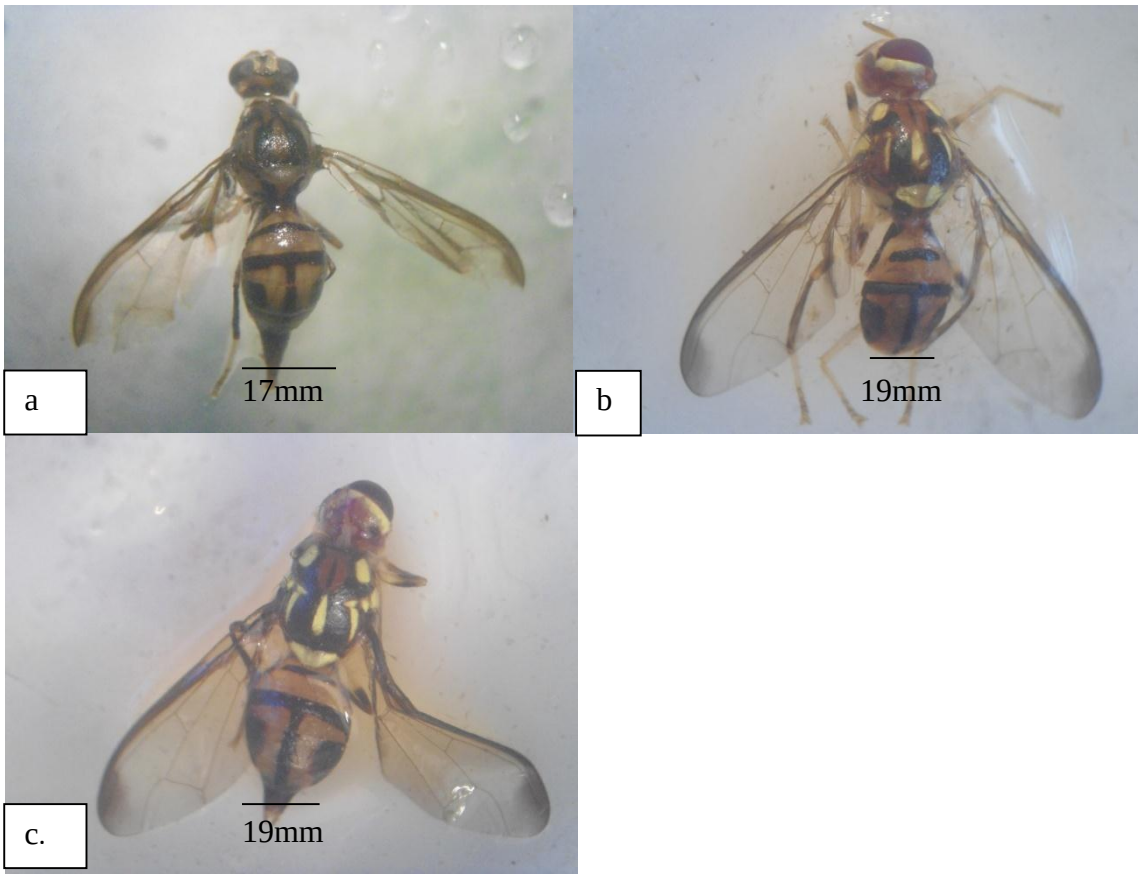

Figure 20. *Bactrocera sp*. a) Adult female *Bactrocera sp.*1;b) Adult male *Bactrocera sp*2; c) Adult female*Bactrocera sp.*2 (10x)

Duration of the Efficacy of the Attractant

The duration of the efficacy of the formulated natural attractant is shown in Figure 21.Regardless of the different treatments, there was an increasing number of insect trapped in day 2 to 4, and gradually decreasing from day 5 to day 14 but increasing from day 15 to 16. During the 17th day to 26th day there was an erratic increase and decreasein the population of attracted arthropods. The highest number of other arthropods trapped was recorded at day 3 with the total of 623 as corroborated by

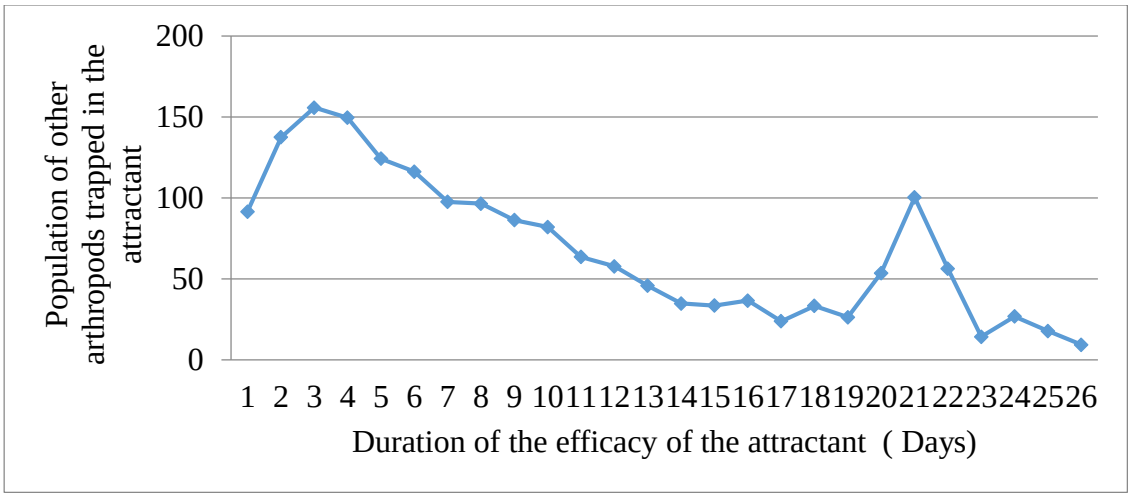

Figure 21. Duration of the efficacy of the different extract in catching insects

Basingan (2011) that the third day of collection yields the highest number of trapped insects. It was observed that during the data gathering the high rainfall cause the abrupt increase of other arthropods population trapped in the attractant from day 20 to 22 as corroborated by Ligat (2012) that adding water to the trap attract more insect even if fruit juice was already consumed.

In spite of the changing population of the insects trapped, the fruit extract was consumed within 10 days. The moscovadosugar solidifies at the bottom of the trapping material butcan still trapped insects up to 26th day.

The possible reason for the erratic number of insects and other arthropods collected in the traps can be attributed to the following factors: decrease in the volume of the attractant as it was consumed by the trapped insect and other arthropods,due to the exposure of the trap to the sun, in result the vinegar juice evaporates leaving the muscovado settled at the bottom of the trap and the extracts become viscous that cause the insect to drink hardly.Other factors that affect the population were the time of collection which is not constant with in the day of collection and the location of the trap.

Population of other Arthropods Trapped in the Attractant

The populations of the arthropods trapped in the different extracts areshown in Table 5. The statistical analysis shows that the number of arthropods trapped on the different attractant is highly significant. The table reveal that T_9 (muscovadoextract) has the highest number of trapped arthropods, followed by T_7 (mango extract), T_5 (guavaextract), T_1 (banana and strawberryextract), T_2 (banana and guavaextract), T_6 (bananaextract), T_8 (fruit muscovado extract), T_3 (banana and mango extract),T_4 (strawberry extract), T_{10} (vinegar juice), T_{11} (crude vinegar) and T_{12} (water), respectively.

The different extracts were effective in trapping insects and other arthropods.

Tables 5.The meantotal population of trapped insects on the different treatments for 26 days

TREATMENTS	TOTAL	MEAN
T_1 (banana and strawberry extract)	752	188.00^{ab}
T_2(banana and guava extract)	726	181.50^{ab}
T_3(banana and mango extract)	641	160.25^{b}
T_4(strawberry extract)	607	151.75^{bc}
T_5(guava extract)	750	187.50^{ab}
T_6(banana extract)	666	166.50^{ab}
T_7(mango extract)	798	199.50^{ab}
T_8(fruit muscovado extract)	659	164.75^{ab}
T_9(muscovado extract)	894	223.50^{a}
T_{10}(vinegar juice)	414	103.50^{c}
T_{11}(crude vinegar)	40	010.50^{d}
T_{12}(water)	3	000.75^{d}
SUB TOTAL	6,950	1,738

Means with the same letter is not significantly different at 5% level of significance (DMRT)

Families of other Arthropods Trapped in the Attractant

There were 49 families of insects trapped in the attractant. Among the 49 families, 15 were trapped less than three times throughout the 26 days. There were also two other arthropods that was trapped.From the trapped arthropods there were 24 families of non-beneficial arthropods and 12 families were classified asbeneficial.

These insect families are the following from the order Diptera: Scotopsidae, Anthomyiidae,Muscidae, Sarcophagidae, Chironomidae, Agromyzidae, Tabanidae, Psychodidae, Drosophilidae, Tipulidae, Sipsidae, Culicidae and Calliphoridae.The pictures of the different families of order Diptera are shown in Figure 9. Order Lepidoptera: Noctuidae,Pyralidae,Sessidae and Plutillidae (Figure10.). Order Coleoptera: Chrysomilidae,Dermistidae,Coccinilidae,Nitidulidae, Staphilinidae,Scarabaeidae andCarabaeidae (Figure 11); Order Hymenoptera: Vispidae,Braconidae,Formicidae, IchneumonidaeandApidae (Figure 12); and Order Hemiptera: Lygaeidae,Micropezidae andAphididae (Figure 13) and Blattodea: Blatellidae (Figure 14.a); Neuroptera: Chrysopidae (Figure 15.a). The two arthropods (Spider (Figure 16a), mites (Figure 16b-c)are shown in Figure 16.

Visiting insectsare: Meloidae (Figure 17.a), Glechiidae, (Figure 17.b), Doliichopolidae (Figure 17.c), Elatiridae (Figure 17.d-e), Sphingidae (Figure 17.f), Curculionidae (Figure 17.h), Papilionidae (Figure 1.7i), Miridae (Figure 17.j), Arctiidae (Figure 17.k), Cicadellidae (Figure17.l), Acroceridae(Figure 17.m), Bruchidae(Figure 17.n),Pterophoridae (Figure 17.o), Hemerobiidae (Figure 17.p), Labiduridae (Figure 17.q).

Both beneficial and pest were trapped in the different attractant which disagree with Basingan, 2011 stated that crude vinegar is used to enhance the aroma of the attractant and was believed to drive away and lessen beneficial insects that will be trapped

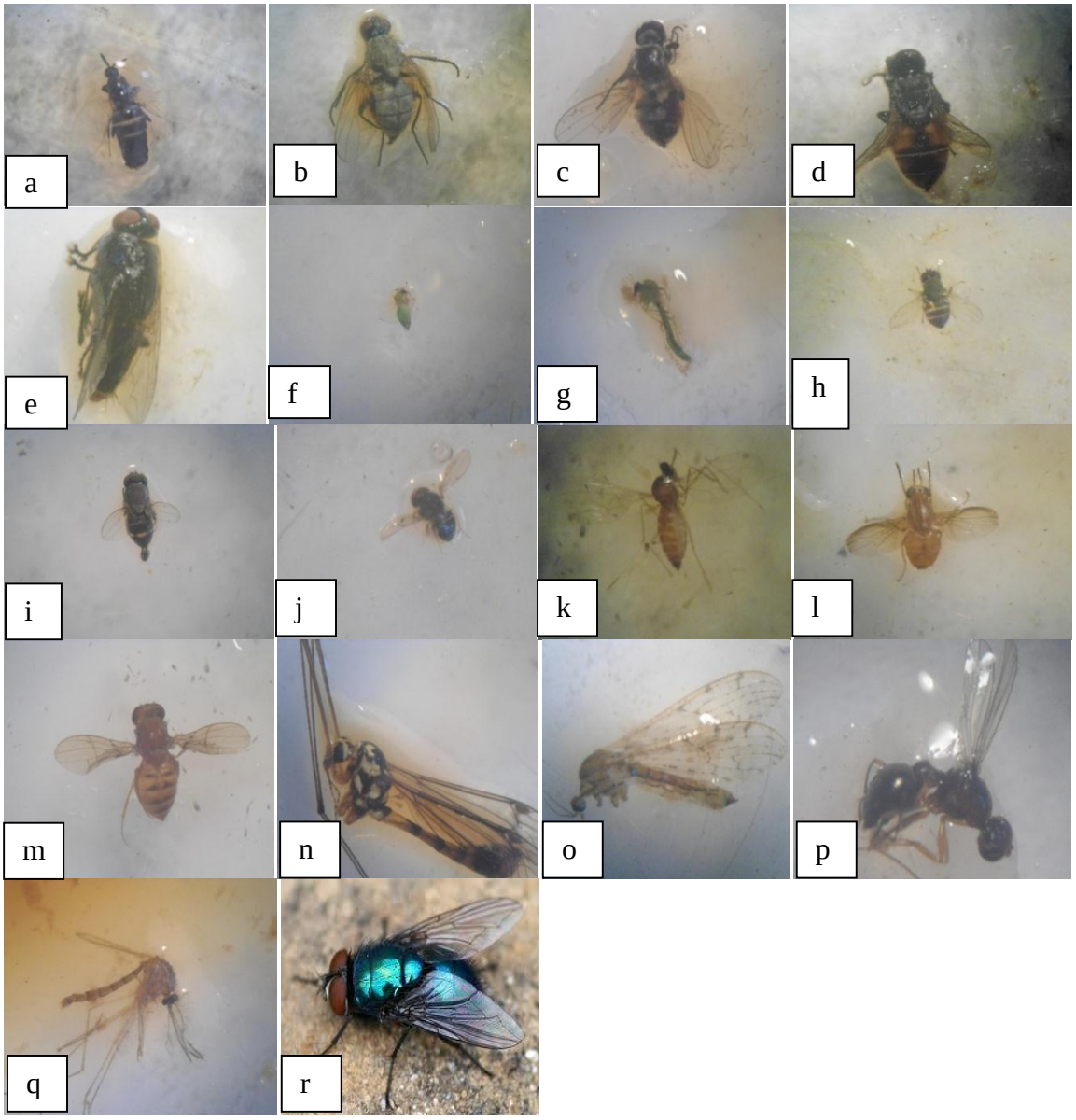

Figure22.Families of Order Diptera; a) Scotopsidae; b-c) Anthomyiidae, d) Muscidae; e)Sarcophagidae; f-g) Chironomidae; h-i) Agromyzidae; j.) Tabanidae; k)Psychodidae; l-m) Drosophilidae; n-o) Tipulidae; p) Sipsidae; q)Culicidae; r) Calliphoridae(10x)

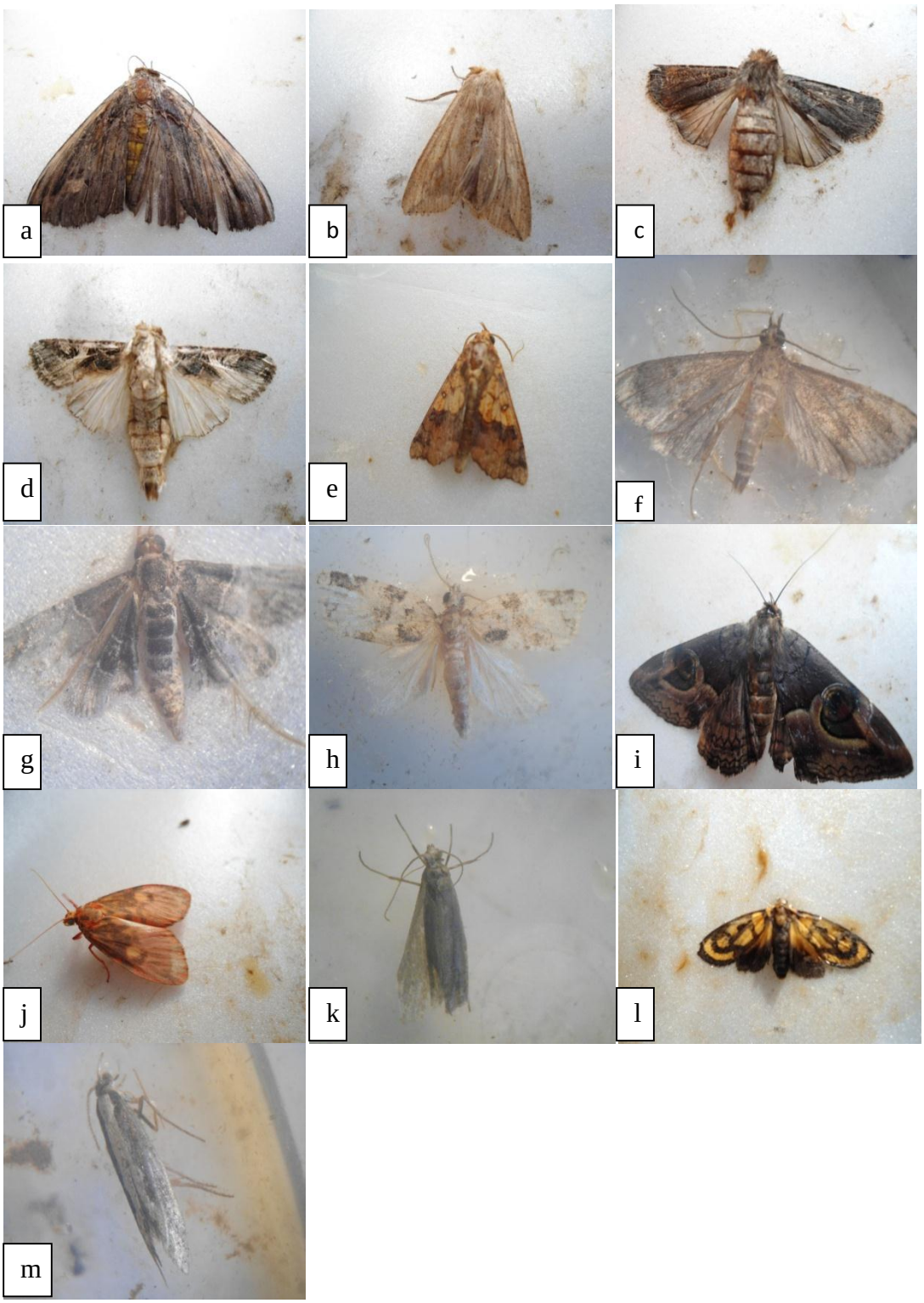

Figure 23.Families of Order Lipedoptera; a-e) Noctuidae; f-k)Pyralidae; l) Sessidae: m)Plutillidae

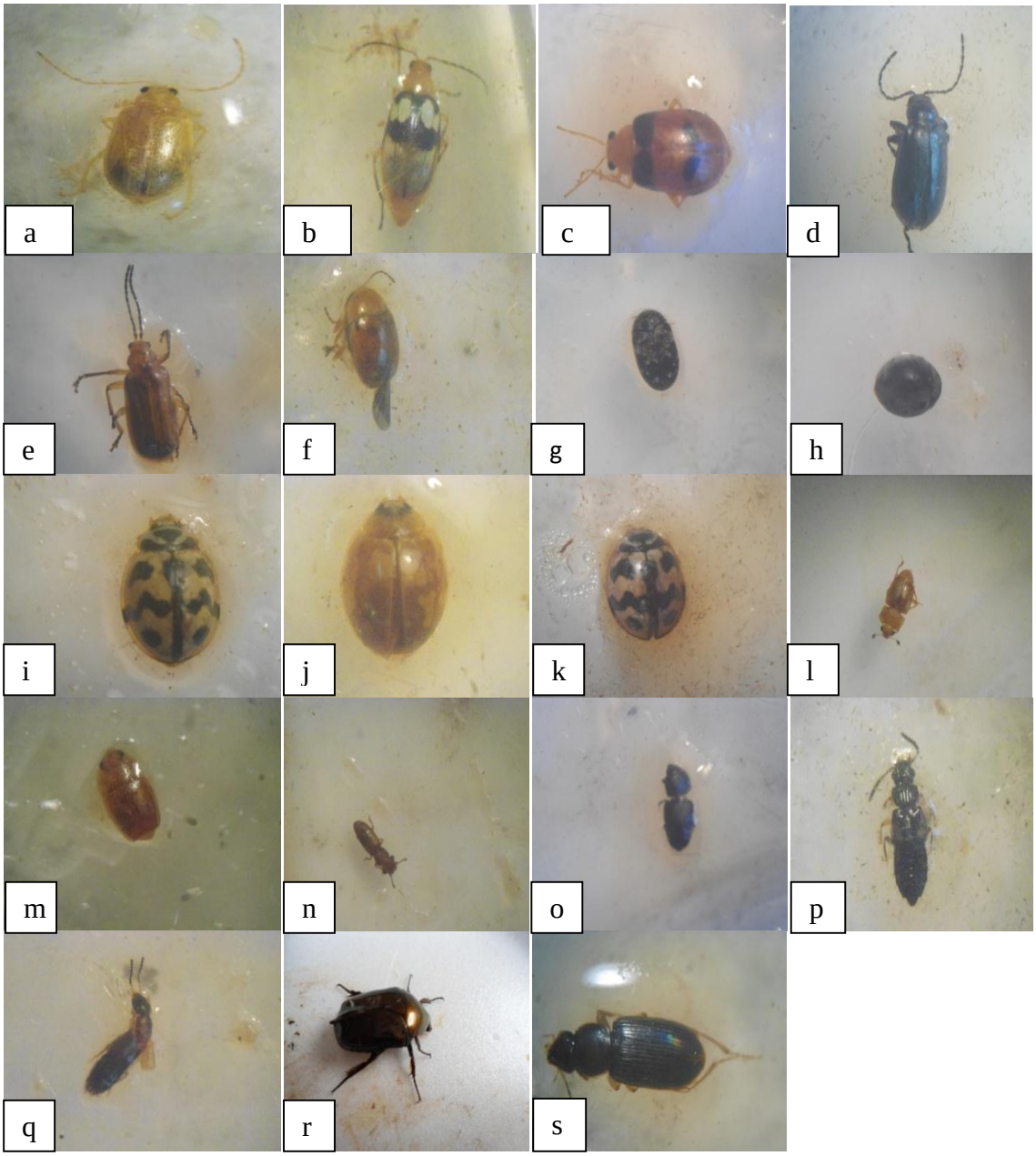

Figure 24.Familiesof Order Coleoptera;a-f) Chrysomilidae; g) Dermistidae; h-k)Coccinilidae; l-o) Nitidulidae; p-q) Staphilinidae; r) Scarabaeidae; s)Carabaeidae (10x)

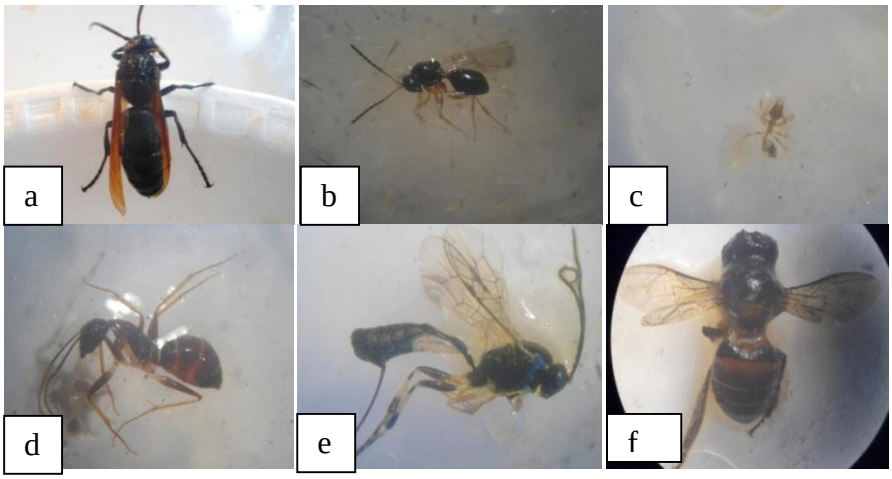

Figure 25.Families of Order Hymenoptera; a) Vispidae; b) Braconidae; c-d) Formicidae; e)Ichneumonidae ; f) Apidae (10x)

Figure 26.Families of OrderHemiptera; a)Lygaeidae; b) Micropezidae; c) Aphididae (10x)

Figure 27 .Family of Order Blattodea. a)Blatellidae(10x)

Figure 28.Family of Order Neuroptera: a) Chrysopidae (10x)

Figure 29.Other arthropods; a) spider; b-c) mites (10x)

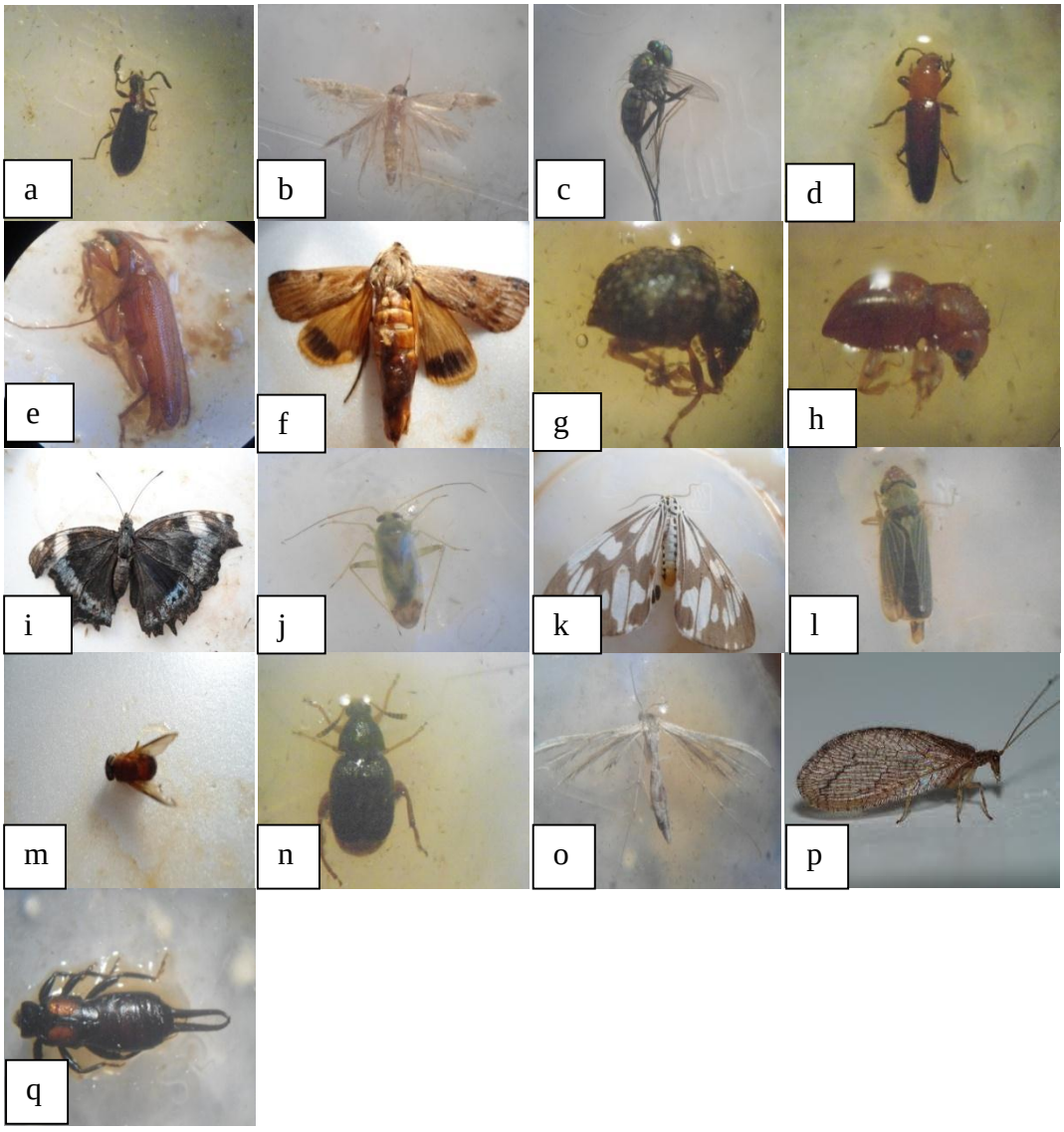

Figure 30.Visiting insect; a) Meloidae; b) Glechiidae; c)Doliichopolidae; d-e) Elatiridae; f) Sphingidae; g-h) Curculionidae; i)Papilionidae; j)Miridae; k) Arctiidae;l) Cicadellidae; m) Acroceridae; n)Bruchidae;o) Pterophoridae;p) Hemerobiidae; q) Labiduridae (Dermaptera) (10x)

Cost of Production

An expenses used in making the different fruit extracts and vinegar juiceis presented in Table 6.

Table 6. Expenses in the different fruit extracts and vinegar juice preparation

TOTAL INVESTMENT	UNIT			AMOUNT
A. Fruits and muscovado				
a. Muscovado sugar	12 kg			780.00
b. Banana fruit	6 kg			105.00
c. Strawberry fruit	2 kg			200.00
d. Mango fruit	2 kg			50.00
e. Guava fruit	2 kg			20.00
SUB TOTAL				1,155.00
B. Fermentation materials				
a. Chopping board	1piece			50.00
b. Knife	1 piece			75.00
c. Mesh cloth	1piece			5.00
d. Manila paper	4 pieces			25.00
e. Robber band	30 pieces			15.00
f. Vinegar	2 gallons			280.00
g. Earthen jar	5 pieces			250.00 (hire)
SUB TOTAL				700.00
C. Trapping materials				
a. Styrofoam	48 pieces			79.75
b. Bottle	48 pieces			96.00 (hire)
c. Straw	1 roll			50.00
d. Stick	24 pieces			48.00
SUB TOTAL				273.75
	No. of worker	Per day	Days	
D. Man power	1	150	10	1500.00
a. Food	1	35	10	350.00
SUB TOTAL				1,850.00
TOTAL				3,978.75

There were 13 gallons of 1.5 soft drink container of the formulation. The price of 150ml formulation would be 31.00. The price was based on the current price of methyl eugenol sold in the market.

It impliesthat production of different fruit extracts and vinegar juicefor fruit fly control is profitable.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at Balili Experimental Station, La Trinidad Benguet from December 2012 to March 2013 to determine the best formulation that attract adult fruit fly; identify the species of fruit fly trapped in the attractant; determine the duration of the efficacy of the attractant; to determine the population and families of the other arthropods trapped in the attractant; and know the cost of production in preparing fruit extract and vinegar juice.

The different fermented fruit and vinegar juice extractshas highly significant different from each other. Numerically treatment 9 (muscovadoextract) attracted the most number of fruit fly with the total of 37.

There were nine species of fruit fly that was trapped in the different treatments. These were *Neoceratitiscyanescens*(Bezzi), *Bactrocerainvadens*(Tsuruta and White), *Bactroceratrayoni*(Froggatt), *Bactroceraoccipitalis*(Bezzi), *Bactroceraphilippinensis*(Drew and Hancock), *Bactroceracucurbitidae*(Coquillet), *Bactroceradorsalis*Hendel and two unidentified species. Among the species of fruit fly trapped in the attractant female has higher number as compared to male.

The duration of efficacy of formulated natural attractant lasted for 26 days. Regardless of the changing number of insect trapped the third day of collection yields the highest number of trapped arthropods with the total of 623. Rainfall affect the number of arthropods trapped per day.

The arthropods trapped in the attractant belong to 8 orders under class Insecta and two Suborders of class Arachnida. Further, the orders trapped were Diptera with 15

families; Lepidoptera with 9 families; Coleoptera with 11 families; Hymenoptera with 5 families; Hemiptera with 5 families; Blattodea with 1 family; Neuropterawith 2 families and Dermaptera with 1 family. The two Subordersunder class Arachnida that was trapped belong to Aranae and Acari.

Formulated attractant is worth working because total cost of production for the whole experiment was just Php. 3,978.7 compared to the price of synthetic chemicals sold in the market.

Conclusion

All the treatments except treatment 10 (vinegar juice)and treatment 11 (crude vinegar) are effective in trapping adult fruit flies. All the treatments also are effective in trapping both non-beneficial and beneficial arthropods. The efficacy of the formulated attractants lasted for 26days. The third day of collection yields the highest number of trapped arthropods.

Recommendation

Tap water and muscovado alone is therefore recommended for fruit fly trap formulation. It is also recommendedto refill the extracts in the traps with water after ten days from set up. The different fruit extracts and vinegar juice can be used to control other insect pests. Collection of trapped insects must be done every day at the same time and windows of traps must be wider.

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