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A HERPETOLOGICAL SURVEY OF
GREAT SMOKY MOUNTAINS NATIONAL PARK

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by Willis King

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A REPORT ON THE HERPETOLOGY
of
GREAT SMOKY MOUNTAINS NATIONAL PARK

by

Willis King

This report deals with the occurrence and distribution of 70 species, representing equal numbers of amphibians and reptiles. Twelve of the amphibians and 19 of the reptiles are reported from the Great Smoky Mountains for the first time. The records of occurrence combine those given in earlier literature and the results of field collecting by the author and his associates from June, 1934, to April, 1938. Undoubtedly as further work is done, the species list as well as the distribution of the known forms will be enlarged. This is brought out by the fact that during the last 6 months of the present study, 4 species not previously taken were added to the list and 3 others discovered in earlier collections. It is recognized that a survey of this nature can never be complete, and the present paper is presented only as a summation of the information up to the present time.

GEOGRAPHICAL AREA TREATED

The Great Smoky Mountains consist of one high divide with numerous lateral ridges, extending from the Pigeon River on the east to the Little Tennessee on the west. The crest of the ridge is the North Carolina-Tennessee State Line. The main axis of the park is generally east and west, and approximately 54 miles long. The north-south width of the park varies from 10 to 19 miles, while the foothills of the Smokies extend some 5 miles beyond the park boundary on the north side

and 1 to 3 miles on the south side. The lowest point in the park is at the mouth of Abram's Creek at approximately 850 feet elevation. The top of Olingmans Dome at 6,642 feet is the highest.

The Great Smoky Mountains are justly known as the biological heart of eastern United States. Zoologists and botanists alike find the region unsurpassed throughout the north temperate zone in the variety and abundance of its living forms. Although this paper is primarily a report on the fauna of the park proper, collections have been made in adjacent territory and important additions to the lists thereby obtained. The Little Tennessee, Tuckasegee and Oconalufy Rivers and the Cataloochee Divide have formed the southern boundary for the purposes of this study. On the west and northwest Chilhowee Mountain is a natural barrier to earth-bound species. Collections have not been made on Chilhowee Mountain east of Little River. Only a few collections have been made north of the park boundary, these principally in Tuckaleeschee Cove and near Gatlinburg. The Pigeon River from the State Line to Waterville Lake forms the eastern boundary of the area studied. This report probably does not include all the species which occur in the foothills area surrounding the park and may occasionally penetrate the Great Smoky Mountains proper.

PREVIOUS WORK

Because the Great Smokies were so inaccessible until only recent years, the herpetological work done in the region has been limited. However, the fame of the area as a collecting ground, especially for salamanders has spread widely. Blatchley described Plethodon jordani and Gyrinophilus danielsi in 1900 from specimens collected at Indian

Gap, on the State Line. Dunn (1926) in his monograph of the Family Plethodontidae lists several species from the Great Smokies, but actually entered the area only at Mount Sterling. Pope (1928) spent a day or two in the vicinity of Bryson City and Andrews Bald. McClure (1931) studied the salamanders of LeConte Creek, but reports only 6 species. Weller (1931), made the first list of the salamanders from the area, recording 12 species. Necker (1934) reported 7 frogs, 2 lizards, 10 snakes and 2 turtles, mostly from the vicinity of Greenbrier. Harper (1935) recorded a few of the common species of frogs and toads from Gatlinburg and Bryson City, both localities bordering the park. King (1936) described Desmognathus wrighti from Mount LeConte.

In addition to the above reports which deal specifically with the Great Smoky Mountains, several workers have studied the amphibians and reptiles of the Southern Appalachians, particularly western North Carolina. Cope (1870, 1889, 1898-1900), reported some of the species of the Southern Appalachians. Brimley (1912), contributed "Notes on the Salamanders of the North Carolina Mountains.....", wherein Plethodon metcalfi and Pseudotriton ruber schencki were first described. Dunn (1916) collected in the Blue Ridge and reported on the "Reptile and Amphibian Collections from the North Carolina Mountains....". Pope (1924) contributed valuable life history data on several of the Plethodonts, particularly Desmognathus phoca, D. quadra-maculatus and D. fuscus carolinensis. Noble (1927) studied the life histories and evolution of several of the Plethodonts occurring in western North Carolina. Bailey (1937) contributed several locality records for species of Genera Plethodon and Eurycea. In addition there have been many papers dealing with the

life histories of species that occur in the park, but which are beyond the scope of this paper to report.

DISTRIBUTION AND RELATIONSHIP OF ORDERS

Among the amphibians and reptiles, the salamanders of the Family Plethodontidae alone have been sufficiently collected and studied to give a clear idea of the species occurring here, and there are many gaps even in this group. Although much is yet to be learned, the present paper will help fill in many of these spaces, and throw some light on the faunal relationships encountered in the region. Problems of origin, dispersal, and the influence of diastrophic movements have only partially been satisfactorily described and explained. Even though some information might be available which pertained to one group of plants or animals, such as the salamanders, there was no evidence whether that held true for any other group, the snakes for example.

CAUDATA

Of the 24 species of salamanders known to occur at Great Smoky Mountains National Park, 20 belong to the Family Plethodontidae. At least 10 of these are strictly Appalachian species. One, Plethodon jordani, has not been reported outside of the Great Smokies. The lunglessness of this Family is generally attributed to an early adaptation to a mountain brook habitat, and the center of origin placed in the Southern Appalachians. This gives increased importance to this region, and necessarily requires that all the Plethodonts listed actually refer back to this area, at one time or another in their history. Dunn (1923) in writing on some of the problems of geographical distribution of amphibians, states, "All this leads to one conclusion: that the

Plethodontidae originated in and have dispersed from the mountains of the eastern United States, in a word from Appalachia. We have arrived at this result irrespective of the fact that the primitive forms are at present restricted to Appalachia, by arguments from the center of the range, from the origin in mountain brooks (the anatomy), and from the present position of the mountain brook forms (the ecology)." True, many of the species have abandoned the mountain brook habitat for a near-terrestrial existence, and have migrated from the area, but their history can be traced in many cases and their origin placed in the Southern Appalachian area.

SALIENTIA

The frogs and toads occurring in the park are on the whole, species widespread over eastern United States. The presence of Pseudacris nigrita feriarum, an Appalachian Mountain species, and Gastrophryne carolinensis from the Piedmont and southern Mississippi provinces are of special note. Other typically southern frogs and toads are absent.

LACERTILIA

Three of the 8 species occurring are widespread in their geographical range and five are southeastern in their distribution. The Eumeces complex, composed of species E. fasciatus, laticens and inexpectatus, and the presence of Anolis carolinensis are of special note.

SERPENTES

The snakes rival the salamanders in number of species represented, and offer a very interesting composition of forms. Eleven, or half of the total species, can be classed as widespread in distribution. Southeastern United States contributes a total of 6 or 27 percent of the

snakes, in contrast to the 2, or 8 percent of all salamanders derived from those provinces. There are no snakes present which might be considered principally Appalachian in distribution. The absence of lowland races of Elaphe, Lampropeltis, Matrix and Coluber is interesting. The snake population in East Tennessee deserves further study, because it is a meeting ground of so many northern and southern, eastern and mid-western subspecies. Jones (1928) lists 30 snakes as occurring in Tennessee but gives no locality records.

TESTUDINATA

The Testudinata are represented by only 5 species. Two or these ^{three} are general over eastern United States, one is a Mississippi Valley species, one an eastern form, and one jointly occupies the Tennessee Valley and part of the Gulf drainage of the Piedmont. The mountain streams in the Great Smokies are not favorable to this group of reptiles.

BIOTIC RELATIONSHIPS

Cain (1930) in dealing with the floristic affinities of the trees and shrubs of the Great Smoky Mountains and eastern Tennessee divided the species into two groups, Intraneous and Extraneous. The Intraneous group includes the species which are not near the limits of their distribution and are wholly indigeneous to the region. The Extraneous group includes the species which are locally near the limits of their distribution. Several sub-groups are recognized under each main group. It was found possible to use the same scheme of classification, with modifications, to show the affinities of the amphibian and reptile populations. A lack of distribution data may in a few cases result in a species being put in the wrong classification, but an effort has been

made to assign the species as accurately as possible. Table I contains a summary of the following list:

GEOGRAPHIC AFFINITIES OF THE AMPHIBIAN AND REPTILE FAUNA
OF THE GREAT SMOKY MOUNTAINS

I. INTRANEOUS. (Species not near the limits of their distribution).

A. Species widespread over eastern United States, except, (1) Coastal Plain south of Virginia, (2) The highest Appalachians, and (3) New England in some cases.

AMPHIBIANS

Triturus viridescens viridescens (Rafinesque)

Ambystoma maculatum (Shaw)

Plethodon glutinosus (Green)

Pseudotriton montanus montanus (Baird)

Desmognathus fuscus fuscus (Rafinesque)

Bufo americanus americanus Holbrook

Bufo fowleri Hinckley

Hyla crucifer Wied

Hyla versicolor versicolor (LeConte)

Rana catesbeiana Shaw

Rana clamitans Latreille

Rana palustris LeConte

Rana brachycephala (Cope)

Rana sylvatica LeConte

REPTILES

Sceloporus undulatus (Latreille)

Cnemidophorus sexlineatus (Linnaeus)

Eumeces fasciatus (Linnaeus)
Heterodon contortrix (Linnaeus)
Opheodrys vernalis (Harlan)
Coluber constrictor constrictor (Linnaeus)
Elaphe obsoleta obsoleta (Say)
Natrix septenvittata (Say)
Natrix sipedon sipedon (Linnaeus)
Storeria dekayi (Holbrook)
Storeria occipito-maculata (Storer)
Thamnophis sirtalis sirtalis (Linnaeus)
Akistrodon mokasen mokasen (Boauvois)
Crotalus horridus (Linnaeus)
Chelydra serpentina (Linnaeus)
Terrapene carolina (Linnaeus)

B. Species occurring over southeastern United States, including the Coastal Plain, Piedmont, and the lower Mississippi Valley.

AMPHIBIANS

Bufoea gutto-lineata (Holbrook)
Gastrophryne carolinensis (Holbrook)

REPTILES

Onhisaurus ventralis (Linnaeus)
Leiolopisma laterale (Say)
Eumeces laticeps Schneider
Opheodrys aestivus (Linnaeus)
Elaphe guttata (Linnaeus)
Cemophora coccinea (Blumenbach)
Virginia valeriae valeriae Baird and Girard

Tantilla coronata Baird and Girard

Sternotherus minor (Agassiz)

G. Species occurring in the Southern Appalachians, including the Blue Ridge, the Cumberland Plateau and Mountains.

AMPHIBIANS

Plethodon jordani Blatchley

Plethodon metcalfi Brimley

Cyrinophilus danieli danieli Blatchley

Pseudotriton ruber schencki Brimley

Eurycea bislineata wilderae Dunn

Aneides aneus Cope

Desmognathus fuscus carolinensis Dunn

Desmognathus phoca (Matthes)

Desmognathus quadre-maculatus (Holbrook)

Desmognathus wrighti King

II. EXTRANEOUS (Species near the margin of their distribution).

A. Species occurring principally in northeastern United States.

AMPHIBIANS

Cryptobranchus alleganiensis (Daudin)

Eurycea longicauda (Green)

Pseudacris nigrita feriarum (Baird)

REPTILES

Diadophis punctatus edwardsii (Merrem)

Lampropeltis triangulum triangulum (Lacépède)

B. Species occurring principally in the Piedmont and Coastal Plain of southeastern United States.

AMPHIBIANS

Bufo bilineata X. cirrigera (Green)

REPTILES

Anolis carolinensis Voigt

Bufo inexpectatus Taylor

Lampropeltis elapsoides virginiana Blanchard

C. Mississippi Valley

AMPHIBIANS

Necturus maculosus X alabamensis (Viosca)

Plethodon dorsalis (Cope)

Gyrinophilus danieli X duryi (Weller)

Bufo lucifuga Rafinesque

REPTILES

Lampropeltis getulus nigra (Yarrow)

Amyda spinifera (Le Sueur)

D. Species occurring principally on the eastern seaboard, west to the crest of the Appalachians, and beyond in the Southern Appalachians.

REPTILES

Carphophis amoena amoena (Say)

Lampropeltis getulus getulus (Linnaeus)

Chrysemys picta picta (Schneider)

A recent unpublished list of the native trees and tree-like shrubs known to occur at Great Smoky Mountains National Park, includes 125 species. This list of plants was made available to the writer by Dr. H.M. Jennison, formerly Associate Botanist, National Park Service, for the purposes of comparing the geographic affinities shown by the

Table I. Summary of Geographical Affinities of the Amphibians and Reptiles of Great Smoky Mountains National Park. This Table summarizes the general distribution given in the text.

Authorities for the distribution indicated are principally Stejneger and Barbour, "Check List of North American Amphibians and Reptiles", 1933 edition; Wright and Wright (1933), "Handbook of Frogs and Toads"; Dunn (1926, "Salamanders of the Family Plethodontidae"; Blanchard (1924), "Key to the Snakes of the United States, Canada and Lower California"; as well as my own observations and general reading over a number of years. Assignments are as accurate as present information allows. For discussion of the relationships see the text. The classification is patterned after Cain (1930) with necessary modifications. Percentages are figured to the nearest .5.

Geographical Areas	All am- phibians	Percent- ages	Sala- manders	Percent- ages	All Rep- tiles	Per- cent- ages	Snakes	Per- cent- ages	All Species	Percent- ages
I. Intrinsic.	27	77	17	71	25	71	16	73	52	74
A. Eastern United States	15	43	6	25	16	45.5	11	50	31	44
B. Southeastern United States	2	6	1	4	9	25.5	5	23	11	15.5
C. Southern Ap- palachians.	10	28	10	42					10	14.5
II. Extraneous.	8	23	7	29	10	29	6	27	18	26
A. Northeastern United States	3	8.5	2	8	2	6	2	9	5	7
B. Southeastern & Piedmont Coastal Plain	1	3	1	4	3	8.5	1	4.5	4	6
C. Mississippi Valley	4	11.5	4	17	2	6	1	4.5	6	8.5
D. Eastern Sea- board, Part of the Ap- palachian Divide.					3	8.5	2	9	3	4.5
Totals	35		24		25		22		70	

Geographic Areas		Number of species.	Percent of the total
I.	Intraneous	92	73.6
A.	Entire Eastern United States except the southern Coastal Plain in some instances.	43	34.4
B.	Central portion of eastern United States.	12	9.6
C.	Southeastern United States.	19	15.2
D.	Entire Appalachian Area.	6	4.8
E.	Southern Appalachian Area.	12	9.6
II.	Extraneous	29	23.2
A.	Canadian	5	4.0
B.	Northeastern United States.	17	13.6
C.	Piedmont and Coastal Plain.	3	2.4
D.	Mississippi Valley.	4	3.2
III.	Unclassified	4	3.2
Totals:		125	100

Table II. Geographic affinities of the native trees and tree-like shrubs known to occur at Great Smoky Mountains National Park. The list of trees (not reproduced here) is from unpublished data made available to me by Dr. H. M. Jennison, formerly Associate Botanist, National Park Service.

amphibians and reptiles with those indicated by the native trees.

Table II presents this information for 125 species of plants and enables a close comparison with Table I. It will be noted that a few of the sub-groups are not comparable, the principal difference being that the amphibians and reptiles are not represented by a Canadian element, but do include a few species restricted largely to the Atlantic coastal drainage.

In comparing Tables I and II many striking similarities in composition of fauna and flora are brought out. All Intraeuous species make up 73.6 percent of the plants and 74 percent of the animals. This similarity in composition presents an interesting correlation. Of especial note is the preponderance of species that are widespread in eastern United States; of both plant and animal groups it is 44 percent (Plant sub-groups IA and B). Southeastern forms rank second (both Intraeuous and Extraneuous Groups) with 17.6 percent of the trees and tree-like shrubs (including sub-groups IC and IIC) and 21.5 percent of the amphibians and reptiles. The relatively small influence of the typically far southern species of trees and shrubs, estimated by Cain at less than 6 percent, is balanced by the Extraneuous southern species of amphibians and reptiles by a like figure. Cain's explanation "The extent and high altitude of the Southern Appalachians (culminating in the Great Smoky Mountains) accounts for the relative absence of southern forms because of the actual scarcity of climatic and edaphic situations suitable for such a flora," summarizes the underlying causes. Southern Appalachian trees and tree-like shrubs make up 9.6 percent of the total in Table II, while in Table I, all the strictly Southern Appalachian species encountered

are salamanders, and constitute 14.5 percent of all species, 23 percent of the amphibians and 42 percent of all salamanders. The failure for these endemic species to spread more widely seems explained by the absence of suitable habitat elsewhere. Their abundance here is undoubtedly due to the ancient Geologic age of the Great Smoky Mountains and southern Blue Ridge.

INFLUENCE OF GEOLOGY AND PHYSIOGRAPHY

The Great Smoky Mountains are not only the single largest mountain mass in eastern United States, but are the oldest. The Southern Appalachians are thought to have arisen as a result of diastrophic movements, including uplifting and pronounced horizontal thrust, toward the close of the Paleozoic Era. Although the area was peneplaned during the Mesozoic, further uplift occurred in the Cretaceous Period and again in the Pleistocene. Erosion occurred in the interim and is still in operation. The mountainous area has held its character as an uneven land mass since the Paleozoic, never having been entirely inundated since that time. The rocks of the Great Smokies are consequently old, and the greater portion of the park is covered by Cambrian sediments in various stages of metamorphism. A relatively small body of Pre-Cambrian granite and gneiss is found on the Qualla Indian Reservation and the area immediately north of it in the park along Raven Fork. Limestones of Ordovician Age are found in the western end of the Great Smokies and exercise some influence on the faunal populations. The Cambrian rocks are principally of slate, shale, sandstone, graywacke and conglomerate. The conglomerates are especially massive and cap most of the higher peaks. The decomposition of these rocks results in soil which is usually on

Fig. 1. A view of Cades Cove, showing the variety of habitat afforded by cultivated and abandoned fields, wooded slopes, and meandering streams. The Cove is considered a fenster in the Knox dolomite, and has reached a stable level, ranging from 1700 to 1800 feet in elevation.



the acid side of neutrality. Only in the relatively small flat areas of the coves at low elevations is the soil of any great depth.

Cades Cove, lying in the western end of the park is exceptionally interesting, both from the standpoint of its geology and its fauna. The Cove consists of approximately 2,500 acres of flat or gently rolling land, surrounded by mountains. The flat land has been in cultivation for almost a hundred years. The Cove is regarded as a fenster in the Knox Dolomite Formation of Ordovician Period. The limestone has been worn away by surface and underground waters, so that the Formation is largely gone, leaving the attractive valley. The presence of the limestone which is more recent than the Cambrian rocks, has enabled a few animals (not found elsewhere in the park) to penetrate into the Cades Cove area. The following should be mentioned in this connection:

Eurycea lucifuga

Castrophryne caroliensis

Ophisaurus ventralis

Chrysaora picta picta

Campophora coccinea

Natrix septemvittata

The last four species are not restricted to limestone areas outside the park, so their presence here should be attributed at least in part to the comparatively lower elevations obtaining in the Cades Cove area, and the occurrence of suitable habitat not necessarily requiring limestone strata as a base.

The Great Smokies are therefore a physiographic unit, and should be considered as one faunal or floral area. Too frequently faunal

reports deal with artificial boundaries and exaggerate the importance of state boundary lines. In this paper the state is given in connection with locality records only when the collection was made near a village or in a geographically recognized area outside the park, or when two related subspecies of a form are known to occupy opposite sides of the North Carolina-Tennessee State Line. This type of distribution is known for only the chain snake, Lampropeltis getulus.

No more scenic or rugged area occurs in eastern United States than the Great Smokies. Along the State Line, an elevation of more than 5,000 feet is maintained for more than 36 consecutive miles. There are 16 peaks whose summits are more than 6,000 feet in elevation. The break from the top is rapid, especially so on the north side of the park. At elevations of 5,000 feet to 1,500 feet on that side, the gradient on the principal streams averages close to 8 percent. On the North Carolina side the average elevations are higher and the streams descend more slowly, especially below 4,000 feet. The gradient here will run from 4 to 6 percent on the average. The streams have been the paths of migration for many of the amphibians, especially the salamanders. Their rugged character, clear cold water, and sheer beauty are well known.

Figures II and III give the distribution of amphibian and reptile species according to elevation. Collection records show that 19 amphibians and 23 reptiles have not been found above 3,000 feet which is approximately the mid-point in elevation represented. On the contrary only 4 salamanders and 1 snake (a melanistic phase of the garter snake, (Thamnophis sirtalis)) are restricted to elevations above 3,000 feet. There is a definite falling off of species around 2,500 feet, which marks

Fig. 2. A list of the amphibians of the Great Smoky Mountains National Park, with the elevations which each is known to occupy. The lowest point in the Park, the mouth of Abrams Creek, is approximately 850 feet in elevation. The highest is the top of Clingmans Dome, 6,642 feet. If a species is known to enter any band of 500 feet, it is given as occurring throughout that band. If a species has been taken on the line between two bands, it is listed as occurring in both the band above and below. Species marked with a dot (.) are herein reported from the Great Smokies for the first time.

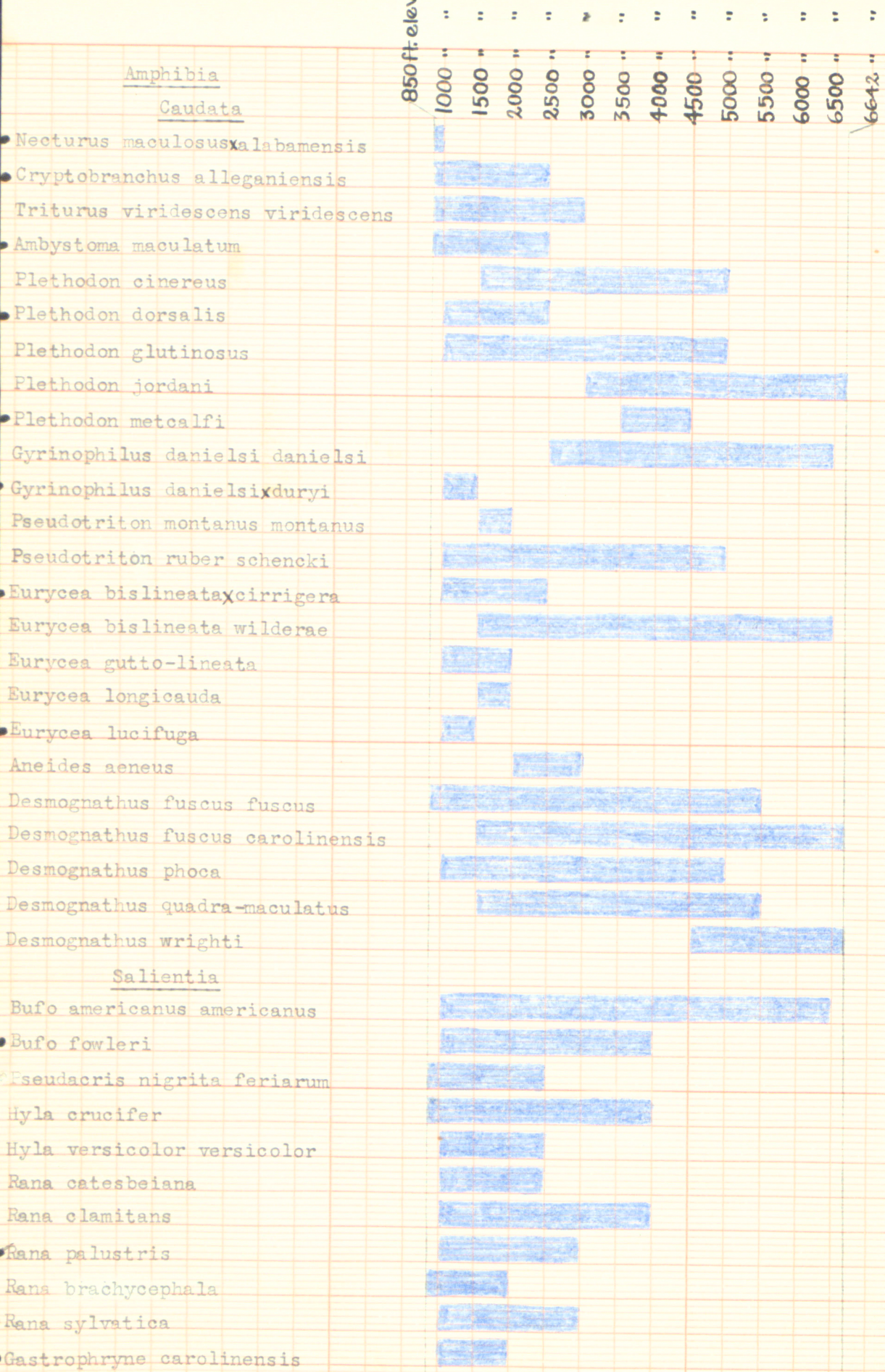


Fig. 3. A list of the reptiles of the Great Smoky Mountains National Park, with the elevations which each is known to occupy. The interpretation is the same as for Fig. 2.



about the upper limit of what is considered the Upper Austral Zone. A second break occurs at from 4,000 to 5,000 feet. This marks the average maximum elevation for the western half of the park and in the eastern portion the lower border of the spruce-fir forest. The effect of the forest types on faunal distribution is discussed later in this paper. In connection with the above, it is interesting to note that only 7 salamanders, 1 toad and 2 snakes are known to occur normally above 5,000 feet. The limiting factors in the vertical distribution are probably only secondarily the effect of altitude. The requirement for occurrence at an elevation is suitable habitat, which in turn depends on the nature of the rock and earth, and even more upon proper water conditions and the plant community.

INFLUENCE OF CLIMATE ON FAUNA

The Great Smoky Mountains have no single climate. At the lowest elevations light, temperature and moisture conditions are comparable to those in the vicinity of Sevierville, Tennessee or Bryson City, North Carolina. On the high mountains such as Clingmans Dome, Guyot and LeConte entirely different conditions prevail. Partial weather data has been kept for a period of years at Gatlinburg, Elkmont, and Bryson City, but the data is very meager for the high mountains. The effect of the great variation in climate from the lowest to the highest elevations most certainly affects the animal populations. Spring comes from two weeks to a month later at 6,000 feet than it does at 1,500 feet elevation. This can be readily seen in the blooming period in the same species of such plants as Claytonia virginica, Houstonia caerulea, Azalea calendulacea, Halesia carolina, and others that transcend the elevations of-

forded by the Great Smokies.

Elkmont, located near the center of the park at 2,150 foot elevation, offers conditions more nearly average than any other weather station in or near the park. Climatological records over a ten year period (1927, 1929-1937) show an average annual precipitation of 65.5 inches and an average mean temperature of 55.8 degrees Fahrenheit. Humidity and light readings are not available. The lowest winter temperatures are about zero and the highest summer readings reach 95 to 100 degrees Fahrenheit.

The Tennessee Valley Authority now has rain gauges placed at several places in the upper Tennessee Valley, including one on Clingmans Dome. Precipitation data are available from the last locality only for 1936 and 1937. During these two years the rainfall was 87.5 and 89.5 inches respectively. At Elkmont during the same years, the precipitation was 56.3 and 55.5 inches. For further comparison the rainfall at Knoxville was 49.6 and 50.3 during the same years. The horizontal distance from Clingmans Dome to Elkmont is not more than 8 miles, while Knoxville is more than 30 miles in a direct line northwest from Elkmont. Two years are too brief a period to make any conclusive comparisons, but do indicate that the rainfall on the higher peaks may be as great as 80 to 90 inches annually. In a few years further quantitative data will be available.

The nature of the spring controls the time of emergence and the beginning of breeding activities for the amphibians and reptiles. Dates are given for several of the species listed under the species descriptions. The season varies considerably and an average date upon which a species may be expected to make its appearance or lay its eggs can hardly be determined. The same is true of the fall hibernation. Frequently some of

the more common snakes are seen on sunny days in November. Undoubtedly climate either directly or indirectly through its influence on the growth of vegetation, plays a large part in determining the occurrence and distribution of many of the amphibians and reptiles found locally.

INFLUENCE OF VEGETATION ON FAUNAL DISTRIBUTION

The abundant and highly varied flora of the Great Smoky Mountains has been commented upon by practically every botanist who has visited the area (Calyon, 1923). Probably the Great Smokies will continue to be known for its plant life more than for any other single feature. At least 125 species of native trees and tree-like shrubs occur within its boundaries. About 40 percent (38 to 40) of the forest cover types recognized for eastern United States are represented (see ref. cited). The number of herbaceous plants, shrubs and vines is still in the speculative stage, but is indeed impressive. The effect of the wide variation in forest types and ground cover on the faunal populations naturally is great. The total acreage shown within the park boundary is approximately 440,000 acres and at least half of this total area is in virgin forest and will remain so. Most of the cut-over areas are revegetating rapidly under the protection afforded by the National Park Service.

The importance of vegetation in regulating the environment and thereby creating varied faunal habitats can scarcely be over estimated. The presence of the spruce-fir forests on the high peaks and ridges in the eastern three-fifths of the Great Smokies marks an environment not only highly characteristic in climate and soil, but in the composition of ground-story plants. The following species are typical of this

habitat:

Plethodon jordani

Desmognathus fuscus carolinensis

Desmognathus wrighti

Thamnophis sirtalis sirtalis (melanistic phase)

Forests at this elevation are cold and wet. The surface of the ground rarely becomes dry, and a heavy protective layer of moss and ferns not only conserves the moisture but offers the type of habitat desired by the salamanders noted above.

Perhaps the second most distinctive correlation exists between the animals and plants in the pine-oak-heath complex at elevations below 3,000 feet. This type of forest is warm, dry and light. There is considerable ground cover, but it is easily penetrated. Species most commonly associated with this habitat include:

Plethodon cinereus or P. dorsalis

Plethodon glutinosus

Liolopisma laterale

Amphis carolinensis

Rhynchelytes laticens

Opheodrys aestivus

Lampropeltis elapsoides virginiana

Cnemidophorus coccineus

Virginia valeriae valeriae

Tantilla coronata

Crotalus horridus

Terrapene carolina

Other groups of species might be listed which occupy principally the moist valleys along streams, or the open forested slopes of the coves. However, these lists cannot be clear cut and need not be given here because habitat preferences are indicated whenever possible in the separate species accounts. It is interesting to note that the abundance of decaying logs, often moss covered, influences to a large degree the relative abundance of many of the forms, especially the salamanders. The practice of felling and flattening dead trees as a fire hazard reduction measure, so popular in parks and forests during recent years, probably has favored the salamanders, lizards and snakes, but has been derogatory to many kinds of birds. Certainly there is still an abundance of dead wood in the Great Smokies, both felled and standing. The collector soon recognizes that some of the plant communities offer undesirable habitat for amphibians and reptiles. Principal among these are the heath balds or slicks. These are practically impenetrable and have a heavy layer of peat over an extremely acid soil. Frequently the hardest places to collect yield the poorest results, both in species and individuals.

Disturbance of the original vegetative cover seems in general to be adverse to the salamanders and beneficial to the snakes. Clearings attract birds, mammals and insects, which furnish food for the snakes, but admit light which dries out the soil and makes conditions unfavorable for the moist skinned amphibians. In logged-over areas, the amphibian and reptile forms will usually persist, even with reduced numbers, unless fire follows the logging to complete the devastation. Almost invariably success in collecting specimens of salamanders declines in an area for a period of years following logging. Streams which harbored

good populations of such species as Desmognathus quadrimaculatus became poor hunting grounds for the herpetologist. At low elevations the effects of logging on the fauna are not so pronounced.

SPECIES ACCOUNTS

In the succeeding pages of this report, the status and known distribution of each species reported from the Great Smoky Mountains National Park is given.

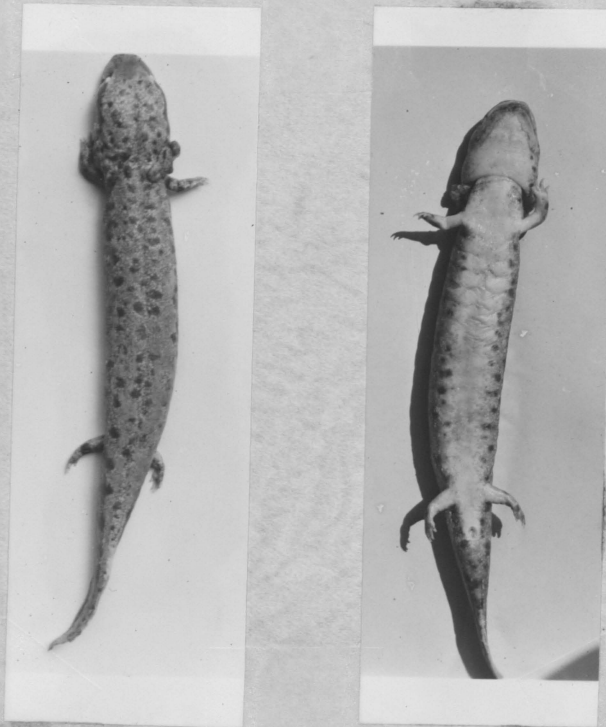
CAUDATA

Necturus maculosus X alabamensis (Viosca)

Two adults and several larvae of this salamander were taken by Dr. Carl Hubbs and the writer from Abrams Creek, just above its junction with the Little Tennessee River, on September 6, 1937. We were seining for fish and were fortunate in obtaining the mud-puppy. The stream is quite clear, and has only a moderate current. The stream bed has many projecting rock ledges and large flat stones which offer suitable habitat for the salamander. The species has not been taken elsewhere in the park.

Viosca (1937), in a tentative revision of the Genus Necturus, indicates that the mud-puppy of the upper Tennessee drainage is N. maculosus. Very little material has come from this region and it is only recently that a workable series has been obtained. In his revision, Viosca did, however, describe a new species, Necturus alabamensis, from north central Alabama, with the type locality on the Black Warrior River near Tuscaloosa. This new form has many of the characters of N. maculosus, but is a smaller animal. The specimens from the Great Smoky Mountains are in many respects intermediate between N. maculosus and Viosca's N. alabamensis. It is my opinion that N. alabamensis should be listed as a subspecies of N. mac-

Fig. 4. Dorsal and ventral views of Necturus maculosus x alabamensis. This animal, an adult female measuring 229 mm., in total length was taken from the Clinch River at Norris, Tennessee. Note the unpigmented venter and the tendency for the dorsal spotting to fall into rows.



ulosus, and the specimens from the upper Tennessee regarded as intergrades with the balance of characters in favor of the southern form.

Dr. A.R. Cahn has contributed several specimens of Necturus maculosus from the Clinch River, taken just below Norris Dam. I have examined these animals closely and they are the same as those from Abrams Creek. A table of measurements of specimens from Abrams Creek and the Clinch River is given for purposes of reference (see Table III).

A description of the animal, in life, based on 3 specimens from Norris, follows. The color is dark amber, russet brown or brownish gray, grayer on the sides and lighter ventro-laterally. The dorsum is flecked with small white or yellow spots which disappear in formalin. Black spots, more or less arranged in rows are prominent. The dorso-lateral rows contain the largest spots, which are in the region of the groin and the proximal two-thirds of the tail. The median rows of spots (usually 2 rows visible) are smaller, and may unite at the base of the tail or extend on to the tail, bordering its dorsal edge. The longitudinal rows of spots lose their identity in irregular spotting on the head. The pigmentation on the sides is somewhat more irregular, and the spotting is only indefinitely arranged in two longitudinal rows. The zone between the pigmented sides and the unpigmented venter varies with individuals and with age, but all specimens examined have a plain median band from neck to anus. The muzzle is obtusely rounded to slightly truncate. A dark line on the canthus extends from the area about the nostril through the eye to the base of the gills. The muzzle and forehead are decidedly flattened. The form is on the whole, smaller, slenderer, more flattened, has a more primitive pigment pattern, a somewhat larger eye and a reduced

Table III. Measurements of 5 specimens of Necturus maculosus from the Clinch River at Norris, Tenn., and 2 from Abrams Creek in Great Smoky Mountains National Park. The number of teeth is half the number present on both sides. I am indebted to Mrs. Helen T. Gaige for the loan of the three specimens from the University of Michigan Museums, to Dr. A.R. Cahn of the Tennessee Valley Authority for obtaining live Necturus for me, and to Dr. Carl L. Hubbs for his part in helping collect the specimens from the Great Smoky Mountains.

	T.V.A. Coll., Clinch River		Univ. of Mich. Coll., No. 82957 Clinch River			G. S. M. N. P. Abrams Creek		Averages
Sex	Female	Female	Female	Female	Male	Female	Female	
Total length	218	229	227	225	213	240	216	224
Length of head	35	37	38	39	37	42	38	36.6
Length of body	118	124	117	116	111	124	109	117
Length of tail	67	68	72	70	65	74	69	69.3
Head and body	151	161	155	155	148	166	147	154.7
Width of head	24	26	28	28	25	28	25	26.3
Depth of head	14	15	16	15	16	17.5	16	15.6
Head length in body length	3.6	3.4	3.1	3.0	3.0	3.0	2.9	3.1
Head width in head and body length	6.3	6.2	5.5	5.5	5.9	6.1	5.9	5.9
Body width	25	26	26	26	22	23	22	22.9
Body depth	17	19	23	22	22	18	15	19.4
Body width in body length	4.7	4.8	4.5	4.5	5.0	5.4	5	4.8
Body depth in body length	6.9	6.5	5.1	5.3	5.0	6.9	7.3	6.1
Maxillary teeth	-	9	8.5	9	8.5	8	8	8.5
Premaxillary teeth	8	11	13.9	11	11	12	10.5	11
Mandibular teeth	5.5	5.5	7	6	5	5.5	6	5.8

number of teeth, in comparison with typical N. maculosus.

Six larvae taken from Abrams Creek, with the adults mentioned above, are from 35 to 37 mm. in total length. These show three dark brownish stripes, one on the dorsum and one on either side. The median stripe widens on the head and narrows to a blunt point on the muzzle. The lateral stripes occupy approximately two-thirds of the lateral body surface, and extend beyond the gills to the eye and more narrowly to the tip of the snout. Separating the dark bands are creamy-white stripes, which unite on the snout and extend in broken fashion on to the tail. The upper parts of the limbs are dark and the under parts, together with the venter, are creamy white.

The fauna of the Alabama drainage system is in general different from that of the Tennessee, but some species of aquatic cold blooded vertebrates are known to occur in both. Dr. Hubbs has found a few cases of carry-over in fishes (unpublished data), and the small mud turtle, Sternotherus minor, a companion species to the Tennessee Necturus, also occurs in the more southern drainage in Alabama (Stejneger and Barbour, 1933). The possible effects of earlier stream piracy, and the changes in drainage even prior to Recent Time are interesting phases of the distribution problem and deserve further study in southeastern United States. Both the mud-puppy and the mud-turtle are "old" species and may well antedate the present drainage systems.

Cryptobranchus alleganiensis (Faudin)

This, the largest of the American salamanders, occurs in the larger streams of the Great Smokies. Specimens have been taken in Little River near Elkton at 2,200 feet elevation, in the West Prong of Little Pigeon

River near Gatlinburg and in Abrams Creek at 900 ft. elevation. The species has been observed in the Middle Prong Little Pigeon below Greenbrier and in Hazel Creek and Deep Creek in North Carolina. It probably occurs in most of the larger streams of the park below 2,500 feet elevation.

A female specimen taken at Elkmont, August 28, 1936, contained ripened eggs. A male taken two days earlier regurgitated a mass of the eggs of the species when it was chloroformed. At this season males may be readily distinguished from females. In males the region about the vent is greatly swollen and a marginal row of enlarged tubercles encircles it. Males also show more expansive folds of skin on the toes and a larger fold on the outside of the lower leg and upper tarsus regions than do females. The head is somewhat broader and heavier in appearance in the male. Skin on the lateral portions of the body also seems more convoluted. The largest specimen in the collection, a male No. Ca-4 collected in the Little Pigeon River near Gatlinburg September 2, 1936 by Donald Payne, measured 686 mm. in total length. The head is 38 mm. wide at the widest point and 30 mm. thick at the posterior angle of the mouth. The tail including the dorsal skin fold is 80 mm. high, 262 mm. long, with the skin fold greatly convoluted. A female, No. Ca-3, collected at Elkmont by Ralph Proffitt, August 28, referred to above, is 635 mm. long, the head is 72 mm. wide at the widest point and 29 mm. thick at the posterior angle of the mouth. Its tail is 55 mm. high, 233 mm. long, with the skin fold smooth and only slightly convoluted.

The importance of this species in the economy of the stream is not well understood, especially in this section of its range. It is unlikely

that it competes severely with other species such as rainbow trout. It does not appear to be abundant in park streams.

Triturus viridescens viridescens (Rafinesque)

The scarcity of ponds in the mountain area limits the distribution of this species. Wherever a natural or artificial pond does occur, or in pockets caused by a stream overflowing, newts are almost certain to be found. Courtship behavior has been observed most commonly in March but records of mating activity have been reported as early as January 15. The species is very common in the Cades Cove area, where several sink-holes and marshy spots occur. It has also been taken on Laurel Creek, at the Sinks on Little River, near Gatlinburg, at Elkmont, Chilhowee and Greenbrier. The red^left stage is frequently found on wet trails or under logs on ridges several hundred yards from any permanent water.

Ambystoma maculatum (Shaw)

The spotted salamander is found in habitats similar to those where the common newt occurs, but is more limited both as to numbers and localities. The species has been observed in Cades Cove, at the Sinks on Little River, Laurel Creek sink holes, Gatlinburg, the Sugarlands area and at Elkmont. It doubtless occurs at several other localities within the park. In general the distribution is scattered, in pools and sink holes below 3,000 feet elevation. Adults are rarely collected or seen except during the short breeding period.

The species usually follows the wood frog (Rana sylvatica) closely in its spring emergence, and begins breeding activity often before the ice is all out of the ground. The breeding season at this latitude naturally

is quite variable. The usual procedure is that a warm spell of weather in late January or early February brings out some of the animals and a few egg masses result. Unless the warm weather continues for a week or longer, the principal breeding period is postponed until such a period does arrive.

In 1935, the first egg mass was seen January 17 along Dudley Creek near Gatlinburg, although the peak of egg laying was not reached until a month later. In 1936, the first eggs were found February 24 in the Sugarlands area. In 1937, the first eggs were laid in the pool at the Sinks on Little River January 15, and several warm days brought the activity to completion. Adults were seen in a small pond at Elkmont January 23, 1938, and eggs were laid on January 30, while at the Sinks on Little River A. maculatum laid its eggs the week of February 6 to 12. In the last location, I have counted as many as 95 egg masses of this species in a pool not over 20 feet in diameter.

Plethodon cinereus (Green)

The red-backed salamander is an uncommon species in the Great Smokies and appears to occupy a slightly different position than does the closely related species P. dorsalis. All our collections have been made from pine-oak or mixed hardwood forests between 1,500 and 5,000 feet elevation. The species seems to prefer slopes having fairly dry soil. On the other hand, P. dorsalis seems to occupy the flatter moister areas at lower elevations. The two species are also readily distinguished by the greater pigmentation of the belly in P. cinereus, the relative length of the tail which equals or exceeds the head and body, and the larger number of costal grooves (18 to 20) in this species. P. dorsalis

on the other hand has the belly lighter, tail not exceeding the head and body in length, and usually 16 to 18 costal grooves.

Park records are scattered from White Rock in the east to Forge Creek in the west end of the park, including stations at Trillium Gap on Brushy Lead, the Newfound Gap Highway, Elkmont, the Sinks on Little River and White Oak sinks. Weller (1931) records the species from the slopes of Mount LeConte. Inasmuch as he states the specimens are of the red-backed phase and have 21 costal grooves it is likely that they are of this species.

Plethodon dorsalis (Cope)

Original collections of this species were confused with those of P. cinereus. The differences are outlined under the description of that species. P. dorsalis also appears slightly more robust.

An old sawmill site on the floor of White Oak Sinks yielded 24 specimens in an hours collecting, March 22, 1935. The animals were found under practically every old board and slab and occasionally under flat stones and logs. The species is common along the bases of the ridges between Gatlinburg and the Sugarlands area. Park collections from the above localities and three others on the Tennessee side of the park range in elevation from 1,300 to 2,000 feet. The species has not yet been taken on the North Carolina side of the park, but may occur there, most likely toward either end.

Plethodon glutinosus (Green)

Plethodon glutinosus is common and widespread in the Great Smokies, up to as great an elevation as 5,000 feet. It does not appear to enter the spruce-fir forest to any great extent and is most common on oak and

pine clad ridges at moderate elevations. The collection at Great Smoky Mountains National Park includes specimens taken from 20 localities well distributed over the entire park area. Occasional specimens have the white mottling reduced or nearly absent, but a careful examination leaves no doubt as to the identity of the form. On the high hardwood ridges running off from Gregory Bald, Thunderhead and other peaks in the west end of the park, the species is frequently encountered in company with P. jordani. There is no evidence of intergradation.

Plethodon jordani (Blatchley)

Probably more herpetologists search for this species in the Great Smokies than for any other kind of salamander. It is very common and widely distributed above 4,000 feet elevation, but has been taken on Indian Creek, North Carolina and Ramsey Prong, Tennessee as low as 3,100 feet. It is most abundant in the red spruce-Fraser's fir forest and is also found on the hardwood covered ridges in the west end of the park at suitable elevations. The park collection contains specimens from at least 20 different localities, and the species has been seen but not collected in at least that many more places.

The cheek patches are usually well developed rosy-red, but occasional specimens have an orange or even yellow cast. In relatively few individuals the red pigment is poorly developed, and I have seen only two in several hundred live and preserved specimens that showed no trace of red, orange or yellow on the cheek patches.

No one has yet succeeded in finding the eggs of this species. The forest floor where the species is most abundant consists of a heavy layer of moss with only a little soil over rock. This rock usually is

Fig. 6. The headwaters of the Road Prong of the West Prong, Little Pigeon River. The location shown is just below Indian Gap (5000 feet elevation) and is the type locality for Plethodon jordani and Gyrinophilus danielsi danielsi. Desmognathus fuscus fuscus, Desmognathus fuscus carolinensis, Desmognathus quadra-maculatus, Desmognathus wrighti, and Eurycea bislineata wilderae are present in the same locality.



a mass of boulders of such proportions that collecting below the surface becomes a well nigh impossible feat.

Measurement and study of a series of 67 entire individuals shows a size range of 43 to 149 mm. total length. The animals group themselves logically into two groups, one ranging from 43 to 63 mm. and the other 80 to 149 mm. It is likely that the first contains individuals in their second year of growth, while the second group contains specimens in their third and subsequent years of growth. There is some indication of a break between 98 and 104 mm. but I have not measured enough specimens to determine whether or not this holds true in a large series. Apparently the animals do not reach sexual maturity before their third summer or a size of 80 mm. Small individuals, between 30 and 40 mm. have been noted in nature, in April and May. Frequently individuals are taken which are in the process of devouring small snails, beetle larvae and other insects. The mucus from this species is extremely viscous and is removed from the human skin with difficulty.

Plethodon metcalfi Brimley

The presence of this species in the Great Smokies comes as a surprise to most herpetologists. Stejneger and Barbour in their Check List (1933) state, "It apparently occupies all the ranges of the Southern Blue Ridge except the Great Smokies and the Nantahalas." This statement is exactly that given by Dunn (1926) in his Monograph of the Family Plethodontidae.

The park collection contains a series of 16 specimens of the species ranging from 40 to 120 mm., including individuals of both sexes. The writer collected 15 of these on Hyatt Ridge, on September 12, 1934, at

elevations from 3,500 to 4,100 feet. My Raymond Fleetwood, former Resident Wildlife Technician, collected one specimen on Cataloochee Divide at 4,500 feet elevation, June 11, 1935. I have seen and taken the species at Highlands, North Carolina in numbers; and when the specimens from the two localities are compared, they are identical. P. jordani occurs on the same ridges and I have taken it less than a mile from the point where P. metcalfi was taken. A comparison of local specimens of the two species leaves no doubt as to their distinctness. P. metcalfi is generally less heavily pigmented, especially on the ventral body portions, has one less costal groove (15), and is withal a slimmer and less muscular species. The submental gland on the male is quite highly developed.

Collections were made in oak-chestnut forest, under logs, in areas having relatively good deep soil. The presence of the species on the two ridges in question is not difficult to explain. Balsam Mountain extends from the State Line, the main crest of the Smokies, southward eventually joining the main mass of the Balsam Mountains. It rarely dips below 3,000 feet elevation. The type locality for the species is Sunburst, North Carolina near the southern end of the Balsam Divide, less than 20 miles from the points of collection in the park, and in the same country. Extending east from Black Camp Gap on Balsam Mountain is the Cataloochee Divide, all of which is in Haywood County, North Carolina. Hyatt Ridge likewise joins Balsam Mountain before it reaches the State Line. The path of migration has been an easy one. Undoubtedly P. metcalfi has been unable to spread farther into the Smokies because of the presence of P. jordani and the necessity of crossing an unfavorable habitat (spruce-fir forest). Its presence on Balsam Mountain, Cataloochee

Divide, Hyatt Ridge and probably Mt. Sterling Ridge, as well as other tributary ridges is rather to be expected.

Gyrinophilus danielsi danielsi (Blatchley)

This is one of the strikingly colored salamanders of the Great Smokies. The scattered black spots on the deep salmon ground color, together with the broad flat head and prominent canthus rostralis readily distinguish it. It is typically found under the stones and in the soft banks of small streams at elevations above 2,500 feet. Occasionally it is found under stones, logs or moss on ridge tops several hundred feet from any water. The species is seldom numerous in any locality but is widely distributed over the park in suitable elevations and habitats. The collection at Great Smoky Mountains National Park includes specimens from Tricorner Knob, Mount Chapman, Pecks Corner, Laurel Top Mountain, Gregorys Bald and Indian Gap (the type locality) along the State Line, and also from Cataloochee Divide, Mount LeConte, the Chimneys area, and Haw Gap on Jenkin Trail Ridge. Weller (1931) lists a specimen in the Ohio State Museum collection from Gatlinburg. I am familiar with the history of this specimen and know that it was collected by F.O. Hazard of Wilmington, Ohio, on LeConte Creek above Gatlinburg at an elevation of 2,600 feet.

On the night of April 20, 1937, Mrs. King and I were driving from Gatlinburg to Waynesville between 8 and 9 P.M. It was a warm, foggy night, following a period of showers. On the Newfound Gap road, Tennessee side, between 3,500 and 5,000 feet elevation we saw at least 200 salamanders of this species crawling about on the road. They could be seen at considerable distance because of the contrast of their light

bodies on the black surface of the road, but even more striking was the reflection from their eyes. They nearly always turned toward the car lights and their eyes shone back at us like two small balls of fire. I had seen light reflection in frogs eyes many times, but this was a new experience. The presence of so many of these comparatively uncommon animals made the observation all the more interesting.

Gyrinophilus danielsi X duryi (Weller)

The relationships of the three known forms of Gyrinophilus, namely G. porphyriticus (Green), G. danielsi (Blatchley), and G. duryi (Weller) have not been clearly known. Stejneger and Barbour in their 1933 edition of the Check List classify all three as subspecies of G. porphyriticus. It is the writer's opinion that sufficient material is at hand to indicate what the relationship actually is, at least in reference to G. danielsi and G. duryi.

Gyrinophilus danielsi Blatchley is a species of the higher mountains, and in the Great Smokies typical specimens have not been taken below 2,500 feet elevation. The T.V.A. collection at Norris contains two Gyrinophilus from Great Smoky Mountains Caverns, which are situated in Tuckaleechee Cove at about 1,200 feet elevation. Very recently, I have also obtained two more specimens from Little River, one at 1,100 feet and one at 2,100 feet elevation. These four are alike in body proportions and general appearance. The color in life is salmon-red, darker than G. danielsi from higher elevations. The pigmentation on the head is decidedly less heavy than the latter form. The canthus rostralis is less pronounced and the snout is decidedly more rounded. The body wall is more translucent and does not become as brown in formalin as does G. danielsi.

Table IV. Comparative measurements of a series of Gyrinophilus danieli.

The measurements given in the first column are based on two specimens of G. danieli duryi, one of which is Weller's Type, C S N H No. 499a, taken at Carter County, Kentucky, and the other from the collection at Wilmington College, taken in Pike County, Ohio, in 1929. The second column is derived from four specimens taken in the Great Smoky Mountains at elevations from 1000 to 2100 feet. The last column is taken from measurements of five adult specimens collected along the State Line in Great Smoky Mountains National Park above 5,000 feet in elevation.

	<u>G. danieli duryi</u> from Ohio and Kentucky	<u>G. danieli X duryi</u> from the foothills of the Great Smokies	<u>G. danieli danieli</u> from high elevations in the Great Smokies
Total length	148.5	144	135.4
Head length	21	20	21.6
Body length	77.5	71	61.2
Tail length	60	55.5	52.6
Head and body	88.5	92	82.8
Head length in body length	3.25	3.5	2.8
Head width	12	12.5	13.6
Head width in head and body length	6.6	7.4	6.1

Dorsal spotting is mainly of small black dots which encroach on the ventral portion of the body only in the anterior region. These characters agree quite closely with G. duryi as described by Weller (1930). Weller's description of the animal is accepted even though it was placed in the wrong Genus, namely Pseudotriton, at the time. No specimens of the form from Tennessee have been reported, to my knowledge. It is evident that G. danielsi and G. duryi are very closely related and intergrade in the southern extremities of the Great Smoky Mountains and possibly the Blue Ridge. G. danielsi appears the most primitive. The more elongate body of G. duryi according to Dunn (1926) would indicate a more recent origin. This fits in well with the geological story. The two animals are so near alike anatomically, that I am reducing them to subspecies under the form first described. They there become Gyrinophilus danielsi danielsi (Blatchley) and Gyrinophilus danielsi duryi (Weller), respectively. Only in this way can the specimens at low elevations in the Great Smoky Mountains be satisfactorily placed.

The first specimen of G. danielsi X duryi that was taken in the park, was found by a labor crew engaged in cleaning a roadside ditch on Little River. The salamander was running through the shallow muddy water, in the process of swallowing a Plethodon glutinosus. The Gyrinophilus was 156 mm. long and the Plethodon 145 mm. long. The latter was still wriggling when its captor was taken. Apparently Gyrinophilus is quite cannibalistic in its habits. I found the second specimen of G. d. X duryi at Elkmont. I have lived at that locality nearly four years but this salamander waited until a warm rainy night in early April, 1938, to crawl out on the highway and be discovered.

The Tennessee Valley Authority Collectionist Norris has specimens of typical G. porphyriticus from Anderson County and Union County in East Tennessee. The private collection of Mr. Arthur Stupka, Park Naturalist at Great Smoky Mountains National Park, also contains a typical specimen of the species from Hocking County, Ohio. All of these are distinct from the G. danielsi-duryi complex, and appear one and the same species.

Pseudotriton montanus montanus (Baird)

The park collection contains only two specimens of this species taken within the Great Smokies. One, an adult, was taken from under a board in a muddy spot at the Sinks on Little River, at an elevation of 1,565 feet. The other, a fully grown larva, was found in an old spring house at Mount Sterling, at 1,600 feet elevation. The species is certainly rare locally.

Pseudotriton ruber schencki (Brimley)

This subspecies of P. ruber is widespread in the Great Smokies but the form is rare above 3,000 feet elevation. The park collection contains specimens from 17 localities. It prefers springs and muddy seeps, but may be found along small streams. There are two records from unusually high elevation for this species, both 5,000 feet: one from Boulevard Ridge collected by the writer, and the other from Hughes Ridge collected by Maurice Sullivan, former Resident Wildlife Technician. It prefers wetter places than does G. danielsi danielsi and shuns streams of rapid and rocky descent. I have taken the two species together on Ramsey Prong at 3,100 feet elevation, and at the Chimneys Camp Ground 250 feet lower.

After heavy rains in midsummer adults are frequently seen on roads,

trails and open areas, more commonly at night, but occasionally during the day. Larvae are common in springs and small slow moving streams.

Eurycea bislineata X cirrigera (Green)

In addition to E. bislineata wilderae, which is quite distinct, another sub-species of bislineata occurs in the Great Smokies that for a considerable time was an enigma to me. The latter form occurs below 2,500 feet in elevation in springs, marshy areas, and small streams. It does not leave these wet places for a semi-terrestrial existence as does E. b. wilderae. After examining a series of 18 specimens rather closely and comparing them with E. bislineata bislineata from Hocking County, Ohio, and E. b. cirrigera from Marshall County, Alabama, it is apparent that the local specimens are intergrades with the balance of characters in favor of E. b. cirrigera.

The local form is recognized by its generally brown color. The ventral area is yellow and the dorsal area plain brown with only a few specimens showing scant spotting. The sides of the body are finely pigmented, grading from a grayish brown mottling along the ventral border to a dense dark brown dorso-laterally, sharply marked off from the lighter dorsum.

Secondary sex characters are more highly developed than in E. b. bislineata, as evidenced by a well formed naso-labial tubercle, swollen snout and slightly enlarged premaxillary teeth in the male. Females with well developed eggs have been taken at Elkmont throughout March, and eggs have been noted in April.

A large taken at the Park Headquarters Area April 8, 1937, measures 54 mm. in total length. Another, with the same date, is 39 mm. long.

Table V. Comparison of Eurycea bislineata bislineata (from Dunn (1926), and specimens from Ohio), Eurycea bislineata cirrigera (from Dunn (1926) and one specimen from Marshall County, Alabama), and Eurycea bislineata from low elevations in the Great Smoky Mountains. The Great Smokies specimens are most nearly E. b. cirrigera, as can be seen from the comparative data. Only characters in which the two subspecies differ are listed.

Character	<u>E. b. bislineata</u>	<u>E. b. cirrigera</u>	<u>E. bislineata</u> from low elevations in the Great Smokies
Distal grooves	15	14	14
Spaces between appressed toes	3	2	2
Shape of head	broad oval	blunt, almost trapezoidal	intermediate
Length of eye as to dis- tance to tip of snout	longer	shorter	equal
Meso-labial swelling in male	slight	well developed cirrus	pronounced tubercle
Outline of upper jaw	convex	straight	straight
Teeth, in order of length	3-4-2-5-1	4-3-2-5-1	3-4-2-5-1
Dorsal keeled below	not keeled below, or on distal 1/3 only	on distal 2/3	on distal 1/2
Dorsal teeth	6-7 arise opposite posterior corner of nares, bend in and back and almost meet	4 arise behind inner corner of nares, remain separated by width of nares	5 to 8 arise behind inner corner of nares, re- main separated
Ground pattern	dark line from eye to tip of tail, gray mott- ling below, yellow venter	broad band eye to tip of tail, darkest dorso-laterally, bright yellow venter	brownish, dark- est dorso- laterally, lighter dorsally, yellow venter
Dorsal spotting	median, comparatively few spots	diffuse, numerous small spots	little or none

The upper row of larval areas is visible on the smaller specimen but cannot be seen on the larger one. The middle row is clearly visible on both and the lower row very indistinct. There are 14 costal grooves between the logs. The sides of the body and tail show the formation of the brown pigment characteristic of the adult. Two small salamanders from the same locality measure 57 and 60 mm. and would pass for E. b. bislineata, but show a tendency toward increased pigment on the sides of the body and tail. Apparently this increases in extent with age, for no adults have been found which might be called E. b. bislineata.

The form has been taken at Anthony Creek in Cades Cove, at the Laurel Creek sink holes, from a woodland pool at the Sinks on Little River, at Elkmont, Gatlinburg and the Park Headquarters Area, all in Tennessee.

Eurycea bislineata wilderae (Sunn)

This is one of the common salamanders in the Great Smokies. It may be found in nearly every spring, seep and permanently damp places at suitable elevations. In fact, it appears fairly terrestrial in habit, and is frequently found under logs, bark of fallen trees or moss at considerable distance from water. I have not taken it below 1,700 feet, but have found it on the highest peaks, including the very top of Clingmans Dome at 6,642 feet. The park collection contains 63 specimens from 22 localities.

Weller (1931) mentions 4 specimens in the Ohio State Museum from Gatlinburg which is at 1,300 feet elevation. I am certain that the specimens in question came from LeConte Creek in the vicinity of Cherokee Orchard at 2,600 feet elevation.

There is some variation in anatomical characters shown by a large

series. This is particularly noticeable in amount of pigmentation between the dorso-lateral stripes, and the extent to which the lines remain unbroken on the tail. The largest adult specimen reported by Dunn(1926) measured 93 mm. in total length and the largest larvae, 51 mm. These measurements are exceeded by several specimens in the collection at Great Smoky Mountains National Park. On Baxter Creek, a tributary of Big Creek, I found a colony of exceptionally large individuals. Three of these measure 96, 98 and 99 mm., respectively. One larva is 60 mm. in length. From Road Frong, a headwater stream of the Little Pigeon, two exceptional adults were taken, one of which is 98 mm. long and the other 120 mm.

The form is distinct locally from E. bislineata X cirrigera which ascends only a relatively short distance into the foot hills of the Great Smokies.

Average sized adult specimens are from 60 to 90 mm. in total length. Eggs of the species have been noted in April, under stones and leaves where there was sufficient flow of water to provide aeration. These were attached singly or in small clusters.

Eurycea gutto-lineata (Holbrook)

Dunn (1926) reports collecting this species in the vicinity of Mount Sterling, North Carolina. In conversation, Dr. Dunn has told me of the methods he employed in collecting and of the streams he worked. I have searched the same streams as well as others both by day and by night, not once but many times, and still I have not encountered the species in the Great Smokies. The country has been rather severely logged and much of it burned over since Dr. Dunn collected there, but

the species should at least have persisted. Probably as more work is done it will turn up some day unexpectedly.

Eurycea longicauda Green

This species is known only from several scattered localities in the park at low elevations. The park collection contains specimens from Cades Cove, Laurel Creek and White Oak Sinks. Dunn (1926) records one specimen from Mount Sterling. Hassler (1929) reports taking the species on "Panther Creek", which I believe is more properly referred to as Panther Branch, a small tributary of LeConte Creek.

Eurycea lucifuga (Rafinesque)

No specimen of this species has come from within the park boundary proper, but several collections have been made at Great Smoky Mountains Caverns, in Tuckaleechee Cove. The elevation at the Caverns is not greater than 1,200 feet, and the distance less than a mile from the park. In fact the underground stream found in the Cavern arises in part from the drainage into White Oak Sinks, which is a large sink within the park. It is likely that the species does occur in the cave in the floor at White Oak Sinks and in other caves and sinks in the Cades Cove area, but it has not been found there up to the present time.

Aneides aneus (Cope and Packard)

Weller (1931) reports a single specimen of this species taken by Mr. Ralph Dury of the Cincinnati Society of Natural History, at Cherokee Orchard on the slope of Mt. LeConte. This is the only Great Smokies record for the species to date and repeated search for it both at Cherokee Orchard and elsewhere has failed to bring any more specimens to light. I have seen this specimen and it is correctly reported. It is

to be sought for at moderate elevations in hardwood forests, beneath bark on logs or stumps, often some distance above the ground.

Desmognathus fuscus fuscus (Rafinesqua)

Salamanders of the Desmognathus fuscus complex present one of the most interesting taxonomic puzzles to be found in the Great Smokies. This is apparent when one examines a series of specimens representing great variation in color pattern and coming from separate isolated communities at elevations varying from 1,000 to 5,000 feet. The effect to isolation is very evident, so that a collection of the species from one watershed is almost certain to have recognizable differences from those taken only a few miles away. The principal differences are in degree of coloration and color pattern, or may be expressed in size or extent of development of the ridge on the dorsum of the tail.

The most typical specimens are taken at lower elevations. In cold springs and shallow trickles at elevations of 3,500 to 5,200 feet, the populations are commonly very light in color. Weller (1931) recognized this in collections made at Indian Gap. Recent collecting in the same locality bears out his findings. The ventral mottling is light but extends over the entire belly region. Yellow on the ventral areas and yellow or grayish brown fairly fine mottling on the dorsal areas typify such collections. The usual pattern of fusing dorso-lateral light areas bordered by darker areas may or may not be in evidence. The tail is more nearly round in such specimens, but the group as a whole is readily separated from D. f. carolinensis which may occupy the same habitat, at least in part. Similar populations occur on Bote Mountain near Spence Field and at Haw Gap near Blockhouse Mountain.

Fig. 7. A small stream on the south side of Cades Cove, at 1800 feet in elevation. This stream offers the type of habitat preferred by Desmognathus fuscus fuscus, Desmognathus phoca, Eurycea bislineata x cirrigera and Pseudotriton ruber schencki.



Frequently individuals of this species are found which resemble D. nhoca, because of their relatively large size and distinctness of the light dorsal areas. D. f. fuscus, however, lacks the complete lateral row of light areas between the fore and hind leg insertions, and shows at least traces of ventral mottling. Rarely do these characters fail to separate the species, in which event, however, a search for vomerine teeth, if the specimen is an adult male (these teeth being absent in adult males of D. f. fuscus) will settle the question.

There is evidence of intergradation with D. f. carolinensis in the eastern end of the park. Collections from Big Creek, at an elevation of 3,000 feet are definitely intermediate in character. Big Creek is a tributary of the Pigeon River which in turn adjoins the watershed of the French Broad, where Dunn (1926) states that intergradation occurs. Dunn however reported both forms from Mt. Sterling, in the Big Creek area. The specimens in question have the keel on the tail fairly well developed, are more robust in body than is D. f. carolinensis generally; but approach that form in development and arrangement of pigment.

Adult males of D. f. fuscus taken at low elevations are sometimes almost a jet black. A collection made on Anthony Creek at 1,800 feet elevations included two such specimens, in which solid color predominated. Others are extremely mottled and variable in color pattern.

Eggs of the species are found the latter half of July, at elevations of 2,000 to 3,000 feet. Its egg laying habits have been described by others, Pope (1924), and Dunn (1926). These do not seem to differ locally in essential details. The eggs are laid under moss or loose bark, which usually is a few inches over or from permanent water. The female stays

with the eggs apparently until they hatch. Recently laid eggs have been found on Little River above Elkmont from July 15 to 20. Well developed embryos were noted at Bryson Place on Deep Creek at 2,500 foot elevation on July 30, 1934.

D. fuscus fuscus is definitely a species of small waters. At high elevations it shares this habitat with D. f. carolinensis at least during the latter's reproductive season. At lower elevations it may compete with D. phoca, but usually one or the other of these two species dominates a locality. Mids Branch at Elkmont, a small open stream, is excellent collecting for D. phoca, while an unconfined spring and marshy area on Jakes Creek a short distance away never fails to give D. f. fuscus in numbers. Only rarely does D. quadra-maculatus enter the latter's territory. This has been noted, however, a few places in the Abrams Creek watershed and in spring fed streams at high elevations. To say that all the species referred to above occupy separate habitats is not true, yet one can see preferences by careful study in any particular locality.

The difference between northern and southern races of D. fuscus fuscus has tempted taxonomists to recognize two subspecies. The author is of the opinion that a representative series of specimens from the Great Smokies shows as wide a range in coloration and anatomical measurements as exists between typical northern and southern representatives. It would be unwise to confuse the picture by naming local variations as subspecies. The park collection contains specimens from 24 localities.

Desmognathus fuscus carolinensis (Dunn)

What has been stated regarding the variation of D. f. fuscus in

the Great Smokies is doubly true of D. f. carolinensis. Its intergradation with that species in the Big Creek watershed has been mentioned. The Carolina dusky salamander is found throughout the length of the main divide of the Great Smokies and extends its distribution laterally at suitable elevations. It occurs on the top of Clingmans Dome (6,642 feet) and as low as 1,400 feet at Gatlinburg. It has been taken in more than 40 localities, well distributed over the park. It is quite terrestrial in habit and may be found a considerable distance from any surface water. It should be noted in this connection that water is frequently found a short distance below the surface of the ground, and the animals are able to reach it easily through the loose overlying rocks.

The wide variation in pigment pattern and in color presented by this subspecies is enough to convince one that here is an animal still undergoing extensive variation and in process of adapting itself to a fairly complex and densely populated environment. Isolated mountain coves contain populations that differ from those in other coves, and which in turn are quite unlike specimens taken along the higher sections of the State Line. Selection of useful characters and persistence of variations seems to be still in force.

Pope (1929) brought out the relation which Dunn's D. imitator has to this form and correctly regarded it as a color variety of carolinensis. The presence of the light cheek patches, varying from yellow or orange to red is an interesting character worthy of carefully controlled genetical experimentation. Out of a series of 285 specimens, 20 percent show yellow, orange or red colored cheek patches. However, of those collected below 3,000 feet elevation only 5 to 6 percent have the character, while above

5,000 feet 24 percent have yellow, orange or red cheek patches. The origin of this character, together with its possible value to the creature, is a matter for interesting conjecture, but one beyond the scope of this paper to answer.

Old males tend to grow quite dark so that only solid colors of purplish brown to black remain in many individuals. Females remain lighter and show the widest array in coloration. The colors shown vary from lemon yellow to black, with mixtures of brown orange, red and bronze. The arrangement of pigment varies from the simple outline of rows of rounded spots shown by the Desmognathus larva, to a confusing array of fusion of spots, presence of a dorsal band or zig-zag pattern, to a perfectly uniform condition.

A number of localities, notably Indian Camp Creek and Ramsey Frong at 3,000 to 4,000 feet elevation support populations of this species which closely resemble D. fuscus ochrophaeus of the Northern Appalachians. In fact a close comparison with specimens of the latter species taken near Aurora, West Virginia, can show no appreciable difference in body proportions or coloration. It would seem proper, however, to refer all local specimens to the form D. f. carolinensis.

Egg clusters have been observed under moss or leaves quite close to water, during late July and August. Larvae are abundant in the spring fed trickles and seeps, as well as quiet pools in small streams most everywhere above 3,000 feet.

Desmognathus wrighti King

This species was first described by me (1937). It is a dwarf form, restricted to the spruce-fir forests, usually above 5,000 feet in eleva-

tion. Its small size when mature (35-50 mm.), its limited range, and its striking coloration, which is highly protective, account for its having been overlooked previously. It is typically brown, less frequently yellow or reddish, with a pattern of inverted V's usually visible on the back. It is found under logs and stones on the forest floor. It has been taken in several localities from Clingmans Dome to White Rock along the State Line, and at Flat Creek, at Mount Sterling Ridge, and on several of the high ridges extending to either side of the State Line. The lowest elevation at which it has been found is at Ramsey Cascades at approximately 4,500 feet elevation. The species is highly terrestrial in habit.

Desmognathus phoca (Matthes)

This species has been taken at least in 30 different localities in Great Smoky Mountains National Park, from Mount Sterling Creek to Abrams Creek and from Gatlinburg to Bryson City. It is a common inhabitant of small streams, side channels of larger streams and trickles coming from springs. It occurs at elevations between 1,200 and 5,000 feet. It is more of a stream species than D. f. fuscus but shuns the large boulders and cascades of mountain streams so frequently inhabited by D. quadra-maculatus.

Moore Spring just under Gregory Bald has the three species, D. f. fuscus, D. phoca, and D. quadra-maculatus living in it. The same is true for Ramsey Prong, (Middle Prong Little Pigeon) and the tributaries of Abrams Creek below Cades Cove. Habitat preferences are indicated by the species concerned, but considerable overlapping exists.

Desmognathus quadra-maculatus (Holbrook)

This is the largest of the Plethodonts found in the park and is almost invariably found in or along streams above 2,000 feet elevation.

Occasionally it is taken as low as 1,500 feet, as on Rabbit Creek, a tributary of Abrams Creek, and extends as high as 5,200 feet at Indian Gap. It appears to be widespread over the park and has been collected at 37 localities, including almost every principal watershed. At higher elevations it invades the springs, where it may occur in company with D. f. fuscus and more rarely D. f. carolinensis and Gyrinophilus danielsi danielsi.

It does not seem to vary greatly throughout the park, except that specimens from the east end, especially in Cosby Creek, are browner and grayer than the normal. The sight of several of these large salamanders on a wet boulder has been commented upon by herpetologists and laymen alike. The species is indeed agile, and one gets a good work-out collecting a series. The secret is to look for them along the stream in wet spots, rather than out in the rougher stream bed, even though they may be more abundant in the latter place. Its breeding habits are well discussed by Pope (1928).

SALIENTIA

Bufo americanus americanus Holbrook

This toad is widely distributed in the Great Smokies and may be found almost anywhere except on the highest mountain tops. The park collection contains specimens from 29 localities.

The breeding season begins with warm spring weather usually between March 15 and 30, and extends well into April. An early warm period will bring out a few individuals even during January, as occurred in 1937, and on February 12, 1938.

Some of the adult females taken locally are exceptionally large. I have three females^{specimens} which measure 109, 110, 115 mm., respectively, in body length (No. Baa-39, 40, 74). Males have been taken which measure up to 90 mm. in body length. Toads are frequently found hibernating under large stones, in soft banks, or under heavy leaf litter.

They are more common about fairly wet open areas at low elevations, but often climb into drier woods. It is not unusual to find these toads on the high dry ridges several hundred yards from any water. American toads have been taken by me and Arthur Stupka, Park Naturalist, almost on the very top of Mt. Sterling Ridge, near the fire lookout tower at 5,800 feet. Toads apparently return to suitable breeding grounds upon reaching maturity because, of those taken so far from water, a majority are immature specimens in their second or third seasons growth. Frequently individuals are encountered which are brick-red in color. This color phase seems most common on drier and higher areas.

Bufo fowleri Hinckley

Fowler's toad is less common than the American toad, but is fairly well distributed below 2,500 feet in elevation. The park collection contains specimens from 14 localities. Its occurrence above 3,000 feet is sporadic, and the highest record for the species in the park is 4,000 feet on Mount Sterling Ridge. Harper (1935) records the species from Bryson City at 1,800 feet. B. fowleri is definitely a lowland form. It seems to be more common in the west end of the park than in the east end, no doubt because of the generally lower elevations and more favorable breeding areas.

Fowler's toad reaches the height of its breeding season generally

about two weeks later than does the American toad. Both species are often heard calling from the same pond or ditch bank, and a few breeding individuals of both species have been seen to deposit eggs the same day. It is sometimes difficult to refer small toads to one or the other of the two species but it is doubtful if cross breeding occurs except rarely. Its smaller size, smoother skin, more than one wort per dorsal color spot, greater restriction of pigment on ventral area, its vastly different and more penetrating voice serve to distinguish this toad from its relative. The habitat preferences of the two species are fairly well marked. B. fowleri usually stays near the breeding grounds and wanders less than does B. a. americanus. As mentioned above there is little conflict in their use of the same ponds or marshy area for breeding purposes, because of the later breeding season of this species.

Pseudacris nigrita feriarum (Baird)

This is one of the first frogs to emerge in the spring, and may appear during a period of warm wet weather in late winter. In fact, I have heard the species call every month during the year in the Great Smokies (1937). Mating begins soon after emergence and eggs can usually be found from late February to early April. In 1937, a premature period of spring weather brought the species out in large numbers on January 13 and egg masses were found on following days. In 1938 breeding was first observed February 11. This frog prefers small ponds, ditches and marshy meadows, and apparently does not move far from its chosen habitat. The highest elevation at which I have taken the species is 2,500 feet at Fightin Creek Gap. It avoids the rapidly flowing streams and heavily timbered areas. In some places it appears to have invaded farther into the mountains following the cutting of the forests.

I have heard this species call throughout its mating period for four spring seasons in the Great Smokies and noted that, although calls may be heard during any part of the day and night, there are two periods of greatest activity. One is in the morning, from 9 to 12 A.M., as the sun is warming the earth and air. The other is late afternoon and early evening, 4 to 9 P.M.

Many of the local specimens have the dorsal stripes partially broken up into spots, and a pigment pattern somewhat irregular. Mr. Charles Walker examined a series of the species from the park collection and pronounced them typical P. n. feriarum. Necker (1934) reports P. n. triseriata from Greenbrier. Undoubtedly the form reported is P. n. feriarum, as additional collections from that area indicate. The triseriata form does not appear to enter the Great Smokies. P. n. feriarum locally is quite abundant in localities where it occurs. The park collection contains specimens from 5 localities and I have heard the species in at least twenty others. As one drives north and west from the Great Smokies, the form of Pseudacris encountered changes shortly after one drives north or west from Sevierville and Newport. The form there encountered approaches P. n. nigrita in color pattern and body proportions. Certainly it is distinct from P. n. feriarum in the Great Smokies. The call of feriarum is lower pitched and slower than the frog from the lower country beyond the foothills.

Hyla crucifer Wied

This small Hyla is found in suitable habitat in the lowlands and cleared areas of the park, up to elevations of 4,000 feet. The park collection contains specimens from only 5 localities, but the species

is widespread and abundant generally. In the spring it emerges shortly after P. n. feriarum appears and occupies similar habitat. When both species occur together, the spring peeper does not appear as numerous as does Pseudacris, but it is more widely distributed.

Its anatomy and habits do not appear appreciably different from descriptions of the species elsewhere.

Hyla versicolor versicolor (LeConte)

The tree toad is well known by local residents in the Great Smoky Mountains, and its call, frequently heard in late spring and before and after summer showers, is often commented upon. The species emerges usually in April, and tends to remain near its breeding grounds until about the first of June, after which time it is heard calling from shrubs and trees, often a considerable distance from water. Egg laying may extend well into May in this region. I have not heard the species in the mountains above 2,500 feet in elevation. The species is fairly well distributed over the park, occurring commonly in the coves along streams or ponds.

Rana catesbeiana Shaw

The bull frog occurs in the Great Smokies only on the large streams below 2,500 feet elevation. It is nowhere numerous, and fully grown individuals are rare. I have recorded the species from several localities along Abrams Creek, Little River as high as Elizabethton and the West Prong of Little Pigeon River at Sugarlands. Kecker (1934) records the species from Greenbrier, on the Middle Prong of Little Pigeon River, at 1,700 feet elevation. An absence of ponds and favorable habitat limits its distribution. The species has been severely persecuted by local residents,

and deserves the protection afforded by the National Park Service.

Rana clamitans Latreille

The green frog is widely distributed locally in small marshes, streams, ponds and sink holes. I have taken the species at Elkmont, Park Headquarters Area, Cades Cove, West Frong Little Pigeon River at 3,900 feet elevation (highest local record), Cosby Creek, Cataloochee Creek, Straight Fork and Waterville, North Carolina. Its call is frequently heard during the summer evenings. The species does not ordinarily make its appearance locally until late April, and egg laying may occur from that time through June.

Rana palustris LeConte

The pickerel frog inhabits available pools and banks of small streams in the Great Smokies. All individuals taken or recorded were at elevations below 3,000 feet. I have specimens from Abrams Creek, Cades Cove, Elkmont, Meigs Creek, Dudley Creek, Cataloochee Creek and its tributary Caldwell Fork, and Waterville, North Carolina. The only place where I have found the frog to be abundant is along an artificial pond of not more than 3 acres, on Cataloochee Creek at an elevation of 2,100 ft. Here the species is present by the thousands. My earliest record of egg laying by the species is March 21, 1935 in Cades Cove.

Rana brachycephala (Cope)

The few leopard frogs which have been taken in the Great Smokies have come from the western end of the park, below 2,000 feet elevation. The form here seems to be R. brachycephala of the north rather than the southern leopard frog, R. sphenocenthala. I have taken the species at Chilhowee, Tennessee, at 900 ft. elevation; and former Resident Wildlife Technician Raymond Fleetwood collected one of these frogs on Cane

Creek at 1,250 feet elevation. Neckar (1934) also reports taking it in Cades Cove. It is not common.

In two specimens (No. Rp-1 and 2, both males) the head length enters the body length 3 times; there are three well marked rows of spots below the lateral skin folds; the spot on the tympanum is poorly indicated; and the tibio-tarsal articulation just reaches to the snout.

Rana sylvatica LeConte

The wood frog is the first of the Salientians to make its appearance locally. Its early breeding habits have heretofore aided it in escaping herpetologists collecting in the Great Smokies region. The species is the most abundant and widespread of the Ranidae within the park. It breeds in ponds formed by springs and stream overflows, in sink holes, temporary pools, and in fact almost any body of still water. All park records are below 3,000 feet in elevation. I have taken the species from the following localities: Cades Cove, the sink holes near Laurel Creek, Moigs Creek, Elksont, the Sinks on Little River, Sugarlands, Dudley Creek, Greenbrier, Cataloochee Creek, and Deep Creek.

As many as 200 of these frogs have been seen in a pool not over 20 feet in diameter. As many as 28 egg masses have been counted attached to a single piece of brush. In 1925, the species emerged for the first time on January 21; in 1937, wood frogs were heard calling on January 13; and in 1938 on January 22. Apparently the species will emerge during any warm period in late winter. Egg laying follows in a day or two, the weather permitting. In 1938, the first eggs were noted January 23. These hatched a month later. Tadpoles of this species were seen undergoing metamorphosis at Gatlinburg June 10 to 14, 1934, and at the Park

Headquarters Area May 18 to 22, 1938.

This is one of the most attractively colored species of frogs, and has a remarkable ability to change from gray to various shades of red and brown. Some individuals appear almost black. The species may call throughout the day, but is most active during the warmer part of the day and early evening. Its inactivity at night probably is due to the lower night temperatures slowing physiological processes.

Gastrophryne caroliensis (Holbrook)

The narrow mouthed toad escaped my detection through three collecting seasons, but was finally encountered on August 9, 1937, in the Cades Cove area. This species seems partial to pools in limestone strata, and for that reason its distribution is greatly restricted in the Great Smokies. The animals were calling in chorus and mating on August 10, 1937, in roadside ponds and grass bordered ditches in the Cades Cove and Tuckaleechee Cove areas, the later being just outside the park.

LACERTILIA

Anolis carolinensis Voigt

The Carolina chamelcon has been observed only in the west end of Great Smoky Mountains National Park. Wildlife technicians of the National Park Service have recorded the species from Twentymile Creek, Chilhowee, Abrams Creek and Cades Cove. It has been reported from Gatlinburg but is rare at that place. Jones and Ressler (1927) reported the species from Montvale Springs, Blount County, Tennessee, and from a second location four miles east of Townsend on the Elkmont Pike (Tennessee Route 73). The latter is well within the park.

Sceloporus undulatus (Latreille)

The pine swift occurs throughout the park in relatively dry hardwood and oak-pine forests. It is most common on dry ridges below 3,000 feet, but may go higher, as it does on the top of Bullhead Mountain at 4,250 feet. The species is too widely distributed to necessitate giving locality records. Pine swifts have ^{been} found active during warm periods in February, as was noted February 12, 1938, along Hoige Creek, Little River, and are frequently seen during sunny days in March and April.

One specimen No. Su-10, has a forked tail, an uncommon expression of regeneration following an injury.

Onhisaurus ventralis (Linnaeus)

This legless lizard is known from the Cades Cove area only. It is the only species listed in this report which is not supported by one or more museum specimens. The local residents of Cades Cove recognize the animal and describe it accurately. It was collected in this locality by Professor D.C.V. Ressler of the University of Tennessee, between 1928 and 1930, but the specimens were destroyed by a fire which consumed the University's Biology Building in 1932. The species inhabits cultivated areas and is considered common throughout much of Tennessee.

Cnemidophorus sexlineatus (Linnaeus)

The race-runner is uncommon in the park, and has been recorded only from Twentymile Creek, Abrams Creek, Chilhowee, Deep Creek and the Sugarlands area, all below 3,000 feet elevation. Its preferred habitat, a dry, fairly open, sandy terrain is very limited in the Great Smokies.

Leiolopisma laterale (Say)

This small lizard has been taken in Cades Cove, Elkraont, the Sugarlands area and near Cherokee Orchard in the Great Smokies. Probably it has a wider local distribution than the records indicate, but escapes observation because of its secretive habits. The Cherokee Orchard specimen was taken by the writer and F.O. Hazard in 1932 and is in the collection of the Biology Department, Wilmington College, Ohio.

Eumeces fasciatus (Linnaeus)

This lizard is fairly widespread over the park, below 2,500 feet elevation. The park collection contains specimens from 9 localities. It is most often seen about old buildings and wooden bridges. Eggs of the species have been encountered a number of times under large boulders in fairly dry situations, during the latter half of July.

The largest specimen of E. fasciatus in the park collection, No. Ef-7 measures 176 mm. in total length and 72 mm. snout to vent. A few individuals show 8 upper labials on one side or both, although 7 is the usual number.

Eumeces laticeps (Schneider)

A study of the lizards of the Genus Eumeces from the Great Smokies convinces one of the separate identity of E. fasciatus and E. laticeps and also shows how closely related the two are both in structure and ecology. Dr. Edward H. Taylor was kind enough to examine the park's collection of the lizards of the Genus Eumeces and check the identifications.

E. laticeps is a species of dry pine-oak hillsides below 2,500 feet elevation. All records from the park are from the west end and include

specimens from Eagle Creek, Twentymile Creek, Chestnut Flats Road, Weigs Creek, Wears Cove Gap and Elkmont. The largest specimen, No. El-4, measures 245 mm. in total length and 113 mm. from snout to vent. The number of upper labials is generally 8 in local specimens, but 7 is a frequent number.

Eumeces inexpectatus Taylor

After examining the park's collection of lizards of the Genus Eumeces, Dr. Edward H. Taylor pronounced two specimens to be of this species. One of the characters noted is the smaller size of the scales on the under side of the tail than that which obtains in the related species found locally. The specimens designated E. inexpectatus were collected, one on Twentymile Creek, North Carolina, by former Resident Wildlife Technician, Maurice Sullivan, and the other on Laurel Creek, Tennessee, by Park Naturalist Arthur Stupka. Undoubtedly the species is more widely distributed in suitable habitat and low elevations within the park.

SERPENTES

Carphophis amoenus amoenus (Say)

The ground snake is frequently found in the Great Smokies, in open areas, under logs and stones. It seems partial to old dwelling or barn sites, probably because of the more abundant food supply. Its known altitudinal distribution extends from the lowest elevations in the park to the highest record at Rye Patch on Long Hungry Ridge at 4,300 feet. The park collection contains specimens from 9 localities.

The local form is referable to C. a. amoenus rather than C. a. helenae although some specimens show a tendency toward the latter form

in extent of fusion of the internasal and prefrontal scales. A series of 16 specimens contains 11 with internasals and prefrontals entirely separate, 1 with them separate on one side and partly fused on the other, 3 with them almost fused on one side and fused on the other. No specimens examined to date have these scales entirely fused on both sides. It is recognized that the population of this species in the lower foothills of the Great Smokies on the Tennessee side of the park is an intergrading one, but the best procedure is to group all specimens under C. amoena amoena. The largest specimen in the park collection, Cas-5, a female taken at Kephart Prong, North Carolina by me, measures 284 mm. in total length.

Diadophis punctatus edwardsii (Merrem)

This snake is probably the most widely distributed and most abundant of any snake in the Great Smokies. It occurs from the lowest elevations, 1,000 feet, to as high as 5,800 feet on Andrews Bald. It may be found in open areas or in dense woodland. I found one individual on the top of the Chimneys, an isolated and exposed rock mass at 4,700 feet elevation. The park collection contains specimens from 13 localities.

Some of the local collections of this species show a tendency toward intergradation with the closely related subspecies D. p. punctatus. In a series of 8 specimens the ventrals plus caudals range from 209 to 224, and average 215. Three of the 8 specimens have the neck ring incomplete, while 5 have the ventral spotting imperfectly developed. One specimen, No. Dpe-9 has the ventral pigmented areas well developed, has an interrupted neck ring, but has 219 ventral plus caudal scales. It is referred to D. p. edwardsii although its pigment pattern resembles D. p. punctatus. Specimen No. Dpe-6 has the lowest number of ventral plus caudal scales,

Table VI. Anatomical data on 8 specimens of Dinodphis punctatus edwardsii from the collection at Great Smoky Mountains National Park. Abbreviations in the Table signify: inc. - incomplete, comp. - complete, pres. - present.

Specimen No.	Locality	Elevation feet	Ventral scales	Anal scales	Total	Ventral spotting	Neck ring	Sex	Total length	Tail length
1-2	Chimneys	4,700	158	52	210	pres-inc	inc	male	397	86
1-3	Gregory Ridge	5,750	154	57	211	" "	comp	"	334	79
1-4	Straight Fork	3,100	157	56	213	" "	" "	"	380	86
1-6	Jenkin Trail Ridge	4,000	162	47	209	complete	"	"	338	65
1-7	Cades Cove	1,800	160	53	213	none	"	female	381	81
1-9	Sponce Field	5,000	166	53	219	pres-inc	inc	"	418	82
1-11	Andrews Bald	5,800	158	66	224	none	"	male	353	86
1-12	Sugarland Ridge	4,000	155	65	220	pres-inc	comp	"	312	78

(all measurements are in millimeters)

209, and has the ventral spotting developed sufficiently to resemble D. p. edwardsii. A representative series of these snakes were examined by Mr. Roger Conant and I follow his recommendation in calling them all D. p. edwardsii.

Heterodon contortrix (Linnaeus)

The distribution of this species within the park appears to be confined to elevations below 2,500 feet. Its preference for open sandy habitat is well known. The species has been collected at Cades Cove, Elkmont, Sugarlands and Cherokee. There is considerable variation in pigmentation of specimens taken locally. Two melanistic individuals are contained in the park collection. The most common color phase found is that of gray ground color with brown blotches. Adults may develop bright reddish brown, orange and yellow markings.

The largest specimen Ho-3, from Cherokee, North Carolina, is a male measuring 860 mm. in total length.

Opheodrys aestivus (Linnaeus)

The rough green snake has been taken in the Great Smokies at Forney Creek, Deep Creek, Elkmont, Greenbrier, Gatlinburg and the Sugarlands areas. Specimens from all these localities are in the park's collection of amphibians and reptiles. The species has been found only at elevations below 2,500 feet. One female collected at Deep Creek by Maurice Sullivan, former Resident Wildlife Technician, laid eggs in captivity July 8, 1935. The species seems more numerous than its relative O. vernalis.

Opheodrys vernalis (Harlan)

The smooth green snake is an uncommon resident in the Coves of

the Great Smokies at relatively low elevations. It has been taken at Greenbrier and above and below Gatlinburg on the Little Pigeon River.

Coluber constrictor constrictor (Linnaeus)

This snake inhabits old fields and areas about buildings, where apparently it finds its choice food most numerous. I have seen numbers of these snakes along Fightin Creek, a tributary of the West Prong of Little Pigeon, and at Elkmont. It has also been taken at Kephart Prong of the Oconalufy, Fish Camp Prong of Little River, and Low Gap on the State Line. Necker (1934) reports the species from Greenbrier. It has been found up to 4,000 feet in elevation.

Elaphe guttata (Linnaeus)

This is one of the handsomest snakes in the Southern Appalachians. It is fairly common below 2,500 feet elevation, in either wooded or open areas. The park collection contains specimens from Townsend, Fightin Creek Gap, Elkmont, Park Headquarters area and Forney Creek. The habit of crawling upon and resting on travelled roads costs many snakes of this species their lives. It permits handling readily.

Elaphe obsoleta obsoleta (Say)

This snake is both numerous and widespread in the Great Smokies. Collections have been made at only 4 points, but the species has been recorded at numerous other places. Specimens between five and six feet in length are not uncommon. It inhabits wooded areas, and has been seen at localities as high as 4,000 feet elevation. The ability of the species to climb trees is well known. I watched one of these snakes climb a slender grapevine, less than $1\frac{1}{2}$ inches in diameter, which extended at least thirty feet up to a limb of a tree.

Lampropeltis olivacea virginiana Blanchard

Only one specimen of this snake has been found in the Great Smokies. This came from Round Top Mountain along the north boundary of the park, on November 20, 1935 at approximately 2,000 feet elevation. It was found hibernating in the ground by a CCC crew engaged in excavating a trail through pine-oak woods.

The red pigment does not encroach on the margins of the ventrals in the anterior two thirds of the body, while there is a slightly reddish cast on the posterior ventral portions of the body and tail. A series of specimens might indicate the local representative of the species is other than L. o. virginiana, but the one specimen at hand seems to be of this geographic race.

Lampropeltis getulus getulus (Linnaeus)

A collection of five chain snakes from the Great Smokies indicates that the region is near the zone of intergradation of L. g. getulus and L. g. nigra. Although it is recognized that the small series makes for errors in interpretation, differences in color pattern and geographical position are sufficiently evident on the specimens at hand to indicate the presence of L. g. getulus on the North Carolina side of the Great Smokies and L. g. nigra on the Tennessee side. This type of Distribution holds true for a surprisingly few species, considering the height and barriers of climate and forest encountered on the high divide of the Great Smokies.

<u>No.</u>	<u>Sex</u>	<u>T.L. mm.</u>	<u>Cross bands</u>	<u>V. scales</u>	<u>Sub-caudals</u>
Lgg-1	Immature	287	39	197	50
Lgg-2	Male	895	38	209	54
Lgg-3	Female	1064	42	210	42

*The first specimen was taken at Deep Creek, the second at Smokeont, and the third between Peals Gap and Tapoco, North Carolina. The last was found on the highway, April 17, 1938, at the southwest end of the Great Smokios. It is a beautiful specimen and is a perfect intergrade between L. g. getulus and L. g. nigra. Trapido, in a note published in Copeia (1938, No. 1) reports L. g. nigra from western Tennessee and states he believes L. g. getulus and L. g. nigra intergrade in the bottom lands of the Mississippi. There is ample evidence that the zone of intergradation is farther east and actually is the southwest portion of the Great Smoky Mountains, and probably extends farther south and slightly west.

Lampropeltis getulus nigra (Yarrow)

Two chain snakes collected in Cades Cove can definitely be referred to this subspecies. There is evidence of variation of characters, tending toward L. g. getulus, particularly in the small number of light cross bands.

Descriptive measurements:

<u>No.</u>	<u>Sex</u>	<u>T.L. mm.</u>	<u>Cross bands</u>	<u>V. scales</u>	<u>Sub-caudals</u>
Lgn-1	female	616	40	210	49
Lgn-2	"	825	50	208	49

Sub-caudals 3 and 4 on snake Lgn-2 are undivided. Cope (1898) mentions this character but states he does not believe it to be significant.

Mr. Roger Conant of the Philadelphia Zoological Garden examined the snakes referred to this and the preceding subspecies, and reported the specimens as I have listed them. The chain snake is not common in the Great Smokies. A number of other specimens have been seen but were not taken because this snake is considered a valuable member of the park's fauna.

Lampropeltis triangulum triangulum (Lacepede)

The house snake inhabits both wooded and open areas in the Great Smokies, but can scarcely be considered common. Collections from the park are scattered, coming from seven different locations ranging from 1,800 to 4,600 feet.

The average number of dorsal blotches is low for this subspecies (35.5), and some specimens show a tendency for the dorsal saddles to extend down to the second row of scales (Ltt-2 and 8).

A summary of these characters is given in further explanation:

<u>No.</u>	<u>Dorsal saddles</u>		<u>Blotches extend to</u>			<u>Sex</u>
	<u>on body,</u>	<u>on tail</u>	<u>ant. third,</u>	<u>middle,</u>	<u>post-third</u>	
2	55	- 13	4	5	4	male
4	53	- 9	3	4	3	female
5	33	- 8	2	2	2	"
6	35	- 8	4	5	4	male
8	36	- 7	3	3	2	female
9	40	- 11	3	3	3	immature
10	36	- 12	3	4	3	"
11	36	- 9	4	4	3	female

Specimens Ltt-5 and 6, female and male, respectively, were taken in

copulation on Caldwell Fork, Cataloochee Creek, May 21, 1935, by Maurice Sullivan, former Resident Wildlife Technician at Great Smoky Mountains National Park. The female resembles L. t. sypila greatly, as noted above, while the male is typical L. t. triangulum. This mating record together with the fact that the collection is from the North Carolina side of the park, throws the balance in favor of calling all our specimens L. t. triangulum. On the Tennessee side of the park, where inter-gradation is more likely to be expected, the specimens are more nearly L. t. triangulum.

The park collection contains specimens from Rough Creek on Little River, Bote Mountain, Jenkins Trail Ridge, and Ravensford in addition to those listed above.

Cemophora coccinea (Blumenbach)

The park collection contains one specimen of this species, taken in Cades Cove at 2,000 feet elevation, by former Resident Wildlife Technician Raymond Fleetwood. A failure to find other individuals of this snake indicates that it is rare in the park. Undoubtedly it is found only at relatively low elevations.

Natrix septemvittata (Say)

The queen-snake appears to be restricted to the western end of the park, and is common only in limestone strata. The park collection contains four records from Abrams Creek and its tributaries, all 1,700 feet and lower, and one record from Twentymile Creek at 1,400 feet. The relative docility of this snake compared with the meanness of the common water snake is quite evident in handling specimens of the two species.

Natrix sipedon sipedon (Linnaeus)

The common water snake has been found in practically every watershed in the park. It ascends the streams when the forests are removed, coming to occupy higher elevations than it did originally. It is in this way enlarging its territory following man's interference with natural conditions. Ordinarily it does not invade streams bordered by heavy virgin forests very far. Usually it stays below 3,500 feet, but I have taken it at Moore Spring, just under Gregory Bald at 4,800 feet elevation. It is especially abundant on Little River below 2,200 feet, the Middle Prong of Little Pigeon below Greenbrier, Forno Creek, and the Left Fork of the Conalufly.

The species is despised by fishermen, and at one time an effort was made to control its numbers in the park. It was later decided to conduct an investigation on the food habits of the species. A total of 98 snakes were killed by Park Wardens and examined by the writer, to learn to what extent the species fed on trout. Fifty of the stomachs were empty, so gave no clue as to feeding habits. Twenty-nine stomachs contained fish remains. Two of these definitely contained rainbow trout, and one a small-mouthed black bass. In eight stomachs the material was beyond identification except that it was originally fish. Of the non-game species, Nocomis micropogon, Catostoma anomalum, Hypentilium nigricans and Cottus sp. were the fishes commonly taken by the snakes. Seventeen stomachs contained amphibian remains, including tadpoles of Rana and salamanders of the Genus Desmognathus. Two stomachs contained invertebrate remains, one a slug and one a grasshopper. The snakes examined ranged from 10 to 39 inches in length, averaging 24.8 inches.

They came from Little River (4), Middle Prong of Little Pigeon (27), Bradley Fork (3), Forney Creek (32), Deep Creek (12) and Cataloochee Creek (20). It was not believed that sufficient evidence was found to convict the water snake, but undoubtedly the species does at times feed heavily on trout. It, like most any other creature, is quick to take advantage of a readily available food supply.

At the present time the species does not appear to be on the increase and no control measures are in force. Its breeding habits are well known and local observations substantiate the usual reports. In late April or May, it is not uncommon to see a large female ardently encircled by two to a dozen smaller males, all trying to copulate with her. If she decides to move her position a writhing mass of snakes ensues. The species is one of the first to emerge in the spring. In 1933, the species was out at Elkmont on March 18. In 1936 the first record was March 1. One of these snakes was seen crawling from a snow bank at Smokemont the last week of December, 1935.

Storeria dekayi (Holbrook)

Dekay's snake has been taken only in two localities in the Great Smokies, near the top of Parson's Bald at 4,000 feet, and in the Sugarlands area at 1,500 to 1,600 feet. It doubtless is more widespread but its retiring habits have aided it in escaping observation.

Storeria occipito-maculata (Storer)

The red-bellied snake is uncommon in the Great Smokies. It seems to prefer semi-open areas and has been collected most often under logs. Cades Cove, Laurel Creek, Tremont and Flat Creek have yielded specimens. The latter locality is interesting in that it is at 4,950 feet elevation,

yet affords the type of habitat utilized by the species, namely, an open place with adequate ground cover.

Virginia valeriae valeriae (Baird and Girard)

Park Naturalist Arthur Stupka collected one specimen of this snake in the basement of his house at Gatlinburg on August 27, 1936. To date, this is the only record for the area. The snake, a female, is exceptionally large, measuring 290 mm. in total length.

Thamnophis sirtalis sirtalis (Linnaeus)

The garter snake presents the most interesting "snake" problem in the Great Smokies. Specimens taken at lower elevations are normal in coloration while those from the spruce-fir forests and frequently elsewhere above 3,500 feet, are melanistic. This has been observed by other workers here, but sufficient data has not been gathered to solve the problem nor does the present paper attempt to do so.

Garter snakes are fairly common in the Great Smokies, and may be found both in wooded and open areas. The park collection contains a series of 46 of these snakes from 32 widely distributed localities and all elevations obtainable. A majority of the specimens were taken above 4,000 feet, because of the interesting form of the species at higher elevations.

An examination of the number of rows of body scales shows no variation, nor does there seem to be appreciable differences in head scalation. The black individuals lack the dorsal and lateral stripes, and are quite dark throughout. While I have found no melanistic individuals below 3,000 feet, I have taken normally colored specimens as high as 5,000 feet, and a few specimens taken higher show very faint indications

of striping. The ventral scales on 9 specimens taken above 5,000 feet average 149 in number (range 142-156); on 10 taken from 4,000 to 5,000 feet average 148 (range 142-156); on 5 taken from 3,000 to 4,000 feet average 146 (range 141-153); on 5 taken from 2,000 to 3,000 feet average 145 (range 142-151). It is doubtful if this is a significant variation that would hold true over a larger series.

There is a noticeable difference in the behavior of snakes taken from the high and low elevations. The former are much more docile and do not resist capture or handling as does the common colored phase. Differences in air temperature may account for the differences in behavior. The snakes of the black phase appear thicker bodied than their lowland relatives. At Three Forks on Raven Fork, at 4,280 feet, both color phases occur, and the same is true for a number of other localities at comparable elevations.

The problem was presented to the late Dr. Blanchard, an authority on the group. Dr. Blanchard was of the opinion that the problem required controlled breeding experiments to solve, and that taxonomic treatment should follow. The writer concurs. This is all the more true since melanistic colonies if not races of black garter snakes are known to exist elsewhere. The writer wishes to report the existence of the form here, and hopes that proper studies can be made to determine its true status.

Tantilla coronata Baird and Girard

Park Naturalist Arthur Stupka has contributed the only specimen of the species taken in the park area. It was collected at Gatlinburg, April 5, 1936.

Akistrodon mokasen mokasen (Beauvois)

The copperhead is considered an uncommon snake in the Great Smokies, certainly being less abundant than the timber rattler. It is partial to old building sites, rock piles such as old stone fences, and brier thickets in former clearings. It has been taken several times from under the fallen bark about the base of dead chestnut trees. The species is not usually met with above 2,500 feet.

The park collection contains specimens from Deep Creek, West Prong Little River, Park Headquarters and Sugarlands areas. Hocker (1934) also reports it from Greenbrier. The species doubtless is more widely distributed over the park in favorable habitats. The smallest specimen at hand is 232 mm. in length, taken at Sugarlands August 15, 1937, and the largest, a male taken just outside my office window, July 24, 1937, measures 930 mm.

Crotalus horridus Linnaeus

The timber rattler is common and widespread in the Great Smokies. It has been collected at 15 localities within the park, and has been seen and reported from many others. It does not appear to enter the spruce-fir forest appreciably, and is most likely to be encountered in the rougher portions of the terrain. Second growth clearings, rocky slopes, and oak-pine woods are favorite environments.

The area on Little River near the mouth of Fish Camp Prong is probably the "snakiest" place in the park, as far as finding rattlers goes. Fire Guard Wesley Ogle found one monster 66 inches long there, and at another time a mother and seven young. The young, which were taken on August 31, 1937, average 336 mm. in total length. In this

same area, I have followed a party of five people along a newly dug trail, and found a rattlesnake in striking position and distance from the passersby. It made no move until I attempted its capture.

It seems significant that with all the outdoor work which has been going on in the park since 1933, no one has been bitten while at work or walking the trails. Snakes have been seen many times, but the only bites have come from some one playing with a rattler or attempting to capture it without knowing how. At one time (summer of 1935) there were as many as 4,000 CCC enrollees, foremen, relief workers, and National Park Service employees working every day where a rattlesnake might be encountered, and no one was bitten while on duty. There are four or five recent records of people being bitten in the Great Smokies, and none of these were fatal.

There are many local beliefs regarding the rattlesnake. A popular one is that the yellow individuals are all females and the black ones males. Upon examination this is not always borne out. The large yellow specimens usually are females, but infrequently males answer the same description. The males tend to be darker in the posterior third of the body than do females, but females have been taken which were quite dark throughout. There is all degree of variation between yellow and dark phases, the yellow being more common locally. Average sized adults measure about 48 inches in total length.

A rattlesnake reported taken at the head of Cosby Creek near Inadu Knob at 5,500 feet, July 4, 1936 contained a red squirrel in its stomach. Other specimens have been found that had eaten gray squirrels and cotton tail ^{ed} rabbits. The eastern chipmunk seems to be a favorite item of diet.

Rarely does the timber rattler ascend higher than 5,000 feet elevation.

TESTUDINATA

Sternotherus minor (Agassiz)

While seining for fish in Abrams Creek September 6, 1937, Dr. Carl Hubbs and I collected two of these turtles. They were taken at 850 feet elevation, well out in the stream, from under large flat rocks, where they had retreated. The water is clear in Abrams Creek and the current only moderately swift. I had previously seen the species about two miles above on the same stream (August 28, 1934) but had failed to capture any specimens. It is unlikely that the species occurs in any other stream within the park.

Chelydra serpentina (Linnaeus)

The common snapper undoubtedly inhabits the lower portions of many of the streams of the Great Smokies. It occurs in Little River as high as Elkmont at 2,200 feet elevation and has been reported from the West and Middle Prongs of Little Pigeon River, the latter by Necker (1934). It is not well adapted to life in the swift, rocky streams of the higher altitudes. Several small turtles of the species, 4 to 6 inches in body length, were seen swimming in Little River near Townsend, on March 30, 1938.

Terrapene carolina (Linnaeus)

The terrapene is very common in the Great Smokies and may be found on the roads or trails in large numbers during the summer, especially after rains. I have observed the species at Parsons Branch, Cades Cove, numerous places along Little River, Mount Harrison, Sugarlands, Greenbrier, Bradley Fork and Deep Creek. I have not found

the species above 4,000 feet elevation.

It frequently makes its nest and deposits its eggs in the soft dirt of newly constructed trails. Egg laying has been noted on several occasions during June. One female was observed laying her eggs on Bote Mountain on June 11, 1937.

Chrysemys picta picta (Schneider)

The small marshy areas and ponds in Cades Cove offer suitable habitat for this species, which appears to be restricted to that section of the park. The elevation at which specimens were taken is approximately 1,750 feet. The turtle probably occurs along Abrams Creek to the mouth of the stream and may have entered the park by that route. Another possibility is that the species is a faunistic relic from an ancient peneplain and has persisted only in the Cades Cove region, because of the presence of small pools on the limestone strata.

Amyda spinifera (Le Sueur)

To date no specimens of the soft shelled turtle have been secured within the park boundaries, but it is known to occur in Little River between Walland and Townsend, the latter location at 1,100 feet, and in the West Prong of Little Pigeon below Gatlinburg. One specimen, No. AS-1, was taken by Harnest Ogle, August 15, 1937, while fishing in the latter stream about two miles below Gatlinburg at approximately 1,000 feet elevation. The species probably occurs in lower Abrams Creek but has escaped detection.

SUMMARY

The present paper aims to bring together all available data on the occurrence of amphibian and reptile species at Great Smoky Mountains National Park. A total of 70 species are reported. These are: 24 salamanders, 11 frogs and toads, 8 lizards, 22 snakes, 5 turtles. Thirty-one or 44 percent of these have not been previously reported from the area. The faunistic relationships of the species are given according to a modified classification used by Cain (1930) in reporting the floristic relationships of the trees of the region. A majority of the species, 74 percent, are considered Intraeuous, meaning that they are not near the limits of their known distribution. Of these, 44 percent are widespread over eastern United States. Southeastern United States, including the Coastal Plain, is second in number of species contributed. This region accounts for slightly over one-fifth of the total species. The Southern Appalachians are recognized as the center of origin and dispersal of the lungless salamanders belonging to the family Plethodontidae. Strictly Southern Appalachian influence is confined to that group among the animals reported.

A comparison of the faunistic relationships shown by the amphibians and reptiles with the floristic relationships presented by 125 species of native trees and tree-like shrubs indicates a remarkable similarity in composition of forms. The percentages of species having a widespread distribution over eastern United States, those occupying southeastern United States, the Mississippi Valley, etc., is very close in these two groups of life forms. The type of forest influences the animal species present at that place. The correlation is most evident in the spruce-

fir forests at high elevations and in the pine-oak forests at low elevations.

The Great Smoky Mountains are considered the oldest mountain mass in eastern United States. As such, terrestrial habitat has been afforded plant and animal species continuously since the close of the Paleozoic Era. An exception to the general absence of limestone strata is found in the Cades Cove area, where an outcrop of Knox dolomite aids in creating habitat utilized by 6 species which have not yet been found elsewhere in the park. A review of the elevations attained by the various species shows that 42 do not exceed 3,000 feet in elevation, and 18 more drop out before reaching the proximity of the 5,000 foot contour. Only 5 species are restricted to the land above 3,000 feet elevation.

The Great Smoky Mountains lie in a strategic location faunistically, and intergradation or proximity to the region of intergradation is encountered in the following species:

Necturus maculosus X alabamensis (Viosca)

Eurycea bislineata X cirrigera (Graen)

Gyrinophilus danielsi X duryi (Weller)

Bombognathus fuscus fuscus X carolinensis (Dunn)

Carphophis amoena amoena X helenae (Kennicott)

Diadophis punctatus edwardsii X punctatus (Linnaeus)

Iampropeltis getulus getulus X nigra (Yarrow)

There is evidence that the mid-puppy of the upper Tennessee drainage is intermediate between the well known Necturus maculosus of the lower Tennessee and Ohio systems and a species recently described by Viosca (1937) from north central Alabama, and named N. alabamensis. The local race seems to be the most primitive and possibly gave rise to both the

other forms.

Specimens of Gyrinophilus danieli taken below 2,000 feet in the Great Smokies are readily distinguished from those taken at higher elevations, and resemble G. duryi as described by Weller in 1930. Sufficient evidence is at hand to designate the two forms as subspecies rather than full species. G. danieli, being the older, becomes G. danieli danieli Blatchley, and G. duryi a subspecies, G. danieli duryi (Weller).

In only one case are different but closely related subspecies found on opposite sides of the State Line. This is true of Lampropeltis getulus, since the subspecies L. g. getulus is found on the North Carolina side and L. g. nigra on the Tennessee side. There is evidence of intergradation between the two subspecies in the extreme west end of the Great Smokies.

The collection of amphibians and reptiles upon which this report is largely based, is kept at the naturalist and wildlife headquarters of Great Smoky Mountains National Park. The field work was done in connection with other wildlife activities, from June, 1934, to April, 1938.

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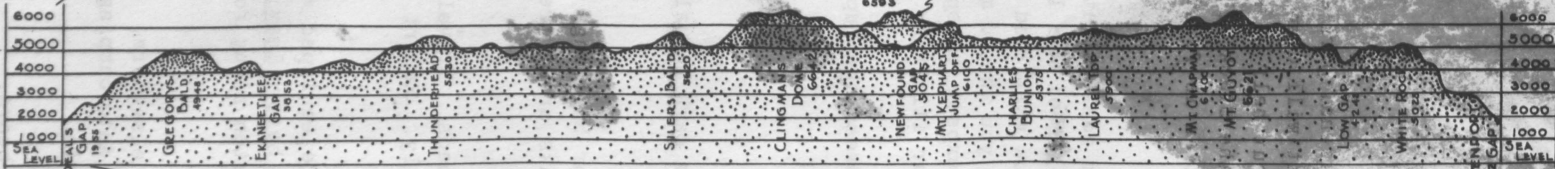
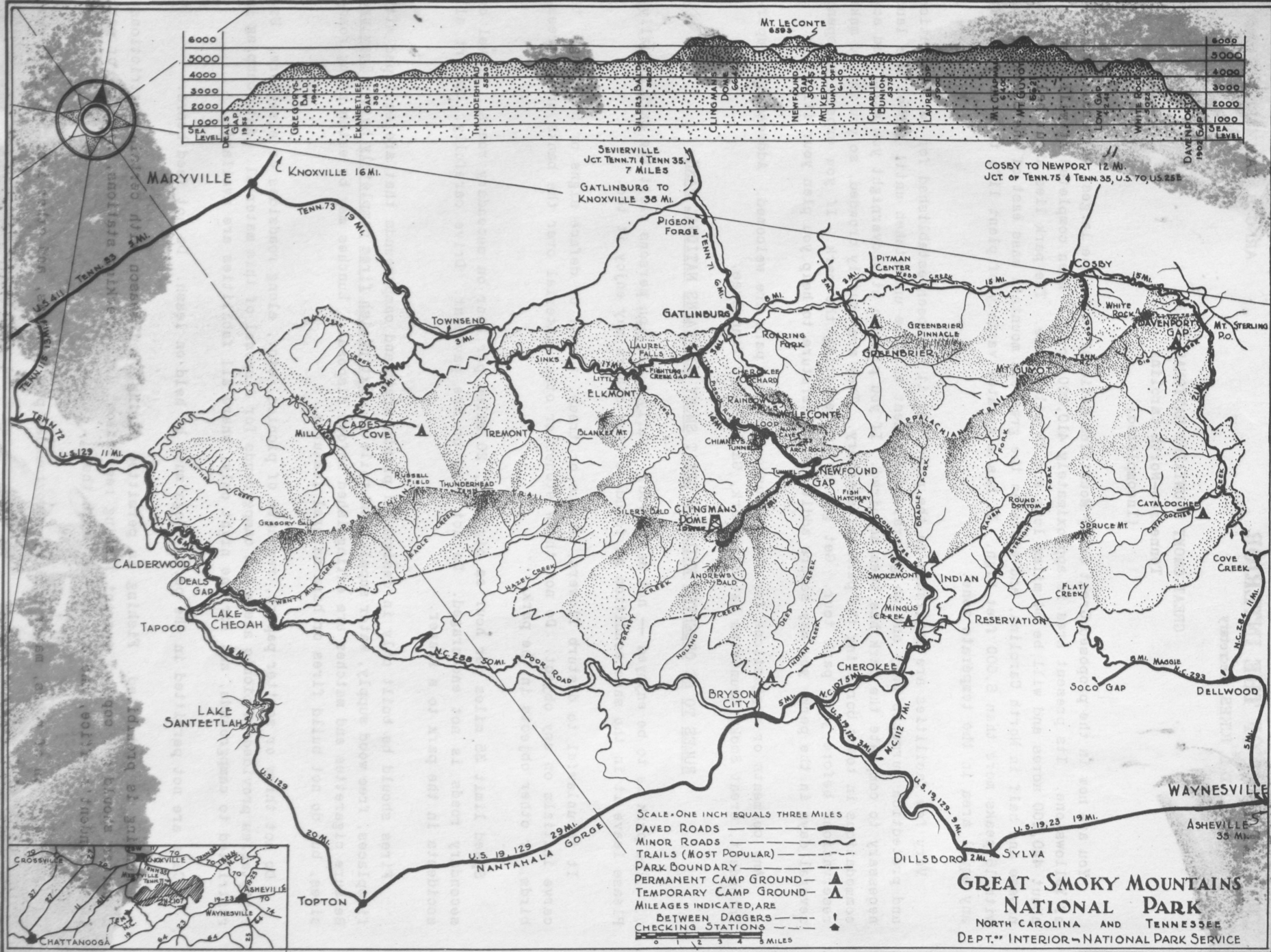
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- SCALE - ONE INCH EQUALS THREE MILES
- PAVED ROADS —————
 - MINOR ROADS - - - - -
 - TRAILS (MOST POPULAR) - - - - -
 - PARK BOUNDARY —————
 - PERMANENT CAMP GROUND —▲
 - TEMPORARY CAMP GROUND —▲
 - MILEAGES INDICATED ARE BETWEEN DAGGERS ———— !
 - CHECKING STATIONS ———— !
- 0 1 2 3 4 5 MILES

**GREAT SMOKY MOUNTAINS
NATIONAL PARK**
NORTH CAROLINA AND TENNESSEE
DEPT. OF INTERIOR - NATIONAL PARK SERVICE