In the event other agencies contemplate undertaking a nest tagging system, several factors should be taken into consideration. Most important is the selection of interested personnel for the banding operations. Primarily they must be interested in dove banding and be schooled in the importance of nestling banding and the preparation and record keeping necessary both in the banding and tagging system. In carrying out a banding or tagging program, the nesting areas should be visited at least once every seven days. Our experience indicates that in longer intervals nestlings will hatch and leave as indicated by droppings found in nests. More frequent trips will also eliminate the use of elastic tape on birds that are too young to satisfactorily band. The number of lost tags or nests can be reduced considerably if the tags are securely fastened to the trees in conspicuous locations by use of nylon cord or large-head-roofing nails.

CONCLUSION

In conclusion, the authors feel the cooperative mourning dove nestling banding program is the most important dove study project yet undertaken and will bring out many factors to facilitate management of this species. Not only will the program directly benefit the species under consideration, but it will greatly add support to the cooperative efforts of State and Federal agencies working on a problem important to both.

A PRELIMINARY REPORT FROM THE SOUTHEASTERN COOPERATIVE DEER DISEASE STUDY[1]

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Authoritative sources indicate that shortly following the Civil War a major disease disaster occurred among the deer (*Odocoileus virginianus*) of the southeastern United States. This die-off encompassed a wide area and mortality reached serious proportions. State and Federal files show that similar outbreaks have been occurring in the Southeast since 1890 (Foote, 1955). During the fall of 1949 losses were very high and ninety percent of the entire deer population of one area succumbed to a condition of undetermined origin (Holland, 1957). In September and October of 1955 several eastern states reported that field personnel had observed an abnormally high number of dead deer on certain localized areas (Foote, 1955), and since this time sporadic losses have been recorded from a number of herds (Cannon, 1957). Although the last major deer disease outbreaks in the Southeast were in 1955 (Table I), at present conservationists are concerned with the possible and highly probable reoccurrence of so-called "blue-tongue, black-tongue, hemorrhagic septicemia," or other conditions of undetermined origin.

Many proposals have been offered regarding the reason(s) for each deer die-off; however, it has been seldom that a confirmed laboratory diagnosis was made. This has not been the fault of either the state agencies or the laboratories involved. The greatest single reason for the present dearth of information on deer diseases of the Southeast can be explained in that no one state has been justified in maintaining a full time diagnostic and research service, for the sole purpose of working with deer. This was not economically feasible nor even practical; therefore, most deer disease investigations in this area have been a "hit-and-miss proposition." In considering the numbers of necropsies (P. M.) relative to total deer losses encountered in 1955 (Table I), this past inadequacy becomes more apparent.

In 1949 the U. S. Forest Service and representatives of the Southeastern Association of Game and Fish Commissioners suggested the need for a co-

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operative approach to the problem. In response to suggestions from field personnel in the states affected by unusual deer mortality in 1955, the Deer Disease Subcommittee of the Forest Game Research Committee of the Southeastern Section of the Wildlife Society was formed. The purposes of the meeting were twofold: "(1) to summarize the history of past deer die-offs and past efforts to determine the causative agents; (2) to suggest a fact finding program which could be coordinated with similar work outside the Southeast" (Foote, 1955). From the above meeting and the subsequent efforts of many individuals, the Cooperative Deer Disease Study was formed.

This organization (C.D.D.S.) is supported through cooperative arrangements between the Southeastern Game and Fish Commissioners and the U. S. Fish and Wildlife Service. A brief description of this report, and the activities to date of the organization are discussed.

PART I. ORGANIZATION AND FACILITIES

Through the personal interest and cooperation of specialists in the sciences of nutrition, toxicology, virology, bacteriology, parasitology, mycology, pathology, and ecology, a consultant service is available for the Cooperative Deer Disease Study. This includes authorities in the above sciences, and where indicated these individuals have volunteered their assistance in the actual field work.

In order for a diagnostic laboratory to function effectively it is essential that the personnel maintain proficiency in the standard techniques, and at the same time stay abreast with the newer developments in diagnostic procedures. This phase of the study is accomplished through routine practice with "unknown conditions" of cattle, swine, goats, mink, chinchillas and snakes (thus far). In this way more practical methods are being attained for the preservation of specimens under field conditions, and faster and more accurate procedures are being devised for isolating and identifying the many pathogens. Concurrent studies with various toxic compounds also are being inaugurated.

Paralleling the laboratory aspects of this work a complete literature review on all diseases of deer and related species is being made. These accounts are abstracted and systematically filed (Levine, 1955) for immediate use as future references.

In adjunct to the regional diagnostic service afforded by the C.D.D.S., some basic research projects are being undertaken. These include an anatomical study of the southeastern deer (*O. virginianus*), which will eventually incorporate histological studies of this species. A survey of the intestinal parasites of *O. virginianus* also is in progress, and a screening procedure to determine the incidence of brucellosis and leptospirosis among southeastern deer populations is anticipated.

A fully equipped field laboratory is maintained for this cooperative study, and is within 36 hours travel time from any southeastern district in which an outbreak might occur. Qualified personnel will accompany the unit, which will include a veterinarian trained in deer diseases and a registered medical technologist. The investigators will be prepared to stay in the area as long as it is necessary to obtain sufficient information and materials for confirming a diagnosis. Where it is applicable or possible, control measures will be recommended.

Adequate space and facilities have been allocated as a central location for the C.D.D.S. This includes a private laboratory containing the standard equipment needed for studies of this kind (refrigerator, incubator, centrifuge, microtome, technicon, autoclave, and two binocular microscopes). An air-conditioned animal room also has been assigned to the project and a colony of 90-100 chinchillas is kept for use as experimental subjects. For transmission studies where the deer is needed, a 1½-acre enclosure for these animals has been constructed. Many additional resources of the institution are available when they become necessary.

PART II. ARSENIC POISONING IN WHITE-TAILED DEER

History

On August 14, 1957 the state of Louisiana had estimated a loss of thirty deer within a period of three weeks. The mortality involved Madison, Tensas and Concordia parishes of the eastern Mississippi levee area. Within the next eight days several additional carcasses were found and an enzootic was declared by state officials (Newsom, 1957).

Upon notification the field investigators were dispatched to the area and, upon arrival at Ferriday, Louisiana (District IV Headquarters), arrangements already had been made for a systematic search for sick or dead deer. During this time a survey of the area was made and any history of possible significance to the problem was recorded. In view of the close association between certain environmental factors and the causes of death, the following information is presented in outline form (Wills, 1957):

1. An extremely heavy deer population of approximately 50,000 animals was recorded. As many as 225 deer were observed in one pasture. The cattle population in some regions also was quite high.
2. An estimated two-thirds of the endemic area was in woodland, and there was evidence of a browse line in mid-August and September.
3. Considerable cotton farming in the three parishes was noted. Deer were often seen in cotton fields and in some instances these animals had consumed cotton plants.
4. Studies in 1955-56 showed that the cotton boll weevil (*Anthonomus grandis*) had developed a resistance to the chlorinated hydrocarbons. It was necessary to recommend the arsenical organic phosphate combinations as insecticides in this area (Roussel *et al.*, 1955-56).
5. Cotton was dusted every 4 to 5 days from an airplane, and tricalcium arsenate (60%) in various combinations with methylparathions or nicotine sulfate was used (Jordan, 1957). There were noticeable amounts of cotton dust on the treated plants. Dusting began in early July.
6. Rangers began finding deer carcasses in mid-July. Verification of 43 carcasses was made by local game personnel within the three weeks period of heaviest losses, and total mortality was later estimated at sixty deer. Dead animals were located near water sources and from a few hundred yards to several miles from cultivated fields.
7. Several live deer had been seen by state personnel, and a general description of these animals is summarized as follows:
   (a) lethargic and very weak;
   (b) rough or ragged hair coats with areas of alopecia;
   (c) erratic actions and muscular incoordination;
   (d) manifestations of nervous disorders.

Field Studies

Within a few days after the arrival of the research team, there was substantial evidence that the die-off had subsided. After seven days of field work, only 14 carcasses had been observed, and 13 of these were so badly decomposed that an adequate post mortem examination could not be performed. Fortunately, one adult doe showing obvious signs of illness was captured. The animal died shortly after capture and was transported to a suitable location for necropsy. The case history of this subject is illustrated under the following headings:

Clinical Signs: Two-year old, 115 pound doe in moderate physical condition, showing gross signs of weakness and incoordination. The body temperature after a 250-yard run was 105° F. Excessive salivation. Respirations rapid and labored. Accelerated heart beat. Dilatation of the pupil (eye).

Necropsy Findings: Slight congestion of the cerebral vessels. Hyperplasia of the cardiac musculature. Petecheation of the epiglottis and pharynx. Scattered ecchymosis within the rumenoreticular fold, omasum and abomasum. Moderate enteritis throughout small intestine. Liver slightly granular, with some distention and hyperplasia of the bile duct. Hyperemia of the kidneys and a mild cystitis. The other organs and tissues of the body were normal in appearance. There was no significant parasitism.

From the described deer bacterial and mycotic cultures were made in the field. Tissue specimens were collected for viral and histopathological studies, and the rumenal contents and a portion of the liver were saved for toxicological determinations. Standard procedures were used in collecting and preserving all materials obtained for future inquiry (Gradwohl, 1948).

Laboratory Studies

The specimens were returned to the central laboratory for processing. The procedures employed are briefly outlined in their separable categories.

Virology: At the time of necropsy suspensions of the brain, liver, spleen, kidney and lymph nodes were prepared. A Waring Blender was employed for this purpose and sterile physiological saline was used as a diluent. These suspensions were transferred to sterile screw top test tubes and held at –20° F. At this time duplicate portions of these tissues were placed in 50 percent glycerol-saline solution and refrigerated. These specimens were macerated and filtered through a Setiz filter, and the material was inoculated into chick embryos. Seven days postinoculation no mortality or dwarfing of the embryos had occurred, and further passage of this material was considered unnecessary (Cunningham, 1952).

Bacteriology: As a part of the post mortem procedure whole blood was aspirated under aseptic conditions and tryptose broth contained in the St. Louis type culture bottle was inoculated. Organ inoculations (brain, liver, spleen and kidneys) were made into thioglycollate and tryptose broths. Duplicate cultures were made and one set was incubated under anaerobic conditions. Routine isolation procedures were conducted, and all organisms acquired from the initial cultures were subcultured. Through biochemical methods the isolates from the subject were identified as follows (Breed *et al.*, 1958; Miller, 1952; Smith and Conant, 1952): *Pseudomonas aerugenosa, Aerobacter aerogenes, Paracolobacterium aerogenoides, Micrococcus aureus, Salmonella enteriditis.* After careful consideration these organisms were considered as enteric contaminants.

Mycology: Extracts from the blood, liver and spleen were inoculated on a modified Sabaroud's agar and duplicate cultures were held at 37° C. and 22° C. for a period of six weeks. No growth was obtained on these cultures and the possibilities of systemic mycosis were discarded (Mycology Unit, C.D.C., 1957).

Histopathology: Parts of the brain, lungs, liver, cervical lymph nodes, renal lymph nodes and kidneys were fixed in formalin, sectioned (6 microns) and stained by Mayer's hematoxylin and eosin procedure (Guyer, 1953). These tissues were thoroughly examined for pathological processes, and the liver and kidneys were found to show significant alterations. Pronounced degenerative changes were observed in the liver cells and there was some evidence of zonal necrosis. The vessels of the glomeruli of the kidneys were dilated and swollen, and the renal tubules showed varying degrees of edema and degeneration. There was an absence of leucocytic infiltration into either organ, which strongly suggested that the disease entity was not associated with an infectious agent. The histopathological studies on this deer were indicative of poisoning (Sikes, 1957).

Toxicology: At the time of necropsy an aliquot (1000 ml.) of rumenal ingesta and a portion of liver were obtained for toxicological studies. The ingesta was found to give a positive Reinsch test for the presence of a heavy metal, which was later confirmed by the Gutzeit test as being an arsenical compound (Sippel, 1957). The concentration of arsenic in the rumenal contents was determined to be .088 mgm./100 ml. ingesta; the concentration of arsenic in the liver was slightly less than 5 p.p.m. (Cox, 1957).

Diagnosis

The doe examined and necropsied was suffering from chronic arsenical poisoning. At the rate of arsenic consumption indicated by analysis of the ingesta and liver tissue, this deer would have lived only a few more days had she not been captured.

Discussion

Since the ancient Greeks and Romans, arsenic has been the favorite tool of the professional poisoners, and many of the "famous murders in history" have been accomplished by the continued administration of small doses of these compounds (Boyd, 1950). Arsenic has little taste, and when "used skillfully," the symptoms of poisoning could be made to develop insidiously and to simulate disease (Goodman and Gilman, 1955).

Arsenic poisoning in humans is still prevalent. Medicaments containing arsenic frequently give rise to symptoms of poisoning due to the cumulative action of the compound, and chronic arsenic poisoning often results from exposure to certain paints, dyes, cosmetics and insecticides. At higher doses an acute form of arsenic poisoning occurs, and death usually follows within 24 hours (Goodman and Gilman, 1955).

Arsenic is apparently as toxic to domestic animals as it is for men. Many reports are on record where serious losses of livestock have occurred from both the chronic and acute forms of the metal poisoning (Harkins and Swain, 1908; Kinsley, 1929; Pollock, 1929; White, 1929; Siebold, 1957). In 1954 the Michigan Department of Conservation conducted controlled experiments to determine the toxicity of various "arsenic debarkers" for deer, and in these studies the toxic potentials of arsenic were found to closely parallel those of cattle and sheep (Switzenberg, 1954-55).

The fatal dose of arsenic varies widely with the purity of the preparation, and there is considerable evidence to show that these compounds are active only in the trivalent form. It is thought that the body reduces pentavalent arsenicals to the trivalent form before an effect is exerted on the physiology of the animal (Goodman and Gilman, 1955). The acute LD_{50} of the trivalent arsenical has been reported at 10 mgm/kg. body weight, thus providing a concentration of 10 to 15 p.p.m. in the liver tissue (McGirr, 1956). This would indicate that a much lower tissue concentration would be expected from the chronic type poisoning. With reference to the deer under consideration, it should be reiterated that this animal was "carrying" slightly less than 5 p.p.m. arsenic in the liver tissue. The rumenal contents also showed a relatively high concentration of the metal, and all clinical signs associated with this case were indicative of heavy metal poisoning. Necropsy and histo-pathological studies further confirmed the diagnosis (Boyd, 1950; Anderson, 1953).

Conclusion

After an analysis of the ecology and history of the area in which the deer mortality occurred, it seems plausable to assume that the entity was associated with the cotton dusting procedures being employed at that time. Although more subjects would have been ideal for study, the single deer necropsied offers substantial evidence that the "Louisiana deer die-off" (July-August, 1957) was due to arsenical poisoning.

It is suggested that the deer population (Madison, Tensas and Concordia parishes, Louisiana) be reduced to a level whereby the animals are not forced to rely upon cotton as a means of obtaining nutrition. Although the recent die-off was inconsequential, unless a balance is established between total deer population and carrying capacity, serious trouble from other conditions can be anticipated.

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TABLE I

SOUTHEASTERN DEER MORTALITY (Foote, 1955)

Year	*State*	*Location*	*No.*	*Estimated Total Loss*	*Diagnosis*	*Remarks*
1955	Alabama	Oakmulgee Forest	4	..	undetermined	No P. M.
1955	Alabama	Choccohocco Forest	5	..	undetermined	.....
1955	Arkansas	Ozark National Park	26	500–1000	indefinite	5 P. M.
1955	Georgia	Chattahoochee	81	..	caustic poison	3 P. M.
1955	Georgia	Piedmont	10	..	undetermined	No P. M.
1955	Louisiana	Madison Parish	several	..	liver flukes	1 P. M.
1955	N. Carolina	Uhwarrie and Proximity	18	25	undetermined	.....
1955	N. Carolina	Pisgah	124	3–500	indefinite	1 P. M.
1955	S. Carolina	Berkeley County	10	12 plus	liver flukes	1 P. M.
1955	Tennessee	Polk County	71	..	caustic poison	2 P. M.