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FRESHWATER BIVALVES OF ARTIFICIAL AND NATURAL CREEK PONDS IN EAST CENTRAL TEXAS

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Diverse freshwater bivalve faunas were characteristic of various river ecosystems of eastern Texas (Strecker, 1931). Substantial environmental impact upon these faunas has involved water pollution and reservoir construction (Neck, 1982). These reservoirs contain fewer species than free-flowing rivers, but often support very dense populations (Neck).

Additional anthropogenic habitats also exist in this area. Innumerable small bodies of water have been constructed for water sources for livestock (small ponds), flood prevention (Farquhar et al., 1980), or merely as a result of removal of soil and subsoil for fill ("borrow pits"). Nothing is known of the bivalve fauna of ponds in Texas except for brief reports by Frierson (1917, 1923). The unionid fauna of a similar pond in Kansas was reported by Murray (1960).

The primary purpose of this study was to determine which bivalve species are able to establish and maintain populations in small ponds. Secondary purposes were, with observations and literature survey, to determine possible methods of entry into the ponds and to examine biological characteristics which allow species to function in pond habitats.

Study Area and Methods

The study area was a 1500-acre tract of post oak woodlands and improved pastures in Van Zandt and Henderson counties in east central Texas. Bivalve faunas of 15 ponds of variable origin were surveyed by dragging rakes and nets along pond bottoms during periods of low water levels. Notes were made concerning size, origin and relative location to Purtis Creek, which is a tributary of Cedar Creek of the Trinity River drainage. During severe droughts, flow of Purtis Creek may become subterranean or non-existant between permanent ponds. Such low levels of water flow could be a recent phenomenon following alteration of local aquifer conditions by water mining and land cover alteration. Surveys were made on the following dates: 5 Sept. 1978, 4 - 5 Aug. 1980, 19 Feb. 1981, 11 Mar. 1981, and 30 July 1984.

Results and Observations

A total of five bivalve species was found in 10 of the 15 surveyed ponds (Table 1). *Anodonta imbecilis* Say, 1829, was present in only three ponds and was not abundant in any. *Uniomerus tetralasmus* (Say, 1830) was the most abundant species and also was found in the largest number of ponds. *Ligumia subrostrata* (Say, 1831) and *Toxolasma texasensis* (Lea, 1857) were less abundant than *U. tetralasmus*, but developed high density populations in some ponds. The single species of fingernail clam, *Sphaerium partumeium* (Say, 1822), was observed in only a few ponds but was usually common when present.

Species compositions of the different ponds were quite variable. Only one pond (#8) contained all five species, although two other ponds (#7 and #15) contained all four unionid species. The single pond (#8) with all five species is located out of the floodplain of Purtis Creek, but supported a relatively dense fish population and had the most diverse pond-margin flora of all ponds. Two of the three ponds with four species are located in the floodplain of Purtis Creek.

Differential abundance of bivalves with reference to reducing substrate (as indicated by strong sulfur smell of black organic layer within pond 7 in the floodplain of Purtis Creek) indicated that *L. subrostrata* may be more resistant to anoxic conditions than *U. tetralasmus* and *T. texasensis*. One area of pond 7 (located within the floodplain of Purtis Creek) contained a small pool with a black organic-rich substrate with a strong odor of sulfur. This area contained 21 *T. texasensis* (11 males: 10 females), 2 *U. tetralasmus*, and 27 *L. subrostrata* (11 males: 16 females). Another low area (with some water and no sulfur layer) contained 15 *T. texasensis* (9 males: 6 females) and 18 *U. tetralasmus*. All of the above counts are of live individuals.

Descriptions of typical individuals recovered in this study are presented to document local phenotypes of these species in east central Texas. Shells of *U. tetralasmus* from these ponds possessed no rays on the periostracum and had whitish nacre. Posterior end was directed ventrally but was not extremely drawn out as in *declivus* Say, 1831. Internally, a very low ridge runs posterio-ventrally from the pseudocardinal teeth. Lack of growth ridges on shells of *U. tetralasmus* indicates that shell deposition is rather continuous, i.e. these ponds are not often completely dry. *L. subrostrata* possessed greenish rays except in the largest shells which are uniformly dark brown. The posterior end points dorsally (in both males and females). Nacre is whitish with pink to purple undertones. The ridge running from the pseudocardinal teeth is more strongly expressed than in *U. tetralasmus*. *T. texasensis* possess

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whitish nacre with iridescent highlights with limited light salmon nacre present in the central dorsal area of some individuals. Shells of *A. imbecilis* are light brown with only limited expression of greenish rays. *S. partumeium* were a brownish red in color.

No physicochemical data were recorded for these ponds but the water tends toward acidic levels. Valves of *U. tetralasmus* and *T. texasensis* exhibit shell etching with some internal redeposition of shell material occurring at the umbo. Variation in degree of shell etching in *U. tetralasmus* from different ponds was evident. Shells of *S. partumeium* below water level were noticably softer than shells above the water level.

At times of low water levels, the bivalves of these ponds are more susceptible to predation. Smaller individuals, especially *T. texasensis* and small *U. tetralasmus*, are eaten by raccoons, *Procyon lotor*. Larger individuals, especially *U. tetralasmus*, are very susceptible to predation by great blue herons, *Ardea herodias*. In pond 13, 32 of 47 dead *T. texasensis* valve pairs were broken while only 13 of 83 dead *U. tetralasmus* and one of 8 dead *L. subrostrata* were broken. Evidence of utilization of *L. subrostrata* by humans for fish bait was observed at several ponds.

One collection of bivalves from Purtis Creek at FM 316 (upstream of all pond sites) revealed a fauna dominated by *L. subrostrata*. Total bivalve count was as follows: *L. subrostrata* - 11; *T. texasensis* - 8; *A. imbecilis* - 5. Lack of *U. tetralasmus* in this sample may indicate that *U. tetralasmus* is uncommon in the creeks of this area and has become more abundant following widespread pond construction.

Discussion

The repetitive occurrence of a limited number of species of bivalves in the ponds surveyed in this study indicates that only a few species are able to colonize and survive in small ponds in east central Texas. Occurrence of the same unionid species in ponds in Louisiana (Stern and Felder, 1978) and of related unionid species in Kansas (Murray, 1960) indicates that a predictable pond mussel fauna characterizes this habitat over much of the south central United States. A discussion of methods of entry into these ponds and biological characteristics of surviving species is presented below.

Origin of Pond Bivalve Populations

Definite information regarding the origin of these pond bivalve populations was not discovered during this study.

However, several possibilities have been considered and are discussed below.

1) Bivalves in ponds may represent species which were present in the drainage prior to impoundment of water; however, most ponds in drainages are above the floodplain of Purtis Creek. This possibility is not a likely origin for clams in borrow pits which were created without regard to natural drainages. Certainly bivalves in floodplain ponds (#7, #15) are derived from naturally-occurring populations.

2) Bivalves could also enter ponds as attached glochidia during flood events when fish may disperse from stream to pond. Such an occurrence would appear unlikely for most ponds constructed in drainages because these are generally out of the normal floodplain. Several borrow pits with bivalves could have received founding individuals in this manner. As these small ponds without runoff-collecting abilities are especially susceptible to desiccation, one can assume that periodic introduction of those species present would be required.

3) Movement of bivalve species via waterfowl phoresy has been assumed to be common (Kew, 1893) on rather limited observations. Most published observations of bivalves on waterfowl have involved fingernail clams (Kew, 1983) and would indicate such an immigration method is more likely for *S. partumeium* than the unionids found during this study. However, Frierson (1899a, b) reported that he had "twice . . . killed wild ducks with unios attached to their toes and . . . seen what I *believed* to be unios *hanging* from the feet of others flying overhead." (Italics are those of Frierson, 1899b). Unfortunately, Frierson (1899a) gave no size or species details on these observations. Elsewhere, Frierson (1899b) remarks that he was "not ... then interested in the study of Unionidae." Therefore, one cannot be sure that unionids were involved, although fingernail clams would be difficult to observe on overhead flying waterfowl.

4) Unionids could have been introduced into these ponds via glochidia on stocked fish. No stocking records are available for these ponds, although such activities undoubtedly occurred in ponds which contain fish and lie above the floodplain of Purtis Creek. Introduction of unionids via stocked fish from hatcheries has long been assumed to occur (see Johnson, 1970:387), but I know of no published surveys of bivalves in fish hatchery ponds other than those which involved problems in fish parasitism (Murphy, 1942). However, several bivalve species have been found in such ponds in a central Texas fish hatchery (Neck, unpub. data).

5) Bivalves could have been deliberately introduced into these ponds by humans for various purposes. Likely purpose would be for future utilization as fish bait. Utilization of unionids as fish bait in the study area has been documented above. Such an origin of these pond bivalve populations is possible (even probable) but almost impossible to document. S. partumeium is certainly too small to be considered useful as fish bait.

Biological Characteristics of Pond Bivalves

Species without some of the following biological characteristics could not survive in temporary or greatly fluctuating ponds, unless they have dependable methods of dispersal. Much has been written concerning transport of freshwater bivalves via waterfowl, and a quick review of the pertinent literature was presented above.

1) Bivalve species present in these ponds must be able to withstand highly variable water conditions concomitant with alterations in water level. During periods of no rainfall and lack of strong winds, the water in these ponds will tend to stratify. Physiological studies on L. subrostrata have revealed survival of anoxic periods and toleration of severe ion depletion (Dietz, 1974; Scheide and Dietz, 1982). Juveniles of S. partumeium are able to aestivate in moist vegetational mats even though adults may be reproducing at the same time in deeper water (Way, et al., 1980).

2) Bivalves in small ponds may also face the threat of total desiccation of their habitat. U. tetralasmus is well-known to withstand complete desiccation of ponds for several months (Simpson, 1898:283; Strecker, 1908; Isely, 1914; Coker, et al., 1921:100; Frierson, 1923). Simpson (1989:283) also reported on the ability of L. subrostrata to withstand periods of desiccation. Van Der Schalie (1940) reviewed the reports of resistance to habitat desiccation in unionids and found that "at least four species [U. tetralasmus, T. texasensis, L. subrostrata, and Amblema plicata] have been observed living through dry periods by aestivating." Significantly, three of the above species were abundant in ponds surveyed in this study. A. plicata is common in many Texas reservoirs but is not found in small ponds (Neck, unpublished data). The only unionid species found in these ponds, but not reported above to withstand desiccation (A. imbecilis), is very uncommon in these ponds. L. subrostrata is known to utilize atmospheric oxygen for respiration (Dietz, 1974). At least some intertidal bivalves are able to utilize atmospheric carbon dioxide for operation of the succinate pathway

(anaerobic respiration) during periods of stress and/or low oxygen tensions (Ahmad and Chaplin, 1984).

3) A. loss of dependency of a fish-host-dependent glochidial stage would also be expected of unionids in such habitats, but would also reduce migratory opportunities. Such a facultative dependency has been reported for several unionid species, including A. imbecilis (see review of literature by Fuller, 1974), although recent investigations have cast doubt on the phenomenon. Tucker (1928) demonstrated experimental infection of A. imbecilis on green sunfish (Lepomis cyanellus) and suggested that fish parasitism could be facultative in this species. Fish hosts of the same four unionid species found in ponds during the current survey were reported by Stern and Felder (1978) from two ponds in Louisiana. Previous records were summarized by Fuller (1974), except those for U. tetralasmus which were unknown until the report by Stern and Felder (1978).

4) Species tolerant of such ecological conditions would be expected to tend toward hermaphroditism. Such a condition is known to occur in A. imbecilis (Sterki, 1898; Van Der Schalie, 1970), but simultaneous hermaphroditism has been documented as the major reproductive mode for only five (Van Der Schalie, 1970) of the over 200 species of unionids in North America (Burch, 1975). Kat (1983) reported that the ratio of male: female gonadal tissue in A. imbecilis varies among populations with different habitats and population densities.

Summary

A survey of bivalve molluscs present in small ponds in east central Texas revealed four unionid species and one fingernail clam. Possible methods of entry of these species into ponds include natural phoresy and human-mediated means. Biological characteristics of species able to survive in these ponds in this geographical area include physiological tolerances, adaptable breeding systems, and phoretic capabilities.

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Table 1. -- Freshwater bivalves of ponds at study site, Henderson and Van Zandt counties, Texas. A. i. = Anodonta imbecilis; U. t. = Uniomerus tetralasmus; L. s. = Ligumia subrostrata; T. t. = Toxolasma texasensis; S. p. Sphaerium partumeium.

		Bivalve Counts					
Pond #	Area	A.i.	U.t.	L.s.	T.t.	S.p.	Species #
1	.34						0
2	.07						0
3	.49		18		5		2
4	.09		7				1
5	.01						0
6	.07		42				1
7	.13	3	22	9	42		4
8	.35	1	5	21	37	22	5
9	.02			13	2		2
10	.02						0
11	.18		15		3		2
12	.01						0
13	.04		45	4	27	18	4
14	.04		11				1
15	.03	1	1	27	21		4
Total Ponds (15)		3	9	5	7	2	-
Total Individuals (442)		5	166	94	137	40	-