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ANATOMY AND LIFE CYCLE OF THE SNAIL RUMINA DECOLLATA (PULMONATA: ACHATINIDAE)

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ABSTRACT. The anatomy of the gastropod *Rumina decollata* (native of the Mediterranean region, introduced in the southeastern U.S.) is described from gross dissection of organ systems. Reproduction is traced through copulation, egg-laying, and rapid direct development to maturity. At Abilene, Texas, the animal was found to be active following late summer rains and intermittently through the winter (burrowing in very cold weather), going into estivation for the dry summer season.

Rumina decollata L. is a terrestrial snail with a coiled shell, belonging to the Order Pulmonata, Family Achatinidae. The species name refers to the broken apex of the shell, a decollated shell. Native of the Mediterranean region, the animal is now widely distributed in the southeastern and south central portions of the United States. Although it is a rather common garden pest in the states on the northwestern side of the Gulf of Mexico, little descriptive literature concerning this species has been published.

DISTRIBUTION AND OCCURRENCE

Rumina decollata is indigenous to the Mediterranean region and was introduced into the United States early in the 19th Century at Charleston, South Carolina. Pilsbry (1905) summarized the distribution of this species as follows: entire Mediterranean region, the typical forms from southern France, Italy, Sicily, and the Canary Islands; introduced in the Azores, Madeira, and Cape Verde Islands, Bermuda, Santo Domingo, Cuba, and Charleston, South Carolina. Cheatum (1934) reviewed the distribution of the species in the New World, citing various collections and published reports: "For the past three years, this species has been thriving in several backyards in Oak Cliff, a suburb of Dallas. . . . On a recent trip . . . found in abundance along the banks of the Guadalupe River, one-half mile southwest of Greene[2] . . . In Breckenridge Park, San Antonio, this species is distributed all along the banks of the San Antonio River . . . Johnson (. . . 1900) speaks of a colony that lived for a while in Philadelphia . . . Smith

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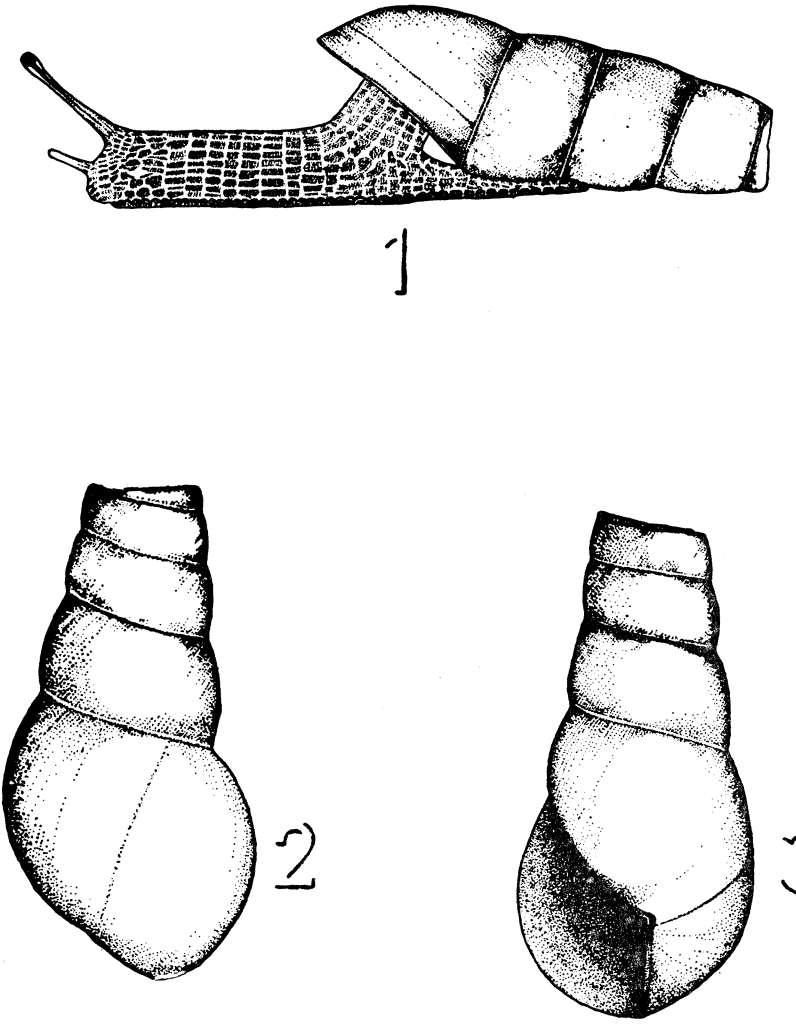
[2] Misspelling of Gruene, near New Braunfels, Comal County. (Information supplied by Dr. S. W. Geiser.)

(. . . 1912) notes the shells as common in cemeteries of New Orleans, La., and the older parts of Mobile, Ala. Ferriss (. . . 1914) calls attention to its being found by Camp in Brownsville, Texas. Recently *Rumina* has been collected in the south part of Houston, Texas. . . . It seems quite probable that this species occurs over a much wider area in the southern United States than hitherto reported." Large numbers have been found in gardens in San Angelo, Texas, and it was collected by the writer in Abilene.



***Rumina decollata*. Fig. 1, fully extended; Fig. 2, ventral view; Fig. 3, dorsal view.**

METHOD OF STUDY

The snails for this study were collected in the southwestern part of the City of Abilene, Texas. Numerous snails were observed actively crawling about following a late summer rain. The collection was made in August, 1950, at which time specimens of all sizes were taken.

Culturing *Rumina decollata* was not at all difficult, and it was found that the species would live and breed with little attention. Specimens of all sizes were kept in a glass terrarium with three to four inches of soil which was kept damp. This container was kept in a room where the temperature remained fairly constant at 20° C. The snails would eat a wide variety of organic matter, both plant and animal material. They were fed commercial preparations of fish food, cereals, dried shrimp, and various green vegetables, but preferred and thrived on lettuce leaves and rolled oats. The snails would drink water from low containers placed in the terrarium.

Activities of the animals were easily observed through the glass walls without disturbing them. Certain individuals were separated and kept in individual containers for the collection of specific data on the life cycle. The death rate of the original collection was four per cent for a period of ten months.

The anatomical studies were made using both freshly killed and preserved specimens. These terrestrial pulmonates were best killed by asphyxiation in stoppered bottles entirely filled with water. After about twenty-four hours, when all the dissolved oxygen had been used up, the snails were found to be insensitive and extended. The preserving fluid used was five per cent formalin or seventy per cent ethyl alcohol. Freshly killed specimens were excellent for the initial identification of organs, but the preserving solution served as a hardening agent of the tissue to allow for a more intensive examination.

Dissection was done with the aid of a wide-field binocular microscope. No histological studies were made.

GENERAL HABITS

Rumina decollata will thrive in many soil types in the South. It appears that temperature and moisture are the limiting factors in distribution.

The colony at Abilene, Texas, was found in a heavy loam soil containing much clay, but the snails grew equally well when transferred to a sandy soil. The colony was associated with the arthropod, *Armadillidium vulgare*, the common sowbug or pillbug. Some specimens were found extended and crawling about; others were entirely covered

by humus or had only the apices of their shells visible. Both living and dead shells were found. While most of the snails burrow in the soil during a dry period, some remain on the surface and only withdraw into the shell. The snails are very active after a rainy period, but will not become extended while rain is falling due to the sensitivity of the tentacles which are withdrawn immediately upon contact.

Rumina decollata is active intermittently throughout the winter in the South. A rainy period followed by a few warm days results in their appearance at the surface of the ground. A few cold days, however, will cause them to burrow into the soil, sometimes far enough down to cover their shells completely.

The snails have an aversion to light and usually remain hidden by day and feed mainly at night or after rain. Observation of laboratory specimens was most rewarding at night.

In their natural habitat the snails feed upon living vegetable matter, from which fragments are torn and swallowed by means of the radula, a tongue-like structure. During feeding, the snail can pass this organ against the roof of its mouth, or can advance it to the jaw, or can even project part of it beyond the jaw. The radula does not bite the food taken into the mouth and thus mince it, but rasps it to pieces.

DESCRIPTION

SHELL.—*Rumina decollata* is a univalve (Plate I) having the shell spirally coiled to the right, the whorls built around a hollow central columella. The shell is turriculated, longitudinally striated with irregular elevated lines or wrinkles, which are a litte more prominent near the sutures. Coils are tightly fused together at the sutures, and the sutures are not deeply indented. The whorls ordinarily are four; occasionally five are found. The variation occurs due to the habit of decollation. Young snails develop seven distinct whorls before decollation, which begins in the fifth whorl. A portion of the fifth whorl remains, giving a broken appearance. It was observed that the snails would, on occasion, aid in the decollation by striking the shell against rocks or the glass wall of the terrarium. No snails of this collection reached an adult size without decollation; however, Ferriss (3) reports that Mr. Camp found a large colony in a Brownsville, Texas, garden and succeeded in getting a few specimens without losing the points, carrying them in cotton.

The maximum size reached by snails in the collection was 29 mm. in length and 11 mm. in diameter. The body whorl is more than double the width of the truncated apex, the spire almost three times the length of the aperture. The large anterior opening faces to the right.

In the truncated form of the apex of the spire, this species resembles *Pupa torticollis* and *Bulimus multilatus*. It is sufficiently distinct from the latter, to which it is more closely related than to the other, by its more cylindrical and less conical form, being less robust and more elongated; the aperture is narrower and forms a smaller proportion of the total length. The shell of *Rumina decollata* turns an opaque white after the death of the animal.

EPIPHRAGMA.—During hibernation the shell aperture is closed leaving only a small hole for breathing. The head and foot are withdrawn into the shell and the edges of the mantle approximate to form an almost complete disc filling up the aperture. A membrane (epiphragma) is secreted by the edge of the mantle. The epiphragma is essentially a layer of dried slime, supplemented and strengthened by the addition of calcium phosphate. It hermetically seals, during estivation, and prevents the loss of moisture. The epiphragma is dropped when the animal resumes an active existence at the beginning of a moist season.

GENERAL BODY ANATOMY.—The body of the snail is composed of three regions, the visceral hump, the head, and the foot. The visceral hump is the portion of the body covered by the shell when the animal is extended; the head and foot make up the portion outside the shell. The elongated foot is blunt anteriorly and pointed posteriorly, and its pedal gland opens above the front of the foot and below the inferior lip of the head. There is no boundary between the head and the foot, and the whole can be retracted within the shell by the action of the columella muscle.

The two pairs of tentacles on the head are tactile and capable of invagination. The first are short and olfactory in function; the larger posterior pair bear a pair of simple eyes at their tips. Both pairs of tentacles are hollow and when retracted are turned outside-in by contraction of a muscle attached to the inside of the tip. The mouth is a transverse slit just ventral to the anterior pair of tentacles. The reproductive aperture is on the right side of the body below and behind the second pair of tentacles.

The junction of the visceral hump with the rest of the body is seen anteriorly as a thickened collar, which is the edge of the mantle and the seat of the secretion of the principal layers of the shell. The external opening of the mantle cavity and the anal opening are adjacent and lie in the posterior region of the mantle collar. The first turn of the spiral contains the mantle cavity, the kidney, and the heart. The remainder of the coiled visceral hump contains the lobes of the digestive

gland, loops of intestine, albumen gland of the reproductive system, and the ovo-testis.

DIGESTIVE SYSTEM.—The alimentary canal begins with the buccal mass. The ventral mouth has three lips, two lateral and one ventral. On the roof of the mouth is a small transverse bar, the jaw, and in conjunction with this works the radula. The radula lies upon a thick muscular cushion on the floor of the snail's mouth in a ventral diverticulum of the buccal cavity called the radula sac. A tough membrane covers its under surface, and it bears many rows of teeth. The central tooth of the radula is supported by tissue resembling cartilage, which also serves for the attachment of muscles. The whole forms the rounded organ which is the buccal mass.

The esophagus is narrow and passes from the buccal mass through the nerve ring to a thin-walled crop. A pair of salivary glands lies on each side of the crop, and their two ducts pass forward through the nerve ring to open into the top of the buccal mass. The crop is succeeded by the thin-walled stomach, which is wider than the crop and receives the ducts of the digestive glands. The intestine lies within the larger left digestive gland and follows an S-shaped course to the rectum which lies along the inner margin of the mantle cavity.

RESPIRATORY SYSTEM.—The mantle cavity is developed as a lung with a small external opening, the pneumostome. The mantle forms the roof of the lung cavity and is highly vascular. The floor of the cavity is arched and has a layer of muscles. Muscular contraction and relaxation result in the change in size of the cavity, with resultant intake and expulsion of air. Exchange of gases occurs with the blood vessels in the roof of the cavity.

EXCRETORY SYSTEM.—The excretory system is simple, there being one kidney drained by a single kidney duct. The ureter is a thin-walled tube that passes along the edge of the kidney, runs along the right border of the mantle cavity parallel to the rectum, and opens by an elongated slitlike opening in the right edge of the pneumostome above the anus.

CIRCULATORY SYSTEM.—In the mantle cavity lying anterior to the kidney, is the pericardium enclosing the ventricle and single auricle. The muscular ventricle is smaller than the large thin-walled auricle. A single aorta leaves the ventricle and divides into an anterior (cephalic) aorta which supplies the head and foot, and a posterior (visceral) aorta which passes along the ventral surface of the digestive gland to supply the whole visceral hump. From the terminal branches of these arteries the blood enters a system of irregular lacunae, the haemocoele. The haemocoele discharges blood returning to the heart

into the circulus venosus, which empties into afferent vessels. The afferent vessels lie along the sides of the mantle cavity, blood from the head and foot passing into the left arm of the afferent vessel and blood from the visceral hump entering the right arm. The afferent vessels break up into a capillary system in the roof of the mantle cavity, reuniting to form the efferent branchial vessel (pulmonary vein) which returns the blood to the heart. The efferent branchial vessel is the most prominent vessel and lies along the middle of the roof of the mantle cavity. The part of the right arm of the afferent branchial vessel lying alongside the kidney gives rise to afferent renal vessels. An efferent renal vessel joins the efferent branchial vessel immediately before it enters the auricle.

NERVOUS SYSTEM.—The anterior part of the nervous system is enclosed in a nerve ring which encircles the esophagus. The ganglia and nerves forming the ring are enclosed in dense connective tissue. A pair of lobed cerebral ganglia forms the roof of the ring. The ventral part of the nerve ring is made up of the pedal, pleural, and visceral pairs of ganglia. Laterally, the pedal and pleural ganglia are linked on either side to the cerebral ganglia by the cerebro-pedal and cerebro-pleural connectives.

From the cerebral ganglia pass forward a pair of cerebrobuccal connectives leading to the buccal ganglia, two pairs of tegumentary nerves, and a pair of prominent optic nerves which run alongside the retractor muscles of the posterior tentacles.

From the pedal ganglia pass numerous pedal nerves to the nerve net in the foot.

The visceral ganglia give rise to visceral nerves which pass posteriorly. Laterally, arise a pair of pallial (mantle) nerves, and posteriorly the genital nerve and the median mantle nerve.

REPRODUCTIVE SYSTEM.—The reproductive system is hermaphroditic. Eggs and sperm are produced in the ovo-testis which is protandrous, preventing self-fertilization. The ovo-testis is a small gland found in the apex of the visceral hump, lying in the inner surface of the right digestive gland. From the ovo-testis, the convoluted hermaphrodite duct runs to the albumen gland. The albumen gland lies between the left digestive gland and the coiled right digestive gland. From the albumen gland arise two ducts, the larger of which is the female duct (oviduct) and the smaller the male duct (vas deferens). The vas deferens coils slightly toward its junction with the penis. The muscular penis is protrusible through the common genital opening, and is withdrawn again by the retractor muscle attached to its posterior end. The oviduct opens into a short, thick-walled vagina. Both

vagina and penis open into a common genital atrium with the opening to the exterior far forward on the right side. At the junction of the vagina and penis a spermathecal duct begins, lies close to the oviduct, and then diverges and enlarges to form a bulbous spermatheca, for the storage of spermatozoa from another snail.

The anterior part of the reproductive system, including the common genital atrium, the penis, the vagina, and the anterior parts of their ducts, lies in a body cavity which also contains the anterior portion of the alimentary canal and the anterior portion of the nervous system.

REPRODUCTION

Cross-fertilization is the rule in these hermaphroditic snails. There is reciprocal fertilization, that is mutual impregnation, preceded by a preparatory event in which two snails approach each other and evert the genital atrium. Copulation occurs in forty to sixty seconds. Copulation of snails in this collection began in the middle of September and continued for a period of three weeks. After copulation occurred, the snails were isolated and each was found to produce numerous clutches of eggs.

The first eggs were laid in from nine to nineteen days following copulation. This irregularity is due probably to delayed fertilization or retention of the eggs in brood pouches. The average time interval was 13 days. Successive clutches of eggs were then laid at intervals into the early spring. The tendency is for the total number of eggs in a clutch to increase in successive clutches. The number of eggs per clutch varied from 7 to 30. Three typical cases are as follows: snail No. 4, six clutches of eggs totaling 85 eggs, laid between October 8 and November 18; smallest clutch, 7, largest, 24. Snail No. 7, four clutches of eggs, totaling 70 eggs, laid between September 3 and October 29; smallest clutch, 7, largest, 26. Snail No. 8, ten clutches, totaling 143 eggs, laid between October 12 and November 19; smallest clutch, 7, largest, 30.

The eggs measure 2 mm. in diameter. There is some slight variation in this size. The zygote is enveloped in great quantities of albumen and the whole is encased in a calcareous test, not unlike that of birds. The eggs are laid in small holes in the soil.

The usual period of incubation varies from twenty-five to thirty-six days, or an average time of 28.5 days. In one case it was only nine days. This very short incubation time occurred in September, at the onset of egg laying. This variation could occur if the eggs were retained in a brood pouch for further development.

DEVELOPMENT AND GROWTH

The eggs hatch directly into small snails. The spiral shell begins as a capsule, additions being made at the open or mouth end. Development is very rapid. The young snails are active and feeding on the day after hatching. The shell consists of one and one-half whorls 1.75 mm. in length when hatched. In ten days the length has increased to 5.6 mm. with four complete whorls. When twenty days old, there are six whorls with a length of 9 mm. At the end of a month's growth, the snails have reached a length of 12 mm. with seven whorls and decollation in the fifth whorl. After decollation there is increased growth in the anterior whorls and adult size is reached at two and one-half months. At this time they are 12.5 mm. long.

After attaining adult size, snails in this collection went into hibernation for a period of five weeks. Following hibernation the young snails began copulating and produced eggs.

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