URBAN WILDLIFE AND COMMUNITY HEALTH: GRAY SQUIRRELS AS ENVIRONMENTAL MONITORS

by
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ABSTRACT

This paper emphasizes the value of urban wildlife as environmental monitors for hazards of public health concern. A comprehensive model, utilizing gray squirrels, (Sciurus carolinensis) *was developed through the collaboration of wildlife biologists and investigators in allied disciplines. This study includes 1) documentation of the diseases and parasites of squirrels which are potentially pathogenic for humans, 2) evaluation of the squirrel as an indicator of radioactive materials, pesticides and heavy metals and 3) baseline information on the biology and physiology of the species.*

For over half a century wildlife biologists have promoted a better understanding of man's role in the world ecosystem by emphasizing the various values of our wildlife resources. Regrettably, in many instances the image projected to the public is that only game animals have any value and then only as a source of recreation for one sector of the human population. In recent years, this image has led to increasing pressure from the non-hunting sector and has prompted governmental agencies to consider other values for all wildlife and to sponsor legislation that provides for the financial support of a broad spectrum of wildlife programs. One non-recreational value of wildlife is their relevancy as environmental monitors for hazards of public health concern (Bigler et al 1975).

In this paper we describe a model utilizing the gray squirrel, *Sciurus carolinensis,* as a monitor of zoonotic diseases and environmental conditions in an urban environment. The one-year cooperative project initiated in January 1974, was designed to 1) document microbes and parasites of the squirrels which are potentially pathogenic for humans 2) evaluate the squirrel as an indicator of pesticides, radioactive materials and heavy metals, and 3) obtain baseline information on the biology and physiology of the species. Detailed results of this study are being published elsewhere. In the present paper we will emphasize the operational design, conduct and workability of this multiagency and multidisciplinary investigation.

The success of this endeavor depended upon the integrity of the following collaborators. E. C. Prather, N. J. Schneider, F. M. Wellings, A. L. Lewis, M. S. Chan, J. A. Tomas, L. E. McEldowny, E. Lassing, E. Buff, J. G. McKinnon, L. Nalley, M. Jefferies, and E. Lewis, Florida Department of Health and Rehabilitative Services; F. H. White and D. L. Forrester of the University of Florida; J. Jenkins and A. Davis, University of Georgia; D. Cooperrider and L. Kuhns, Florida Department of Agriculture and Consumer Services; M. Beljic, Jacksonville Department of Recreation.

STUDY DESIGN

Squirrels were captured alive in cage type traps baited with peanut butter and pecans throughout the city of Jacksonville, Florida. Animals were trapped each month of 1974. There were 36 collection sites (12 each in three areas) with a minimum of five squirrels captured per site (Fig. 1). Three sites were sampled every month, with one site in each of the three areas being selected monthly.

Squirrels were taken to the Health Program Office (HPO), Florida Department of Health and Rehabilitative Services, Jacksonville for processing within 24 hours of their capture. Each individual was immobilized with ketamine hydrochloride and exsanquinated via cardiac puncture. Blood was aliquoted into portions for serology, hematology, serum electrophoresis, blood chemistries, bacterial and viral isolation attempts, and blood parasite studies. Hair and skin scrapings were obtained from the muzzle and body of each squirrel for mycological studies. Urine samples collected from

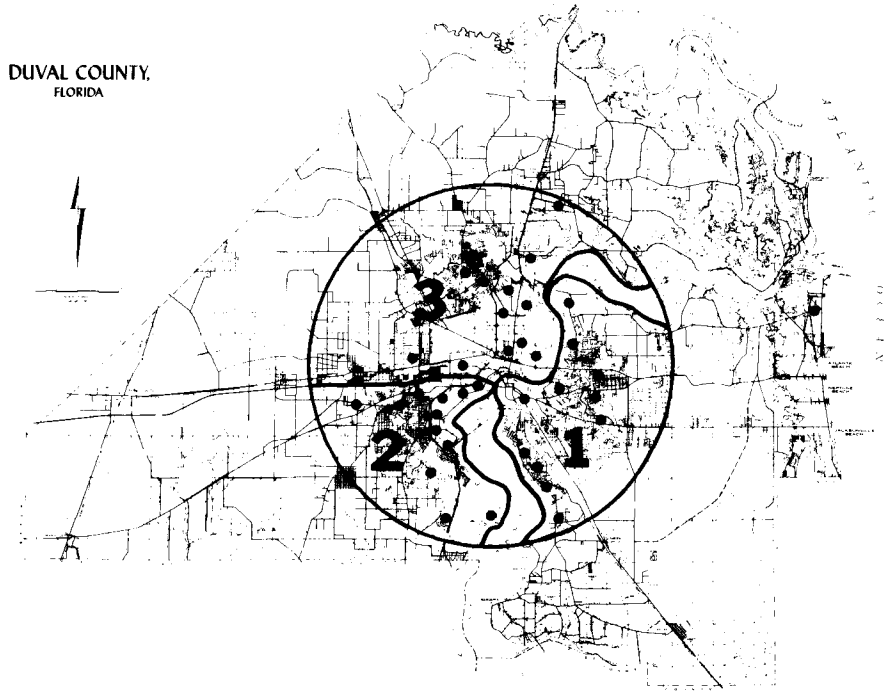

Figure 1. Jacksonville, Duval County, Florida. Circle encompasses the approximately 456 km² study area in the city (2200 km²). Numbers designate sub-divisions of the study area and dots the individual collection sites. Only one collection site was not in the study area.

each squirrel's bladder via needle and syringe were tested for chemical analysis and cultured for leptospires. One kidney was cultured for leptospires, while both kidneys were removed for atomic absorbtion spectrophotometry analysis for concentrations of lead, cadmium and zinc. Small intestines were stripped to obtain fecal samples for enterovirus studies and omental fat samples were collected from selected animals for pesticide analysis. Hair samples were collected for mercury analysis. The brain was removed then halved and quartered with three portions frozen and one formalized. Eye lenses and gonads were preserved in 10% buffered formalin for aging and reproductive studies. The appropriate materials were then shipped to the various collaborators.

The carcass with remaining skin and viscera intact was labeled, wrapped in a plastic bag, and frozen on dry ice for shipment to the University of Florida. Upon arrival specimens of heart, lung, liver, spleen, kidney and brain, swabs of oral cavities and the contents of the large intestines were inoculated into bacteriologic media. Each squirrel captured underwent a thorough examination for ecto and endoparasites. Eviscerated and skinned bodies were then returned to the HPO for transshipment to the University of Georgia for cesium 137 analysis.

RESULTS

Biology

Of the 180 squirrels examined, 73 were males and 107 were females. Using a modification of Fisher and Perry's (1970) eye-lens weight curve for gray squirrels, we determined that

144 (80%) of the squirrels were less than 2 years of age. Preliminary results of reproductive studies indicate that most young are born in January-February and July-August.

Infectious Diseases and Parasites

Mycotic Disease - Cultures of hair-skin scrapings and toenails of 180 squirrels yielded 942 isolates of fungi representing 19 genera (Lewis et al., 1975). Of the isolates, 170 represented recognized human pathogens and 142 squirrel pathogens. Only four species, *Candidia albicans, Microsporum gypseum, Scopulariopsis brevicaulis,* and *Trichophyton mentagrophytes* appear to have great potential for transmission to humans. Even though *T. mentagrophytes* and *Mucor* sp., recognized squirrel pathogens, were recovered from 107 (59%) squirrels, only seven animals had skin lesions attributable to these fungi.

Bacterial, Viral and Rickettsial Disease—Cultural or serologic evidence was not found of infections with tularemia, leptospires, enteric bacteria, rickettsial and chlamydia agents, encephalomyocarditis virus, squirrel fibroma virus, rabies virus or eastern and Venezuelan equine, St. Louis and California encephalitis viruses (White et al., 1975). Mouth swabs revealed alpha-hemolytic *Streptococcus* sp. in 98 percent of the cultures, *Staphylococcus epidermidis* in 92 percent, *Enterobacter* sp. in 39 percent, *Bacillus* sp. in 25 percent, and *Staphylococcus aureus* in 2 percent. Isolation attempts in tissue culture systems yielded 5 isolates of enterovirus similar to human echoviruses.

Parasites—Fleas (*Orchopeas sp.*) were found on most squirrels. Acanthocephalans, strongyloides, tapeworms and pinworms were present in varying degrees. Microfilaria and biting lice were also found. Most squirrels had coccidia with several species represented. Evidence of *Trichinella spiralis,* sarcocystsis and besnoitia infections were not found. Antibodies to toxoplasmosis were not found in any of the squirrel sera examined.

Environmental Pollutants

Heavy Metals—Concentrations of lead and zinc in the kidney of 180 squirrels were determined and found similar for all age groups, however, concentrations of cadmium increased up to two years of age (McKinnon et al., 1976). Values for 12 rural squirrels were significantly lower than those of the urban animals. There were no differences in mean concentrations of the metals when urban squirrels were grouped by the land usage pattern of the sites in which they were captured. Grouping squirrels by human socioeconomic strata for the city revealed that squirrels in low socioeconomic areas have significantly higher levels of lead than those animals residing in middle or high socioeconomic areas. Squirrels were found to reflect accurately increased lead levels in water at a cemetery serviced by lead water pipes.

Hair samples from 90 animals provided baseline information on concentrations of mercury in urban squirrels. While these studies are not yet complete preliminary data suggest that this species may be a very sensitive indicator of mercury in specific urban environs.

Pesticides—Pesticide levels were determined for 22 squirrels. Residue levels were generally low and collections from parks and residential areas were comparable (Nalley et al., 1977). These data would seem to indicate that gray squirrels are probably not sensitive indicators of pesticides.

Cesium-137—Body burdens of cesium-137 were determined for 56 squirrels. Mean concentrations tended to have the same pattern as displayed by raccoons (*Procyon lotor elucus*) collected in North Florida (Bigler et al., 1975). However, some series of squirrels collected in specific habitat types had mean values two to three times greater than the overall mean.

Physiologic Studies

Hematology—The following hematologic values were obtained from all 180 squirrels: Erythrocyte sedimentation rate, packed cell volume, hemoglobin (Hb) concentration, erythrocyte and leukocyte counts, differential leukocyte counts, blood platelet counts, Hb electrophoresis, and erythrocyte fragility (Hoff et al., 1976a). Significant differences were not noted when results were compared by age, sex and month of capture.

Blood and Urinary Chemistries—Uric acid, blood urea nitrogen, glucose, total serum protein, cholesterol, triglyceride, calcium, magnesium, phosphorus, and chloride

concentrations in the blood plus pH, bilirubin, ketone, blood, protein, and glucose levels in the urine were determined when possible (Hoff et al., 1976b). Significant differences were not noted for any of these values when compared by age, sex, breeding status, month of capture or habitat type. Depressed blood glucose and elevated blood urea nitrogen levels were observed in squirrels with shock syndrome.

Serum Protein Electrophoresis—Serum proteins were electrophoretically separated into seven fractions (Chan et al., 1976). The prealbumin fraction showed no significant variation in the percentage for squirrels bled at different times of the year. Immunoelectrophoretic separation also provided information on the heterogenicity of the gray squirrel serum.

DISCUSSION

The significance of studies designed to utilize our wildlife resources as environmental indicators may not be readily apparent. However, we must agree with McCully (1973) that this approach to wildlife research "frequently suggests avenues of research not previously imagined, which . . . may result in benefits for man, his domestic animals and last but not least, the free-living animals."

With proper marketing the concept of utilizing wildlife resources as sensitive biological indicators of changes in environmental quality may gain widespread public acceptance. Even people who are skeptical about the need for wildlife populations should be able to appreciate their value as monitors of diseases and pollutants that affect community health.

Because of people's constant movement throughout their lifetimes, it is very difficult to document the long term effects of many industrial toxicants in urban environments. Recent studies have already shown increased levels of lead in suburban dogs (*Canis domesticus*) (Thomas et al., 1975) and urban rats (*Rattus norvegicus*) (Mouw et al., 1975) and detected particulate matter in the lungs of urban sparrows (*Passer domesticus*) (McArn et al., 1974). We envision that future studies may utilize urban wildlife to evaluate the effects of other airborne pollutants such as increased ozone, nitrogen dioxide, sulfur dioxide, sulfuric acid mist and carbon monoxide levels.

The significance of the results obtained in our study is difficult to ascertain for lack of comparable data. However, we feel our objectives were adequately achieved within our working constraints. We established selected biological and physiological baseline parameters for the population. It was concluded that the squirrels do not constitute a public health hazard in relation to diseases. The effects of the various diseases upon the squirrels themselves, however, need to be examined more critically than was possible in the conduct of this investigation. The squirrels proved to be sensitive indicators of lead in water, cesium-137 and mercury, but not pesticides. It would appear that the squirrel is generally a suitable animal for urban environmental monitoring.

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