A C T A T H E R I O L O G I C A

VOL. 19, 15: 235—245. BIAŁOWIEŻA September, 1974

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Ecology of an Opossum Population in Virginia, 1963—69*

[With 4 Tables & 2 Figs.]

Population dynamics of the opossum (*Didelphis marsupialis*) were studied from September 1963 to September 1969 near Richmond, Virginia, US. Opossums were live trapped on a 136.4 hectare study area. Seventy-two individuals were racaptured on 135 occassions. Population size was variable among years and seasons, but tended to oscillate near an annual density of 2 opossums per 40.47 hectares (100 acres). Densities were lower than those reported from forested areas elsewhere in the species' range and paralleled levels reported on non-forested lands in central US. On a seasonal basis, numbers were highest in summer and fall and lowest in winter. At first capture the ratio of immatures to adults was 1.48:1.0. The sex ratio was near unity for immature and adult segments of the population. The trap revealed longevity of females (3.1±0.69 months) was significantly different ($P<0.10$) from that of males (2.03±0.33 months). Male opossums averaged 1.19±0.15 Kg at first capture and were not significantly different from females which averaged 1.18±0.13 Kg. Opossum captures (101/135) were concentrated in forested areas designated as deciduous low and deciduous medium cover types. Diversity (*H*) and equitability (*E*) measures corroborated the apparent habitat preference for dense forest cover. There was no evidence that opossum densities influenced habitat selection.

1. INTRODUCTION

The opossum (*Didelphis marsupialis* Linnaens, 1758) is the only marsupial found in the U.S. Though relatively common in the Piedmont physiographic province of Virginia no long-term study of their population ecology has been done. Wood & Odum (1964) have reported a nine--year study of medium-sized mammals, including opossums, carried out in the coastal plain of South Carolina. Other studies have been reported from the central US (Shirer & Finch, 1970; Lay, 1942; Reynolds, 1945; Wiseman & Hendrickson, 1950; Verts, 1963; and

* Supported in part by Contracts DA49 193 MD 2439 with the U.S. Army Medical Research and Development Command, Washington, D.C.; AT (40-1) 3514 with the Division of Biology and Medicine, U.S. Atomic Energy Commission, Washington, D.C.; and AI06666 with the National Institute of Allergy and Infectious Diseases, U.S. Public Health Service, Washington, D.C.

Holmes & Sanderson, 1965) and the eastern US (Hamilton, 1958; and Llewellyn & Dale, 1964).

This report concerns aspects of the ecology of a population of opossums studied over six consecutive years from September 1963 through September 1969 near Richmond, Virginia, US. The specific population parameters studied included seasonal and annual fluctuations; age and sex structure; longevity; body weight characteristics; and the distribution of captures in relation to the vegetative mosaic of the study areas. Limited data were gathered on reproductive biology. Food habits were not studied. Trap revealed movement data are not reported but are available from the authors. Data on tick infestations of the opossums have been reported elsewhere (Sonenshine & Stout, 1971).

2. MATERIALS AND METHODS

The study was done at one locality in the Piedmont physiographic province near Richmond, 2.4 km S of Montpelier in Hanover County, Virginia, US. This region of Virginia is rural and the gently rolling landscape is a mosaic of pine and mixed hardwood forests, maintained pastures, and marginal farms.

2.1. Description of Study Area

A trapping grid, ultimately covering 136.4 hectares in two separate but adjoining parts, was established (Fig. 1). Approximately three-fourths of the study area was bounded by continuous forest, with the remainder being continuous with old fields.

The vegatative cover was mapped after qualitative classification by the methods of Kuchler (1956). Three physiognomic categories were used: woody deciduous broadleaf, woody evergreen needleleaf, and herbaceous (old fields). Further subdivision of the woody deciduous cover was as low (less than 3.1 high), medium (3.1 to 7.7 m high), and tall (over 7.7 m high). Frequency of stem counts of each type served as the criterion for determining dominance within a plot.

The vegetative cover of the study areas is relatively heterogeneous owing to past landuse patterns (Fig. 1). A detailed description of the old fields (herbaceous) is given in Sonenshine & Stout (1968). The remaining forested portion is second or third growth deciduous forest dominated by oaks (*Quercus alba, Q. rubra, Q. velutina, Q. marilandica,* and others), hickories (*Carya ovalis* and *C. glabra*), black gum (*Nyssa sylvatica*) and American beech (*Fagus grandifolia*). Understory shrubs include *Carpinus caroliniana, Cornus florida, Corylus americana, Vaccinium* sp. and *Cercis canadensis*. Occasional stands of Virginia pine (*Pinus virginiana*) occupy small fields abandoned 30-40 years. In all approximately 190 species of vascular plants were identified on the study areas (unpublished data, D. E. Sonenshine).

2.2. Trapping Procedures

A summary of our trapping effort is as follows: September 1963 to September 1964 on 17.8 hectares of Area A (Plots 1A-F through 3A-F) (Fig. 1) with 29—42 traps for a total of 1,266 trap nights; October 1964 to December 1965 on 26.7 hectares of Area A (Plots 1A-F through 4A-F) with 41 traps for a total of 2,955

trapp nights; January 1966 to October 1969 on all of Area A (104.8 hectares) with 72 traps for a total of 17,177 trap nights; and from October 1967 to September 1969 on 31.6 hectares of Area B with 50 traps for a total of 3,544 trap nights. Traps were always arranged in a systematic pattern but the interval between traps was 61 or 122 m depending on the number of traps in use. After December 1965 all traps (72) on Area A were at 122 m intervals with the trap at the center of each 1.5 hectare plot in the trapping grid. Likewise, traps were placed at 80 m intervals on Area B during the entire study.

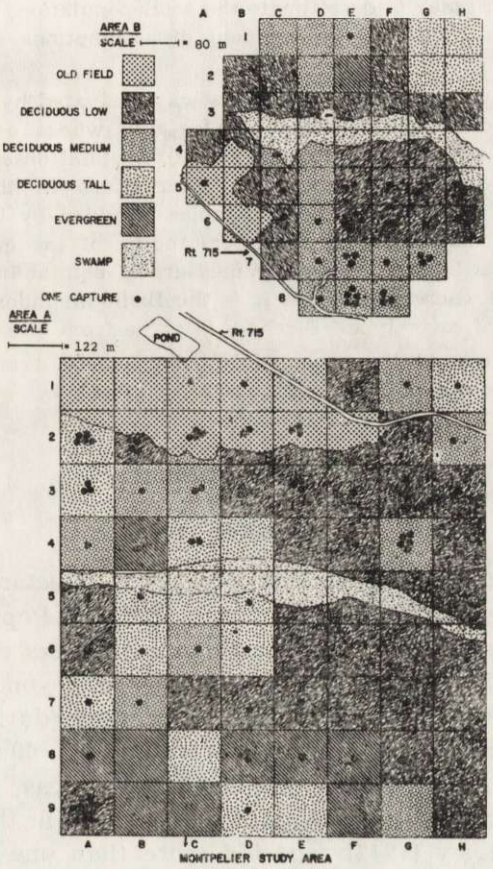

Fig. 1. Cover maps of the two adjacent parts of the study area near Montpelier, Hanover County, Virginia, US, illustrating the vegetation types and distribution of opossum captures, 1963—69. Areas A and B include 7.4 hectares of swamps. The junction of the two areas occurred approximately at the paved road (Route 715).

Traps in use were of wire mesh construction 23×23×50 cm with a single door (National Live Trap Co.). Ten traps of similiar construction but with gravity-drop doors were also used. Traps were baited with sardines and peanut butter. Prior to January 1966 traps were opened 4 consecutive days at 3 week intervals. All traps were opened for 4 consecutive days every other week from January 1966 until October 1969.

Captured animals were tagged with monel ear tags, weighed, sex and age status noted, and released at the point of capture on the same day. Young in the pouch were counted and toe-clipped or ear tagged depending on size.

2.3. Analysis of Data

Abundance of opossums was calculated as minimum numbers alive per time period by the calender of captures method (Petrusewicz & Macfadyen, 1970:33). The procedure may underestimate the total population, but provides a relative index of abundance that is independent of assumptions such as randomness of captures, etc.

Use of the various cover types by opossums was evaluated by the Brillouin index of diversity calculated as $H=c:N\ (1\log_{10}N!\ -\sum\log_{10}n_i!)$, where c=3.321928, the scale factor for conversion of logarithms to base 2 (bits), N=total observations in all cover types per time period, and n_i=number of observations in the ith cover types (Lloyd, Zar & Karr, 1968). Conversion tables provided by Lloyd *et al.* (1968) were used in all calculations. Further understanding of the evenness of captures among the cover types is provided by the measure of equitability, E, as defined by Pielou (1966, 1969), where $E=H/H_{max}$, H is the Brillouin index, H_{max} is the $\log_2 S$, and S is the number of cover types. E ranges in value from 0 to 1.

Standard errors are used throughout this paper where a measure of variation is provided.

3. RESULTS AND DISCUSSION

3.1. Population Trends

The minimum number of opossums per 40.47 hectares (100 acres) of study area during 1963-69 is shown in Fig. 2. Population size was variable among seasons and years. Opossum numbers during 1963 early 1964 and mid-1967 appeared to have increased beyond average levels. Otherwise, the trend was for regular oscillations during the years of study. Average annual density was 2 opossums per 40.47 hectares.

Opossum densities on the Montpelier study areas were low when compared with some populations studied elsewhere in the species' range. In eastern Texas Lay (1942) reported more than one opossum per 1.2 hectares. Holmes & Sanderson (1965) estimated 47 opossums per 40.47 hectares in favorable habitat in east-central Illinois. Both of these studies were carried out on non-agricultural land. On mainly cultivated land Wiseman & Hendrickson (1950) estimated 0.93 opossums per 40.47 hectares in southeastern Iowa and Verts (1963) estimated 1.4 per 40.47 hectares in Illinois. Wood & Odum (1964) trapped only 18 opossums over a 9 year period on abandoned farm land in South Carolina. These studies suggest opossum populations reach highest densities in forested, non-agricultural areas and achieve modest numbers on agricultural lands. We conclude our populations were substantially lower

than might be expected from forested areas and more similiar to densities reported on non-forested lands in central US. Llewellyn & Dale (1964) have reported a study of opossums in a forested area in Maryland, but were unable to estimate densities.

Seasonally the opossum population reached minimum numbers during the first quarter (January, February, and March) of five of the six years (Fig. 2). We believe opossums tended to be less active (mobile) during winter and hence were not as likely to be trapped (McManus, 1969). Some surface activity does continue in spite of low ambient temperatures.

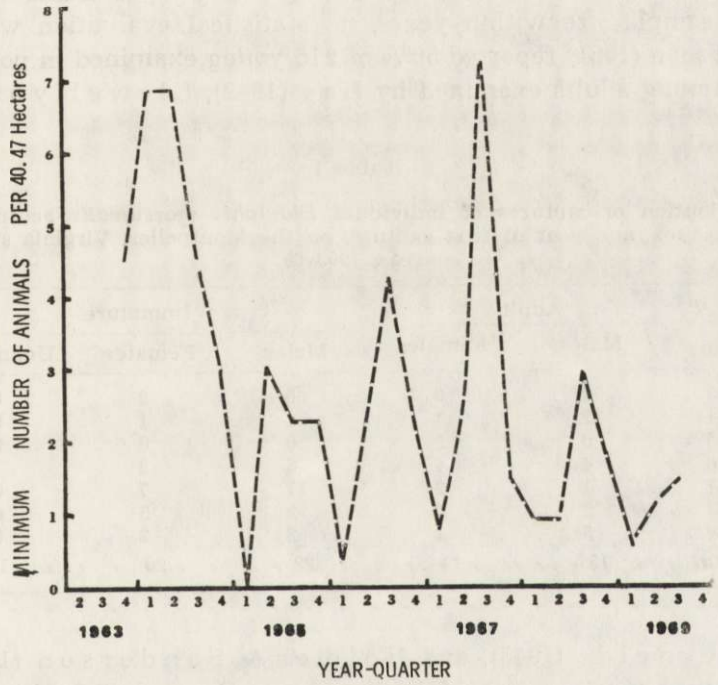

Fig. 2. Minimum numbers of opossums per 40.47 hectares known to be alive per quarter (*e.g.*, January, February, and March) during 1963—69 on the Montpelier, Virginia study areas.

For example, Hamilton (1958) found considerable frost damage to the ears and tails of these animals in New York. Subsequently, opossum numbers peaked in the second and third quarters (except for 1964) (Fig. 2). This period of increase coincides with the reproductive season (Reynolds, 1945; and Llewellyn & Dale, 1964).

The evidence we have on abundance of opossums over a six year period suggests the population was at or near carrying capacity (*K*).

3.2. Age and Sex Structure

Summarized in Table 1 are data on sex and age at first capture for 72 opossums live trapped during the study. Based on age at first capture, we trapped 29 adults and 43 immatures. Considerable recruitment of young animals occurred during 1966 and 1967 (Table 1) and was reflected by sharp increases in minimum numbers (Fig. 2). Increases in populations in other years were apparently a combination of recruitment of offspring from resident adults and of some adult immigration onto the study areas.

The sex ratio of the total adult sample was near unity (Table 1); likewise, the immatures were captured in nearly equal numbers. Owing to small sample size within years, no statistical evaluation was made. Sanderson (1961) reported 50% of 216 young examined in pouch were female. Among adults examined by Lay (1942), Llewellyn & Dale

Table 1

Distribution of captures of individual *Didelphis marsupialis* according to age, sex, and year of first capture, on the Montpelier, Virginia study areas, 1963-69.

Year of First Capture	Adult		Immature		
	Males	Females	Males	Females	Unknown
1963	1	0	0	2	0
1964	2	1	1	1	0
1965	0	2	0	0	0
1966	4	4	6	3	1
1967	1	2	11	7	0
1968	2	4	2	5	0
1969	5	1	2	2	0
Total	15	14	22	20	1

(1964), Reynolds (1945), and Holmes & Sanderson (1965), the sex ratio was nearly equal. Males were sometimes slightly favored, but the deviations were not statistically different from unity.

3.3. Reproduction

The earliest any female was observed with young in pouch was March 25, 1964. Llewellyn & Dale (1964) stated that in Maryland opossums bred in early February and may have young in pouch until August. We found young in pouches in March (1), June (4), July (3), and August (1). In Missouri Reynolds (1945) found the opossum to have two litters per year. We can report litter size on 3 females which had 6, 7, and 9 young. Llewellyn & Dale (1964) reported 4—5.4 young per adult female.

3.4. Trap Revealed Longevity

The frequency distribution of trap revealed longevities of opossums is given in Table 2. Most animals (44 of 66 individuals) were observed only for one month (Table 2). Llewellyn & Dale (1964) recaptured only 50% of the captures (n=224) reported in their study, and Lay (1942) racaptured 51% (=117). One female opossum at Montpelier was retrapped over an 8 month period (Table 2). The greatest estimated age given by Llewellyn & Dale (1964) was 36 months. Lay (1942) trapped one individual more than 11 months.

Table 2

Frequency distribution and mean (±SE) trap revealed longevities of 66 *Didelphis marsupialis* live trapped on the Montpelier, Virginia study areas, 1963-69.

Trap Revealed Longevities (months)	Frequency	
	Males	Females
1	26	18
2	1	1
3	3	3
4	1	1
5	2	2
6	0	1
7	2	1
8	1	0
9	0	1
10	0	1
18	0	1
Total	36	30
Mean (±SE)	2.03±0.33*	3.10±0.69

* Means are significantly different ($P<0.10$).

The mean longevity of females, 3.1 ± 0.69 months, was significantly different ($p<0.10$) from that of males, 2.03 ± 0.33 (Table 2). The apparent longer life span may reflect great female trap susceptibility (Sanderson, 1961), rather than a time difference in longevity. Likewise, Holmes & Sanderson (1965) claimed males were captured less frequently than females and young animals. Our estimates of longevities are, if averaged, in close agreement with Lay's (1942) value of 83 days.

The rapid turnover of the opossum population may have been the result of emigration. Mortality may have played some role as Fitch & Shirer (1970) reported 3 of 9 opossums under study with radiotelemetry were preyed on by the horned owl (*Bubo virginianus*). The horned owl was present on the Montpelier study areas.

3.5. Body Weights

Fifty-five of 72 opossums were weighed at first capture. Males (n=30) averaged 1.19±0.15 kg and females (n=26) 1.18±0.13 kg. The weight difference between the sexes was not significant ($t=-0.02$). The frequency distribution of 125 body weights obtained during the study is given in Table 3. Individual males tended to achieve higher body weights than females. Few data are available in the literature on opossum body weights. Wiseman & Hendrickson (1950) reported 5 males averaged 3.08 Kg and 10 females 1.85 Kg.

3.6. Habitat Diversity

The spatial distribution of opossum captures according to cover types on the study areas is shown in Fig. 1. Opossum captures tended to be concentrated in forested areas designated as deciduous low and deciduous

Table 3

Frequency distribution of body weights of 66 *Didelphis marsupialis* captured or recaptured on the Montpelier, Virginia study areas, 1963-69.

Body Weight (grams)	Frequency	
	Males	Females
0.0-0407.3	6	9
452.6-0859.9	18	10
905.2-1312.5	15	14
1357.8-1765.1	5	10
1810.4-2217.7	6	12
2263.0-2670.3	7	5
2715.6-3122.9	7	1
Total	64	61

medium cover types. Specifically, 74.8% (101/135) of the captures were in these two cover types. Previous radiotracking studies (Shirer & Fitch, 1970) and live trapping efforts (Llewellyn & Dale, 1964) have concurred on the preference of opossums for woodlands as opposed to open areas and grasslands.

The data presented in Table 4 suggested opossum captures were nonrandomly distributed with regard to our vegetational cover types. We utilized the information theoretical measure, H, to evaluate the diversity (uncertainly of prediction) of habitats frequented by our live trapped sample. Values of H were low and somewhat variable (Table 4). These results support our earlier conclusion that opossums were not uniformly trappable in all habitats.

Further examination of habitat diversity was made to determine if population density influenced *H*. For example, low values of *H* could be associated with low population densities and therefore reflecting redundancy of habitat selection by individuals. Conversely, high *H* values associated with high densities might result from a movement of individuals into habitats not of optimal quality, as in the case of subordinate red grouse (*Lagopus lagopus scoticus*), observed by Jenkins, Watson & Miller (1963:368). The linear correlation (*r*) between habitat diversity, *H*, and opossum population density for the period 1964-69 was −0.21 and not significant. Thus, we conclude our data do not support the hypothesis that population density influenced the diversity of cover types used by opossums.

Table 4

Distribution of captures of *Didelphis marsupialis* according to vegetation type and year*. The Brillouin index of diversity (*H*) is shown for each year. Equitability, *E*, of cover type utilization is shown as percentage (range 0-100).

Vegetation Type	1964	1965	1966	1967	1968	1969
Deciduous Low	4	1	11	23	16	5
Deciduous Medium	4	1	6	12	15	3
Deciduous Tall	1	1	3	4	2	5
Evergreen	0	0	6	3	0	1
Old Field	1	0	1	1	2	3
Total	10	3	27	43	35	17
H Values	1.261	0.861	1.715	1.508	1.326	1.726
E Values (%)	54.338	37.111	73.880	64.972	57.125	74.363

* Owing to slight successional changes in vegetation types over the period of study, data given here does not coincide exactly with Fig. 1.

The measure of equitability, *E*, was used to evaluate the evenness of captures of opossums among the vegetation types (Lloyd & Ghelardi, 1964). The more even the distribution of captures among the various habitats the nearer *E* approaches unity. Observed values of *E* varied among years from 0.371 in 1965 to 0.743 in 1969 (Table 4). Equitability did not approach unity in any year, thus corroborating previous findings of apparent habitat preference for dense forest cover.

The linear correlation between *E* and the minimum number of opossums during 1964-69 was not significant ($P<0.05$, $r=0.21$, 4 df). Nor was *E* correlated with total yearly captures ($P<0.05$, $r=0.52$, 4 df). Therefore, we conclude densities observed in this study did not influence equitability of cover type selection as revealed by live trapping.

Acknowledgements: We whis to express our appreciation to several persons who cooperated in trapping the animals examined in this study. We are grateful to

Clayton P. Rudolph and Charles Tatem, both of the Virginia State Health Department, for their assistance in trapping animals in the period through 1965; to Harvey Philips, Nelson Quick, Robert Miller, Dr. Sushil Gilotra, and B. H. Powell, all of whom trapped animals while employed by Old Dominion University.

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Accepted, January 9, 1974.

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EKOLOGIA POPULACJI DYDELFA PÓŁNOCNEGO W WIRGINII, 1963-69

Streszczenie

Zbadano dynamikę populacji dydelfa północnego *Dydelphis marsupialis* Linnaeus, 1758, od września 1963 r. do września 1969 roku, na powierzchni położonej w pobliżu Richmond, Wirginia, USA. Obszar doświadczalny, na którym łowiono zwierzęta wynosił 136,4 ha (Ryc. 1). Zwierzęta łapano przy pomocy pułapek żywołownych, przy czym ponownie złowiono 72 osobniki w 1935 złapaniach (Tabela 1). Liczebność populacji zależała nie tylko od roku, ale zmieniała się zależnie od sezonu, choć nie odchylała się istotnie od średniej wynoszącej 2 osobniki na 40 ha. Zagęszczenie było niższe niż podawane z terenów zalesionych na których też dydelf żyje, ale porównywane z zagęszczeniem na terenach nieleśnych centralnej części USA. Najwyższą liczebność notuje się latem a najniższą zimą (Ryc. 2). Przy pierwszym złowieniu stosunek młodych do dorosłych wynosi 1,48:1,00. Stosunek płci jest bliski jedności, niezależnie od wieku. Dzięki odłowom stwierdzono, że długość życia samic (3,1±0,69 miesiąca) jest istotnie wyższa w porównaniu do samców (2,03±0,33 miesiąca) (Tabela 2). Samce ważą średnio 1,19±0,15 kg, przy pierwszym złowieniu nie różniąc się istotnie od samic (1,18±0,13 kg) (Tabela 3). Dydelfy łowiły się głównie na terenach lasów liściastych (Tabela 4) a przy tym zaobserwowano wyraźną preferencję środowiska o gęstym zakrzewieniu.