DOG ECOLOGY WITH REFERENCE TO SURVEILLANCE FOR RABIES AND CHARACTERIZATION OF RABIES VIRUS ISOLATES IN PLATEAU STATE, NIGERIA

BY

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A Dissertation submitted to the Postgraduate School, Ahmadu Bello University, in Partial fulfillment of the requirements for the degree of Doctor of Philosophy

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CERTIFICATION

This thesis entitled Dog Ecology with reference to surveillance for Rabies and Characterization of Rabies Virus Isolates in Plateau State, Nigeria by Ekle Anthony Joseph Okoh meets the Regulations Governing the Award of the degree of Doctor of Philosophy of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to my late uncle, Johnson Igwe Abarike.

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ABSTRACT

Two aspects of rabies problem in Plateau State of Nigeria namely the ecology of the domestic dog, including attitudes towards dog ownership, and its possible role in the perpetuation of rabies, and antigenic characterisation of rabies virus isolates were studied. The dog ecology study was carried out by direct street counts and questionnaire survey of 10% city streets in Jos selected by stratified random technique. It was found that the estimated overall population was 4,200 dogs by the street count technique, and 10,560 by the compound questionnaire method. Dogs were most numerous in the Jos Township and Native Town (Jenta) which are in the centre of town and fewest in the low density Government residential area (GRA). The overall dog to human ratio was 1:4 but ranged from 1:3 in Jos Township and Native Town to 1.6 in the GRA. The average number of dogs per compound was 4. Dog bites were most common in residential areas with high dog populations. Dog ownership was more common among civil servants and farmers, compared with traders businessmen and semi-skilled, self-employed artisans (mechanics, welders, truck drivers, carpenters etc). Protection and Security ranked highest among the reasons and fear of transmission to humans was the most important deterrent to dog ownership. Stray dogs were regarded

as a major problem and was attributed to bree by owned dogs which then escape from their compoun because of poor care. The visibility c. stray dogs has given the impression of overpopulation in certain sections of the town. Immunization rate for rabies in dogs and veterinary service utilization were highest in Jos Township and the Government Residential Area (GRA) but less in Angwan Rogo. However, the entire community appeared to recognize the importance of immunizing dogs against rabies.

Between 1970 and 1981, a prevalence rate of rabies based or specimens submitted to the laboratory was 22.6 percent in the State. About 43.1 percent of the 376 positive cases were from stray dogs. the period, a total of 52,391 dogs were reportedly vaccinated and 35,505 dogs were licenced. The frequencies of rabies were high in March-April and September-October. The disease appeared to be more prevalent in Jos and Barkin Ladi Local Government Areas. The dog accounted for 87.5 percent of all positive cases. Also 5,379 dog bites in humans were reported and the bite rate per 10,000 human population ranged between 3.2 in Nassarawa to 46.7 in Jos, with a mean of 12.24. Only 1360 of 4311 persons requesting antirabies postexposure treatment were given antirabies vaccine. The age groups 10-14 and 15-19 of both male and female sexes were at highest

risk of dog bites. Twenty-six human deaths due to rabies were reported.

Prospective surveillance study between January 1982 and December 1983 showed more rabies cases in each of the two years than any other year, since 1954. The incidence of rabies was 35.4 percent in the state with high disease incidences in Jos, Barkin Ladi, Pankshin and Langtang. The cases peaked only in September and October in contrast to the two peaks as observed in the retrospective study. An annual exposure rate of 133 per 100,000 persons was recorded in the 2 year period. Twelve cases of human rabies occurred during the period.

The antigenic composition of 41 isolates of rabies virus obtained from predominantly the dog was determined with a panel of 80 monoclonal antibodies. Characterization of the isolates using a panel of 36 antinucleocapsid monoclonal antibodies showed all the isolates to rabies, however antiglycoprotein neutralization with a panel of 44 monoclonal antibodies grouped the virues into 7 antigenic variants. In vaccination-challenge test in mice, Pitman-Moore human rabies vaccine. protected against only one of the seven variants but the low egg passage (LEP) Flury vaccine used for dog vaccination, in Nigeria protected guinea pigs against challenge with all the seven variants.

INTRODUCTION

Canine rabies control programmes in developing countries, based on models from technologically developed countries, have frequently been ineffective even if materials and funds were available (Beran, 1981). A major cause has been insufficient basic information on the ecology of the local dogs and their relationship to human society. Studies on the ecology of dogs in different regions and some studies in each country are needed to design ecologically and sociologically appropriate programmes. Rabies control programmes must be based on a knowledge of the epidemiology of the disease in specific countries (Beran, 1970a & b). Neither data nor procedures applicable in one country can be transferred to another. Data on reservoir host ranges, population densities, and distribution of dog and other domestic animals ownership in urban and rural areas of the countries, the societal patterns which influence transmission of the rabies virus are essential prerequisites for planning control programmes (Beran et al., 1968; Beran and Gregorio, 1966a & b).

Although there are good reasons to encourage studies on canine populations and associated public health problems, such a study is seriously lacking in Nigeria. Rabies is a major health problem in Nigeria (Nawathe, 1980, Anosa et al., 1980), however the rabies problem remains unclear from several aspects.

Official disease reporting is rudimentary, hence information is lacking on the prevalence and distribution of the disease. No wildlife reservoir host has been clearly identified although sporadic cases in wildlife have been reported (Okoh, 1976; Kasali, 1977). The domestic dog seems to be the major source of human exposure to rabies, and perhaps also the reservoir host.

Additional benefits can be derived from accurate estimates of the pet numbers in a given geographical area. Health agencies can better evaluate their rabies control programmes (Anderson and Cameron, 1965). Population estimates also assist in the planning of stray animal control. In addition, pet animal populations can serve as resources for epidemiological research of acute and chronic diseases, for example salmonellosis (Kaufmann, 1966) and Leukemia (Dorn et al., 1967). The practical importance of investigation dog populations seems clear from studies carried out in different parts of the world (Dorn et al., 1967; Marx and Furcolow, 1969; Beck, 1973; Scott and Causey, 1973; Franti and Kraus, 1974; Franti et al, 1974; Beck, 1974; Anvik et al. 1974; Schneider and Vaida, 1975; Beck, 1975; Griffiths and Brenner, 1976; Heussner et al., 1978; Heussner and Grant, 1978; Franti et al., 1980; Nassar and Mosier, 1980; Rangel et al., 1981; Beran, 1982). However, in Nigeria studies of dog ecology and man-dog interrelations

have not been carried out.

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 problems associated with free-roaming or stray animals in a community. Some officials argue that "irresponsible owners" are a major reason for pet overpopulation, free-roaming pets, and associated community health problems (Djerassi et al., 1973; American Veterinary Medical Association, 1974; Hummer, 1975; Collins, 1976). Before a practical solution can be found, or the problems properly defined, one must determine attitudes of people regarding issues such as irresponsible pet ownership, overpopulation, and potential community health problems resulting from stray or free-roaming animals, as well as possible solutions to control of pet populations and stray animals.

The problem of canine rabies control in Nigeria might be more complex by the isolation and identification of rabies-related viruses namely Mokola and Lagos bat viruses from this geographical region (Boulger and Porter-field, 1958; Shope et al., 1970; Familusi et al., 1972; and Kemp et al., 1972, 1973b). Recently, Foggin

(1983) reported the isolation of Mokola virus from one dog and several cats in Zimbabwe. Some of these rabies-related viruses could be confused clinically with paralytic rabies (Kemp et al., 1972) especially as the current routine diagnostic methods for rabies may not differentiate rabies from rabies-related viruses (Shope, 1975). The extent to which they cause problems in man and the role of rabies-related viruses in canine in Nigeria has not yet been determined (Ezeokoli and Schnurrenberger, 1977; Umoh et al., 1984).

There are several unconfirmed reports of anti-rabies vaccine failures in Nigeria (Okoh, 1981, 1983). The possibility exists that the vaccine failures could be due to rabies-related viruses (Umoh et al., 1984). Hybridoma antibodies have been produced against rabies and rabies-related viruses and their components (Koprowski and Wiktor, 1980). Hybridoma antibodies against nucleocapsid antigens of rabies and rabies-related viruses have been used for differentiating members of the lyssavirus group (Flamand et al., 1980a, 1980b; Wiktor et al., 1980).

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 could hamper the rabies

control effort. It is therefore necessary to determine the existence of these rabies-related viruses, and variants of the classical rabies virus in our canine population.

The objectives of this study therefore are:-

(a) To obtain basic information on dog population dynamics in Jos, for a clearer understanding of rabies epidemiology.

(b) To characterise the rabies problem in Plateau State by retrospective and prospective studies of existing data.

(c) To study the antigenic characteristics of rabies virus isolates so as to determine presence or absence of rabies-related viruses or variants of rabies viruses in the canine population.

REVIEW OF LITERATURE

History

Rabies has always been associated primarily with dogs and descriptions of the disease in these animals in Ancient Mesopotamia date from the Third Century B.C. (Johnson, 1959; Tierkel, 1971), and in China from about 555 B.C. (Theorides, 1974, Miller and Nathanson, 1977). It was also known to the Greeks and Romans who recognised that the disease could be transmitted in the saliva of a rabid dog by biting. The Romans described the infectious material as a virus (the Latin word for poison) (Steele, 1975), and Celsus in the first century A.D. appears to have been the first to associate rabies in animals with hydrophobia in man (Irvin, 1970; Steele, 1975).

From this time until the 19th century the pattern of the disease in Europe appears to have been of outbreaks in wild and domestic dogs followed by infection in other animals and in humans. It is probable that these outbreaks may have been preceded by epizootics in foxes (Anon 1972; Shope, 1976). There are many accounts of people and domestic animals being attacked by rabid foxes and other wild animals (Zinke, 1804; Irvin, 1970; Anon, 1971; Steele, 1975); for example, Johnson (1959) and Irvin (1970) cited wolf rabies in Western Europe in 1271. At least seven epizootics are known to have occurred in

foxes between 1803 and 1928 (Galtier, 1881; Anon, 1971). One major outbreak in which this species was implicated occurred during the period of the Napoleonic Wars, but after 1880 the disease in wildlife appeared to wane. However, rabies continued to occur in domestic animals, particularly dogs, until the turn of the century.

In view of the fear engendered by the disease, it is perhaps not surprising that it became common to adopt many curious and superstitious practices to avoid its inevitable outcome (Theorides, 1974; Steele, 1975; Miller and Nethanson, 1977). Yet some scientific progress towards its understanding was also made. Several workers, of whom the first was Zinke (1804) succeeded in transmitting the disease to healthy dogs by inoculation of infected saliva, while Galtier (1879) by intravenous inoculation of the same material was able to protect sheep against subsequent challenge. Galtier also showed that the rabbit was a useful experimental animal for the study of rabies (Pasteur et al., 1884). He thus paved the way for Pasteur and his co-workers to develop virus attenuated for dogs but having a uniform (fixed) incubation period in rabbits and to prepare the first nervous tissue vaccines for immunization of dogs and man (Plasteur, 1885).

The experiments of Zinke and Galtier (Zinke, 1804; Galtier, 1881) convinced authorities that rabies was an infectious disease and that the control of dogs might lead to its elimination. Early in the 19th Century quarantine regulations, elimination of stray dogs, and muzzling were introduced in Scandinavia and by 1826 (Galtier, 1881) this area was free from dog rabies. Dog control regulations were also applied successfully to other urban centres in Europe, but these areas frequently became re-infected after a few years (Galtier, 1881).

A brief historical review of rabies in Asia was given by Tierkel in 1971 (Tierkel, 1971). In the mid 19th century several reports of the disease in dogs in China were made by resident Europeans and the disease in man was well known to Chinese physicians (Steele, 1975). However, the study of the disease in the East did not really begin until the early 1900s when Pasteur Institutes were established in India, Iran, Vietnam, and Indonesia (Tierkel, 1971). In India, shortly after this time Semple (1911) produced the first fully inactivated rabies vaccines and in 1920 Japan became the first country to practice the large-scale vaccination of dogs (Meno and Doi, 1921). This, combined with other control measures, led to the final eradication of the disease in that country in 1956, after a massive outbreak of canine rabies from 1948 to 1950 in the Kanto district which

includes the Tokyo metropolis (Shimada, 1971).

Rabies has been known in North Africa since ancient times and was mentioned by the School of Alexandria (Theorides, 1974). In 1858 preventive measures were introduced in Algeria to control the extensive spread of the disease, which a few years later was reported as enzootic in Ethiopia (Steele, 1975). Curiously, travellers such as Burrow in 1806 and Livingstone in 1857 commented on the complete absence of the disease (Bisseru, 1971) and in 1893 the first outbreak known to have occurred in South Africa was caused by a dog imported from England (Bisseru, 1971). This paucity of reports of rabies in the African continent is particularly interesting in view of the fact that rabies may have originated there (Shope, 1976).

Rabies is thus one of the oldest and most feared diseases in recorded history, having been reported as early as the 2300 years B.C. (Tierkel, 1959). This dreaded disease has survived over 500 years inspite of concerted efforts to control it. The apparent failure to eliminate rabies from our environment is not due to lack of technological know-how, as several other great epidemic diseases namely plague, small pox, typhoid have controlled or eliminated in the intervening period. Rabies, however, possesses certain epidemiologic attributes that render elimination of the virus from

from the environment difficult.

Host Range

Though rabies affects all warm blooded animals, they are not equally susceptible (Chalmers and Scott, 1969; Kaplan, 1969; Kaplan and Koprowski, 1980). As stated before, birds and opposums are highly resistant. Rodents, lagomorphs, deer, wild dogs, have an "ecological" resistance, because of their small size or peculiarities of habit and habitat, they are very rarely infected (Chalmers and Scott, 1969; Winkler et al., 1972a; Bernard, 1979). Laboratory-reared rodents are rarely, if ever infected, hence bites by laboratory mice or rats are usually not considered exposure, (except rodents used in rabies diagnosis or research). The susceptibility of bats appears to vary from place. Apart from the vampire bats of Central and South America (Pawan, 1936b) rabies has been reported in 26 out of 40 species of insectivorous and frungivorous bats in North America (Constantine, 1966; Constantine and Woodall, 1966). Bat rabies is rare in Europe, Asia and Africa (Turner, 1976). Rabies related viruses have been isolated from bats in Nigeria and South Africa (Shope et al., 1970; Meredith et al., 1971; Tignor et al., 1981). The role of the bat as reservoir of infection for other animal species has not yet been clearly delineated.

Feral wild animals such as coyotes, foxes, racoons, skunks, civet cats, mongoose, jackals (Chalmers and Scott, 1969; Kaplan, 1969; Turner, 1976a; Bernard, 1979) are highly susceptible and important in the natural history of the virus. The relative susceptibility of these animals depends on the strain of rabies virus. For instance, a strain of virus isolated from a fox requires 100 times less virus to infect a fox than a skunk, but foxes are more resistant to rabies of bat origin than skunks (Sikes, 1962; Constantine and Woodall, 1966). The cow is perhaps the most susceptible of the domestic animals (Koprowski, 1955). Swine are less susceptible than the dog or cow, andthe cat is more resistant than the dog to street virus but not to the Flury strain (Walker and Crawley, 1959; Cabasso et al., 1965).

Man is relatively resistant to rabies, only about 20 per cent of untreated persons bitten by unknown rabid animals develop the disease (Clark et al., 1975). Some of the human resistance may be attributable to non-biological factors. Protective clothing and post exposure first aid tend to reduce exposure of the wound to virus-laden saliva, and human beings are often not as severely bitten as smaller animals.

The incidence of human rabies generally correlates with canine rabies; control of canine rabies usually results in drastic reduction in the incidence of human rabies regardless of the incidence of wildlife rabies (Turner, 1976a). Children are at the greater risk of rabies (than adults) partly because theyoung are more susceptible to infection with the virus. More importantly, children have greater contact with dogs and wildlife because of their uninhibited curiousity, and are usually less capable of escaping a rabid animal (Shope, 1975). No racial, genetic or socioeconomic differences in susceptibility have been reported.

Rabies is maintained in two interrelated phases described as urban and sylvatic. In the former, domestic and stray dogs and cats are involved whereas in the latter infected wild animals transmit the disease. Even dog rabies was considered by Johnson (1959) to be primarily a disease of wild canine species, domestic dogs having no role in the maintenance or spread of the diseases before the 18th century, when industrialization began in Europe and America. The increase in urban rabies became more of a problem as cities increased in size. Nowadays it is rigorously controlled in those parts of the world where the efficient application of public health measure is possible (Steele, 1975).

Sylvatic rabies, on the other hand, presents a much more intractable problem and a constant threat to man and his livestock. Rabies epizootics in wild life have been reported since the Middle Ages but have only been extensively studied, chiefly in Europe and North America, since the current upsurge began. These epizootics are characterised in particular locations by the predominance of one or two carnivore species as the main victims and reservoirs (Chalmers and Scott, 1969; Steck, 1974) and the pattern of the epizootic in an area remains stable over many years. The red fox is probably the animal most susceptible to rabies (Chalmers and Scott, 1969) and it has been implicated in several major epizootics, including the present one in Europe. Since the Second World War, there have been large-scale agricultural and industrial change in Northern Europe, to which the fox has proved more adaptable than its natural competitors. Furthermore, the number of foxes increased during the war, presumably due to the suspension of hunting so that the population became better suited for the maintenance and spread of rabies (Taylor, 1976a). A few other animal species, including badgers, martens and deer, are regularly found to be infected, but these are regarded as having no significance in maintaining the current outbreak. The isolation of rabies like viruses in rodents in Central Europe

(Sodja et al., 1971) is also considered to be of no epizoological importance (Forster et al., 1977).

Among other animals known to be important in maintaining rabies are the jackal and mongoose in parts of South Africa and the wolf in Southeastern Europe, the Middle and Near East, Mexico, and Northern Canada (Bissseru, 1972). Rats are still regarded as a potential source of human infection in Lebanon and parts of North Africa (Turner, 1976a), and enzootic rabies in rodents has also been reported from Thailand (Hummeler et al., 1967).

Epidemic Models

Two epidemic models have been applied to explain the persistence of rabies in wildlife (Chalmers and Scott, 1969; Bacon and Mcdonald, 1980). According to the first and perhaps more popular model, rabies virus is maintained as mild, silent, smouldering epidemics (or epizootics) in the wildlife host reservoir (Tierkel, 1959; Kaplan, 1969; Shope, 1975). These hosts vary from place to place, foxes in Europe, skunks, racoons, foxes in the Americas, mongoose in South Africa and the Caribbean Islands. Regardless of the specific host, rabies is thought to be maintained by continued interaction between infected animals and new susceptible hosts. According to Kendals threshold

theorem, if the contact rate between infected and susceptible animals is such that an infected fox infects more than one susceptible fox, the frequency of disease would increase exponentially and an epidemic occurs. Conversely if each infected animal meets and infects less than one susceptible animal, the frequency of disease decreases exponentially and the virus should disappear from the environment. If, however an infective animal meets and infects on the average only one susceptible host before it dies, the virus will "smoulder" definely in a steady-state endemicity as long as susceptible hosts are available. It has been suggested that a population dersity of one susceptible fox per square kilometre is sufficient to maintain rabies in this manner. To eliminate the virus thus maintained, the fox population must be reduced to one per 4 or 5 square kilometers (Kaplan, 1969).

The success of this model depends to a great extent on the availability of new susceptible hosts and efficient transmission. In real populations of finite size, susceptible hosts may not always be available. Foxes for example, breed only once a vear and rabies can occur at any time (Bacon and MacDonald, 1980). If a rabies epidemic destroys a lot of foxes rapidly, the birth of new foxes may not be able to replace susceptible host rapidly enough. Thus according to the model above,

the frequency of the disease will decline unless new susceptible hosts accumulate. Hence the incidence of rabies would be expected to oscillate with changes in the population of susceptible host.

The current epidemic of fox-rabies going on in Europe is an excellent example of the 'Smouldering epizootic' model described above (Kaplan, 1969; Bacon and MacDonald, 1980).

Chalmers and Scott (1969) have proposed an alternative model in which rabies virus is seen to have survived by adaptation of certain preferred hosts such that a mutually non-detrimental ecological balance or "climax" is established. They described four such climaxes:- the Desmodontied (Vampire bat) climax in Central and South America; the Musterlid climax in North America, Greenland and Europe; the Viverid (mongoose) climax in India, South Africa and the Caribbean, and the Canid (dog) climax in Africa, India and South East Asia. Infection of these climax hosts may occasionally result in overt disease and death, but generally in inapparent infection or in transient illness with recovery. Such infected and recovered animals became "healthy" carriers capable of transmitting the disease to other animals. Thus the virus is maintained in a "natural" cycle of infection within the climax host.

Occasionally virus infection spills over from the climax hosts into other less adapted hosts, producing an "aberrant" cycle of infection which is generally manifest as epizootics in wild animals. Rabies in Canidae (Foxes etc for example, is regarded as an overspill from the mustelid climax. Accidental infection of deadend hosts such as man and cattle occur sporadically during the epizootics in the aberrant cyl cycle hosts. These dead-end hosts do not usually participate in the transmission of the virus and are irrelevant as far as survival of the virus in the environment is concerned.

The fact that rabies has survived through 5000 years is good evidence for its ability to adapt to hosts.

The climaxes should be regarded as dynamic systems subject to change as a result of environmental pressures and human interference. It is likely that old climaxes disappear under the pressure of environmental change, and new ones replace them. The epizootics described in the past and the present may be the evolutionary process for the establishment of new, stable climaxes system following long term disruption of former climax associations (Lloyd, 1976).

Biological Properties Influencing Epidemic Behaviour

The epidemiologic pattern of rabies is also influenced in some incompletely understood way, by certain biological properties of the virus. The long incubation period (Debbie, 1974) provides for easy introduction of the virus into rabies-free area by infected animals not yet showing signs. Long incubation periods in the wild allows time for new susceptible hosts to accumulate, sustaining the smouldering epidemics which may maintain the virus in the wild. Neurotropism and the shedding of the virus from exocrine glands are two other biological properties which enhance survival of the virus. Neurotropism, particularly the relative selective localization of virus in the limbic system, provides the basis for behavioural changes which maximise successful transmission. Friendly and paralytic behaviour in rabid animal ensure infection within members of a group of animals since such behaviour will result in a high index of individual contact. The furious form of rabies promotes spread of the disease to other groups and species, since the fury drives the animal to attack other species.

The secretion of the virus from the salivary glands combined with the bite provides an extremely efficient method of inoculating the virus into the host with little risk of exposure to the environment.

Geographical Distribution of Rabies

In Britain, geographically isolated from mainland Europe by the sea and appparently free from wildlife rabies, the authorities were much slower to introduce measures for dog control. Although the disease had been present in the country for most of recorded history and in the 19th century was presenting a serious problem in industrial midland towns, (Johnson, 1959; Anon, 1971; Disseru, 1972, Steele, 1975) no attempt was made to deal with it on a national basis until 1831, when a bill was introduced in Parliament to "prevent the spreading of canine madness". The bill did not become law but local authorities were later given various powers to control dogs (e.g. muzzling, destruction of strays etc). (Anon, 1971; Bisseru, 1972; Steele, 1975). It was not until 1897 that legislation requiring a quarantine period for infected animals was introduced, yet by 1903 Britain was free from rabies. Apart from an outbreak between 1918 and 1922, probably caused by the illegal importation of dogs by servicemen returning from the First World War, the country remained free from the disease until 1969 and 1970. In each of these years a dog became rabid after being released from the statutory six months in quarantine. Fortunately, neither of these incidents led to cases of secondary infection and despite the importation of about 5000 dogs

and cats per year into the country, Britain has returned to its rabies-free status (Anon, 1971; Bisseru, 1972; WHO, 1977a).

With the exception of Scandinavia and Britain, complete elimination of rabies from Western Europe proved virtually impossible because of its persistence in the wildlife. Despite its apparent disappearance from some areas for long periods, it has emerged at intervals with the consequent spillover into dogs and other domestic animals. Two major resurgences of the disease in Central and Western Europe have been associated with the First and Second World Wars. As Schoop (1966) has pointed out however, in the first, from 1918 to 1922, dogs were mainly implicated, while in the second, which started in 1939 and is still continuing foxes are the main cause of dissemination.

At the beginning of the Second World War, numerous cases of rabies in foxes and badgers were reported in Poland; in 1948 the disease reached Czechoslovakia and Austria, and by 1950 was present in West Germany. It was temporarily halted at the Rhine in 1960, but has since continued to spread westward. Its presence in Belgium and Luxembourg was confirmed in 1967 and in 1968 it entered France. In Germany and Denmark which became reinfected in 1964, the disease has been

controlled but not eradicated by drastic reduction of the fox population, but in France this procedure has been less successful and the disease has continued to spread westward (Anon, 1971).

Rabies was unknown in the American Continent until the mid - 18th century, when it was probably imported by European settlers taking dogs with them. The first reports of rabies in the Western Hemisphere was of an outbreak in dogs and cattle in Barbados in 1741 (Steele, 1975) and in dogs in Virginia in 1753 (Shope, 1976). The first major epizootic in North America was reported between 1768 and 1771 when foxes and dogs spread the disease to pigs and other domestic animals, and by 1775 dogs rabies was widespread in all the colonial states. Wildlife rabies was also recognised in the eastern states in the 18th century and after the Civil War, dog rabies was prevalent in most of the U.S. (Bisseru, 1972). Canine control measures were introduced unsuccessfully at the beginning of the 20th century and it was not until the 1950s when a policy of widespread dog vaccination was adopted that urban rabies was successfully controlled (Steele, 1975; Tierkel, 1975).

In South America a major epizootic was reported in Peru between 1803 and 1808 when man, domestic animals, and even fowl were said to have been infected

(Steele, 1975). Although the epizootic subsided, the disease remained endemic. Rabies was also reported in Argentina in 1806, Uruguay in 1807, and Chile in 1838 (Fleming, 1972). The disease also occurred in Colombia in the early 19th century where intensive measures to control dogs were taken in order to curtail the outbreak (Bisseru, 1972).

The problem of rabies transmitted by bats, which is almost exclusively confined to the Americas, constitutes a recent chapter in the history of the disease (Chalmers and Scott, 1969; Bisseru, 1972). There are a number of reports by the early Spanish colonists of vampire bats attacking other animals and men, and of deaths caused by such bites, but it is only since 1921 that vampire bats have definitely been associated with rabies, particularly the paralytic or dumb form seen in cattle (Pawan, 1936a; Baer, 1975). Derriengue is the common Spanish name for this form of the disease in cattle, the history of which was described by Johnson (Galtier, 1879). The first diagnosis of rabies in a non-hematophagous bat was made in Trinidad in 1931 and since then regular diagnoses of rabies in insectivorous and frugivorous bats have been made in various parts of the American continent (Baer, 1975).

Rabies is still present in most parts of the world except Australia, New Zealand, and Antartica, and countries such as Britain and Japan which have succeeded in eliminating the disease remain free from it because of their geographical isolation and strict control measures (Kaplan, 1969; Anon, 1971; Shimada, 1971; Nobuto, 1971; Bisseru, 1971; Blamire, 1973 and Acha and Hubbard, 1975). In other countries such as Denmark (WHO, 1959) which have freed themselves of rabies, the disease has reappeared after variable periods of time. In 1959 the Veterinary Public Health Unit of the World Health Organization (WHO) began regular surveys of rabies (WHO, 1959) which since 1969 have been supplemented by a monthly surveillance of the disease in the Americas carried out by the Pan American Zoonoses Center (PAZC) in Buenos Aires. In addition, the yearly incidence of rabies is published in the annual Animal Health Year Book, published jointly by WHO, Food and Agriculture Organization (FAO), and the Office International des Epizootics (OIE) (Anon, 1960 - 1975). Unfortunately the number of countries sending statistics to WHO is declining (WHO, 1977); furthermore, the accuracy of reporting varies from country to country, so that the world picture presents an impression rather than a precise record (Turner, 1976a).

Compared with many other diseases which occur on a global scale, human deaths and animal losses from rabies may not be striking although they are far from insignificant. Most of the cost is involved in preventive measures, from the rounding up of stray animals to the provision of massive veterinary vaccination programmes and postexposure treatment for man (Kaplan, 1969). However, it is estimated that in the area between tropical Mexico and North Argentina the scarcely credible number of 1 to 2 million animals die each year from vampire bat rabies, at an annual cost to the farming industry of 80 to 250 million dollars (Linhart, 1975) and in the last few years appreciable losses of cattle infected with rabies have also been reported from Canada, U.S., and South Africa, and in Europe from France, Germany, and the U.S.S.R. (WHO, 1959; Chalmers and Scott, 1969).

Animal species currently important in the maintenance and spread of sylvatic rabies are discussed in the works of Baer (1975) and the spread of fox rabies in Europe has been discussed in at least three lengthy articles since 1976 (Lloyd, 1976; Toma and Andral, 1977; Wachendorfer, 1978). However, foxes are not usually considered to be a direct hazard to man (Kauker, 1975). The dog still remains the animal likely to infect man (WHO, 1959; Tierkel, 1975; Turner, 1976a). Despite the

decline in the last 20 years or so in the incidence of infection in dogs in the U.S., it is mainly this species whose bites cause 30,000 postexposure treatments or man to be given each year (Corey and Hattwick, 1975). Kappus (1976) has pointed out that this species should still be regarded as important in rabies transmission to humans in North America, chiefly in rural areas where there is contact with infected animals.

In Africa, particularly in the north and west of the continent, Asia, Southeast Europe, and Central and South America, urban rabies remains of overriding importance and it is in these areas that most human exposures occur (WHO, 1959). In India and the Phillipines, the situation is of particular concern (WHO, 1959; Tierkel, 1975; Turner, 1976a). It has been estimated that in India there are more than 18,000 deaths from rabies each year, while more than 3 million people receive postexposure vaccination (Schwabe, 1971) with nervous tissue vaccines (Semple, 1911) a procedure which itself entails considerable discomfort and no little risk to the patient (Abdussalam and Bogel, 1971).

Rabies in Nigeria

In Nigeria, the evidence of the long history of rabies is contained in the fact that every Nigerian language has a name for rabies in dogs: "Ciwon Kare" (Hausa) "Digbolugi" (Yoruba), "Ginnaji" (Fulani) (Nuru, 1973). It has been reported at one time or a other from all sections of Nigeria (Owolodun, 1969; Banerjee and Elegbe, 1970; Nuru, 1973; Ezeokoli et al., 1981; Ikede and Adeyefa, 1982) and comprehensive reviews of the disease were given by Umoh and Belino (1979) and Fagbami et al., (1982). Many animal and human cases are probably unreported especially in rural areas where veterinary and hospital facilities are inadequate (Nuru, 1973).

Difficulties in obtaining reliable data on rabies in Nigeria have been encountered by others (Nuru, 1973). However, reports from other parts of the country (Owolodun, 1969; Elegbe and Banerjee, 1970; Fagbami et al., 1981) have implicated rabies as one of the major public health problems in the country.

Reservoir Hosts

How rabies virus is maintained in Nigeria is not clearly elucidated. Although exhaustive screening for wildlife rabies has not been carried out, evidence available from epidemiological surveys (Ezeokoli and

Schnurrenberger, 1977; Beran, 1981) and samples submitted to the diagnostic laboratory indicate that wildlife plays a negligible role in the maintenance of rabies in Nigeria (Tomori, 1980). There were no confirmed cases of rabies in over 2000 wild animals tested between 1923 and 1970 (Boulger and Hardy 1960; Banerjee and Elegbe, 1970). However, 94% cases occur in dogs and the virus therefore appears to be maintained primarily in dogs (Owolodun, 1969; Nawathe, 1980). It is estimated that Nigeria has a population of 2.3 million dogs (C.D.C., 1973), although no national or individual state canine census has ever been conducted in Nigeria. Recently, strains of rabies virus were isolated from a monkey and two hyraxes in Ibadan, and one each from a caracal lynx and a civet cat at the Ibadan and Jos Zoological gardens respectively (Annual Reports, University of Ibadan Virus Research Laboratory 1969, 1972; Okoh, 1976; Kasali, 1977). In addition, two rabies-related viruses, Mokola virus isolated from wild shrews caught in Ibadan (Shope et al., 1970; Kemp et al., 1972) and Lagos bat virus isolated from fruit bats in Yaba, Lagos (Boulger and Porterfield, 1958) are known to exist in Nigeria. However, rabies virus has not been isolated from bats or shrews and possibility of wildlife reservoirs in some of these animal species has been expressed but not proven

(Okoh, 1976; Tomori, 1980). The report by Kemp et al., (1973b), that shrews can be experimentally infected with Mokola virus by several routes and that such shrews can transmit the virus by bite, focuses renewed attention on the role of wildlife in the ecology of rabies infection in Nigeria (Tomori, 1980).

McMillan and Boulger (1960) reported that the ground squirrel (Xerus erythropus) is susceptible to experimental infection with street rabies virus. The Hausa and Fulani people of northern Nigeria genuinely fear the bite of the ground squirrel and firmly believe that madness culmination in death, would occur 1 to 6 months after the bite (Zwart, 1969).

The available circumstantial evidence supports the rabies-canid climax model of maintenance of rabies in Nigeria. The evidence include (a) the well accepted existence in West Africa of 'Oloufato' (Bouffard, 1912), a non-fatal disease of dogs which has been identified as rabies (Chalmers and Scott, 1969) (b) occasional reports of human rabies resulting from bites of apparently normal dogs (Anon, 1932), (c) the lack of directional spread of rabies epidemics which should be expected if the virus was maintained by sequential spread among susceptible hosts, as seen in fox rabies in Europe. On the contrary, rabies outbreaks in Nigeria occur in a

random manner consistent with independent, local initiation. More concrete evidence such as the existence of animals that have recovered from infection or are healthy carriers, is required to buttress the canid-climax model.

Prevalence

While the dog remains the most important animal host in Nigeria, livestock are also involved though to a relatively small degree (Boulger and Hardy, 1960; Owolodun, 1968; 1969; Elegbe and Banerjee, 1970; Banerjee and Elegbe, 1971). Over a 15-year period (1967-1981), 354 samples were received from states in the south-western part of Nigeria for diagnosis at the Department of Veterinary Pathology, University of Ibadan. Twenty-three percent canine cases were found putrid and unsuitable for examination while 232 (65 percent) of the remaining 331 specimens were found positive for rabies. These consisted of 218 dogs (94 percent); 6 cats (2.6 percent); 2 cattle (0.86 percent); 3 sheep (1.3 percent); 1 goat (0.43 percent); and 2 caracals (0.86 percent) (Ikede and Adeyefa, 1982).

The rabies diagnostic results of the National Veterinary Research Institute Vom (1968 - 1977) indicate that of the 1,655 specimens received from the ten States in the northern part of Nigeria, Bendel and Cross River

States, only 608 (36.7 percent) were positive for rabies (Anosa et al., 1980). This consisted of 572 dogs (94 percent); 10 cats (1.6 percent); 11 cattle (1.8 percent); 5 sheep (0.8 percent); 3 goats (0.5 percent); 2 pigs (0.3 percent); 2 donkeys (0.3 percent); 1 horse (0.2 percent) and 1 ferret (0.2 percent). In both cases, though the sampling may be biased in favour of canine rabies, this is probably because the disease is more recognised in dogs than in the other species. Nevertheless, the data indicate that the domestic dog is still the major factor in the urban pattern of rabies in Nigeria. However, the incidence of rabies in livestock is worth noting enough it would appear that most of this have been due to dog bites (Owolodun, 1968; Elegbe and Banerjee, 1970; Okoh, 1981).

The National Veterinary Research Institute, Vom recorded 538 cases of rabies diagnosed between 1970 and 1978; 94 percent (504) of cases were dogs, cats and cattle accounted for 1.6 percent each, and the remaining 0.5 percent was spilt between rat, lynx, civet cat and monkey (Nawathe, 1980). The virus therefore appears to be maintained primarily in dogs.

Recent evidences which have highlighted the possibility of occult and chronic forms of rabies as

well as post vaccinal clinical disease (Fekadu, 1972; Fischman and Strandberg, 1973; Doege and Northrop, 1974) makes the situation precarious and calls for a reappraisal of current reports of rabies occuring in dogs within a year of antirabies vaccination (Okoh, 1981, 1983). Some factors such as poor handling and administration of anti-rabies vaccines, poor immune responses due to innate factors and immuno-suppressive diseases in vaccinated animals as well as poor immunogenicity of the vaccine are likely factors.

The potential hazard of rabies in Nigeria has been described by several workers (Thorne, 1954; Boulger and Hardy, 1950; Owolodun, 1969; Ezeokoli and Schnurrenberger, 1977; Umoh and Belino, 1979; Fagbami et al., 1981). The recorded number of people bitten and subsequently receiving anti-rabies treatment annually has increased from 6,000 persons (Boulger and Hardy, 1960), to 7,549 victims (Fagbami et al., 1981) but it is estimated that over 10,000 persons are involved annually (Nawathe, 1980). The reported number of human deaths attributed to rabies has increased from 120 in 1925 to 340 in 50 years (1928 to 1978) (WHO, 1984). One hundred and sixty-nine cases of human rabies were recorded in a survey of 38 hospitals and five epidemiological units nationwide for a 10-year period, 1969 to 1978 (Fagbami et al., 1981).

There are several superstitious beliefs as to the cause of rabies in dogs and these vary from state to state (Fagbami et al., 1981). Also native treatment measures, may also play a role in under-reporting of the disease (Fagbami et al., 1981).

Rabies in Plateau State of Nigeria

The history of rabies in the present Plateau State, appears to be very long as evidenced by the fact that every tribe of the state has a native name for rabies in dogs, for example "Rou Vu" (Berom); "As Titar" (Angas) and "As Georun" (Ankwai).

Prior to 1955 (Anon, 1957) when the rabies diagnostic service was set up and served mainly Plateau Province, rabies had been a health hazard to the people of the area. Very serious outbreaks of the disease occurred in Jos township and the neighbourhood and it would seem rabies was either on the increase in the province or was attracting more attention (Anon, 1927; Beaton, 1928; Henderson, 1929; Anon, 1930 - 35; 1966 - 70). The rabies diagnostic services continued its work and became to be relied upon as a main rabies diagnostic centre in Northern Nigeria (Anon, 1964 - 65).

Canine rabies is widespread in Plateau State but the true annual incidence and geographical distribution on the disease are lacking. Earlier examination of the problem (Owolodun, 1969; Banerjee and Elegbe, 1970) have been based on laboratory data which did not necessarily reflect the populations at risk.

Cases of dog bites inflicted on people appear frequently in Plateau hospitals and health clinics (Anon, 1977, 1978). There are very few attempts made towards epidemiological study of dog bites locally and nationwide (Kale, 1977; Fagbami et al., 1981). The frequency of the administration of post-exposure prophylaxis (PEP) in Plateau State remains to be studied although a hospital survey of the problem between 1970 - 1980 gave a figure of 7,549 over the ten-year period retrospectively examined (Fagbami et al., 1981).

Control of Rabies

The ultimate solution to the rabies problem is predicated on the control and eventual elimination of the disease from animal populations. Prevention in human beings, livestock and in the reservoir hosts is based primarily on breaking the cycles of transmission in the reservoir hosts and, secondarily, on protection of these alternate hosts from exposure or infection (Beran, 1981).

Control may be accomplished by the setting up of transmission barriers principally by mass animal vaccination, elimination of stray dogs, and the reduction of excessive numbers of wildlife reservoirs.

Vaccination Against Rabies and Dog Licensure

When compulsory rabies vaccination programmes are instituted, rabies in dogs decline (Tierkel, 1959; Sikes, 1968; Glosser et al., 1970; Tierkel, 1975a; Nielson et al., 1979). The objective of vaccinating dogs against rabies is to eliminate dogs as the primary source of human exposure. Vaccination levels of 70 percent of a given population are postulated to protect against outbreaks of rabies in that population (Kappus, 1976). This hypothesis requires that the 70 percent of vaccinated dogs be randomly distributed in the population. In real life, most dogs vaccinated against rabies are generally well cared for, and are more or less confined and, therefore, not likely to be exposed. Making vaccination a prerequisite to licensure (Glosser et al., 1970) further identifies licensure as a function of dog rabies control. At the same time, however, licensure will concentrate the rabies control effort on the low-risk (owned) dog population rather than on free-roaming feral dogs. The critical part of thedog population for contracting

rabies is the percentage of unvaccinated free-roaming dogs. The control of the latter category of dogs is a complex issue, not to be resolved through legislation combined with continuing education of the dog-owning public (Taylor, 1976) on the values and responsibilities of pet dog ownership.

Methods of dog vaccination campaigns

(a) Continual dog vaccination at private or governmental Veterinary Clinics to which dog owners take their dogs

It is the responsibility of dog owners to obtain first vaccination at 3 - 4 months old, a second dose one year later and booster doses every 2 - 3 years thereafter with live or inactivated and adjuvanted virus vaccines (Bech-Nielsen et al., 1979). The advantages of this method are that little government effort or expense is needed where veterinary clinics already exist. It works well in conjunction with mandatory licensing and taxing of dogs with the requirement that valid certificates of vaccination be furnished by the owners. This method is most applicable where there are few unowned dogs and the population will voluntarily follow the regulations. When fully implemented, it

continually maintains a high immune level within dogs, ensuring against focal outbreaks of rabies (WHO, 1984).

The disadvantages of the method are that it does not reach unowned dogs and because of the owner efforts and expenses involved, it encourages people to declare their dogs unowned. A high level of compliance by upper and middle class owners of pet dogs may mask a low level of vaccination coverage in the lower class neighbourhoods and non-residential urban areas where rabies is being maintained endemically.

(b) Dog vaccination campaigns through neighbourhood vaccination centres

Community-wide campaigns are usually conducted every 2 years or when focal outbreaks appear between regularly scheduled campaigns. The personnel are commonly government employees, trained for their work, pre-exposure immunized against rabies, and temporarily assigned to the rabies control programme. The advantages of this method are that neighbourhood centres are more conveniently located for most ddog owners than are veterinary clinics. They are relatively easy to publicise and frequently civic organizations and local mass media may effectively

participate in community education and by announcing schedules. Neighbourhood centres are relatively economical to operate and if neighbourhoods are well mobilized, can be very efficient in vaccination time. Vaccination centres may be the only feasible approach when household compounds are not open to vaccinators to enter and vaccinate dogs during times when the masters of the hou eholds are away (WHO, 1984).

The disadvantages are that vaccination clinics rely on owner initiative to bring their dogs. Unowned dogs, and owned dogs which may be difficult to manage off the owner's premises will not be brought. This method encourages people to disclaim ownership of dogs which may live on and even receive food on their premises. Dog owners may be hesitant to mingle their dogs at vaccination centres, recognizing hazards of animal fights, picking up of fleas or ticks, and transmission of infectious diseases. In mixed neighbourhoods, high compliance by some portions of the neighbourhood may mask low compliance of the most critical portions.

(c) House to house dog vaccination campaign with complete coverage of residential areas and selected dog removal

Communities are usually systematically covered every 2 years or when focal outbreaks appear between regularly scheduled campaigns. The campaigns are based on vaccination of all dogs, bith owned and unowned, in residential neighbourhoods, and on vaccination or removal of dogs in non-residential areas. Usually dogs are vaccinated during campaigns without charge to residents. The vaccinators follow set house to house schedules. They must both convince the local residents of the importance of dog vaccination as well as vaccinate the dogs, so it is important that they be well acquainted with and preferably from the areas where they are working (WHO, 1984).

The advantages of this method are that a sufficient percentage, usually at least 90 percent, of all dogs in communities are vaccinated. Residents are encouraged to claim dogs owned or at least recognized. Vaccinators become highly proficient in capturing and vaccinating dogs. Community acceptance is maximised by not killing dogs except on special request (WHO, 1984).

The disadvantages of the method are that training and pre-exposure immunization of the vaccinators are costly. House to house vaccination does not work well in large urban centres where neighbours do not know each other, and does not work well if owners are charged fees for dogs vaccinated (WHO, 1984).

(d) House to house dog vaccination campaigns with entire community coverage and no dog removal

This modification involves complete systematic coverage of entire communities by vaccinators going houte to house in residential neighbourhoods. In addition the vaccination teams capture, vaccinate and release all dogs at non-residential places such as a plaza, markets, abattoirs, food processing centres, garbage piles and other areas providing food and harborage to dogs. Usually at least 90 percent of the dogs in all areas of control communities are vaccinated. Surveillance must be continuous, and prompt action taken upon any re-entry of rabies. Campaigns are usually repeated every 2 years or when rabies reappears (WHO, 1984).

The advantages of this method are that there is minimal disruption of normal community functions and community acceptance will be high. Only one agency, the government service vaccinating dogs is involved, compared with programmes in which animal patrols, police and other agencies must follow the vaccinating teams. Coordination of multiple agencies may be more complex than operation of a single agency. Continuous control actions, which are always difficult to fund and maintain, are not applied between campaigns (WHO, 1984).

The disadvantages are that this method is least effective where natural barriers to re-entry of rabies into control areas exist. Surveillance must be continous and campaigns promptly re-instituted upon re-entry of rabies. However, it must be kept in mind that social, economic and educational differences influence whether or not a particular type of rabies control programme is going to work in a particular area (Sikes, 1971).

Types of Rabies Vaccines

Vaccines for use in Animals

Widespread use of inactivated nerve-tissue vaccines prepared from fixed viruses in the brains of mature goats or sheep, and in more recent years, of modified live-virus (MLV) vaccines prepared from low egg passage (LEP) and high egg passage (HEP) Flury strains in chicken embryos has significantly reduced the occurrence of rabies in many countries (Tierkel, 1959; Sikes, 1975; WHO, 1984). LEP, HEP, Street-Alabama-Dufferin (SAD), Challenge Virus Standard (CVS), and other strains of virus have been adapted to grow in cell culture or have been propagated in the brains of neonatal animals rather than mature animals. This has resulted in potent vaccines containing less tissue mass and with fewer neuroallergic problems.

Increasing use of inactivated vaccines for animal immunization can be expected as a result of recent improvements in vaccine production techniques (WHO, 1984). Although the use of MLV can be justified in areas with extensive rabies in domestic species (Tierkel, 1959; WHO, 1984), immunization with inactivated vaccines is to be preferred when the disease has been brought under control (WHO, 1981).

Human Vaccines

There are three types of human vaccines

(1) those derived from nerve tissue of adult animals (e.g. sheep, goats, rabbit) or newborn animals (e.g. rabbit, rats, and mice);

(2) those derived from avian tissues (e.g. duck embryo); and

(3) those prepared in cell cultures (e.g., human diploid cell strains or animal cell cultures).

In most instances a Pasteur or similar strain of virus is used for production purposes, although specific adaptation to different culture systems is required. For all types of vaccine, the virus is inactivated by one of a variety of physical or chemical agents, e.g., ultraviolet light, phenol, or B-propiolactone (WHO, 1984).

Virus grown in duck embryos and inactivated by B-propiolactone is also used as a vaccine. This vaccine was developed to avoid the neuroparalytic factors contained in brain-tissue vaccines.

Vaccines prepared in cell-culture are now available and appear to combine safety with high antigenic content. A vaccine developed from an adapted Pasteur strain of virus grown in a human diploid cell strain and inactivated with

B-propiolactone is produced commercially in France and the Federal Republic of Germany. Following successful clinical trials in thse countries, and in Iran and the United Kingdom, it is now licensed for use in a number of countries for both pre and post-exposure immunization. In the USA a subunit vaccine, prepared from the Pasteur strain of rabies virus grown in human diploid cells, disrupted with tri-n-butyl phosphate and inactivated with B-propiolactone, has been licensed for both pre and post- exposure use in human beings (WHO, 1984).

Although the incidence of side-effects following the administration of cell-culture vaccine is extremely low, improved methods of vaccine purification and concentration are being sought. The possibility of using purified virus glycoprotein for immunization is being examined in several laboratories (WHO, 1984).

Vaccines for use in Wildlife

Attempts to immunise wildlife species with inactivated vaccines by the oral or enteric route have been unsuccessful (WHO, 1984). Recently, modified live-virus vaccines for the oral immunization of foxes have been developed and tested in the field, first in Switzerland and then in the Federal Republic of Germany

(Meyer et al., 1972; Black and Lawson, 1973; Steck et al., 1982).

The problems and limitations of rabies vaccines are varied whehter for animal, human or wildlife use. Safety can be a concern when MLV is used in animals that are likely to be immuno-suppressed as a result of recent administration of steriod or the presence of immunosuppressive disorders such as feline leukemia (Bellinger et al., 1983). LEP and SAD viruses have caused a number of vaccine-induced rabies cases in dogs and cats respectively, and in some countries are no longer ecommended for use in these species (Dean and Guevin, 1963; Vaughn and Gerhardt, 1965; Kappus, 1976; Humphrey et al., 1978; Pederson et al., 1978; Erlewein, 1981; Esn et al., 1982; Bellinger et al., 1983).

Use of MLV vaccine in a species for which is not explicitly recommended can result in cases of vaccine-induced rabies. Parenterally administered modified live-virus vaccines are not recommended for use in wildlife animals kept as pets or in zoos (WHO, 1984).

Contaminating agents can also be a problem with MLV vaccine. Parvoviruses have recently been recognised as extraneous agents in MLV cell-culture-propagated vaccines, probably because these viruses

are present as contaminants in trypsin or in the mammalian sera used in vaccine manufacture. Because the viruses are small and highly resistant to heat inactivation, they survive measures that eliminate less hardy contaminants (Sikes, 1975).

Vaccines prepared from adult central nervous tissue (Semple type of vaccine in which the virus is completely inactivated in the presence of phenol and the Fermi type in which the virus is only partially inactivated by phenol treatment and the vaccine contains living infective virus) contain neuro-paralytic factors such as myelin. To reduce the hazard from these substances, vaccines are now prepared on a large scale from the brains of sucking animals, since these contain smaller amounts. However, to ensure a low level of these factors, it is necessary, in the case of mouse sucklings, to use animals under 9 days of age at the time of harvest (Kaplan and Koprowski, 1973).

The production of nerve-tissue rabies vaccines from the brains of adult animals has been discontinued in recent years in a number of countries (WHO, 1984). The Expert Committee on Rabies supports the trend to limit or abandon completely, where economically and technically possible, the production of such

encephalitogenic brain tissue vaccines, and strongly advocates the production and use of inactivated cell-culture rabies vaccines in both developed and developing countries (WHO, 1984).

Vaccines such as duck embryo vaccine were developed to avoid neuroparalytic factors but the indications are that although neuroparalytic hazards have been reduced, allergenic risks still exist. It is less dangerous than the brain tissue vaccine, but also less antigenic (Koprowski, 1966).

Recently a dog and several cats died in Zimbabwe from Mokola virus infection even though the dog had been given an inactivated rabies vaccine (Foggin, 1982). The Zimbabwe episode suggests that it is possible to conceive that some of rabies diagnosed in dogs and cats in the past could be infections with rabies-related viruses. The report from Zimbabwe supports the view of Shope and Tignor (1971) that a polyvalent vaccine or appropriate combined vaccine regimen should be available for use in certain areas where rabies and rabies-related viruses exist.

Postexposure treatment of rabies is not 100 percent effective (Wiktor, 1980). Failure occurs even when the vaccine can be assumed to be potent and the treatment prompt (Hattwick et al., 1972, CDC. 1976).

Antigenic differences among strains of rabies virus have been suspected to be responsible for such failures (Wiktor and Koprowski, 1980).

Stray Dog Control

Mass vaccination will not reach the stray or ownerless dog, a factor which remains a potential threat in the transmission of rabies (Tierkel, 1959). An efficiently conducted programme requires the operation of a local pound or humane shelter where stray dogs may be kept for a few days and, if unclaimed at the end of that period, destroyed humanely. Collection of stray dogs should be carried out by teams of dog wardens and assistants in animal patrol vehicles usually jeeps or pickup trucks equipped with cages, dog catching and restraining devices. Personnel responsible for this activity should be qualified and trained (Tierkel, 1959). Licencing or registration of all dogs is often a valuable adjuvant as if properly enforced, it identifies the ownerless strays (Tierkel, 1975).

Methods available for humane dstruction of stray dogs include (1) chemical methods using either gases (e.g. carbon monoxide chamber or employ-inhalant poisons notably ether, chloroform, Halothane, Hydrogen cyanide and carbon dioxide) or compounds given as

intravenous injections are considered appropriate for euthanasis if restraint facilities and trained personnel are available for administration. Pentobarbital, of immediate action and relatively low cost is the most used barbiturate. Compound T-61, a combination of 3 drugs is effective for intravenous or intracardial euthanization. Lethal drugs such as succinyl-choline-chloride can also be used by direct muscular injection using distance propelled syringe darts (WHO, 1984). (2) Rapid decompression chambers produce hypoxia by evacuation of air to 68.8 mm of mercury or lower. (3) Electro-lethalators are also available in some countries for destrucvion of stray dogs.

Destruction of Dogs without initial capturing

The methods include (1) Shooting: In residential areas dog can be killed either with a shot-gun or preferably a long rifle equipped with a silencer. In rural areas dogs and cats can be killed when found far from houses, using a shot-gun or rifle; (2) Capture guns use compressed carbondioxide or percussion caps to propel syringes or darts to inject target dogs with immobilizing drugs. (3) Oral poisoning: in urban residential areas meat and fish baits or chicken heads are commonly used. Strycnmine and sodium cyanide are

are frequently used and are cheap but very hazardous and inhumane. In non-residential areas, shooting and capture gun methods are preferable. When all dogs which have taken poison baits are dead, the carcasses and remaining baits must all be collected and deeply buried to prevent any scavenger animals or persons from accidental poisoning. Stray dog control has its problems and limitations. Animal pounds are costly to build and operate. They are practical in large urban centres in which unconfined and unowned dogs may wander through neighbourhoods and dog removal is needed as an adjunct to owner vaccination and control of dogs.

Alternative methods for euthanizing dogs require specialized facilities and training of personnel. While some inhalant poisons like chloroform are cheaper and nonflammable, others like Nitrous oxide gas is relatively expensive for animal euthanasia; and, others like Hydrogen cyanide, constitute a personnel hazard that should probably be used only where pounds may be located in uninhabited open areas. Shooting though the cheapest method and can be applied at long distances requires special material, great caution and skilled marksmen. Oral poisons such as strychnine and sodium cyanide are very hazardous and inhumane.

Wildlife Control

Techniques available for population reduction programmes include poisoning, gassing, trapping and hunting. The most efficient and certainly most economical techniques have been poisoning and gassing. These methods must be applied with extreme caution, especially in areas of dense human and domestic animal populations. Use of poisons has proved more feasible with small reservoir species for example strychnine-treated eggs for skunks and thallium sulphate for mongooses.

Reduction of Excess Numbers of Wildlife Reservoirs

Outbreaks of rabies in Wild animals occur generally when the population of the species becomes particularly dense in an area (Tierkel, 1959; WHO, 1972; Wanderler et al., 1974; McLean, 1975b). Organised trapping and poisoning programme are the most effective means of reducing this overpopulation to a safe level in areas menanced by wildlife rabies (Lewis, 1975; Tierkel, 1975). Any predator control technique should be directed not toward extintion of a reservoir species but toward reduction of a species population to a level too low to support an epizootic of rabies (Sikes, 1975).

Many limitations of cost and danger restrict the effective wide scale use of trapping, poisoning, gassing and hunting. Trapping reservoir species such as foxes and mongooses has been used in some areas but this is both expensive and less effective than poisoning animals or gassing dens (Sikes, 1975). Trapping is frequently the method of choice in most areas because it is safer than poisoning (Tailor, 1966; Lewis, 1975; Bateman, 1976). For many species, poisoning is far more efficient and economical than trapping, the latter being quite ineffective (Marx, 1966). Where poisons have been used it was possible to devise protected bait stations, thus minimizing the danger of accidental poisoning of children and domestic animals. Gassing of dens is applicable on a seasonal basis for short periods of time when the families of reservoir animals are together. If reduction programmes are not continued with persistence year after year, wildlife populations tend to rapidly return to previous levels.

As a result of the above problems and limitations in wildlife control, other principles of control, such as developing a practical, safe and effective oral vaccine for use in terrestrial wildlife had to be investigated (Sikes, 1975). Promising results have been

obtained in experiments on immunizing foxes with vaccine (Schmidt and Sikes, 1968; Baer, 1971; Debbie et al., 1972; Black and Lawson, 1973; Baer, 1975) and the procedure has also been applied in field conditions namely in Europe and Canada (Wachendorfer, 1968; Meyer et al., 1972; Steck et al., 1982). Vaccination has received increasing attention as a potential means of wildlife rabies control (Baer, 1975; Winkler and Baer, 1976).

There are, of course, many questions still to be answered before such a product can be used in mass vaccination campaigns for foxes and possibly other species. These include as discussed by Baer et al., (1971); (1) A pathogenesis study to determine the precise site of primary replication of the vaccine (2) safety testing in foxes, in which vaccinated animals are tested for possible excretion of virus in saliva, lacrimal secretion, urine or feces, and a test of any virus isolated for enhanced virulence. This would also include further tests in foxes to be sure that none develop clinical rabies, including uninoculated contacts along with vaccinates to see if contact transmission would occur. (3) The course of infection with ERA virus in other animals to see if any developed clinical rabies (4) The survival of virus under field conditions and development of a suitable bait.

Another possibility is the principle of population control by interrupting the reproduction cycle through the use of hormones (Baer, 1975; Sikes, 1975).

Ecology of the Dog

Before any rabies control programme is initiated, data should be obtained on patterns of dog ownership relationship of animals to human society, population, density, age structure and turnover, habitat, relationship of dogs to other reservoir species, etc. (Beck, 1973; Selby et al., 1980; 1983; WHO, 1983; WHO, 1984). Priority should be given to obtaining such ecological data from areas where the risk of exposure and the likelihood of spread of infection are greatest. Wide variations exist in the relationship of dogs to human society trhoughout the world and the success of a canine rabies control programme in a specific country will depend largely on its adaptation to local ecological and social patterns (WHO, 1984; Beran, 1981). In broad terms, dogs can be divided into three distinct groups, on the basis of their relationship to human society:

(1) Owned dog: considered as the property, or part of, a specific household to which it provides economic or social value. An owned dog may be restricted or unrestricted in movement. In rabies

control programmes, these dogs may be vaccinated and/or harbourage, at least during part of the year, from more than one household. Depending on the society, such dogs may be vaccinated or removed at the initiative of the community, but not of the individual. In many developing countries, these dogs hold the key to the success or failure of programmes.

(3) Stray dog: an owned dog that is not wanted by residents of the community. Stray dogs may be found individually or in packs. In rabies control programmes, they can usually be removed without producing objections from the public (WHO, 1984).

The acquisition of knowledge concerning dog population along with sociological and demographical data regarding dog-human relationships will result in a significantly better understanding of the following:

(a) The incidence and persistence of dog rabies in urban and rural communities in relation to dog population densities and demography.

(b) The relationship between dog movement, dog social interactions, and rabies transmission between individuals within populations and the spread of the disease into new areas.

(c) Regional and local sociological and cultural practices that result in the presence of dog population susceptible to rabies and cultural activities leading to endemic dog rabies situations.

(d) Dog behaviour and human attitudinal and cultural practices as related to the effectiveness of dog control and rabies vaccination programmes (Selby et al., 1979; 1980, Beran, 1982; WHO, 1983; WHO, 1984).

Data from population studies of pet animals and their owners have several important uses including:

(1) Planning for veterinary services, including defining the need or lack of need for certain specialties.

(2) Developing data for control of canine and feline diseases (Anderson and Cameroon, 1955).

(3) Providing base-line data in studying incidence and prevalence of zoonotic disease (Schnurrenberger, et al., 1961; Dorn, 1967; Anvik et al., 1974) as canine and feline population data are indispensable in estimating the potential threat of these diseases to man populations.

(4) Providing quality control and comparison data for disease studies. With detailed descriptive data on animal populations, it is possible to generalise more broadly the findings from intensive study of a limited sample within that population.

(5) Determining the impact of domestic animals on the environment, particularly with reference to pollution, noise and nuisance factors (Senn and Lewin, 1975; Kahrs et al., 1978 Heussner and Grant, 1979).

(6) Comparing changes in zoographic patterns, both in terms of describing various aspects of the animal population as well as in how changes in pet animal populations reflect concomitant urbanization and changes in behaviour or style of living among human populations (Feldman, 1977).

(7) Facilitating comparison of various animal health characteristics among geographic-political units. Distribution differences can provide useful clues concerning etiologic factors in similar human diseases, such as certain site-specific cancers (Cohen et al., 1969; Priester, 1979).

In order to answer these and related questions, large scale, multicentre, co-ordinated studies probably would be needed. For the reasons given earlier and

because of the intriguing questions raised by findings from recent surveys of dog and cat populations, many researchers believe pet ownership as a phenomenon concerning the health of both human and nonhuman populations deserves continued and intensified study (Senn and Lewin, 1975; Feldman, 1977; Heussner and Grant, 1978).

In most of the world and especially in tropical countries, the animal reservoir of rabies is the dog, and the magnitude of the problem of human rabies depends basically on the relationship of dogs to people. The maintenance of the disease essentially reflects transmission of the virus from dogs to other domestic animals, and to man, with human beings as dead-end hosts. The most cost-effective and logical approach to the control of the disease is via the animal reservoir host (WHO, 1984). Much as the study of the ecology of the dog is essential, it has not been studied in Nigeria. Reliable and accurate dog population data are not readily available for most parts of the country, and in view of the increased concern with pet population growth, such data are vitally needed.

In ecological studies it is often necessary to estimate the number or abundance of animals (Beck, 1973). There are various techniques for doing this (Zippin,

1958; Hanson, 1968; Beck, 1973; Schemnitz, 1980) but only some are practical for use in rabies control and when assessing the effectiveness of a dog control programme (Beck, 1983, 1984). These methods are modifications of ecological techniques developed for wild species and precise validity must be stressed. No practical method can determine the exact number of dogs in a population size (Beck, 1973, 1983). At this time, the best validation will be to use several methods with the same population (Beck, 1983). Estimates of abundance tend to be validated when several methods, differing conceptually give comparable results (Hanson, 1963). As a general rule, free-ranging dogs are best surveyed in the early morning, a time of dog activity, less human activity, and good visibility (Beck, 1973, Fox et al., 1975).

Dog abundance is related to different epidemiological situations, to different culture areas, to different rural and urban habitats, to areas of different human settlement patterns and also to different social strata of human rural and urban populations (WHO, 1983). Dog population density is commonly indicated as a dog to human ratio, occasionally also as dogs per household. In many situations it would be more meaningful to express it as numbers of dogs per unit area, or to have it related to both surface

area and human population (WHO, 1983).

Various methods are available for estimating the number of free-roaming carnivores, all of which are based on two assumptions (Davis and Winstead, 1970; Caughley, 1977):

(1) that mortality, emigration and recruitment into the population are minimal during the period of census, or that corrective factors can be incorporated into resultant estimates;

(2) that all individuals within the population to be estimated have an equal chance of being counted.

Techniques that have been used to obtain estimates of dog densities include:

(a) Total or direct counts: This method simply consists of making direct visual counts of individual dogs in a defined geographical area and within a limited period of time in order to meet the assumptions mentioned above. Direct counts are not practical over large geographical areas nor in sizeable cities but can be used in small communities and rural situations where dog populations are small (Gipson, 1982). Under certain conditions, estimates of density may also be obtained by counting dogs along stratified samples of randomly selected streets or in quadrants (Gipson, 1982;

WHO, 1984). These data can then be estrapolated to the entire study area. In some circumstances, data derived from this technique may also be used to compare dog densities between areas when expressed, for example, as the mean number of dogs observed per unit of land area (e.g. dogs/hectare).

(b) Estimates from rate of capture: Assuming certain constraints such as a closed population, equal intensity of capture effort and probability of capture, and unvaried environmental conditions, estimates of dog populations can be obtained by plotting on graph paper either the sum of daily capture, the cummulative sum of capture, the probability of capture or the catch-effect required (Beck, 1983). Plots can be smoothed and/or extrapolated to provide estimate of dog population size. More complete explanation of these procedures are detailed by Caughley, (1977); Davis and Winstead (1980) Schemnitz (1980).

(c) Estimates from recaptures: The reliability of these techniques are dependent upon the same constraints as mentioned in (b) above. They are commonly known as the "Perterson-Jackson" or "Lincoln" index and are based on the use of a simple ratio obtained by capturing a number of individuals, marking or tagging them, and releasing them back into the population. The population

is subsequently sampled again by trapping and total dogs caught and the numbers that are marked are determined (Beck, 1973; 1983). The population estimate is then obtained as follows:

$$\text{Estimated dog population} = \frac{\text{No. dogs subsequently caught}}{\text{No. marked dogs recaptured}}$$

$$\frac{\text{No. dogs caught, marked and released}}{\text{No. marked dogs recaptured}}$$

OR

$$\text{Estimated dog population} = \text{No. dogs initially trapped, marked and released} \times \frac{\text{Total No. of dogs subsequently caught}}{\text{No. marked dogs recaptured}}$$

The statistical procedure currently described as the most suitable for analysis of capture-recapture data are described in several works (Jolly, 1965; Caughley, 1977, Beck, 1983).

(d) Photographic "recapture" method: Dogs in urban areas do not have to physically captured in order to mark them. Studies by Beck (1973), Heussner et al., (1978), Daniel (1980) used a method whereby dogs were "marked" by photographing them. Subsequent sampling then determined the number of "recaptures" on any given day based on the number of dogs that had been photographed previously. In other studies a modification

of Schnabel's statistical analysis for multiple recaptures (Day et al., 1980) was used (Hanson 1967; 1968; Beck, 1982). This technique has the advantage of reducing sampling error since capture ratios are averaged (Beck, 1973). Photographic recapture has several advantages over actual capture as there is no possibility of developing trap shyness or proneness as the animal does not know he has been trapped. Photographing the dogs is faster and easier than trapping and is acceptable to the general public (Beck, 1983).

The work of Beck (1973) employed several alternate methods for estimating dog abundance and compared the numberical values derived from each as a measure of their availability. Such comparison are recommended when uncertainty exists as to which method of population estimating is most suitable for a given situation (WHO, 1983). While the phtographic multiple recapture method may be suitable for smaller areas where the dog population consists of mixed breeds and individuals can be distinguished on the basis of colour, identifying markings and size. Native dogs in some geographical areas are more physically uniform in appearance and distinguishing individuals would be difficult or impossible. In such area physically marking individuals may be necessary (Beck, 1973, 1983).

(e) Indices: The techniques involve establishing a relationship between the numbers of animals present in an area and some measurable environmental factor. So far the only published attempt to establish relative figures of dog abundance and distribution in a city used the number of sightings of dogs at large by school children in Bristol, United Kingdom (Harris, 1981). Another index which could possibly be used is the widely recorded frequency of reported dog bites in relation to the dogs present in an area. But this figure depends on a great variety of factors (Marr et al., 1979). Indices of relative abundance generally require less effort to obtain than actual densities and are particularly valuable for determining changes in population size over time or for comparisons between environmentally similar areas. As with all other techniques previously discussed, certain assumptions, must be made in order to obtain valid indices (WHO, 1983).

The density and distribution of dogs, whether in urban or rural areas vary depending upon environmental factors, availability of food, water and shelter, and human cultural practices and customs. Because of these variations, the selection of sampling units or methods of stratification of study areas, the results of which are later extrapolated to estimate total densities, have to be carefully considered (WHO, 1983). For example,

the commonly used procedure of sampling to obtain a dog to human ratio and applying it to the total human population in a city to estimate total dog numbers, does not take into account variations in the frequency of dog ownership as a result of such factors as economic status. Sampling procedures are therefore an extremely important component of population estimation techniques (WHO, 1983).

(f) Estimator for unidentified individuals: The various methods for estimating animal populations by actual removal of animals can be analogously applied by mathematical removal (Hanson, 1968). Basically, removal uses various formulae that estimate the slope of the line generated when the daily removal is plotted against the number previously removed. This line can be extended to cross the theoretical point on the graph of total removal, that is, the population that must be present (Beck, 1983).

If the removal of dogs lowers the population, it is theoretically possible to calculate the decline to estimate the total number of animals that could be "theoretically" removed. Plotting the numbers removed each day against the accumulated total removed to date, could be extended to the point where, theoretically, all animals are removed, that is, the total population

that was present in the area (Davis and Winstead, 1980).

Unless the capturing significantly lowers the population faster than it can recover, this method is less useful than the recapture methods previously discussed (Beck, 1983). The method is biased slightly downward, but the bias becomes less as the size of the sample plots is made smaller (Beck, 1983).

(g) Questionnaire and Household Survey: The number of owned dogs may be established by questionnaire surveys, or from the records of licensing of dogs (Schnurrenberger et al., 1961; Marx and Furcolow, 1969; Kelly, 1980; Nassar and Moiser, 1980; Rangel et al., 1981; Beran, 1982).or during vaccination campaigns (Beran et al., 1972). If there is any indication that a sizeable proportion of a dog population escapes these censusing procedures, the techniques used for estimating wildlife abundance have to be applied (WHO, 1983).

Also, in recent years canine and feline population estimates of different households in urban, sub-urban and rural localities have been made from stratified random sampling or completely random sampling of either the rural or urban communities (Schneider and Baida, 1970; Franti et al., 1974a Wilbur, 1975; Franti et al 1980).

The assumptions implicit with any method should be met and statistical confidence limits, which give a statement regarding the probability that a population estimate is within certain limits, should be developed, whenever possible (Beck, 1984).

Rabies-Related Viruses

The rabies-related viruses have all been isolated in Africa, a finding which supports the idea that rabies virus itself originated in that continent (Shope, 1976). Lagos bat virus (Boulger and Porterfield, 1958) was isolated in 1956 from the brain of a frugivorous bat, Eidolon helvum on Lagos Island in Nigeria. In 1974 the virus was also isolated in a rodent, pussilus in the Central African Republic (Bishop, 1979). Lagos bat virus has recently also been recovered from a number of sick bats in Natal (Meredith and Standing, 1981). Three isolations of Mokola virus were made in 1968 from the viscera of shrews (Crocidura sp.) captured near Ibadan in Nigeria (Shope et al., 1970) and another isolate in 1969 (Kemp et al., 1972). Another isolate from shrews was made in 1974 in the Cameroons (Bishop, 1979). Mokola virus was also isolated in 1968 and 1971 from two young children suffering from central nervous system disease one of whom died (Kemp et al., 1972; Familusi and Moore, 1972; Familusi

et al., 1972); from humans or domestic animals, birds, bats, or shrews in Nigeria (Shope and Tignor, 1971; Kemp et al., 1972).

The virus nevertheless can infect adults as demonstrated by the recent infection of a laboratory worker in West Germany. Fortunately, the individual concerned had a high level of rabies neutralizing antibody prior to infection, which may have aided his recovery (Bishop, 1979).

Also recently Mokola virus was obtained from several cats and a dog dying from Mokola virus infection in Zimbabwe (Foggin, 1982). The dog had been recently vaccinated with a potent inactivated rabies vaccine which had, as would be anticipated from cross-neutralization tests (Shope et al., 1970) failed to protect it against infection.

Duvehage virus was isolated in 1970 from the brain of a man in the Republic of South Africa who developed a rabies-like illness after being bitten on the hip by a bat (Meredith et al., 1971). Duvenhage virus has been isolated from two bats near Hamburg and presumed to have been carried by sea from South Africa (Schneider and Meyer, 1981).

Shope et al., (1970) showed that rabies virus could no longer be regarded as a single serological entity when he demonstrated that Lagos bat virus and Mokola virus, isolated in Africa, were related to rabies virus. The interrelationships were demonstrated in both serum neutralization and complement fixation tests and Schneider and Schoop (1972) suggested that the two new viruses, together with Nigerian horse virus (Porterfield et al., 1958) should be regarded as new serotypes sharing common antigen on the ribonucleoprotein which was responsible for the cross-reactivity observed in complement fixation and immunofluorescence tests.

The results of cross-neutralization tests within the Lyssa group, however, seem to vary between laboratories and cross-protection tests to determine antigenic relationship between rabies, lagos bat, and Mokola viruses have also proved difficult to interpret (Tignor and Shope, 1972; Bishop, 1979). There seems to be difficulties such as interference and prozone effects inherent in the tests (Bishop, 1979).

Tignor et al., (1973) showed that the cross-reactions among the Lyssaviruses make it difficult and often impossible to differentiation them by routing serologic tests, including fluorescent antibody (FA)

tests. Some differentiation was achieved with highly specific antisera produced by immunization with highly purified viral glycoprotein antigens (Schneider et al., 1972) but this technique was too involved to be used for routine laboratory diagnosis. A relatively rapid assay technique for laboratory differentiation of the viruses was recently described (Ezeokoli and Tignor, 1982) who suggested that the rabies serogroup viruses can be differentiated by means of the complement-mediated cytotoxicity assay. This is because the asymmetric (One-way) patterns of cross-relations among tested viruses were similar to the patterns of cross-protection observed in vaccination challenge tests which hitherto is the most reliable method of differentiating the serogroup viruses (Tignor et al., 1973; Tignor et al., 1977). Furthermore, the cytolytic activity appeared to be a better estimator of the protective properties of immune serum than the in-vitro virus neutralisation test. Therefore the cytotoxicity assay is said to have potential application not only as rapid diagnostic tool for differentiating between the rabies-serogroup viruses, but also a more effective alternative (than the in-vitro neutralization test) for assessing the effectiveness of rabies vaccines.

There are at least 4 serotypes in the genus Lyssavirus. Serotype 1 has the prototype strain CVS and includes the majority of field and laboratory strains from different parts of the world and the newly recognised rodent isolates from areas in Central Europe. Serotype 2 has prototype strain Lagos bat, isolated from pooled brains from frugivorous bats in Nigeria (Boulger and Porterfield, 1958), and South Africa (Meredith and Standing, 1981) and Central African Republic (Crick, 1983). Serotype 3 has Mokola isolated on several occasions from shrews (Kemp et al., 1972) and man (Familusi et al., 1972; Crick, 1983). In Nigeria, Cameroon, and Zimbabwe (Foggin, 1982) as the prototype. Serotype 4 has as its prototype strain Duvenhage isolated from a man bitten by a bat in South Africa (Meredith et al., 1971).

Other possible serotypes are Kotonkan virus from Culicoides species in Nigeria (Kemp et al., 1973) and Obodhiang virus from Mansonia uniformis mosquitoes in Sudan (Shope, 1975).

Preliminary results indicate that selected monoclonal nucleocapsid antibodies allow for differentiation between the serotypes of Lyssavirus and also between certain variants of the serotype 1 viruses (Flamand et al., 1980). Antiglycoprotein monoclonal

antibodies show a much greater diversity when reacted with several viruses indicating the number of glycoprotein determinants to be much higher than those of the other structural antigens (Flamand et al., 1980b). So far, single specificity hybridomas, e.g. those reacting with one single strain only were found for the virus strains CVS, PM and ERA (Flamand et al., 1980b).

Production and Use of Monoclonal Antibodies in Characterization of Rabies and Rabies-Related Viruses

Monoclonal antibodies are produced by immunization of mice with B-propiotactone-inactivated rabies virus with isolated nucleocapsid or with live virus and the subsequent fusion of splenocytes from these mice with mouse myeloma cells deficient in hypoxanthine phosphoribosyl-transferase (Koprowski et al., 1977). The resulting hybridomas secrete antibodies directed mostly against either virus nucleocapsids (Flamand et al., 1980a) or virus glycoproteins (Flamand et al., 1980b). Few hybridomas secrete antibodies directed against the NS or M proteins of rabies (Koprowski and Wiktor, 1980).

Structural Antigens of the Rabies Virion

The understanding of the working of hybridoma monoclonal antibodies can best be comprehended with a knowledge of the structural antigens of the rabies virion. Rabies virus particles contain five distinct polypeptides four of which have been shown recently to be distinct antigens: the glycoprotein G and the membrane protein M2 antigens are located on the outer surface of the virus membrane; the nucleoprotein N and the protein M1 are internal antigens closely associated with the virus RNA which together with the largest protein L, form the so-called replicative complex of the virus (Crick, 1983). The glycoprotein was shown to be the only antigen capable of inducing the formation of virus-neutralizing antibodies and of protecting animals against subsequent challenge with rabies virus (Cox et al., 1977; Wiktor and Koprowski, 1980; Dietzschold et al., 1983; Wunner et al., 1983). N, M1 and M2 - antigens induce the formation of antibodies demonstrable by complement-fixation and precipitation techniques, but the sera have no virus neutralizing activity (Koprowski and Wiktor, 1980; Wiktor, 1981).

All four antigens induce antibodies which by immunochemical staining of rabies virus-infected cells specifically identify their respective antigen

(Koprowski, 1980; Wiktor, 1980).

The nucleoprotein antigens of different rabies viruses were shown by serological and peptide analyses to be closely related and are considered to represent the group-specific antigen of the genus Lyssavirus (Koprowski, 1980).

Antibodies directed against the nucleocapsid antigens stain intracytoplasmic inclusions of acetone- or formalin-fixed virus-infected cells, and they show no virus-neutralizing or immunolytic activity (Wiktor, 1980). Antibodies directed against the glycoprotein antigen stain the membrane of virus-infected unfixed cells and lyse them in the presence of active complement (Wiktor, 1980). Both types of antibodies bind specifically to the corresponding purified antigens in radio-immunoassay (Wiktor, 1980; Koprowski, 1980; Flamand et al., 1980b)

The group of hybridomas that secrete antibodies against the NS or M protein is not well defined (Wiktor, 1981). The antibodies show binding to antigens of purified virions in radioimmunoassay, but their activity is lower than that of the antibody secreted by anti-N or anti-G hybridomas (Wiktor, 1981). Anti-N hybridomas can be further distinguished from anti-G hybridomas since the former stain intracytoplasmic inclusions in

cells infected with rabies virus after fixing with formalin but not with acetone (Flamand et al., 1980a). Anti-N hybridoma shows less neutralizing activity than anti-G hybridoma (20 to 50 plaque-forming units versus 10,000 plaque forming units), but the two are equally active in lysing rabies-infected cells in the presence of complement and in staining antigens present on the surface of live virus-infected cells (Wiktor, 1980). Of a large number of hybridomas obtained from several fusion experiments, 36 hybridomas showed anti-nucleocapsid specificity and 44 showed anti-glycoprotein (Schneider, 1980; Flamand et al., 1980a; 1980b; Wiktor, 1983). These hybridomas were cloned and tested for purity and stability (Flamand et al., 1980a; 1980b). They were then used for analysis of several laboratory strains of rabies virus and rabies-related virus as well as analysis of a number of e field virus isolated (Wiktor and Koprowski, 1980; Schneider, 1982, Sureau et al., 1983). Antigenic differences were detected on both nucleocapsid and glycoprotein levels (Flamand et al., 1980a; 1980b; Wiktor, 1981). The 25 monoclonal anti-N antibodies displayed different specificities for the different viruses and were categorised into eight groups. A basic panel of three hybridomas is sufficient for differential diagnosis of rabies infection by staining

antigens in impression smears of cells from infected animals or human beings and for recognising immediately whether infection is due to the rabies virus or rabies-related viruses (Flamand et al., 1980a).

Similarly, the anti-glycoprotein monoclonal antibodies were classified into several groups of reactivity by the virus neutralisation procedure. These hybridomas allow differentiation of strains of rabies from one another as well as from the rabies-related viruses (Flamand et al., 1980b). Another interesting observation has been the identical reactivity of either glycoprotein or nucleocapsid proteins of rabies viruses isolated from the same geographical area and animal species in the case of isolates from France and Germany or the USSR (Wiktor, 1981; Sureau and Rollin, 1982).

Monoclonal antibodies have also been used to identify strains of virus involved in the postvaccinal rabies infection in cats and dogs to determine whether the disease and death of the animals had been induced by the vaccine virus or had resulted from natural infection with a street virus (Wiktor, 1981; Erlewein, 1981; Esh et al., 1982).

Antinucleocapsid antibodies

Table A (Appendix 1) shows the number and the specificities of anti-nucleocapsid hybridoma antibodies reacting with nucleocapsids of different members of the rabies-fixed and rabies-related groups of viruses (Flamand et al., 1980). Most of hybridomas secreted antibodies that reacted with the four fixed-rabies strains and the HEP strain. This reactivity was greater, by far, than that with rabies-related viruses (Flamand et al., 1980a). One hybridoma antibody, 502 - 2, reacted with all rabies and rabies-related viruses; 103 - 7 reacted with rabies viruses only while another hybridoma antibody, 422 - 5, reacted only with rabies-related viruses (Flamand et al., 1980a). Antibodies secreted by seven hybridomas did not bind to the nucleocapsids of HEP, but did react with the nucleocapsids of all other fixed rabies viruses. Of these, three reacted with the three rabies-related viruses as well, (Flamand et al., 1980a; Wiktor and Koprowski, 1980). The specificities displayed by hybridomas 389, 237 - 3, and 222 - 9 made it possible to distinguish among the three rabies-related viruses.

The investigation was extended to viral isolates from different parts of the world, and this enabled the construction of a panel of anti-nucleocapsid antibody clones and FA staining of brain impressions from

infected animals, the presence of rabies or rabies-related viruses has been diagnosed consistently, and differentiation among some of the individual strains within each groups is possible.

Antiglycoprotein Antibodies

On the basis of their reactivity with purified virions of several strains of virus, glycoprotein hybridoma antibodies were classified into 14 distinct groups (Table 8 Appendix 1). Antibodies of the hybridomas in Group I cross-reacted with all rabies and rabies-related viruses; and antibodies of hybridomas from Group II, III, and IV cross-reacted with all and either one or two rabies-related viruses. Antibodies produced by hybridomas from the remaining groups cross-reacted with a fewer number of viruses. Each of three hybridomas groups showed a single specificity: Group XII for CVS, Group XIII for Kelev, and Group XIV for Mokola (Flamand et al., 1980b).

The 25 antiglycoprotein hybridomas listed in Table 8 (Appendix 1) were evaluated for the presence of neutralising activity against the eight virus strains listed in the same table (Flamand et al., 1980b). A complete correlation between binding activity in RIA and virus neutralisation was obtained for PM, HEP and

Kelev viruses. However, the Duvenhage virus, which reacted positively in RIA with 11 hybridomas, was neutralised by one hybridoma only, 613 - 2. Mokola virus was also neutralised by one hybridoma, 491 - 1, even though it had reacted positively with two additional hybridomas in the RIA test, Lagos bat virus was not neutralised by any of the three hybridomas with which it had shown binding in RIA. Of 19 hybridomas which showed binding to standard challenge virus (CVS) in RIA 12 neutralised the virus. Finally, the ERA virus was neutralised by all two of 19 hybridomas positive in RIA. Recently, the antigenic structure of the glycoprotein has been investigated (Dietzschold et al., 1983). Based on the pattern of reactivity of a panl of glycoprotein variants with neutralizing monoclonal antibodies, four distinct antigenic sites on the glycoprotein can be delineated (Lafon et al., 1983). However, it is not known which antigenic sites were responsible for confering immunity against rabies infection.

Nine rabies viruses, originally isolated from humans and from different species of animals on four continents, were tested in a neutralisation test with nine hybridoma antibodies (Wiktor et al., 1980). As shown in Table C (Appendix 1) viruses AF and SF, isolated from foxes in France and Germany, respectively, showed identical

patterns of cross-reactivity with neutralising hybridoma antibodies. The two viruses isolated from humans in the USSR also showed identical patterns of cross-reactivity. Each of the remaining viruses had distinctive specificities. Since the number of field isolates was rather small, it was not possible to determine whether viruses isolated from the same species of animal and/or the same geographical area are more likely to cross-react with hybridoma antibodies in the same way as viruses isolated from different animal species and/or distant geographical area. Hybridomas of different groups probably recognize different antigenic determinants on the glycoprotein (Flamand et al., 1980b). At present at least nine antigenic determinants were recognized on CVS, seven on PM, nine on ERA, eight on HEP, eight on Kelev, five on Duvenhage, two on Lagos bat and two on Mokola virus. These are conservative estimations, however, as Flamand et al., (1983b) assumed that hybridomas of the same group size recognize the same antigenic determinants. If the antibodies are assayed with a larger panel of viruses, further subdivisions of the group may result (Flamand et al., 1980b).

Why antibodies react with the glycoprotein but do not neutralise the ERA virus (Table C, Appendix 1) is

an intriging question. This could not be answered by differential affinity of a given antibody for a different antigen. At present no satisfactory explanation could be offered for this puzzling observation, except by the multiplicity of sites on the glycoprotein (Flamand et al., 1980b).

It appears that out of 16 antigenic determinants so far identified on the CVS rabies virus, glycoprotein and nucleocapsid, for example, nine are shared with Duvenhage, six with Lagos bat and five with Mokola virus (Flamand et al., 1980a; 1980b). Among the rabies virus strains, CVS, PM ERA and Kelev were found to differ from one another by only a few antigens on the glycoproteins; in contrast, HEP differed from the others mainly in nucleocapsid antigens. It has already been shown that rabies and rabies-related viruses may be differentiated by using monoclonal antibodies that react with the nucleocapsid (Flamand et al., 1980a). This diagnostic procedure can be amplified by using the anti-glycoprotein antibodies of groups I, II, III, VII, IX and XIV, which react with one or more of the rabies-related viruses. Thus it is now possible to identify several strains of rabies virus by their reaction with five or six anti-glycoprotein monoclonal antibodies. This procedure was recently employed in order to identify the virus present in the brain of cats that

died after vaccination with a modified live rabies vaccine (Esh et al., 1982).

Rabies virus glycoprotein is the only viral antigen that induces the production of virus-neutralizing antibodies (VNA) and confers immunity against lethal challenge infection with rabies virus (Cox et al., 1977). Recently, the antigenic structure of the glycoprotein has been investigated. Based on the pattern of reactivity of a panel of glycoprotein variants with neutralizing monoclonal antibodies, four distinct antigenic sites on the glycoprotein can be delineated (Lafon et al., 1983). Furthermore, immunization experiments in which mice were immunized with purified fragments, derived from purified rabies virus glycoprotein, showed that three peptide fragments induced VNA (Dietzschold et al., 1982). However, it is not known which antigenic sites are responsible for confering immunity against rabies infection. In general, fragments of the glycoprotein that maintain the entire antigenic structure of the intact glycoprotein could provide a basis for determining the smallest immunogenically active unit (Dietzschold et al., 1983).

MATERIALS AND METHODS

Dog Population Studies

Study Area

The dog population study was carried out in Jos, capital of Plateau State. Jos (Appendix A) is situated approximately on Latitude 9.5° North and Longitude 8.5° East, with a population of about 94,451 inhabitants (1963 census). Jos stands beautifully on the northern end of the plateau. The city lies close to the geographical centre of Nigeria. Around Jos itself the landscape is broken by rocky outcrops and to the south is an open plain with a few scattered trees. Picturesque village surrounded by cactus hedges originally planted for security purposes are typical outside the city. Jos is an oasis of climatic splenour in a blazing tropical zone. The two main seasons of the year are a wet and a dry period that roughly coincide with summer and winter seasons of the northern latitudes. The Jos Plateau has the same seasons as the surrounding country, but with modifications range from 50° to 95°F, and the average annual is higher than that for the surrounding country (Anon, 1972).

From October to March, when there is little or no rainfall, the harmattan, a dry north-east wind from

the Sahara Desert carries minute particles of dust that choke the atmosphere with a thick orange-brown haze. During this period, the maximum temperature variations occur; the days are warm and the night temperature sometimes drop close to freezing point.

Jos township (Appendix 1) was officially founded in 1915 but by 1912 there were enough residents to warrant the designation "Hausa settlement in Jos". From the very beginning the colonial administration tried to keep culturally dissimilar ethnic groups separate (Anon, 1972). Under the 1917 Township and Public Health ordinance the 1918 city layout divided the settlement into three major sections. Native Town to the north, while south and east to the Native Town lay the Township which was a separate entity of its own within Jos Division, South-West of the township, but in a special "reservation" apart from most of the indigenes, is the Government Reservation Area.

The structural pattern established then has yet to be significantly modified, although historical physical development details are worthy of note. Native Town has expanded westward and northward flanking Bauch road. On the other hand, the 'European Reservation' subsequently remained Government Reservation Area (GRA) has expanded westward

and southward. City expansion during the last 32 years has overshadowed the pace of development in any historical period of the same length. Structural characteristic of the urban conglomeration remain to some extent unchanged, what has happend is a radical expansion of the sections along the northern, southern and (less dramatically) eastern sectors. Native Town has widened its northern and western perimeter to Delimi, Nassarawa Gwong, Dongon Dutse and Gangere, and Jentar new Layout and Jentar extension respectively (Gan, 1980). Jos has approximately 18,418 compounds which have been divided by Jos Local Government into 23 wards. A compound was defined as a yard usually consisting of 2 or more houses and may contain up to 4 or 5 families.

The 94,451 (1963) population figure for Jos is now very conservative. The town is famous for its cool weather and fascinating topography which has made it a magnetic holiday resort. In terms of modern amenities, Jos ranks as one of the leading towns in Nigeria. There are eight banks, including a branch of the Central Bank of Nigeria, numerous insurance companies, twenty standard hotels as well as tourist attractions like the Jos Wildlife Par , Museum, a Zoological garden and standard shopping areas. Almost all social amenities available in modern cities

can be found in Jos. There are for instance over 16 post primary institutions and institutions of higher learning, prominent among these being the University of Jos, the Institute for Policy and Strategic Studies, and the National Veterinary Research Institute at Vom (Anon, 1979). There are in the state capital two government hospitals including a University Teaching Hospital and two mission (voluntary agency) hospitals.

Because of its favourable climate and its mining activities, Jos Plateau has probably the largest concentration of resident European population in former British West Africa. Although government census figures do not distinguish between temporary and permanent European residents, it may be said that while the total European population of the Jos Plateau is second to Lagos, the Plateau has a larger number of permanent European residents (Gan, 1980).

The major geographical feature of the State is its location on the highest plateau in Nigeria with an average latitute of 1,200 metres above sea level. The landscape rises steeply from the plains of River Benue in the south and decends towards Bauchi in the northeast (Anon, 1977). Plateau State is located more or less in the centre of the country between latitutes 7^{o} and 25^{o} each (Fig. 2). It has a population of

2,026,657 (1963) census) which constitutes 3.65 percent of the total population of Nigeria.

Dog Population Estimation in Jos

Population estimation was done by two methods namely (1) Street count and (2) Compound Questionnaire Survey. A large detailed map of Jos (Appendix A) was obtained from Plateau State Urban Development Board, Jos and the various socioeconomic and land use districts plotted to stratify Jos into five areas namely: Government Reservation Area (GRA), Jos Township, Jos Native Town, Masalachi Jama'a - Delimi - Gangare and Nassarawa Gwong-Dogon Dutse. The best possible 1982 projected human population based on 1963 national census estimates of the urban community and that of each of the stratified areas were obtained from Plateau State Ministry of Economic Planning, Statistics Section, Jos and Plateau Urban Development Board, Jos respectively. The stratified areas included:

(i) Government Reservation Area (GRA) a high class residential area of approximately ten square kilometres and with an estimated human population of 10,000 (1963);

(ii) Jos Township covering an area of 14 square kilometres and a human population

of 22,000 (1963 census);

(iii) Jos Native Town (Jenta - Angwan Rogo) an area of ten square kilometres and predominantly a low class residential area with a population of 23,451 (1963 census);

(iv) Masalachi Jama'a - Delimi - Gangare zone, a commercial area of 10 square kilometres and a population of 20,000 (1963 census); and

(v) Nassarawa Gwong-Dogon Dutse an essentially middle class area with a population of 19,000 and covering an area of approximately 10 square kilometres.

(a) Street Dog Count:

The streets in each area were listed and numbered serially. Ten percent of the streets was randomly selected for counting of dogs using a table of random numbers. Higher National Diploma student volunteers at the National Veterinary Research Institute, College of Animal Health and Husbandry were trained and assisted in the dog counting study. The team of students surveyed the areas one at a time, walking up or down each of the streets to be counted in the stratum and recording dogs seen in the street, taking

advantage of local areas that are best for observation such as specific market streets, dump sites and known pathways. A proforma for recording counts was provided (Appendix 2) to aid the enumerators. The counts were made early in the morning between 6.00 a.m and 7.30 a.m., a time of maximum dog activity, less human activity and good visibility (Beck, 1973; Fox et al., 1975), between June 20 and July 31, 1982. The same street was enumerated for six days by the same person in the team. The technique used was a modification of that of Beck (1973) in that dogs were not photographed but observed and some physical characteristic feature to identify them noted. A multiple observation/re-observation technique was employed to that the counts were then averaged to reduce sampling errors. Each day, the study area was surveyed by food and every dog within a given distance was recorded on the proforma (Appendix 2). The number of counted dogs in the selected streets in each area was used to estimate the population of dogs in each area. An estimate of the entire dog population in the entire city was determined from all counts of the five areas. In this approach, the underlining assumption was that dogs was uniformly distributed in the various zones.

(b) Compound Questionnaire Survey of Dogs

The compound survey was done using the same street as for the street count. In addition to dog population studies, the compound survey was used to obtain information on zoographic and demographic aspects of dog ownership and attitudes of dog ownership. An adult member of every tenth compound on each side of the selected street was interviewed for about 20 minutes using the questionnaire designed for compound survey (Appendix 3). Data collected also included information on number of dogs in compound, movement of dogs and public health problems created by dogs.

The number of people and the size of the area were used to determine dog-to-human index for each area. The age, sex and breed of each dog were recorded as stated by the owner but occasionally the information was cross-checked by examining the dog. The use of veterinary services among dog owners was determined. A "user" of veterinary services was defined to be an individual who has taken his dog to a veterinarian in the past one year.

Variables that were evaluated as determinants of dog ownership were the family life cycle, the respondents sex and age, their like versus dislike of dog, whether or not the family owned or rented its residence, and

the family's socio-economic class. The latter variable was defined by use of the income status of residents and of the different areas as described by Sutter, 1970; Gan et al (1980). The family life cycle was a measurement that combined age of the head of the family and marital status as well as the age of any children in the family (Wenger, 1972).

Attitudes Towards Responsible Dog Ownership

The questions for this study were designed so that responses could be in Lickert scale, that is, responses were listed in a scale of strongly agree or strongly disagree. The results of a preliminary evaluation of data from a pilot study suggested that respondent's area of residence, age and dog ownership might influence their opinions. Thus these three factors were considered as independent variables in the present analysis of the data.

Statistical Analysis

Statistical Package for Social Sciences (SPSS) (Nie et al., 1970) was used to analyse all the data. The statistical tests of significance included the chi-square test and analysis of variance.

Retrospective Study of Rabies in Plateau State
1970 - 1981

Information on the number of patients treated for bite and possible exposure to rabies during 1970 to 1981 in Plateau State was determined by reviewing registers for dog bites and anti-rabies vaccination at all nine governmental and six voluntary agency hospitals located in the State. In addition, hospital records and discharge statistics were reviewed in depth to obtain patient variables, site of bite, length of hospitalization, anti-rabies treatment, and clinical manifestations. The quarterly epidemiological records and annual reports of the Ministry of Health for the 1970 - 1981 period were retrieved and reviewed to obtain information about reported human rabies cases by local government areas in Plateau State by month, and by year.

Information was also collected on the following: (a) annual number of anti-rabies vaccination administered to dogs; (b) stray dogs impounded in the state during the study period; (c) the results of dog brain examinations at National Veterinary Research Institute Rabies Diagnostic Laboratory, Vom.

Information sought included the age and sex of the victims, the site of bite, the severity of the bite, the

time interval between the bite and attendance at the hospital, and the status of the attacking dod. In addition information on the post-exposure treatment given was sought. The main hospital register was used to compile information about the total attendance at the hospital and the monthly prevalence of dog bites. For comparison, a 20 percent systematic hospital population attending hospital for reasons other than dog bite and rabies was used to evaluate the effects of age and sex on the risk of dog bite. Controls were patients who never had bites throughout the period.

Statistical Analysis

Odds ratios were calculated and 95% confidence interval (C.I.) were set up (Liliefield, 1983; Schwabe, 1977) for age and sex categories. A value of odds ratio greater than unity indicated increased risk for dog bite with the factor and less than unity indicates decreased risk. A 95% confidence interval which does not include unity is statistically significant.

Rabies and Dog Bite Surveillance in Plateau State 1982 - 1983

In December 1981, a letter (Appendix 4) was circulated to all veterinarians and medical officers in veterinary clinics and government and voluntary

agency hospitals located in Plateau State through their respective professional service heads namely Ministry of Animal and Forest Resources and the Health Management Board, Jos, Plateau State respectively notifying them of rabies surveillance study being conducted for the State for the period January 1982 to December 1983 and seeking for their active collaboration in the study. Public awareness was aroused in the State through mass media informing the public of the exercise objectives and soliciting their co-operation to control rabies in the state. Local administration and professional services within the state utilized to spread and create more awareness of the exercise included: veterinary posts, local administration, the police, hospitals and primary health centres.

Accordingly in collaboration with the state Chief Veterinary Officer and Chief Medical Officer, animal and human rabies surveillance case reporting forms (questionnaires) were designed (Appendix 5) and distributed to all Divisional Veterinary Officers (DVOS) and Medical Superintendents (MS) in both government and voluntary agency hospitals.

Public campaigns were mounted in the major local government areas for continual surveillance in order to facilitate prompt reporting and investigation of

animal bites; when rabies was suspected, the animal(s) involved were apprehended and detained for observation where quarantine facilities existed. Cases of clinically diagnosed rabies in animals were reported to government veterinary clinics, human exposures and cases of human rabies brought to the attention of the hospital or investigated by the Epidemiological unit of the Ministry of Health, Plateau State. If the probable source of exposure was within a rabies control area, it was investigated by the local veterinary officer of the local government area. Diagnostic laboratory reports on all specimens received, both positive and negative were rendered as much as possible prompty by the Rabies Diagnostic Laboratory of NVRI, Vom which was geared for field investigation of outbreaks and diagnosis of rabies.

An epidemiological evaluation of the surveillance system was established by providing mechanisms for reporting to the data centre in Vom and ensuring effective flow of information. Data to be recorded and assessed were determined as contained in the questionnaire (Appendix 5) and the DVOs and MS were visited monthly to collect the completed surveillance case reporting forms and obtain additional data such as the doses of vaccines supplied by NVRI for the period;

the number of vaccinated dogs, number of impounded stray dogs, dog bites, post-exposure prophylaxis and follow-up, source and type of human anti-rabies vaccine and any human rabies cases encountered. The CVO, CMO, DVOs and MS were subsequently visited for oral interviews. Discussions were held with them on the information in the questionnaire as well as on their views and experience with rabies and control problems. A list of questions (Appendix 6) were prepared ahead of time and each officer interviewed was presented with essentially the same question. Opinions on the problems of persistence and possible control of rabies in the State were also sought from the officers.

Rabies Diagnosis

Rabies diagnosis was performed using Seller's method (WHO, 1973) backed up with the mouse inoculation test using 3-5 day old suckling mice (Koprowski, 1973). The State and private veterinary practitioners had been informed of this free diagnostic service and urged to send in specimens.

Characterisation of Rabies Virus Isolates from Plateau and Other States of Nigeria

Monoclonal Antibodies

A panel of 36 monoclonal antibodies (MCA) specific for nucleocapsid (NC) (Flamand et al., 1980a) and 44 MCA specific for the glycoprotein (GP) (Flamand et al., 1980b) antigens of the virion were provided by Dr. T. J. Wiktor of the Wistar Institute, Philadelphia. Two fluorescein - labelled anti-NC MCA 502 - 2 and 422 - 5 used in the direct fluorescent antibody (FA) staining procedure were kindly provided by CENTECOR, Malvern, Pennsylvania.

Virus Isolates

A total of forty-one rabies virus isolates, 32 from Plateau State and 9 from other states of Nigeria were included for monoclonal antibody typing. The number of isolates, the origin, clinical and epidemiological data of the cases from which the isolates were recovered are given in Table 74.

Cell Cultures

Mouse Neuroblastoma (NA) was used in replication and characterization studies of the rabies virus isolates from Nigeria. The cell line was obtained from Dr. T. J. Wiktor of the Wistar Institute, Philadelphia.

Propagation of Virus

Suspension of original brain material of first mouse passage brain tissue of each virus isolates was prepared by homogenisation in Eagle's minimum essential medium supplemented with 10% fetal calf serum (MEM - 10) in a volume necessary to obtain approximately 10% brain suspension in Tenbroek homogeniser in Biogard hood (Baker Co. Inc. Maine). The suspension was clarified by centrifugation at 1600 rpm at -20°C for 10 minutes using IEC PR-J centrifuge (-20°C) (Damon/IEC Division, U.S.A.), the supernatant collected and tested for sterility and stored at low temperature of -70°C in Forma Bio-Freezer (Forma Scientific, Marcetta, Ohio).

Neuroblastoma (NA) cells were trypsinised, resuspended in MEM-10 at concentration of $1x10^6$ cells/ml. A volume of 1ml of NA cell suspension was mixed with (0.2 - 0.3ml) of brain suspension of the virus 200 to 300 microlitres (ul) to be propagated in a micro Test II plate. Two hundred microlitres (ul) of the virus-cells suspension was placed in each well of 6-well Terasaki plate. Both micro Test II Terasaki plates were then incubated at 37°C for 3 days, in a Co_2 incubator (Hotpack, Philadelphia, Pennsylvania). The medium was changed after 24 hours to remove brain debris. After 3 days incubation the Terasaki plate was fixed in cold

acetone and examined by a direct FA technique to assess the level of virus infection of the cells as expressed by the proportion of fluorescent cells. At the same time, duplicate Terasaki plates were fixed in cold acetone and the cells stained with fluorescein-labelled MCA 502 - 2 (which reacts with rabies and rabies-related viruses) or with MCA 422 - 5 (which reacts with rabies-related viruses - Lagos bat, Mokola and Duvenhage only) (Flamand et al., 1980; Wiktor et al., 1980). When 90-100% of cells were infected the culture in T-25 bottle was used for testing with the anti-nucleocapsid monoclonal antibodies (Anti-NC MCAs).

The Terasaki plate(s) were fixed as follows: moistened strips of filter paper which provided humid atmosphere for the infected cells were first removed from the Terasaki plate and the plates were washed with 10ml of PBS and rinsed in cold acetone (80% Acetone, 20% Distilled water). The plates were then fixed with fresh 80% acetone at room temperature for 30 minutes and then air dried in an incubator ($37^{o}C$).

The FA conjugate (5 microlitre (ul) of a direct anti-rabies FA conjugate) was added to each well of fixed dried plate. The plate was then incubated 30 minutes at $37^{o}C$, washed twice with PBS and once with distilled water drained and examined wet under

epiillumination by a Leitz FA microscope.

The infected medium was removed from T-25 culture flask and stored at -70°C for subsequent viral titration and characterization by anti-glycoprotein neutralization. The cells in the T-25 flask were trypsinised, resuspended in 2ml MEM-10. Aliquots of 0.5ml. were dispensed into Falcon Microtest II plate and T-25 flask. From the Microtest II plates, 0.01ml of infected cells were transferred into Terasaki plates. The Microtest II and Terasaki plates were then incubated at 37°C in CO_2 incubator for three days after which the Terasaki plate was stained with a direct FA conjugate to assess the level of cell infection as expressed by the percent of fluorescent inclusions. The Microtest plate was kept in paralled with the Terasaki plate to be used in case of accidental destruction of the cells in the Terasaki plate.

Infected cells were split repeatedly in the original T-25 culture flask until all cells in the NA culture were infected and showed a positive staining by direct FA procedure. The virus containing medium from this culture or after an additional infected-cells transfer was harvested and titrated and subsequently used for virus neutralisation with a penal of anti-GP MCAs.

If no virus was present after the second infected cell splitting, the culture was considered negative and its propagation discontinued. Each isolate was similarly propagated in neuroblastoma cell culture. Medium from the T-25 flasks was collected 3 days after infection and stored at -70°C. Infected cells were trypsinised and new cultures initiated using a 1:4 split ratio. As described above, an aliquot of cells was placed in Terasaki plates for monitoring the extent of infection. This procedure was repeated until all cells in the culture were infected. The virus from such neutralisation assay with the panel of MCA specific for rabies and Mokola glycoprotein antigen.

Characterisation of Rabies Virus MC Antigen by Analysis with Anti-Nucleocapsid-Monoclonal Antibodies

When 90 - 100% of cells were infected the NA culture in T-25 flask was used for testing with the anti-nucleocapsid (NC) monoclonal antibodies. Characterisation of nucleocapsid (NC) antigens, virus titrations and virus neutralization procedures were performed by a micro method using Micro Test II and Terasaki plates.

Infected cell cultures were adjusted to a concentration of 2×10^6 cells/ml and distributed into 36 walls of Terasaki plate (Falcon 3034) at 10 microlitres (ul)/well. Plates were incubated at 37°C

for 24 hours, washed once with phosphate-buffered saline (PBS) pH 7.5, fixed for 30 minutes in cold 80% acetone in distilled water, and dried. Ten ul of each of 36 monoclonal antibodies of the panel was placed in individual wells and incubated for 30 minutes at 37°C. Plates were then washed twice with PBS and drained. Five microlitres (ul) of fluorescein-labelled anti-mouse gamma globulin was added to each well and incubated for 30 minutes at 37°C. Plates were then washed twice with PBS, and once with distilled water and then drained. All plates were examined under ultraviolet light with a microscope equipped for epi-illumination.

Titration of Virus

Ten-fold serial dilutions of the virus were performed in flat-bottom microtitre plates. Infected cells were placed in Terasaki plate and incubated for 4 days before FA staining.

To each well was added one drop of a freshly trypsinised resuspended cells adjusted to 1 x 10^6 cells per ml. Aliquots of 10 microlitres (ul) of the virus-cell suspension were then transferred from the micro Test II plates into Terasaki plates, starting with the highest virus dilution. Both the Micro Test II plate and the Terasaki plate were then incubated for four days at 37°C in a CO_2 incubator.

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At the end of the incubation the Terasaki plate was fixed in 80% acetone and 5 microlitres (ul) of a direct anti-rabies FA conjugate added to each well. The plate was incubated for 30 minutes at 37°C in a CO_2 incubator, after which it was washed twice with PBS and once with distilled water and examined under UV illumination. The highest dilution showing 100 percent of FA positive cells (the titre of the virus) was used in the virus neutralization test with a panel of anti-GP MCAs.

Virus Neutralisation with a Panel of Anti-Glycoprotein Monoclonal Antibodies (Anti-GP MCAs)

A 1:10 dilution of the Anti-GP MCA in MEM-10 prepared from a panel of 44 antibodies was used.

Six 5 - fold dilution of the virus were prepared in sterile test tubes. Starting from the highest dilution, a drop of virus was placed in the vertical series of MCA in the Microplate. This procedure of adding virus to MCA was repeated for the next five virus dilutions, i.e. from the fifth test tube down to first test tube.

The content of the microplates was then mixed by agitation using a Cooke's Shaker and incubated for 60 minutes at 37°C in a CO_2 incubator. After incubation, one drop of NA cell suspension (1×10^6 cells/ml) was

added to each well of the microplate. The MCA-virus mixture was again mixed by agitation in a Cooke's Micro Shaker and 0.01ml. or 10 microlitre (ul) of the mixture then transferred from the microplate into Terasaki plate starting the transfer by the highest virus dilution and using a new tip for each antibody. Both microplate and Terasaki were then incubated for 4 days at 37°C in CO_2 incubator. The plates were then fixed and stained with a direct anti-rabies FA conjugate and examined under UV light.

Three rows of virus-cell mixture and one medium only controls were added to the wells of the microplate and Terasaki plates and stained along with MCA-Virus-Cell mixture at the end of incubation.

The absence of infected cells indicated neutralisation. If all cells were infected, this indicated that the corresponding antibody did not have neutralizing activity for the given virus. The presence of few infected cells was considered as a positive neutralization.

Cross Protection Experiments with Pitman-Moore (PM) Experimental Vaccine

Protection studies were carried out in 5-week-old ICR mice. The mice were immunized with 1:30 dilution

of Pitman-Moore (PM HDCS) rabies vaccine (similar to Human vaccine) supplied by Dr. T. J. Wiktor of Wistar Institute Philadelphia. The mice received 0.5ml of this dilution of the vaccine intraperitoneally (I.P.) on days 0 and 7. The antigenic value of this vaccine was 10.0 IU/ml as determined by the standard NIH potency test in mice (Wiktor et al., 1983). Forty groups of 5 ICR mice supplied by Wistar, (labelled 1-40), vaccinated with the PM vaccine served as the test animals while a corresponding number of groups with a corresponding number of unvaccinated mice labelled 41-80 served as controls. Two weeks after the first vaccine dose, vaccinated mice and a corresponding number of unvaccinated control mice were challenged intracerebrally (i.c.) with 0.03ml, of the various tenfold dilutions of the homologus virus used for vaccine preparation and with the following street virus variants from Nigeria numbered as follows: 1, 4, 15, 36 and 39. These selected variants were used in the cross protection studies either because of their extreme glycoprotein antigenic variation (1, 4, 36, and 39) or because they represented the predominant variant groups as determined from the antiglycoprotein neutralisation characterization of the rabies virus strains (15). The challenge virus titre was $10^{7.3}$ $ICLD_{50}$/ml and dilutions 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4} and 10^{-5} of the virus

were made in MEM-10 and used for challenging vaccinated mice.

The mice were fed and watered ad libitum, their cages were cleaned as required throughout the three weeks observation period, and mortalities were recorded daily.

In all experiments, mice were observed for 21 days after I.C. inoculation, at the end of which time titres of the challenge viruses were calculated by the methods of Reed and Muench (1938).

Protection Experiments in Guinea Pigs Using Low Egg Passage (LEP) Flury Vaccine Produced in Nigeria

Guinea Pigs

Healthy guinea pigs each weighing between 350 and 400 grams were used for the cross protection studies and to measure virulence of the LEP for guinea pigs. The animals were arranged in groups of 10 guinea pigs per cage. This constituted the test and control animals for the protection studies. The animals were fed green vegetables and grass and commercial guinea pig pellets and clean tap water. The beddings were changed when necessary and the animal house well ventilated, cleaned, washed and disinfected every week.

Test Variants

The following street rabies virus variants were used for the protection experiment: 1, 4, 15, 36 and 39. The variants were representatives of groups of antigenic variants of rabies virus strains characterised by the use of hybridoma monoclonal antibodies.

Vaccine

Modified live rabies virus of the LEP strain (Koprowski and Black, 1950) produced in embryonating chicken eggs (is the preferred vaccine for protecting dogs 3 months of age or older against rabies (Dean et al., 1964) was used as the vaccine. Studies were undertaken to correlate results of protection experiments in mice with those in guinea pigs. The vaccines used were sampled from batches 13, 14, 15 and 16 of LEP (Flury) produced in Vom in 1983 for issue to the field for rabies control. The LEP vaccine had median titre of $10^{4.5}$ $ICLD_{50}$/ml in mice. Each vial of LEP was reconstituted in 2.5ml cold sterile distilled water. Five-fold dilutions were made from the reconstituted pooled contents of vials: undiluted, 1:5, 1:25, 1:125 dilutions. The vaccine was used within 30 minutes after reconstitution.

Six groups of 100 guinea pigs per group were vaccinated with 0.5 ml dilutions (Neat; 1:5, 1:25, 1:125) of the vaccine injected deep into the gastrocnemius muscle. At the same time, an equal number (100 per group) of healthy unvaccinated guinea pigs of similar weight were included side by side as controls. The animals were observed daily for 3 weeks for any mortalities.

Seven litters (about 10 baby mice each) of Swiss Webster white baby mice (6 days old) were inoculated intracerebrally with 0.02 ml of the variants 1, 4, 15, 36 and 39 to obtain mice $ICLD_{50}$/ml of virus for challenging vaccinated guinea pigs. The mice were observed for 3 weeks for signs of rabies or death. The $ICLD_{50}$/ml of each strain was then calculated using the formula of Reed and Muench (1938). Brains were harvested from moribund animals and used to prepare a 10% suspension (W/V) in MEM-10. The suspension was then centrifuged for 10 minutes at 1600 rpm and the supernatant liquid aliquoted into sterile vials, labelled and stored at -70^{o}C for subsequent use as challenge virus.

Immunization and Challenge of Guinea Pigs

Guinea Pigs were immunised with neat, 1:5, 1:25 and 1:125 dilutions of LEP (Flury) vaccine provided by the National Veterinary Research Institute Vom, Nigeria. The guinea pigs received 0.5 ml of these dilutions of the vaccine intramuscularly on days 0 and 7. Forty-eight groups of 10 guinea pigs thus vaccinated served as the test animals while a corresponding number of unvaccinated guinea pigs served as controls. Two weeks after the first vaccine dose, vaccinated guinea pigs and a corresponding number of unvaccinated guinea pigs were challenged intramuscularly (i.m.) with 0.5ml of the various tenfold dilutions of CVS and with the street variants #1, #4, #36 and #39. These selected variants were used in the protection study either because of their extreme glycoprotein antigenic variation (#1, #4, #36 and #39) or because they represented the predominant variant groups (#15) as determined from the antiglycoprotein neutralization characterization of the rabies virus isolates. The challenge virus titre was $10^{7.3}$ICLD$_{50}$/ml. and dilutions neat, 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4} and 10^{-5} of each of the virus variants were used for challenge. Mortalities were recored daily for 3 weeks and percentage mortalities calculated and plotted.

Neutralization Tests

Virus neutralization tests were performed with serum from surviving guinea pigs by methods described by Koprowski and Johnson (1952).

In the experiments, animals were observed for 30 days, at the end of which time titres of the serum were calculated by the formular of Reed and Muench (1938).

RESULTS

Street and Compound Counts: Estimation of Dog Population in Jos

Estimation of dog population in Jos is shown in Table 1. The overall population based on 10 percent random sampling of the streets was 4,200 while that of compounds also based on 10 percent random sampling of compounds was 10,560 dogs. Tables 1 and 2 show summaries of the details of street and compound counts in relationship to the five strata of the city. The Government Reservation Area (GRA) showed fewer dogs by street and compound dog counts, than Jos Township, Jos Native Town and Delimi-Nassarawa Gwong-Dogon Dutse areas. However, stratum 5 (Angwan Rogo and the suburbs) a predominatly muslem area showed the least number of dogs in both street and compound counts (Table 1).

Demographic Factors

A total of 500 compound involving over 4,200 people in Jos comparised the study population. A total of 480 compounds were interviewed. Twenty were either not interested or refused to cooperate with the interviewers.

Table 3 shows selected demographic variables of the 480 compounds by dog ownership status. A total of

two hundred and seventeen compounds (45.2 percent) did not own dog at the time of the interview while 263 (54.8 percent) owned dogs. Table 4 shows the category of dog ownership in Jos. About twenty -eight percent compounds never owned dogs, 16.7 percent owned a dog previously while majority of the households, 54.8 percent (263 compounds owned a dog or more at the time of the survey.

Table 5 shows categories of pet-owning compounds in the city. One hundred and fifty three compounds owned no pets (dog and cats), 190 compounds owned dog only, 36 owned cat only while 53 owned both dog and cat. Forty-eight compounds kept other animals such as monkeys, chimpanzees, horses, hyaenas etc) not considered as pets in this study. Table 6 shows the distribution of other variables including households according to residential areas.

Characteristics of dog owners are shown in Table 1. The mean age of head of compound was 36.8 years. The size of compound ranged from 1 to 40 individuals. The mean size was 8.8, the mean time being 8.6 years. The mean number of individuals per dog-owning compounds was 8. The distribution of family type showed that couple with children were in 78.3 percent (376) compounds 2.9 percent (14) compounds were couple without children,

14.2 percent (68) compounds were single male while 4.6 percent (22) compounds were occupied by single females.

The housing type most frequently occupied were house (49.8 percent) or 239, followed by apartment (39.4 percent or 189), while other housing type (temporary squatters) comprised 10.8 percent or 52 compounds. 303 compounds (63.8 percent) were owned while 177 (36.2 percent) of the compounds were rented.

49.8 percent (339) compounds were fenced completely, 22.9 percent (110) were partially fenced. The rest had either no yard or were without fence. 81.6 percent (387) compounds allowed keeping of pets while 18.4 percent (93) did not allow pets in their compounds.

Most of the owned dogs (51 percent) were adopted from abandoned dogs, an important source of dogs were neighbours (Table 7).

The dog-cat category of compounds surveyed by the occupation type of the head of compound is shown in Table 8. Farmers owned most dogs or cats and dogs, followed by civil servants. The category of pet-owning compounds and stratified residential areas is shown in Table 9. Jos township showed the highest dog-owning compounds (30.5 percent) followed by Delimi - Nassarawa

Gwong stratum (25.3 percent) and Jos Native Town 19.5 percent respectively.

The size of family in the five areas is shown in Table 10. Five or more persons per family were recorded mostly in Jos Township (28.3 percent) followed by Jos Native Town (25.6 percent). Angwan Rogo and the suburbs showed the least number of persons per family (7.5 percent).

Tables 11 and 12 show the distribution of pet-ownership by family type and category of dog ownership by family type and category of dog ownership by family type respectively. Couple with children owned dogs more than other family type, even among those who owned dogs at the time of the survey.

Zoographic Factors

The mean number of dogs owned by a compound was 4. Two hundred and eight (79.1 percent) compounds owed more mongrels, 29 (11 percent) kept pure exotic breeds and 21 (8 percent) compounds kept crossbred dogs. The breed of dogs in 5 compounds (1.9 percent) was not stated. The mean duration of time a dog was owned was 3 years. The mean age at which a dog was reportedly obtained irrespective of the source of the animal was less than one year, that is, when the dog was a

puppy. The mean number of litters per year per bitch was approximately 2.

The most common sex of owned dog was intact female (131) 49.8 percent, followed by intact male (91) 34.6 percent. Neutered male comprised 12.9 percent (34) while sprayed female was 0.4 percent (1).

Values and Limitations of Dog Ownership

The major reasons why people own dogs is given in Table 13. The chief reason was for protection or security of houses, hotels, and as shop guards. The major advantages of dogs as companion animals is given in Table 14. Again protection of compounds, shops and personal values was the chief advantage given. The most stated disadvantage of owning dogs was pet diseases (27.3 percent) followed by noise, odour and waste pollution (14.9 percent). Some respondents (35.5 percent) did not appear to know any disadvantages of keeping their dogs (Table 15).

The reasons for not keeping a dog as stated by non owners is given in Table 16. Dissatisfaction with dogs was the chief reason (24.4 percent) followed by religious belief (12.7 percent). Other joint reasons constituted 21.6 percent of the responses.

The main stated reason for no longer owning dogs as given by previous dog owners was that the dog died either from automobile accident or pet disease (Table 17). Also the major advantage of dogs stated by former owners was protection or security of property (Table 18) while the biggest disadvantage of owning dogs as stated by them was pet diseases (Table 19).

The major reasons for stray dogs as stated by respondents are as shown in Table 20. Two hundred and one (20.9 percent) respondents gave the most common reason as escape from houses. This was closely followed by uncontrolled breeding by dog owners 192 (19.9 percent) respondents.

However, 127 (59.3 percent) respondents would not want their dogs impounded of stray while only 18.1 percent (87) would want their dogs impounded of stray. 266 respondents had no opinion on this question. 93.8 percent (450) respondents agreed that stray dogs bite while the rest (30)had no stated opinion. On the question of licensing dogs, 127 (48.3 percent) licensed their dogs in 1981, 34 (12.9 percent) did not because they considered licensing of dogs irrelevant, 102 either did not know dogs should be licensed or failed to have their dogs licensed because of shortage of tags in the veterinary clinics.

Only 26 (9.9 percent) dog-owning respondents used their dogs for hunting, 213 (81 percent) respondents used their dogs for purposes other than for hunting. On the other hand 24 (9.1 percent) respondents had no stated opinion. One hundred and seventy three (65.8 percent) dog owners stated that they gave their dogs obedience training. 2.7 percent (7) of the respondents said their dogs received obedience training in an obedience school run by the Police Force in Bukuru. 60 (22.8 percent) did not give obedience training to their dogs while 23 (8.7 percent) had no response to the question.

Most respondents (157) 59.7 percent said their dogs slept outside the house while 102 (38.8 percent) stated that their dog slept inside their houses. 4 (1.5 percent) respondents did not know where their dogs slept. On where their dogs spends the day mostly, 166 (63.9 percent) respondents stated outside, 70 (26.6 percent) said "inside" while 25 respondents did not know where their dogs spent most of the day but thought the dog roamed the streets during the day. On where the dog stays when outside, most dog-owning compounds (65 percent) stated that their dogs roamed free (Table 21).

The reasons for not neutering (spraying or castrating) dogs are given in Table 22. 135 (51.3 percent) respondents had no stated reason for not neutering their dogs. However, it would appear the idea was dreaded among owners as majority (104 or 39.5 percent) feared the act would stop their dogs from breeding and render their dogs less active for the functions carried out by dogs.

Responses to selected opinionnaire regarding values and limitations are shown in Table 23. A majority of the respondents significantly agreed with the statement that a dog is an ideal companion animal ($P < 0.05$). When asked what type of dog they would want to own as a companion animal, the respondents were divided as to whether or not they wanted to own a large dog. However, most respondents preferred a dog they could control and that was friendly ($P<0.05$). Most of the respondents stated that they were afraid of dogs, believed that dogs developed close relationship with their owners but disagreed that a dog was an important member of the family ($P < 0.05$). Approximately 63 percent of the present owners agreed with the statement that a dog would be a playmate for their children while 24.8 percent of those who never owned dogs agreed with the same statement.

One hundred and seventy-nine (37.3 percent) respondents did not see veterinary services presently offered as too expensive. Only 0.6 percent (3) said it was too expensive, while 62.1 percent did not appear to know the true situation or had no opinion. On adequacy of veterinary services, 455 (94.8 percent) respondents did not know whether the type of services offered were adequate or not; 18 (3.7 percent) said no to the question while only 7 (1.5 percent) stated that veterinary service was adequate.

Two hundred and ten (93.3 percent) (210) respondents used the Veterinary Hospital Jos for treatments and vaccination of their pets. 14 (2.9 percent) owners used the Veterinary Clinic of the National Veterinary Research Institute, Vom while 0.2 percent of dog owners had not used any veterinary clinics in Bukuru. 53.1 percent (255) dog owners had not used any veterinary clinic at the time of the survey.

Respondents numbering 245 (51 percent) were not aware of the Rabies law in the state, while 33.3 percent (160) had knowledge of the existence of the law. 75 (15.6 percent) were however, silent on the issue. Similarly 357 (74.8 percent) respondents had no knowledge of the existence of dog control law in the state. Only 65 (13.5 percent) respondents were aware of the

existence of this law. 56 (11.7 percent) had no stated opinion apparently unaware of the law.

167 (63.4 percent) Dog-owning compounds (167 or 73.5%) took their dogs to the veterinary clinic for treatment at least once the previous year (1981). A total of 85 (32.3 percent) dog-owning compounds did take their dog to the clinic, while 11 (4.2 percent) were silent on the use of veterinary clinic during the period.

The percentage of dog-owning compounds utilizing veterinary clinics by residential areas stratified is shown in Table 24. Jos Township compounds owning dogs shown the highest veterinary visits followed closely by the Government Reservation Area (GRA).

Table 25 shows the distribution of stated rabies immunisation according to the residential areas. Both puppy and adult dog rabies vaccinations were highest in the GRA and least in Angwan Rogo and suburbs. Adult dog vaccination stated, was about the same in both GRA and Jos Native Town, 23.2 percent and 23.7 percent respectively. Generally there was statistically significant difference in either puppy or adult dog rabies vaccination between the stratified areas ($P < 0.05$).

Dog-Person Ratio

Table 26 shows the dog to person to ratio by area. The dog-person ratio ranged from 0.16 in the GRA to 0.31 in Angwan Rogo. The range was 0.16 and 0.31. There was a high partial correlation coefficient between human and canine population (Table 26), similarly there was a high correlation between bites and dogs (Table 27 and bites and person between the residential areas (Table 28).

Bite/Person Ratio

Also the number of dog bites per 100 persons among the various residential area varied significantly ($P < 0.05$). The ratio ranged between 0.02 or 2 of every 100 persons in the GRA to 0.16 or 16 of every 100 persons in Delimi - Nassarawa Gwong - Dogon Dutse area (Table 28).

Bite/Dog Ratio

There was also a significant variation in the number of bites per every 100 dogs in the various areas ($P < 0.05$), ranging from 0.13 or 13 bites per every 100 dogs in the GRA to 0.58 or 58 bites for every 100 dogs in Delimi stratum (Table 27).

A Survey of Attitudes Toward Responsible Dog Ownership Overpopulation

Responses to items relating to overpopulation or stray dog in the community are shown in Table 29. Concerning "irresponsible owners" as the major cause of too many stray dogs, the distribution of responses differed between present owners, previous owners and those who never owned dogs ($P < 0.05$). A majority of respondents agreed that overpopulation of dogs is a major problem "in our society today". Concerning stray dogs being a problem "in my neighbourhood", 54.8 percent present owners agreed compared with persons who never owned dogs 70.8 percent and previous owners (76.6 percent). The responsible differed significantly among the ownership category ($P < 0.05$).

Community Health Problems

Responses to items relating to potential community health problems are depicted in Table 30. There was difference in the distribution of responses between owners and non-owners in their overall opinions towards potential public health problems. Although a considerable number of the respondents had no opinion on some issues, the distribution pattern did not appear to differ among the ownership categories. However, in general, the responses to the opinions "I don't like

stray dogs because they can spread disease" differed significantly among categories of ownership ($P < 0.05$). Present owners tended to agree more strongly to the former response while they tended to disagree more on the latter response than previous owners and those who never owned dogs. On the other hand, people who never owned dogs tended to agree more with the latter opinion.

Opinions on "free roaming or stray dogs tend to bite" were not too divided. Concerning destruction of property by dogs, the distribution of resonses differed significantly among the ownership categories. However, a good number of both owners (158) and nonowners (99) had no opinion on the statement. For the question about nuisance and pollution by dogs, the distribution of responses did not appear to differ among the categories of pet ownership. However majority of the respondents who strongly agreed were present dog owners.

Population control

Opinions about methods of controlling dog populations are given in Table 31. The respondents generally agreed that "spaying or castrating pet dogs is a good idea" to reduce dog overpopulation. However among present dog owners there was a sharp difference in the distribution of responses 104 (39.5 percent) agreed while 68 (25.8 percent) strongly disagreed with the statement.

The rest were either neutral or had no opinion on the statement.

Most respondents agreed with a systme of fines to control free-roaming dogs in the community, but the distribution of responses differed significantly among the categories of pet ownership ($P < 0.05$). Those who never owned dogs tended to agree more strongly. Similarly responses differed by categories of ownership on "If I had a dog, I would not want it neutered". Even among present owners only 14 (5.3 percent) strongly agreed while 44 (16.7 percent) strongly disagreed (Table 31). The rest were either neutral or had no opinion on the issue.

Finally one item dealt with one possible reason for not owning a dog, that is, if ownership might annoy the neighbours (Table 31). Again the distribution of responses differed significantly among ownership categories ($P < 0.05$). Of present dog owners 195 (74.1 percent) disagreed or strongly disagreed, whereas only 27 (19.7 percent) those who never owned dogs disagreed or strongly disagreed with the statement. The others were either neutral or had no opinion.

Rabies Control and Related Matters

Opinions about items related to dog bites, rabies control and medical expenses on veterinary services are

shown in Table 32. Regarding rabies vaccination most respondents agreed strongly with the statement "If I owned a dog, I would make sure it had rabies vaccination". Yet the distribution of responses did not appear to differ significantly among dog ownership categories. However, present dog owners agreed more strongly than those who never owned dogs.

Similarly the distribution of responses among the various dog ownership categories varied significantly ($P < 0.05$) on the veterinary medical expenses which could determine the ease of veterinary utilization in the community. About seventy-six percent present owners disagreed or strongly disagreed that veterinary medical services were expensive compared to about sixty percent of those who never owned dogs who also disagreed or strongly disagreed that they would not own a dog "because of medical expenses for veterinary services."

The responses pertaining to the importance of immunising a dog against rabies also varied among the categories of dog ownership. However most respondents among present owners and nonowners of dogs agreed that "it is important to immunize a dog for rabies."

EPIDEMIOLOGY OF CANINE RABIES

Retrospective Studies: Prevalence and Geographical Distribution 1970 - 1981

A total of 1,665 specimens, mostly animal heads were received from Plateau State between Januay 1970 and December 1981 (Table 33). Of these submissions, 200 were unfit for examination either because the animal heads had been roasted (96) or the heads (brains were extremely putrid (104) before submission, and only included in the data presented (Table 33). Three hundred and seventy six (22,62 percent) of the specimens were positive for rabies. All the positive cases were diagnosed by both direct histological examination of brain material from the field and by biological test in laboratory mice. About 43 percent (162 of the 376) cases were positive rabies cases in stray dogs.

Fig 3 is a map of Plateau State showing reported rabies cases in humans, dogs and wildlife by LGC during the 12 years. It will be observed (Table 33) that more than half of the positive cases (94,13 percent) in dogs were from Jos and Barkin Ladi Local Government Areas; being mainly from Jos, Vwang Kuru, Bukuru, Barkin Ladi and Ganawuri areas. Mangu and Akwanga Local Government Areas contributed 2.4 percent and 1.6 percent of the positive cases respectively. It appears therefore, that

Jos and Barkin Ladi areas of Plateau State constitute the core of the endemic zone in Plateau State. Also more cases were reported from the northern highlands than the southern lowlands of the state. Fig 4 shows positive rabies cases and suspects for Jos and Barkin Ladi which had complete records for the 12-year period. Fig. 5 gives the urban and rural distribution of rabies cases in the State during the period.

The average annual number of positive cases recorded was 31 (Table 34). Table 34 also gives the summary of the number of reported dogs vaccinated against rabies as well as the number of stray dogs impounded in relation to the number of confirmed canine rabies cases during the 12-year period. A total of 52,391 dogs were reported vaccinated during the period. The total number of dogs licensed was 35,505 while the number of stray dogs impounded yearly rose from 142 in 1970 to 545 in 1981. A total of 106,261 doses of Low Egg Passage (Flury) strain vaccine for dogs were issued to the State for dog immunisation during the period. The year 1981 was remarkable for rabies control efforts as seen from the highest figures of vaccinations, vaccine issue, number of impounded dogs and the number of dogs licensed. Apparently there was a seasonal variation in the occurrence of rabies in Plateau State as indicated by rises in the number of positive cases recorded for the months of

January, March - April and September - October during the study period (Table 35). Fig. 6 gives the annual distribution of suspected and confirmed rabies cases in dogs submitted during the 12-year period. Rabies peaked in 1975 and started declining thereafter. A comparison of canine rabies cases and reported vaccine usage is shown in Fig. 7.

The prevalence of rabies in the various species of animals in Plateau State is summarised in Tables 36 and 37. The dog was the species most commonly affected, accounting for 87.53 percent of all the positive cases diagnosed in Plateau State during the 12-year period. Rabies was also diagnosed in 7 cattle, 1 goat, 1 sheep, 2 pigs, one donkey and horse each among domestic animals. In these species, there was invariably a history of the animal having been previously bitten by a "mad" dog. Cat rabies accounted for 2.24 percent of the total animals cases. Rabies was also diagnosed in two civet cats and caracal lynx during the period in the State. Figure 8 shows the percentage of rabies cases in dogs over all confirmed rabies cases in all animals in the State during the 12-year period.

A summary of the clinical features of cases of rabies derived from information supplied on the specimen submitted for the 12-year period is given in Tables 38

and 39. Detailed clinical information was not always supplied for every specimen received. More cases were recorded in older dogs than in animals less than one year old. It is noteworthy that 23 puppies of various ages died of rabies between 1970 and 1981 in the State. Of these, one was 5 months, eleven were 4 months; eight were 3 months while three cases were 6 and 7 weeks old. There were more cases of rabies in male than in the female animal.

The most outstanding observation was that in the State 'furious' form of rabies appeared to be much more common (69.5 percent) of all rabies positive cases than the 'dumb' or paralytic form of rabies.

Also during the 12-year period, 104 out of 308 proven cases were in young, usually unvaccinated dogs. One-third was under 1 year of age and about one half had been bitten by a stray dog two to three weeks before becoming sick.

Six rabid dogs were apparent vaccine failures. Four had been vaccinated within 12 months and two at 17 and 29 months prior to death (Table 40).

Human Rabies

During the 1970 - 1981 period, information on the actual number of persons who died as a result of rabies

was not complete. However 26 human deaths due to rabies were reported in Plateau State between 1976 and 1981 by the Epidemiological Unit of the Ministry of Health, Plateau State. According to the annual report of the Ministry for 1978, 8 persons died of rabies in Plateau State in 1977 alone, and rabies ranks eight among the major infectious diseases in the State. Cases occurred in seven local government areas, namely: Jos, Barkin Ladi, Akwanga, Shendam, Langtang, Pankshin and Kanam with Barkin Ladi Local Government Area having the highest number of 5 followed by Jos with 4 cases. All the victims were bitten by dogs.

Reported Dog Bites in Plateau State 1970 - 1981

During the 12-year period, a total of 3,379 dog bites were reported all over Plateau State with an annual average of 281 bites. The reported bite rate for the over all population was 12.24 per 10,000. Table 41 shows details of the prevalence of reported bites and suspected rabid dogs submitted from the various local government area (LGAs) during the period. The bite rate per 10,000 human population ranged between 0 in Nassarawa to 7.3 in Jos. Similarly the number of animals with proven rabies varied from 1 case in Lafia to 70 cases in Jos during the period.

The overall number of bites and the type of reported bitting animals are given in Table 42. Bites due to dogs and cats accounted for 82.53 percent of the total bites (4109), the dog accounting for 82.23 percent and cat 0.29 percent. There were two bites by pigs. Bites from wild animals accounted for 0.27 percent.

The number of reported bites and number of positive canine rabies cases were highest in Jos followed by Barkin Ladi (Table 41). Six local government areas reported less than 100 bites and another six did not submit specimens during the 12-year period. The bite rate for 10,000 human population of the State for the entire period was 12.24. There was a considerable variation in reported bite rates between the different local government area that reported bites.

Table 42 also shows the annual figures for the years 1970 to 1981 and indicates that the highest number of bite cases in the 12-year period was recorded for 1980. The mean numbers of all bites for the period was 281.6 while the mean bites in which the dog was rabid was 19.8 (Table 42).

The highest rates of all bites and bites involving rabid dogs were in the ages less than 20 years in either sex (Table 43). More males of all age groups were bitten than female. Also 144 dogs bites were inflicted

on persons whose ages were not given (Table 43).

Risk of Bite

The odds ratio values of dog bites according to age and sex in relation to the total age groups for the 12-year period is shown in Table 44. Overall, age groups 10-14 and 15-19 showed odds ratio values 2.5 and 3.4 respectively. All other age group values were either less than or approximately 1. Similarly, the male age group 15-19 showed higher odds ratio value of 3.8 then the female counterpart (2.60). In the age group 10-14 both sexes showed relatively similar odds ratio values of 2.4 for male and 2.6 for female youths. However, the odds ratios were conspicuously higher than 1 in both sexes of the age groups 10-14 and 15-19 but less than or approximately 1 in the other age groups irrespective of the sex of the victim.

More bites reportedly occurred in towns than in villages and mining settlements (Table 45), villages (27.33 percent) and mining settlements (11.08 percent).

Of the total 3379 bites by dogs, anatomical location of bites was reported for only 608 bite cases. Of these, 320 (52.63 percent) alone were on the leg or foot while 266 were on the arm or hand. The head and neck had 18 (1 percent) while the trunk had 4 bites (0.7 percent).

to rabid dogs. The location of 2771 (82 percent) dog bites were not specified and 173 of these were inflicted by rabid dogs.

Severe wounds requiring surgical treatment amounted to 338 (10 percent) of all cases, while bites of medium severity mostly scratches with bleeding 1127 (33.36 percent) formed a considerable number of the cases. Also about an equal number of persons 1128 (33.38 percent) had superficial bites with slight bleeding. The severity of 786 cases (22.3 percent) was not stated.

About 1095 (32.4 percent) of all dog-bites was a result of aggravation of the animal by the victim.

Owned dogs were involved in 556 cases (16.5 percent) of the dog bites while 695 (20.57 percent) bites were said to have been inflicted by dogs whose ownership status was not indicated. 2128 (63 percent) bites were reportedly due to stray dogs. Only 627 bites (18.56 percent) of bites were by reportedly vaccinated dogs. The vaccination status of dogs involved in 2,752 bites was not known (Table 46).

About twenty percent of the dogs involved in bites were quarantined in veterinary clinics after the bites while 46.4 percent were not. About 33 percent of the dogs were killed immediately after they had bitten

people, while 14 dogs died naturally after biting (Table 46).

Table 47 shows the kind of antirabies treatment given to the exposed victims. About 3169 persons (93.8 percent) received cleaning and dressing only, 2814 (83.3 percent) were given antibiotics in addition, notably penicillin with streptomycin. There was no record for 210 cases. Tetanus toxoid was administered to 2405 persons (71.2 percent).

Antirabies vaccine (ARV) was given to 1360 persons while 2019 were not given (Table 47). Of patients vaccinated, 614 persons (45.2 percent) completed the prescribed course of treatment. Among the remaining 746 patients, treatment was discontinued on the doctors' instruction in 108 (14.53 percent). The main reason for discontinuation was satisfactory health status of the dog after quarantine observation or failure to detect rabies virus in exposing dog brains sent to the laboratory for confirmation. The remaining 630 (46.91 percent) patients discontinued treatment for reasons other than the doctor's instruction. Records of patients developing side-effects while on the treatment with ARV was not available and none of the patients was given booster doses of ARV after the last immunizing dose.

The majority of victims were treated for the first 14 days. After that the number of victims reporting for further treatment declined greatly with the result that only 5 persons were seen by day 28 post-exposure. By day 36 and beyond no victim reported back (Table 47).

RABIES SURVEILLANCE, PLATEAU STATE 1982-1983

Incidence and Distribution of Animal Rabies

Between 1982 and 1983, 588 specimens were submitted to the laboratory for rabies examination following the active surveillance for rabies initiated in the State. Table 48 shows the number of dogs examined and shows a steady annual increase, an average of 294 in specimen submission accompanied by an apparent variation in positive cases for each of the years of the surveillance. About 36.0 percent of cases submitted were positive for rabies in 1982 and 34.72 percent in 1983.

Table 49 gives the principal indicators of rabies in the State during the period. There is an indication of more laboratory confirmed cases in dogs in each of the two years (1982 and 1983) than any other year since 1970, inspite of the anti-rabies campaign carried out in the State in 1981. An apparently large number of dogs were vaccinated against rabies in 1981. There were 108 confirmed cases of rabies in 1982 and 100 in 1983. Table 49 also indicates that the cases were among domestic animals with dogs accounting for 99.52 percent (208) and goat just 0.48 percent of the accumulated total. Rabies was not diagnosed in any of the wildlife species submitted for examination during the surveillance period.

The distribution of cases by local government areas (Table 50) emphasises the higher incidence in Jos, Barkin Ladi, Pankshin and Langtang, the highland areas of the State. Table 51 gives the ownership and vaccination status of dogs confirmed rabid in 1982 - 1983. Unvaccinated dogs constituted the bulk of rabid dogs (105/108), 97.2 percent compared with (3/108) 2.79 percent in vaccinated dogs in 1982. Rabies was confirmed in both owned and stray dogs with a higher frequency in owned dogs 59.3 percent (64/108) than 40.7 percent (44/108) in stray dogs in 1982. The picture was generally the same in 1983 except that the incidence was just lower in 1983 than in 1982. For the two year period the incidence of canine rabies was 35.4 percent Owned dogs constituted 61.1 percent (127/208) while stray dogs constituted 38.9 percent (81/208) of cases. Similarly the incidence in nonvaccinated dogs was 98.5 percent (205/208) compared to 1.4 percent (3/208) in dogs that had received Low Egg Passage (Flury) vaccine.

Fig. 9 depicts the monthly distribution of submissions and cases during the 2-year period. Generally rabies was endemic and occurred in more numbers the months of September and October of each year.

The age and sex distribution of dogs examined are shown in Table 52. Adult dogs contributed 98.6 percent

in compounds or residential yards. Uninhabited buildings harboured 56 cases (27 percent) whereas the rest were found in street or play ground (39 cases) or farmland (37 cases). Suspected and confirmed cases were strictly more common in the urban areas than in rural areas (Table 55).

Post-Exposure Prophylaxis (PEP) in Human, Plateau State 1982 - 1983

The mean annual incidence of persons seeking antirabies treatment in the 14 local government areas was 13.3 per 10,000 people (Table 56).

The mean annual incidence of persons seeking post exposure prophylaxis (PEP) varied depending on the reporting LGA, ranging from 1.25 per 10,000 in Awe to 45.55 per 10,000 persons in Jos the State capital. Considering the State as a whole, 2431 (56.4 percent) of the 4311 persons seeking anti-rabies treatment actually received PEP (Table 57). The others received first aid wound dressing, antitetanus and antibiotic courses (Table 57).

A total of 1201 persons (49.4 percent) given PEP for whom age was given were under 20 years and 1.23 percent (30 persons) were under 10 years (Table 53). Persons reporting possible exposure (3367 or 78.1

percent) were under 10 years (Table 59).

The age distribution and source of exposure for receipients are shown in Table 58. About sixty percent of cases receiving PEP were males while females made up 39.7 percent of cases. The nature of exposure, percentage of proved rabid animals, type of PEP given median delay in starting PEP, and days of exposure were more or less the same for males and females (Table 58) were not specified and 173 of these were inflicted by rabid dogs.

Severe wounds requiring surgical treatment amounted to 338 (10 percent) of all cases, while bites of median severity mostly scratches with bleeding 1127 (33.36 percent) formed a considerable number of the cases. Also about an equal number of persons 1128 (33.38 percent) had superficial bites with slight bleeding. The severity of 786 cases (22.3 percent) was not stated.

Table 61 shows the number of animals confirmed rabied and the number of persons treated in each LGA. The highest is Jos and lowest Awe and Wase. The range is from 0 to 43.

Table 62 shows the monthly distribution of exposure incidents and post-exposure prophylaxis and rabies in animals. The exposure incidents clustered around

September and October. Although people were treated for rabies exposure in every month of the year, 943 (38.8 percent) of the 2431 persons treated with anti-rabies vaccine for whom data were available received the treatment in the period August to October.

Because of some ambiguity in the questions relating to type of exposure and site of bite in analysing the questions, those responses that were contradictory and uninterpretable were deleted. In those cases in which the kind of exposure was identified, bites accounted for 95.9 percent, nonbites including handling and eating of rabid dogs, scratches and saliva contact accounted for 1.9 percent (Table 63).

Exposure was on the upper extremities in 485 of 905 persons exposed by rabid dogs and on the lower extremities in 332 of 905 persons (Table 64).

Semple vaccine was most commonly used (896) followed by HDCV (783) and finally by DEV (752). The use of HDCV was common in the missionary hospitals located in Hos, Bassa, Akwanga while Semple vaccine and duck embryo vaccine were commonly used in the government hospitals. Treatment regimens of the persons who received Semple or duck embryo vaccine were similar in that persons treated received all 14 doses in cases where the animal was proven rabid or could not be located

after an unprovoked attack by an unvaccinated or stray dog. However, 27 percent received fewer than 14 doses in instances where the dog involved was quarantined and subsequently proved to be rabies free or in circumstances of provoked bites, teasing animals, feeding or helping injured dogs.

Treatment regimens of persons who received HDCV varied considerably (Table 65). Most victims (507 of 755) got the second dose of the vaccine while only 48 persons got the third or fourth dose. Majority of victims received the complete 14 doses of either DEV or Semple vaccine. About 20 of 730 persons and 90 of 878 persons bitten by dogs received less than the recommended 14 doses of DEV and Semple vaccine respectively.

Delay in initiating treatment for rabies was common, for only 210 (8.6%) of 2431 persons seeking PEP started treatment the second day after exposure (Table 66 and Fig. 11). By day 3 post-exposure treatment was initiated for 400 of the 2431 persons exposed. After 10 days, the rate of initiation of treatment slowed markedly. Even as late as day 20 after exposure 200 persons (8.2 percent) had not yet received prophylaxis. Fifty seven of these persons began treatment between day 21 and day 26 after exposure, and 15 persons were not treated until more than 28 days after exposure. The

median delay between exposure and the start of treatment was approximately 3 days and this varied from one LGA to the other and between rural and urban areas. In metropolitan Jos LGA it was as short as 24 hours after exposure in contrast to rural Nassarawa where it was 6 days.

None of the patients treated with ARV received the usually recommended booster dose of vaccine on the tenth and twenthieth days after the last immunizing dose. Only 86 persons (3.54 percent) returned for routine follow-up after a month. Of these, 74 were ascertained not to have developed rabies and the fate of 4237 persons was unknown as to the sequelae vis-a-vis rabies. However, 12 persons died showing classical symptons of hydrophobia inspite of PEP. The distribution of deaths from rabies during 1982 and 1983 was Jos (1), Pankshin (3) and Langtang (8).

Antigenic Analysis of Rabies Virus Isolates from Plateau and Other Areas of Nigeria using Monoclonal antibodies

Details of the sources of virus isolates and their recovery in neuroblastoma (NA) cell cultures are presented in Appendices 7, 8 and 9. For the majority of samples, 100 percent cell infection was observed after the first or the second cell transfer. One or two additional transfers were necessary for the isolation of

five of the strains. No virus could be isolated from Nos. RD. 208/82 and RD. 10/83 but they were originally known to be positive cases of rabies. The virus was not viable in the specimens. Also rabies virus was not isolated from RD. 11/83, RD. XX/83, RD. 93/83 and RD. 19/83 which were originally known to be without rabies infection but included as controls.

Nucleocapsid (NC) antigenic characterization

All the strains tested gave positive results with all anti-NC MCA except 422-5. The NC pattern of reactivity of all the variants were different from the pattern of reactivity of the reference Mokola, Lagos bat and Duvenhage viruses (Table 67 and Fig. 12).

Glycoprotein antigenic patterns of isolates

The 41 strains of virus originally classified as rabies could be subdivided into seven groups on the basis of antigenic properties of their glycoproteins (Fig. 13) and 14 strains comprising isolates numbers 7, 9, 11, 13, 15, 16, 20, 21, 22, 24, 25, 26, 27, 29, 33, 38, 40, 41, 43, 45, and 46 were group A variants. Fifteen of the group A variants were from Plateau State, one from Bendel, two from Gongola, and Benue one each from Kaduna and Niger States respectively (Fig. 15).

Eleven strains (Isolates number 2, 5, 6, 14, 17, 18, 19, 31, 35, 37 and 44) were group B variants and originated from Plateau (Fig. 15).

One strain No. 12 (of dog origin from Bendel) differed from the others by lack of neutralization by MCA 509-6, 231-22, 1105-3, 240-3, 1117-8, 226-11, 248-8, 1113-1, 1109-3, 1114-2 and 1101-3 and constituted group C variants.

Another strain (No. 1 of dog origin also from Bendel State) differed from the rest by lack of neutralization by MCA 509-6, 231-22, 240-3, 1117-8, 226-11, 248-8, 1113-1, 1118-6, 1120-10 and 1101-3, and so formed group D variant.

One strain (No. 4 of dog origin from Kaduna State) differed from all the rest by resisting neutralization by anti-GP monoclonal antibodies 509-6, 231-22, 101-1, 1111-1, 1112-1, 240-3, 1117-8, 226-11, 248-8, 1113-1, 1103-4, 1115-3, 1118-6, 1120-10 and 1101-3 and was classified as group E variant.

Five strains (Nos. 28, 30, 34, 39 and 42) differed from the rest by lack ofneutralization by five MCAs namely 240-3, 1117-8, 226-11, 248-8 and 1113-1 and were grouped as F. In this group, one variant originated from Plateau State, three from Bendel State and one

from Niger State (Fig. 15). Four of the group F variants were of canine origin while one was of feline origin.

Out of 18 selected Anti-Glycoprotein MCAs representing all antigenic sites, No. 36 isolate of dog origin from Bendel State was neutralized by all except MCA 231-22 (Fig. 14). This isolate was classified as group G.

Strains Nos. 49 and 50 presented different patterns of reactivity from all other strains tested. They were in fact the rabies virus seed used for the production of animal rabies vaccine in Nigeria (the Low Egg Passage, LEP, Flury strain vaccine produced at the National Veterinary Research Institute Vom, Nigeria). Comparative analysis of virus No. 50 and the Wistar LEP demonstrated great similarity despite the different history of propagation.

Fig. 16 shows the comparison of isolates from vaccinated dogs and Flury vaccine virus. The glycoprotein reactivity pattern of LEP (Flury) contrasts very much with those of isolates Nos. 22, 25 and 38 indicating the isolates were not vaccine viruses.

Protection Studies

Mice immunised with serial dilutions of an experimental rabies vaccine prepared from the Pitman

Moore (PM) virus propagated in human diploid cells (HDCS) were equally well protected against challenge with the homologous PM virus and against challenge with virus strain No. 39 only and did not survive challenge against strains Nos. 1, 4, 15, and 36 belonging to different variants (Table 8, Figs. 17 and 18). The antigenic value of the PM-HDCS vaccine was 10.0 IU/ml. Vaccine diluted 1:30 protected mice against at least 10,000 LD_{50} of CVS. At a dilution of 1/270, the vaccine protected 22 out of 30 mice infected with the homologous PM strain of virus.

The cross protection study in mice using the vaccine thus showed good protection against only one of the five variants representing groups,A, D, E, F and G respectively. Group B variant was inadvertently omitted from the protection study with the PM vaccine. However the test was designed to see if the extreme antigenic variation of some of variants was protected by vaccine. Only No. 39 in the F group of variants was protected by the vaccine. Other variant groups were poorly protected by the vaccine.

The protection studies with live avianised LEP (Flury) standard vaccine is given Fig. 19. The vaccine protected against the variants quite well even when the vaccine was diluted 1:125 (Table 69), and injected into guinea pigs.

DISCUSSION

Dog Population Estimates of Jos

Information collected in this study of dog population may suffice for administrative purposes and possibly for planning of rabies control campaigns in developing countries. For technical and financial reasons such countries may not affort the other complicated methods for estimating dog population. About 4 percent of compounds did not cooperate, a figure typical of surveys in general (Nassar and Mosier, 1982). If factors causing nonresponse were not in any way correlated with the variables under study, one would expect no bias in results. In contrast, one can make the extreme assumption that all dog-owning compounds that did not respond belong to a group that may be classified as irresponsible owners. In this instance, the present analysis would be biased toward those res responsible pet owners who bring pets regularly to the veterinary clinic or hospital.

In the present survey, the random sample of streets was chosen from the list of available streets in Jos metropolis as furnished by Jos Urban Development Board and the Ministry of Land and Surveys, Jos, Plateau State. There might have been some bias introduced if some streets were shorter than others or vice versa.

However, this was taken care of by random sampling of the streets and the selection of the compounds from every tenth compound in the same selected street. Moreover the underlying assumption in the survey is that dogs were uniformly distributed in the stratified sampled.

The methods presented in this study are useful in gathering data to estimate pertinent pet population characteristics. Results from such studies form a basis for decision making by governmental bodies concerned with pet population and control.

Reliable estimates for dog populations are still rare (WHO, 1984). In general, American and European countries report a dog to human ratio between 1:10 and 1:6 respectively. But there is no doubt that the abundance of dogs varies considerably from country to country and within geographical regions within countries (Beran, 1982; Rangel et al., 1981). A striking example is given by Ezeokoli et al., 1982) for Kaduna State in Nigeria. In northern Kaduna State there is less than 1 dog per 1000 inhabitants, while in southern parts of the same State the dog to human ratio lies between 1:27 and 1:30 (WHO, 1984). In the Jos study the ratio of dog to human was 1:4, ranging from 1:3 in Jos township and Native Town to 1:6 in the Government

Reservation Area (GRA). The average number of dogs per compound was 4. Our study thus suggests a higher dog to human ratio in Plateau than in Kaduna State. An explanation for this could be the existence of many pagan tribes keeping dog in Plateau State. All animals listed during the compound interview were considered to be owned by that compound. The dogs listed during the street (were considered as either "stray" or 'uncontrolled' or unwanted dogs. The term 'uncontrolled' was used to refer to owned animals allowed to run at large and the term 'stray' used to refer to rejected or lost animals running at large. The term 'unwanted' was used to refer to once-owned dogs that have been abandoned. The staggering discrepancy between the street and compound counts is hard to explain as looking around town, it would appear that there was a population explosion among dogs. Thus there had been rampant dog-biting of people in the streets by stray or uncontrolled dogs before the survey. Anyone making house to house visits ran a definite risk of being bitten by a dog; it was no exaggeration to say that even children playing outdoors were sometimes attacked by stray or rabid dogs. An explanation for the discrepancy could be that owners were beginning to retrain their dogs to their houses instead of allowing them to roam free in the streets. Prior media

communication campaign on anti-rabies control in the state which immediately preceeded this census could have created some awareness on owners on the need to restrain their dogs to their compounds.

Furthermore, the survey was carried out in late June to July when dog activity was considerable; and not during the peak of rainy season or the harmattan cold when dogs are least active (Nuru, 1973). The observation of less dogs in the streets in contrast to a higher population of dogs in the compound surveys was therefore not expected as it has been generally claimed that most dogs in African cities roam the streets and are probably feral and unowned (Engmann and Engmann, 1973; Fakadu, 1982).

It has been observed that in urban areas straying or loose pets are more common in low income higher density areas while ownerless stray dogs are common in lower human density areas (Beck, 1973, 1974, Rangel, et al., 1981; Harris, 1981). The density and origin of street dogs in cities of tropical areas may be different from the situation described above (Beran, 1982). This was the observation in the Jos study. The Jos study might serve as a basis for the design of field studies that will hopefully result in practical protocols for future use.

Dog Control in Jos

The simplest way to control free-roaming dogs is undoubtedly to discourage dog ownership. However whether the Nigerian society can be persuaded to accept such a policy is conjectural. Ownership of male or spayed dogs encouraging the surrender of unwanted dogs and prohibiting the abandonment of dogs are all measures that will show results only if they are applied simultaneously. Where this is done there is likely to be a profound drop in the number of free-roaming dogs within several years, and dogs will be in demand rather than being in surplus.

The success of dog control programs depends on a co-operating public (Feldmann and Carding, 1973). Dog lovers, more than dog haters, must be convinced that officials, from Veterinary Department and Jos Urban Development Board are carrying out measures that will improve conditions for all pets, as well as for the human population. Irresponsible pet ownership, however, cannot be abolished legislatively. The owners responsible behaviour toward his pet and his neighbours can be achieved only through education.

Campaings to achieve responsible ownership should include information on the reproductive patterns of pet animals, methods of contraception, and essentials of

proper maintenance. School children are a particularly receptive audience since they are invariably interested in pets. Children might also be taught how to avoid being bitten by roaming animals. Youngsters who know about the hazards of urban pets and the duties of responsible pet ownership can be a cadre to carry this message into the compounds of the communities they belong.

The general public will not comply with the control measures advocated by this study and which has also been incorporated as statutes in the Dogs Act and Dogs Laws (MacGregor, 1964), unless they are informed about hazards represented by stray and straying pets and the desirability of owning male or sprayed female pets. They will most probably not turn in unwanted pets.or refrain from abondoning animals until they are convinced that efficient, humane and practical methods are followed in capturing, impoundment, and euthanasia of stray animals.

Organised veterinary services can contribute substantially in educating the public. Local, regional, and national veterinary bodies should work through the mass communication media and with local governments, schools, philantropic societies, and groups of concerned citizens so that the message of responsible pet ownership becomes part ofthe conventional wisdom in the State.

As the behaviour of stray and straying pets increasingly impinges upon human rights and previledges, especially in Jos city, more and more voices will be raised to demand curbs and regulations. One who suffers harm to himself or his property can seek no recompense when a free-roaming dog is to blame. Veterinarians and public health professional ought to be informed concerning overpopulation of pet animals and be willing to implement practical solutions to the problems caused by free-roaming and unwanted pets especially dogs. Sporting purposes or exhibition from a hobby or recreational standpoint which is characteristic of the advanced western societies was absent in the Jos study. Thus major segments of society whose co-operation is imperative inlcude pet owners, law enforcement and judicial agencies; merchandisers of dogs.

Existing Dogs Act and Dogs Law (MacGregor, 1964) provides for adequate control of Dogs and therefore of rabies but the great difficulty is to enforce the law. These rules and regulations are not impossible for the average individual to abide by, but should serve the citizen and the animals in a most beneficial way. While a review of the laws with a view to raising the cost of dog licenses and methodology of enforcing the law clearly spelt out and placed directly under the control of veterinarians, to achieve full implementation

with resulting compliance requires co-operation by all dog owners plus a dedication by the regulatory agency involved.

An obvious finding in this study is that unlike the western society the most significant reasons why people owned dogs was mainly to help fulfil physical needs essentially protection or security. Reasons such as the dogs role as a co-therapist for the mentally disturbed patients, relief from loneliness, emotional involvement attached to owning pets, pets surrogating children or keeping dogs as a status symbol were not significant reasons for owning dogs in the study.

Values and Limitations of Dog Ownership

A majority of respondents, both owners (49.2 percent) and nonowners (32.4 percent) agree or strongly agreed that the issue of irresponsible dog owners was a problem in our society, yet it was nonowners who agreed more strongly. Most respondents also agreed that dog overpopulation is a problem. However, concerning issues of overpopulation in their community or in their neighbourhood, it was the non owners who agreed most often that a problem existed at the local level. This response pattern may reflect the true situation existing within the community; but if there is an overpopulation or stray dog problem at the

community or neighbourhood level, a number of dog owners do not believe that they are contributi to this problem.

The response partaining to potential community health problems related to free-roaming or stray dogs suggest that the respondents had some knowledge of such problems; however, for specific medical problems such as animal bites, and diseases that man can acquire from dogs, the average person's knowledge is superficial. When dogs or cats are allowed to stray or roam free, a number of community health problems may arise (Carding, 1973; Beck et al., 1975; Steele, 1976; Okoh, 1982). The results of this study indicated that although both owners and nonowners agreed that there is a need for control measures to prevent free-roaming dogs in the neighbourhood, nonowners agreed to a greater extent. This is in agreement with the results of another study (Wilbur, 1976).

In general, individuals in the study 'who own a pet' have a greater empathy towards the animal and a stronger tendency to overlook the negative characteristics of that particular animal and inconveniences associated with pet ownership. Protection appears important and will affect the roles of dog in our society. Some (though few) respondents kept dogs for food in the survey.

This could be due to the fact that the study was based on a relatively heterogenous society residing in the urban area. Dog meat is cherised among the netaives in the suburban and rural areas of the Jos Local Government Council and indeed among the native of the State. Renting versus owning a house did not significantly limit dog ownership. This was also true for other aspects of housing, e.g., limited space, fenced or open house. Although the values (Hartley and Shames, 1959; Phireas, 1974; Bridger, 1976; Wilbur, 1976 and limitations (Anon, 1974) or pet ownership have been discussed by others, quantitation of these aspects as they relate to individuals in the general population are uncommon (Lehman, 1928; Gundby, 1979). One may argue that it is impractical to assess values and limitations on an individual basis because problems with pet ownership are societal issues. However, these issues can be addressed by assessing values and limitations on an individual and family basis and then combining these data into population subgroups for further analysis (Selby, 1978; Hodge, 1976; Wilbur, 1976 and Gundby, 1979).

In the present study, the dog was not considered to be a member of the family although it was found to have developed a close relationship with family members. The family with children was more likely to own a dog.

Love or affection were not considered to be significantly important factors of dog ownership as in the European and American studies (Selby et al., 1980; Wilbur, 1976). Possible inconvenience of dog ownership considered important by some owners were the tendency to bite, noise, overprotective nature of dogs and damage to neighbours property.

No dog population study has been done in Nigeria hitherto this study. The Jos popul tion study is the first of its kind in the country. Also this is the first time the attitudes of Nigerians towards dog ownership and the values and limitations of dog ownership have been studied. Similar studies should be done in other towns of the country as before a practical solution can be found to specific problems associated with control of stray dogs and rabies, an estimate of the population is a prerequisite. This Jos study has provided a base-line for further similar works.

DESCRIPTIVE STUDY OF CANINE RABIES 1970-1981

Canine Rabies

Canine rabies is well established in Plateau State, however, there appears to be a decline in the annual number of confirmed rabid dogs in recent years. The actual number of rabid dogs in the state are under-estimated because many sick dogs are never examined. Furthermore, positive results in those dogs examined are probably under-reported because the impression smear test used in laboratories often fails to detect Negri bodies in early stages of disease (Banerjee and Elegbe, 1970; Courtois et al., 1974). In 1974, 39.13 percent of 155 examined dogs were positive and in 1975 the highest number of positive cases in the 12 years was recorded. The 1974 rate is comparable to that found in other African studies (Belcher et al., 1976; Courtois et al., 1964).

Rabies problem in the State was not restricted to the urban areas alone but appeared to be a great problem in the rural villages. Jos and Barkin-Ladi areas of the State constituted the core of the rabies endemic zones in Plateau. More canine rabies cases were reported from the northern high plateau than the southern lowlands. This might reflect differences in the two areas. The inhabitants of the northern highlands are mostly non-moslems, while those of

the southern lowlands are mostly moslems who do not keep dogs.

Rabies occurred throughout the year during the 12-year period but the frequency was high during the breeding season (July to September). This is the period when many dogs are on the streets. The observation in this study contrasts with that of Nuru (1973) who observed canine rabies peaks in September and October in Kano, Nigeria. However the discrepancy could be that dogs were exposed during the breeding season but came down with rabies later, after the season a reflection of the long incubation period in dogs.

Retrospective Study of Dog Bites

The age groups 10-14 years in both male and female sex categories and 15-19 in the female sex appeared to be at higher risk of dog bites and consequently of rabies. Children and youths less than 20 years of age have the highest rate because they are intimately associated with dogs as pets. They are often abusive to pets, and in many instances, they do not know how to care for pets properly. In addition, persons less than 20 years of age are more likely to be engaged in activities which excite dogs (Parrish et al., 1959). Also a possible explanation forthe higher odds ratio in the female than male sex could be associated with

relatively greater fear for dogs by the females. This could also be explained by the activity of the male and female, the male being more active than female.

Although there was no record of occupation of victims it could be inferred that since the majority were under 20 years of age they were school children.

The severity of wounds sustained from dog bites in relation to the risk of rabies is a factor of the site and extent of the injury. 2537 (75.1 percent) of all the reported dog bites were inflicted on the extremities, while 0.5 percent of the injuries were on the head and all the victims' size in comparison to that of the dog. About 75.percent of victims with known ages, in the report by Harris et al., (1974) were below the age of 10; while Kale (1977) reported 2.7 percent in the same age group. Our observations compares well with Harris et al., (1974) while it deffered markedly from Kale (1977) who reported 2.7 percent in the same age group.

Parrish et al., (1959) used a biological gradient to classify the severity of dog bites with respect to extent of the injury. Using a modification of that classification 10 percent of the wounds in this study were regarded as 'severe'. Parrish et al. (1959) reported 14 percent, Morton (1973) 4.5 percent, Beck et al. (1975)

3.4 percent and Robinson (1976) 10 percent of bites in their studies as being severe. A probable explanation for this dispartity when viewed along with the Plateau study is the relative subjectivity of the criterion as well as the fact that this was a retrospective study and therefore more likely to be less accurate. The severity of the bite has a considerable bearing on the treatment of the victim particularly with respect to rabies prohylaxis. An analysis of the cases with severe wounds showed that 181 (53.6 percent) were males. and 288 (85.3 percent) were under 20 years of age, with the age groups 14-19 contributing 29.41 percent of the total.

The population of dogs in Plateau State based on veterinary clinic attendance was put at approximately 300,000. The ownership of dog reported in dog bite cases was, however, claimed in only 16.46 percent (556) of the bite cases for which information was available. The fear of medico-legal involvement by owners could be suspected as a reason for not claiming ownership of most dogs involved in bite cases.

Of all reported dog bites 18.56 percent were claimed to have been inflicted by dogs vaccinated against rabies. It is possible that the majority of the 2752 dog bites on whom no record was kept about ownership were due to strays.

There was no information about the age or breed of the biting dogs but forty-six of them were reported to be bitches that whelped a few days previously. All of these bitches apparently attacked their victims without provocation in attempt to protect their puppies and this supports the finding is contrary to that of Parrish et al. (1959).

The management of dog bite victims in the period was unsatisfactory in many respects. The type of human antirabies vaccine used was not indicated in most of the treatments. It was referred to vaguely as ARV (Anti-rabies vaccine).

None of these vaccinees was given booster doses of the vaccine on the tenth and twentieth days after the last daily dose as recommended by the Fourth W.H.O Expert Committee on rabies (1960). This could either be that the victims did not turn up for the booster or they may have been scared off by the cost of the vaccine. Investigations have revealed a shortage of antirabies vaccines in most of the hospitals surveyed (Fagbami et al., 1981). As a result many patients have to purchase vaccines from elsewhere at exorbitant prices and those that cannot afford this either become apathetic towards antirabies treatment or resort to native "treatment" (Anosa et al., 1980). This and

the lack of good record keeping make it difficult to accurately determine the total number, doses and rate of anti-rabies vaccinations (Fagbami et al., 1981).

Twnety-six cases of human rabies were reported by the Epidemiological Unit of the Ministry of Health Plateau State during the period. The fact that rabies carries a virtually 100 percent fatality rate calls for a higher level of vigilance in the follow-up of those exposed (Shah, 1975). However, as many as 90 percent of the patients in this study had less than 15 days of follow-up and it is difficult to know how many actually died from rabies.

The data presented by Boulger and Hardy (1960) indicated that a case of human rabies in Nigeria following a dog bite on the arm occured after an incubation period of 7 weeks despite injections of rabies vaccine. Coulanges et al. (1975) also reported a case of a 12-year-old-child who, despite prompt treatment with rabies vaccine, developed rabies within 10 days of facial injury from a rabid dog. Similarly Warrell (1976), reported the cases of two Nigerian children aged 9 and 14 years who inspite of prolonged and full immunization with antirabies vaccine (21 and 14 days courses respectively) developed rabies on the thirty-fourth and forty-ninth day respectively.

The high incidence of dog bites in Plateau State appears to be consistent with the large population of free-roaming dogs in the main towns. Some of these dogs may be traceable to particular owners, but most are probably true strays. Thus, people in the State, especially in urban areas, live under high risk of rabies infection.

It has been shown (Glosser et al., 1970; Tierkel, 1948; 1949; Wells, 1954) that there is a close relationship between the number of canine rabies cases and resultant cases in humans, and that when dog rabies is controlled the number of cases drops correspondingly, as does the number of human post-exposure vaccinations administered. The impact of canine immunization in urban rabies control has been shown in many countries. In the United States (Glosser et al., 1970), a nation-wide rabies control programme interrupted the urban cycle of dog-to-dog transmission, inspite of a steadily increasing population. Another successful rabies control programme was carried out in Malaya in the 1950's and canine rabies was reduced to nill (Wells, 1954). In Ethiopia, where canine vaccination was carried out without destruction of stray dogs, rabies in owned dogs and the number of post-exposure treatments decreased (Fekadu, 1982).

Another emerging problem is the frequent occurrence of rabies in vaccinated dogs. In a previous survey, six cases in vaccinated dogs.were recorded in a ten-year period (1970-1980) in Plateau (Okoh, 1981). Three cases of rabies in dogs which had been vaccinated one year, three months and six weeks earlier occurred in Vom, Plateau State in 1982 (Okoh, 1983). These three cases within a year could be an indicator of problem.

Despite the existence of rabies legislation in the State and the availability of vaccines for canine immunization, deaths from rabies are still frequent in Plateau State. In fact the disease is ranked as the eight of the first ten communicable diseases in the State.

Surveillance Study of Rabies in Plateau State 1982--1983

Plateau State recorded 209 cases of rabies in domestic animals during the 2 years: 109 in 1982 and 100 in 1983. These were the highest figures since 1954. Whether this was solely due to more awareness of rabies or a true increase in the incidence of the disease remains unclear. The 208 cases in dogs reportedly exposed 4311 persons whereas none of the wild animals exposing 17 persons was positive for rabies virus. This represented a ratio of 43 human exposures

requiring treatment per 100 rabid domestic animals (41/100 for rabid dogs).

More people died of clinical rabies than is revealed by this survey perhaps because many cases are not reported or confirmed (Fagbami et al., 1981).

The observation of peaks of canine rabies cases in September and October agrees with the studies of Nuru (1973) who observed canine rabies peaks in September and October in Kano Nigeria, and with those of Belcher et al., (1976) which showed September and October peak in Ghana. The reason for the peaks in September and October may be attributed to breeding season of dogs, a period of fighting among dogs on heat, cultivation of the land and other social activities (Zwart, 1969). The major significance of the seasonal peak is that stray dog collection and mass immunization campaigns should be timed to preceede its occurrence.

The annual vaccination rate in dogs cannot be calculated because the size of dog population is not known for Plateau State. However judging from the number of dogs seen in the State veterinary clinics and treatment centres and the number of dogs vaccinated against rabies before and after the campaign, it would appear that the annual vaccination rate for the State is still well below the 70 to 80 percent necessary to

interrupt transmission (WHO, 1973; Tierkel et al., 1950). During the period the survey of compounds that a 45.9 percent vaccination rate was observed for dogs in Jos, a probable relection of the situation State-wide. However, LEP (Flury) vaccine supply seemed inadequate and this was a constraint for regular mass vaccination campaigns.

The finding that male dogs were more affected than female dogs are consistent with other studies in this country (Elegbe and Banerjee, 1970; Zwart, 1969) and elsewhere (Beran et al., 1966a, 1968, 1982; Winkler, 1979) and this may be due to preponderance of male dogs due to greater preference for male dogs among the people and to more fighting among male dogs.

Wildlife cases which were sporadic in the early and mid 1970s in the State (Okoh, 1976, Kasali, 1977, Banerjee and Elegbe, 1970) were conspicously absent in the two years. However, the possibility of wildlife acting as reservoir of infection for domestic animals needs to be investigated. Twenty-three puppies of various ages died of rabies between 1970 and 1981. Of these one was 5 months while three were 6 to 7 weeks old. Dumb rabies has been reported in eight-week-old puppies (Adeyanju and Addo, 1977). The "furious" form of rabies appeared to be much more common (69.9 percent) than the "dumb" or "paralytic" form (9.4 percent).

Most of the specimens submitted were from cases which had either been shot or clubbed because of their furious behaviour. The observations compare with those made in East Africa (Rweyamamu et al., 1973), where the "furious" form appeared to be more common (74.3 percent) than the "dumb" form (4.7 percent). However, in West and Central Africa the paralytic syndrome has been reported to be more common than the furious form and to be widespread (Thorne, 1954; Thiery, 1959; Chalmers and Scott, 1969).

There is a need to co-ordinate rabies control activities under a single authority or to form a standing committee from the agencies concerned. This would improve the exchange of surveillance information and provide programme administrators with better feedback.

Improved methods of active patient immunization are now available with the development of anti-rabies vaccine produced from human diploid cells (WHO, 1973, Helmick, 1983). This vaccine is more potent in stimulating antibody production, causes few side-effects, and requires a shorter treatment schedule than older vaccine (Helmick, 1983; Mann et al., 1980). The introduction of the new vaccine will improve prophylaxis results and should enhance patient co-operation.

The initial operating costs of an improved rabies control programme, with adequate immunization coverage and elimination of stray dogs would be higher than current expenditure. However, the current cost of treatment for dog bites in Jos alone during 1979 was estimated to be approximately ₦100,000. Some of these treatment costs would be reduced with better dog control and should be diverted into preventive programmes. The increased cost is clearly justified by the large number of dog bites and the unacceptable current level of death from human rabies in the State.

If a pilot programme in Jos were successful in achieving improved public education, owner responsibility, and co-ordination of vaccination and stray dog control, similar rabies control programmes should be extended to cover the rest of the State and the rest of Nigeria.

Post-Exposure Prophylaxis (PEP) in Human

Post-exposure prophylaxis (PEP) was infrequent or irregular in seven of the local government areas essentially because of unsteady supply of antirabies vaccine. This necessitated victims going in search of PEP in other LGAs in the State or even outside the State to get PEP. Only eight major LGAs, in the study, Shendam, Jos, Akwanga, Keffi, Pankshin, Bassa, Langtang

and Lafia had hospitals where rabies PEP could be given completely and even among them there were significant differences in the vaccines used and treatment regimen.

There are several acceptable alternatives in the management of exposures involving dogs or cats. If the biting animal be examined by the veterinarian immediately, and if it is found rabid, initiate treatment of the person that the animal be placed under observation for 10 days. Similarly treatment may be initiated if the dog or cat is not immediately available, and treatment than may be terminated if the animal is later found to be healthy. Because of these and other variables, one must be cautious in drawing conclusions about the quality of medical treatment provided to persons exposed to rabies in the geographical area studied. Nevertheless, an average delay of more than 7 days before the initiation of treatment of persons exposed to both stray and owned dogs indicates a significant deficiency in view of the endemic pattern of rabies in the State.

The age and sex distribution of the persons given antirabies treatment in the study and the seasonality of exposure are similar to those reported earlier in the retrospective studies and those observed by earlier workers in this country (Nuru, 1973; Elegbe, 1975; Kale, 1977; Anosa et al., 1980; Fagbami et al., 1981).

People were treated in absence of specific diagnosis provided there was evidence of dog bite. Kanam which had no canine rabies during the period studies, treated 40 persons for possible exposures to rabies from dog bites. It would have been desirable to examine the persons exposed to proven rabid animals as a subcategory within the groups of persons treated, unfortunately the data were not adequate for such an examination.

The treatment rate in this study was 63.3 persons per 100,000 population which is similar to that reported by Fagbami et al., (1981) for the nation. The distribution of human antirabies vaccines for the entire State for 1983 (or any year) could not be determined as most hospitals in the State purchased the vaccines of assorted kinds directly from different sources and the purchase was often no co-ordination. As such it was not possible to estimate the total doses of human ARV purchased for use during the period.

A total of 7,549 victims of animal bites received post-exposure antirabies treatment over a 10-year period in Nigeria (Anosa et al., 1980). The finding of 4311 animals bite victims seeking post exposure antirabies prophylaxis within two years in Plateau State alone indicates the magnitude of the problem in the State in particular and the nation at large.

The observations made in the prospective study reaffirm those reported earlier in the retrospective study and also confirm the work of other workers (Kale 1977, Anosa et al., 1980; Fagbami et al., 1981).

The human diploid cell antirabies vaccine (HDCV) has been shown to promote an antibody response in man comparable to or better than that obtained with duck-embryo vaccine (Acki et al., 1976) and Semple type brain tissue vaccine (Shah et al., 1976, Shah, 1975). HDCV is expensive, but its effectiveness at doses as small as 0.1 ml given once intradermally, with negligible risk of adverse reactions makes it a superior alternative to the existing antirabies vaccines (Turner et al., 1982 AICF Morbidity and Mortality Weekly Report, 1980, 1982). The high default rate associated with the use of duck-embryo and Semple vaccines as revealed in this study is a serious handicap to their use, whereas primary immunization with HDCV can be conveniently completed in 5 to 6 injections (Bahmanyer et al., 1976 Bahmanyer 1976, Kuwert et al., 1976, Mean et al., 1978, Roumiantzeff et al., 1983).

The September - October peak in total exposures was primarily the result of a large increase in exposures involving dogs that were reported during the months. The seasonal fluctuation in exposures

involving dogs generally paralled that for total exposures. However several problems prevented the achievement of satisfactory dog vaccination levels and human post-exposure vaccination. First dog owners and human dog bite victims found it difficult to reach the single clinic site remotely located. Secondly mass vaccination campaigns were conducted at irregular intervals. These should be maintained on an annual schedule with most of the educational and immunization activities timed to just precede the July to August transmission period. Thirdly, antirabies vaccines for both animals (dogs) and human have not been available in adequate quantities to cover the estimated dog population and human post-exposure prophylaxis respectively. If sufficient vaccine supplies were maintained and well-publicized neighbourhood and state-wide vaccinations campaigns were held regularly, access to and use of immunization services would undoubtedly improve. The same is true for post-exposure prophylaxis in dog-bite victims.

Characterization of Rabies Virus Isolates

The results of monoclonal antibody typing confirm that the isolates were rabies viruses. No rabies-related viruses (Mokola, Lagos bat or Duvenhage) was detected in all the samples, an observation similar

to that of Umoh et al. (1984). Even all the isolates from Bendel State which borders on Ibadan in Oyo and Lagos in Lagos State where Mokola and Lagos bat viruses were first isolated in Nigeria (Boulger and Porterfield, 1958; Shope et al. 1970) were rabies virus strains. However, it is suggested that further studies be carried out to determine the presence or otherwise of rabies-related viruses in the cat and dog populations in the state and Nigeria as a whole.

The NC patterns of the Nigerian isolates to a great extend corresponded to the dog isolates from central and north Africa and also to canine and goat isolate patterns from Burundi in Africa. This finding confirmed earlier observations by Wiktor et al. (1980); Sureau and Rollin (1982).

It is of interest that 22 variants under group A had identical glycoprotein neutralization pattern with the virus strain Massachusetts 1983, isolated from a 30-year old American Architect from Waltham, Massachusetts that contracted rabies in Ososo, Bendel State, Nigeria following exposure to a dog bite (CDC, MMWR, 1983).

On the basis of the glycoprotein pattern, it would appear that dog rabies viruses are not homogeneous even within a geographical area. Six strains from dogs

and one from a cat showed the greatest and contrasting variation in glycoprotein antigens but the variation does not spread outside the State. Mapping of isolates according to areas of origin gives clear geographical differences, for example between isolates from Plateau and Bendel States in particular. Bendel State is about 200 kilometres from Plateau. It is interesting to note that all 5 isolates from Bendel State belonged to five different antigenic groups (A, C, D, F, G) in contrast to Plateau where 15 of 21 belonged to A and 11 belonged to B and 1 to F. It is suggested that more work be done in the southern state to see if this type of antigenic variation is common or unusual to the State.

The samples examined in this study were not collected in a random fashion and, therefore, the results do not necessarily represent actual prevalences of the strains. However, some important relationships can be extracted from the data. Variants in Group A were most common in the samples and were encountered in all the States examined irrespective of the size of the samples from the area. Group B variants comprised the second frequent isolates and together and together with group A formed 80.5 percent (33 out of 41) of the characterised field isolates. It is of interest that some dog strains reacted identically

with both panels of anti-NC and anti-GP MCAs, even though they were isolated from locations some 200 kilometres or more apart. Two additional strains (No. 39 from a cat, and No. 16 from a goat) showed an identical pattern of reactivity suggesting that these animals could have been infected by dogs. Also there isolates from dogs that had been vaccinated in accordance with the local rabies regulations showed GP pattern that did not conform with those of the seed and vaccine strains but was identical to street rabies virus variants of group A. This indicated that the vaccinated dogs actually were infected with street rabies and not vaccine strain or rabies-related virus.

The occurrence of street rabies in vaccinated dogs dying from the didsease suggests failure or the LEP vaccine to protect against the invading street variants although it was not possible to determine the antibody titre of the dying vaccinated dogs. Occasionally failure occurs even when the vaccine can be assumed to be potent (Hattwick et al., 1972; CDC, 1976). Antigenic differences of rabies virus were suspected to be responsible for vaccine failure but until recently with availability of monoclonal antibody technique, there was no way to detect these differences (Wiktor et al., 1980).

The antigenic variation may have important implication in the occurrence of rabies in vaccinated dogs. Comparison of the glycoprotein pattern of the Flury LEP vaccine seed and the virus isolates from vaccinated dogs indicated some antigenic differences between the vaccine and the isolates, and indicated the dogs were most likely infected with the street viruses and not vaccine induced.

Protection Studies

The failure of Pitman Moore inactivated vaccine to protect practically four of the five groups representatives (Nos. 1, 4, 15, and 36) indicates that in fact there exist in nature certain variants of rabies virus against which conventional vaccines do not fully protect (Schneider and Meyer, 1981; Wiktor et al., 1980; Sureau et al., 1983). This study further indicates that a panel of virus neutralizing monoclonal antibodies representing major antigenic determinants may selectively identify such variants of field virus strains and thus may be extremely helpful in epidemiological investigations.

The results of this study further indicate that there are good grounds for suspecting that there is a sylvatic reservoir of rabies in Nigeria. The glycoprotein pattern of variants in groups B, C, D,

and E resembled the GP pattern of Pennsylvanian bat rabies virus with special reference to failure to be neutralized by anti-GP MCA 509-6 and 231-22 (Wiktor, Personal Communication). The range of reservoir may be much greater than that indicated by the occurrence of clinical disease in dogs, which is largely a reflection of the canine population density. Various species of bats occur in Nigeria but not much is known of rabies in them except Lagos bat virus, a rabies-related virus was isolated from a bat in Lagos (Boulger and Porterfield, 1958). However, only a limited number of bat specimens have been examined (Tomori, 1980). In northern Nigeria there is a suspicion that there may be sylvatic rabies involving ground squirrel (Zwart, 1969; Boulger, 1967), the jackal and possibly other carnivores (Okoh, 1976).

The results of guinea pig protection test with LEP were different from using PM probably because one (PM) is killed while the other (LEP) is live and so inducing various grades of immunity in the animals. It could also be explained by difference in the antigenic sites which are fewer in PM than LEP and so might be less protective.

The results of cross-protection experiments in Guinea Pigs proved to be different from those expected

in the mice protection experiment using inactivated PM - HDCV vaccine. Mice immunised with the inactivated vaccine were not protected or were only partially protected when challenged with the street variants. The immunised guinea pigs on the other hand were protected against challenge with the field strains that were apparently not closely related to the vaccine strain.

There does not appear to be a close relationship between closeness of antigenic pattern and protection. It is interesting that F which differed from PM vaccine virus in at least three antigenic points was fully protected whereas, G which seemed to be completely homologous (which had all the antigenic points of PM vaccine virus) was not protected. It would appear that these groups that were not protected might have extra antigenic points in their virulence pattern. They might have alternative or extra sites that ought to be blocked for neutralization to occur. Although there are marked antigenic differences among several field isolates and viruses used for vaccine production, it is uncertain whether these differences account for vaccination failures observed in humans and animals (Wiktor, 1983). The finding of seven antigenic variant groups in a relatively small number of isolates examined suggests the possible existence of more

variant groups in Nigeria. This call for further examination of rabies virus isolates as there might be variants resisting protection with vaccines in nature. If this holds then this will be important in Nigeria as the HDCV (Pitman-Moore vaccine) is now widely used in the country.

The finding of 5 groups with extremely heterogerous antigenic variation in Bendel area is quite interesting. Whether this is a chance finding is not known but also calls for further studies in that state and Nigeria as a whole.

SUMMARY AND CONCLUSIONS

The estimated free-roaming dog population in Jos based on 10 percent random sampling of the streets was 4,200 while that of owned dogs based on 10 percent random sampling of compounds was 10,560. While the technique of the dog population census contrasts with those used by other workers in dog studies in other parts of the world, the results are comparable as no practical method can determine the exact number of dogs in a population but estimates can be used to monitor trends in population size. The rather low free-roaming dog figure was not expected as it has been generally claimed that most dogs in African cities roam the streets. The rather small size might indicate that people were becoming more aware of the need to restrain their dogs to their compounds.

A questionnaire survey on the demographic, zoographic and attitude to dog ownership in Jos showed that 55% of compounds owned dogs, the mean number of dogs owned per compound was 4 and the female intact dog was commonest. The mean age of dog owned was 3 years and the mean length of time dog was 3 years too. The mean number of litters was approximately two. Most dogs were obtained from neighbours, and the most important reason for

obtaining a dog was for protection and not for the love to keep a pet. Farmers and civil servants owned the largest number of dogs. Dog to human ratio was 1:4 in Jos, a ratio that appears less than those obtained in American and European studies where figure 1:10 and 1:6 respectively have been given. The Jos study suggests a higher dog to human ratio in Jos than in Kaduna where less than 1 dog per 1000 inhabitants have been reported. Opinionnaire survey on aspects of public health, dog control and veterinary utilization showed that irresponsible owners were the major cause of too many stray dogs and that dog over-population is a major problem in the city today. Non owners of dogs tended to agree more strongly on opinion items related to dog bites, rabies control and medical expenses on veterinary services rendered in the city. Use of veterinary services by dog owners was higher in the city centre and the Government Reservation Area than the suburban areas.

An obvious finding in the survey is that unlike the western society dogs were not kept for surrogating children relief of loneliness or as a status symbol; owners and nonowners alike strongly disagreed that a dog should be part of their family.

The opinionnaire survey also showed that most people's knowledge was superficial with regards to

problems on diseases they could acquire from dogs and this could be another reason for keeping too many dogs. As many as 75 percent of compounds owning dogs were ignorant of the existence of both rabies law and dog control regulations in the State and this further makes the enforcement of the Dog Act and Dog Law difficult.

Rabies is endemic in the State and the prevalence rate in 12 years (1970-1981) was about 22 percent with an annual average number of 31 cases. The prevalence rates of rabies were high in March-April and September-October and the dog accounted for most positive cases 87.5 percent. A prospective surveillance study carried out in recent years (1982-1983) showed the highest recorded incidence of the disease in the State since 1954. Similarly more dog bites in human beings were recently reported (4, 311) in two years compared to 3,379 reported in the State between 1970 and 1981. High proportion of bites were also inflicted in villages and mining settlements where anti-rabies post-exposure prophylaxis were too costly or not available. The surveillance study confirm most retrospective findings. A total of 2431 people received anti-rabies vaccines of different types predominantly Semple type in all the 14 Local Government Areas but

treatment regimen differed considerably from one Local Government Area to another depending on the availability of anti-rabies vaccine. Delay in receiving treatment for rabies was common and was as late as 20 days after exposure. Recently (1982-1983) 12 people died in the State, 1 in Jos, 3 in Pankshin and 8 in Langtang. These recent cases indicate that human rabies is under-reported and calls for intensified efforts to bring the disease under control in the State.

The Antigenic composition of 41 strains or rabies virus isolated from different animal species was determined with a panel of 80 monoclonal antibodies (MAbs). No differences between isolates could be detected by fluorescent antibody staining technique with 36 MAbs specific for the nucleocapsid antigen but the virus neutralization assay with 44 MAbs specific for the glycoprotein antigen revealed seven patterns of reactivity. 36 out of 41 strains could be classified into three groups comprising 21, 11 and 5 strains respectively; 4 strains represented a unique pattern of reactivity. Comparison of reactivity pattern of three strains of rabies isolated from dogs in which the disease was suspected to be vaccine-induced with reactivity pattern of the Flury LEP vaccine virus demonstrated that vaccine could not be

implicated in the death of these animals.

A human rabies vaccine produced the Pitman-Moore rabies strain (PM) failed to protect mice that were challenged with six of the seven variant representatives. Studies in guinea pigs showed that guinea pigs vaccinated with LEP (Flury) vaccine and challenged with the same representatives of the seven groups of rabies variants survived challenge, even after vaccination with high 1:125 dilution of vaccine.

Major Conclusions

The major conclusions of this study are:

(a) The dog population in Jos was estimated to be about 10,560 dogs assuming that half of the dogs found in street were not accounted for in the compound survey.

(b) Dog bites and rabies are widespread in Plateau State and its prevalence in large urban communities is about the same as in the rural areas and mining camps.

(c) The domestic dog appears to be the major reservoir and source of exposure to rabies.

(d) The high risk age groups were between 10 and 20 years.

(e) Inadequate/unavailability of human antirabies vaccines is a major constraint to effective

post-exposure prophylaxis in the State.

(f) Analysis of antigenic composition of 41 isolates of rabies virus from different animal species in Nigeria showed them to be all rabies (rather than rabies-related), however with difference in the glycoprotein antigens. The 41 isolates could be classified into 7 antigenic variants using the antiglycoprotein monoclonal antibodies.

(g) Cross-protection studies in mice using an experimental human vaccine indicated that there exists in nature in Nigeria certain variants of the rabies virus against which conventional vaccines may not fully protect. However, similar studies in guinea pigs indicated that LEP (Flury) used for vaccination in dogs in Nigeria protected against all the variants.

Areas of Further Studies

Areas of further studies should include the following:

(i) Extention of the dog ecology and epidemiology to other cities and States of the country;

(ii) Continued characterization of rabies virus isolates to get a total picture or extent of antigenic variants of

rabies and the distribution of rabies-related viruses such as Mokola and Lagos bat especially in dogs and hosts other than the shrew and fruit bats respectively.

(iii) Extension of the cross-protection studies of rabies variants in the natural host, the dog using the LEP vaccine.

(iv) Further investigation of the role of antigenic variants in vaccination failures of man and animals.

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Table 1: Estimated Dog Population: Street and Compound Counts, Jos, Plateau State Nigeria

Area (Stratum)	Street Count		Compound Count	
	Average*	Estimate**	Count+	Estimate++
1. GRA	40	400	116	1,160
2. Jos Township	99	990	292	2,920
3. Jos Native Town	141	1,410	283	2,830
4. Delimi-Nassarawa Gwong-Dogon Dutse	122	1,220	272	2,720
5. Angwan Rogo and Suburbs	20	200	93	930
Total	422	4,220	1,056	10,560

*Average dogs in 10% streets in the stratum.

**100% estimate of street count.

+No of dog in 10% Compounds in the stratum.

++100% estimate Compound count.

Table 2: Dog/Person ratio by Residential Area, Jos, Plateau State

Area (Stratum)	Dog	People	Ratio
1. GRA	116	715	1:6
2. Jos Township	292	1,110	1:3
3. Jos Native Town	283	1,097	1:3
4. Delimi-Nassarawa Gworg-Dogon Dutse	273	984	1:3
5. Angwan Rogo and Suburbs	93	299	1:3
Total	1,056	4,205	1:4

Table 3: Selected Demographic variables of 480 Compounds by Dog Ownership Status

Variable	Dog Owner Status		
	Nonowner (217)	Dog Owner only (263)	All Compounds (480)
Mean (number) per Compound (individuals)	6	8	8.80
Length in years, in present Compound	5	8	6.62
Mean Age of head of Compound (in years)	37	36	36.82
Number Dogs Owned per Compound	-	4	4
Mean length of time, in years since owing a dog	-	3	3.35yrs.
Total persons in compound	1,218	4,205	5,423

Table 4: Category of Dog Ownership, Jos, Plateau State, 1982

Category of Ownership	No of Compounds	Percentage of Compounds
Never owned a Dog	137	28.5
Owned Dog Presently	263	54.8
Owned Dog Previously	80	16.7
Total	480	100.0

Table 5: Category of Pet-Owning Compounds* in Jos, Plateau State, 1982

Category	No Pets (Dogs and Cats)	Dog only	Cat only	Dog and Cat	Total
No. (%)	153(35.4%)	190(44.6%)	36(8.3%)	53(12.3%)	432

*Excludes vacated compounds, uncompleted buildings or public (office) buildings and Total does not add to 480 because other pest (Monkey, Chimpanzee, Horses etc 48 or 10% in all were not considered as true pets by criteria used. Pets in the study were dogs and cats only.

Table 6: Some Variables of Subpopulations in Residential Areas in Jos, Plateau State, 1982

Residential Area	Variables considered				
	No. and Percentage Compounds	Compound size	No. Persons Bitten	No. Dogs	No litters
GRA	75(15.6)	715	15	116	32
Township	128(26.7)	1110	159	292	80
Native Town	128(26.7)	1097	145	283	57
Delimi-Nassarawa Gwong-Dogon Dutse	112(23.3)	984	158	272	52
Angwan Rogo	37(7.7)	299	45	93	23
Total	480	4205	522	1056	224
Mean	-	8.79	2.0	4.15	0.88
Standard Deviation	-	5.63	1.8	2.81	0.97
Variance	-	31.68	3.57	7.92	0.94
No. Compounds Reporting	-	478	255	254	130

Table 7: Sources of Dogs as reported by Owners, Jos, Plateau State, 1982

Source of Dog	No. (Percent) Respondents
Breeder	29(11.0%)
Neighbour	81(30.8%)
Pound (impounded strays)	6(2.3%)
Others (abandoned; lost and adopted)	136(51.7%)
Not stated	11(4.2%)
Total	263(100.0%)

Table 8: Dog - Cat Category of Compounds by Occupation of Head of Families, Jos, Plateau State, 1982.

Category of Household	Occupation of Head of Families								
	Hotelier	Unemployed	Business Person/ Contract-or	Civil Servant	Farmer	Auto Mecha	Housewife (Full-time)	Student	Total
No Pets	4(2.6)	13(8.5)	15(9.8)	29(19.0)	36(23.5)	28(18.3)	27(17.6)	1(0.7)	153
Dogs only	2(1.1)	24(12.6)	24(12.6)	40(21.1)	55(28.9)	22(11.6)	22(11.6)	1(0.5)	190
Cat only	1(2.8)	5(13.9)	5(13.9)	3(8.3)	11(30.6)	4(11.1)	7(19.4)	-	36
Dog and Cat	-	11(20.8)	8(15.1)	12(22.6)	13(24.5)	5(9.4)	4(7.5)	-	53
Total	7(1.6)	53(12.3)	52(12.0)	84(19.4)	115(26.6)	59(13.7)	60(13.9)	2(0.5)	432

*Figures in brackets indicate percentages

Table 9: Category of Pet-Owning Compounds by residential Area, Jos, Plateau State, 1982

Dog - Cat Category	Residential Areas					
	GRA	Jos Township	Jos Native Town	Delimi-Nassarawa Gwong-Dogon Dutse	Angwa Rogo and Suburbs	Total
No Pets	16(10.5)	43(28.1)	48(31.4)	38(24.8)	8(5.2)	153
Dog only	30(15.8)	58(30.5)	37(19.5)	48(25.3)	17(8.9)	190
Cat only	9(25.0)	6(16.7)	9(25.0)	8(22.2)	4(11.1)	36
Dog and Cat	14(26.4)	16(30.2)	17(32.1)	5(9.4)	1(1.9)	53
Total	69(16.0)	123(28.5)	111(25.7)	99(22.9)	30(6.9)	432

Table 10: Size of Families by Residential Area, Jos, Plateau State, 1982

Family size	Residential Area					
	GRA	Jos Township	Jos Native Town	Delimi-Nassarawa Gwong-Dogon Dutse	Angwan Rogo Suburbs	Total
1	2(8.3)*	6(25.0)	7(29.2)	5(20.8)	4(16.7)	24(5.0)
2	-	4(26.7)	7(46.7)	4(26.7)	-	15(3.1)
3	5(20.8)	6(25.0)	7(29.2)	4(16.7)	2(8.3)	24(5.0)
4	11(23.9)	7(15.2)	12(25.1)	13(28.3)	3(6.5)	46(9.6)
5 or more	57(15.4)	105(28.3)	95(25.6)	86(23.2)	28(7.5)	371(77.3)
Total	75(15.6)	128(26.7)	128(26.7)	112(23.3)	37(7.7)	480(100)

*Figures in brackets indicate percentage of families

Table 11: Category of Pet Ownership by Family Type: Jos, Plateau State, 1982

Category of Pet Ownership	Family Type				
	Couple with children	Couple without children	Single Male	Single Female	Total
No Pets	97(63.4%)	5(3.3%)	43(28.1%)	8(5.2%)	153(35.4%)
Dog only	163(85.8%)	5(2.6%)	15(7.9%)	7(3.7%)	190(44.0%)
Cat only	32(88.9%)	1(2.8%)	2(5.6%)	1(2.8%)	36(8.3%)
Dog and Cat	46(86.8%)	2(3.8%)	2(3.8%)	3(5.7%)	53(12.3%)
Total	338(78.2%)	13(3.0%)	62(14.4%)	19(4.4%)	432(100%)

X^2 = 39.6 df 9 significant at P <0.05

Table 12: Category of Dog Ownership by Family Type, Jos, Plateau State, 1982

Ownership	Couple with children	Couple without children	Single Male	Single Female	Total
Never Owned a dog	92(76.0)	5(4.1)	16(13.2)	8(6.6)	121
Own dog presently	226(85.9)	7(2.7)	19(7.2)	11(4.2)	263
Owned dog previously	38(79.2)	2(4.2)	5(10.4)	3(6.3)	48
Total	363(3.2)	14(3.2))	45(10.4)	10(2.3)	432

χ^2 = 25.5 df 6 significant at $P < 0.05$.

Figures in brackets are percentages of compounds

Table 13: Reasons for Owning a Dog as Stated by Dog Owners Jos, Plateau State, 1982

Reason	NO (%)
Family pet (for children to play with)	60(12.6%)
Companionship	56(11.8%)
Hunting	14(2.9%)
Gift (given by a neighbour or a relative)	7(1.5%)
Breeding value (Reproduces high grade puppies)	21(5.7%)
Waste disposal (takes care of children wastes)	1(0.2%)
Protection/Security (Home, Hotel or shop guards)	234(49.3%)
Abandoned, needed home	19(4.0%)
Wanted dog	43(9.1%)
Replace previous pet .	2(0.4%)
Others (physical beauty; cleanliness of dog, graceful pet)	11(2.3%)
Unknown	1(0.2%)

Table 14: Major Advantages or Conveniences of Dogs as Companion Animals as Stated by Respondents, Jos, Plateau State, 1982

Item	No. (%)
Companionship	122(25.4)
Working animal	3(0.6)
Sports value	3(0.6)
Breeding value	30(6.2)
Temperament (e.g. intelligent, quiet, gentle, playful	10(2.1)
Pleasure (gives me/us joy)	15(3.1)
Challenge (a symbol of status in the society)	6(1.2)
Hunting	19(4.0)
Affecting or Love	8(1.7)
Protection (Security of household, shops etc)	243(50.5)
Beaty (clean, graceful, exotic taste	6(1.2)
Replaces previous pet	3(0.6)
Others (a specific delicacy, meat supplement)	7(1.5)
Not stated	6(1.2)

Table 15: Major Disadvantages or Inconveniences of Owning Dogs as Companion Animals as Stated by Dog Owners, Jos, Plateau State, 1982

Item	No. (%)
Economics (costs too much to keep) - -	10(2.8)
Physical requirements or need for restraint -	17(4.8)
Responsibility (care when family is away) - -	23(6.5)
Physical characteristics (too large, too small) -	1(0.3)
Allergy - - - -	8(2.3)
Pet diseases - - - -	97(27.3)
Breeding problem - - - -	2(0.6)
Noise, Odour, Waste pollution - -	53(14.9)
Overpopulation - - - -	4(1.1)
Bad temperament or habit of pet (over-protectiveness; bites	14(3.9)
Unknown, Have not noticed any inconveniences -	126(35.5)

Table 16: Reasons for not Having Dog as Stated by Nonowners Jos, Plateau State, 1982

Reason	No. (%)
Housing limitation (lack of space or need for monetary security deposit with landlord)	8(2.1%)
Economic factors (can't afford it, costly to maintain dogs, unable to care for)	28(5.9%)
Transient status (students, businessmen/women move too frequently in and out of Jos)	16(4.2%)
Dissatisfaction with dogs	94(24.4%)
Destructiveness (dogs too destructive; kill livestock)	15(3.9%)
Inconvenience (other more important things to do that can't give me time for dogs)	45(11.7%)
Lost or stolen	6(1.6%)
Have not found a suitable dog	15(3.9%)
Against culture (my tribe forbids the keeping of dogs)	27(7.0%)
Against religion (Moslem faith prohibits keeping of dogs	49(12.7%)
Others (Don't want to be taken to court because of dog bites; fear of bites)	83(21.6%)
Not stated	4(1.0%)

Table 17: Reasons for no Longer Owning Dogs as given by previous Dog Owners Jos, Plateau State, 1982

Reason	No (%)
Died (accident or pet disease) - -	36(45.0)
Disappeared from home - - -	7(8.8)
Too destructive to property - - -	2(2.5)
Behaviour with children (fond of biting children) -	4(5.0)
Gave away - - - -	10(12.5)
Moved (Transfer) - - - -	8(10.0)
Unable to provide care (economics) - -	11(13.8)
Transiet status - - - -	1(1.3)
Others (noise, odour, wastes from dogs) - -	1(1.3)

Table 18: Major Advantages or Conveniences of Dogs as Stated by Former Dog Owners, Jos, Plateau State, 1982

Item	No (%)
Companionship - - - -	25(25.5)
Affection or Love - - -	1(1.0)
Sports Value - - - -	2(2.0)
Protection - - - -	2(2.0)
Beauty (Cleanliness, graceful breed) - -	53(53.1)
Breeding Value - - - - -	3(3.1)
Pleasure - - - -	3(3.1)
Recreation - - - -	1(1.0)
Challenge - - - -	1(1.0)
Temperament (intelligent, quiet, gentle, playful -	1(1.0)
Unknown (Don't really know) - - -	6(6.1)

Table 19: Disadvantages of Owning Dogs as Stated by Former Owners Jos, Plateau State, 1982

Main Disadvantages	No (%)
Economics of owning a pet (cost of feeding, carring for dogs) -	3(3.8)
Physical requirements or needs for restraint (housing space; leash	2(2.5)
Responsibility (e.g care when family is away on vacation) -	2(2.5)
Pet disease - - - -	23(29.1)
Breeding problem (reproduction and associated problems) -	2(2.5)
Overpopulation - - - -	1(1.3)
Noise, Odour, Waste - - -	15(19.0)
Bad temperament (over protective nature, bites) -	8(10.1)
Other (Problem of having to make dogs stay at home) -	2(2.5)
Not stated - - - -	21(26.6)

Table 20: Reasons for stray Dogs as stated by Respondents, Jos, Plateau State, 1982

Reason	Responses No (%)
Breeding (uncontrolled breeding, too many dogs) -	192(19.9)
Escape from home (inadequate care or provisions for dogs making it necessary for dogs to look for food or similar needs) - - -	201(20.9)
Release (As a result of care, poverty of owners who cannot afford to keep them) - -	167(17.3)
Abandonment (Previous owners who or vacated old residences)	117(12.1)
Other (Non-enforcement of dog control on the part of stray dog catchers) - - -	148(15.4)
"I really don't know why" - - -	138(14.3)

Table 21: Responses on Where Dog Stays **when Outside the Compounds,** Jos, Plateau State, 1982

Location	Frequency	Percentage
Yard	33	12.5
Cage	32	12.2
Roams free	171	65.0
Chain (leash)	23	8.7
Don't know	4	1.5
Total	263	100.0

Table 22: Reasons for not Neutering Dogs as Stated by Owners Jos 1982

Reason	Frequency (Percentage Respondents)
Neutering seen to be a Cruel act to dogs -	11(4.2%)
No prior knowledge of neutering - -	13(4.9%)
Use for breeding - -	40(14.3%)
Neutering weakens and makes dogs less active in their jobs such as hunting, guard watch -	64(25.3%)
No reason - - -	135(51.3%)

Table 23: Responses to Selected Opinionnaire Regarding Values and Limitations of Dog by Status (Category) of Ownership Jos, Plateau State, 1982

Statement	Ownership category	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	No opinion	X^2 Value
*The ideal companion animal is a dog	Present owner	78(29.7)	136(51.7)	25(9.5)	8(3.0)	4(1.5)	12(4.6)	252.74
	Previous owner	12(18.8)	16(25.0)	15(23.4)	8(12.5)	5(7.8)	8(12.5)	
	Never owned	4(2.9)	11(8.0)	14(10.2)	32(23.4)	64(46.7)	12(8.8)	
*If I had a dog as a companion animal, I would prefer a large one	Present owner	29(11.0)	91(34.6)	30(11.4)	28(10.6)	41(15.6)	44(16.7)	76.73
	Previous owner	5(7.8)	16(25.0)	7(10.9)	7(10.9)	14(21.9)	15(23.4)	
	Never owned	3(2.2)	9(6.6)	19(13.9)	12(8.8)	25(18.2)	69(50.4)	
*If I had a dog as a companion animal I would prefer an aggressive dog	Present owner	8(3.0)	43(16.3)	37(14.1)	64(24.3)	83(31.6)	28(10.6)	27.97
	Previous owner	1(1.6)	5(7.8)	6(9.4)	13(20.3)	29(45.3)	10(15.6)	
	Never owned	8(5.8)	13(9.5)	14(10.2)	12(8.8)	1(0.7)	89(65.0)	
*I like a dog that I can control and does what I want it to	Present owner	75(28.5)	82(31.2)	19(7.2)	5(1.9)	5(1.9)	77(29.3)	81.69
	Previous owner	14(21.9)	17(26.6)	6(9.4)	1(1.6)	1(1.6)	25(39.1)	
	Never owned	8(5.8)	13(9.5)	14(10.2)	12(8.8)	1(0.7)	89(65.0)	
*My dog is friendly	Present owner	22(8.4)	96(36.5)	54(20.5)	6(2.3)	16(6.1)	69(26.2)	143.87
	Previous owner	1(1.6)	4(6.3)	5(7.8)	1(1.6)	2(3.1)	51(79.7)	
	Never owned	1(0.7)	3(2.2)	15(10.9)	6(4.4)	5(3.6)	107(78.1)	
*I am afraid of dogs because they can cause rabies	Present owner	45(17.1)	82(31.2)	61(23.2)	28(10.6)	8(3.0)	39(14.8)	67.61
	Previous owner	25(39.1)	16(25.0)	10(15.6)	-	4(6.3)	9(14.1)	
	Never owned	59(43.1)	55(40.1)	11(8.0)	3(2.2)	-	9(6.6)	

Table 23 continued

Statement	Ownership Status	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	No opinion	X^2 Values
*Dogs tend to form close relationships with their owners	Present owner	153(58.2)	103(39.2)	2(0.8)	2(0.8)	1(0.4)	2(0.8)	41.26
	Previous owner	32(50.0)	28(43.8)	2(3.1)	1(1.6)	-	1(1.6)	
	Never owned	38(27.7)	89(65.0)	3(2.2)	-	1(0.7)	6(4.4)	
*A dog should be considered an important member of the family group	Present owner	14(5.3)	90(34.2)	15(5.7)	31(11.8)	106(40.3)	7(2.7)	58.30
	Previous owner	4(6.3)	10(15.6)	5(7.8)	11(17.2	29(45.3)	5(7.8)	
	Never owned	1(0.7)	15(10.9)	3(2.2)	42(30.7)	63(46.0)	13(9.5)	
+I would or do like my own dog but dislike other people's dog	Present owner	1(0.4)	6(2.3)	50(19.0)	10(3.8)	9(3.4)	187(71.1)	13.37
	Previous owner	-	2(3.1)	12(18.8)	4(6.3)	1(1.6)	45(70.3)	
	Never owned	1(0.7)	2(1.5)	14(10.2)	8(5.8)	-	112(81.8)	
*If we owned a dog as a pet, it would be a playmate for our children	Present owner	10(3.8)	156(59.3)	19(59.3)	9(3.4)	47(17.9)	22(8.4)	83.32
	Previous owner	4(6.3)	18(28.1)	7(10.9)	6(9.4)	21(32.8)	8(12.5)	
	Never owned	1(0.7)	33(24.1)	12(8.8)	32(23.4)	35(25.5)	24(17.5)	

* X^2 Significant association at $P < 0.05$

+ X^2 Not significant

Table 24: Frequency of Dog Owning Compounds Utilizing Veterinary Clinics by Presidential Area Jos, Plateau State 1982

Status*	Residential Area					
	GRA	Jos Township Town	Jos Native Town	Delimi-Nassarawa Gwong Dogon Dutse	Angwan Rogo & Suburbs	Total
Did not visit	3(3.5%)	38(32.9%)	16(18.8%)	29(34.1%)	9(10.6%)	96
Visited	44(26.3%	46(27.5%)	40(24.0%)	27(16.2%)	10(6.0%)	167

X^2 = 26.7 df4, Significant at P < 0.05.

* Compounds that utilized veterinary clinics at least once in 1981.

Figures ex-brackets indicate number of compounds

Table 25: Dog Rabies Vaccination by Residential Area, Jos, Plateau State, 1982

Item		Residential Area					
		GRA	Jos Township	Jos Native Town	Delimi-Nassarawa Gwong Dogon Dutse	Angwan Rogo & Suburbs	Total
*Puppy Vaccination	No	18(9.2%)	53(27.0)	52(26.5%)	55(28.1%)	18(9.2%)	196(82%)
	Yes	29(67.4%)	4(9.3%)	7(16.3%)	2(4.7%)	1(2.3%)	43(18%)
Total		47(19.7%)	57(23.8%)	59(24.7%)	57(23.8%)	19(7.9%)	239(100%)
*Adult Vaccination	No	1(2.9%)	10(28.6%)	11(31.4%)	10(28.6%)	3(8.6%)	35(15%)
	Yes	46(23.2%)	43(21.7%)	47(23.7)	46(23.2%)	16(8.1%)	198(85%)
Total		47(20.2%)	53(22.7%)	58(24.9%)	56(24.0%)	19(8.2%)	233(100%)

*X^2 = 77.2 df. 4 significant $P < 0.05$

**X^2 = 7.8 df. 4 significant $P < 0.05$

+In Nigeria dogs are given half dog dose of LEP (Flury) at 3 months (regarded as puppy vaccination) and full dose at 6 months regarded as adult vaccination. The survey inquired into vaccination of dogs for 1981 calender year.

Table 26: Dog to Person Ratio by **Residential Area in the Stratified Areas of** Jos, Plateau State, 1982

Area	Dogs	People	Dog-person	X^2 Value	r*
Government Reservation Area (GRA)	116	715	.16		
Jos Main Township	292	1,110	.26		
Native Town (Jenta - Bauchi Road)	283	1,097	.26		
Delimi-Nassarawa Gwong-Dogon Dutse	272	984	.28		
Angwan Rogo and Suburbs	93	299	.31		
Total	1,056	4,205	.25		
$\bar{X}$	211.2	841	-	48.27	0.931
S	98.0	342.05	-		

*r = Partial correlation coefficient between canine and human populations

Table 27: Bites per 100 dogs by Residential Area, Jos, Plateau State, 1982

Area	Bites	Dogs	Bites per 100 dogs	X^2	r*
Government Reservation Area (GRA)	15	116	13		
Jos Main Township	159	292	54		
Native Town (Jenta-Bauchi Road)	283	51	-		
Delimi-Nassarawa Gwong-Dogon Dutse	158	272	58		
Angwan Rogo and Suburbs	45	93	48		
Total	522	1,056	46		
$\bar{X}$	104.40	211.2	-		
S	68.67	98.0	-	76.88	0.966

X^2 = 76.9 with df. = 4 and $P < 0.05$.

r* = Partial correlation coefficient between bites and dog population.

Table 28: Bites per 100 persons by Residential Area, Jos, Plateau State, 1982

Area	Bites	People	Bites Per 100 Persons
Government Reservation Area (GRA)	15	715	2
Jos Main Township	159	1,110	14
Native Town (Jenta-Bauchi Road)	145	1,097	13
Delimi-Nassarawa Gwong-Dogon Dutse	158	984	16
Angwan Rogo and Suburbs	45	299	15
Total	522	4,205	12

X^2 = 102.3 d.f. 4, P <0.05

Table 29: Responses to Opinionnaire Items Directly Related to Overpopulation in Dog Population compared by Status of Dog Ownership, Jos, Plateau State, 1982

Item	Ownership Category	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	No Opinion	X^2 Value
+The major cause of too many stray dogs is irresponsible owners	Present owner	4(1.5)	11(4.2)	14(5.3)	44(16.7)	174(66.2)	16(6.1)	13.48
	Previous owner	1(1.6)	3(4.7)	2(3.1)	5(7.8)	50(78.1)	3(4.7)	
	Never owned	3(2.2)	-	4(2.9)	16(11.7)	105(76.6)	9(6.6)	
*Overpopulation of dogs is a major problem in our society today	Present owner	55(20.9)	58(22.1)	31(11.8)	45(17.1)	43(16.3)	31(11.8)	44.35
	Previous owner	18(28.1)	20(31.3)	7(10.9)	8(12.5)	5(7.8)	6(9.4)	
	Never owned	48(35.0)	51(37.2)	17(12.4)	6(4.4)	3(2.2)	12(8.8)	
*We have too many (and overpopulation) of dogs in our community	Present owner	19(7.2)	105(39.9)	19(7.2)	42(16.0)	54(20.5)	24(9.1)	57.42
	Previous owner	8(12.5)	39(60.9)	5(7.8)	6(9.4)	2(3.1)	4(6.3)	
	Never owned	23(16.8)	89(65.0)	2(1.5)	10(7.3)	7(5.1)	6(4.4)	
*Free-roaming and stray dogs are a problem in my neighbourhood	Present owner	52(35.0)	92(35.0)	41(15.6)	23(8.7)	26(9.9)	29(11.0)	31.17
	Previous owner	9(14.1)	40(62.5)	7(10.9)	-	5(7.8)	4(3.7)	
	Never owned	18(13.1)	79(57.7)	13(9.5)	6(4.4)	10(7.3)	11(8.0)	

* = A positive association at P value $P < 0.05$ level of significant for X^2 values df 10

Table 30: Response to Opinionnaire Items Related to Potential Public Health Problems as a Result of Overpopulation in the Dog Population of Jos, Plateau State Nigeria - 1982

Item	Ownership Category	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	No Opinion	X^2 Value
*I don't like stray dogs because they can spread disease	Present owner	61(23.2)	129(49.0)	27(10.3)	11(4.2)	8(3.0)	27(10.3)	22.85
	Previous owner	17(26.6)	29(45.3)	6(9.4)	-	-	12(18.8)	
	Never owned	31(22.6)	86(62.8)	3(2.2)	5(3.6)	2(1.5)	10(7.3)	
+Free-roaming or stray dogs tend to bite and inflict wound on people	Present owner	79(30.0)	150(57.0	11(4.2)	4(1.5)	7(2.7)	12(4.6)	11.67
	Previous owner	17(26.6)	41(64.1)	-	-	2(3.1)	4(6.3)	
	Never owned	50(36.5)	79(57.7)	2(1.5)	-	2(1.5)	4(2.9)	
*The major problem that dogs cause is destroying other people's property	Present owner	5(1.9)	11(4.2)	29(11.0)	23(8.7)	37(8.7)	158(60.1)	28.49
	Previous owner	2(3.1)	1(1.6)	8(12.5)	3(4.7)	9(14.1)	41(64.1)	
	Never owned	3(2.2)	16(11.7)	8(5.8)	3(2.2)	8(5.8)	99(72.3)	
+Free-roaming or stray dogs create a nuisance and cause pollution of streets and public parks with their faeces	Present owner	47(17.9)	120(45.6)	30(11.4)	2(0.8)	11(4.2)	53(20.2)	14.34
	Previous owner	14(21.9)	33(51.6)	5(7.8)	1(1.6)	-	11(17.2)	
	Never owned	36(26.3)	71(51.8)	8(5.8)	-	3(2.2)	19(13.9)	
*I don't like dogs because they can spread disease	Present owner	15(5.7)	31(11.8)	91(34.6)	19(7.2)	22(8.4)	85(32.3)	65.41
	Previous owner	12(18.8)	14(21.9)	18(28.1)	2(3.1)	1(1.6)	17(26.6)	
	Never owned	35(25.5)	37(27.0)	29(21.2)	2(1.5)	2(1.5)	32(23.4)	

Table 30: continued

Item	Ownership Category	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	No Opinion	X^2 Value
+Dogs are a hazard to our traffic and cause road accident	Present owner	6(2.37)	35(13.3)	65(24.7)	19(17.2)	15(5.7)	123(46.8)	14.83
	Previous owner	4(6.3)	9(14.1)	13(20.3)	5(7.8)	5(7.8)	28(43.8)	
	Never owned	5(3.6)	33(24.1)	27(19.7)	14(10.2)	4(2.9)	54(39.4)	
+Free-roaming or stray dogs harbour diseases man can catch	Present owner	37(14.1)	140(53.2)	31(11.8)	10(3.8)	13(4.9)	32(12.2)	9.94
	Previous owner	12(18.8)	30(46.9)	6(9.4)	2(3.1)	3(4.7)	11(17.2)	
	Never owned	16(11.7)	88(64.2)	8(5.8)	3(2.2)	5(3.6)	17(12.4)	

* = X^2 Significant at $P < 0.05$

\+ = X^2 Not significant.

Table 31: Responses to Opinionnaire Items Related to Methods of Dog Population Control/or Control of Stray Dogs in Jos, Plateau State, 1982

Item	Ownership Category	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	No Opinion	X^2 Value
*If I had a dog I would have it neutered (i.e. spayed or castrated)	Present owner	14(5.3)	68(25.9)	39(14.8)	59(22.4)	44(16.7)	39(14.8)	55.54
	Previous owner	7(10.9)	12(18.8)	15(23.4)	9(14.1)	4(6.3)	17(26.6)	
	Never owned	21(15.3)	15(10.9)	25(18.2)	27(19.7)	4(2.9)	45(32.8)	
*The community should have fines for letting dog wander or runfree	Present owner	74(28.1)	70(26.6)	24(9.1)	27(10.3)	42(16.0)	26(9.9)	50.60
	Previous owner	18(28.1)	28(43.8)	8(12.5)	1(1.6)	3(4.7)	6(9.4)	
	Never owned	68(49.6)	45(32.8)	9(6.6)	4(2.9)	3(2.2)	8(5.8)	
*I would not want to own a dog because it might annoy my neighbours	Present owner	2(0.8)	28(10.6)	19(7.2)	75(28.5)	120(45.6)	19(7.2)	136.53
	Previous owner	-	18(28.1)	5(7.8)	10(15.6)	23(35.9)	8(12.5)	
	Never owned	12(8.8)	72(52.6)	10(7.3)	13(9.5)	14(10.2)	16(11.7)	
*I would like my dog to be impounded if it is stray	Present owner	36(13.7)	55(20.9)	22(8.4)	41(15.6)	55(20.9)	1(0.4)	43.78
	Previous owner	9(14.1)	13(20.3)	10(15.6)	8(12.5)	4(6.3)	20(31.3)	
	Never owned	32(23.4)	36(26.3)	11(8.0)	10(7.3)	5(3.6)	43(31.4)	
*I believe that spaying or castrating companion dogs is a good idea to reduce dog population	Present owner	15(5.7)	89(33.8)	42(16.0)	18(6.8)	50(19.0)	6(9.4)	24.04
	Previous owner	4(6.3)	18(28.1)	12(18.8)	6(9.4)	6(9.4)	18(28.1)	
	Never owned	12(8.8)	46(33.6)	19(13.9)	19(13.9)	7(5.1)	34(24.8)	

* = X^2 significant at $P < 0.05$
Figures in brackets are percentages

Table 32: Responses to Opinionnaire Items Related to Dog Bite and Rabies Control and Veterinary Service Utilization, Jos, Plateau State, 1982

Item	Ownership Category (Status)	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	No Opinion	X^2 Value
+If I owned a dog I would make sure it had rabies vaccination	Present owner	192(73.0)	56(21.3)	7(2.7)	1(0.4)	4(1.5)	3(1.1)	18.97
	Previous owner	49(76.6)	13(20.3)	1(1.6)	-	1(1.6)	-	
	Never owned	82(59.9)	38(27.7)	6(4.4)	-	2(1.5)	9(6.6)	
*I would not want to own a dog because of medical expenses for veterinary services	Present owner	4(1.5)	4(1.5)	30(11.5)	76(29.0)	123(46.9)	25(9.5)	34.78
	Previous owner	2(3.1)	-	4(6.3)	17(26.6)	22(34.4)	19(29.7)	
	Never owned	3(2.2)	3(2.2)	20(14.6)	48(35.0)	34(24.8)	29(21.2)	
+It is important to immunise a dog for rabies	Present owner	170(64.6)	48(18.3)	17(6.5)	2(0.8)	2(0.8)	24(9.1)	12.76
	Previous owner	50(78.1)	6(9.4)	2(3.1)	-	1(1.6)	5(7.8)	
	Never owned	84(61.3)	34(24.8)	5(3.6)	-	3(2.2)	11(8.0)	
*I am afraid of dogs because they can cause rabies	Present owner	45(17.1)	82(31.2)	61(23.2)	28(10.6)	8(3.0)	39(14.8)	67.61
	Previous owner	25(39.1)	16(25.0)	10(15.6)	-	4(6.3)	9(14.1)	
	Never owned	59(43.1)	55(40.1)	11(8.0)	3(2.2)	-	9(6.6)	
*One of the reasons I do not like dogs is because they bite	Present owner	56(21.3)	104(39.5)	59(22.4)	9(3.4)	7(2.7)	28(10.6)	35.68
	Previous owner	20(31.3)	20(31.3)	11(17.2)	1(1.6)	5(7.8)	7(10.9)	
	Never owned	56(40.9)	58(42.3)	11(8.0)	2(1.5)	1(0.7)	9(6.6)	
*If I had a dog as a companion animal I would prefer an aggressive dog	Present owner	8(3.0)	43(16.3)	37(14.1)	64(24.3)	83(31.6)	28(10.6)	27.97
	Previous owner	1(1.6)	5(7.8)	6(9.4)	13(20.3)	29(45.3)	10(15.6)	
	Never owned	2(1.5)	7(5.1)	9(17.3)	33(24.1)	57(41.6)	29(21.2)	

* = X^2 Significant at $P < 0.05$

\+ = X^2 Not significant

Table 33: Prevalence of Canine Rabies in Plateau State by Local Government Area (LGA), 1970-1981

Local Government Area	Human/Population* at risk	No. Dogs Examined for rabies	No. Positive Rabies cases	Positive Case per 10000 human population
Whole State	2,759,693	1,665	351	1.27
Akwanga	242,191	40	7	0.29
Awe	169,633	7	3	0.18
Barkin Ladi	183,740	254	88	4.79
Bassa	153,875	13	7	0.45
Jos	347,035	1,206	203	5.85
Kanam	130,965	11	3	0.23
Keffi	231,075	22	6	0.26
Lafia	224,794	12	4	0.18
Langtang	99,499	15	4	0.40
Mangu	203,709	21	9	0.44
Nassarawa	210,810	6	3	0.14
Pankshin	172,745	30	6	0.35
Shendam	291,785	15	5	0.17
Wase	99,828	10	3	0.31

*1976 Projected population of Plateau State based on 1963 Nigerian Census; Source: Statistical Yearbook 1975 - 1977 Department of Economic Planning, Statistics Section Jos, Plateau State.

Table 34: Number of Dog Vaccinations, Impounded Dogs and Annual Number of confirmed Canine Rabies Cases, Plateau State, 1970-1981.

Number	1970-1981 average	Year												
		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981+	Total
Canine rabies	31	22	28	7	35	48	70	43	44	14	21	27	27	376
Vaccinations	4,366	726	643	672	980	1683	4670	4806	4806	5840	5640	8700	13223	52391
Vaccine (LEP) issued* (doses)	13,328	-*	-*	-*	-*	2720	16288	21487	18992	10234	9830	8655	17955	106261#
Dogs impounded	179	142	134	145	152	148	138	146	152	145	154	153	545	2154
No. Dogs reclaimed	76	72	65	59	69	56	59	64	67	55	62	58	231	917
No. of Dogs licensed	2958	420	476	521	812	916	2114	2756	3962	4567	3720	4569	10672	35505

* Based on Plateau State demand; # Total for 8 years (1974-1981) issued by the National Veterinary Research Institute, Vom.

\+ Rabies campaign year

-* Records not available

Table 35: Monthly Distribution of Positive Canine Rabies Cases in Plateau State, Nigeria, 1970 - 1981

	Monthly Number of Cases for each Year													
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total	Monthly Average
January	1	1	1	3	8	9	3	2	0	5	2	2	37	3.08
February	1	1	0	1	7	2	2	2	0	1	1	0	19	1.58
March	2	4	1	3	3	8	4	2	3	0	3	2	35	2.92
April	1	2	1	0	4	6	5	3	1	1	4	2	30	2.50
May	3	6	1	3	5	5	6	2	0	1	3	1	36	3.00
June	3	2	1	3	2	7	5	3	1	4	4	0	35	2.92
July	3	2	1	3	6	4	2	3	4	3	3	0	34	2.83
August	0	1	0	5	3	4	4	3	0	1	2	1	24	2.00
September	3	2	1	4	1	4	3	4	0	4	1	3	30	2.50
October	2	1	1	2	5	3	5	4	2	3	1	1	30	2.50
November	1	3	1	2	3	1	1	3	0	3	0	1	19	1.58
December	2	1	0	1	4	2	2	3	3	2	1	0	22	1.83
	22	26	9	31	45	60	42	34	14	28	27	13	351	

Table 36: Distribution of Positive Rabies Cases Among Different Species of Animals, Plateau State, 1970-1981

Species	Years												Total	Percent of Total for each species in 12 years
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1978	1980	1981		
Dog	22	26	9	31	45	60	42	34	14	28	27	13	351	93.4
Cat	1	1	-	-	2	-	-	-	-	-	1	2	9	2.2
Cattle	-	-	-	-	1	3	1	2	-	-	-	-	7	1.7
Goat	-	-	-	-	-	-	1	-	-	-	-	-	1	0.3
Sheep	-	-	-	1	-	-	-	-	-	-	-	-	1	0.3
Pig	-	-	-	1	-	1	-	1	-	-	-	-	2	0.5
Donkey	-	-	-	1	-	-	-	-	-	-	-	-	1	0.3
Horse	-	-	-	-	1	-	-	-	-	-	-	-	1	0.3
Givet Cat	1	-	-	1	-	-	-	-	-	-	-	-	2	0.5
Caracal lynx	-	-	-	-	-	-	1	-	-	-	-	-	1	0.3
% Dog	91.67	96.3	100	91.18	91.84	98.36	93.33	87.18	100	100	96.43	86.67	376	93.4
% other species	8.33	3.7	0	8.82	8.16	1.64	6.67	12.82	0	0	3.57	13.33	25	6.4

Table 37: Number of Reported and Confirmed Animal Rabies Cases, Plateau State, Nigeria, 1970 - 1981

Year	All Animals	Number of Reported and Laboratory Confirmed rabies cases							
		Dog		Cat		Domestic Animals		Wildlife/Zoo Animals	
		Pos.	Neg.	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.
1970	81	21	46	1	7	-	-	1	4
1971	100	26	66	1	3	-	-	-	4
1972	57	9	37	-	-	-	6	-	5
1973	92	31	45	-	4	3	3	1	5
1974	126	45	70	2	1	1	5	-	2
1975	181	60	104	-	3	5	4	-	5
1976	125	42	70	-	2	2	3	1	5
1977	185	34	138	2	2	3	3	1	3
1978	151	14	130	-	-	-	2	-	5
1979	182	28	145	-	1	-	-	-	8
1980	194	27	157	1	5	-	3	-	1
1981	191	13	169	1	5	-	-	-	3
Total	1,665	351	1,177	8	33	14	40	3	50

Table 38: Clinical Data on Positive Animal Rabies Cases Diagnosed in Plateau State, Nigeria 1970-1981

Species	Positive	Fate			Form of Disease			Human Exposure
		Killed	Died	Not Given	Furious	Dumb	Not Indicated	% of Animals involved
Dog	351	266	31	54	264	35	52	97.8
Cat	9	4	3	2	6	2	1	1.8
Cattle	7	6	-	1	4	-	3	..
Pig	2	2	-	-	2	-	-	0.4
Goat	1	1	-	-	1	-	-	-
Sheep	1	-	-	1	1	-	-	-
Donkey	1	-	-	1	1	-	-	-
Horse	1	-	1	-	-	1	-	-
Givet Cat	2	-	2	-	-	2	-	-
Caracal lynx	1	-	1	-	-	1	-	-
Human*	26*	-	26*	-	-	-		-
Total**		279	38	59	279	41	56	-
% of Total	376	74.20	10.11	15.70	74.20	10.90	14.89	100

*Died between 1977 and 1981 data supplied by Epidemiological Unit Ministry of Health, Jos, Plateau State

**Excludes Human Cases

Table 39: Sex and Age Distribution of Animal Rabies Cases in Plateau State, Nigeria, 1970-1981

	Number of Positive Animal Cases							
	Males		Females		Sex Unstated		Total	
Age (Years)	No	%	No	%	No	%	No.	%
0.0 - 0.5	35	16.28	12	10.08	0	0.00	47	12.50
0.6 - 1.0	68	31.63	31	26.05	10	23.81	107	28.00
1.1 - 1.5	48	22.32	32	28.57	24	57.14	106	28.19
1.6 - 2.0	25	11.63	19	15.97	0	0.00	44	11.70
2.1 and above	17	7.61	9	7.56	0	0.00	26	6.91
Unknown	22	10.23	14	11.76	8	19.05	44	11.70
Total	215	.	119		42		376	100.00

Table 40: Confirmed Rabies Cases in Vaccinated Dogs, Plateau State, 1970 - 1981

Case No.	Location	Age in (years)	Sex	Clinical Syndrome	No Previous Rabies Vaccinations	Vaccine Used	Interval Between Lest Vaccination And Onset of Disease
1	Jos	1	M	Dumb/ paralytic	None	LEP*	29 months
2	Kuru	2½	M	Furious	None	LEP	6 days
3	Kuru	2	M	Furious	None	LEP	17 months
4	Jos	1	F	Furious	None	LEP	2½ months
5	Anglo Jos	2½	F	Dumb/ paralytic	None	LEP	1 month
6	Jos	1½	M	Furious	None	LEP	12 days

*LEP (low egg passage) Flury Strain Vaccine

Table 41: Prevalence of Dog Bites and Rabid Dogs in Plateau State by Local Government

Local Government	Population* at risk	Number of dog bites	Rate per 10,000 population	No. Dogs Examined for Rabies	No. Dog Positive Rabies Cases	Rate of dog bite per 10,000 population
Whole State	2,759,693	3,379	12.24	1,665	376	1.36
Akwanga	242,191	90	3.72	13	9	0.37
Awe	169,633	56	3.30	0	0	0
Barkin-Ladi	183,740	440	23.95	254	88	4.79
Bassa	153,875	150	9.75	13	7	0.45
Jos	347,035	1,620	46.68	1,360	252	7.26
Kanam	130,075	63	4.81	0	0	0
Keffi	231,075	150	6.49	0	0	0
Lafia	224,794	179	7.96	2	1	0.04
Langtang	99,499	163	16.38	5	4	0.40
Mangu	203,709	87	4.27	10	9	0.44
Nassarawa	210,819	67	3.18	0	0	0
Pankshin	172,745	102	5.90	8	6	0.
Shendam	291,785	172	5.89	0	0	0
Wase	99,828	40	4.09	0	0	0

*Projected population of Plateau State based on 1963 Nigerian Census: Source Statistical Yearbook 1975 - 1977 Department of Economic Planning, Statistics Section, Jos, Plateau State.

Table 42: Reported Annual Dog Bite Cases and Rabid Dogs in Plateau State, 1970-1981

Year	Human Population*	Dog Bites	Rate of Dog bite per 10,000 Population	Bites in which Dog confirmed rabied in lab No. (%)	Total No. Dogs Examined for Rabies	Total No. Dog Positive Rabies
1970	2,409,058	159	0.66	13(8.2)	81	22
1971	2,469,285	138	0.56	12(8.7)	100	28
1972	2,531,017	153	0.60	4(2.6)	57	7
1973	2,594,293	246	0.95	27(11.0)	92	35
1974	2,659,150	225	0.85	25(11.1)	126	48
1975	2,725,628	243	0.89	37(15.2)	181	70
1976	2,793,768	315	1.13	36(11.4)	125	43
1977	2,863,614	395	1.38	37(9.4)	185	44
1978	2,955,103	340	1.16	9(2.7)	151	14
1979	3,008,455	356	1.18	15(4.2)	182	21
1980	3,083,798	377	1.22	15(4.0)	194	27
1981	3,160,568	432	1.37	8(1.8)	191	17

*Source: Statistical Yearbook 1971 - 1977 Department of Economic Planning, Statistics Sections, Jos, Plateau State

Table 43: Age and Sex Distribution of Dog Bite Victims in Plateau State, 1970-1981

	MALE			FEMALE		
Age Group (Year)	Population* at Risk	Number of Bites	Rate per 10,000 persons	Population* at risk	Number of Bites	Rate per 10,000 persons
Under 1	56,019	0	0.00	58,306	0	0.00
0 - 4	182,801	60	3.28	187,808	28	1.49
5 - 9	231,924	295	12.66	242,431	106	4.37
10 - 14	141,523	445	31.44	147,300	206	13,64
15 - 19	95,823	658	68.67	99,734	215	21.56
20 - 24	197,543	307	15.54	205,606	146	7.10
25 - 29	148,894	175	11.75	154,922	110	7.09
30 - 34	103,194	150	14.53	107,406	97	9.03
35 - 39	82,555	142	17.20	85,925	56	6.52
40 - 44	64,865	22	3.39	67.512	9	1.18
45 - 49	48,648	12	2.47	50,634	0	0
50 - 54	33,906	2	0.59	35,290	0	0
55 and above	85,490	0	0	88,991	0	0
Age not stated	-	62	-	-	82	-

*Based on the 1963 Nigerian Census of the population of Plateau State project at 2½% commulative 1976 increase.

Table 44: Odds Ratio (OR) Values of Dog Bite Victims According to Age and Sex in Relation to the Total Age Groups Plateau State 1970-1981

Age Group (in Years)	Male			Female			Overall Male & Female Odds Ratio
	Cases	Control	OR	Cases	Control	R	
Under 1	0	29,205	0	0	25,004	0	0
1 - 4	60	22,994	0.21	28	24,078	0.19	1.95
5 - 9	295	19,917	1.17	106	20,223	0.85	1.04
10 - 14	445	14,578	2.4	206	12,568	2.65	2.50
15 - 19	658	13,499	3.8	215	13,358	2.60	3.40
20 - 24	307	17,573	1.37	146	16,503	1.43	1.39
25 - 29	175	16,701	0.82	110	14,488	1.23	0.95
30 - 34	150	13,080	0.90	97	11,178	1.40	1.06
35 - 39	142	9,842	1.14	56	6,330	1.43	1.28
40 - 44	22	8,062	0.21	8	5,511	0.23	0.23
45 - 49	12	4,062	0.20	0	2,463	0	0.17
50 - 54	2	4,269	0.04	0	4,320	0	0.03
55 and above	0	9,014	0	0	3,478	0	0
Age unstated	62	0	0	82	0	0	0
All Age Groups	2,330	183,491	1	1,049	169,502	1	1

Table 45: Distribution of Animal Bites According to Type of Residence of the Persons Bitten Plateau State, 1970-1981

Type of Animal	Total	Towns	Villagers	Mining Settlements	Temporary nomadic
Total Bites all animals	4109(100)	2528(100)	1123(100)	456(100)	2(100)
All Dog Bites	3370(82.2)	2150(85.11)	839(74.7)	388(85.11)	2(100)
Bites by all rabies positive animals	353(8.6)	169(6.7)	150(13.4)	34(7.5)	-
Bites by rabies positive dogs	347(8.4)	186(7.4)	127(11.3)	34(7.5)	-
All cat bites	12(0.3)	8(0.3)	4(0.4)	-	-
Bites by rabies positive cats	5(0.1)	3(0.1)	2(0.2)	-	-
*Other bites	12(0.3)	12(0.5)	-	-	-
Bites by other rabies positive animals	1**(0.0)	-	**(0.1)	-	-

* Includes 2 pigs 1 monkey 2 Zebras; 2 Insectivorous bats, 3 Rabbits and 2 Rats bites cases

** One positive pig bite involving instant death of a 5 year old boy in Vwang Village in Jos LGA Plateau State in 1977

() Figures in brackets indicate percentage of total bites by each category (column)

Table 46: Ownership, Immunization and Quarantine Records of Bite Cases Involving Dogs, Plateau State, 1970-1981

Item		No of Bites	Percentage of Bites
Ownership			
Ownership claim	...	556	16.5
Not indicated	...	695	20.5
Stray dog bites	...	2,128	63.0
Immunisation			
Claimed	...	627	18.6
Vaccination status unknown	...	2,752	81.4
Observation			
Bites in which exposing dogs were quarantine		682	20.2
Dogs not located, absconded		1,567	46.4
Dogs killed after exposure		1,116	33.0
Dog died after exposure		14	0.4

Table 47: Type and Duration of Post-Exposure Treatment of Dog Bite Victims in Plateau State, 1970 - 1981

Type of Treatment	Not Treated	% Treated
Cleaning and dressing of wounds	3,169	93.8
No records of cleaning and dressing	210	6.2
Antibiotics administered	2,814	83.3
No records of antibiotic treatment	565	16.7
Tetanus toxoid	2,405	71.2
No record of anti-tetanus treatment	974	28.8
Anti-rabies Vaccine (ARV)		
Administered	1,360	40.2
Not given	2,019	59.7
Duration of Treatment		
1 - 7 days	797	23.6
8 - 14 days	1,872	55.4
15 - 21 days	705	20.9
22 - 28 days	5	0.1
29 days and over	-	-

Table 48: Dog Brain Specimens From Plateau State Examined for Rabies at Rabies Diagnostic Laboratory NVRI, Vom, (1982- 1983)

	Total	Positive for rabies	Percent Positive for rabies	Total	Positive for rabies	Percent Positive for rabies
January	21	8	38.1	19	6	31.6
February	23(1R)	9	39.1	25	7	28.0
March	27(1R)	7	25.9	23(1)	6	26.1
April	25(4)	10	40.0	27(2)	8	29.6
May	25(2)	7	28.0	20(1)	5	25.0
June	20(1)	6	30.0	23(3)	8	36.4
July	26	9	34.6	25(3)	3	12.0
August	25(1)	9	36.0	33(2)	6	18.2
September	38	14	36.8	24	15	62.5
October	31(2)	15	48.4	29(1)	17	58.6
November	19(1)	7	41.2	20(1)	10	50.0
December	20(1)	7	35.0	21(1R)	9	42.9

R = Roasted

Figures in brackets indicate putrid dog heads

Table 49: Principal Indicators of Rabies Status Plateau State as Observed during Rabies Surveillance, 1982-1983

	1981**	1982	1983
*Cases of human rabies	3	7(52)	5(64)
Persons bitten	1,432	2056	2255
Persons treated	1,432	2056	2255
Dogs vaccinated	26,578	6500	3257
Total dog submission for laboratory examination	213	300	288
Laboratory confirmed cases in dogs	21	108	100
Laboratory confirmed cases in other animals**	1	0	1
Canine population+	462,525	418,544	502,140
Funds available (Naira)	₦50,000	₦26,000	₦20,000

+Dogs seen once for any kind of treatment in each of the years in the state Veterinary Clinics and treatment centres.

In 1982 none of 4 cats, 1 goat and 3 cattle submitted was positive; in 1983 none of 4 cats, 2 monkeys, 3 fruit bats, 2 lynxes submitted for rabies examination was positive; one goat # was positive rabies.

*Human cases diagnosed clinically based on history and source of exposure from records of the state Hospitals.

**1981 data included for comparison as it was the year the National Antirabies campaign was also carried out in the state. In 1981 only one of 6 cats was reported rabid; one monkey and one caracal lynx were negative.

Table 50: Incidence of Canine and Human Rabies in Plateau State, January 1982 - December 1983

LGA	Human			Canine				
	No. of Dog Bites	No. of Cases	No. of Deaths	No. of reported canine outbreak/ laboratory submissions()	No. of animals confirmed	No. of Dogs quaran-tined	No. of dogs vaccinated	No. of dogs licensed
Akwanga	217	7	2	6(27)	17	0	868(7)	868
Awe	25	0	0	2 0	0	0	12	0
Barkin Ladi	285	15	0	21(115)	41	0	111	0
Bassa	247	3	0	6(12)	10	0	42	0
Jos	1856	5	2	18(261)	43	115	4846(42)	486
Kanam	117	0	0	3 0	0	0	68	0
Keffi	175	0	0	6(9)	3	0	724(37)	598
Lafia	189	0	0	4(5)	5	0	50	0
Langtang	230	40	8	10(43)	25	0	1004(7)	0
Mangu	201	0	0	3(24)	10	0	207	0
Nassarawa	151	0	0	8(4)	4	0	1032	0
Pankshin	289	34	0	15(48)	31	0	1265(117)	33
Shendam	272	12	0	10((40)	19	0	661(5)	0
Wase	57	0	0	[illegible]	0	0	10	0
Total	4311	116	12	112(588)	208	115	10,901(215)	1,985

*Epidemiological Unit; () Number of laboratory submissions

Table 51: Ownership and Vaccination Status of Laboratory confirmed rabid dogs in Plateau State 1982-1983

Year	Total Submitted Cases	Total of Confirmed Positive Cases in Dogs	Confirmed Cases Vaccinated Dogs	Confirmed Cases Unvaccinated Dogs	Confirmed Cases owned Dogs	Confirmed Unowned Dogs
1982	300	108	3(2.78%)	105(97.22%)	64(59.26%)	44(40.74%)
1983	288	100	0	100(100.0)	63(63.0)	37(37.0)
Total	588	208	3(1.44)	205(98.55)	127(61.06)	81(38.94)

Table 52: Age and Sex of Dogs Submitted for Rabies Diagnosis from Plateau State, 1982 - 1983

Category		Rabid (%)	Non Rabid (%)	Total
Age	Puppies	3(1.4)	45(11.8)	48
	Adult	205(98.6)	335(88.2)	540
	Total	208(100.0)	380(100.0)	588
Sex	Male	151(72.6)	295(77.6)	446
	Female	57(27.4)	85(22.4)	142
	Total	208(100.0)	380(100.0)	588

*Puppies = Young dogs less than six months.

Adult dogs = dogs six months and older.

Table 53: Time of Biting by Dogs Submitted for Rabies Diagnosis, Plateau State 1982-1983

	Rabid(%)	Non Rabid (%)	Total
Morning	44(21.1)	66(17.4)	100
Afternoon	43(20.7)	103(27.1)	146
Evening	48(23.1)	114(30.0)	162
Night	73(35.1)	97(25.5)	170
Total	208(100.0)	380(100.0)	588

Table 54: Characteristics of Abnormal Dogs Submitted for Rabies Diagnosis Plateau State, 1982-1983

Characteristics	Rabid (%)	Non Rabid (%)	Total
Aggressive	94(45.2)	152(40.0)	246
Overly friendly	6(2.9)	27(7.1)	33
Wobbly	19(9.1)	19(5.0)	38
Paralysed	62(29.8)	95(25.0)	157
Injured	27(13.0)	87(22.9)	114
Total	208(100.0)	380(100.0)	588

Table 55: Area of Dog Submission, Plateau State, 1982-1983

Area	Rabid (%)	Non Rabid (%)	Total
Urban	106(51.0)	193(50.8)	299
Rural	85(40.8)	145(38.1)	230
*Other	17(8.2)	42(11.1)	59
Total	208(100.0)	380(100.0)	588

*Include temporary settlements of Plateau area of Federal Territory; and Tin Mining Camps.

Table 56: Characteristics of 14 Local Government Areas (LGA) Included in Surveillance of Human Rabies Post-Exposure Prophylaxis (PEP) Plateau State, 1982-1983

LGA	Number of Persons Exposed	LGA Population	+Incidence of Bites per 10,000 persons	Biting Animals*	
				No. Exam	No Confirmed rabid
STATE TOTAL	4,311	3,239,901	133.1	588	209(35.5)
Akwanga	217	284,332	7.6	27	17(63.0)
Awe	25	199,151	1.2	0	0(0)
Barkin Ladi	285	215,714	13.2	115	41(35.6)
Bassa	247	180,650	13.7	12	10(83.3)
Jos	1,856	407,423	45.5	261*	43(16.5)
Kanam	117	153,754	7.6	0	0(0)
Keffi	175	271,283	6.4	9	3(33.3)
Lafia	189	263,910	7.2	5	5(100)
Langtang	230	116,813	19.7	43	25(58.1)
Mangu	201	239,156	8.4	24	10(41.7)
Nassarawa	151	247,503	6.1	4	4(100)
Pankshin	289	202,803	14.2	48	31(64.6)
Shendam	272	342,558	8.0	40	19(47.5)
Wase	57	114,851	5.0	0	0(0)

*Percent of all PEP using rabies vaccine (Human diploid cell rabies vaccine; Duck embryo vaccine or sample vaccine). Preponderant rabid animal is the one accounting for plurality of rabies case. +In persons per 10,000; using 1982 census of LGAs based on 2½% cummulative annual increase on 1963 national census figure for Plateau State. Dogs were preponderant animal except one case in goat in Jos.

Table 57: Human Antirabies Treatment Regimens Plateau State 1982-1983

Type of regimen	No.	(%)
Local Treatment of Wounds		
Cleaning and dressing only	3001	(69.6)
Cleaning and suturing	406	(9.4)
Cleaning and local infltration with antirabies serum	548	(12.7)
Total	3955	(91.7)
Antibiotics		
Penicillin only	2802	(65.0)
Penicillin and Streptomycin	647	(15.0)
Tetracycline	103	(2.4)
Total	3552	(82.4)
Tetanus toxoid		
One doses	2279	(52.9)
Two doses	129	(3.0)
None given	1903	(44.1)
Total given	2408	(55.9)
Antitetanus serum		
Given	239	(5.5)
Not given	4072	
Antirabies vaccine (ARV)		
Given	783	(32.2)
Duck embryo vaccine		
Given	752	(30.9)
Semple vaccine		
Given	896	(36.9)
Total Given ARV irrespective of vaccine type	2431	(56.4)
Antirabies vaccine not given	1880	(43.6)

Table 58: Age and Sex Distribution of 2431 Persons Receiving Antirabies Vaccine, by Species of Exposing Animal

Person's (Vaccinees) Age group (year)	Exposing Animal								
	Dog		Cat		Wildlife		Total		
	Sex of Victim		Sex of Victim		Sex of Victim		Total	Total	Total
	M	F	M	F	M	F	M	F	Both sexes
0 - 4	1	1	-	-	-	-	1	1	2
5 - 9	15	10	1	1	1	-	17	11	28
10 - 14	299	272	5	3	4	1	308	276	584
15 - 19	371	157	2	-	-	-	371	316	687
20 - 29	290	157	2	7	2	-	294	164	358
30 - 39	278	107	6	5	4	-	288	112	400
40 - 49	146	64	-	-	1	-	147	64	211
50 - 59	26	12	-	-	-	-	26	12	38
60+	0	0	-	-	-	-	-	-	-
Unknown	14	9	-	-	-	-	14	9	23
Total	1440	948	14	16	12	1	1466	965	2431

Table 59: Characteristics of the Sources of Exposure, Plateau State, 1982 - 1983

Type of Exposing Animal	No (%) Persons reporting exposure incidence	1982 - 1983 Animals Examined for Rabies	
		No (%) of persons receiving PEP	No (%) of Rabid animals
Animal Sources			
Dog	4183(97.0)	2383(98.0)	208(35.4)
Cat	88(2.0)	30(1.2)	0(0)
Goat	15(0.3)	0(0)	1(0.3)
Wildlife	25(0.6)	18(0.7)	0(0)
Total	4311(100)	2431(100)	-

Table 60: Type of Animal and Mode of Exposure in PEP Recipients Plateau State, 1982 - 1983

	All Sources	Dogs No (%)	Cats No (%)	Wild No (%)	Pet-wild* No (%)
Animal proven rabid?					
Yes	905(37.2)	95(37.8)	0(0)	0(-)	0(-)
Not examined	1468(60.4)	1420(59.3)	30(100)	7(100)	11(100)
Other	58(2.4)	58(2.4)	-(0)	-(0)	-(0)
Method of exposure					
Bite	2331(95.9)	2283(95.4)	30(100)	7(100)	11(100)
Nonbite	48(1.9)	48(2.0)	-(-)	-(-)	-(-)
Unknown	52	-	-	-	-
+Median delay from exposure until PEP per Biting Animal	3	3	3	10	10

*A pet-wild animal ia a wild animal kept as a pet, such as chimpanzee, monkey, squrrel, hare, rabbit.

+In days.
Figures in brackets indicate percentage of exposure by species for positive or negative cases.

Table **61:** Number of Persons treated with Rabies Vaccine, Number per Rabid Do: and Number per 10,000 Population, by Local Government Area (LGA)

LGA	No Dogs confirmed rabid	Persons treated	Persons treated per rabid animal	Persons treated per 10,000 population-
Akwanga	17	123	7.2	4.32
Awe	0	**0**	0	0.0
Barkin Ladi	41	205	***5.0***	9.5
Bassa	10	**78**	7.8	4.3
Jos	40	1,200	27.9	29.4
Kanam	0	40	0	2.6
Keffi	3	**64**	21.3	3.5
Lafia	5	**89**	17.8	3.4
Langtang	***20***	160	6.4	13.7
Mangu	10	**54**	5.4	2.3
Nassarawa	4	**32**	8.0	0.0
Pankshin	31	210	6.8	10.3
Shendam	19	176	**9.3**	5.1
Vase	0	**0**	0	0.0
State Total	208	**2,431**	11.7	7.5

•Based **on** 1982 **State Population** Projected at ***2i%*** **1963 National** Census

Table 62: Monthly Distribution of Human Exposure, PEP and Rabies in Animals Plateau State, 1982 - 1983

	HUMAN		ANIMAL	
Month	No of Persons Exposed	No of Persons vaccinated	No Rabies Cases Examined	No Rabies Positive Cases
January	212	105	40	14
February	205	104	48	16
March	245	109	50	13
April	355	147	52	18
May	326	254	45	12
June	330	251	42	14
July	345	237	51	12
August	400	271	58	15
September	569	353	62	29
October	688	319	60	32
November	396	165	39	17
December	240	116	41	16
Total	4,311	2,431	589	208

Table 63: Age Distribution and Type of Exposure, By Anatomic Site of 2431 Plateau State Receiving Rabies Vaccine, 1982

Age and type of exposure	Legs or foot	Trunk	Head or neck	Arms or hand	Site Not stated	Total
Total	1254	18	17	1142	0	2431
Age group (in years)						
0 - 4	-	-	2	0	0	2
5 - 9	-	15	4	0	0	28
10 - 14	321	12	0	151	0	484
15 - 19	369	4	0	314	0	687
20 - 29	250	2	0	306	0	558
30 - 39	214	-	0	186	0	400
40 - 49	66	-	0	145	0	211
50 - 59	12	-	0	26	0	38
60 or older	0	-	0	0	0	0
Age not stated	13	-	0	10	0	23
Type of exposure	1026	18	17	1169	201	2431
Multiple bite (2 or more bites)	209	0	12	557	0	778
Single bite	817	18	5	612	0	1452
Nonbite	0	0	0	0	201	201
Not stated	0	0	0	0	0	0

Table 64: Age, Sex and Type of Exposure of 905 Persons Exposed to Rabid Dogs Plateau State, 1982 - 1983

		Number of Persons Exposed	(%) Rabid Dog
		No	%
(a)	Age (Years)		
	Under 15	132	14.6
	15 and over	746	82.4
	Age Unknown	27	3.0
(b)	Sex		
	Male	683	75.5
	Female	207	23.0
	Sex unstated	15	1.7
(c)	Exposure		
	Total bites	905	100.0
	Head or neck	56	6.1
	Hand or arm	409	45.1
	Foot or leg	310	34.2
	Trunk	22	2.4
	Not reported	8	1.0
	Scratch	42	4.6
	Handled	15	1.5
	Others	4J	4.7

*Ate or processed dog meat.

Table 65: Distribution of 2431 Persons Receiving Treatment by Species of Animal and Type of Vaccine Used, Plateau State, 1982 - 1983

	Doses of rabies vaccine (Semple and duck embryo)				Human Diploid Cell vaccine (HDCV)			
	14	14	15	Total	1 Dose	2 Doses	3-4 Doses	Total
Dog	203(90)*	518(788)	9(0)	730(878)	220	507	48	775
Cat	22(0)	0(0)	0(0)	22(0)	8	0	0	8
Wildlife	0(18)	0(0)	0(0)	0(18)	0	0	0	0
Total	225(108)	518(788)	9(0)	752(896)	228	507	48	783

*Figures in brackets is for Semple Vaccine, the unenclosed figures are for Duck embryo rabies vaccine.

Table 66: Days of Delay Before Initiation of Antirabies Treatment, Plateau State, 1982 - 1983

Days of Delay	No. Person Treated	Percent of Person Treated
1	139	5.9
2	210	8.6
3	400	16.4
4	226	9.3
5	206	8.5
6	230	9.5
7	220	9.0
8	200	8.2
9	150	6.2
10	250	10.3
10(11-28+)	200	8.2
Total	2431	99.9*

Table 67: Immunoreactivity of Hybridoma Antibodies with the Nucleocapsid Antigen of Street and Laboratory Rabies Virus Isolates from Plateau and Other Areas of Nigeria

Isolate Number	Animal Species	Nucleocapsid Monoclonal Antibodies																																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	3
1. RD37/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
2. RD205/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
4. RD216/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
5. RD222/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
6. RD236/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
7. RD192/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
9. RD104/83	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
11. RD105/83	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
12. RD106/83	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
13. RD195/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
14. RD 32/83	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
15. RD200/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
16. RD111/83	Goat	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
17. RD 49/83	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
18. RD248/82	Dog	+	+	+	+	+	+	+	+	+	+	++	+	+	+	++	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
19. RD125/83	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
20. RD251/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
21. RD234/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
22. RD101/83	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
24. RD120/83	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
25. RD110/83	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
26. RD207/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
27. RD193/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
28. RD244/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
29. RD216/81	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
30. RD119/81	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
31. RD231/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
33. RD 90/83	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
34. RD213/82	Dog	+	+	+	+	+	+	+	+	+	++	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
35. RD227/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	

P.T.O

Table 67 continued

Isolate Number	Animal Species	Nucleocapsid Monoclonal Antibodies 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
36. RD243/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	±	+	+	+	+	+	+	+	+
37. RD 43(83	Dog	+	+	+	+	+	+	±	+	+	±	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	±	+	+	+	+	+	+	+	+
38. RD157/82	Dog	+	+	+	+	+	+	+	±	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	±	+	+	+	+	+	+	+	+
39. RD241/82	Cat	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	±	+	+	+	+	+	+	+	+
40. RD250/82	Dog	+	+	+	+	+	+	±	+	+	+	+	+	+	+	+	+	+	+	±	-	+	+	+	+	+	±	+	+	+	+	+	+	+	+
41. RD 12/83	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	±	+	+	+	+	+	+	+	+
42. RD203/82	Dog	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	±	+	+	+	+	+	+	+	+
43 RD240/82	Dog	+	+	+	+	+	+	±	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	±	+	+	+	+	+	+	+	+
44. RD232/82	Dog	+	+	+	+	+	±	±	±	+	+	+	+	+	+	+	+	+	+	±	-	+	+	+	+	+	±	+	+	+	+	+	+	+	+
45. RD 15/83	Dog	+	+	+	+	+	±	+	+	+	+	+	+	+	+	+	+	+	+	±	-	+	+	+	+	+	±	+	+	+	+	+	+	+	+
46. RD223/82	Dog	+	+	+	+	±	±	+	±	+	+	+	+	+	+	+	+	+	+	±	-	+	+	+	+	+	±	+	+	+	+	+	+	+	+
VOM SEED		+	+	+	+	+	+	±	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	±	+	+	+	+	+	+	+	+
LEP (FLURY) VOM		+	+	+	+	+	+	±	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	±	+	+	+	+	+	+	+	+
MOKOLA	-	+	+	+	+	+	±	±	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	..	..	-	-	-	-	-	-	-
LAGOS BAT	-	+	+	+	+	±	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	..	..	-	-	-	-	-	-	-
DUVENHAGE	-	+	+	+	+	+	±	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	..	-	-	-	-	-	-	-	-

The anti-nucleocapsid antibodies 1 - 36 are also designated by the following numbers
1 = 502-2, 2= 103-7, 3= 206-1, 4= 209-1, 5= 229-1, 6= 290-2, 7= 515-3, 8= 104-4, 9= 111-1, 10= 111-14
11= 239-10, 12= 389-1, 13= 377-7, 14= 102-57, 15= 222-9, 16= 237-3, 17= 120-2, 18= 364-11, 19= 714-3
20= 422-5, 21= 816-1, 22= 817-5, 23= 818-5, 24= 822-7, 25= 701-9, 26= 703-8, 27= 715-3, 28= 721-2
29= 801-1, 30= 802-2, 31= 803-6, 32= 804-9, 33= 805-3, 34= 806-1, 35= 807-5, 36= 808-2

Positive reaction (+); negative reaction (-).

Table 68: Cross Protection Study with Rabies Vaccine* (PMHDCS) in Mice

Isolate	Treatment	++Isolate dilution					
		Undiluted	-1	-2	-3	-4	-5
ID	Vaccine+	6/10**	3/10	3/10	3/10	3/10	2/10
	Control	10/10	10/10	10/10	10/10	10/10	10/10
4E	Vaccine	8/10	8/10	7/10	6/10	4/10	3/10
	Control	10/10	10/10	10/10	10/10	10/10	10/10
15A	Vaccine	9/10	8/10	8/10	5/10	5/10	2/10
	Control	10/10	10/10	10/10	10/10	10/10	10/10
36G	Vaccine	8/10	7/10	7/10	6/10	2/10	1/10
	Control	10/10	10/10	10/10	10/10	10/10	10/10
39F	Vaccine	1/10	2/10	2/10	0/10	0/10	0/10
	Control	10/10	10/10	10/10	10/10	10/10	10/10
PM	Vaccine	1/10	0/10	0/10	0/10	1/10	1/10
	Control	10/10	10/10	10/10	10/10	10/10	10/10
CVS	Vaccine	3/10	2/10	2/10	1/10	1/10	1/10
	Control	10/10	10/10	10/10	10/10	10/10	10/10

*Vaccine supplied by Dr. T. J. Wiktor, Wistar Institute Philadelphia.

+Vaccine used at 1 : 30 dilution.

++Log_{10} Mouse LP_{50} was $10^{7.3}$ $ICLD_{50}$ and 0.03ml was injected i.c.

Table 69: Cross Protection Study with LEP (Flury) Vaccine in Guinea Pigs

++Isolate	Treatment	Isolate dilution					
		Undiluted	-1	-2	-3	-4	-5
ID	Vaccine+	8/10	2/10	2/10	1/10	1/10	0/10
	Control	10/10	10/10	10/10	10/10	10/10	10/10
4E	Vaccine	8/10	5/10	2/10	1/10	1/10	1/10
	Control	10/10	10/10	10/10	10/10	10/10	10/10
15A	Vaccine	9/10	8/10	2/10	2/10	1/10	1/10
	Control	10/10	10/10	10/10	10/10	10/10	10/10
36G	Vaccine	7/10	4/10	2/10	2/10	0/10	0/10
	Control	10/10	10/10	10/10	10/10	10/10	10/10
39F	Vaccine	1/10	2/10	2/10	1/10	1/10	2/10
	Control	10/10	10/10	10/10	10/10	10/10	10/10
CVS	Vaccine	6/10	2/10	2/10	1/10	1/10	1/10
	Control	10/10	10/10	10/10	10/10	10/10	10/10

*Vaccine supplied by National Veterinary Research Institute, Vom, Nigeria.

+Vaccine used at 1:125 dilution

**No. of deaths/No. of inoculated.

++Log_{10} Mouse LD_{50} was $10^{6.2}$ and 0.5ml quantity was injected i.m.

FIG. 1 Federal Republic of Nigeria showing the geographical position of Plateau State



FIG. 2 Plateau State Showing the 14 Local Government Areas

FIG. 3 Rabies cases in human, dogs and wildlife in Plateau State 1970-1981 by LGA and Number of reported cases

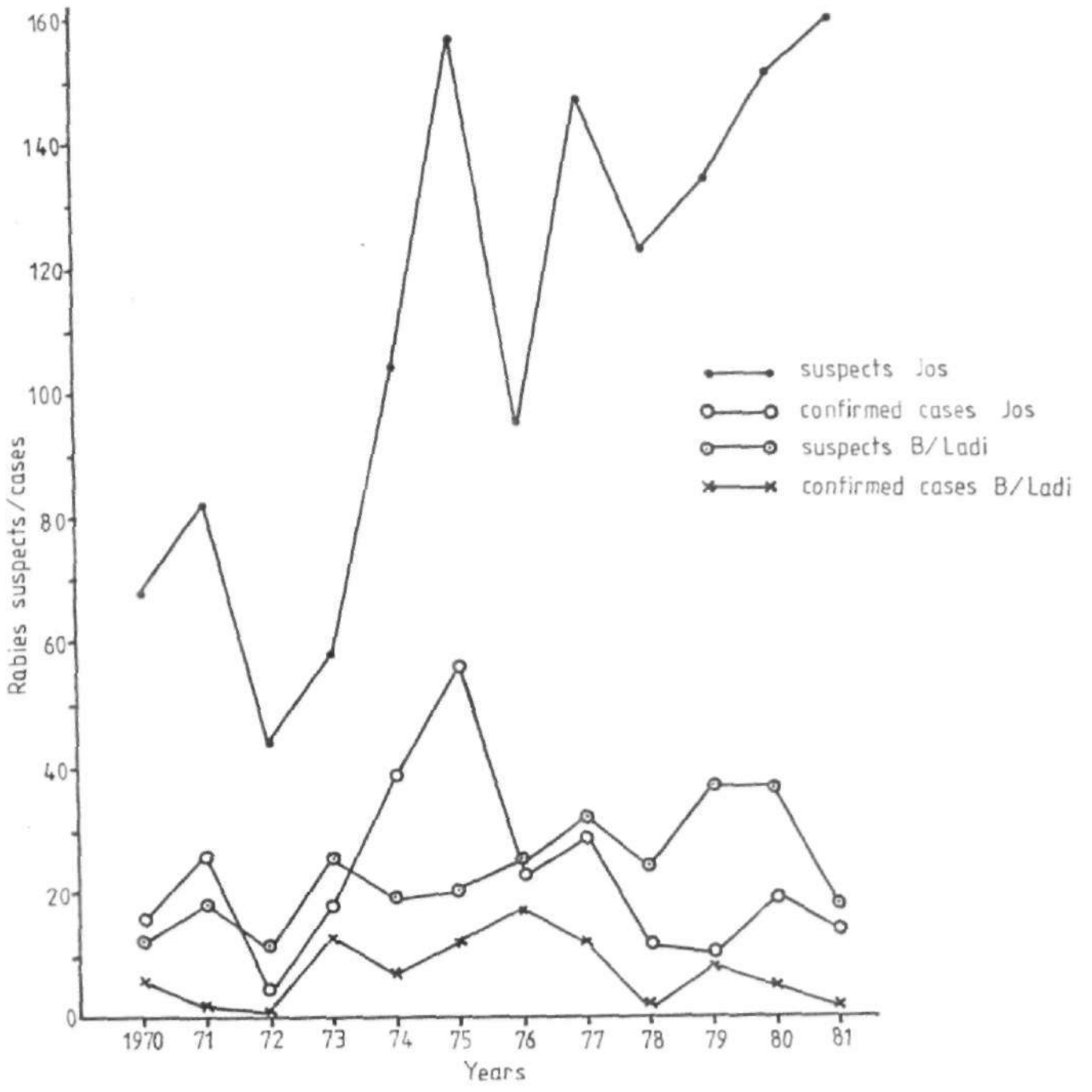

160
140
120
100
80
60
40
20
0
Rabies suspects/cases
suspects Jos
confirmed cases Jos
suspects B/Ladi
confirmed cases B/Ladi
1970
71
72
73
74
75
76
77
78
79
80
81
Years

FIG. 4

FIG. 4 Number of rabies suspects and cases by year in Jos and Barkin Ladi Local Government Areas

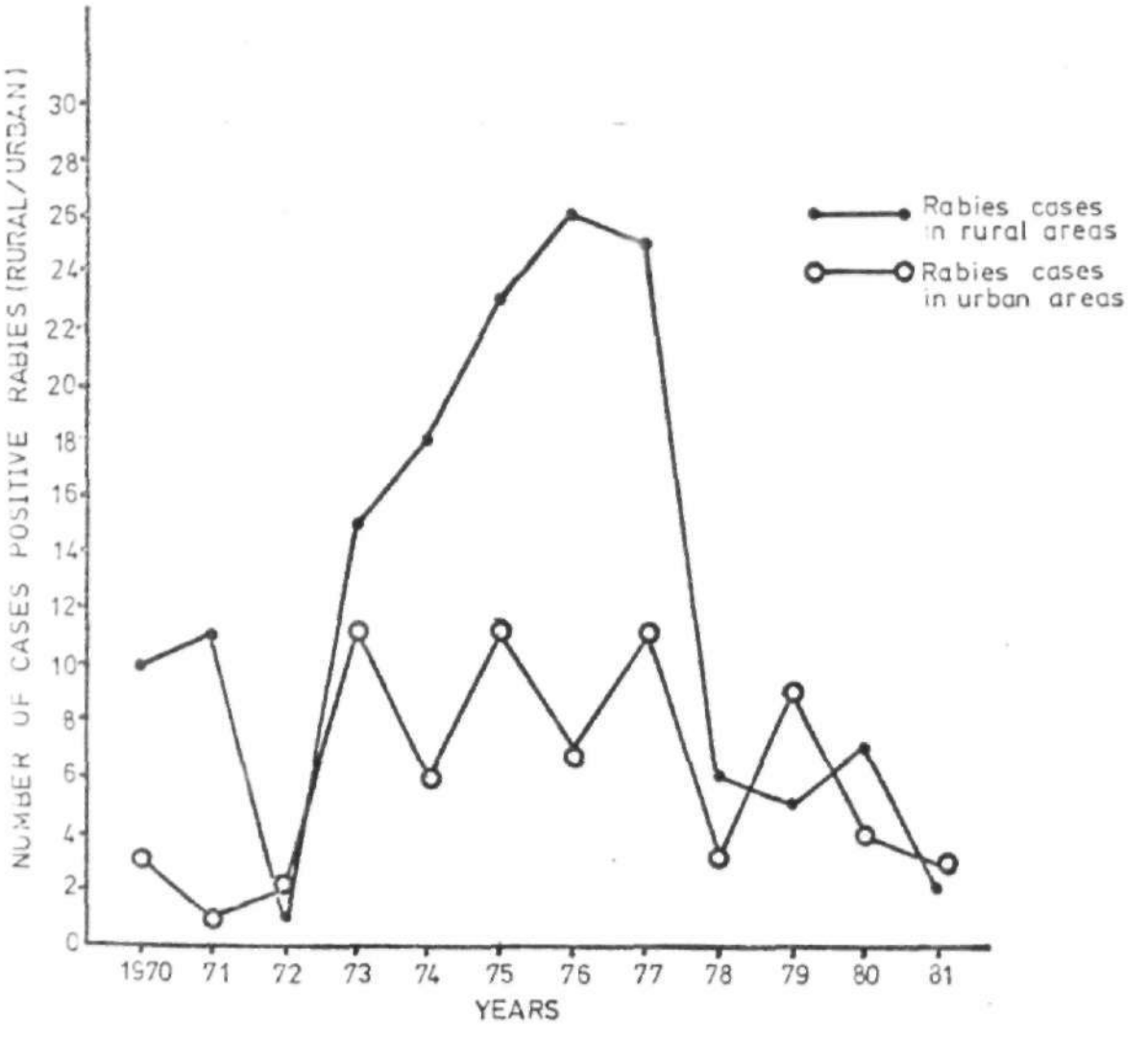

NUMBER OF CASES POSITIVE RABIES (RURAL/URBAN)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
1970
71
72
73
74
75
76
77
78
79
80
81
YEARS
Rabies cases in rural areas
Rabies cases in urban areas

FIG. 5

FIG. 5 Distribution of Rabies cases in urban and rural areas, Plateau State 1970-1981

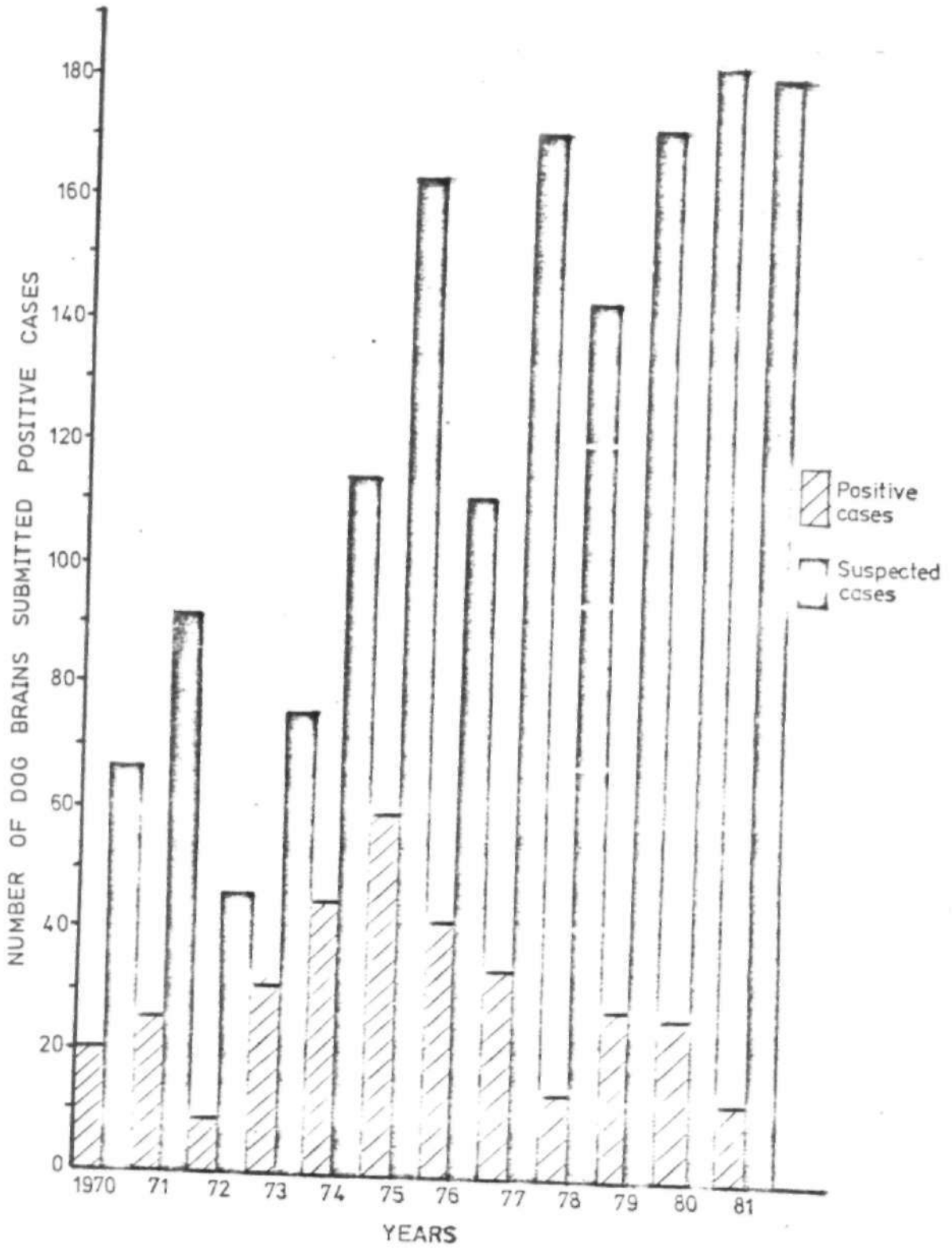

NUMBER OF DOG BRAINS SUBMITTED POSITIVE CASES
180
160
140
120
100
80
60
40
20
0
1970
71
72
73
74
75
76
77
78
79
80
81
YEARS
Positive cases
Suspected cases

FIG. 6

FIG. 6 Distribution of positive canine rabies cases in Plateau State 1970-1981

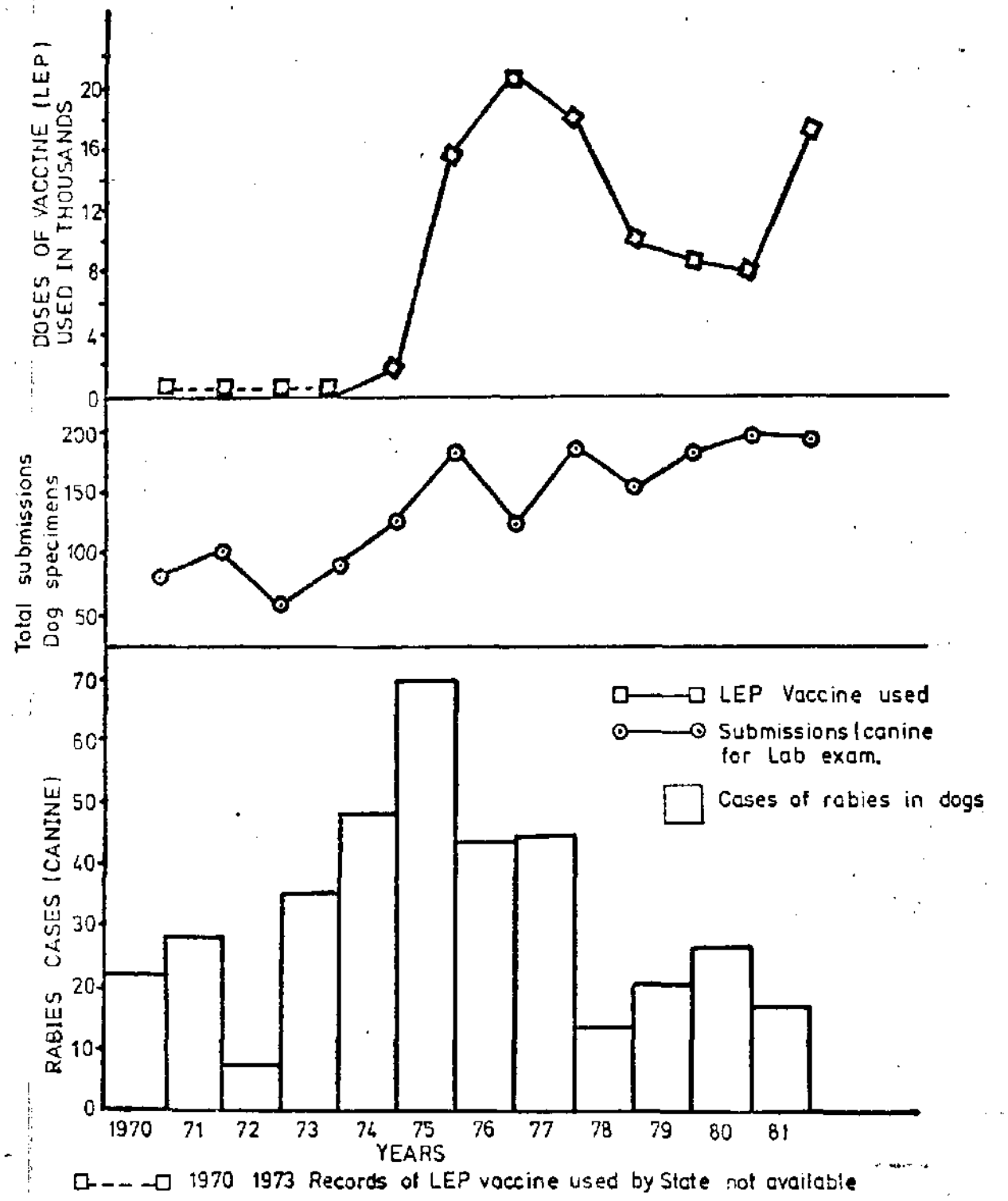

DOSES OF VACCINE (LEP) USED IN THOUSANDS
20
16
12
8
4
0
Total submissions Dog specimens
200
150
100
50
RABIES CASES (CANINE)
70
60
50
40
30
20
10
0
1970
71
72
73
74
75
76
77
78
79
80
81
YEARS
LEP Vaccine used
Submissions (canine for Lab exam.
Cases of rabies in dogs
1970 1973 Records of LEP vaccine used by State not available

FIG. 7

FIG. 7 Dog rabies cases compared with canine vaccine usage Plateau State 1970-1981

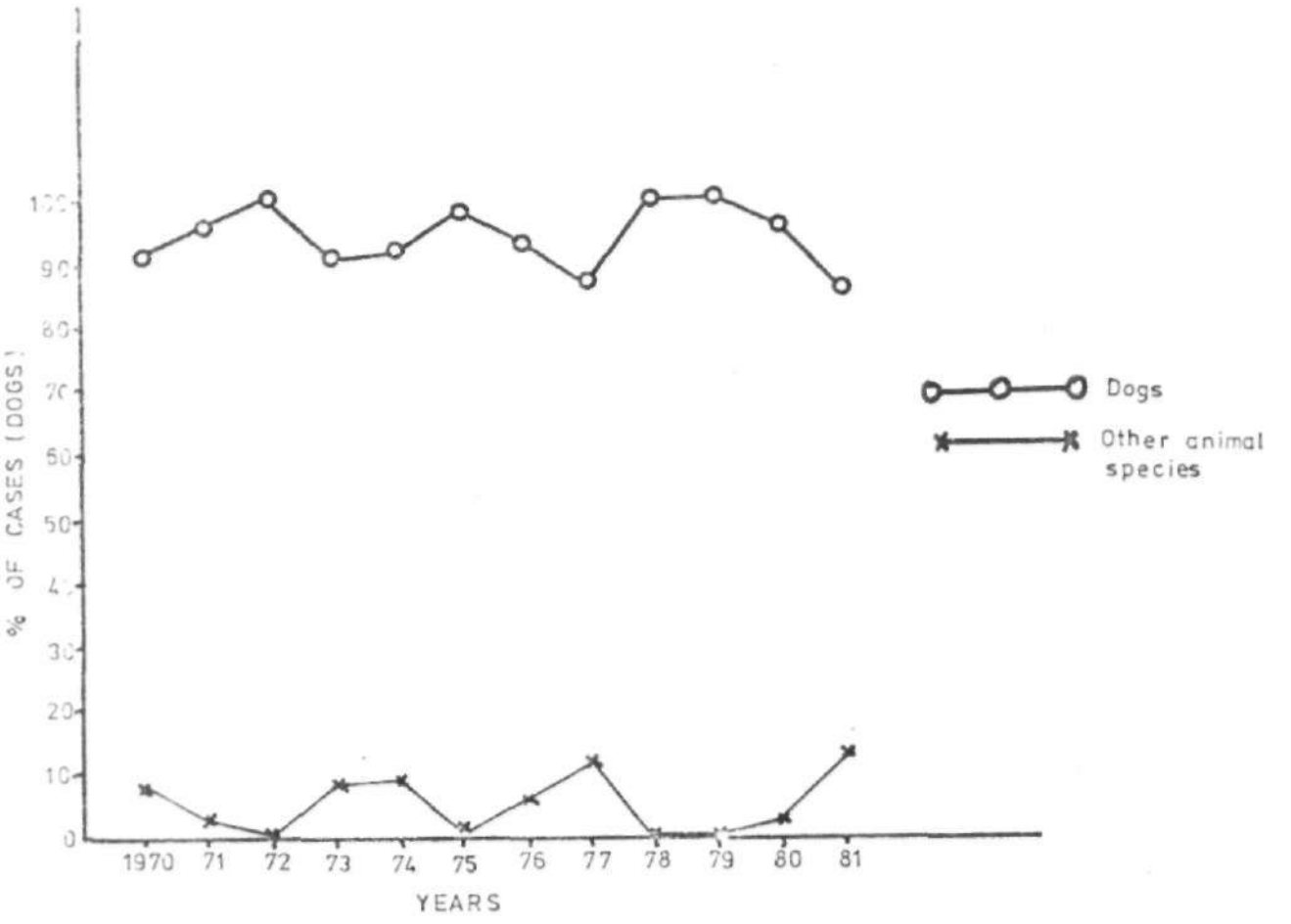

% OF CASES (DOGS)
100
90
80
70
60
50
40
30
20
10
0
1970
71
72
73
74
75
76
77
78
79
80
81
YEARS
Dogs
Other animal species

FIG. 8

FIG. 8 Percentage rabies cases in dogs by year, Plateau State 1970-1981

FIG 9

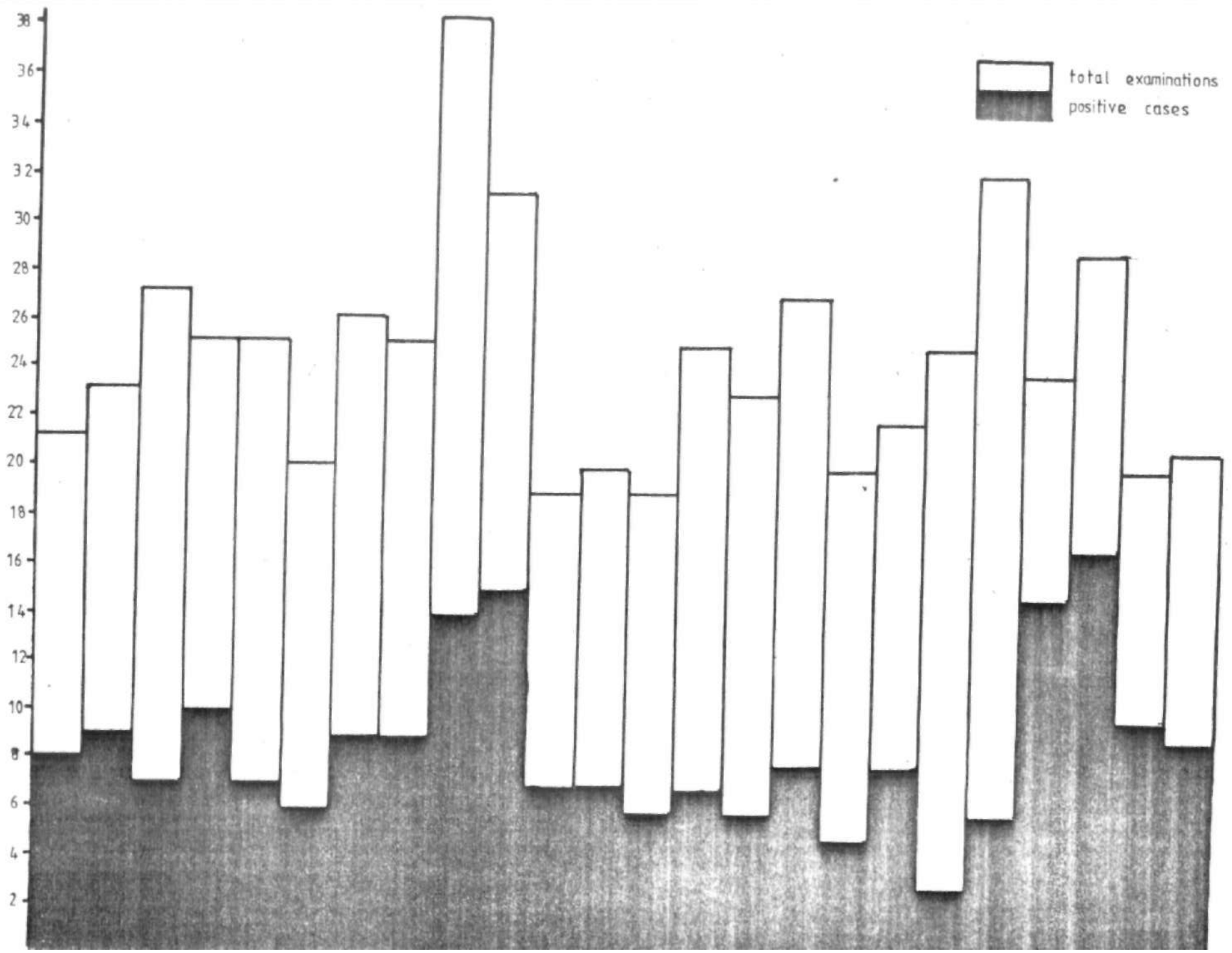

38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
total examinations
positive cases

FIG. 9 Distribution of cases of rabies according to month of diagnosis Plateau State 1982-1983

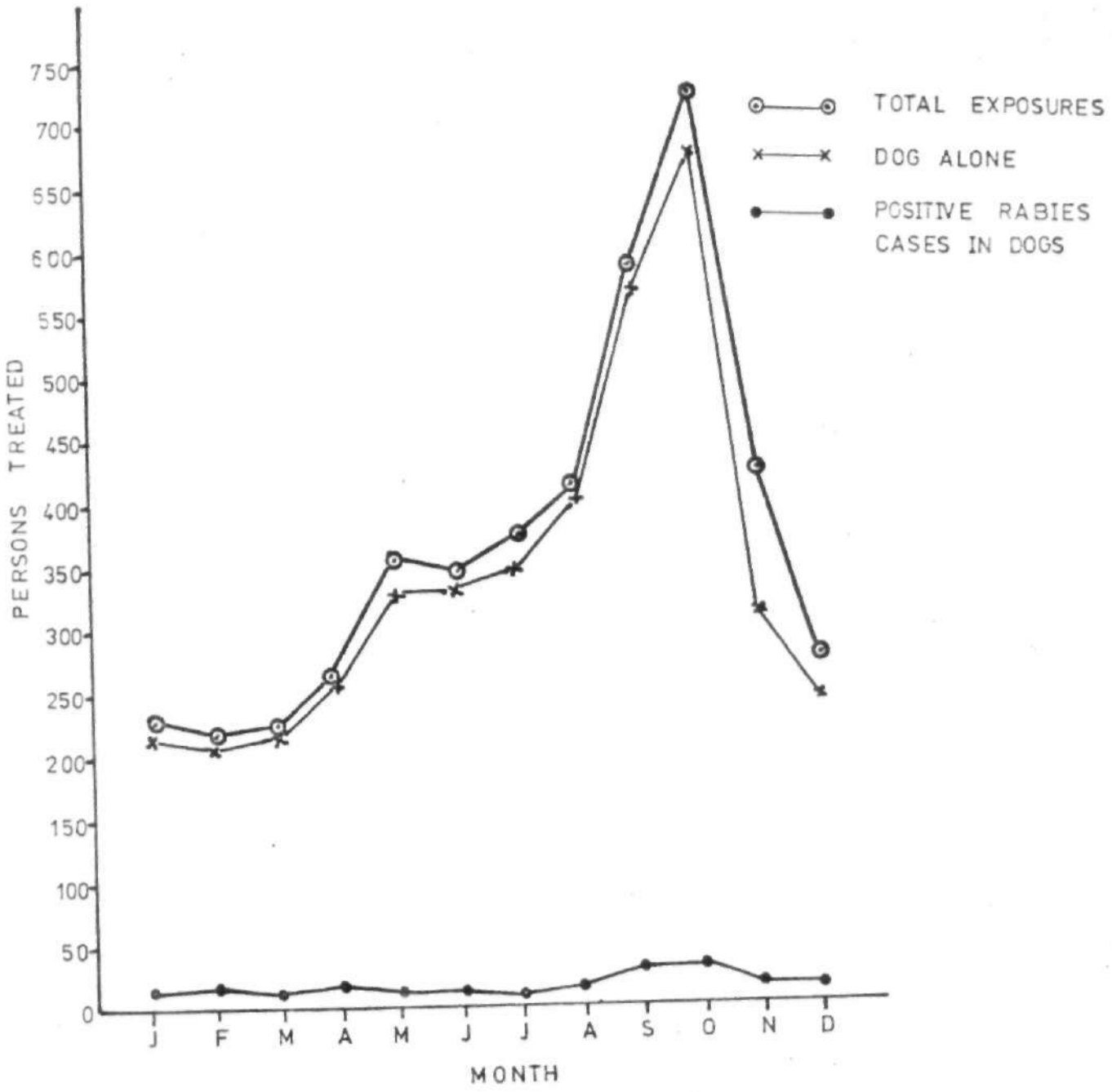

TOTAL EXPOSURES
DOG ALONE
POSITIVE RABIES CASES IN DOGS
PERSONS TREATED
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
J
F
M
A
M
J
J
A
S
O
N
D
MONTH

FIG. 10

FIG. 10 Monthly distribution of Persons receiving post-exposure prophylaxis (PEF) in relation to confirmed rabies cases in dogs

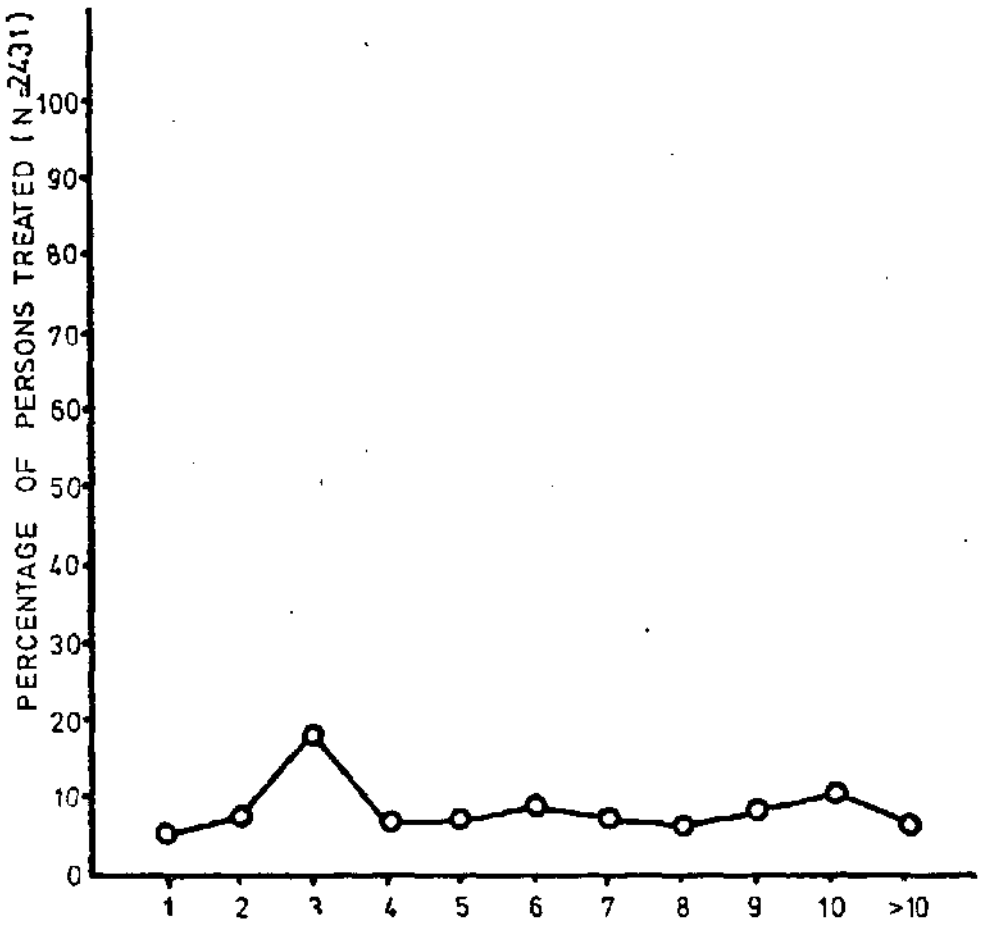

PERCENTAGE OF PERSONS TREATED (N=2431)
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
>10

FIG. 11

FIG. 1| Days of delay before initiation of antirabies treatment

HYBRIDOMA NUMBER / STRAIN NUMBER	RABIES: 1, 2, 4, 5, 6, 7, 9, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, MASS 1983	STANDARD STRAINS: M	LB	D
502-2	■	■	■	■
422-5	□	■	■	■
111-14	■	■	■	■
802-2	■	■	■	■
804-9	■	■	■	■
805-3	■	■	■	■
111-2	■	■	■	■
389-1	■	■	■	■
822-7	■	■	■	■
816-1	■	■	■	■
808-2	■	■	■	■
104-4	■	■	■	□
222-9	■	■	■	□
817-5	■	■	■	□
807-5	■	■	□	□
239-10	■	■	□	□
237-3	■	■	□	□
703-8	■	■	□	□
377-7	■	□	□	□
515-3	■	□	□	□
209-1	■	□	□	□
229-1	■	□	□	□
590-2	■	□	□	□
120-2	■	□	□	□
103-7	■	□	□	□
714-3	■	□	□	□
818-5	■	□	□	□
701-9	■	□	□	□
715-3	■	□	□	□
721-2	■	□	□	□
806-1	■	□	□	□
364-11	■	□	□	□
206-1	■	□	□	□
102-27	■	□	□	□
801-1	■	□	□	■
803-6	■	□	■	■

■ - positive FA staining; □ = no staining.

FIG. 12

FIG. 12 Immunoreactivity pattern of virus isolates with nucleocapsid monoclonal antibodies (NC MAbs)

ANTIGENIC SITE		MONOCLONAL ANTIBODY NUMBER	GROUPS OF RABIES VARIANTS GP NEUTRALIZATION							
			7, 9, 11, 13, 15, 16, 20, 21, 22, 24, 25, 26, 27, 29, 33, 34, 40, 41, 43, 45, 46, MASS 1983. A	2, 5, 6, 14, 17, 18, 19, 31, 35, 37, 44 B	C 12	D 1	E 4	28, 30, 32, 39, 42 F	G 36	PM
I		509-6 1								
II	A	231-22 2								
		220-8 3								
	B	162-3 4								
		1116-1 5								
		1119-14 6								
		1121-2 7								
		101-1 8								
		1111-1 9								
	C	1112-1 10								
		1105-3 11								
		1107-1 12								
		240-3 13								
		613-2 14								
		719-3 15								
		1117-8 16								
		226-11 17								
III	A	194-2 18								
		248-8 19								
		1113-1 20								
	B	507-1 21								
		718-4 22								
		120-6 23								
		1103-4 24								
		1115-3 25								
		1122-3 26								
		127-5 27								
IV		110-3 28								
V		1118-6 29								
		1120-10 30								
		1109-3 31								
		1114-2 32								
		1116-2 33								
		176-2 34								
		193-2 35								
		904-4 36								
		1101-3 37								
		523-11 38								
		1108-1 39								
		1119-8 40								
		504-1 41								
		508-9 42								
		419-2 43								
		422-2 44								

■ = neutralized; □ = not neutralized

FIG. 13

FIG. 13 Rabies variants from Nigeria obtained from glycoprotein neutralization with specific anti-glycoprotein monoclonal antibodies



NB No samples collected from states not showing variants

FIG. 14

FIG. 14 Distribution of Rabies variants by State from which isolates were examined

ANTIGENIC SITE		MONOCLONAL ANTIBODY NUMBER	#22	#25	#38	Flury LEP	PM
I		509 – 6	■	■	■		■
II	A	231 – 22					■
		220 – 8	■	■	■	■	■
	B	162 – 3					■
		1116 – 1					■
		1119 – 14					■
		1121 – 2					■
		101 – 1					■
		1111 – 1					■
	C	1112 – 1					■
		1105 – 3	■	■	■		■
		1107 – 1					■
		240 – 3	■	■	■	■	■
		613 – 2					■
		719 – 3	■	■	■	■	■
		11117 – 8	■	■	■	■	■
		226 – 11	■	■	■	■	■
III	A	194 – 2					■
		248 – 8	■	■	■		
		1113 – 1	■	■	■		
	B	507 – 1	■	■	■		■
		718 – 3					■
		120 – 6	■	■	■	■	■
		1103 – 4					■
		1115 – 3					■
		1122 – 3					■
		127 – 5	■	■	■	■	■
IV		110 – 3					■
V		1118 – 6				■	
		1120 – 10				■	
		1109 – 3					■
		1114 – 2					■
		1116 – 2					■
		176 – 2				■	■
		193 – 2					
		904 – 4	■	■	■		■
		1101 – 3			■	■	■
		523 – 11	■	■	■		
		1108 – 1					■
		1119 – 8					■
		504 – 1	■	■	■		■
		508 – 9	■	■	■	■	■
		419 – 2	■	■	■	■	■
		422 – 2	■	■	■	■	■

(black square = not neutralized; white square = neutralized)

FIG. 15

FIG. 15 Comparison of isolates from vaccinated dogs with LEP (Flury) and PM Wistar

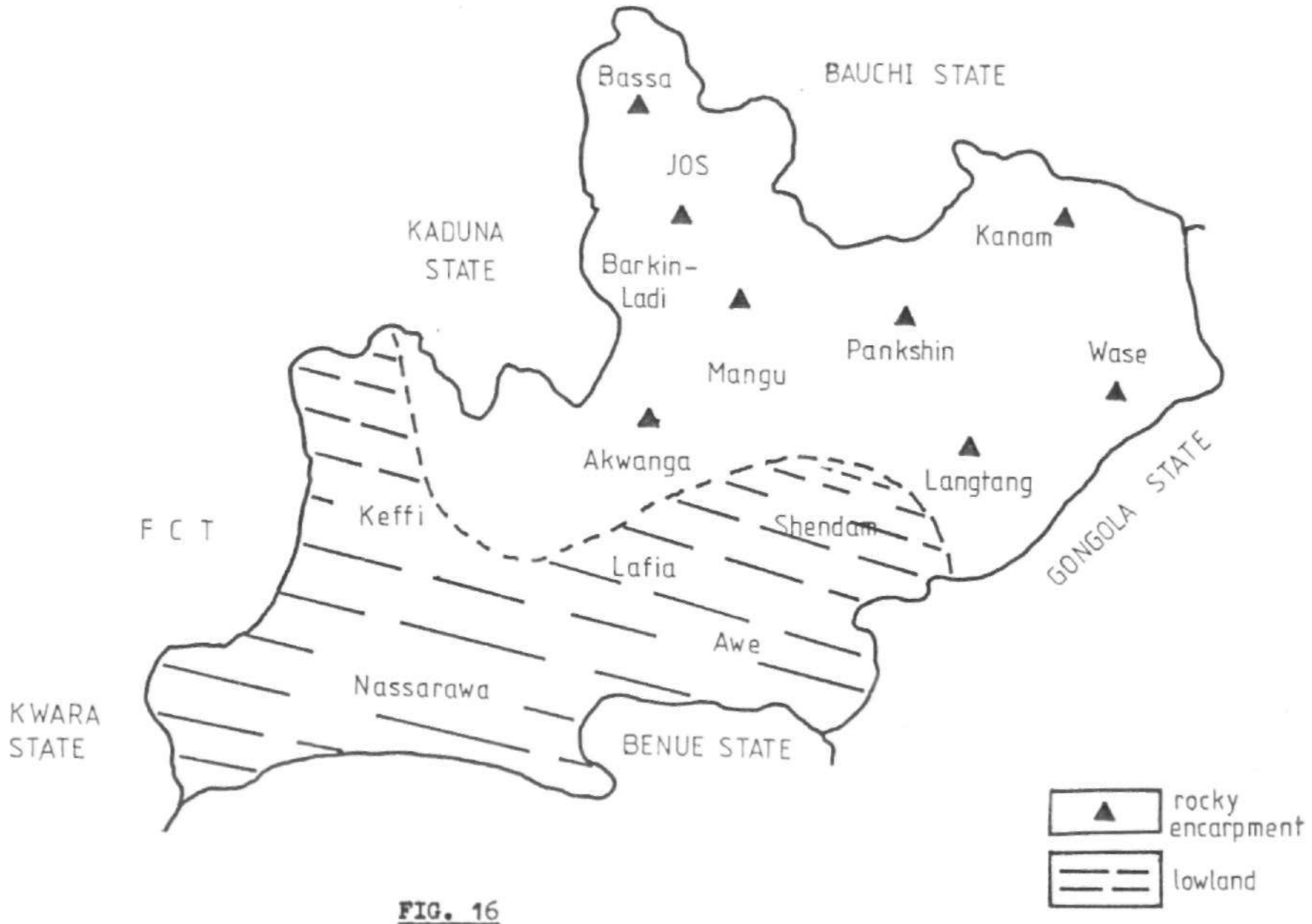

Bassa
BAUCHI STATE
JOS
KADUNA
STATE
Barkin-
Ladi
Kanam
Pankshin
Wase
Mangu
Akwanga
Langtang
GONGOLA STATE
F C T
Keffi
Shendam
Lafia
Awe
Nassarawa
KWARA
STATE
BENUE STATE
rocky
encarpment
lowland

FIG. 16

FIG. 16 Major biotic regions Plateau State

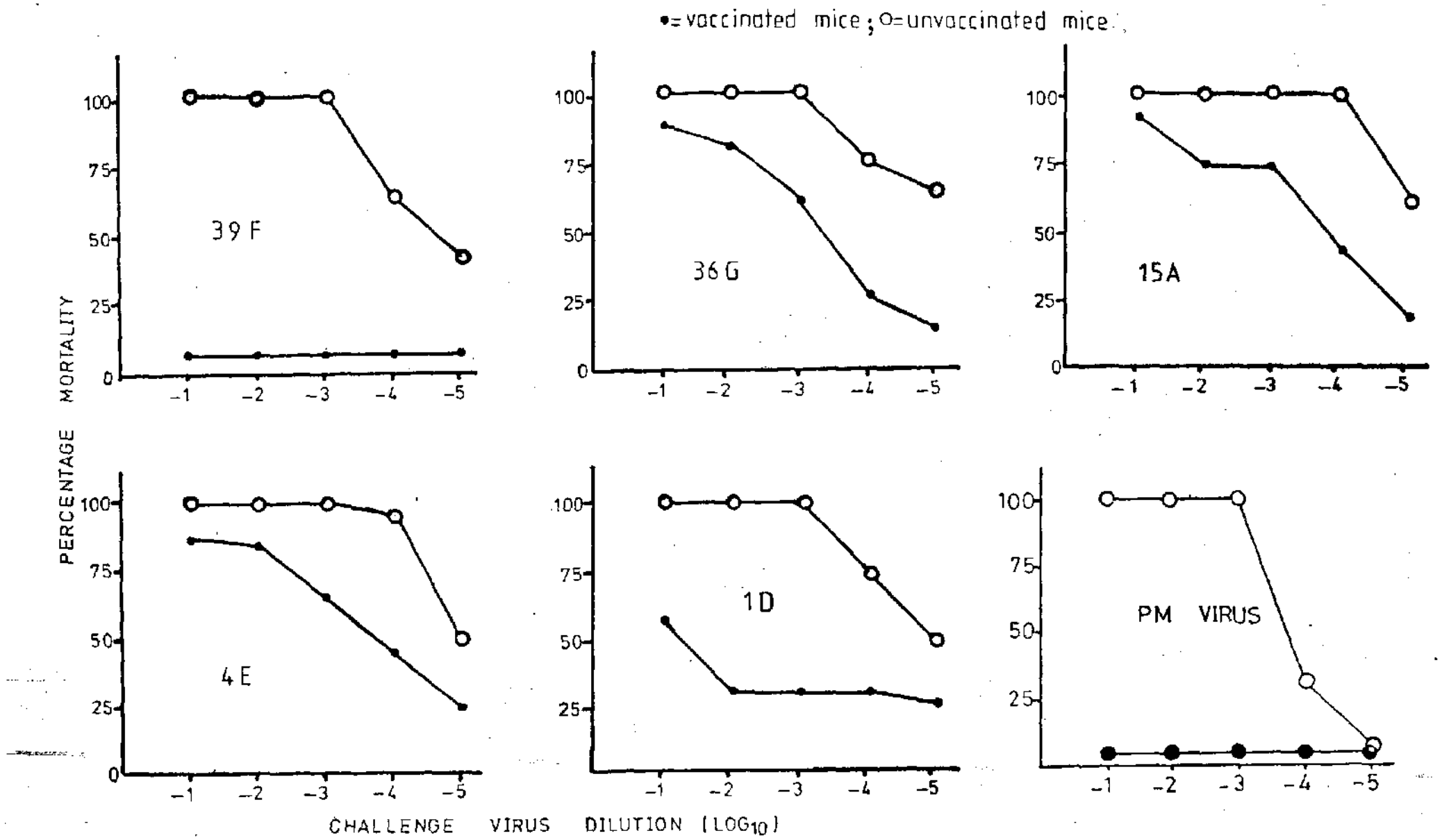

•=vaccinated mice; o=unvaccinated mice.
PERCENTAGE MORTALITY
100
75
50
25
0
39 F
36 G
15A
4 E
1 D
PM VIRUS
-1
-2
-3
-4
-5
CHALLENGE VIRUS DILUTION (LOG10)

FIG. 17

FIG. 17 Protection Plots of Vaccine Prepared from Pitman-Moore Virus Vaccine against challenge of five strains of characterised street rabies virus

antibody number	PM	animal strains (dog, cat, and goat antigenic variants)				
		good protection	partial protection	poor protection		
		F39	D1	G36	A15	E4
1118—6						
1120—10						
193—2						
248—8						
1113—1						
523—11						

■ = NEUTRALIZED ; □ = NOT NEUTRALIZED

FIG. 18

FIG. 18. Relationship between Glycoprotein pattern of reactivity of Pitman-Moore (PM) and Nigerian street rabies strains and protection against Pitman-Moore Vaccine (PMHDCS)

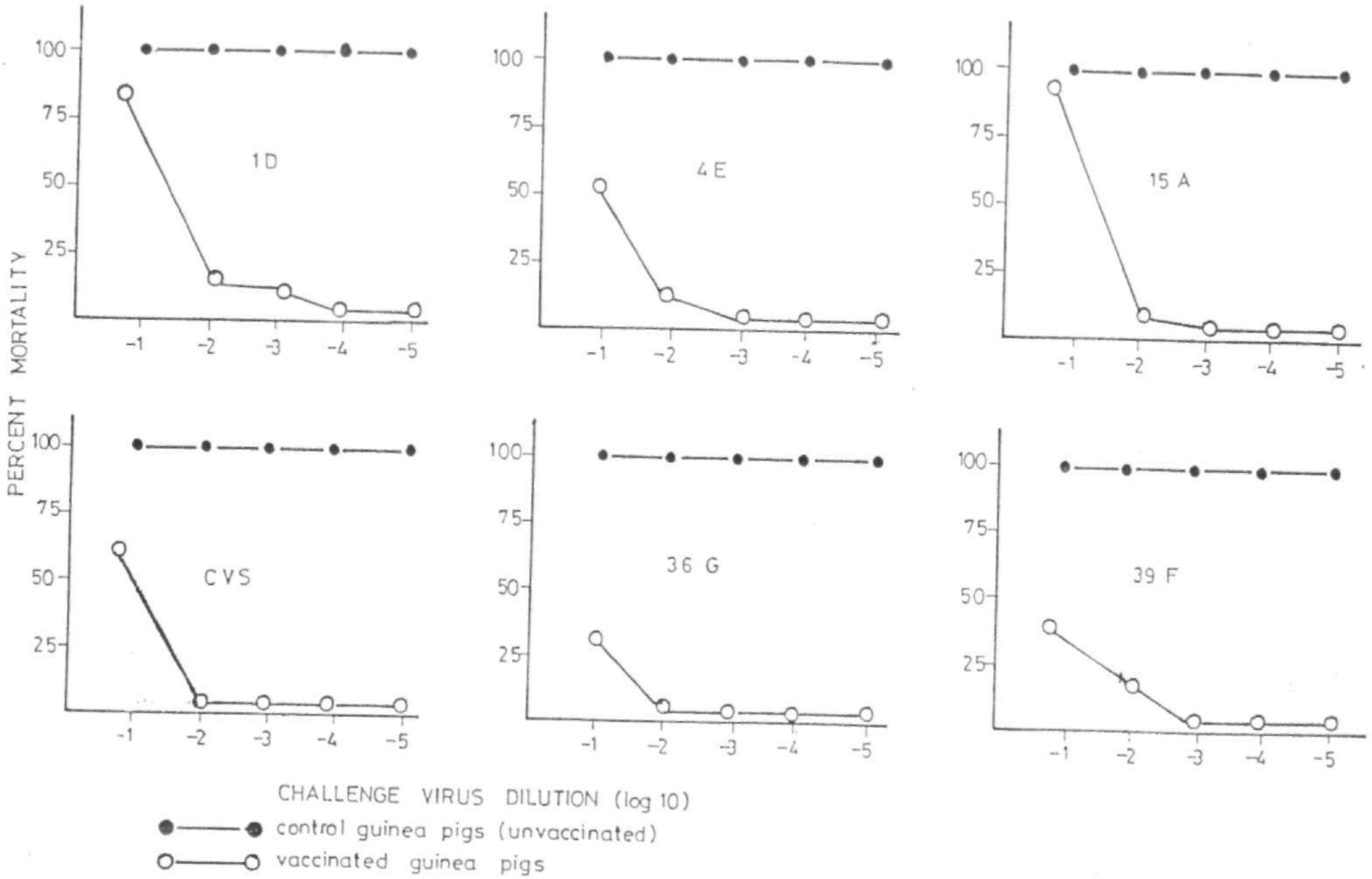
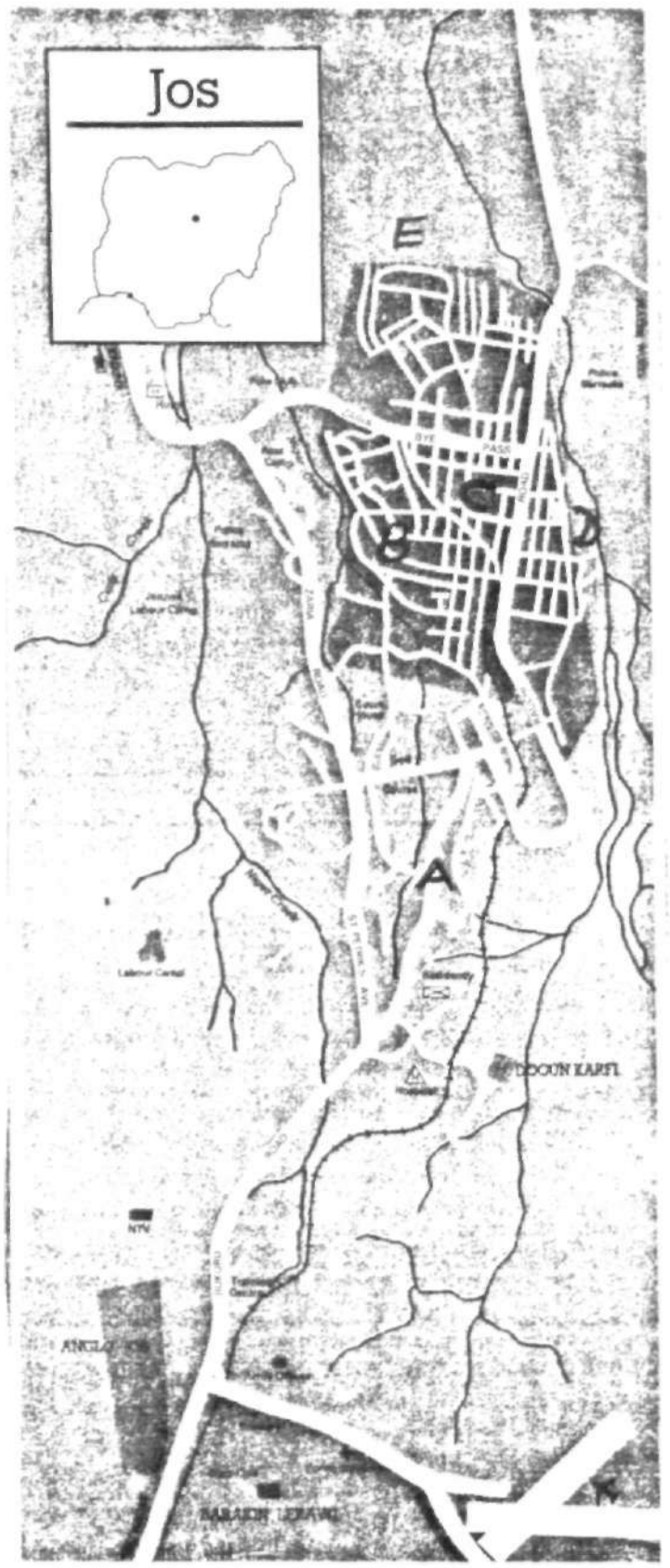

PERCENT MORTALITY
100
75
50
25
1 D
4 E
15 A
CVS
36 G
39 F
-1
-2
-3
-4
-5
CHALLENGE VIRUS DILUTION (log 10)
control guinea pigs (unvaccinated)
vaccinated guinea pigs

FIG. 19

FIG. 19 Protection Plots of LEP (Flury)
Canine vaccine against challenge of strains
of characterised street rabies virus
using Guinea Pigs

APPENDIX 1: Street Map of Jos, Nigeria



APPENDIX 2: STREET DOG CENSUS DATA, JOS PLATEAU STATE, NIGERIA 1982

Area _____ Socioeconomic level _____ Date _____ Reported by _____

Street Name and Number	Breed			Sex		Age			Lactating Females
	Dog Number	Identify Breed	Crossbreed	Native breed	Male	Female	Puppy	Juvenile	Adult	Size of litter

Appendix 3

STUDY OF DOGS IN COMPOUNDS IN JOS
PLATEAU STATE, NIGERIA

Schedule A

COMPOUND IDENTIFICATION

1. Age of Head of Compound _____

2. Address of Residential Area _____

_____
Street Name and House Number

3. Occupation of Head of Compound _____

4. Interviewer _____

5. Interviewed _____

6. Case No. _____

STUDY OF DOGS IN COMPOUNDS IN JOS, PLATEAU STATE, NIGERIA

Schedule B

1. Do you have dogs in your compound

( ) Yes ( ) No

2. How many people live in your compound _____

3. Type of Household?

( ) Couple with children

( ) Couple without children

( ) Single male

( ) Single female

4. How long have you or your family lived at your present address? _____

5. What type of residence do you or your family live in? ( ) House

( ) Apartment

( ) Other (specify please)

6. Are pets allowed where you live?

( ) Yes ( ) No

7. Do you ( ) own ( ) rent your present residence?

8. Does your residence have a yard?

( ) Yes ( ) No

9. If your residence has a yard, is the yard (backyard primarily).

( ) completely fenced
( ) partially fenced
( ) not fenced

10. I would like my dog(s) impounded if stray
( ) Yes ( ) No

11. If you have female dog, how many litters did she yelp the last one year _____

12. Do you think stray dogs are more liable to bite?
( ) Yes ( ) No ( ) Don't know

13. Do you think Veterinary Services are too expensive?
Yes ( ) No ( ) Don't know ( )

14. Do you think veterinary services are adequate?
Yes ( ) No ( ) Don't know ( )

15. How many people were bitten by your dog last year _____
Indicate number of persons

16. Do you have companion animals or pets other than dogs in your household?
( ) Yes ( ) No
If Yes check cat ( )
Monkey ( )
Chimpanzee ( )
Horse ( )
Others specify _____

17. If you do have dogs what is the number of dogs _____ that you presently have in your household?

18. Which Veterinary Clinic do you attend? _____

(At this stage we would like you to furnish us additional information on each dog you now have in your household (Schedule C).

19. Is there a Rabies ordinance in Plateau State?

( ) Yes
( ) No
( ) Don't know

20. Which of the following account for stray dog problem in your area.

( ) Breeding
( ) Pet escapes
( ) Pet releases
( ) Pet abandoned after move
( ) Other of inadequate or improper feeding

SCHEDULE C

Please complete one of these forms for each dog in the household. Check the categories that apply and complete the questions asked in the space provided.

21. Breed ( ) purebred ( ) crossbred (mixed)

22. Breed _____
if crossbred, predominant breed

23. Animal's age or date of birth _____

24. Animal's sex: ( ) Male ( ) neutered (castrated male)
( ) Female( ) neutered (sprayed female)

25. If not neutered, give reason _____

26. How long has the animal lived in your household?

_____

27. At what age was the animal obtained? _____

28. Why was the animal obtained? _____

29. From whom was the animal obtained
( ) breeder ( ) neighbour ( ) stray
( ) animal pound ( ) other _____

30. Have any of your dogs been treated or seen by a specify veterinarian in the last one year?
( ) Yes ( ) No ( ) Don't know

32. Describe the major advantages or convenience of owning this particular animal. (check as many as apply)

( ) Companionship	( ) Hunting
( ) Working animal	( ) Love and affection
( ) Sports value	( ) Protection
( ) Breeding value	( ) Pet is physical or characteristics
( ) Pet's temperment and habits	( ) Replaces lost stolen or pet that died.
( ) Pleasure	( ) Other (specify) ___
( ) Challenge	_____

33. Describe the major disadvantages or inconveniences of owing this particular animal. (Check as many as apply)

( ) economics of owning pet	( ) diseases of pet
( ) physical requirement or retraint	( ) reproduction and associated problem.
( ) responsibility - care when family is away from home	( ) noise odour, problems with household training or disposal of faeces.

( ) physical characteristics ( ) overpopulation
( ) allergy ( ) negative temperment or habit of pet.

( ) other (specify) _____

_____

34. Has this dog received any formal obedience training by either ( ) owner or ( ) obedience school?

35. Has this animal been trained to hunt? ( ) Yes ( ) No ( ) Don't know

36. Where does this dog sleep? ( ) inside (indoors) ( ) outside ( ) Don't know

37. Where does this dog stay during most of the day?
( ) inside ( ) outside ( ) other _____ (specify)

38. When the dog is outside, is he or she a majority of the time: ( ) confined to a yard?
( ) confined to an animal? ( ) allowed to roam free?
( ) restrained run on a chain?

39. Has this dog received any immunizations against rabies?
(a) as a ( ) puppy? ( ) Yes ( ) No ( ) Don't know
(b) as an adult? ( ) Yes ( ) No ( ) Don't know
(c) during the past one year ( ) Yes ( ) No ( ) Don't know
(d) If the animal has been immunized, what other diseases has the animal be immunized for?

_____

40. Is your pet licensed? ( ) Yes ( ) No

41. If not, why not? ( ) too expensive ( ) inconvenience
( ) irrelevant ( ) other _____
(Specify)

42. If an animal city-wide immunization clinic was held to vaccinate dogs for rabies, would you take your pet to be vaccinated at this clinic?

( ) Yes ( ) No ( ) Don't know

(If more than one dog is in your household, complete questions 23 to 42 of Schedule C).

Case No: _____

STUDY OF DOGS IN COMPOUNDS IN JOS
PLATEAU STATE OF NIGERIA

SCHEDULE D

If you do not know have a dog in your compound but have previously owned a dog, would you please give us the following information:

43. Breed: _____

44. Sex: ( ) Male ( ) Female

45. Date when pet last owned (e.g November 1975 _____

46. Please check the reason or reasons for no longer owning this animal
( ) died or was killed
( ) disappeared
( ) animal was too destructive
( ) behaviour problem with child or pet
( ) moved
( ) animal got too big for residence or yard
( ) gave away
( ) family member allergic
( ) other (specify) _____

47. Describe the major advantages or convenience of owning this particular dog. (check as many as apply)

( ) companionship	( ) breeding value
( ) love and affection good pet	( ) pleasure
( ) working animal	( ) challenge
( ) hunting animal	( ) pet's temperament and habits.

( ) protection ( ) replaces lost, stolen or pet that died

( ) pet's physical beauty or characteristics ( ) Sour of meat

( ) Others (Specify) _____

_____

48. Describe the major disadvantages or inconveniences of owning this particular dog. (Check as many as apply)

( ) economics of owning dog
( ) physical requirement or restraint
( ) responsibility-care when family is away from home
( ) physical characteristics
( ) Allergy
( ) diseases of dog
( ) reproduction and associated problems
( ) overpopulation
( ) noise, odour, problem with house training or disposal of faeces.
( ) negative temperament or habit of dog
( ) other (specify) _____

_____

49. Length of time the dog live in your compound ____

_____

50. How long has it been since you have owned this animal _____

_____

51. Do you plan on getting another dog in the next year? ( ) Yes ( ) No ( ) Don't know.

SCHEDULE E

STUDY OF DOGS IN COMPOUNDS IN JOS
PLATEAU STATE OF NIGERIA

52. If you do not presently have a dog, have you ever owned a dog?
( ) Yes ( ) No

53. If you do not have a dog in your compound could you tell me why you do not have or may be do not want a dog?
( ) housing limitations, space, or deposit required
( ) transient (status student, travel or move too often)
( ) destructive habits of pets to property
( ) against my culture
( ) inconvenience
( ) lost or stolen pet
( ) feel inadequate to provide care
( ) have not found the animal I want
( ) against my religious belief

54. Are you aware of existence of dog control law in Plateau State?
( ) Yes ( ) No

55. Do you think veterinary services are too expensive
( ) Yes ( ) No ( ) Don't know

56. Do you think stray dogs are more liable to bite?
( ) Yes ( ) No ( ) Don't know

SCHEDULE F

STUDY OF DOGS IN COMPOUND JOS, PLATEAU STATE, NIGERIA

This opinionnaire was developed to obtain information about your personal feelings and attitudes toward dogs, also, some of the questions are concerned with the dogs in your community.

1. Please read each question carefully.
2. Data from an individual questionnaire is considered confidential and only summarized data will be used.
3. Answers to the opinion-questions are scaled from strongly agree to strongly disagree.
4. Based on your personal opinion, check only one category for each item. For example -

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	No opinion
A dog gives me a sense of joy		X				

5. If you do not have enough knowledge to form an opinion about a particular statement, check "no opinion".

57. The ideal companion animal is a dog.

58. If I become frustrated, a dog might sense my problem, and by his actions help relieve my problem.

59. Overpopulation in dog populations is a major problem in our society today.

60. If I had a dog as a companion animal, I would prefer a large dog.

61. If I owned a dog I would make sure it had rabies vaccination.

62. I would not want to own a dog because of medical expenses for veterinarians.

63. A dog gives/would give me a sense of well being.

64. One of the reasons I want to or do own a dog is for protection.

65. The major cause of too many stray animals is irresponsible owners.

66. We do not own a dog because we do not have enough room.

67. I like a dog that I can control and does what I want it to.

68. Owning a dog creates extra work, for example: feeding bathing and letting or taking them outside for exercise.

69. Many dogs cause excessive noise.

70. Dogs tend to form close relationships with their owners.

71. If I am alone, a dog would relieve my sense of loneliness.

72. It is important to immunize a dog for rabies.

73. If we owned a dog it would be because I wanted a pet.

74. I dislike stray dogs because they attack and kill my poultry.

75. I would not want to own a dog because it might annoy the neighbours.

76. I am afraid of dogs because they can cause rabies.

77. One of the reasons I do not like dogs is because they bite.

78. If we owned a dog it would be a playmate for our children.

79. I consider dogs as breeding animals and thus a supplemental source of income.

80. One of the reasons I do not like dogs is because they tear things up and damage property.

81. If I had a dog as a companion animal I would prefer an aggressive dog.

82. I don't like stray dogs because they can spread disease.

83. Free-roaming or stray dogs harbour diseases man can catch.

84. Dogs need to be able to roam

85. Dogs are a hazard to our rafice and cause road accidents.

86. I believe that spaying/castrating pet dogs is a good idea to reduce dog population.

87. My dog is friendly.

88. How our family pet is treated or cared for causes friction between the various members of the family.

89. We do not own a dog because it is against our culture to keep dogs.

90. A dog gives/would give me a sense of joy.

91. The community should have fines for letting dogs wander or runfree.

92. Free-roaming or stray dogs are a problem in my neighbourhood.

93. Free-roaming or stray dogs tend to bite and inflict wounds on people.

94. I would enjoy owning a dogs as a hunting companion or for sport.

95. If I had a dog I would not have it neutered (e.g. spayed or castrated).

96. I don't like dogs because they can spread disease.

97. It costs too much to fee a dog.

98. When I become angry, I can get rid of my anger by talking to or playing with my dog.

99. The major problem that dogs cause is destroying other people's property.

100. If I had a dog as a companion animal I would prefer a friendly dog.

101. Stray dogs are common because pets escape and get lost.

102. Free roaming or stray dogs create a nuisance and cause pollution of streets and public parks with their faeces.

103. I enjoy owning a dog because of the love and affection I can give it.

104. I would like my dog to be impounded stray.

105. Stray dog are common in our environment because dogs are abandoned after people move.

106. We have too many (an over-population) of dogs in our community.

107. I would not want to own a dog because of the emotional trauma it would cause if the animal were lost or died.

108. A dog should be considered as part of a family group.

109. I do not like dogs because of damage to property such as livestock.

110. I would or do like my own dog, but dislike other people's dogs.

111. I dislike dogs because dog ownership is against my religious belief.

112. Free roaming dogs destroy chicken and bite sheep and goats and other domestic livestock.

Appendix 4

Ref. No. TRD/RES/Vol.1/48

National Veterinary Research
Institute,
Vom via Jos.

29th December, 1981

_____

_____

_____

Sir:

Study of Epidemiology and Public Health
Significance of Rabies in Plateau State

We are carrying out a research project on the above topic to last from January, 1982 to December, 1983 inclusive.

In Nigeria, there is no zoonotic disease that generates as much fear in the minds of people as rabies. Canine rabies appears to be endemic in many parts of the northern states especially in Plateau State. Since 1928 when the laboratory diagnosis of rabies was first confirmed in three dogs in the former Plateau Province rabies problem has continued to increase in Plateau. Recent observations on the occurrence of rabies all over Plateau State, judging from reports and specimens examined at the Rabies Diagnostic Laboratory, Vom, seems to show many similarities with observations made in Plateau Province in the 1930s.

The presence and magnitude of the disease in domestic animals such as dogs is an indicator of likely danger to man especially as the disease is greatly under reported. In fact since 1973 considerable cases of positive rabies in Barkin Ladi and Vom and their environs to name a few, seem to be on the increase. Despite control efforts which consist of vaccination of dogs and cats and control of stray dogs, rabies has continued to plague the people of Plateau.

It is in the light of the above that the National Veterinary Research Institute, Vom in conjunction with the Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria is co-ordinating a study of the epidemiology and public health significance of rabies in Plateau State of Nigeria. The project is sponsored by the Governing Board, National Veterinary Research Institute, Vom, Plateau State.

The objective of the study is to identify human, dog and environmental determinants of rabies in Plateau State with a view to finding realistic and effective rabies control or eradicative measures based on the study. Aspects of the study will include dog census; study of the attitudes to dog ownership in Jos; rabies prevalence and vaccination patterns in dogs and human beings from 1970 to 1981 and incidence from 1982 to 1983; of dog bites in hospitals (Private, Mission and Government) to be examined.

We are, therefore, seeking your kind co-operation in making the necessary administrative and professional arrangements so as to allow us easy access to existing medical records and data on rabies and allow us collect specimens on rabies in the Veterinary Clinics/Human Hospitals and Health Centres/Epidemiological Unit; Zoo/Wildlife Unit as applicable, throughout Plateau State.

We shall also collect rabies specimens and issue appropriate sets of questionnaires to all State Veterinary Clinics/Centres where dog quarantine for rabies is practiced and Hospital/Dispensaries and Health Centres as soon as we get the go-ahead from you.

Dr. A. E. J. Okoh, of the National Veterinary Research Institute, Vom is our researcher of the project under the supervision of Professor P. Addo, Dr. J. Umoh and Dr. Ezeokoli of Ahmadu Bello University, Zaria, and will visit your Veterinary/Medical Officers all over Plateau State in connection with the project. We shall be very grateful if you give him all the necessary co-operation on this project.

We shall be grateful for your prompt action so that the project can get started immediately.

Yours faithfully

Signed
Dr. A. G. Lamorde, Director
National Veterinary Research Institute

copy to:

1. The Medical Superintendent
   i/c. General Hospital
   BARKIN LADI

2. The Medical Superintendent
   i/c General Hospital
   AKWANGA

3. The Medical Superintendent
   i/c General Hospital
   KEFFI

4. The Medical Superintendent
   i/c General Hospital
   LAFIA

5. The Medical Superintendent
   i/c General Hospital
   PANKSHIN

6. The Medical Superintendent
   i/c General Hospital
   SHENDAM

7. The Medical Superintendent
   Seven Days Advert. Hospital
   JENGRE

8. The Medical Superintendent
   i/c General Hospital
   LANGTANG

9. (a) The Medical Superintendent
   i/c General Hospital
   NASSARAWA

10. The Medical Superintendent
    i/c General Hospital

11. The Medical Superintendent
    i/c General Hospital
    KANAM

12. The Medical Superintendent
    i/c Plateau Hospital
    Jos

13. The Medical Superintendent
i/c Our Lady's Hospital
AKWANGA

14. The Medical Superintendent
i/c S.I.M. (Evangel(Hospital,
(Jankwani) Jos, Zaria Road, Jos

15. The Medical Superintendent
i/c Plateau Hospital, Jos

16. The Medical Superintendent,
i/c Vom Christian Hospital
Jos.

17. The Officer-in-charge
Government Dispensary
KURU

18. The Officer-in-charge
Government Dispensary
GANAWURI

19. The Officer-in-charge
Government Dispensary
RIYOM

20. The Officer-in-charge
Government Dispensary
VOM

21. The Officer-in-charge
Government Dispensary
BOKKOS

22. The Officer-in-charge
Government Dispensary
BISICHI

23. The Officer-in-charge
Government Dispensary
BACHIT

24. The Officer-in-charge
Government Dispensary
KWALL

25. The Medical Superintendent
i/c Bukuru (Muslem)

26. The Officer-in-charge
Government Dispensary
RIM

27. The Officer-in-charge
Government Dispensary
HOSS

28. The Officer-in-charge
Rural Health Centre
BUKURU

29. The Medical Superintendent
i/c ECWA Hospital
JOS

30. The Officer-in-charge
Government Dispensary
PAMYAM

31. The Officer-in-charge
Government Dispensary
BUTURA

32. The Chairman
Jos Teaching Hospital
JOS, Plateau State

33. D.V.O. Ministry of Agric
& Forestry Resources,
AKWANGA, Plateau State

34. D.V.O
Ministry of Agric & Forestry Resources
KEFFI

35. D.V.O.
Ministry of Agric & Forest Resources
KEFFI

36. D.V.O.
Ministry of Agric & Forestry Resources
PANKSHIN, Plateau State

37. D.V.O.
Ministry of Agric & Forestry Resources
LANGTANG

38. D.V.O.
Ministry of Agric & Forestry Resources
NASSARAWA, Plateau State

39. D.V.O.
Ministry of Agric & Forest Resources
LAFIA

40. D.V.O.
Ministry of Agric & Forest Resources
BAUJA

41. D.V.O.
Ministry of Agric & Forest Resources

42. D.V.O.
Ministry of Agric & Forest Resources
SHENDAM

43. D.V.O.
Ministry of Agric & Forest Resources
WASE

44. D.V.O.
Ministry of Agric & Forest Resources
KANAM

45. The Officer-in-charge
Jos Wildlife Park
Maiango Road, JOS

46. The Officer-in-charge
Jos Zoological Society
Jos

47. The Chief Vet. Res. Officer
Diagnostic & Investigation Division
National Vet. Res. Institute
VOM

48. The Officer-in-charge
Rabies Diagnostic Lab.
National Vet. Res. Institute
VOM

PLATEAU STATE HEALTH SERVICES MANAGEMENT BOARD

Ref: No. HSMB/SEC/1118/Vol.11/545

3rd March, 1982

The Medical Superintendent i/c
All General Hospitals
Plateau State

The Officers i/c
All Health Centres
Plateau State

LETTER OF INTRODUCTION

This is to introduce to you the bearer Dr. A.E.J. Okoh, Chief Veterinary Research Officer, National Veterinary Research Institute, Vom who sought the Board's approval to carry out a research project on the study of Epidemiology and public health significance of Rabies in Plateau State which is to last from January, 1982 to December, 1983.

2. In view of the above, you are hereby requested to give the team your maximum co-operation to enable the project to be successful.

3. Please return the letter to him after reading through to enable him show the next Medical Supt. or the next officer i/c of the other Health Institution in the State.

Signed
Supen, P.
for: Executive Secretary

MAFR/VET/DI 5-21/1/182

Ministry of Animal & F/Resources
Private Mail Bag 2183
Jos

1st February, 1982

The Divisional Veterinary Officer
Ministry of Animal & F/Rources
Veterinary Division

Jos, Pankshin, Langtang, Shendam,

Akwanga, Keffi, Nassarawa

The Project Manager
L.I.B.C. Buturo

The Project Manager
Heipang Cattle Ranch, Heipang

The Project Manager
Wase Cattle Ranch, Wase

The Wildlife Officer
Jos Wildlife Park
Jos

STUDY OF EPIDEMIOLOGY AND PUBLIC HEALTH SIGNIFICANCE OF RABIES IN PLATEAU STATE FROM JANUARY 1982 TO DECEMBER 1983

The National Veterinary Research Institute, Vom in conjunction with the Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria is coordinating a study of the epidemiology and public health significance of rabies in Plateau State of Nigeria.

2. The object of the study is to identify human, dog and environmental determinants of Rabies in Plateau State with a view of finding realistic and effective rabies control or eradicative measures based on the study. Aspects of the study will include dog census, study of the Plateau inhabitants (in urban and rural set-up); attitudes to dog-ownership; rabies prevalence and vaccination patterns in dogs and human beings from 1970 to 1980; and the incidence from 1981 to 1983 of dog bites in hospitals (Private, Mission, Govt.) to be examined. Dr. A. E. J. Okoh, Chief Veterinary Officer from Vom will soon be visiting your veterinary clinics in connection with the above project.

3. You are, therefore, requested to allow him access to all your existing records on rabies. There will be questionnaires given to you by the above officer for completion.

4. You are to give him your maximum co-operation.

Signed
Dr. A. G. Anono .
for: Permanent Secretary

copy to:
The Director
National Veterinary Research Institute
Vom

Above for your information and follow-up; reference your letter No. TRD/RES/VOL.1/48 of 29th December, 1981.

(Sgd) Dr. A. G. Anono
for: Permanent Secretary

THE WISTAR INSTITUTE
THIRTY SIXTH STREET AT SPRUCE
PHILADELPHIA P.A. 19104

September 3, 1982

Dr. A. E. J. Okoh
National Veterinary Research Institute
Diagnostic and Investigation Division
P. O. Box 160
Vom, Nigeria
West Africa

Dear Dr. Okoh

I read your letter of July 13th with great interest and I share your opinion that it is a good time to take a serious look at the rabies situation in your country, particularly the possibility of identifying different strains of rabies and rabies related viruses.

We are well prepared to become involved in such a project using the newly developed technology of monoclonal antibodies. This work would be divided into two phases.

First, you will have to collect a large number of virus strains (up to 50) from different animal species and of wide geographical origin. The material should be either original brains from infected animals or the first mouse brain passage. This collection of virus strains will be sent (in dry ice), or better yet hand-carried by you, to Wistar.

In the second phase, the strains will be characterized using monoclonal antibodies against the nucleocapsid and glycoprotein antigens and by the cross-protection test. This could take from six months up to a year.

We are ready to accept you in our laboratory for this period of time and provide you with the necessary materials, reagents and animals. We are not able however, to cover your travel expenses and salary, which should be provided by your government or other sources. Your appointment will have to be approved by the Staff Council of the Wistar Institute, so please provide me with your curriculum vitae, list of publications, and at least two references from people familiar with your work.

We will obtain and send to you the official US Importation Permit necessary for introducing the infectious material in the USA, Prior to your departure you will have to be immunised against rabies.

This project can be initiated as soon as possible. I am looking forward to collaborating with you.

Yours sincerely,

Signed
Tadeusz J. Wiktor, D.V.M.

AHMADU BELLO UNIVERSITY
FACULTY OF VETERINARY MEDICINE

DEPARTMENT OF PATHOLOGY AND MICROBIOLOGY

Zaria Kaduna State
Nigeria

11th October, 1982

The Director
National Veterinary Research Institute
Vom,
Plateau State

Dear Sir:

RABIES RESEARCH TECHNIQUE ATTACHMENT

Dr. A. E. J. Okoh is required to study the different strains of rabies virus isolated in Nigeria as a part of his Ph.D work. This will entail the use of such techniques as DNA probing and Monoclonal antibody technology which are not available in Nigeria at present.

Wistar Institute, Philadelphia and Centres for Disease Control, Atlanta, Georgia, are excellent places to undertake their study. Staff in these two places are presently working in this area. As World Health Organization (WHO) reference centres they accept scholars from all over the world provided these scholars are supported by their home governments.

This study will involve the passage of virus isolates in mice, the preparation of antibodies among others. It is expected that the work can be completed in 9 months to 1 year.

I recommend that the study be started as soon as possible preferably by January 1983.

...2"

I hope that arrangements will be made for Dr. Okoh to carry out this study. It will be be the first important attempt to differentiate the different strains of rabies in Nigeria.

Thank you for your cooperation.

Yours sincerely,

Signed
C. O. Njoku
Professor and Head of Dept.

cc: Dr. J. U. Umoh
Major Adviser

WISTAR INSTITUTE

THIRTY SIXTH STREE AT SPRUCE PHILADELPHIA P.A. 19104

March 28, 1983

Dr. A. Okoh
Diagnostic and Investigation Division
P. O. Box 160
Vom via Jos
Nigeria
WEST AFRICA

Dear Dr. Okoh,

I am sending you the USD Permit for Importation into the USA of rabies virus strains.

The permit is for 20 strains, but I believe that this number is not limitative and you can bring with you any number you wish.

Sincerely yours,

Signed
Tadeusz J. Wiktor

T.JW/Sks
Enclosure

Appendix 5

FORM: A

PROSPECTIVE STUDY FORM - ANIMAL (DOG)
PLATEAU STATE

RABIES CASE RECORD BITING ANIMAL

(To be filled out by Veterinary Services for every case of rabies and bite case involving animals)

Date _____

Biting Animal Case No. _____

Name and address of owner _____

_____

_____

State Kind of Animal _____
(e.g. Dog, Cat etc)

Description:

Breed _____ Age _____ Sex _____ Size ____

Number of times Dog has 1 bitten other people past year _____

Is dog Vaccinated against rabies? _____
Type of Vaccine _____ Date _____

Do you possess the Current dog license?
( ) Yes ( ) No

Does your dog involve in fighting other dogs frequently
( ) Yes ( ) No ( ) Don't know

Circumstance of bite accidental or provoked ( )
unprovoked ( ) Don't know ( )

Where is the dog under observation ( ) killed
( ) escaped ( ) Don't know

Did owner witness bite incident Yes ( ) No ( )

Outcome of the observed dog during _____ days

(Number of days dog quarantined)

Outcome

Signs of rabies ( )

Healthy ( )

If signs of rabies

Results of laboratory

Examination: _____

	Positive	Negative
Negri bodies	( )	( )
Animal inoculation	( )	( )

*Indicate whether (a) Veterinary Clinic (give name & address _____

_____

(b) Owners home _____

or (c) Unknown _____

Died without signs of rabies ( ) Others (flourescent antibody etc) ( )
( )

Animal was quarantined at _____ Date _____

Animal could not be found because _____

Animal was killed/died brain sent to _____
(Name of Laboratory

Date: _____
(Date sent to Laboratory)

Observations of animal, showed no signs of Rabies after 10 days, thus:

( ) Was released from quarantine at _____

Date _____

(Name of Vet Clinic)

Clinical signs appeared on _____ reported to
(Date)

Divisional Health Office (or name appropriate office)

_____

Animal died of Rabies, confirmed by laboratory on

_____ Date _____

Name of Laboratory where confirmed _____

_____

Signature of Veterinary Officer: _____

Address: _____

Date: _____

PROSECTIVE STUDY FORM - HUMAN BITES
(PLATEAU STATE)

CASE RECORD FOR HUMAN RABIES EXPOSURE

Date: _____

Case No. _____ Referred by _____
(Name of Hospital or Vet. Clinic)

Person bitten TRIBE/RACE _____

Name _____ Date and Time of bite _____

(Morning) (Afternoon) Evening) (Night)

Age: _____ Geographical locality of biting

Episode _____

Sex: _____ Occupation _____

House Address _____ Site(s) of bite on the body

_____ _____

_____ Nature of bite _____

Single ( ) Mild ( )
Multiple ( ) Moderate ( )
Severe ( )

Animal _____ Died of Rabies, confirmed by Lab.
(State kind of animal)

_____
(Name of Lab. where confirmed)

Vicinity of bite

Inside the house ( ) In the neighbourhood* ( )

Inside the compound ( ) The street (or road) in front of the home ( )

Inside the yard ( ) The street (or road) at the back of the home ( )

*(The area within two blocks radius of the home)

Circumstance of Bite (check appropriate answer please)

Bitten while visiting home ( )

Bitten while petting or playing with dog(s) ( )

Bitten while ridding bicycle, motor vehicle, autocycle ( )

Child running while playing ( )

While playing in the field ( )

Playing with chained dog ( )

Feeding dog ( )

Abusing or teasing dog ( )

Separating fighting dogs and cats

Separating fighting dogs ( )

Accidentally stepping or falling on dog ( )

Picking up or holding dog ( )

Helping injured dog ( )

Playing roughly with the dog owner or relation ( )

Picking up pup ( )

Abruptly arousing sleeping dog ( )

Other reasons: _____

_____

Other persons bitten by the same animal, if any ____

_____

(fill separate form for any person bitten by same animal please)

Treatment

Local wound treatment _____
(State the type of treatments)

VACCINE	SERUM
Size or quantity of individual dose ____	Dose _____
Route of administration _____	Date administered _____
Dates administered _____	Source of Serum
Type of vaccine (etc) _____	_____ Results of sensitivity Test* positive ( ) Negative ( )
Manufacturer: _____	Manufacturer: _____
Previous rabies vaccine Treatment? No/Yes	Previous serum treatment? No/Yes
Date _____ Type _____	Date: _____ Type _____

Were there complications of treatment? If so, specify _____

_____

Status of exposured person after 6 months:

Alive ( )
Died of rabies ( ) Date of death _____
Died of other causes ( )
Unknown ( )

Status of other persons bitten by the same animal if known _____

Signature of Medical Officer/Official _____

Address: _____

Date: _____

Appendix 6 (a)

Questions asked the Chief Veterinary Officer Divisional Veterinary Officers (DVO) during oral Interview on their views and experience with rabies and control measures in Plateau State of Nigeria

(1) What type of services does the Veterinary Division under your headship offer Jos Community and the state in general? Specifically how would you classify veterinary service utilization according to type of services you render to dog and cat owners sir?

(2) What is the potential growth of veterinary services for dogs and cats in Jos and its environs?

(3) Is rabies a problem in Plateau State? What statistics do you have for the magnitude and extent of the disease in the State?

(4) What rabies control programm do you have for the state? Is the disease under effective control or do you have any constraint(s) militating against curbing the disease?

(5) Are dogs kept in large numbers by the various communities and tribes of the State? What is the dog population of the state and the state capital? What is your experience on the distribution of dogs in the local government areas?

(6) As part of the national antirabies campaing launched in April 1982, your state conducted various activities towards the control of rabies in Plateau State.

*The Divisional Veterinary Officer (DVO) in-charge of each LGA of Plateau State was asked similar questions only relevant to his area of jurisdiction.

Can you please enumerate the activities your Division carried out towards the national objectives. Was the campaign in the State successful and can you elaborate on the success? What areas do you think are left for improvement for better campaigns in the State in future?

(7) Do you have an animal control agency in Jos if so what role has your ministry/division towards the goals of the body? What constraint(s) if any, do you think militate against the success of the programs of the agency and how have you tackled them? When was the last dog and cat census conducted in Plateau?

(8) How much do you laise with the State Ministry of Health, the State Health Management Board and the law enforcement agencies in a bid to control rabies in the state capital and part of the State? Is the relationship cordial and enhancing solution to the problems of stray dogs rabies or do you have suggestions on possible improvement of the roles played by all the parties concerned so as to have better control of the situation?

(9) Does your Division have statistics of owned and stray dogs for Jos in particular and the other local government headquarters?

(10) The public has often criticised the veterinary services in Plateau State as one of the major quality contributors to the present apparent dog population explosion in Jos. What do you have

to say on this criticism? Do you exonerate the profession from blame?

(11) How have you coped with the problem of too many stray and uncontrolled dogs and other animals in Jos municipality in terms of personnel, equipment and other relevant needs for the successful reduction or control of the terrible situation?

Appendix 6 (b)

Questions* asked the Chief Medical Officer (CMO) and Medical Superintendents (MS) during oral interviews on their views and experience with rabies and control measures in Plateau State of Nigeria

(1) What statistics do you have for Plateau State on human rabies cases, incidence, surveillance data? Do you think rabies is a serious problems in the state Sir?

(2) How many human rabies cases have your hosptials recorded in the State since the creation of states in 1968? Specifically how many actual cases, post-exposure vaccinations and post-vaccinal complications were encountered?

(3) Do you have rabies surveillance receiving centres in the State? What are their roles? Do you think their services adequate? Are there rooms for improvements if so in what areas?

(4) What suggestions would you offer for the alarming dog-bite problems in Jos and other local government headquarters of the State?

(5) What constraints, if any does your department have towards victims? How have you tried to solve them?

(6) What is your relationship with the Veterinary profession and other agencies in efforts to control rampant dog bites and excess dogs in Jos?

*Medical Superintendent (MS) in-charge of each Hospital in Plateau State was asked similar questions only relevant to his area of jurisdiction.

(7) Do you think diagnostic facilities for human rabies in particular adequate and meeting problem? What suggestions do you have for this conspicuous handicap? What do you say to the establishment of a joint rabies diagnostic service for both human and animal specimens in Plateau State?

(8) The public has often criticized the medical services in Plateau State as one of the major quality contributors to the present apparent inadequate provision of anti-rabies vaccines, anti-rabies serum and human rabies immune globulin for exposed persons. They have also criticized the lack of rabies diagnostic facilities in government hospital laboratories and even the Teaching hospital in the State inspite of the numerous cases of human exposure in your State in particular. Do you have any comment on these criticisms?

(9) As part of the national antirabies campaign launched in April 1981 Plateau State conducted various activities towards public awareness and education on rabies and the need for dog control. Can you enumerate specifically what role the Ministry of Health played during the campaign in your State?

(10) What suggestions do you have for more effective remedy for rampant dog bites and other associated environmental problems from an apparent dog population explosion?

(11) Do you agree with a suggestion of creating special health centres for rabies and dog-bite victims? Is it not better to seek World Health Organisation

assistance for some constraints especially in diagnostic facilities training of personnel and supply of better vaccines for the state hospitals?

(12) Thank you very much Sir, for the valuable interview and for giving me your time.

(13) In what ways have you sought public co-operation for and what has been the response of the general public towards controlling an apparent pet population explosion in Jos?

(14) What suggestions do you have for seeking more effective remedies for problems evolving from too many dogs, rampant dog bites and other associated environmental problems in Jos and other local government areas?

(15) In notice you do not appear to have any serious problem with antirabies vaccine for routine prophylatic immunization and rabies campaign in your State. Is my observation right or do you have problem in this regard? Are you meeting the vaccine demand?

(16) Thank you very much Sir for a very valuable interview and for giving me your precious time.

Appendix 7: Clinical and Epidemiological data relating to Animal Cases of Rabies from Plateau and Other areas of Nigeria which Isolates were characterised by Hybridoma Monoclonal Antibodies (MCAs)

Isolate Number	Animal Species	Age	Sex	State/Locality of case	Nature of Exposure if any	Observation Quarantine	Furious/ Dumb Paralytic type	Rabies Vacci- nation	Owned Stray
#1(RD 3783	Dog	6yrs	M	Bendel(B/City)	Intimate contact with two children also bit a man	killed	Furious	None	Owned
# 2(RD205/82)	Dog	Adult	M	Plateau (Barkin Ladi)	Bit a boy visiting dog owner's house	killed	Furious	None	Owned
*# 3(RD208/82)	Dog	Adult	M	Sokoto (State)	Bit a person, dog hunts bats and known to have eaten bats	killed	Furious	None	Owned
# 4(RD216/82)	Dog	Adult	M	Kaduna (Kaduna)	Dog chased another dog into a yard and bit a security worker	killed	Furious	None	Stray
# 5(RD222/82)	Dog	Adult	F	Plateau (Vom)	None	Died in Vet Clinic 13th day in quarantine	Dumb	None	Owned
# 6(RD236/82	Dog	Adult	M	Plateau (Jos)	Bit two dogs (catchers (wardens)	killed	Apparently healthy	None	Stray
# 7(RD192/82	Dog	Adult	F	Benue (Oju)	Bit a woman while visiting owner's house	killed	Apparently healthy	None	Owned

**Positive Rabies originally but was not viable at Wistar

Appendix 7 continued

Isolate Number	Animal Species	Age	Sex	State/Locality	Nature of Exposure if any	Observation/ Quarantine if any	Furious/ Dumb Paralytic	Rabies Vacci-	Owned/ Stray
#3(RD11/82	Cat	Adult	M	Plateau (Jos)	Scratched owner	killed	Furious	None	Owned
# 9(RD104/83	Dog	2years	M	Plateau (Pankshin)	Unprovoked bite	killed	Furious bit two dogs in other person's house	None	Owned
#10(RD10/83)	Cat	Adult	F	Plateau (Jos	Bit owner	killed	Furious	None	Owned
# 11(RD105/83)	Dog	Adult	M	Plateau (Barkin Ladi	Bit a 4 years-old boy on the face	killed	Apparently healthy	None	Owned
# 12(RD106/83)	Dog	Adult	M	Dendel (B/City)	Bit a woman and a child	killed	Furious	None	Owned
# 13(RD195/82)	Dog	Adult	M	Plateau (Vwang)	Bit two children on provocation	killed	Apparently healthy	None	Owned
# 14(RD32/83)	Dog	Adult	M	Plateau (Ex-land (Barkin Ladi)	Bit a woman visitint owner's compound	killed	Apparently healthy	None	Owned
# 15(RD200/82)	Dog	Adult	M	Plateau (Panyam)	Bit a boy	killed	Furious	None	Stray

* Originally known to be negative but used as control

** Positive Rabies originally but not viable at Wistar

Appendix 7 continued

Isolate Number	Animal Species	Age	Sex	State/Locality	Nature of Exposure	Observation/ Quarantine if any	Furious/ Dumb Paralytic type	Rabies Vacci-nation	Owned/ Stray
16(RD111/83)	Dog	Adult	F	Plateau (Vom)	Nine	Died in Quarantine in Vom Vet Clinic	Furious (Attempted) Biting people	None	Owned
17(RD49/83)	Dog	Adult	M	Plateau (Akwanga)	Bit two children without provocation	killed	Furious	None	Stray
18(RD248/82)	Dog	Adult	F	Plateau (Wamba Akwanga)	Bit a lady	killed	Furious	None	Owned
19(RD125/83)	Dog	Puppy	M	Plateau (Du via (Bukuru)	Bit six persons at a stretch	Euthanised in Vom Vet. Clinic at owner's request	Furious	None	Owned
20(RD251/82)	Dog	Puppy	M	Benue ((Makurdi)	Bit owner and three members of his family	killed	Furious	None	Owned
21(RD234/82)	Dog	Adult	M	Niger (Kutugi)	Roaming village bit a dog, goat and a small child	killed	Furious	None	Stray

Appendix 7 continued

Isolate Number	Animal Species	Age	Sex	State/Locality of case	Nature of Exposure if any	Observation/ Quarantine if any	Furious/ Dumb Paralytic type	Rabies Vaccination	Owned/ Stray
/22(RD101/83)	Dog	Adult	F	Plateau (Vom)	None	Quarantine and died in Vet. Clinic Vom	Dumb	Vaccinated at 3 months age on 10/3/83	Owned
/23(RDIX/83)	Monkey	Adult	F	Plateau (Jos) Zoo)	None	Died in Zoo	Not	None stated	Owned
/24(RD120/83)	Dog	Adult	M	Plateau (Zawan)	Bit four children while playing	killed	Furious	None	Stray
25(RD110/83)	Dog	Adult	M	Plateau (Vom)	None	Died in a bush after 5 days agony	Dumb	Vaccinated	Owned
/26(RD207/82)	Dog	Adult	F	Plateau (Jos)	Wondered into a compound bit a girl and a man	killed	Furious	None	Stray
27(RD193/82)	Dog	Adult	F	Kaduna (Kafanchan)	Bit a person	killed	Furious	None	Stray

*Original brain known to be rabies negative.

ppendix 7 continued

solate umber	Animal Species	Age	Sex	State/Locality of case	Nature of Exposure if any	Observation/ Quarantine if any	Furious/ Dumb Paralytic type	Rabies Vacci- nation	Owned/ Stray
18(RD244/82)	Dog	Adult	F	Bendel (B/City)	None the dog was bitten by another dog previously	Died in Vet Clinic B/City	Dumb(Para- lysis of lower jaw, handling tongue and salivation)	None	Owned
19(RD216/81)	Dog	Adult	F	Plateau(Jos)	Bit a person	Killed	Furious	None	Owned
20(RD119/83)	Dog	Adult	M	Bendel (B/City)	Bit a person	killed	Furious	None	Stray
21(RD231/82)	Dog	2yrs	M	Plateau (Nassarawa)	Bit 3 persons and a dog. Dog reportedly bitten by another dog previously	killed	Furious	None	Owned
22(RD93/83)	Monkey	Adult	F	Plateau (Jos)	Bit a person	killed	Furious	None	Owned
23(RD90/83)	Dog	Adult	M	Plateau (Kuru)	Dog being treated for piroplasmosis and convulsion at Vom Clinic, changed temper- ament and bit owner's wife.	Died in clinic Quarantine on 8th day of observa- tion	Furious	None	Owned

Appendix 7 continued

Isolate Number	Animal Species	Age	Sex	State/Locality of case	Nature of Exposure if any	Observation/ Quarantine if any	Furious/ Dumb Paralytic type	Rabies Vacci-nation	Owned/ Stray
34(RD213/82)	Dog	Adult	M	Niger (Kontagora)	None	Died in Vet Clinic Minna	Dumb(Mouth open as if there is foreign body in throat)	None	Owned
35(RD227/82)	Dog	Adult	F	Plateau (Rukuba)	Bit a person	killed	Furious	None	Owned
36(RD243/82)	Dog	Adult	M	Bendel (B/City)	None	Died in Quarantine	Dumb (Paralysis of lower jaw and hanging tongue)	None	Owned
37(RD43/83)	Dog	Adult	M	Plateau (Vom)	None	Died in Quarantine in Vom Clinic	Furious	None	Owned
38(RD157/82)	Dog	Adult	M	Plateau (Vom)	Bit other dog and a sheep and attempted biting people	killed	Furious	vacci-nated	Owned
39(RD241/82)	Cat	Adult	M	Bendel(Warri)	Fought with a stray dog before becoming sick	Died in owner's house	Dumb	None	Owned

Appendix 7 continued

	Isolate Number	Animal Species	Age	Sex	State/Locality of case	Nature of Exposure if any	Observation/ Quarantine if any	Furious Dumb Paralytic type	Rabies vaccination	Owned/ Stray
#	40(RD250/82)	Dog	Adult	M	Gongola (Yola)	Bit a woman an adult dog and three puppies	killed	Furious	None	Stray
#	41(RD12/83)	Dog	Adult	M	Plateau (Zawan)	Bit a man and a child	killed	Furious	None	Owned
#	42(RD203/82)	Dog	Adult	M	Gongola (Garkida)	Bit a child	Died in Yola Vet. Clinic	Furious	None	Stray
#	43(RD240/82)	Dog	Adult	M	Bendel (B/City)	Bit a person	killed	Furious	None	Stray
#	44(RD232/82)	Dog	Adult	F	Plateau (Jos)	None	killed	Furious	None	Owned
#	45(RD15/83)	Dog	6yrs	M	Bendel (B/City)	Bit other dogs entered a yard and bit a man	killed	Furious	None	Owned
#	46(RD223/82)	Dog	Adult	M	Plateau (Chugi)	Wandered into the victims' house and bit him unprovoked	killed	Furious	None	Owned

Appendix 8: Distribution of Characterised Rabies Virus Isolates by States, Nigeria

State	Animal Species	# of Brain sample	# Recovered by Tissue Culture	# of Samples with adequate infectivity for NC characterisation	# of Samples with adequate titres for GP characterization
Plateau	Dog	27	27	27	27
	Cat	2	0	-	-
	Goat	1	1	1	1
	Others	2	-	-	-
Bendel	Dog	5	5	5	5
	Cat	1	1	1	1
Benue	Dog	1	1	1	1
Gongola	Dog	2	2	2	2
Kaduna	Dog	2	2	2	2
Niger	Dog	2	2	2	2
Sokoto	Dog	1	0	0	0
Total Samples		46	41	41	41

*Include 2 monkey brains from Jos Zoo suspected rabid

NC = Nucleocapsid Test; GP = Glycoprotein Test

28 from Plateau State

13 from other Areas of Nigeria.

Appendix 9: Recovery of strains in Neuroblastoma (NA) Cell cultures

	Sample Number	1st split		2nd split		3rd split		4th split	
	MCA	502-2	422-5	502-2	422-5	502-2	422-5	502-2	422-5
1.	RD.37/83	100	0	100	0	100	0		
2.	RD.205/82	80	0	100	0				
3.	RD.208/82	0	0	0	0	0	0	Eliminated	
4.	RD.216/82	80	0	100	0				
5.	RD.222/82	80	0	100	0	100			
6.	RD.236/82	80	0	100	0	100	0		
7.	RD192/82	40	0	80	0	100	0		
8.	RD.11/83	0	0	0	0	0	0		
9.	RD104/83	1	0	20	0	100	0		
10.	RD.10/83	0	0	0	0	0	0	Eliminated	
11.	RD.105/83	100	0	100	0	100	0		
12.	RD.106/83	100	0	100	0				
13.	RD.195/82	100	0	100	0				
14.	RD.32/83	40	0	80	0	100	0		
15.	RD.200/82	20	0	80	0	100	0		
16.	RD.111/83	100	0	100	0	100	0		
17.	RD.49/83	80	0	100	0	100	0		
18.	RD.248/82	20	0	80	0	100	0		
19.	RD.125/83	80	0	100	0	100	0		
20.	RD.251/83	20	0	80	0	100	0		
21.	RD.234/82	20	0	20	0	30	0	100	0
22.	RD.101/83	80	00	100	0	100	0		
23.	RD.xx/83	0	0	0	0	0	0	Eliminated	
24.	RD.120/83	100	0	100	0	100	0		
25.	RD.110/83	80	0	100	0	100	0		
26.	RD.207/82	40	0	100	0	100	0		
27.	RD.193/82	40	0	100	0	100	0		
28.	RD.244/82	5	0	20	0	100	0		
29.	RD.216/81	5	0	20	0	100	0	100	0
30.	RD.119/83	20	0	80	0	100	0		

Appendix 9 continued

	Sample Number	1st split		2nd split		3rd split		4th split	
	MCA	502-2	422-5	502-2	422-5	502-2	422-5	502-2	422-5
31.	RD.231/82	80	0	100	0	100	0		
32.	RD.93/83	0	0	0	0	0	0	Eliminated	
33.	RD.90/83	100	0	100	0	100	0		
34.	RD. 213/82	1	0	20	0	100	0		
35.	RD.227/82	80	0	100	0	100	0		
36.	RD.43/83	5	0	20	0	100	0		
37.	RD.43/83	20	0	100	0	100	0		
38.	RD.157/82	5	0	20	0	100	0		
39.	RD.241/82	10	0	10	0	20	0	100	0
40.	RD.250/82	20	0	80	0	100	0		
41.	RD.12/83	80	0	100	0	100	0		
42.	RD.203/82	80	0	100	0	100	0		
43.	RD.240/82	80	0	100	0	100	0		
44.	RD.232/82	80	0	100	0	100	0		
45.	RD.15/83	100	0	100	0				
46.	RD.223/82	20	0	80	0	100	0		

*Percent of cells with positive FA staining using MCA 502-2 (rabies and rabies-related viruses) and 422-5 (rabies-related viruses only).

Appendix 10

Table A: The Members of the Lyssa Genus of the Rhabdoviridae and their Geographical Distribution

Virus	Species from which virus has been isolated	Geographical Distribution
Rabies*	Many Warm-Blooded animals	Worldwide
Lagos bat*	Bats	Nigeria, Central African Republic South Africa
Mokola*	Man, Shrews, dogs, cats	Nigeria, Cameroons, Zimbabwe
Duvenhage	Man, rats	South Africa, Germany

Source: World Health Organization 1 Rab. Res. 177* (1982)

*Viruses occur in Nigeria

Appendix 10

Table B: Specificity Determination for Rabies Virus Hybridoma Antibodies

Definition of Antibody Specificity	Testing Procedure										
	RIA	Immunolysis	Infected Cells Immunofluorescence			Virions	Viral Components RIA				
			Live	Staining Acetone Fixed	Formalin Fixed	Neutralization (PFU $\log_{10}$)	N	G	NS	cr	M
Anti-N	+	-	-	INC	INC	-	+	+	-		?
Anti-G	+	+	ME	ME	ME	+	+	-	+		?
						(4.0)					
Anti-NS	+	-	-	-	INC	-	+	-	-		?
Anti-M	+	+	ME	ME	ME	(1.3-1.7)	+	-	-		?

Note: INC = Cytoplasmic Inclusions
ME = Membrane of Infected cells
N = Nucleocapsid
G = Glycoprotein
NS = Nonstructural protein
M = Matrix Protein

Source: Wiktor, 1980

Appendix 10

Table C: Classification of Nucleocapsid Hybridomas

Hybridomas Immunizing	Number in the Group	Representative	Rabies CVS ERA Kelev Flury-LEP	Flury HEP	Mokolo	Lagos Bat	Davenhage	Hybridoma* group
ERA		950-2						
CVS	11		+	+	-	-	-	A
Kelev								
Kelev	1	510	+	+	-	-	+	B
Kelev	1	502-2	+	+	+	+	+	C
ERA	3	104-7	+	-	+	+	+	D
CVS	2	222-9	+	-	+	+	-	E
Kelev	1	237-3	+	-	+	-	-	F
Kelev	1	389	+	-	-	+	+	G
Mokola	1	422-5	-	-	+	+	+	H

SOURCE: Flamand et al., 1980

*These groups were established on the basis of various cross reactivities.

NOTE: + = Positive in binding assay; - = no detectable binding.

Appendix 10

Table D: Differential diagnosis of members of the Lyssavirus group by FA staining with nucleocapsid hybridoma antibodies

Viruses		FA staining with hybridoma antibodies*						
		Basic panel			Confirmatory panel			
Group	Strains	502-3	103-7	422-5	377-7	222-9	237-3	389
Rabies	Street and fixed	+	+	-	+	+	+	+
	CVS-11	+	+	-	-	+	+	+
	HEP	+	+	-	+	-	-	-
Rabies-related	Duvenhage	+	-	+	-	-	-	+
	Lagos bat	+	-	+	-	+	-	+
	Mokola	+	-	+	-	+	+	-

Source: Wiktor et al; 1980

Appendix 10

Table E: Immunoreactivity of Antiglycoprotein Hybridoma Antibodies Against Rabies and Rabies-Related Viruses*

Hybridoma		Rabies				Rabies-Related				Hybridoma Group
Origin	No.	CVS	PM	ERA	HEP	Kelev	DUV	LAG	MOK	
Kelev	502-2	x	+	x	+	+	x	x	x	
	523-1	+	+	+	+	+	x	x	x	I
ERA	120-61	x	+	+	+	+	x	x	-	II
ERA	110-10	x	+	+	+	+	x	-	-	
	176	x	+	+	+	+	x	-	-	
Kelev	507-1	+	+	+	+	+	x	-	-	
	509-6	+	+	+	+	+	x	-	-	III
	528-2	x	+	+	+	+	x	-	-	
AF	613-2	+	+	+	+	+	-	-	-	
ERA	193-9	x	+	+	+	+	-	-	-	
Kelev	503	+	+	+	+	+	-	-	-	IV
	522-3	x	+	x	+	+	-	-	-	
CVS	231-22	+	+	+	+	-	-	-	-	V
ERA	194-2	+	+	+	-	-	x	-	-	VI
ERA	101-1	+	-	+	+	-	-	-	-	VII
	162	+	-	+	+	-	-	-	-	
CVS	248-9	+	+	+	-	-	-	-	-	VIII
Kelev	514-2	-	-	-	+	+	x	-	-	IX
Kelev	504-1	-	-	-	+	+	-	-	-	X
ERA	127-5	-	-	+	-	+	-	-	-	XI

Appendix 10: Table E continued

Hybridoma		Rabies		Rabies-related					Hybridoma Group
Origin	No.	CVS	PM	ERA	HEP	Kelev	DUV	LAG	MOK	
CVS	220-8	+	-	-	-	-	-	-	-	XII
	240	+	-	-	-	-	-	-	-	
Kelev	359-2	-	-	-	-	+	-	-	-	XIII
	508-9	-	-	-	-	+	-	-	-	
Mokola	419-1	-	-	-	-	-	-	-	-	XIV

Note: + = Positive results in RIA and in neutralization test

x = Positive results in RIA and negative results in neutralization test

\- = No binding in RIA

AF = Street virus, all other rabies strains are fixed viruses

DUV = Duvenhage; LAG - Lagos Bat; MOK - Mokola

Source: Flamand et al., 1980b

Appendix 11

RABIES

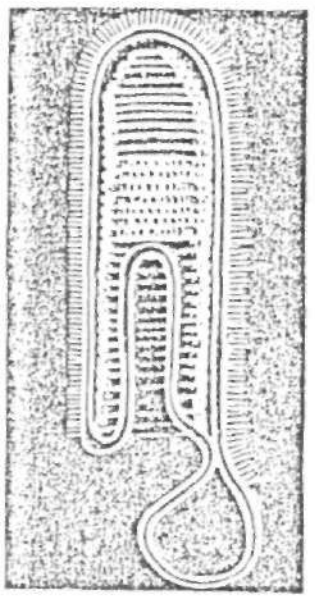


Fig. 3. Diagram of structure of rabies virus

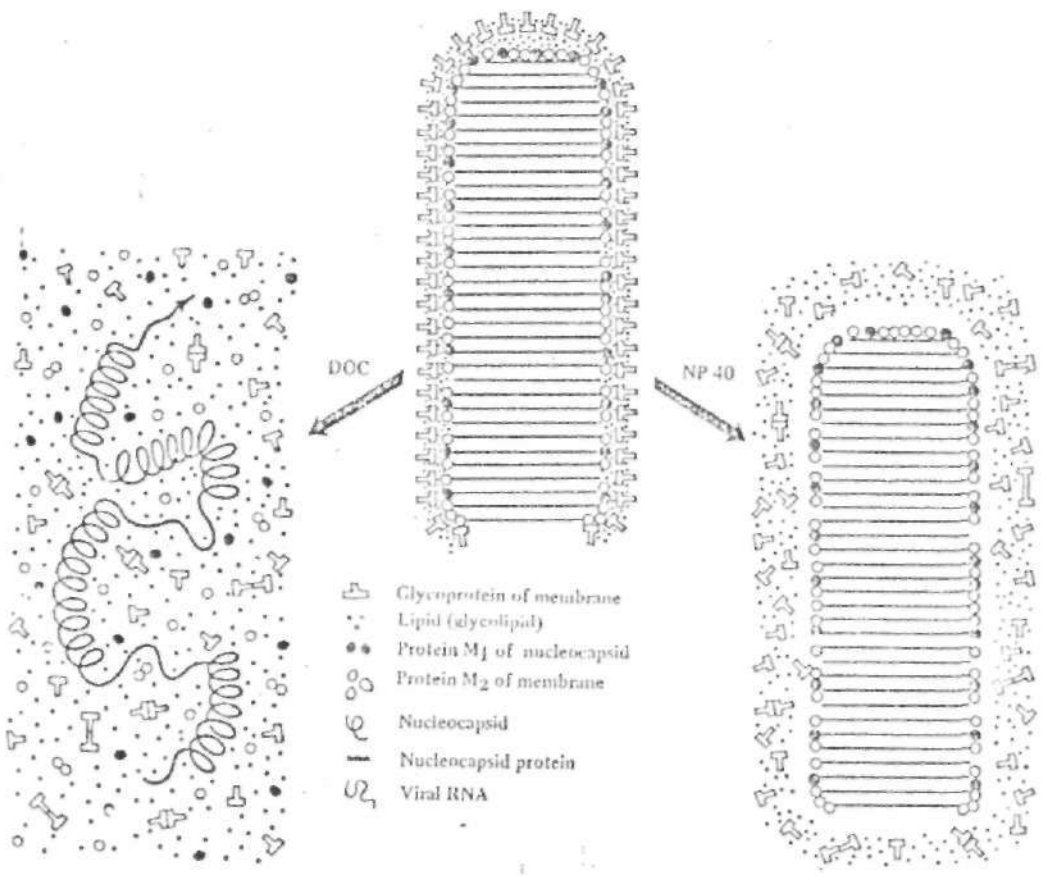


Fig. 4. Chemical structure of rabies virus disrupted by deterdents (Sokol, 1975)