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Articles

Some Extinct Molluscs of the U. S. A.

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Abstract

A synoptic historical review of mollusc extinctions during the past century in the USA is presented, with focus on taxa of riverine, insular, and spring habitats. Dam construction and pollution prove to have been potent factors in the alteration of aquatic habitats, and concomitantly in loss of many mollusc species in the southeastern USA; destruction of the native flora and the introduction of exotic plants and predators have contributed to the decimation of terrestrial molluscs, especially on the Hawaiian Islands.

Introduction

Alteration of pristine habitats has been occuring in areas of the United States ever since the first Europeans arrived, and as a result, many animals have become extinct. My goal in this paper is to draw attention to the past extinctions and present conservational problems faced by molluscs in the United States, an often little publicized but important group of invertebrates.

Molluscs as a group have a tendency to be very localized, and have suffered a large number of extinctions as unique and diverse habitats have been destroyed. The molluscs which have become extinct in the United States during the past one hundred years can conveniently be classified into three groups: those of riverine habitats, island habitats, and spring or pond habitats. The main factors that caused extinctions among riverine taxa have been stream impoundment and pollution. Extinctions among island molluscs can be attributed to habitat destruction, the effects of introduced plants and animals, and overcollecting. Species inhabiting springs and ponds have been affected primarily by habitat destruction.

Riverine Species: The Southeastern USA

The molluscan faunas of the river systems of the southwestern United States are remarkable, particularly those of the Coosa and Tennessee Rivers (see Figure 1). No other area in the world can match the endemic gastropod fauna of the Coosa River drainage or the endemic bivalve fauna of the Tennessee River drainage. Unfortunately, however, the mollusc faunas of these and other United States rivers have been decimated during the twentieth century (refer to Table 1 for a synopsis of these and other extinctions covered in this paper).

Pleuroceridae

The endemic Coosa River genus *Gyrotoma* of the family Pleuroceridae (river snails) is extinct. Goodrich (1924) noted that this genus was endemic only to the main channel of the river, confined to approximately the lower two thirds of the river. This genus was adapted to swiftly flowing water (Ahearn, 1947), which may explain its limited range.

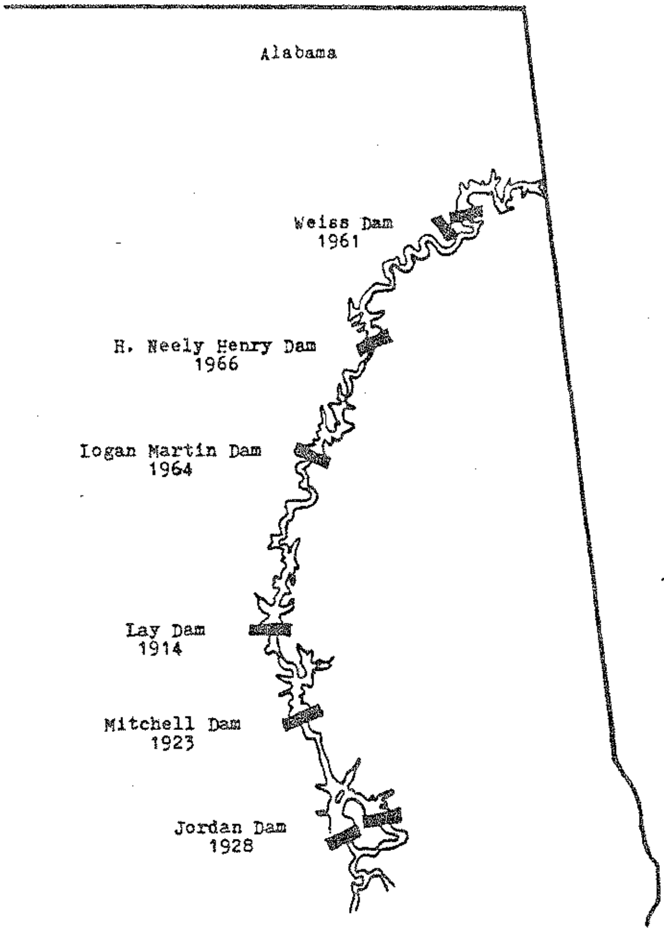

Figure 1. Coosa River system, eastern and central Alabama, USA. Construction dates indicated for the major dams on the river.

It is thought that all of the endemic Coosa River drainage species in the genus *Goniobasis* (= *Elimia*) are extinct (G. M. Davis, pers. comm.), although some species still survive in the unflooded portions of a few tributaries. This genus lived in the main stem of the Coosa River and its tributaries, generally in the upper half of the drainage system (Goodrich, 1944a). Two species of this genus, *Goniobasis catenoides* and *G. boykiniana*, were endemic to the Chatahoochee River system in Georgia. Both were severely affected by siltation which resulted from agricultural activities (Clench & Turner, 1956), and *G. boykiniana* was also eliminated in one area by an impoundment (Stein, 1967).

All species in the genus *Leptoxis* from the Alabama River drainage, which includes the Coosa River system, are endemic (Goodrich, 1922). The numerous taxa found in the Coosa River were generally confined to the lower half of the drainage. These have mostly been extirpated, although a small number may survive in tributaries. *Leptoxis melanoides* was probably endemic to the Black Warrior River of Alabama (Goodrich, 1922), and became extinct most likely as a result of habitat destruction. A probable subspecies of the river snail *Pleurocera verrucosa* from the Little Tennessee River disappeared after the implementation of the TVA hydroelectric schemes, the last dam of which was the controversial Tellico Dam (C. B. Stein, pers. comm.).

Other Gastropod Families

Several Coosa River endemic hydrobiids are now extinct. At least five (but probably more) belonged to the genus *Somatogyrus*. The endemic species *Clappia clappi* is also extinct (Stein, 1976). The genus *Tulotoma* (family Viviparidae) is endemic to the Coosa and Alabama River drainages; if the genus ever inhabited the Tallapoosa River, it was extirpated long ago by siltation (W. J. Clench, pers. comm.). Siltation also caused its disappearance from the Alabama River, and in the Coosa River the genus has been affected by impoundments (Stein, 1976). Living specimens of *T. angulata* were collected at Wetumpka, Alabama, on 1 August 1964 (Patterson, 1964). This discovery is important because Wetumpka is a short distance downstream from the lowermost hydroelectric dam (built in 1928) on the Coosa River. Since it survived downstream from this dam for over 35 years, there is reason for cautious optimism that the species still survives.

The genus *Neoplanorbis*, containing four species and the monotypic genus *Amphigyra* may comprise a subfamily of the freshwater limpets known as the Neoplanorbinae. These extinct forms were confined to swift currents in the lower portion of the main stem of the Coosa River (Stein, 1976). One other extinct Coosa River gastropod is the Coosa scale shell, *Lepyrium showalteri showalteri*, a member of the endemic Alabama family Lepyriidae. The only known habitat of this snail has been destroyed (Stein, 1976).

Unionidae

At least four mussels that were endemic to the Coosa River are extinct: three *Pleurobema*, and one in the genus *Alasmidonta* (Stansbery, 1976). *Alasmidonta mccordi* is known only from the holotype which was collected in 1956 (Athearn, 1964), and the type locality was destroyed by an impoundment in the 1960s (Athearn, pers. comm.).

The freshwater mussel genus *Dysnomia* (= *Epioblasma*) is widely distributed in some of the larger rivers of the Eastern United States. Stream impoundment seems to be the most important factor in the decline of this genus, with pollution and siltation as contributing factors (Stansbery, 1970b). Of the Ohio River basin fauna: "The extinct species were characteristic of the riffle habitats. . . This type of habitat has all but disappeared from the Ohio Basin and is being further reduced by the construction of new and higher dams" (Stansbery, 1970a). The extinction of *Dysnomia lefeverei* of the Black River in Missouri resulted from dredging operations. The recovery pearly mussel *Elliptio nigella* is listed as extinct, its disappearance largely caused by pollution in the form of surface runoff (Opler, 1977, and pers. comm.).

Ecological Effects of Dam Construction

All of the snails mentioned above became extinct because of the effects of hydroelectric dams. As far as the Pleuroceridae of the Coosa River are concerned, "hydroelectrification of the Coosa River, Alabama has caused miles of rapids, the natural habitat of pleurocerids to be covered with deep water" (Goodrich, 1944a; over 90 percent of the 89 endemic Coosa River pleurocerids have met this fate). Rapids interspersed with areas of relatively quiet water in a river provide excellent habitat for snails and mussels (Ortmann, 1924). Flowing water is essential to stream dwelling species because it contains a large amount of dissolved oxygen, keeps the stream bed free of silt and mud, carries away waste materials and organic debris, and aids in reproduction (Stansbery, 1971).

Snails and mussels are important components of stream ecosystems: snails feed on algae; mussels act as cleansing agents by feeding on suspended organic debris, and through formation of beds facilitate the stabilization of river bottoms (Davis, 1977). Both snails and mussels are also food sources for many animals. Mussel larvae (glochidia) are eaten by fish, a vital part in the life cycle of the mussel. The glochidium goes through a parasitic phase within the host fish, encysting within the gills before rupturing and dropping to the river bottom as a juvenile mussel. The host fish presumably derives some nutritional benefit from the mucous enveloping the glochidial masses; and the mussel glochidia receive nutrition, protection against bacterial infection, and a means of dispersal.

Hydroelectric impoundments negatively impact molluscs in a variety of ways. Sunlight is prevented from reaching the river bottom, and as a result the algae upon which the animal depend cannot survive; river flowing into an impoundment deposits sediment, smothering the bottom dwelling life (Stansbery, 1970a). Molluscs are also affected by acidic conditions in the bottom of impoundments, since the acid which results from the decomposition of organic debris dissolves the calcium carbonate of their shells. The relatively stagnant water of impoundments presents yet another problem for mussels because moving water is necessary for the transport of male gametes (Stein, 1971). Although some species can survive behind dams, reproduction often fails to take place. Stansbery (1971) indicated "nearly all of the specimens we obtained from the old channel of the impounded Tennessee River. . . appeared to be healthy and growing, but young specimens were absent. it appeared that no successful reproduction had taken place since impoundment." The operation of hydroelectric facilities also impacts mollusc populations below the dam. The amount of water let out depends upon the quantity of electricity being produced, and at times can be a raging torrent. Areas downstream from dams thereby become clogged with mud and salt coming from the dam water.

Insular Species: The Hawaiian Islands

The Hawaiian Islands harbor one of the most spectacular molluscan faunas in the world, 1061 endemic species having been named (Hart, 1975), with many more still to be described (Solem, pers. comm.). The high degree of localization in many species of Hawaiian tree snails has made them especially vulnerable to extinction.

In the land snail genus *Carelia* (a member of the endemic family Amastridae), twelve species and subspecies are known only from subfossil remains, while seventeen survived up until recent times (Cooke, 1931; Hart, 1976). *Carelia* was last collected alive in 1945-1947 (Arnemann, pers. comm.), and the genus is considered to be extinct today (Solem, pers. comm.). With the exception of one form from Niihau, all of the species of *Carelia* were endemic to the island of Kaui. There is a possibility that the genus was dying out naturally at the time of its discovery, but introduced cattle and pigs have probably been the main causes of its demise—cattle destroyed forests by trampling the vegetation, while pigs ate the snails. The destruction of forests for agriculture has also had an adverse impact on *Carelia* (Kondo, pers. comm.). Kondo has also documented the extinction of the genera *Pterodiscus, Planamstra,* and *Leptachatina*. Additionally, only 30 of the 200 living or recently extinct endemic species of the family Endodontidae have been described. The exact causes of the extinction of these animals are unknown, but deforestation, introduced mammals and carnivorous snails, and dilution of habitat have all been implicated in the extirpation of native Hawaiian land snails. Introduced ants have also had a severe impact on ground-dwelling snails below 2000 feet elevation on all the main islands.

Approximately 20 of the 41 species in the endemic Oahu genus *Achatinella* are now extinct, and the few thriving colonies of this genus of tree snails will probably soon be extirpated (Hart, 1978a; see the Red Data Book [IUCN, 1983] writeup on this group). The factors involved in the decline of this genus are numerous. Overcollection of these animals for their beautiful shells caused the initial decline in the population size (Hart, 1978a). The effects of introduced animals have also been severe. More than 90 years ago, Baldwin (1887) noted that introduced cattle, mice, and rats were taking a toll on *Achatinella*. Hart (1978a) adds that pigs, sheep, and goats have adversely affected these snails by destroying vegetation. But the introduced carnivorous snail *Euglandina rosea* has had the greatest impact of any introduced animal. It has been estimated that one third of the *Achatinella* known to have existed in the last 20 years have succumbed to *Euglandina* predation (Hart, 1975). Biological pollution of native forests by introduced plants has also had adverse effects, as *Achatinella* has adapted to only a small number of these exotics. Another factor has been habitat loss from fires, commercial logging (in the 19th century), military activities, and particularly agricultural operations (Hart, 1978b).

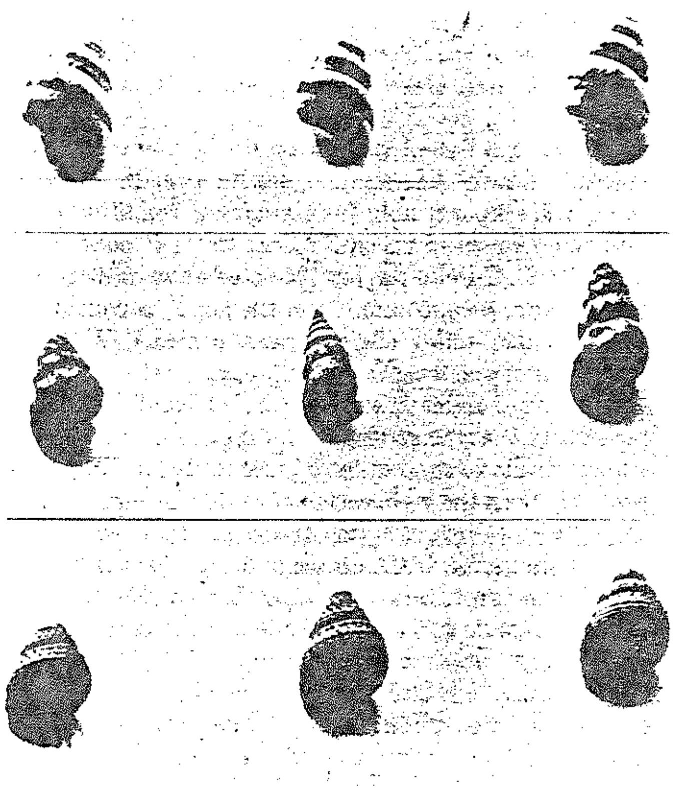

Figure 2. Representative molluscan taxa: top, *Achatinella*; middle, *Goniobasis*; bottom, *Leptoxis*. See text for discussion of status.

Spring and Pond Species

Several species of molluscs confined to small spring and/or pond habitats scattered throughout the United States have become extinct. Among species in the family Hydrobiidae, *Amnicola neomexicana* was restricted to a thermal area near the Socorro Mountains in New Mexico. The original habitat of this snail has been destroyed because the springs are now intercepted at the surface, with the water being piped off to other areas; it may be extinct. The extinction of *Fontelicella* sp. from a single spring on the Manse Ranch in the Pahrump Valley, Nevada, is probably traceable to the fact that its spring habitat dried up in 1975 as a result of excessive ground-water pumping (Landye, pers. comm.). The Fish Springs pond snail *Stagnicola pilsbryi* of southwestern Utah may have been exterminated when its wetland habitat was burned for waterfowl management (Bickel, 1977); the US Fish and Wildlife Service has recently contracted a survey for this snail. The specific causes of the loss of the Utah pond snail *Stagnicola utahensis* are unknown, but lowered lake levels due to both natural and human-influenced causes, and the alteration of shoreline springs were doubtless important factors (Bickel, 1977). The extinction of *Marstonia olivacea* from Big Spring Creek in Huntsville, Alabama, is presumably due to the fact that the limited habitat of this snail has been destroyed by stream channelization and pollution (Thompson, 1975).

The Greenfield ramshorn snail *Helisoma magnifica* of the family Planorbidae is endemic to Greenfield Pond, North Carolina (Fuller, 1977). It is unclear whether this species still survives; eggs were found several years ago (Morrison, pers. comm.). *H. magnifica* is thought to have gone extinct when the water level of Greenfield pond was decreased twenty feet in order to kill off aquatic vegetation, thus causing the snails to freeze to death during the winter (Imlay, 1977). The factors which caused the loss of another Greenfield Pond endemic, the Cape Fear ramshorn snail *Taphius eucosmius*, have not yet been ascertained (Fuller, 1977).

Conclusions

Habitat destruction has been a factor in nearly every extinction discussed in this paper, and in many cases it was the only cause. Hydroelectric dams and pollution have had a particularly severe impact on riverine taxa, and, as Stansbery (1977) indicated, "we are left with the inescapable conclusion that we are gradually destroying nearly a thousand endemic species of freshwater molluscs. This fauna. . . is in the process of being eliminated in only a century or two." The spectacular insular Hawaiian fauna is suffering a similar reduction due in large part to parallel habitat loss.

Virtually all the extinct molluscs of the United States were geographically localized to some extent. The degree of localization varied considerably among species, but even those which were confined to fairly large sections of a single drainage system had restricted enough ranges for one threat to have been sufficient to destroy the species. Many species have probably become extinct prior to their even being known to science, and extinctions among undescribed taxa will continue to occur as long as unique habitats are destroyed. If some remnants of our great molluscan fauna are to be preserved, action must be taken rapidly to remove the threats outlined above. If not, some of the most spectacular molluscan faunas in the world will be lost forever.

Acknowledgments

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Table 1. List of presumed extinct molluscs in the United States. Last collection date and/or extinction date appended to specific name when known. Asterisk = personal communication. Range key: Coosa River = CR; Chattahoochee River = ChR; Black Warrior River = BWR; Coosa-Alabama Rivers = C-AR; Tennessee River = TR; Ohio River = OR; Black River, AK = BR;AK; Wabash River = WR; Apalchicola River = AR; Oahu, Hawaii = OH; Kaui, Hawaii = KH; Hawaii = HA; New Mexico = NM; Nevada = NV; North Carolina = NC; Alabama = AL; Utah = UT.

Species	Authority	Range
Apella alabamensis	Stein (1976)	CR
Apella ampla-1914	Stein (1976)	CR
Apella carinifera-1914	Stein (1976)	CR
Apella excisa-1928	Stein (1976)	CR
Apella hendersoni-1914	Stein (1976)	CR
Apella incisa-1928	Stein (1976)	CR
Apella laciniata-1928	Stein (1976)	CR
Apella lewisi-1914	Stein (1976)	CR
Apella pagoda-1928	Stein (1976)	CR
Apella pumila-1928	Stein (1976)	CR
Apella pyramidata-1964	Stein (1976)	CR
Apella spillmani-1964	Stein (1976)	CR
Apella walkeri-1923	Stein (1976)	CR
Goniobasis alabamensis-1964	Stein (1976)	CR
Goniobasis bellula-1964	Stein (1976)	CR
Goniobasis boykiniana	Stein (1976)	ChR
Goniobasis brevis	Stein (1976)	CR
Goniobasis catenoides-1800's	Stein (1976)	ChR
Goniobasis clausa-1964	Stein (1976)	CR
Goniobasis crenatella-1966	Stein (1976)	CR
Goniobasis fallax	Stein (1976)	CR
Goniobasis fascinans-1966	Stein (1976)	CR
Goniobasis furva	Stein (1976)	CR
Goniobasis fusiformis	Stein (1976)	CR
Goniobasis gibbera-1964	Stein (1976)	CR
Goniobasis hartmanianum-1966	Stein (1976)	CR
Goniobasis haysiana-1923	Stein (1976)	CR
Goniobasis impressa-1964	Stein (1976)	CR
Goniobasis jonesi-1964	Stein (1976)	CR
Goniobasis lachryma-1966	Stein (1976)	CR
Goniobasis laeta-1966	Stein (1976)	CR
Goniobasis macglameriana-1966	Stein (1976)	CR
Goniobasis osculata	Stein (1976)	CR
Goniobasis pilsbryi-1964	Stein (1976)	CR
Goniobasis pupaeformis-1964	Stein (1976)	CR
Goniobasis pygmaea-1914	Stein (1976)	CR
Goniobasis vanuxemia-1966	Stein (1976)	CR
Leptoxis aldrichi-1914 or 1923	Stein (1976)	CR
Leptoxis brevispira-1914	Stein (1976)	CR
Leptoxis clipeata-1964	Stein (1976)	CR
Leptoxis coosaensis-1914	Stein (1976)	CR
Leptoxis flexuosa-1923	Stein (1976)	CR
Leptoxis formani-1923	Stein (1976)	CR
Leptoxis griffithiana-1928	Stein (1976)	CR
Leptoxis ligata-1928	Stein (1976)	CR
Leptoxis lirata-1914	Stein (1976)	CR
Leptoxis melanoides	Stein (1976)	BWR
Leptoxis occulata-1923	Stein (1976)	CR
Leptoxis showalteri	Stein (1976)	CR
Leptoxis sulcata-1964 or 1966	Stein (1976)	CR
Leptoxis torrefacta-1914	Stein (1976)	CR
Leptoxis vittata-1928	Stein (1976)	CR
Somatogyrus constrictus-1928	Stein (1976)	CR
Somatogyrus crassus-1928	Stein (1976)	CR
Somatogyrus hendersoni-1923	Stein (1976)	CR
Somatogyrus pygmaeus-1914	Stein (1976)	CR
Neoplanorbis carinatus-1923	Stein (1976)	CR
Neoplanorbis smithi-1923	Stein (1976)	CR
Neoplanorbis tantillus-1923	Stein (1976)	CR
Neoplanorbis umbilicatus-1923	Stein (1976)	CR
Tulotoma angulata	Davis (1974)	CR
Tulotoma coosaensis	Davis (1974)	CR
Tulotoma magnifica	Davis (1974)	C-AR
Amphigyra alabamensis-1914	Stein (1976)	CR
Clappia clappi-1923	Stein (1976)	CR
Lepyrium showalteri showalteri	Stein (1976)	CR
Pleurocera verrucosa ssp.	Stein (1980)	TR
Achatinella abbreviata	Hart (1978a)	OH
Achatinella buddi	Hart (1978a)	OH
Achatinella caesa	Hart (1978a)	OH
Achatinella cestus	Hart (1978a)	OH
Achatinella decora	Hart (1978a)	OH
Achatinella dimorpha	Hart (1978a)	OH
Achatinella elegans	Hart (1978a)	OH
Achatinella juddi	Hart (1978a)	OH
Achatinella juncea	Hart (1978a)	OH
Achatinella lehuiensis	Hart (1978a)	OH
Achatinella livida	Hart (1978a)	OH
Achatinella papyracea	Hart (1978a)	OH
Achatinella phaezona	Hart (1978a)	OH
Achatinella rosea-1960's	Hart (1978a)	OH
Achatinella spaldingi	Hart (1978a)	OH
Achatinella stewartii	Hart (1978a)	OH
Achatinella thaanumi	Hart (1978a)	OH
Achatinella valida	Hart (1978a)	OH
Achatinella viridans	Hart (1978a)	OH
Achatinella vittata	Hart (1978a)	OH
Achatinella vulpina	Hart (1978a)	OH
Carelia anceophila	Cooke (1931)	KH
Carelia bicolor-1945/47	Hart (1976)	KH
Carelia bicolor angulata	Hart (1976)	KH
Carelia cummingiana	Opler (1977)	KH
C. c. meinecki	Hart (1976)	KH
Carelia glossema	Opler (1977)	KH
Carelia hyattiana	Cooke (1931)	KH
C. kalalauensis-1945/47	Opler (1977)	KH
Carelia knudseni	Cooke (1931)	KH
Carelia olivacea	Opler (1977)	KH
C. o. baldwini	Hart (1976)	KH
C. o. priggeyi	Cooke (1931)	KH
C. o. propinquella	Hart (1976)	KH
Carelia paradoxa	Cooke (1931)	KH
Carelia periscellis	Cooke (1931)	KH
Carelia tenebrosa	Opler (1977)	KH
Carelia turricula	Opler (1977)	KH
genus *Leptachatina*	Kondo*	HA
genus *Planamastra*	Kondo*	HA
genus *Pterodiscus*	Kondo*	HA
Amnicola neomexicana-1971	Opler (1977)	NM
Fontelicella n. sp.-1975	Landye*	NV
Helisoma magnifica-1947	Opler (1977)	NC
Marstonia olivacea	Thompson (1975)	AL
Stagnicola pilsbryi	Bickel (1977)	UT
Stagnicola utahensis	Bickel (1977)	UT
Taphius eucosmius eucosmius	Fuller (1977)	NC
Mussels:		
Dysnomia arcaeformis-1940's	Opler (1977)	TR
Dysnomia biemarginata	Stansbery (1970b)	TR

Dysnomia cincinnatiensis	Stansbery*	OR
Dysnomia flexuosa-1940's	Opler (1977)	TR
Dysnomia florentina	Stansbery (1976)	TR
Dysnomia lefevrei	Buchanan*	BR,AK
Dysnomia lenoir-1965	Opler (1977)	TR
Dysnomia lewisi-1940's	Opler (1977)	TR
Dysnomia personata-1800's	Opler (1977)	OR
Dysnomia propinqua-1910's	Opler (1977)	TR
Dysnomia sampsoni-1910's	Opler (1977)	WR
Dysnomia steardsoni-1910's	Opler (1977)	TR
Dysnomia turgidula	Imlay (1977)	TR
Elliptio nigella-1954	Opler (1977)	AR
Alasmidonta mccordi-1964 or 1966	Athearn*	CR
Pleurobema hartmanianum	Athearn*	CR
Pleurobema nucleopsis	Stansbery (1976)	CR
Pleurobema showalteri	Stansbery (1976)	CR

Correction

In John Lane's article on Alta California monarch overwintering sites, published in *Atala* Vol. 9, line 2 of paragraph 2 on page 17 should read "until the early 1880s" (cf. "1800s").