THE EPIDEMIOLOGY OF RABIES IN MACHAKOS DISTRICT, KENYA

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1 INTRODUCTION.

Kenya has experienced several rabies outbreaks since the first rabies case was confirmed in a dog in the outskirts of Nairobi in 1912 (Hudson, 1944). Dog vaccinations, started in the late 1950s in conjunction with dog movement restrictions, appeared to have effectively controlled the disease so that by the early 1970s it was virtually eliminated in most parts of the country (Kariuki and Ngulo, 1985). However, between 1974 and the early 1980s, rabies had spread to most parts of the country including those areas which had previously been declared rabies-free (Kariuki and Ngulo, 1985; Kariuki, 1988).

The rabies problem in Kenya has been particularly serious in Machakos District, where the disease has been endemic since the mid 1950s, even persisting during the 1960s and early 1970s when rabies was controlled in the rest of the country (Kariuki, 1988). During the period 1983-1992, Machakos District accounted for 29% (623/2149) of the confirmed animal rabies cases countrywide (Chong, 1993). Despite the once-a-year dog vaccination campaigns coupled with the destruction of unconfined dogs applied by government veterinary staff, there remained a large and relatively uncontrolled dog population (both rural and peri-urban) in the district and the proportion of dogs immunised was insufficient to control canine rabies. In the period 1981-1990, 8027 people were officially reported to have been bitten by dogs in the district out of which 4947 received post-exposure treatment and 22 died of rabies (records of the Machakos District General Hospital). During the same period, 505 animal rabies cases were confirmed (records of the Machakos District Veterinary Department). These officially reported cases should only be considered as an indication of the rabies situation in the district rather than a precise record, as the majority of cases go unreported (Kitala *et al.*, 1994)

In response to this situation, a one-year community-based active surveillance project for rabies was conducted in six randomly selected rural and peri-urban areas in Machakos District. The objectives of this project were to estimate the incidence of human and animal rabies in the district and to collect data on dog ecology and demography considered necessary for proper planning and implementation of a rabies control programme (Beran and Frith, 1988; Wandeler *et al.*, 1988; WHO 1988; WHO/WSPA 1990). We have previously reported on the dog ecology and demographic results (Kitala and McDermott, 1995). In this paper we describe the distribution of animal and human cases recorded as rabies suspects and their clinical and laboratory follow-up.

2 MATERIALS AND METHODS.

2.1 Study area and data collection.

The 6 study areas were described and mapped in Kitala *et al.* (1993). Briefly, the study areas were selected by a stratified random sample with six of ten divisions and one sublocation per division selected. A list of households for each study sublocation was compiled with the assistance of the local chief and administrator. The households were re-ordered by random selection and visited in order until 25 dog-owning households had been interviewed. After consulting with local leaders, a rabies worker per sublocation was recruited. Public meetings were also held to describe study objectives, encourage reporting of all animal-bites, suspected rabies cases including animals found dead and to answer any questions.

After an initial training programme on rabies and aspects of data collection, the rabies workers actively followed-up all animal-bites and suspected rabies cases for one year. The data were recorded in stan-

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dard forms according to WHO (1992). Rabies suspect animals were categorised into primary and secondary cases. Primary suspects were animals showing signs consistent with rabies but for which the exposing animal was unknown while secondary suspects were animals exposed by the primary suspects. A human rabies suspect was any man exposed to a rabies suspect animal. The rabies workers not only collected intact heads of rabies suspect animals but also collected heads from any animal found dead (mostly road-kills). The workers were visited at monthly intervals to assess their data collection, to collect specimens for rabies diagnosis and to provide results of previous diagnoses (note that due to delays in rabies testing all human suspects were actively encouraged to seek post-exposure vaccine). Rabies was diagnosed at the Central Veterinary Laboratory in Kabete using the fluorescent antibody test (FAT) according to the method described by Kissling (1975).

3 RESULTS.

3.1 Active surveillance for animal-bite and rabies cases.

A total of 277 animal rabies suspects, 194 primary and 83 secondary, were reported. Of the 194 primary suspects, 179 (92%) were dogs. Dogs also accounted for the majority (80% (66/83)) of secondary suspects. Table 1 shows the distribution of the primary and secondary animal rabies suspects by species and sublocation. Of the 66 dogs secondarily exposed, 63 (95%) were bitten by other dogs. Using dog population estimates for the study area, this converts to a dog-to-dog exposure rate of 1230/100000 dogs. The number of exposed animals per rabies suspect dog ranged from 1-8 animals (mean= 1.8) and 14 dogs confirmed positive exposed 30 dogs. Of the 83 exposed animals, 55% (46/83) were alive at the end of the follow-up period and a further 30% (25/83) experienced an event directly related to the exposure including: death due to bite wounds (8), sold (3), killed by their owners (9), and death due to confirmed rabies (5) (Table 2). Of the 30 dogs exposed to the 14 confirmed rabid dogs, 18 were alive at the last follow-up date, 3 were killed by their owners, 5 died of the bite wounds, 1 disappeared, and 3 died of other causes. There were 92 human cases of animal-bite reported (89 bitten by dogs) equivalent to an annual incidence of animal-bites of humans of 234/100000 people.

3.2 Rabies diagnosis.

Table 1 : Distribution of primary/secondary rabies suspects by species and sublocation in Machakos District, Kenya, 1992-1993.

	Sublocation						
Species	**Ikombe**	**Kikambuani**	**Mikuyuni**	**Muvau**	**Ngoni**	**Sultan Hamud**	**Total**
Dog	85/18	13/2	19/5	21/9	16/7	25/25	**179/66**
Cat	1/0	0/0	10/0	1/0	0/0	1/0	**4/0**
Honey Badger	1/0	0/0	5/0	0/0	0/0	0/0	**6/0**
Squirrel	1/0	0/0	0/0	1/0	0/0	0/0	**2/0**
Rabbit	0/0	0/0	0/0	0/0	1/0	0/0	**1/0**
Cattle	0/0	0/6	0/1	0/0	0/0	0/2	**0/9**
Sheep	0/1	0/0	0/0	0/0	0/0	0/0	**0/1**
Goat	1/0	0/2	0/2	0/2	0/0	0/1	**1/7**
Donkey	1/0	0/0	0/0	0/0	0/0	0/0	**1/0**
Total	**90/19**	**13/10**	**25/8**	**23/11**	**17/7**	**26/28**	**194/83**

There were 130 specimens examined for evidence of rabies. 96 were from rabies suspect animals of which 49 (51%) were positive and 34 were from animals found dead (mostly road-kills along the Mombasa-Nairobi road) of which 5 (15%) were positive. Dogs accounted for 81% (44/54) of the confirmed rabid animals for an annual confirmed dog rabies incidence of 900 cases /100000 dogs. The distribution of the specimens testing positive by species and sublocation is shown in Table 3. One human death due to rabies was recorded providing a point estimate of 25 deaths per million inhabitants.

Table 2 : Follow-up results of animals exposed to animals with rabid signs in Machakos District, Kenya, 1992-1993.

	Species				
Follow-up results	**Cattle**	**Dog**	**Goat**	**Sheep**	**Total**
Died of bite wounds		7		1	**8**
Sold	3				**3**
Disappeared		2	2		**4**
Killed by owner		8	1		**9**
Died of confirmed rabies	1	4			**5**
Died of other causes		8			**8**
Alive	5	37	4		**46**
Total	**9**	**66**	**7**	**1**	**83**

3.3 Clinical signs.

The clinical signs manifested by 87 primary animal rabies suspects (clinical signs of 9 secondarily exposed animals were not recorded) submitted for diagnosis and the number confirmed is summarised in Table 4. The most frequently reported clinical signs were aggressive behaviour (characterised by biting incidents), random walking and drooling of saliva. An animal was classified as being aggressive if it attempted to bite at any time in the course of clinical disease. There was a strong positive association between aggressive behaviour and a positive FAT result (OR = 3) and also between drooling of saliva and a positive FAT result (OR = 6). No association was found between paralysis and a positive FAT result (p = 0.7432).

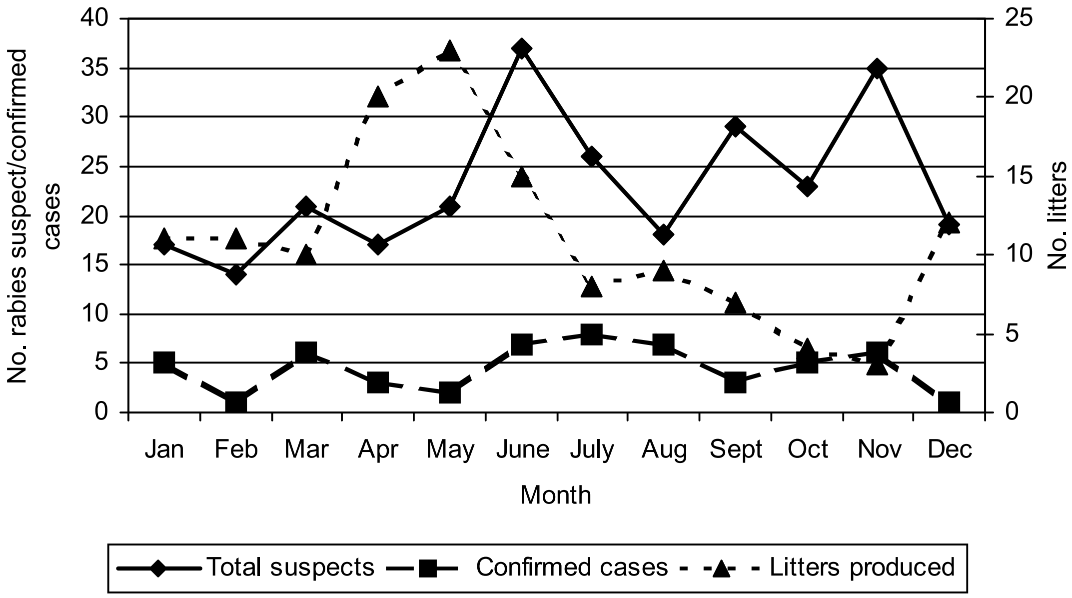
Table 3 : Distribution of specimens testing positive over total specimens tested for rabies virus on FAT by species and sublocation in Machakos District, Kenya, 1992-1993.

	Sublocation						
Species	**Ikombe**	**Kikambuani**	**Mikuyuni**	**Muvau**	**Ngoni**	**Sultan Hamud**	**Total**
Dog	17/41	1/2	7/12	3/5	7/11	9/16	**44/87**
Cat	0/1	0/0	0/1	1/1	0/0	1/1	**2/4**
Honey Badger	0/1	0/0	1/5	0/0	0/0	0/1	**1/7**
Squirrel	0/0	0/0	1/5	2/4	0/2	1/6	**4/17**
Rabbit	0/0	0/0	1/5	0/0	0/1	0/0	**1/6**
Cattle	0/0	0/0	0/0	0/0	0/0	1/1	**1/1**
Sheep	0/0	0/0	0/0	0/0	0/0	1/2	**1/2**
Dik Dik	0/0	0/0	0/0	0/0	0/1	0/1	**0/2**
Stone Hyrax	0/0	0/0	0/1	0/0	0/0	0/1	**0/2**
Mon-goose	0/0	0/0	0/0	0/0	0/1	0/0	**0/1**
Vervet Monkey	0/0	0/0	0/1	0/0	0/0	0/0	**0/1**
Total	**17/43**	**1/2**	**10/30**	**6/10**	**7/16**	**13/29**	**54/130**

3.4 Seasonal variation in the incidence of rabies suspects.

Although rabies suspect animals were reported throughout the year, distinct peaks were observed in the months of June, September and November. The main June peak was preceded by a peak in the number of litters born to 128 bitches followed in the study sites (Figure 1). The pattern of confirmed rabies mirrored that of suspect cases (Figure 1) indicating that specimen collection and diagnostic methods were probably consistent throughout the year.

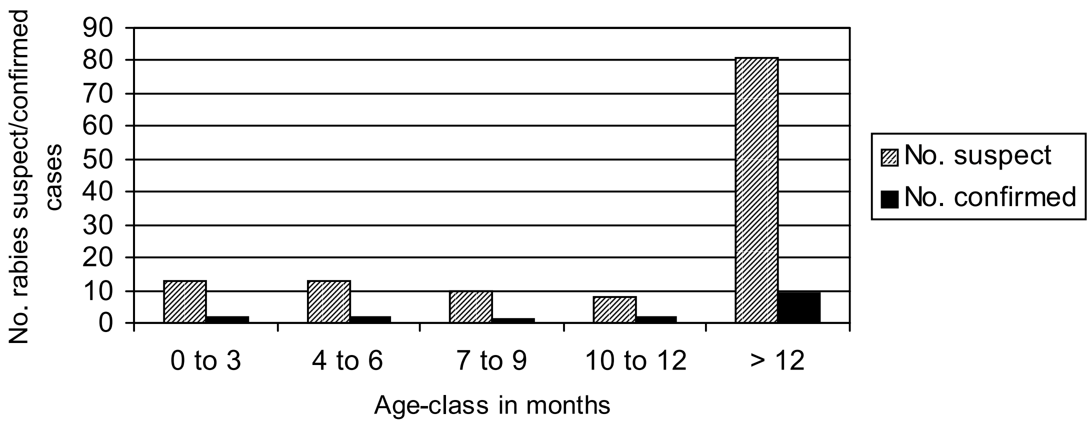
Figure 1 : Temporal relationship between suspected and confirmed rabies cases and dog fecundity in Machakos District, Kenya, 1992-93.



3.5 Sex and age structure of the rabies suspect dogs.

The male : female ratio of 238 rabies suspect dogs was 1:0.72 and the mean age for the 125 rabies suspect dogs with known ages was 2.9 years. The majority (65%) of the suspects were at least one year of age, with 10% being less that or equal to 3 months old (Figure 2). The mean age of 16 confirmed rabid dogs was also 2.9 years; 9 of the dogs (56%) were a year old and above and 2 (13%) were three months old and below (Figure 2).

Figure 2 : Age distribution of suspected and confirmed cases of rabies in Machakos District, Kenya, 1992-93.



3.6 Ownership and vaccination status of the rabies suspect dogs.

The owners of 46% of 179 rabies suspect dogs could not be identified. There was a strong negative association between a positive test result and the ownership status of a rabies suspect dog (OR = 4). A small proportion (14%) of 96 rabies suspect dogs whose owners were identified, reported that their dogs had been vaccinated against rabies. Two of 16 dogs reportedly vaccinated tested positive on FAT; one had reportedly been vaccinated three years earlier and the other 3 days prior to developing rabid signs.

Table 4 : Proportion of 87 animal rabies suspects submitted for diagnosis which were FAT positive by clinical signs reported in Machakos District, Kenya, 1992-1993.

Clinical Sign	Number submitted	Number positive	Proportion positive
Aggression	52	32	0.62
Random walking	48	32	0.67
Drooling of saliva	57	37	0.65
Sudden change in behaviour	29	8	0.28
Paralysis	16	7	0.44
Hyperaemic eyes	8	5	0.62
Depraved appetite	6	1	0.17

4 DISCUSSION.

The results of this active surveillance project in Machakos District demonstrate the central role that dogs play in the maintenance and transmission of rabies in the district. The vast majority of the rabies suspect animals (92%) and confirmed rabid animals (81%) were dogs. In addition, 97% (89/92) of cases of animal-bites of humans were also due to dogs. These results are consistent with what has been observed in many countries in Africa, in which dogs consistently account for over 80 to 90% of confirmed cases (Tierkel, 1975; Acha, 1981; Bogel *et al.*, 1982; WHO, 1992). The annual incidence rate of 900 confirmed rabies cases/100000 dogs in Machakos estimated in this study is much higher than annual incidence rates (per 100000 dogs) of dog rabies in some African countries/regions including: Natal, South Africa (11.8), Zimbabwe (11), Zambia (3.3), Malawi (12.8), Lesotho (1.5), Madagascar (4.7), Kenya (3-8), Tanzania (1-6), and Serengeti, Tanzania (8-16) (Gascoyne, 1994). Since not all cases had samples submitted the true rate may actually be higher. Estimates from passive recording systems in the other countries are likely to suffer even more from under-reporting. Kitala *et al.* (1994) estimated that active surveillance in Machakos uncovered approximately 40 times more cases than passive reporting. This improved reporting underscores the importance of developing public participation in any rabies control programme.

The high incidence of rabies in Machakos is probably a function of high dog density, minimal dog control and low vaccination rate of dogs (Kitala *et al.*, 1993). In previous dog ecology and demographic studies in Machakos, Kitala *et al.* (1993) found that the majority of dogs (81%) were never restricted at any time and spent most of their time scavenging for food, that reported vaccination cover of the dog population was less than 33% of dogs over 3 months of age and that dog densities were quite high, ranging from 6 to 110 dogs km^{-2}. These are far below WHO (1992) control targets.

The proportion of submitted samples positive for rabies (51%) is comparable to estimates from other African countries. It is similar to a proportion positive of 49% reported for specimens submitted by non private practitioners in the Natal area of South Africa but is higher than the proportion of 42% reported for specimens submitted by private practitioners from the same area (Kretzmann, 1993). Foggin (1988) reports a positivity proportion of 36% for Zimbabwe and positivity proportions of 50 and 58% have been reported for Swaziland and Kenya respectively (Dlamini, 1995; Chong, 1993). The proportion of submitted samples testing positive will be largely linked to the true incidence of rabies in a given area, so that in high incidence areas such as Machakos, a high proportion of samples tested will be positive since there is a high prior probability that dogs exhibiting nervous signs have rabies.

Given this high proportion of rabies suspects testing positive and the long lag between human exposure and FAT diagnosis, the clinical signs of the rabies suspect animal and the details of the exposure incident are used to guide post-exposure treatment decisions. However, the clinical signs associated with rabies are not pathognomonic and can be mistaken for canine distemper and many other pathological conditions (Fekadu, 1993). The greatest problem in relying on clinical signs to guide post-exposure treatment decisions is that some rabid dogs may die without showing any signs of illness while others develop dumb rabies, which can easily be misdiagnosed (Fekadu, 1988). In this study, a high proportion (52/87; 60%) of specimens submitted for diagnosis were from animals manifesting signs suggestive of the furious form of rabies (aggression and random walking) and only a small proportion (16/87; 18%) manifested signs indicative of the dumb form of the disease (paralysis). Any dog that attempted to bite at any stage during the clinical course was automatically categorised as aggressive by the rabies workers, because biting rabid dogs pose the greatest threat to man. Different diagnostic methods may account for the variations in the proportions of furious and dumb rabies reported in various studies. The proportions in this study are lower than some reports from elsewhere in Africa (Boulger and Hardy, 1960; Minor, 1977) but similar to others (Ryeyemamu *et al.*, 1973; Barnard, 1979; Okolo, 1986; Foggin, 1988). Kappus (1976) found aggression in only 26% of rabid dogs in a study in the USA. The high proportion of submitted samples positive in this study indicates that the furious form of rabies is well known to the people of Machakos. The dumb form may be less well known.

Although rabies-suspect and confirmed cases were reported throughout the year in Machakos, distinct peaks were observed in the dry months of June through to November. Similar patterns have also been observed in Botswana (Sehularo, 1995), Kwazulu Natal in South Africa (Bishop, 1995), Ghana (Addy, 1985), and in Nigeria (Fagbami *et al.*, 1981), where peak rabies incidence coincided with the dry season of the year. Bigler *et al.*(1973) found that rabies in the USA occurred throughout the year but peak incidence was associated with the breeding season for dogs. This pattern is likely due to the increased movements of and contacts between dogs looking for mates. In Machakos, this will be exacerbated since dogs are rarely restricted in their movement, and there is only minimal effort to control dog breeding through castration of male dogs and spaying of females (Kitala *et al.*, 1993). Coordinating rabies control programmes with this seasonal peak may increase efficiency. We plan to investigate this in subsequent transmission models.

The sex structure of rabies cases is similar to that of the overall Machakos dog population (M:F ratio of 1:0.72 for rabies suspect dogs versus 1:0.67 for all dogs (Kitala *et al.*, 1993)). However, rabies suspects were comparatively older than the overall population. The majority (65%) of the rabies suspect dogs and 56% of the confirmed rabid dogs were at least one year of age (compared to 50% of the general population). Only 10% of the rabies suspects and 13% of the confirmed cases were 3 months or younger (versus 26% of the general population). This older age distribution of rabies cases was also noted by Foggin (1988) in Zimbabwe (76% of confirmed rabies cases were in dogs greater than one year of age and only 4% were under 3 months of age). Brooks (1990), also in Zimbabwe, noted a large proportion of older dogs with rabies (66%) but 20% of his confirmed rabies cases were in dogs 3 months of age or younger. We expect younger dogs to have a lower incidence of rabies, since they are less mobile and thus should have less contacts with other dogs. However, despite this lower risk of younger dogs, we and others have argued (Kitala and McDermott, 1995; Perry and McDermott, 1995) that the rapid turnover of dog populations necessitates more frequent vaccination and vaccination of younger dogs than the current practice of annual vaccination of dogs older than 3 months of age.

The owners of 46% of the rabies suspect dogs could not be determined, despite our previous observations (Kitala *et al.*, 1993) that the ownership of virtually all dogs in Machakos under normal circumstances can be determined. Two factors may be important. The first is that rabies infection destroys the usually very strong territorial instincts of dogs making them wander far from home. Of rabies suspect dogs diagnosed by FAT, dogs whose owners could not be traced were 4 times more likely to be confirmed rabid. In addition, fear of prosecution and/or paying for the post-exposure expenses of exposed humans would almost certainly cause dog owners to deny owning a dog suspected of being rabid. Foggin (1988) and Kretzmann (1993) report a much higher proportion (66%) of ownerless rabid dogs in Zimbabwe and Natal, South Africa respectively. We suspect that the active follow-up of rabies suspect cases by community rabies workers in Machakos may have contributed to the higher success rate in identifying dog owners in this study.

In summary, the results of the active surveillance for rabies provides a significantly higher estimate of the incidence of animal rabies than traditional passive surveillance. The dog appears to be both the principal reservoir and transmitter of the disease to both man and his other domestic animals. The economic losses due to rabies in Machakos are substantial in terms of direct costs of post-exposure treatment of humans, deaths of other domestic animals after a suspected exposure to rabies, and the uncostable loss of human lives due to the disease. The unacceptably high incidence of rabies in Machakos is mainly a function of high dog density, minimal dog control and the low vaccination coverage of the dog population. The current rabies control programme is clearly ineffective and needs to be revised if rabies is to be controlled. Fortunately, public awareness of rabies in Machakos is high and a well planned rabies control programme is likely to receive good community cooperation. This planning process needs to consider both our rabies epidemiology and dog ecology findings but also the logistics of mobilizing community participation. Pilot control programmes thus developed should then be assessed in field trials with communities as the unit of observation.

5 References.

ACHA, P.N. – 1981 - A review of rabies prevention and control in the Americas. *Ibid.* 93: 9-52.

ADDY, P.A.K. – 1985 - Epidemiology of rabies in Ghana. *In:* Rabies in the Tropics, Edited by Kuwert, E., Merieux, C., Koprowski, H. and Bogel, K. Springer-Verlag, Berlin. pp. 497-515.

BARNARD, B.J.H. – 1979 - Simptome van hondsdolheid by huis- en plaasdiere in Suid-Africa en Suidwes-Africa. *Journal of the South African Veterinary Association,* **50,** 109-111.

BERAN, G.W. and FRITH, M. – 1988 - Domestic animal rabies control: an overview. *Reviews of Infectious Diseases*, **10,** S672-677.

BIGLER, W.J., MCLEAN, R.G. and TREVINO, H.A. – 1973 - Epizootiologic aspects of raccoon rabies in Florida. *American. Journal of Epidemiology*, **93,** 326-335.

BISHOP, G.C. – 1995 - Canine rabies in South Africa. *In :* Proceedings of the Third International Conference of the Southern and Eastern African Rabies Group, Harare, Zimbabwe, 7-9 March, 1995. Fondation Marcel Merieux, Lyon, pp. 104-111.

BOGEL, K., ANDRAL, L., BERAN, G., SCHNEIDER, L.G. and WANDELER, A. – 1982 - Dog rabies elimination. A trend analysis and programme proposal prepared by a WHO working group. *International Journal of Zoonoses*, **9,** 97-112.

BOULGER, L.R. and HARDY, J. – 1960 - Rabies in Nigeria. *West African Journal of Medicine*, **9,** 223-234.

BROOKS, R. – 1990 - Survey of the dog population of Zimbabwe and its level of rabies vaccination. *Veterinary Record*, **127**, 592-596.

CHONG, W.K. – 1993 - Rabies in Kenya, *In*: Proceedings of the Southern and Eastern African Rabies Group International Symposium, Pietermarizburg, South Africa, 29-30 April, 1993, pp. 57-67.

DLAMINI, R.X. – 1995 - Rabies in Swaziland. *In*: Proceedings of the Third International Conference of the Southern and Eastern African Rabies Group, Harare, Zimbabwe, 7-9 March, 1995. pp. 58-60.

FAGBAMI, A.H., ANOSA, V.O. and EZEBUIRO, E.O. – 1981 - Hospital records of human rabies and antirabies prophylaxis in Nigeria, 1969-1978. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **75,** 872-876.

FEKADU, M. – 1988 - Pathogenesis of rabies virus infection in dogs. *Reviews of Infectious Diseases*, **10**, S678-683.

FEKADU, M. – 1993 - Canine rabies. *Onderstepoort Journal of Veterinary Research*, **60**, 421-427.

FOGGIN, C.M. – 1988 - Rabies and rabies-related viruses *in* Zimbabwe: historical, virological and ecological aspects. Ph.D. thesis, University of Zimbabwe.

GASCOYNE, S. – 1994 - Rabies in the Serengeti region of Tanzania. ODA/NRRD Animal Health Programme Final Report. Institute of Zoology - Regent's Park and London School of Hygiene and Tropical Medicine, London. pp. 57.

HUDSON, J.R. – 1944 - A short note on the history of rabies in Kenya. *East African Medical Journal*, **21**, 622-627.

KAPPUS, K.D. – 1976 - Canine rabies in the United States, 1971-1973: study of reported cases with reference to vaccination history. *American Journal of Epidemiology*, **103**, 242-249.

KARIUKI, D.P. – 1988 - The epidemiology and diagnosis of rabies in Kenya. *Kenya Veterinarian*, **12**: 32-35.

KARIUKI, D.P. and NGULO, W.K. – 1985 - Epidemiology of animal rabies in Kenya (1900-1983). *In*: Rabies in the Tropics, Edited by Kuwert, E., Merieux, C., Koprowski, H. and Bogel, K. Springer-Verlag, Berlin. pp. 451-464.

KISSLING, R.E. – 1975 - The fluorescent antibody test in rabies, *In*: The Natural History of Rabies Vol. 1, Edited by Baer, G.M. New York, Academic Press. pp. 401-416.

KITALA, P.M. and MCDERMOTT, J.J. – 1995 - Population dynamics of dogs in Machakos District, Kenya: implications for vaccination strategy. *In*: Proceedings of the Third International Conference of the Southern and Eastern African Rabies Group, Harare, Zimbabwe, 7-9 March, 1995. Fondation Marcel Merieux, Lyon, pp. 95-103.

KITALA, P.M., MCDERMOTT, J.J., KYULE, M.N. and GATHUMA, J.M. – 1993 - Features of dog ecology relevant to rabies spread in Machakos District, Kenya. *Onderstepoort Journal of Veterinary Research*, **60**, 445-449.

KITALA, P.M., MCDERMOTT, J.J., KYULE, M.N. and MATERE, C.N. – 1994 - Investigation of rabies incidence and control by active surveillance in Machakos District, Kenya. *Kenya Veterinarian*, **18,** 2, 528-530.

KRETZMANN, P.M. – 1993 - Problems associated with rabies diagnosis in a busy private practice. *In*: Proceedings of the Southern and Eastern African Rabies Group International Symposium, Pietermarizburg, South Africa, 29-30 April, 1993, pp. 49-56.

MINOR, R. – 1977 - Rabies in the dog. *Veterinary Record*, **101**, 516-520.

OKOLO, M.I.O. – 1986 - Rabies in Anambra state, Nigeria. *Veterinary Record*, **119**, 18.

PERRY B.D and MCDERMOTT J.J. – 1995 - Data gathering and analysis for improved decision support to rabies control. *In*: Proceedings of the Third International Conference of the Southern and Eastern African Rabies Group, Harare, Zimbabwe, 7-9 March, 1995. Fondation Marcel Merieux, Lyon, pp. 184-193.

RYEYEMAMU, M.M., LORETU, K., JAKOB, H. and GORTON, E. – 1973 - Observations on rabies in Tanzania. *Bulletin of Epizootic Diseases in Africa*, **21**, 19-27.

SEHULARO, K. – 1995 - Rabies in Botswana. *In*: Proceedings of the Third International Conference of the Southern and Eastern African Rabies Group, Harare, Zimbabwe, 7-9 March, 1995. Fondation Marcel Merieux, Lyon, pp. 50-52.

TIERKEL, E.S. – 1975 - Canine rabies, *In*: The Natural History of Rabies Vol. 11, Edited by Baer, G.M. New York, Academic Press. pp. 123-137.

WANDELER, A.I., BUDDE, A., CAPT, S., KAPPELER, A. and MATTER, H. - 1988). Dog ecology and dog rabies control. *Reviews of Infectious Diseases*, **10**: S684-688.

WHO – 1988 - Report of a WHO consultation on dog ecology studies related to dog rabies control, 22-25 February, 1988. World Health Organization, Geneva (WHO/Rab.Res/88.25).

WHO – 1992 - WHO Expert Committee on Rabies, 8th report. WHO Technical Report Series 824. World Health Organization, Geneva.

WHO/WSPA – 1990 - Guidelines for dog population management. World Health Organization, Geneva (WHO/Zoon/90.165).