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BEHAVIOR OF WHITE-TAILED DEER
AND
FACTORS AFFECTING SOCIAL ORGANIZATION OF THE SPECIES

by
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A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Wildlife Management
School of Natural Resources
The University of Michigan
1962

Committee:

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ACKNOWLEDGMENTS

I wish to express my appreciation to Professors Archibald B. Cowan, George S. Hunt, and Warren W. Chase for their assistance throughout the course of the study and in the preparation of this manuscript.

My thanks are extended also to Dr. Francis C. Evans and members of the Edwin S. George Reserve Committee for placing the facilities of the Reserve at my disposal. The Committee also provided financial assistance in the form of Edwin S. George Reserve Scholarships during the summers of 1961 and 1962.

Special thanks are due to Mr. and Mrs. Richard J. McNeil for their many helpful observations and suggestions, and for their assistance in marking deer. Several graduate students in the Departments of Wildlife Management and Zoology also aided in capturing and marking deer.

The Game Division, Michigan Department of Conservation, provided trapping, handling, and marking equipment.

My sincerest appreciation is extended to my wife, Jane, for her unfaltering assistance and encouragement.

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INTRODUCTION

The study of the behavior of an animal is an important cognate to the study of population dynamics and to management of the species; and it provides a more complete knowledge of the animal's natural history.

This report is primarily concerned with the behavioral relationships between does and fawns of the white-tailed deer (Odocoileus virginianus borealis Miller) and the processes which bring about the social organization of the species. The information was obtained primarily from observations of deer in wild habitat in southern Michigan during the period from June 15, 1961 to October 1, 1962. I have interpreted the observed behavior in terms of the advantages and disadvantages to the individual and to the species.

In many instances, proof of theory is not given, only the observational evidence with my interpretation is presented. Where applicable, comparisons are made of the behavior of white-tailed deer with that of other wild and domestic ungulates.

The scientific names of mammals are according to Palmer (1954), those of birds according to Peterson (1960), and those of plants according to Fernald (1950).

REVIEW OF LITERATURE

Social Organization

The development of social organization in mammals is highly dependent on the interaction between the female of the species and her offspring during parturition and the following few days (Collias, 1956). However, a study of social organization should also include data from birth to maturity because behavior and organization change with the age of the animal. The degree of social organization in mammals covers the span from the highly social black-tailed prairie dog (*Cynomys ludovicianus*) (King, 1955) to the solitary moose (*Alces alces*) (Denniston, 1956). There usually are however, within each species, fluctuations from the predominate type of social organization that are associated with seasonal changes.

Comparative behavior studies lead to the conclusion that the presence or absence of a given type of social behavior affects the type of social organization developed by the species (Scott, 1956). Stated more specifically, the presence of a given behavior pattern determines the type of social organization which may be developed from it.

In many animal species, the general social organization is well known; however the various behavior patterns which, must be developed to attain this organization, are obscured, often by the secretive habits of the animal itself. Such is the case with the white-tailed deer.

Although winter concentrations of white-tailed deer often suggest a herd-like organization, it is the general opinion of most observers that the major organizational unit consists of the adult doe and her offspring (Severinghaus and Cheatum, 1956). Palmer (1951), writing of the semi-tame deer of the Tomhegan Camps in Maine, describes a very strong matriarchal grouping in which an old doe, "Diana" remained the undisputed leader of several generations of her offspring. Other workers (Caton, 1877; Newsom, 1926; Townsend and Smith, 1933; Severinghaus and Cheatum, 1956) indicate that the usual family group comprises a doe and her fawns of two successive years rather than the stronger matriarchal unit that Palmer mentions.

Collias (Kabat, Collias, and Guettinger, 1953) studied the behavior of deer in large groups at winter feeding stations in the Flag deer yard in Bayfield Co., Wisconsin, and reported:

> The most common and consistent type of group was that of a doe and her fawn. We noted 22 such family groups that appeared to be definite and consistent. At least one doe had two fawns with her. The evidence for the existence of doe-fawn groups was the close association of the two, their movements about together, the extreme wariness of the doe and the strong tendency of the fawn to follow her when she fled in alarm.

The significance of the doe-fawn relationship during the winter is illustrated in the following observation from the same study.

> ...., many fawns were <u>not</u> with does. Twenty-two of these lone individuals were identified, which was equal to the number of fawns definitely identified as being with does. Sometimes fawns fed alone at a station, and sometimes they came in with other deer. They did not, however, consistently associate with other individuals. In addition, they were strikingly lacking in alertness. Frequently such fawns would disregard the alarm of older deer and continue feeding after the other deer had gone, and when they joined a group of deer in fleeing the food area, the lone fawns as a rule were the last to leave the food area and the first to return.

With the exception of Palmer's (1951) observations, little information is available concerning the maintenance of family ties during a fawn's second winter. Caton (1877) noted briefly that female fawns accompanied the doe for two years and the male fawns for one year.

Other groupings are observed in white-tailed deer but none is so conspicuous or consistent as the doe-fawn group. During the summer, small groups of two to four bucks are often seen (Townsend and Smith, 1933; Ismond, 1952; Severinghaus and Cheatum, 1956). The maintenance of composition of these groups were ascertained by observing the various shapes and forms of the growing antlers.

Groups of deer in the early autumn may be composed of several does and their fawns, but these may be only temporary (Severinghaus and Cheatum, 1956). As autumn progresses, the rut starts, and these groups will then include one or more bucks; but the consistency of the grouping is loose and erratic because of the variability of the relationship between the does and bucks during the breeding season.

Seton (1927) quotes hunters as having observed large herds of white-tailed deer, with as many as 200 individuals, on the Texas prairies about 1850. Such groupings, if they actually did exist, are perhaps indication of an adaption to open plains habitat, for it is noted that most herd organized ungulates such as the bison (Bison bison), caribou (Rangifer articus), pronghorn (Antilocapra americana), and many of the African species are associated with vast treeless areas.

A comparison of behavior among the Cervidae shows the social organization of the mule deer (Odocoileus hemionus hemionus) (Einerson, 1956), and the Columbian black-tailed deer (Odocoileus hemionus columbianus) (Linsdale and Tomich, 1953; Taber and Dasmann, 1958), to be similar to that of the white-tailed deer. Generally, a family unit consists of a doe and her fawns of the year, and may include her fawns of the previous year. The unit breaks up briefly when the fawns of the year are born. Doe fawns born to the doe two years previously leave to have their own fawns, and the bucks tend to form small, all male groups. The fawns of the previous year may rejoin the doe a few weeks after the fawns of the year are born. There is much antagonism on the part of the doe toward any deer that comes near the young fawns.

Both the mule deer and the coast black-tailed deer may be migratory in some locations (Leopold et al., 1951). The usual trend is a downward movement from higher elevations, to better range, with the approach of winter storms; the reverse is true in the spring. These movements are not organized herd movements, but rather a gradual drifting of deer to a more suitable elevation. Yarding, such as that experienced by the white-tailed deer in its northern ranges, is uncommon.

The social organization of the elk or wapiti (<u>Cervus canadensis</u>) is based on a herd system (Murie, 1951). The cow elk are the leaders of the herd, and the calves are incorporated into the herd at the age of three weeks (Altmann, 1956).

The herd nature of the elk is further exemplified during the breeding season when the mature bulls gather harems of cows. They herd the cows together and defend them until the rut is over or until they no longer are able to protect them from the advances of rival bulls. During the rut, group movements concerned with feeding, protection from weather changes, and escape from disturbance are still initiated by the mature cows. The position of the harem bull is one of dominance, not leadership (Altmann, 1956).

F. Frasier Darling (1937), in one of the foremost descriptions of vertebrate behavior, has discussed the social organization of the red deer (Cervus elaphus) of the Scottish Highlands. The organization is mostly herd-like, similar to that of the North American elk. The mature cow, or hind as it is called, leads the small herds throughout the year; the stags dominate only during the rut. As with the elk, the males express very little leadership.

The behavior of moose (Alces alces) has been studied extensively, and the social organization has been shown to be primarily that of a solitary animal (Peterson, 1955; Denniston, 1956; Altmann, 1958). The moose cow provides intensive protection for her calf, and allows little or no contact between the calf and other moose for the first year of its life, with the exception of association with a bull for a few days during the breeding season. When the next calf is born, the yearling moose may or may not associate with other moose while it is isolated from its dam and her new calf. In many cases, the yearling may remain with the cow and her calf during the yearling's second year.

During the rut the mature bulls dominate the cows and younger bulls, but there is no acquisition of a harem as in the elk and red deer. A bull may stay with an individual cow for 7 to 12 days, usually leaving the cow's calf unmolested (Altmann, 1959).

Winter aggregations of moose are small, and size is usually related to the severity of the weather and the available food supply. The moose are tolerant of each other, but are highly independent and do not respond to stimuli as a herd unit (Denniston, 1956).

The group organization of the roe deer (*Capreolus capreolus*) of the Old World, is oriented mainly around the territorial defense of an area usually no larger than a few hundred acres (Delap, 1957). The grouping consists of a buck, a doe, and the fawn of the year. The yearling deer are driven off when the new fawn is born, and are frequently seen wandering extensively in search of mates and new territories. Both the buck and the doe defend the territorial ground against other deer.

During the winter, the deer are more tolerant of other roe deer, but this is primarily due to the limited amount of suitable winter habitat.

Classification of Behavior

During the past one hundred years, scientists have described and analyzed the behavior of hundreds of different animal species, and from this information they have developed one basic generalization--the stimulus-response theory (Scott, 1958).

The theory states that a response, which is called behavior, is always initiated by some cause or stimulus. A stimulus can be considered to be a change in the internal or external environment of the animal, and the response is an attempt to adapt to the change. Scott (1958) defines the law of adaptation as a basic biological principal which may be stated thus: "An organism tends to react in ways which are favorable to its existence." Scott further states that adaptation is more than a simple reaction to physical force, and the motion of response is not necessarily the resultant of the physical energy of the stimulus involved. Generally there is a tendency for an organism to respond to only one stimulus at a time. No matter how many stimuli may be operating in the environment, some will be totally disregarded.

The behavior that an animal exhibits at any particular time usually can be classified into one of several types. There are instances of course, when a particular behavior pattern may be included in two or more types simultaneously. Scott (1956, 1958) has listed and defined the following behavior classifications frequently used in descriptive and experimental studies.

Contactual behavior may be defined as simply maintaining bodily contact and, as Allee (1931) has shown, the formation of simple aggregations through behavior of this sort occurs very widely throughout the animal kingdom. The adaptive significance of the behavior may vary a great deal. A group of mammals may huddle together for warmth, whereas a group of paramecia may form because the bodies of their fellows afford protection against unfavorable chemical conditions. This extremely simple type of social behavior affords a possible basis for the evolution of higher types of behavior.

Ingestive behavior is that concerned with the taking of liquids and solids into the digestive tract. It may have an important social significance in animals which feed their young, and becomes highly social in the nursing behavior of mammals.

Epimeletic behavior (Greek: epimeleteon = care giving) is defined as giving care or attention. It has been called maternal behavior but is also found in males in animals like the ostrich which incubates the eggs, and in many other animals where there is bi-parental care of the young.

Et-epimeletic behavior (Greek; aeteo = to beg + epimeletic) pertains to calling or signalling for care or attention. It is often called care-soliciting behavior. The behavior may be vocal as in infant mammals, or simply some sort of movement, as in the larvae of bees and ants. This behavior could be called infantile behavior except that it also occurs in adult animals. In most cases it is used as a substitute for direct adaptation by an individual which is unable to adapt to a situation.

Allelomimetic behavior (Greek; allelo= mutual +

mimetikos = immitative) may be defined as any behavior in which animals do the same thing with some degree of mutual stimulation and consequent coordination. It is developed to a high degree in schools of fishes, flocks of birds, and herds of mammals. It could be called imitative behavior, however, to most people, this implies some degree of learning and the idea of a model and a mimic, neither of which is necessarily involved.

Investigative behavior is the sensory inspection of the surrounding environment. This has been called exploratory behavior in the rat, where the animal actively explores the environment with nose and vibrissae. However, an animal with highly developed eyes merely has to glance around the area without movement of the whole body.

Agonistic behavior (Greek; agonistikos = combatitive) is defined as any behavior associated with conflict or fighting between two individuals. The term fighting behavior was originally used, but it was found that the patterns of behavior involved in escape or passivity were very closely related and could not be included under the narrow term of fighting.

Eliminative behavior is associated with the elimination of urine and feces from the body. Special behavior is rarely seen in aquatic animals, but highly elaborate patterns may be developed in terrestrial species which build nests or lairs. In such forms as the wolf and the pronghorn, it may acquire considerable social significance.

Sexual behavior is that associated with the fertilization process and includes the usual courtship and copulation behavior of animals. It occurs very widely though not universally throughout the animal kingdom and is undoubtedly one of the most primitive forms of social behavior.

Shelter-seeking and escape behavior are self-explanatory terms. It should be noted however, that other types of behavior may enter into the behavior pattern of an animal, before it seeks shelter or escape, such as investigation of the surrounding area or a care-soliciting action.

Many observations of deer behavior which fall into each of the above types are found in the literature. In the discussion of my observations of behavioral relationships between white-tailed does and their fawns, I will include additional information from the literature where it is applicable to the situation.

THE STUDY AREA

The present study was conducted on the University of Michigan's Edwin S. George Reserve, which is under the directorship of the University's Museum of Zoology.

Size and Location

The George Reserve is an 1100 acre tract (Ryal, 1961) of abandoned agricultural land located in the southwestern corner of Livingston County, Michigan. It is situated 3½ miles west of the small community of Pinckney, and is surrounded by agricultural land and state-owned recreational land.

Physiography and Soils

The steeply undulating topography of the Reserve (Figure 1), intermixed with level outwash plains and wet lowlands, is the result of glacial water action (Cantrall, 1943). A large esker extends southwestward from the northeast corner of the area for a distance of about one-half mile, terminating in a large outwash plain which covers much of the center of the Reserve. Numerous kettle-holes that were formed by huge blocks of slow-melting ice are found on the area, and several hills and knolls which may represent kames are prominant features of the Reserve.

Figure 1. Physiographic map of the Edwin S. George Reserve

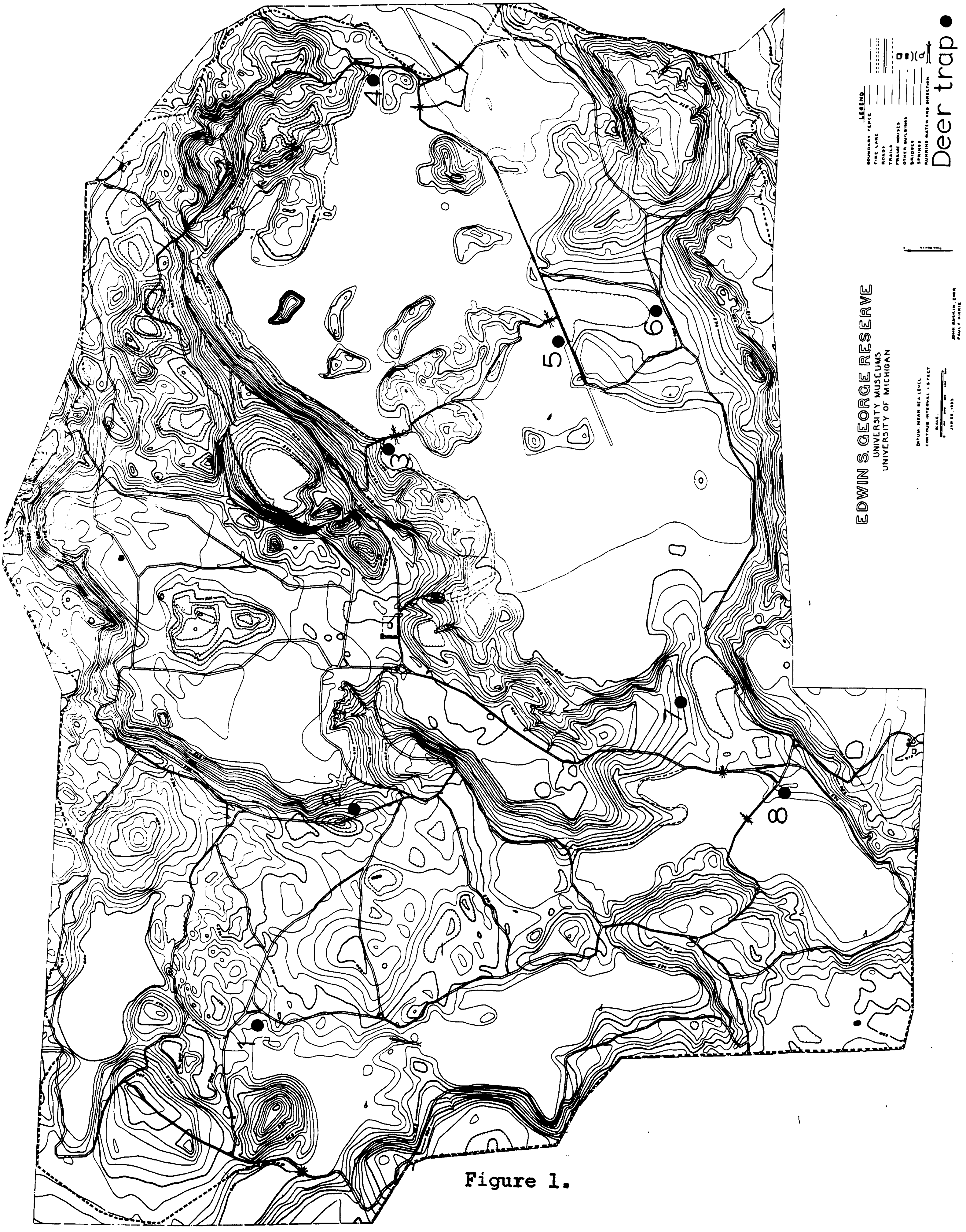
EDWIN S. GEORGE RESERVE
UNIVERSITY MUSEUMS
UNIVERSITY OF MICHIGAN
LEGEND
BOUNDARY FENCE
FIRE LANE
ROADS
TRAILS
FRAME HOUSES
OTHER BUILDINGS
BRIDGES
SPRINGS
RUNNING WATER AND DIRECTION
Deer trap ●
DATUM, MEAN SEA LEVEL
CONTOUR INTERVAL - 5 FEET
SCALE
PAUL F HICKIE
1
2
3
4
5
6
7
8

Figure 1.

The elevation of the Reserve ranges from 885 feet to 1000 feet above mean sea level (Figure 1). Those areas below 900 feet elevation are occupied by marshes and swamps. Other lowlands occur between 900 feet and 925 feet elevation, but these are relatively dry. Much of the undulating topography occurs at elevations between 925 and 975 feet. The outwash plain, the esker ridge, and the summits of some hills are above the 975 foot level.

The extremely variable topography of the Reserve, and the associated cover types, provide sufficient diversity for escape and other deer activities.

There are four small bodies of open water on the Reserve. One is a natural bog-lake and the remaining three are artificially constructed ponds. A drainage canal is located along the south edge of the large east-central lowland.

There are several springs on the area, and thus with the large areas of wet lowland, the available surface water is more than adequate to meet the water requirements of the deer population during most years.

The soil types of the Reserve are patchy in distribution due to the irregular topography. The most common soils are porous, coarse textured sands and sandy loams of the Bellefontaine series, with a few patches of Miami loam (Wheeting and Berquist, 1928). The soil of the tamarack swamp is Rifle peat and that of the marshes is Carlisle muck. A small area of leather leaf bog has a Greenwood peat soil.

Weather

The general region is characterized by moderately cold winters and short, mild summers. Snow cover is variable, often not remaining on the ground for more than a few days at a time. The prevailing winds are westerly.

Table 1

Monthly precipitation and temperatures[1]

Month	Precipitation in Inches	Average Maximum Daily Temperature in Degrees F.	Average Minimum Daily Temperature in Degrees F
JANUARY	1.77	29.05	14.57
FEBRUARY	2.11	32.79	16.58
MARCH	2.36	39.70	22.24
APRIL	3.59	55.99	35.34
MAY	2.82	67.14	44.76
JUNE	3.59	78.34	56.95
JULY	2.91	81.87	59.47
AUGUST	3.80	81.12	58.43
SEPTEMBER	2.65	73.91	50.72
OCTOBER	2.79	61.75	40.65
NOVEMBER	2.58	46.32	31.54
DECEMBER	1.50	33.31	19.56

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[1] Compiled from Edwin S. George Reserve weather records.

Weather records have been taken on the Reserve since 1950. Table 1 shows the average monthly precipitation and temperatures for the 10-year period from 1952 to 1961, inclusive.

The average annual precipitation for the period was 32.77 inches, and the average number of consecutive days with minimum temperature above 32 degrees F. was 142. The meteorological effects are not considered to cause any great hardship to the deer population.

Vegetation

From all indications, the natural vegetation of the upland portion of the Reserve prior to settlement consisted of Oak-Hickory forest (Cooper, 1958). The lowland swamps apparently have undergone typical hydric succession, but the past history of the vegetation is not completely clear (Cantrall, 1943).

Upon settlement, the clearing of hardwoods for crop and pasture land changed the area considerably. Cantrall (1943) reported that the majority of clearing and agriculture use occurred prior to 1900. The present cover composition of the area consists of many open grasslands in addition to the remaining hardwood forest and swamps (Figure 2). Tody (1949) calculated the portions of the Reserve covered by grassland and woodland to be 39.7 per cent and 34.6 per cent, respectively.

The present proportion of grassland and woodland

Figure 2. Aerial photograph of the Edwin S. George Reserve.

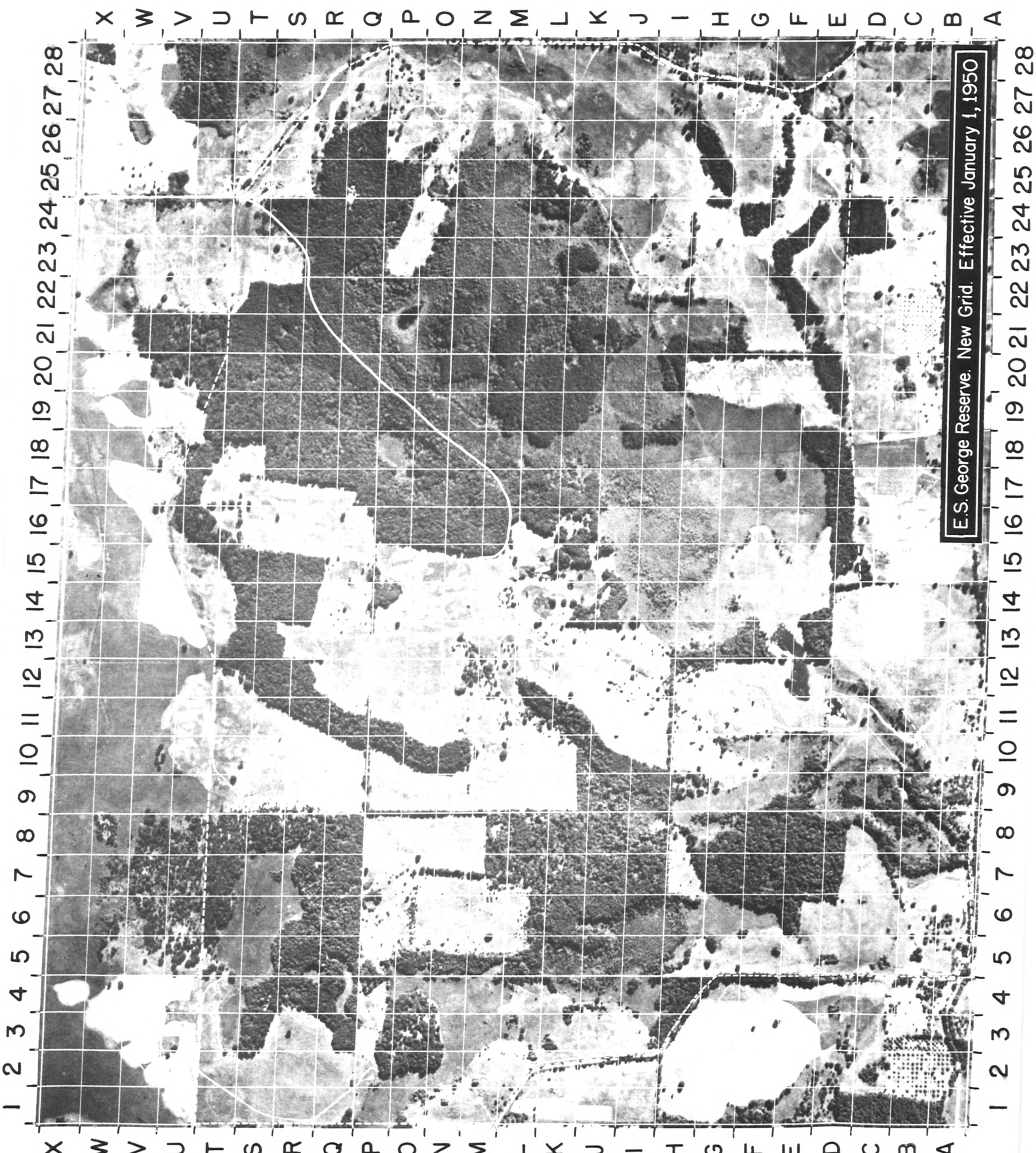
E.S. George Reserve. New Grid. Effective January 1, 1950
A B C D E F G H I J K L M N O P Q R S T U V W X
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

Figure 2.

is undoubtedly different than these values. Meagher (1958) illustrated the changes in the composition of vegetation on the Reserve utilizing photographs taken from identical locations in 1949 and 1958. The encroachment of woodland into the various old-fields is obvious. A visual comparison of present conditions with the aerial photograph taken in 1950 (Figure 2) also shows the effect of stand closure. The deer population most certainly expresses an effect on limiting closure.

The dominant tree species in the woodland type of the Reserve are black oak (Quercus velutina), white oak (Q. alba), and a hybrid hickory (Carya ovata×ovalis), in that order of abundance (Benninghoff, 1962). Wild black cherry (Prunus serotina) and sassafras (Sassafras albidum) are common where openings occurred and near the forest edge. In the forested areas of the western portion of the Reserve there is an increased frequency of red maple (Acer rubrum) in the tree layer, but the total amount for the area is far less than that of the oak and hickory.

The low trees and shrubs commonly include black cherry, sassafras, service berry (Amelanchier arborea), witch hazel (Hamamelis virginiana), hazel nut (Corylus americana), and juniper (Juniperus virginiana and J. communis var. depressa). Few saplings of the dominant tree species are found, except at the forest edge. However, there is a high proportion of seedlings of these dominant species in the herb layer.

The most common low shrubs and herbs include highbush blueberry (*Vaccinium corymbosum*), black huckleberry (*Gaylussacia baccata*), dewberry (*Rubus flagellaris*), bracken fern (*Pteridium aquilinum* var. *lactusa*), woodland sedge (*Carex pensylvanica*), Kentucky bluegrass (*Poa praetensis*), Canadian bluegrass (*Poa compressa*), pussy toes (*Antennaria neglecta*), and hog-peanut (*Amphicarpa bracteata*).

The grassland type is composed of many complexes of vegetation which vary with topography, soils, drainage and other physical factors. On the George Reserve, the most common grassland species are Canadian bluegrass, goldenrod (*Solidago nemoralis*, *S. juncea*, and *S. rigida*), lespedeza (*Lespedeza capetata* and *L. virginica*), tick-trefoil (*Desmodium sessilifolium*), blazing star (*Liatris aspera*), pussy toes (*Antennaria plantaginafolia* and *A. neglecta*), hawkweed (*Hieracium longipylum*), fall witchgrass (*Leptoloma cognatum*), and panic grass (*Panicum oligosanthes*) (Benninghoff, 1962). Milkweed (*Asclepius syrica*), and witch-grass (*Agropyron repens*) are most common in low depressions.

There are several clones of aspen (*Populus grandidentata* and *P. tremuloides*) which are rapidly filling in several of the smaller openings. Hawthorn (*Crataegus* spp.) and the junipers are common, especially in the fields formerly used as pastures. Blackberry (*Rubus alleghen-*

iensis), dewberry (Rubus flagellaris), and stag-horn sumac (Rhus typhina) are found in dense patches scattered throughout the grasslands of the Reserve.

Wall (1962) presented a detailed analysis of the grassland species important to deer on the George Reserve.

There are two large swamps on the Reserve which serve as wintering grounds for deer in the most severe weather. The only important tree species is tamarack (Larix laricina). Several shrub species are found in the swamp including poison sumac (Rhus vernix), grey dogwood (Cornus racemosa), red osier dogwood (Cornus stolonifera), spirea (Spirea alba), and dwarf birch (Betula pumila).

Throughout the area, along the edges of swamps and marshes, important browse species, such as red osier, grey dogwood, silky dogwood (Cornus obliqua), and willows (Salix spp.) are present in great abundance.

During the period of active agricultural use several small apple orchards were planted, probably all in conjunction with homesteads. These apple trees provide much fruit for the deer during the late summer. In winter, the trees are heavily browsed.

Recent History

In 1926, the late Col. Edwin S. George purchased the contiguous tract of land composed of all or part of 12 abandoned farms. During the following year, a fence, seven feet high with a one foot overhang on each side, was constructed. In March 1928, six white-tailed deer, two bucks and four presumably pregnant does, were purchased from the Cleveland Cliffs Iron Company on Grand Island, Michigan and were introduced into the enclosure. Although there is some ingress and egress over the fence, the present deer population is principally descendent from these six animals.

In 1930, Col. George donated the area to the University of Michigan, with the stipulation that the natural succession should not be altered by farming, burning, logging, or other form of environmental manipulation. The Reserve has been used as a field laboratory for ecological and natural history studies by graduate students and independent researchers.

The effect of the rapidly increasing deer population first became obvious in 1931 with the presence of conspicuous deer trails and the noticeable browsing of shrubs around the marshes and swamps (Hickie, 1937). A population of approximately 160 deer, as determined by a drive count, was present in December 1933 (Hickie, 1937). Removal of the surplus by hunting was initiated that year, with ten deer being killed. In 1934, the deer herd increased to an estimated 210 animals (O'Roke and Hamerstrom, 1948). A more intensive hunting policy was followed thereafter; and, in recent years, an overwintering population of 50 deer has been the goal of the management program for the area. Meagher (1958) has reviewed the population figures for the herd from 1933 to 1957, inclusive.

The 1960 deer drive indicated a fall population of 83 animals on the Reserve (W. W. Chase, Personal communication, September 1961). Two deer were later found dead, but one was determined to have been killed prior to the census drive (R. J. McNeil, Personal communication, June 1961). Thirty deer were taken during the 1960 harvest (Camburn, 1962). Thus, approximately 52 adult and yearling deer were present on the area during the first summer of this study.

On December 9, 1961, a deer drive accounted for 95 deer (Chase, personal communication, January 1962). Forty-five deer were taken in the 1961 harvest (Camburn, 1962). In addition, I personally saw two deer jump the fence and escape from the Reserve. Another deer was found dead of gun-shot wounds which were inflicted the last day of the 1961 harvest and one deer died of injuries sustained when being trapped. Four deer were illegally removed from the Reserve in the late winter, and two more were killed in August 1962 (F. L. Camburn, Personal communication, October 1962). Therefore, the adult and yearling deer population during the early summer of 1962 was approximately 42 (95 - 53) if the figures for the 1961 deer drive are assumed to be correct.

A "Lincoln Index" census of the deer was conducted from April 15, 1962 until July 28, 1962, using the marked deer (see section on Materials and Methods) and basing the index on "sight recaptures". When all of the marked deer were utilized in the census, an estimate of 44 deer was obtained. When only the conspicuously marked (collared) deer were included, an estimate of 49 deer was obtained. The latter figure would appear to be more accurate in view of the increased ability to determine if a deer is collared or not rather than marked with some less conspicuous marker.

These summer populations of 1961 and 1962, approximately 52 and 45 respectively, plus the fawns produced in each of these years, provided the behavior information for this study.

MATERIALS AND METHODS

Equipment

To facilitate long-distance observation, a 20-power Argus spotting scope and 7 x 50 Bausch & Lomb binoculars were used. When a stalking method of observation was employed, small, light-weight 6 x 25 Bushnell binoculars proved to be the most useful. To aid in concealment, I often used a two-piece camouflage suit similar to those used by archers in stalking game.

An automobile and a battery powered artificial light were utilized in making some observations.

To avoid repetition, the equipment used in capturing and marking deer is described in the following section.

Capture and Marking of Deer

The identification of individual animals is an essential part of any behavior study; without this information many of the details of social organization can only be surmised (Scott, 1956). To aid in the identification of individual deer and family groups, it was necessary to capture and individually mark as many animals as possible. Twenty-five deer were successfully marked.

Very young fawns were captured by hand and older deer were live-trapped. Hand capture was most frequently effected by walking or driving over the area, and then searching intensively any location from which an obviously non-pregnant adult doe was flushed. Usually fawns less than an estimated four days old could be captured easily. One fawn was captured in June 1961, and six more were captured in June 1962. The earliest date that a fawn was captured was June 7, the latest, June 19.

Stevenson box traps were used to live-trap deer. Following capture of a deer, the small side door or one of the large end doors was opened, and the animal was allowed to run into a 7' x 7' net with 5-inch mesh. The deer was then held immobile by hand or by tying its legs. Covering the animal's eyes with a dark cloth aided immeasurably in keeping the deer quiet. No attempt was made to anesthetize any of the deer.

Six deer, two fawns and four adults, were captured in this manner during September and October, 1961. Nine more deer, five fawns and four adults, were captured in January and February, 1962. In July 1962, one adult doe was captured. Three additional deer were trapped, but escaped from the handling net before they were tagged.

Marking was accomplished with six different devices. The one used most extensively was an aluminum ear tag with a 1-inch diameter disc (Figure 3, A; Figure 4). The tag is available from NASCO, National Agricultural Supply Company, Fort Atkinson, Wisconsin. Five colors (red, yellow, green, blue, and aluminum) were used. It was originally planned to use a single tag per animal, to be

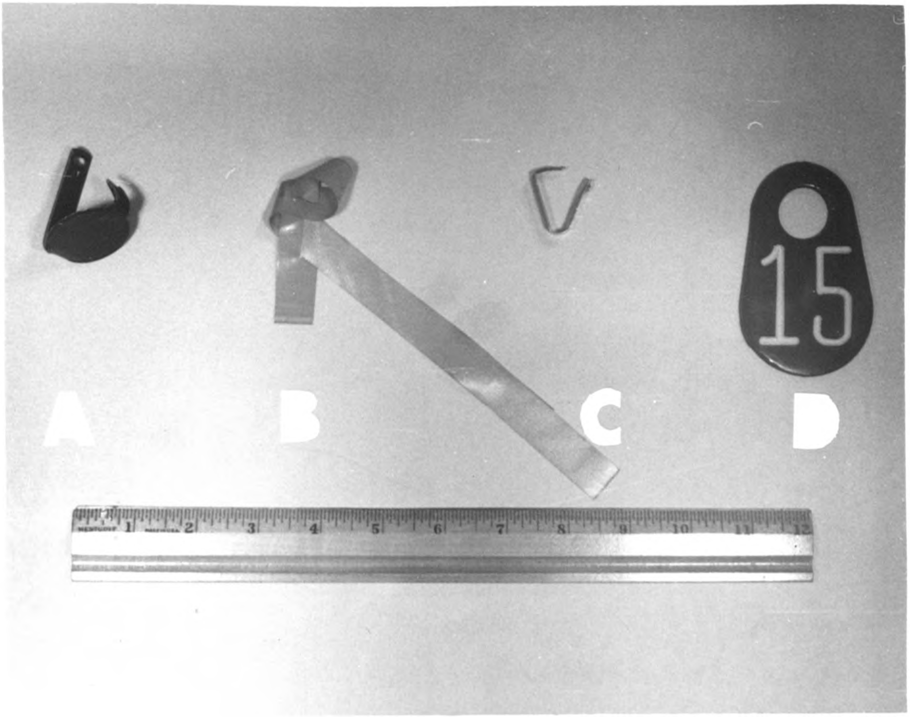

Figure 3. Identification tags for marking deer; A. Colored ear tag, B. Plastic impregnated nylon streamer, C. Michigan Department of Conservation tag, D. Numbered plastic tag.

Figure 4. Fawn marked with colored ear tag.

placed in the upper or lower half of the pinna of the ear with the disc facing anteriorly or posteriorly. With these combinations it would have been possible to mark 40 animals, each with a single identifying tag.

After tagging several animals in this manner, it was found that due to the shape of the upper edge of the pinna, the tags placed there were difficult to see. Also, the aluminum color did not show well against the white-haired background of the interior face of the pinna. It was often difficult to discern between green and blue colored discs in the field. Therefore, because of the small number of deer that I expected to capture, two tags were sometimes employed, utilizing either a yellow or red disc in combination with another color.

These colored ear tags were placed on all deer captured with the exception of five of the fawns captured in June 1962. There was no known loss of these ear tags during the study.

Twelve deer were marked with plasticized nylon tape streamers (Figure 3, B). The streamer material, "SAFLAGS", is produced by the Safety Flag Company of America, Pawtucket, R. I. The streamers, ½-inch x 12 inches, were available in five colors (red, orange, yellow, green, and white), and were attached to the ear directly by slitting the pinna and using a jesse knot as described by Craighead and Stockstad (1960) (See Figure 5). Only one ear was marked in this manner, but as a result the

Figure 5. Fawn marked with colored nylon streamer

Figure 6. Hind leg of fawn marked with colored nylon streamer.

identification of different animals was considerably more accurate than when just the disc was used.

Each of five fawns captured in June 1962 was marked in this manner, and in addition, the same tagging material was attached to the hind leg (same side as ear streamer) by making a vertical incision in the flesh anterior to the Achilles tendon (tendo calcaneous) and encircling the tendon with the jesse-knotted streamer (Figure 6). This method is similar to that described by Cook (1943) for marking muskrats, foxes, opossums, and skunks with bird bands.

Almost every deer handled was tagged with official, numbered ear tags of the Michigan Department of Conservation (Figure 3, C). These tags were of no aid to field identification of individual deer, but were used primarily for specific identification of the deer for age data at such time as when the animal might be shot or otherwise recovered.

A large oval plastic tag (Figure 3, D) was attached to the ear of four different animals. These markers were attached to the pinna with one of the colored discs or a numbered ear tag. Identification was greatly simplified by this device, but its durability was not as great as desired. All four markers were eventually lost at intervals of 15 days, 2½ months, 4 months, and 5 months after tagging.

Plastic collars (NASCO, National Agricultural Supply

Company, Fort Atkinson, Wisconsin) in two colors, yellow and white, with 1½-inch numbers, were used to mark 13 deer (Figure 7,A; Figure 8). These marking devices were the best for visual observation of a tagged animal, however, due to the small size of the numbers of the collar, it was often necessary to utilize an accessory identification device, such as an ear disc or streamer to positively identify the individual deer.

Two deer lost their collars during the course of the study. A male fawn originally captured in June 1961, was subsequently trapped in January 1962, and was marked with a collar. The animal was observed several times thereafter, but when seen on April 26, 1962, the collar was missing. One eight-month old doe fawn was trapped on two occasions in February 1962, and each time, upon release, it got a hind foot caught in the collar and pulled it over its head. It was necessary to leave room for growth when placing collars on partly grown fawns.

It was found that utilizing a combination of tagging devices greatly enhanced the identification of individual deer. When only a single device was used, such as a colored ear disc, identification was difficult, and at best uncertain.

An additional device was used to mark deer without capturing them in the spring and summer of 1962. A self-attaching collar was developed for gallinaceous forest birds by Romanov (1956) in Russia, and was redesigned

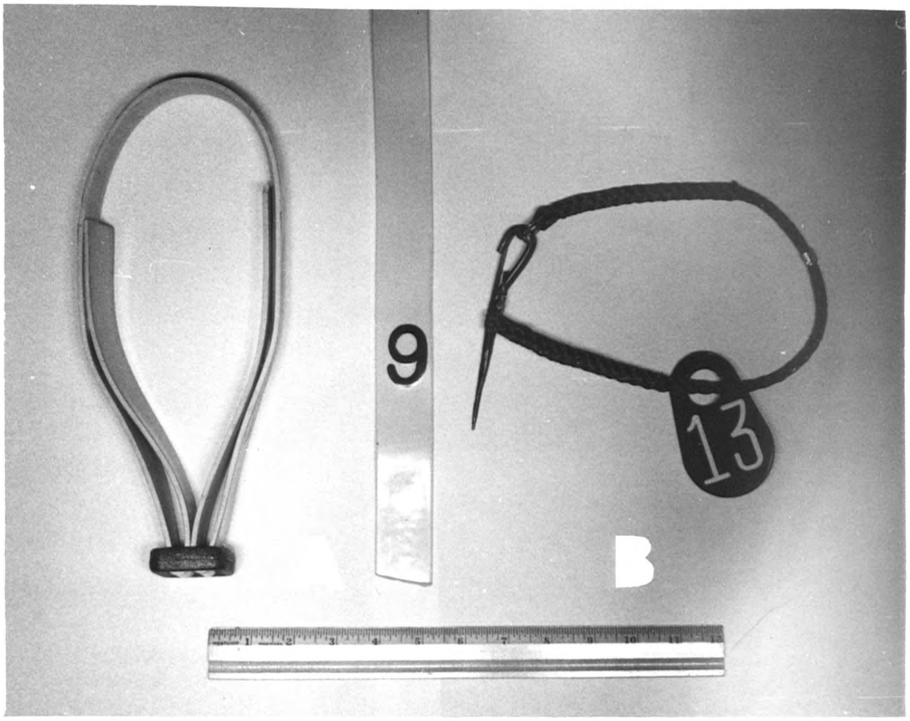

Figure 7. Plastic collars used for marking deer. A..Numbered plastic collar and buckle. B. Self-attaching poly-vinyl rope collar.

Figure 8. An adult doe with a combination of marking devices.

for marking deer by Louis J. Verme, Michigan Department of Conservation. (Figure 7, B). It was possible to mark four different deer in this manner; however, two of these had been previously marked by other methods.

The Stevenson box traps, the handling and marking equipment, and all of the marking devices with the exception of the nylon ear streamers, were supplied by the Game Division, Michigan Department of Conservation.

Throughout the course of this study, I noticed that the deer with the colored streamers moved their ears with greater frequency than those with no ear streamers. There were, however, no concentrated efforts on the part of the deer to remove any of the marking devices. It is my opinion that the markers did not significantly alter the behavior of the deer, and in no way adversely affected the results of this study.

The information concerning the captured deer and their markings is listed in the Appendix.

Observation

The majority of data concerning behavior in this report is based on observations of deer in the wild. The greatest proportion of observations were made during the peaks of deer activity in early morning and evening. However, to cover the full daily cycle of activity, observations were also made during the middle of the day, and at night using the moon or artificial light for illumination.

Notes were usually taken on the spot, and were edited each evening as needed. The grid location (Figure 2) weather, and time (in the 24 hour clock system) were recorded with each observation.

In June, when the young fawns remained hidden in heavy cover for much of the time, observations were achieved most effectively by stalking on foot, taking advantage of the cover, terrain, and wind direction whenever possible. Later, during the months of July and August, when the fawns are actively following the does, observations could best be made from high topographic features overlooking open fields, forest edge, marshes, and swamps.

As deer are often less alarmed by a vehicle than by a person on foot, a number of observations were made using an automobile as a blind. When artificial light was used, it was noted that the deer usually became alert momentarily only, then returned to their previous activity.

Scott (1958) suggested that allowing animals to become thoroughly accustomed to the observer is preferable to making observations from a blind. However, the limited time available for this study did not warrant this approach.

PRE-FAWNING BEHAVIOR

I suppose, for the sake of argument, that it can be said that pre-fawning behavior begins on the date of conception. However, for the purpose of this discussion, the pre-fawning period will be the last two months of gestation prior to parturition. This places the beginnng of this period about the last week of March or the first week of April in the northern ranges of the white-tailed deer. By this time the heavy snows, which have forced the deer to congregate in yards, are melting and the deer are usually able to move about in search of food with little restriction of movement. Although the deer of the George Reserve are rarely, if ever, forced into yard conditions, I think that it is necessary to define the pre-fawning period with the yarding phenomenon in mind, if the behavior information is to be considered applicable to the more northern parts of the White-tail range.

As the present study was not initiated until June 1961, the discussion includes data from only one pre-fawning period, that of 1962.

<u>Group Size and Composition</u>

As might be expected from the discussion of social organization in the review of literature, the most common grouping observed during the pre-fawning period was that of adult does and their fawn(s) of the previous year. The relationship was usually surmised by the association of the fawn(s) with the doe. However, it was difficult to ascertain that the animals seen together from time to time were the same, or that they actually were related. Several marked deer presented the opportunity to collect positive data regarding some of these problems.

An adult doe (Deer No. 15) was observed repeatedly with two doe fawns (Deer No. 12 and Deer No. 13) throughout the late winter and spring of 1962. All three were captured at the same trap location (Trap No. 3). On February 22, 1962, Deer No. 15 was captured and Deer No. 13 was recaptured in the trap at the same time. On February 25 they were seen together at J-17, and on the following day they were seen at R-26, almost 1300 yards from the previous location. Thereafter, the more or less constant association of the three deer gave credence to the idea that they were a related doe-fawn group.

During the period from March 24 to June 2, the three deer were observed together 18 times. On four of these occasions other deer were present in the group. Table 2 shows the breakdown on observations of the marked deer during this period.

Another grouping of marked deer which appeared to be a doe-fawn group was that of Deer No. 16, an adult doe, and two doe fawns, Deer No. 10 and Deer No. 11. The association between the doe and the two fawns was less

TABLE 2

Observations of an adult doe (Deer No. 15) and two fawns (Deer No. 12 and Deer No. 13) March 24, 1962 to June 2, 1962

Grouping	No. of Observations	Remarks
Deer No. 15 with Nos. 12 and 13	14	
Deer No. 15 with Nos. 12 and 13 and other deer	4	Groups of 4, 7, 10, and 12 deer
Deer No. 15 with Deer No. 12	1	
Deer No. 15 with Deer No. 13	1	
Deer No. 12 with Deer No. 13	4	
Deer No. 15 alone	4	
Deer No. 12 alone	2	Once with two other deer
Deer No. 13 alone	1	

TABLE 3

Observations of an adult doe (Deer No. 16) and two fawns (Deer No. 10 and Deer No. 11) March 24, 1962 to June 2, 1962

Deer No. 16 with Nos. 10 and 11	4	
Deer No. 16 with Nos. 10 and 11 and other deer	1	Group of 11 deer
Deer No. 16 with Deer No. 10	1	
Deer No. 16 with Deer No. 11	0	
Deer No. 10 with Deer No. 11	0	
Deer No. 16 alone	5	
Deer No. 10 alone	1	
Deer No. 11 alone	6	Three times with other deer

constant than that for the previously described group. All three deer were captured at the same trap location (Trap No. 1), and it was noted that both fawns were much smaller (estimated 40 to 50 pounds) than most of the fawns on the area. I am reluctant to state with confidence that this doe-fawn group was an actual kindred relationship, but I believe however, that Deer No. 10 and Deer No. 11 were definitely twin fawns, as evidenced by their similar size and their close association after the 1962 fawning season (see Figure 14, section on "Range"). Table 3 shows the observations of the three deer during the pre-fawning period.

Larger groupings were not common, but on March 26, a group of seven was observed which appeared to be two doe-fawn groups.

> March 26, 1962. (I-27) 1800. Deer No. 5, an adult doe, feeding with two fawns; another adult doe with three fawns (one visibly smaller than the other two). When startled by the car, all fawns ran to respective adults. Fed for 15 minutes, then ran off together. (Appeared to be two doe-fawn groups, but smaller fawn was possible orphaned in harvest or otherwise separated from mother, and thus only associating with group. There was however, a set of triplets reported by Dr. John Kerr in June 1961, about 200 yards north of this location.

Deer No. 5 was known to have two fawns in the summer of 1961 and they were still with her on December 8. When Deer No. 5 was seen on February 21, 1962, only one fawn was present.

Other large groupings included a group of 11 at R-4 on April 4, a group of 12 at S-10 on April 25, a group of 10 at F-12 on May 21, and a group of seven at K-12 on May 23.

At the end of the 1961 deer harvest there were only two known adult bucks on the Reserve. The presence of one was shown by the finding of a freshly shed right antler in February. A 1½ year old buck, with spike antlers, was captured in September 1961. It was subsequently recaptured on January 30 and February 13, 1962, but was never seen again.

Because of the few adult bucks present, it is difficult to determine the relationship between bucks and adult does during the prefawning period.

Isòlation of the Doe

The majority of writings on habits of white-tailed deer indicate a strong tendency for the doe to remain isolated much of the time immediately prior to parturition. A few single does were observed throughout the pre-fawning period, with a greater incidence of this type of grouping toward the latter weeks of the period. It must be noted, however, that 12 fawns were removed during the harvest (in addition to one later found dead and one trap-killed fawn), and this could very well account for some does not being accompanied by fawns of the previous year. My observations indicate that does are more tolerant toward fawns during the latter portion of the pre-fawning period than has otherwise been reported.

An adult doe (Deer No. 15) was very tolerant of her fawns (Deer No. 12 and Deer No. 13) during the last month of gestation, as shown by the following summary of observations of this family group.

May 7, 1961.	Deer Nos. 15, 12, and 13 together at K-12, Deer No. 15 obviously pregnant.
May 8	Deer Nos. 15, 12, and 13 together at N-14.
May 10,	Deer No. 15 alone at N-18.
May 11,	Deer Nos. 15, 12, and 13 together at Q-12.
May 13,	Deer No. 12 alone at M-11.
May 18,	Deer No. 15 alone at M-15.
May 19,	Deer Nos. 15, 12, and 13 together at K-12.
May 20,	Deer No. 15 alone at R-16.
May 21,	Deer Nos. 15, 12, and 13 with seven other deer at F-12. Deer No. 15 chased Deer No. 1 (buck fawn) several times.
May 22,	Deer Nos. 15, 12, 13 and 4 (doe fawn) at N-14.
May 23,	Deer Nos. 15, 12, and 13 with four other deer at K-12.
May 25,	Deer Nos. 15 and 13 at K-13.
May 28,	Deer Nos. 15, 12, and 13 together at P-15.
May 29,	Deer Nos. 12 and 13 together at P-14. (I thought Deer No. 15 was away having fawn)

May 30, 1962	1800, Deer Nos. 12 and 13 at O-12. 1930, Deer Nos. 15, 12, and 13 at P-11. (Deer No. 15 still obviously pregnant.)
May 31,	Deer Nos. 12 and 13 at Q-13.
June 2,	Deer No. 15 alone at N-14, still pregnant.
June 4,	Deer No. 12 alone at Q-14.
June 8,	Deer No. 12 alone at T-17, P-13, Q-17, and P-9.
June 17,	Deer No. 15 alone at M-15, obviously no longer pregnant.
June 21,	Deer No. 15 with two fawns at N-16. Fawns estimated to be 10-12 days old.

During this period, there was no agonistic behavior observed between the doe and the two fawns. When the doe delivered her fawns of the year, she remained very secretive and was not observed from June 2 to June 17. Deer No. 13 was not seen during this period, and Deer No. 12 was seen on only two days. I believe the one-year old fawns, classed now as yearlings, remained in the vicinity of Deer No. 15 and her young fawns.

Observations of other marked deer also indicate a considerable tolerance on the part of pregnant does toward yearling deer. On several occasions, Deer No. 8, an adult doe, and Deer No. 9, a two-year old doe, were seen with Deer No. 1, a buck fawn, and an unmarked buck fawn. The relationship between these deer is not known, but it is known that Deer No. 1 was a single fawn in 1961. Deer No. 8 and Deer No. 9 were pregnant. The following is a summary of the observations of these deer during the last five weeks of the pre-fawning period.

May 7, 1962.	Deer Nos. 8, 9, and 1, with one unmarked deer at G-10.
May 8,	Deer Nos. 8, 9, and 1, with one unmarked deer bedded at J-11.
May 19,	Deer Nos. 9 and 1 with one unmarked deer at F-11.
May 20,	Deer No. 1 and one unmarked deer at F-11.
May 21,	Deer Nos. 8, 9, and 1, with seven other deer at F-12. Deer No. 1 chased several times by Deer No. 15, adult doe.
May 23,	Deer Nos. 8, 9, and 1, with one unmarked deer plus Deer Nos. 15, 12, and 13 at K-12.
May 29,	Deer Nos. 8 and 1, with two unmarked deer at J-11.
June 2,	Deer No. 8 alone at G-10.
June 6,	Deer Nos. 9 and 1, with one unmarked yearling buck at G-10.
June 7,	Deer No. 9 with newborn male fawn (Deer No. 18) at I-9.

Here is an instance of a pregnant doe allowing two yearling deer, both males, to accompany her until parturition. As Deer No. 1 was a single fawn in 1961, the three deer were definitely not all related, and therefore shows the tolerance of a pregnant doe toward other deer.

While the above information is insufficient to say that all does are tolerant of other deer as they near parturition, for this certainly is not the case, it is sufficient to state that all does need not have complete isolation prior to parturition.

The isolation of the doe prior to giving birth to the new fawn would seem to be advantageous from the aspect that there would be no other deer close by to harass the doe and its newborn fawn. However, if white-tailed does near term were universally intolerant of other deer, especially their own fawns of the previous year, then a high density of deer might disrupt the ability of the doe to obtain the desired isolation. If this were the case, then the rate of fawn mortality at birth could possibly be much higher than at present.

FAWNING BEHAVIOR

Actual parturition was not observed during the course of this study. To span the gap between the discussion of pre-fawning and post-fawning behavior, I have reviewed information on fawning behavior from appropriate publications. In addition, I have included information obtained through personal interview with Mr. Ralph Blouch and Mr. Herbert Johnson, Research Biologists, Michigan Department of Conservation. Both Mr. Blouch and Mr. Johnson have had several years of experience with experimental deer research at the Houghton Lake (Michigan) Wildlife Experiment Station. Their studies on physiology and nutrition have placed them in position to be aware of the behavioral factors involved in the birth processes of deer.

Fawning Site

The paucity of information in the literature concerning deer births observed in the wild permits, at best, only conjecture about the actual site of parturition. Ismond (1952), basing his deductions on the location of the pregnant doe prior to parturition, came to the following conclusions concerning deer on the George Reserve.

> Choice of area for fawning seems to cover a wide range. One consistent requirement seems to be an area shaded either by trees or brush and a floor either of dry leaves or grass. Soil types, presence or absence of low brush or bracken, distance to water, or topography seem to make little difference. The degree of slope may limit the use for fawning, but a more or less level area, about four feet in diameter is sufficient for the birth bed. In that water is available throughout the area, the effect of this requirement is not considered very great.

Townsend and Smith (1933) reported that fallen tree tops appeared to be favored places for giving birth to fawns. The utilization of isolated thickets and islands for fawning was noted by Seton (1927).

During the present study only three very young fawns were sighted. On June 17, 1961, a young fawn, as evidenced by its very wobbly gait, followed a doe from a narrow stretch of marsh onto a tamarack covered island at K-26. It is assumed that the fawn was born in the area of the marsh, because it was still unable to travel well, and frequently became entangled in the marsh vegetation.

On June 7, 1962, at about 1900, a fawn was observed following a doe (Deer No. 9) from a staghorn sumac-covered, south-facing slope into a woodlot at H-9. The fawn was very unsteady on its feet, and progressed very slowly. Upon capture, it was noted that the umbilicus was very moist, with about one inch of the cord remaining. As Deer No. 9 was observed to have been pregnant on the previous evening, the fawn (Deer No. 18) was known to be very young. It is my opinion that the fawn was born on the slightly brushy hillside.

Deer No. 8, an adult doe, was observed to emerge from a marsh at F-9 on the evening of June 18, 1962. The doe was no longer pregnant and a search for her fawns was initiated the following morning. One fawn (Deer No. 23) was found in the marsh, about 100 feet from the edge. The fawn made no attempt to run and was easily captured. The umbilical scar was moist, and the fawn was unsteady on its feet when released. The fawn was found about 15 hours after the doe was first identified as being no longer pregnant, and as the age of the fawn was probably not much greater than this time interval, the location of birth can be assumed to be very near the location where the fawn was found. This was further substantiated by a large, freshly used deer bed found near by. The presence of a twin fawn was suspected, but an intensive search did not reveal it at that time. A second fawn was later observed with Deer No. 8 and the marked fawn.

Older fawns, two to five days old, were observed. They were found in various topographic and cover situations, but were generally seen in a marsh or within 200 feet of its edge.

My observations, based on location of young fawns, neither corroborates nor contradicts the conclusions of other workers. It seems, as Severinghaus and Cheatum (1956) have suggested, that the fawn is born where ever the doe happens to be and that there is little active selection of the birth place by the doe.

Time of Birth

The circumstances concerned with the capture of the fawns born to Deer Nos. 8 and 9 discussed in the above section indicate that the fawns were born in the afternoon, sometime between 1300 and 1700. An observation of a doe, at 0500 on June 25, 1962, that appeared to be in labor as evidenced by frequent arching of the back and straining of abdominal muscles, indicated that birth would take place during the morning hours. Irregular terrain, a variable wind, and extremely dry ground conditions prevented a prolonged observation of the incident.

Herbert Johnson (Personal communication, September 1962) indicated that the majority of fawn births at the Houghton Lake deer pens occur during the daylight hours, with peaks of birth acitivity between 0600 and 0900 and between 1600 and 1900. Relatively few fawns have been born at night. This is in contrast to the commonly believed notion that most fawns are born at night, which has probably been construed because of the infrequent opportunity to observe parturition in the wild.

An advantage to the species of daytime birth might be the effect of warm temperatures to aid in the drying of the new born fawn. A fawn born at night usually would be exposed to lower temperatures. A second possible advantage of daytime birth could be that most potential predators of fawns, with the exception of man and Falconiform birds, are nocturnal.

Behavior at Parturition

There are two characteristics of the doe which become obvious when she nears termination of pregnancy. One is of a physiological nature, the formation of milk and the obvious swelling of the udder. This trait becomes noticeable 1½ to 2½ weeks prior to parturition (Johnson, Personal communication, September 1962). Although it is relatively reliable in penned deer, it is of little use in predicting the date of parturition in wild deer which are not observed daily. The second factor is the degree of isolation of the doe prior to parturition.

As labor commences, a penned deer may become very restless, with much pacing, or she may lie quietly with only occasional heaving of the abdomen (Johnson, Personal communication, September 1962). There is relatively little vocalization on the part of the doe except for occasional grunts, although Ford Kellum (Severinghaus and Cheatum, 1956) observed a doe in labor bleating frequently when another doe was present.

Several workers (Haugen and Davenport, 1950; Haugen and Speake, 1957a; Golley, 1957) have reported on the actual birth of fawns in pens and all are in general agreement on the relative quickness of the birth process. The time lapse from the first appearance of the forehooves of the fawn until the second fawn, in the case of twins, is born and cleaned was about 20 minutes. Johnson's (Personal communication, September 1962) observations corroborated these reports. The doe may be standing or reclining when the fawn is born, but the latter is more frequently observed (Johnson, Personal communication, September, 1962).

The consumption of the afterbirth has followed parturition in every fawn birth at the Houghton Lake deer pens. (Johnson, Personal communication, September 1962). Blouch (Personal communication, September 1962) stated that the fetal membrances were even removed from stillborn fawns, and in one instance, after removing the afterbirth, a doe trampled the dead fawn to the point of severing the legs from the body.

The comsumption of the afterbirth serves to eliminate the evidence of birth and thus removes the odor of flesh from the area. This undoubtedly decreases the chance for the newborn fawn to be discovered by a predator. Severinghaus and Cheatum (1956) and Johnson (Personal communication, September 1962) believe that the consumption of the afterbirth may be of nutritional value to the doe and may aid the stimulation of lactation, perhaps due to the hormonal content of the flesh and fluids. The odor of the afterbirth is probably the stimulus for its consumption.

Precocity of the Fawn

The period of life immediately following birth is of utmost importance to the survival of the fawn. The fawn must be able to nurse within a few hours after birth.

Johnson (Personal communication, September 1962) stated that the ability to stand and nurse is highly variable among fawns due to the nutritional condition of the does, but this usually occurs between one and four hours following birth. Frequently, a fawn may be too weak to stand or otherwise unable to reach the udder to nurse. In such cases, a doe will sometimes lie down for the fawn to nurse (Blouch, Personal communication, September 1962). If the fawn is unable to stand, and the doe is not willing to lie down to be nursed, the fawn must be bottle fed. In the wild, the fawn would die. This is one of the many obscure factors concerning the rate of mortality among natural deer populations.

Haugen and Speake (1957a) reported twin fawns nursing when 8½ and 32 minutes old, respectively. The fawns were able to stand 19 and 23½ minutes after birth. It was not stated whether the doe was lying down when the latter fawn nursed; she undoubtedly was for the first fawn.

The fawn's alertness to its environment has been noted by Haugen and Speake (1957a) in that twin fawns alertly cocked their ears at the sound of a passing automobile when they were 28 and 36 minutes old respectively. The fawn of another doe responded similarly when 75 minutes old.

Vocalization of very young fawns is limited and is usually apparent only when the animal is molested. The fawn (Deer No. 18) born to Deer No. 9 bleated repeatedly when captured. It was an estimated five to six hours old. All other captured fawns bleated when handled, but they were all 15 or more hours old. The limited use of vocal communication probably reduces the opportunity for a predator to find the new born fawn.

POST-FAWNING BEHAVIOR

My observations indicate that post-fawning behavior can be subdivided into four stages relative to the development of the fawn. These are: 1) the neonate or newborn period lasting from birth until the age of about four days, 2) a period of isolated training lasting from four days to three or four weeks of age, 3) a period of actively accompanying the doe, from the age of three or four weeks until mid-September, and 4) social integration into larger groups. The first three periods are based on the physical and sociological development of the fawn. The last stage, social integration into larger groups, appears to be triggered by the physiological or psychological state of the doe rather than the age or degree of development of the fawn.

Neonate Period

Isolation of the Fawn

Although the fawn of the white-tailed deer is extremely precocious in its ability to get to its feet and stand, it has poor coordination and is unable to walk with stability for the first few days. For this reason, the fawn spends much of its early life bedded down, resting, rising only to nurse or change position. The fawn is isolated entirely from all other deer, with the exception of its dam. As twin fawns are usually found in separate locations, it appears that the fawns are even separated from their siblings.

Observations of doe-fawn groups during this period indicate that although the doe is usually not far away from her fawn, she nevertheless does not maintain close contact with it. With the exception of four instances, when does were moving fawns from one location to another, a doe was never found closer than 60 feet from a fawn's bed. Seton (1927) wrote that he thought the doe bedded with the fawn at night to provide warmth for the young animal. The absence of adult-deer beds adjacent to the beds of fawns, some of which appeared to have been used almost continuously for 24 to 48 hours, tends to refute this conclusion.

Many workers have reported that very young fawns have relatively little body odor. This, coupled with very limited movement and therefore limited deposition of odor on the ground from the interdigital glands provides considerable protection from predators. The infrequent presence of the doe near the fawn's bed also decreases the chance for discovery by a predator.

Nursing and Contactual Behavior

Although nursing during the neonate period was not observed, several generalizations can be discussed. Because of the isolation of the fawn, it appears highly probable that the doe determines the nursing interval. This is not the case for penned deer. Johnson (Personal communication, September 1962) indicates that the fawn of a penned deer has the doe at its own disposal and that it nurses with greater frequency than under natural conditions.

The newborn fawn probably does not need a large volume of milk to sustain itself during the first few days in view of the fact that much of the time is spent resting and little strenuous activity results. The first milk secretion following parturition is colostrum and is low in volume. Larger volumes of milk are produced a few days following parturition and pituitary stimulation is necessary to continue milk secretion (Nalbandov, 1958). It is my opinion that the return of the doe to nurse the fawn is stimulated by the pressure of milk in the udder.

Collias (1956) noted that the newborn lamb (sheep) or kid (goat) usually terminated any nursing attempts on the first day. As the lamb or kid becomes older, it is the adult that generally terminates nursing. This is probably the case for white-tailed deer.

Active vocalization on the part of the fawn has been observed during the neonate period. Such et-epimeletic behavior has been noted on the George Reserve by Hatt (1937), and by myself. The calls of the fawns are generally short, soft bleating sounds, repeated at 10 to 15 second intervals. Such occasions are probably the result of one of two factors, the failure of the doe to return to nurse before the fawn becomes excessively hungry, or the presence of some disturbance that forced the fawn to move from its bed and become "lost". While such vocalizations would serve to help reunite the doe and the fawn, it could betray the presence of the fawn to any predator in the area.

Contactual behavior begins almost immediately following the birth of the fawn with the removal of the fetal membranes. Such contact is usually associated with a licking activity on the part of the doe. The doe licks the entire fawn but most frequently concentrates around the anal region and the head. As it becomes older, the fawn occasionally reciprocates, but this may serve more as a stimulus for the doe to lick the fawn than as a case of mutual grooming. Severinghaus and Cheatum (1956) have suggested that the licking behavior of the doe serves to eliminate fly larvae infestations from the body openings.

Imprinting

The fawn very quickly learns to associate the presence of the doe with nursing as evidenced by the following or "heeling" behavior of the young deer. Also, when the fawn is only two or three days old it generally is able to discern between its dam and other mobile objects as noted by its attempts to escape from the latter.

Only one observation was made concerning the critical time for imprinting. On June 8, 1962, a female fawn (Deer No. 20) was captured and restrained for marking. The fawn was then carried about 70 feet to a sunny opening so photographs could be taken. The fawn was returned to its bed and released. A total of 15 minutes had elapsed. Upon release, the fawn did not run as expected, but instead, briefly ran its nose along my trouser legs and then followed behind me for 15 feet. The fawn then stopped and walked away along the edge of the marsh. Apparently the fawn had not become completely imprinted to its dam, and was at the age when it might attach itself to any substitute for a mother. The fawn was estimated to be three days old using the criteria formulated by Haugen and Speake (1957b).

Escape Behavior

The approach of a man to a doe and her newborn fawn usually results in the noisy escape of the doe. There may be a variety of signals prior to and during the escape. These may include stamping the front feet, snorting (often in unison with stamping), twitching the tail, erection of the tail hairs and hairs surrounding the tarsal and metatarsal glands, and alternately lowering and quickly raising the head as though to gain a better perspective of the intruder. One feature is present almost every time a doe with a very young fawn is disturbed. The doe runs with her tail tucked down tight against the hindquarters rather than with her "flag" up as is typically associated with white-tailed deer. As human observers we are unable to determine the role played by odors emitted from the external glands of deer. Signals of this sort may also be given prior to the escape of the doe.

Of particular interest is the reaction of the fawn to the escape behavior of the doe. Most observers have reported that when not accompanied by the doe, a fawn remains in a "skulking" position, with head outstretched close to the ground and with ears laid back close to the neck. My observations indicate that the "skulking" or "freezing" attitude is stimulated by the alert stance or sudden movement of the doe. Also unless the stimulus is reinforced, the "freezing" response usually subsides within 10 minutes.

Of the seven fawns captured during the study, four were lying with their heads up and each one watched, with movements of head and eyes, as it was approached. On one occasion the fawn was observed to have its head up and was looking around about seven minutes after its dam had left her bed 60 feet from the fawn.

The remaining three fawns that were hand captured were walking with their respective dams prior to capture. All three dropped to the "freezing" position and two were captured immediately. In the last of these instances, the fawn jumped up and ran 13 minutes after its dam had left the area.

On six other occasions a doe with a young fawn was noted to become suddenly alert or to run at my presence. In each instance, the fawn dropped immediately into the "freezing" position, or did so after running a few steps in the direction the doe had fled.

Defense of the Fawn

During the course of this study, man was the only potential predator observed to encounter deer although foxes and occasionally stray dogs were present on the area. All of the seven fawns captured by hand bleated loudly when restrained. On two such occasions the fawn's mother ran in a wide circle about 150 feet from the fawn and its captors. Both does snorted repeatedly, and when they were not running they stamped their front feet vigorously on the ground. They made no attempt to come close to the fawns.

Ismond (1952) reported a doe-fawn (almost a year old) chasing a red fox (*Vulpes fulva*), but there were no such instances involving adult does with young fawns in the vicinity. The chasing of bobcats (*Lynx rufus*) by adult mule deer does has been noted frequently in the Western states (Linsdale and Tomich, 1953). Mr. Elsworth M. Harger (Research Biologist, Michigan Department of Conservation) found a coyote (*Canis latrans*) killed by doe with a fawn in the Upper Peninsula of Michigan (G. S. Hunt, Personal communication, November 1962).

Period of Isolated Training

As the fawn develops strength and balance it is able to walk effectively when four or five days old. The fawn does not travel with its dam on her daily travels for food and water until it is three or four weeks of age.

Isolation of the Fawn

During this second stage of physical and social development the fawn remains in a relatively small area. The size of this area depends on topography and vegetation and appears not to be larger than eight to ten acres. Although the fawn does not follow the doe on her longer travels, it frequently does so within this small area.

When the doe is not present, the fawn spends much of the time resting in some well secluded covert. However, it frequently wanders about the area alone. Normally the fawn is prevented from contact with other deer, except a twin, by the action of the doe. As only one doe uses a specific area to raise her fawn, contacts between the fawn and other deer are usually associated with deer passing through the area.

Ingestive Behavior

Ingestive behavior of the fawn during this period consists mainly of nursing the doe when she periodically returns to the fawn's location. The fawn frequently takes herbaceous vegetation in its mouth, but it is not known if the plant material is actually swallowed.

When the doe returns to the fawn, the sight or sound of the approaching deer appears to be the stimulus for the fawn to go to its mother to nurse. Final recognition between the deer, probably based on odor, is necessary before the doe allows the fawn to nurse. Observations of this behavior are discussed concerning ingestive behavior in the section on "Period of actively accompanying the doe". I think that it can be assumed that the same factors are in force during this earlier stage of development.

When twins are involved, the sight of one fawn nursing may be the stimulus for the second fawn to nurse, because almost invariably both fawns will nurse simultaneously although they do not necessarily begin at the same time. In penned deer this characteristic tends to disappear, as often one fawn will be seen to nurse while the twin is engaged in some other activity (Johnson, Personal communication, September 1962). This may be due to the fact that the doe is more readily available to the fawn's nursing needs. The fawn will attempt to nurse from either side of the doe, or from the rear, placing its head between the doe's hind legs.

Of particular interest is the position of the doe during the nursing activity. She usually is standing in a relaxed position at the onset of nursing, with her head raised but not as high as that of an alert deer. As the fawn nurses the doe tends to arch her back, and her head is lowered. If the doe does not lick the fawn during nursing, and this is often the case, she merely stands in this position, with her back arching more as nursing progresses. Even when the doe is licking the fawn, her back is still arched, but perhaps to a less noticeable degree because of her activity.

The arching of the back is also characteristic of the position of the doe during urination, during and immediately following copulation, and at parturition. It is my opinion that the arching of the back is caused by neuro-stimulation of the urogenital system. During urination, copulation, and parturition, physical pressures could result in such stimulation. The stimulus obtained by suckling causes a neural reflex to go to the hypothalamus and thence to the posterior lobe of the pituitary, which responds by releasing oxytocin, which in turn, causes contractions of the uterus and in the myoepithelial tissue of the mammary gland (Nalbandov, 1958). The contraction of the myoepithelial tissue of the breast results in the "let down" of milk. Contractions of the uterus due to oxytocin could be the cause of the arching of the back.

Nursing is usually terminated by the doe. She simply steps over the fawn as it is nursing and walks away. Only once was a fawn observed to attempt to nurse immediately after the doe had terminated the nursing activity. As the fawn moved into the nursing position for the second attempt, the doe lifted her hind leg over the fawn, took a step, and then she kicked the fawn vigorously in the thoracic region. The fawn then walked away and made no further attampts, to nurse. If this is typical of the behavior of a doe at secondary nursing attempts, it seems probable that fawns soon learn to accept the termination of nursing as imposed by the dee.

The number of times that nursing was actually observed does not warrant a lengthy discussion of duration of nursing. The longest observed period of continual nursing was 90 seconds. At the other extreme, several occasions were simply quick nuzzles at the doe's udder and it is not known if actual nursing took place.

When the doe is actively feeding and the fawn is with her, the fawn may take bits of grass and other herbaceous material protruding from the sides of the doe's mouth. Such behavior was not frequently observed, but it seems that it would serve to test the palatability of things to eat. It might in a sense be classified as investigative behavior. No fawns were observed to drink surface water during this period.

Investigative Behavior

The visual, auditory, and olfactory senses of the white-tailed deer are known to be acute, and they have been discussed at length by many workers. The senses of the young fawn are almost on a par with those of the adult. The difference lies in the degree of association of the perceived objects, sounds, and odors with their potential danger. Another difference is the attention span. An adult deer will often stand motionless watching an unidentified object for as long as 10 minutes before proceeding to investigate further, leaving the area, or returning to its prior activity. On the other hand, a two or three-week old fawn generally will not be attentive toward an unidentified object for more than one or two minutes. This does not appear to be a matter of sight acuity however, for a fawn is capable of discerning the presence of a man in the open at a distance of 200 to 300 feet.

A fawn may at times appear to be more acute in noticing strange noises and objects than is its dam. The sounds of dogs barking in the distance will quickly alert a fawn while a doe may continue to feed. Perhaps an ability of the doe to judge the distance and direction of sounds can account for this difference in behavior.

When wandering about the area, a fawn, whether alone or with its dam, spends much of its time smelling and licking various plants, approaching objects such as stones, sticks, and trees, and in general, exploring its environment. A fawn frequently cocks its ears as though listening and takes occasional glances around the immediate area.

Reaction to Twin

Twin fawns spend almost all of their time together during this period. The action of one fawn appears to be closely associated with whatever the other fawn is doing at that particular time. For example, if two fawns are walking or feeding and then one lies down, the second fawn generally will lie down also within a short time. Then when one rises again, the other usually will rise shortly. There appears to be more urgency on the part of a fawn to follow any action of its sibling which goes from a resting phase to an active one than the reverse. Such behavior would tend to prevent a fawn from being "left behind".

A twin fawn is continually more aware of the position of its sibling than it is of its dam's location. This is probably due to the fact that a greater proportion of of time is spent with its twin.

It appears that twin fawns tend to wander farther, and, when left by themselves, they are more active than a single fawn. A limited number of observations indicate that twin fawns begin to follow their dam on long travels at an earlier age than single fawns.

As far as I have been able to discern, there appears to be no particular role of dominance between twin fawns. Only further studies with marked animals can determine the importance of this psychological factor.

Reaction to Deer Other Than Family Group

The White-tail fawn is an inquisitive animal and will often approach deer other than the family group. Such attempts at socialization are quickly thwarted by the doe if she is present. The doe will frequently drive her fawn away from the other deer in a manner similar to a dog herding sheep, or as is more often the case, the doe will chase the other deer away. Such agonistic behavior usually includes display patterns; the doe will extend the neck and head level with the spinal column, and then lay her ears back along the neck. If the deer does not retreat, the doe will usually run at the deer, sometime striking it with a front foot. I have never observed a retaliatory action from any deer driven from another's fawn.

The following field notes will serve to illustrate some of the reactions between fawns and other deer when the dam is not immediately present.

> July 12, 1961. (M-27) 1845--Doe feeding in edge of marsh near firebreak. 1848--Fawn and yearling buck (spike buck with wart on left shoulder) crossed road near Trap No. 4. Buck kicked fawn lightly on the back with left front

foot. Both fawn and buck pranced about in play for about 30 seconds, then fawn ran out of sight and the buck walked northeast toward small marsh; then out of sight behind thicket. 1851--Doe alert in direction fawn had gone; about 150 yards between doe and fawn-buck sequence.

July 7, 1962. (L-4) 1836--Two unmarked fawns (less than one month old) trotted south out of marsh, they immediately went out of sight behind aspen clone; no doe in sight. 1854½--Both fawns trotted into opening, stopped, alert to sound in brush to southeast (straight ahead 300 feet); tails tucked down. 1855--Both fawns feeding; a buck (probably a yearling, four-point) emerged from woods where noise was heard before. 1956--Buck approached fawns from about 250 feet with stiff-legged gait; fawns alert. Buck snorted and trotted toward fawns. Fawns ran (away) with tails up into aspen clone; out of sight. Buck trotted down slope to aspen clone and walked along just within its edge. 1900-Buck in aspen clone out of sight; fawns out of sight; (Buck appeared to be in playful mood).

July 12, 1962. (L-4) 1810--Single unmarked fawn at east edge of opening. Actually appears to be eating grass. Tail down. 1816--Fawn feeding in NW direction; moved about 20 feet in six minutes. (Tarsal gland hairs very white, prominant). No doe in sight. 1825--Fawn still feeding; not ranging far. No doe in sight. 1827--A deer snorted four times about 150 feet west of observer (Fawn about 200 feet east of observer). Deer, a yearling doe, then ran north, down hill; fawn not alerted. Doe alerted toward observer, but apparently did not identify me. 1830--Yearling doe approaching fawn slowly; fawn walking toward doe. They licked each other's face and ran nose along face. Yearling does not appear to be mother of fawn; no udder. 1831--Yearling doe and fawn feeding. 1835--Yearling doe out of sight in woods. Fawn feeding in field. Fawn still not more than 50 feet from where first seen.

As noted above, the fawn may cautiously approach another deer, or may quickly flee from it. It would appear that the reaction of the fawn is governed by the actions of the older deer in most cases.

Escape Behavior

During this period of isolated training, the escape behavior of the doe is similar to that described in the neonate period. When the doe is alarmed by some noise or object, she will give any one or several of the signals mentioned in the previous discussion. The doe may however, break into a full run without any apparent signal. I have found that a doe that is with or near her fawns will run with her tail tucked down tightly against her hindquarters. However, if the doe is not in the immediate vicinity of her fawns, she may run with her tail either up or down. The fawn always runs with its tail up.

The advantage of the doe escaping with her tail down so that the white "flag" is not exposed would appear to be the decreased opportunity to betray the position of her fawns. Yet this is paradoxical, for it would seem that it would be more advantageous for the fawn to run with its "flag" covered and thus aid in avoiding detection by potential predators. This is especially true during early stages of development when the escape behavior of the doe has often been suggested to function in leading predators away from their fawns.

If a fawn is with a doe when she becomes alarmed it immediately becomes alert. As the signals a doe may give are varied, it is difficult to ascertain which signals are most important in attracting the attention of the fawn. As the doe becomes alert, the fawn will usually stand still, with head up and looking in the same direction the doe is watching. As previously mentioned, the attention span of the fawn is short, and soon the alerted fawn will lower its head. It will often walk or trot to its mother's side. If the doe is extremely excited, the fawn may become nervous also, may pace about close to the doe, and may even attempt to nurse. There were no observations of fawns assuming a "freezing" position at such times. However, observations of this behavior at a later stage in the development of the fawn indicates that it probably still occurs during this period.

When the doe is sufficiently alarmed to run, the fawn will follow almost immediately. At this stage of development, rarely does the fawn make the initial flight movement. The fawn usually follows the doe, but quite frequently it will run in a direction different from that of the doe. In one instance a fawn was observed to take a flight direction 120 degrees from that of the doe. If twins are involved, and one takes a flight direction different from that of the doe, the other fawn usually follows its sibling. This again is probably the result of continuous association between twin fawns.

When a fawn is alone, it will invariably run from an intruder. It always runs with its tail up and there usually is no preparatory signal given other than an alert stance.

Period of Actively Accompanying the Doe

When the fawn reaches the age of three or four weeks it begins to follow the doe as she wanders about her home range. There does not appear to be a line of demarcation between this period of social development and the isolated training period. There is a gradual change in the ability of the fawn to withstand greater exertion and thus it attempts to travel farther. The doe does not actively encourage the fawn to follow her. Apparently the strength of imprinting and the fawn's physical capabilities are sufficient for the purpose.

Although this period is characterized by the active presence of the fawn with the doe, there are instances when the fawn may be left behind, and the doe wanders about alone, often for as long as eight or ten hours.

Ingestive Behavior

While the frequency of nursing decreases during this period, the nursing activity is still the strongest bond between the fawn and its dam. In the discussion of ingestive behavior during the neonate and isolated training periods, it was noted that the frequency of nursing was controlled by the doe in that she periodically returned to the fawn's location. As the fawn becomes physically capable of following the doe, this nursing pattern is no longer followed with regularity. The fawn can stay with the doe, and although the doe can discourage nursing by kicking or stepping over it, the fawn usually determines the frequency of nursing attempts.

As there are times when the doe and fawn are separated, the epimeletic and et-epimeletic forms of behavior included with nursing frequently resemble those of earlier stages of development. Excerpts from field notes can better illustrate the reactions involved.

> July 16, 1961. (M-27) 1842--An adult doe walked onto Reserve road east of gravel pit; walked south on road for about 25 yards; then walked into edge of marsh. Feeding; alert; raises head and looks about every 30-40 seconds. 1847--Doe alert to passing car about 200 yards to the east. 1852--Deer still feeding, but alert to passing truck. 1900--Doe feeding in same position, not alerted to passing car. 1910--Observer drove past doe at about 150 feet distance; doe ran out of sight into thicket. 1911--Two fawns feeding on west side of gravel pit at M-26 (I parked car farther down the road and returned on foot). 1914--Fawns on top of hill. 1919--Doe walked out of marsh; stopped; fawns ran to doe. Fawns nursing, one on each side. Doe's tail up during nursing; fawns' tails wagging while nursing. Fawns allowed to nurse 90 seconds. Fawns stopped nursing only when doe walked away. 1921--Fawns following doe slowly as she walks north toward base of large hill at O-27. 1928--Fawns following along behind doe as she feeds. Fawns feeding also; no further attempts at nursing made.

> August 2, 1961. (o-27) 1855--Two fawns at south base of large hill. 1856--One fawn

> bedded down in small clone of forbs, other fawn feeding nearby. 1857--Second fawn bedded down about 15 feet from first fawn. 1905--First fawn gets up, licks left flank and shoulder and then walks toward the second fawn. Second fawn alert toward first fawn. When first fawn reaches second fawn they rub sides of (their) heads together. First fawn then walks three or four feet and lies down again without making any preparatory bed. 1907--Adult doe walking toward fawns from west (a ridge on which a road is built prevents doe and fawns from seeing each other). When doe crossed road, she stopped about 75 feet from the fawns. Doe alert toward fawns; no vocal expression heard. Fawns got up and ran to doe. The second fawn (of above) got there first and went directly to the udder from a position between doe's front legs. The first fawn approached udder from left side. The doe stepped over the second fawn so both fawns were nursing from left side. The fawns nursed for 75 seconds. They became very abusive toward end of nursing (strongly butting and nudging udder). The doe hunched up slightly during nursing. While nursing, fawns wagged their tails continuously; the doe held her tail stiff about 20 degrees above horizontal. To terminate nursing the doe merely lifted her left hind foot over the fawns and walked away. The second fawn followed the doe for about five feet, but no further attempts (at nursing) were made. The doe and the fawns resumed feeding on grasses and forbs. 1915--Both fawns out of sight behind hill.

Although these animals were not marked, I am reasonable sure that they were the same family group in each instance. During each of the observations the wind was from the west, but in the first instance, the doe was east of the fawns and in the second, their relative positions were reversed. The stimulus that caused the fawns to run to the doe was apparently sight or sound of the approaching deer rather than odor carried on the wind.

Collias (1956) has noted that one signal stimulating and permitting the kid (goat) or lamb (sheep) to nurse is the abrupt cessation of movement by the dam which then stands still while the young one sucks. In each instance of nursing during this study the doe has always stopped walking and feeding prior to the successful approach of the fawn to nurse.

The following observation, although not directly associated with nursing, illustrates the response of the fawn to a sound stimulus.

> July 19, 1962. 2015--A lone fawn was sighted at K-4 and it ran NE about 180 feet, then stopped on the top of a small hill. The fawn was an estimated five weeks old, and we decided to attempt capture by chasing it toward one of us or into the nearby marsh. The fawn was aware of me (LMQ) on an adjacent hill and had its attention focused on me. A second person (Mrs. R. J. McNeil) remained near the bottom of the hill, and a third party (R. J. McNeil) attempted to get behind the fawn and move it toward the marsh. McNeil was out of sight of the fawn and about 35 yards from it when the fawn shifted its attention to a sound made by the man. The fawn looked again toward me and then began trotting toward the sound it had heard. The fawn was in full view of McNeil when about 25 yards from him but continued to run toward him. The fawn ran to within five or six feet of McNeil and then stopped. McNeil moved slowly away from the fawn to see what it would do. The fawn then took two steps toward the man, hesitated for an instant, then turned and ran.

It would appear that the fawn responded to the sound of the man walking as perhaps it would if its dam were approaching. The action was definitely initiated by sound. The fawn was possibly less alert than usual when running toward the sound because of the stress placed on it by my presence.

During this period there is naturally an increased use of forage on the part of the fawn, and subsequently a decreased reliance on nursing. The fawn's use of forage at the beginning of the period may be limited to taking bits of vegetation protruding from its mother's mouth. The foraging activity of a two-month old fawn is very quickly seen to be similar to that of an adult deer. The fawn never remains long in one place, and subsequently feeds on several species of plants in a short span of time. This is identical to the activity of the adult deer. The transference of this habit to the fawn is most probably due to the frequent attempts by the fawn to "catch up" with the doe.

Weaning appears to be the result of two main factors, 1) the reduced need for milk by the fawn and therefore a reduction in nursing frequency, and 2) the reduced supply of milk produced by the doe. From general observation, it is apparent that nursing is uncomfortable to the doe, and it is my opinion that when the discomfort to the animal due to pressure from a large volume of milk in the udder is greater than the discomfort received during nursing, then the doe allows the fawn to nurse. And, as the fawn grows older and takes a proportionately larger volume of milk, the time intervals between the build-up of pressure becomes longer. If such is the case, then a natural self regulating mechanism is involved which determines the time of weaning.

The weaning process may not be completed during this period and fawns may be observed to nurse even after the deer begin to associate in larger groups. The fawn's desire to nurse probably outlasts the supply of milk produced by the doe.

On June 24, 1961, an adult doe and a yearling doe were alerted by my car. The yearling doe became slightly nervous and trotted to the adult doe. The yearling then nuzzled the udder of the doe and nursed briefly. The adult doe had a well developed udder and did not reject the nursing attempt of the yearling. No fawn was ever seen with the adult doe which was readily identifiable by a noticeable limp as it walked. Altmann (1960) has reported yearling elk nursing adult cows on two different occasions. In each instance the cow had apparently lost its calf.

Concerning the doe-yearling nursing incident, a dead fawn was found on June 3, 1961, within 100 yards of the observation location. The fawn was believed to have been killed by a fox (McNeil, 1962). As the adult deer was never seen with a fawn it is probable that the dead fawn was hers. The yearling doe was not rejected in its nursing attempts because of the unrelieved pressure in the adult's udder.

Adult deer frequently were seen to feed on submerged aquatic plants in the artificial ponds and marshes when water was at a high level. This appeared to be a taste oriented habit acquired by only a few of the deer. Some repeatedly were observed in this activity while others were never seen in the vicinity of the open water. Although adult deer frequently were observed to drink surface water, fawns were never seen to do so. Several fawns of varying ages were observed in marshes, but none was observed to drink. Perhaps the fluid obtained in nursing and from plants meets the water requirements during the early stages of development of the fawn.

Investigative Behavior

Soon after the fawn begins to actively follow its dam, it develops investigative traits which are similar to adult deer. When the fawn is feeding it pauses every 40 to 50 seconds to glance around the area. Such quick appraisals of the area are usually associated with determining the location of its dam or that of its sibling.

When a sound, different from the usual background noise, is heard, the fawn quickly responds by raising its head to full height with ears cocked forward. If not excessively alarmed, it usually resumes feeding more quickly if the sound is repeated than if emitted only once. This may be because the distance and direction of the sound are not readily determined when it is not repeated.

Reactions of six-week old fawns to unidentified objects are very similar to those of adult deer. The fawn usually will approach the object slowly, with a stiff gait, stamping one of its front feet at various short intervals. It may slowly lower its head so that its eyes are level with the tops of plants and then quickly raise it. Such behavior is seen frequently in adult deer. It may serve to give the deer a different perspective of the object, or it may be an attempt to cause the object to move. The hair of the tail and the tufts of hair around the tarsal and metatarsal glands may be erected and become very noticeable. No fawn less than five months old was observed to snort as do adult deer when alarmed or curious.

The stiff-legged gait of deer and stamping of the front feet serve as a warning for other deer present. Upon execution of such behavior, other deer become alert, watching in the same direction as the alerted deer. Often, deer alerted by the warning signals of another deer are the first to run even though they are not aware of what has caused the original alarm or curiosity.

There are insufficient data to determine how the fawn learns the traits of warning behavior, but it might be conjectured that the fawn becomes aware of the actions of the doe under certain stresses and then copies them. When later confronted with an identified object the fawn then responds with actions similar to those of the doe.

Reactions to Deer Other Than the Family Group

Although the fawns actively follow their mother during this period, they are still prevented from making and maintaining social contact with other deer in most instances. The following excerpts from field notes serve to show typical responses of adult does in preventing such contact.

> August 14, 1961. (F-12) 1805--Doe and male fawn (Deer No. 1) feeding on sweet clover north of pond. 1809--Doe alerted to car on main (Reserve) road, but did not move; fawn out of sight, bedded down. 1813--Doe alert to south and west; resumed feeding. 1815--Doe alert to west (toward road), then to south (across pond), then resumed feeding. 1820--A second fawn (Deer No. 1 known to be a single fawn) entered sweet clover from woods at east edge of opening. The tagged fawn (No. 1) got up quickly; the two fawns approached each other with heads and necks outstretched; both walking slowly. The mother of the tagged fawn was watching intently. When the fawns touched noses, the untagged fawn shook its head violently to the left then jumped into the air, coming down stiff-legged on all-fours; it then ran off a few feet. The untagged fawn then approached the doe (mother of No. 1); when about five feet from the doe it (the fawn) quickly ran away about 20 feet. A second doe ran from the woods, ran around the untagged fawn and drove it back into the woods; Deer No. 1 followed. Shortly (30 seconds) the first deer slowly walked into the woods.

> July 15, 1962. (E-11) 1940--Deer No. 9 (Two-year old doe) feeding in blackberry patch northwest of pond. Two yearling does feeding at and in edge of pond. Deer No. 9 and yearlings about 150 feet apart; neither concerned about the other. Fawn of Deer No. 9 not in sight. 1947--Yearling does still in pond, but out of sight. 1950--Considerable splashing, yearlings may have left pond. Deer No. 9 alert toward splashing; begins walking rapidly toward area. 1952--Deer No. 9 with head and neck outstretched,

chasing yearlings; but they did not leave area. 2000--Deer No. 9 with fawn (Deer No. 18) alert. 2004--Both Deer Nos. 9 and 18 walking northeast. 2006--Yearlings snorted and ran northeast of Nos. 9 and 18; doe and fawn alert to snorts and other movements. 2007--Yearlings snorted again; fawn immediately alert in their direction. 2008--Doe and fawn walking west out of sight.

August 2, 1962. (Q-2) 0530--Yearling doe (Deer No. 10) walking and feeding along firebreak in southeast direction generally on a course to intercept a doe and two fawns feeding in field. One of the fawns is marked (Deer No. 21). 0533--Fawn (Deer No. 21) walked toward Deer No. 10 with tail stiff and horizontal, neck outstretched. Deer No. 10 approached fawn with head and neck outstretched. They touched noses briefly then the fawn ran about 20 feet. The other fawn repeated the above action almost exactly the same. 0535--The adult doe then laid her ears back, with neck outstretched chased the yearling. Deer No. 10 then continued southeast. Doe and fawns feeding near apple tree.

August 15, 1962. (N-14) 1940--Deer No. 13 (yearling doe) feeding near apple tree near big house. Deer No. 15 (adult doe and mother of No. 13) trotted toward (apple) tree then slightly beyond it to northeast. Deer No. 15's two fawns follow. Deer No. 15, with ears laid back, neck outstretched, ran at Deer No. 13 and chased it away. The fawns followed the running yearling (apparently unable to distinguish between escape behavior and agonistic behavior of No. 15). Deer No. 15 remained to eat apples. 1943--Fawns of Deer No. 15 began to walk toward Deer No. 13 (Fawns and yearling stopped running about 150 feet NE of apple tree). One fawn walked up to head of Deer No. 13. The yearling licked the face and ears of the fawn. The fawn walked along flank, put head to udder (Deer No. 13 is a barren yearling). No. 13 turned her head to anal region of the fawn and the fawn trotted off 10 to 15 feet. Deer No. 15 trotted toward Deer No. 13 and when about 30 feet away from the yearling, No. 15 broke into a fast run (no bounding), chasing Deer No. 13 at very close range (5 to 10 feet) for at least 100

> yards, then out of sight. The fawns followed the two running deer. The four deer were later seen feeding in opening at 0-15; Deer No. 13 feeding slightly apart from the doe and fawn.

The agonistic behavior shown by adult does to other deer which venture too near their fawns is characterized by a posture of ears laid back along neck and with head and neck outstretched. Quite often the challenged deer will retreat without actually being chased. The stretching out of the head and neck, and the flattened down ears can be observed in the actions of the fawn when assuming a "freezing" attitude and also when they approach other deer. In the latter case, it does not appear that a challenge is being issued, but rather that the fawn is approaching the other deer in a state of "apprehensive curiosity".

Interactions between fawns and deer other than the family group when the doe is not present are usually infrequent because the fawns are normally with their dams most of the time. Such interactions when they do occur are usually associated with curiosity on the part of the fawn rather than active participation of the other deer. In one notable instance, et-epimeletic behavior on the part of a fawn, apparently separated from its dam, accounted for a series of interactions with other deer.

> July 22, 1961. (Q-1, Q-2, R-1, R-2) 1940--A single fawn standing near west fence (Q-1), about 40 feet north of edge of woods; very alert. 1942--Second doe (from earlier in notes) feeding

in wooded portion of fence row. 1946--The doe that walked behind me at 1930 ran south into marsh; fawn alert in the direction. 1950--Fawn aware of fox squirrel in the branches over its head; watching squirrel as it moves in tree; fawn does not appear to be nervous. 1953--The second doe standing on hind legs to feed on oak leaves; then walked into opening again. Fawn still standing next to fence. Doe alerted toward fawn, apparently caught scent on wind; about 150 yards separate them. 1955--A hawk (Buteo sp.) calls twice very loudly, second doe alert in direction of hawk calls (NE), which is also the direction that doe came from. Doe runs north and east (as hawk calls resume) then stops as hawk calls fade in distance. 2000--Second doe feeding north across opening, alert to every bird call and other sounds; fawn still standing near fence, alert. 2006--An 8-point buck enters open field from northeast corner. Second doe alert toward southeast then north toward buck. The fawn is standing in the firebreak then runs toward southwest corner of opening where the first doe (seen prior to 1940) emerges from the woods. The fawn then runs north along west fence, ahead of doe into wooded portion of fencerow. The first doe is feeding in the fencerow. The second doe and the 8-point buck feeding in center of open field about 150 feet apart. The doe in the wooded portion of fencerow is apparently not the mother of the fawn, because at 2010 the fawn left the fence row and ran to the second doe and immediately tried to nurse, then quickly turned away and uttered a short bleat (the first part of the bleat was low and guttural then rose to a higher pitch similar to a loud cat "meow"). The doe made no visible attempt to reject the fawn. The fawn then ran toward the 8-point buck, stopped when about 30 feet from him and uttered another bleat, then ran back to the doe. Meanwhile, a 6-point buck and the first doe entered the field. The fawn then very quickly (in succession) tried to approach the 8-point buck, the second doe, and the first doe, and was rejected each time. The 8-point buck rejected the fawn by turning and taking a few rushing steps toward it. The first doe rejected the fawn when their muzzles touched, (the fawn jumped back probably from odor or a snort from the doe). 2020--The 8-point buck aware of observer and slowly approached me; then ran north followed by 6-point buck. The does ran north followed by the fawn.

Interactions between adult does and other deer when the fawns are not present do not appear to be of an aggressive nature. On several occasions during the summer of 1962, Deer No. 16, an adult doe with two fawns, was observed to feed with other deer with no apparent antagonism. There appears to be no concerted attempt on the part of the does to remain separated from other deer, regardless of sex, if their own fawns are not in the immediate vicinity.

Reaction to Other Animals

Riney (1951) has discussed the role of birds in alerting mule deer to possible danger through the medium of alarm calls of the various species. If the deer are not alarmed to the point of running for the shelter of surrounding cover, they become quieted as soon as the birds resume their normal "non-alarmed" behavior.

During the present study, deer were alerted to my presence on several occasions by the alarm cries of blue jays (_Cyanocitta cristata_). If I remained immobile for a period of time sufficient to allow the birds to cease their alarm cries the deer would soon return to their previous activity. If the birds continued to be alarmed, the deer would usually leave the area, even though I was reasonable sure that they actually had not seen me.

Small ground nesting birds are flushed frequently by feeding deer. Usually the sudden flight of the bird from near the deer's feet will result in a startled jump backward or to the side. If a deer has been alerted to some other disturbance previous to the flushing of the bird, the deer may respond with a much longer run, perhaps even to the extent of entering the protective cover of a woods or marsh. On one occasion, a vesper sparrow (Poaecetes gramineus) was flushed by a deer, but rather than fly away, the bird remained in the area of its nest and hovered very close to the deer's head. This hovering flight continued for about 45 seconds, during which the deer merely winced, blinked its eyes, or pulled its head back from the bird as it repeatedly came close. The bird made no actual contact with the deer, and the deer continued to feed, moving slowly away from the nest site. The bird then discontinued the hovering "attack" and returned to a bush near the nest.

Deer frequently become alert to the hunting cries of hawks (Buteo spp.) but on only one occasion (page 82, this paper) did a deer respond to a hawk call by a directional movement. The action of this doe appeared to be directed toward the probable location of her fawns, as they were not with her. Hawks of the genus Buteo are known to eat deer carrion, but have not been reported as actually preying on fawns (Riney, 1951). It may be that this behavior stems from earlier evolutionary stages when larger raptorial birds capable of preying on fawns were abundant. Such a suggestion has been made for the behavior of mule deer regarding sounds made by predatory mammals (Linsdale and Tomich, 1953).

The red fox is the only potential mammalian predator of fawns on the George Reserve, with the exception of occasional stray dogs. I observed no interactions between deer and foxes, although the latter were seen frequently, and at least two litters of pups were whelped during the second year of the study. In June 1961, a fox was seen dragging a partially eaten fawn toward its den, and it was believed a fox had killed the fawn (McNeil, 1962).

Interaction between deer and other small mammals were observed, and generally no alarm was exhibited. Fawns were extremely curious about the activities of fox squirrels (Sciurus niger), and were seen to watch them for several minutes at a time. Deer and raccoons (Procyon lotor) were seen to drink from a pond when only 15 feet apart with no apparent concern for each other.

On one occasion in March 1961, prior to the present study, I observed three deer (sex and age unknown) take alarm and retreat running when a woodchuck (Marmota monax) approached to within 120 feet of them and then stood on its hind legs.

In general, most small mammals were not considered to be of great importance in the behavior reactions of white-tailed deer on the George Reserve.

Play Behavior

Play behavior in the white-tailed deer is not well developed (Severinghaus and Cheatum, 1956). During the present study, very few observations were made that could even remotely be thought of as play. These few instances consisted of two or more deer, usually with a fawn involved, jumping around stiff-legged in a small area, then chasing one another for short distances. There were no elaborate games of "Tag" and "King of the Hill" such as described for red deer (Darling, 1937) and goats (Collias, 1956).

Eliminative Behavior

There appears to be little social significance associated with elimination of body wastes by white-tailed deer. Certain predictable characteristics are noted however.

Deer seldom urinate or defecate while bedded down. The animal usually rises, perhaps stretches its body by standing on front legs and alternately extending its hind legs, then walks off a few feet and defecates. Urination usually follows a few minutes later, when the deer is walking or feeding.

When defecating, the deer usually does not interrupt its prior activity, however, when a deer urinates, it stops all previous activity, arches its back, spreads its hind legs and relieves itself. This characteristic stance has also been noted in the discussion of nursing.

Seton (1927) and Nichol (1938) have described the habit of white-tailed deer urinating on their own tarsal glands. The latter worker has termed this behavioral trait as "unexplained" in function and "important" in the deer's life and well being. During this entire study, this behavior trait was never observed. It may be that the trait more readily occurs in penned animals.

Escape Behavior

When the fawn is actively accompanying the doe, escape behavior begins to resemble that of adult deer. Usually, when a doe with a fawn is alarmed, she will exhibit any or all of the previously described warning signals. The deer may, however, take full flight with no apparent prior signal. The fawn's response to warning signals is varied. It may become alert toward the doe or in the direction of the supposed danger; it may run to its dam, and it may even attempt to nurse because of the doe's non-moving stance. Rarely does the fawn run to escape cover before the doe, unless it is the first deer in the group to be disturbed.

One aspect of escape behavior that reflects remnants of earlier stages of fawn development is that of a "freezing" reaction. This is commonly seen in the neonate period, but it was not observed during the period of isolated training, although it probably occurs. Two instances of this behavior were observed in older fawns.

> July 19, 1961. (Q-4) 1930--A fawn standing in a small glacial depression. When approached by observer's car (75 feet), the fawn dropped immediately to the ground, but did not put its head low. (The area where the fawn dropped was fairly open, lily-pads and cattails, and the fawn could be seen easily from the car). After about 45 seconds the fawn raised its head higher and looked about, then arose and ran into the cattails out of sight; there were no adult deer in sight.
>
> July 28, 1961. (N-15) 0830--A doe and fawn entered the edge of woods east of Hill an' Dale House. The doe was aware of the car in which I was sitting, but was more concerned about noises being made by a worker about 100 yards farther east. After about 30 seconds the fawn laid down but did not lower its head. When the doe turned to leave about three minutes later, the fawn got up and followed. There were no discernible signals given by the doe.

In both of these instances, there was stress placed on the fawn, once in the form of the sound of my approaching automobile (fawn did not appear to see car), and in the second case, the alert stance of the doe (again, the fawn was not aware of the car). However, in each case, there was no reinforcement of the "freezing" behavior by sudden movements of the dam. I think that when the fawn is able to see the object causing the alarm, the behavioral traits exhibited by older deer would be utilized rather than a regression to neonate behavior.

When does and fawns are escaping together, they may follow one another, or they may go separate directions. As discussed in the isolated training period, a fawn will usually follow its twin if it goes in a direction different from that of its dam.

In general, as fawns become older, the form of escape behavior becomes more allelomimetic in nature, several deer responding to the same stimulus in a similar manner. In many cases it is a chain reaction, first one deer running, then another, until finally there is a wild scramble of fleeing deer. When fawns are the first of a group to be alarmed, they may take the lead, with the adult deer following.

An observation by Riney (1951) concerning mule deer is very typical of white-tailed deer and can be used to summarize the escape behavior of deer. Riney states that:

> Reactions of deer to a disturbance vary from mild curiosity to headlong flight and may vary among individuals, being different for the sexes, the various age groups, and at different seasons. As a general rule, the more sudden and greater the disturbance, the quicker and stronger the reaction. But if a deer or group of deer has already been alerted by some disturbance, then the slightest sound or movement is apt to cause flight.

Social Integration into Larger Groups

This fourth stage of social development in the white-tailed fawn is based on factors other than age and physical development. The period, which starts prior to the breeding season, is characterized by an increased tendency for deer to congregate in small groups. The deer are much quieter, less easily alarmed, and adult does are extremely tolerant of other deer that come in contact with their fawns.

On the George Reserve, this phenomonon was observed by McNeil (Personal communication) to begin about the second week in September in 1960. My own observations placed it at approximately the same time in the summers of 1961 and 1962.

Additional deer may be involved, but the usual grouping appears to consist of a doe, her fawns, and her yearling fawns of the previous year. This has often been surmised, but by observing marked deer, it has been proved to exist for at least some family groups.

Deer No. 15, an adult doe, and her two doe fawns of 1961, Deer Nos. 12 and 13, were constant companions until the doe gave birth to new fawns in June 1962. The two yearlings were not seen with Deer No. 15 during the entire summer, with the exception of one agonistic encounter (see page 80, this paper). Then, on September 19, 1962, the doe, her yearlings, and her two current fawns were observed to be grouped together, feeding and wandering about the area. The same grouping was observed on six occasions prior to September 28 by Bernard E. Wall, a graduate student living on the area.

That a doe becomes tolerant of other deer which make contact with her fawns, when only two or three weeks previously she would have driven them away, indicates a physiological or psychological change in the temperment of the doe. This change coincides with pre-rut changes of the bucks. The physiological changes in the males are accompanied by the hardening of the antlers, the removal of the dried vascularized skin or velvet, and the swelling of their necks. I think it can be assumed that the alteration of behavior in the does is related to the physiological preparation for the breeding season. The factor which initiates the change in does is unknown. However, the seasonal regularity of day length indicates that decreased light duration and intensity may be a prime factor. Other factors such as temperature, food supply, or internal rhythms may be involved.

Two facts are certain: 1) the change occurs, and 2) the change is an essential stage, not so much in the social development of the fawn as for successful completion of breeding. If, for example, the doe remained intolerant to the presence of other deer near her fawns, then her behavior in isolating her fawns would act as a deterrant to successful breeding because she would have the tendency to drive the breeding male away from the fawns and therefore herself.

The period of calmness prior to the rut allows the does to feed quietly without having to be overly concerned about their fawns. This is necessary to gain the much needed energy for the rut and sufficient fat deposits to tide the deer over the winter and thus produce healthy fawns the following spring.

At the onset of this integration period the fawn is very curious about other deer and may repeatedly approach each one present. After a few days the fawn appears to become adjusted to the presence of other deer and usually feeds quietly with the group. However, it still maintains a close tie with its dam, returning to her to nurse (if weaning is not completed), running to her when alarmed, and following her if she leaves the group. In general, although there is socialization with other deer, the family group of the year remains intact.

SEXUAL BEHAVIOR

The various aspects of the breeding of white-tailed deer have been reported by many workers (Caton, 1877; Lantz, 1910; Newsom, 1926; Seton, 1927; Skinner, 1929; Nichol, 1936; Bronson, 1942; Carhart; 1946; Severinghaus and Cheatum, 1956), and I will not attempt to reiterate it here. My discussion concerns only the role played by young deer.

Precocial sexual behavior in mammals in not uncommon. Scott (1958, p. 21) observed a 12-day old lamb attampting to mount the mother of a newborn lamb. The older lamb then attempted to mount its own mother. Scott suggests that the odor of the newborn lamb acted as a stimulus for the sexual behavior. Collias (1956), in describing the sexual behavior of male kids (goats), noted that mounting of other kids, male or female, was first seen on the ninth day after birth. This was followed and accompanied by pelvic thrusts (12th day) and penile erections (three months).

During the present study, precocial sexual behavior was observed in males only once. In this instance, a male fawn (Deer No. 21), 58 days old, was observed to smell the genitalia of its dam. It then tried to mount the doe and made three pelvic thrusts. The doe made no attempt to avoid the fawn. The fawn and its twin (sex unknown) tried to nurse almost immediately afterward, but were avoided by the walking movement of the doe.

Precocial sexual behavior was not recorded in female fawns, but as the male is the aggressor, it is possible that female sexual behavior could be exhibited and simply not recognized as such.

Cheatum and Morton (1946) concluded that "apparently bucks do not attain sexual maturity in their first year and are about 18 months old at the time of their first (participation in the) rutting season". While the foregoing is generally true, Johnson (personal communication, September 1962) reported that a male fawn successfully mated with a female fawn on January 29. On December 2, 1961, on the George Reserve, a buck fawn (Deer No. 1), 170 days old, mounted its own dam and made several pelvic thrusts. The doe did not attempt to avoid the fawn. This was the only instance of participation of a buck fawn during the 1961 breeding season. Breeding of female fawns was not observed.

During the rut, when bucks are actively pursuing does, there appears to be no agonistic behavior between bucks and male fawns accompanying the does. Neither was there any antagonism between does and their doe fawns in the presence of a breeding male. As buck fawns do not usually participate in the breeding the former observation is not unexpected. That a doe does not discourage the presence of her doe fawn when she herself is recptive indicates that the doe fawn is probably not in heat. Generally the peak of fawn birth to adult does is about one month earlier than the peak for does bred as fawns. As most adult does would have been bred by the time the doe fawns first come into heat, it can be assumed that there would be no antagonism between the deer for this reason.

When a buck was seen actively pursuing a doe, it was noted that the fawns remained in the immediate vicinity as the doe tried to avoid the buck. The running activity of the doe and buck did, on occasion, result in a following response by the fawns. While this following response might have resulted indirectly from the courting behavior, a more simple explanation would be that of allelomimetic behavior. It appeared that the fawns responded to the running of the adult deer as they might in an escape reaction.

No copulation activity was observed during the breeding season other than that of the male fawn (Deer No. 1). Therefore, the behavior of fawns in the presence of the actual mating is not known.

Three instances of obvious sexual behavior outside of the normal breeding season were observed. In late April 1962, a male fawn was observed to mount an adult doe, perhaps its own dam. No particular avoidance action was noted. In the second occasion, on May 28, 1962, a male fawn with errupting antlers was seen to mount a doe fawn (Deer No. 11) and remain mounted for about 30 seconds. The doe, almost a year old, remained motionless with back arched while the buck made several pelvic thrusts. In the last instance, a yearling buck with forked antlers (June 1961) mounted another buck. The second deer moved quickly to avoid the aggressive buck.

Each of these instances occurred during the period of early antler growth and it is probably that increased testosterone in the endocrine system was the cause of the sexual behavior.

RANGE

Home range is that area traversed by the individual animal in its normal acitvities of food gathering, mating, and care for its young (Burt, 1943). Occasional sallies outside of the area, perhaps exploratory in nature, should not be considered as part of the home range. The size of the home range for individuals of a particular species vary with sex, age, and season.

The range of the white-tailed deer has been discussed by many workers, and it is the general opinion that the seasonal range is not greater than one mile (Severinghaus and Cheatum, 1956). However, the summer and winter ranges of an individual deer are often quite different and may be separated by a considerable distance. Tagging studies in Minnesota (Olsen 1938; Morse, 1942) indicated that marked bucks recovered during hunting seasons were, on the average, five to six miles from the wintering areas where they were originally captured. The seasonal differences in the range of does was considerably less, the majority being taken within one mile of the tagging site in one study (Olsen, 1938), and an average of four miles in the other (Morse, 1947). McBeath (1941) reported that 82 per cent of 39 tagged deer recovered in northern Michigan were taken within 15 miles of the winter yard where they were captured. The distance between summer and winter ranges in southern Michigan is undoubtedly less than in northern Michigan because of milder climatic conditions and the extreme dissection of habitable deer range by urban and agricultural uses in the south.

The fence surrounding the George Reserve results in home ranges for deer which are certainly artificial, and for this reason, little information was obtained concerning deer movements that are applicable to deer under natural conditions. However, some knowledge of the relative size of a deer's range during various aspects of its life history can be discussed.

During this study the sightings of all marked deer were recorded on maps. Four adult does (Deer Nos. 8, 9, 15, and 16) were captured in January and February 1962. They were seen frequently and their movements were recorded in relation to the pre-fawning and post-fawning periods. The pre-fawning period as defined previously was considered to begin in the last week of March. Only observations after March 24 are included. The beginning of the post-fawning period was not generalized, but was dependent on the approximate date of parturition for each individual. Observations on this aspect of the behavior study were terminated on September 15, the approximate date when social integration of fawns into larger groups began.

To determine the size of the range for each deer during the various periods, connecting lines were drawn from points 330 feet (the width of one grid sector, Figure 2) beyond the outermost sight locations of the tagged animal. The area within these boundaries was then measured with a planimeter. Where certain topographic features indicated possible restrictions on the range of a particular deer, the lines connecting widely spaced locations followed more closely to the intermediate locations thus forming irregular boundaries. The distance of 330 feet was selected because it was the most accurate measurement applicable to the aerial grid map.

Deer No. 8, an adult doe, was seen 16 times during the pre-fawning period. The estimated range was approximately 240 acres, and the greatest linear dimension was 1725 yards (Figure 9). Deer No. 8 gave birth to twin fawns (one is Deer No. 23) on June 18. The doe or the fawns were seen 10 times during the post-fawning period. The estimated post-fawning range was 87 acres.

There were 14 pre-fawning observations of Deer No. 9, a two year old doe (Figure 10). The range of this doe was estimated to be 215 acres and was at least 1655 yards long. A single male fawn (Deer No. 18) was born to Deer No. 9 on June 7. The doe or the fawn was later observed on 11 different occasions. The range of the doe during the post-fawning period was approximately 128 acres.

The great similarity in the ranges of Deer Nos. 8 and 9, both in size and shape, and the relative ages of

Figure 9. Pre-fawning and post-fawning ranges of Deer No. 8. 1962

LEGEND

🔴	Late winter sight location
○	Pre-fawning sight location
— —	Pre-fawning range boundary
●	Post-fawning sight location
- - - -	Post-fawning range boundary
X	Fawn alone
⊗	Fawn with doe

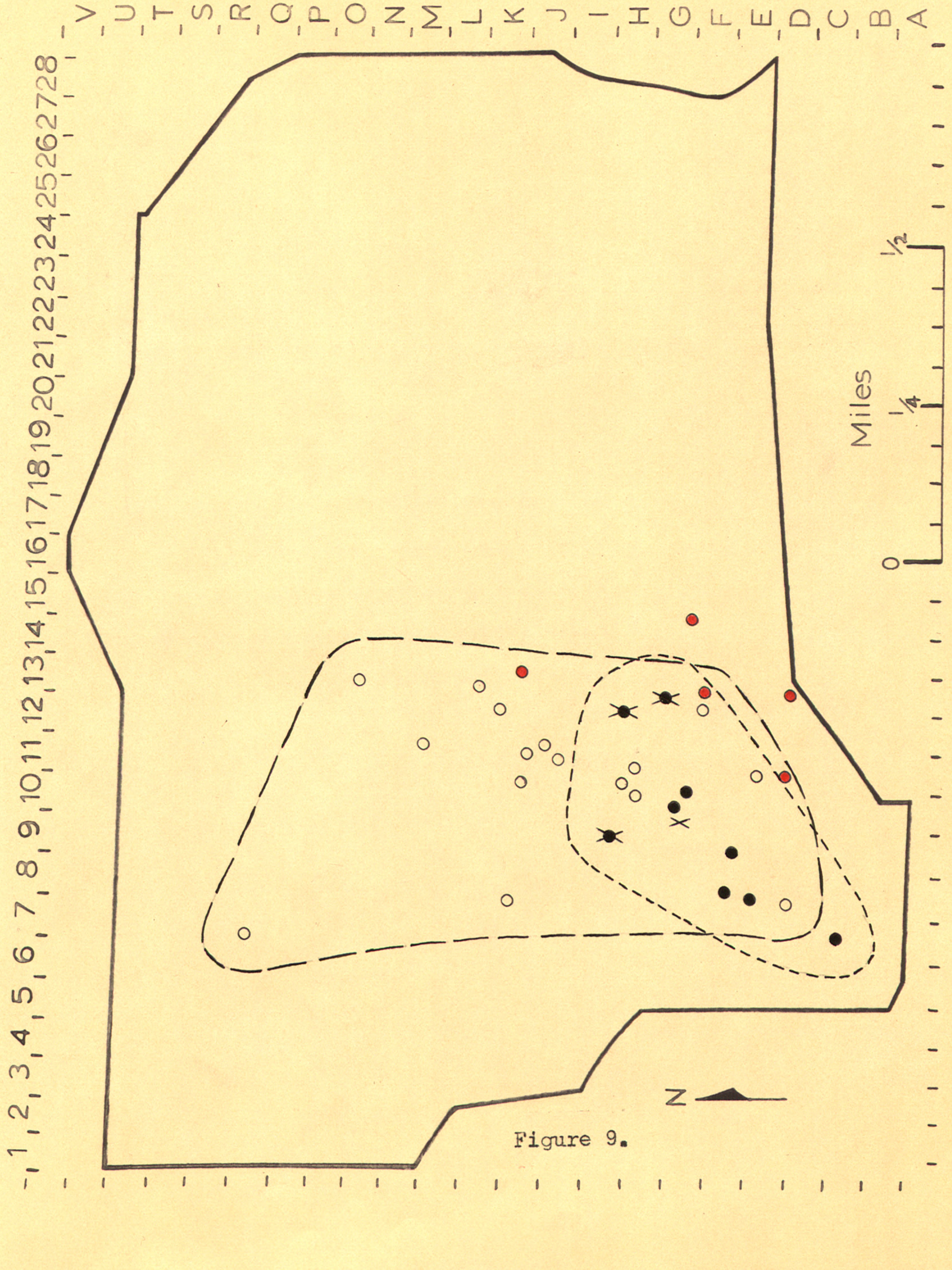
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Figure 9.

Figure 10. Pre-fawning and post-fawning ranges of Deer No. 9. 1962

LEGEND

🔴 Late winter sight location

○ Pre-fawning sight location

— — Pre-fawning range boundary

● Post-fawning sight location

- - - - Post-fawning range boundary

X Fawn alone

✖ Fawn with doe

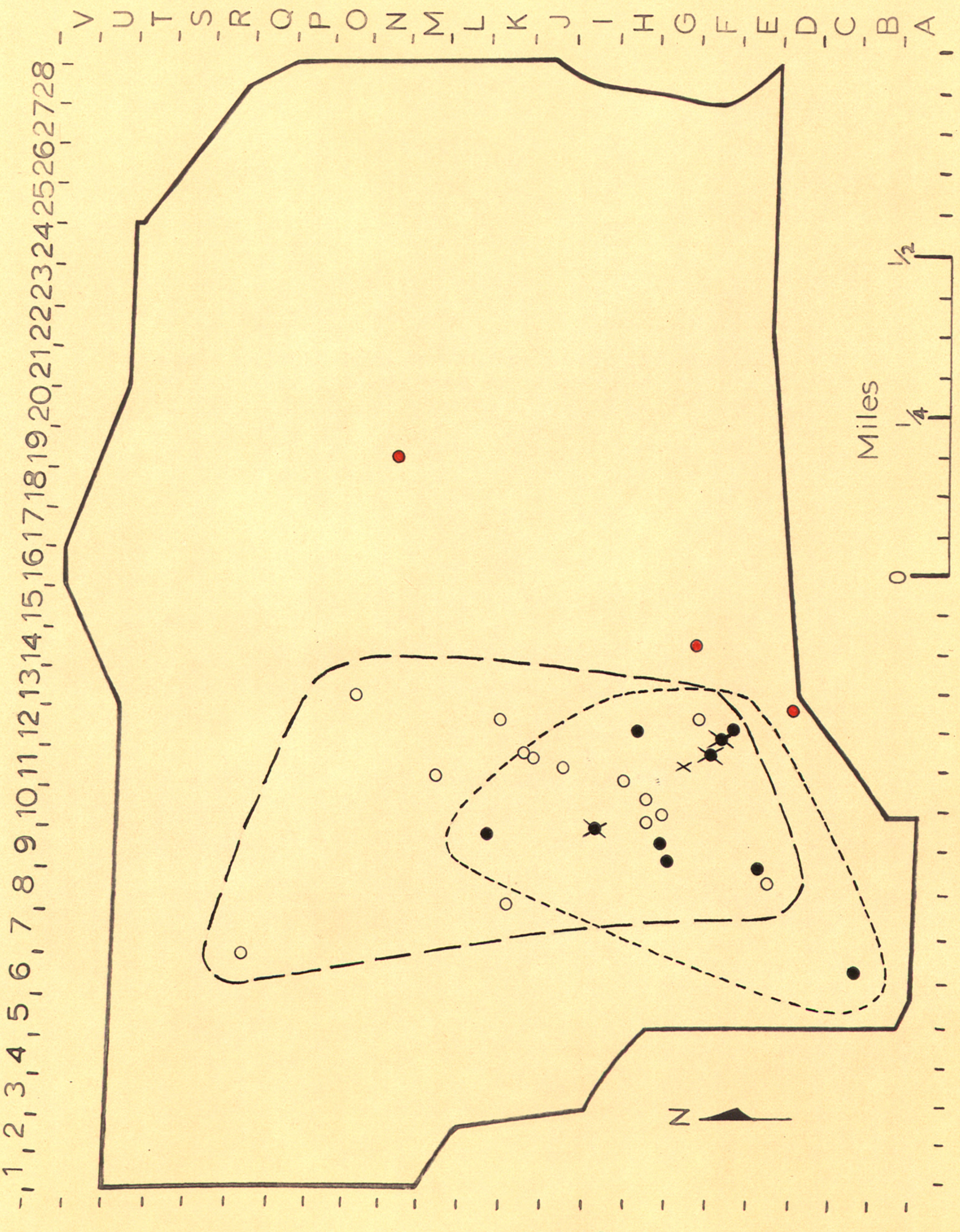
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Figure 10.

Figure 11. Pre-fawning and post-fawning ranges of Deer No. 15. 1962

LEGEND

🔴 Late winter sight location

○ Pre-fawning sight location

—·—Pre-fawning range boundary

● Post-fawning sight location

----Post-fawning range boundary

X Fawn alone

⊗ Fawn with doe

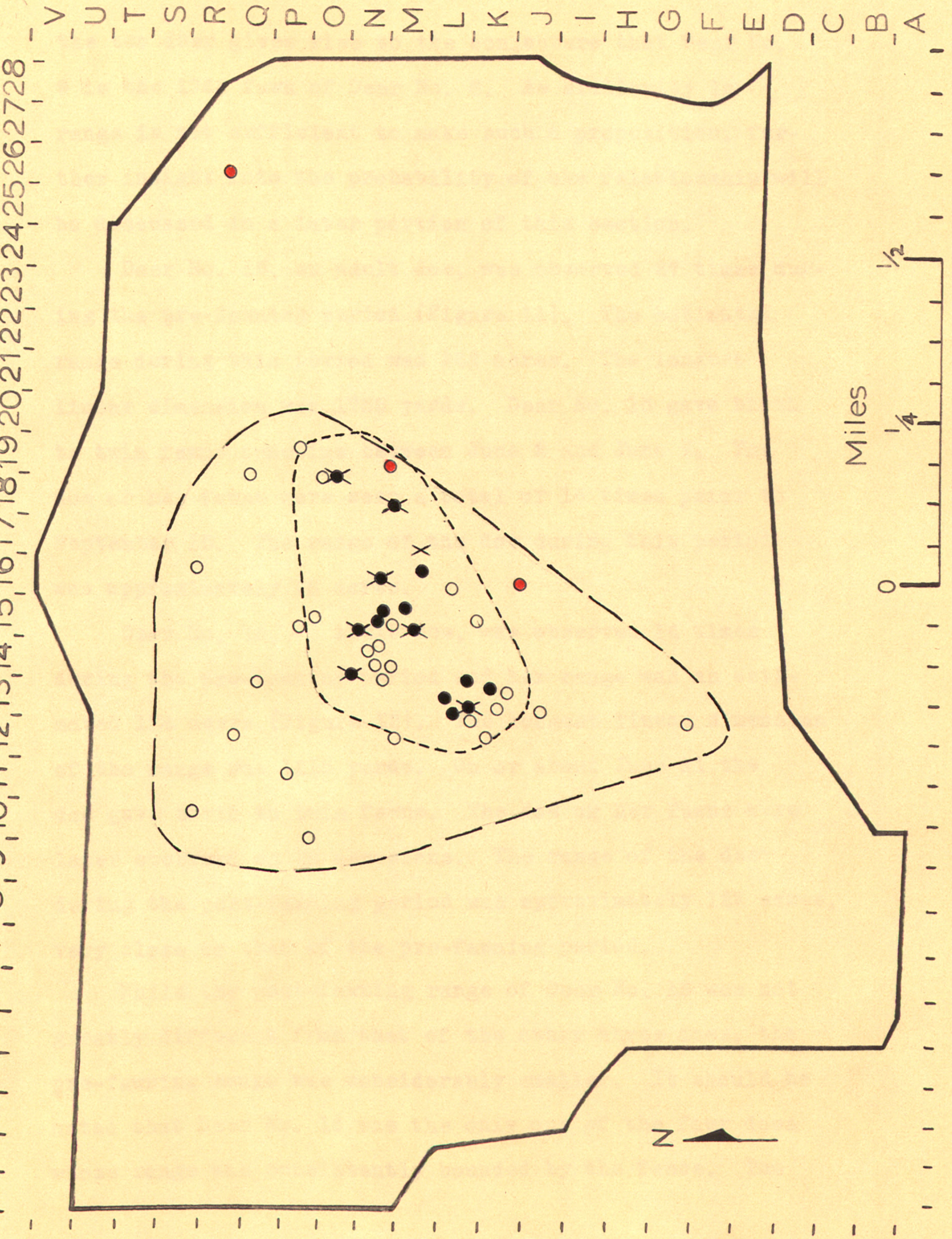
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Figure 11.

the two deer gives rise to the conjecture that Deer No. 9 is the 1960 fawn of Deer No. 8. As similarity in range is not sufficient to make such a proposition, further insight into the probability of the relationship will be discussed in a later portion of this section.

Deer No. 15, an adult doe, was observed 27 times during the pre-fawning period (Figure 11). The estimated range during this period was 252 acres. The longest linear dimension was 1755 yards. Deer No. 15 gave birth to twin fawns sometime between June 2 and June 7. The doe or her fawns were seen a total of 16 times prior to September 15. The range of the doe during this period was approximately 73 acres.

Deer No. 16, ad adult doe, was observed 14 times during the pre-fawning period and her range was an estimated 124 acres (Figure 12). The longest linear dimension of the range was 1215 yards. On or about June 11 the doe gave birth to twin fawns. The doe or her fawns were later observed on 20 occasions. The range of the deer during the post-fawning period was approximately 129 acres, very close to that of the pre-fawning period.

While the post-fawning range of Deer No. 16 was not greatly different from that of the other three does, the pre-fawning range was considerably smaller. It should be noted that Deer No. 16 was the only one of the four does whose range was consistently bounded by the fence. The

Figure 12. Pre-fawning and post-fawning ranges of Deer No. 16. 1962

LEGEND

🔴 Late winter sight location

○ Pre-fawning sight location

— —Pre-fawning range boundary

● Post-fawning sight location

- - - -Post-fawning range boundary

✕ Fawn alone

⊗ Fawn with doe


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19
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21
22
23
24
25
26
27
28
Miles
0
1/4
1/2
N

Figure 12.

other deer tended to use the more central portions of the Reserve.

The average size of the pre-fawning range of the four does was 208 acres. That for the post-fawning period was 104 acres. The significantly smaller ranges during the post-fawning period are probably the result of two factors: 1) the restricted movement of the fawns and the relatively close contact maintained by the doe, especially during the first month following parturition; and 2) the apparent preference to remain in one particular home area. Further evidence for the second factor was obtained from movements of five marked yearling deer.

Deer No. 12 and Deer No. 13, bothyearling does, were observed 34 and 29 times respectively, during the period from early February to mid-September, 1962. If the single observations at locations A and B (Figure 13) are considered to be exploratory sallies from the normal range, the ranges of the two deer were approximately 312 acres for Deer No. 12, and 255 acres for Deer No. 13. These two deer were the 1961 fawns of Deer No. 15, as noted on page 38 of this paper. A comparison of the shapes and sizes of the ranges of these deer with that of Deer No. 15 (Figure 11) shows the strong attachment yearling deer have for the area frequented by their dam. It is not suggested that the preference for the area is the result of association with the doe during the pre-fawning stages only. It is suggested,

Figure 13. Ranges of Deer No. 12 and Deer No. 13, twin yearling does. February 1-September 15, 1962.

LEGEND

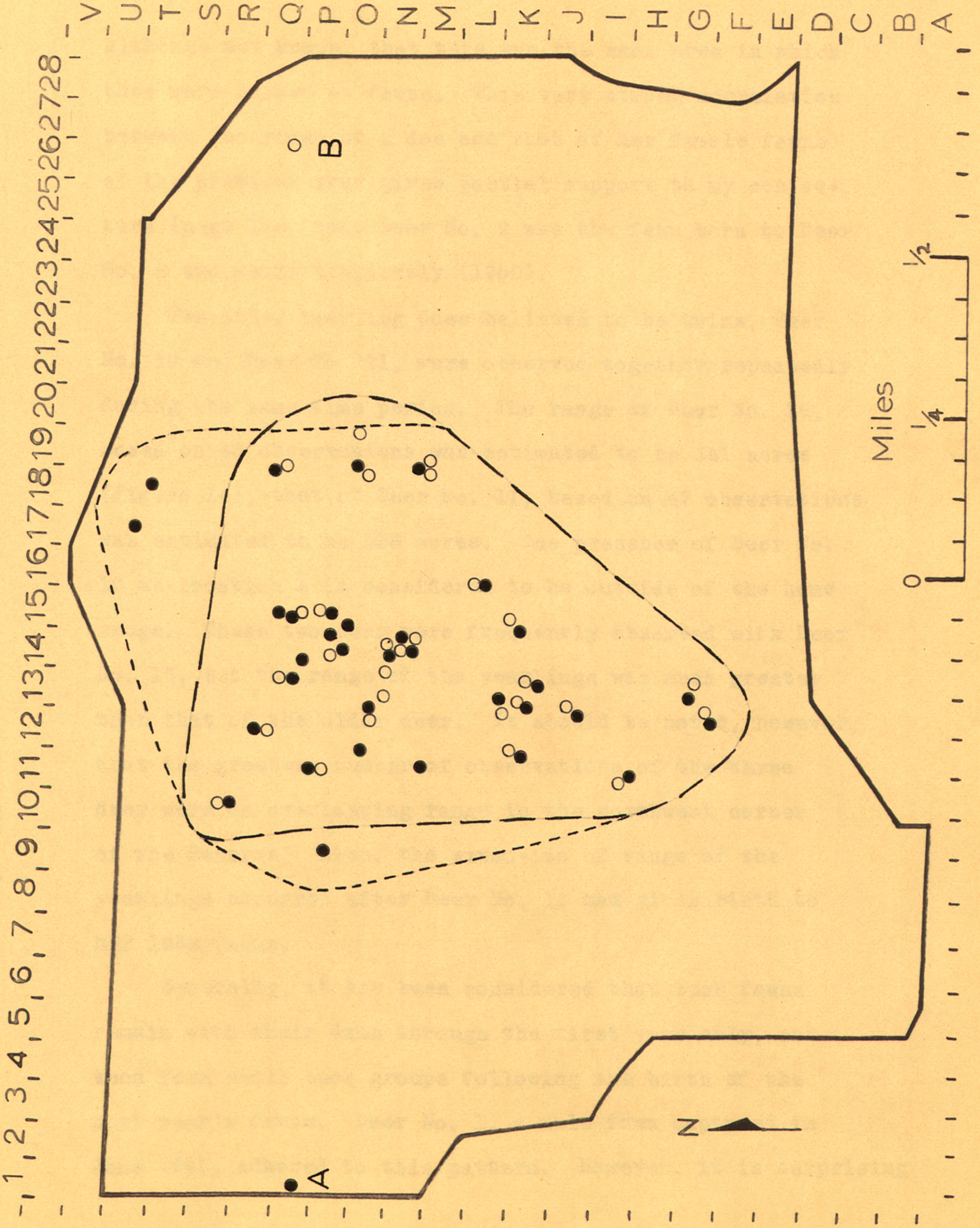
● Sight location, Deer No. 12

○ Sight location, Deer No. 13

----Range boundary, Deer No. 12

— —Range boundary, Deer No. 13

A, B Exploratory sallies


V U T S R Q P O N M L K J I H G F E D C B A
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
A
B
Miles
0
1/4
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N

Figure 13.

although not known, that this was the same area in which they were raised as fawns. This very strong correlation between the range of a doe and that of her female fawns of the previous year gives partial support to my conjecture (page 100) that Deer No. 9 was the fawn born to Deer No. 8 two years previously (1960).

Two other yearling does believed to be twins, Deer No. 10 and Deer No. 11, were observed together repeatedly during the same time period. The range of Deer No. 10, based on 43 observations was estimated to be 341 acres (Figure 14); that of Deer No. 11, based on 47 observations was estimated to be 338 acres. The presence of Deer No. 10 at location A is considered to be outside of the home range. These two deer were frequently observed with Deer No. 16, but the range of the yearlings was much greater than that of the older deer. It should be noted, however, that the greatest number of observations of the three deer were on overlapping range in the northwest corner of the Reserve. Also, the extension of range of the yearlings occurred after Deer No. 16 had given birth to her 1962 fawns.

Generally, it has been considered that buck fawns remain with their dams through the first year only, and then form small buck groups following the birth of the next year's fawns. Deer No. 1, a male fawn captured in June 1961, adhered to this pattern. However, it is surprising

Figure 14. Ranges of Deer No. 10 and Deer No. 11, twin yearling does, February 1-September 15, 1962.

LEGEND

● Sight location, Deer No. 10

○ Sight location, Deer No. 11

- - - -Range boundary, Deer No. 10

— —Range boundary, Deer No. 11

A Exploratory sally

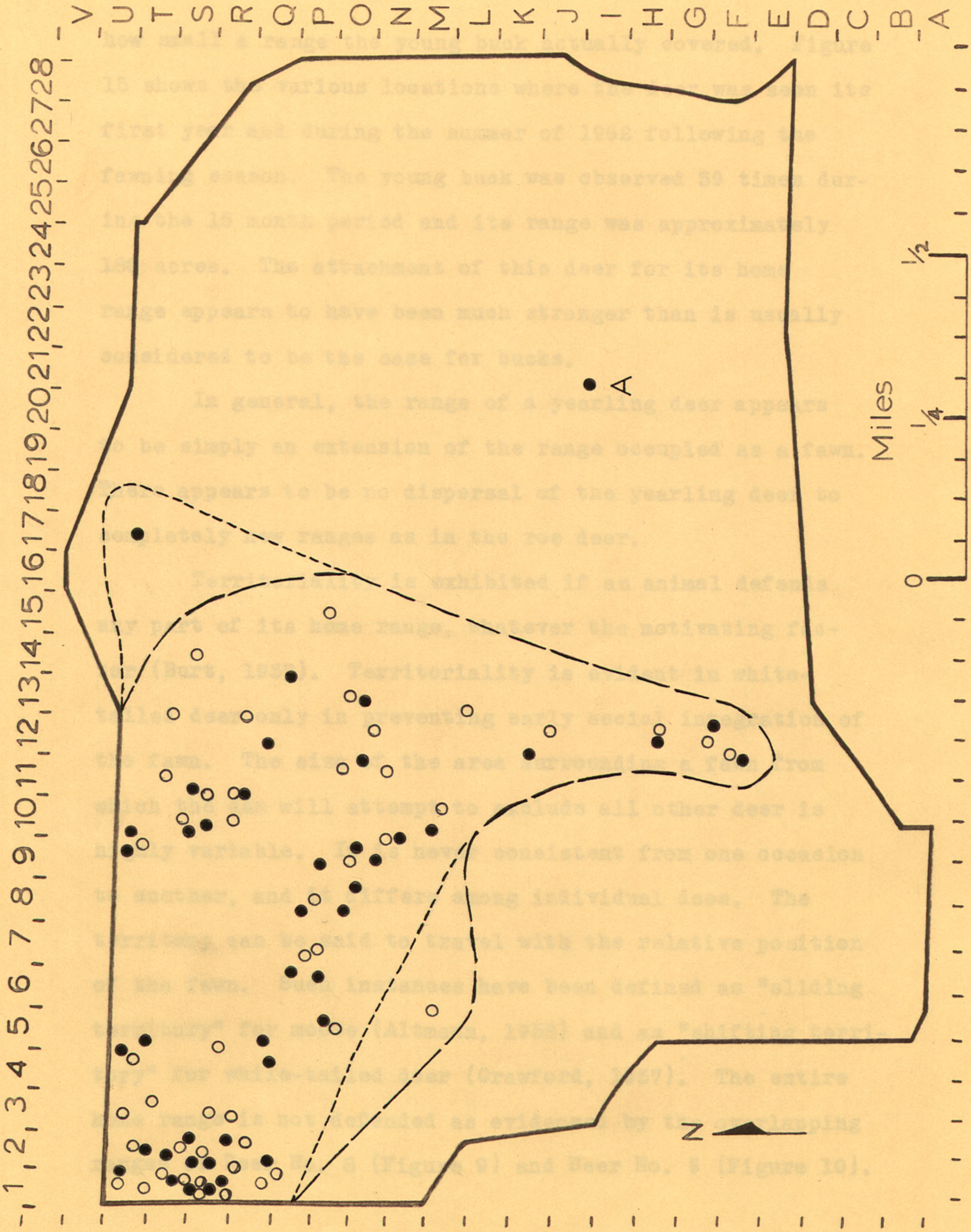
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Figure 14.

how small a range the young buck actually covered. Figure 15 shows the various locations where the deer was seen its first year and during the summer of 1962 following the fawning season. The young buck was observed 39 times during the 15 month period and its range was approximately 180 acres. The attachment of this deer for its home range appears to have been much stronger than is usually considered to be the case for bucks.

In general, the range of a yearling deer appears to be simply an extension of the range occupied as a fawn. There appears to be no dispersal of the yearling deer to completely new ranges as in the roe deer.

Territoriality is exhibited if an animal defends any part of its home range, whatever the motivating factor (Burt, 1957). Territoriality is evident in white-tailed deer only in preventing early social integration of the fawn. The size of the area surrounding a fawn from which the dam will attempt to exclude all other deer is highly variable. It is never consistent from one occasion to another, and it differs among individual does. The territory can be said to travel with the relative position of the fawn. Such instances have been defined as "sliding territory" for moose (Altmann, 1958) and as "shifting territory" for while-tailed deer (Crawford, 1957). The entire home range is not defended as evidenced by the overlapping ranges of Deer No. 8 (Figure 9) and Deer No. 9 (Figure 10).

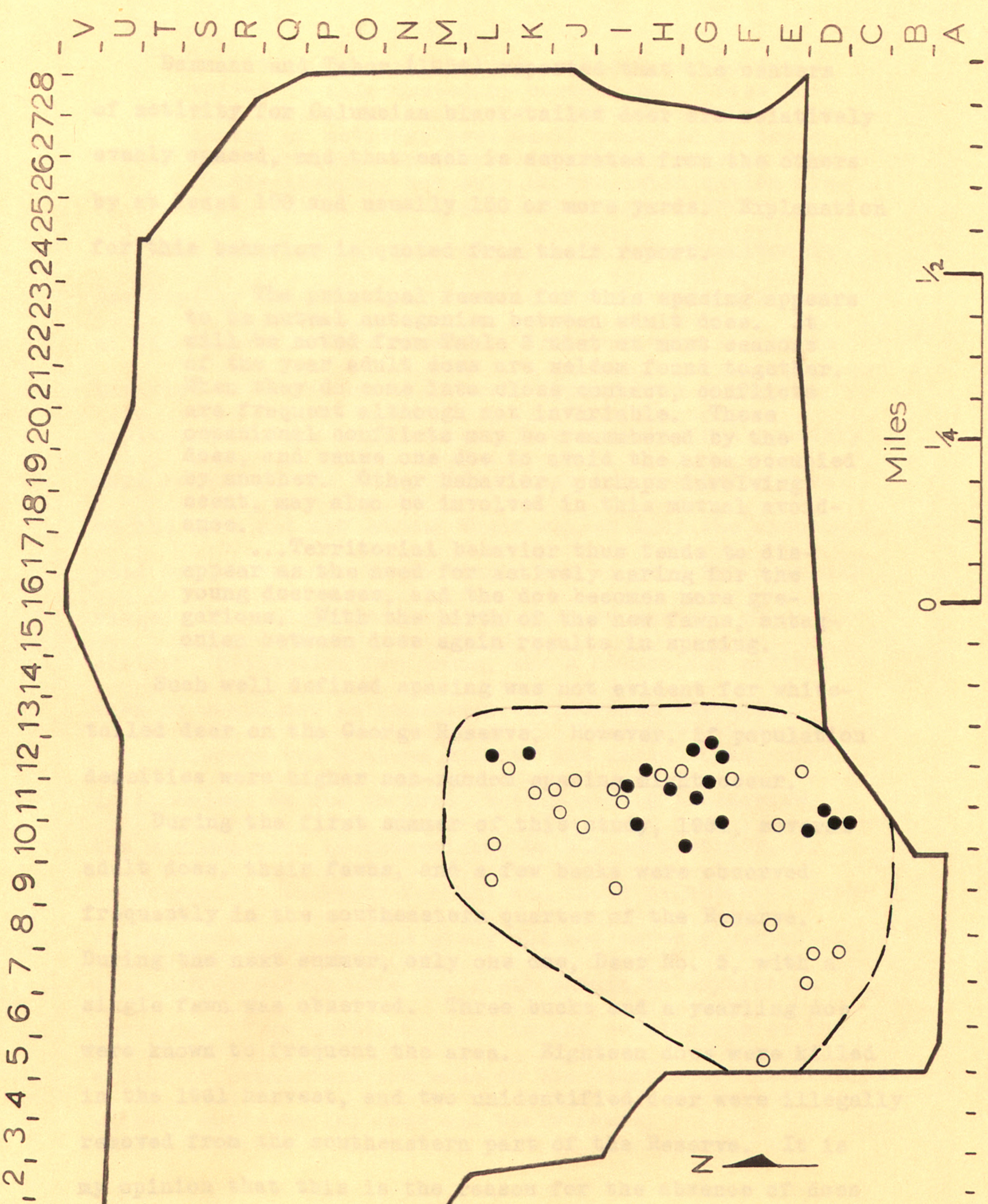
Figure 15. Range of Deer No. 1, buck fawn.
June 20, 1961-September 15, 1962

LEGEND

● Sight location, June 20, 1961-June 1, 1962

○ Sight location, June 1-September 15, 1962

— —Range boundary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23
24
25
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1/4
1/2
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Figure 15.

Dasmann and Taber (1956) reported that the centers of activity for Columbian black-tailed deer are relatively evenly spaced, and that each is separated from the others by at least 100 and usually 150 or more yards. Explanation for this behavior is quoted from their report.

> The principal reason for this spacing appears to be mutual antagonism between adult does. It will be noted from Table 3 that at most seasons of the year adult does are seldom found together. When they do come into close contact, conflicts are frequent although not invariable. These occasional conflicts may be remembered by the does, and cause one doe to avoid the area occupied by another. Other behavior, perhaps involving scent, may also be involved in this mutual avoidance.
>
> ...Territorial behavior thus tends to disappear as the need for actively caring for the young decreases, and the doe becomes more gregarious. With the birth of the new fawns, antagonism between does again results in spacing.

Such well defined spacing was not evident for white-tailed deer on the George Reserve. However, if population densities were higher non-random spacing might occur.

During the first summer of this study, 1961, several adult does, their fawns, and a few bucks were observed frequently in the southeastern quarter of the Reserve. During the next summer, only one doe, Deer No. 5, with a single fawn was observed. Three bucks and a yearling doe were known to frequent the area. Eighteen does were killed in the 1961 harvest, and two unidentified deer were illegally removed from the southeastern part of the Reserve. It is my opinion that this is the reason for the absence of does in this area. Dasmann and Taber (1956) noted that:

> Evidence that memory or habit may be involved is illustrated by certain adult does that died during the heavy mortality of 1951-52. The center of activity previously occupied by these deer continued to be avoided by neighboring does in the absence, not only of the intimidation display, but of the original does themselves.

The same type of phenomenon could have resulted in the limited occurrence of does in the southeastern area of the Reserve. This, however, involves very intricate behavior interactions. It would appear that a simpler explanation might be more readily acceptable and possibly more accurate. It is my belief that the remaining does on the area did not extend their ranges into the unoccupied region because there simply was no need for a larger range. If a range provides the various factors of food, shelter, protection for young, and a chance for mating, then it would not be necessary to increase its size.

Although the minimum size of the range of an animal is dependent on the various factors needed to survive, the maximum size is determined, in all probability, by intraspecific behavior factors and their relation to population density. As this study did not cover a period of time sufficient to note any great change in population densities, I am unable to come to any conclusions on the effect of population increase on the behavior relationships between white-tailed does and their fawns.

CONCLUSIONS

It has been noted that comparative behavior studies lead to the conclusion that the presence or absence of a given type of social behavior affects the type of social organization developed by the species.

The various behavior patterns discussed in this paper lead to the social organization of the white-tailed deer--the predominance of small groups usually centered around the doe and her offspring of two successive years. As it is difficult to ascertain which of the behavior traits are of greatest importance in the development of this social organization, a comparison with the behavior of other Cervidae is essential.

The social organization of the moose, as discussed in the literature review, is primarily that of a solitary animal. The social organization among elk is of a herd nature. The white-tailed deer is intermediate between these forms of organization.

In Table 4, I have compared the various behavior traits instrumental in the social organization of white-tailed deer with those described for moose and elk by Altmann (1958). One will note that the behavioral traits of deer are intermediate between those for moose and elk within each catagory listed.

Table 4. Comparison of behavior patterns in three wild ungulates

Behavior	Moose calf[1] *Alces alces shirasi*	White-tailed deer fawn *Odocoileus virginianus borealis*	Elk calf[1] *Cervus canadensis nelsoni*
Ingestive Et-epimeletic	Takes initiative to nurse at intervals. Huddles up to dam to be licked and nosed. Close contact.	Is hidden alone. Waits for dam to return to nurse. Runs to dam as she approaches within sight.	Is hidden alone or in "pools". Waits for dam to return to nurse and lick.
Communicative Warning, flight	Sparse vocal expression. Warning by gait and posture. Flight in unison with dam after delayed reaction.	Little vocalization. Warning by alert stance. Sudden movement of doe causes fawn to drop and hide.	Bark warning causes calf to drop and hide. Cow-elk takes off, leaves calf. Back and forth call as a bond on migration route.
Play	Solo play around dam. Rushing and kicking game. Dam does not participate.	Very little play when fawn is young. Some prancing or jumping around doe.	Social play with other calves. Tag and rush game. Water game, squealing and rushing. Yearlings and cows participate at times.
Allelomimetic and Antagonistic	Executes warning gait and angry bristling up and chewing like dam at 2 mo. up. At times disregards dam's efforts to keep it from other moose.	Exhibits all warning signals except snorting at 6 weeks. Fawn readily approaches other deer with head and neck outstretched as in display reaction of adult.	At time of herd integration, exhibits all gait and posture signals, vocal communication still limited. No antagonistic behavior in first year.
Integration into social group life	Limited, at 3-4 mo., at rutting period of dam. Loose integration. Stays with dam.	At 3 to 3-1/2 months. Prior to breeding season. Maintains ties with dam.	At 3 weeks, during spring migration with nursery herd.
After weaning	Stays in closest contact with dam.	Stays with dam generally, but may temporarily join other deer.	Stays with herd but at a distance from dam.
At birth of new calf or fawn	Outer fringe area. Many attempts to return close are frustrated.	Stays in general area of dam, but usually with other yearling deer, perhaps own twin. Attempts to join doe and fawns are frustrated.	Either stays in fringe of herd or joins roaming bands.

[1] After Altmann, 1958.

The isolation of the white-tailed fawn from other deer, with the exception of its sibling(s), appears to be the principal factor preventing the species from developing a herd-type organization such as in elk. That the isolation of the fawns does not persist following the breeding season prevents the deer from becoming a solitary animal.

The deer is often subject to extremes of population density. Severe winter weather in the North often forces large numbers of deer into relatively small yarding areas. Here the deer are forced to associate closely whereas they would not do so if milder weather conditions prevailed. The only apparent detrimental effect of such crowding is the overbrowsing of the vegetation and the resulting starvation of the deer. The effect of adrenal stress and shock due to crowding may be a factor contributing to starvation, but this has not been proven.

At the other extreme, individual white-tailed deer have been known to live an almost solitary existence. Successful repopulation of areas where deer had been extirpated, such as the southern 34 counties of Michigan (McNeil, 1962), indicates the ability of the animal to survive and reproduce under low population density conditions.

The ability of deer to survive under a wide range of population densities and an extreme variety of habitat types indicates the value of the social organization to the species.

SUMMARY

A descriptive study of the factors affecting the development of social organization in white-tailed deer was conducted on the Edwin S. George Reserve from June 15, 1961 to October 1, 1962.

A total of 26 deer were captured and marked for individual identification. Of these, 21 were known to be alive at the conclusion of the study.

The pre-fawning behavior of adult does was noted to consist primarily of maintaining ties with her fawns of the previous year until a few days prior to parturition. The variable tolerance of pregnant does toward the presence of other deer would appear to assure fawning success even when population densities are high. High population densities would be detrimental to fawning success if the does were universally intolerant of the presence of other deer as they neared parturition.

Although actual parturition was not observed, certain aspects of fawning behavior were obtained from the literature, field observations, and personal interviews with deer research biologists.

The location of the doe at parturition is apparently random without active selection of an area by the doe.

Most fawn births occur during the daylight hours, with peaks of fawning between 0600 and 0900 and between 1600 and

1900. The period of time between the beginning of delivery until the last fawn is born and cleaned, in the case of multiple births, is generally not longer than 20 minutes.

The doe invariably eats the afterbirth following the birth of a fawn. This serves to remove the odor and visible traces of the recent birth, and it may aid in stimulating lactation. The rapid completion of the birth process and the consumption of the afterbirth undoubtedly decreases the opportunity for predators to find the doe and fawn when they would be in an extremely vulnerable position.

The newborn fawn is precocious, and although the ability to stand and nurse is variable, this usually occurs between one and four hours following birth.

There are four major stages of social development of the white-tailed fawn. The first of these is the neonate period. It lasts until the fourth day following birth, and is characterized by the complete isolation of the fawn except for the periodic return of the doe to nurse.

The neonate period allows for the establishment of contactual and ingestive behavior. The fawn becomes aware of the doe and imprinting takes place. The fawn learns to follow closely behind the doe for short distances.

The escape behavior of the doe and the associated "freezing" attitude of the fawn provides a mechanism by which predators might be lured away from the otherwise defenseless fawn.

The second stage of post-fawning behavior is the <u>period of isolated training</u>. It lasts from four days of age until the fawn is three or four weeks old.

The isolation of the fawn serves to make the young deer aware of its immediate surroundings. It is left alone much of the time and thus takes the initiative to acquaint itself with plants, other deer, and other objects.

The fawn's association with its dam is primarily concerned with nursing which occurs at irregular intervals. However, through this association, the fawn attempts to feed on vegetation, learns to associate danger with certain objects, and recognizes signals of alarm on the part of the doe.

The fawn responds to its dam on the basis of sound or sight with final recognition based on odor. Association with other deer appears to be the result of the fawn approaching the adult deer because of the resemblance to its dam. The action and probably the odor of the adult deer determines the extent of association between the fawn and the approaching deer.

I have observed no behavioral interaction between the doe and its fawn which serve to enforce the isolation situation. As the age at which a fawn begins to actively follow its dam is variable, I assume that the length of the period of isolated training is determined by the physical ability of the fawn to actively follow the doe.

As a general observation, I believe that twin fawns begin to follow the doe at an earlier age than single fawns. This may be due to the greater activity of a fawn influenced by its twin.

The third phase of post-fawning behavior is the period of actively accompanying the doe, which begins during the third or fourth week after birth. There does not appear to be a line of demarcation between this and the previous period. The doe does not actively encourage the fawn to follow her. The strength of imprinting and the fawn's physical capabilities are sufficient for the purpose.

The frequency of nursing during this period is gradually reduced in frequency but still remains the strongest bond between the doe and her fawn. Forage comsumption by the fawn may begin with removal of pieces of vegetation from the dam's mouth. The habit of walking as they feed appears to be transferred from adult deer to fawns because of the latter's attempts to "catch up".

Weaning is the result of two factors, 1) the reduced need for milk on the part of the fawn and 2) a reduction in milk production by the doe. Weaning is generally effected by mid-September but nursing may continue later if the production of milk is sufficient.

By the time a fawn is six weeks old, it develops investigative and warning behavioral traits similar to that of adult deer. All of the various signals used by adult deer, with the exception of snorting are exhibited by fawns of this age.

The adult doe actively prevents social contact between its fawn and other deer by agonistic reactions toward the other individuals. Such encounters are usually brief, involving display actions and active pursuit. Actual body contact occasionally occurs.

Small mammals were not observed to cause any significant alteration in the behavior of white-tailed deer. However, the alarm and hunting calls of some birds were noted to elicit alarm and escape reactions.

Eliminative behavior and play behavior among white-tailed deer do not appear to be of any major sociological importance.

Escape behavior of fawns begins to resemble that of adult deer when the fawn is about two months old. Rarely is the fawn the first deer to run from a particular disturbance. Occasionally, fawns resort to the "freezing" response noted in the neonate period if they become alarmed but are unable to see the object causing the disturbance.

The fourth of the major post-fawning phases of behavior is the <u>social integration of fawns into larger groups</u>. Beginning in mid-September there is a physiological or psychological change in the does which is concurrent with the pre-rut physiological changes in males. The doe no longer prevents her fawn from making social contact with other deer. The period of calmness following the change in the behavior of the does allows the deer to feed quietly and thus become nutritionally prepared for the forthcoming breeding season and the winter.

Precocial sexual behavior, although not uncommon among most mammals, was observed only once. Only one male fawn was observed to be sexually aggressive during the breeding season. No doe fawns were observed to be in heat.

The average size of the pre-fawning range of four adult does was 208 acres. The average post-fawning range was calculated to be 104 acres. The range of a yearling or an adult deer appears to be simply an extension of the range occupied as a fawn.

There is a "shifting" or "sliding" territory of variable size around each fawn or set of twins from which all other deer are generally excluded by the agonistic behavior of the doe. This is maintained from the birth of the fawn until mid-September.

A comparison of behavior of white-tailed deer with that of moose and elk shows that the various behavior patterns of deer are intermediate between those for the other two Cervidae. These behavior patterns result in social organization which is also intermediate between the solitary organization of moose and the herd structure of elk.

The social organization of deer is one factor which permits the species to survive in variable habitat types and under extremes of population density.

APPENDIX

LIST OF CAPTURED DEER AND IDENTIFICATION TAGS

Deer No.	Sex	Age (years)	Date caught	Location	Numbered tags	Markers
1	M	Fawn	6/16/61	F-11	48701	Yellow ear tag, lower left. Recaptured 1/27/62, white collar No. 102. Lost 4/26/62. Self-attaching collar No. 1980, Blue No. 10, 5/20/62.
2	F	2½	9/17/61	Trap No. 2	48702 48703	Aluminum ear tag, lower right. White plastic No. 1, left ear. Killed 1/2/62.
3	M	1½	9/19/61	Trap No. 2	48704 48705	Yellow collar No. 2. Blue ear tag, lower right.
4	F	Fawn	9/23/61	Trap No. 4	48706 48707	Red ear tag, lower right.
5	F	3½ est.	10/2/61	Trap No. 4	48708 48709	White collar No. 101, Green ear tag, lower right.

Deer No.	Sex	Age (years)	Date caught	Location	Numbered tags	Markers
6	F	Fawn	10/3/61	Trap No. 4	48718	Yellow ear tag, lower right. Killed 1/2/62
7	M	3½ est.	10/5/61	Trap No. 1	48720 48721	Yellow collar No. 1. Aluminum ear tag, lower left. Jumped Reserve fence 12/16/61.
8	F	3½ est.	1/23/62	Trap No. 8	48722	Yellow collar No. 3. Blue ear tag, lower right.
9	F	1½	1/29/61	Trap No. 3	48724	Yellow collar No. 5. Red ear tag, lower left, facing backwards.
10	F	Fawn	2/1/62	Trap No. 1	48726	Yellow collar No. 4. Red ear tag, lower left, facing backwards. Yellow plastic No. 1 in right ear.
11	F	Fawn	2/3/62	Trap No. 1	48729 48730	Green ear tag, lower left. Blue plastic tag No. 6 in right ear. Recaptured 2/18/62, Blue No. 6 lost. Put red nylon streamer in left ear.

Deer No.	Sex	Age (years)	Date caught	Location	Numbered tags	Markers
12	F	Fawn	2/4/62	Trap No. 3	48731 48732	Yellow collar No. 6. Yellow ear tag, upper right. Self-attaching collar 1981 with Black No. 12. 6/1/62 (?).
13	F	Fawn	2/10/62	Trap No. 3	48733 48734	Yellow collar No. 7. Yellow ear tag, upper left, backwards. Recaptured 2/22/62, placed orange nylon streamer in right ear.
14	F	Fawn	2/16/62	Trap No. 5	48735 48736	Yellow collar No. 8. Red nylon streamer in right ear. Deer injured in trap, but released. Found dead 3/8/62, markers recovered.
15	F	3½ up (?)	2/22/62	Trap No. 3	48737 48738	Yellow collar No. 10. Yellow ear tags, lower right and lower left. Green nylon streamer in left ear.
16	F	3½ up (?)	2/22/62	Trap No. 1	48739 48740	Yellow collar No. 11. Yellow ear tag, lower left; red ear tag, lower right. Green nylon streamer in right ear.

Deer No.	Sex	Age (years)	Date caught	Location	Numbered tags	Markers
17	M	2	4/??/62	N-26	----	Self-attaching collar 1967 with Green No. 18
18	M	Fawn	6/7/62	G-10	48741	White nylon streamer right ear. White nylon streamer right leg.
19	F	Fawn	6/7/62	E-8	48742	Red nylon streamer right ear. Red nylon streamer right leg.
20	F	Fawn	6/8/62	P-4	48744	Orange nylon streamer left ear. Orange nylon streamer left leg.
21	M	Fawn	6/9/62	N-2	48745	White nylon streamer left ear. Green nylon streamer left leg.
22	F	Fawn	6/12/62	C-6	-----	Yellow nylon streamer left ear. Yellow nylon streamer left leg.
23	F	Fawn	6/19/62	F-9	-----	Yellow nylon streamer right ear. Yellow nylon streamer right leg.
24	F	Adult	(Crippled deer, right front foot broken and flopping as she walks, notch torn in lower side of left ear).			
25	F	3½ (?)	7/28/62	Trap No. 6	48746 48747	Yellow collar No. 12. Red ear tags, lower right and lower left. Red and white nylon streamer right ear.

Deer No.	Sex	Age (years)	Date caught	Location	Numbered tags	Markers
26	F	(?)	(?)	T-7	-----	Self-attaching collar 1997 with Yellow No. 5.

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