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IMPLICATIONS OF LAND AND FRESH-WATER GASTROPODS IN ARCHEOLOGICAL SITES

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Snails have been of passing interest to a few archeologists in the New and Old Worlds. Archeologists have recognized their presence in archeological sites in all parts of the world. In some cases, the archeologists supposed that snails must have been eaten and, in a very few cases, archeologists have had snails identified and occasionally have drawn ecological significance from certain species. This paper is an attempt to describe snails and their significance to archeological studies. Land and fresh-water snails are members of the phylum Mollusca. They belong to the class Gastropoda, the subclass Pulmonata, the order Stylommatophora and the families Polygyridae, Bulimulidae, Archatinidae, Oleacinidae, Zonitidae and Helicinidae (Burch 1962).

The most characteristic aspect of the snail is its shell. It may be conical, pupiform, discoidal or turreted, but it always has a columella. Like all mollusks, they have a mantle through which are perforations for the respiratory organs and the anus. The foot contains the mouth, two pairs of tentacles (the upper pair having the eyes at the tips), and the genital opening (Burch 1962). A significant feature is found in the mouth. Snails have a radula. It is a "... ribbon-like organ with many fine chitinous teeth used in rasping food." When the snail is feeding the radula protrudes through the mouth and is moved across a cartilage by strong muscles. This allows the snail to rasp off particles of food over which it crawls. The great diversity in the form of the radular teeth among various groups of snails has been the basis for a large part of their classification (Burch 1962:2). The radular formula for snails is written in the following form: 24-1-24 Biomphalaria alexandrina, 130±-1-130± Physa (Malek 1962). The middle number represents the central cusp and the flanking numbers represent the number of cusps on either side of the middle cusp (Fig. 2).

Snails are able to move their shells in a number of angles demonstrating torsion (Borradaile et al. 1961). They are univalve mollusks with either gills or lungs, often hermaphroditic and exhibiting reciprocal fertilization (Farb 1963). One snail will assume the part of the female and the other the part of the male. They shortly reverse the positions (Wiswell and Browning 1967). Eggs are produced in a limited period of time during the summer and as many as two hundred eggs may be produced in a single mating (Polley...
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McClure, Dept. of Zoology, U. of Texas; personal communication). The eggs hatch during late August or early September.

Snails may cluster around a specific plant which they eat alive and dead, use for shade and for moisture (McClure, personal communication). They generally need to be near a source of lime or calcium carbonate material in some form (Burch 1962) which they may ingest as small bits of limestone (Dias-Piferrer 1961). The epidermis of angiosperms, decaying plants, minute fungi, lichens, algae, and mosses form the primary food sources. They may, however, eat other snails.

Harry (1967) described three types of behavior in fresh-water snails. These were reactions to changes in the ion content in the water. The forms he observed were: 1) normal crawling and feeding, 2) distressed behavior manifested by retraction into the shell or extension on a surface, 3) retracted behavior manifested by retraction into the shell and detachment from all surfaces. Polley McClure (personal communication) described three types of behavior for land snails. They are: 1) normal feeding and crawling, 2) estivation, withdrawing into the shell due to temporarily unfavorable conditions, and 3) hibernation during winter months. During their winter hibernation, they burrow into the ground to varying depths (Wiswell and Browning 1967). Bulimus may burrow from two to four inches and Ruminia decollata may be found a foot or more below the surface. Other snails may bury themselves so that only their aperture is exposed to the surface.

After feeding, land snails climb for three to six hours on the average, during which time their body size shrinks due to moisture loss. They are generally immobile while aloft. (Blinn 1963). Feeding and most activity occurs at night so that they climb to attach themselves beneath leaves or other protection during the daylight hours. They may have a home range which is more or less restricted by the amount of moisture on the ground (Lokke 1963, and Van Der Schalie and Getz 1962). This range may shift with variation in temperature and/or moisture (Segal 1961). Thus, they live where there is "... certain condition of lime, moisture and light" (Lee 1952: 59). The rates of function shift with changes in moisture and temperature (Van Der Schalie and Getz 1962).

The lifespan of a snail may be between one and four years depending on the environmental conditions. They generally become senile when they achieve a certain size (McGraw 1961). During the winter hibernation there is about an 18% mortality rate (when the shells are oriented naturally with the aperture upward) which increases slightly among individual snails that orient their apertures downward (Carney 1966).
There is a fundamental difference between the snails in the eastern and western United States. In addition there is a third division in southern Texas and in southern Florida (Burch 1962). These differences are based on occurrences of snail families. The boundary for the eastern and western divisions is the eastern edge of the Rocky Mountains.

Much description of snail species was done in the eastern United States during the early and middle 19th century. One of the more recent descriptive compilations was made by Pilsbry (1939) who provided detailed physical descriptions and the geographical ranges of species. He identified snail species in northwestern Arkansas in 1903. Berry (1962) described the snails of the Canadian Rockies providing physical descriptions and ranges. Allen and Cheatum (1961) provided the first descriptive information directed specifically toward archeologists.

No work on archeological specimens from Arkansas has been attempted. In the archeological sites of Texas there are a few species that are regularly encountered. They are:

*Rumina decollata*. Found in damp areas in which the ground level humidity is greater than 44% (Lokke 1963). They are a Mediterranean snail presumably imported by the Spanish. These nails burrow deeply into the ground during their winter hibernation.

*Bulimus dealbatus*. These snails are encountered in semi-arid to arid areas in grassy fields with low brush (Allen and Cheatum 1961). They are the most frequently encountered snail found in central Texas sites. In western Texas other species of Bulimus are encountered. Presumably these were eaten by the Indians.

*Mesodon thyroidus*. These are found in heavily wooded areas (Allen and Cheatum 1961) and around moist midden trash. They are very sensitive to moisture (Dr. H. Gray Merriam, Dept. of Zoology, U. of Texas, personal communication).

*Polygyra texana*. Found in open fields and open woods, these snails are the most populous natural species in the Texas area (Allen and Cheatum 1961).

*Anguispira alternata*. Woodlands and upland grasses form the preferred habitat of these snails (Allen and Cheatum 1961).

*Helicina orbiculata*. Unprotected fields and open woods form the habitat of these snails (Allen and Cheatum 1961). They may also be located around juniper and pine trees (Polley McClure, personal communication).

*Zonitoides arboreus*. These animals are found in wooded areas bordering streams (Allen and Cheatum 1961). They prefer a high humidity environment.
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_Euglandina texasiana_. Found in protected areas where abundant moisture occurs (Allen and Cheatum 1961) these snails are fragile and require special care in collection.

_Succinea grosvenori_. These snails are encountered in moist wooded areas with considerable woodland floor cover (Allen and Cheatum 1961).

_Carychium exiguum_. These very small snails are found in moist wooded areas (Allen and Cheatum 1961). They are about the size of a pin head so careful collection is necessary.

_Helicodiscus singleyanus_. Found beneath leaves and rotting logs in moist wooded areas, these animals must be collected carefully as they are pin head in size (Allen and Cheatum 1961).

_Zonitoides excavatus_. This western snail prefers damp protected environments and may be found in a non-calcareous habitat (Sparks 1963).

Snails have been noted by archeologists working in sites all around the world. Numbers of snails were observed by A. T. Jackson (Mayhall 1939) at Oso Creek and by Holden (197) at Murrah Cave. Jackson (1938) again mentioned snails, this time at the Fall Creek sites. Martin (1933), Campbell (1947), Schmitt and Tolden (1953), Suhm (1957, 1959), Crook and Harris (1957), Col. Thomas Kelley (1961), Scheutz (1961), Allen and Cheatum (1961), Johnson (1961), Honea (1962), Johnson, Suhm, and Tunnell (1962), Reed (1962), Shafer (1963), Pollard, Greer and Sturgis (1963), Watt (1965), Story and Shafer (1965), Parmalee (1965), Scheutz (1966), Sorrow (1966), Sorrow, Shafer and Ross (1967), Hester (1968) and M. B. Collins (personal communication) have all mentioned land snails in connection with archeological sites. Most merely mention the presence of snails. A few had the snails identified and still fewer drew cultural and/or ecological implications. There is only one which identifies, makes cultural and ecological inferences and quantification (Parmalee 1965).

When the presence of snails is noted in the literature, more often than not they will be merely mentioned in passing. More often the presence is not even noted. However, the following reports merely note the presence of snails: Holden (1937), Holden (1938), Jackson (1938), Johnson, Suhm and Tunnell (1962), Shafer (1963), Pollard, Greer, and Sturgis (1963), Story and Shafer (1965), and Sorrow, Shafer and Ross (1967). They do not draw any conclusions about the snails. The following reports noted the presence of snails and suggested that they were utilized as food: Suhm (1957, 1959), Kelley (1961), Scheutz (1961), Honea (1962), Jelks (1962), Reed (1962), Watt (1965), Parmalee (1965), Scheutz (1966), and Sorrow (1966). These reports mention snails as food sources and occasional-
ly draw further conclusions. The following reports noted their use as decoration: Mayhall (1939), Martin (1933), Tolden (1953), Scheutz (1963), Parmalee (1965), and Hester (1968). In the following reports snails were identified by species: Campbell (1947), Suhm (1957, 1959), Crook and Harris (1957), Allen and Cheatum (1961), Watt (1965), Parmalee (1965), and Scheutz (1966). The following reports utilized snails to draw ecological inferences: Suhm (1957, 1959), Crook and Harris (1957), Allen and Cheatum (1961), Reed (1962), and Parmalee (1965). Only one report contains all the possible uses to which snail shells may be put (Parmalee 1965). Collins (personal communication) may make some important conclusions from snails from his salvage work in Val Verde county.

Fresh water snails that have been encountered in archeological sites are:

*Helisoma trivolis.* These snails are found in permanent or temporary water and reach maximum size in semi-stagnant water (Allen and Cheatum 1961).

*Lymnaea dalli.* Found in shallow water with mud bottoms, these snails prefer areas of considerable pond vegetation (Allen and Cheatum 1961).

*Pseudosuccinea columella.* These animals prefer shallow and stagnant water with abundant vegetation (Allen and Cheatum 1961).

*Helisoma anceps.* These snails prefer fresh flowing water (Allen and Cheatum 1961).

Little has been published on fresh-water snails from archeological sites. Parmalee (1965) found three species of aquatic snails at Tick Creek Cave, Missouri. From these three species, he reconstructed the stream environment near the site. One species was evidently large enough to eat and was found in large numbers. Sorrow (1966) found one aquatic snail from the Pecan Springs site probably coming from the spring. Scheutz (1966) found aquatic snails in the Granberg site and assumed that this represented periodic flooding of the site. Cheatum (1966) identified aquatic snails at the Devil's Mouth site.

It has been suggested that snails may act as scavengers on midden debris. The snail *Mesodon thyroidus* is often found today, around trash heaps where there is an abundance of moisture. *Rumina decollata* will often be found in similar conditions. Most often they will collect under boards and bricks (H. Gray Merriam, personal communication). Bulimulus prefers grassy dry areas, but may collect around dryer trash piles of organic material.
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It is often implied rather than stated, that snails were eaten as food by prehistoric Indians. Such an implication appears in Scheutz (1963) in which a net bag containing Bulimulus and Unio shells was described. Similarly, at the Granberg site in Bexar county (Scheutz 1965), a large quantity of mature Bulimulus shell were found. Sorrow (1966) observed snail association with hearths and food refuse areas. A correlation of snails and intensive occupation was noticed by Jackson (1938).

It has been stated in several reports that the snails must have been eaten. Suhr (1959) suggested that the snails at the Williams site had been eaten and that Bulimulus had been eaten at Smith Rock-shelter (1957). Allen and Cheatum (1961) stated that snails were used as food, and Kelley (1961) stated that Bulimulus were eaten at the Crumley site. Martin (1938) said that snails in the Val Verde area were eaten raw or roasted, and Jelks (1962) stated that Central Texas Aspect Indians prepared snails by boiling or steaming. He suggests that they were placed in nests of damp leaves placed over hot stones. Harrington (1960) suggests the utilization of snails for food in northwest Arkansas; however, fecal analysis (Wakefield & Dellinger 1936) failed to produce indications of snail radulae in bluff-dweller coprolites. In Missouri, Parmalee (1965) stated that snails there had been used as food. And in Iraq, Reed (1962) stated that Helix was eaten by peoples there.

Unfortunately, eyewitnesses to Indians eating snails are few and far between. Cabeza de Vaca indicated that Indians on the coast would leave the coast when the cactus tunas were ripe to eat the tunas. While they were doing this, apparently they also collected snails. Honea (1962) compared the middens of northwest Africa to those of central Texas. He found that Takrouian Berbers and some unidentified group of Berbers are presently making burned rock middens and eating snails. Nick Hopkins (Department of Anthropology, University of Texas, personal communication) stated that Maya Indians at Chuj, Cuchimatan and Zinacantan in Chiapas eat snails today. They make special trips to the lowlands to collect them. The snails are boiled and sucked out of their shells. Ruecking (1955), in discussing the Coahuiltecans, mentioned that they ate a wide variety of foods and that little was not utilized. No mention was made, however, of their eating snails. Mayhall (1939) discussed a wide variety of food utilized by the Atakapa, Karankawa and Tonkawa but no specific mention was made of snails. In discussing the Coahuiltecans, Newcomb (1961: 41) says that "few living creatures were overlooked as a source of food. . . ." Again, there is no specific mention of snails. The ethnographic evidence is very poor.

There is, however, one means by which reasonably good evidence of the use of snails for food may be obtained. It will be remembered that the snail has a mouth part called the radula. "The radular
ribbon is enclosed in a radular sac inside the muscular buccal mass. It is a membranous ribbon (lingual ribbon) with a large number of transverse rows of teeth which overlap like shingles on a roof. The central tooth or ‘rachidian’ is bicuspid in the Planorbidae, and there is a series of duplicating teeth on each side of the central tooth. . . . If the radular formula of a Biomphalaria is given as 24-1-24, this means that in each transverse row there are 24 teeth on each side of the central tooth (Malek 1962: 22)." The teeth are made of a chitinous material which are moved across a cartilage when the snails are feeding (Burch 1962). "The number, shape, size and position of cusps on central, lateral and marginal teeth are important in taxonomy. In pulmonates the rows of teeth on the lingual ribbon may be V-shaped as in the Physidae or in a straight line as in the other families" (Malek 1962: 22).

Since the radula is made of tough chitinous material like the shell, it is resistant to acidic action for a period of time longer than 24 hours (Malek 1962). Thus, an ingested snail would be digested except for the radula. The radula, then, would be present in coprolites found in archeological sites. After removing the radulae from the fecal samples, they could be compared to mounted slides of radulae from identified species of snails.

Slides of the radulae of known snail species may be prepared in the following manner:

"1. From the head-foot organ of the snail remove buccal mass together with jaws around mouth opening.
2. Wash in warm water for a few minutes and transfer to a 10 per cent solution of sodium or potassium hydroxide. It requires at least a day for all the tissues around the radular ribbon to be digested.
3. Wash radula and jaws in water to remove the hydroxide then add a two-per cent solution of hydrochloric acid to neutralize the excess hydroxide.
4. Stain in an aqueous solution of orange G for an hour (haematoxylin stains could also be used). Wash in water and destain with two per cent solution of HCl.
5. Transfer radula to a small drop of glycerine on a slide, and with a fine clean brush clean the ribbon, especially the lower surface. The ribbon should then be flattened in the center of the slide with the teeth upwards.
6. Remove glycerine with 95% alcohol. You can place the jaws on the same slide or on a separate slide. Dehydrate with two successive changes of absolute alcohol on the slide, one drop each. Clear the chitinous ribbon in one drop of xylol and mount in
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Canada Balsam. If the ribbon is not well flattened break it horizontally into two pieces. You can also mount in 'Euparal' directly after the dehydration in 95% alcohol” (Malek 1962: 119-120).

These slides can be used to compare known species to the radulae found in fecal samples. In this way it may be shown that snails were eaten.

Snails were used as decoration by Indians in Texas. Martin (1933) mentioned decorated snail shells from Val Verde county in some sites other than Shumla Caves. These snails were painted red or black with lines painted on in the form of chevrons. He also illustrated five shells strung on a lechugilla leaf. At the Blue Mountain rockshelter, Holden (1938) described a single snail shell bead with a hole rubbed into the body whorl. The following year, Mayhall (1939) described a burial excavated by A. T. Jackson at False Oso Creek. The burial (M-28) had a bracelet of 16 snail shells around one arm. Another shell bead was found by Schmitt and Tolden (1953) in Oklahoma. Scheutz (1961) described a group of snails strung on a fiber cord from the Shumla Caves. In Missouri, Parmalee (1965) found a number of perforated river snails. Finally, Tommy Hester (1968) excavated a burial that had a cache of 430 Bulimulus near the left foot of the burial. In addition, there were two bifaces, one bone awl and one stemmed knife with the burial.

Snails may be used to a limited extent to determine the climatic and ecological conditions during the past. They are sensitive to ground level conditions (McClure, personal communication) and occupy narrow zones of preference (Van Der Schalie and Getz 1962). They may congregate around a source of lime (Burch 1962). Environmental factors are important to general activity, habits, and success of snails, varying in degree according to species (Diapiferrer 1961). When the environment becomes unfavorable they may estivate, up to five years for one species. Reed (1962) attempted to make climatological inferences from large land snails in Iraq. He was largely unsuccessful because he chose a large adaptive snail which happened to be utilized as food by earlier inhabitants of the area. Cheatum (1966) utilized snails to establish that the climate in the Amistad area has not changed significantly since the occupation of sites used for analysis. He stated that the smaller species are generally better indicators of climate than the larger specimens. In 1963 Cheatum and Allen (1963) compared Pleistocene gastropods of Ben Franklin and Clear Creek samples. The Ben Franklin fauna reflected a wetter climate than there is in the area at the present time and the Clear Creek fauna were more like the present. Cheatum and Allen (1965) determined, in north Texas, that during the Pleistocene, snails now common in Wisconsin were common in north Texas. With the retreat of the glaciers and the general desiccation...
of the area the snails moved north. No significant faunal changes have occurred in northern Texas since the retreat some 9,000 years ago. Emiliani (1968) used snails in northern Europe to measure temperature and environmental change. Crook and Harris (1957) used snails to show that there was a Pleistocene climate during the time in which the Lewisville site was presumably inhabited.

Gastropods are sensitive to environmental changes and tend to be limited to a varying extent, to a particular set of conditions. They are limited by chemicals in the water if they are aquatic (Harry 1967), as well as the availability of lime, moisture, suitable food, the proper temperature, and the proper light conditions (McClure, personal communications). Some reports have attempted environmental reconstructions to a varying degree.

In 1959 Orchard (in Suhm 1959) concluded that the area around the Smith rockshelter had not changed much since aboriginal habitation. He broke down the habitats of snails at the Williams site (in Suhm 1959) by species. This was limited, though, to brief comments. The Wetherill Mesa Project produced samples of microscopic snails taken from soil samples (Colyer and Osborne 1965) which were identified. Parmalee (1965) was able to determine that the environment around Tick Creek Cave, Missouri consisted of damp woods of oak and hickory with an abundance of rotted logs and forest floor debris. He was also able to determine the nature of streams near the site from snails. Allen and Cheatum (1961) identified snails commonly found in archeological sites and listed their environments. They provided a helpful field guide for the identification of snails from archeological excavation.

Attempts to utilize snail shells for dating archeological deposits have been made. Sam Valastro (Assistant Director of the University of Texas Radio-Carbon Dating Laboratory, personal communication) has dated Bulimulus shells and associated charcoal from the Smith rockshelter (Suhm, 1959). The snails dated a little more than twice as old as the charcoal. This ratio was consistent in all the samples run. He suggests that the area in which the snail lives influences the amount of fossil calcium carbonates assimilated into the shell. The dilution of the fossil calcium carbonates in these particular snails was about five or six percent. Since snails need a source of lime (Burch 1962) and ingest small bits of limestone (Dias-Piferrer 1961), it is to be expected that snails would give an older date than charcoal. With a number of correlations between snail shells and carbon dates a correction factor may be worked out for various areas making snails useful in radiocarbon dating. In addition to radiocarbon dating Allen and Cheatum suggest that Oxygen 18 may be used in dating snail shells. Relative dating using extinct and newly introduced snails may be used with caution. Rumina decollata and Helix have been introduced to America from Europe. Rumina pre-
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sumably was introduced by the Spanish in the middle sixteenth century and Helix has recently been introduced.

Snails are restricted to a specific set of conditions at ground level. These conditions are more or less restrictive, depending on the species under consideration. Many of the more sensitive species are small and special care should be taken to collect them.

Gastropods are frequently encountered in archeological sites. Most species occur in a natural depositional population. However, one species apparently was brought in: Bulinulus. Inferential evidence suggests they were eaten and used for decoration. The scant ethnographic data, Hopkins (personal communication), and Honea (1962), indicate that snails are edible.

They are important to the archeologist because of their cultural uses as food and decoration and their possibilities in determining climatic and environmental changes. Dating is another use for time because of the fossil calcium carbonates assimilated into the shells. Relative dating must be done with care realizing that fossil snails may be carried into a site and that Rumina may burrow deeply.

Unfortunately, most archeological reports merely mention the presence of snails. A few reports contain species identification and only one report provides population counts (Parmalee 1965). Population concentrations may be important temporally and spatially. They may represent climatic change or concentrations of food refuse. I suggest that matrix samples be systematically collected and be washed through a fine screen to retrieve the smaller species. Searches through fecal material from sites should be made in order to retrieve any radulae that might be there. Important archeological information can be gained from snails in conjunction with vertebrate and pollen analysis. They deserve better treatment than they have hitherto received.

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