Small Animal

The Evidence for Environmental Contamination with Parasiticides

In UK Small Animal Practice

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Author: Nicole Dyer

This document has been created to provide a summary of individual scientific papers that are part of the growing body of evidence of environmental contamination with widely used veterinary parasiticide medications, and the pathways via which these compounds may be entering the environment.

This is not intended to be a systematic review of all the evidence available, but it includes key papers that have been cited regularly within resources published by Vet Sustain and other veterinary organisations.

The key take home points from these papers are:

- **Fipronil and imidacloprid are present in UK waterways at concerning concentrations;**
- **A significant pathway for contamination is through household drains via wash off from pet bathing, bedding and handwashing;**
- **Pets may also directly transfer chemicals into the environment from swimming and from hair shedding.**

Title	Potential role of veterinary flea products in widespread pesticide contamination of English rivers.		
Authors	Perkins, R., Whitehead, M., Civil, W. and Goulson, D.		
Journal	Science of the total environment	Year	2021
Link	https://doi.org/10.1016/j.scitotenv.2020.143560	Open Access	No
Summary			
Sample population	English fresh water samples from 20 rivers routinely monitored by the Environment Agency (EA) between 2016-2018		

Study Details	• Data was sourced from the EA
	    • Samples were analysed for a host of chemical compounds as part of the EA chemical surveillance programme
	    • Imidacloprid and fipronil were monitored by the EA during the entire period
	    • Metabolites of fipronil were only monitored by the EA from 2017 onwards

Outcomes Assessed	• The number of sites and samples that tested positive for imidacloprid, fipronil and the fipronil metabolites: fipronil sulfone and fipronil sulfide • The concentrations of these chemicals when detected in samples • Whether concentrations exceeded previously published invertebrate toxicity levels

Key Findings	• Fipronil was detected at all 20 sites and in 98.6% of samples
	    • Mean concentration was 17ng/l (range <0.3ng/l-980ng/l)
	    • 21.6% of samples exceeded the acute toxicity limit applied (20ng/l)
	    • 82.5% of samples exceeded the chronic toxicity limit applied(3.2ng/l)
	
	• Fipronil sulfone was detected at 18 sites and 96.5% of samples
	    • Mean concentration was 6.5ng/l (range <0.2-39ng/l)
	    • 91.9% of samples exceeded the acute toxicity limit applied(1.3ng/l)
	    • At least 96.5% exceeded the chosen toxicity limit applied (0.17ng/l – below the minimum level of detection possible)

	• Fipronil sulfide was detected at 18 sites and 68.7% of samples
	    • Mean concentration was 0.78ng/l (range: <0.2-5.3ng/l)
	    • 56.8% of samples exceeded the acute toxicity limit applied (0.62ng/l)
	    • At least 68.7% of samples exceeded the chronic toxicity limit applied(1.4ng/l – below the minimal level of detection possible)
	
	• Imidacloprid was detected at all 20 sites and 65.9% of samples
	    • Mean concentration was 31.7ng/l (range:<1 – 360ng/l)
	    • 0.3% of samples exceeded the acute toxicity limit applied(200ng/l)
	    • 27.5% of samples exceeded the chronic toxicity limit applied(35ng/l)
	
	• Concentrations of all products were higher when closer to waste water treatment sites suggesting entrance via domestic waste water

Limitations	• Data is from 2016-2018 so may not reflect current levels and potentially changing patterns • Use of fipronil and imidacloprid in agriculture eg. as seed coating preparations, is still a possibility within this time period as complete bans were not in place until 2017 and 2018 respectively, so this may contribute to observed concentrations in some source locations. Records suggest usage stopped prior to these bans, but this does not exclude unrecorded applications of products.

	• The paper states that *"currently, no environmental quality standards exist for imidacloprid, fipronil, fipronil sulfone or fipronil sulfide in British surface waters."* Acute and chronic toxicity limits vary across sources and there are gaps in knowledge as to the most appropriate values to apply. There are also stated uncertainties regarding the bioavailability of the parasiticides in the environmental compartments studied, and therefore uncertainties regarding the most appropriate toxicity thresholds to be applied. However, the authors have chosen limits reported within other peer-reviewed publications that are higher than those proposed or accepted in other toxicology databases, so these are likely to be conservative.

Title	Down-the-drain pathways for fipronil and imidacloprid applied as spot-on parasiticides to dogs: Estimating aquatic pollution.		
Authors	Perkins, R., Barron, L., Glauser, G., Whitehead, M., Woodward, G. and Goulson, D.		
Journal	Science of the Total Environment	Year	2024
Link	https://doi.org/10.1016/j.scitotenv.2024.170175	Open Access?	Yes
Summary			

Sample population	● For experimental method: ● 98 client owned dogs and their owners were assessed for wash-off of topical spot-on products after bathing, handwashing and bed laundering ● 12 beds were assessed for longer term wash-off of topical spot-on products when laundered. ● For concentration modelling: ● Data on measured imidacloprid and fipronil concentrations in wastewater influent and effluent, upstream and downstream of waste water treatment works (WwTWs) were obtained from the 3rd UK Water Industry Research Chemical Investigation Program (CIP3) Report, Volume 5 (effluent from 30 sites, influent from 12 of these 30 sites. 18-20 samples per site)
Study Details	● 50 dogs had a fipronil spot-on product applied ● 48 dogs had an imidacloprid spot-on product applied ● All dogs were supplied a standardised bedding to use during the study ● 12 unused beds had 0.2ml (20mg) fipronil or imidacloprid product applied and were then exposed to ambient household environment ● Dogs were washed at 5, 14 or 28 days post-application. On the same day, handwashing and bed laundering were performed. Each client was asked to stroke their dog's coat for 2 minutes and then perform handwashing in both groups. In the imidacloprid group they also performed a 'baseline' hand-wash prior to stroking. ● The 12 unused 'spiked' beds were washed at 1,2 or 3 months post application. ● Waste water was collected from each event and analysed for the presence and concentration of the applied chemicals

	• The proportion of product applied found in the washed off wastewater was calculated. Using sales data and previous data on frequency of emitting activities by owners, population level emissions were estimated. • Data from water monitoring of fipronil and imidacloprid concentrations was used to take a mean concentration per site and apply a risk quotient depending on the concentration compared to predicted no effect concentrations (PNEC). Due to a wide range in PNECs reported for the compounds, 2 values were used from 2 accepted frameworks; the EU biocides assessments and the CIP3 reports, and the NORMAN Association (Network of Reference Laboratories, Research Centres and Related Organisations for Monitoring of Emerging Environmental Substances). Influent and effluent concentrations were used to estimate per capita load of compounds and therefore possible contribution of veterinary products to concentrations.
Outcomes Assessed	• Confirmation of the presence of the studied compounds in wash-off from treated dogs. • Calculation of the mass wash-off (mg of product) and wash-off percentage (percentage of the amount of product applied) for each washing event. • Estimation of the contribution of Veterinary products to current measured pollution.
Key Findings	• Fipronil and imidacloprid were detected in 100 % of wash-off samples (bathing, bed washing and owner hand-wash) • Wash-off percentage decreased with increasing days since application for bathing

	and handwashing but no significant difference was seen with time from application for bed washing. • Mass wash-off ranged from 0.0009 mg – 46.2 mg for imidacloprid (0.0004-16.8% of applied mass) and 0.002–32.9 mg for fipronil (0.001–24.5 % of applied mass) • An estimated 9.1 % of imidacloprid and 6.0 % of fipronil applied in dog spot-on products may pass into household waste water through the combination of these routes. • Concentration of both compounds are higher downstream of waste water treatment discharge points compared to upstream. • Concentrations were considered high risk downstream of waste water treatment facilities and moderate to high risk upstream depending on whether NORMAN or EU PNEC values were applied. • Estimated per capita emissions of fipronil and imidacloprid via pet bathing, handwashing and bed washing after spot-on use could account for up to 42.9% of observed levels in wastewater influent.
Limitations	• Only 1 washing event at 1 time point performed per animal; persistence of emissions or the effect of the washing event on subsequent emissions is therefore unknown. • Assumptions made in modelling may lead to over or under estimation of emissions.

Title	Dog swimming and ectoparasiticide water contamination in urban conservation areas: A case study on Hampstead Heath, London

Authors	Yoder, L.E., Egli, M., Richardson, A.K., Brooker, A., Perkins, R., Collins, C.T., Cardwell, J.M., Barron, L.P. and Waage, J.		
Journal	Science of The Total Environment	Year	2024
Link	[ttps://doi.org/10.1016/j.scitotenv.2024.176686](https://doi.org/10.1016/j.scitotenv.2024.176686)	Open Access?	Yes
Summary			
Sample population	Water samples from 6 ponds within Hampstead Heath; 3 in which dog swimming is allowed and 3 in which dog swimming is prohibited and pond access by dogs is restricted. 101 dog owners in the Hampstead Heath area.		
Study Details	• Dog activity was observed in each pond to calculate the average number of dog entries and immersion events. • Water samples were taken in duplicates on 2 different dates from each pond. Samples were taken from the main designated swimming site or a site under observation in no-swimming pools. A sample was taken from 3 additional sites and then combined for each pool. • Water samples were analysed for concentration of fipronil and imidacloprid and for other contaminants of emerging concern (CECs). • Correlation of concentration with observed activity level within ponds was assessed.		

	• Risk quotients were estimated for each pond using the highest concentration of fipronil or imidacloprid detected for the location and the lowest predicted no effect concentration (PNEC) as used by the NORMAN Association (Network of Reference Laboratories, Research Centres and Related Organisations for Monitoring of Emerging Environmental Substances) • A Questionnaire was distributed to people who walk their dogs in Hampstead Heath, assessing flea and tick products used on their pets, frequency of use and opinions towards these products.
Outcomes Assessed	• Quantitative analysis of concentrations of imidacloprid and fipronil residues in Hampstead Heath ponds • Whether other CECs typically observed in urban surface waters were present in the same ponds, which may suggest contamination with wastewater sources.The parasiticide treatment habits of dog owners who swim their dogs on Hampstead Heath • Awareness of the environmental impact of flea and tick treatments amongst these dog owners.
Key Findings	• In the non-swimming pools, imidacloprid and fipronil were below the limits of detection or quantification in all samples. • In the swimming pools, imidacloprid and fipronil were detected at concentrations exceeding the NORMAN PNEC. • There was a positive correlation between level of dog activity and parasiticide concentrations detected. Whilst it was not significant for fipronil when non-swimming pond results were removed from the model, it remained so for imidacloprid.

	• Mean concentrations of samples from each pond exceeded other reported PNECs or environmental quality standards. All mean concentrations also met or exceeded previously reported chronic toxicity levels, and for the main entry site, samples of 2 ponds exceeded reported acute toxicity concentrations for imidacloprid. • The number of other CECs present was considerably lower than reported in other water monitoring studies for London, with 7/163 tested for presence at detectable concentrations. Concentrations were 5 fold lower than reported for wastewater affected areas within London, suggesting another route of contamination. • Questionnaire results showed that the majority (81%) of respondents allowed their dog to swim in Hampstead Heath, with most reporting a frequency of daily-weekly. • 78% gave regular prophylactic parasiticide treatments, with frequency varying. • Out of the respondents that had used a flea product in the last 12 months and let their dogs swim, 68% were able to identify the product used: 44% used a product containing fipronil or imidacloprid. • 86% of respondents were unaware of possible environmental effects of parasiticide treatments. • 90% of respondents cited their vet as a source of information regarding treatments.
Limitations	• Limited time periods sampled. • Questionnaire responses may not be reliable

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Title	Pet dogs transfer veterinary medicines to the environment.		
Authors	Diepens, N.J., Belgers, D., Buijse, L. and Roessink, I.		
Journal	Science of the Total Environment	Year	2023
Link	https://doi.org/10.1016/j.scitotenv.2022.159550	Open Access?	Yes
Summary			
Sample population	9 dogs recruited from 27 respondents to a survey of staff within the Environmental Science group of Wageningen University and Research Centre in the Netherlands.		
Study Details	• Hair samples were provided from all 9 of the dogs with non-standardised collection technique (brush or clipped). • Urine samples were provided from 6 of the dogs. • 3 of the dogs participated in a swimming experiment in which they swam in a pool of water for a non-standard amount of time. Water samples were collected at baseline and after each dog; water was not changed between dogs. • All hair, urine and water samples were analysed for: afoxolaner, fluralaner, fipronil and imidacloprid. • Any current parasite treatment being used for the dogs was recorded and for any other animals in the household.		

	• A blue tit's nest containing dog hairs was acquired during the study from an abandoned nest, and the hairs also submitted for testing
Outcomes Assessed	• Chemical concentrations of the stated compounds in hair, urine and water samples from the study dogs and the relationship between this and the participant's current treatment regime. • Chemical concentrations of the stated compounds in hair found in a single blue tit nest.
Key Findings	• 1 or more of the compounds were detected in 5/6 urine samples • 2 or more of the compounds were detected in all of the hair samples • Some dogs urine and hair samples tested positive for parasiticide products that were not reported as being used as part of their preventative regime • Fluralaner was detected in 2/6 urine samples and 7/9 hair samples • Afoxolaner was detected in 5/6 urine samples and 0/9 hair samples • Imidacloprid was detected in 3/6 urine samples and 9/9 hair samples • Fipronil was detected in 2/6 urine samples and 7/9 hair samples • The dogs with fluralaner detected in their urine and with the highest concentrations detected in their fur were treated with a fluralaner product. The dog with the highest concentration of imidacloprid in their urine and fur was treated with an imidacloprid product. The other dogs were treated with products with active ingredients not tested for within this study. 1 dog received no recent treatment.

	• The hair sample from the birds nest tested positive for imidacloprid, fipronil and fluralaner • The water samples tested positive for imidacloprid and fluralaner • The first dog to swim had been reported as using a fluralaner treatment, none of the 3 dogs were reported as receiving an imidacloprid treatment.
Limitations	• Small sample sizes for each portion of study • Non-standardised collection technique for hair. Use of a brush may allow contamination from other animals if it is just from within the household • Owner reporting of routine treatments being used may be inaccurate and only the most recent product may have been reported. • Timing of last dose of treatment was not reported

Title	High prevalence of veterinary drugs in bird's nests.		
Authors	de Montaigu, C.T., Glauser, G., Guinchard, S. and Goulson, D.,		
Journal	Science of the Total Environment	Year	2025
Link	https://doi.org/10.1016/j.scitotenv.2025.178439	Open Access?	Yes

Summary	
Sample population	103 (out of a possible 237) blue and great tit nests collected within the UK during Sept- Oct 2020
Study Details	• Great tit and blue tit nests were collected by volunteers contacted via the British Trust for Ornithology (BTO) and from their social media platform Twitter (X). • Information was provided by the volunteers on area of collection, level of urbanisation, presence of livestock within a 200m radius of the nest, the volunteers' own pets and their pet parasiticide use habits. • Number of unhatched eggs or dead chicks found in the nest was recorded. • Hair used within the nests was analysed for 15 insecticides (including the 9 most widely used as ectoparasitic treatments) and 5 metabolites.
Outcomes Assessed	• Presence of insecticide residues within hair samples from the submitted nests • Association between insecticide residues and chick mortality/failure to hatch
Key Findings	• 17/20 of the individual compounds were detected in the nests • All 103 nests tested contained detectable insecticide residues in their fur lining, with a minimum of 2 and a maximum of 11 insecticides found in individual samples • The top three insecticides with the highest percentage of samples above the Limit of Quantification (LOQ) were fipronil (present in 100% of nests tested), imidacloprid (present in 89.1% of blue tit and 87.2% great tit nests tested), and permethrin (present in 89.1% of blue tit and 84.6% great tit nests tested) • The three active substances with the highest concentrations found across fur samples were

	all anti-parasitic substances: dinotefuran, permethrin and cypermethrin. ● Higher chick mortalities were associated with higher concentrations of pesticide products found in the nests.
Limitations	● Nests were collected at the end of the breeding season which may influence expected rate of unhatched eggs and chick mortality ● Volunteer led collection of nests and use of surveys may lead to variations in collection method and a source of bias ● A causal relationship between the presence or concentrations of insecticides within a nest and chick mortality or failure to hatch was not established. ● Strength of correlations also varied between species,more commonly being found when looking at specific compounds within the great tit nests; however species differences and differences in quantity of hair used in nest building could influence levels of exposure and potentially allow for variations in effect. ● The source of the fur detected in nests was not confirmed. The paper states that further studies are warranted to "*identify the species provenance of the fur analysed to establish causation beyond doubt.*"