



MAURITIUS RESEARCH COUNCIL

**CONTROL OF STOMOXYS
NIGRA MACQUART
(DIPTERA: MUSCIDAE) IN
DEER RANCHES IN
MAURITIUS**

Final Report

March 2001

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AGRICULTURAL RESEARCH AND EXTENSION UNIT

Food and Agricultural Research Council

Control of *Stomoxys nigra* Macquart (Diptera: Muscidae) in deer ranches in Mauritius

End of Project Report

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Executive Summary

Stomoxys nigra (Diptera: Muscidae) is haematophagous and causes great irritation to deer and cattle resulting into weight loss. Attempts to control *S. nigra* have included the use of insecticides (residual sprays in open pastures and cowsheds) and trapping of adult flies. Traps (Bourgault, Israeli and Funnel traps) have been used in cow byres and surroundings but with ineffective control.

Several species of parasitoids have been introduced to control larvae and pupae of *S. nigra* in breeding sites (sugar cane fields). Inoculative releases of introduced parasitoids (*Tachinaephagus stomoxicida* and *Trichopria* sp.) have resulted in a substantial reduction of pest population. Yet *S. nigra* still remains a serious problem to deer during summer when the fly population is high.

In 1999, a joint project was put up with Mauritius Meat Producers' Association and Agricultural Research and Extension Unit and partly funded by the Mauritius Research Council to develop a trapping system to attract and kill adult flies in deer ranches. The study focused on investigating the effectiveness of impregnated targets and the Nzi trap against adult *S. nigra*, and their potential use in deer ranches.

Impregnated targets made of jute bags soaked with citrated blood and sprayed with insecticide (Deltamethrin) were placed at feeding sites of deer in April and October when *S. nigra* is low and high respectively. Trapped dead flies were recorded at 24-hour intervals for 15 consecutive days. The impregnated targets were found to be ineffective against *S. nigra* adults.

The Nzi trap, initially developed by International Centre for Insect Physiology and Ecology (ICIPE) to capture the tsetse flies (*Glossina pallipides*) in Kenya, was tested locally in four deer ranches (Salazie, Sans Souci, Pradier and Riche en Eau) to evaluate its efficacy in capturing *S. nigra*.

The Nzi trap is an effective, inexpensive and environment-friendly alternative to insecticides against adult *Stomoxys* flies in deer ranches. No beneficial insects (parasitoids or predators) were recorded in captures. Placement of a minimum of 2 traps per km² in ranches would help reduce *Stomoxys* fly populations. Some 150 traps are being tested on 26 ranches.

Three host odours (with octenol, butanone and cow urine) were tested, but did not improve the efficacy of the traps.

Two dyes, royal blue and pthalogen blue, were compared on the cotton cloth component. Both were equally attractive to *Stomoxys* flies, with royal blue proving less costly.

Currently, research is being undertaken on the perception of deer ranch owners on the Nzi trap, through a questionnaire-based survey. The trap design is being improved so that it can better withstand adverse climatic conditions.

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1.0 INTRODUCTION

1.1 Project description

In Mauritius, about 65,000 deer are raised (55,000 heads in ranches and 10,000 in feedlots) and about 500 tons of deer meat are produced for local consumption annually.

Stomoxys nigra (Diptera: Muscidae) is one of the major pests that affects deer farming. The adult flies burrow into the hairs of deer to reach the skin and feed on their blood. Their collective feeding behaviour at a particular point results into intradermal blisters leading to bleeding sores on the animals. Secondary myiasis flies (e.g. *Chrysomia megacephala*) deposit their eggs upon them and maggots develop therein. Besides, *Stomoxys* flies are also reported to be a potential vector of Surra disease.

1.2 Biology of *Stomoxys nigra* Macq.

Females of *S. nigra* deposit eggs in decaying sugar cane trash left in sugar cane fields after harvest. Larvae develop and pupate in the trash. After emergence, males and females search for their hosts to feed on their blood. The life cycle from egg to adult is completed in about 20 days, and adults live up to three weeks.

During the cooler period of the year, the fly population is normally considered low but during the summer months, high temperatures cause a seasonal increase in fly activity in ranches of the humid and super humid areas. During such period, the pest causes great irritation to deer resulting in weight loss.

1.3 Control of *Stomoxys nigra*

Research has been undertaken on physical, chemical and biological methods of control. Three types of traps (Bourgault, Isreali and Funnel) have been used against the pest. The Bourgault and Isreali traps were not effective whereas funnel traps caught significantly large numbers of *S. nigra* from closed cowbyres. No trap has been developed to control *Stomoxys* flies in deer ranches and open pastures.

In these situations, insecticides have so far been the only means to control adult *Stomoxys* flies. Regular insecticide applications are essential during rainy periods because sprays are easily washed away by rain. Such a practice is expensive and gives only temporary relief to animals. Besides, it may have adverse effects on beneficial organisms and the environment.

Two species of parasitoids (*Tachnaephagus stomoxicida* and *Trichopria* spp.) have been released, and exert significant control of larvae and pupae of *S. nigra*. During the cooler periods of the year, the population of the parasitoids decline drastically compared to that of *S. nigra*. Soon after the start of the sugar cane harvest, the higher biotic potential of *S. nigra* helps it build up a large population again. Periodic releases of parasitoids are thus needed to boost the parasitoid population at the start of the sugar cane harvest and during the summer months.

In Kenya and in other African countries, traps have been effectively used to control the tse-tse fly. The International Centre of Insect Physiology and Ecology (ICIPE) has developed the Nzi trap made of cotton cloth (phthalogen blue and black), mosquito

netting and clear plastic. It works through the attraction of flies to large blue and black objects. Once flies are attracted and trapped, they die from prolonged exposure to direct sunlight. This trap has been effective to mass capture tsetse flies, horseflies and *Stomoxys* spp. Host odour baits (octenol, butanone, acetone and cow urine) incorporated in the traps have been known to increase the tse-tse catches.

1.4 Aim of project

The aim of the project was to develop an effective trapping system to lure and kill *Stomoxys nigra* in deer ranches.

1.5 Objective of Project

The specific objectives of the project were:

- a. To test the efficacy of insecticide-impregnated targets against *Stomoxys nigra*
- b. To evaluate the efficacy and attractiveness of Nzi trap

2.0 MATERIALS AND METHODS

2.1 Sites of study

The studies were conducted in deer ranches at Salazie, Sans Souci, Pradier and Riche en Eau. These four sites are at different altitudes (Table 2.1) with an annual rainfall ranging from 2000 to 5000 mm and evaporation from 1,400 to 1,600 mm. The vegetation consists of woodlands and patches of open grassland where deer normally aggregate during feeding hours. *Stomoxys nigra* is known to occur in low numbers during the cooler period of the year and in high numbers during summer.

Table 2.1: Acreage and herd size of sites of study

Site	Altitude (metre)	Acreage (ha)	Herd size
Salazie	500	1000	600
Sans Souci	277	75	200
Pradier	600	250	250
Riche en Eau	110	380	1000

2.2 Testing of insecticide-impregnated targets against *Stomoxys nigra*

The trial was conducted at Salazie in April 1999 when population level of *S. nigra* was low and in October 1999 when the pest population was high. Jute bags, each of size 53 cm x 71 cm, were soaked with two litres of citrated bovine blood treated with Deltamethrin (6 g/litre) and used as targets. These targets were stretched out between two adjacent trees and secured in place. A plastic sheet was stretched below each target to collect dead flies.

The insecticide-impregnated targets were placed at a distance of 1 km from each other at four sites where deer normally fed. The number of dead flies was recorded every 24 hours for 15 consecutive days.

2.3 Evaluation of the efficacy of Nzi trap

This study comprised three experiments:

- a. Investigation on the attractiveness of Nzi trap to capture *Stomoxys nigra*.
- b. Evaluation of the effect of synthetic host odours and cow urine on trap catches
- c. Evaluation of the efficacy of the trap made of cotton cloth dyed with pthalogen blue and royal blue

2.3.1 Investigation on the attractiveness of Nzi trap to capture *Stomoxys nigra*

This trial was undertaken at Salazie deer ranch between April and October 1999. One Nzi trap was set (at ground level) in an open location at about 10 metres away from a feeding site. Catches were collected at weekly intervals to determine the fly numbers, percentage of *S. nigra* caught and sex ratio.

2.3.2. Evaluation of the effect of synthetic host odours and cow urine on trap catches

Sixteen (16) traps were placed in four ranches at Salazie, Sans Souci, Pradier and Riche en Eau from November 1999 to February 2000. In each ranch, four traps were placed at a minimum distance of 1 km from each other at feeding sites of deer. The first trap was baited with octenol, second with butanone, third with cow urine and the fourth (control) without any odour bait. Octenol and butanone were dispensed from sealed glass vials (with very fine apertures) at about 0.5 mg/h. Cow urine (250 ml) was dispensed from an open glass bottle. Odour sources were placed at ground level. Captures were collected at weekly intervals.

2.3.3. Evaluation of the efficacy of the traps with cotton cloth dyed with pthalogen blue and royal blue

One trap (model of ICIPE with cotton cloth dyed with pthalogen blue) and the other (model of ICIPE with royal blue cotton cloth) were placed at Salazie during March and April 2000. Trap catches were collected at weekly intervals.

3.0 RESULTS

3.1 Testing of insecticide-impregnated targets against *Stomoxys nigra*

The daily average number of dead flies per target in April and October was 10 and 17 respectively. These targets attracted very low numbers of flies (Tables 3.1a & 3.1b) especially during the peak fly season (October).

Table 3.1a: Number of *Stomoxys nigra* (adults) collected from insecticide-impregnated targets (T1-T4) at four sites - Salazie, April 1999.

Day	T1	T2	T3	T4	Mean
01	11	9	12	10	10.5
02	2	15	7	15	9.8
03	7	5	14	18	11.0
04	18	10	11	0	9.8
05	5	7	15	17	11.0
06	6	10	17	11	11.0
07	17	5	13	8	10.8
08	8	14	11	5	9.5
09	15	3	13	7	9.5
10	5	17	9	0	7.8
11	0	14	11	15	10.0
12	22	7	0	14	10.8
13	7	11	15	9	10.5
14	4	18	18	7	11.8
15	17	1	1	15	8.5

Table 3.1b: Number of *Stomoxys nigra* (adults) collected from the insecticide-impregnated targets (T1 – T4) at four sites - Salazie, October 1999

Day	T1	T2	T3	T4	Mean
1	19	16	19	14	17.0
2	12	14	13	25	16.0
3	11	7	21	15	13.5
4	18	20	14	17	17.2
5	25	19	10	13	16.8
6	20	12	22	15	17.2
7	19	10	23	14	16.5
8	7	25	19	17	17.0
9	21	19	14	16	17.5
10	24	15	17	13	17.2
11	12	19	23	18	18.0
12	17	14	16	21	17.0
13	8	23	20	17	17.0
14	24	21	17	7	17.2
15	14	21	7	25	16.8

3.2 Evaluation of the efficacy of Nzi trap

(i) Catch level

An average of 92 *Stomoxys* flies was caught daily during April. No significant increase was observed in May and June. Thereafter the daily catch increased to an average of 150 flies between July and September and reached a peak of 510 during October.

(ii) Insect species composition in catches of Nzi trap

More than 90 % of trap catches were Dipterans. Species captured were *S. nigra*, *Musca domestica*, (Muscidae); green and blue bottle flies (Calliphoridae); fruit flies (Tephretidae); mosquitoes (Culicidae) and vinegar flies (Drosophilidae). Other insects captured were small moths (of uneconomic importance) that were grouped as "Lepidopterans" (Table 3.2).

The percentage of *S. nigra* in the trap during April – October ranged from 37.6 % to 99.2 % (Table 3.3). *Musca domestica*, *Lucilia* sp. and *Chrysomya* sp (green and blue bottle flies), and other Dipterans were captured in comparatively lower numbers. The percentage of Lepidopterans varied between 1.5 % to 8.7 %. *Bactrocera cucurbitae* (fruit flies) was recorded in 2 catches and two individuals of *Apis mellifera* (honeybees) were caught during the whole study. No predators and parasitoids beneficial insects were captured (Tables 3.2 & 3.3).

(iii) Percentage of *Stomoxys nigra* and sex ratio

Between 19th April and 21st October, the percentage of captured *S. nigra* varied from 37.6 % to 99.2 %. The period under study showed 3 distinct phases: Phase I (19/04 – 07/06); II (14/06 – 26/08) and III (02/09– 21/10).

Table 3.2: Percentage of *Stomoxys nigra* and other insect species captured in Nzi trap Salazie, April and June 1999

Date	Total captures	Percentage of insects captured							
		<i>Stomoxys nigra</i>	<i>Musca domestica</i>	Green bottle fly	Blue bottle fly	unidentified Lepidopterans	<i>Aphis mellifera</i>	<i>Bactrocera</i> spp.	Other dipterans
20/4	653	41.2	14.1	10.7	1.1	1.5	0.1	0.1	31.1
21/4	201	32.0	24.3	5.5	2.0	6.5	0	0	29.6
22/4	314	34.4	15.9	1.0	0.6	7.9	0.3	0	39.8
26/4	863	49.4	15.9	0.7	0.9	6.7	0	0	26.4
28/4	147	51.7	26.5	2	1.8	7.4	0	0	10.9
14/6	396	91.2	5.8	1.0	1.0	0	0	0	1.0
16/6	309	46.0	7.4	1.9	0	8.7	0	0.3	35.6
18/6	218	66.5	17.4	4.6	0	1.8	0	0	9.6
21/6	274	59.1	15.0	4.7	0.4	4.7	0	0	16.1
23/6	557	75.9	0	4.3	1.8	2.0	0	0	16.0

- During phase I, the percentage catch of *S. nigra* ranged from 37.6 % to 49.2 % (except on 17/5) with a sex ratio (M:F) of 1:1. In phase II, catches of *S. nigra* ranged from 52.5 % to 94.6 % and sex ratio varied from 1:3 to 1:8. In phase III, up to 99.2 % of the catches were *S. nigra* with a sex ratio ranging from 1:1 to 1:4 (Table 3.3).

**Table 3.3: Capture and sex ratio of *S. nigra* in Nzi trap
– Salazie, April to October 1999.**

Phase	Period	Total captures	Capture of Dipterans*	<i>S. nigra</i>	
				Number (%)	Sex ratio (M:F)
I	19/4 - 26/4	2036	1066 (52.4)	855 (42.0)	1:1
	26/4 - 02/5	905	427 (47.1)	439 (48.5)	1:1
	02/5 - 10/5	1329	566 (42.6)	500 (37.6)	1:1
	10/5 - 17/5	779	16 (2.1)	691 (88.7)	1:1
	17/5 - 24/5	709	342 (48.3)	349 (49.2)	1:2
	24/5 - 31/5	1762	863 (49.0)	867 (49.4)	1:2
	31/5 - 07/6	668	348 (52.1)	302 (43.9)	1:3
	07/6 - 14/6	953	81 (8.5)	860 (90.3)	1:2
II	14/6 - 21/6	788	308 (39.1)	431 (54.7)	1:3
	21/6 - 28/6	1002	335 (33.4)	640 (63.9)	1:3
	28/6 - 07/7	918	372 (40.6)	482 (52.5)	1:3
	07/7 - 14/7	1306	228 (17.5)	1047 (80.2)	1:7
	14/7 - 21/7	1364	195 (14.3)	1129 (82.8)	1:8
	21/7 - 28/7	979	223 (22.8)	707 (72.2)	1:3
	28/7 - 04/8	959	217 (22.6)	674 (72.4)	1:8
	04/8 - 11/8	1510	109 (7.2)	1267 (90.5)	1:7
	11/8 - 20/8	2265	120 (5.3)	2122 (93.7)	1:5
	20/8 - 26/8	1429	63 (4.4)	1346 (94.2)	1:4
	26/8 - 02/9	557	8 (1.5)	538 (96.5)	1:2
III	02/9 - 10/9	541	8 (1.5)	522 (96.5)	1:2
	10/9 - 16/9	524	17 (3.2)	497 (94.8)	1:1
	16/9 - 23/9	2407	60 (2.5)	2342 (97.3)	1:3
	23/9 - 29/9	1092	49 (4.5)	1040 (95.3)	1:4
	29/9 - 05/10	1669	28 (1.7)	1637 (98.1)	1:2
	05/10 - 13/10	4055	24 (0.6)	4042 (99.2)	1:2
	13/10 - 21/10	6153	74 (1.2)	6067 (98.6)	1:4

* Dipterans included all other than *S. nigra*

3.2.1 Evaluation of the effect of synthetic host odours and cow urine on trap catches

All the Nzi traps, whether baited with octenol, butanone or cow urine, or without bait captured adult *S. nigra*. Catches of other Dipterans and Lepidopterans were very low (<1.5 %). Between November 1999 and February 2000, about 53,000, 42,000 and 20,000 adults of *S. nigra* were captured in the 4 traps at Riche en Eau, Sans Souci and Salazie deer ranches respectively. At Pradier deer ranch, about 26,200 *Stomoxys* were caught during November – December.

Quartiles from cumulated counts over the period were analysed for significant variance. No significant differences were observed among catches by traps with and without bait ($P < 0.05$).

Table 3.4a: Number of *Stomoxys nigra* adults caught in traps (with and without bait) - Riche en Eau, October 1999 to February 2000

Week	Odour bait			Control
	Butanone	Octenol	Cow urine	
1	1403	2913	0	0
2	219	2688	609	326
3	564	437	1076	360
4	1053	49	380	343
5	412	3656	1797	896
6	23	0	70	11
7	0	11	6	0
8	2100	4200	2400	1900
9	3700	2000	2500	900
10	1100	700	2100	2700
12	1500	800	0	2000
13	723	311	113	126
14	350	5	1000	200
15	151	0	25	0
16	0	54	5	14
Total	13,298	17,824	12,081	9,778

Table 3.4b: Number of *Stomoxys nigra* adults caught in traps (with and without bait) - Sans Souci, October 1999 to February 2000

Week	Odour bait			Control
	Butanone	Octenol	Cow urine	
1	1249	4084	3124	4490
2	523	2345	116	404
3	0	3070	0	871
4	1236	1100	5	3041
5	1254	1073	1404	104
6	0	389	325	400
7	0	0	45	751
9	800	73	1560	2500
10	0	52	1172	0
11	223	65	74	4
12	3530	0	0	73
13	5	0	200	0
14	0	120	48	0
Total	8,820	12,370	8,073	12,638

**Table 3.4c: Number of *Stomoxys nigra* adults caught in traps (with and without bait)
Salazie, October 1999 to February 2000**

Week	Odour bait			
	Butanone	Octenol	Cow urine	Control
1	712	3753	1979	944
2	739	532	29	127
3	1878	356	950	287
4	975	312	1092	119
5	0	539	112	985
6	250	5	0	132
7	19	180	0	0
8	130	641	200	525
9	447	0	122	143
10	12	5	12	232
11	0	0	138	350
12	19	14	4	11
13	200	12	23	0
Total	5,381	5,810	4,461	3,855

**Table 3.4d: Number of *Stomoxys nigra* adults caught in traps (with and without bait)
Pradier, October to December 1999**

Week	Odour bait			Control
	Butanone	Octenol	Cow urine	
1	1070	1461	3496	2434
2	2598	1375	2077	1109
3	1106	1050	1108	0
4	79	2258	556	4000
5	234	0	15	4
6	158	0	0	0
Total	5245	6144	7252	7543

3.2.2 Evaluation of the efficacy of the trap made of cotton cloth dyed with pthalogen blue and royal blue

The number of *S. nigra* caught in the trap with cotton cloth dyed pthalogen blue did not differ significantly with that caught in the trap with royal blue cloth.

**Table 3.5: Number of adult *Stomoxys* captured in traps (pthalogen blue or royal blue)
- Salazie, March to April 2000**

Date	Nzi trap colour	
	Pthalogen blue	Royal blue
20/03/00	130	525
27/03/00	165	0
03/04/00	232	12
10/04/00	0	138
19/04/00	23	12
25/04/00	32	12
Total	582	699

4.0 DISCUSSION

Insecticide-impregnated targets (jute bags treated with bovine blood and insecticide) attracted low numbers of *Stomoxys* flies during April and October. On the other hand, the Nzi trap was effective in capturing significantly larger numbers of *S. nigra* (both males and females) whether the pest population was low or high.

During the period when *S. nigra* population was low, about 50 % of catches were muscoid flies other than *S. nigra*. During the peak fly season, the percentage of *S. nigra* adults caught in traps reached up to 99 %. No parasitoid or predator was captured in traps.

During April and June, an average of 92 flies was caught daily and the sex ratio (M:F) varied from 1:1 to 1:3. The daily catch was almost doubled (150 flies/day) between July and September. A peak daily catch of 510 flies was reached during October. Significantly larger numbers of females were captured. This indicates that higher numbers of females are present in deer ranches during the fly season. These females cause more harm to animals because newly emerged ones need to feed on blood for four consecutive days in order to produce eggs.

Synthetic host odours (octenol, butanone) and natural odours (cow urine) did not increase trap captures. No significant differences were observed between catches by traps with or without bait. It has been reported elsewhere that octenol increases significantly trap captures, but this is not borne out by local data.

5.0 CONCLUSION

The Nzi trap is an effective environmental-friendly alternative to insecticides against *S. nigra* flies. Once the flies are caught in the trap, they die from exposure to direct sunlight. The Nzi trap does not have any adverse effect on beneficial insects. It can also be a useful tool for ecological research.

During the fly season, placement of a minimum of 2 traps (without odour bait) per km² at sites where deer normally aggregate would help reduce the numbers of males and females *S. nigra* in ranches. It is not expensive, costing about 400 rupees. The

model with royal blue cotton cloth was 50 % less expensive than that dyed pthalogen blue, but equally effective. It can be easily set up in deer ranches and serviced at regular intervals.

Maintenance visits are necessary on a weekly basis to check catches. As dead and decaying flies in collecting bags may have a repellent effect on flies attracted by the colour of the traps, these collecting bags need to be changed whenever catches reach some significant number (about 1000) or at weekly intervals.

Observations indicate that after 6 weeks of exposure to the sun, the cloth on the trap gradually loses its bright colour and takes on a yellow-grey tint. Besides, the trap is prone to damage under windy conditions and during cyclonic weather.

Following demonstrations of the efficacy of the trap and its construction, twenty-six members of the Mauritius Meat Producers' Association (MMPA) have acquired a total of 150 traps to be used against this pest on their ranches.

Currently, research is being undertaken on the perception of deer ranch owners on the Nzi trap, through a questionnaire-based survey. The trap design is being improved so that it can better withstand adverse climatic conditions.

The successful development of this trap during the first phase of the project now leads to the implementation of the second phase to determine the combined effect of Nzi traps and biological control agents for a more durable control of *Stomoxys nigra*.
