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(Gould). It is probably more closely related to *P. reesei* Morrison.

VENTRIDENS EUTROPIS Pilsbry

Ventridens intertextus eutropis Pilsbry, 1946, Acad. Nat. Sci. Philadelphia Monogr. no. 3, *2:* 470, fig. 255.

Ventridens eutropis is anatomically distinct from *V. intertextus* (Binney) and I have seen no intergradation in shell characters.

Pilsbry gave the type locality as "Cherry Valley," east of Watertown, Tennessee. But Cherry Valley is west of Watertown. It is known from Cheatham, DeKalb, Macon, and Wilson Counties, Tennessee.

VENTRIDENS VOLUSIAE (Pilsbry)

Ventridens intertextus volusiae (Pilsbry), Acad. Nat. Sci. Philadelphia Monogr. no. 3, *2:* 471.

Ventridens volusiae has not been dissected; however, the shell differences are constant. It is a species of the St. Johns River Valley of northeastern Florida. It is known from Duval, Lake, St. Johns, Seminole, and Volusia Counties, Florida.

DISPERSAL OF AQUATIC GASTROPODS VIA THE INTESTINAL TRACT OF WATER BIRDS

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The occurrence of gastropods in isolated bodies of water has interested biologists for many years. Most authors (e.g. Kew, 1893, Boycott, 1936 and Baker, 1945) agree that birds are primarily responsible for transporting snails overland. The usual assumption is that snails become attached to the external surfaces of resting or feeding water birds and can remain attached and viable for sufficient lengths of time to effect dispersal. Malone (1965) showed that this is possible and that water birds do provide an effective and readily available means of dispersal for fresh-water snails.

Seldom has the possibility of viable snails being carried in the intestinal tract of birds been considered. Pascal (1891) suggested that the egg masses of *Lymnaea auricularia* might pass through the tract of swans but apparently he did not actually recover eggs from the feces of the birds. Kobelt (1871) thought that snails might pass unharmed through birds. His suggestion was tried by Bondesen and Kaiser (1949) with *Hydrobia jenkinsi.* They found that no snails passed unbroken through ducks.

My research was undertaken to determine if juveniles and adults or egg masses of *Physa anatina* and *Helisoma trivolvis* could be dispersed via the intestinal tract of birds. Both species commonly occur in isolated bodies of water in west Texas. Mallard ducks (*Anas platyrhynchos*) and killdeer (*Charadrius vociferus*) were considered as examples of agents transport.

This research was supported by National Institutes of Health Grant GM 11394-01A1. I am grateful to Vernon W. Proctor for giving helpful suggestions and to E. P. Cheatum for aiding in identification of the snails.

Methods and Results. Ducks were placed in wire cages and fed aquatic vegetation containing large numbers of snails and egg masses. Each bird ingested about 75 to 100 egg masses per meal. Estimates of the number of snails eaten per trial ranged from 50 to 200. After feeding, the birds and cages were inspected for adhering egg masses and snails. Brown wrapping paper was placed beneath the cages and the first several droppings passed by each bird were collected.

Feces were inspected with a dissecting microscope. Any egg masses or embryos found were placed in small dishes of water and *Chlamydomonas* sp. for observation. To provide for undetected snails, the feces were placed in jars of soil and water with *Elodea.* All cultures were placed in a 27°C light room. Controls treated similarily hatched within 5 or 6 days.

Five ducks were used for 47 trials with *Physa.* Only 2 intact egg masses were recovered from the feces. The first of these contained 17 embryos, none of which developed further. Seven eggs were contained in the second; 4 developed normally and hatched on the fourth day following recovery. Five juveniles were found in a gallon jar which had received feces 14 days earlier. These probably developed from an egg mass. Juvenile and adult snails were never found in the feces. Shell fragments were frequently seen indicating that most if not all had been crushed. Apparently the egg masses were usually broken and the embryos scattered during passage through the tract. Twenty-eight individual *Physa* embryos in various stages of development were recovered from feces. An attempt was made to culture these but none were viable.

Eight trials were made with ducks and *Helisoma.* Neither embryos nor juveniles and adults were recovered from the feces. However, one snail was found in a culture of feces 23 days after passage. No other *Helisoma* were recovered from birds, suggesting that this individual was probably a contaminator.

Post mortem inspection of the intestinal tract of 10 ducks indicated where the snails were being killed during passage. The birds were fed vegetation with *Physa* each 15 minutes for one hour. Fifteen minutes after the last meal, they were killed. Material found in all portions of the tract was removed, inspected, and cultured.

Neither juvenile and adult snails nor egg masses were found past the gizzard. Portions of 4 egg masses containing 31 embryos were taken from the gizzard. None developed further. Only one snail was recovered from the gizzard. It was found just inside the entrance. The snail's peristome was damaged but the snail was living when recovered. However, it died within the following hour. Only shell fragments were found in the lower portion of the gizzard where grit is contained.

The only viable snails recovered from the dead ducks were found in the crop. Four juveniles and 9 egg masses containing 153 embryos were recovered. All the juveniles lived and 136 of the embryos hatched within 5 days.

Egg masses were mixed with zooplankton and fed to killdeer. Individual birds were placed in a cage consisting of two compartments. Each was fed in one compartment then moved into the next where feces were collected. Ten killdeer were used for 56 trials with *Physa* and 20 with *Helisoma*. Each bird ate 10 to 20 egg masses per meal. No juvenile and adult snails were fed nor were post mortem studies conducted with killdeer.

Feces collected from killdeer were placed immediately in well oxygenated water. This procedure was not possible with the bulky duck feces but did not hamper inspection of killdeer feces. Egg masses wre quickly separated from the feces by gentle agitation, removed, and cultured in the same manner as those taken from ducks.

A total of 45 *Physa* egg masses were recovered from the feces of killdeer. Only 3 of these contained viable embryos. 17 of 26 embryos contained in the 3 egg masses hatched. Embryos contained in the remaining 42 egg masses were killed during passage. One hundred and thirty-two individual embryos from broken egg masses were recovered, but as with ducks, none was viable.

Only 8 *Helisoma* egg masses were recovered from the feces of killdeer. None of the embryos contained in these developed. Thirty-seven individual embryos were found in the feces; none survived passage.

Discussion

It seems unlikely that dispersal of *P. anatina* and *H. trivolvis* via the intestinal tract of birds is of much significance, particularly with the latter. Apparently the only important aspect of internal transport is the possibility of snails and egg masses being carried in a bird's crop. Ingested food is not exposed to significant digestion before it enters the gizzard. Thus, if snails and egg masses contained in the crop were vomited, they would be viable. Bondesen and Kaiser (1949) did not consider this possibility in their study of *Hydrobia jenkinsi.*

Although internal transport of snails by birds seems possible, external transport as demonstrated by Malone (1965), is a much more effective mechanism of dispersal. The passage of viable snails through birds is probably a matter of chance and appears to be a rare occurrence. On the other hand, snails frequently become attached to the surfaces of birds and the opportunities for dispersal are probably numerous.

The distance snails can be carried internally is limited by the time required for food to pass through the intestinal tract and also by the period that snails can survive within the tract. In this study, the last of an entire meal seldom required over 2 hours to be passed by either ducks or killdeer. Viable embryos recovered from feces had always passed within 30 to 45 minutes following ingestion. Thus, it is unlikely that embryos could survive a maximum passage of 2 hours.

Dispersal via the crop probably has significance only involving short distances. Unfortunately, the rate of passage of food from the crop of ducks is not known. However, only 3 of the 10 ducks killed had food in their crops 15 minutes after eating.

Snails adhering to the surfaces of birds are likely to be carried great distances. Sufficiently small snails can remain attached to birds indefinitely and the period that snails can survive out of water far exceeds their period of survival within the intestinal tract.

Fresh-water gastropods apparently have not acquired resistant eggs to enable them to be dispersed via the avian intestinal tract. For aquatic organisms that are easily desiccated, this has proven to be a highly effective mechanism of dispersal. For example, Proctor (1964) found that the eggs of many crustaceans are sufficiently resistant to withstand passage through the intestinal tract of ducks. Apparently no selective advantage has been placed upon resistant eggs for snails since juveniles and adults can usually resist the amount of desiccation encountered during an overland journey.

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NOTES AND NEWS

Ruth Ingersoll Baily died suddenly January 11, 1965. She was born in Montrose, Colorado, but at an early age, her mother took her to San Diego, California, where she lived much of her life. She was an alumna of Mills College. She met Joshua L. Baily, Jr., on the beach at La Jolla, where they both were collecting shells. They were married in San Diego, Feb. 19, 1917. Mrs. Baily was a member of the Society of Natural History of San Diego, the Historical Society of San Diego, many other San Diego organizations, the Mills College Club, the Academy of Natural Sciences of Philadelphia, the American Malacological Union, etc. As joint author with Dr. Baily, she published several papers on mollusks. All who knew Ruth will miss her keenly, and she still lives in our memories. — Editors.