

**FINAL REPORT:
COMPILATION OF ALABAMA CRAYFISH MUSEUM HOLDINGS AND
CONSTRUCTION OF A GEO-REFERENCED DATABASE**

REVISED EDITION

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BY

Christopher A. Taylor, Ph.D.
Center for Biodiversity and Ecological Entomology
Illinois Natural History Survey
1816 S. Oak
Champaign, IL 61820

AND

Guenter A. Schuster, Ph.D.
Department of Biological Sciences
Eastern Kentucky University
521 Lancaster Ave.
Richmond, KY 40475

PREPARED FOR

State of Alabama
Department of Conservation and Natural Resources
Wildlife and Freshwater Fisheries Division
64 North Union Street, Suite 567
P.O. Box 301456
Montgomery, AL 36130-1456

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INTRODUCTION

As pointed out by Schuster and Taylor (2004) and others (Boschung and Mayden 2004, Lydeard and Mayden 1995), the aquatic biodiversity of Alabama may exceed that of any other state or province in North America. Recent distributional and ecological information has been compiled for major aquatic groups such as fishes (Boschung and Mayden 2004, Mettee et al. 1996) and unionid mussels (Williams et al. in press). However, for crayfishes such information is sorely lacking. To address the deficiency in baseline distributional information for Alabama crayfishes the current study was undertaken with four main objectives in mind. The first objective was to determine the extent of Alabama crayfish holdings in various museums in the United States. Secondly, museums with significant holdings were visited and at which time specimens were identified or had their identifications confirmed. Basic curation of specimens was also performed where required during museum visits. Thirdly, all museum specimens with adequate locality information were geo-referenced. Geo-referenced locations were then included in a database that also contained species names, common location names, river drainages, and life-history stages of specimens in that respective lot. Lastly, invalid taxonomic names for specimens in museum holdings were corrected. Hence, the resulting database contains the most current list of crayfish taxa known to occur or known to historically occur in Alabama and detailed locality information for all records in a geographic information system (GIS) usable format.

METHODS

Curators or collection managers at museums known to harbor crayfish collections were queried as to their holdings of Alabama crayfishes. Electronic records from those museums containing more than 50 records were then integrated into a single Microsoft Excel database. A record is defined as a collection of one species of crayfish from a single location. The number of specimens present in a record is unlimited. With one exception, museums with more than 50 Alabama records that had not been previously examined by the authors were then targeted for visits. Museum visits were conducted at various times during the contract period and consisted of identifying previously unidentified Alabama species, confirming identifications of specimens that did not fit known distributions, and, if necessary, curating specimens by assuring that proper preservative levels were present and assisting museum staff with cataloging of specimens. Two visits were made to the United States National Museum of Natural History Smithsonian Institution (Jan. 06, Jan. 07), three visits were made to the Tulane University Museum of Natural History (Feb. 06, May 06, July 06), and one visit each was made to the University of Alabama Museum of Natural History (Oct. 06) and Auburn University Museum of Natural History (Oct. 06). Visits to the Museum of Comparative Zoology at Harvard and the North Carolina State Museum of Natural History were deemed unnecessary due to the small size of their holdings and/or the lack of questionable records in their holdings. Visits to the Illinois Natural History Survey Crustacean Collection and the Eastern Kentucky University Museum of Zoology were also not conducted as these were the home institutions of the authors and their respective holdings of Alabama crayfishes have been previously examined.

Once confirmed, all of the records in the MS Excel database were batch georeferenced using GEOLocate (V 2.13) and entered into a Microsoft Access database in a decimal degree format. A trained data specialist visually confirmed and when necessary corrected these records using hard copy county road and topographic maps or electronic maps in the software package TopoUSA (DeLorme). Comments were included to clarify why in the judgment of the data specialist the original data needed to be corrected. Collection records with missing or poor locality records were given a latitude and longitude of 0,0.

Institutional acronyms used in this report and accompanying database are as follows: Auburn University of Natural History (Auburn); University of Alabama Museum of Natural History (UA); Eastern Kentucky University Museum of Zoology (EKU); Museum of Comparative Zoology at Harvard University (MCZ); Illinois Natural History Survey Crustacean Collection (INHS) United States National Museum of Natural History Smithsonian Institution (USNM); North Carolina State Museum of Natural History (NCSM); Tulane University Museum of Natural History (TU).

RESULTS

A total of 4649 records of Alabama crayfishes were obtained from 7 museums (Fig. 1). Of these, 330 (7.1%) records did not have adequate information for georeferencing. In addition, 249 records did not contain date of collection. The largest holdings of records were found at USNM with 54.8% of all records, TU with 17.3%, and UA with 10.5%. The temporal distribution of Alabama crayfish collections was very uneven (Fig. 2). Sixty-three percent of all records were collected during the 1960's and 1970's with 17.1% of collections were made during the 1990's. Little activities was seen in the state prior to 1960 with only 9.0% of collections being made prior to that year.

The geographical distribution of Alabama records strongly favored upland drainages in northern and central portions of the state. The Tennessee River drainage was the single most collected drainage, containing 23.6% of all records (Fig. 3.). The Tombigbee, Black Warrior, Cahaba, Coosa, Tallapoosa, and Alabama drainages combined accounted for 56.3% of all records. The coastal drainages of southeastern Alabama, including the Choctawhatchee, Conecuh, Escatawpa, Perdido, and Yellow, accounted for only 9.3% of all records (Fig 4).

The compilation and examination of museum records for the current study revealed 85 described crayfish species known to occur in Alabama (Table 1). Of these species only *Orconectes virilis* is deemed to be non-native. Range maps for each species showing locations of collection sites are included in Appendix 1. For many species individual dots can represent multiple collections at one site.

In addition to the 85 described species, other potential undescribed species were present in museum records compiled and examined. The database records of USNM contains one *Cambarellus*, three *Cambarus*, and nine *Orconectes* manuscript species

names. In addition, the Auburn University database contains two *Cambarus* taxa as being undescribed, and the UA collection contains five taxa (three *Orconectes* and two *Procambarus*) as undescribed. Distribution maps of undescribed taxa are not included in Appendix 1.

DISCUSSION

A total 4649 records that include both described and unidentifiable or undescribed taxa (denoted by sp. in species field) are included in the Microsoft Access database that accompanies this report. All records with adequate locality information are geo-referenced using decimal degrees and are immediately usable for GIS applications. The compilation of these records, in addition to visual examination of over 2000 museum specimens confirm that with 85 currently described crayfish species, Alabama is the most diverse state or province in North America. However, these records do not reflect an up-to-date assessment of the Alabama crayfish fauna. With 3107 (76.3%) records being collected prior to 1987 and 1379 (33.8%) of records predating 1970, the ability to determine current population trends and distributions is severely hampered. More alarming is the under-representation of burrowing crayfish species, primarily those classified as primary burrowers (Hobbs 1981, Hobbs 1989). Of the 4649 records, only 212 (4.9%) are of species that spend most of their lives in subterranean burrows. This under-sampling prevents an assessment of both historical and current population levels and biogeography.

Manuscript names are usually the result of uncompleted taxonomic work by previous researchers and can indicate the presence of undescribed taxa. The abundance of manuscript names in museum collections reveals, in part, the understudied nature of the crayfish fauna in Alabama. The crayfish workers who thought these forms were undescribed species, for the most part, were Drs. Horton H. Hobbs, Jr. of USNM and Joe F. Fitzpatrick, Jr. of TU and the University of Southern Alabama, both of whom were familiar with the Alabama fauna. Our preliminary examinations reveal that at least one manuscript name may be applicable to a previously described species (*Orconectes jonesi*) However, most may represent undescribed species. As taxonomic revisionary work was not a goal of this project there remains a great need for additional taxonomic evaluation of museum collections and field collecting. One noteworthy example is the presence of *Procambarus zonangulus* in Alabama. *Procambarus zonangulus* is a member of the *P. acutus* species group and has been considered by some to be the form present in most of the Gulf Coastal Plain, including Alabama (Huner 2002). We did not find specimens assignable to *P. zonangulus* during our museum visits, however we follow Huner (2002) in including it in our species list (Table 1.). In the absence of database records for the species, a range map for *P. zonangulus* is not included in this report.

In summary and conclusion, future efforts in Alabama should include, but are not limited to: 1) taxonomic revisions of numerous crayfish groups and descriptions of new taxa; 2) additional field collections in undersampled drainages, especially in coastal drainages of southeastern Alabama; 3) additional field collections in regions where last

known collections predate 1987; and 4) statewide collections of primary and secondary burrowing species.

BIBLIOGRAPHY

- Boschung, H. T. and R. L. Mayden. 2004. Fishes of Alabama. Smithsonian Institution, Washington, DC.
- Hobbs, H. H. Jr. 1981. The crayfishes of Georgia. Smithsonian Contributions to Zoology, No. 318.
- Hobbs, H. H. Jr. 1989. An illustrated checklist of the American crayfishes (Decapoda: Astacidae, Cambaridae, and Parastacidae). Smithsonian Contributions to Zoology, No. 480.
- Huner, J. V. 2002. *Procambarus*. Pages 541-584, in Biology of Freshwater Crayfish, D. M. Holdich, ed. Blackwell Science, Oxford, UK.
- Lydeard, C. and R. L. Mayden. 1995. A diverse and endangered aquatic ecosystem of the southeast United States. Conservation Biology 9(4): 800-805.
- Mettee, M. F., Jr., P. E. O'Neil, and J. E. Pierson. 1996. Fishes of Alabama and the Mobile Basin. Oxmore House, Inc., Birmingham.
- Schuster, G. A. and C. A. Taylor. 2004. Report on the crayfishes of Alabama: literature review and museum database review, species list with abbreviated annotations and proposed conservation statuses. Illinois Natural History Survey, Center for Biodiversity Technical Report 2004 (12). 47pp.
- Williams, J. D., A. E. Bogan, and J. T. Garner. Freshwater Mussels of Alabama and the Mobile Basin in Georgia, Mississippi and Tennessee. In press, University of Alabama Press, Tuscaloosa, AL.

Table 1. Preliminary checklist of the crayfishes (Cambaridae) of Alabama

Subfamily **Cambarellinae** Laguarda 1961

Genus ***Cambarellus*** Ortmann 1905

Subgenus ***Dirigicambarus*** Fitzpatrick 1983

Cambarellus (D.) shufeldtii (Faxon 1884)

Subgenus ***Pandicambarus*** Fitzpatrick 1983

Cambarellus (P.) diminutus Hobbs 1945

Cambarellus (P.) lesliei Fitzpatrick and Laning 1976

Subfamily **Cambarinae** Hobbs 1942

Genus ***Cambarus*** Erichson 1846

Subgenus ***Aviticambarus*** Hobbs 1969

Cambarus (A.) hamulatus (Cope 1881)

Cambarus (A.) jonesi Hobbs and Barr 1960

Cambarus (A.) veitchorum Cooper and Cooper 1997

Subgenus ***Cambarus*** Erichson 1846

Cambarus (C.) bartonii cavatus Hay 1902

Cambarus (C.) howardi Hobbs and Hall 1969

Subgenus ***Depressicambarus*** Hobbs 1969

Cambarus (D.) englishi Hobbs and Hall 1972

Cambarus (D.) graysoni Faxon 1914

Cambarus (D.) halli Hobbs 1968

Cambarus (D.) latimanus LeConte 1856

Cambarus (D.) obstipus Hall 1959

Cambarus (D.) striatus Hay 1902

Subgenus ***Erebicambarus*** Hobbs 1969

Cambarus (E.) rusticiformis Rhoades 1944

Cambarus (E.) tenebrosus Hay 1902

Subgenus ***Exilicambarus*** Bouchard and Hobbs 1976

Cambarus (E.) cracens Bouchard and Hobbs 1976

Subgenus ***Hiaticambarus*** Hobbs 1969

Cambarus (H.) girardianus Faxon 1884

Cambarus (H.) longirostris Faxon 1885

Cambarus (H.) manningi Hobbs 1981

Subgenus ***Jugicambarus*** Hobbs 1969

Cambarus (J.) distans Rhoades 1944

Cambarus (J.) parvovulus Hobbs and Shoup 1947

Cambarus (J.) unestami Hobbs and Hall 1969

Subgenus ***Lacunicambarus*** Hobbs 1969

Cambarus (L.) diogenes Girard 1852

Cambarus (L.) ludovicianus Faxon 1884

Cambarus (L.) miltus Fitzpatrick 1978

Subgenus ***Puncticambarus*** Hobbs 1969

Cambarus (P.) coosae Hobbs 1981

- Cambarus (P.) scotti* Hobbs 1981
- Subgenus ***Tubericambarus*** Jezerinac 1993
- Cambarus (T.) acanthura* Hobbs 1981
- Cambarus (T.) polychromatus* Thoma et al. 2005
- Genus ***Fallicambarus*** Hobbs 1969
- Subgenus ***Creaserinus*** Hobbs 1973
- Fallicambarus (C.) burrisi* Fitzpatrick 1987
- Fallicambarus (C.) byersi* (Hobbs 1941)
- Fallicambarus (C.) danielae* Hobbs 1975
- Fallicambarus (C.) fodiens* (Cottle 1863)
- Fallicambarus (C.) oryctes* (Penn and Marlow 1959)
- Genus ***Faxonella*** Creaser 1933
- Faxonella clypeata* (Hay 1899)
- Genus ***Hobbseus*** Fitzpatrick and Payne 1968
- Hobbseus prominens* (Hobbs 1966)
- Genus ***Orconectes*** Cope 1872
- Subgenus ***Crockerinus*** Fitzpatrick 1987
- Orconectes (C.) erichsonianus* (Faxon 1898)
- Subgenus ***Gremicambarus*** Fitzpatrick 1987
- Orconectes (G.) compressus* (Faxon 1884)
- Orconectes (G.) virilis* (Hagen 1870)
- Subgenus ***Hespericambarus*** Fitzpatrick 1987
- Orconectes (H.) perfectus* Walls 1972
- Subgenus ***Orconectes*** Cope 1872
- Orconectes (O.) australis australis* (Rhoades 1941)
- Orconectes (O.) sheltae* Cooper and Cooper 1997
- Subgenus ***Procericambarus*** Fitzpatrick 1987
- Orconectes (P.) durelli* Bouchard and Bouchard 1995
- Orconectes (P.) forceps* (Faxon 1884)
- Orconectes (P.) mirus* (Ortmann 1931)
- Orconectes (P.) placidus* (Hagen 1870)
- Orconectes (P.) putnami* (Faxon 1884)
- Orconectes (P.) spinosus* (Bundy 1877)
- Subgenus ***Tragulicambarus*** Fitzpatrick 1987
- Orconectes (T.) lancifer* (Hagen 1870)
- Subgenus ***Trisellescens*** Bouchard and Bouchard 1995
- Orconectes (T.) alabamensis* (Faxon 1884)
- Orconectes (T.) chickasawae* Cooper and Hobbs 1980
- Orconectes (T.) cooperi* Cooper and Hobbs 1980
- Orconectes (T.) holti* Cooper and Hobbs 1980
- Orconectes (T.) jonesi* Fitzpatrick 1992
- Orconectes (T.) validus* (Faxon 1914)
- Genus ***Procambarus*** Ortmann 1905
- Subgenus ***Girardiella*** Lyle 1938
- Procambarus (G.) hagenianus hagenianus* (Faxon 1884)
- Subgenus ***Leonticambarus*** Hobbs 1972

- Procambarus (L.) capillatus* Hobbs 1971
Procambarus (L.) escambiensis Hobbs 1942
Procambarus (L.) hubbelli (Hobbs 1939)
Procambarus (L.) shermani Hobbs 1942
- Subgenus ***Ortmannicus*** Fowler 1912
Procambarus (O.) acutissimus (Girard 1852)
Procambarus (O.) acutus acutus (Girard 1852)
Procambarus (O.) bivittatus Hobbs 1942
Procambarus (O.) evermanni (Faxon 1890)
Procambarus (O.) hayi (Faxon 1884)
Procambarus (O.) hybus Hobbs and Walton 1957
Procambarus (O.) lecontei (Hagen 1870)
Procambarus (O.) lewisi Hobbs and Walton 1959
Procambarus (O.) lophotus Hobbs and Walton 1960
Procambarus (O.) marthae Hobbs 1975
Procambarus (O.) verrucosus Hobbs 1952
Procambarus (O.) viaeviridis (Faxon 1914)
Procambarus (O.) zonangulus Hobbs and Hobbs 1990
- Subgenus ***Pennides*** Hobbs 1972
Procambarus (P.) clemmeri Hobbs 1975
Procambarus (P.) lagniappe Black 1968
Procambarus (P.) penni Hobbs 1951
Procambarus (P.) spiculifer (LeConte 1856)
Procambarus (P.) suttkusi Hobbs 1953
Procambarus (P.) versutus (Hagen 1870)
Procambarus (P.) vioscai paynei Fitzpatrick 1990
- Subgenus ***Remoticambarus*** Hobbs 1972
Procambarus (R.) pecki Hobbs 1967
- Subgenus ***Scapulicambarus*** Hobbs 1972
Procambarus (S.) clarkii (Girard 1852)
Procambarus (S.) okaloosae Hobbs 1942
Procambarus (S.) paeninsulanus (Faxon 1914)
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Fig. 1. Number of Alabama crayfish records from respective museums geo-referenced and integrated into accompanying database. Numbers do not include records with incomplete locality data or missing date of collection. Six records that had yet to be accessioned into a museum collection are also not included.

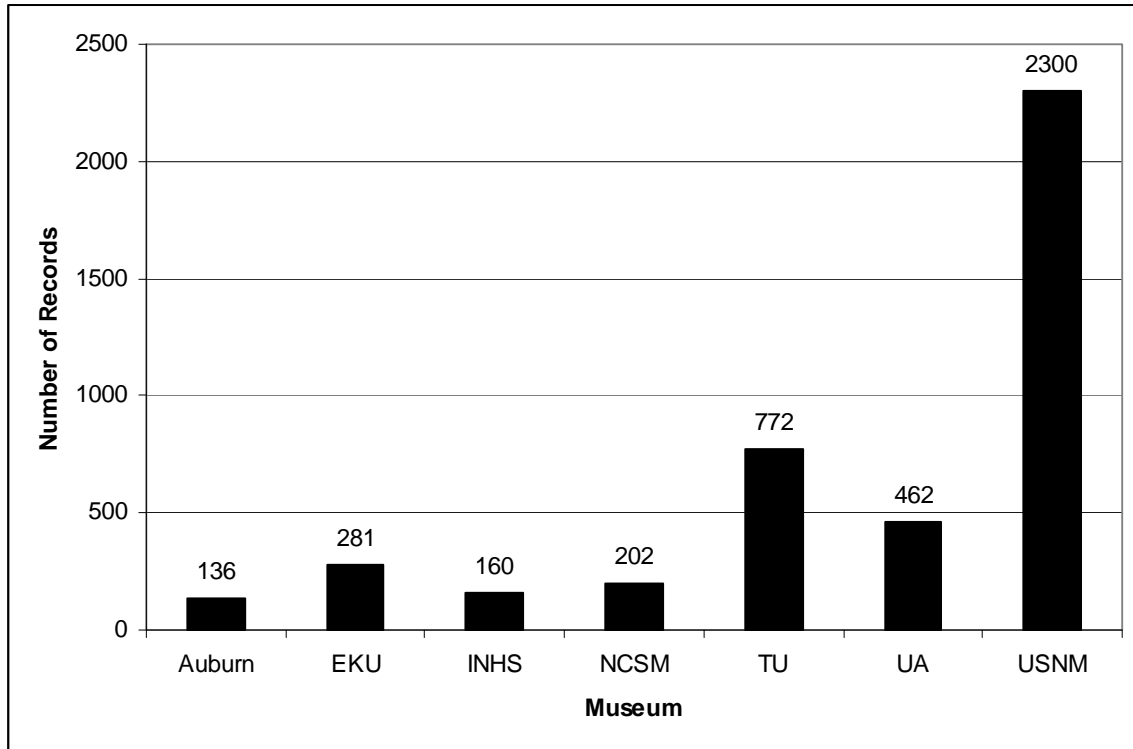


Fig. 2. Number of Alabama crayfish records geo-referenced and integrated into the accompanying database plotted by decade of collection. Numbers do not include records with incomplete locality data or missing date of collection.

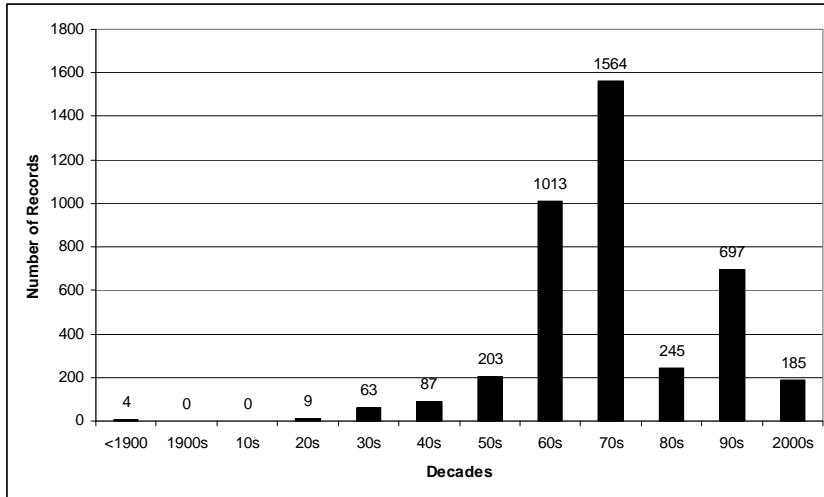


Fig. 3. Number of Alabama crayfish records geo-referenced and integrated into the accompanying database plotted by major river drainage (AL = Alabama, BW = Black Warrior, CH = Chattahoochee, CO = Coosa, MO = Mobile, TA = Tallapoosa, TN = Tennessee, TO = Tombigbee).

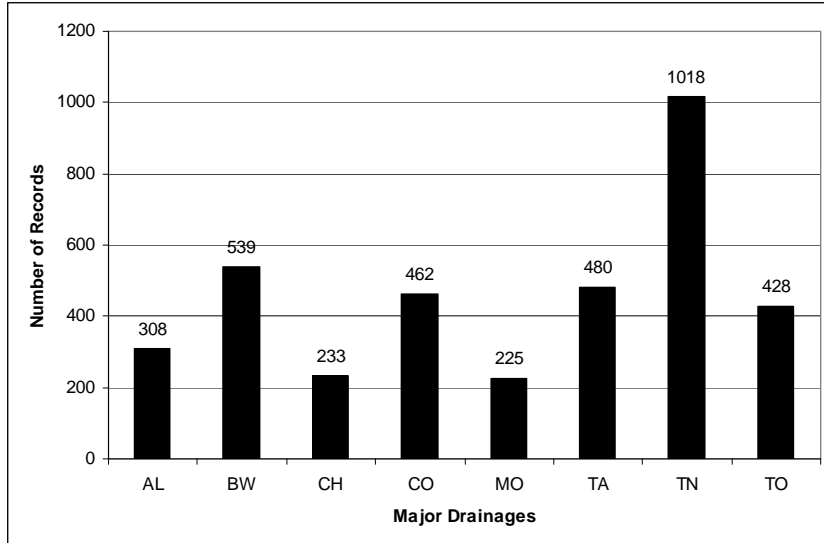
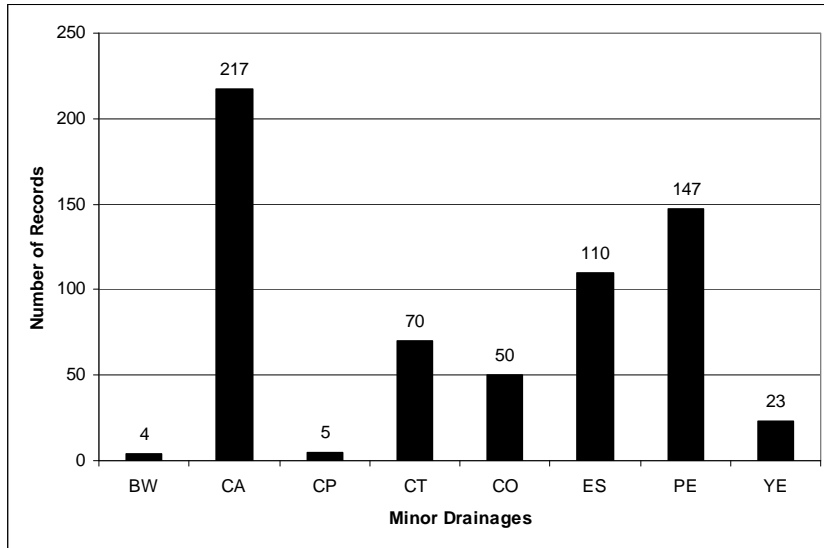


Fig. 4. Number of Alabama crayfish records geo-referenced and integrated into the accompanying database plotted by minor river drainage (BW = Blackwater, CA = Cahaba, CP = Chipola, CT = Choctawhatchee, CO = Conecuh, ES = Escatawpa, PE = Perdido, YE = Yellow).



APPENDIX 1.

Range maps for all species documented by museum visits and museum record compilation. Colors represent the below physiographic provinces following Mettee et al. (1996).

