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Features of dog ecology relevant to rabies spread in Machakos District, Kenya

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ABSTRACT

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A random sample of households in Machakos District of Kenya was surveyed using personal interviews to determine features of dog ecology relevant to the spread of rabies. A mean of 1,35 dogs/household, a dog to person ratio of 1:9,6 and a mean of 10,4 dogs/km^2 were estimated. The male to female ratio was 1:0,67 with 26 % of the dog population being less than three months old. The dogs had a mean age of 1,8 years. The proportion of the dogs which fed on household leftovers and waste was 94,7 %. Dogs were restricted in 19,4 % of the households, while 69 % of the dogs spent all of their time free outdoors. One-third of the dog population over three months old had been vaccinated against rabies. Considering the endemic status of rabies in Machakos District, methods which could be devised to control the disease are discussed.

INTRODUCTION

Rabies, a disease of ancient times, continues to persist as a major public health problem in most parts of the developing world. Globally, estimates show that about 35 000 persons die from rabies and about 3,5 million receive post-exposure treatment every year (Bogel & Meslin 1990). Almost all the reported deaths (99,9 %) occur in the developing countries and most cases of treatment (89,5 %) also occur there (Acha & Arambulo 1985). Dogs are the main transmitters of rabies in most developing countries (WHO 1982). By contrast, immunization programmes for dogs coupled with restrictions on dog movement and destruction of dogs not in compliance with restriction regulations, have dramatically reduced the level of canine rabies in the developed world, so that wildlife is now the major reservoir of the disease there (Acha & Arambulo 1985).

Rabies has been officially reported in Kenya for many years. The first documented case was diagnosed in 1912 in a dog which had been attacked and bitten by a jackal in the outskirts of Nairobi (Hudson 1944). Records at the Central Veterinary Laboratory show that Kenya experienced rabies epidemics in the early 1930s, late 1940s and early 1950s. However, the widespread deployment of an egg-adapted modified live virus vaccine in the 1950s and 1960s, effectively controlled rabies so that by 1973, the disease was virtually eliminated from the country (Kariuki & Ngulo 1985). But since then, the rabies situation in Kenya has changed dramatically. Following an outbreak in 1974 in Taita/Taveta District and another one in 1979 in the Trans Mara area of Narok District, the disease spread to most areas of the country. Over 200 animal rabies cases have been confirmed each year since 1982, but this is undoubtedly an underestimate of the true rabies incidence;

the disease is now more widespread and prevalent than at any time in its history (Kariuki 1988). The dog remains the main vector of rabies in the country, accounting for 64,2 % of the confirmed cases (Veterinary Department Records, unpublished).

The rabies problem is particularly great in Machakos District, where the disease has been endemic since the mid 1950s. Despite control efforts which include annual dog vaccinations, confinement and destruction of "stray" dogs, the disease has not been contained and animal cases and human dog-bite exposures have increased in the last decade. From 1982 to 1987, a total of 5 264 human animal-bite cases (Machakos District Veterinary Department) and 11 human deaths (Machakos District Hospital) from rabies were recorded. It must, however, be emphasized that the official recorded figures of cases provide only an indicator of the extent of the rabies problem as many cases go unreported.

It has been recognized that for appropriate formulation and implementation of dog rabies control programmes, prior knowledge of the dog population is required (WHO 1987; Baer 1988; Wandeler, Budde, Capt, Kappeler & Matter 1988). Ecological data, including information on patterns of dog ownership, relationship of animals to human society, their density, age, structure and turnover, habitat, and other factors, are required (WHO 1987). This information allows decisions to be made concerning the appropriate mix of control strategies, such as "stray" dog control, reproductive control, and vaccination for a given area (Wandeler *et al.* 1988). However, except for Brooks (1990), there are few studies on dog populations in Africa which effectively try to collect this necessary data (Brooks 1990).

In the present study, a random sample survey was conducted in Machakos District of Kenya to determine the parameters of dog ecology, mentioned above, that are relevant to rabies spread. This data will then be used to devise practical alternate rabies control programmes and to compare these alternatives by means of a field trial in Machakos District.

MATERIALS AND METHODS

Sampling procedure

The study areas were selected using a stratified random sampling technique. Six of the ten administrative divisions of the district were randomly selected. This was followed by a random selection of one sublocation per each selected division. Fig. 1 shows the locations of the selected sublocations within Machakos District. In liaison with the local administration, a list of all households in the selected sublocations was compiled. A list of households was then randomly ordered and households were visited until 25 dog-owning households were obtained. The final sample

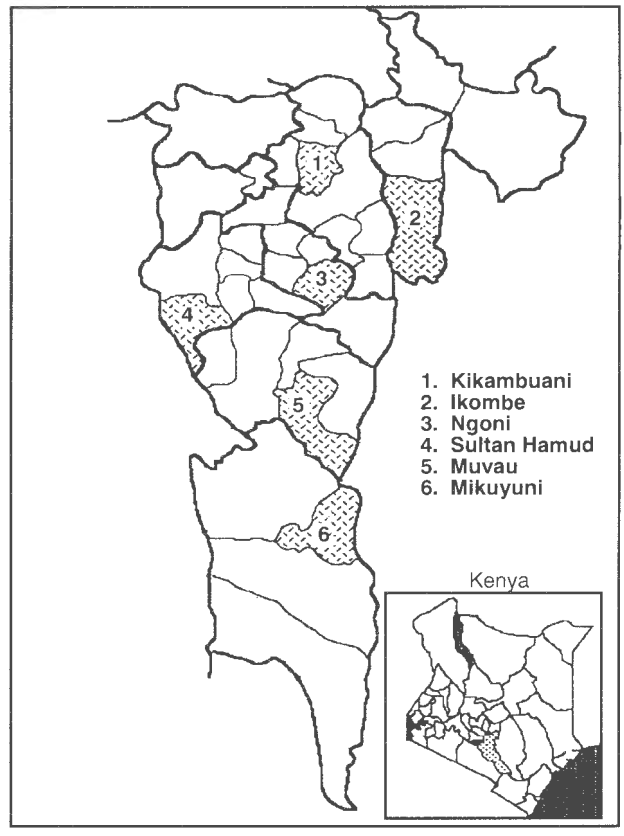

FIG. 1 Map of Machakos District showing the locations of the six study sublocations

consisted of 150 dog-owning households (out of 237 total households visited) and covered 2,7 % of the district's land area and 2,5 % of the district's human population.

Questionnaires

Two questionnaires, one for household information and the other for individual dog information, were designed, based on the World Health Organization Guidelines for Dog Rabies Control (WHO 1987) (with minor modifications). Households were visited and either the household head or another adult person was interviewed. A subsequent visit was made if any of these persons were not at home at the time of the first visit. The interviews were conducted in the local language (Kikamba).

The data were entered into a computer database package (Dbase IV, Ashton-Tate, Torrance, CA, USA). Tables of descriptive statistics were generated using PROC FREQ in SAS (PC-SAS version 6.04, SAS Institute, Inc. Cary, North Carolina).

The number of dogs per sublocation was calculated by multiplying the average number of dogs/household by the total number of households listed in the

TABLE 1 Distribution of characteristics of survey dog population by sublocation in Machakos District, Kenya, 1991

Sublocation	No. of households interviewed	No. of dogs surveyed	Average dogs/house	Average/ dog-owning house	Households with dogs %	Dog:person	Dogs/km^2
Kikambuani	47	52	1,11	2,08	53	1: 8,5	83,4
Mikuyuni	47	49	1,04	1,96	53	1:16,0	9,2
Sultan Hamud	31	67	2,16	2,68	81	1:12,9	3,5
Ngoni	43	56	0,77	2,24	58	1:12,5	14,7
Muvau	35	52	1,49	2,08	71	1: 5,5	13,9
Ikombe	34	44	1,29	1,76	74	1:11,3	8,6
Overall average			1,35	2,13	63	1: 9,6	10,4

sublocation. This number was then divided by the size in kilometres of each sublocation to estimate the number of dogs/km^2. Assuming a human growth rate of 4 % per annum for the district, an extrapolation of the human population from the 1989 national census (Machakos District Bureau of Statistics) was made for the year 1991; these human population estimates were then used to calculate the dog:person ratio.

RESULTS

Out of the 238 households visited, only one household owner refused to participate in the study, giving a response rate of 99,6%. The characteristics of the dog population in the interviewed households (by sublocation) are shown in Table 1.

Dog population and density

The estimated dog population density for the district was 10,4 dogs/km^2. This converts to a total dog population of 147 503 dogs for the entire Machakos District. An alternative dog population estimate can be made based on the 1989 human census extrapolated to 1991 and using the dog:person ratio of 1:9,6. Based on this calculation, the district's dog population was estimated at 155 735 dogs.

Age structure and sex and breed distribution

Fig. 2 shows the age structure and sex distribution of the dogs owned by the households interviewed. The mean age of the dogs was 1,8 years. Approximately 26 % of the dogs were puppies less than three months old. An additional 20 % of the dogs were juveniles more than three months old but less than nine months old. Adult dogs were classified as those above nine months old and comprised approximately 53% of the surveyed dogs. There was a predominance of male dogs in all the age categories with a sex ratio (male:female) of 1:0,67. Most dogs were local breeds (93,4 %). Of the remainder 6,3% were crossbreds and 0,3% purebreds.

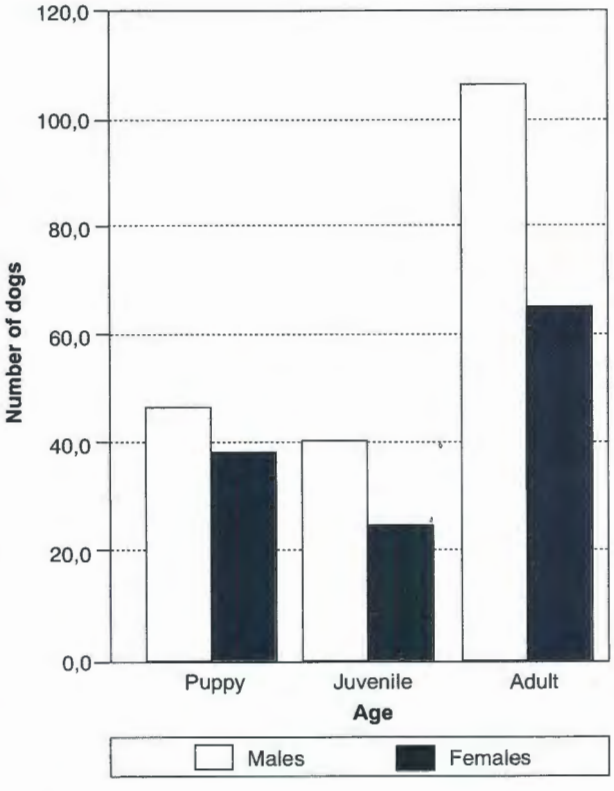

FIG. 2 Sex and age distribution of dogs surveyed in Machakos District, Kenya

Reproductive indices

Out of the 65 adult bitches sampled, 85 % had whelped at least once and the mean number of litters/bitch was 2,1. Information on the last litter (which the respondents were likely to remember) was obtained. The mean litter size was 5,2 with a stillborn rate of 1,4 %. Mortality rate during the pre-weaning period was 22 %, disposal rate 54 %, lost rate 2,8 %, and killing rate 4,1 %. The proportion of puppies alive at time of weaning was 15,7 %.

Reproduction control

The survey results revealed that dog owners did little to control dog breeding. Out of the 106 adult male dogs sampled only 27,4 % had been castrated and no adult female dog had been spayed.

Dog restriction

Out of the 150 dog-owning households surveyed, 19,4 % restricted their dog movements at all times through fencing (5 %), leashing (6 %), and indoors (8,4 %). A large proportion of the dogs (69 %) were never restricted and spent all of their time free outdoors.

Dog food sources

The great majority of the sampled dogs fed on household leftovers and waste (94,7 %); only 5,3 % were fed commercial dog food. Scavenging of household garbage by dogs was common. Householders reported that their garbage was scavenged by a variety of dogs, including their own dogs (81,3 %), neighbours' dogs (75 %), and unknown dogs (45 %).

Dog functions

Almost all the respondents (99,4 %) reported that guard duties were their dog's primary function; hunting and herding were each described by 0,3 % of the respondents as the primary reason for keeping dogs.

Dog ownership

The bulk of the surveyed dogs was reportedly owned by household heads (60 %), while children, mostly boys, owned 27 % of the dogs. Other adult household males and females owned 13 % of the dogs.

Sources of dogs

The most common source of dogs was as gifts (56 %; 41,6 % from neighbours and 14,4 % from outside the neighbourhood). Another 34,7 % of the dogs were offsprings of a bitch from the household. Very few dogs (9,3 %) were reportedly bought or traded from either within or outside the neighbourhood.

Dog bites

In the 12 months preceding the survey, 14 household members were bitten by dogs giving a dog-bite prevalence of 40/100 000 people. People were bitten by their own dogs (21 % of all bites), neighbours' dogs (50 %), and unknown dogs (29 %).

Dog vaccination

Of the 236 dogs which were more than three months old, 33 % were reported to have been vaccinated against rabies.

DISCUSSION

Dog ecology studies have been recognized as necessary prerequisites to the planning and implementation of sound dog rabies control programmes (WHO 1987; Beran & Frith 1988; Wandeler *et al.* 1988). Collection of data on dog ecology would provide information on high risk components of the dog population in terms of their capacity to transmit rabies, and to develop methods to access these components with vaccination and other control measures.

The collection of data from personal interviews resulted in an almost 100 % response rate. This method was considered the most appropriate because Kenya, a developing country, does not have the telephone and mail facilities needed for providing a representative sample. A similar response rate has been reported in Zimbabwe (Brooks 1990).

The survey results for the largely rural areas of Machakos District indicated a high dog population density. The estimate of 10,4 dogs/km^2 for the district is higher than the estimate obtained for rural areas of Zimbabwe of six dogs/k^2 (Brooks 1990). A number of factors could be attributed to this high dog population density. Firstly, dog owners make little effort to control dog breeding through spaying of bitches and castrating of adult males. This, coupled with the high dog mobility in search of food, results in constant contact of dogs for mating. The reproductive potential of these dogs was also relatively high as reflected by the proportion of breeding bitches (85 %), mean litters/bitch (2,1), mean litter size (5,2), puppy mortality rate (22 %), and the proportion of puppies and juveniles (46 %). In the Zimbabwe study, 60 % of the bitches were breeding with a mean of 1,4 litters/bitch, a puppy mortality rate of 51,9 %, and a mean litter size of 4,8 puppies (Brooks 1990). Secondly, the people of Machakos District traditionally like dogs. Dogs are used for a number of duties; principally guarding, but also hunting. Thirdly, dogs can be acquired relatively cheaply and easily. Over half (56 %) of the surveyed dogs were acquired as gifts, while 35 % were offsprings of household bitches. There appeared to be very little trading or purchase of dogs.

The survey results also demonstrated that there is a high potential for transmission of rabies from dogs to humans. The human dog-bite prevalence of 40 per 100 000 people was estimated for the 12 months preceding the survey. It is believed that the origin of the dog bites, especially unprovoked by either the householder's own dog or especially from unknown dogs (21 % and 29 % of the reported cases, respectively) would pose a high risk of rabies exposure to the bite victims. The human rabies risk is the subject of an on-going active surveillance programme for rabies due to be completed in July 1993.

In the light of these survey results, potential canine rabies control measures for Machakos District can be suggested. Since the spread of rabies will depend mostly on dog population density and movement, there is a need to control dog numbers through spaying and castration. Spaying of bitches would require some specialization which may be out of reach of most people; however, since a small proportion of the adult male dogs have been castrated (27,4 %), this effort needs to be encouraged. The habitat carrying capacity for the dogs needs to be reduced by educating people on proper methods of garbage disposal; use of fenced-off home garbage pits would be suitable. Since it appears that most dogs would roam in search of food, responsible dog ownership would need to be addressed by encouraging people to keep dogs they can feed.

The Veterinary Department should also make an effort to increase dog vaccination coverage. For effective rabies control the goal should be at least 70 % immune dogs in a population (Wandeler 1985). The 33 % dogs reportedly vaccinated is too low to prevent rabies transmission. The department could make use of the local administration and veterinary extension workers to publicize vaccination campaigns. An estimate of the number of vaccine doses required could be made prior to the vaccination campaign by using the extension workers to estimate the number of dogs in their respective areas. The timing of the campaigns would also be crucial. It was observed that most likely children would take the dogs to vaccination centres which are at times far apart. The campaigns should coincide with the school holidays when children are available. The high proportion of young dogs in this survey would suggest that the vaccination campaigns should be sustainable by instituting them either on an annual or preferably a biannual basis.

For any rabies control programme to have any success, public sympathy, understanding and participation in the programme is very important. There is a high awareness of rabies in Machakos District and compliance with a well organized campaign is likely to be high. This could be heightened by a public education programme. The target groups for the educational programmes would be the household heads and the young boys who together owned the bulk (87 %) of the surveyed dogs.

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