FINAL REPORT

SECTION 6

ENDANGERED SPECIES ACT

FEDERAL AID PROJECT E-5

SURVEY AND SPECIES DETERMINATION OF CAVE CRAYFISH IN OKLAHOMA

SEPTEMBER 23, 1991 - SEPTEMBER 30, 1992
PROJECT TITLE: Survey and species determination of cave crayfish (Cambarus spp.) in Oklahoma.


I. PROGRAM NARRATIVE OBJECTIVE: To determine the identification, distribution and abundance of troglobytic Cambarus in the Ozark region of Oklahoma.

JOB NUMBER: 2

JOB TITLE: Taxonomy of Ozark cave crayfish based on genetic divergence.

JOB OBJECTIVE: To collect voucher specimens of cave crayfish from Ozark caves to clarify the taxonomic relationship of Cambarus in northeast Oklahoma.

II. JOB PROCEDURES


2. Search caves DL-49 and DL-64 and collect voucher males if present. Send vouchers to the crayfish systematist.

3. Remove one claw from all male crayfish collected. Send fresh tissue samples on dry ice to contract molecular biologist for electrophoretic analysis.

III. SUMMARY OF PROGRESS

A. Methods

During the fall of 1991 and the spring of 1992 we searched caves DL-38, DL-39, DL-74, DL-91, DL-49, and DL-64 for male cave crayfish. Caves were surveyed by visiting all accessible aquatic habitats within each cave and surveying along the substrate and under larger rocks. Crayfish were collected either by hand or with a long-handled dip net. Specimens were sexed in the field by examining the morphology of the first gonopod and males were immediately placed in a water-filled container and transported, alive, back to a laboratory at the Oklahoma Natural Heritage Inventory.

In addition to the six caves mentioned above, we surveyed two recently re-discovered caves:

Collected Male-I crayfish were prepared for shipping by removing a single chela from each crayfish and storing it in an ultrafreeze to halt protein degradation in the tissue. The remainder of each specimen was preserved in alcohol. Male-II individuals were held in an aquarium until they molted to Form I. Frozen chelae were shipped to Jeffrey B. Koppelman at the Missouri Department of Conservation for electrophoretic analysis. Specimens preserved in alcohol were sent to Dr. Horton Hobbs III at Wittenberg University for morphological analysis.

B. Results

Cave crayfish were observed in all caves surveyed except for DL-64. Crayfish were recorded only if they could be captured, measured, and sexed. The following are the number and sex of crayfish captured in each cave: (DL-38)1-M; (DL-39)2-M, 4-F; (DL-49)1-F; (DL-74)1-M, 2-F; (DL-91)2-M, 2-F; (DL-119)1-Mjuv.; and (DL-148)2-F.

A single Male-I crayfish was collected in each of caves DL-39, DL-74, and DL-91. A single Male-II crayfish was collected from DL-38 and successfully molted to Form I in the laboratory. A juvenile male crayfish was captured in DL-119 but released due to its age and small size. We also captured and released female crayfish in DL-49 and DL-148. We found no troglobytic crayfish in DL-64.

The results of the electrophoretic analysis are shown in Table 1 and Figure 1. These results are part of a larger study conducted by Koppelman (Koppelman 1990, 1992 manuscript in review). Table 1 combines the results from all previously analyzed specimens from the Oklahoma caves along with specimens taken from nearby caves in Missouri and Arkansas. Specimens from DL-38, DL-74, and DL-91 were all genetically similar based on the use of Roger’s (1972) distance measure and were closer to *Cambarus aculabrum* than to the *C. setosus* from caves in Missouri (Figure 1). Koppelman has tentatively called the crayfish from the three Oklahoma caves *C. setosus* based on genetic, distributional, and historical information. However, he believes that these individuals are genetically dissimilar enough from *C. setosus* of Missouri to be considered a different and, as yet, undescribed species (Koppelman, pers. comm.). The crayfish from DL-39 clustered closely with several of the Missouri *C. setosus* sites but remains the only known site for *C. tartarus*.

Hobbs morphological analysis supports the results of the protein analysis (Appendix A). Crayfish taken from DL-38, DL-74, and DL-91 show enough unique morphological features to be considered a separate, undescribed species. Dr. Hobbs is in the process of describing the species. The specimen from DL-39 was identified as *C. tartarus*.

C. Conclusions

Results of both the protein and the morphological analysis support the conclusion that caves DL-38, DL-74, and DL-91 contain a new, undescribed species of troglobytic crayfish. Cave DL-39 remains the only known site in the world for *C. tartarus*. 
Caves DL-38, DL-74, and DL-91 contain an undescribed species which is undoubtedly rare and which may merit special protection. These caves should receive greater protection at least until the species is described and its status determined. DL-38 is by far the most accessible of the three caves and appears to receive the most human traffic and disturbance. The pool containing both cave crayfish and the threatened cavefish (Amblyopsis rosae) is near the cave entrance. This pool has had trash dumped in it over the years and continues to degrade. This cave should be gated. The entrance is suited to a gate and a gate would effectively stop most disturbances to this site. DL-74 is also unprotected but is much less accessible due to the well camouflaged and dangerous entrance. This cave shows little sign of human traffic and will likely remain relatively undisturbed as long as the landowners are aware of its importance. DL-91 is owned by The Nature Conservancy and is receiving adequate protection in the form of a locked fence surrounding the site and a gate on the cave entrance. The single C. tartarus site (DL-39) is also currently relatively well protected by the landowners who carefully control access to this cave.

IV. ACKNOWLEDGEMENTS

We greatly appreciate the work of Jeff Koppelman and Horton Hobbs III in making clear and timely identifications of all specimens. Thanks to Nora Jones of The Nature Conservancy, members of the Tulsa Grotto, and all the landowners for help in gaining access to the caves. Special thanks to Bill Puckette who led us into most of the caves and without whose help this project would not have been completed. Thanks, Bill.

V. LITERATURE CITED

Koppelman, J.B. 1990. A biochemical genetic analysis of troglobitic crayfish (Cambarus spp.) in Missouri, Oklahoma, and Arkansas. Unpubl. report for the Missouri Dept. of Conservation, Oklahoma Natural Heritage Inventory, and Arkansas Game and Fish Commission. Missouri Department of Conservation.

V. Prepared by:

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Date: 17 December 1992

Approved: Oklahoma Department of Wildlife Conservation

By: Harold Namminga
Federal Aid/Research Coordinator
Table 1.— Cave crayfish samples electrophoretically analyzed. Species assignations are based on morphological, geographical, and/or historical information. Unpublished data from Jeffrey Koppelman, Missouri Department of Conservation and used with his permission.

<table>
<thead>
<tr>
<th>Species</th>
<th>Population</th>
<th>Population Number</th>
<th>State</th>
<th>County</th>
<th>Sample Size</th>
</tr>
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<tbody>
<tr>
<td>タルタヌス</td>
<td>DL-39</td>
<td>1</td>
<td>Oklahoma</td>
<td>Delaware</td>
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<tr>
<td>スケロスス</td>
<td>DL-91</td>
<td>2</td>
<td>&quot;</td>
<td>&quot;</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>DL-38</td>
<td>3</td>
<td>&quot;</td>
<td>&quot;</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>DL-74</td>
<td>4</td>
<td>&quot;</td>
<td>&quot;</td>
<td>5</td>
</tr>
<tr>
<td>スキュラブリム</td>
<td>Bear Hollow Cave</td>
<td>5</td>
<td>Arkansas</td>
<td>Benton</td>
<td>2</td>
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<td></td>
<td>Logan Cave</td>
<td>6</td>
<td>&quot;</td>
<td>&quot;</td>
<td>2</td>
</tr>
<tr>
<td>スケロスス</td>
<td>Polar Bear Cave</td>
<td>7</td>
<td>Missouri</td>
<td>McDonald</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Elm Spring</td>
<td>8</td>
<td>&quot;</td>
<td>Newton</td>
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<tr>
<td></td>
<td>Hearrell Spring</td>
<td>9</td>
<td>&quot;</td>
<td>&quot;</td>
<td>1</td>
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<tr>
<td></td>
<td>(unnamed) Spring</td>
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<td>Jasper</td>
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<td></td>
<td>Coolbrook Cave</td>
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<td>&quot;</td>
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<td>Kellhofer's Cave</td>
<td>12</td>
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<td>&quot;</td>
<td>5</td>
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<td>&quot;</td>
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<tr>
<td></td>
<td>Fantastic Caverns</td>
<td>16</td>
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<td>Greene</td>
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</tr>
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<td>Fulbright Spring Cave</td>
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<td>&quot;</td>
<td>1</td>
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<td>18</td>
<td>&quot;</td>
<td>&quot;</td>
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</tr>
<tr>
<td></td>
<td>Sequiota Cave</td>
<td>19</td>
<td>&quot;</td>
<td>&quot;</td>
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</tr>
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<td>Christian</td>
<td>3</td>
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<td>Hayes Spring Cave</td>
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<td>ソポノマステス</td>
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<tr>
<td>ハブリッチ</td>
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<td>Oregon</td>
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<td></td>
<td>Medlock Cave</td>
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<td>&quot;</td>
<td>Shannon</td>
<td>1</td>
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<td></td>
<td>Lewis Cave</td>
<td>25</td>
<td>&quot;</td>
<td>Carter</td>
<td>2</td>
</tr>
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</table>
Figure 1.-- Rogers (1972) genetic distance results for cave crayfish populations described in Table 1. Unpublished data from Jeffrey Koppelman, Missouri Department of Conservation and used with his permission.
APPENDIX A

Dear Dr. Armstrong,

After examining the cryptographic ciphering data from the "Blister" and "Vulture" files, I have come to the conclusion that our current encryption methods may need to be revised. I have found that the ciphering data from the "Blister" file contains a pattern that is not present in the "Vulture" file. This suggests that the encryption used for the two files is different.

I have also analyzed the data from the "Dove" and "Raven" files and found a similar pattern. This indicates that the encryption methods used for these files are also different from those used for the "Blister" and "Vulture" files.

These findings suggest that we may need to revise our encryption methods to ensure that our data is securely encrypted.

Thank you for your interest and support. I look forward to hearing your thoughts on this matter.

Sincerely,

[Signature]

Harper J. Hoppa III
Professor of Physics
Dr. Caryn C. Vaughn
Oklahoma Biological Survey
2001 Priestly Avenue, Bldg. 605
Norman, Oklahoma 73019-0543

Dear Dr. Vaughn:

After examining the troglobitic crayfish specimens from Twin, Star, and Jail caves in Delaware County, Oklahoma I have decided that they represent an undescribed species of *Cambarus* (*Jugicambarus*). I have looked at a limited number of cave crayfishes from Oklahoma, Missouri, and Arkansas that are housed in the Natural Museum of Natural History, Smithsonian Institution and have compared the Delaware County cave specimens with them and feel confident that those populations in Twin, Star, and Jail caves represent a new species.

As I indicated to you in a recent phone conversation, I am winding down the fall term and that is to be followed by a field trip to do some work in Tennessee and Alabama caves during early December. I shall also be going to Washington, D. C. in mid-December and will do some more work in the Smithsonian. Hopefully I shall have the description of the crayfish completed by the new year.

Thank you for your interest, enthusiasm, and help in the ongoing study of the cave crayfishes of the Ozarks. Have a happy Thanksgiving.

Sincerely,

Horton H. Hobbs III
Professor of Biology