DOG POPULATION STUDIES AND EPIDEMIOLOGY OF RABIES IN CAMEROON

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A thesis submitted to the Post Graduate School
Ahmadu Bello University, Zaria, Nigeria,
in partial fulfilment for the award of the degree of
MASTER OF SCIENCE
in Veterinary Public Health and Preventive Medicine

Department of Veterinary Public Health
and Preventive Medicine,
Faculty of Veterinary Medicine,
Ahmadu Bello University, Zaria, Nigeria.

November, 1992.

"Among scientists are collectors, classifiers, and collective tidiers-up; many are detectives by temperament and many are explorers; some are artists and others artisans. There are poet scientists and philosopher scientists and even a few mystics".

Sir Peter Medawar

"In Rabies we have a disease which strikes with terror whenever it is referred to, and a disease which wages war with man and animals; it is not a disease of the past, it is present in many countries and current trends confirm that it is a disease of the future. It is an absolute necessity to be vigilant against it in all countries".

Goret, P (1966)

DECLARATION

I hereby declare the originality of this work carried out by me in the Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria under the supervision of Professors J.U. Umoh, J.B. Adeyanju and Dr. E.S. Essien.

The work of other investigators has been dully acknowledged and referenced.

No part of this thesis has previously been submitted for the award of a degree or diploma.



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Date: 23rd June 1993

CERTIFICATION

This thesis entitled "DOG POPULATION STUDIES AND EPIDEMIOLOGY OF RABIES IN CAMEROON" by TONG, John Chuo meets the regulations governing the award of a degree of Master of Science of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated specially to my late mother, Cecilia Sih Itung for her love and care for all her children until death did us part.

ACKNOWLEDGEMENT

Several persons have contributed in one way or the other to the success of this study. I, therefore can not mention their names and individual contributions in this brief acknowledgement. However, the contributions of some people are so invaluable and distinct that one can hardly afford not to acknowledge them individually.

I am particularly very much indebted to Professor J.U. Umoh, my supervisor and chairman of my supervisory committee, for his guidance, keen interest in this work and high level of understanding throughout my course of study.

My sincere appreciation and gratitude go, yet to Prof. J.U. Umoh, for the pains taken and the patience exercised in reading my proposal, interim reports, and thesis drafts, as well as the constructive criticisms and suggestions made by him.

Prof. J.B. Adeyanju and Dr. E.S. Essien did not only readily agree to serve as members of my supervisory committee, but also willingly took the pains of reading the thesis drafts and offered several suggestions. Their contributions remain inestimable in this study. To them I am most grateful.

Profound gratitude also goes to the entire members of my family for their moral and financial support throughout my stay in Nigeria. I also deeply appreciate the fact that they have borne with patience and understanding my long absence from home.

Furthermore, I wish to express my gratitude to the Cameroon Government for the scholarship awarded to me for this M.Sc. work.

The staff of the Ministries of Livestock, Fisheries and Animal Industries and Public Health, Yaounde, Cameroon as well as those of Preventive Medical Service (CDMP) Bamenda are also appreciated for their high level of co-operation in permitting me to collect data on animal and human rabies.

Sincere gratitude and appreciate are also extended to all the friends who assisted in the administration of the questionnaire on dog population studies in Bamenda and Wum towns.

Special people like Miss Akeh Juliana, Mr. Mengnjo Cyprian, Kimeng Henry, Azang David, Amadou Monkaree and the rest of the ladies and gentlemen whose names can not all be mentioned here, are highly appreciated for their friendliness and encouragement during my stay in Zaria.

Thanks also go to the staff members of the Department of Veterinary Public Health and Preventive Medicine and fellow graduate students for their co-operation and understanding throughout my course of study.

Finally, I wish to express my gratitude to Real Waves Computers for their impressive work in word processing this thesis.

ABSTRACT

The data on dog population studies revealed that many households (70.5%) in the study area kept dogs, though the reasons for owning dogs differed slightly as people in Bamenda kept dogs mainly as guards (80.8%), while dogs in Wum were mostly used for both guarding and hunting (49.7%).

Dissatisfaction for dogs was seen in 32.6% of the households that did not own dogs while majority of them (64.4%) said they liked dogs but were either poor or still planning to acquire one. Only 3% of the households said it was against their religion/culture to keep dogs. Majority of the dogs in both towns were young with 61.9% between three months to two years and 13.7% less than three months. There was a large preponderance of local dogs (91.6%) compared to other breeds and more males (55.0%) than females (43.77c)

Dog owners fed and handled their dogs in 90.8% of the households that owned dogs and this is an indication that the accessibility of owned dogs for an antirabies vaccination campaign could be quite high. However, the attitude of dog owners towards antirabies vaccination of their dogs differed in the two towns perhaps because of the difference in their socio-economic status. About 68.2% of the households that owned dogs in Bamenda had vaccinated their dogs against rabies, while in Wum, 57.8% of the households complained of poverty, ignorance of vaccination and other reasons.

Households acquired their dogs from several sources with 57.9% of those that owned dogs acquiring them through purchase. Puppies delivered by owned dogs had a high survival rate although the rate was higher for dogs in Bamenda (78.1%) than in Wum (09.2%). Although a stray dog count was not done, Bamenda appeared to have more unowned or stray dogs than Wum according to the respondents in these towns.

The attitude of people in both towns towards dogs was good and most people (94.9%) were aware of rabies and its major mode of transmission. The. overall dog-to-human ratio was 1:8.0 and ranged from 1:6.6 in Bamenda to 1:8.5 in Wum. The average number of dogs per household in all the sampled households was 1.2 with a range of 1.1 in Bamenda to 1.3 in Wum. The prevalence of previous dog bites was higher in Bamenda (29.4%) than in Wum (14.1%). Dog ownership was more common among civil servants (36.1%) and farmers *{25.07c)* compared to businessmen (22.8%), technicians (8.2%) and others (7.9%). The use of dogs as guards ranked highest (56.3%) amongst reasons for keeping dogs, while poverty (37.9%;) and hatred for dogs (32.6%) were the major reasons for not owning dogs

The data on rabies revealed that canine rabies cases were increasing (37 to 42), while the numbers pets vaccinated against rabies each year was decreasing (15,941 to 10,123) from 1985/86 to 1989/90. The distribution of the number of confirmed rabies cases in dogs, the number of biting dogs observed for rabies, the number of biting dogs that died during observation and the number of antirabies vaccination varied from one Province to another and within the Provinces. Provinces with more rural inhabitants had low rabies and antirabies vaccination activities, while those with majority of inhabitants in urban areas had high activities.

However, the rabies situation was different for human beings as more deaths due to rabies were seen in Provinces with a majority of rural population. Canine and human rabies cases were reported every year in Cameroon with an average of 36.8 confirmed cases in dogs and 22.4 deaths due to rabies in human beings each year. A total of 435 rabies cases were reported in the country, 278 (63.9%) of them in dogs and 157 (36.1%) in human beings. The ratio of dog-to-human rabies was 1:0.6 but ranged from 1:0.1 to 1:3.3 throughout the period under study. The difference between canine and human rabies cases was, however, not significant ($p > 0.05$).

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CHAPTER ONE

1.0 INTRODUCTION

Before canine and human rabies can be effectively controlled in any given locality like Cameroon, information must be available on the ecology of dogs and man-dog interrelations. Such information includes the abundance of dogs, the population structure, the ratio of owned versus unowned dogs and dog population dynamics.

Population estimates also assist the planning of stray animal control. Meanwhile, pet animal populations can serve as resources for epidemiological research of acute and chronic diseases, for example, leukaemia (Dorn *et al*, 1967). The natural epidemiological spread of canine rabies depends on the tradition of human-dog relations, as well as the structure and density of existing dog population with stray dogs playing a crucial role in the spread of the disease (WHO, 1984a).

A high proportion of freely-roaming and poorly supervised dogs is one of the major obstacles to canine rabies control (WHO, 1988) and also the percentage of dogs accessible for vaccination is determined by the ratio of owned versus unowned dogs and by owner attitudes (Wandeler, 1984).

The practical importance of investigation of dog populations in Cameroon seems clear from studies carried out in different parts to the world (Dorn *et al*, 1967; Beck, 1973; Scott and Causey, 1973; Franti and Kraus, 1974; Beck 1974; Beck, 1975; Heussner and Grant, 1978; Nassar and Mosier 1980; Rangel *et al*., 1981, Beran, 1982; Okoh, 1986; WHO, 1988). Responsible pet ownership has become an increasing concern of medical professionals and national, state and community officials (Selby *et al*., 1979). This concern includes the environmental impact of pet's solid and liquid wastes and the more specific associated" with free-roaming or stray animals in a community (Okoh, 1986). Some officials argue that "irresponsible

pet owners" is a major reason for pet overpopulation, free-roaming pets and associated community health problems (Djerassi, *et al.*, 1973; Hummer, 1975; Collins, 1976).

Precise information on the dog population and man-dog interrelations in relation to rabies control in Cameroon are grossly lacking. However, dog population studies based on questionnaires only may lead to a preponderance of data concerning restricted and semi-restricted dogs with very little information on freely-roaming or stray dogs (WHO, 1988).

Since ancient times, rabies has been described as a dog's disease. Plutarch, Homer, Vergil, Ovid and other early writers made allusions to rabies. The code of Hammurabi of the 23rd century B.C. mentions the spread of rabies from dogs to man but it is Aristotle (322 B.C.) who observed that 'mad' dogs transmitted the disease to other animals through a bite (Tierkel, 1958). The Roman Pliny, the Elder even recommended the livers of 'mad' dogs as a remedy for rabies (Parish, 1968). Rabies has been and is still regarded in all parts of the world as one of the most terrifying diseases known to man and as one of the diseases causing the most terrible death (Kaplan, 1977). The first outbreak of rabies in Africa was reported in 1893 in a dog imported from England at Port Elizabeth, South Africa (Rollinson, 1956) and since then rabies outbreaks have been reported in all African countries. Despite significant scientific breakthroughs and advances in its prevention and control, rabies remains one of the most dreadful and gruesome of the human communicable, infectious diseases (Acha and Arambulo, 1984). The problem of human rabies in the countries of the tropics, Cameroon inclusive, is basically urban in nature, where there is a close relationship between dogs and people (Acha and Arambulo, 1984). The maintenance of rabies constitutes essentially a dog-to-dog, dog-to-other domestic animals and dog-to-human being cycle, with human beings as the dead end host (Acha and Arambulo, 1984).

World-wide, the dog is still considered the principal "vector" in transmitting rabies to man, irrespective of whether the reservoir hosts are wildlife or dogs themselves (WHO, 1984a) and dogs have also been shown to be responsible for more than 80% of bite wounds in those seeking antirabies treatment in Africa (Turner, 1976). World-wide, canine rabies reservoirs are responsible for 99% of human deaths due to rabies and for 90% of post-exposure treatments (WHO, 1988). Rabies has continued to plague the Cameroonian populace despite control efforts which consist essentially of the vaccination of dogs and sometimes cats, the control of stray dogs and also the antirabies treatment of exposed human beings.

The major objectives of this work are as follows: To:

1. estimate the population of owned dogs in two towns in Cameroon.

2. categorise the population structure of owned dogs into age, sex and breed distributions.

3. stratify the distribution of owned dogs according to the occupations of the dog owners.

4. map out the major sources or origins of owned dogs, the major reasons for owning dogs and the major factors that encourage the straying of owned dogs (i.e. feeding, degree of confinement, socio-cultural patterns of the study area).

5. evaluate the knowledge and attitude of both dog owners and non-dog- owners about rabies, its control and prevention.

6. analyse the prevalence of rabies in both dogs and human beings in Cameroon and to compare this with antirabies vaccination data of dogs so as to assess the impact of such vaccinations on the frequency and distribution of the disease.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 DOG POPULATION STUDIES

Data on dog abundance, ratio of owned versus unowned dogs and dog population dynamics are all important for the planning of rabies control (Wandeler, 1984).

2.1.1 Dog Abundance

The abundance of dogs is related to different epidemiologic situations, to different culture areas, to different rural and urban habitats, and to different social strata of human rural and urban populations (WHO, 1984a).

The number of owned dogs may be established by questionnaire surveys, or from records of licensing of dogs (Schnurrenberger *et al.*, 1961; Kelly, 1980; Rangel *et al.*, 1981) or during dog vaccination campaigns (Beran *et al.*, 1972).

Estimates of dog densities can be obtained from techniques like total or direct counts (WHO 1984a), estimates from rate of capture (Schemnitz, 1980; Davis and Winstead, 1980) and estimates from recaptures (Jolly, 1965; Caughley, 1977).

Beck (1973) also employed several alternate methods in Baltimore for estimating dog abundance and compared the numerical values derived for each as a measure of validity.

Most of the published reports on dog populations consider only owned dogs and their number is established by questionnaire surveys or from licensing records (Wandeler, 1984). Dog abundance varies considerably from country to country and within geographical regions, within countries as was found in Kaduna State, Nigeria

(Ezeokoli, *et al.*, 1981). Generally, straying or loose pets are more common in low-income high density areas in urban areas, while ownerless stray dogs are more common in low human density areas (Beck, 1974; Harris, 1981).

Reliable estimates for dog populations are still rare (WHO, 1984a), but generally, American and European countries report a dog-to-human ratio between 1:10 and 1:6 with the ratio of owned dogs to people usually higher in rural areas of a country (Schnurrenberger *et al.*; 1961; Kelly, 1980; Rangel *et al.*, 1981). In a survey in Jos, Nigeria, a dog-to-human ratio of 1:4 was reported (Okoh, 1986).

2.1.2 Habitat

Dogs inhabit a great variety of different habitats depending on the abundance, distribution and predictability of resources (shelter, food and water) for dogs (WHO, 1984a). One complicating problem in habit analysis is the wide variation in cultural practices even within the same city (WHO, 1984a).

Daniels (1980) considered harsh climate and particularly, cold, winter weather and also extreme heat as factors that tend to make survival more difficult for dogs, hence lower free-roaming dog densities.

The economic status and density of human population largely determine the availability of shelter in urban areas and sites offering complete cover including vacant buildings and garages, as well as those under construction, and passages (Fox *et al.*, 1975). Water availability in most areas is not a limiting factor except in arid habitats, while garbage from homes, at market places or at centralised dumps is the major source of food for dogs in urban areas as well as rural areas (WHO, 1984a).

2.1.3 Population Dynamics

Some of the vital statistics which determine the structure and turnover of a dog population include age and sex ratios, natality and rearing success and survival and mortality rates (Wandeler, 1984). Detailed procedures for collecting and analysing carnivore population statistics have been described (Dixon, 1981).

2.1.3.1 Age Ratios

Age ratios can provide important information regarding the population for example, young-to-adult ratios are an indication of natality and productivity of the population and the pattern of mortality (Downing, 1980). The mean age of populations of owned and well-supervised dogs in the USA was approximately 4.5 years (Beck, 1973; Nassar and Mosier, 1980) and females were slightly older and had a slightly longer life expectancy (Beck, 1973).

2.1.3.2 Sex Ratios

According to Downing (1980), the data on sex ratios are important in the understanding and interpretation of other vital statistics that are frequently expressed separately for each sex. Sex ratios are commonly expressed as the number of males per 100 females (WHO, 1984a). A sex ratio of 1:1 in adult dogs was reported by Beran (1982) in a survey in the Central Philippines. Meanwhile Okoh (1986) reported a ratio of 1:1.4 in a survey of owned dogs in Jos, Nigeria.

However, in many other surveys on predominantly owned dogs, the sex ratio gave a preponderance of males to females (WHO, 1984a).

2.1.3.3 Natality and Rearing Success

Young dogs become sexually mature at an age of 6 and 12 months and some shortly after reaching adult size. Females usually reach puberty earlier than males, smaller breeds earlier than large breeds. The distribution of oestrous cycles is even throughout the year in most breeds and intervals between oestrous cycles average between 7 and 8 months. The average length of gestation is 63 days ranging from 59 to 68 days. The mean litter size is 7 but there is considerable variation with small breeds having smaller litters than large breeds (McDonald, 1975; Jochle and Andersen, 1977; Shille and Strabenfeldt, 1980). Very little breeding success among unowned dogs in urban areas in USA has been reported by Beck (1973) and Fox *et al.* (1975), while reproduction among owned dogs in Manhattans and Kansas was found to be very low (Nassar and Mosier, 1980).

2.1.3.4 Mortality

Traffic accidents and a wide variety of different diseases are the causes of mortality (Beck, 1973).

2.1.4 Source of Dogs

Urban stray dog populations appear to be continuously "seeded" from owned, home-fed populations through abandonment, release or escape (WHO, 1984a). In rural areas in Alabama, Scott and Causey (1973) found that half free-roaming dogs captured were owned-animals. According to Downing (1980), a survey in U.S.A. showed that the sources of dogs include professional breeders, pet shops, neighbours, or friends, stray, born in home, animal shelter, advertisement and others. A survey in Jos, Nigeria, revealed that most of the owned-dogs (51%) were

adopted from abandoned dogs; and another important source of dogs was neighbours (Okoh, 1986).

2.1.5 Dog Feeding

Beck (1973, 1975) states that urban U.S.A. dogs find food at home, eat garbage and receive handouts. According to him (Beck, 1973), and Daniels (1980), the frequent occurrence of unsupervised dogs in alleys where there are garbage containers and in parks at evenings indicates that they easily learn to find food in the urban environment. In a publication on dog ecology in the Central Philippines, it is stated that owned dogs scavenged garbage, received leftover human food and frequently ingested human faeces (Beran, 1982). In a similar survey in Tunisia, only a small proportion of owned-dogs were chained up all the time and only these animals were fed by their owners, while dogs permitted partial or total freedom had to look for food, consisting of garbage, rodents and insects (WHO, 1984a).

2.1.6 Dog Functions

Relatively short and incomplete accounts on the cultural and economic values attributed to dogs have been published with a few detailed accounts in Polynesia (Luomala, 1960) and in Alaska (Nelson, 1973). Frank (1965) cited close to 600 publications in her review of the role of the dog in African cultures. The reason for the association of people with dogs is frequently not so obvious (Meggitt, 1965). Dogs can be kept as pets and companions, for hunting, as guard dogs, draught animals, for food or for commercial buying and selling, etc. (WHO, 1984a). Dogs can also be rejected because they are unclean, because they bite or because they are "vectors" of disease, pests or nuisances. In Jos, Nigeria, Okoh (1986) reported that the most stated disadvantage of owning dogs was pet disease followed

by noise, odours and waste pollution nuisances. In different cultures, dogs are regarded as supernatural or related to supernatural powers either as divine beings or evil spirits (WHO, 1984a). Dogs constantly clean up and permanently guard a settlement, but other duties like hunting, pulling vehicles, etc. may be performed only during relatively short periods (Meggitt, 1965). According to Okoh (1986), the chief reason for owning dogs in Jos was for protection or security of houses, hotels and as shop guards.

Dogs are eaten by many ethnic groups and in many cultures in all continents (WHO, 1984a). The ethnic distribution of ritual killing and eating of dogs in Africa has been described by Frank (1965) who has suspected that dog eating is originally an agricultural trait of West Africans. However, no explanation is given for this association. Luomala (1960) has also described the complicated relations in Polynesia between dogs as food, as gifts and offerings and as other items of value. Dogs eat refuse and human faeces and this is recognised as a cleaning function and often esteemed. In some places, they are even left to clean and guard babies and small children (Frank, 1965). A large proportion of the older breeds of dogs in Eurasia and Africa were raised to guard livestock but other guarding functions in premises and plantations have not yet been the focus of ethnographical studies (WHO, 1984a). However, the attitude towards dogs vary from ethnic group to ethnic group (Frank 1965). Dogs are despised and mistreated by some African ethnic groups, while in others, the dog is a venerated culture hero as the bringer of fire or grain. In a few areas it is an offence to kill a dog (WHO, 1984a) and some muslims believe that djinns (ghosts) may take the shape of a dog and in such areas unknown dogs are treated with respect or contact with them is avoided (Zbinden, 1953).

2.2 EPIDEMIOLOGY OF RABIES

Rabies, also known as Lyssa or hydrophobia, is an acute viral disease of the nervous system affecting all warm-blooded animals. The disease is characterised by a progressive encephalopathy resulting in disturbances of consciousness, nervous irritability, paralysis, coma and death (Ezebuiro, *et al.*, 1980).

2.2.1 The Virus

The rabies virus is one of the seventy-two viruses that belong to the Rhabdovirus group. The Rhabdoviruses are bullet-shaped viruses varying from 100-300 um in length and about 70 um in diameter (Brown and Crick, 1977). The rabies particle contains a double helical ribonucleoprotein surrounded by a closely associated matrix layer. These two structures form the nucleocapsid which is enclosed in a lipid envelope from which spike projections protrude (Wiktor *et al.*, 1973). These spikes consist of glycoprotein G, and contain the specific antigen responsible for the production of neutralising antibody in the host animal (Wiktor *et al.*, 1973). The spikes are also important in the attachment of virons to susceptible cells (Murphy, 1985).

The rabies virus does not exist free in the environment and is fragile, easily inactivated by disinfectants like bichloride of mercury and strong acids and bases (Kaplan and Koprowski, 1966). It retains its infectivity for several weeks at 25°C or for several months at 4°C (Kaplan, 1977).

2.2.2 Variants of Rabies Virus

Based on the pattern of reactivity to a panel of glycoprotein monoclonal antibodies, distinct antigenic sites on the glycoprotein can be delineated (Lafon *et*

al., 1983). It seems that viruses isolated from the same host species within the same geographic area are likely to show identical patterns of cross-reactivity. For example, three rabies variants with distinctive antigenic characteristics were isolated in three immigrants in the United States and for each of the three isolates, identical variants were found in specimens from rabid animals obtained from or near the country in which the patient lived before immigrating to the United States (Smith *et al.*, 1991). Also studies with 41 rabies isolates from Nigeria (mostly of canine origin), have identified seven variants which show different patterns of cross-reactivity in their glycoprotein antigens (Okoh, 1986). This same study (Okoh, 1986), also showed that dog rabies viruses in Nigeria are not homogeneous even within a geographical area because all of 5 isolates obtained from Bendel State belonged to 5 different antigenic variants; in Plateau State, 3 different antigenic variants were identified.

2.2.3 Susceptible Animals

All warm-blooded animals, even birds are susceptible to rabies (Haig, 1977), but according to WHO Experts on the disease, not all animals are equally susceptible (Kaplan, 1977). The most highly susceptible are foxes, coyotes, jackals and wolves, kangaroo rats, cotton rats and common field voles. The next most susceptible group contains many species which are important in maintaining reservoirs of infection in wildlife in many different parts of the world. Dogs are only listed to be moderately susceptible but they are, without any doubt, the animals most likely to spread the infection to human beings (Kaplan, 1977).

2.2.4 Transmission

Exposure to rabies occurs when a person or an animal comes into physical contact with saliva of a rabid animal or an environment containing live rabies virus

(Hattwick and Gregg, 1975). Dogs are responsible for more than 80% of the bite wounds in those seeking antirabies treatment in Africa (Turner, 1976) and 95% in the Americas (Acha and Fernandes, 1976). The virus cannot penetrate intact skin but even a lick by an infected animal can be dangerous if the skin is grazed or damaged in some other way. Inhaling airborne virus into the nose and throat is the rarest recorded route of infection in man (Warrell, 1977). Corneal transplantation has also been reported as a specialised route of infection in man (Baer *et al.*, 1982). Post vaccinal rabies has also been reported by Warrell (1977). Exposure due to bite depends on certain epidemiologic factors like presence of rabies in the area; the state of the biting animal - whether provoked or not; and whether the biting animal was shedding rabies virus at the time of the bite or not (Ezebuiro *et al.*, 1980).

2.2.5. Incubation

In all warm-blooded animals, the length of the incubation period depends mainly on the amount of virus that enters the body following bites or licking of abraded surfaces (Haig, 1977).

However, other factors also have a marked influence. These are, the site of bite or abrasion, the treatment given to the wounds, the strain of the virus and possibly pregnancy and such undefinable factors as severe mental stress (Haig, 1977). In domestic animals, the incubation period generally ranges from 5 days to 15 months but usually between 2 weeks to 12 months (Haig, 1977), while in human beings the period is more variable ranging from 9 days to many years (Warrell, 1977; Smith *et al.*, 1991).

2.2.6 Pathogenesis

Following inoculation into the muscle, the virus can only be recovered from the site for a brief moment, usually not over 24 hours (Baer, 1975; Murphy and

Bauer, 1974). The virus enters an eclipse phase 3 hours after inoculation (Baer *et al.*, 1968). The initial replication occurs in striated muscle cells at the site of inoculation (Murphy *et al.*, 1973) and this serves as an amplifying source of the virus for assault on exposed endings of peripheral nervous system and the motor nerve endings deep in the muscles (Tignor and Smith, 1981).

Entry of the rabies virus into nerve endings begins an infection phase in which neuronal infection and centripetal passive movement of the virus within the axons leads to invasion of the central nervous system (Murphy, 1988). When the virus enters the peripheral nerve, it moves passively towards the central nervous system in the axoplasm at a speed of 0.02mm/sec (Ercegovac, 1976).

Once in the brain, the virus multiplies in the nerve cells in all parts of the organ and infection of the cells of the limbic system which is closely associated with emotional behaviour is especially important (Kaplan, 1977).

Johnson (1971) pointed out that this is the adaptation which almost more than any other, is likely to drive the infected animal into frenzies of rage and so cause it to attack and bite, and transfer the infection.

Dumb rabies and the terminal stage of furious rabies which result in depression and coma are results of infection of the higher centres of the brain (Murphy, 1985). Having multiplied in the brain cells, the virus then moves outwards (centrifugally) to the periphery once more, still via the nerves. The virus is thus conveyed to practically every tissue and organ, in the body including, of course, the salivary glands, and so finds its way into saliva (Kaplan, 1977).

2.2.7. Pathology

At necropsy, grossly visible congestion of meningeal vessels of the brain and spinal cord are commonly seen (Dupont and Earle, 1965). Tissues revealing the greatest degree of pathological changes and from which rabies virus is most readily

recovered include the substantial nigra, Ammon's horn and the hippocampus major (Fenje, 1968).

Negri bodies within affected neurons are the most characteristic, and indeed are the only pathognomonic findings. These cytoplasmic inclusions are sharply defined, spherical or oval eosinophilic Feulgen negative bodies (Matsumoto, 1963).

Negri bodies occur in about 75 to 90% of animals which have died of rabies in the field (Dupont and Earle, 1965). Large neurons of the hippocampus are the favoured area for search of Negri bodies, although the midbrain, cerebellum, various ganglia and motor nuclei have frequently been reported as important sites of Negri bodies in some studies showing higher prevalence, than in the hippocampus (Beran, 1981).,

In the brain, nerve cells in the grey matter are the most affected site in the spinal cord and histological lesions are most marked in the nerves and posterior root ganglia corresponding to the sites of exposure. Subependymal and subcortical demyelination may be observed (Perl, 1975).

Other histopathologic findings include a variable degree of cerebral oedema, perivascular cuffing, neuronophagia and neuronal degeneration and these changes are usually sparse in relation to the extent of the terminal infection (Murphy, 1977). Haemorrhagic disturbances of the gastrointestinal tract of dogs have been described (Adeyanju and Addo, 1977). The virus is also readily isolated from the salivary glands or saliva of carnivores 4 - 5 days prior to onset of clinical signs until death (Ezebuiro *et al.*, 1980).

2.2.8 Clinical Signs

Rabies is usually described as taking two clinical forms; furious and dumb. In the dog, the illness is ushered by a prodromal period with irritability, abnormal sensations about the wound site and hyperaesthesia of the skin. Animals may claw

and chew at the skin until it is dehaired and abraded (Beran, 1981). There is also a change in the behaviour and the animal may develop hallucinations and may seek seclusion and hide in dark places (claustrophobia). The animal then goes into either furious or dumb rabies (Ezebuiro *et al.*, 1980).

The furious rabid dog is a serious community hazard. There is dilatation of the pupils and a non-focusing stare fox-like squint, strabismus and mucopurulent lacrimal discharges. There is also a change in voice due to laryngeal paralysis (Ezbuiro *et al.*, 1980).

Intense conjunctival secretions and salivation with head characteristically held at a downward angle causing drooling or frothing of tenacious saliva could often be noticed. Frothing at the mouth and the holding of the tail tightly between the rear legs have been described as characteristics of canine rabies through the ages (Beran, 1981) as the clinical disease becomes apparent.

Rabid dogs characteristically develop a threatened or aggressive pattern of behaviour. There may be alertless, loss of natural timidity, aberrant sexual behaviour and aggressiveness (Johnson, 1971).

Snapping at or attacking people or other animals which seem threatening, biting cages or buildings after being confined, or aggressively seeking to attack real or even imaginary objects within range are characteristic. During the attacks, the animal apparently feels no pain and may lacerate their mouths or knock out their teeth in the frenzy. Animals may wander and may attack a large number of people and or animals (Beran, 1981). In spite of these behavioural aberrations, most dogs continue to recognise their owners and to respond in a quieting way to their voices (Kaplan, 1977).

As the clinical disease progresses, there is a development of increased muscle tone and difficulty in swallowing owing to painful and spasmodic contractions of the muscles of deglutition when fluid comes in contact with the face. Often, the mere sight of liquids will induce such contractions; hence the common name

"hydrophobia" or "fear of water". This, of course, does not seem to develop in all cases of rabies (Baer *et al.*, 1977).

If the dog is presented late in the course of the disease, the clinician may fail to recognise any neurological disorder and may therefore, suspect renal disease, toxaemia, or circulatory collapse etc. (Minor, 1977).

The paralytic or dumb rabid dog appears to be poisoned and these signs may develop following the early signs of the disease or may follow the furious stage. Paralysis commonly begins in the head and neck, then one or both hind legs causing the animal to sway or fall (Beran, 1981). There is incoordination followed by ascending paralysis. The paralysis of the jaws results in its hanging open and thick saliva drools from it (Peace and Hopes, 1970) and the animal is unable to swallow food and water even if it tries to eat (Beran, 1981). The affected dog falls, ultimately becomes comatose, and death ensues, usually from respiratory failure (Beran, 1981).

2.2.9 Diagnosis

For many years, the diagnosis of rabies during life was a clinical one, depending on the skill and knowledge of the physician or veterinary surgeon (Kaplan, 1977).

The diagnostic procedures conventionally used in the diagnosis of rabies include histopathology, animal inoculation, fluorescent antibody test (FAT), serum neutralisation (SN) and complement fixation tests (CFT). (Ezebuiro *et al.*, 1980)

FAT is one of the best single tests available for rapid diagnosis of rabies (WHO, 1984b). Frequently the FAT is positive when Negri body examination is unsuccessful and when mouse inoculation is negative (Ezebuiro *et al.*, 1980).

However, this technique has sometimes given misleading results when newly introduced into a laboratory, so it should be run in parallel with mouse inoculation

tests for at least one year in non-experienced laboratories before proficiency can be assured (Wachendorfer *et al.*, 1984).

After death, the diagnosis could be confirmed by microscopic examination of the brain. Negri bodies, when found are specific indicators of infection by rabies virus, but cases occur in which they are very few or even not found at all (Kaplan, 1977).

Fluorescent-positive, mouse-negative specimens can occasionally be expected, especially in decomposed material (Wachendorfer, 1966), since FAT detects inactivated as well as live antigen. In this respect, fluorescence tests are more sensitive than tests in mice (Dean and Abelseth, 1973).

The mouse inoculation test (MIT) is still one of the most useful tests in the diagnosis of the disease and is recommended whenever humans have been exposed to suspect animals and FAT is negative (Wachendorfer, 1983).

Since mouse inoculation is time-consuming and expensive, other techniques have been developed. One of them uses mouse neuroblastoma cells grown on LabTek 8 chamber slides on which the virus is inoculated and then subjected to direct FAT after incubation at 37°C for 20 hours (Perrin, *et al.*, 1986). Perrin *et al.*, (1986) have also developed a sandwich enzyme linked immunosorbent assay (ELISA) called rapid rabies enzyme immunodiagnosis (RREID) for the detection of rabies antigen in fresh brain suspensions. The test is 97% in agreement with FAT and can be read with the naked eye. The rapid fluorescent focus inhibition test (RFFIT) (Smith *et al.*, 1973) employs BHK-21 cells in LabTek 8 chamber slides and the presence of virus is detected by direct FAT.

Due to common nucleocapsid antigen, rabies-related viruses can not be differentiated from actual rabies virus using FA test. Differentiation of rabies related virus is possible using monoclonal antibodies due to variations in the composition of the glycoproteins and nucleocapsid proteins (Wachendorfer, 1983).

Rabies related viruses have been detected by FAT due to a decreased intensity of fluorescence when stained with rabies conjugate (WHO, 1984b).

Adequate methods for making antemortem confirmation of rabies in animals and man are not available. The corneal test (Schneider, 1969) in which impressions are made of the cornea of the living suspect and examined by FAT can serve as a useful tool in this respect. However, it has not been completely evaluated but should be considered where diagnosis of a clinical case is necessary, while keeping in mind that a negative result does not rule out rabies (Ezebuiro *et al.*, 1980).

2.2.10 Treatment

The first clearly documented cases of recovery from a naturally acquired case of human rabies was reported by Hattwick *et al.* (1972) and this was the case of a six-year-old boy bitten by a rabid bat in October, 1970. A few instances of recovery have been recorded with the use of modern means of symptomatic treatment and intensive care which includes support of respiratory and circulatory functions and electrolyte balance, rehydration, administration of neuroleptic and anticonvulsive drugs, etc., (WHO, 1984b). Guidelines for post-exposure treatment of rabies are given by WHO expert committee on Rabies (WHO, 1984b).

2.2.11 Prognosis

Human rabies has about 100% case fatality rate. There are only few well documented cases of recovery from rabies in humans. However, reported survival of a natural case of clinical rabies suggests that aggressive supportive therapy may occasionally be life - saving (Hattwick *et al.*, 1972). It is widely believed that the development of symptoms of rabies is a prelude to inevitable death but this view is

increasingly being questioned. There is now acceptable evidence that at least in some animals recovery from rabies may not be an exceptionally rare event.

Also, experimental work in animals has shown clearly that some infections may be abortive and some of these may be followed by immunity (Kaplan, 1977).

The question of latency and abortive rabies especially the secretion of rabies virus by dogs that appear healthy has been raised from time to time. As a rule, rabies in dogs is always considered a fatal disease but it is now known that dogs can survive an experimental rabies infection with or without sequelae (WHO, 1984a) and such dogs are subsequently shown to be immune (Nilsson, 1970; Fedaku *et al.*, 1982).

In Nigeria, antibodies against Mokola virus were found in a bat and bird (Ruegsegger *et al.*, 1961; Kemp *et al.*, 1972; Bells, 1975). The conclusions generally reached from these findings are that rabies is not necessarily fatal to man and animals, that there are sub-clinical infections probably due to attenuated strains of rabies virus (Reugsegger *et al.*, 1961) or as yet unidentified related viruses (Shope *et al.*, 1970).

2.2.12 Epidemiology of Rabies

Rabies presents as a distinct problem in different parts of the world with a minimised risk to human beings in the more affluent societies of the industrialised nations while it causes numerous human deaths and unmeasurable human anguish and suffering in the less industrialised societies which comprise the poor developing nations (Acha and Arambulo, 1984). The pattern and occurrence of rabies in animals in the tropics is the reverse of that in most temperate countries where the risk of human rabies from dog bites has been significantly reduced, if not altogether eliminated (Acha and Arambulo, 1984). As an example, 97.5% of rabies cases in animals in Tropical America were reported in dogs, cats and other domestic

animals, while 81.3% of such cases in Temperate America were in wildlife species (i.e. skunks, bats, foxes, raccoons) (Acha, 1981).

Members of the order Chiroptera, particularly insectivorous bats in the United States and vampire bats in Central and South America have served as "vectors" of rabies in man and animals and have been experimentally shown to be capable of secreting the virus for prolonged periods (Ezebuiro *et al.*, 1980). In the United States of America, skunks, bats, raccoons are the main wildlife species responsible for the persistence of wildlife rabies and in 1979 they accounted for 84.0% of wildlife rabies (WHO, 1984a). In the Asian continent dog rabies accounted for between 79 - 98% of all reported cases in India and the Philippines during the 1973 WHO world survey of rabies (WHO, 1973) and for between 92.2 to 99.5% for 7 years in Thailand (1975-81) and 2 years in Vietnam (1977 and 1979) (WHO, 1984a). However, there was a wide variation in the distribution of animal rabies in the different, then Republics of USSR. In some parts, urban or dog rabies persisted, elsewhere many cases were reported in cattle and wildlife (WHO, 1973). In South east Asia, some 9,000 cases of animal rabies were reported from Thailand and Indonesia in 1980 and 99% of these cases were in dogs (Bahnemann, 1981). According to the 1986/87 WHO world survey of rabies, the trend of rabies was stable in Asian countries although an increase was reported in Indonesia, Nepal, Saudi Arabia, Syria and a decrease in Iran, Iraq, Sri Lanka and Thailand (WHO, 1989a). In the same survey, the incidence of rabies was reported to be decreasing in Brazil, Colombia, Costa Rica, Peru and Surinam and increasing in Ecuador, El Salvador, Guatemala, Haiti and Nicaragua. The trend was stable in the rest of the American countries (WHO, 1989a). In the tropics, rabies occurs in two epidemiologic forms: 1: urban rabies, with the dog as the principal reservoir and transmitter, and 2: sylvatic rabies reported in various species of wildlife (Acha and Arambulo, 1984). Ezebuiro *et al.*, (1980) considered these two patterns important because they differ in their potential hazard to humans and also in the tendency for

unilateral transmission from wildlife to domestic animals but rarely from domestic animals to wildlife. Apart from the wildlife reservoirs, there is evidence that a carrier state of rabies exists in dogs and healthy dogs have been shown to secrete rabies virus in saliva for 19 months and over (Fedaku, 1972, 1975), while the presence of antibodies against rabies have been reported in unvaccinated dogs (Ogunkoya *et al.*, 1990).

A total of 72,960 rabies cases, comprising 52,478 cases in animals and 20,482 in human beings were reported from the whole world in 1981 (WHO, 1981). Of the total known animal rabies cases in the world, 47.1% occurred in the tropics with 96% of cases in dogs in urban areas, while 99.9% of the total estimated and reported human deaths from rabies were also in the tropics. About 89.5% of post-exposure treatment (523,592) cases were still in the tropics (Acha and Arambulo, 1984). Acha (1981) reported that rabies was a human and animal health problem in almost all tropical America where an average of 300 persons died of the disease and approximately 300,000 persons received post-exposure vaccination annually.

In Europe, wildlife rabies is a problem in many Western European countries except Scandinavian countries which are free. Foxes are the most important wildlife in the epidemiology of rabies in Europe. For example, about 25% of people who died from rabies between 1966 to 1973 were bitten by foxes (Kauker, 1975). The red fox also accounted for 74.1% of all the recorded rabies cases in Europe between 1977 and 1981 (WHO, 1984a). Within the same period (1977 - 1981), wildlife rabies predominated rabies in other animals and man with the dog and human rabies accounting for only 7.4% and 0.1% respectively (WHO, 1984a). The incidence of the disease was highest in the, then Federal Republic of Germany, followed by Austria, France, Democratic Republic of Germany, Hungary, Switzerland etc. (WHO, 1984a).

According to the WHO world survey of rabies in 1986/87 the trend or incidence of the disease in Europe was decreasing in the Federal Republic of

Germany and Greece and increasing in Czechoslovakia, Democratic Republic of Germany, Hungary, the Netherlands, Poland and Yugoslavia, while it was stable in all other European countries (WHO, 1989a).

Between 1970 and 1980, a total of 258,464 rabies cases, comprising 197,754 cases (76.5%) in dogs, 38,132 (14.8%) in farm animals, 10,597 (4.1%) in cats, 3,975 (1.5%) in wildlife, 2,765 (1.1%) in human beings and the rest (2.0%) in unspecified animal species were reported in Latin America. Canada and U.S.A. reported a total of 62,132 cases of which 76.5% were in wildlife, 14.6% in farm animals, 4.9% in dogs, 4.0% in cats, and 0.1% in human beings and unspecified animal species each within the same period (WHO, 1984a).

During the 1986/87 WHO world survey of rabies, out of a total of 57,928 rabies cases reported, 56,716 (97.9%) were in animals and 1,212 (2.1%) in human beings (WHO, 1989a). In the same year (1986/87), 4,479,712 persons were treated for exposure to suspected rabid dogs (419,585), cats (25,562), other domestic animals (19,630) and wildlife (14,935) (WHO, 1989a). Cattle, goats, pigs, horses and water buffaloes (Arambulo, *et al.*, 1972) were among the domestic animals in which rabies also occurred.

A total of 500 cases of rabies in domestic livestock other than cattle were reported between 1979 and 1980 in Latin America (Acha and Arambulo, 1984).

Generally, wildlife rabies appeared to be more serious in the temperate, industrialised countries of Europe and America (WHO, 1973); although the scope and significance of wildlife rabies is not yet clear in many parts of the tropics except the vampire bat rabies in Central and South America and Mongoose rabies in Cuba, Grenada, Puerto-Rico, Dominican Republic and the U.S. virgin island (Acha 1981).

Children account for the largest percentage of human rabies cases and those in the 1 - 14 year age group, constitute a high vulnerable group to rabies (Acha and Arambulo, 1984).

2.2.13. Epidemiology of Rabies in Africa

Since the first outbreak of rabies was reported in Port Elizabeth, South Africa, in a dog imported from England in 1893, numerous outbreaks of the disease have been reported from different parts of the continent (Rollinson, 1956). Several workers have, now and then for more than forty years reviewed the rabies situation in Africa. Such workers include Hudson (1944), Owoludun (1969), Benerjee and Elegbe (1970), etc. and all of them noted an increase in the incidence of the disease in Africa (Magembe, 1984).

In Africa, dogs are well known to be responsible for the dissemination and persistence of rabies in North, East, West and Central African regions. South of the continent, i.e. South Africa, Namibia and Zimbabwe, the situation is different and wildlife animals (Felidae, Yellow mongoose and jackals) play an important role in the epidemiology of rabies, being apparently chief "vectors" of the disease in circumscript areas. In this case, the dog is considered either to represent the "vector" or victim of wildlife rabies (WHO, 1984a). The dog accounts for over 80% of animal rabies in those African countries where dog rabies is predominant (Boulger and Hardy, 1960; Fagbami *et al.*, 1981; Addy, 1984; Siongok and Karama, 1984; Magembe, 1984; Mariam, 1984). Between 1986 and 1987, a total of 2,086 laboratory confirmed rabies cases were reported in domestic animals with 1,486 (71.2%) from dogs, 119 (5.7%) from cats, 443 (21.2%) from ruminants, 35 (1.78%) in equines and 3 (0.1%) in other domestic animals. Human rabies cases reported within the same period amounted to 306, while a total of 64,103 persons received post-exposure treatment due to exposure from dogs (51,628 = 80.5%), cats (4,940 = 7.7%), other domestic animals (6,439 = 10.0%) , fox (1 = 0.00%) and other wild animals (1,095 = 1.7%) (WHO, 1984a). The trend of rabies in Africa was said to be increasing in Burkina Faso, Ethiopia, Ghana, South Africa and Tanzania, with decreasing reports from Tunisia and Zimbabwe and stable in all other African

countries. The foci of the disease was evenly distributed within each territory in all African countries that had rabies except Burkina Faso where rabies was limited to certain areas (WHO, 1989a). Libya and Mauritius were declared rabies-free between 1986 and 1987 (WHO, 1989a), while the disease was endemic in the rest of the continent. A high incidence of rabies had earlier been reported in West African countries by several workers including Ezeokoli and Schnurrenberger (1977), Umoh and Belino (1979), Fagbami *et al.*, (1981) and Addy (1984). Hyenas play a major role in behaving as an active or passive carrier of rabies in Ethiopia (Mariam, 1984), while in Zambia canine rabies is tied up with wildlife rabies. The two cycles of urban and peri urban canine rabies and wildlife rabies overlap with the wildlife rabies maintaining a higher prevalence than periurban canine rabies (Zyambo *et al.*, 1984). Rabid jackals infect dogs and other domestic animal species, disseminate rabies over wide areas and may, under certain conditions provide a reservoir of infection in Zimbabwe (Foggin, 1984). Kudu antelopes (*Tragelaphus strepsiceros*) have also been shown to have rabies and unlike cattle and deer, kudu rabies is apparently not a dead end infection and the disease can be spread horizontally among kudu and also between kudu and cattle through direct transmucosal transmission (Barnard and Hassel, 1981). Addy (1984) reported the incidence of rabies to be at its peak in the months of July, September, November and January in Ghana, while Tomori and David-West (1984) reported more rabies outbreaks or cases in the dry season months of October to March in Nigeria. However, more cases were reported in the hot season (March to August) than in the cold season in Tunisia (Chadli and Benlasfar, 1984). The incidence of human deaths due to rabies was related to that of the disease in domestic animals in many African countries like Nigeria, Ghana, Morocco etc. (Ezeokoli and Schnurrenberger, 1977; Umoh and Belino, 1979; Fagbami *et al.*, 1981; Tomori and David-West, 1984; Addy, 1984; Bakkali, 1984). Children less than 15 years old form the bulk of those exposed in many, if not all African countries (Boulger and Hardy,

1960; Fagbami *et al.*, 1981; Belcher *et al.*, 1976; Ayalew, 1984; Chadli and Benlasfar, 1984; Bakkali, 1984). Male patients account for majority of reported rabies cases in Nigeria (Fagbami *et al.*, 1981), Morocco (Bakkali, 1984), Tunisia (Chadli and Benlasfar, 1984).

Between 1964 and 67, Cameroon reported 150 animal rabies cases, 148 of which were from dogs and 2 from cats, while 9 human rabies cases were reported within the same period (WHO, 1984a). In 1987, out of 126 cases of Laboratory confirmed rabies in Cameroon, 124 were from dogs and 2 from ruminants and in the same year, 1,574 persons were treated for exposure to suspected rabid dogs (1,527) and cats (47) (WHO, 1989a). Again, 11 cases of laboratory confirmed rabies, all in dogs were reported in Cameroon in 1988 and in the same year, 1,295 persons were treated for exposure to suspected rabid dogs (1,253) and cats (42) (WHO 1991b).

2.2.14 Rabies-related viruses

Seven rabies-related viruses have been isolated in Africa and four of these viruses (Lagos bat, Mokola, Kotonkan and Nigerian horse virus) have been isolated in Nigeria (Beran, 1981, WHO, 1984a).

The Lagos bat virus was originally isolated from the pooled brains of fruit bats (*Eidolon helvum*) shot in Lagos Island, Nigeria, in 1956 (Boulger and Potterfield, 1958).

Though pathogenic for mice, dogs and monkeys, Lagos bat virus is not known to cause human disease.

The Mokola virus was first isolated from shrews trapped in Ibadan, Nigeria in 1968 (Shope *et al.*, 1970) and has also been isolated from shrews in Cameroon (Le Gonidec *et al.*, 1978) and from cats and a dog in Zimbabwe (Foggin, 1983).

Kemp *et al*, (1972) have shown that the shrew can transmit Mokola virus to other animals. Mokola virus has been isolated from two patients with central nervous system infection, the first with aseptic meningitis (Familusi and Moore, 1972) and the second a fatal case of encephalomyelitis (Familusi *et al*., 1972).

Histopathologic sections of the brain of human beings infected with Mokola virus as well as the brains of experimentally infected monkeys and dogs also show inclusion bodies similar to Negri bodies (Familusi *et al*., 1972). This, therefore, means that laboratory examination for Negri bodies in suspect rabies cases should be interpreted with caution though one way to distinguish between the two viruses is that the incubation period of unadapted street rabies virus in suckling mice (10 - 21 days) is longer than that of Mokola virus (about 4 days) (Tomori and David-West, 1984). The kotonkan virus was isolated from culiciodes in Nigeria in 1970 (Shope *et al*., 1970). Other rabies-related viruses have been isolated in other parts of Africa for example, Obodhiang virus was isolated from pools of *Mansonia uniformis* mosquitoes in 1963 (Shope *et al*., 1970) and Duvenhage virus discovered in South Africa in 1970 in the brain of a man who died apparently from rabies after being bitten by a bat (Meredith *et al*., 1971). The kotonkan and Obodhiang viruses are the two arthropod borne rhabdoviruses. An atypical rabies virus strain also exists in Ethiopia in which rabid dogs do not show the significant clinical symptoms (Fedaku *et al*., 1982). The Lagos bat, Mokola and Duvenhage viruses have been placed in the same group of the genus Lyssavirus of the family Rhabdoviridae (Shope *et al*., 1970).

2.2.15 Rabies Control

Rabies has survived over 500 years inspite of concerted efforts to control it (Okoh, 1986). The control and prevention strategies of rabies in human beings, livestock and other non-reservoir (dead end) hosts are based on breaking the cycles

of transmission in reservoir hosts and secondly on protection of these alternate hosts from exposure or infection (Beran, 1981).

According to WHO (1984a), control measures should be applied to canine rabies irrespective of the presence or absence of rabies reservoir in wildlife. The basic principles of the control of animal rabies as recommended by World Health Organization (WHO) Expert Committee on Rabies include elimination of stray dogs, canine vaccination and control of wildlife (WHO, 1982; WHO, 1984a). In addition, the Committee also recommended the following specific control measures in areas affected with rabies:-

1. registration, licensing and taxation of dogs
2. elimination of stray dogs.
3. restraining of dogs while the control campaign is underway
4. vaccination of dogs free of charge,
5. provision of adequate facilities for diagnosis.
6. reduction of wildlife species where these are a reservoir of the disease and
7. a continual and energetic publicity campaign.

However, it is very difficult to implement these basic principles and specific measures in most countries and this is largely responsible for the continued occurrence of rabies in these countries (Ezebuiro *et al.*, 1980). Rabies control programmes must be based on a knowledge of the epidemiology of the disease in specific countries (Beran, 1970).

The high proportion of free-roaming and poorly supervised dogs is one of the major obstacles to canine rabies control and this often makes vaccination programmes suffer due to inadequate coverage so that the disease incidence decreases but can not be completely eliminated (WHO, 1989).

There have been many types of antirabies vaccines produced since the original vaccine was developed from the spinal cord of experimentally infected rabbits by Pasteur (Bunn, 1984).

The first vaccine for dogs was developed by Umeno and Doi (1921) using phenolised rabbit brain.

Koprowski and Cox (1948) developed a modified live virus rabies vaccine of chick embryo origin and such vaccines were shown to produce immunity for at least 3 years (Tierkel *et al.*, 1959).

Rabies vaccines for dogs have cycled from inactivated nervous tissue origin (NTO) vaccines to modified live virus (MLV) vaccines and now back to inactivated vaccines but primarily of tissue culture origin (TCO) (Bunn, 1984). The vaccines that are available today for use in dogs can be divided into 3 groups; the modified live virus (MLV) vaccine; the inactivated nervous Tissues Origin (NTO) vaccines and the inactivated cell culture origin (CCO) vaccines (Bunn, 1984).

The availability of vaccines in each group varies from one country to another depending on whether the vaccines are produced locally or are imported (Bunn, 1984).

Attempts to control canine rabies in Nigeria have been directed towards controlling the disease in dogs and cats (Fagbami *et al.*, 1981) by stray dog control and by vaccination with modified live virus (MLV) chick embryo origin vaccine (LEP and HEP). The Flury Strain of the vaccine is manufactured domestically by the National Veterinary Research Institute (NVRI) Vom.

A total of 108,360,216 animal vaccines were domestically produced between 1986 and 1989 in all those countries in the world engaged in domestic vaccine production for animal use. Also a total of 6,791,925 doses of animal vaccines were imported by countries that did not manufacture vaccines locally and also by countries that also manufactured animal vaccines for rabies. Some countries relied solely on the importation of animal vaccines for rabies (WHO, 1989a). A total of

30,059,956 doses of human rabies vaccines were produced locally in various countries, while 1,412,560 doses were imported by different countries (WHO, 1989a)

The immunogenicity of modified live virus (MLV) vaccines is enhanced if the vaccines are given intramuscularly (IM) instead of subcutaneously (SC) (Johnson *et al.*, 1957; Brown *et al.*, 1973) but for safety reasons the site should be confined to the muscles of the thigh (Cabasso, 1962). The National Association of State Public Health Veterinarians of the United States as well as other parts of the world, recommend that all vaccines should be administered at 3 months of age and again 1 year later (The National Association of State Public Health Veterinarians, 1978).

Cases of rabies in vaccinated dogs have been reported for low-egg-passage (LEP) Flury strain vaccine in many countries including USA (Cabasso, 1962; Kappus, 1976; Constantine *et al.*, 1978), France (Rembinger, 1959; Blancou *et al.*, 1983), Zimbabwe (Lawrence, 1956), Kenya (Minor, 1977), South Africa (Barnard *et al.*, 1977), Tunisia (Haddad *et al.*, 1985), Nigeria (Okoh, 1982; Okoh, 1983; Bobade *et al.*, 1981; Oboegbulum *et al.*, 1987). A possibility exists that the vaccine failures in Nigeria could be due to rabies-related viruses (Umoh *et al.*, 1984.)

Since routine rabies vaccines do not protect against the rabies-related viruses (Shope and Tignor, 1972; Foggin, 1982; Crick, 1983), their existence in the canine population in Nigeria, Cameroon, Central African Republic, Zimbabwe and South Africa could hamper the rabies control effort. A vaccination failure rate of 2.5 cases per 10,000 doses of antirabies vaccine (ARV) has been reported in the former Anambra State, Nigeria (Oboegbulum *et al.*, 1987).

Since 1972, WHO has been co-ordinating research on the immunization ofwildlife against rabies.

In recent years, attempts have been made to reduce the dog and wild animal population in the hope that this would break the chain of natural transmission of rabies but experience has shown that this does not work. Even the killing of animals

on the scale required to control rabies is no longer tolerable in modern society hence the only technique available today for control of rabies in those animals that remain out of physical reach is oral rabies vaccination (ORV) (WHO, 1989b).

Immunization with inactivated vaccine by oral or enteric route has so far not given applicable results but trials with oral and enteric live virus vaccines have clearly shown that a number of strains are highly effective when applied directly on the tongue and buccal mucosa or when ingested with appropriate bait (WHO, 1984b).

Many modified live virus vaccines have been used in attempts to immunize foxes orally and these include CVS and HEP Flury which are not effective at high concentrations of virus. One strain which has consistently been shown to be an effective immunogen is SAD strain or its derivatives (Debbie *et al.*, 1972; Steck *et al.*, 1982). The first field trial with SAD was carried out in Switzerland, beginning in 1978 and its use has since then resulted in the virtual elimination of rabies from that country. So far, about 1,000,000 baits have been distributed in this country (WHO, 1989b)

A SAD derivative called SADB19 has also been used in the former Federal Republic of Germany since 1983 and has resulted in a 60% reduction of fox rabies in that country without any case of vaccine induced rabies in approximately 10,000 rabid animals examined after the placement of over 8,000,000 baits in nine European countries (WHO, 1989b).

Recombinant vaccines have also been tried as candidate vaccines for oral immunization of carnivores. The Human adenovirus 5 rabies recombinant (HAd5RG) has been tested orally in wildlife animal species, mainly skunks but also foxes and raccoons have produced seroconversions that resisted challenge in these animals. Others are the vaccinia-rabies recombinant (VRG), SAG1 and ERA strains used in dogs (WHO, 1991).

Five different types of baits are being used in Europe:

(1) Chicken heads in Switzerland,

(2) Turbingen fox bait in France, Italy, Austria, Yugoslavia and Czechoslovakia,

(3) The fishmeal polymer (FMP) bait from Merieux used in limited areas in France and Belgium,

(4) "virbac" bait in France and

(5) The East German bait (WHO, 1990).

However, the WHO recommendation that "no live vaccine be used for any wildlife species kept as pets or in zoos or exhibitions" still stands (WHO, 1980; WHO, 1982).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY AREA

3.1.1. Bamenda

For dog population studies, two towns Bamenda and Wum were selected. Bamenda town is found in Mezam Division in the North West Province where it serves as the Divisional as well as the Provincial headquarters. It covers a total surface area of 1,108 square kilometers and according to the second census of Cameroon in 1987, the population of the town was 110,000 with an annual growth rate estimated at 2.74%.

The population of the town in 1991 was, therefore, put at 122,560 with an estimated annual growth rate of 2.74% of 1987 census. The town is bounded on the West by Mbengwi and Bali, to the north by Bafut, to the east by Bambui and to the South by Akum and Santa. The town as well as the whole province lies in the high plateau and there are two distinct seasons: the dry and rainy seasons with the rainy season lasting for about seven months, while the dry season lasts for about five months from the beginning of November to the middle of March. The natural vegetation is predominantly savanna, that is, the tropical grassland. Christianity and Islam are the forms of religion practised in the town although non-believers or pagans also exist in the province as a whole.

The Provincial Delegation of the Ministry of Livestock Fisheries and Animal Industries, sector unit of Mezam Division, Subsector unit of Bamenda Central, veterinary clinic, OPV (Veterinary Pharmaceutical Office), etc. all make up the veterinary infrastructure in Bamenda.

3.1.2 Wum

Located in Menchum division, Wum central is a cluster of villages including Aghem, Weh, Bu, Befang, Mmen with Aghem at the centre and usually referred to as Wum town. Wum town is the headquarters of Menchum division which is also found in the North West province.

Wum central covers a total surface area of 4,489 square kilometers. Wum town has a population of 27,489 inhabitants. However, the figure for surface area is for the whole of Wum central since the exact surface area of Wum town could not be obtained at the time of this study.

The vegetation, relief structure, climate, religion of Wum town are similar to that described for Bamenda. The major occupation of Wum is subsistence agriculture and veterinary facilities include a sector unit for the Division, a subsector unit for the subdivision and a veterinary treatment centre (clinic).

3.1.3 CAMEROON

Generally, the Republic of Cameroon lies between longitudes 8° and 16° East of Greenwich and latitudes 2° and 13° North of the equator. It is bounded on the West by the Federal Republic of Nigeria, to the east by the Central African Republic and Chad and to the South by Congo Republic, Gabon and Equatorial Guinea. The country covers a total surface area of 475,442 square kilometers and according to the second census of Cameroon/UNFPA* (United Nations Fund for Population Activities), the population of Cameroon in 1987 was 10,493,655; with an annual growth rate estimated at 2.9% . The population of the country is, therefore, estimated at 12,106,000 in 1992 based on the estimated annual growth rate of 1987. The urban population is estimated to represent 37.8%, while the remaining 62.2%

live in the rural areas. Almost 80% of the population is engaged in agricultural activities which are extremely varied. Administratively, Cameroon is divided into 10 provinces, viz:- Adamawa, Centre, East, Far North, Littoral, North, North-West, South, South-West and West. Each province is composed of divisions. There are two distinct seasons in the country and these are the dry and rainy seasons with most of the rainfall occurring between April and October. Two major forms of religion are practised in Cameroon and these are Christianity and Islam although paganism also exists in some minority sectors. The veterinary infrastructure in the country is such that there is a Ministry of Livestock, Fisheries and Animal Industries (MINEPIA) in Yaounde (capital of Cameroon), while each Province has a Provincial Delegation of the Ministry and each Division has a sector unit.

*UNFPA = (United Nations Fund for Population Activities).

3.2 DOG POPULATION STUDIES

3.2.1 Source of data

The information given on dog population studies is based on data collected from Bamenda and Wum towns, both in the North-west province of Cameroon.

3.2.2 Data Collection

The dog population studies were carried out through questionnaire surveys. The questionnaire used was a modification of the WHO Guidelines for dog rabies control (WHO, 1984a). Two surveys were carried out: one in May, 1991 in Bamenda and the other in June, 1992 in Wum.

Households were selected from all the quarters and streets of each town and the questionnaires distributed to these households. At the beginning of each survey, some interviewers were recruited and educated on the content of the questionnaire as well as on how to administer and complete it. Literate households completed their questionnaires, while questionnaires for illiterate households were completed on the spot through interview of the household members by the interviewers. A total of 214 questionnaires were completed in Bamenda and 234 in Wum by both dog owners and non-dog owners. All the completed questionnaires were collected and carried to Zaria for analysis. The questionnaire comprised two parts: Section A, household information and Section B, individual dog information . The content of the questionnaire focussed on information on occupation of the head of household, number of people in the household, dog ownership, reasons for owning and not owning dogs, age, sex, breed, source, use of dogs owned in the households, feeding, handling, confinement, antirabies vaccination, litter turnover, among other parameters.

3.2.3. Data Analysis

The completed questionnaires were analysed using the Statistical Package for Social Sciences (SPSS) (Nie *et al*, 1970) to obtain frequencies, cross tabulations and Chisquare computations.

3.3 EPIDEMIOLOGY OF RABIES

3.3.1 Source of data

The data on canine and human rabies were collected from Annual Reports of all the ten provinces in Cameroon at the Ministries of Livestock and Public Health

for eight fiscal years (1982/83 to 1989/90) and seven years (1984 to 1990) respectively. Data on human rabies were also collected for five years (1986 to 1990) from the Preventive Medical Office of the Bamenda general hospital

3.3.2 Data collection

Letters of introduction to the Minister of Livestock, Fisheries and Animal Industries (MINEPIA), the Minister of Public Health and Chief of Service, Dept. of Statistics were obtained from the Head of Department of Veterinary Public Health and Preventive Medicine, Ahmadu Bello University, Zaria, Nigeria. On presentation of these letters to the respective ministers in Yaounde, Cameroon, approval was granted for data collection. With the aid of these letters, all the available Annual Reports from 1982/83 to 1989/90 on veterinary and from 1984 to 1990 on medical activities for each Province were sorted out. These reports were then carefully screened for data on rabies. The information in the Annual Reports of MINEPIA was documented in fiscal years and similarly extracted. The data collected were classified into number of biting dogs placed under observation, number of biting dogs that died during observation, number of laboratory confirmed rabies cases and the number of pets that were vaccinated against rabies. The data were collected on provincial and annual basis for eight years (1982/83 to 1989/90). The reference laboratories for the confirmation of canine rabies were Pasteur Centre in Yaounde and Lanavet (National Veterinary Laboratory) in Garoua and fluorescent antibody Technique (FAT) and sometimes mouse inoculation test (MIT) were used to confirm canine rabies cases. The data obtained from the Annual Reports in the Ministry of Public Health were documented in single calendar years and similarly extracted. These data comprised essentially the number of human deaths due to rabies every year in each Province for seven years (1984 to 1990). Since laboratory confirmation of human rabies cases is not routinely

CHAPTER FOUR

4.0 RESULTS

4.1 DOG POPULATION STUDIES

A total of 4,184 people lived in 448 households sampled in Bamenda and Wum towns at the time of survey. This means that an average of about 9 people lived in a household.

The heads of these households belonged to several occupations: civil service (35.9%), farming (24.6%), business (21.9%), mechanical repairs, carpentry etc (10.0%) and others (7.6%) (Fig. 1). More civil servants were seen in Bamenda, while more farmers were seen in Wum. The age distribution of the people in the households revealed that most of the population (58.2%) was less than 20 years old, while the active working age group (20 to 50 years) was about 36.3%. There were few old people (more than 50 years old) in both towns (Fig.2). Of the 448 households sampled, 316 (70.5%) owned one or more dogs and the total number of dogs owned was 549 (Table 1). The number of households with dogs was statistically significant ($p < 0.05$). The dog to household ratio was 1:0.8 (10 dogs in every 8 households), while the dog to person ratio was about 1:8.0. According to the age distribution of owned dogs, the number of dogs in each age group decreased with an increase in age with majority of the dogs (61.9%) aged between 3 months and 2 years (Fig.3). The distribution was practically the same in the two towns when considered separately, i.e. there was no statistically significant difference ($p > 0.05$). Most of the dogs were therefore, young with very few dogs (3.8%) aged more than 5 years. The age of the dogs ranged from one month to eight years three months. The mean age of the dogs was 1 year eight months. The sex distribution of the dogs revealed more males (55.0%) than females (43.7%), while a few dogs (1.3%) were neutered (Fig. 4). The sex ratio was estimated at 125 males to every

100 females. There was however, no statistically significant difference between owned male and female dogs ($p > 0.05$). Over 90% of the dogs were local or native dogs with only a few mixed breeds (5.8%) and Alsatians (2.6%) (Fig. 5). The ratio of local dogs to other breeds was 109 local dogs to every 10 dogs of other breeds. The difference in the number of local dogs and other breeds of dogs was statistically significant ($p < 0.05$). Households without dogs had several reasons for not keeping dogs: poverty (37.9%), hatred for dogs (32.6%), against religion or culture (3.0%), other reasons 26.5%). Religion and culture did not affect dog ownership very much since all the 3.0% came from Bamenda only (Fig. 6). Most of the households that gave other reasons said they were either still planning to acquire a dog or that their dogs had died. Some of them sold their dogs because the dogs had become a nuisance. Apart from dogs, other animal species were also kept by many households (64.2%) with majority of them (53.1%) keeping more than one type of animal. Cats were mostly owned in Bamenda, while livestock (goats and pigs) were mostly owned in Wum. A large number of households kept poultry alone (21.1%). Meanwhile no household owned horses or sheep (Table 2). Previous dog bites in the households were reported in 96 households (21.4%) with 51.0% of these households having intrafamily dog bites and 24.0% having members bitten by neighbour's dogs. This implied that majority of the bites (75.0%) were either from dogs owned in the same households (intrafamily) or from neighbours' dogs. However, 25.0% of the households had dog bites from unowned dogs (Fig. 7). Most of the bites according to the concerned households were unprovoked (51.0%), while provoked bites were the smallest (9.4%) (Fig. 8). Distribution of the households according to site of bite showed that the leg had the highest number of bites (62.6%) with the left leg having more bites (36.5%) than the right leg (26.0%). This was followed by bites on the hands which were reported by 29.2% of the households with the right hand having more bites (15.6%) than the left hand (13.5%). Only one (1.0%) household reported a bite on the face (Table 3). Victims

of dog bite were reported to have been taken to the hospital by majority of the households (86.5%), although a few households (12.5%) treated the bite wounds with traditional medicine or antibiotics only (Fig 9), Majority of the households (61.5%) also reported the biting dogs to the veterinary authorities. However, 20 household (20.8% mostly in Wum reported doing nothing to the biting dog, While 9 households (9.3% reported that they could not identify the biting dog. Some households (4) simply settled the matter with the dog owners at home and forgot about it (4.2%), while some killed the biting dogs (4.2%) (Table 4).

The age distribution of the dog bite victims revealed that children between the of ages of 5 and 10 years suffered most (37.5%), followed by those between 21 and 45 years (31.3%), while those above 45 years old were rarely bitten (2.0%) (Fig 10). Dogs were acquired from several sources: through purchase (58.0%), as gifts from friends (17.7%) from owners bitches (12.7%), from more than one source for example purchase/gifts or purchase/owners own bitch etc (11.4%) Fig 11). There was however, no statistical by significant difference between households that purchased their dogs and those who had theirs from other source for ($p > 0.05$). dogs were also kept for several reasons: as guards(56.3%). mostly in Bamenda, as pets (5.1%), for more than one reason (35.8%) with 26.0 of them using their dogs for hunting and as guards mostly in Wum (Fig 12).

Most dog owners kept their dogs in their household either on chain (66.5%) or in the garage or indoors (9.5%) during the day, while most of them allowed the dog to roam about freely in the household or quarters (64.5%) at night (Table 5). More than 90% of the households that owned dogs fed their dogs although dogs sometimes had to look for their own food in some of the household(4.1%). There was a significant difference between households that fed their dogs and those whose dogs were fed by other means ($p \leq 0.05$). Only one household (0.3% reported that it had a dog which it did not feed Fig 13). Dogs were mainly handed by their dogs members; In this study, 227 (71.8%) household out of 316 handled

their dogs. Children and adults in the households handed their dogs in 120 (38.0%) households. Eight(2.5%) households could not handle or play with their dogs (Table 6).

Most households (57.9%) had vaccinated their dogs while 39.6% had never done so. However, the difference was not statistically significant (i.e. $P > 0.05$). Both vaccinated and non-vaccinated dogs were reported by 8 (2.5% households. Most of the household that had never vaccinated their dogs against rabies were reported from Wum (66.4%). (Fig 14). Most of the dogs were last vaccinated in 1991 although 12 (6.6%) households could not remember when last they vaccinated their dogs. Norbivac (manufactured by Intervet., Belgium) was the antirabies vaccine mostly used compared to Rabisin (manufactured by Rhone-Merieux, France) and others, though there was no significant difference in the two types of vaccines used ($p > 0.05$). However, majority of the households (71.3%) that had vaccinated their dogs in Wum did not know the name of the vaccine used. Generally, many households (36.6%) did not know the name of the antirabies vaccine used (Fig. 15). Households with unvaccinated dogs gave several reasons: dog was too young (46.4%); poverty (24.0%); ignorance of vaccination (16.0%); lack of vaccine (6.4%) (Table 7). There was a statistically significant difference between the number of households that complained of poverty and ignorance of vaccination in Bamenda and Wum ($p < 0.05$). However, there was no significant difference between the various reasons for not vaccinating dogs in both towns ($p > 0.05$).

About 95% of all the households sampled were aware of the fact that dogs can transmit disease to man through their bites. Most of the households, especially in Wum, felt that the number of dogs in their quarters was not too much while others, especially those in Bamenda, thought that there were too many dogs in their quarters.

An extrapolation of the dog populations obtained for Bamenda and Wum using the respective 1991 and 1992 human population figures gave a total owned dog population estimate of 22,270 (Appendix 3). The - dog - to person ratio for both towns was 1:7.0 (i.e. 1 dog to every 7 people). About 66.3% households revealed that dogs not belonging to them sometimes ate in their households. Dogs therefore, had access to many households and fed mainly from the dustbins or any food found in these households. Most households (52.7%) especially in Wum said there were no unowned dogs in their quarters, while others (43.3%) said there were such dogs in their quarters and 4.0% did not respond.

These unowned dogs were always in the quarters according to 46.4% of the households who reported the presence of such dogs in their quarters. About 27.8% households said these dogs were strange to their quarters, while both categories of unowned dogs existed in the quarters according to 50(25.8%) households Table 8). A total of 109 households had mature female dogs (bitches) which produced one or two litters in a year and a total of 153 litters were produced by all these females. Hence an average of 1.4 litters produced in each household that had a mature female dog. Bitches whelped once a year in majority of the households (68.8%), while two litters in a year were produced in 23.9% of the households. Few households (7.3%) had 3 to 4 litters in a year from all their bitches. A total of 544 puppies were delivered in 109 households giving an average of about 5 puppies/household or 1.2 puppies/household if all the households sampled are considered.

The litter size ranged from 1-11 puppies with majority of the bitches producing 3-7 puppies. The average litter size was estimated at 3.6 puppies/delivery (litter). A total of 144 (26.5%) puppies died of diseases or were killed by people either deliberately or accidentally. Out of these 144 puppies, 126 (87.5% died from diseases. This implies that 400 puppies survived, giving a puppy survival rate of 73.5%. Of the 400 puppies that survived, 107 (26.8%) were sold by 38 households,

51 (12.8%) were given away as gifts to friends by 29 households, 23 (5.8%) were missing, while 219 (54.8%) were still with their owners in 75 households (Fig. 16). The difference in the distribution of puppies among the various possibilities in both towns was not significant ($p > 0.05$). About 93% households that did not own dogs said they would vaccinate their dogs against rabies if they had any. The opinion of households on how the dog population in their quarters was changing was variable:- the dog population was decreasing (21.7%), increasing (42.4%), constant (19.0%), those that did not know (14.1%) and those that did not respond (2.9%).

4.2 EPIDEMIOLOGY OF CANINE RABIES

4.2.1 Littoral Province.

A total of 9,051 biting dogs were placed under observation for rabies. This gave an average of 1,131 observations every year. The highest number of observations was 1,510 in 1987/88, while the lowest was 860 in 1984/85 (Table 9). Of the 9,051 dogs observed, 84 (0.9%) died during observation giving an average of 10.5 dogs dying every year during observation. The highest deaths (20) were recorded in 1987/88 and this coincided with the year with the highest number of observations (Table 10). A total of 14 confirmed rabies cases were reported. Twelve cases were confirmed from Moungo and Nkam Divisions, while two cases were from Wouri Division. There was no confirmed case from Sanaga - Maritime Division in 8 years. Wouri Division had the highest number of biting dogs under observation. A total of 17,901 dogs and other pets were vaccinated against rabies during the 8 years period with Wouri Division having the highest number of vaccinations (70%). An average of about 2,400 dogs was vaccinated every year (Table 11). Despite the large number of dogs observed and those that died during

observation, no confirmed case was reported in the Province from 1985/86 to 1989/90.

4.2.2 South-West Province

For 8 years, the Province recorded 2,939 observations of biting dogs giving an average of 367 observations per year. Manyu Division had 215 (10.5%) observations, while the other Divisions (Fako, Ndian and Meme) had an approximately equal number (Table 9). Sixty five out of 2,939 dogs under observation died with the highest number of deaths (28) reported in 1983/84 (Table 10). Reports of confirmed rabies cases in dogs were from two years only with 2 cases in Fako Division and 4 cases in Meme Division. This gave the impression that rabies was absent in the other Divisions. Antirabies vaccination activities in the Province revealed that a total of 6,827 pets (dogs mainly) received antirabies vaccination within 8 years giving an average of 853 vaccinations each year. The highest number of vaccinations was obtained in 1984/85 (1,423), while the lowest was obtained in 1988/89 (470) (Table 11). Fako Division had the highest number of vaccinations (41.6%), while Meme and Ndian Divisions together had 49.0% and Manyu Division 9.4%.

4.2.3 North-West Province

Biting dogs that were observed for rabies amounted to 1,341 within the period of study with the highest number of observations being 328 in 1984/85 and the lowest, 75 in 1986/87. A large number of observations was made in 1988/89 and 1989/90. Table 9). An average of 168 biting dogs was observed every year. The highest number of observations was by far smaller than the lowest number of observations in some Provinces. Only 13 (1%) dogs died during observation out of

the 1,341 dogs observed and this was in 1984/85 (8) and 1988/89 (5) (Table 10). Four laboratory confirmed rabies cases were documented in the Province with 2 cases each from the 8 and 5 deaths (Table 9). Mezam Division had 3 (75%) out of 4 cases, while Donga/Mantung Division had one (25%) case. There was no confirmed rabies case in Menchum, Momo and Bui Divisions of the Province. The antirabies vaccination policy in the Province revealed that 11,470 pets received antirabies vaccination within the period of study giving an average of 1,434 vaccinations per year. The lowest vaccination figure was obtained in 1982/83 and the highest in 1989/90 (Table 11). There was generally an increase in the number of antirabies vaccinations each year from 1982/83 to 1989/90. Also, vaccination records revealed that Mezam Division had 8,409 (73.3%) vaccinated pets. Hence the Division (Mezam) had the highest number of observations, confirmed rabies cases and antirabies vaccinations.

4.2.4 West Province

All the biting dogs placed under observation during the study period were 4,280 with an average of 535 observations per year. The highest number of observations (849) was recorded in 1986/87, while the lowest was in 1982/83 (Table 9). Mifi Division had 2,971 (69.4%) observations alone even though observations were documented every year all the other Divisions of the Province. A total of 47 dogs (1.0%) died during observation with the highest deaths (15) recorded in 1984/85 (Table 10).

Twenty confirmed canine rabies cases were documented in the Province and the highest number (7) was in 1985/86 from Bamboutos and Ndé Divisions. According to the Annual Reports, canine rabies was reported in all the six Divisions of the Province at different times and from the Province every year except in 1987/88 (Table 9).

Antirabies vaccination policy in the Province showed that a total of 15,450 dogs were vaccinated against rabies with an average of 1,931 vaccinations per year (Table 11). The vaccination figures were very high for about 5 years (1983/84 to 1987/88) with the highest, 2,540 recorded in 1986/87. Mifi Division had 35.8% of the total vaccinations, while the others each had less.

4.2.5 East Province

For 8 years, only 722 biting dogs were observed for rabies compared to other Provinces like Littoral whose lowest figure in a year was 860 (Table 9). An average of 90 observations was made every year. The distribution of the observations by Division did not reveal any significant difference. Only six dogs (0.8%) died out of the 722 observed. According to the reports, no dog died during observation from 1984/85 to 1989/90 (Table 10).

Twelve laboratory confirmed rabies cases were documented in the Province and this coincided with those years that recorded deaths of biting dogs during observation (i.e. 1982/83 and 1983/84) (Table 10). This implies that not all the confirmed cases were from dogs which died during observation. Some of the confirmed cases were from suspected dogs that were destroyed without observation and their heads sent to the laboratory for rabies diagnosis. The distribution of confirmed rabies cases revealed that Kadey and Haut Nyong were the only Divisions which had confirmed cases, while other Divisions in the Province like Lom and Djerem and Boumba and Ngoko had no confirmed case. A total of 3,6578 dogs were vaccinated during the study period giving an average of 460 vaccinations per year. About 45.9% of the vaccinations were from the Lom and Djerem Divisions. The highest number of vaccinations was 1,249 in 1983/84 and since then the number vaccinated every year was hardly up to 500 (Table 11).

4.2.6 Centre Province

The Province had the highest number of biting dogs placed under observation compared to the rest of the Provinces in the country. For 8 years, 12,439 biting dogs were observed in the Province with an average of 1,555 observations a year. The highest number of observations (4,410) was seen in 1987/88 (Table 9). The number of biting dogs was high from 1986/87 to 1987/88 and this coincided with the period when the highest number of deaths and confirmed rabies cases were recorded in the Province. The number of observations decreased to about 1,000 during the last two years. The lowest number of dogs observed was 717 in 1984/85, yet this figure was higher than total number of observations obtained in some other Provinces like Adamawa, East and South (Table 9). Mfoundi Division had 8,075 (65.0%) observations. A total of 375 deaths (3.0%) were recorded in the Province with the highest deaths (180) in 1987/88. Also, Mfoundi Division had majority of the documented deaths (Table 10). Out of all the 375 dead dogs, 126 (36.2%) cases were confirmed to be positive for rabies. The highest number of confirmed cases was 70 in 1987/88 and this coincided with the year with the highest number of biting dogs observed and deaths. Rabies cases were confirmed from all the Divisions at one time or the other with the exception of Haute Sanaga Division. Mfoundi Division had 85 (67.5%) case followed by Lekie Division with 14 (11.1%). A total of 17,580 dogs were vaccinated against rabies in a period of 8 years. The highest vaccination figure was 4,150 in 1987/88, while the lowest was 1,417 in 1984/85 (Table 11). This gave an average of 2,198 pets vaccinated every year. Mfoundi Division again had the highest, 11,984 (68.0%) vaccinated pets every year. The highest number of observations, deaths, confirmed cases and antirabies vaccinations were seen in 1987/88, while Mfoundi Division had the highest number of observations, deaths, confirmed rabies cases and antirabies vaccinations.

4.2.7 South Province

All the biting dogs observed amounted to 658 with an average of 82 observations per year. Ntem Division had majority followed by Dja and Lobo Divisions. A total of 32 biting dogs (4.9%) died during observation with the highest deaths (14) recorded in 1985/86 (Table 10). Dja and Lobo had 14 deaths followed by Ntem Division with 12 and Ocean Division with 6. The rabies situation in the Province revealed that 36 laboratory confirmed cases were documented in the 8 years (Table 9). Rabies cases had been confirmed in dogs from all the three Divisions of the Province with Ntem Division accounting for 22 (61.1%) cases, while Ocean, Division and Dja and Lobo Division had 9 and 5 respectively. The number of pets vaccinated every year was never up to 1000 except in 1985/86 (1,287).

A total of 3,825 antirabies vaccinations were documented in the 8 years (Table 11). Ntem Division had the highest number of vaccinations as well as observed dogs and deaths during observation.

4.2,8 Adamawa Province

A total of 210 observations were documented with majority of the observations from Vina Division. The highest number of observations in a year was 74 in 1985/86 (Table 9).

Fifteen dogs died during observation (7.1%) with no death in the first 3 years 1982/83 to 1984/85). Mbere and Djerem Divisions had (10) 66.7% of the deaths. Thirteen canine rabies confirmations were documented out of which 11 (84.6%) were confirmed in the last two years 1988/89 and 1989/90 (Table 9). Confirmed rabies cases were reported from all the Divisions of the Province except Faro and Deo Divisions. Vina had the highest number of cases (6) followed by Djerem (4).

A total of 6,621 dogs were vaccinated with the highest number of vaccinations (2,653) in 1983/84. Vina Division again had the highest number of vaccinations.

4.2.9 North Province

In 8 years, the Province recorded a total of 628 biting dogs observed for rabies with the highest number of observations (129) in 1983/84 (Table 9). Benue Division had the highest number of observations followed by Mayo-Rey Division. Thirteen dogs died during observation (2.0%) with one death in 1987/88 and 12 in 1988/89 (Table 10). A total of 34 laboratory confirmed cases of rabies were documented in the Province with the highest number of cases (18) in 1988/89 (Table 9). Benue Division again had the highest number of cases 27, (79.4%), while Mayo-Rey followed with 3 (8.8%) cases. Rabies was reported from all the Divisions within the period of study. The number of confirmed cases increased every year from 1984/85 to 1988/89 (Table 9).

The antirabies vaccination policy revealed that 10,838 pets were vaccinated against rabies in the 8 years with the highest number of vaccinations, 2,118 in 1983/84 and the lowest, 509 in 1982/83 (Table 11). Benue and Mayo-Louti Divisions had majority of the vaccinations.

4.2.10 Far North Province

In 8 years the Province documented a total of 537 observations of biting dogs with the highest observations (126) in 1987/88 and no observations for two years (Table 9). Majority of the observations were registered in Mayo-Danay, Kaele and Diamare Divisions.

No dog out of the 537 observed died during observation (Table 10). However, 1,473 dogs were destroyed following suspicion and the highest destruction (1,156)

was in 1983/84. A total of 29 canine rabies cases were confirmed in the Province with the highest number of cases (12) in 1989/90 (Table 9). The disease was reported every year from 1982/83 to 1986/87 and in 1989/90. With the exception of Mayo-Tsanaga Division, rabies cases in dogs were confirmed from all the Divisions of the Province and the highest number of cases (14) was from Mayo-Sava Division. Antirabies vaccination records showed that a total of 10,257 dogs received vaccination against rabies. The highest vaccination figure(1,641) was obtained in 1986/87, while the lowest (573) was in 1987/88 (Table 11). Most of the vaccinations were in Kaele, Mayo Danay and Mayo-Sava Divisions.

4.2.11 Country Report

According to all the Provincial Annual Reports, a total of 32,805 biting dogs were observed for rabies with 8 years within the highest number of observations in a year (4,410) recorded in the Centre Province in 1987/88 (Table 9).

The Centre Province also had the highest number of observations throughout the study period, 12,439 (37.9%) followed by Littoral Province with 9,051 (27.68%) (Table 9).

About 78.5% of all the biting dogs observed in the country were concentrated in the Centre, Littoral and West Provinces. Up to 7,000 (21.3%) observations were reported in 1987/88 from the whole country while the 1879 (5.7%) reported in 1983/84 were the lowest. However, a large proportion of the observations (63.8%) was seen from 1986/87 to 1989/90.

A total of 650 dogs died during observation for rabies and this represents 2.0% of all the observed dogs. Distribution of the deaths was similar to that of observation with the Centre Province having the highest number of deaths in a year (1987/88) followed by Littoral Province (Table 10). Majority of the deaths (89.0%) was registered in those Provinces with high observation figures (Table 10).

The number of deaths was high between 1985/86 and 1987/88 and generally increased from 1982/83 to 1987/88 and thereafter decreased (Table 10).

Rabies was reported in all the 10 Provinces of Cameroon at one time or the other during the period of study (Table 9). Of all the biting dogs observed for rabies, only 294 (1.0%) were confirmed in the laboratories to be infected with the virus. Hence an average of 36.8 cases were recorded each year. The centre Province again recorded the highest number of rabies cases in a year (70) and also in the whole country (126) and 1987/88 also had the highest number of cases (Table 9). The distribution of rabies cases in other Provinces was not similar to that of biting dogs observed and dogs dying during observation. Provinces like South and North had a very high number of cases, 36 (12.2%) and 34 (11.6%) with low number of observed biting dogs (658 and 628 respectively). However, the West Province had a high rabies activity over the years followed by the North, Far-North, Centre and South Provinces because they recorded confirmed cases for at least 5 years while the others reported rabies for less than 5 years (Table 9). The rabies activity was generally high in Cameroon from 1985/86 to 1987/88 during which 172 (58.5%) cases were confirmed with 131 of them from the Centre and South Provinces. There was an increase in the number of rabies cases in the three northern Provinces in the last 2 years of the study (Table 9). Antirabies vaccination records for 8 years in Cameroon revealed that 104,447 pets were vaccinated against rabies and the distribution of these vaccinations was similar to the Provincial distribution of biting dogs observed and deaths during observation. That is, the Centre and Littoral Provinces had large numbers 16.8% (17,580) and 17.1% (17,901) respectively. This was followed by the West and North-West Provinces, while the East Province reported the lowest number of vaccinations (3,678) Table 11). Besides, 1987/88 had the highest number of vaccinations (4,150). The highest number of vaccinations throughout the whole period of study was 15,941 (15.3%) in 1985/86 followed by 15,803 (15.1%) in 1986/87. The lowest was 10,123 (9.7%) in

1989/90. Vaccination of pets was quite high between 1985/86 and 1987/88 but decreased in the following years so much so that 1989/90 had the lowest number throughout the 8 years. Canine rabies was on the increase during the period of study and the rabies and antirabies activities were mainly concentrated in the Centre and Littoral Provinces. Also, most of the activities were centred in the Divisions where the Provincial capitals were located except in the Far-North Province. The southern part of the country (Centre, Littoral, West, South-West, North-West, East and South Provinces) had more observed dogs, deaths during observations, confirmed rabies cases and antirabies vaccinations than the northern part (Adamawa, North and Far-North Provinces). Some Provinces reported more laboratory confirmed canine rabies cases than the number of deaths during observation (Table 10). Confirmed rabies cases were more frequently reported in the northern part of the country as from 1985.

4.3 Epidemiology of Human Rabies

According to data collected from Epidemiology Unit of the Department Statistics, Ministry of Public Health, Yaounde Cameroon, 157 human deaths due to rabies were documented between 1984 and 1990. An average of 22.4 cases was therefore, reported per year during the 7 years. Human rabies cases were reported every year and from all the 10 Provinces in Cameroon with the highest number of deaths in a year being 52 in 1985 and the lowest being 5 in 1989 (Table 12). The Far North Province had the highest number of cases, 57 (36.3%) followed by the Centre and North-West Provinces with 30 (19.1%) and 22 (14.0%) respectively. Majority of the Provinces, however, accounted for less than 10.0% of all the death search, with the East Province having the lowest number of deaths (0.6%).

The frequency of human rabies cases was high from 1984 to 1986 after which it decreased appreciably in the next 3 years only to rise sharply again in 1990.

Comparison of canine rabies and human rabies cases within the same period of 7 years revealed that a total of 435 rabies cases were reported in Cameroon with 278 (63.9%) canine rabies cases and 157 human rabies cases (Table 13).

The difference between the number of rabies cases in dogs and human beings was not statistically significant ($p > 0.05$). Rabies cases in dogs increased from 1984 to 1988 while that in human beings decreased from 1985 to 1989 and increased in 1990.

There were more human rabies than canine rabies cases in 1984 and 1985 (Table 13) and in the Far North and North- West Provinces (Table 14). The ratio of dog-to-human rabies was 1:0.6 and ranged from 1:0.1 to 1:3.3. Also data on human rabies collected during an outbreak of rabies in Bamenda in 1985/86 revealed that 862 people were bitten by animals (mainly dogs). Out of this number, 479 (55.6%) were bitten by vaccinated pets with good vaccination status, while the rest 383 (44.4%) were bitten by unvaccinated pets (Table 15). The difference was not statistically significant ($p > 0.05$). The highest number of bites by both vaccinated and unvaccinated pets was in August 1985 and people bitten by vaccinated dogs were consistently more than those bitten by unvaccinated ones each month throughout the outbreak except in August 1985. Of the 479 people bitten by vaccinated pets, 462 (96.5%) were bitten by dogs, 15 (3.1%) by cats and 2 (0.4%) by monkeys. An average of 78 people sought post-exposure treatment for rabies every month. However, human deaths due to rabies were recorded only in the first two months (July and August) of the outbreak even though people were still being bitten afterwards. A total of 5 human deaths due to rabies was documented and this was equal to less than 1% of the total number of people at risk during the outbreak (Table 15).

Four out of 5 (80.0%) deaths were males between 5 - 14 years old and 1 female (20.0%) between 1 - 4 years old. The sex distribution of the 862 animals bite cases revealed that more males (55.3%) were bitten by dogs or cats than females

(44.7%), although there was statistically no significant difference ($p > 0.05$) (Table 16). Distribution of the bite cases by age showed that children between 5 - 14 years were at greatest risk (43.2%) of being bitten by dogs. This was followed by those between 15 to 44 years (37.0%). The distribution of bite cases among these age groups did not show any significant difference ($p > 0.05$). Those between 1 to 4 years and above 45 years old had few bites, while children less than 1 year old were never bitten by dogs in Bamenda during the outbreak (Table 16).

Children less than 5 years were rarely exposed to rabies through dog bites while those from 5 to 44 years were at a very high risk since about 80% of those bitten during the outbreak belong to this age group. Data on human rabies also collected from the Bamenda Preventive Medical Centre (CDMP) for 5 years (1986 -1990) revealed that a total of 1,500 people sought post-exposure treatment for rabies within this period in Bamenda. The highest number of bite cases (594) was reported in 1986, while the lowest was in 1990.

The number of bite cases recorded each year decreased throughout the 5 year period and more males than females were bitten consecutively for the 5 years. Furthermore, 827 (55.1%) of bite cases were males, while 673 (44.9%) were females, though there was no significant difference ($p > 0.05$) (Table 17). Again more bite cases 635 (42.3%) were reported in the 5 to 14 year age group, followed by 564 (37.6%) in the 15 to 44 year age group, while no bite case was recorded in infants (less than 1 year old). The difference in the number of reported bites in the 5 - 14 year and 15 - 44 year age groups was not significant ($p > 0.05$) (Table 17).

Table 1: The distribution of households according to dog ownership in Bamenda and Wum Survey (1991/92)

Dog ownership	Number of households		Total	Percentage
	Bamenda	Wum		
Yes	151	165	316	70.5
No	63	69	132	29.5
Total	214	234	448	100.0

Table 2: The distribution of households according to other animal species owned in Bamenda and Wum survey (1991/92).

Animal species	Number of households Bamenda	Wum	Total	Percentage
Cats	17	5	22	7.5
Goats	7	15	22	7.5
Pigs	6	20	26	8.9
Poultry	31	31	62	21.1
Monkeys	1	1	2	0.7
Rabbits	1	1	2	0.7
Horses	0	0	0	0.0
Sheep	0	0	0	0.0
More than one Species	49	106	155	53.1
Others	1	0	1	0.4
Total	113	179	292	100.0

Table 3 The distribution of households with victims of previous dog bites according to the site of bite in Bamenda and Wum survey (1991/92).

Site of bite	Number of households Bamenda	Wum	Total	Percentage
Face	0	1	1	1.0
Head	0	0	0	0.0
Neck	0	0	0	0.0
Left hand	9	4	13	13.5
Right hand	9	7	16	16.7
Abdomen	3	0	3	3.1
Left leg	21	14	35	36.5
Right leg	18	7	25	26.0
Can't remember exactly	3	0	3	3.1
Total	63	33	96	100.0

Table 4 The distribution of households with victims of previous dog bites according to the action taken on the biting dog in Bamenda and Wum survey (1991/92).

Action taken in biting dog	Number of Households Bamenda	Wum	Total	Percentage
Dog was not identified	7	2	9	9.3
Reported dog to vet authorities	50	9	59	61.5
Settled the matter with the owner	4	0	4	4.2
Killed the dog only	0	4	4	4.2
Did nothing	2	18	20	20.8
Total	63	33	96	100.0

Table 5 The distribution of households with dogs according to the method of dog confinement in Bamenda and Wum survey (1991/92).

Method of confinement	Number of households				Total		Percentage	
	Bamenda		Wum					
	Day	Night	Day	Night	Day	Night	Day	Night
On chain in the compound	123	40	87	32	210	72	66.5	22.8
Locked up indoors garage	11	12	19	28	30	40	9.5	12.7
Free to roam about	17	99	57	105	74	204	23.4	64.5
Others	0	0	2	0	2	0	0.6	0.0
Total	151	151	165	165	316	316	100	100

Table 6. The distribution of households with dogs according to dog handling in Bamenda and Wum survey (1991/92).

Handling of dogs	Number of Households Bamenda	Wum	Total	Percentage
Owners only	4	11	15	4.8
Children in the household	33	29	62	19.6
Adults in the household	35	10	45	14.2
Neighbours	1	1	2	0.6
Nobody	4	4	8	2.5
Owner and children	3	0	3	1.0
Owner and adults	4	0	4	1.3
Children and adults	43	77	120	38.0
Adults and neighbours	0	0	0	0.0
Children and neighbours	0	1	1	0.3
Other combinations	24	32	56	17.7
Total	151	165	316	100.0

Table 7 The distribution of households with dogs according to the reasons for not vaccinating dogs against rabies in Bamenda and Wum survey (1991/92).

Reasons for not vaccinating	Number of Household Bamenda	Wum	Total	Percentage
Dog too young	28	30	58	46.4
No money for vaccination	6	24	30	24.0
Ignorant of vaccination	4	16	20	16.0
No vaccine	3	5	8	6.4
Others	1	8	9	7.2
Total	42	83	125	100.0

Table 8 The distribution of households according to the presence of unowned dogs in the quarters in Bamenda and Wum survey (1991/92).

Unowned dogs in the quarters	Number of Households Bamenda	Wum	Total	Percentage
Present	140	54	194	43.3
Absent	56	180	236	52.7
No response	18	0	18	4.0
Total	214	234	448	100.0
These unowned dogs that are present are:				
always in the quarters	72	18	90	46.4
strange to the quarters	23	31	54	27.8
Some are always in the quarters and some strange to the quarters	45	5	50	25.8
Total	140	54	194	100.0

Table 9: The distribution, by Province, of biting dogs placed under observation (O) and confirmed canine rabies cases (C) in Cameroon (1982 - 1990)

Year	1982/83		1983/84		1984/85		1985/86		1986/87		1987/88		1988/89		1989/90		Total	
Province	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C
Littoral	985	3	0	0	860	11	1342	0	1474	0	1510	0	1483	0	1397	0	9051	14
South-West	193	2	253	0	252	0	423	4	497	0	484	0	430	0	407	0	2939	6
North-West	100	0	116	0	328	2	145	0	75	0	90	0	241	2	246	0	1341	4
West	11	1	530	5	593	2	652	7	849	3	166	0	708	1	771	1	4280	20
East	60	9	47	3	56	0	153	0	171	0	38	0	91	0	106	0	722	12
Centre	1598	0	726	0	891	7	717	4	1868	25	4410	70	1010	0	1219	20	12439	126
South	83	0	112	0	58	2	36	14	87	15	85	3	101	2	96	0	658	36
Adamawa	0	0	7	0	20	0	74	2	25	0	0	0	44	3	40	6	210	13
North	0	0	76	0	129	1	77	2	72	4	91	6	98	16	85	3	628	34
Far-North	0	1	12	2	81	1	112	4	124	9	126	0	0	0	82	12	537	29
Total	3030	16	1879	10	3268	26	3131	37	5242	56	7000	79	4206	28	4449	42	32805	294

Table 10 The distribution, by Province, of biting dogs which died during observation (D) and confirmed canine rabies cases (C) in Cameroon (1982 - 1990)

Year	1982/83		1983/84		1984/85		1985/86		1986/87		1987/88		1988/89		1989/90		Total	
Province	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C
Littoral	7	3	0	0	15	11	15	0	15	0	20	0	12	0	0	0	84	14
South-West	4	2	28	0	5	0	4	4	5	0	12	0	7	0	0	0	65	6
North-West	0	0	0	0	8	2	0	0	0	0	0	0	3	2	0	0	13	4
West	5	1	5	5	15	2	0	7	3	3	7	0	2	1	10	1	47	20
East	5	9	1	3	0	0	0	0	0	0	0	0	0	0	0	0	6	12
Centre	0	0	0	0	2	7	8	4	169	25	180	17	5	0	11	20	375	126
South	0	0	8	0	0	2	14	14	4	15	4	3	2	2	0	0	32	36
Adamawa	0	0	0	0	0	0	4	2	0	0	0	0	2	3	9	6	15	23
North	0	0	0	0	12	1	0	2	0	4	1	6	0	18	0	3	13	34
Far-North	0	1	0	2	0	1	0	4	0	9	0	0	0	0	0	12	0	29
Total	21	16	42	10	57	26	45	37	196	56	224	78	35	26	30	42	650	294

Table 11 The distribution, by Province, of canine antirabies vaccination (V) and confirmed canine rabies cases (C) in Cameroon (1982 - 1990)

Year	1982/83		1983/84		1984/85		1985/86		1986/87		1987/88		1988/89		1989/90		Total	
Province	V	C	V	C	V	C	V	C	V	C	V	C	V	C	V	C	V	C
Littoral	2396	3	2143	0	2752	11	2992	0	3400	0	1998	0	1173	0	1047	0	17901	14
South-West	664	2	668	0	1423	0	1326	4	723	0	801	0	470	0	752	0	6821	6
North-West	286	0	565	0	1220	2	1875	0	1714	0	1805	0	2035	2	1970	0	11470	4
West	1332	1	2613	5	1806	2	2138	7	2540	3	1964	0	1460	1	1597	1	15450	20
East	857	9	1249	3	216	0	748	0	78	0	121	0	311	0	98	0	3678	12
Centre	1854	0	1420	0	417	7	1763	4	3098	25	4150	70	1882	0	1996	20	17580	126
South	246	0	538	0	63	2	1287	14	723	15	298	3	327	2	343	0	3825	36
Adamawa	18	0	2653	0	304	0	588	2	625	0	680	0	1015	5	738	6	6621	13
North	509	0	2118	0	1305	1	1602	2	1261	4	1564	6	1819	18	660	3	10838	34
Far-North	1965	1	1014	2	995	1	1622	4	1641	9	573	0	1525	0	922	12	10257	29
Total	10127	16	14981	10	11501	26	15941	37	15803	56	13954	79	12017	28	10123	42	104447	294

Table 12 The distribution, by Province, of human deaths due to rabies in Cameroon (1984 - 1990)

Year Province	1984	1985	1986	1987	1988	1989	1990	Total	Percentage*
Littoral	0	5	0	0	0	0	0	5	3.2
South-West	0	0	0	0	0	0	3	3	1.9
North-West	0	16	5	1	0	0	0	22	14.0
West	3	6	5	3	0	0	0	17	10.8
East	1	0	0	0	0	0	0	1	0.6
Centre	10	14	0	4	1	0	1	30	19.1
South	4	0	0	0	0	0	2	6	3.8
Adamawa	0	0	4	0	0	0	1	5	3.2
North	2	2	1	0	3	0	3	11	7.0
Far-North	8	9	22	2	4	5	6	57	36.3
Total	29	52	37	10	8	5	16	157	100.0
Percentage*	18.5	33.1	23.6	6.4	5.1	3.2	10.1	100.0	

* relative to total number of deaths

Table 13 Comparison, by year, between confirmed canine rabies cases and human deaths due to rabies in Cameroon (1984 - 1990)

Year	Positive canine rabies cases	Human deaths	Total
1984	10	29	39
1985	26	52	78
1986	37	37	74
1987	56	10	66
1988	79	8	87
1989	28	5	33
1990	42	16	58
Total	278	157	435
Percentage*	63.9	36.1	100

* relative to total number of rabies cases

Table 14: Comparison, by Province, between confirmed canine rabies cases and human deaths due to rabies in Cameroon (1984 - 1990).

Province	Confirmed canine rabies cases	Human deaths due to rabies	Total
Littoral	11	5	16
South-West	4	3	7
North-West	4	22	26
West	19	17	36
East	3	1	4
Centre	126	30	156
South	36	6	42
Adamawa	13	5	18
North	34	11	45
Far-North	28	57	85
Total	278	157	435

Table 15 Human exposure and deaths during a rabies outbreak from July 1985 to May 1986 in Bamenda, Cameroon.

Month	Human exposures to			Deaths
	Vaccinated pets	Unvaccinated Pets	Total	
July	-	46	46	3
August	125	169	294	2
September	32	22	54	0
October	58	31	89	0
November	28	6	34	0
December	27	21	48	0
January	38	22	60	0
February	36	16	52	0
March	42	11	53	0
April	60	22	82	0
May	33	17	50	0
June	0	0	0	0
Total	479	383	862	5
Percentage*	55.6	44.4		

* relative to total number of exposures.

Table 16: Monthly distribution, by age and sex, of persons who received post-exposure treatments during a rabies outbreak from July 1985 to May 1986 in Bamenda, Cameroon.

Month	Number of exposures	Sex		Age (years)				
		Male	Female	< 1	1-4	5-14	15-44	45 and above
July	46	30	16	0	3	13	23	7
August	294	167	127	0	30	120	105	39
September	54	37	17	0	4	30	10	10
October	89	39	50	0	5	39	34	11
November	34	18	16	0	9	15	8	2
December	48	24	24	0	3	26	12	7
January	60	33	27	0	1	20	35	4
February	52	28	24	0	5	29	17	1
March	53	27	26	0	5	16	28	4
April	82	45	37	0	2	45	27	8
May	50	29	21	0	4	19	20	7
June	0	0	0	0	0	0	0	0
Total	862	477	385	0	71	372	319	100
Percentage*		55.3	44.7	0	8.2	43.2	37.0	11.6

* relative to total number of exposures

Table 17: Annual age and sex distribution of persons who received post-exposure treatment at the Preventive Medical Centre (CDMP) Bamenda, Cameroon (1986 - 1990)

Year	Number of exposures	Sex		Age (years)				
		Male	Female	< 1	1-4	5-14	15-44	45 and above
1986	594	329	265	0	33	236	230	95
1987	501	285	216	0	28	216	190	67
1988	270	136	134	0	15	123	96	36
1989	112	62	50	0	8	50	39	15
1990	23	15	8	0	1	10	9	3
Total	1500	827	673	0	85	635	564	216
Percentage*		55.1	44.9	0	5.7	42.3	37.6	14.4

* relative to total number of exposures

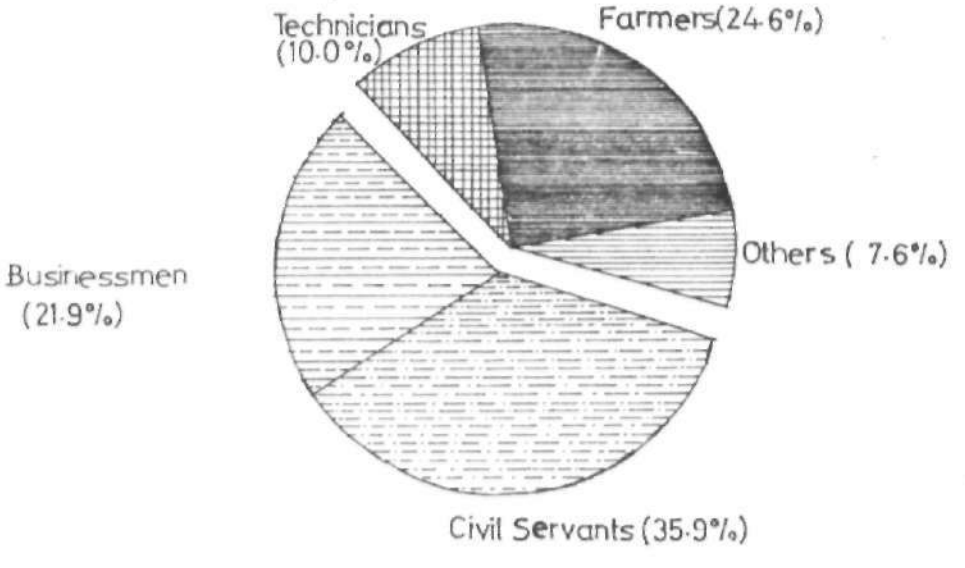

Technicians
(10.0%)
Farmers(24.6%)
Others (7.6%)
Businessmen
(21.9%)
Civil Servants (35.9%)

Figure 1

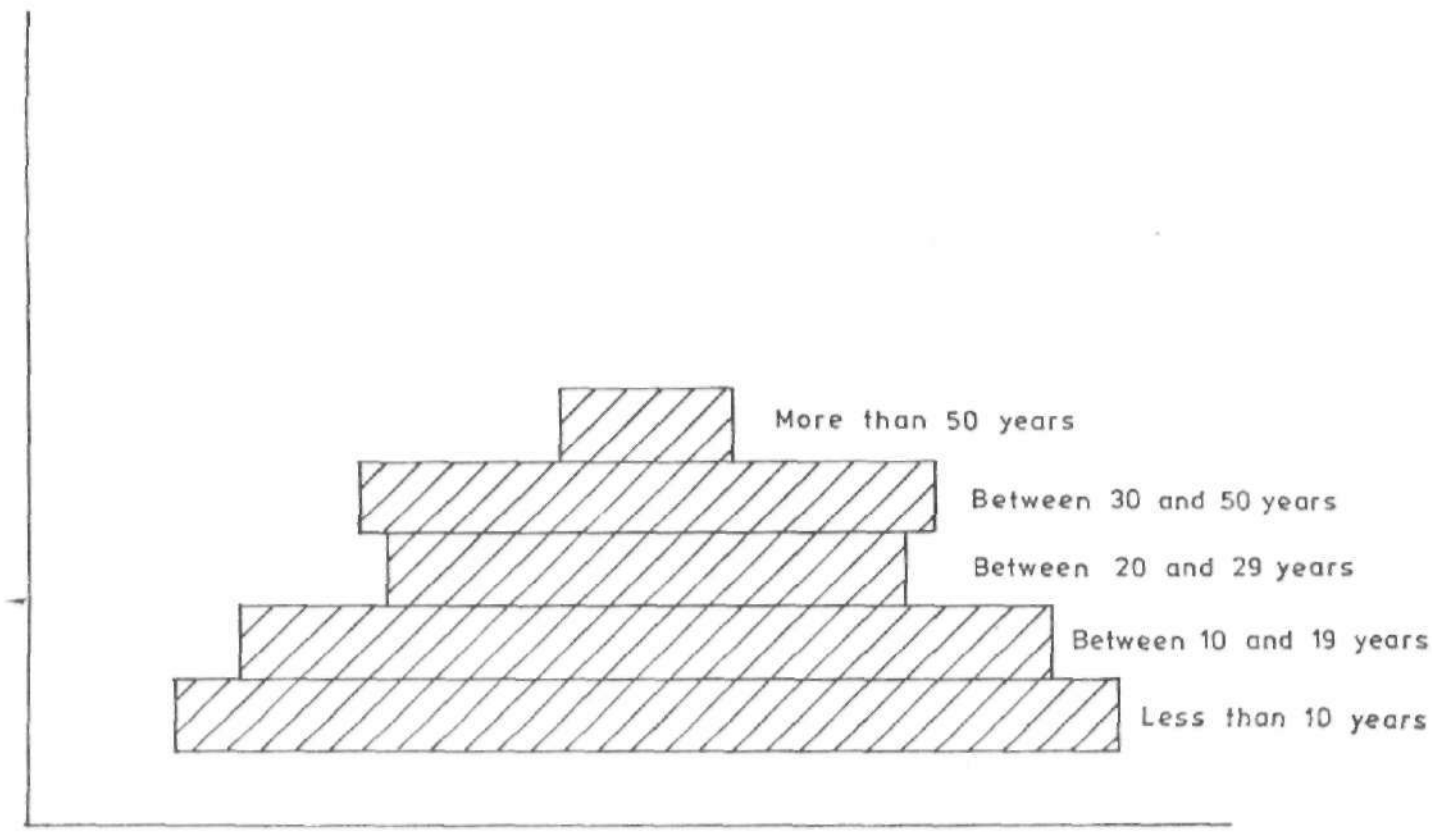

More than 50 years
Between 30 and 50 years
Between 20 and 29 years
Between 10 and 19 years
Less than 10 years

Fig. 2

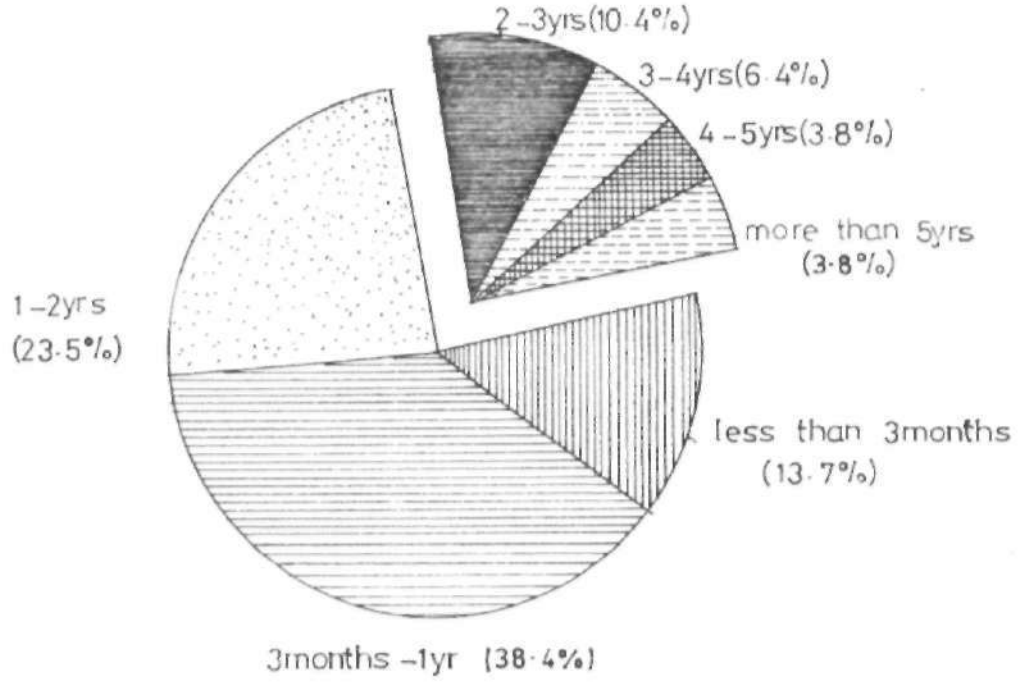

2-3yrs(10·4%)
3-4yrs(6·4%)
4-5yrs(3·8%)
more than 5yrs
(3·8%)
1-2yrs
(23·5%)
less than 3months
(13·7%)
3months-1yr (38·4%)

Figure 3

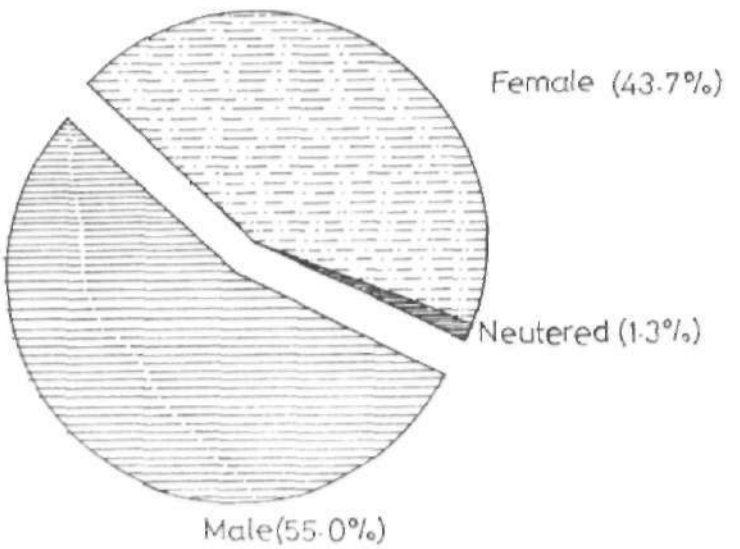


Figure 4

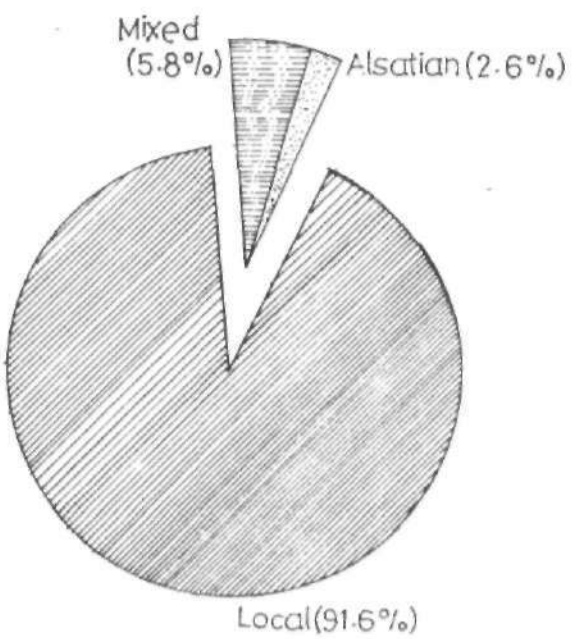


Figure 5

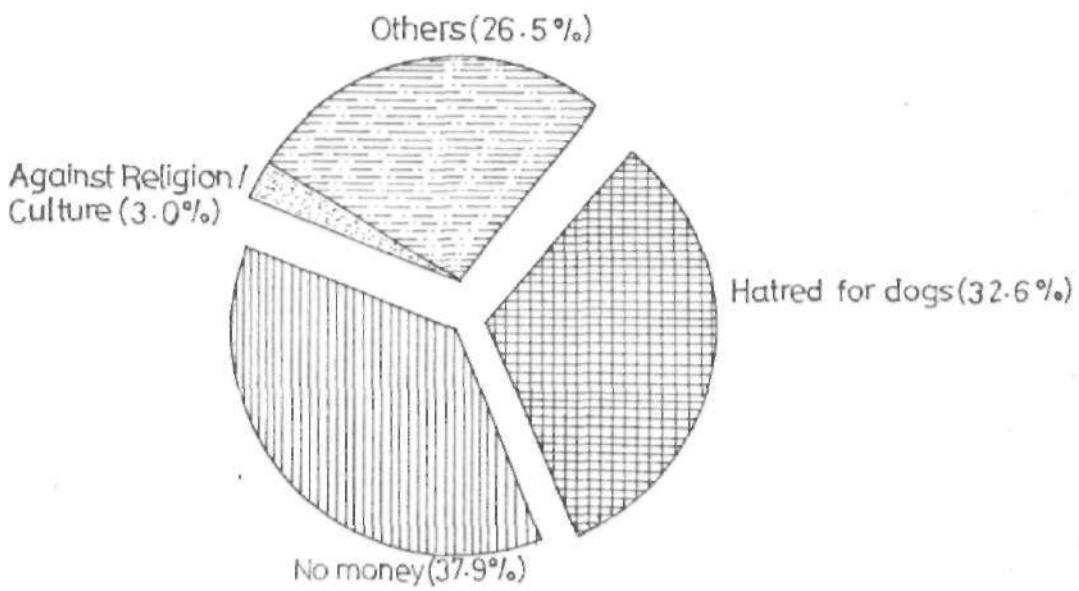

Others (26·5%)
Against Religion / Culture (3·0%)
Hatred for dogs (32·6%)
No money (37·9%)

Figure 6

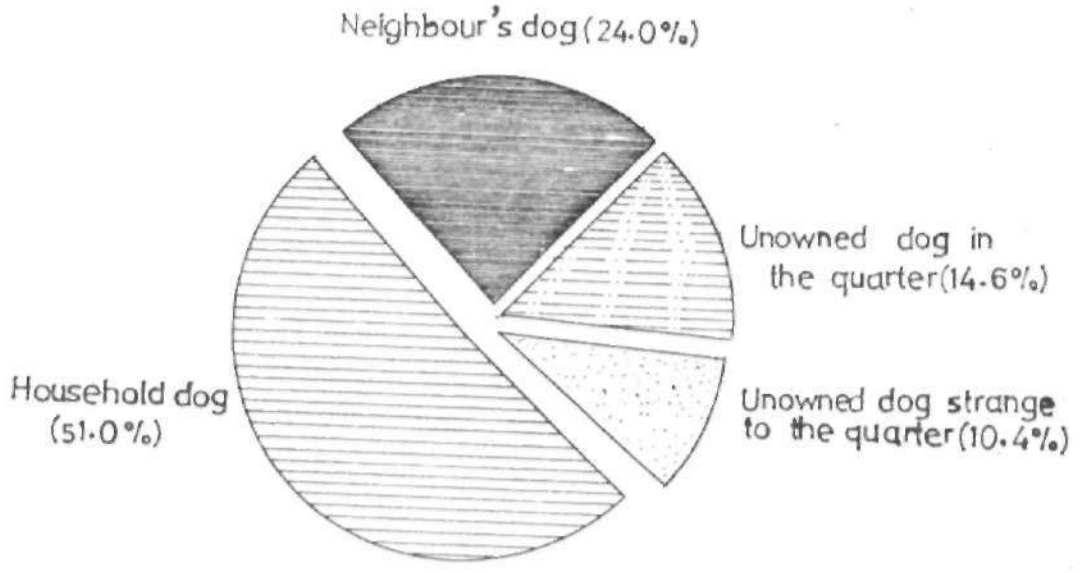

Neighbour's dog (24.0%)
Unowned dog in the quarter (14.6%)
Unowned dog strange to the quarter (10.4%)
Household dog (51.0%)

Fig 7

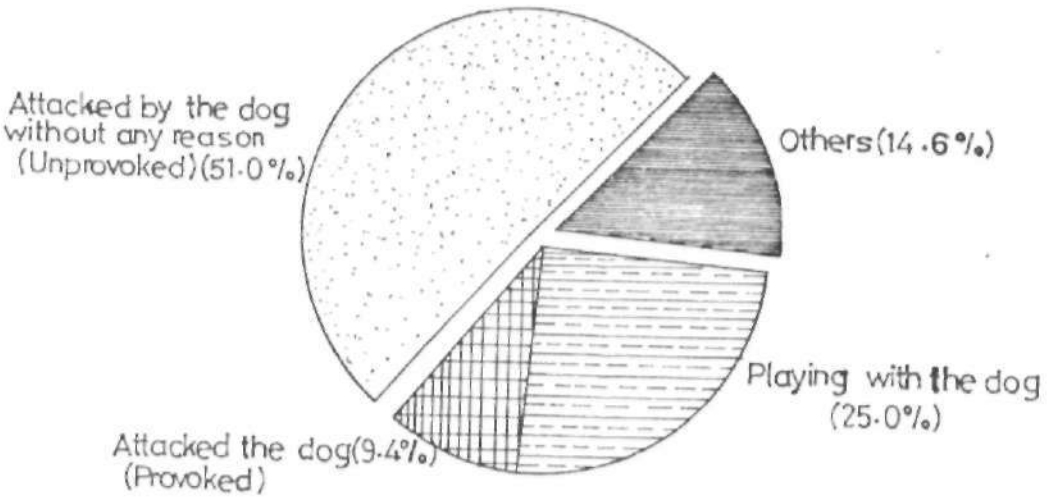

Attacked by the dog
without any reason
(Unprovoked)(51.0%)
Others(14.6%)
Playing with the dog
(25.0%)
Attacked the dog(9.4%)
(Provoked)

Fig 8

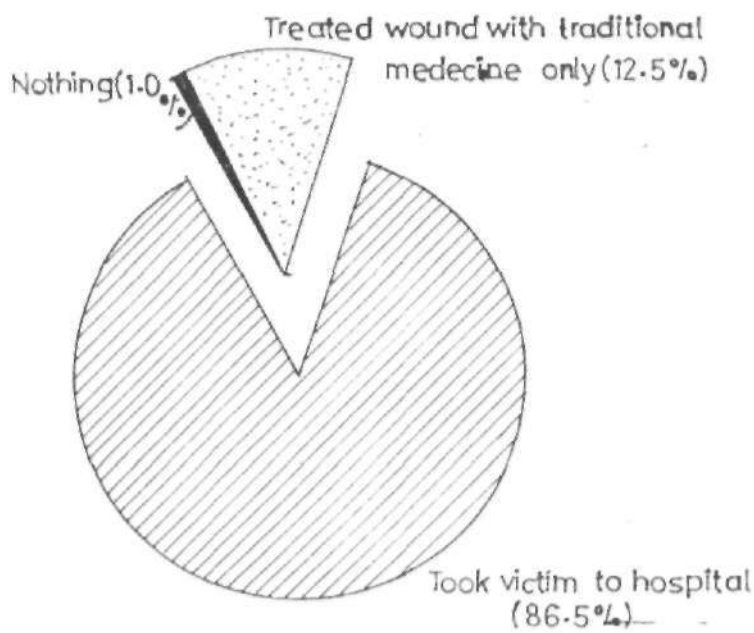

Treated wound with traditional
medecine only (12.5%)
Nothing (1.0%)
Took victim to hospital
(86.5%)

Fig 9

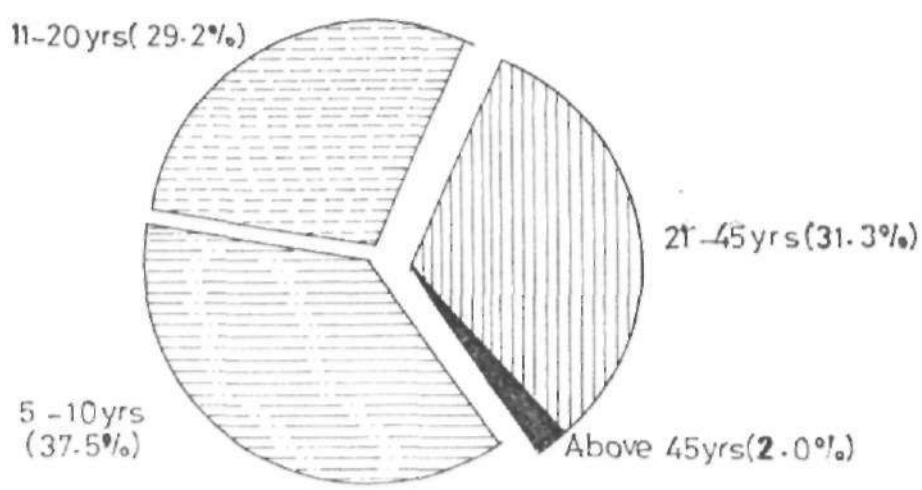


Fig 10

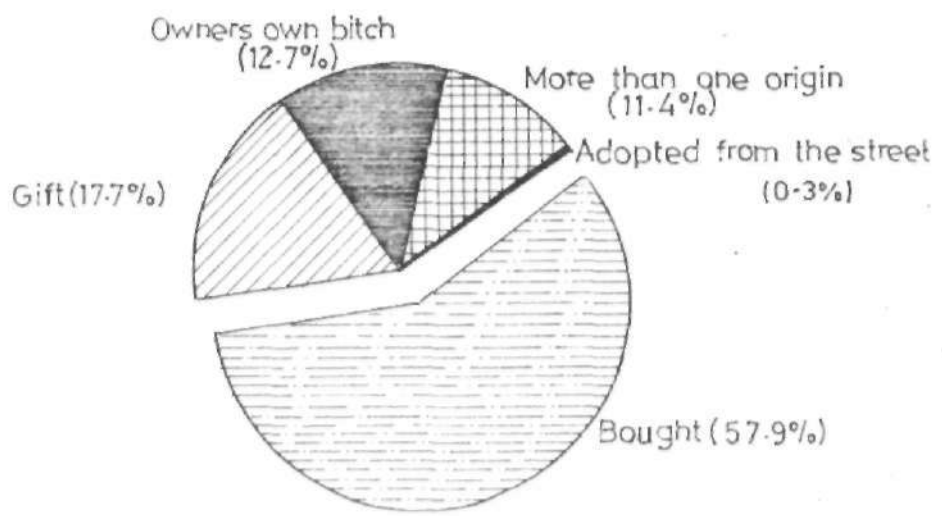

Owners own bitch
(12·7%)
More than one origin
(11·4%)
Adopted from the street
(0·3%)
Gift (17·7%)
Bought (57·9%)

Fig 11

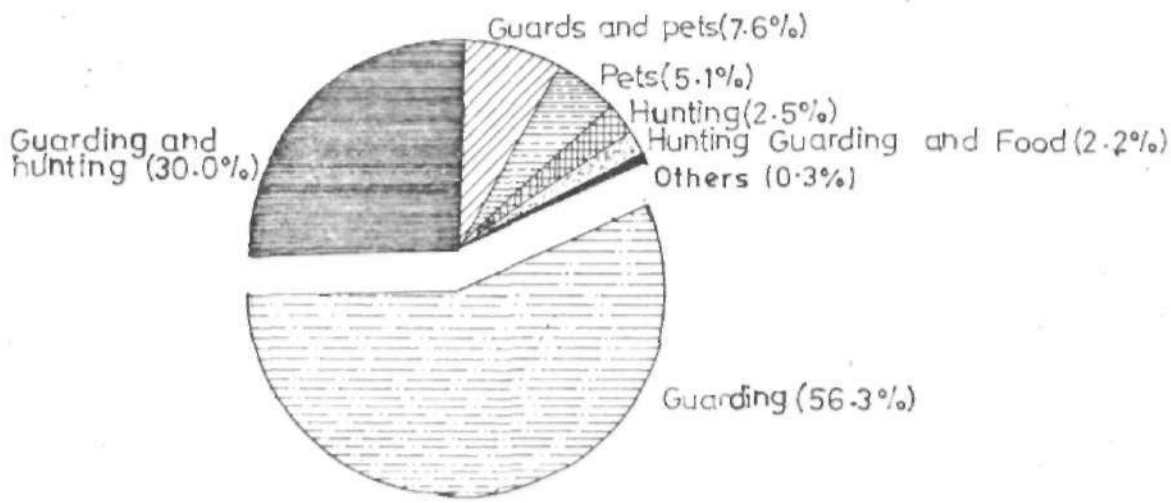

Guards and pets(7.6%)
Pets(5.1%)
Hunting(2.5%)
Hunting Guarding and Food(2.2%)
Others (0.3%)
Guarding and hunting (30.0%)
Guarding (56.3%)

Fig 12

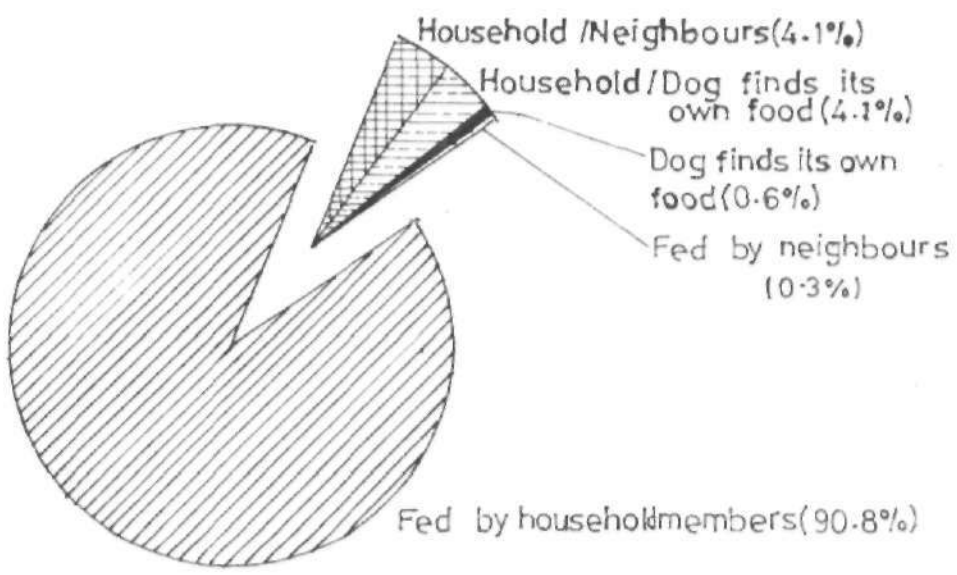

Household /Neighbours(4.1%)
Household/Dog finds its own food(4.1%)
Dog finds its own food(0.6%)
Fed by neighbours (0.3%)
Fed by household members(90.8%)

Fig 10

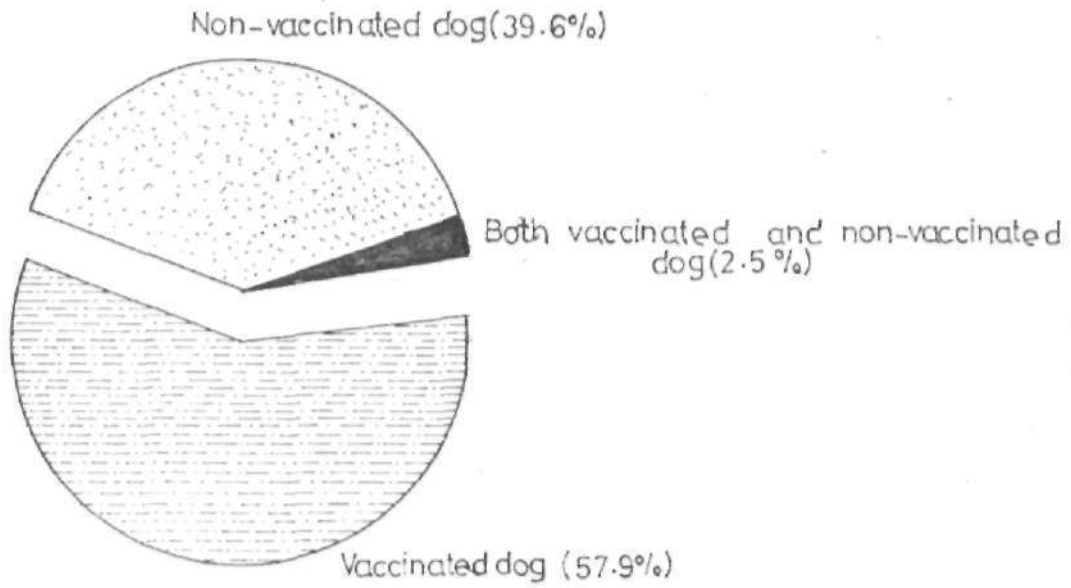

Non-vaccinated dog(39.6%)
Both vaccinated and non-vaccinated dog(2.5%)
Vaccinated dog (57.9%)

Fig 14

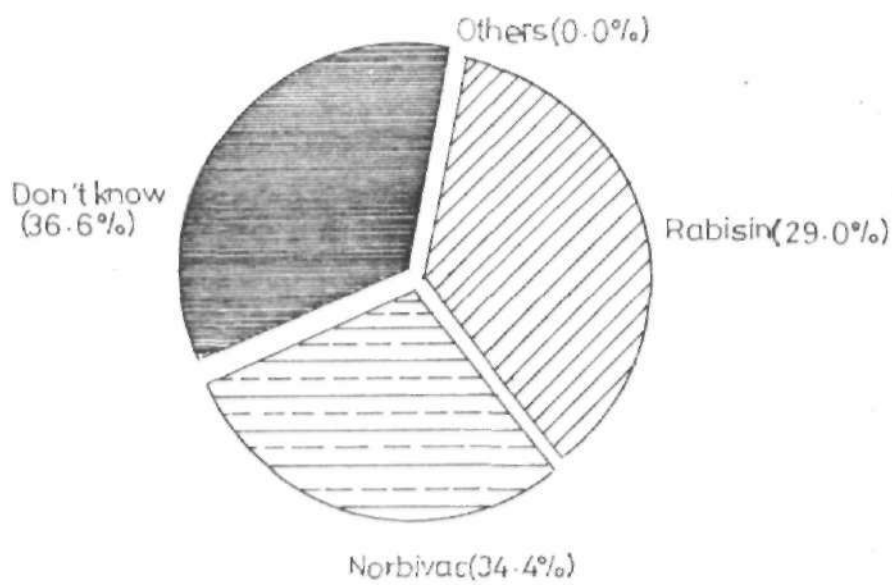


Fig 15

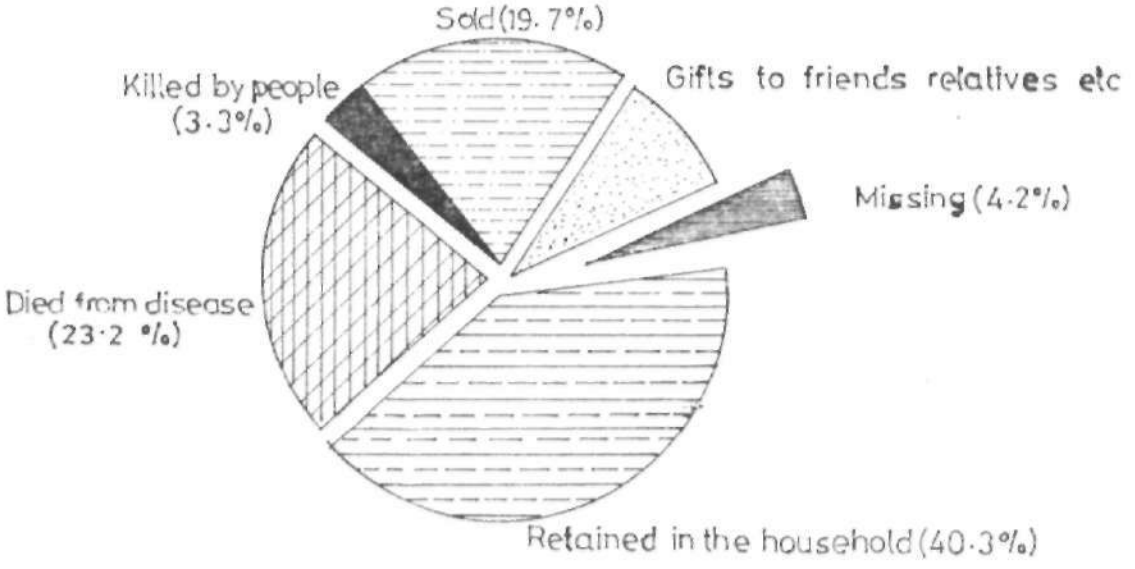

Sold (19.7%)
Killed by people (3.3%)
Gifts to friends relatives etc
Missing (4.2%)
Died from disease (23.2 %)
Retained in the household (40.3%)

Fig 16

CHAPTER FIVE

5.0 DISCUSSION

5.1 Dog Population Studies

That more civil servants, businessmen and technicians were seen in Bamenda is because the town is more urban in nature since it is the Provincial capital of North-West. Wum on the other hand, had more farmers because it is less urbanised than Bamenda with farming being the major occupation. Most people in North-West Province do not fence their households perhaps as a cultural trait and also because of the compact settlement pattern in this area that hardly allows space in the households for fences. The age distributions of people in both towns were similar and agreed with the estimate of the second census of Cameroon in 1987 during which majority of the population was less than 20 years old while very few people were seen above 55 years.

The higher owned dog-to-human beings ratio seen in Bamenda was because of the large dog population obtained for Bamenda following extrapolation using the human population compared to a similar extrapolation for Wum. This did not, however, conform to WHO (1984a) finding that the ratio of owned dogs to people is generally greater in the more rural regions of a country. The high rearing success of puppies seen in both towns could account for the high percentage of young dogs. Also, there were more young dogs because most people require strong active dogs for hunting and as guards. The guarding and hunting functions of dogs were probably responsible for the preponderance of males over females since males are believed to be better suited for these functions due to their aggressive nature. These sex disparity observations have also been reported in Tunisia, Guayaquil and Sri-Lanka (WHO, 1988).

That local breed of dogs predominated other breeds is because they are native to the area and most owners acquired their dogs from other owners around either through purchase, as gifts or from their own female dogs. Non-dog owners said they had no money to keep dogs or hated them because of the economic crisis faced by the country such that people do not even have money to maintain their families. It is also obvious that households that have experienced a dog bite at one time or the other tend to hate dogs. Others may hate dogs because of the nuisance caused by dogs, for example, pollution of the environment and barking among others. Animals other than dogs were also owned by most households because some of them such as poultry, goats and pigs are a source of food or an important source of income, while others like cats could be kept as pets or predators to house rats. Fewer pets were kept in Wum than in Bamenda because most people in Wum are farmers who prefer to keep livestock. The higher dog to person ratio in Bamenda accounted for the higher number of dog bites seen in this town than in Wum. Majority of households with dog bite victims took the appropriate action like taking the victim to the hospital and reporting the biting dog to the veterinary authorities because of the high degree of awareness of rabies in these towns. However, most bites that were not reported to the veterinary authorities might have originated from the family dogs. This is because people not bitten by their own dogs usually report the bite so that the dog owner may incur the cost of post-exposure treatment . Also bites from family dogs are likely not to be reported because of the fear of paying a penalty, especially if the vaccination status of the biting dog is not current. That most dog bites were unprovoked suggests that these dogs were merely aggressive even to their household members or were somehow provoked and the victims never thought so. Lower extremities (legs) suffered more bites in both towns because they are more exposed than any other part of the body to biting dogs. Chadli and Benlasfar (1984) also reported more bites in the lower limbs in Tunisia.

Children between 5 and -10 years suffered more bites than children in any other age group because they are the ones more often attached or associated with dogs in the households or who often play or tease dogs both at home and outside because of their playful tendencies. Households in this area probably preferred to buy dogs of their choice since most of them used their dogs as guards or for both hunting and as guards. The use of dogs differed in the two towns mainly because of the nature of the town and occupation of the household heads. The higher degree of social atrocities like theft and the more urbanised nature of Bamenda accounted for the reason why most dog owners used their dogs as guards compared to the farmers in Wum who used dogs mostly for hunting and guarding. The ritual killing and eating of dogs had long been recognised by Frank (1965) as an agricultural trait of West Africans. Hence it is not strange that some households kept dogs partly as a source of food. For example, dog meat is a delicacy to a few people in Wum and Bamenda especially males who refer to the meat as 'Tlag' or 'Law beef'. A large percentage of owned dogs was allowed to roam freely in the households or quarters at night because this is the time when the movement of people in the households and quarters is supposed to be minimal and when the guarding function is best carried out. Owned dogs that roamed freely both day and night were poorly or not supervised by their owners in terms of confinement and feeding. The fact that most households fed their dogs, yet majority of these dogs fed in households not belonging to them suggests that dog supervision in terms of confinement and feeding was generally poor. If these dogs were properly confined to their households and well fed, they would not stray into other households in search of food. Dog accessibility in both towns was quite high as only 8 (2.5%) out of 316 households could not handle their dogs. Poverty and ignorance of antirabies vaccination probably explain the difference in the number of households that did not vaccinate their dogs since there are poorer and more illiterate people in Wum than in Bamenda. The fact that dogs less than 3 months old were normally not

vaccinated against rabies could be responsible for the few households with both vaccinated and unvaccinated dogs. Also, some households could have many dogs of vaccination age, yet were unable to vaccinate all of them due to financial problems (high cost of vaccine). Supply of the two antirabies vaccines mainly used in the country was probably responsible for the differences in the type of vaccines used since the supply is from different sources and not constant.

The difference in the types of vaccine mainly used in each town could be due to the supply factors since the surveys were carried out at different times. That dogs, especially 'mad' dogs transmit disease through their bites is a well known fact and accounted for the high increase of the disease transmission to man through bites in majority of the households. Dogs frequently had access to most households because they were not properly confined and because most households were not fenced. Most households dumped kitchen wastes and remains of food either in the dustbin or anywhere in the household and this encouraged dogs to feed from dustbins or any food found in the households.

Most mature bitches whelped once a year because the intervals between estrous cycles in dogs average between 7 and 8 months (WHO, 1984a) and this has also been reported in Tunisia (WHO, 1988). The high rearing success of puppies was due to the low mortality rate and accounted for the high percentage of dogs between 3 months and 2 years of age. The higher rearing success seen in Bamenda than in Wum could be due to the difference in the care given to dogs. People in Bamenda probably took better care of their dogs than those in Wum due to a higher socio-economic level in Bamenda than in Wum. That most non-dog owners accepted to vaccinate their dogs if they had any was because of their awareness of the importance of the vaccination in terms of rabies prevention. The overall dog-to-human ration of 1:8 was however, lower than what was seen in Jos, Nigeria (1:4) (Okoh, 1986) and Tunisia (1:3.5) (WHO, 1988) but similar to the ratio observed in Sri-Lanka (1:8) (WHO, 1988). The average number of dogs per household, 1:0.8

was less than Okoh's (1986) finding in Jos, Nigeria and Tunisia(WHO, 1988) but more than the reported ratio for Ecuador (WHO, 1988). The relationship between occupation of the heads of households and dog ownership in which civil servants ranked highest followed by farmers, businessmen, technicians and others was in conformity with what was reported by Okoh (1986) in Jos, Nigeria. The mean age of dogs (1 years 8 months) was quite low compared with dogs in USA (4.5 years), Sri-Lanka (3.4 years) and Tunisia (2.5 years) (Beck, 1973; Nassar and Mosier, 19870; WHO, 1988).

5.2 EPIDEMIOLOGY OF RABIES

The high number of observed dogs, deaths during observation, confirmed rabies cases in dogs and antirabies vaccination, seen in Littoral and Centre Provinces was because majority of the population is urban and urban (dog) rabies tends to predominate in Cameroon. This is based on reports of WHO (1984, 1989a, 1991b) in which the dog accounted for more than 98% reported animal rabies cases. This again probably explains the fact that 96.5% of the dog bite cases from vaccinated pets during a rabies outbreak in Bamenda town (1985/86) was from dogs, 3.1% from cats and 0.4% from monkeys. The East, South-West and Adamawa Provinces had very small numbers of biting dogs observed and confirmed rabies cases because of several reasons. Firstly, the dog population could be small due to the small human population hence a lesser degree of physical contact between dogs and people. Secondly, majority of the population in these Provinces is rural where observations are rarely done and sending of suspected rabies samples to the laboratory is difficult and scarcely done. That only 1.2% of the biting dogs observed for rabies died during observation could mean that most of them were not rabid at the time of biting as was seen in 1985/86 in Bamenda town where 55.6% of human dog bite cases were from vaccinated pets. It could also

mean that the observations were poorly done as a result of inadequate or absence of quarantine facilities in most veterinary clinics in the country and as such the clinicians practice home quarantine. A certain percentage of potentially positive rabies cases are lost since dogs on home quarantine can not be traced if they die during the observation and the owners fail to report the deaths. Therefore, the exact canine rabies incidence in Cameroon remains unknown since rabies cases depend on laboratory confirmations of dogs that die during observation or dogs which are highly suspected to be rabid and are killed and samples sent to the laboratory. The fact that 45.2% of the deaths during observation were confirmed to be positive for rabies implies that more positive cases could have been seen if all the dead samples were sent for autopsy. Hence the rabies incidence in Cameroon according to the data collected was an underestimate of the real situation. Only Pasteur Centre in Yaounde and Laboratoire National Veterinaire (LANAVET) in Garoua carry out rabies diagnosis in the country and probably accounted for the high number of confirmed rabies cases seen in the Centre and North Provinces where these laboratories are located respectively. The nearness of Provinces like South and West to Centre and Far North to North gave them an advantage over others like South-West, North-West and East in terms of access to the rabies diagnostic laboratories. Provinces far from the laboratories find it difficult to transport suspected rabies samples to the nearest laboratory due to bad roads, high transportation costs and lack of cold chain facilities. Low rabies activities were seen in Provinces like the East, Adamawa and South-West because of their small human populations (less then 1 million people) which imply small dog populations. The veterinary infrastructure and facilities could also be responsible since some Provinces such as the Centre have better facilities while others do not even have preservation facilities and funds to transport samples to the laboratory. The low figures seen in some Provinces could, however, be their true rabies incidence since the prevalence of the disease does not necessarily have to be the same throughout

the Provinces. The number of dogs receiving antirabies vaccination decreased as shown by this study due to several reasons. First, is the availability of the vaccines which are imported from Europe and are in short supply in many veterinary clinics especially in the rural areas. Second, is the cost of the vaccine since one dose costs 1,500 Frs CFA (₦112.50) or more in some parts of the country. As such, the low socio-economic pet owners can not afford the money especially when they own more than a dog of vaccination age. The Veterinary Pharmaceutical Office (OPV) is the major source of the vaccine available to pet owners but these offices are situated only in the Provincial capitals and some other big towns in Cameroon. This makes vaccination of dogs in rural areas very difficult when the veterinary clinics run short of their vaccines and such owners will have to either give up the vaccination or travel long distances, incurring extra costs to have their pets vaccinated. With the present economic crisis in the country, most pet owners do not vaccinate their pets and pet care is generally poor. Provinces with more laboratory confirmed rabies cases than the number of dogs which died during observation could be as a result of some biting dogs killed on first presentation without observation and sending the samples to the laboratory for diagnosis. The creation of LANAVET in 1985 probably accounted for the frequently confirmed rabies cases in the three northern Provinces. Human rabies reports from all the Provinces for 7 years suggest that Cameroon is a rabies endemic area. Despite the existing rabies laws and prophylactic antirabies treatment in the country, rabies continues to occur in both animals and human beings. This could be due to several reasons: the antirabies vaccines for human use are not available in adequate quantities to cover the number of patients who may be exposed to rabies; the vaccines when available are very expensive. A single dose of Pasteur rabies vaccine (Vero-cell type) cost 4615 Frs CFA (₦346.125) and the antirabies serum is even more expensive, 10,500 Frs CFA (₦787.500). The third reason is that majority of Cameroonians live in rural areas where there is poverty and a high degree of illiteracy and as a result

they are not adequately informed about rabies. They, therefore, cannot actually appreciate the need to promptly seek post-exposure treatment and some even rely more on traditional healing. This observation was also reported by Ezebuiro *et al.* (1980). Generally, human rabies was a problem in rural areas in Cameroon contrary to the situation in dogs where the problem was urban in nature. This observation is in conformity with what has been reported by Ezebuiro *et al.* (1980). This is perhaps the reason for the high human deaths due to rabies in the Far North, North-West, West and North Provinces where majority of their population is rural. The Centre Province also had a high number of deaths due to rabies perhaps because of the highest number of canine rabies cases seen there. That more males than females were exposed to rabies conformed with reports of Ezebuiro *et al.* (1980) who reported 61% of males and 39% of females seeking post-exposure treatment in Nigeria.

CHAPTER SIX

6.0 CONCLUSION

6.1 DOG POPULATION STUDIES

It can be concluded from the dog population studies that dogs are kept by many households in Bamenda and Wum, although the reasons for keeping them and other parameters differ slightly. Certain dog population parameters in both towns were similar e.g. source of dogs, feeding, confinement, age and breed distributions of dogs.

Although information on stray dog population was not obtained in this study, the accessibility of owned dogs for mass vaccination would be quite high as most dog owners and household members could handle their dogs. Dogs play an important role in the security of the households through their guarding function. The ecology of dogs in Bamenda and Wum could not be well understood due to lack of information on stray dogs but it is the author's hope that the attempt made in this work will act as a stimulus for more detailed studies since this information is very necessary for the prevention and control of rabies.

6.2 EPIDEMIOLOGY OF RABIES

Despite the control and vaccination programmes of rabies in Cameroon since 1948, according to the Diseases of Animal Ordinances (CAP55 of the 1948 Laws), the incidence or rabies has not declined appreciably. The incidence has even been on the increase between 1985 and 1990. Canine rabies thus continues to be an important element of the rabies problem in Cameroon. The cases in dogs and the bites from dogs including escaped and unobserved dogs account for the human

antirabies treatments administered in the country today. The level of awareness of the general public on the dangers of rabies is high although the awareness of the necessity to vaccinate dogs against rabies by dog owners appears to be limited to the urban populations which form only 37.8% of the 10.5 million Cameroonians. The records on rabies, therefore, could not be said to have given a correct picture of the prevalence of the disease. However, these records do illustrate that the disease is widespread in the country and occurs every year in both animals and human beings. With practically no data on rabies in other domestic animals and wildlife, the epidemiology of rabies in Cameroon is not well understood although it can be presumed from the available data that the disease is maintained in an endemic state by dog-to-dog transmission. It is also the author's hope that this study of the epidemiology of rabies in Cameroon will stimulate a more scientific approach in the prevention and control of the disease.

6.3 RECOMMENDATIONS

From the base-line findings of this work, the author wishes to make the following recommendations:

(a) that further works on dog ecology (for both owned and especially unowned dogs) be undertaken in Bamenda and Wum, and indeed other parts of the country or the country at large so as to understand the ecological parameters which could play an important role in the prevention and control of rabies in Cameroon,

(b) that more detailed epidemiologic studies of both human and animal rabies in the country be carried out in order to determine the actual incidence of the disease to enable a more realistic control of the disease.

(c) Both canine and human rabies appear to be on the decrease apparently from failure to observe existing rabies control laws and regulations. A revival or re-enforcement of the rabies laws in the country is suggested so as to control the disease in dogs and thereby reduce or prevent the disease in the human population.,

(d) There is the need for an in-depth study of the attitudes of Cammeroonians towards responsible dog ownership and reasons for keeping excessive dogs as these could elucidate the epidemiology and control of rabies.

REFERENCES

Acha, P.N. (1981): A review of rabies prevention and control in the Americas, 1970-1980. Over-all status of rabies. Bulletin of Office International des Epizooties; 93: 9-53.

Acha, P.N. and Arambulo, P.V. (1984). Rabies in the Tropics. In: Rabies in the Tropics. E. Kuwert, C. Meriux, H. Koprowski, K. Bogel (eds) pages 343 - 359. Springer Verlag Berlin

Acha, P.N. and Fernandes, M. (1976). Recent developments in endemic canine rabies. Symposium on Advances in Rabies Research. Centre for Disease Control, Atlanta Georgia Sept. 7-9 1976

Addy, P.A.K. (1984). Epidemiology of Rabies in Ghana. In: Rabies in the Tropics, E. Kuwert, C. Merieux, H. Koprowski, K. Bogel (eds) pages 497 - 515. Springer Verlag Berlin.

Adeyanju, J.B. and Addo, P.B. (1977) Rabies in an eight weeks old puppy Veterinary Record 101:38

Arambulo, P.V. III, Beran, G.W. Escudero, S.H. III (1972). Rabies can be eradicated from the Republic of Philippines. USMHA Health Reports, 87: 87 - 92

Ayalew, Y. (1984). Analysis of 159 Human Rabies cases in Ethopia. In: Rabies in the Tropics E. Kuwert, C. Merieux, H. Koprowski, K.Bogel (eds) pages 481 - 484. Spring Verlag Berlin.

Baer, G.M., Shanthaveerapa, T.R. and Bourne, G. (1986). The pathogenesis of street rabies virus in rats. Bulletin of World Health Organization 38: 119 - 125.

Baer, G.M. (1975) Pathogensis to the central nervous system. In: The Natural History of Rabies. Baer, G.M. (ed) pages 181 - 198. Academic Press, New York.

Baer, G.M., Cleary, W.F., Diaz and Perl, D.F. (1977). Characteristics of 11 rabies virus isolates in mice, titres and relative invasiveness of virus, incubation period of infection and survival of mice with sequelae. Journal of Infectious Disease 136(3): 326 - 345.

Baer, G.M. Shaddock, S.A. Houft, M.D., Harrison A.K. and Gardener, J.J. (1982). Human rabies transmitted by cornea tranplant. Archives of Neourology 39: 103 - 107.

Bahnemann, H. (1981). Rabies in South East Asia. World Health Organization Regional Office for Southeast Asia, Delhi, India.

Bakkali, M.M. (1984). Eipidemiology and prophylaxis of rabies in Morocco. In: Rabies in the Tropics. E. Kuwert, C. Merieux, H. Koprowski, K. Bogel (eds). Pages 371 - 386. Springer Verlag Berlin.

Barnard, B.J., Geyer, H.J. and Dekoker, W.C. (1977) Neurological symptoms in a cat following vaccination with high egg passage Flury vaccine. Onderstepoort Journal of Veterinary Research 44: 195 - 196.

Barnard, B.J. and Hassel, R.H. (1981). Rabies in Kudus. Journal of South African Veterinary Association 52: 309 - 314.

Beck, A.M. (1973). The ecology of stray dogs: A study of free-ranging urban animals. New York Press, Baltimore, 98 pages.

Beck, A.M. (1974) The Ecology of urban dogs. In: Wildlife in an Urbanizing Environment. J.N. Noyes and D.R. Progulske (eds). University of Massachussetes. Cooperative Extensive Services Amherst 182 pages.

Beck, A.M. (1975). The ecology of feral and free-roaming dogs in Baltimore. In: The Wild Animals. M.W. Fox (ed.) pages 380 -390. Van Nostrand Reinhold Co. New York.

Belcher, D.W., Wurapa, F.K., Attuora, D.O. (1976) Endemic rabies in Ghana. Epidemiology and Control measures. American Journal of Tropical Medicine and Hygiene 25: 724.

Bells, J.F. (1975). Latency and abortive rabies. In: The Natural History of Rabies. Baer, G.M. (ed) 1:331 - 354. Academic Press, New York.

Beran, G.W. (1970). The epidemiology of rabies with particular emphasis on its clinical applications in the Philippines. Journal of Philippines Veterinary Medical Association 2: 70.

Beran, G.W., Nocete, A.P., Elvina, O. Gregorio, S.B., Moreno, R.R. Nakao, J.C. Burchett, G.A. Caniyares, H.L. and Macaract, F.F. (1972) Epidemiology and control Studies on rabies in the Philippines. Southeast Asian Journal of Tropical Medicine and Public Health 3(3): 433 - 445.

Beran, G.W. (1981). Rabies and infections by rabies-related viruses. In C.R.C. Handbook series in Zoonoses. Steele J.H. (ed). Section B: Viral Zoonoses. 11:57 - 135 C.R.C. press Inc.

Beran, G.W. (1982). Ecology of dogs in the Central Philippines in relation to rabies control efforts Comparative Immunology, Microbiology and Infectious Diseases 5: 265 - 270.

Benerjee, A.K. and Elegbe, S.O. (1970). The incidence and diagnosis of rabies in Nigeria. Bulletin of Epizootic Diseases of Africa 18: 53 - 56.

Blancou, J., Firon, J.P. and Rolling P.E. (1983). Absence of immunity response in the dog after vaccination against rabies Records of Veterinary Medicine, 159 (10: 789 - 793.

Bobade, P.A., Aghomo, H.O., Akinyemi, J.O., Akpavie S.O. (1981). Rabies in Vaccinated dogs. Paper presented at the 18th Annual Conference of the Nigerian Veterinary Medical Association, Sept. 1981.

Boulger, L.R. and Potterfield (1959). Isolation of virus from Nigerian fruit bats. Transactions of the royal society for Tropical Medicine and Hygiene 52: 421.

Boulger, L.R. and Hardy, J. 91960) Rabies in Nigeria. West African Medical Journal 9: 223 - 234.

Brown, A.L., Mercy, D.LK. Beckenhauer, W.G. (1973) Modified Live virus rabies vaccine produced from Flury High Egg Passage virus grown on established canine kidney cell line. Three-year duration of immunity study in dogs. American Journal of Veterinary Research 34: 1427 - 1432.

Brown, F. and Crick J. (1977). Rabies virus. In: Rabies The Facts. Kaplan, C. (ed). Pages 22 - 31. Oxford University Press.

Bunn, Th. O. (1984). Rabies vaccines for use in dogs. In: Rabies in the Tropics. E. Kuwert, C. Merieux, H. Koprowski. K. Bogel (eds) pages 221 - 251. Springer Verlag Berlin.

Cabasso, V.J. (1962). Achievements of rabies vaccines (Flury) in animals and problems associated with their use. The Veterinarian 7: 6 - 11.

Cauughley, E. 91977). Analysis of vetebrate populations. J. Wiley and Sons: London.

Chadli, A. and Benlasfar, Z (1984). Epidemiology of rabies in Tunisia. In: Rabies in the Tropics. E. Kuwert, C. Merieux, H. Koprowski, K. Bogel (eds) Pages 363 - 370. Springer Verlag Berlin.

Collins, T.F.B. (1976). Control of pet animals. South African Medical Journal 50: 1054 - 1057.

Constantine, D.G., Bayer, E.V. and Humphrey, G.L. (1978). Vaccine induced canine rabies. California Morbidity and Mortality Weekly Report 27: 224 - 225.

Crick, J. (1983). The rabies virus. In: Proceedings of the symposium on Rabies - A growing threat. Pattison, J.R. (ed.) Warwick University, 15 April, 1983. published by Van Nos trand Reinland United Kingdom. Pages 18 -26.

Daniels T.J. (1980). The social behaviour of free-roaming urban dogs. M.Sc. Thesis. Ohio State University, Columbus, Ohio 144 pages.

Davis, E.E. and Winstead, R.LK. (1980) Estimating the numbers of wildlife populations. In: Wildlife Management Techniques Mannual. Schemintz S.D. (ed) pages 221 - 245. The Wildlife Society, Washington D.C.

Dean, D.J. and Abelseth, M.K. (1973). The flourescent antibody test. In: Labotory Techniques in Rabies. Third edition. WHO monograph series number 23.

Debbie, J.G., Abelseth, M.K. and Baer, G.M. (1972). The use of commercially available vaccines for the oral vaccination of foxes against rabies. American Journal of Epidemiology 96: 231 - 235.

Dixon, K.R. (1981) Data requirements for determining the status of fur bearer populations. In: World-wide Fur Bearer Conference Proceedings. J.A. Chapman and D. Pursley (eds) pages 1360 - 1373. Appalachain environmental Laboratory, Frostburg State College, Frostburg, Maryland 215-332.

Djerassi, C., Isreal, A. and Jochle W. (1973). Planned parenthood for pets? Bulletin of Atomic Science 1: 10 - 19.

Dorn, C.R. Terbrusch, F.G.. and Hibbard, H.H. (1967). A zoographic and demographic analysis of dog and cat ownership in Alameda County, California, 1956. Department of Public Health, State of California, Berkeley, California. Pages 5 - 37.

Downing, R.L. (1980). Vital Statistics of animal populations In: Wildlife Management Techniques Manual Schemintz S.D. (ed) pages 247 - 267. The wildlife society. Washington D.C.

Dupont, J.R. and Earle, K.M. (1965) Human rabies encephalitis. A study of forty-nine fatal cases with a review of the literature Neurology 15: 1023 - 1034.

Ereegovac, D. (1976). On the speed of axonal transport and its mechanism. Acta Veterinaria (Beograd) 26: 173 - 179.

Ezebuiro, E.O., Fagbami A.H., Anosa V.O. (1980). A survey of rabies in man and animals in Nigeria. A study commissioned by the Federal Livestock Department, Federal Ministry of Agricultue.

Ezeokoli, C.D. and Schnurrenberger, P. (1977). Incidence of suspected rabies cases in East Central State of Nigeria. Bulletin of Animal Health Production 25: 443 - 448.

Ezeokoli, C.D., Ogunkoya, A.B., Beran, G., Belino, E.D., Eze, E K. and Barnes, H.J. (1981). The epidemiology of rabies in Kadu na State, Nigeria. Nigerian Veterinary Journal 10: 97 - 98.

Fagbami, A.H. Anosa, V.O. and Ezebuiro E.O. (1981). Hospital records of human rabies and antirabies prophylaxis in Nigeria from 1969 - 1978. Transactions of the Royal Society of Tropical Medicine and Hygiene 75(6): 872 - 876.

Familusi, J.B. and Moore D.L. (1972). Isolation of rabies-related virus from the cerebrospinal fluid of a child with aseptic meningitis. African Journal of Medical Sciences 3: 93 - 96.

Familusi, J.B., Osunkoya, B.D., Moore D.L., Kemp, G.E. and Fabiyi, A.A. (1972). A fatal human infection with Mokola virus. American Journal of Tropical Medicine and Hygiene. 21: 959 - 963.

Fedaku, M. (1972). Atypical rabies in dogs in Ethiopia. Ethiopian Medical Journal 10: 79 - 86.

Fedaku, M. (1985). Asymptomatic non-fatal canine rabies Lancet 1: 569.

Fedaku, M., Chadler, F.W. and Harrison, A.K. (1982). Pathogenesis of rabies in dogs inoculated with an Ethiopian rabies virus strain. Immunofluorescence, histologic and ultrastructural studies of the Central nervous system. Archives of Virology 71: 109 - 126.

Fenje, P. (1968) Advances in rabies research Canadian Journal of Public Health 29: 803.

Foggin, C.M. (1982). Atypical rabies virus in cats and a dog in Zimbabwe. Veterinary Record 110: 308.

Foggin, C.M. (1983). Mokola virus infection in cats and a dog in Zimbabwe. Veterinary Record 113: 115 - 116.

Foggin, C.M. (1984) Mokola virus infection in domestic cats in Zimbabwe. In: Rabies in the Tropics. E. Kuwert, C. Merieux, H. Koprowski, K. Bogel (eds) Pages 65 - 70. Springer Verlag Berlin.

Fox, M.W., Beck, A.M. and Blackman, E. (1975). Behaviour and ecology of a small group of urban dogs (*Canis familiaris*) Applied Animal Ethology 1: 119 - 137.

Frank. B. (1965) Die rolle des hundes in Afrikanishen kulturen. Frantz Steiner Verlag Wiesbaden.

Franti, C.E. and Kraus, J.F. (1974). Aspects of pet ownership in Yolo county, California. Journal of American Veterinary Medical Association 164: 166 - 171.

Haddad, N., Blancou, J. Gritli, A., Koutchouk, A.M., Ben Osmana, F and Ausbert, K. (1985). Study of the activity of two rabies vaccines in Tunisian dogs. Maghred Veterinarian 2 (8): 13-16.

Haig, D.A. (1977) Rabies in Animals. In: Rabies . The facts Kaplan, C. (ed) pages 53 - 69. Oxford University press.

Harris, S. (1981). An estimation of the number of foxes (*Vulpes vulpes*) in the city of Bristol and some possible factors affecting their distribution, Journal of Applied Ecology 18: 455 - 465.

Hattwick, M.A., Weiss, T.A., Stechschulte, C.J., Baer, G.M. and Gregg M.B. (1972). Recovery from rabies. A case report. Annals of Internal Medicine 76: 931 - 942.

Hattwick, M.A. and Gregg M.B. (1975). The disease in man. In: The Natural History of Rabies. Baer G.M. (ed) Vol 2. 281 - 301. Academic Press. New York.

Heussner, J.C. and Grant W.E. (1978). Ecological aspects of urban dog management. A simulation model Animal Regulation Studies 1: 355 - 375.

Hudson, J.R. (1944). A short note on the history of rabies in Kenya. East African Medical Journal 21: 322 - 327.

Hummer, R.L. (1975) Pets in today's society. American Journal of Public Health 65: 1095 -1097.

Jochle, W. and Anderson, A.C. (1977). The estrous cycle in the dog. A review. Theriogenology 7: 113 - 140.

Johnson, R.T. (1971). Pathogenesis of experimental rabies. In: Rabies. Yasuito Nagano and Daveport F.M. (eds) pages 59 - 75. Baltimore University Park Press London.

Johntson, R.V., Newberne, J.W, York, C.J., Burch, G.R. and Brueckner, A.H. (1957). Study with Flury rabies vaccine in puppies. Journal of America Veterinary Medical Association 130: 61 - 63.

Jolly, G.M. (1965). Explicit estimates from capture-recapture data with both death and immigration stochastic model Biometrika 52 (1 and 2): 225 - 245.

Kaplan, M.M. and Koprowski, H. (1966). Laboratory techniques in Rabies. Second edition WHO Geneva Page 293.

Kaplan, C. (1977) The World Problem. In: Rabies, the Facts. Kaplan C (ed) Pages 1 - 12. Oxford University Press.

Kappus, K.D. (1976). Canine rabies in the United States, 1971 - 1973. American Journal of Epidemiology 103(3): 242 - 249.

Kauker, E. (1975). Vorkommen und Verbreitung der Tollwut in Europa on 1966-74. Sitzengsberichte der Heidelberger Akademie de Wissenschaften, 2. Abhanlung, Heidelberg Springer, page 23.

Kelly, T.E. (1980) An effective urban rabies/animal control programm. Journal of American Veterinary Medical Association 177: 1231 - 1234.

Kemp, G.E., Causey, D.R., Dorothy, L., Odeola, A and Fabiyi, A (1972) Mokola Virus. Further studies on IBAN 27377 A new rabies-related etiologic agent of zoonoses in Nigeria. American Journal of Tropical Medicine and Hygiene 2(3): 356 - 359.

Koprowski, H. and Cox H.R. (1948). Studies on chick embryo adapted rabies virus. Cultural characteristics and pathogenicity. Journal of Immunology 601: 533 - 554.

Lafon, M., Wiktor, T.J., MacFarlan, R.I. (1983) Antigenic sites of the CVS rabies virus glycoprotein. Analysis with monoclonal antibody. Journal of General Virology 64: 843 - 851.

Lawrence D.A. (1956). Rabies prophylaxis in southern Rhodesia. Bulletin of Epizootic Diseases of Africa 4: 201 - 204..

Le. Gonidee, C., Richenbach, A., Robin, Y. and Heme, G. (1978). Isolement d'une souche de virus Mokola au Cameroun. Annals of Microbiology (Inst. Pasteur) 129A: 245 - 249.

Luomala, K. (1960). The native dog in the Polynesian system of values. In: Culture in History. Diamond, S. (ed). Columbia University Press.

Magembe, S.R., (19840. Epidemiology of Rabies in the United Republic of Tanzania. In: Rabies in the Tropics. E. Kuwert, C. Merieux, H. Koprowski, K. Bogel (eds) pages 392 - 398. Springer Verlag Berlin.

Mariam, S.H. (1984). Epidemiology of rabies in Ethiopia. In: Rabies in the Tropics. E. Kuwert, C. Merieux, H. Koprowski, K. Bogel, (eds) page 473 - 480, Springer Verlag berlin.

Matsumoto, S. (1963). Electron microscopic studies on rabies in mouse brain. Journal of Cell Biology 19: 565 - 591.

McDonald, L.E. (1975). Veterinary endocrinology and reproduction. Lea and Febiger Philadelphia.

Ogbeogbulum, S.I., Okolo, M.I.O. and Erojikwe, E.E. (1987). Rabies in vaccinated dogs. Observations in Eastern Nigeria. Bulletin of Office International des Epizooties 6: 69 - 76.

Ogunkoya, A.B., Beran, G., Umoh, J.U., Gomwalk, N.E., Abdulkadir, I.A. (1990). Serological evidence of infection of dogs and man by Nigerian Lyssaviruses (family Rhabdoviridae). Transactions of the Royal Society for Tropical Medicine and Hygiene. 84: 842 - 845.

Okoh, A.E.J. (1982). Canine rabies in Nigeria 1970 - 1980 reported cases in vaccinated dogs. International Journal of Zoonoses 9: 118 - 125.

Okoh, A.E.J. (1983). Clinical rabies in 3 vaccianted dogs in Nigeria. Veterinary Record 113: 18.

Okoh, A.E.J. (1986). Dog ecology with reference to surveillance for rabies and characterisation of rabies virus isolates in Plateau State, Nigeria. Ph.D. Thesis, Ahmadu Bello University, Zaria.

Owoludun, B.Y. (1969). Rabies: Present situation in Nigeria West African Medical Journal 18: 143 - 144.

Parish, H.J. (1968) The story of immunization. In: Success with Vaccines. E. and S. Livingsntone Ltd., pages 21 - 28 Edinburgh and London.

Peace, C.K. and Hopes, R. (1970). The case of rabies at New Market. Veterinary Record 886: 299.

Perl, D.P. (1975) The Natural History of Rabies. Baer, G.M. (ed) Vol. 1 pages 235 - 269. Academic Press, New York.

Perrin, P., Rollin, P.E. and Surreau, P. (1986). A rapid rabies enzyme immunodiagnosis (RREID): A useful and simple technique for the routine diagnosis of rabies. Journal of Biological Standards 14: 217 - 222.

Rangel, M.C.F., Cardenas-Lara J. and DeAluja, A.S. (1981). The canine population in Mexico city: an estimate study. Animal Regulation Studies 3: 281 - 290.

Rembinger, P. (1959). Les vaccins Pasteuriens et le vaccin Flury dans la vaccination des animaux. Bulletin of Office International des Epizooties 45:(9-10): 592 - 600.

Rollinson, D.H.L. (1956). Problems of rabies in Africa. East African Medical Journal 33: 425.

Ruegsegger, J.M., Black, J. and Sharpless, G.R. (1961). Primary antirabies immunization of man with HEP Flury virus vaccine. American Journal of Public Health 57: 706 - 716.

Schemnitz, S.D. (1980). Wildlife management Techniques manual. The Wildlife Society, Washington D.C. 686. Pages.

Schneider, L.G. (1969). The cornea test, a new method of intra-vitram diagnosis of rabies ZBL Veterinary Medicine 16: 24 - 31.

Schnurrenberger, P.R, Kangilaski, E., Bashe, W.J. (1981). Characteristics of a rural Ohio dog population. Veterinary Medicine 56: 519 - 523.

Scott, M.D. and Causey, K. (1973). Ecology of feral dogs in Alabama. Journal of Wildlife Management 37: 253 - 265.

Selby, L.A., Rhoades, J.D., Dewett, J.E. and Irvin, J.A. (1979). A survey of attitudes towards responsible pet ownership Public Health Reports 94: 380 - 386.

Shille, V.M. and Strabenfeldt, G.H. (1980). Current concepts in reproduction of the dog and cat. Advances in Veterinary Science 24: 211 - 243.

Shope, R.E., Murphy, F.A., Harrison, A.K., Causey, D.R., and Kemp, G.E. (1970). Two African viruses serologically and morphologically related to rabies. Journal of Virology 6: 690 - 692.

Shope, R.E. and Tignor, G.T. (1971). Rabies and serologically related viruses from Africa. In: Rabies. Nagano, Y. and Daveport, F.M. (eds) University Park Press, Baltimore Pages 53 - 88.

Siongok, T.K.A. and Karama, M. (1984). Epidemiology of Human rabies in Kenya. In: Rabies in the Tropics. E. Kuwert, C. Merieux, H. Koprowski, K. Bogel. (eds). Pages 445 - 450. Springer Verlag Berlin.

Smith, J.S., Yager, P.A. and Baer, G.M. (1973). A rapid reproducible test for determining rabies neutralising antibody. Bulletin of the World Health Organisation 48: 535 - 541.

Smith J.S., Fishbein, D.B, Rupprecht, C.E. and Keith, C. (1991). Unexplained rabies in three immigrants in the United States. A virologic investigation. New England Journal of Medicine 324: 205 - 211.

Steck, F., Wandeler, A., Bichsel, P., Capt, S., Hafliger, U., Schneider, L.G. (1982). Oral Immunization of foxes against rabies. Laboratory and field studies. Comparative Immunology, Microbiology and Infectious Diseases 5: 165 - 171.

The National Association of State Public Health Veterinarians Inc. (1978). Compendium of animal rabies vaccine in the United States 1978. Journal of American Veterinary Medical Association 172: 504 - 541.

Tierkel, E.S. (1958) Rabies, In: Advances in Veterinary Sciences 5: 183 - 186.

Tignor, G.H. and Smith, L. (1981). Mechanisms of entry of rabies virus into the nervous system of the mouse. Proceedings of the fifth congress on Virology. Strasbourg P.W. 12105.

Tomori, O. and David West, K.B. (1984). Epidemiology of rabies in Nigeria. In: Rabies in the Tropics. E. Kuwert, C. Merieux, H. Koprowski, K. Bogel (eds) pages 485 - 490. Springer Verlag Berlin.

Turner, G.S. (1976). A review of the world epidemiology of rabies. Transactions of the Royal Society for Tropical Medicine and Hygiene 70: 175 - 178.

Umeno and Doi (1921). A study in the antirabies inoculation of dogs. Kitsato Archives of Experimental Medicine 4: 89 - 108.

Umoh, J.U and Belino, E.D (1979). Rabies in Nigeria. A historical review. International Journal of Zoonoses 6: 41 - 48

Umoh, J.U., Ezeokoli, C.D. and Okoh, A.E.J. (1984). The role of rabies-related viruses in the aetiology of canine rabies in Nigeria. Tropical veterinarian 2: 33-36.

Wachendorfer, G. (1966). Tollwut epidemiologie, Unterschiede auf dem europaischen und nord-amerikanischen Kontinent. Die Gelben Hefte 12: 495 - 508.

Wachendorfer, G. (1983). Genenwartiger Stand der oralen immunizierung von Funchsen gegen tollwut. Aryniem-Forsch/Drug Research 33: 612 - 613.

Wachendorfer, G, Frost, J.W. and Frohilich, T. (1984) Current diagnostic Procedures of rabies and related viruses. In: Rabies in the Tropices. E. Kuwert, C. Merieux, H. Koprowski, K. Bogel (eds). Pages 40 - 46. Springer Verlag Berlin.

Wandeler, A.I. (1984). Ecological and epidemiological data requirements for the planning of dog rabies control. In: Rabies in the Tropices. E. Kuwert, C. Mericux, H. Korpwski, K. Bogel (eds) Pages 657 - 661. Springer Verlag Berlin.

Warrell, D.A. (1977). Rabies in Man. In: Rabies, The Facts. Kaplan, C. (ed) pages 32 - 52. Oxford University Press.

Wiktor, T.J., Plotkin, S.A., Grella, D.W. (1973). Human cell culture rabies vaccine. Antibody responses in man. Journal of American Medical Association 244: 1170 - 1171.

World Health Organization (1973). WHO Expert Committee on Rabies. Technical Report Series number 523 Geneva.

World Health Organization (1980). Development of strategies for Regional and National Programmes of Dog Rabies Elimination WHO/Rab. Res./80.

World Health Organization (1981). WHO World Survey of Rabies xx Geneva.

World Health Organization (1982). Report of Consultations on the application of monoclonal antibodies in the characterisation and differentiation of Laboratory and field strains of rabies virus. Geneva 16 - 18 September, 1982.

World Health Organisation (1984a) Guidelines for dog rabies control. Genera VPH/83.43.

World Health Organisation (1984b). WHO Expert Committee on Rabies. Technical Report Series Number 709, Geneva.

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

World Health Organisation (1989a). WHO World survey of Rabies. 23 for 1986/87 WHO/Rabies/89.200

World Health Organization (1989b). Report of WHO consultation on requirements and criteria for field trials on oral rabies vaccination of dogs and wild carnivores. Geneva, 1 - 2 March, 1989. WHO/Rab.Res./89.32.

World health Organisation (1990). Report of WHO/APHS consultation on baits and baiting delivery system for oral immunization of wildlife against rabies. Colorado State University, Fort Collins, Colorado, 10 - 12 July, 1990. WHO/Rab. Res./90.36.

World Health Organisation (1991a). Second WHO Consultation on Oral Immunization of dogs against rabies. Geneva 6 July, 1990. WHO/Rab.Res/91.37.

World Health Organization (1991b). WHO World Survey of Rabies. Geneva WHO/Rabies/91.202.

Zbinden, E. (1953). Die Djinn Des Islam Und der altorientalische Geisterglaube. Verlag Paul Haupt Bern and Stuttgart.

Zyambo, G.C.N., Sionzangwe, P.G. and Bussein, N.A. (1984). Rabies in Zambia. In: Rabies in the Tropics. E. Kuwert, C. merieux, H. Koprowski, K. Bogel (eds) pages 415 - 421

APPENDIX

I Letter of Introduction

Letter of introduction from the Head of Department, Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria.

Department of Veterinary Public Health &
Preventive Medicine, A.B.U., Zaria

30th December, 1991.

The Minister,
Ministry of Livestock, Fisheries and
Animal Industries,
Yaounde.

Dear Sir,

LETTER OF INTRODUCTION

This is to testify that TONG JOHN CHUO is a postgraduate student in the Department of Veterinary Public Health and Preventive Medicine and is doing some work on the epidemiology of rabies in Cameroon for a Masters Degree (M.Sc. Veterinary Public Health).

Please kindly permit him collect all relevant data and information on animal rabies from your Ministry for this purpose.

Yours faithfully,

Signed: Prof. J.U UMOH
Head of Department/Supervisor

Departmentof Veterinary Public health &
Preventive medicine, A.B.U., Zaria

30th December, 1991

The Minister,
Ministry of Public Health
Yaounde.

Dear Sir,

LETTER OF INTRODUCTION

This is to testify that TONG JOHN CHUO is a postgraduat student in the Department of Veterinary Public Health and Preventive Medicine and is doing some work on the epidemiology of rabies in Cameroon for a Master s Degree (M.Sc. Veterinary Public Health).

Please kindly permit him collect all data and information on human rabies from your Ministry for this purpose.

Yours faithfully,

Signed: Prof. J.U. UMOH
Head of Department/Supervisor

II QUESTIONNAIRE

Sample of the questionnaire used for dog population studies in Bamenda and Wum towns, Cameroon (1991/1992).

INTSRUCTION:

Kindly fill in the information demanded on the appropriate space provided for each question. Where more than one answer follows a question, tick ( ) the most correct answer(s). All questionnaires shall be treated confidentially.

SECTION A: HOUSEHOLD INFORMATION

1. Date: _____

2. Name of Street or Quarter: _____

3. Name of head of Household: _____

4. Occupation (i) Civil Service: _____

(ii) Business: _____

(iii) Technology: _____

(iv) Farming: _____

(v) Others (Specify) _____

5(a) Is Your home fenced? Yes: _____

No: _____

(b) If Yes, the fence or wall does not restrain (Prevent) dogs: _____ the fence or wall completely restrains (Prevents dogs _____.

6. Number of people in the household:

i) Less than 10 years old: _____

ii) Between 10 - 19 years old: _____

iii) Between 20 - 29 years old: _____

(iv) Between 30 - 50 years old: _____

(v) Over 50 years old: _____

7(a) Do you own a dog or dogs? Yes: _____

No: _____

(b) If yes, number of dogs in the household

i) Less than 3 months old: _____

ii) Between 3 months - 12 months (1 year) old: _____

iii) Between 1 year - 3 years old: _____

iv) More than 3 years old: _____

(c) If No, give reason(s):

i) Hatred for dogs: _____

ii) Against my religion or culture: _____

iii) No money to keep them: _____

iv) Others (Specify) _____

8(a) Do you own other animals in the household?

Yes: _____

No. _____

(b) If yes, Cats: _____

Goats: _____

Sheep: _____

Pigs: _____

Horses: _____

Poultry: _____

Monkey: _____

9(a). Has anybody in your household (compound) ever been bitten by a dog in the past 5 years?

Yes: _____

No. _____

(b) i) By your dog: _____

ii) By your neighbour's dog: _____

iii) By unowned dogs always in the community: _____

iv) By unidentified strange dogs: _____

(c) What part of the body was bitten?

Face: _____

Head: _____

Neck: _____

Left hand: _____

Right Hand: _____

Abdomen: _____

Left Leg: _____

Right Leg: _____

(d) What did you do to the person bitten?

i) Nothing: _____

ii) Took victim to hospital: _____

iii) Treated the wound with traditional medicine only: ____

(e) what did you do to the dog?

i) Did not identify it: _____

ii) Reported to the Veterinary authorities. _____

iii) Settled the matter with the owner at home and forgot:

_____

iv) Killed it: _____

v) Nothing: _____

(f) How old was the bitten household member?

5 - 10 years old: _____

11 - 20 years old: _____

21 - 45 years old: _____

More than 45 years old: _____

(g) Why was the member bitten by the dog?

i) Was playing with the dog: _____

ii) He/She attacked the dog: _____

iii) The dog attacked him/her without any reason: _____

iv) Others (Specifcy): _____

SECTION B: INDIVIDUAL DOG INFORMATION (FOR DOG OWNERS)

1. Owner's name: _____

2. For each dog owned supply the following information:

Dog 1: Age: ------ Sex: ----- Breed: -------

Dog 2: Age: ------ Sex: ----- Breed: -------

Dog 3: Age: ------ Sex: ----- Breed: -------

Dog 4: Age: ------ Sex: ----- Breed: -------

Dog 5: Age: ------ Sex: ----- Breed: -------

3. Source of dog(s)

i) From your own bitch (female dog): _____

ii) Bought it (them): _____

iii) Received it (them) as a gift: _____

iv) Picked it (them) up from the street, market, etc. _____

v) Others (Specify): _____

4. What is your reason for keeping the dog(s) i.e. use of the dog(s):

i) For guarding the compound/house: _____

ii) For hunting: _____

iii) For food: _____

iv) As pets: _____

v) Others (Specify): _____

5(a) How do you confine (restrict the movement) your dogs during the day?

i) By chain in the compound: _____

ii) Lock them up in the house or garage: _____

iii) They are allowed to roam about in the quarter: _____

(b) How do you confine your dogs at night?

i) Chained in the compound: _____

ii) Keep them indoors: _____

iii) They are allowed to roam about in the household or quarter: _____

6. How is the dog fed?

i) Dog finds its own food: _____

ii) Fed by members of the household: _____

iii) Fed by neighbours: _____

7. Who are those who usually handle or play with the dog(s)?

12 What is your impression about dog bites in your quarter/street in the past 1 year?

i) No dog bite: _____

ii) Few dog bites (state approximate number) _____

iii) Many dog bites (" " ") _____

iv) Too many dog bites (" " ") _____

13(a) Do some dogs which are not yours eat at your household?

Yes: _____

No: _____

(b) If Yes, how are they fed?

i) Fed by my household: _____

ii) Feed from dustbin: _____

iii) Feed on any food in the household: _____

14. Do you have unowned dogs (dogs without known owners) in your quarter? Yes: _____ No. _____

If yes, they are always in the quarter: _____

they are unidentified strange dogs: _____

15. How many litters (number of deliveries) did all your female dogs (bitches) have in the past 1 year? _____

16(a) How many litters did each bitch produce in the past 1 year?

Bitch 1: _____ Bitch 2: _____ Bitch 3: _____

(b) Considering the last delivery (whelping)

i) How many puppies were born: _____

ii) How many puppies are still alive and with you in the house: _____

iii) How many died from diseases: _____

iv) How many were killed by people: _____

v) How many were given away as gifts: _____

vi) How many were sold: _____

17(a) For the non-dog owners, if you owned a dog would you vaccinate it against rabies: _____ Why? _____

_____

(b) How is the population of dogs in your quarter/street changing?

i) Increasing: _____

ii) Decreasing: _____

iii) Constant: _____

iv) Don't know: _____

Designed by: TONG JOHN CHUO (D.V.M.)
Department of Vet. Public Health & Prev. Med., Ahmadu Bello University
Zaria, Nigeria

III ESTIMATION OF DOG POPULATION

Estimation of owned dog population and owned dog-to-person ratio in Bamenda and Wum according to questionnaire survey (1991/1992).

According to the second census of Cameroom/UNFPA, the population of Bamenda town in 1987 was 110,000 with an annual growth rate estimated at 2.74.

The population of Bamenda in 1988 = $\frac{102.74}{100}$ x 110000 = 113014

" " " " " 1989 = $\frac{102.74}{100}$ x 113014 = 116110

" " " " " 1990 = $\frac{102.74}{100}$ x 116110 = 1192.91

" " " " " 1991 = $\frac{102.74}{100}$ x 1192.91 = 122560

A total of 1562 people lived in the 214 households sampled in Bamenda.

Therefore $\frac{1562}{122560}$ = 0.013 of the town was sampled.

Hence about 0.013 of the owned dog population was sampled. A total of 242 dogs were owned in the 214 householeds.

Therefore the estimated total number of owned dogs in Bamenda

= $\frac{242}{0.013}$ = 18615

The owned dog to person ratio in Bamenda

= $\frac{122560}{18615}$ = 1:6.6

The population of Wum in 1987 was 27489 with an annual growth rate estimate of 2.5%.

Similar extrapolation of the population from 1987 to 1992 using the estimated annual growth rate gave the population of Wum in 1992 = 31101.

A total of 2622 people lived in the 234 households sampled in Wum.

Therefore $\frac{2622}{31101}$ = 0.084 of the human population was sampled.

This implies that about 0.084 of the owned dog population was also sampled.

A total of 307 dogs were owned in the 234 households. Thus the estimated total number of owned dogs in Wum

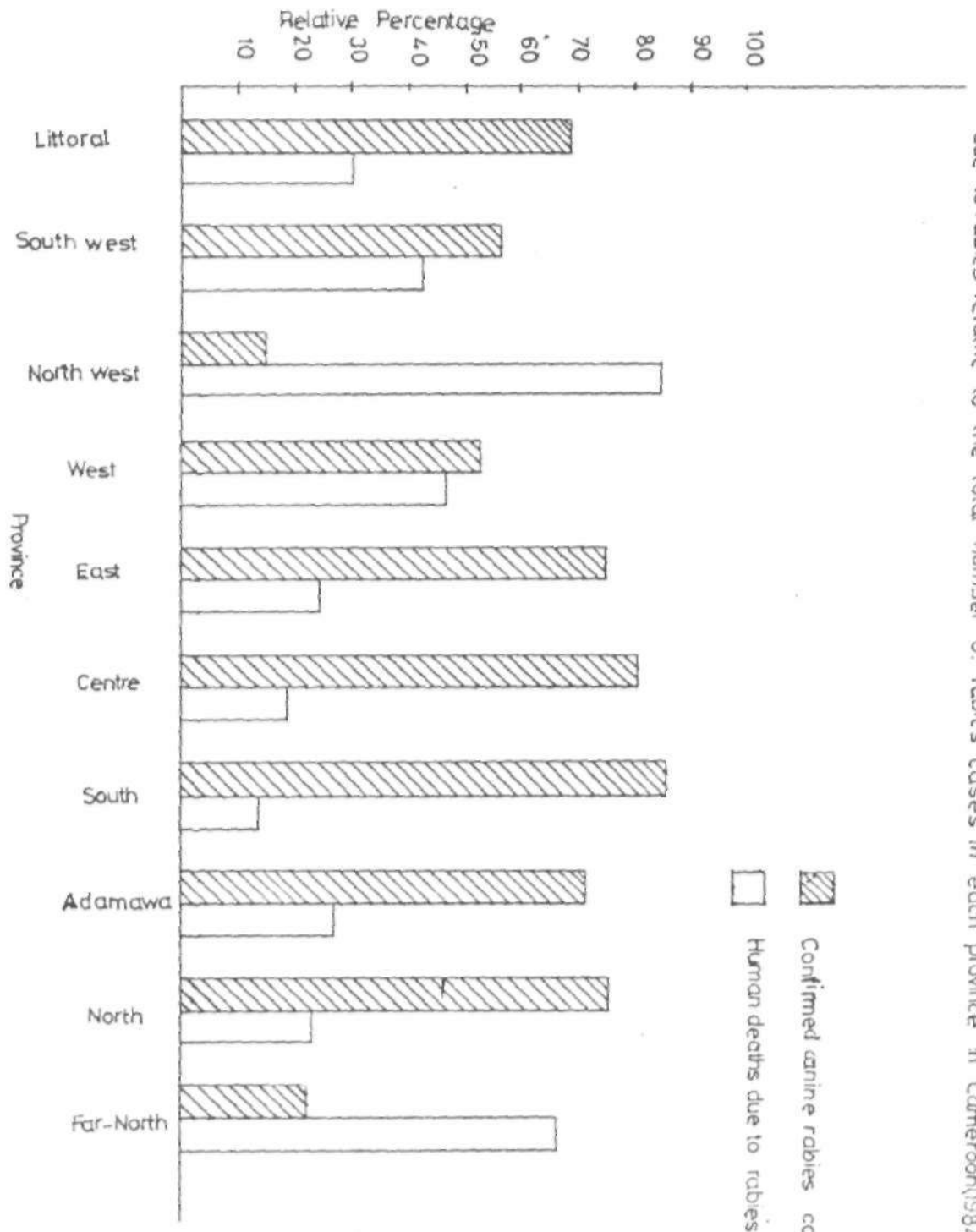
= $\frac{307}{0.084}$ = 3655

The owned dog-to-person ratio in Wum

= $\frac{31101}{3655}$ = 1:8.5

The total number of people in the two towns = 122560 + 31101 = 153661. The total number of owned dogs in the two towns = 18615 + 3655 = 22270. The overal owned dog to person ratio in both towns

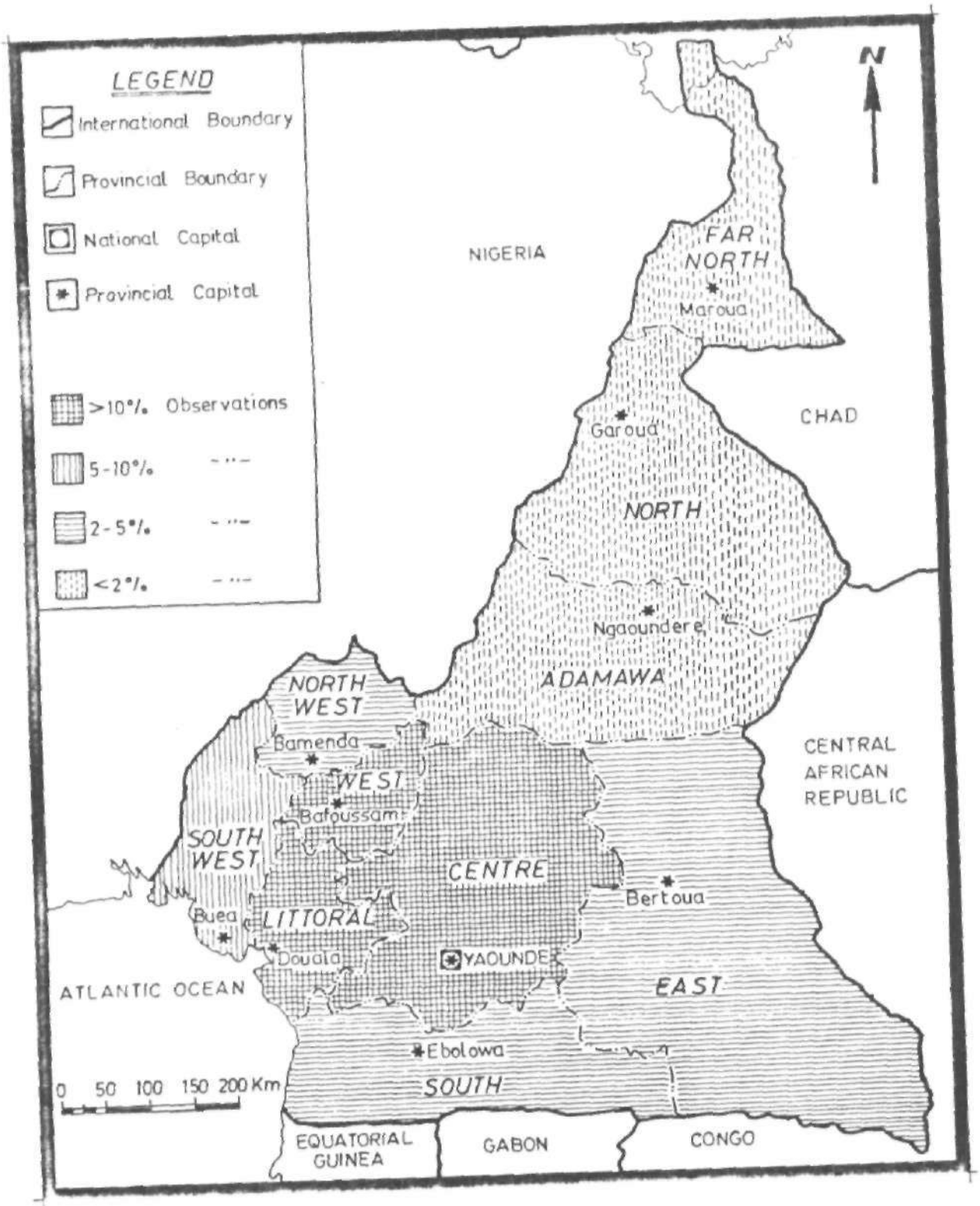
= $\frac{153661}{22270}$ = 1:6.9 ~ 1:7



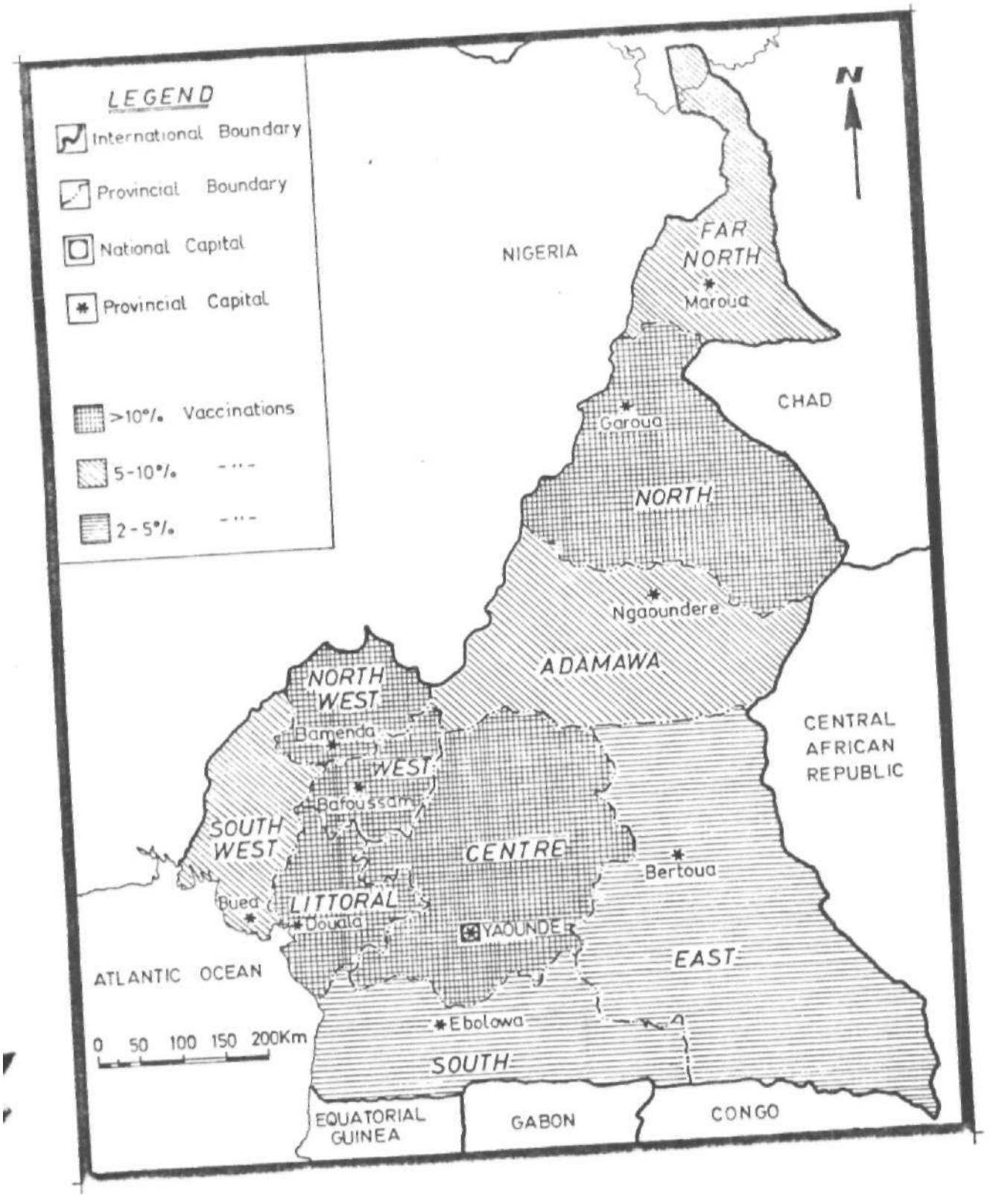
Appendix 4: Percentage distribution, by province, of confirmed canine rabies cases and human deaths due to rabies relative to the total number of rabies cases in each province in Cameroon(1984-1990)

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APPENDIX 5: Percentage Distribution Relative to Total Number of Biting Dogs Placed Under Observation For Rabies in Cameroon (1982/83 - 1989/90).



APPENDIX 7: Percentage Distribution Relative to Total Number of Antirabies Vaccinations in Cameroon (1982/83-1989/90).



APPENDIX 8: Percentage Distribution Relative to Total Number of Human Deaths Due to Rabies in Cameroon (1984 - 1990).

