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Domestic Dog Populations, a Source of Canine Distemper Virus for Wild Carnivores in India, Vaccinating Them - A Biofencing Strategy

Boon Allwin[1]*, Sunita Dhariyam[2] and A Ajay Desai[3]

[1]*Madras Veterinary College, Chennai, Tamil Nadu*

[2,3]*The Mariamma Charitable Trust, Bandipur, Karnataka*

***Corresponding Author:** Boon Allwin, Madras Veterinary College, Chennai, Tanuvas, Tamil Nadu.

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Abstract

Canine distemper is a contagious, incurable, often fatal, multi systemic viral disease that affects the respiratory, gastrointestinal, and central nervous systems. Canine Distemper Virus CDV occurs among domestic dogs and many other carnivores the wild cats especially. Domestic dogs are one of the most numerous encountered carnivores in the world, and they are particularly abundant in tribal hamlets to safe guard the people, they can be excellent reservoirs for pathogens, since they usually live in large populations, are not Vaccinated and are regularly allowed to roam freely, facilitating contact between infected and susceptible hosts. We hypothesize that the wild carnivores commonly have small populations and occur at low densities and are often not suitable to maintain infections like CDV, instead, this pathogens tend to spill over from domestic dogs to wild carnivores through contact and this contact happens when the wild cats prey on the affected dog thus facilitating direct contact hence vaccinating the reservoir surplus (domestic dogs) to avoid the "spill over" to the wild populations will definitely curb the prevalence of Canine Distemper in the big cats – a bio fencing strategy, ultimately a scientific conservation tool. All villages within a two kilometer buffer of the Bandipur tiger Reserve, Karnataka, were identified, totaling to a number of 127 and 1265 dogs were vaccinated.

There were no reported deaths of wild carnivores from Canine distemper within the Bandipur tiger Reserve after the vaccination of domestic dogs. This will serve, as a major large-scale disease control programme by vaccination of domestic dogs to protect CDV outbreak in wildlife, ultimately "bio-fencing" the wild cats.

Keywords: *Canine Distemper; Domestic dogs; Wild Carnivores; Vaccinations*

Introduction

Canine distemper is a contagious, incurable, often fatal, multi systemic viral disease that affects the respiratory, gastrointestinal, and central nervous systems. Canine Distemper Virus CDV occurs among domestic dogs and many other carnivores wild cats especially (Tigers and Leopards), including raccoons, skunks, and foxes. CDV is now becoming fairly common in wild carnivores. CDV belongs to genus Morbillivirus within the Paramyxoviridae family. In addition to causing disease in domestic dogs, CDV can cause high fatality in wild carnivores and can threaten endangered carnivore populations [1]. Key aspects for the control of CDV and for essentially minimizing its threat to wildlife conservation should include the identification of infection and the contributing reservoirs, the mechanism modules by which infections are long sustained within reservoirs, and the routes and sources of transmission from reservoirs to the target species of concern [2].

The virus is quickly killed by disinfectants and sunlight and heat. However, the virus is very stable and can stay active in infected material for several weeks, provided the materials are not exposed to sunlight. At below zero temperatures the virus can stay active for many months, but at temperatures above 32°C it is rapidly inactivated. Like other paramyxoviruses the CDV rapidly invades cells and uses the cell's reproductive mechanism to reproduce itself. Inside the cell the virus is protected and it is very difficult for the immune system to get at it to destroy it. Many thousands of new virus particles are released when the cell dies. There is an involvement of living host system that is necessary for replication, so replication outside the host is impossible.

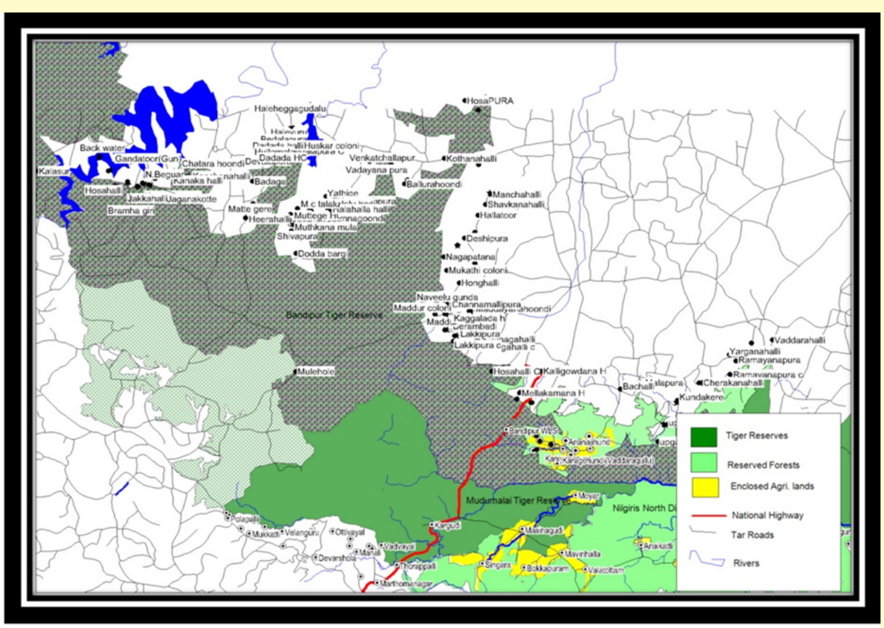
Domestic dogs and many other carnivores, including the big cats, wild dogs, jackals and foxes are affected by CDV. The infection is more severe in puppies. Infected dogs shed the virus through body secretions and excretions, especially respiratory secretions. The main mode of transmission is airborne. Normal animals get the infection by breathing the viral particles. Dogs in recovery may continue to shed the virus for several weeks after symptoms disappear and act as source for contamination. Domestic dogs are one of the most numerous carnivores in the world [3], and they are particularly abundant in urban areas of some developing regions where they can be excellent reservoirs for pathogens, since they usually live in large populations, are not Vaccinated and are regularly allowed to roam freely, facilitating contact between infected and susceptible hosts.

We hypothesize that the wild carnivores commonly have small populations and occur at low densities and are often not suitable to maintain infections like CDV, instead, this pathogens tend to spill over from domestic dogs to wild carnivores through contact and this contact happens when the wild cats prey on the affected dog thus facilitating direct contact hence vaccinating the reservoir surplus (domestic dogs) to avoid the "spill over" to the wild populations will definitely curb the prevalence of Canine Distemper in the big cats - a bio fencing strategy, ultimately a scientific conservation tool.

Materials and Methods

Study area

Bandipur National Park established in 1974 as a tiger reserve under Project Tiger, is a national park located in the south Indian state of Karnataka, India and the park spans an area of 874 square kilometers from 75° 12' 17" E to 76° 51' 32" E and 11° 35' 34" N to 11° 57' 02" N (Figure 1) where the Deccan Plateau meets the Western Ghats and the altitude of the park ranges from 680 meters (2,230 ft) to 1,454 meters (4,770 ft).



Map of the Bandipur Tiger Reserve with the Villages Adjoining the Forest Regions

All villages within a two kilometer buffer of the Reserve forest boundaries were identified, totaling to a number of 127 were covered. In each of these villages/hamlets the local people had been informed of the proposed vaccination project and were open to it.

Direct count estimation method

A proforma form was designed for the study which consisted of village name, number of dogs seen, breed, sex and age of the dogs seen. The counting and vaccinating of the dogs was carried out early in the morning between 6 AM and 10:00 AM and in the evenings 4-7 PM this time was selected because it corresponded with the period of maximum dog activity, less human activity and good visibility. Two people were selected and trained to carry out the counting of dogs. They surveyed the villages one at a time, walking up and down each of the selected village. The number of counted dogs in the selected villages in each of the identified area was used to estimate the population of dogs in that area. An estimate of the entire dog population in the entire Bandipur tiger reserve was determined based on all the counts from these areas. The same persons were used to avoid any overlapping or biased estimations of the dog count.

Questionnaire and household survey estimation method

A structured questionnaire was designed for survey of dogs and in addition, information on geographic locations was tracked using a GPS (Etrex, Garmin[R]) module and demographic aspects of dog ownership and attitudes of dog ownership were carried out. An adult member of every village was interviewed for about 5 mins using the structured questionnaire which covered information about the household, dog population, management of dogs and vaccination program, cases of dog bites, post exposure management.

Vaccination of the dogs

Cold chain

The total numbers of vaccine doses used were 1266 of Canine Distemper (Nobivac DHPPi)[R]. Maintenance of cold chain is very critical in storage of vaccines as their potency, safety and efficacy are determined by the temperature gradient, a portable refrigerator that had a capacity of providing ideal storage conditions (2^0C to 8^0C) for approximated 400 doses of each vaccine. This refrigerator was always functional as it was supported by 12 V connection supplied by the vehicle battery. The remaining vaccines pertaining to that particular period of time were maintained at similar storage conditions at the base camp, maintaining the standard protocol of vaccinations and their storage.

Catching and Restraint of Dogs

The dogs in the villages adjoining the tiger reserve were caught by professional dog catchers with vast experience. The dog's were caught in nets with the least stress inducing strategies and proper non- invasive, less pain inducing equipments. Once caught the dogs were restrained to present in a way that the injection sites were clearly visible in order to avoid wrongful vaccine delivery. The team comprised of 4 dog catchers, 2 surveyors and one veterinarian.

Procedure

The vaccines were administered properly by either S/C or I.M whichever was possible at the time of restraint and care was taken to minimize invasiveness and injected at the proper sites advised by BSAVA (British Small Animal Veterinary Association). No adverse reactions were observed throughout vaccination programme on the dogs after they have been vaccinated recording a zero percent mortality due to vaccine failure/idiosyncrasy. Our aim was to vaccinate 100% of the dog population, but practical feasibility provided almost a 95% cover on the previous estimated dog populations. During the course of vaccinations pregnant dogs were carefully identified and vaccinated with the least amount of invasiveness. Therefore the maternal immunity has a sturdy effect on the new born, being born resistant. Revisits to the villages that were considered critical/sensitive zone area were made in a positive attempt to get the maximum coverage.

Identification

The vaccinated dogs have either been collared or a non-irritant fabric whitener (Eco-Friendly) at the nape region that cannot be reached by the dogs was used. Strict measures to avoid revaccinating the same dog were followed by the team and this was further cross checked by the team member who is the marker.

Results

	Taluk	Village Names	No. of Dogs	GPS Coordinates	
1.	H.d	Kanchanahalli	15	11.91098	76.32303
2.	H.d	Moorbundh	6	11.91477	76.30674
3.	H.d	Kanakahalli Thittu	4	11.91317	76.29886
4.	H.d	Kanaka halli	10	11.92177	76.29357
5.	H.d	Kalasur	8	11.91584	76.33078
6.	H.d	N. Begur	27	11.90812	76.29093
7.	H.d	Mallada Aadi	7	11.90535	76.29005
8.	H.d	Jaganakotte	1	11.90288	76.28719
9.	H.d	Kempanapura	2	11.90417	76.28147
10.	H.d	Jakkahalli	7	11.90114	76.27655
11.	H.d	Bramha giri	9	11.90567	76.26755
12.	H.d	Hosahalli	10	11.90181	76.25542
13.	H.d	Gandatoor (Gundre)	11	11.92496	76.24093
14.	H.d	Hullamala	4	11.93365	76.40047
15.	H.d	Dadada halli	21	11.93926	76.40333
16.	H.d	Dadada halli colony	6	11.92848	76.41014
17.	H.d	Bedalapura	5	11.94262	76.41362
18.	H.d	Bedalapura colony	2	11.94264	76.41362
19.	H.d	Huskar colony	8	11.93670	76.43346
20.	H.d	Haleyuru	9	11.95321	76.41446
21.	H.d	Heggagudalu	6	11.95653	76.42312
22.	H.d	Devalapura	24	11.92540	76.39299
23.	H.d	Kallahalla	12	11.90592	76.39036
24.	H.d	Badaga	7	11.89657	76.38547
25.	H.d	Gadde hoondi	2	11.88603	76.38665
26.	H.d	Matte gere	14	11.88603	76.38677
27.	H.d	Kanthana Aadi	7	11.85694	76.37796
28.	H.d	Heerahalli	11	11.86890	76.37890
29.	H.d	Bankavadi Colony	6	11.87207	76.35051
30.	H.d	Bavikere Aadi	6	11.88787	76.05206
31.	H.d	Bankavadi	14	11.88007	76.35661
32.	H.d	Seegodi Aadi	2	11.87716	76.39001
33.	H.d	Naada Aade	34	11.86689	76.35337
34.	H.d	Kebbepura Aadi	21	11.85543	76.36087
35.	H.d	Moluyor	10	11.86365	76.37100

36.	H.d	Kandhaleke	4	11.88578	76.41897
37.	H.d	Kadabegur	4	11.86670	76.41179
38.	H.d	Kurnagalla	11	11.84919	76.41307
39.	H.d	Hallanahalli	5	11.83893	76.41203
40.	H.d	Muthkana mula	4	11.86470	76.42122
41.	H.d	Shivapura	4	11.85847	76.42307
42.	H.d	Kanakana halli	5	11.83660	76.42689
43.	H.d	Dodda bargi	8	11.83660	76.42689
44.	H.d	Kalanahoondi	6	11.83597	76.43295
45.	H.d	Chikkabargi	2	11.82823	76.44072
46.	H.d	Muttege hoondi circle	3	11.87944	76.42911
47.	H.d	M.c talalu circle	5	11.87444	76.42611
48.	H.d	M.c talalu hadi	9	11.87949	76.40933
49.	H.d	Kadegere	3	11.84675	76.43444
50.	H.d	Channagoondi hadi	7	11.84675	76.43554
51.	H.d	Jaylaxmipura	2	11.86685	76.43140
52.	H.d	Yathige	5	11.89109	76.45538
53.	H.d	Yaswanthpura	4	11.89153	76.46433
54.	H.d	Venkatagiri Colony	3	11.87623	76.46724
55.	H.d	Harahalli Addi	4	11.87422	76.45942
56.	H.d	Channagoondi	3	11.87356	76.45021
57.	H.d	Bankahalli	9	11.88613	76.46998
58.	G.pet	Nagarathnamma colony	2	11.92224	76.60033
59.	G.pet	Kothanahalli Colony	3	11.93323	76.56599
60.	G.pet	Kothanahalli	17	11.92810	76.56740
61.	N.gud	Nagnapur	4	11.90708	76.53270
62.	N.gud	Ballurahoondi	2	11.90321	76.53030
63.	N.gud	Naganapura colony	8	11.92252	76.51718
64.	N.gud	Mahadeva nagar	5	11.92736	76.51456
65.	N.gud	Venkatchallapura	4	11.92535	76.49726
66.	N.gud	Vadayana pura	5	11.91617	76.49262
67.	N.gud	Hosapura	25	11.98466	76.58759
68.	N.gud	Srikantapura	4	11.97516	76.59953
69.	G.pet	Manchahalli	6	11.89461	76.61104
70.	G.pet	Kurubarahundi	2	11.93163	76.60847
71.	G.pet	Shavkanahalli	5	11.88362	76.60666
72.	H.d	Chikkabargi Colony	3	11.82202	76.43579
73.	G.pet	Hallatoor	15	11.87352	76.60006
74.	G.pet	Siddayanapura colony	0	11.85687	76.59733
75.	G.pet	Deshipura	31	11.85064	76.58709
76.	G.pet	Deshipura colony	6	11.84383	76.58065

77.	G.pet	Bargi	22	11.82754	76.59688
78.	G.pet	Mukathi colony	21	11.81962	76.57003
79.	G.pet	Nagapatana	4	11.83242	76.56713
80.	G.pet	Honghalli	22	11.80553	76.58031
81.	G.pet	Hullyammana guddi	9	11.79093	76.57234
82.	G.pet	Naveelu gunda	14	11.78933	76.56044
83.	G.pet	Channamallipura	13	11.78624	76.56881
84.	H.d	Vaderahalli	4	11.78624	76.56921
85.	G.pet	Maddur	9	11.77721	76.55881
86.	G.pet	Maddur colony	37	11.78214	76.54868
87.	H.d	Kudege Colony	4	11.85910	76.41101
88.	H.d	Kudege	6	11.86015	76.41408
89.	G.pet	Berambadi	24	11.76109	76.56777
90.	G.pet	Lakkipura	2	11.75576	76.57756
91.	G.pet	Lakkipura colony	2	11.75089	76.57623
92.	G.pet	Kunnagahalli	13	11.75045	76.59802
93.	G.pet	Kunnagahalli colony	3	11.74758	76.59402
94.	G.pet	Haggada halla	23	11.73058	76.59830
95.	G.pet	Hosahalli Colony	10	11.73108	76.61274
96.	G.pet	Siddayanapura	9	11.72344	76.65620
97.	G.pet	Kalligowdanahalli	31	11.72137	76.65926
98.	G.pet	Muguvanahalli	13	11.69755	76.65119
99.	G.pet	Muguvanahalli colony	4	11.69350	76.65014
100.	G.pet	Mellakamanahalli	22	11.69965	76.63886
101.	G.pet	Melakamanahali colony	6	11.69493	76.63621
102.	G.pet	Karamala	9	11.65943	76.65469
103.	G.pet	Adina kanave	18	11.64513	76.65514
104.	G.pet	Channe katte	6	11.65386	76.65859
105.	G.pet	Mangala	24	11.64973	76.67129
106.	G.pet	Kaniyanpura	5	11.63853	76.66854
107.	G.pet	Kaniyanpura colony	32	11.63276	76.68199
108.	G.pet	Karagihoondi	3	11.63463	76.67654
109.	G.pet	Jakkhalli	13	11.64552	76.68083
110.	G.pet	Booradhara hoondi	10	11.64039	76.68773
111.	G.pet	Anangihundi	8	11.65414	76.68283
112.	G.pet	Chaluvarayanapura	18	11.64469	76.69235
113.	G.pet	Guddekere	11	11.65261	76.69625
114.	G.pet	Yelachatty	13	11.64631	76.70525
115.	G.pet	Lokkere	8	11.65859	76.70536
116.	G.pet	Chikkayelachatty	6	11.65490	76.72783
117.	G.pet	Bachalli	18	11.70449	76.73497

118.	G.pet	Malapura	8	11.70846	76.75471
119.	G.pet	Kundakere	44	11.69314	76.78684
120.	G.pet	upgara colony	4	11.66970	76.77729
121.	G.pet	Upgara	4	11.66574	76.77023
122.	G.pet	Cherakanahalli	11	11.71100	76.80942
123.	G.pet	Kadubur	3	11.70995	76.81992
124.	G.pet	Ramayanapura	15	1 1.73171	76.84469
125.	G.pet	Ramayanapura colony	6	11.71828	76.83914
126.	G.pet	Yarganahalli	27	11.74108	76.84861
127.	C.nagar	Vaddarahalli	9	11.75690	76.88171

H.d- Heggadadevana kote

N.gud- Najangud

G.pet- Gudalpet

C.nagar- Chamraj Nagar

Table 1: *Location of villages and number of dogs vaccinated.*

Number of villages covered and interviewed	127
Total people in the villages covered	8754
Total number of dogs in the reserve	1265
Mean number of dogs/dog	
owning household in the reserve	1.3
Human: dog ratio	6.92:1
Sex distribution	
Male	60.31
Female	40.68
Male to female dog ratio	1.48:1
Age distribution	
<1 yr	29.01% (367)
1–8 yrs	56.28% (712)
>8 yrs	14.70% (186)
Breed distribution	
Desi breed (mongrel)	98.65%(1248)
Identified breeds	1.35% (17)
Utility of dogs	
Security Hunting and Herding	59.76% (756)
Companionship and Pet	28.14% (356)
Breeding	4.27%(54)

Table 2: *Dog demography of the Bandipur tiger reserve.*

Confinement	
Never	70.43%(891)
Partial	13.83%(175)
Unknown	15.73%(199)
Care providers	
Father	7.50 %(95)
Mother	9.88 %(125)
Children	4.82%(61)
Everybody	77.79%(891)
Feeding of dogs	
Family left over	98.26%(1243)
Cook special food	1.26%(16)
Buy commercial food	0.47%(6)
Vaccination of dogs against Canine Distemper- prior to programme	
Vaccinated	0.55% (7)
Not vaccinated	20.40(258)
Unknown	94.86(1200)

Table 3: *Management status of Dogs.*

Discussion

In this study of prevalence of CDV in domestic dogs in the villages, had a similar higher risk of being positive compared to urban locations, suggesting increased quantum of infection in village dog populations due to higher densities and contact rates between dogs due to limited geographical interaction space. Although a cross-sectional study gives only partial information about the patterns of infection that has been prevailing, the differences in prevalence between dogs in villages close to the forest regions and to those villages, further from those areas supports the hypothesis that CDV is endemic in villages adjoining the forests and transmitted to core forests by occasional contacts by the big cats preying on the infected dogs, that aids in direct transmission of the disease. Our observations and personal communications with officials of the local forest department indicate that dogs were abandoned in villages when they showed positive clinical signs for Canine Distemper and when they could no longer manage the animal, the abandoned dog seeks seclusion a sequel to the infection in the less human manipulative zones of the villages, closer to forests paving a easy way for direct transmission. This preying activity could help to spread infections and might explain similar CDV prevalence between wildlife and domestic animals.

The CDV prevalence in dogs could be explained by

1. A constant force of infection in an endemic area,
2. Differential rates of exposure in a population experiencing sporadic outbreaks, in association to the forest regions.
3. An increase in disease exposure with age of the animal and the density of dogs in a particular area that is able to successfully sustain the infection in the population.
4. A recent epidemic (unnoticed in this context).
5. The recovered percentage of dogs in the population that keep shedding the virus for a lifetime till death, this serves as efficient reservoir indwelt, a constant source of infection.

Similar CDV prevalence patterns have been reported for domestic dogs living in high-density areas in villages near the Serengeti National Park (SNP) in Tanzania where it is thought that CDV is maintained in these densely populated areas [4]. Similarly, the prevalence pattern found other villages where the dog population was similar to those found in the low-density populations where younger animals have no or low CDV prevalences, suggesting low recent pathogen circulation or shedding from a convalescent host.

In a domestic dog population CDV was thought to be circulating regularly [5] and there are recorded evidences for the prevalence of CDV in the wild. However, reliable data of the temporal dynamics in wild carnivores was not available and no proper measures have been taken to combat CDV prevalence until the start of this programme. Although other wild carnivores, such as wild dogs, jackals and foxes reported to be susceptible to CDV and being important for maintaining CDV infection worldwide [1,6], it is unlikely that these wild carnivore species inhabiting this region , could have had a role contributing to the CDV epidemic, since these species are less abundant and not widely distributed [7] or could have been reservoirs during the earlier periods where there would have been adequate population to propel and accommodate the disease. In due course of time the jackal, and fox population have been wiped out leaving the disease remnants to their domestic counterparts, the dogs. In this paper, by combining official disease reports, published demographic studies on domestic dogs and prevalence data in domestic and wild canids, we hypothesize that domestic dog populations are the most likely source of infection for wild carnivores through the direct preying of dogs by these big cats. In the region, the transmissions events probably occurred in the forest interface in certain villages, where a high density and an elevated number of dogs allowed to roam freely exist findings were [8]. Although the question of whether a spill-over from domestic dogs to wild carnivores really occurred is not easily answered with retrospective data, the prevalence data from rural dogs with high prevalences also support the hypothesis of an epidemic occurring, concurrently explaining the loss in the jackal and fox population in the respective study area, between 2001 and 2002 in domestic dogs in rural sites, before the CDV outbreak in wild foxes.

To come to conclusions this study draws that transmission of Canine Distemper Virus to wild carnivores is by domestic dogs in regions closely adjoining forest areas. High-density domestic dog populations have been proposed as the likely maintenance population canine distemper virus as reported in the Serengeti ecosystem in Africa [9,10]. Also, domestic dogs were identified as the source of CDV that affected lions (Panthera leo) in the Serengeti [4,11], and also the probable source of rabies in the side-striped jackals (Canis adustus) [12]. In this study, the maintenance of CDV infection in domestic dogs was indirectly recorded as the CDV was confirmed by typical clinical signs; it is probable that CDV transmission across the study area may be maintained by infected domestic dogs left abandoned in neighboring villages. Our immediate target populations, the population of wild carnivores, are non-maintenance populations as reported by Haydon., *et al*. 2002, because their population sizes are well below the suggested CCS necessary to maintain a Morbillivirus, as described by Swinton., *et al*. [13].

If the CDV infection in this region could have followed a trophic level transmission dependent on the food chain from one tier to another and adapted size and density of the susceptible population, it is likely that this pathogen is maintained in a metapopulation, comprising mainly by maintenance patches of domestic dog populations in small packets and non-maintenance populations in villages in the adjoining forest areas, all of them very connected by the movement of potentially infected domestic dogs originated from the maintenance population, which are commonly left abandoned [14,15]. This follows a propagating epidemic pattern among the maintenance host, the domestic dogs.

In the Bandipur wildlife region, the transmission events probably occurred in the rural interface near villages close to forests, where a high density and an elevated number of dogs allowed to roam freely exist. Although the question whether a point source from domestic dogs to wild carnivores really occurred is not easily answered with this retrospective data, the canine distemper incidence data in rural dogs have shown critical variants in the sylvatic transmission of the disease [16]. High-density domestic dog populations have been proposed as the likely maintenance population for canine distemper virus in the ecosystem in Bandipur. Also, domestic dogs were identified as probable source of rabies, as the wild carnivores prey on the rural dogs especially the ones less active or isolated as in this case; there is a direct contact of the agent and the host. Although in this study, the maintenance of canine distemper infection was not addressed directly, it is probable that the rural dog population and our target population, the population of wild carnivores, are both maintenance populations as this mimics a propagating epidemic establishing the "Reed Frost model. A remarkable finding during the study was that the Human-animal conflicts (Tigers and Leopards) were recorded the areas where there was a superfluous dog population, unlike in areas were the dog population was less the humans were falling as prey for these big cats. On the epidemiological aspect if on such happening, the dog that was preyed upon by the tiger or leopard was positive for canine distemper then there is a direct contact of the disease spread in the Sylvatic cycle. Thus, there is a clear transmission of disease from domestic to wild populations and this infected carnivore serves to be a propagating epidemic. A common source epidemic is one in which all cases are infected from a source that is common to all individuals. If the period of exposure is brief, then a common source epidemic is a point-source (or, more briefly, just a point) epidemic. A propagating epidemic is an epidemic caused by an infectious agent in which initial (i.e., primary) cases excrete the agent, and thus infect susceptible individuals, which constitute secondary cases. The shape of a propagating epidemic is defined by a model. One of the basic models is the Reed-Frost model [16]. In this model's classical simple form, the population is divided into three groups, comprising:

1. Infected animals (cases);
2. Susceptible animals;
3. Immune animals.

This modeling will help us to forecast the disease dynamics in the wild populations, but intense study and experimenting is necessary to fill up the equation that has been derived in the model validating the study on the dog ecology.

The model is constructed using the formula:

$C_{t+1} = St\ (1\text{-}q^{Ct})$,

Where:

t = the time period: usually defined as the incubation period or latent period of the infectious agent

C_{t+1} = the number of infectious cases in time period, t+ 1;

St = the number of susceptible animals in the time period, t;

q = the probability of an individual not making effective contact. The value, q, is given by (1 - p), where p = the probability of a specific individual making effective contact with another individual which would result in infection if one were susceptible and the other were infectious. The term ($1 - q^{Ct}$) arises because it represents the probability that at least one of the Ct [16].

However, this theoretical model needs further research, for instance for assessing whether differences in incidence rate when comparing urban and rural areas exist and/or if local cities are maintenance populations by themselves or are part of a metapopulation with other cities in other regions. The wild carnivores studied in this paper are classified as endangered; this study should be viewed as a model that could be applied to other regions of conservation. For example, in the Serengeti, although domestic dogs have been identified as a maintenance population for rabies, the exact extent of the domestic dog reservoir population is difficult to determine as village populations are connected to nearby urban centres, such as Mwanza (200 km from the Serengeti), which may act as the ultimate source of infection. Similarly, in Kenya, a CDV epidemic in 1990 was thought to have originated in the capital Nairobi Alexander and Appel, 1994) and in Namibia, cities were also thought to be the origin of the 2003 CDV epidemic in jackals [17]. Therefore, there is a break in the sylvatic cycle preventing the transmission of disease into the wild carnivores by bio fencing. Intense studies relating to the serum level titre of CDV is essential to assess the efficacy such mass vaccination programmes, these will concentrated in subsequent mass vaccinating schemes [18].

Conclusion

A major consideration for large-scale disease control programmes was aimed to protect CDV outbreak in wildlife is therefore whether control measures (such as dog vaccination) should be targeted primarily to high density urban centers instead of rural sites neighboring protected areas. This is a very first initiative in India aimed at scientific conservation of tigers. Bio-fencing a strategy that will safe guard the wild populations from a these infectious diseases and leading to the scientific conservation of the wild carnivores.

Bibliography

1. Funk SM., *et al*. "The role of disease in carnivore ecology and conservation". In: Gittleman JL., *et al*. (Eds.) Carnivore Conservation. Cambridge University Press, Cambridge, UK (2001): 441-466.
2. Woodroffe R., *et al*. "Managing disease threats to wild mammals". *Animal Conservation* 2.3 (1999): 185-193.
3. Daniels TJ and Bekoff M. "Population and social biology of free ranging dogs, Canis familiaris". J*ournal of Mammalogy* 70.4 (1989): 754-762.
4. Cleaveland S., *et al*. "Serological and demographic evidence for domestic dogs as a source of canine distemper virus infection for Serengeti wildlife". *Veterinary Microbiology* 72.3-4 (2000): 217-227.
5. Chabchoub A., *et al.* "Seroepidemiological survey on canine distemper and canine parvovirosis in the south of Tunisia". *Revue De Medecine Veterinaire* 159 (2008): 224-229.
6. Alexander KA and Appel MJG. "African wild dogs (Lycaon pictus) endangered by a canine distemper epizootic among domestic dogs near the Masai Mara National Reserve, Kenya". *Journal of Wildlife Diseases* 30.4 (1994): 481-485.
7. Acosta-Jamett G ., *et al*. "The role of domestic dogs in diseases of significance to human and wildlife health in central Chile". PhD Thesis. University of Edinburgh, Edinburgh (2009).
8. Acosta-Jamett G., *et al*. "Demography of domestic dogs in rural and urban areas in Coquimbo region of Chile and its implication for diseases transmission". *Preventive Veterinary Medicine* 94.3-4 (2010): 272-281.
9. Cleaveland S., *et al*. "The role of pathogen in biological conservation". In: Hudson RJ., *et al*. (Eds.), The Ecology of Wildlife Diseases. Oxford University Press, Oxford (2002): 139-150.
10. Lembo T., *et al*. "Exploring reservoir dynamics: a case study of rabies in the Serengeti ecosystem". *Journal of Applied Ecology* 45.4 (2008): 1246-1257.
11. Roelke-Parker ME., *et al*. "A canine distemper virus epidemic in Serengeti lions (Panthera leo)". *Nature* 379.6564 (1996): 441-445.
12. Rhodes CJ., *et al*. "Rabies in Zimbabwe: reservoir dogs and the implications for disease control". *Philosophical Transactions of the Royal Society of London Series B: Biological Sciences* 353.1371 (1998): 999-1010.
13. Swinton J., *et al*. "Micro parasite transmission and persistence". In: Hudson RJ., *et al.* Eds. "The Ecology of Wildlife Diseases". Oxford University Press, Oxford (2002): 83-101.
14. Anderson RM and May RM. "Infectious Diseases of Humans: Dynamics and Control". Oxford University Press, Oxford (1991).
15. Grenfell BT and Bolker BM. "Cities and villages: infection hierarchies in a measles meta population". *Ecology Letters* 1.1 (1998): 63-70.
16. Frost WH. "Some conceptions of epidemics in general". *American Journal of Epidemiology* 103.2 (1976): 141-151.
17. Gowtage-Sequeira S., *et al*. "Epidemiology, pathology, and genetic analysis of a canine distemper epidemic in Namibia". *Journal of Wildlife Diseases* 45.4 (2009): 1008-1020.
18. Haydon DT., *et al.* "Identifying reservoirs of infection: a conceptual and practical challenge". *Emerging Infectious Diseases* 8.12 (2002): 1468-1473.

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