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THE ANOLINE LIZARDS OF BIMINI, BAHAMAS

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INTRODUCTION

A brief visit (from September 19 to October 16, 1947) to the newly established Lerner Marine Laboratory on Bimini, Bahamas, British West Indies, afforded me an excellent opportunity to collect and observe the four species of *Anolis* that are found there. Three of these species are represented by local races that are distinct but unnamed at present. As a preliminary to further detailed studies of these lizards, the new races are described herein, together with comments on the related *Anolis* of the Bahamas.

The well-equipped and comfortably appointed Lerner Laboratory provides an exceptionally good situation for the study of *Anolis* under natural and laboratory conditions. I wish to express my sincere gratitude to Charles M. Breder, Jr., the director of the Lerner Laboratory, for making possible my visit to the island and for his many kindnesses that have facilitated my studies. John C. Armstrong, of the Department of Fishes and Aquatic Biology of the American Museum of Natural History, was in residence at the laboratory during my visit and rendered a great deal of assistance in many ways. I am grateful to Arthur Loveridge of the Museum of Comparative Zoölogy at Harvard College for his generosity in providing topotypic material of many of the Bahaman *Anolis*.

DESCRIPTION OF NEW RACES

The four species of *Anolis* present on Bimini are *angusticeps*, *carolinensis*, *distichus*, and *sagrei*. All of these species are poly-

typic, being represented by two or more races occurring in the Bahamas and either Cuba or Hispaniola. The Bimini populations of the first three species named above are sufficiently differentiated from any named forms to warrant nomenclatorial recognition. The population of *sagrei* that inhabits Bimini does not appear to be distinguishable from the Bahaman subspecies, *ordinatus*.

***Anolis angusticeps chickcharneyi*,¹ new subspecies**

TYPE: No. 68620, an adult male in the collection of the American Museum of Natural History, collected by James A. Oliver on the western end of South Bimini Island, Bimini, Bahamas, British West Indies, October 13, 1947. Four additional specimens were collected on October 9 and 13, 1947, at the same locality.

DIAGNOSIS: A subspecies of *Anolis angusticeps* that appears to be intermediate in structural characters between *a. angusticeps* of Cuba and *a. oligaspis* of the Bahamas. It differs from these in possessing six to eight scales on the dorsal surface of the head between the seventh canthals (five in *angusticeps* and nine or 10 in *oligaspis*), in possessing 24 to 32 loreals (17 to 23 in *angusticeps* and 35 to 38 in *oligaspis*), in possessing 34 to 36 lamellae on the fourth toe (33 or 34 in *angusticeps* and 36 to 40 in *oligaspis*), and in having four small scales in contact with the mental posteriorly between the anterior edge of the first sublabial scales (four to six in *angusticeps* and six in *oligaspis*). (See fig. 1.) The dewlap is a pale pink color in life.

DESCRIPTION OF THE TYPE: The head and body are elongate and depressed, with the head twice as long as wide.² The length of the head is equal to one-third of the snout-vent length. The nares are prominent, opening on the dorsal aspect of the head between one-sixth and one-seventh of the head length from the tip of the snout. The fourth toe of the adpressed hind limb reaches a short distance beyond the shoulder. The tail is only slightly compressed, being oval in cross section, without a raised

¹ Named after the mythical spirit to which the natives of Bimini attribute great powers that may be used in a mischievous manner. These spirits are believed to dwell most frequently in the woodlands where this lizard lives.

² Unless otherwise stated, all measurements and scale designations are those defined in Smith, 1946, pp. 18-30, 94.

caudal crest, and its length is approximately one and one-fourth times the snout-vent length.

The canthal ridge is well developed, whereas the frontal and supraorbital ridges are only slightly raised. The scales on the dorsal surface of the head are irregular in shape and distribution, with a rounded rugosity that tends to obscure their true character. There are three pairs of enlarged scales in the frontal series, preceded by three or four irregularly paired smaller scales on the middorsal line of the snout; the largest of the frontal scales are the posteriormost two pairs, which are the only pairs of this series that are not in contact medially, being separated by one to five smaller scales. Four enlarged paired scales form the supra-

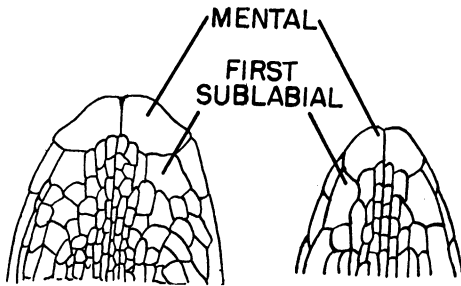


FIG. 1. Drawing of the anterior chin scales of *Anolis angusticeps oligaspis* (left) and *A. a. chickcharneyi* (right), illustrating the differences in the scales of this region. Note that in *chickcharneyi* there are only four scales bordering the mental between the first sublabials, while *oligaspis* has six scales between the first sublabials.

orbital ridges; the scales of the anteriormost pair in this series are more than twice the size of the posterior scales of the series and are the largest scales on the top of the head; they possess a prominent, low, longitudinal keel approximately in the center of the scales. The scales of the paired supraorbitals are separated medially by a single longitudinal row of scales, except the posteriormost pair which are separated by three small scales. The interparietal scale is less than half the size of the orbit; it is narrowly in contact with the posterior pair of enlarged supraorbitals, but is separated from the next to last pair of these by one row of smaller scales.

There are eight canthal scales on the left side and nine on the right side; the sixth on the left and the eighth on the right are

the largest. The anteriormost scales of the frontal series are separated from the canthal scales by four small scales, whereas the posterior frontals are separated from the canthals by a single scale. There are two prominently enlarged supraocular scales and numerous smaller scales in the supraocular disc; the enlarged supraoculars are separated from the scales of the supraorbital ridge by one to three rows of small scales.

The scales surrounding the interparietal are somewhat enlarged but decrease in size posteriorly and laterally; these are flat, irregularly shaped, smooth scales. There is no sharp line of demarcation in size between the scales on the posterior dorsal aspect of the head and those on the dorsal surface of the neck; rather the size and shape of the scales change gradually from the occipital region onto the neck. The scales on the dorsal surface of the neck are small and granular.

The rostral plate is broader than high, without any sharply defined grooves in the upper margin. There are seven small postrostral scales; the first pair of canthals and the first pair of supralabials are in contact with the rostral. There are four more or less well-defined pairs of internasals, with the respective paired scales in contact medially. There are three small supranasals on each side between the paired internasals and the nares. The naris on the left side is surrounded by six small scales, whereas that on the right is surrounded by seven small scales. The canthals are separated from the nares by one to three small scales. The supralabials number 10 on both sides. There are 29 loreals on the left and 26 on the right, arranged in one to four longitudinal rows. There are four suboculars on each side; all are in contact with the supralabials. There are nine infralabials to a point directly beneath the middle of the orbit. The paired mental scales are large and nearly triangular in shape; each is bordered posteriorly by the first infralabial and sublabial scales on each side, plus four small gular scales (fig. 1). There are one to five longitudinal rows of enlarged sublabials; the anteriormost scales are the largest. The gulars are small and oval to subcircular in shape.

The dorsum from the neck to the base of the tail is covered with small, subcircular, smooth, granular scales. Those on the neck are the smallest; those along the middorsal region of the back are slightly larger than those on the lateral body region. The dorsal scales increase in size on the tail, becoming keeled

and imbricate; the middorsal row on the tail is slightly larger than the adjacent rows. The dorsal caudals are arranged in verticils of four or five scales in width along the middorsal line; there is no caudal crest. The scales on the anterior surface of the limbs are enlarged; the prefemorals are three or four times as large as the middorsal scales on the body, but are smaller than the largest scales on the tail.

The scales on the ventral surface of the body are two to three times larger than the largest dorsals, subcircular or oval in shape, slightly convex, smooth, and non-imbricate. They decrease in size posteriorly and laterally, but the pre-anal scales are larger than the largest dorsals on the body. The scales on the throat are smaller than the anterior ventrals, elongate and irregularly oval in shape medially, and imbricate when the dewlap is not extended. On the ventral surface of the tail the scales increase in size distally, becoming strongly keeled, imbricate, and roughly rectangular in shape; and are arranged in verticils corresponding to those of the dorsal scales but with three subcaudals to each of the proximal verticils. The subcaudals are larger than any of the other scales on the body or tail.

All digits, except the first on both the fore and hind limbs, bear well-developed adhesive pads with greatly expanded transverse lamellae on the ventral surface. The first digit has two or three expanded proximal lamellae. The ratio of the width of the adhesive pad to the length of the distal phalanx of the fourth toe on the hind foot is .81 in this specimen. The subdigital lamellae on the fourth toe of the hind foot number 36, of which 19 are on the second and third phalanges.

MEASUREMENTS, IN MILLIMETERS

Snout-vent length.....	49.0
Tail length.....	63.0
Head length.....	16.2
Maximum head width.....	8.1
Maximum head height.....	7.1
Diameter of eye.....	3.9
Snout length (from anterior edge of orbit to anteriormost point on head).....	8.2
Snout width (at level of nares).....	4.4
Length of fore limb.....	16.0
Length of hind limb.....	26.5
Length of fourth toe.....	5.6
Maximum width of adhesive pad on fourth toe.....	0.9
Length of distal phalanx of fourth toe.....	1.1

The top and sides of the head, as well as the dorsal surface of the body, tail, and limbs, are light ash gray with irregular small markings of dark brown and black. There are a small black spot just below and posterior to the ear opening on each side, a small diffuse black axillary spot, and several irregular black spots on the proximal posterior surface of the femur. A series of alternate dark and light brown bands is present on the tail, with the dark bands approximately twice as broad as the light ones. The supralabials and suboculars are considerably lighter in color than the dorsal surface of the head. The chin, throat, belly, and under surface of the limbs are cream color with faint, irregular dark mottling laterally. The under side of the tail is irregularly dark and light brown in color. The expanded lamellae become slightly darkened in color distally. The dewlap is pale pink in life.

VARIATION: The four additional specimens, three females and one male, vary in size from snout-vent lengths of 40 to 45 mm. One of the females is so badly damaged that few data can be obtained from it. Little can be said at this time concerning the variation in this subspecies. The observed variation in the characters used in this study are presented in table 1.

TABLE 1

	<i>angusticeps</i> (3)	<i>chickcharneyi</i> (5)	<i>oligaspis</i> (2)
Number of scales between the seventh canthals	5	6-8	9-10
Number of scales between nares	6	7-9	7-8
Number of loreal scales	17-23	24-32	35-38
Lamellae under fourth toe	33-34	34-36	36-40
Number of small scales bordering mental posteriorly	4-6	4	6

In life this subspecies was always either very light ash gray or light chestnut brown, with a few darker marks, or with a highly contrasting pattern of irregular dark and light mottling. In preservation the type specimen is predominantly light brown with a slight amount of irregularly distributed olive green coloring. Two of the specimens have a faint light lateral stripe on each side extending from the shoulder to the groin.

RELATIONSHIPS: As stated above this subspecies appears to

be somewhat intermediate between *angusticeps* of Cuba and *oligaspis* of New Providence in the morphological characters that have been used to diagnose *chickcharneyi*. This can be seen in table 1.

FIELD OBSERVATIONS: This species was not discovered on Bimini until near the end of my visit, and in consequence only a few specimens were collected. The species has been considered as a rare form in the Bahamas (Barbour, 1937, p. 128), although Barbour and Ramsden (1919) state that it is "not uncommon" in parts of Cuba and the Isle of Pines. I believe that the rarity of this species in the Bahamas is partly because of the restricted ecological niche that it occupies. On Bimini specimens were observed only on the upper branches of light gray-colored trees, such as the fig (*Ficus*), at heights of 6 to 25 feet. The coloration of the lizards is very similar to the color of the bark of the trees on which they occur, making them difficult to locate and collect. Once their habitat had been noted, a number of specimens were seen.

***Anolis carolinensis leneri*,¹ new subspecies**

TYPE: No. 68635, an adult male in the collection of the American Museum of Natural History, collected by James A. Oliver on the southern end of North Bimini Island, Bimini, Bahamas, British West Indies, September 29, 1947. Twenty-four additional specimens were collected between September 22 and October 13, 1947, on North and South Bimini Islands.

DIAGNOSIS: A subspecies of *Anolis carolinensis* that is most closely related to *Anolis carolinensis porcatius* of Cuba. It differs from *porcatius* in lacking a prominent dark postorbital spot and usually (72 per cent of the specimens) lacking a distinct axillary spot, in having fewer loreals (78 per cent have 13 or less compared to 74 per cent of the *porcatius* that have more than 13), and in having two or three infralabials in contact with the sublabials (in 72 per cent of the *leneri* compared with 94 per cent of the *porcatius* that have one infralabial in contact with the sublabials). (See fig. 2.) The large dewlap is deep rose pink in life.

DESCRIPTION OF TYPE: The head and body are elongate and depressed. The head is slightly less than twice as long as wide,

¹ Named for Mr. Michael Lerner, founder of the Lerner Marine Laboratory on Bimini, Bahamas, British West Indies.

and its length is equal to one-third of the snout-vent length. The orbit is moderately large in size; its diameter is approximately equal to one-fifth the length of the head. The nares are prominent, opening on the dorsal aspect of the head approximately one-sixth of the head length from the tip of the snout. The fourth toe of the adpressed hind limb reaches slightly

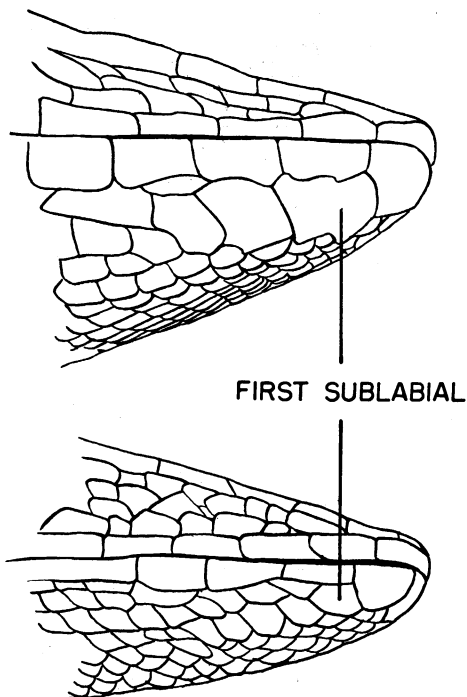


FIG. 2. Drawing of the antero-lateral scales on the lower jaw of *Anolis carolinensis leneri* (upper) and *A. c. porcatus* (lower), illustrating the differences in the scales in this region. Note that in *leneri* the two large anterior sublabials are in contact with the infralabials, while in *porcatus* only the first sublabial touches the infralabials.

beyond the ear opening. The tail is nearly circular in cross section, without a raised caudal crest, and its length is equal to twice the snout-vent length.

The frontal, canthal, and supraorbital ridges are well developed. Three pairs of scales are involved in the frontal ridges; these scales increase in size posteriorly; only the scales of the anterior-most pair are in contact medially, while the two posterior pairs

are separated medially by one or two smaller scales. Three enlarged paired scales form the supraorbital ridges; the scales of the anteriormost pair are more than twice the size of the posterior scales of this series and are the largest scales on the top of the head. The first two pairs of supraorbitals are separated medially by a single longitudinal row of small scales, while those of the last pair are separated by two small scales. The interparietal is one-half the size of the orbit; it is separated from the supraorbital scales by one or two rows of small scales.

There are six canthal scales on each side, the fifth being the largest in size. The anterior pair of scales in the frontal ridge series is separated from the canthal scales by two small scales, whereas the other frontals are separated from the canthals by a single longitudinal row of scales. There are four enlarged supraocular scales and numerous small scales in the supraocular disc; the enlarged supraoculars are separated from the scales of the supraorbital ridge by a single row of small scales.

The scales of the temporal region and the posterior dorsal surface of the head are smaller than the enlarged supraoculars, but larger than the scales on the dorsal surface of the neck. They are flat, irregularly shaped, pavementous scales with low keels. There is a rather sharp line of demarcation in size between the scales on the posterior dorsal aspect of the head and those on the dorsal surface of the neck. This line extends across the back of the head at a point just anterior to the ear opening.

The rostral plate is much broader than high, with six small grooves in the upper margin. Five small postrostral scales and the first pair of supralabials are in contact with the rostral. There are three pairs of internasals, with the respective paired scales in contact medially. There are four small supranasals on each side between the internasals and the nares. There are six small scales surrounding each naris. The second canthal scale on each side is in contact with the naris. The supralabials number nine on the left side and 10 on the right side. There are 11 loreal scales on the left side and 10 on the right side, arranged in one to three longitudinal rows. There are five subocular scales on each side; all are in contact with the supralabials. There are seven infralabials to a point directly beneath the middle of the orbit. The paired mental scales are large and nearly triangular in shape, bordered posteriorly by the first infralabial and sublabial on each side and three small gular scales in the middle. There are one to

five longitudinal rows of enlarged sublabials. The first and second anteriormost are the largest; both are in contact with the infralabials. The gulars are small and oval or rectangular in shape, with low longitudinal keels.

The dorsum from the posterior border of the head to the base of the tail is covered with small, weakly keeled, subcircular, non-imbricate scales. Those on the neck are smallest; those on the median dorsal area larger than the lateral body scales. The dorsals increase in size, becoming more prominently keeled on the tail; the median dorsal row is the largest of the dorsal caudal scales. The dorsal and lateral scales of the tail are imbricate. Distally on the tail the dorsal scales are arranged in indistinct verticils, with three median dorsal scales in each. The scales on the anterior surface of the limbs are much enlarged; the pre-femorals are larger than the median dorsal scales on the body and are equal to, or slightly larger than, the largest scales on the tail.

The scales on the ventral surface of the body are larger than those on the median dorsal surface, subcircular in shape, keeled, and imbricate. They decrease in size posteriorly and laterally; the pre-anal scales are nearly the same size as the lateral scales on the body. The scales on the throat are smaller than the anterior ventrals, elongate and oval in shape medially. There is a progressive decrease in size of the scales from the chest to the gular region. On the ventral surface of the tail the scales increase in size distally, also becoming more sharply keeled and rectangular in shape, and are arranged in verticils corresponding to those of the dorsal scales, with three transverse rows in each.

All digits, except the first on both the fore and hind limbs, bear well-developed adhesive pads with greatly expanded transverse lamellae on the ventral surface. The ratio of the maximum width of the adhesive pad to the length of the last phalanx of the fourth toe on the hind foot is 1.00. The subdigital lamellae on the fourth toe of the hind foot number 46, of which 25 are on the second and third phalanges.

The top and sides of the head, as well as the dorsal surface of the body, tail, and limbs, are normally uniform bright green (irregularly light gray green, green, and brown in preserved condition). The upper and lower labials, chin, throat, ventral surface of the limbs, body, and proximal one-fourth of the tail are light cream color to nearly white, except for the dewlap and the lamellae on the adhesive pads. The ventral surface of the distal

MEASUREMENTS, IN MILLIMETERS

Snout-vent length.....	61.3
Tail length.....	127.0
Head length.....	19.8
Maximum head width.....	11.0
Maximum head height.....	9.0
Diameter of eye.....	4.1
Snout length (from anterior edge of orbit to anteriormost point on head).....	11.0
Snout width (at level of nares).....	4.4
Length of fore limb.....	22.5
Length of hind limb.....	36.5
Length of fourth toe.....	9.8
Maximum width of adhesive pad on fourth toe.....	1.7
Length of distal phalanx of fourth toe.....	1.7

three-fourths of the tail is light green. The dewlap is deep rich rose pink in life. The lamellae of the adhesive pads vary in color from dark gray to black, increasing in intensity of color distally.

VARIATION: The additional 24 specimens of this subspecies vary in size from a snout-vent length of 29.9 to 64.1 mm., with an average length of 49.34 mm. for the series. The males attain a larger size than the females.

	OBSERVED RANGE	MEAN
Adult males (10)	57.2-64.1	60.44
Adult females (7)	42.1-51.3	47.13

The ratio of the maximum width of the adhesive pad to the length of the distal phalanx of the fourth toe varies in 10 adults from .80 to 1.43, with an average of 1.04.

The variation observed in most of the characters of scutellation is rather limited, although a few of the scales (for example, the number of enlarged supraoculars) exhibit considerable variation and are of little value as indicators of population differentiation. The more useful variations studied in this material are indicated below.

In half of the specimens the scales of one or more pairs of the enlarged supraorbital scales are in contact medially, whereas in the remaining half of the specimens all of these scales are separated. In most of the specimens one of the enlarged supraocular scales on each side is in contact with one of the enlarged supraorbital scales. The number of scales in a straight line from the interparietal to the posteriormost pair of frontal scales

(that are in contact medially) varies from six to 12, with an average of 9.3. Approximately one-third of the specimens have only two pairs of internasal scales, whereas all the others have three pairs. Only three individuals vary from the usual condition with six canthals; these have five or seven scales. The number of loreals varies from 10 to 17, with an average of 12.22. The number of supralabials varies from eight to 12, with nine or 10 occurring most frequently. The number of suboculars is normally five, although one specimen possesses six. Both of the enlarged anterior sublabials are in contact with the second or third infralabials in 72.22 per cent of the specimens, whereas in the remainder these scales are in contact only with the first infralabial.

The lamellae under the fourth toe vary in number from 40 to 46, with an average of 42.55. Those on the last phalanx of the fourth toe are either six or seven, with an average of 6.33. The small scales between the enlarged postanal of the males vary in number from one to four, with an average of 3.00.

Seven specimens exhibit a small but distinct axillary dark spot. Four of these are juveniles, two are adult females, and one is an adult male. No specimen exhibits the distinct postocular dark spot that characterizes most members of the *carolinensis* complex, although an occasional individual has indistinct and irregular dark areas in that region. These seem to be the result of preservation and were not observed in the living specimens. The normal green color is changed to a uniform dark brown when the animal is cold or when found in dark surroundings. In preservation most specimens acquire a light brown color, although some are irregularly light gray green, green, and brown intermixed. Specimens observed in the field and in the laboratory were never seen with any color other than the uniform green or uniform brown dorsal coloration.

RELATIONSHIPS: This subspecies is related to a group of populations widely distributed throughout the Bahamas (*brunneus*, *fairchildi*, and *smaragdinus*), the southeastern United States (*carolinensis*), Cuba (*porcatus*), and other islands of the West Indies. All of these except *carolinensis* have been accorded subspecific status in the species *porcatus* (Barbour, 1937). There are no data to indicate that *carolinensis* should be treated differently from the other forms. In fact it appears to be more closely related to some of these races than certain of the latter do to each other. None of the populations seems to have evolved

sufficiently to have acquired reproductive isolation from adjacent races and all are very similar in morphological attributes. Thus from the information available it appears that all of these forms are more properly considered as subspecies of a single, wide-ranging, polytypic species that should be called *carolinensis* Voigt, 1832. Other races and relatives of this species occur in several parts of the West Indies, but these do not involve any close relationship to *leneri* and will not be considered here.

The most easily perceived differences between *leneri* and its close allies are in coloration: *leneri* lacks the prominent dark postocular spot and usually the axillary spot, either or both of which is present in varying degrees of development in all of the other races of the species. Individuals of *porcatus* from Cuba occasionally lack one or both of these marks, but most of the Cuban specimens possess at least one of the pairs of spots. In addition to these features of coloration, *leneri* differs from many of its allies in lacking well-defined dark markings on the chin or throat, whereas most of the races of *carolinensis* have such markings. The chin and throat in *leneri*, whether light or dark, are unicolored, without dark spots, longitudinal streaks, or dark mottling.

Topotypic material of all of the Bahaman races, as well as specimens of *porcatus* from Cuba and *carolinensis* from the Carolinas, has been examined during the course of this study. In addition to the differences in coloration *leneri* differs from these forms as follows:

1. *brunneus* (type locality, Crooked Island) has a slightly longer and proportionately wider snout than *leneri* (the ratio of width of snout to width of head in *brunneus* is 47.25 compared to 43.19 in *leneri*), has more prominent keels on all scales, especially those of the dorsal surface of the head, and has only one sublabial in contact with the infralabials.

2. *carolinensis* (type locality, "Carolina") has relatively smaller dorsal scales that are more prominently keeled than those of *leneri*, the tail is compressed slightly so that it is oval in cross section rather than circular as in *leneri*, and the head is shorter and broader than that of *leneri* (the ratio of width of snout to width of head in *carolinensis* is 46.51 compared to 43.19 in *leneri*).

3. *fairchildi* (type locality, Cay Sal Islands) possesses relatively larger temporal scales, fewer scales in a line from the interparietal forward to the anterior pair of frontals (four as compared with a

minimum of six), has only one infralabial in contact with the anterior sublabials, and has larger postanal scales in the male (equal to two or three times the interspace in *fairchildi* as compared with a size equal to the interspace in *lernerii*).

4. *porcatus* (type locality, "Cuba") has the frontal and canthal ridges more rugose in adults, has a greater number of loreal scales (average 17.50 as compared to an average of 12.22 in *lernerii*), usually has only a single infralabial in contact with the anterior sublabials, and has more lamellae on the distal phalanx of the fourth toe (mean, 7.18 compared with 6.33 in *lernerii*).

5. *smaragdinus* (type locality, Long Island) possesses larger and more regularly arranged scales in the frontal and supraorbital ridges, is considerably smaller, and has a shorter, broader snout (the ratio of width of snout to width of head in *smaragdinus* is 50.73 compared to 43.19 in *lernerii*).

Geographically *lernerii* is closest to the Floridian population of *carolinensis*, whereas the nearest geographic locality from which an insular race of the species has been named is Cay Sal, the type locality of *fairchildi*. However, from the comparative morphological studies made of these closely allied races, *lernerii* appears to be most closely related to *porcatus* of Cuba. When this species has been studied throughout the Bahamas, *lernerii* may prove to be more closely related to subspecies on some of the larger islands that have a closer geographic proximity than Cuba—for example, Andros or Grand Bahama.

Because of its apparent closer relationship with *porcatus*, the new subspecies has been most closely compared with that race. As is characteristic of larger populations (Dobzhansky, 1941, chap. 5), the Cuban *porcatus* exhibits greater variation than the Bimini race in most of the characters studied. All of the Bimini specimens can be separated from all of the Cuban *porcatus* by one or more of the color characters mentioned above. In addition to these differences there are at least four characters of scutellation that indicate mean differences between the two forms. However, no single scale character permits segregation of all specimens in any population. These characters provide an indication of the direction of the genetic drift in the respective populations rather than an expression of fixed differences.

In the Cuban *porcatus* the loreals vary from 12 to 31, with an average of 17.50, while in *lernerii* these scales number 10 to 17, with an average of 12.22. Seventy-four per cent of the *porcatus*

examined have more than 13 loreals, whereas 78 per cent of the *lernerii* have 13 or fewer loreal scales.

In regard to the number of infralabials in contact with the two enlarged anterior sublabials, 94 per cent of the Cuban *porcatus* have only a single infralabial in contact, while 72 per cent of the *lernerii* have two or three infralabials in contact with the sublabials.

The number of lamellae under the fourth toe in Cuban *porcatus* varies from 40 to 56, average 46.45, as compared with 40 to 46, average 42.55, in *lernerii*. Another mean difference is observed in the number of small scales between the enlarged postanal scales of the males: in *porcatus* none to four, average 1.89; in *lernerii* one to four, average 3.00.

In this study I have considered only the named Bahaman populations of *carolinensis*. I have not tried at this time to analyze all of the Bahaman populations of the species. In consequence I cannot comment on the relationships of *lernerii* to the undescribed populations of the species *carolinensis* that occur on the other islands that make up the Bahamas. Whether or not the name *lernerii* should be applied to specimens from adjacent islands, I cannot say at the present time. Barbour and Shreve (1935) refer representatives of this species from Andros Island, New Providence, and Eleuthera to *smaragdinus*. Five specimens collected on Andros by C. M. Breder, Jr., in 1933 more closely resemble topotypic material of *smaragdinus* than they do *lernerii* or Cuban *porcatus*, and they are certainly racially distinct from either of the latter.

FIELD OBSERVATIONS: I found this lizard first on North Bimini Island in clusters of "needles" of the "Australian pine" (*Casuarina*) at a height of 6 feet above the ground. This was in a grove of "Australian pines" near a "fresh water" pond at the southern end of the island. Specimens of this species could always be found by looking on the pines in this grove. Only two specimens were seen at any other locality on North Bimini: one was found approximately one-quarter of a mile north of this location in a hedge of "Australian pine," and the other was found on the base of a small palm about 100 feet north of this grove. Usually specimens were found on or in clusters of "needles," although occasionally they were seen on the limbs or trunk of the trees.

On South Bimini there are very few of the "Australian pines,"

and this lizard is found on palms, agaves, and several thick-leaved green shrubs. Since it occurred there on a greater variety of shrubs it was more difficult to find and collect than on North Bimini. Specimens were seen or collected in the middle and western sections of South Bimini. Because of the bright green coloration normally exhibited, this species blends well with the green background in which it is most frequently found. Shy and retiring, it characteristically begins a slow, stealthy retreat as soon as an intruder is seen. When disturbed it endeavors to escape by getting out of sight on the opposite side of a limb and

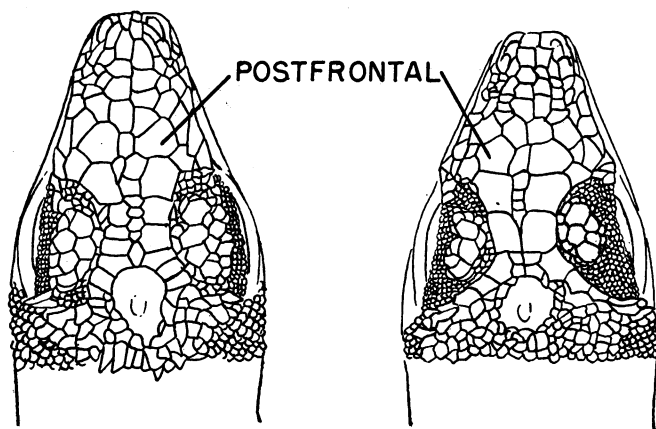


FIG. 3. Drawing of the dorsal surface of the head of *Anolis distichus distichoides* (left) and *A. d. biminiensis* (right), illustrating the differences in the dorsal head shields. Note that *distichoides* has only two scales in contact with the postfrontal laterally, whereas *biminiensis* has three scales touching these shields laterally.

by moving higher up in the tree or shrub. Apparently undisturbed specimens were noted at heights of 3 to 10 feet above the ground, and when disturbed were seen to flee to a height of 25 to 30 feet. This lizard on different occasions was found on the same tree or shrub with each of the other three species, although in a different part of the tree.

***Anolis distichus biminiensis*, new subspecies**

TYPE: No. 68640, an adult male in the collection of the American Museum of Natural History, collected by James A. Oliver on the western end of South Bimini Island, Bimini, Baha-

mas, British West Indies, October 8, 1947. Nineteen additional specimens were collected on the middle and western sections of South Bimini Island between October 8 and 13, 1947.

DIAGNOSIS: A subspecies of *Anolis distichus* that is most closely related to *Anolis distichus distichoides* from Andros Island, Bahamas. It differs from *distichoides* in usually (79 per cent of the specimens) having three or four scales in contact laterally with the postfrontals (73 per cent of the *distichoides* examined have only two scales in contact laterally with the postfrontals; see fig. 3), and in having fewer scales in a straight line from the interparietal to the posteriormost pair of frontals that are in contact medially (78 per cent of the *biminiensis* have fewer than eight, whereas 82 per cent of the *distichoides* have more than eight). The new subspecies has a yellowish orange dewlap in life.

DESCRIPTION OF THE TYPE: The head and body are moderate in length, stocky, only slightly depressed. The width of the head is equal to two-thirds of the head length; the latter is slightly more than one-fourth of the snout-vent length. The orbit is relatively large in size, its diameter slightly more than one-third of the length of the head. The nares are small, opening on the dorsal aspect of the head approximately one-twelfth of the head length from the tip of the snout. The fourth toe of the adpressed hind limb reaches to the posterior edge of the mouth. The tail is compressed laterally, with a slightly raised irregular caudal crest formed by the enlarged middorsal scales on the tail. The tail is broken, but appears to have been approximately one and one-third times as long as the snout-vent length.

The frontal and supraorbital ridges are weakly developed but distinct. There are five more or less paired scales extending along the middorsal line of the head from the rostral plate backwards; these increase in size posteriorly, with the last pair being the largest; none of these scales is keeled or bears a low ridge. The posteriormost pair of these scales is followed by a single small scale and a pair of large, irregularly hexagonal scales, the postfrontals, which are the largest paired scales on the dorsal surface of the head and are exceeded in size only by the interparietal; each has a low, nearly indistinct longitudinal ridge. The postfrontals are followed posteriorly by the paired series of five or six enlarged supraorbital scales; the anteriormost pair of supraorbitals nearly equals the postfrontals in size and is three

or four times the size of the posteriormost pair. The supra-orbitals bear a low, rounded, longitudinal ridge; the members of the pairs of this series are separated by a single longitudinal row of small scales, except for one pair, the scales of which are in narrow contact for less than one-fifth of their length, and the anteriormost pair of which is separated by two scales for less than half its length. The interparietal scale is approximately one-half the size of the orbit and is slightly larger than the postfrontals; it is in contact with two of the supraorbitals on each side and is preceded by a single small, elongate, oval scale. There are eight scales in a line from the interparietal to the posteriormost pair of frontal scales that are in contact medially.

There are six canthal scales on each side, the fifth being the largest in size. The anterior pair of scales in the frontal ridge series is separated from the canthals by two to three smaller scales, whereas the posterior pair is separated by a single longitudinal series of scales. There are six enlarged supraoculars, surrounded by a few irregular scales that are nearly as large as the smallest enlarged scales and by numerous minute, granular scales; the enlarged scales are separated from the enlarged supraorbitals by one to four small scales. There are four to eight longitudinal rows of slightly enlarged scales in the temporal region, extending backward and downward in an arc from the upper posterior edge of the orbit to the ear opening. The scales bordering the interparietal laterally and posteriorly are smaller than the enlarged supraoculars, but larger than the scales on the neck; they are flat, irregularly shaped, pavementous scales that decrease in size laterally and posteriorly. There is no sharp line of demarcation in size between the scales on the posterior dorsal aspect of the head and those on the dorsal surface of the neck.

The rostral plate is much broader than high, but because of injury or wear the exact upper margin cannot be defined accurately. Posteriorly the rostral appears to be bordered by the first supralabials, the first canthals, two small scales on each side anterior to the nares, and the first pair of median scales on the snout. Since the paired series of scales on the snout pass gradually from frontals to internasals, no attempt has been made arbitrarily to designate the separate categories, except in the case of the large postfrontals. The nares are separated from the paired median scales by one to two scales, and are surrounded by five to six small scales. The supralabials number nine on each

side. There are 19 loreal scales on the left and 20 on the right side, arranged in one to five longitudinal rows. There are six to seven suboculars, of which five are in contact with the supralabials. There are five infralabials to a point directly beneath the middle of the orbit. The paired mental scales are large, irregularly quadrangular in shape, bordered posteriorly by the first infralabial and sublabial and three small gular scales on each side. There are one to six longitudinal rows of enlarged sublabials. The first three anteriormost are the largest and are in contact with the first and second infralabials. The gulars are small, smooth, oval, pavementous scales, decreasing in size posteriorly and laterally.

The dorsum from the posterior border of the head to the base of the tail is covered with small, smooth, circular and oval-shaped granular scales. Those on the lateral and middorsal area are subequal in size; the dorsals increase in size on the limbs and tail. Those on the tail are imbricate and keeled, with the scales in the median dorsal row greatly enlarged and mucronate, forming an irregular low caudal crest. The irregularity of the crest results from the sequential arrangement of three to four large middorsals in a longitudinal row followed by one or two smaller middorsals, and then three or four large scales again, etc. The lateral caudal scales do not correspond to the sequential arrangement of the median dorsal caudals, so that the tail is not marked by well-defined verticils. The scales on the anterior surface of the limbs are much enlarged and imbricate; the prefemorals are much larger than the largest dorsals and approximately twice the size of the largest ventrals.

The scales on the ventral surface of the body are more than four to six times larger than the median dorsal scales on the body, subcircular in shape, smooth, and pavementous. They decrease in size posteriorly and laterally; the pre-anal scales are two to three times as large as the middorsal body scales. There is a pair of slightly enlarged postanal scales that are one and one-half to two times larger than the adjacent scales and are separated medially by three smaller scales. The scales on the throat are equal to, or slightly smaller than, the anterior ventrals; those involved in the dewlap are elongate and oval in shape. On the ventral surface of the tail the scales increase in size distally, becoming sharply keeled and nearly rectangular in shape.

On the fore limb the second, third, and fourth digits bear

well-developed adhesive pads with greatly expanded transverse lamellae on the ventral surface. The fifth digit has the lamellae only moderately expanded, while the first digit has only four or five slightly expanded proximal lamellae. On the hind limb the digital pads are well developed on the third, fourth, and fifth digits, only moderately developed on the second, and practically absent on the first digit which has three or four slightly expanded proximal ventral scales. The ratio of the maximum width of the adhesive pad to the length of the last phalanx of the fourth toe on the hind foot is .68. The subdigital lamellae on the fourth toe of the hind foot number 38, of which 20 are on the second and third phalanges.

MEASUREMENTS, IN MILLIMETERS

Snout-vent length.....	49.4
Tail length.....	?
Head length.....	13.7
Maximum head width.....	9.2
Maximum head height.....	7.7
Diameter of eye.....	4.9
Snout length (from anterior edge of orbit to anteriormost point on head).....	6.4
Snout width (at level of nares).....	3.5
Length of fore limb.....	24.0
Length of hind limb.....	34.0
Length of fourth toe.....	8.5
Maximum width of adhesive pad on fourth toe.....	1.3
Length of distal phalanx of fourth toe.....	1.9

The top and sides of the head, as well as the dorsal surface of the body, tail, and limbs, are normally light mouse gray (brownish gray in the preserved condition). There are occasional small spots and short streaks of black on the head, body, and tail, in addition to small irregular areas of black pigment on the scales. The supraorbital ridges are black; there is a prominent supra-orbital black spot, a black spot above each ear opening, and an irregular black area in the occipital region of the head. The upper labials and suboculars are slightly lighter than the top of the head; the lower labials are light gray to white, with irregularly distributed black pigment. The gulars, as well as the ventral scales on the body and limbs, are white to dirty white with small flecks of darker coloration but no spots or streaks. In life there is a small area of light yellowish orange coloration surrounding the vent and on the base of the tail. This coloring disappears rapidly

in preservation. On the digits there is an increase in the amount of dark pigment distally, both dorsally and ventrally. Distally the subcaudals become darkly pigmented, so that the distal half of the tail is virtually the same color above and below. The dewlap is yellowish orange in life.

VARIATION: The 19 additional specimens vary in snout-vent length from 25.2 to 49.8 mm., with a mean length of 40.62 mm. The males attain a somewhat larger size than the females: 10 adult males vary from 38.3 to 49.8, with a mean of 46.66; four adult females vary from 36.3 to 44.2, with a mean of 41.82. The ratio of the maximum width of the adhesive pad to the length of the distal phalanx of the fourth toe in 10 adults is .44 to .76, with a mean of .64.

The number of paired scales on the middorsal area of the snout varies from four to six, with 67 per cent having either four or five. The number of enlarged paired supraorbitals is three to seven, with an average of 5.54; the number of these scales in contact medially is zero to four, average 1.77. The number of supraorbitals in contact with the interparietal varies from one to three, with an average of 2.0. Eighty-one per cent of the specimens have a single interparietal, whereas in 19 per cent this scale is divided transversely to produce a small anterior section.

The number of scales in a straight line from the interparietal anteriorly to the posteriormost pair of frontal scales in contact medially is one to 12, with an average of 5.55 and with 78 per cent of the specimens having fewer than eight. The number of scales in contact with the postfrontals laterally is two to four, with 79 per cent having three or four. The number of upper labials varies from seven to nine, with an average of 7.90.

The number of lamellae under the fourth toe is 36 to 39, average 38.4. Those on the last phalanx of the fourth toe are either nine or 10, with a mean of 9.4.

The observed variation in regard to coloration is slight, and primarily involves the amount and distribution of the darker pigment. Several specimens have the black supraocular spots expanded and modified to form a black bar that extends completely across the top of the head. Three or four specimens have the throat and gular area heavily pigmented throughout. Living specimens of this lizard were light mouse gray, dark slate gray, or of intermediate coloration. None exhibited a green or dark brown coloration.

RELATIONSHIPS: The closest relative of *biminiensis*, geographically and morphologically, is *distichoides* Rosén of Andros Island, Bahamas. The typical subspecies, *distichus* Cope, described from New Providence, is the only other Bahaman race of the species now recognized. Topotypic material of both of these races has been examined, and significant differences in scutellation are noted. The newly described race differs most noticeably from topotypic specimens of *distichus* in having one or more of the enlarged supraorbitals in contact with the interparietal (none in contact in *distichus*), in having a higher number of lamellae on the fourth toe (36 to 39 as compared with 33 to 35 in *distichus*), and in being predominantly gray in coloration with a yellowish orange dewlap (as compared to a light brownish color with a light yellow dewlap, *vide* Rosén, 1911).

The two most important differences in scutellation between *biminiensis* and *distichoides* are: (1) the number of scales in contact laterally with the postfrontal (three or four in 79 per cent of the *biminiensis* compared to two in 73 per cent of the *distichoides*); and (2) the number of scales in a line from the interparietal to the posteriormost pair of frontals that are in contact medially (78 per cent of the *biminiensis* have fewer than eight compared to 82 per cent of the *distichoides* which have more than eight). Other tendencies of differentiation are seen in the number of paired scales in contact on the snout (67 per cent of the *biminiensis* have five or fewer compared with 73 per cent of the *distichoides* with six or more), the number of supraorbitals in contact with the interparietal (two or three in 81 per cent of the *biminiensis* compared to one or none in 63 per cent of the *distichoides*), and the color of the dewlap (yellowish orange in *biminiensis* compared to yellowish red in *distichoides*, *vide* Rosén).

FIELD OBSERVATIONS: Like *chickcharneyi*, this species was not observed on Bimini until near the end of my visit, but a series of 20 specimens was collected. These lizards were found at a comparatively low height on the trunks of trees of a light gray color, such as the fig (*Ficus*) and the silver thatch palm (*Coccothrinax*). On several occasions they occurred on the same trees as *chickcharneyi*, with the latter on the upper branches at a height of from 6 to 25 feet while *biminiensis* was found on the trunk at a height usually below 6 feet. However, *chickcharneyi* appears to be less abundant and to occur in a more restricted habitat than *biminiensis*. This apparent difference in abundance may be

enhanced by a dissimilarity in behavior: *chickcharneyi* seemed to be notably more shy and retiring than *biminiensis*.

***Anolis sagrei ordinatus* Cope**

TYPE LOCALITY: "W. Indies."

NOMENCLATORIAL REMARKS: In 1864 Cope described *Anolis ordinatus* on the basis of a male and a female from the West Indies in the collection of the British Museum. Boulenger (1885) considered *ordinatus* a synonym of *sagrei*. In 1887, Cope referred Bahaman specimens both to *Anolis sagrei* (from New Providence and Abaco) and to *ordinatus* (Turks Island), without comment. In the same year Garman (1887) allocated Cuban specimens to *sagrei* and made the following remarks about *ordinatus*: "We have this variety of *A. sagrae* [*sic*] from the Bahamas, by C. J. Maynard; New Providence, Bahamas, by F. K. Shaw; the Florida Keys by Count L. F. de Pourtales; and from Nassau, Bahamas, by J. C. Comstock."

Stejneger (1904) followed Garman in considering the two forms to be distinct, but restricted the application of *A. ordinatus* to the "northern Bahaman specimens" and of *A. sagrei* to material from Cuba. Rosén (1911) compared his material from Andros and New Providence Islands, Bahamas, to specimens in the British Museum and concluded that *sagrei* and *ordinatus* merely represented different age groups of the same form. Barbour and Shreve (1935) used the name *Anolis ordinatus* for specimens from New Providence. In 1937 Barbour designated *ordinatus* as the Bahaman subspecies of *sagrei*, with the typical race an endemic of Cuba and the Isle of Pines. I follow Barbour's allocation of *ordinatus* as the Bahaman race of *sagrei*.

SYSTEMATIC REMARKS: In an endeavor to determine the status of the Bimini population of this species, specimens from Cuba, Andros, New Providence, and the Florida Keys were studied. The material from the three Bahaman localities did not show any marked or constant variations that could be used to distinguish between them. However, the Bahaman lizards (*ordinatus*) do differ from the Cuban (*sagrei*) and from the Florida Keys (*stejnegeri*) specimens in the following two characters:

	<i>ordinatus</i>	<i>sagrei</i>	<i>stejnegeri</i>
Paired supraorbitals	One or more in contact medially	None in contact	None in contact
Color of skin of dewlap (preserved condition)	Medium to dark gray (nearly black)	Light brown to light gray	Burnt orange

In addition to these characters there are several qualitative differences that are readily apparent when representatives of the three forms are compared:

1. The caudal crest is more prominent in *ordinatus* and *sagrei* than it is in *stejnegeri*, but the vertical margins of the caudal verticils are more distinct in the last named than in the other two.

2. The lateral dorsal scales of *stejnegeri* are larger, more sharply keeled, and more imbricate than are the same scales in *ordinatus* and *sagrei*. In the last two forms these scales are granular or almost tubercular.

3. The large midventral scales at the anterior end of the unexpanded dewlap are pure white without dark spots in *stejnegeri*, usually pure white without dark spots or occasionally with minute dark spots in *sagrei*, and white but heavily spotted with dark pigment in *ordinatus*.

4. The over-all color of *stejnegeri* is much lighter than that of *ordinatus* or *sagrei*.

The results of this study confirm the distinctness of the three named forms and indicate that all three are races of a single species, *sagrei*. Up to the present those dealing with the population have treated *stejnegeri* as a distinct species although pointing out its close relationship to *sagrei*. When Barbour (1931) described *Anolis stejnegeri* he stated that it was "not very distantly related to *A. ahli* and *A. mestrei* of Cuba," but he did not comment on its relationship to *sagrei*. Actually *stejnegeri* is much closer to *sagrei* than it is to either *ahli* or *mestrei* and differs from these two in the same way that *sagrei* does. As noted above, Garman included specimens from the Florida Keys (presumably *stejnegeri*) under *Anolis ordinatus*. Smith (1946) in his discussion of *stejnegeri* states, "The relationship of this species with the common *Anolis sagrei* of the coastal areas about the Caribbean Sea is very close; they can be separated only on the basis of the dewlap color. Further investigation of the variation in this character in *sagrei* and *stejnegeri* will be of considerable interest,

as it will reflect upon the validity of the latter species." I believe that the status of *stejnegeri* is more accurately expressed by designating it as a subspecies of *sagrei*. Certainly its origin and relationships are manifestly closest to *sagrei* and *ordinatus* than to any other *Anolis*. From the data available there is no evidence that it has differentiated sufficiently to acquire the status of a species.

Anolis sagrei sagrei is an inhabitant of Cuba and the Isle of Pines ("probably introduced into Jamaica and Belize," Barbour, 1937, p. 126). *Anolis sagrei ordinatus* is widely distributed in the Bahamas, while *Anolis sagrei stejnegeri* is now known only from the Florida Keys. Further analysis of this species in the Bahamas and Cuba will most certainly necessitate the recognition of additional subspecies.

FIELD OBSERVATIONS: This is by far the commonest reptile that occurs on Bimini, and the most abundant lizard that I have ever seen. That this does not represent a peculiar local situation is attested by Barbour (1904) who says, "This is the most widely distributed and abundant lizard in the Bahamas." On Bimini this species was frequently seen foraging on the ground, or resting on low bushes and on trees only a short distance above the ground. When on the trunk of a palm or other sizable tree, they are most often in a vertical position with the head lowermost but pointed upward and out at an angle of approximately 30 degrees from the vertical axis of the body.

Seventeen of these lizards found in a small area (approximately 55 by 12 feet) in front of the laboratory residence were marked and casually observed for a period of slightly less than one month. They were marked by clipping various combinations of the digits on the four limbs. In addition the adults were marked with small, colored, celluloid canary bands that were sealed at a suitable diameter with acetone. The use of the colored bands made possible the identification of individual lizards from a distance without disturbing them. This technique, suggested to me by Joseph R. Bailey and Charles Walker, proved most satisfactory. Of the 11 individuals marked, only three lost the bands during the course of the observations. Two of these were expected losses as I was trying to determine the minimum sized lizard that could be banded. The bands when properly applied did not seem to hinder the lizards in any way, although one lizard

was observed to bite the band occasionally after it had been on for more than a week.

The lizards studied varied in size from one with a snout-vent length of 19 to one of 57 mm. After being marked each lizard was released at the same spot where it had been captured. Fourteen individuals, or 82 per cent of these marked, were recaptured or sighted again one or more times. The maximum number of times that any individual was seen or recaptured was 23. Two of the three lizards that were not seen again were the smallest lizards marked, with snout-vent lengths of 19 and 22 mm., respectively. The third was also a young or subadult specimen, with a snout-vent length of 33 mm.

It is planned to present elsewhere at a later date a detailed account of the individual and social activity of this species, but a summary of the more important observations can be outlined:

1. Definite territories are maintained and defended by both sexes after the mating season has terminated.

2. The territories occupied during the daytime by four adult females (snout-vent lengths from 39 to 45 mm.) in the area were contiguous but did not overlap. Two of the females whose daytime territories adjoined were found on three occasions to overlap in their night-time sleeping sites.

3. Two large males (54 and 57 mm. snout-vent length) occupied territories that adjoined one another and that included the territory of more than one adult female. Within the area occupied by each large male there was a smaller male (41 and 44 mm. snout-vent length) that remained within a smaller territory than that occupied by the larger male.

4. Within the territory of each adult female from one to five young or subadult (19 to 33 mm. snout-vent lengths) lizards occurred.

5. A definite hierarchy existed within a territory: larger individuals usually dominated smaller individuals. Since the males attain a larger size than the females, males usually dominate females, although the largest males appeared to ignore, and were ignored by, the females that lived within their respective territories.

6. Head nodding is the principal reaction employed in defending territories against intruding lizards. It is invariably responded to by females and juveniles (from 28 mm. up) with

head nodding, whereas males usually responded by distending their dewlaps.

7. Defoliation of the bushes as a result of the hurricane of September 17, 1947, appeared to disrupt the established territories primarily through reduction in the available shelter and the resultant increase in visual range.

COMPARISON OF THE FOUR SPECIES OCCURRING ON BIMINI

The species of *Anolis* found on Bimini (the differences discussed here apply only to the species representatives on Bimini) differ markedly from one another in morphological attributes, coloration, ecological preferences, behavior, and relative abundance. On the basis of these differences they may be placed into species pairs that do not necessarily indicate phylogenetic affinities. The forms *chickcharneyi* and *leneri* resemble each other in being strongly depressed and elongate in habitus, in possessing well-developed adhesive pads on the digits, in being almost entirely arboreal, and in being shy and retiring in their actions. On the other hand, *biminiensis* and *ordinatus* are moderately stout in proportions and only slightly depressed, they have the adhesive pads only moderately developed, they do not appear to be restricted to an arboreal habit, and they are agile and alert in their actions. The detailed differences are given below.

MORPHOLOGY: Two sets of data are presented to indicate differences in proportions. These are the ratio of the head width to the head length and the maximum diameter of the adhesive pad to the length of the distal phalanx of the fourth toe.

	HEAD WIDTH/HEAD LENGTH	DIAMETER OF ADHESIVE PAD/ LENGTH OF PHALANX
<i>chickcharneyi</i> (4)	45-52, mean 49	0.75-1.42, mean 1.07
<i>leneri</i> (25)	49-61, mean 55	0.80-1.43, mean 1.04
<i>biminiensis</i> (20)	57-69, mean 66	0.44-0.76, mean 0.64
<i>ordinatus</i> (56)	52-68, mean 61	0.53-0.67, mean 0.61

A further proportional difference is seen in the length of the hind limb.

	FOURTH TOE OF ADRESSED HIND LIMB REACHES TO:
<i>chickcharneyi</i>	Slightly beyond shoulder
<i>leneri</i>	Slightly beyond ear
<i>biminiensis</i>	Posterior angle of mouth
<i>ordinatus</i>	The orbit

The tail in *chickcharneyi* and *leneri* is nearly round, being subcircular in cross section, and lacks a raised crest. In *biminiensis* and *ordinatus* the tail is compressed laterally, being ovate to lanceolate in cross section, and bears a raised crest of enlarged, mucronate middorsal scales.

The chief differences in scutellation are indicated in table 2.

In *chickcharneyi* and *biminiensis* only the canthal ridges of the head are well developed, while the frontal and supraorbital ridges are low and rounded. In *leneri* all three ridges are well developed and prominent in the adults. In *ordinatus* the canthal and frontal ridges are well developed but rounded, whereas the supraorbital ridge is low and rounded, not prominent.

COLORATION: The most noticeable difference in external coloration is the range of color variation exhibited by the species. Only *leneri* possesses a green coloration; it is usually bright green in life but changes to a uniform dark brown when cold or when on a dark background. The race *ordinatus* is uniformly light brown, gray, or even black, or exhibits a pattern consisting of a broad, zigzag, light brown vertebral stripe, with dark brown sides. *Anolis d. biniensis* is either light or dark gray in color, whereas *chickcharneyi* is light ash gray or light chestnut brown with a few darker marks, or occasionally with a highly contrasting pattern of irregular dark and light mottling.

An interesting difference between these species is noted in relation to the distribution of black pigment in the posterior part of the peritoneal cavity. All of the species have the peritoneum heavily pigmented with black, and all have the liver dark grayish green. In *biminiensis* there is additional black pigment on the mesocolon (or mesorectum) only. In *leneri* there is additional black pigment on both the mesocolon and the mesoduodenum, although only a sprinkling on the latter. In *ordinatus* the entire large and small intestines are heavily pigmented with black pigment that stops abruptly at the pylorus, leaving the stomach white. In the male the testes are covered with black pigment, but the ovaries of the female are light in color, as is the pancreas in both sexes. The condition seen in *ordinatus* is striking and represents a marked difference from the condition seen in the other three forms. The same distribution of black pigment in the peritoneal cavity is found in the other races of *sagrei* (*s. sagrei* and *s. stejnegeri*) but has not been observed in any representatives of the other three species studied by me. I can offer

no suggestion concerning the possible significance of these differences.

ECOLOGICAL PREFERENCES: *Anolis sagrei ordinatus* appears to have the greatest ecological tolerance of any reptile found on Bimini. It is found in the greatest number of different habitats and is almost equally abundant everywhere. It is mainly an inhabitant of open shrubby areas and clearings, being least common on the arid, open sand flats and in the thick "coppet." It is seen frequently foraging on the ground in clearings, running

TABLE 2
SCUTELLATION OF BIMINI *Anolis*

Character	<i>a. chickcharneyi</i>	<i>c. lernerii</i>	<i>d. biminensis</i>	<i>s. ordinatus</i>
Dorsal scales	Small, smooth, granular to pavementous; less than half the size of ventrals	Moderate to large, keeled, non - imbricate; subequal to ventrals	Small, smooth, pavementous; less than half the size of ventrals	Moderate, keeled, mid-dorsals imbricate, lateral dorsals granular; less than half the size of ventrals
Ventral scales	Large, smooth, pavementous	Moderate to large, keeled, imbricate	Large, smooth, pavementous	Large, keeled, imbricate
Head shields	4 paired supra-orbitals; 24-32 loreals; 10 supralabials	3 paired supra-orbitals; 10-17 loreals; 8-12, mean 9.5, Supralabials	5 - 6 paired supra-orbitals; 19-20 loreals; 9 supralabials	4 - 5 paired supra-orbitals; 16-23 loreals; 6-7 supra-labials
Lamellae on fourth toe	36	40-46	36-39	33-38

along the dead sea-weed litter of the ocean beaches, on the bushes and trees of the yards on North Bimini, or at the edge of the thickets on South Bimini. When found on trees and shrubs it is most often at a height of less than 6 feet. This species was found on all four islands of the Bimini group that were visited and was the only *Anolis* so widely distributed.

Anolis carolinensis lernerii, as already noted, occurs in a different habitat on North Bimini than that in which it is found on South Bimini. With but one exception, it was seen only on the "Australian pines" (*Casuarina*) on North Bimini, and except for

two individuals, these were in a grove of pines at the northern end of a "fresh water" pond at the southern end of the island. On the pines they were most common in or on the thick clusters of "needles" between 3 and 10 feet above the ground. On South Bimini, where the introduced "Australian pine" is a rarity, this species was found on small palms, agaves, and several different types of thick-leaved, green shrubs. On South Bimini *lernerii* was found only on the middle and western sections of the island.

Anolis distichus biminiensis was found only on trees with a light gray-colored bark, such as the fig (*Ficus*) and the silver thatch palm (*Coccothrinax*), where it characteristically was found on the trunk or on larger branches at a height of less than 8 feet. None was seen on the ground, although on at least two occasions individuals were observed less than a foot above the ground. This species was collected from the middle and western sections of South Bimini Island, and it was not observed at any other localities.

Anolis angusticeps chickcharneyi appears to have the least ecological tolerance of the species occurring on Bimini. It was found only on the upper branches of larger trees with a light gray-colored bark, such as the figs, but was not seen on the silver thatch palm or other palms with a light gray-colored bark. It was observed at heights of from 6 to 25 feet, and was recorded only from the western section of South Bimini Island.

At different times two or more species have been seen on the same tree. For example, on a large fig on South Bimini *biminiensis* was seen on the trunk at a height of about 3 feet, on the upper branches of the tree at a height of about 15 feet two *chickcharneyi* were seen, and in the leafy foliage near the end of one of the lower limbs a specimen of *lernerii* was shot. This was the only occasion on which *lernerii* was found near either *chickcharneyi* or *biminiensis*. I have found *lernerii* and *ordinatus* together on "Australian pines" on North Bimini, and *biminiensis* and *ordinatus* have been seen on the same tree. The interspecific relationships and ecological preferences of these four species would provide most interesting studies, and it is hoped that further work can be done on these subjects in the near future.

BEHAVIOR: There are apparently significant differences in the behavior of members of the four species. These differences would doubtless be more obvious during the breeding season.

The behavior characteristics noted during my brief study of the four species primarily concern escape reactions or flight movements. The two forms *chickcharneyi* and *lernerii* habitually begin a slow and stealthy withdrawal as soon as an intruder is sighted. Characteristically, both endeavor to move out of sight of the intruder by going to the opposite side of a tree limb or shrub branch and then ascend to a greater height. Both species are easily caught by hand if they are discovered before they get out of reach or out of sight in an inaccessible situation.

By comparison, *biminiensis* and *ordinatus* are alert and active lizards that remain in position and watch the intruder until his approach is too close. If specimens of *ordinatus* are encountered on the ground in an open spot, they will run to a near-by tree or shrub and climb to a suitable vantage point from which to observe the intruder. When encountered suddenly from a short distance or when approached too closely, these lizards will also move to the opposite side of a limb or trunk away from the intruder and ascend to a greater height. Both appear to rely more on their agility to escape capture, whereas *chickcharneyi* and *lernerii* seem to employ stealth and prompt withdrawal to avoid capture. The last two species cling more closely to limbs and branches during escape, and it is doubtless at such times that their depressed habitus assists them in making themselves less conspicuous.

RELATIVE ABUNDANCE: The apparent relative abundance of the four species depends upon so many factors that it may not provide a reliable indication of their actual relative abundance. The number of specimens gathered by me on Bimini does not provide an accurate basis for establishing the relative abundance of the lizards because the collecting was highly selective. Furthermore, two of the forms, *chickcharneyi* and *biminiensis*, were not observed on North Bimini Island where most of the collecting was done. These two species actually may not be present on that island, since I do not recall observing their preferred habitat in that locality. However, too little collecting has been done in Bimini to say definitely whether the two species are present or absent on any of these islands.

On the four islands studied at Bimini, *ordinatus* is by far the most abundant lizard. On some of the smaller cays this was the only *Anolis* found. Conversely, there appears to be little doubt that *chickcharneyi* is the least abundant *Anolis* at Bimini. Because of its restricted ecological habitat and its shy behavior, its

true abundance is most certainly greater than its apparent abundance. Whether *lernerii* is more abundant than *biminiensis* is difficult to decide with confidence. The first-named form was discovered during the early part of my visit, and once its ecological niche had been noted specimens could be collected at will. By contrast, *biminiensis* was not observed until near the end of my stay on Bimini, but a fair number of specimens were collected. Certainly among the *Anolis*, *lernerii* is next to *ordinatus* in abundance on North Bimini, and I believe that probably it is also the second most abundant *Anolis* on South Bimini Island, but I do not have any quantitative data to support such an impression.

Interesting data for three of the species on Andros Island, Bahamas, have been made available to me by my colleague, Charles M. Breder, Jr. Breder visited Mangrove Cay, Andros Island, on January 20, 1933, and engaged 10 local boys to collect amphibians and reptiles. He provided them with a single collecting gun and a supply of formalin. When he returned six days later, he found that the collecting party had been increased to a total of 30 boys. These boys were gathering all amphibians and reptiles they could, or cared to, collect for a small monetary reward. Thus it seems safe to conclude that the relative numbers of the different species provide an approximate indication of the abundance and/or the availability of the respective species in the vicinity of Mangrove Cay. The total number of lizards obtained by this method was 875. Of this number, 752 were *Anolis*, distributed according to species as follows: *carolinensis*, 8; *distichus*, 164; and *sagrei*, 580.

RELATIONSHIPS AND ORIGIN: Our knowledge of the Bahamas is still far too limited to permit accurate and detailed analysis of the fauna, but some of the broader relationships can be indicated. The general conclusions presented by Stejneger in 1904 concerning the relationships of the Bahaman amphibians and reptiles remain fundamentally unchanged despite a vast increase in material collected. As Stejneger pointed out, the majority of the amphibians and reptiles occurring on the islands of the Great Bahama Bank are either conspecific with forms living in Cuba and Hispaniola (primarily the former island) or else are most closely related to these. The relationship is commonly through a series of insular subspecies.

In respect to Bimini, which is situated closer to Florida than to Cuba or Hispaniola, it might be expected that part of the fauna

would be Floridian. Five species found in Bimini are also known either from the Florida mainland or from the Florida keys. One of these, *Eleutherodactylus ricordii planirostris*, is represented in both localities by the same subspecies (Goin, 1947). Two of the five are monotypic species, *Hyla septentrionalis* and *Sphaerodactylus notatus*. Two species of *Anolis* occur in both areas, but are represented by different races in each locality: *carolinensis carolinensis* and *sagrei stejnegeri* of Florida and *carolinensis lernerii* and *sagrei ordinatus* on Bimini. The species *carolinensis* is widely distributed in the southern United States and is probably represented there by more than one subspecies, implying that it is an older inhabitant of the continent than the other species mentioned here.

This similarity in part of the fauna of the two localities is not evidence that the species involved were derived either from Bimini or from Florida. Such a derivation would be difficult to explain in view of the physiographic and oceanographic conditions that exist between the two places. This faunistic affinity is easily explained and readily supported by factual data through derivation of the related fauna of both localities independently from Cuba. Of the forms mentioned here, only *Anolis carolinensis* has spread beyond the political limits of the state of Florida. *Eleutherodactylus ricordii* is found throughout the length of Florida in isolated colonies (Goin, *supra cit.*), whereas the remaining forms are found only in southern Florida or the keys. Carr (1940) has discussed the West Indian element in the herpetological fauna of Florida. He states that "*S. [haerodactylus] notatus* shows strong indications of natural introduction," but that *Eleutherodactylus ricordii* and *Hyla septentrionalis* have "all the earmarks of banana, tobacco-bale or lumber stowaways."

In regard to the *Anolis*, *angusticeps*, *carolinensis*, and *sagrei* are obvious derivatives from Cuba that have been isolated in the Bahamas sufficiently long enough to have become racially distinct from the Cuban populations. The first two species are represented by more than one insular race on the Great Bahama Bank, and it seems likely that when the islands are explored more thoroughly additional subspecies of all three species will be recognized. None of these species is now known to occur on Hispaniola.

The fourth species found on Bimini, *distichus*, is not known in Cuba at the present time but is found on Hispaniola and on the adjacent coastal islands where it is represented by a number of

endemic races (Mertens, 1939; Cochran, 1941). The distribution of this species in the Bahamas is more difficult to account for than that of the other *Anolis*. As Stejneger pointed out, the southeastern Bahamas ("Great Inagua and Turks Islands") show "strong relationships" to Hispaniola. However, all of the Bahaman records for *distichus* are west of longitude 74° W. In view of the extensive herpetological collections from Inagua and Turks Islands it does not seem likely that this species would have been overlooked if it actually occurred there. The species formerly may have had a wider distribution than at present, or it may be an unrecorded inhabitant of the islands of the southeastern Bahamas.

In summary, three of the four species of *Anolis* found on Bimini are directly related to Cuban species through a series of insular races, while the fourth species is Hispaniolan in its affinities. It is not possible to state with any certainty how these species reached Bimini, but in view of the geological and oceanographic data it seems most likely that the four species reached the Great Bahama Bank as waifs from Cuba and Hispaniola through accidental dispersal. It is impossible to state how many different invasions are represented by these species. Our present knowledge of the distribution of the species is undoubtedly misleading because of differences in collecting techniques employed, differences in proportional abundance of the lizards on different islands, and differences in accessibility of the different ecological niches inhabited by the lizards. It seems apparent that despite its poorer representation in collections *carolinensis* is one of the most widely distributed of the four species and has undergone more obvious differentiation than any of the other species. Therefore it seems probable that this species represents the earliest invader of the genus *Anolis* on the islands of the Great Bahama Bank.

SUMMARY

1. Three new subspecies of *Anolis* are described from Bimini, Bahamas, British West Indies. These are: *Anolis angusticeps chickcharneyi*, *Anolis carolinensis leneri*, and *Anolis distichus biminiensis*. The fourth *Anolis* inhabiting the islands is *Anolis sagrei ordinatus* Cope.

2. The four species on Bimini differ markedly in morphological attributes, coloration, ecological preferences, behavior, and relative abundance. On the basis of these differences they can be allocated into two species pairs: (1) *angusticeps* and *carolinensis*

that are strongly depressed and elongate in habitus, with well-developed adhesive pads on the digits, are almost entirely arboreal in habits, and are shy and retiring in behavior; and (2) *distichus* and *sagrei* that are moderately stout in proportions and only slightly depressed, have the adhesive pads only moderately developed, are not restricted to an arboreal habit, and are agile and alert in behavior.

3. The Bahaman representatives of the species *angusticeps*, *carolinensis*, and *sagrei* are Cuban in origin, whereas the representative of *distichus* appears to be a derivative of Hispaniola.

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