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A STUDY OF *POLYGYRA INFLECTA* (SAY)

BY ALLAN F. ARCHER

Polygyra inflecta (Say) is an inhabitant of the Alleghanian region. It ranges from the Ozark uplift, including the eastern portions of Oklahoma, Arkansas, Missouri, and Iowa, eastward to the Appalachian Mountains, but it does not appear to pass beyond them. Its southernmost limit is northern Florida, from where it occurs as far north as northern Illinois and southern Michigan. Binney's statement that it inhabits the Sea Islands of Georgia is erroneous. It thus appears that its range is much greater than that of the closely related *P. rugeli* (Shuttleworth), the latter being largely confined to the Cumberland subregion. Its occurrence in the southern states is discontinuous, being abundant in some places or scarce or absent in others, particularly where *P. rugeli* happens to be common. Its scarcity is especially noticeable in southeastern Kentucky, southwestern Virginia, and the Great Smoky Mountains of Tennessee and North Carolina. On the other hand, it is a fairly common snail in many parts of Alabama, Tennessee, Kentucky, and the area of the Ozarks. Throughout its range in the middle western states, it is very uniformly distributed, being seldom absent from any considerable area.

EXTERNAL MORPHOLOGY

In contrast with some widely distributed species of *Polygyra* this species varies surprisingly little in external appear-

ance. The greatest range in size is from as little as 9 mm. in diameter to as much as 15 mm. The largest race known is found in the Great Smoky Mountains (Yancey County, North Carolina). Those inhabiting the Middle West are generally of about 12 mm. in diameter.

The shell is very subglobose, imperforate, and covered with short, flexible periostracal hairs. The aperture is armed with three denticulations, a flat tooth on the inner rim of the outer portion of the peristome, a narrow tooth on the basal rim, and a long, slightly arched parietal lamella. To each of these denticulations there are corresponding pits in the soft parts just back of the edge of the mantle. This species is readily distinguishable from *P. rugeli* in that the outer lip is continuous with the peristome, and not broadly inflected as in the latter. The color of the shell is generally brownish horn, but may sometimes be of an ivory yellow or a ruddy hue. The aperture varies from porcelain white to a delicate pink.

The foot is rather long and slender as are also the eye-peduncles. The edge of the mantle and the sole of the foot are gray. The head and eye-peduncles are black.

INTERNAL ANATOMY

The jaw is broad and arched, with blunt ends, and possesses a variable number of ribs. The number of teeth on single row in the radula is variable, the laterals being roughly from 20 to 30. The central tooth and lateral teeth look much like those of other species of *Polygyra* whose radulae have been observed. The mesocones are large and conspicuous, and the entocones are almost absent. The ectocones are much reduced and blunt. The marginals are bicuspid or even tricuspoid. The radula is asymmetrical.

The genitalia are characterized by the following features: the ovotestis is branched; the hermaphrodite duct convoluted; the albuminiparous gland and oviduct are long; the spermatheca is small and globular with a duct proportionately

shorter than that of most species of *Polygyra* whose anatomy has been studied; the penis is long and curved.¹

VARIATION

Although, as already stated, there is little variation in this species throughout most of its range, yet there are two readily distinguishable varieties known.

Polygyra inflecta approximans Clapp occurs in an ill-defined area in central Alabama which includes Calhoun County, where I found it in 1932, and extends southwestward to the junction of the Black Warrior and Tombigbee rivers. This variety may be distinguished from *P. inflecta* by the outer tooth which is nearer the basal tooth. It is to be considered a genetic rather than an environmental form, as it occupies the same type of country as the typical species.

Polygyra inflecta edentata (Sampson) is characterized by the absence of the outer and basal teeth. It is confined to the Ozark Mountains. Although formerly considered a distinct species from *P. inflecta*, the two seem so closely related that they are here considered as merely varietally differentiated. One described form, *P. i. media* Pilsbry, looks much like a connecting link. It has the outer and basal teeth much reduced. *P. edentata magazinensis* Pilsbry and Ferris has a less rounded aperture which is more constricted behind the peristome. This is another described form which for convenience is placed here under the second variety.

SYSTEMATIC POSITION AND CLASSIFICATION

Polygyra inflecta belongs to the Section Triodopsis Rafinesque. By its relationships it is located next to *P. tridentata* (Say) and its allies. From this group it can be readily separated by its imperforate umbilicus and hirsute epidermis. Although the value of keys is sometimes questionable, a key is inserted here for the purpose of pointing out the most evi-

¹ A good figure of the genitalia of *P. inflecta* is given in Pilsbry, *Manual of Conchology* (1894), IX, second series, pl. 30, fig. 12.

dent features by which different forms in this group may be distinguished from one another and from some near relatives.

- A. Perforate umbilicus *P. tridentata* and allies
- A. Imperforate umbilicus.
 - B. Epidermis lacking hairs
 - *P. appressa* and allies (one exception)
 - B. Epidermis hirsute.
 - C. Diameter 20 mm. or more; lip thin, broadly flaring.
 - A large snail *P. obstricta*
 - C. Diameter 15 mm. or less; lip thicker and less flaring
 - *P. inflecta* and allies
 - a. Two teeth on the peristome.
 - b. Outer tooth nearly continuous with inner rim of peristome.
 - c. Outer tooth separated from basal tooth by a definite gap *P. inflecta*
 - c. Outer tooth close to basal tooth, only separated by a small notch
 - *P. inflecta approximans*
 - b. Outer tooth deeply set in the aperture
 - *P. rugeli*
 - a. One tooth or no tooth on the peristome.
 - bb. Outer tooth present; basal tooth absent
 - *P. smithii*
 - bb. Outer and basal teeth absent
 - *P. inflecta edentata*

The following summarizes the classification used in this paper and the range of each of the species under discussion:

Polygyra rugeli (Shuttleworth). Occurring in the Cumberland subregion and as far south as Alabama and Georgia.

Polygyra inflecta (Say). Throughout much of the Alleghanian region as already indicated.

Polygyra inflecta edentata (Sampson). Ozark Mountains of Missouri and Arkansas.

Polygyra inflecta approximans Clapp. Central Alabama.

Polygyra smithii Clapp. Northeastern Alabama.

HABITATS

The apparent difficulty in finding *P. inflecta* in quantity is due to its habitats and mode of life. In the Middle West its favorite habitat is a depression in the ground filled with fallen leaves and plant débris. As a rule such spots are not in thick woods, but in open groves, very open woods chiefly of oak, on dry hillsides, or in upland country. On the whole these snails live in country nearly the same as that preferred by *Polygyra fraterna* (Say). The under sides of planks in open fields also serve as habitats for *P. inflecta* quite as much as for *P. fraterna* and *P. hirsuta*. These spots, however, are suitable places only during periods of inactivity; specimens are otherwise rather hard to find unless one may happen upon them swarming over rocks, leaves, or grass. Such a find is exceedingly rare. In general, the environment is rather different from that sought by many other Polygyrae. It may suffice to point out that oak woods which are favorable habitats for this species are usually shunned by many other species. On the other hand, the woods and forests so frequented by the North American forest snails are poor spots for *P. inflecta*. In the southern United States the habitats are similar in character in that they consist of open and cut-over country, river bluffs, and dry, open, rocky places supporting a growth of oak or cedar trees. Virgin forests are poor hunting grounds for collectors seeking this species in the South.

It seems clear that *P. inflecta* is not a true forest snail, but rather one that has profited by human intervention in the environment. In this respect it is quite like *P. appressa*, *P. hirsuta*, *P. stenotrema*, *P. fraterna*, and *P. tridentata*. To a greater or lesser degree all these species show tendencies of becoming inhabitants of the open country as have the European Helices. At any rate, *P. inflecta* is successful in getting a living in conditions poorly tolerated by the "forest" snails. Undoubtedly, it escapes detection not merely by reason of its hairy shell incrustated with leaf mold which blends so well with its surroundings, but also because of its exceptional habitats. Provided suitable food and a damp shelter may be had,

the general nature of the surroundings appears to matter little.

As regards abundance, very satisfactory numbers of adults may be found in suitable localities provided they are sought during the periods of inactivity, when they are concentrated. Very frequently the snails hibernate in pairs.

HABITS AND REPRODUCTION

The life history of *P. inflecta* is not complex, although up to the present time it has been unknown. In nature this snail is so inconspicuous that it is difficult to observe its life processes. It is, however, one of the most satisfactory of laboratory animals.

During the period of hibernation, *P. inflecta* is buried under leaf mold. The aperture is sealed by a strong, transparent epiphragm derived from slime secreted when the snail went into winter quarters. The period of emergence from hibernation depends on the climate. In Ann Arbor, Michigan, I have found the snail emerging at an air temperature of 45 degrees Fahrenheit. For a short time after this its existence is purely vegetative. It feeds voraciously on anything that suits its fancy. Of what the food consists mainly as far as specific plants go it is not possible to say here. Leaf mold is an important item. In the laboratory the snail accepts many kinds of herbaceous plants without much discrimination. It feeds on dead organic matter both plant and animal. The laboratory animals show a preference for lettuce and dandelions. They also eat the cadavers of snails as well as dead insect larvae. Organic fats such as butter are accepted.

In the northern latitudes sexual congress begins after the middle of April. Matings take place from that time on into the summer. The mating behavior is simpler than that of many of the *Helices*. The mating snails may be observed in each other's company for some time before copulation begins. They maneuver around until they are nearly facing each other, with the right side of the head of one close to the right side of the head of the other. This brings the genital pores,

situated almost directly beneath the right eye, in juxtaposition. These animals are hermaphrodites, one snail acting as the female, the other as the male, although at subsequent matings the former may act as the male, and the latter as the female. Apparently in *Polygyra* only one set of sex organs is functional at a time. However, in *P. profunda* (Say) it has been noted that during coitus the snail acting as the male also everts the female organs. There is no mutual fertilization in this case, and the reason for this is not well understood. When the animals of *P. inflecta* are sufficiently excited, the genital pores begin to dilate. Soon the penis begins to erect, as does also the vagina. In the case of the latter this condition serves to bring down the mouth of the spermatheca. The everted vagina now appears as a large, white, thick-headed club; the penis as a smaller, white club with a narrowed apex. The penis is inserted into the aperture of the vagina. The organs continue to enlarge, crowding against each other. The united genitalia undergo a change of appearance. They partly coil around each other, and leave their horizontal position, assuming a vertical one. The fully erect organs resemble a cylinder which is larger than the head of either snail. The two remain in this position for some time until orgasm has been experienced. The sperm being transferred to the spermatheca, the organs detumescence and uncoil. Altogether this process takes less than three-quarters of an hour. This is in contrast with the larger *Polygyrae*, for example *P. profunda*, which has been observed in coitus for well over six hours. Matings take place at night.

The eggs are laid the day following the mating. In about two days the young hatch out. There are about half a dozen eggs in a clutch. The young on hatching have attained the first or nuclear whorl stage. Growth continues throughout the active periods in the summer and most of the fall. The final completion of growth is not reached until the following summer. As a general thing the span of life is from two to three years, but some individuals survive for a longer period. There is no evidence of as great longevity as is known to be

the case for some species of snails, for very rarely is a shell found showing the usual characters of old age.

ENEMIES AND ADAPTATIONS

Enemies of *P. inflecta* consist largely of predatory mammals. The shrew is known definitely to be one. The skunk, opossum, and raccoon may also be possible enemies, as there is evidence of their using snails as food. Birds may be suggested as a possibility, but whether they are important enemies or not is hard to say. The gnawed shells are mute testimonials of the part played by mammalian enemies. However, in any one locality the numbers of shells so mutilated are not large. In fact, they are much fewer than those of some other species of *Polygyra*. On the whole the chance of survival of individual snails appears to be good. The protective factor in this species lies in its inconspicuous exterior to whose surface dirt clings. Since it blends in so well with its surroundings, it readily escapes the detection of possible enemies. Then, too, it is quite likely that the hairy shell is repugnant to many creatures such as birds.

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