

Dogs and Dog Control in Developing Countries

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CHAPTER

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Introduction

Of all the mammals with which humans have a close relationship, the domestic dog (*Canis familiaris*) has the longest association with man. The bond is believed to have begun some ten to twelve thousand years B.C. in Eurasia (World Health Organization [WHO] 1990) as wolves learned to follow the encampments of man to secure easy food. A degree of mutual acceptance developed between the two species, with each gaining something from the association. Mankind gained protection from having the animals around its camps and, probably, some assistance in hunting activities. Dogs gained a degree of protection from the human groups and from a ready and constant source of food arising from human hunting and other human waste, including excrement. Individual animals were then selected by man for their bidable character, and the ancestors of the current dogs were born.

Few human societies today do not have a relationship with dogs. Man-dog relationships are almost as numerous as the varieties of human society (World Health Organization 1990). In many cultures in Africa, in Zimbabwe and Kenya, for example, dogs are val-

ued for the protection they afford to both men and livestock from human intruders and wild animals (Butler and Bingham 2000). In some cultures in western Africa and in southeast Asia, dogs are valued as a source of protein in the human diet. In Polynesia the two enjoy a complex relationship, as dogs can be seen as food, gifts, and offerings. In many cultures dogs are associated with the forces of the supernatural, either divine or demonic. Some religions consider dogs to be unclean in a spiritual sense, for example, Islam (Beck 2000). However, in some predominantly Muslim countries, such as Tunisia in North Africa, dogs are seen in a positive light. In contrast, Hindu, Jain, and Buddhist cultures, such as in India and Nepal, teach a “no kill” philosophy (yet are among the societies where the greatest levels of destruction of unwanted dogs are prevalent) (WHO 1990). In some developing countries, pet dogs are kept far more for social status than for companionship. Throughout much of the developing world, dogs are essential to the management of domestic waste, especially in areas of higher human population density, such as big towns and cities.

Dogs’ activities in these areas are widely thought to keep the populations of other less desirable creatures, such as rats, mice, and cockroaches, under control.

Even among very similar societies the relationship with dogs may vary. In a number of European cultures, there is no word that readily corresponds to the English word “pet.” The relationship between urban Americans and their pet dogs is different—if not in type, then in magnitude—from that seen among most of the dog-owning public in the United Kingdom. Within the United Kingdom, the relationship between many country folk and their dogs is very different from that of urban-dwelling people and their dogs.

The relationship between a community and its dogs is not always entirely positive, and many cultures identify similar problems associated with having dogs in their midst. For example, in South Africa, the Soweto community identified the problems caused by dogs as road accidents, barking and fighting, biting children and killing livestock, and uncontrolled fecal contamination (Beck 2000). Such problems exist in many cultures, throughout the developed and developing worlds.

It is against this background of a wide range of man-dog relationships that dogs in the developing world must be seen and understood. Knowledge about and understanding of the complexity of the relationships between dogs and local people is essential to any attempts to regulate the human-dog relationship officially and to control any problems caused by dogs.

Given the wide range of relationships between societies and the dogs associated with them, it is not surprising that the structures of canine population vary considerably too. Various attempts to classify the canine population have been made. These classifications all use the degree of dependence on and supervision by man. Beck, based in the United States, has identified three types of dogs seen: pets who never roam without supervision; pets who stray or roam; and ownerless animals who are free to roam (Matter and Daniels 2000). WHO recommends a four-point classification system (1990):

Restricted dogs, who are fully restricted or supervised and fully dependent on man for food and other resources;

Family dogs, who are semirestricted (and thus roam for part of the time) and fully dependent on one or more families for food and shelter;

Neighborhood dogs, who are either semirestricted or entirely free to roam and who are only semidependent on one or more families for food and shelter;

Feral dogs, who live wholly unrestricted lives and do not depend at all for food deliberately given by any person or group.

As a survival strategy in developing countries, neighborhood dogs in urban areas often behave the same as well-socialized pet dogs and are thus often indistinguishable from owned-but-straying dogs (Matter and Daniels 2000). In many Western societies, the stray dog population comes almost

entirely from abandoned pets and often bears a striking resemblance to identifiable breeds. However, in developing countries, most of the stray dog population, whether neighborhood dogs or feral dogs, is much more uniform in conformation and appearance (Matter and Daniels 2000).

The proportion of the dog population that is owned varies considerably throughout the world. In Chad a maximum of 10.6 percent of the total dog population is considered "ownerless," while in Sri Lanka the figure is over 19 percent (Kayali et al. 2003). In Hong Kong 75 percent of the stray dog population is considered to arise from abandoned pet dogs (Dahmer, Coman, and Robinson 2000). Between 5 and 15 percent of the dog population in Tunisia was considered "stray." In much of Africa, many owned dogs are never restricted and stray freely: 78 percent of owned dogs in Nigeria and 54 percent in Zambia (Beck 2000). In Nepal and Indonesia, up to 70 percent of the dog population is associated with more than one household (WHO 1988).

The population density of dogs varies considerably throughout the world, too, although the figures arrived at are often little more than guesses. The figures given for the dog-to-man ratio vary from 1:3.5 in rural Tunisia, to 1:4.5 in the communal lands of Zimbabwe, to 1:8 in Sri Lanka and 1:16 in urban Zimbabwe (WHO 1988; Butler and Bingham 2000). Among the factors that contribute to this large variation are the socioeconomic class of the community, land type and use, and the degree of urbanization. Generally, dog population density rises as the human population rises (Butler and Bingham 2000).

These few figures show that throughout much of the developing world, a large population of dogs roams freely throughout the human community and is able to

breed in an uncontrolled manner. It is these animals who are largely responsible for the various nuisances identified with human-dog association mentioned earlier. In addition to problems associated with noise, ordure, and aggression, much of the developing world is afflicted by zoonotic diseases that these free-roaming dogs are, in part, responsible for spreading. Estimates vary between sixty and one hundred for the number of diseases that may be transferred from dogs to man; however, many of these are somewhat esoteric and rare or theoretical in nature.

Zoonotic Diseases Spread by Dogs

A few diseases stand out as the main zoonoses associated with dogs: rabies, echinococcosis, and toxocariasis.

Rabies

Rabies is a viral disease of all mammals, including man. It is often said that rabies is 100 percent fatal but 100 percent preventable by vaccination. This is slightly misleading, since the disease is only 100 percent fatal once patients become symptomatic (Briggs 2002). Rabies has been recognized as a disease for perhaps five thousand years, and the relationship between a rabid animal's bite and a new case has also been known for a very long time. The disease is untreatable but preventable by either pre-exposure prophylactic vaccination or, because of the long incubation period, by post-exposure vaccination with concomitant administration of passive immunity through rabies immunoglobulins. In developing countries dog bites are the cause of the vast majority of human rabies cases. In India over 90 percent of human cases were caused by exposure to a rabid dog (WHO 1988). Although only twelfth on WHO's list of causes of mortality,

rabies has a special place in societies where it is endemic because of the well-known and ghastly symptoms that accompany the disease. Official estimates put the total number of rabies cases worldwide as twenty-five to thirty thousand human deaths *per annum* (Kayali et al. 2003). There is considerable evidence that these figures may be underestimates, with work from Tanzania suggesting that the underestimation may be by a factor of between ten and one hundred (Cleaveland et al. 2002). Of these human rabies deaths, the largest number occurs in south Asia, most notably in India, though, curiously, recent work in India suggests that the number of human cases in that country may have been overestimated. Because of the close affinity between children and young dogs, most of the human cases are in young people (Wright 1991; Sharma, Kumar, and Chawla 2002). WHO states that 45 percent of rabies cases occur in children under fifteen years of age. Most of these cases are males, probably due to the bolder, more adventurous play of boys and youths, and most of the cases from the developing world occur among the socially disadvantaged. This partly explains the underreporting of cases and the low priority attached to rabies in most developing countries.

Echinococcosis

This is a disease caused by intermediate forms of the canine cestode worms *Echinococcus granulosus* and *E. multilocularis*. Dogs are infected with these parasites by eating hydatid cysts found in the offal of many mammals, including common ruminants. The ingested forms attach to villi and develop in the dog's small intestine. On maturity the worms produce eggs, typically thirty-four to fifty-eight days following ingestion by the dog. Eggs are produced for at least eighty days and in enormous numbers. *Echinococcus* eggs are passed

in the dog's feces and then dispersed over considerable distances in the environment, where they are ingested by intermediate hosts such as sheep, goats, and other animals. When people ingest *echinococcus* eggs they become at risk of developing echinococcosis, which is the development of hydatid cysts in humans, commonly in the liver or lungs but also, and more seriously, in the brain (Macpherson and Craig 2000). The free-roaming dog population is at greatest risk of becoming infected, and this is especially true in areas where poor slaughterhouse hygiene is normal. In many cultures in the developing world, across much of North Africa, the Levant (the region of the eastern end of the Mediterranean Sea), and into south Asia, dogs are the principle method of disposing of unwanted offal from many small-scale, often unofficial, slaughterhouses. Education of slaughterhouse workers is often very poor, since they typically come from the most downtrodden and oppressed sections of society, and thus the risks associated with poor work practices are not appreciated (Hammond and Sewell 1990). Home slaughter of stock for consumption is also a common factor, since community dogs are likely to be given the unwanted offal. Some tribal peoples, especially in Kenya and Sudan, are particularly at risk of echinococcosis because of cultural practices that encourage very close associations between dogs and food preparation practices. There is also no veterinary care available to these people or their animals, so worm burdens in dogs remain high. Women of these tribes are at increased risk, because they are mainly involved in food preparation and disposal. Infection rates in dogs can be very high, ranging from less than 1 percent of dogs infected in Pretoria, South Africa, to 50 percent and 60 percent in Kenya, Sudan, and Tanzania. Similar high infestation rates among

dogs are seen in China. In Kathmandu, Nepal, 5.7 percent of free-roaming dogs near slaughterhouses were infected, as were a smaller percentage in the rest of the city. In Uruguay 13.2 percent of the dog population was infected, and the infection was attributed to poor slaughterhouse practice (Macpherson and Craig 2000).

Toxocariasis

This is a disease caused by exposure to an environment contaminated by canine feces. *Toxocara canis* is a common roundworm (nematode) of dogs (Overgrauuw and van Knapen 2000). Adult worms live freely in the lumen of the guts of dogs, where they feed off intestinal contents. They produce large numbers of eggs, which are shed in the feces. The eggs are not immediately infectious and must undergo development over several weeks or months in the environment before becoming infectious. (The time taken for development depends on environmental conditions.) Upon ingestion of contaminated soil or oral contact with soil-exposed hands, the larvae hatch and migrate via the bloodstream throughout the body as visceral larval migrans. In young dogs they migrate from the lungs up the trachea and into the gut, where they develop to maturity. In non-target species, such as humans, however, the larvae remain as larvae in the various body tissues, where they survive for long periods but do not develop further. Dogs with a *Toxocara* infestation are not themselves infectious because of the period of larval development in the environment that is needed. Nursing bitches and young pups pose a risk, however, as pups can acquire infection from their dam's milk. Migrating *Toxocara* larvae pose a health risk to young children. Although a number of disease entities are recognized as a result of infection with *Toxocara* larvae, the most serious and best

known is the ocular larva migrans form of the disease, where larvae, often many years after their ingestion, cause damage to the retina of the eye. This can result in loss of visual acuity and even blindness. Although the disease is generally considered in developed countries as a risk to children who play in playgrounds contaminated with dog feces, it clearly poses a risk to children in developing countries where high numbers of free-roaming dogs defecate freely throughout the environment and where infant and child hygiene has not reached the obsessive levels seen in some developed countries.

Control Issues in the Developing World

While figures for the incidence of echinococcosis and toxocariasis are not readily available, and those for rabies fatalities are subject to considerable error from poor reporting procedures in developing countries, it is obvious that large populations of poorly regulated dogs pose a risk to the health of the human population. Coupled with the types of problems associated with free-roaming dogs reported in Soweto, South Africa, there is a strong case for introducing some means of dog control in most developing countries. The success of such control measures depends heavily on an understanding of the dog ecology and the nature of the dog-human bond in the locale under consideration. Lack of appreciation of these issues is, I believe, one of the main reasons why efforts to control free-roaming dogs in developing countries so often fail.

In many developing countries, efforts to control the often large populations of free-roaming dogs typically focus on mass removal of dogs. In most cases, in south Asian countries, this is done by killing the

dogs found on the streets. In many cases these campaigns do not discriminate between the owned-but-roaming-unsupervised animals and neighborhood dogs in an area. Consequently, there is often considerable antagonism between the government functionaries charged with collecting dogs and the population at large, particularly where, as in much of south Asia, there is a general religious (Hindu, Buddhist, and Jain) sentiment against killing animals. Societies often become very polarized, with some sections strongly advocating the removal of all dogs from the streets and other groups arguing equally forcefully to abandon the culling policies.

Many of the methods civic authorities use to remove dogs are less than satisfactory when viewed from an animal welfare perspective. The government employees charged with the task are often from the least-educated, socially deprived, and oppressed sections of society. In northern India, for example, only Dalits of the lowest caste, Harijan, will catch dogs. These poorly educated people are poorly trained and poorly supervised, since few higher officials in the government service want to be associated either with the Harijan dogcatchers or with the act of dog catching itself. The methods used to remove dogs vary. In some places, such as Kathmandu and, formerly, in Jaipur, it is done by indiscriminate use of poison, the most commonly used of which is strychnine. Not only does such poisoning risk poisoning other creatures, including children, but also few poisons are humane in action. (Strychnine, which causes respiratory arrest through paralysis of the respiratory muscles, for example, is clearly distressing to the poisoned animal.) Indiscriminate distribution of poison also has the environmental disadvantage of dead and dying animals left throughout the environment who must be removed.

In many places where poisoning is not used, dogs are caught and

removed to some central facility to be killed. The techniques used for catching are often far from humane themselves. In India, where there is some of the most thorough animal welfare legislation in the world, the method laid down by law involves catching the free-roaming dog in a large sack (Prevention of Cruelty [Capture of Animals] Rules 1979). This method, which is used in the Jaipur animal birth control (ABC) program, has been examined by many veterinary surgeons and welfare activists and adjudged humane by all except one animal welfare group, which could provide no justification for its opinion. However, in much of the developing world, even where laws do exist, they are poorly enforced, and such is the case with dogcatching in India. Most municipal dogcatchers use other methods that are contrary to the provisions of the animal welfare legislation. This can include using long iron tongs, similar to very large fire tongs, with which the animals are grabbed by whichever part of their anatomy presents itself. This can often lead to penetrating injuries of soft tissues. In other cases the animals are lassoed variously with chains or ropes often held on poles. This method is favored in Hong Kong and throughout much of India. It is also the method advocated by the group referred to earlier that objected to the sack method. Catching dogs by nooses often results in partial or complete loss of consciousness due to cerebral anoxia through occlusion of the carotid and other arteries to the brain.

Having restrained the dog, no matter how poorly, the dogcatcher must then move the animal into a suitable vehicle for transport to central depots. With the sack method of catching, this is done by carrying the dog to the vehicle in the sack and then emptying the sack into the vehicle. With the tongs method, the dog is lifted up by the tongs and put in the vehicle. To make this process easier, the

tail or a hind leg is often held by an assistant, and the animal is stretched to reduce struggling. With nooses and chains, the catcher will whirl the animal around his head on the end of the noose before releasing it, airborne, into the catching vehicle. Some catching teams carry truncheons with which to beat the animal if the dog attempts to bite during the catching process.

Once in the vehicle, animals may be held for many hours, even days, usually without food or water. In some cities in India, it is the practice to fill a caged vehicle until no more dogs can be stuffed in. In such cases some animals have to stand on dogs beneath them. Once returned to the central depot, these dogs may be electrocuted, gassed, or drowned. In a method documented in the city of Vishakhapatnam, the caged dogs were doused with water and the metal cage connected to the electrical supply to electrocute the animals en masse. In India, the electrical current is often variable in supply, and due to overcrowding, many animals are not in contact with the metal fabric of the cage. Thus, this method of electrocution was far from efficient, with some animals taking many minutes before expiring. Those who were not killed in the ordeal were clubbed to death.

It is unfortunate, given the considerable effort and the very serious welfare implications for the dogs concerned, that it is now well recognized that mass removal of dogs will not work as a means of controlling the population or the spread of diseases such as rabies. As long ago as 1988, WHO "strongly insisted that administrators obtain proof that elimination has a significant positive impact on rabies' endemicity and/or epidemiology before deciding to continue dog removal" (WHO 1988). The evidence for this statement is fairly clear throughout the devel-

oping world. In Delhi a concerted effort at dog removal killed a third of straying dogs with no reduction in the dog population (Blue Cross of Hyderabad/Animal Welfare Board of India 2000). In Hong Kong approximately twenty thousand dogs were killed by the government and another thirteen thousand by welfare organizations every year, in an operation that has been described as "annual harvesting," similar to that practiced in wild animal control in Africa, with little impact on the free-roaming dog population (Dahmer, Coman, and Robinson 2000). In Ecuador the elimination of 12–25 percent of the dog population each year for five years did not reduce the population (WHO 1988). In rural Australia a 76 percent reduction in the free-roaming dog population failed to achieve a lasting reduction in the population, and the number of free-roaming dogs returned to precull levels within one year (Beck 2000). In Kathmandu street dogs have been poisoned for at least 50 years with little long-term effect on the population. In Chennai (formerly Madras), India, the municipal authorities' dog-culling program had been in operation for 120 years yet is still required because of the dog problem (Blue Cross of Hyderabad/Animal Welfare Board of India 2000). Dog-removal programs do not control the dog population, or the various diseases and nuisances associated with dogs, because of their high reproductive potential and the continuing presence of an empty biological niche with unexploited resources. More puppies are born to the surviving animals, and more of them survive, and more dogs migrate into the area recently rendered dog-free. Dog removal may indeed be counterproductive when considered from a rabies-control perspective. The spread of rabies among the dog population is encouraged by high population turnover (Blancou 1988; Beran 1991). Rabies is also

overrepresented in young animals. Thus, by removing dogs, the rate of population turnover and the proportion of young animals are increased. Both lead to conditions that encourage rabies transmission. Many areas endemic for rabies already have high rates of dog population turnover and high proportions of young dogs in the population (Daniels and Bekoff 1989). In Tunisia 30–35 percent of the population is replaced each year. In Mexico 38 percent of the dog population is between three and twelve months of age (Beck 2000). In West Bengal, India, only a third of pups survive one year (Beck 2000). In Zimbabwe's communal lands, 71.8 percent of dogs die in their first year, and pup mortality is estimated at 52.6 percent in the first month of life (Butler and Bingham 2000). The causes of young dogs' deaths is not fully known and will vary from culture to culture but will include distemper and parvovirus infection; road and other accidents; active culling by man in some countries, particularly of female pups; fights; and starvation. Although the reproductive potential of dogs is high generally, it may not be as high in all environments as some workers have assumed. Figures from Jaipur show that breeding of street dogs in that city follows a unipolar seasonal pattern as is seen in many wild canids, but which is not considered normal for *Canis familiaris*. In Jaipur there is a very marked breeding season in autumn (Chawla and Reece 2002). Clearly, being receptive to breeding only once a year reduces the reproductive potential of the species. Anecdotal evidence, however, suggests these findings may not apply throughout the subcontinent, emphasizing the need for knowledge of the local ecology of the free-roaming dog population in any control program.

Despite the considerable mass of evidence and the advice of WHO, many municipal authorities in India

and elsewhere in the developing world continue to chose the removal option over other alternatives of dog or rabies control. In part this is because of the lack of understanding and awareness of the issues involved. In part it is also because transient politicians and officials feel under pressure to act—and to be seen to act—when dog problems are drawn to their attention, as they frequently are, particularly by the better-educated and more influential members of society.

Not every attempt to remove dogs ends in their killing. Recently in Jodhpur in Rajasthan a removal program was begun which included keeping the dogs in pounds. This has also been attempted in Turkey. As a means of controlling the free-roaming dog population, this has not worked for the same reasons that killing the removed dogs does not work. Furthermore, keeping large numbers of dogs in pounds is expensive and difficult to do if the animals' welfare is taken into account. Diseases tend to spread more rapidly among large groups of dogs and establishing a social order within such groups results in fighting and injuries. The number of dogs found in the typical city in a developing country also precludes this approach. One Indian city, Hyderabad, is believed to have a dog-to-man ratio of 1:40 (Blue Cross of Hyderabad/Animal Welfare Board of India 2000), which implies a total dog population of between fifty and one hundred thousand. Jaipur, a city of roughly two million people, has an estimated fifty to sixty thousand dogs. Figures of this magnitude, typical for many cities, make establishing pounds impractical. In some Indian cities, the removed dogs are relocated to the nearest jungle area. This, too, does not control the population and has the added disadvantage of spreading problems associated with free-roaming dogs to other areas, usually with lower human and dog populations.

The relocated dogs can cause severe disruption to livestock in their efforts to find food, which are often unsuccessful and lead to dogs dying of starvation.

In some developing countries, some of the problems caused by street dogs are addressed through mass parental vaccination campaigns in an attempt to eradicate rabies from the cities involved. This method has been used on a truly heroic scale in parts of South America (Largi et al. 1988). A similar scheme was recently piloted successfully in Chad (Kayali et al. 2003). Millions of doses of rabies vaccine have been given annually to free-roaming dogs. This method has worked to control rabies in the areas where it is applied but, of course, does nothing to address the other problems of disease and nuisance caused by a burgeoning street dog population. Recently a modified rabies virus has been incorporated into an oral vaccine preparation for dogs. This should make mass vaccination of large proportions of the free-roaming dog population much easier, which will enable the threshold level required for rabies control to be reached. It is hoped that trials of this vaccine will be allowed by the Indian government shortly to control rabies in this country.

The control efforts, which are advocated by WHO and others, involve a three-part program featuring responsible pet ownership with licensing of pet dogs, sterilization and vaccination of free-roaming dogs, and habitat control (WHO 1990).

Responsible pet ownership requires educating the public in the correct ways to own a pet dog and care for it. It would include such matters as sterilization of animals; appropriate and timely veterinary treatment, including vaccination and anthelmintic administration; and the need to exercise control over pet dogs' activities by, for example, exercising the animal only

on a lead and in an appropriate place. Governments play a role in this with a sensible licensing regime to regulate dog ownership. Licenses can be made less costly for sterilized and vaccinated dogs, thus encouraging these desirable actions. Such a regime of responsible pet ownership would be particularly valuable in many developing countries where the increasingly affluent middle classes have taken to keeping dogs as status or fashion symbols. This trend tends to mean that many people have no knowledge of correct dog care and appropriate social etiquette. In the Western world it is now commonplace for dog owners to be expected to clean up the ordure their charges leave in public places. Municipal laws demand such activity. However, in much of south Asia, especially, such a law would have little chance of success because of deeply ingrained attitudes based on caste and the quasi-religious concept of impurity and pollution that would prohibit much of society from even contemplating handling, even indirectly, their dog's feces. For licensing systems for dogs to be effective, they would need to be enforced and possibly accompanied by the removal, after suitable warnings, of unlicensed animals. This requires considerable municipal investment in identifying licensed dogs and humane removal and kenneling of apparently unlicensed dogs while awaiting confirmation of the animal's status. In much of the developing world, any licensing regime is, in effect, a means of boosting the income of the responsible government enforcers through bribery.

It is generally believed that dogs exist in very few places where they have no referral household or community (WHO 1990). The exception to this is around food markets, slaughterhouses, temples, and roadside restaurants, where sufficient food is available without the active involvement of humans in feeding the dogs. In north India,

however, these conditions are common, and unofficial food sources are freely available to dogs. The availability of resources may be a limiting factor in the size of the free-roaming dog population (Butler and Bingham 2000). It thus follows that, if these resources can be controlled, the free-roaming dog population should also be controlled. In many developing countries, civic infrastructure does not include even basic sanitation and access to indoor, drained lavatories, much less the efficient disposal of household waste. Waste in developing countries has a much higher organic content than that in developed countries because the consumer culture has yet to develop, and very securely wrapped convenience foods do not feature in the typical diet. Many workers concerned with dog ecology in developing countries believe that the success of the dog population depends on the free availability of human waste food and feces, which enables females to maintain the high levels of fecundity required to offset the high mortality rate among pups and young dogs (Butler and Bingham 2000; Dahmer, Coman, and Robinson 2000). In contrast, workers studying in developed countries believe the availability of shelter may be the limiting factor determining dog population size (A.M. Beck, personal communication, June 23, 2004). Experience in India supports the food-availability hypothesis where areas, which are kept clean because they house senior government officials, for example, have very low dog populations. In contrast, areas with no civic amenities—where the population is obliged to put its rubbish out on the streets and where many are obliged to defecate in open spaces—have large dog populations. The amount of shelter available to dogs will be similar in each area or may, indeed, be lower in the dense, unplanned housing typ-

ical of poor areas. What does seem without doubt is that, were governments to make concerted and constant efforts to reduce the availability of food and shelter in the towns and cities of the developing world, the population of free-roaming dogs would be reduced. It has been suggested that, were a civic government to implement suddenly and rigorously such a plan for civic cleanliness and order, there might be a concomitant need to instigate some form of “humane culling” of the dog population. Failure to do so may otherwise result in large numbers of dogs with insufficient food fighting over the remaining resources, migrating to other areas with serious consequences to population stability in the new areas, and ultimately starving to death. A rigorous civic hygiene plan undoubtedly would result in a reduction in the nuisances caused by free-roaming dogs, including those diseases associated with the animals. This would be welcome in the fight against rabies, for example, but would confront animal welfare organizations in these cities with a difficult and unpleasant problem.

The third part of a plan to control free-roaming dog populations as envisaged by WHO is the introduction of sterilization and vaccination of dogs from this population. These plans, as previously mentioned, are known in much of the developing world as animal birth control (ABC) programs and in the Americas as trap-neuter-release (TNR) programs, have been part of WHO policy to control the health problems associated with large dog populations since 1990. There have been ABC programs in India since before this; however, the program in Madras (now Chennai) began in 1964 (Blue Cross of Hyderabad/Animal Welfare Board of India 2000). The concept is now widespread across many developing countries. Unfortunately most programs are conducted with little

financial help from the civic authorities, with animal welfare organizations bearing most of the costs associated with them. Indeed, the motivation behind many ABC programs is driven by animal welfare rather than public health, which does cause some conflict, particularly with those medical doctors whose professional lives involve dog bite clinics that see dozens of bitten people each day. The basic premise behind ABC programs is that captured dogs would be sterilized, vaccinated against rabies, and returned to the exact location whence they came. They would thus maintain their position in the hierarchy of free-roaming dogs, preventing migration and population instability while not contributing to the number of puppies produced. In this way it was hoped that many of the problems with large, unsupervised dog populations would be controlled.

The Jaipur ABC Program

One of the problems with WHO's approach to dog population control was that it seemed counterintuitive. There was little positive evidence to prove that the methods advocated would work, even if it was reasonably well established scientifically that mass removal of dogs would *not* work. In an attempt to correct this situation, an ABC program was established in Jaipur in late 1994 with a view to collecting data on the efficacy of such programs. Initially the Jaipur program was a pilot program. Once the pilot had been completed with results that looked positive, the ABC program was expanded to cover most of the city. Jaipur, the rapidly expanding capital of the desert state of Rajasthan, has a population of about two million people. The methods and results of the Jaipur ABC program are detailed in Anderson et al. (1981).

The Jaipur ABC program has divided the city into areas and further subdivided these using major geographical features as the boundaries. Dogs are caught from one of these areas using the sack method referred to earlier. The location of each dog is recorded as accurately as possible, and the dogs are transported back to the ABC kennels and veterinary operating suite located in an animal welfare nongovernmental organization (NGO)'s premises. The dogs are kenneled individually, given a quick veterinary examination, and registered before being allowed to settle in. In the Jaipur program, approximately 10.3 percent of dogs captured are killed humanely since they are found to be suffering from serious disease or illness or to be temperamentally unsuited to life on the streets among a high-density human population. (The concept of a strict "no kill" policy in the context of a major ABC program is nonviable if only because of the number of animals involved.)

The next day the dogs are fasted and given pre-medication. They are prepared individually for surgery and given anesthetic, antibiotics, and analgesics. All animals are vaccinated against rabies using a modern vaccine that gives three years' immunity. The dogs are marked permanently by removing a notch from the cranial border of the left pinna and a five-digit, alphanumeric, unique tattooed number in the right pinna. The dogs are then sterilized by complete ovariohysterectomy through a right flank incision; males are sterilized by castration through a single pre-scrotal incision. The Jaipur program concentrates on sterilizing female animals since they produce the puppies. Prepubescent male puppies are also castrated. Some programs sterilize all dogs, including adult males. With limited resources available, however, it is hard to see why castration of even

large numbers of male dogs is attempted since the remaining unaltered males will continue to sire pups by every unaltered female available. The limited surgical skill of some veterinary surgeons in some developing countries may account for this policy difference, however, since castration is the easier procedure.

Once the surgical procedure is completed, the animals are returned to their individual kennels to recover. They are examined by veterinary surgeons daily until they are considered to have recovered sufficiently to endure the rigors of life on the streets. At all stages of the ABC program, the dog is accompanied by a registration card to avoid any confusion as to his or her identity and location. Records are maintained of all information deemed relevant so the program can be monitored carefully. The Jaipur program aims to catch unaltered adult male dogs, in addition to the sterilized individuals, so that they may be vaccinated against rabies and so identified by an ear notch and tattoo. The adult males are also returned to their exact location in the city. By vaccinating only these adult dogs, the hierarchy is less disturbed (since the males maintain their own territories), but the percentage of the total dog population that is vaccinated against rabies is increased. Research from rabies-control programs in Europe and elsewhere and epidemiological theory indicate that a certain threshold percentage of vaccinated dogs must be achieved to prevent continuance of the urban rabies cycle (Margawani and Robertson 1995). According to WHO this threshold percentage for rabies is about 70 percent, though exactly how this figure has been derived seems unclear from the literature.

The Jaipur program has attempted to record all manner of data on its effects and on the ecology and behavior of the dog popu-

lation it is trying to control. As of 2004 more than thirty thousand animals had entered the program and more than twenty-four thousand sterilization and vaccination operations had been performed. An additional three thousand animals had been vaccinated against rabies. Population censuses indicate that about 70 percent of the female population had been sterilized and vaccinated. The total population in a smaller representative area of the total area covered by the ABC had declined by 28 percent from its peak. It has been established that dogs in Jaipur breed seasonally (in late autumn) and have an average litter size of 5.62 pups.

The program does not have an active re-vaccination component because the available scientific evidence suggests that street dogs do not usually live long lives (Butler and Bingham 2000; Coyne et al. 2001). The vaccine given confers protection for three years, according to the manufacturer's information, and possibly longer if given, as it is in the program, intramuscularly (Daniels and Bekoff 1989). However, some dogs are recaptured for other reasons or by mistake. From these the Jaipur program has some migration and longevity data. Of recaptured dogs 21.5 percent had traveled less than five hundred meters from the place of original capture and release. Only 15.2 percent of recaptured dogs had survived longer than a thousand days from the date of their original release.

Arguments about animal welfare in developing countries carry little weight with governments and decision makers. However, if the concept of ABC programs, together with the other dog-control measures mentioned, can be shown to have a positive effect on human health, then governments may show greater interest in implementing these control programs, which would improve the animal

welfare situation. To this end the Jaipur ABC program has attempted to collate data on human rabies cases occurring in the city. As with much of the developing world, disease-reporting procedures leave much to be desired. However, figures for human rabies cases from the main state hospital in the city suggest that the number of cases has fallen in the area covered by the ABC program from a pre-ABC peak of ten cases a year to no reported cases in 2001 and 2002. In areas of the city not served by the ABC, the number of cases has risen as the outlying areas develop. The total number of cases seen in the hospital, regardless of the place of origin, has remained approximately static. This would seem to suggest that the program is having an effect on the levels of rabies infection within Jaipur city.

In an attempt to prove that the ABC program benefits the dogs of Jaipur, a study of the incidence rates of the two commonest disease processes of street dogs (e.g., transmissible venereal tumor and parasitic mange) was undertaken from the records maintained by the ABC program. Although subjective assessment of the city's dogs' condition indicates that ABC dogs are in better condition than those who have not been through the ABC program and that dogs in Jaipur are in better condition than those elsewhere, this study failed to indicate any difference in the diseases' incidence rates.

The various results of the Jaipur ABC program indicate that a concerted effort to sterilize and vaccinate free-roaming dogs from the city's streets may indeed stabilize or reduce the dog population and control rabies, the most serious disease associated with dogs.

Armed with data such as these, one would think that the program would be applied throughout the developing world. Unfortunately this has not been the case to date, for a number of reasons. In south

Asia government is extremely bureaucratic and cautious. Dog control does not readily fall within any particular department's sphere of influence: health departments claim that dog control is not their problem, and veterinary departments claim rabies is a human disease. Improvements in civic infrastructure are the responsibility of other departments that have little incentive to be involved in the "degrading" area of waste management when larger development projects such as road and bridge construction are available. In India, Nepal, and Sri Lanka, most of the effort promoting ABC programs as a part of the total control of free-roaming dogs has come from animal welfare organizations. In the case of India this has, until lately, been greatly helped by support from government due to former minister Maneka Gandhi's passionate interest in animal welfare. (India has one of the most advanced government structures in the world for improving animal welfare.) The human health issues have not been emphasized, so ABC programs and their proponents are seen as being "for" dog welfare protection and advancement rather than attempting to help the human population at large. Unfortunately, many organizations undertaking ABC programs in developing countries are somewhat economical with the truth and creative in their accounting procedures, often encouraged in this approach by per capita payments for each dog entering the program. Thus achievements may be on paper only. Opponents of humane dog-control measures or those who remain to be convinced are thus handed plenty of ammunition by examples of where such measures have not achieved what was claimed for them.

It is interesting to note that free-roaming dogs and their associated problems, particularly rabies, were controlled in the United Kingdom

and some European countries in the early part of the twentieth century by a strictly enforced licensing regime, along with stray elimination programs and rigid quarantine procedures and concomitant improvements in civic hygiene. In England, for example, for much of the twentieth century, it cost as much to license ownership of a dog for a year as it did for a man to obtain government permission to take a wife for life! The fact that these measures were successful at controlling free-roaming dogs and rabies emphasizes that control is possible and that control measures must be suitable to the society and situation in which they are applied.

Conclusion

The roles of dogs in developing countries are varied and range from the venerated to the impure, from the tolerated to the loved. In many situations dogs undoubtedly do sterling work for their community as guard dogs, affording protection against a dangerous, uncontrolled world and providing a means by which much human waste is removed from the environment of man (thus suppressing populations of other more pestilential creatures such as rats and cockroaches). Unfortunately dogs' very success at living with and relying on man can create problems for both the dogs and their associated human populations. The dogs suffer from very short life expectancies and high rates of mortality, among the young especially, and these deaths are often unpleasant. The human population is subjected to minor problems by a large free-roaming dog population, including noise and environmental soiling by ordure, and to some major public health issues, such as rabies, from which about thirty thousand people die each year, mainly in developing countries. Some measure of control of the dog population would seem desirable in many of these

countries. The control measures applied and the future development and refinement of the human-dog bond must be in accordance with the local customs, beliefs, and wishes of the human population as well as the ecology of the dog population locally.

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