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fauna before the river was impounded by Tims Ford Dam in December 1970. Although there is presently a diversified fauna in the area above Tims Ford Dam and in the area between Tims Ford Dam (ERM 133.3) and the Alabama line (ERM 34.0), Tims Ford Dam will undoubtedly have a significant effect on the mussel fauna of Elk River. Fauna in the reservoir will be lost due to deoxygenation as a consequence of stratification of Tims Ford Reservoir. Mussel fauna downstream of Tims Ford Dam will survive only if conditions for a warm-water fishery are met.

A total of 61 species of mussels have been recorded for Elk River. Forty-eight species comprise the fauna now present.

There has been a significant increase in species of mussels, usually associated with larger rivers, in lower Elk River. Isom and Yokley (1968) made a similar observation on Bear Creek and conjectured that impoundment had affected the composition of the fish population and, consequently, the mussel parasite-fish relationships responsible for intrusion of big-river species.

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The Mussels of the Flint and Paint Rock River Systems of the Southwest Slope of the Cumberland Plateau in North Alabama — 1965 and 1967

ABSTRACT: *A total of 30 mussel species was collected from the Flint and Paint Rock river systems in Alabama as compared with 50 recorded previously.* Villosa iris *was the only new species recorded. Thus, a total of 51 species is now known from the two river systems. The number of species collected in*

1965 and 1967 represents a loss of 42% of the known mussel fauna. Reasons for the decline in the number of mussel species are not known at this time. It is significant, however, that there has been no increase in the number of large-river species associated with impoundment as has been noted in Bear Creek and Duck and Elk rivers.

INTRODUCTION

The mussels studied were collected from the Flint and Paint Rock river systems in N Alabama. These tributaries of the Tennessee River are located N of the river in Jackson and Madison counties, Ala., and Lincoln Co., Tenn., and drain the southwestern slope of the Cumberland Plateau. This drainage is opposite, or S of the Elk River drainage (Isom *et al.*, in press) with which it is contiguous.

METHODS

Samples were collected with a Needham scraper and by hand from the streams and from muskrat heaps where possible. Most of the material collected was placed in the Ohio State University Museum of Zoology. Dr. David H. Stansbery, Ohio State University, identified or confirmed identification of some species. His contribution is gratefully acknowledged.

PHYSIOGRAPHY, GEOLOGY AND CLIMATE

Flint River, in Madison Co., Ala., and Lincoln Co., Tenn., rises on the Cumberland Plateau and the smooth plain that is part of the eastern Highland Rim of the Interior Low Plateau (Fenneman, 1938). Elevations on the Cumberland Plateau range from 1500 to 1700 ft above sea level. The Highland Rim ranges from 590 to 850 ft above sea level.

Rocks in Madison Co. are of sedimentary origin and consist of Chickamauga limestone, Fort Payne chert and Tuscumbia limestone (Swenson *et al.*, 1958). The local formations consist of the Gasper, Hartselle sandstone, Bangor limestone and, at the highest elevation, the Pottsville limestone. Average yearly temperature is 61.5 F (16.4 C), and average yearly precipitation is 51.71 inches (131.34 cm) (Swenson *et al.*, 1958).

The Paint Rock River Valley is largely in a smooth, alluvial plain in Jackson Co. in the Cumberland Plateau section of the Appalachian Plateau physiographic province (Fenneman, 1958; Swenson *et al.*, 1951). The alluvia in this valley and tributary valleys are young and are predominantly a mixture of materials derived from sandstone and limestone (Swenson *et al.*, 1951). Average annual temperature at Scottsboro in Jackson Co., Ala., is 60.8 F (16 C), and average annual mean precipitation is 52.65 inches (133.73 cm) (Swenson *et al.*, 1951).

RESULTS AND DISCUSSION

A. E. Ortmann (1925) reported on mussels from the Flint and Paint Rock river systems based on material in the Carnegie Museum collected by H. H. Smith and H. E. Wheeler, on a report by C. T. Simpson (1914), and on material in the Bryant Walker collection. The mussels in these systems have not been re-evaluated since that time.

Our stations and findings are reported in Table 1. We collected two Cumberlandian species (*Fusconaia barnesiana* and *Villosa vanuxemi*) and *Villosa iris* (probably an Ohioan species) from a station on Flint River near Hazel Green, Ala., which is considerably upstream of stations from which Ortmann (1925) reported nine species — five of Cumberlandian origin and four of Ohioan or unknown origin — and 16 species from another station, all but one of which (*Cyclonaias tuberculata*) are usually associated with small streams similar to Flint River.

We collected 19 species from Paint Rock River, Trenton, Ala., from which Ortmann also reported 19 species. We collected 10 of the 19 species reported by Ortmann and recorded nine new species for the station. One of these nine new species, *Villosa iris*, is a new record for the drainage system. Two of the 12 species we collected from Paint Rock River, Hollytree, Ala., were also reported by Ortmann. In addition, we collected 20 species from a station 2 miles downstream from Hollytree for a total of 26 species that includes three of the five species reported by Ortmann and 19 species that are new records for the station area.

Ortmann collected 3 species from Larkin Fork (tributary of Paint Rock River), and the authors collected 5, 1 of which was reported by Ortmann, for a total of 7 species for this station. The authors collected 17 species from a station at Walker's Mill Ford below Trenton and 11 species at Swain. These stations were not reported by Ortmann. In addition, Asiatic clams (*Corbicula manilensis*) were reported from Flint River Miles (FRM) 36.9 and 48.1, and undetermined Sphaeriidae was reported from FRM 36.9 and 41.6 (Anon., 1971).

TABLE 1.—Mussel species collected from the Flint and Paint Rock river systems, Alabama, 1965 and 1967

	Flint River	Paint Rock River		
Species	Hazel Green 1965	Trenton 1965	Hollytree 1965	2 miles below Hollytree 1967
Unionidae				
*Fusconaia cuneolus**	....	....	....	X
*F. edgariana**	....	....	....	X
*F. barnesiana**	X	X	X	X
Amblema (costata) plicata	....	X	X	....
Quadrula pustulosa	....	....	....	....
Q. cylindrica	....	X	....	X
Tritogonia verrucosa	....	X	....	X
*Lexingtonia dolabelloides**	....	X	X	....
*Pleurobema oviforme**	....	X	X	X
Elliptio crassidens	....	....	....	X
E. dilatatus	....	X	....	....
Lasmigona costata	....	X	X	X
Anodonta grandis	....	....	....	....
Ptychobranchus fasciolaris	....	X	....	X
Obovaria subrotunda	....	X	X	X
*Actinonaias pectorosa**	....	X	....	....
Plagiola lineolata	....	....	....	....
Truncilla truncata	....	X	X	....
T. donaciformis	....	....	....	....
Leptodea fragilis	....	X	X	X
Proptera alata	....	X	X	X
*Carunculina moesta**	....	....	....	X
*Villosa nebulosa**	....	....	....	....
*V. taeniata**	....	....	....	X
*V. vanuxemi**	X	X	....	X
V. iris	X	X	....	X
Lampsilis ovata	....	X	X	X
L. fasciola	....	X	X	X
*L. virescens**	....	....	....	X
*Dysnomia capsaeformis**	....	X	X	X
Total	3	19	12	20

Water hardness (51 to 140 mg/l total hardness as $CaCO_3$) and *p*H (7.2 to 8.2) appear optimum for mussels in the Paint Rock and Flint rivers as compared with other streams such as the Duck and Elk rivers.

Reasons for the decline in number of mussel species are not known. Water hardness and *p*H appear optimum for mussels. It is significant that there has been no increase in the number of large-river species associated with impoundment as has been noted elsewhere.

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TABLE 1.—(continued)

	Paint Rock River		
Species	Larkin Fork S of Hollytree 1967	Walker's Mill Ford 1967	Swain 1967
Unionidae			
*Fusconaia cuneolus**	....	X	....
*F. edgariana**	....	....	X
*F. barnesiana**	....	....	....
Amblema (costata) plicata	X	X	....
Quadrula pustulosa	....	X	....
Q. cylindrica	....	X	....
Tritogonia verrucosa	....	X	....
*Lexingtonia dolabelloides**	....	X	....
*Pleurobema oviforme**	....	....	X
Elliptio crassidens	....	....	....
E. dilatatus	....	....	....
Lasmigona costata	X	....	....
Anodonta grandis	....	X	....
Ptychobranchus fasciolaris	....	....	X
Obovaria subrotunda	X	....	X
*Actinonaias pectorosa**	....	....	....
Plagiola lineolata	....	X	....
Truncilla truncata	....	X	....
T. donaciformis	....	X	....
Leptodea fragilis	....	X	X
Proptera alata	....	X	....
*Carunculina moesta**	....	X	X
*Villosa nebulosa**	....	....	X
*V. taeniata**	....	....	X
*V. vanuxemi**	....	X	X
V. iris	X	....	....
Lampsilis ovata	....	....	....
L. fasciola	....	X	X
*L. virescens**	X	X	....
*Dysnomia capsaeformis**	....	X	X
Total	5	17	11

* Cumberlandian species

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Colony Formation of the Western Harvester Ant in a Chronic Gamma Radiation Field

ABSTRACT: *A colony of Western harvester ants,* Pogonomyrmex occidentalis, *became established in a chronically exposed gamma radiation field located on the native short-grass plains of Colorado. The exposure level at the nest site was 18 R/hr. At the end of the colony's first and second seasons the nest mound diam were 25 and 36 cm, respectively. There were no apparent habitat modifications to suggest any avoidance response to the radiation.*

INTRODUCTION

Within the animal kingdom, the insects are among the most resistant to radiation. Lethal exposures for some adult insects range well beyond 100,000 R (Cole *et al.*, 1959). Insect sterility studies (Bushland and Hopkins, 1951; Rhode, 1961) have shown that a few thousand roentgens is sufficient to produce sterility while allowing near-normal mating behavior.

The response of natural insect populations to increased environmental radiation levels (as could result from radioactive fallout) is of interest. Brower (1966) reported behavioral changes in an ant (*Formica integra*) colony exposed to chronic gamma irradiation of 10 R/hr. He noted a substantial emigration from the colony late the first summer following initiation of irradiation. During the next 2 years he observed sunken runways leading from the nest, abandonment of the habit of banking the colony with debris and a general decline in numbers of ants. He reported that the emigration probably resulted from decreased food supply (radiation had reduced the plant community) rather than a direct radiation effect. He suggested, however, that the abandonment of banking the aboveground portions of the nest was most likely a radiation avoidance response.

EXPERIMENTAL FACILITY AND PROCEDURE

The observations reported here are part of a study of the effects of chronic and semichronic gamma irradiation on a native short-grass plains ecosystem in the Pawnee National Grasslands of N-central Colorado. The irradiation facility (Fraley, 1971) consisted of an 8750 Ci cesium-137 source centrally located within a circular 1.17 ha study area. The chronically exposed portion of the study area has been continuously irradiated since April 1969, except for periods up to 4 hr per day for a maximum of 5 days per week to permit data collection.

OBSERVATIONS AND DISCUSSION

A colony of Western harvester ants, *Pogonomyrmex occidentalis* (Cresson), established itself in a chronically irradiated area receiving 18 R/hr at the soil surface. A photographic record showed no mound building or other signs of colony formation at the nest site as of September 1969, 6 months after initiation of irradiation. By August 1970, a colony was well established and had built a gravel-covered mound approximately 25 cm in diam. At that time much of the nearby plant community had been killed by the radiation. Only scattered clumps or infrequent individual plants of the more radioresistant species remained.

At the end of the 1971 growing season, the mound size had been increased to approximately 36 cm in diam. The mound did not outwardly appear to differ from others of the same size located outside the radiation field.

Since the ant colony was established adjacent to a previously barren spot, it was somewhat difficult to evaluate the performance of the usual disc-clearing habit (Wheeler, 1910) by this colony. The ants failed, however, to clear the existing vegetation from the side of the mound away from the barren area. Some of this vegetation, which consisted primarily of blue grama, *Bouteloua gracilis*, was living through 1970, but appeared to be mainly standing dead early in 1971. Observations on nearby unirradiated colonies of approximately the same size showed a gradation of conditions ranging from distinct, well-cleared concentric discs completely surrounding the mound to small acentric discs with some vegetation next to the mound. By autumn 1971, the combined effects of radiation and natural weathering had removed the plants and made disc-clearing unnecessary.

In addition to the general overall radioresistance displayed by insects, the Western harvester ant possesses several characteristics which make it particularly well-suited to withstand chronic radiation exposure. The nest structure, consisting of an earthen mound aboveground and living quarters extending several feet below the soil surface (Wheeler, 1910), provides much natural shielding for the ants. Fraley (1971) reported the belowground exposure relative to the surface value at selected soil depths for this facility. At the 9 m source-to-nest distance, he found the 5- and 10-cm depth exposures to be only about 10 and 2.5%, respectively, of surface exposure.

The ants' social structure creates another advantage in that only adult workers would regularly be subject to aboveground exposure. Immature ants are reared within the nest and the reproductive individuals remain there except for short periods during mating. Also, the omnivorous habit of this species (Cole, 1968) probably permits it to be less responsive than other more selective consumers to the radiation-induced modifications in the plant community.

These observations from a high-intensity gamma radiation field show *P. occidentalis* to be much less susceptible than was *F. integra*, as reported by Brower (1966). The Western harvester ant was able to establish a flourishing colony at an exposure of 18 R/hr whereas an *F. integra* colony receiving 10 R/hr gradually declined. There were no sunken runways or other modifications of the habitat to suggest any avoidance response to the radiation. The possible lack of early disc-clearing around the nest was not interpreted as being abnormal. The particular life style of the Western harvester ant probably makes it less susceptible to radiation exposure than many other insects. This does not preclude the possibility of a parallel between the Western harvester ant and the dominant plant species (Fraley, 1971) of the short-grass plains in being comparatively resistant to gamma radiation.

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