Extended Essay : BIOLOGY

A study of the effectiveness of parts of blue-veined Roquefort cheese as baits for trapping Aedes mosquitoes.

3,784 words

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Abstract:

This extended essay is a study into whether it is the part of blue-veined cheese with fungus or the part of blue-veined cheese without fungus that mosquitoes are attracted to , and thus to find which overall smell most lures them; the smell of blue-veined cheese, the smell of blue-veined cheese without fungus, or the smell of the fungus itself. This was done by breeding up batches of mosquitoes and growing up Petri-dishes of Penicillium roqueforti fungus and placing the mosquitoes and the bated lures in a mosquito-netting covered fish tank. The baits tested included Roquefort cheese (to represent the blue cheese), Neufchatel (to represent the cheese without fungus) and Petri dishes of the Roquefort's fungus, Penicillium roqueforti, each bait having a sticky trap designed near it on which the mosquitoes were to get stuck if they were attracted to the bait.

It was found that it was the fungus in the blue cheese that Aedes albopictus mosquitoes were most attracted to, not the part of the part of the blue cheese without the fungus, as the fungus attracted 57.9% of mosquitoes in the tank whereas the blue cheese without the fungus only lured 24.7% of the mosquitoes in the tank. When all three samples were tested against one another, the blue cheese against its fungus against the blue cheese without any fungus, it was found that the mosquitoes were only slightly more attracted to the blue cheese than to its fungus (catching 44% versus 31% of mosquitoes in the tank), but much less attracted to the cheese without the fungus (which only caught 24% of mosquitoes in the tank). I was found that the smell of the blue-veined cheese as a whole would make the most attractive smelling mosquito bait out of the three samples.

(Words=296)

Introduction:

Why I chose this particular topic of investigation:

I chose to carry out my experiment on Aedes mosquitoes, which are commonly found in Hong Kong, because mosquitoes often bite me, and also because I read an article in the SCMP newspaper (see appendix) in November 2002 which claimed that Aedes mosquitoes were attracted to fine red wines and blue-veined cheeses. I chose to investigate the latter attractant, being the more financially feasible of the two. I was curious to investigate what part of blue cheeses mosquitoes were so attracted to and hence to find which part could best serve as a bait for a mosquito trap.

In the past year there has been an alarming increase in the number of dengue fever victims in the previously "dengue free" Hong Kong region (1). The Hong Kong government has since set up an insecticide spraying workforce to spray urban areas. Not only can insecticides be environmentally unsound but the Aedes mosquitoes are becoming immune to them (2). People in general tend to not be particularly comfortable having their surroundings doused in poisonous chemicals either. *Effective mosquito lures in urban places could help to solve* this problem

Dengue Fever and Aedes Mosquitoes:

Dengue Fever is a virus which is transmitted to humans through the bites of infected female Aedes mosquitoes (1). Aedes mosquitoes generally become infected through feeding on the blood of an infected human and once infected can continue to spread the virus for the rest of their natural lives (1). Aedes

mosquitoes can also transmit the Dengue virus to their offspring via their eggs (transovarial transmission) (1).

The most dangerous mosquitoes of the Aedes genus can be found in Hong Kong(3); the Aedes aegypti species or *yellow fever mosquito* (figure 1).

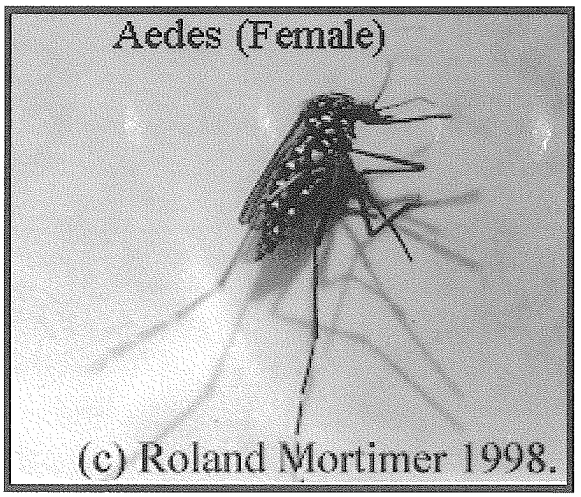


Figure 1: *Aedes aegypti are between three and four millimeters in length (not including leg length) which is smaller than most other species, including Aedes albopictus*(3). *It is totally black apart from white 'spots' on the body and head regions and white rings on the legs (which are not easily visible to the naked eye). Aedes aegypti is a vector for both yellow fever and dengue fever*(4). *It feeds predominantly at dusk and at dawn*(4). *They seldom disperse more than 100m from their breeding site (5)*

and the Aedes albopictus species which is more commonly known as *the Asian Tiger Mosquito* (next)

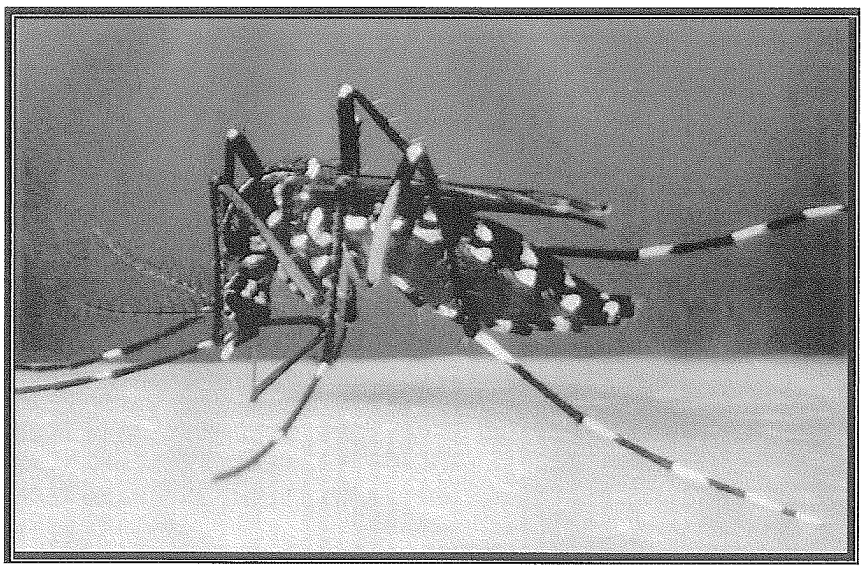


Figure 2: *Aedes albopictus (Asian Tiger Mosquito) is easily recognizable amongst other breeds of mosquito in Hong Kong due to its prominent black and white stripes along its thorax and legs. It is currently squeezing out the smaller Aedes aegypti species from South East Asia*(6) *and is also a vector for both yellow fever and dengue fever(7). It feeds during the day*(6).

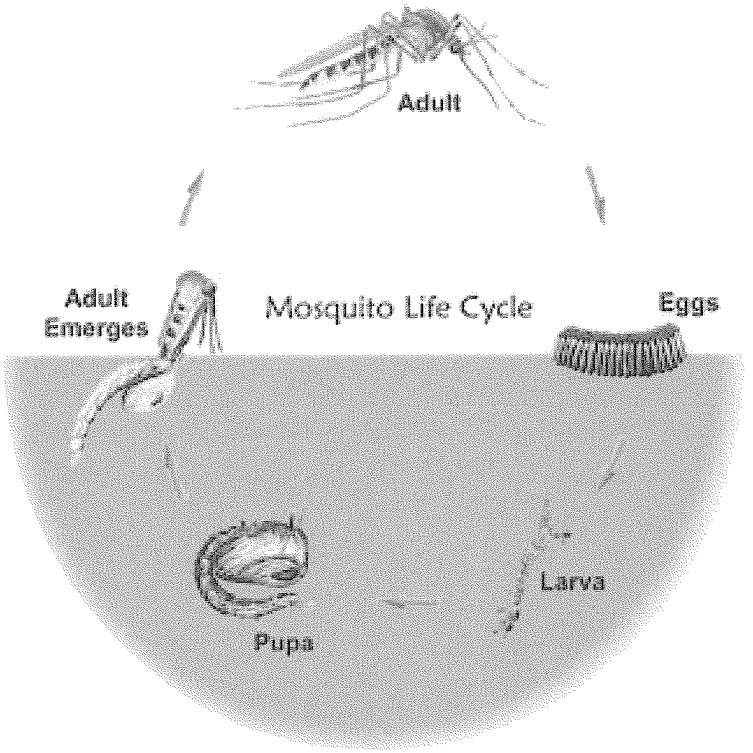


Figure 3

There are four different, closely related strands of the Dengue virus, which make the development of a vaccine against Dengue very difficult (as any of the four strands may cause the disease)(1) . The symptoms of someone infected with the Dengue virus are very similar to a severe flu; high fever, severe headache, muscle and joint pains, even rash (7) .

Although one may catch one of the four strands and achieve lifelong immunity against that particular strand of the virus (as people seldom die when infected with only one of the viruses for the first time) it will only give partial or transient protection against infection from any of the other three strands of the virus (1). There is strong evidence to suggest that subsequent infection by a different strand of the virus greatly increases the risk of developing a far more serious complication of the Dengue strain: Dengue Hemorrhagic Fever (DHF)(1). DHF is characterized by fever as high as 41 °C, febrile convulsions and internal

hemorrhaging. DHF kills a far higher percentage of patients than just Dengue fever does (1).

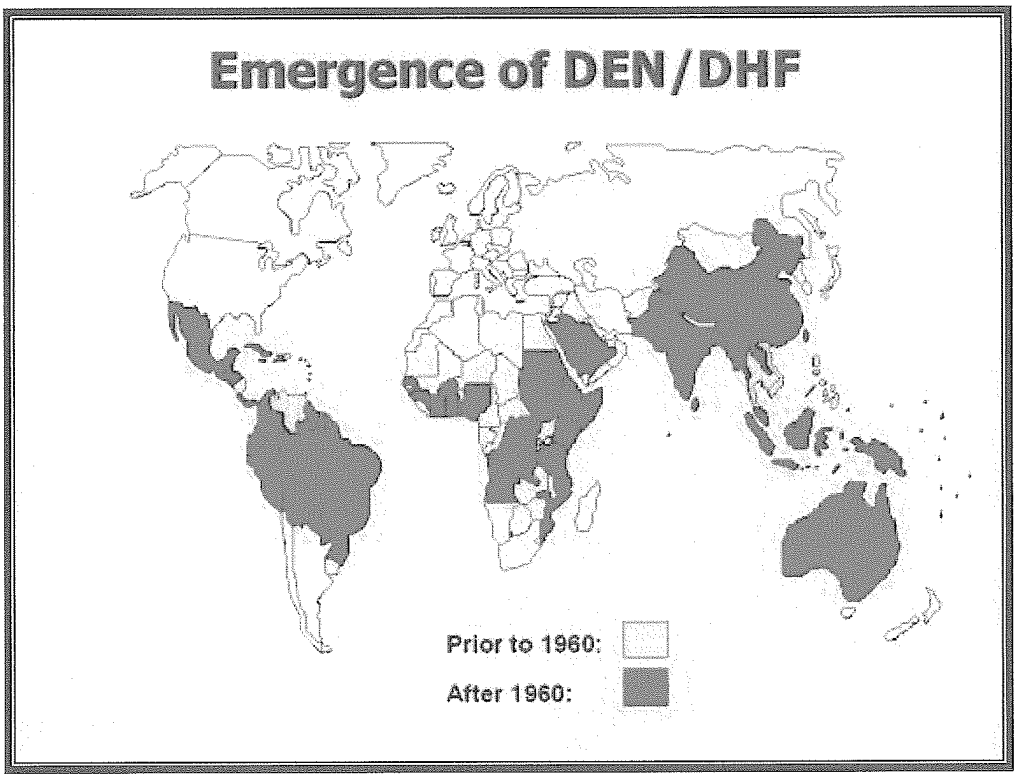


Figure 4: *Illustrating the prevalence of the Dengue virus around the world.*

About Blue-Veined Cheese

Although there are numerous types of blue-veined cheese, I chose to study the behaviour of mosquitoes under one type of blue cheese only, that of Roquefort blue cheese, which is readily available in Hong Kong. Roquefort cheese is made in the Roquefort region in Southern France (8). It is made from the milk of the "Laucane" breed of ewes (8).

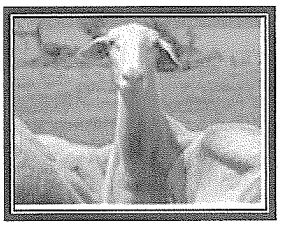


Figure 5

"Laucane" ewes whose milk is used especially for making Roquefort blue cheese (8).

Figure 6

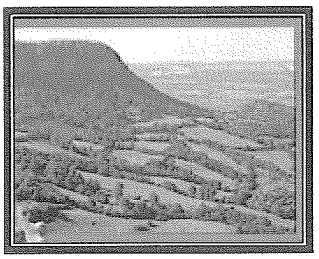


Figure 7

The Roquefort region in the south of France.

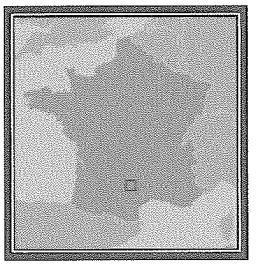
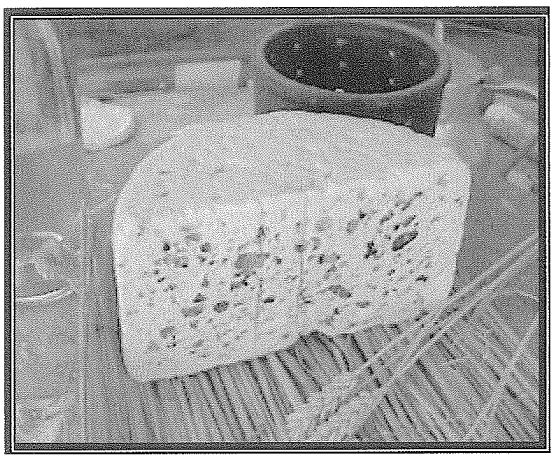


Figure 8

Its characteristic blue-green colour is due to the Penicillium roqueforti fungus which is introduced to the plain sheep cheese whilst aging in the caves of the Roquefort region (8).

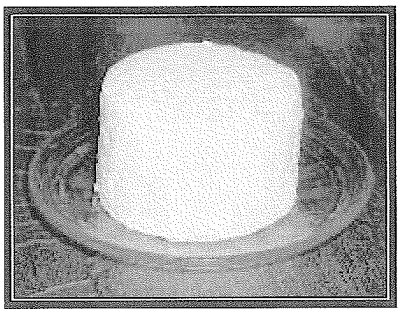


Roquefort cheese with its characteristic blue green coloured fungus,Penicillium roqueforti.

Figure 9

As it was not possible to obtain Roquefort sheep cheese before being treated with the penicillium roqueforti fungus, the closest cheese to the plain cheese used in making Roquefort I found was that of Neufchatel. Neufchatel is actually a very young, relatively scentless goat's cheese which is often used as a starting base when making blue cheese at home (9). I chose this goat's cheese above other

sheep cheeses, even those made from the milk of "Laucane" sheep (which produce the milk used especially for Roquefort cheese), as nearly all sheep cheeses on the market in Hong Kong already have their own characteristic and pungent smells, which would interfere with my results.



Neufchâtel; plain, creamy, scentless goat's cheese often used as a blue cheese starting base for people making blue cheese at home(9).

Figure 10

Aim:

There are predominantly two parts to my aim; firstly, to show if the fungus in the Roquefort cheese or the part of the Roquefort cheese without the fungus, is what makes the cheese so attractive to Aedes mosquitoes. This is to be done by testing the relative attractiveness of the Roquefort cheese fungus (Penicillium roqueforti) in comparison with the attractiveness of the fungus-free part of Roquefort (represented by Neufchatel cheese).

The second part of my aim is to investigate the relative attractiveness of both these components of blue cheese against the Roquefort cheese itself. This is to be done with the aim of investigating which of the three is the most alluring to mosquitoes and hence suggesting which of the three would therefore make the most attractive smelling bait which could then be used to flush Aedes mosquitoes from their urban hiding places into traps.

The relative attractiveness of the smell of the fungus compared with the fungus-free part of Roquefort cheese (the Neufchatel cheese) compared with the smell of actual Roquefort cheese itself is to be determined through seeing how many

mosquitoes in a set time period get caught on sticky-card lure strategically placed near the source of each smell (bait), all in a small controlled environment.

Method:

Apparatus List:

-fish tank (30cm x 60cm x 40cm)

-mosquito netting

-3 x dark coloured empty and washed food tins

-6 x wooden popsicle/ice-block sticks

- tooth picks

-double sided scotch tape

-mounting tape

-masking tape 2 inches wide

-sticky cardboard/paper from cockroach traps

-scissors

-white board marker

-thread

-needle

-masking tape 2 inches wide

-glass rod

-glass bacteria spreader

-250cc conical flask

-aluminium foil

-20x Petri dishes with lids (10 to have nutrient agar placed in them, 10 to remain as they are)

-pestle, mortar

-matches

-Bunsen-burner

-top-pan balance

-spatula

-autoclave tape

-autoclave machine

-plastic weighing boat

-measuring cylinder

-rubber gloves

-refrigerator

Chemical List:

-rain water

-distilled water

-nutrient agar powder

-Roquefort cheese

-Neufchatel cheese

-kerosene

-"Baygone" bug spray

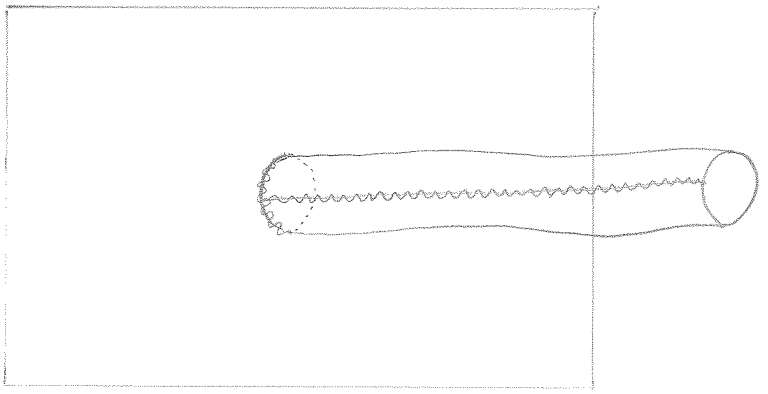
Procedure:

Method used for Preparation of the Fish Tank:

Preparing the netting:

A rectangular area of 30cm x 50 cm of mosquito netting was cut out with the scissors. The 50 cm edges were sewn together with needle and thread to make a sleeve with a diameter of about 11 cm (2 to 3 cm larger than the diameter of the Petri dishes).

80cm x 50cm of mosquito netting was cut out. The marker was used to draw and cut out a circle of 11cm in diameter from the centre of this netting. The sleeve of mosquito netting was then sewn to this "mouth" using the needle and thread.



The making of the mosquito traps:

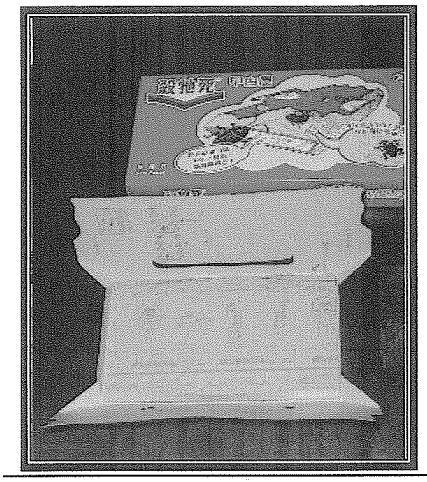


Figure 11: *Cockroach card*

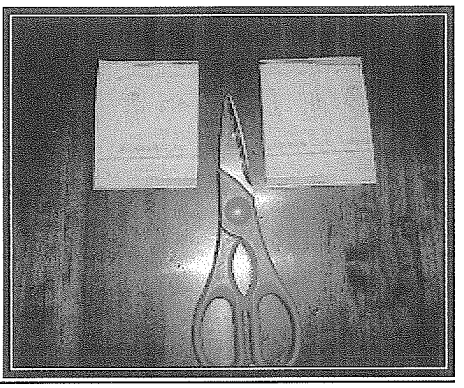


Figure12: *Cockroach card cut in half*

A piece of sticky cockroach-card was cut out of its container and then cut in half creating two pieces of card each about 8cm x 10cm (keeping the non-sticky protective cover on throughout).

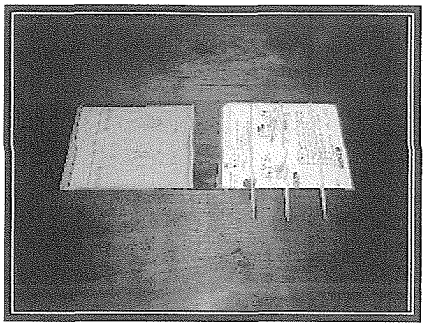


Figure 13: *Three tooth picks stuck onto one of the cards with double sided scotch tape*

Three toothpicks were stuck onto one of the cards using double sided scotch tape. The length of tooth pick sticking out was trimmed to 1.5 cm in length. This length was altered according to whether the trap was to be placed in a Petri-dish of fungus or cheese.

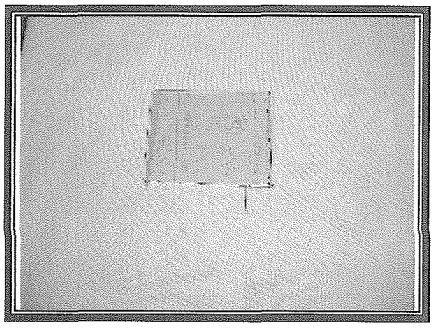


Figure 14: *The three toothpicks sandwiched between the two sticky cards*

The second piece of sticky card was then placed on top of the first card which had the toothpicks stuck to it, sandwiching the three toothpicks between the two pieces of card.

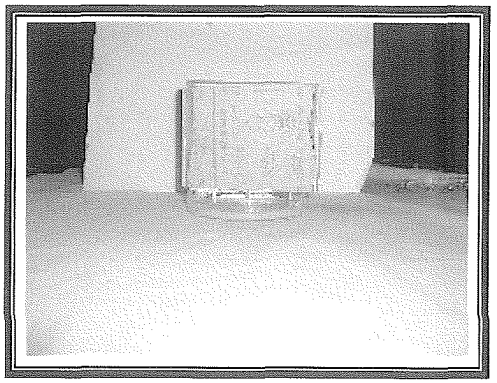


Figure 15: *Sticky card lure placed in a Petri dish. The Petri dish was to contain either fungus or cheese during the testing.*

Sticky cards which were not to be placed in any Petri-dish (i.e. the control) had three pieces of 10 cm long mounting tape fashioned around the pieces of toothpicks jutting out, to form a stable base.

Figure 16: *Front view of sticky card lures not placed in Petri-dishes with mounting tape bases.*

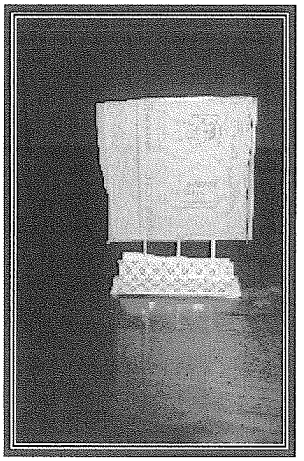


Figure 16

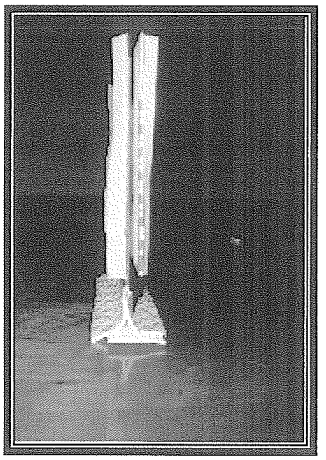


Figure 17

Figure 17: *Side view of sticky card lures not to be placed in any Petri-dishes but with mounting tape fashioned*

Method used for Obtaining Mosquito Larvae:

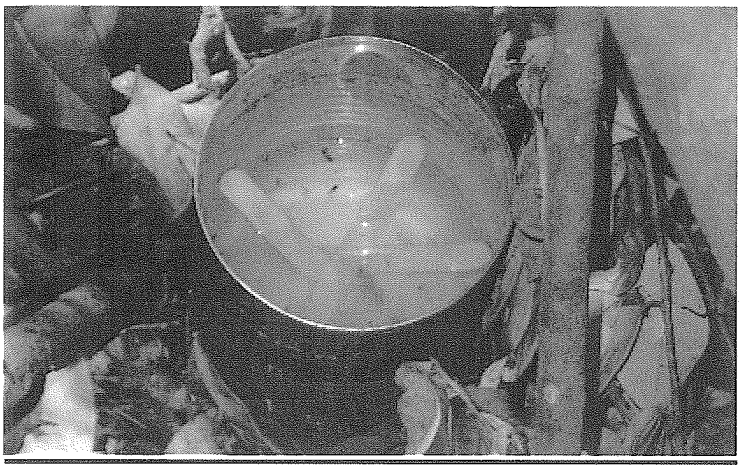


Figure 18: *One of the dark coloured food tins half-filled with rain water and three popsicle sticks on the Mount Butler Hillside.*

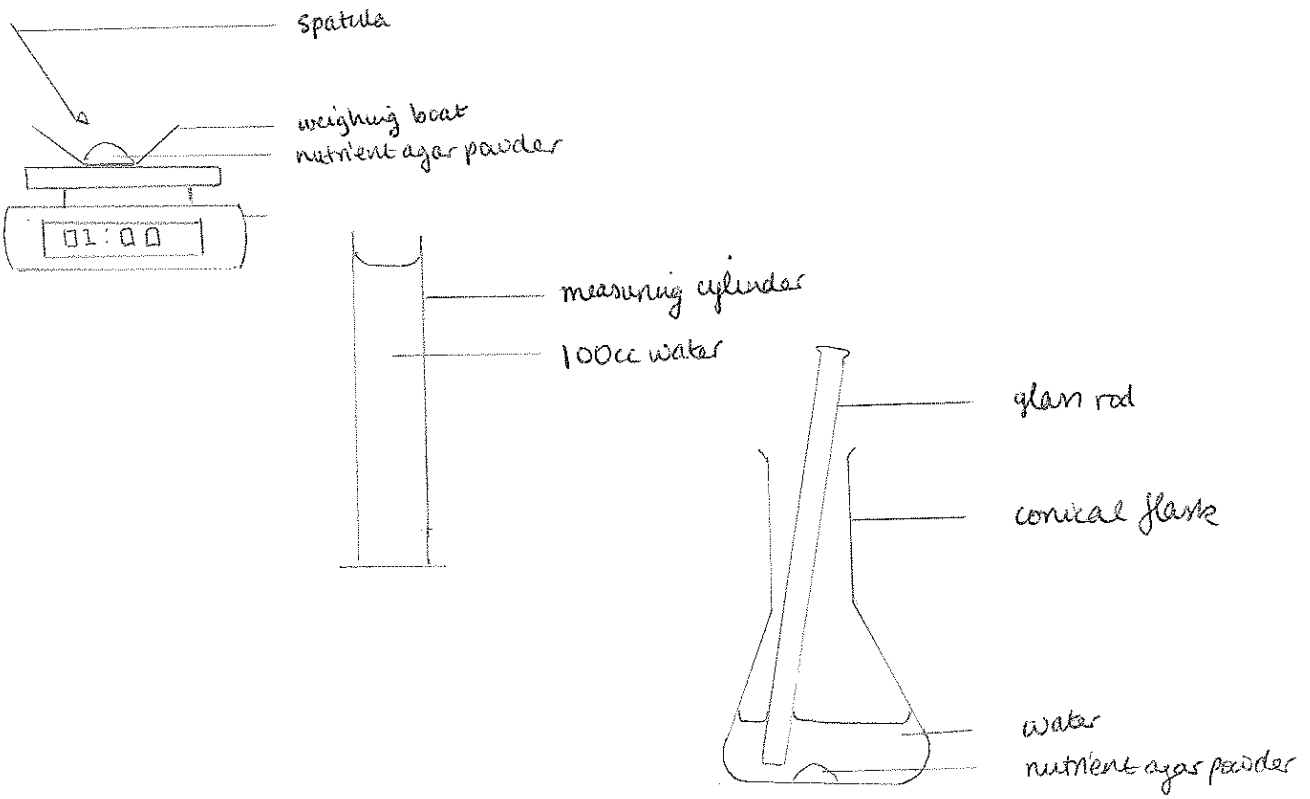
Two of the dark food tins were half-filled with rain water and three Popsicle sticks placed in each. The containers were placed in a densely vegetated area on the Mount Butler hillside. The containers were checked after four days and then every day after that until larvae became visible, after which one of the containers

was placed in the fish tank with the mosquito netting taped down around the tank with masking tape.

Mosquito netting was taped over the other container to prevent mosquitoes escaping before that particular batch was used.

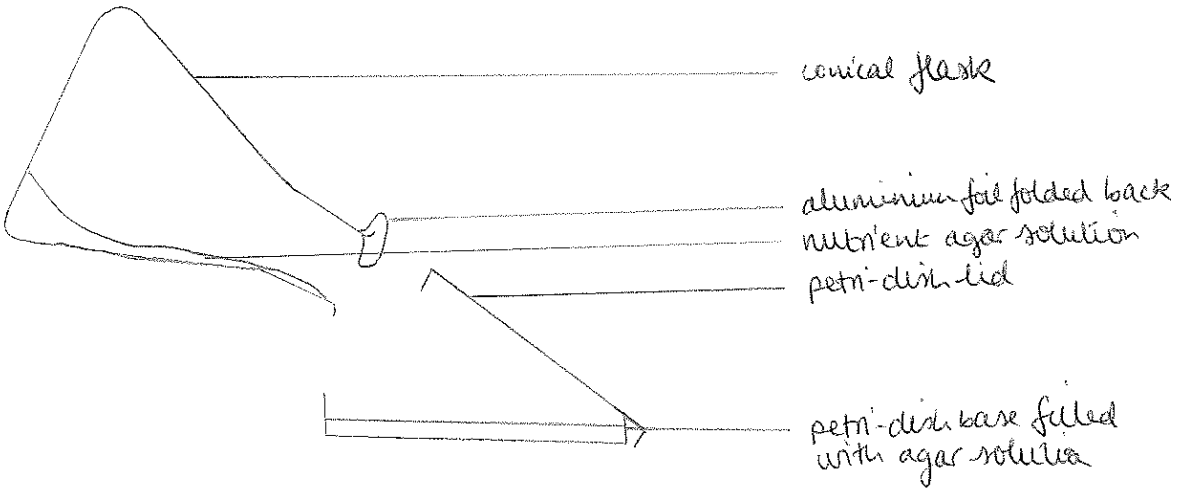
Method used for Preparation of the Agar Plates:

Ethanol of 95 % proof was used to sterilize the bench top, hands and apparatus. The 1.00 g of nutrient agar powder which was weighed out using a spatula and weighing boat on top of a top-pan balance, and the 100 cc of water which was measured out with a measuring cylinder, were all rigorously mixed together in the conical flask using a glass rod.



The top of the conical flask was covered with aluminium foil to prevent bacteria from entering. Autoclave tape was placed on the aluminium foil to indicate successful autoclaving. The flask was then placed in the autoclave machine. After autoclaving the solution was poured into the Petri-dishes.

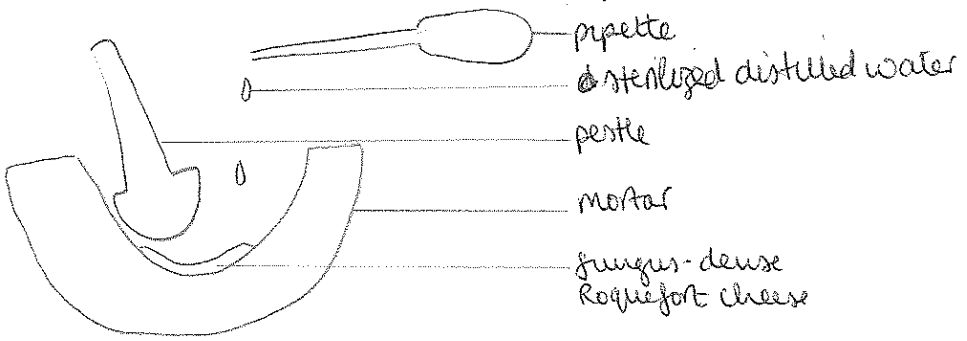
To pour the plates the bench top and hands were sterilized with 95% proof ethanol and a Bunsen was lighted. The aluminium foil was half drawn back and the mouth of the flask was passed through the Bunsen flame; the mouth of the conical flask was kept passing in and out of the Bunsen flame.



About 20cm^3 of solution was poured into each dish. This made five Petri-dishes of agar solution. The Petri-dishes were stored in the refrigerator until needed for culturing the Pencillium roqueforti fungus.

To culture the Penicillium roqueforti fungus:

1cm³ of Roquefort cheese which was particularly dense with the fungus was mashed up using the pestle and mortar. A few drops of sterilized distilled water were added to help the mashing process.



The glass spreader was used to scrape a thin layer of the mash onto three agar plates, completely covering every part of the nutrient surface. The plates were kept on the balcony where it was warmest, to speed up the fungal growth. When the plates were completely covered in fungus they were stored in the fridge for one week. If the plates were not used within the week they were thrown out and another batch of fungus-agar plates was made.

Method of testing:

All tests were started at 7.00 am in the morning on days when the weather forecast was said to be hot and humid and about fifteen mosquitoes had already hatched out. All experiments were for 48 hours, after which the results of where all the mosquitoes in the tanks were positioned were recorded. The sticky-card protective covering was removed before the start of each test and a table-spoon of kerosene was placed on top of the water in the container in the tank to prevent anymore mosquitoes from hatching out. Rubber gloves were used to place the kerosene, sticky-card lures and Petri-dishes in the fish tank. Bug Spray was used

to kill off the remaining mosquitoes that had not gotten stuck to any sticky-card lures at the end of each test.

The first test carried out was the control, whereby two prepared traps (the kind with the double sided tape fashioned at the base) were positioned at either end of the fish tank. The protective covering was taken off the sticky cards and the cards were placed at either end of the tank.

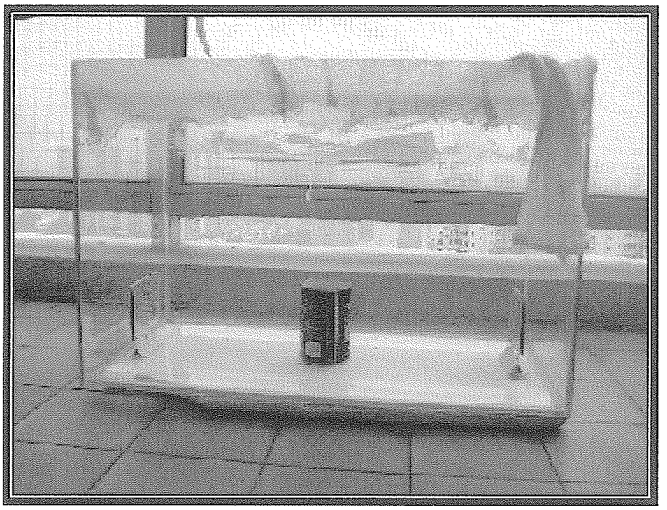


Figure 19: *The control, set up between two sticky card lures only on either side of the tank with the food tin containing mosquito larvae in the centre.*

The next test was carried out with a sticky-card with the tooth picks at the base placed in 30g of Roquefort cheese (which was measured out using the top pan balance). This was placed at one end of the fish tank. At the other end of the tank a sticky card was placed.

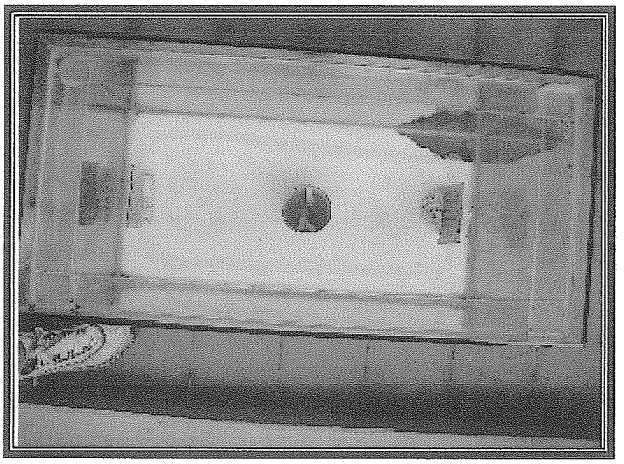


Figure 20: *A sticky-card lure with Roquefort cheese (on the right) is tested against a plain sticky-card lure (on the left)*

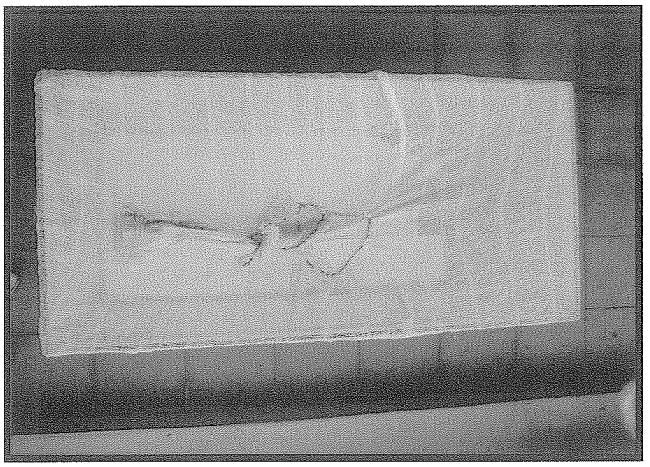


Figure 21: *Top view of the tank with netting*

The next test was carried out between sticky-card and a Petri-dish of cultured Penicillium roqueforti which had a sticky-card with the toothpicks sticking out of the base stuck upright into the agar plate.

The following test carried out was between a sticky-card at one end of the tank and another sticky-card placed in a Petri-dish of 30g of Neufchatel cheese at the other end of the tank.

A test was also carried out between a Petri-dish of the cultured fungus and 30g of the Neufchatel cheese.

The last test was carried out between 30g of Roquefort cheese and a Petri-dish of the cultured fungus.

As many of the tests were repeated as possible.

Results:

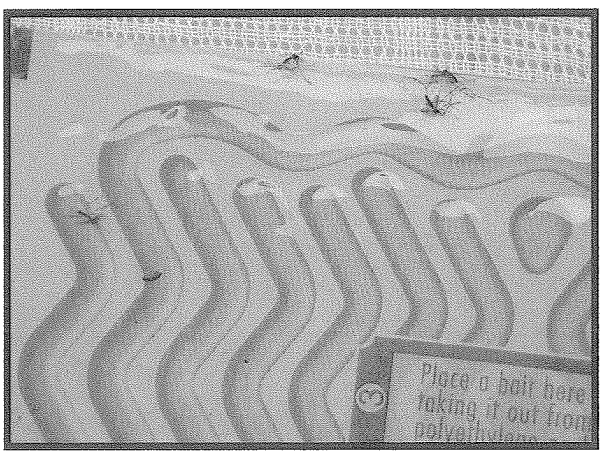


Figure 22: *Showing only Aedes albopictus mosquitoes stuck to the sticky paper*

Table 1: Showing the amount of mosquitoes caught onto the respective sticky-cards when different parts of blue cheese were used as bait

	Part of blue cheese used as bait to get mosquitoes stuck to the sticky-card							
	None (just sticky card on one side of the tank)	Roquefort cheese	Penicillium roqueforti fungus		Average	Neufchatel cheese		Average
Total number of mosquitoes in the tank	15	17	15	16	15.5	17	16	15
No. of mosquitoes identified as the Aedes albopictus species of mosquito	15	17	15	16	15.5	17	16	15
No. of mosquitoes identified as the Aedes aegypti species of mosquito	0	0	0	0	0	0	0	0
Number of mosquitoes not caught on the sticky card	13	6	7	6	6.5	12	12	12
Percentage of mosquitoes not caught on the sticky card	86.7	35.3	46.7	37.5	42.1	70.6	80	75.3
Number of mosquitoes caught on the sticky card	2	11	8	10	9	5	3	4
Percentage of mosquitoes caught on the sticky card	13.3	64.7	53.3	62.5	57.9	29.4	20	24.7

Chart 1: Showing the results of different parts of blue cheese as lures to get the mosquitoes stuck onto the sticky-card

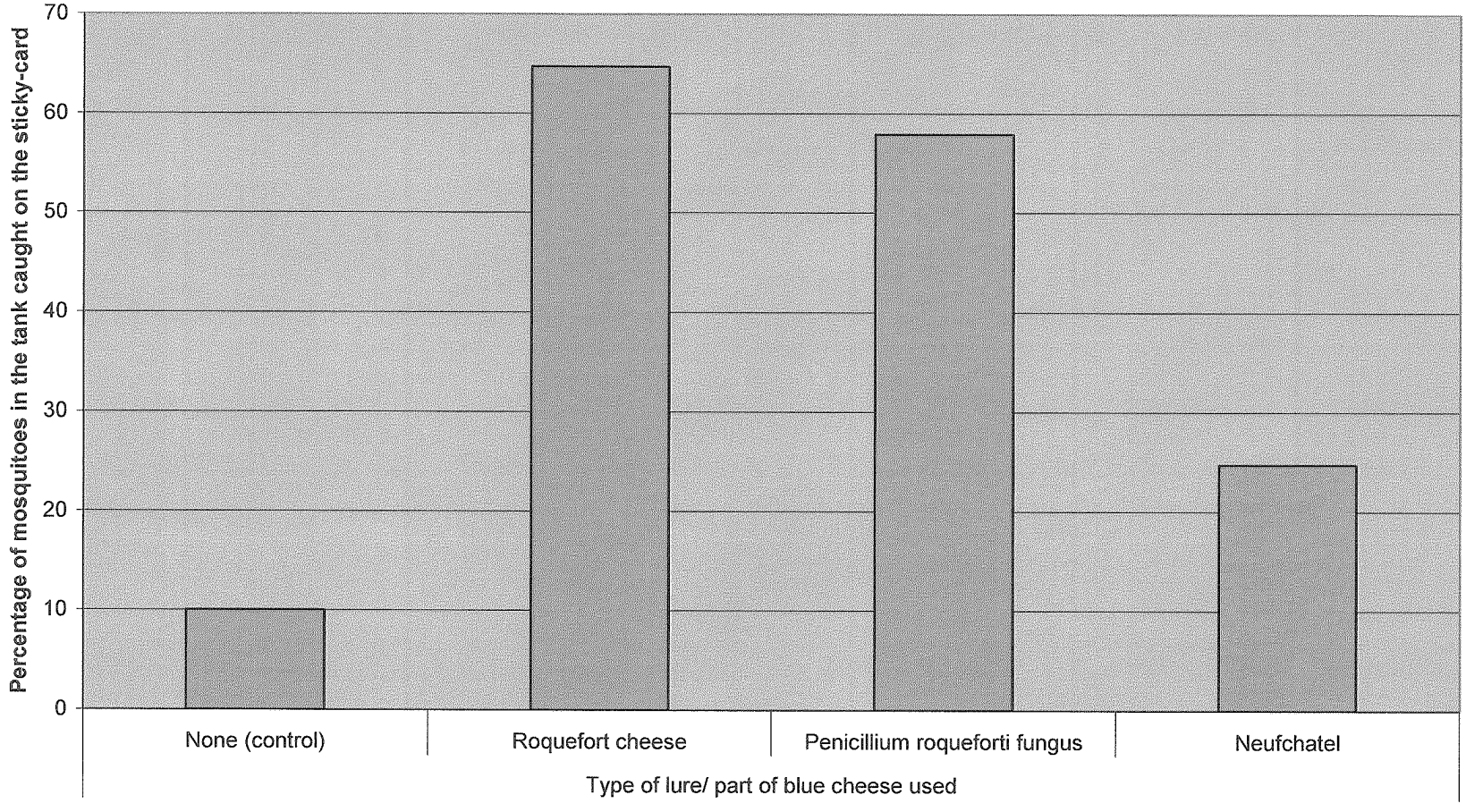
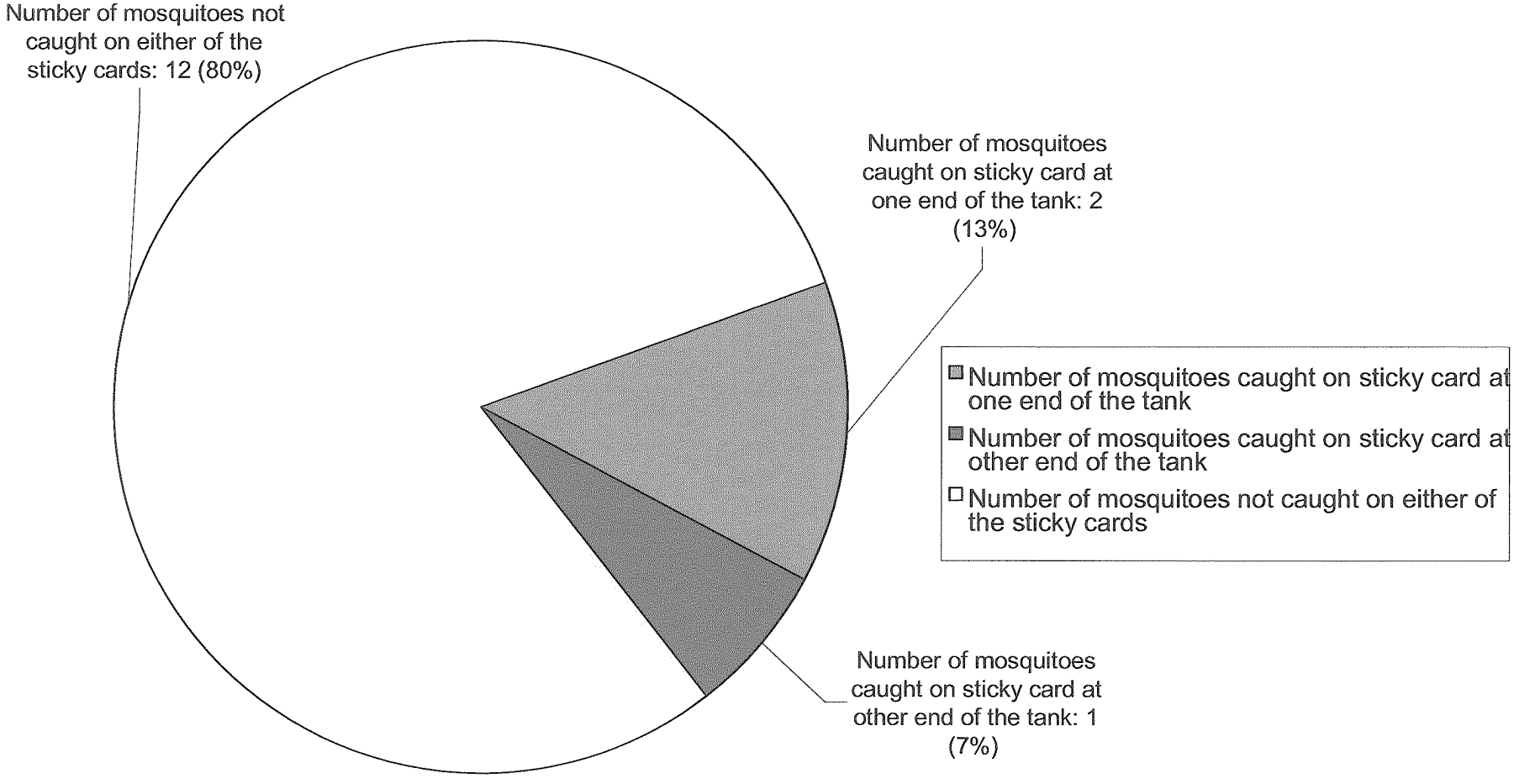


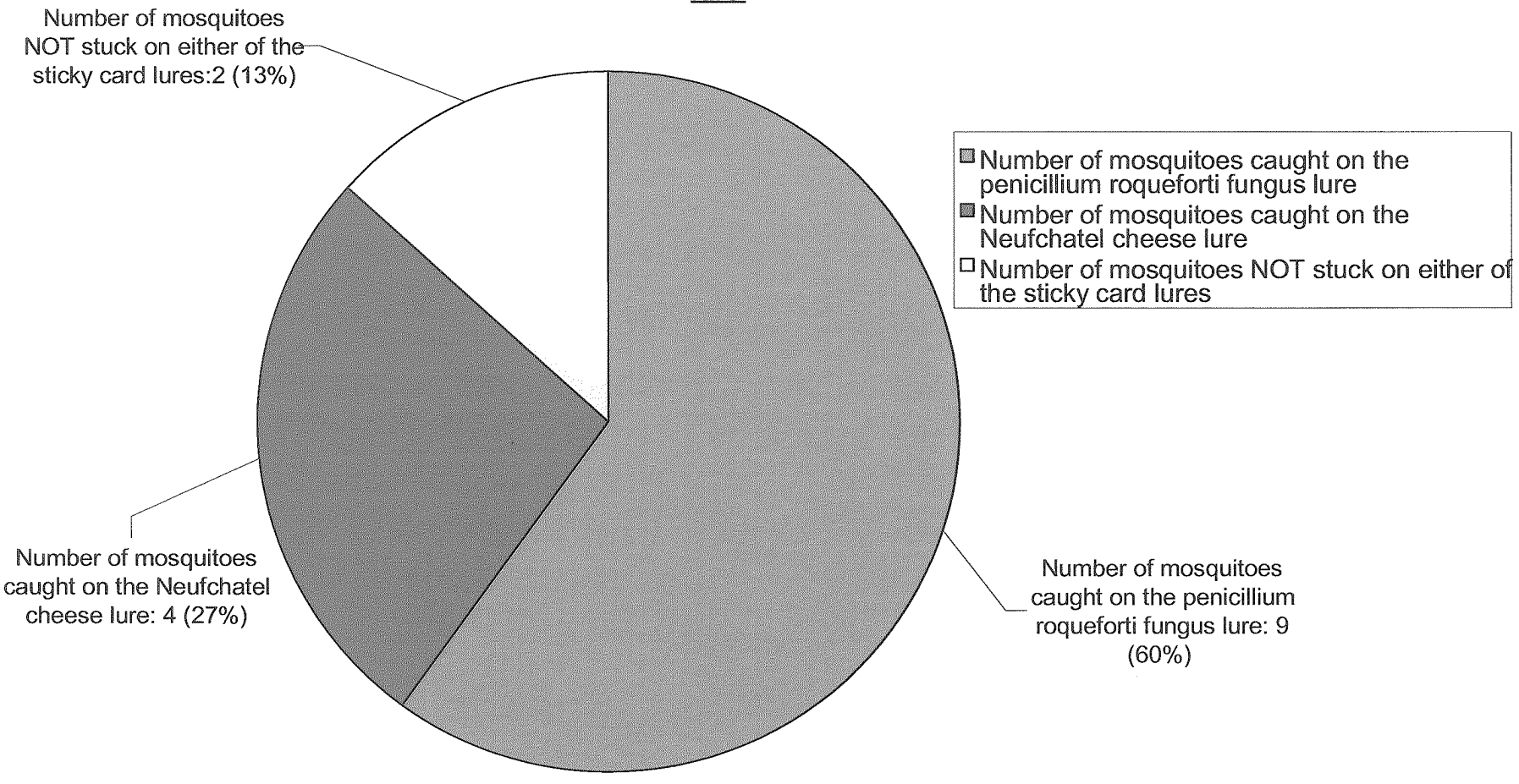
Table 2: Showing the number of mosquitoes caught on the sticky cards when parts of blue cheese were tested as lures against one another

	Parts of blue cheese used as lures against each other					
	Penicilliu m Roqueforti Vs.	Neufchatel	Penicillium Roqueforti Vs.	Roquefort Cheese	(CONTROL) Nothing (sticky paper only)Vs.	Nothing (sticky paper only)
Total number of mosquitoes *in tank*	15		16		15	
No. of mosquitoes identified as the **Aedes Albopictus** species of mosquito	15		16		15	
No. of mosquitoes identified as the **Aedes Aegypti** species of mosquito	0	0	0	0	0	0
Number of *mosquitoes* stuck on the sticky paper-	9	4	5	7	2	1
Percentage of mosquitoes stuck on the sticky paper	60	26.7	31.2	43.8	13.3	6.7
Number of mosquitoes NOT stuck on the sticky paper	2		4		12	
Percentage of mosquitoes NOT stuck on the sticky paper	13.3		25		80	

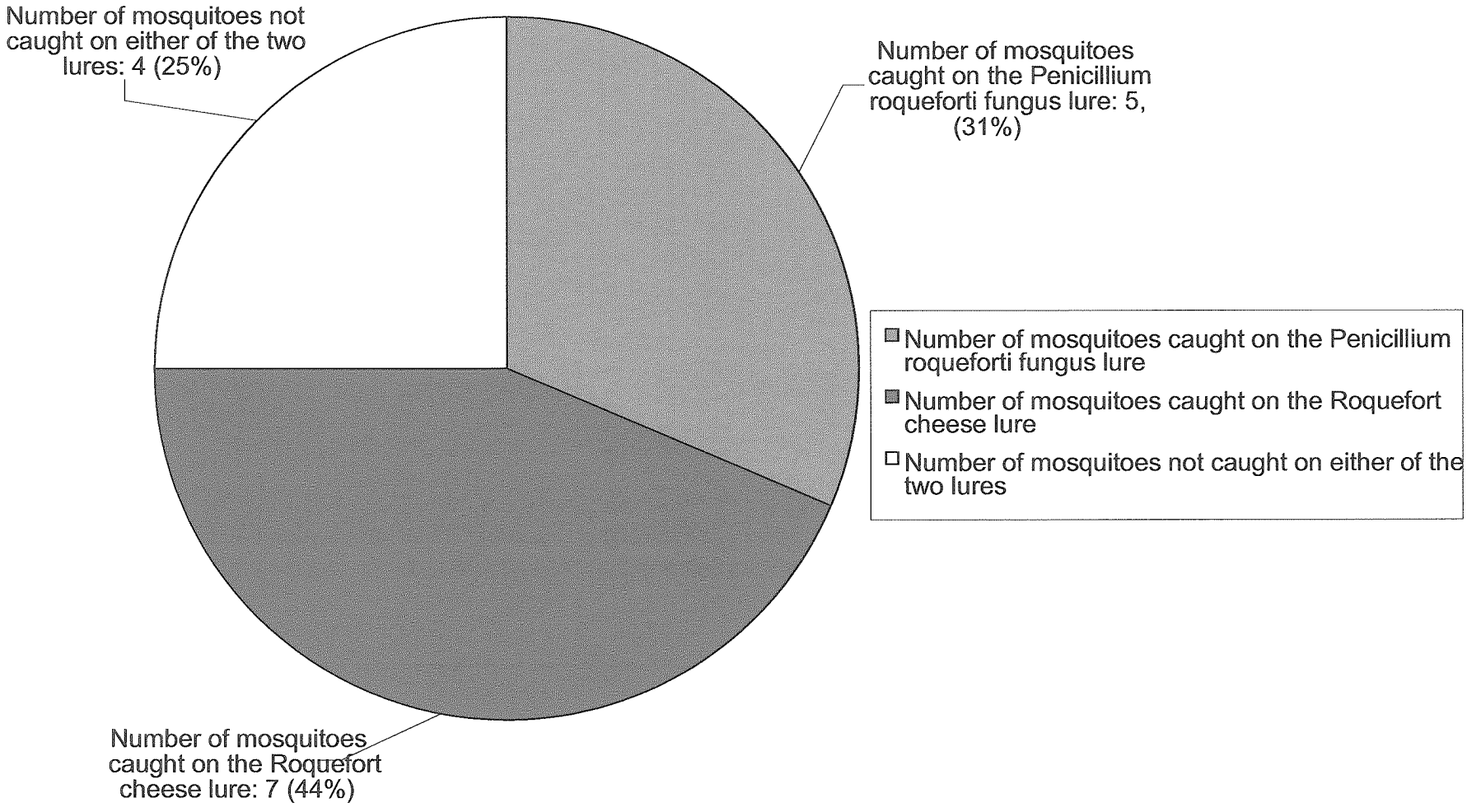
Pie Chart 1: (The Control) Showing the number of mosquitoes caught on the sticky-cards at either end of the tank without the use of any lures



Pie Chart 2: Showing the number of mosquitoes caught wih the Pencillium roqueforti fungus lure in comparison with the number of mosquitoes caught with the Neufchatel Cheese lure



Pie Chart 3 : Showing the number of mosquitoes caught with the Roquefort cheese lure in comparison with the number of mosquitoes caught with the Penicillium roqueforti lure



Conclusion:

Part 1:

My results strongly indicate that it is the blue cheese fungus (Penicillium roqueforti) which seems to make the Roquefort cheese so attractive to the mosquitoes, not the cheese part itself (the fungus-free part of Roquefort cheese represented by the Neufchatel cheese). This is indicated by results obtained when the Penicillium roqueforti fungus and the Neufchatel were tested, each by itself, as lures in the tank.

Looking at Table 1, the fungus lured 57.9% of all the mosquitoes in the tank. Under the same conditions the Neufchatel cheese by itself only managed to lure 24.7% of the mosquitoes that were in the tank. The fungus lured more than twice as many mosquitoes than the Neufchatel cheese did, both in terms of raw numbers of mosquitoes (an average of 9 in comparison with an average of 4) and also in terms of the percentage of mosquitoes caught onto the sticky paper (an average of 57.9% compared with the Neufchatel's 24.7%). The latter is especially visually explicit in the bar chart of Chart 1, in which the bar representing the percentage of mosquitoes caught with the fungus lure is much taller than the bar representing the percentage of mosquitoes caught with the Neufchatel lure.

This large difference in the relative attractiveness of the fungus in comparison with the Neufchatel cheese (representing fungus-free Roquefort cheese) is further visually demonstrated by Pie Chart 2's results, in which the fungus and Neufchatel cheese were tested in competition with each other in the same tank (the fungus at one end and the Neufchatel at the other). One can see that the penicillium roqueforti lure caught 60.0% of mosquitoes in the tank whereas the Neufchatel lured little more than 26.7% of mosquitoes in the tank. Basically, the fungus, in corroboration with the Table 1 results, lured more than twice as many mosquitoes in the tank than the Neufchatel cheese.

Part 2:

When all three parts of the Roquefort blue cheese were tested in comparison with one another, results indicated that both the Roquefort cheese itself and its Penicillium roqueforti fungus were more attractive smelling to the mosquitoes than the Neufchatel cheese, as shown by Table 1's results. The Neufchatel cheese attracted an average of 24.7 % of mosquitoes in the tank whereas both the Penicillium roqueforti fungus and the Roquefort cheese lured more than twice as many; the Penicillium roqueforti attracted an average 57.9% of mosquitoes that were in the tank and the Roquefort cheese attracted 64.7% of mosquitoes that were in the tank.

However it is important to note that on looking at the Table 1 results one can see that the actual numbers of mosquitoes caught between fungus and the actual Roquefort cheese lure the is actually extremely close. The single test carried out for the Roquefort cheese bait lured 64.7% mosquitoes in the tank compared with average of 57.9% of mosquitoes caught on the lure using Penicillium roqueforti fungus as bait. The relative difference between Penicillium roqueforti's 57.9% mosquitoes caught and Roquefort cheese's 64.7% is so close that one cannot really strongly say that the Roquefort cheese is actually more attractive smelling to the mosquitoes than the smell of its fungus- especially

after taking into account the random movement of some mosquitoes, any possible anomalies and the fact that the tests were carried out so few times, each with so few mosquitoes

Nevertheless, Table 2 and Pie-chart 3 further indicate that Roquefort cheese is slightly more attractive smelling to mosquitoes than Penicillium roqueforti is- as when both were tested against one other in the same tank (the Roquefort cheese on one side and the Penicillium roqueforti fungus on the other) the Roquefort cheese lured more mosquitoes onto its sticky paper than the fungus did. The Roquefort cheese lured 43.8% of the mosquitoes in the tank whilst the fungus lured only 31.2% of them. The actual number of mosquitoes caught by each (7 versus 5) is still terribly close, with only a difference of two mosquitoes between them. The results do corroborate however with the Table 1 and Chart 1 findings that the Roquefort cheese is slightly more attractive smelling than its fungus.

Therefore in conclusion, my results weakly indicate that Roquefort cheese itself would make the most attractive smelling bait for a mosquito trap out of the three baits tested (slightly better than its fungus and much better than the Neufchatel cheese). My results do strongly indicate however that it is the fungus in the blue cheese which seems to make it so attractive to the mosquitoes, not the part of the blue cheese without the fungus.

It would be interesting to further research and possibly identify the actual chemicals produced by the fungus which seem to be so attractive to the mosquitoes, which could in the future then be synthetically mass manufactured and sold as mosquito bait.

Evaluation:

One of the biggest limitations I experienced carrying out this experiment was the fact that there were so few mosquitoes in each of the tests. This is a problem because it means my results cannot be seen to hold much conviction when taking into account the random and or anomalous movements of the mosquitoes. Given that the mosquitoes were all 'home grown' it took nearly two weeks just to get fifteen mosquitoes hatched out, and considering up to ten batches of mosquitoes were needed all together, waiting any longer for more mosquitoes to hatch out would have taken up far too much time. If time had permitted I would have bred up many more mosquitoes for each test.
It must also be taken into account that, given the time period, only one type of blue cheese was tested (Roquefort blue cheese only) and only one species of Aedes mosquitoes happened to be caught and tested also (that of Aedes albopictus), therefore one cannot justifiably generalize that these results are indicative of all blue cheeses and all Aedes mosquitoes. If time had permitted I would have tested a large range of blue cheeses, say at least ten, as well as testing at least ten other species of Aedes mosquitoes.

Another important limitation was that the experiments were not repeated enough times- some or perhaps most of the results obtained could be one time flukes or anomalous without my ever realizing it, as the tests have not been repeated enough times to dismiss such a possibility. This exacerbates the possible unreliability in the conviction of my results. Ideally each test should have been carried out at least ten times in order to achieve a more accurate array of results from which an average could be obtained, which would reduce the number of possible anomalies and achieve a higher percentage of more accurately feasible results. Obviously however, carrying out each of the eight

tests ten times each was unrealistic time-scale wise as it would have taken many more months to have completed.

The method of the experiment was changed after the first few 'practice' tests were carried out, such as the placement of the sticky paper. Originally it was simply stuck onto the side of the glass, with the Petri-dish containing the source of the smell right in front of the sticky-card. This however, failed to catch many mosquitoes at all, even when Roquefort cheese was used as the 'lure'. Nearly all the mosquitoes in the tank would rush to the cheese itself but not continue past it and get caught on the sticky card. The sticky-card was therefore redesigned to the 'toothpick-style' whereby the double sided sticky paper was actually embedded into and above the source of the smell. This was a more successful method of capturing the mosquitoes onto the sticky-card, and more indicative of which smells of the blue cheese were attracting them.

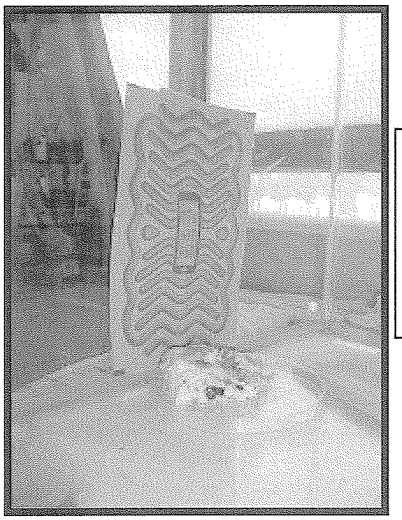


Image 24: *Showing the first (failed) attempt at a sticky-card lure*

Finally the type of sheep cheese used as the basis of the Roquefort cheese without fungus was not actually the true white cheese Roquefort is made from. The true white sheep's cheese from which Roquefort is made from should ideally come from "Laucane" sheep (8). This cheese was unavailable in Hong Kong. This will effect on results as the real Roquefort "Laucane" white cheese may have had a very different allure for mosquitoes than Neufchatel has.

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Image Acknowledgements:

Figure 1:
Copied from the World Wide Web
http://www.microscopy-uk.org.uk/mag/art98/aedrol.html
cited July 24th 2003

Figure 2:
Copied from the World Wide Web
http://www.co.cal.md.us/services/mosquito.htm
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Figure 3:
Copied from the World Wide Web:
http://www.epa.gov/pesticides/factsheets/malathion4mosquitos.htm
cited February 16th 2004

Figure 4:
Copied from the World Wide Web:
http://www.who.int/csr/disease/dengue/impact/en/
cited January 21st 2004

Figures 5, 6, 7& 8:
Copied from the World Wide Web:
http://www.roquefort.fr/
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Figure 9:
Copied from the World Wide Web:
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Figure 10:
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Appendix:

Reuters, Agence France-Presse | rural credit reforms which President Chen Shui-bian has been forced to withdraw. *AFP* Chen rattled – Page 6

Fine wine and smelly cheese the best traps for dengue mosquitoes

■ Jo Bowman

Hong Kong's battle to eradicate dengue fever could soon be helped by the discovery of a weak spot in the armour of mosquitoes – their passion for fine food and drink.

An American researcher at the United States Department of Agriculture has found that the breed of mosquitoes responsible for spreading dengue fever, the *aedes aegypti*, are attracted to blue-vein cheese and full-bodied red wine.

Dr Dan Kline's research is being followed up by insect specialists in Australia's tropical far north, which has had recent outbreaks of dengue fever, in the hope that traps using gourmet mosquito snacks can reduce the need for chemical sprays.

Hong Kong's health authorities say they will look into the US and Australian research, and consider using such traps if they proved effective and cost-efficient.

The link between cheese and dengue-carrying mosquitoes was found when the Americans observed that these insects, along with the *anopheles gambiae* responsible for spreading malaria in Africa, tended to bite people's feet and ankles. On a hunch that it was the odour of feet that was attracting them, they put a slice of cheese in a tank of mosquitoes and watched them pounce.

After trying many different varieties, Dr Kline found that the most popular item on the mosquito buffet was blue-vein cheese.

Dr Scott Ritchie, a research entomologist at the Tropical Public Health Unit in Queensland, Australia, plans to build on this research and is seeking funding to investigate the taste preferences of dengue-carrying mosquitoes.

He said Dr Kline, a former colleague, had said the mosquitoes were also attracted to rich red wines. "What we're interested in doing is looking at a variety of different chemicals that could be attractive to the mosquitoes and use these to lure them to a booby trap," Dr Ritchie said.

"It's more a lure-and-kill approach rather than a broadcast approach, but it's not saying there's not going to be any room for spraying."

Dr Ritchie said it was unlikely that miniature wine bars stocked with cheesy nibbles would be set up to attract biters.

"We would be more likely to find the active ingredient in the cheese and use that rather than the cheese itself. And there's going to be other things that are attractive to the mosquitoes, so it may be a combination of things that we use," he said.

"They'll have some sort of lure, maybe three or four different chemicals, then maybe an insecticide in it or maybe some glue, so they'd get stuck."

In Hong Kong, where 20 people have contracted dengue fever locally recently, officials said they were open to suggestions.

A spokesman for the Health, Welfare and Food Bureau said the most effective way to control mosquitoes was to eliminate potential breeding places, such as blocked drains and other places where water could stagnate.

He said the controlled use of World Health Organisation-recommended pesticides was the "second line of defence".

The South China Morning Post article dated November 24th 2002 that gave the idea for this investigation.

Figures 11-23:
My own photographs

Image of SCMP newspaper article:
Scanning of my own copy of the newspaper