

Rhipicephalus sanguineus, *Ehrlichia canis* and current tick control methods on Curaçao.

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ABSTRACT

Tick infestation can result in physical damage and transmission of pathogens like *Ehrlichia canis*. The prevalence of *Rhipicephalus sanguineus* ticks and *E. canis* was determined among 200 dogs receiving veterinary care. They were found to be respectively 65% and 23%. Ehrlichiosis prevalence appeared 7,2% higher in purebred dogs. The mean number of ticks found on dogs was 6,6 and all adult ticks were identified as the *R. sanguineus* species.

To prevent ticks applying products on the dog as well as in the environment is useful. Shampoo, Preventic® collars and Frontline® products were identified as most effective products while the use of powder, Paramite® or no tick control products at all resulted in high numbers of ticks.

Applying pest control in both house and garden proved most affective to decrease tick numbers.

Customer satisfaction varied from 50-100% and was particularly high with Preventic®, Paramite® and ovitrol. No correlation between customer satisfaction and the number of ticks on the dog was found. Owner knowledge about ticks, tick-borne diseases and tick prevention is little so in order to deal with tick related problems extensive client education by veterinarians and pharmacological companies is recommended.

11% of the dogs have been taken abroad from which 50% to the Netherlands. Future research to the vectorial capacity of the collected ticks at Utrecht University will allow determining possible consequences of importing dogs from Curaçao.

1. INTRODUCTION

Ticks are a local and global problem. Not only can they cause physical damage and discomfort due to their feeding behavior. They can also act as vector and reservoir of important pathogens of animals as well as humans (Lord 2008).

Samples with ticks, found on dogs send from the island of Curaçao prior to this research, showed the most frequently found tick is *Rhipicephalus sanguineus*, also called brown dog tick. *R. sanguineus* belongs to the 10% of 867 known ticks species implicated to transmit different pathogens (Jongejan and Uilenberg 2004). This tick species is known to be a vector of *Ehrlichia canis*, *Babesia vogeli* and *Hepatozoon canis*. The tick is able to acquire the pathogen from an infected host during a blood meal, maintain infected through multiple life stages by the means of transstadial passage and pass it on to other hosts when feeding again (Kahl et al. 2002). The infection is most efficiently transmitted from tick to host during salivation and regurgitation at the attachment site during ingestion of a blood meal (Oyamada et al. 2005, Kidd et al. 2003).

Canine monocytic ehrlichiosis in dogs is caused by the rickettsia *Ehrlichia canis*, an intracellular bacteria, that parasitizes monocytes. *E. canis* has a worldwide distribution but primarily occurs in tropical climates, this distribution is related to distribution of the vector (Neer et al. 2002). The transmission is transstadially, but not transovarially (Groves et al. 1975). Ticks can transmit infection 155 days after becoming infected and thus act as a reservoir for *E. canis* (Harrus et al. 1997). The pathogenesis involves acute, subclinical and chronic phases. First lethargy, weight loss, anorexia, fever, splenomegaly and lymphadenomegaly occur. Hemorrhagic tendencies can cause petechiae, ecchymoses and pale mucous membranes. These clinical signs can resolve spontaneously but the dog may remain subclinically infected and subsequently develop the chronic phase of the disease (Harrus et al. 1997). The most common hematologic findings are thrombocytopenia and anemia. Infection can be fatal. (Jongejan and Uilenberg 2004).

R. sanguineus is believed to be involved in the transmission of other major pathogens such as *Leishmania infantum* and *Anaplasma platys* (Dantes-Torres 2008).

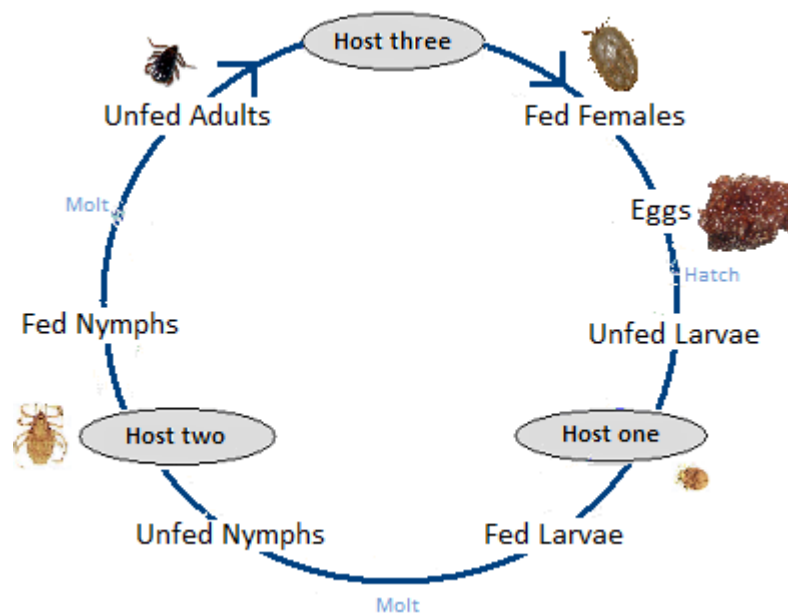
Dogs taken by their owners travelling to warm regions are liable to catch (sub)tropical tick-borne diseases. Signs usually just become apparent after returning home.

The primary host of *R. sanguineus* is the domestic dog; they are hosts for all stages of development. Yet the tick is capable of parasitism on small animals like rodents, cattle and humans (Dantes-Torres et al. 2008, Dantes-Torres et al. 2006, Estrada Pena et al. 2004). On dogs the adult ticks are found primarily in the ears, along the neck and shoulder and between the toes. Nymphs are found in the ears and longhaired areas of the neck and larvae are found on the stomach and flanks (Estrada Pena et al. 1999, Latreille 1806). The reason ticks are often found on the head and neck area is probably that ticks attach while the dog is moving forwards, self-grooming is difficult in this area and the skin is thinner (Mumcuoglu et al, 1993).

The life cycle of *R. sanguineus* contains three developmental stages: larvae, nymphs and adults. All of these stages feed on a host, fall off, and develop into the next stage. This leads to the possibility of three hosts in one cycle which is an important factor in pathogen transmission. Of course one dog can be used multiple times as a host in one cycle (Dantes-Torres, 2008).

Illustration one reflects the life cycle. In optimal conditions a cycle is completed in 63-91 days (Dantes-Torres 2008, Estrada Pena 2004).

Illustration 1 Life-cycle of *R. sanguineus* ticks



There are several methods to control *R. sanguineus* on the dog as well as in the environment. Given the fact that *R. sanguineus* is endophilic control methods should include ticks in the indoor environment (Dantes-Torres, 2008).

Non-chemical methods consist of removal of ticks from dogs by hand with a single slow pressure movement close to the attachment site without twisting or crushing (Blagburn and Dryden 2009). Changing the habitat by minimizing refuge areas as floorcracks, gardenwaste and long grass is also important.

When the infestation is great the use of acaricides might be implicated. Acaricides can be used on the dog as well as the environment (Dantes-Torres 2008).

Several pharmacological products for use on dogs are available in the veterinary clinic and pet shops on Curaçao such as spot-on formulations, shampoos, impregnated collars, sprays, injections and dips. The acaricides they contain are fipronil, amitraz, methoprene, pyrethrins, piperonyl, phosmet and ivermectin. Ingredients, product formulation and effective periods will be discussed in Appendix 1.

1.1 GLOBAL IMPORTANCE AND RESEARCH OBJECTIVES

The island of Curaçao lies in the Caribbean Sea, 12 degrees North latitude, 86 degrees western longitude. Approximately 140 thousand people live on the island. The climate is tropical and dry, most rain falls between October and January.

There are several reasons to do research on ticks on Curaçao;

Veterinarians on the island report ticks and tick-borne diseases, especially ehrlichiosis, to be a major problem. So far no research has been done to assess the situation. Recently, a similar research was performed on shelter dogs on Aruba which showed that 96% of all dogs carried ticks and 58% of the dogs tested positive with a Snap 3Dx test for *E. canis*. These are high numbers and because of the similar dog population on Curaçao, similar results can be expected (van der Straten 2008).

This research can also provide valuable information for the Dutch veterinary practice. Over the last five years two out of twenty-seven traceable cases of dogs with *E. canis* positive Immunofluorescence tests were traced to Curaçao (F. Blaauw 2009).

Assessing the use of tick control products including the owner satisfaction and accuracy of application might help pharmaceutical companies develop better products for Curaçao and comparable environments. Also it will allow these companies as well as veterinarians to give more accurate information and education to their clients.

Some tick species can carry human pathogens. Therefore it is important to be aware of the present tick species for public health. For example, *R. sanguineus* ticks are known to be vectors of *Rickettsia rickettsii* which causes Rocky Mountain spotted fever and *Rickettsia conorii*, responsible for Mediterranean spotted fever (Dantes-Torres, 2008, Little et al, 2007).

The main objective of this research is to answer the following questions;

- Prevalence of different tick species on dogs
- Number of ticks found per dog
- A pilot study to assess the use of tick control methods, the owner satisfaction and effectiveness of the products considering the number of ticks on a dog.

In the nearby future ticks collected in this research will be examined at Utrecht University to see if and which pathogens they carry. The main pathogens found will presumably be *E. canis* and *B. vogeli*.

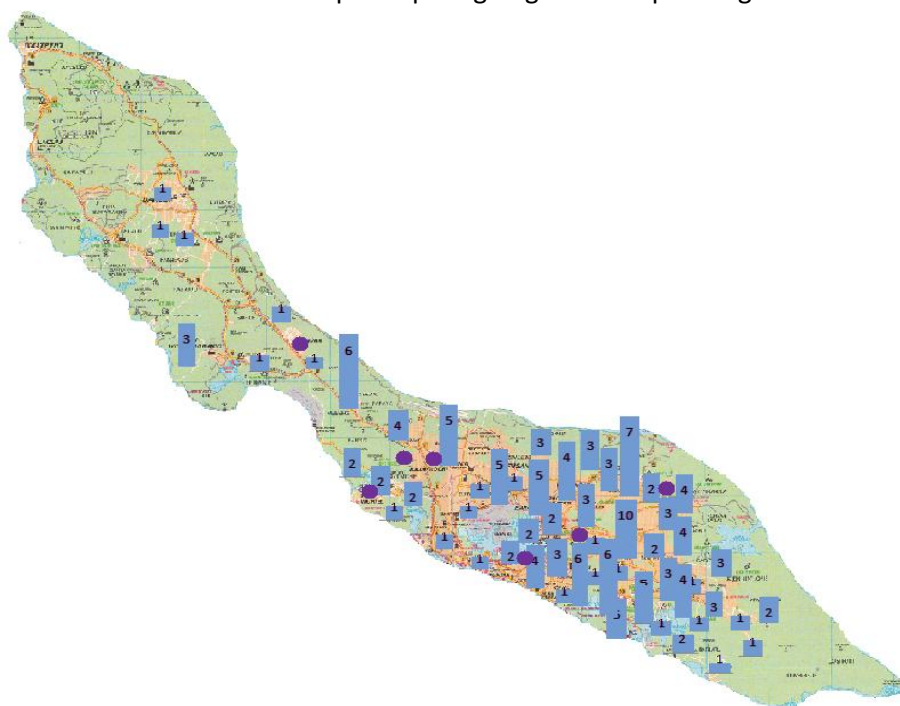
2. MATERIALS AND METHODS

2.1 TESTGROUP

The test group consists of dogs brought to the veterinary clinic by their owners. This group contains both healthy dogs, often in need for their annual vaccination, as well as dogs with clinical illness. In order to select dogs randomly the expected number of patients for a particular consulting-hour was estimated, depending on time of day and clinic location. If more than four dogs per hour were expected every one out of two dogs was included in the research. If less than four dogs per hour were expected all dogs visiting the consulting hour were included.

In two months 200 dogs were included in the research. The seven different cooperating clinics, purple spots, and the dog living area distribution over the island are shown in illustration 2.

Illustration 2 Distribution of participating dogs and cooperating clinics on the island of Curaçao.



2.2 PROTOCOL

When a patient, randomly selected by the method just described, entered the consultancy all general information was recorded from the computer onto a questionnaire, appendix 2. This information consisted of family name, age, breed and clinical history. Subsequently size, coat type and coat color were determined by the examiner.

After this a couple of questions were consulted with the owner (Appendices II) and the dog was examined for ticks. All ticks were collected using a forceps and placed in a cup containing 70% ethanol. The cup and questionnaire were labeled. In some cases it was impossible to collect all ticks due to lack of time or dog behavior.

If the check up by the veterinarian indicated the animal was currently suffering from ehrlichiosis this was added to the information on the questionnaire. In these cases a 3Dx© Snaptest and in some cases blood evaluation was performed to confirm this suspicion.

Collected ticks were packaged and send to Utrecht Centre for Tick-Borne Diseases. In the laboratory determination of tick species took place. With PCR and Reverse Line Blot techniques it is possible to identify pathogens ticks might carry. In the future all collected ticks will be submitted to this analysis.

3. RESULTS

This research includes 113 female and 87 male dogs. The mean age of the participants is 3,06 years. Out of 200 owners, 26 turned out to be unaware of the existence of ehrlichiosis.

According to the owners 154 of the dogs never suffered from ehrlichiosis, 29 at any time suffered from ehrlichiosis and 17 are currently suspected of the disease.

The mean number of dogs per household was found to be 2,54 which means the 200 participating owners own a total of 507 dogs from which 108 are presumed by the owner to have suffered from ehrlichiosis at some time in their lives.

3.1 TICKS

A total of 1314 ticks were collected. All adult ticks collected belong to the species of *Rhipicephalus sanguineus*. Most ticks were found on the predilection sites; ears, paws and neck. Out of 200 participating dogs 71 were free of ticks. The mean number of ticks found on a dog was 6,6 but since a lot of dogs did not carry any ticks the median number of ticks is 2.

Table 1 Determination results; distribution of ticks between sexes and stages

	Female <i>R. sanguineus</i>	Male <i>R. sanguineus</i>	Nymph <i>R. Sanguineus</i>	Larvae <i>Rhipicephalus spp.</i>
Total	521	635	156	3
Mean	2,6	3,2	0,8	0
Median	1	1	0	0

Observations show that the sex-ratio of adult ticks is 55-45% male/female.

No species determination was done on the larvae. But considering the trend of adult ticks it is very unlikely these belong to another species.

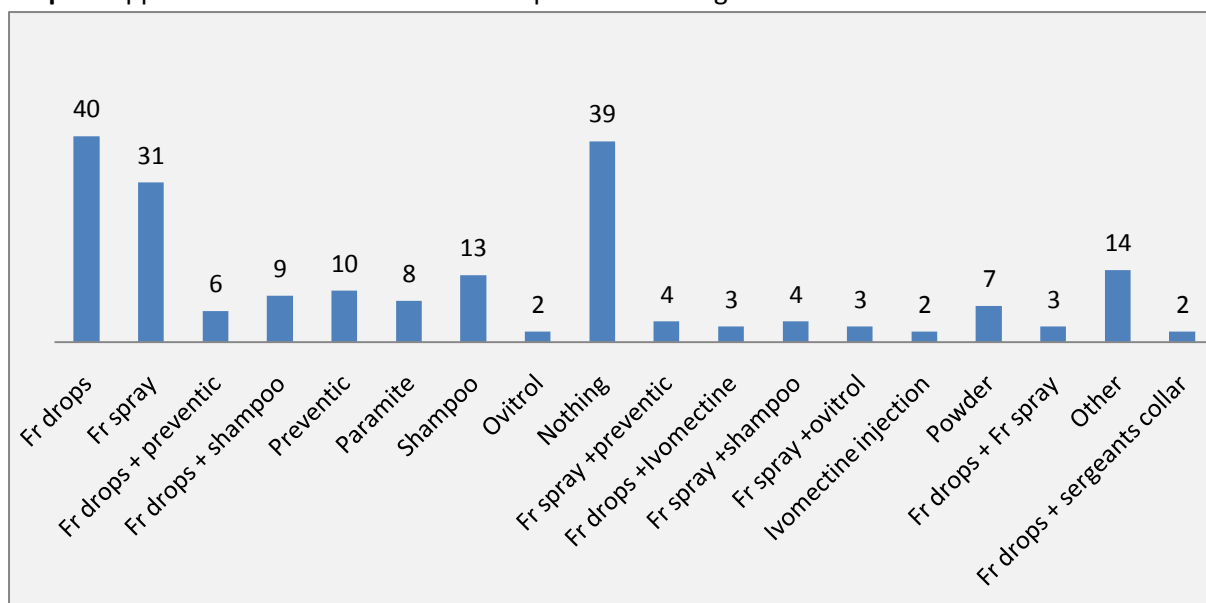
Table 2 Prevalence of ehrlichiosis in purebred and crossbred dogs

	Dogs did suffer ehrlichiosis	Dogs did not suffer ehrlichiosis
Breed	24	65
Crossbreed	22	89

When comparing purebred and crossbred dogs a difference in ehrlichiosis prevalence is found. 27% of purebred dogs has suffered from or is currently suffering from ehrlichiosis compared to 19,8% of crossbred dogs.

3.2 TICK CONTROL PRODUCTS

Graph 1 Application of different tick control products on dogs

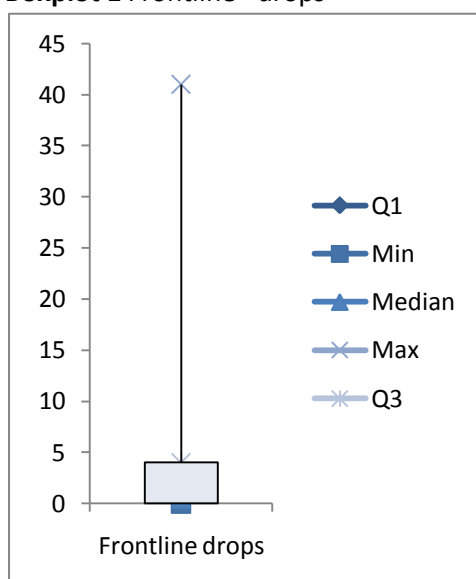


A total of 17 different products or combinations of products were used by more than one owner. The 'other' category encloses garlic, nime plant extract, scalibor® collar, amitraz, fermetrine, creoline, chlorine and buttermilk. A few of these products might not be conventional tick prevention products but the owners bought them for this purpose. Frontline® drops is the most used product followed by Frontline® spray. Shampoo of different labels and Preventic® collars are also commonly used.

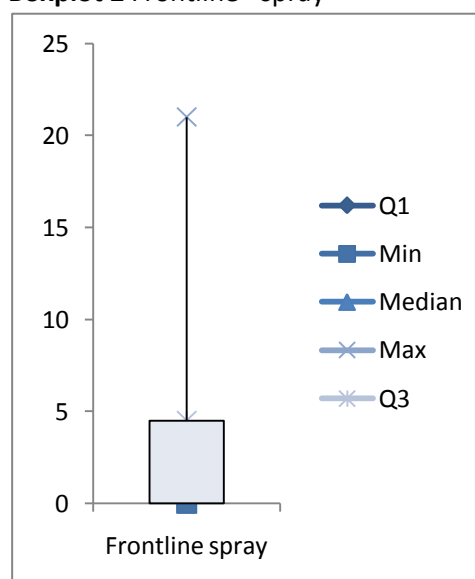
19,5% of the owners does not use any tick control products. They give various explanations such as costs, young age of the animal and unawareness of risks that come with ticks.

The effectiveness of the most sold products will be evaluated by comparing the number of ticks on the dogs. In this comparison only dogs with correct product application according to veterinary advice will be included to prevent high numbers of infestation due to expiration of the product effective period.

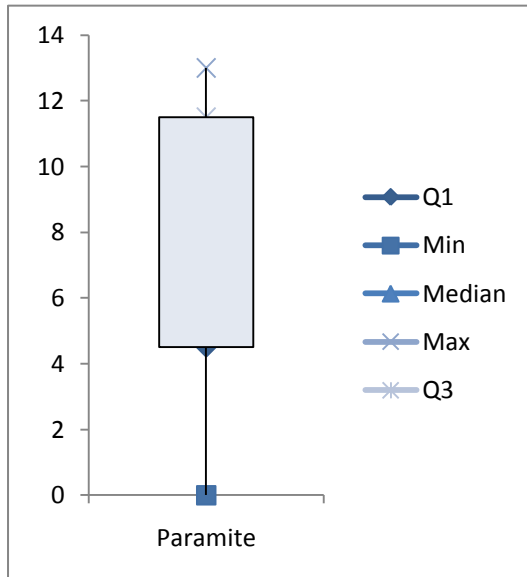
Boxplot 1 Frontline® drops



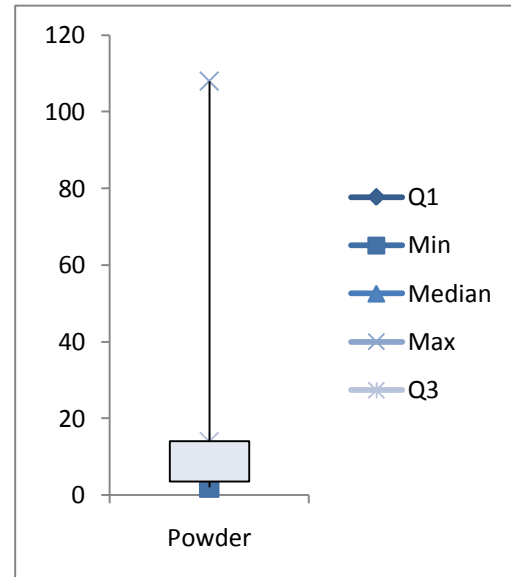
Boxplot 2 Frontline® spray



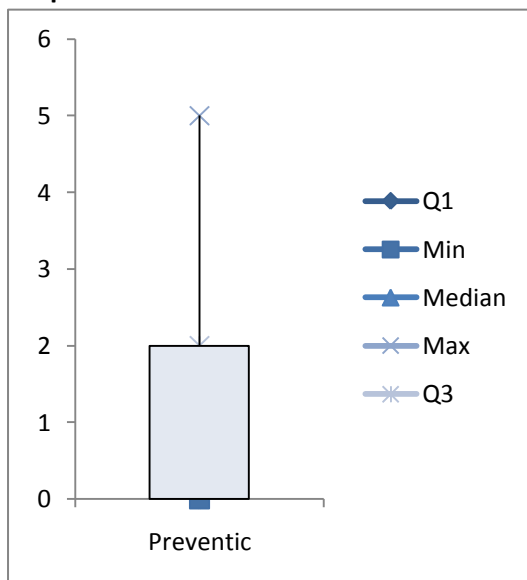
Boxplot 3 Paramite®



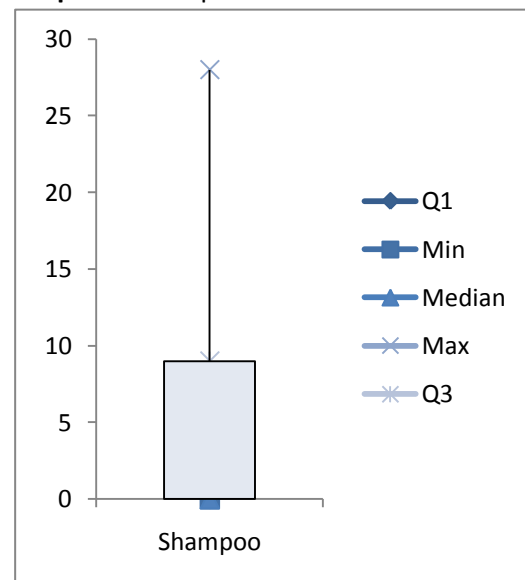
Boxplot 4 Powder



Boxplot 5 Preventic® collar



Boxplot 6 Shampoo



Box plot 1-6 above show that the highest amount of ticks was found with the application of powder. Also, there were no dogs with powder application that were free of ticks.

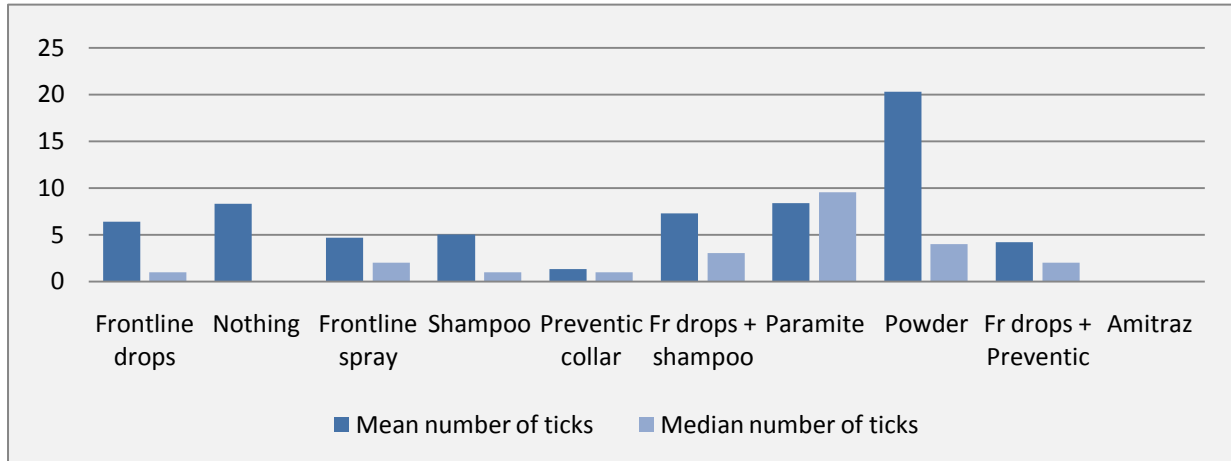
The effectiveness can best be assessed by comparing the median number of ticks. By this standard shampoo of different brands is the most effective product, judging the number of ticks, followed closely by Preventic® collar, Frontline® drops and Frontline® spray. The median number of ticks of Powder and Paramite® lies far from the other products so they can be considered the least effective out of the compared products.

Table 3 Tick control use conditions

	Familiar with ehrlichiosis	Not familiar with ehrlichiosis	Dog did suffer from ehrlichiosis	Dog did not suffer from ehrlichiosis
Tick control	146	28	41	122
No tick control	16	10	5	32

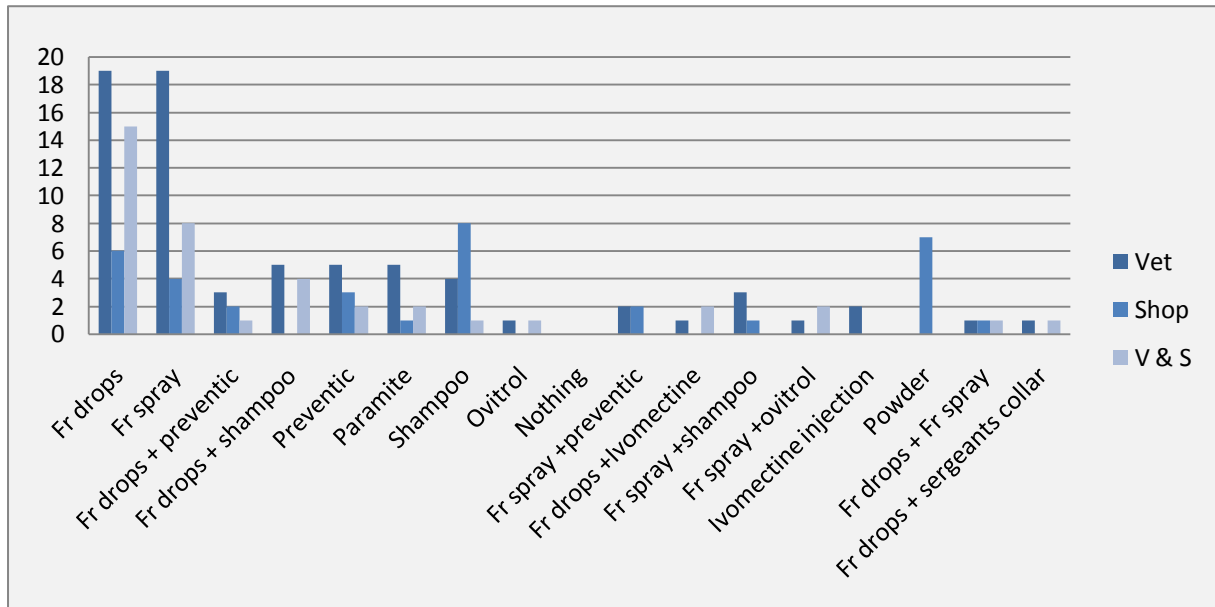
As shown in table 3 acquaintance with ehrlichiosis and history of ehrlichiosis influence the use of tick control products. Of clients familiar with ehrlichiosis 90% uses tick control products facing 74% of clients not familiar with ehrlichiosis. From owners with dogs that suffered from ehrlichiosis 89% uses tick control products and from owners with dogs without this clinical record 79%.

Graph 2 Number of ticks collected with different products



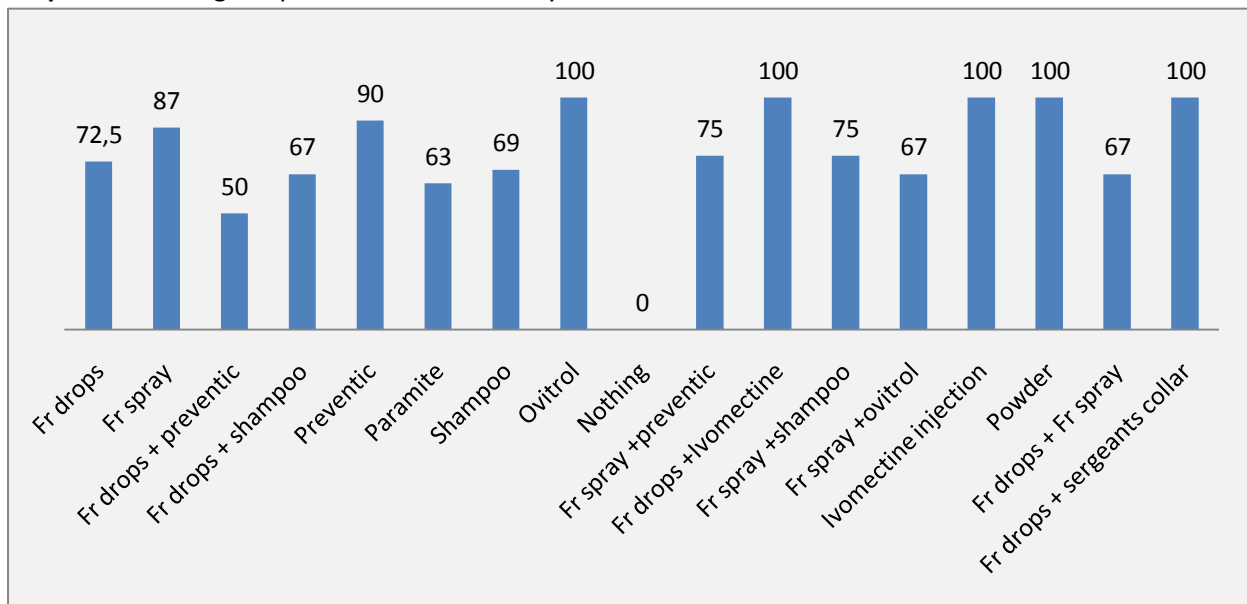
The mean and median number of ticks with the use of different products is shown in graph 2. This graph does not take correct use of the product into account. Powder results in the highest mean number of ticks, though this might be caused by a few extreme values because the median number of ticks lies much lower. The highest median number of ticks is found with Paramite®. The least ticks were found with Amitraz®, Frontline® drops and Preventic® collar use.

Graph 3 Product purchase location



Graph 3 shows that tick control products are mainly bought at the veterinary clinic, that is 37,5%. 23% of the respondents bought control products at pet shops or other stores like supermarkets. The remaining 20% bought tick control products at the veterinarian as well as at stores or pet shops.

Graph 4 Percentage of products used correctly

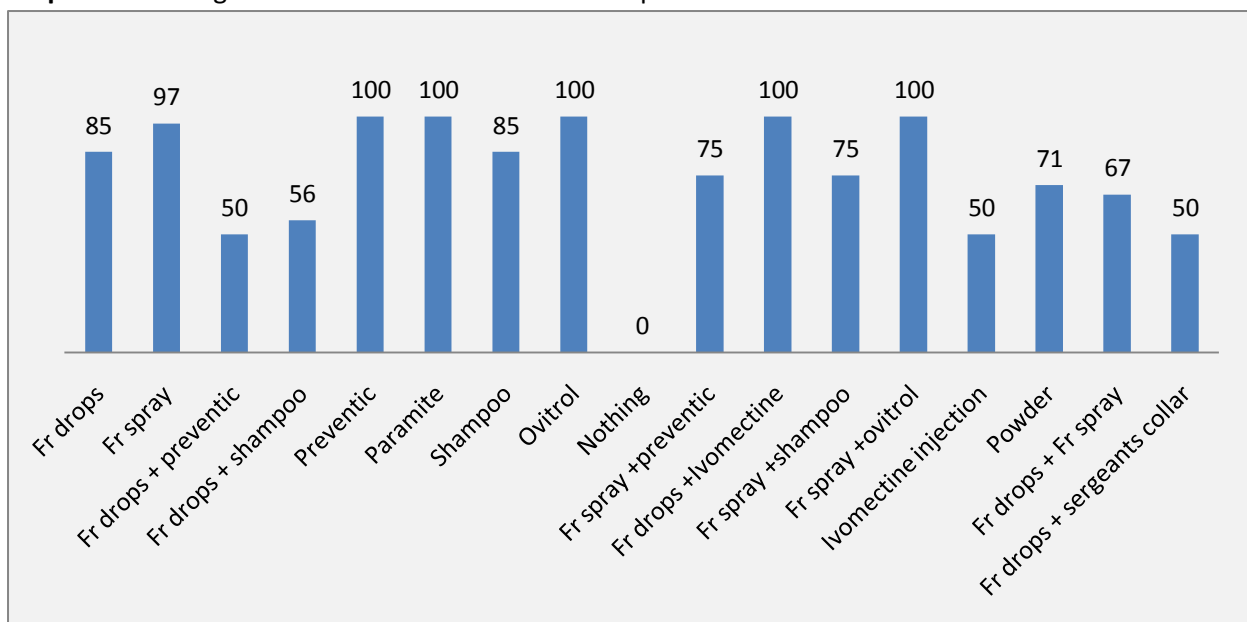


This graph displays the percentage of respondents that use products as instructed by the manufacturer. They were asked how often they applied products and their answer was compared to the information in the manual of the product.

All products turned out to be used well by at least 50% of the clients. Most correctly used products are powder of different brands, Ovitrol® shampoo, Frontline® drops combination with Sergeants® collar and ivomectin injection.

Of all ticks, 643 were on dogs with well applied products. Which was a total of 122 dogs so the mean number of ticks was 5,3. This mean turns out 1,3 lower than the overall mean number of ticks.

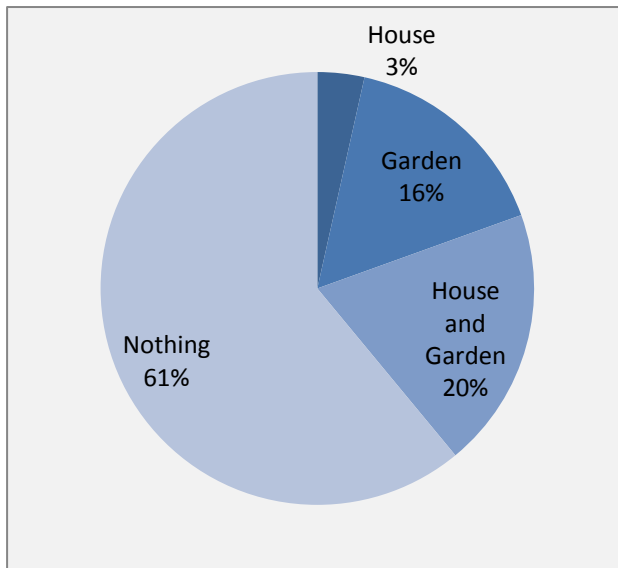
Graph 5 Percentage of satisfied clients with different products



Graph 5 displays the percentage of clients satisfied with the products they use. Of all users at least 50% is content with the product. Mean satisfaction is 79%. Clients are extremely satisfied with Preventic®, Paramite®, Ovitrol®, Frontline® drops + ivomectin and Frontline® spray + Ovitrol®. Comparing to the mean number of ticks with these products, especially Paramite®, shows satisfaction does not necessarily correlate with low numbers of ticks.

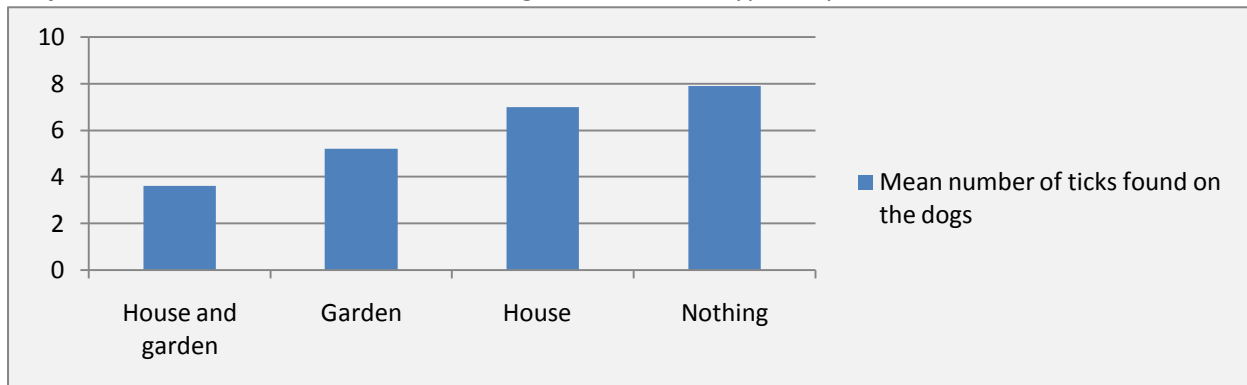
3.3 PESTCONTROL

Graph 6 Use of different types of pest-control



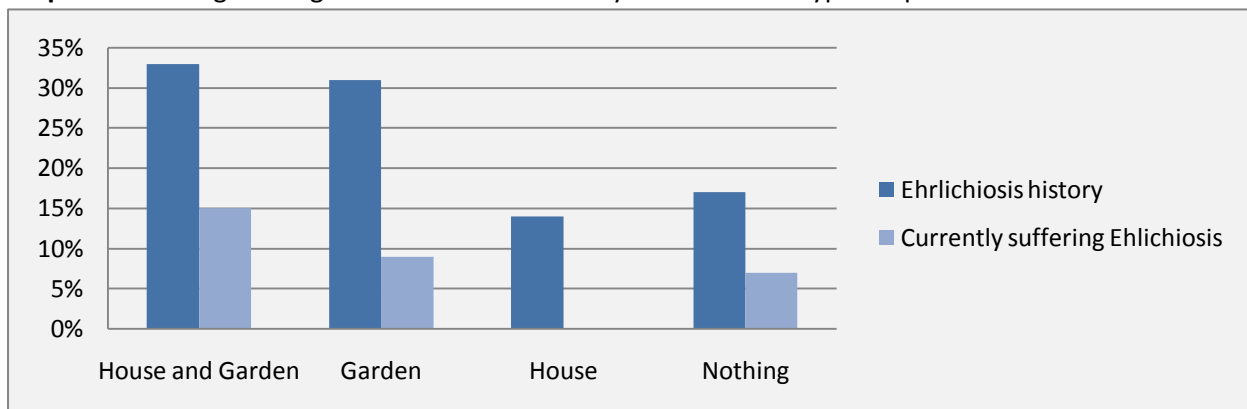
The use of different types of pest-control is displayed in graph 6. 39% of the participants use some sort of pest-control. Most of them apply products in their house as well as garden.

Graph 7 Mean number of ticks found on dogs with different types of pest-control



A clear relationship between the use of pest-control and the mean number of ticks is shown in graph 7. According to these results the best way to prevent ticks is to use pest-control inside as well as outside. Not engaging pest-control leads to more ticks on dogs living in the area.

Graph 8 Percentage of dogs with ehrlichiosis history with different types of pest control



In graph 8 a higher prevalence of ehrlichiosis is found with dogs in whose environment pest-control is applied. Except for indoor pest-control with which least dogs are suffering from or have suffered ehrlichiosis.

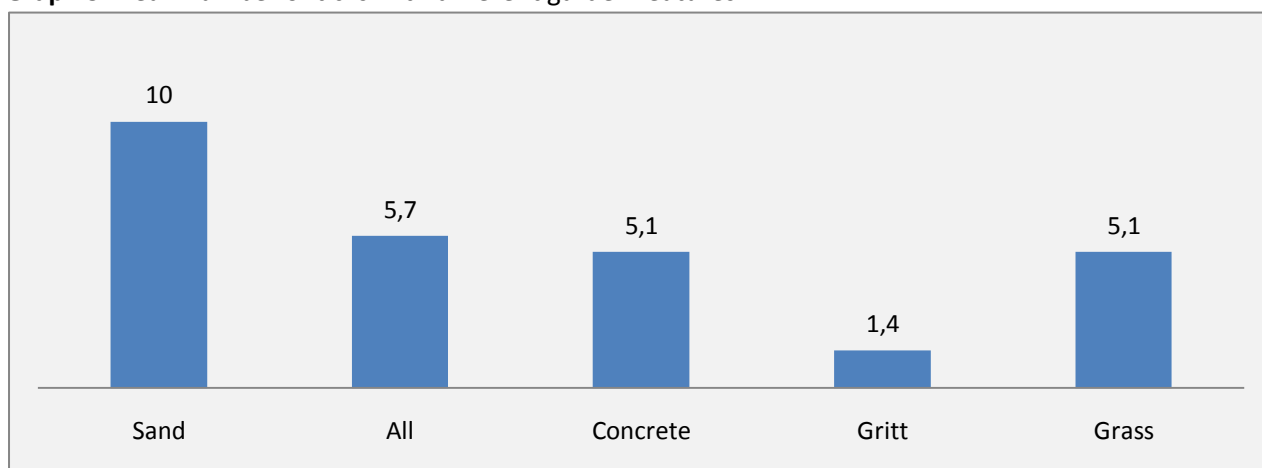
3.4 ENVIRONMENTAL INFLUENCES

Table 4 Number of ticks compared to dog living situation

	Cage	Inside	Free	Inside and free
Dogs in this category	18	38	89	56
Total number of ticks	108	211	769	226
Mean number of ticks	6	5,6	8,6	4

Table 4 shows the number of ticks found on dogs living in different situations. Free living dogs appear to carry the highest number of ticks followed by dogs living in a cage. Least ticks are found with dogs living both in- and outside.

Graph 9 Mean number of ticks with different garden features



In graph 9 different garden features are compared. A participant was allocated to the 'all' category if more than 2 different features were apparent in its environment.

Concrete, grass and combined garden features seem to give comparable mean numbers of ticks. While grit gives a much lower number of ticks, sand results in the highest number of ticks.

3.5 FOREIGN COUNTRIES

From all 200 participating dogs, 22 have been taken abroad by their owners. The countries they took them to include the Netherlands (11), Belgium (2), the USA (3), Aruba (2), Bonaire (2), St. Maarten (1), Egypt (1), Dominican public (1) and Germany (1). One owner possessed a boat and traveled around the world bringing the dog with her.

4. DISCUSSION AND RECOMMENDATIONS FOR FURTHER RESEARCH

According to the information on the questionnaires 108 out of 507 dogs suffered from ehrlichiosis. This information was attained from owners and when possible confirmed with veterinary documentation. Because of this some of the information could be considered unreliable.

4.1 TICKS

To define the mean of 6,6 ticks per dog it should be compared to data found in other researches. A mean of 18 *R. sanguineus* was found in a research by Burgdorfer et al, 1975, in the United States. In 1993 Mumcuoglu found a mean of 16,4 in Israel. In Thailand a mean of 3,4 ticks per dog was found (Nithikathkul et al, 2005) and in Nigeria this mean was found to be 4,2 (Agbolade et al, 2008). In these studies either no tick control products are used, Nithikathkul et al 2005, the use is not mentioned in the article, Burgdorfer 1975 and Mumcuoglu 1993, or use of tick control products occurs during the research, Agbolade et al 2008.

The resemblance between this research and the research in Nigeria is the allowance of tick control products during the research. This might explain the greater similarity in mean number of ticks compared to the other researches.

Table 1 shows a higher percentage of male ticks over female ticks was found on the dogs. The male/female ratio is 55-45%. A possible explanation lies in the fact that female ticks detach after mating and engorging, leave the host, deposit eggs and die in as little as 6 days while male ticks stay on the host after mating and seek additional females to mate. All in all male ticks stay longer, up to 568 days in the environment and can even change hosts in their adult state. This is also important for pathogen transmission because male ticks are able to transmit pathogens intrastadially (Little et al, 2007). Similar sex ratio results were found in France, Egypt, Thailand and Israel but no explanation was given (Mumcuoglu et al, 1993, Nithikathkul et al, 2005).

While this research only included dogs receiving veterinary care obtained results cannot be extrapolated to the entire dog population on Curaçao. Local veterinarians believe a large amount of dogs do not receive veterinary care. Owners of those dogs are probably less likely to apply tick control products and therefore the results concerning number of dogs per household, tick numbers on dogs and prevalence of ehrlichiosis might reveal to be higher in this group of dogs.

This is underlined when comparing results from this research to a similar research on the island of Aruba by Drs. G. van der Straten in 2008 with stray dogs. For example ehrlichiosis prevalence and numbers of ticks turned out way higher when examining stray dogs.

To get an overall picture of Curaçao a similar research could be performed among dogs not receiving veterinary care or randomly selected dogs. This could be achieved by, for example, selecting participants using a telephone book and random name picking.

4.2 TICK CONTROL PRODUCTS

The effectiveness of products can best be assessed by comparing the median number of ticks. By this standard shampoo of different brands is the most effective product, judging the number of ticks, followed closely by Preventic® collar, Frontline® drops and Frontline® spray. The median number of ticks of Powder and Paramite® lies far from the other products so they can be considered least effective of the compared products.

With all graphs and box-plots which accounted number of ticks one should keep the possibility in mind the owner removed ticks by hand. This way the number of ticks might give a distorted picture

of product efficiency. This might also contribute to the low number of ticks with dogs on which shampoo was used. In the process of brushing and washing the owner has close contact with the dog and might remove present ticks.

In table 2 a possible correlation between breed and ehrlichiosis prevalence is indicated. Previous researches to *E. canis* already showed a higher prevalence of ehrlichiosis in German Shepherd Dogs whereas crossbreeds were significantly under-represented (Harrus et al. 1997, Stephenson et al. 1978). Further research should be done to find an explanation for this relationship.

Graph 3 shows that expensive products with known labels are most likely to be bought at a veterinarian. During the research veterinarians often explained clients the importance of tick control and recommended certain products, mostly Frontline® drops and Frontline® spray. Therefore it is credible that of all products sold at veterinarians these products are the gross of sold products. Besides, the number of products like shampoo and powder were underrepresented in the veterinary clinic in comparison to pet shops.

Graph 4 shows that the products with most inaccurately application are Frontline® drops combinations, Paramite®, Frontline® spray with Ovitrol® and shampoo's. The reason for wrong application of Frontline® drops and combinations may lay in the difference between the Frontline® drops manual and veterinary findings. On Curaçao veterinarians in actual practice advise to use Frontline® drops and spray once a month considering the abundance of ticks. While some Frontline® manuals tells clients application once every three months should be sufficient to prevent ticks.

In the graph with number of satisfied clients one can see that not all clients are content with the efficacy of the products. This might not always be a product error because it is possible a client is not satisfied with the action of a product while it is not administrated the right way. Besides people have different expectations of products. Some dogs were invested with ticks and still owners claimed to be happy about their tick control product where others were dissatisfied with a product because one tick was found on their dog.

4.3 PESTCONTROL

The result that dogs in whose environment pest-control is applied have a higher incidence of ehrlichiosis was unexpected. Especially when looking at the number of ticks with different pest-control methods. Here a decreasing effect of pest-control on tick numbers is shown. The possible cause of this unexpected result is the unreliability of the ehlichiosis history data. This information is provided for by the owner who does not have profound knowledge of the disease and might confuse it with other diseases or just the presence of ticks. This is emphasized by the fact that some owners told not to be familiar with ehrlichiosis but later answered positive to the question if their dog ever suffered from it.

Another possible explanation is disease of their dog made owners more aware of tick risks and after this they started tick prevention including pest-control measures.

Though *R. sanguineus* is endophilic it appears garden pest-control is of greater influence than the use of indoor pest control to reduce tick numbers on dogs. This result depends on the distribution between indoor and outdoor tick numbers. No research has been done on this subject yet.

4.4 ENVIRONMENTAL INFLUENCES

Considering the different numbers of ticks found in certain living situations, table 4, most ticks are found on dogs living freely. It is plausible higher numbers of ticks would be found on dogs that live in a cage. This because engorged female ticks tend to lay eggs close to the dogs resting place to enhance the chances of their offspring to find a host (Dantes-Torres 2008). This theory is however not supported by the research results.

The finding of a mean of 5,6 ticks per dog in the inside environment can be explained by the fact that, as mentioned above, *R. sanguineus* is endophilic, in contrast to other tick species.

Garden features might influence the number of ticks on a dog. The real deviating numbers came with grit and sand gardens. Grit results in low and sand in high numbers of ticks.

A research to habitat and climate preferences of *Ixodes ricinus* ticks by Estrada-Pena, 2008, shows that though macroclimate may determine regional distribution, microclimate variables such as soil aspect and vegetation are of great importance for tick survival within an ecological area. Though so far, no research has been done to assess the precise influence of different soil types on tick survival. This subject is interesting for further research because it might become possible to develop a garden design that reduces tick numbers to apply in highly infested areas. This measure would be a lot more ecologically sound than using chemical pest-control. Using acaricides can cause environmental pollution and toxicity to non-target organisms such as humans. Indiscriminate use can also lead to acaricide resistance (Dantes-Torres 2008).

Another possible environmental factor contributing to the number of ticks on dogs is the presence of other animals like rodents. These, often free living, animals can act as tick reservoirs (Garris 1991). On Curaçao little is known about ticks on animals other than dogs. It is important to assess the role of these other animals for the possibility of developing an integrated tick control or even tick eradication program (George et al. 2002). Currently on Curaçao a research is worked on to investigate ticks on iguanas, amongst other things.

4.5 FOREIGN COUNTRIES

11% of the participating dogs have been taken abroad by their owners. A total of nine different countries were visited on 24 journeys.

5. CONCLUSIONS

Since this research is more of a pilot study, a lot of variables are present. With every comparison between specific results the other variables should be kept in mind. To support relations found a sequel study should be performed where variables are identified and minimized.

Furthermore a lot of information was obtained by questioning the pet owners. It is very likely that by incomprehension or ignorance not all questions were interpreted and answered correctly.

Though, due to this no precise or significant outcomes can be expected, this research gives a clear overall picture and points out possible topics for further research.

On Curaçao ticks and tick borne diseases are an important problem. The prevalence of ticks on dogs receiving veterinary care was 65%. The mean number of ticks on these dogs was 10 resulting in an overall mean of 6,6 ticks per dog. No other species could be determined but *Rhipicephalus sanguineus*. 23% of the dogs suffered ehrlichiosis at some point in their lives. The prevalence turned out 7,2% higher in purebred dogs.

80,5% of the participating owners used tick control products, though not all of these used products are originally indicated for tick control. Out of 16 different sold products and product combinations Frontline® drops and Frontline® spray were most bought. Most products were bought at veterinarians, that is 37,5%, 23% was bought at pet shops and with the remaining 39,5% purchase location was variable.

Concerning product effectiveness, most ticks were found on dogs with powder, Paramite® and no tick control application. Least ticks were found with shampoo, Preventic® collar and Frontline® products.

Of all contestants 79% declared to be satisfied with the used product. High rated products were Preventic®, Paramite® and ovitrol. However customer satisfaction turned out to not necessarily correlate with the number of ticks found.

To control ticks in the environment 39% of the owners uses pest control. A significant relationship between the use of pest control and tick infestation is indicated.

Another environmental influence on numbers of ticks is garden type. Major differences in tick numbers with various soil types were found. Further research is needed to illustrate the exact relationship.

To improve the situation on Curaçao education and further research are prominent points of interest. This research points out education on the following topics could help to improve the situation.

- The hazard of ticks and ehrlichiosis since 13% of the participating owners is unfamiliar with the disease.
- The availability of different products to control ticks and how to correctly apply them. Only 84% of the products were applied accurately while correct application decreases the mean number of ticks with almost 20%. Some products clients used for tick control were not suited for this purpose, for instance Paramite®, which is used by eight owners as it is not a registered dog tick control product.
- Since a relationship between the use of pest control and the mean number of ticks is shown veterinarians and pharmacological companies should pay attention to this subject in their owner education. To best prevent ticks owners should use pest control inside as well as outside.

- Results show being familiar with ehrlichiosis or having a dog that suffered from it increase the use of tick control products. This emphasizes the importance of client education because this result suggests that if better client education is realized more tick control products will be used.

Collected ticks will be examined at Utrecht University to determine the number and kind of pathogens they carry. With this result the significance of importing foreign dogs and dogs travelling from Curaçao to the Netherlands (5,5%) can be defined.

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APPENDIX 1

Product information obtained from manufacturer manuals and research.

Frontline® spot on, active ingredient fipronil 9,7%. Protection up to two months.

Frontline® spray, active ingredient fipronil 0,29%.

Fipronil is a non-competitive gamma-amino-butyric acid (GABA) inhibitor. After being applied on the skin it spreads to all lipid-containing structures in less than 24 hours.

Preventic® collar, active ingredient amitraz 9%. Provides 95% efficacy against ticks up to three months. For use on dogs over 12 weeks of age. Amitraz is a formamidine that kills ticks by inhibiting mixed function oxidases resulting in neuronal hyperexcitability and death (Blagburn and Dryden 2009).

Vet Kem® Ovitrol Plus Fea, Tick and Bot Spray, active ingredients methoprene 0,27%, pyrethrins 0,20%, piperonyl butoxide 0,37%, n-octyl bicycloheptene dicarboximide 0,62%. Protection up to two months.

Vet Kem® Ovitrol Plus Shampoo, active ingredients (S)-Methoprene 1,10% and Pyrethrins 0,15%. For use on dogs over 12 weeks of age.

Ivomectin® 200 ml 1% sterile solution for cattle and swine is also used on dogs to prevent ticks.

Because this is off label use no dosage and dose interval is available. Veterinary clinic's on Curaçao use 1ml per 20kg subcutaneous injection once a month as a guideline.

Research to the effect of ivermectin® on *Rhipicephalus sanguineus* at the Faculty of Medicine in Cairo by Morsy et al showed this dosage to make all ticks drop off within 3 to 4 days. The dropped of ticks were completely inactivated (Morsy and Haridy 2000). Ivomectin® is also given orally.

Wellmark® Paramite Dip, active ingredient phosmet 11,75%. Protection up to 16 days. Not indicated for use on dogs.

There is no anti-tick vaccine available for use in dogs. The fact that dogs do not develop immunity against *R. sanguineus* is an important limiting factor (Dantes-Torres 2008).

As 95% of the ticks live in the environment use of in- and outdoor acaricides should be included in the control strategy [Dantes-Torres].

Vet Kem® Siphotrol Plus Fogger enables tick control indoor and Siphotrol Yard Spray can be used for tick control in the outdoor environment. Both contain permethrin 2,5%, a third generation synthetic pyrethroid that modulates gating kinetics of sodium channels in nerves resulting in membrane depolarization and death of the ticks (Blagburn and Dryden 2009).

These acaricides give tick-control up to four weeks.

APPENDIX 2

Questionnaire 'Karpattenziekte'

Date: _____
Dog number: _____
Owner: _____
Telephone number owner: _____
Adress: _____
Name of dog: _____
Sex: M / F
Age: _____
Breed: _____
Furtype: Long haired / Medium-long haired / Short haired
Furcolor: DARK / INTERMEDIATE / LIGHT / SPOTTED

Are you familiar with the Karpattenziekte? Yes/No
Has your dog had this disease before? Yes/No

Do you have more dogs, if yes, how many?
Have your other dogs ever had Karpattenziekte? Yes/No

Do you use tick prevention on your dog? Yes/No

Vet	(Pet) Shop				
Frontline plus	Frontline spray	Ovitrol	Preventic collar	Paramite	
Ivomec injectable	Shampoo	Other:			

How often? _____

Environment	What, how often?	_____
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Are you satisfied with these products? Yes/No

Do you remove ticks from your dog? Yes/No
How often?
Can you give an estimate of the amount of ticks?

Does your dog live inside or outside?
INSIDE / PART INSIDE, PART OUTSIDE / OUTSIDE
KENNEL / CHAIN / LOSE

Have you ever taken your dog abroad?
