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Problem of the Hybridization of the Red Cave Salamander, Eurycea lucifuga (Raf), and the Long-Tailed Salamander, Eurycea longicauda melanopleura (Green)

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THE PROBLEM OF HYBRIDIZATION OF THE RED CAVE SALAMANDER, EURYCEA LUCIFUGA (RAF), AND THE LONG-TAILED SALAMANDER, EURYCEA LONGICAUDA MELANOPLEURA (Green)

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During the past six years the author has studied the zones of intergradation of the subspecies of Eurycea **longicauda**, the long-tailed salamander. It was found that although E. **lucifuga**, the red cave salamander, is almost always associated with the subspecies of E. **longicauda**, interbreeding seems to occur very rarely. Mittleman, (**Proc. New Eng. Zool Club**, 21:104-105) reports intergrades of **E. lucifuga** and **E. l. longicauda** from the Cumberland Plateau of Tennessee and Kentucky.

In central and western Tennessee the author found the red cave salamander to be associated with another subspecies of **E. longicauda** - namely **E. l. guttolineata.** This form and the red cave salamander are found together around springs in central and western Tennessee. In Union County, Illinois, the red cave salamander is associated with **E. l. longicauda.** The intergrades involving the above forms are discussed in another paper to be published in the future.

In this paper I am concerned with the problem of hybridization between E. **lucifuga** and **E. l. melanopleura**, both of which are common around springs and in the twilight zones of caves in Northwestern Arkansas, South Central Missouri, and Eastern Oklahoma. Both forms migrate far into caves and lay their eggs in the water of drip pools on the floors of caves. The larvae follow trickles of water out of the caves and larval life is spent on the outside where food is available. On metamorphosing and attaining sexual maturity they again penetrate caves to reproduce.

Over 400 specimens, 200 or more of each species, were collected in Foshee Cave, five miles west of Locust Grove in Independence County, Arkansas. These collections were made monthly throughout 1958 and 1959, and at irregular intervals since then. All specimens, excepting a few used for dissection or given to other herpetologists, were preserved in 60% isopropyl alcohol and stored in the Museum of Biology at Arkansas College in Batesville, Ark.

Although in 1958 and 1959 none of the hybrids collected seemed to be first-generation hybrids, in March, 1960, and October, 1960, hybrids were collected from Foshee Cave which appeared to be F_1 hybrids. In October, 1962, additional F_1 hybrids were collected from Foshee Cave. The female hybrids were tight with eggs. Some of these females and adult males of

melanopleura were placed in a refrigerated aquarium. All were lost subsequently when someone decided to defrost the refrigerator, but excellent color photos of these hybrids are in the hands of the author.

Among the more than 200 specimens of **melanopleura** from Foshee Cave, 7.7% showed some degree of hybridization or genetic influence of **lucifuga**, yet none of the 200 specimens of **lucifuga** collected at about the same time from the same cave showed any evidence of genes from another species. Since hybridization of these species is apparently rare, an effective isolating mechanism must be in operation. It seems likely that the breeding season must be involved in this isolation because a study of the ovarian cycles of both species showed that they had different breeding seasons. **Lucifuga** has a summer breeding season, with all egg laying completed by the end of August, whereas **melanopleura** is an autumn breeder, starting in September and finishing in November.

As soon as females of either species have finished egg laying they leave the cave to seek food outside where they remain until swollen with developing eggs for the next breeding season. They re-enter the cave while the eggs are still relatively immature but remain in the front of the cave in the twilight zone where they probably can obtain aquatic isopods and amphipods for food. As the exhausted females of **lucifuga** leave the cave, egg laden females of **melanopleura** are migrating into the cave.

Males of **lucifuga** apparently enter the cave in greater number than is required as the data shows that males are still present after all females are gone from the cave. Since the males of **lucifuga** remain in the cave much longer than the laying season, they are still there when the first **melanopeura** arrive for egg laying (Table 1). On the other hand, all male **melanopleura** have left the breeding area before the first egg laden **lucifuga** arrive (with mature eggs). Therefore, hybridization would have to involve male **lucifuga** and female **melanopleura**.

The question of the fate of the hybrids was partially answered by the finding of first-generation hybrids in October, 1962, packed with eggs and entering the cave along with dozens of egg laden **melanopleura**. As pointed out earlier, remote hybrids make up a large percentage (7.7%) of the population of **melanopleura** in this cave. The individuals apparently breed with the rest of the species.

It is clear that hybridization has been introgressive as far as **melanopleura** is concerned. It might be supposed that breeding back with **lucifuga** would be likely to occur, but measurements and color pattern do not indicate its occurrence.

That hybrids breed with the melano-

pleura population, it was assumed that they were aberrant specimens of **lucifuga**, since the head and coloration suggested that species. The general color of recent hybrids is silver gray with some red on the dorsal part of the tail; the pattern of **melanopleura** is not evident. More remote hybrids have the pattern of **melanopleura**, but indistinctly so.

Thus, in this one location (Foshee Cave), hybridization occurs between **E. lucifuga** and **E. l. melanopleura**. In most areas the distinct breeding seasons are sufficient to serve as a barrier between the species. It is the lingering of the male **lucifuga** in the breeding area of the **melanopleura** that makes hybridization possible. Why this lingering? It is possible that the cave temperature in the breeding area is a little colder than in other places. The writer and his students have noted many times that this cave seems colder than other caves. Metabolic activities may be retarded, enabling the males to delay their return to the outside.

Since interbreeding does not occur regularly and the species are sympatric, it would not seem wise to regard **E. lucifuga** and **E. l. melanopleura** as conspecific but only as two species that can hybridize under certain conditions.

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TABLE 1

Monthly Time Table of Reproductive Condition in Female Salamanders Collected in the Twilight Zone of Foshee Cave. (N) is the number of specimens collected.

	E. lucifuga	E. l. melanopleura	Total Specimens (Both Species & Sexes)
January	No specimens	No specimens	
February	Eggs medium to small (2) Males (5)	No specimens	7
March	Eggs medium size (8) Males (7)	1 hybrid tight with eggs, balance no eggs (12) inc. males	21
April	Eggs medium size (6) Males (12)	No discernible eggs in body cavity (10)	22
May	Eggs large (15) Males (15)	Very small eggs (12) present Males (0)	42
June	6 packed with eggs 7 exhausted Males (20)	Eggs small (10) Males (0)	43
July	Females tight with eggs (9) Males (9)	Eggs small (7) Males (0)	25
August	A few packed with eggs (3) others exhausted (7) Males (8)	Eggs small (8) Males (3)	29
September	Males only (12)	Eggs medium (14) to large Males (17)	43
October	Males only (10)	Eggs large (12), 1 exhausted female - Males (10)	33
November	Males only (6)	Females tight with eggs (7) Females exhausted (7) Males (12)	32
December	Males only (5)	Males only (10)	15