(18) cm. long, in fruit diverging from the upper 1/3-2/3 of the stem, fruiting calyx 9-15 mm. long and 5-8 mm. broad, lower 1/4-1/3 united, lobes lanceolate to linear-lanceolate, somewhat attenuate; petals (5) 10-15 (23) mm. long, red-purple; fruit 4-5 mm. wide by 3-4 mm. high: carpels 10-12, glabrous, 3-4 mm. high by 2-2.5 mm. broad, smooth to slightly wrinkled on the back, sides thin, smooth to slightly reticulate, beak large, hollow, dehiscent, forming about 1/3 of the carpel; back of the carpel-body prolonged about 1 mm. into a white chartaceous collar subtending the base of the beak.

This species ranges through the plains and prairies of the western third of Oklahoma, and in the Arbuckle Mts., southward into Texas through the prairies and plains situated roughly between the Edwards Plateau and the Eastern Timbers. Specimens were cited by Martin in 1938 (l.c., supra).

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Physiographic Influences of the Edwards Plateau on its Endemic Amphibian Fauna—a Résumé

Lawrence Curtis

It has long been known that the geographic ranges of certain plants and animals not only closely parallel each other, but also the physiography of their habitat. Indeed, plants and animals seem often to follow clearly certain intangible lines, in their distribution. A careful student perhaps half-consciously senses these associations, continuously. One's idea of a desert embraces a variety of peculiar associated plants and animals — cactus, sage brush, the horned toad, the rattlesnake, the road runner, the prairie dog. The idea of swamps brings to the mind luxuriant mosses, ferns, cypress, as well as mosquitoes, frogs, water moccasins. Darwin (1859, pp. 256-78) noted this phenomenon of "associations" of organisms, and considered it an important factor in the geographic distribution of animals. Other biologists went further; in 1899 W. L. and P. L. Sclater divided the land surface of the globe into six primary "realms" according to the distinctness of their mammals. Theirs was one of the first attempts to a zoögeographical classification of the world; it was soon followed by many others of a more restricted nature. Merriam (working primarily on the vertical distribution of mammals in mountainous regions) described various "life zones," and Cope observed regions which he termed "biotas." Cope's biotas, more comprehensive than previous divisions, were based on both the fauna and the flora (Cope, 1880). Dice (1943) divided North America into what he termed "biotic provinces." A biotic province as he defined it is "... a considerable and continuous geographic area ... characterized by the occurrence of one or more ecologic associations that differ, at least in proportional area covered, from the associations of adjacent provinces." The parallel between biotic and physiographic provinces is very striking.

In general, a biotic province is based on seven important factors: peculiarities of vegetation type, ecological climax, flora, fauna, climate, physiography, and soil (Blair, 1950). The formulation of the biotic province concept made possible a much more comprehensive study of animal distribution. Such study has been of value in getting at the basic concepts of evolution.

The biotic provinces of Texas have been delimited by Blair. Although he follows closely those originally described by Dice (*op. cit.*), he has proposed a new province, the "Balconian biotic province" based primarily on the endemic salamander fauna. This new province is congruent with the Edwards Plateau — the primary delimiting factor.

Physiographic Description of the Edwards Plateau

The Edwards Plateau, as treated here biologically, takes in the plateau as limited by Sellards, Adkins & Plummer (1933, figs. 3, 4), the Lampasas Cut Plain and Comanche Plateau of Raisz (1939) and the Central Mineral, or Llano Uplift region. Following Blair, the Stockton Plateau lying west of the Pecos is not included.

Most of this area lies on the Comanchean; but igneous intrusives and sediments as old as pre-Cambrian are exposed in the Llano Uplift region. The Comanchean sediments have been much dissected, particularly in those parts of the area near the Balcones Escarpment. This escarpment, which forms the southern and eastern boundary of the plateau and continues as far north as Waco, is probably the most important single factor governing plant and animal distribution in Texas. Many eastern organisms have their western limits determined by the escarpment: conversely, many western species find their eastern limit there. There are also distinct endemic forms whose ranges follow the escarpment very closely. Smith & Buechner (1947) have studied the influence of the escarpment on reptiles and amphibians, while Tharp (1939) noted its effects on the vegetation.

With such a significant and striking physiographic factor affecting biological distribution, the adjacent Edwards Plateau offers a most interesting field for ecological study.

The flora and fauna of the Edwards Plateau is markedly different from that of adjacent territories. The plateau is xeric; having little rainfall, scrubby and scant vegetation, a porous soil, but little standing water, and an evaporation rate exceeding the precipitation rate. Adjacent lowlands are of mesic character, with more rainfall, lush vegetation, less porous soil, much standing water, and a rainfall rate exceeding the evaporation rate (Smith & Buechner, *op. cit.*)

Its vegetation is characteristically scrubby. Scrub forests of Mexican cedar *(Juniperus mexicana)*, Texas oak, *(Quercus texana)*, and stunted live oak, *(Quercus virginiana)* form the most common association. This occupies the more dissected parts of the area, to the near exclusion of all others (Blair). Mesquite is also common.

The underground caverns are of especial interest. They are a primary factor in determining the endemic amphibian fauna of the Plateau. The limestone rocks underlying the Edwards Plateau hold vast reservoirs of artesian water. As this water passes from the Plateau to the Gulf Coastal Plain, immense quantities are forced through the Balcones fault to the surface by artesian pressure. Here fissure or artesian springs are formed, many of very large outflow. The Comal Springs of New Braunfels discharge daily 212 million gallons (Fenneman, 1932). Conditions are thus optimal for the presence of vast subterranean caverns. Nowhere else in the United States are there so many partially and un-explored caverns. One of the most remarkable ave faunas is here also. The Ney Cave near Bandera has the largest bat population of any cave in the United States;

it is estimated at from 20 to 30 millions. There are 62 known caves in the Edwards Plateau alone *(Caves of Texas,* 1948), and more are being found constantly. Few of these have been explored adequately; some not at all, much less mapped and studied.

The Endemic Amphibian Fauna of the Edwards Plateau

As the environmental factors are varied and limited, so also are the physiological tolerances, life histories, feeding habits, and evolutionary history of the animals varied and limited. As a consequence their distributional patterns are very much affected. Some of the amphibians endemic to the Edwards Plateau are listed below, with factors suggested that possibly contribute to their confined presence. Although the two Anurans listed are not endemic to the plateau, their presence is so characteristic of the area that they are included here.

Anura

Eleutherodactylus latrans (Cope). Barking frog; cliff frog. Found in caves and cliffs all over the Edwards Plateau. The name "barking frog" (a 'book name') comes from the loud dog-like barking call the animal makes after rains, and at night. The natives who hear these loud barking noises but have never seen the frog, have held the large collared lizard *(Crotaphytus collaris)* responsible. This lizard (which is abundant and commonly seen in the same habitat) is therefore by them called the "mountain boomer." Such a loud frog call may have definite survival value; *i.e.*, in a situation like the Edwards Plateau, suitable habitats (cliffs near the summits of hills) are often separated by rather long distances, and thus a voluble call is necessary to attract faraway mates.

This genus is peculiar among frogs in its adaptation of breeding habits to the meager amount of moisture present, by modification of its metamorphosis. While most frogs pass through a long metamorphosis, with perhaps months spent in an aquatic tadpole or larval stage, *Eleutherodactylus* lays its eggs under rocks. Even has it been reported to keep its eggs moist by urinating upon them (Jameson, 1950), although an excessive mucous secretion seems more plausible. The tadpole stage is passed within the egg; and thus a mature frog emerges, without the dependence on permanent water for its metamorphosis.

In winter it often retreats to the caves where it "hibernates" after a fashion in the warm, even temperature.

Syrrhophus marnockii Cope. Little cave frog. Like *Eleutherodactylus,* this species is characteristic of the Edwards Plateau, although it is more of a year-around inhabitant of the caves, and also plentiful beneath ledges and rocks. Its call is a chirping, very cricket-like noise. It often ventures forth at night in search of food. Little is known of the breeding habits of this species; but it is believed to pass the tadpole stage within the egg as does *Eleutherodactylus.* Some students have opined that it may undergo development in the permanent waters of the caves.

Caudata

The endemic salamander fauna is perhaps the most interesting group of vertebrate animals inhabiting the plateau.

Typhlomolge rathbuni Stejneger. Texas blind cave salamander. Originally found in an artesian well 190 feet deep at the U.S. Fish Hatchery at San Marcos, this remarkable amphibian has interested scientists ever since as the third known blind salamander from the caves of the world. It retains its external gills. The other two possess early gills but lose them as they mature and develope lungs. No *Typhlomolge* had ever been found without gills, and zoologists have speculated on what it would "turn into" at maturity. It was learned that actually it breeds in the larval state — that it is a "permanent larva" — a neotenic condition.

Although originally taken from the artesian well at San Marcos, *Typhlomolge* has since been found in nearby Ezells Cave. Its eyes are vestigal and covered by the skin (Eigenmann, 1909). It has little or no sensitivity to light, but has tactile organs well "tuned" to any vibration in the water. Captive specimens feed well on *Daphnia.* This blind cave salamander lacks pigment and is pinkish white. The long attenuated limbs are characteristic. Little is known of its breeding habits.

The following species of neotenic salamanders have been found only in the Edwards Plateau: *Eurycea neotenes* Bishop & Wright, *E. latitans* Smith & Potter, *E. nana* Bishop, and *E. pterophila* Burger, Smith & Potter. Although these three salamanders are also degenerate, they have not retrogressed to the extreme extent of *Typhlomolge*. They still retain a fair amount of skin and eye pigment, and the eyes are functional, although poorly developed. These species of *Eurycea* also breed in the larval or gilled state and undergo no further metamorphosis.

Eurycea nana has been found in the open waters of springs at the head of the San Marcos River, during the summer months. They disappear into the underground recesses during winter months, although the water temperature fluctuates but little between summer and winter. All three species of *Eurycea* listed here have been discovered and described in the past decade. It is very probable that more species will be found when more collecting is done in the area.

So far, *E. latitans* has been taken only from the type locality (Cascade Cavern near Boerne)[1], *E. nana* only from the head waters of the San Marcos River, whereas *E. neotenes* is found from Bexar County north and west to Travis and Kerr Counties (Brown, 1950).

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[1]As this goes to press, Milstead (Herpetologica, vol. 7, p. 2, 1951) records an *Eurycea latitans* from an open stream in Kerr County, about 38 miles west of Cascade Caverns.