

Near the Yacht Club pier were found many *Polinices heros*, and their red-brown "sand-collars." In the Jacquet were many *Litorina littorea* and *Litorina rudis*. On the exposed beach, nearer the town, we found *Mytilus edulis*. On the rocks, in the Racquet, we found *Thais lapillus* and a host of *Acmaea testudin- alis* ranging in size from one-eighth of an inch to about an inch in diameter. In the mud, at the base of the rocks, were a multitude of *Buccinum undatum*, *Neptunea decemcostata*, ranging in size from one-eighth of an inch to about an inch in diameter. In the mud, at the base of the rocks, were a multitude of *Buc- cinum undatum*, *Neptunea decemcostata*, and *Colus stimpsoni*, all alive and half-buried. Some dead specimens of *Aporrhais occi- dentalis* were also found, five of them being full-grown.

On the suggestion of Capt. Danforth, we constructed a dredge, and endeavored to dredge Bear Island Bar from his motor-boat. Here we found quantities of *Lacuna vineta*, *Alec- trion obsoleta*, *Cylichna alba*, and two *Polinices triseriata*.

There were some soldiers encamped at Digby, and they used to gather *Litorina littorea* and steam and eat them, without any flavoring. They sometimes ate *Thais lapillus* also. One day, after a rain, we found two *Helix hortensis* crawling along the road.

A NEW TYPE OF THE NAUAD-GENUS FUSCONAIA.
GROUP OF F. BARNESIANA LEA.

BY A. E. ORTMANN.

During the study of the nauad-fauna of the upper Tennessee, the present writer found that there exists, in this region, a peculiar type of shells, belonging to the genus *Fusconaia*, the various forms of which have been described previously under a great number of specific names, which, however, seem to belong all to one species. In addition, among material received from L. S. Frierson from the Ozark Mountains, a form was discov- ered which presented the same structure.

The oldest name for the upper Tennessee form is *Unio bar- nesianus* Lea. A more detailed account of its various phases is to be given elsewhere, and it suffices here to mention only those

forms which belong
three local, or ecologi

1. FUSCO

U. barnesianus Lea
Lea, '60. *U. Lyoni*
lenticularis Lea, '72.

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in the development
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2. FUSCONAIA B/

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3. FUSCONAIA BA/

U. tumescens Lea, '4
Lea, '71.

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the upper Tennessee form is *Unio bar-* detailed account of its various phases is and it suffices here to mention only those

forms which belong here. According to obesity, I distinguish three local, or ecological races:

1. FUSCONAIA BARNESIANA (Lea) 1838.

U. barnesianus Lea, '38. *U. meredithi* Lea, '58. *U. pudicus* Lea, '60. *U. Lyoni* Lea, '65. *U. tellicoensis* Lea, '72. *U. lenticularis* Lea, '72.

As the normal (most abundant) forms we may regard *U. meredithi*, *pudicus* and *lenticularis*, which differ from each other only in the development of the rays (topotypes examined). *U. barnesianus* is a slightly more elongated individual, with poorly developed rays. *U. tellicoensis* (topotypes examined) is a *lenticularis* slightly more swollen; and *U. lyoni* forms the transition toward var. *tumescens*, having a little more elevated beaks, greater obesity, and rather distinct rays.

2. FUSCONAIA BARNESIANA BIGBYENSIS (Lea) 1841.

U. bigbyensis Lea, '41. *U. estabrookianus* Lea, '45. *U. fassinans* Lea, '68. *Pleurobema fassinans rhomboidea* Simpson, '00.

The most frequent form is *fassinans rhomboidea* (topotypes examined), with rays poorly developed. *U. bigbyensis* has more distinct rays; *U. estabrookianus* (topotypes examined) is an old, overgrown form, without rays; *U. fassinans* is founded upon an individual (type examined, also topotypes), which is exceptionally elongated, without rays.

3. FUSCONAIA BARNESIANA TUMESCENS (Lea) 1845.

U. tumescens Lea, '45. *U. crudus* Lea, '71. *U. radiosus* Lea, '71.

U. tumescens is the most typical form, greatly swollen, with more or less developed rays; *U. radiosus* (type and topotypes examined) is less swollen, but for the rest like *tumescens*; *U. crudus* (topotypes examined) lacks rays, and has much eroded beaks, but stands close to *radiosus*.

The mutual relations of these forms may be understood by the help of the following key. Only the three largest divisions are to be regarded as varieties, in the other forms the characters are merely individual, although specimens representing only

one (or a few) of these "forms" often prevail at a given locality.

- a₁. Flat, compressed, dia. of shell less than 40 per cent of the length (var. *bigbyensis*).
- b₁. No rays, or rays obscure, color of epidermis brown, dark.
- c₁. Rhomboid in shape.
- d₁. Large. *Estabrookianus*.
- d₂. Smaller. *Fassinans rhomboidea*.
- c₂. More ovate, tapering behind. *Fassinans*.
- b₂. Rays distinct, well developed over most of the disk. Ground color of epidermis lighter. *Bigbyensis*.
- a₂. Moderately convex, dia. 40-49 per cent of length. *Barnesiania typica*.
- b₁. Beaks not elevated, shape trapezoidal, rhomboid, or subovate.
- c₁. Dia. about 41 or 42 per cent; size small.
- d₁. Shape somewhat elongate (trapezoidal); rays obscure. *Barnesianus*.
- d₂. Shape shorter (rhomboidal).
- e₁. Rays obscure. *Lenticularis*.
- e₂. Rays present, color of epidermis lighter.
- f₁. Rays few. *Meredithi*.
- f₂. Rays numerous. *Pudicus*.
- c₂. Dia. about 45 per cent; larger. Shape subovate. Rays obscure. *Tellicoensis*.
- b₂. Beaks more elevated, shape subtriangular. Dia. 46 per cent, with rather distinct rays. *Lyoni*.
- a₃. Much swollen, dia. over 50 per cent. Beaks elevated. (var. *Tumescens*).
- b₁. Without rays. Dia. 51 per cent. Beaks much eroded. *Crudus*.
- b₂. With rays. Dia. about 56 per cent or more.
- c₁. Dia. about 56 per cent. *Radiosus*.
- c₂. Dia. about 64 per cent. *Tumescens*.

As to the geographical distribution, it should be briefly stated that the swollen forms (a₃) inhabit the largest rivers; the compressed forms (a₁) are found in the headwaters, and the inter-

mediate forms (a₂) between. Intergrades are frequent.

All these shells have the same basic structure, and the slightest question that arises is the question of the soft parts of the shells. Over three dozens have been examined at leisure, and the following are representatives of the three main groups, showing the individual variations.

Gravid females have been examined on May 11, '13; May 15, '13; May 22, '14; May 25, '14; July 13, '13; July 14, '13; July 14, '14 (immatures evidently is a summer species).

The soft parts are those of a nautilus. The mantle is separated from the anal opening, which is absent (or torn?) and the gills are free from abdominal Placentae well developed and distinct. *Branchial opening* with distinct, but small papillae. Gills connected at base only.

While thus the *Fusconia* group is quite unique in the color of the gonads, egg masses, etc.

The soft parts are often of a shade to orange, and the orifices, and mantle-margin often the orange is replaced

¹ In NAUTILUS, 28, 1914, p. 31, "bema fassinana." This is a mistake. *robema* all right, but are the form to the *oviforme-group*, and should be treated as such (Lea). These will be treated more

mediate forms (a_2) belong to the streams of moderate size. Intergrades are frequent.

ANATOMY.¹

All these shells have the same, and an extremely characteristic and unique structure of the soft parts, so that there is not the slightest question that they belong together. I have examined the soft parts of some 200 specimens in the field, and over three dozens have been preserved in alcohol, and have been examined at leisure in the laboratory. They include representatives of the three main varieties, and of practically all of the individual variations.

Gravid females have been found on the following dates: May 11, '13; May 15, '13; May 16, '13; May 20, '13; May 20, '14, May 22, '14; May 25, '14; July 5, '13; July 9, '13; July 10, '13; July 13, '13; July 14, '13. *Glochidia* have been observed on May 20, '14 (immature), and July 14, '13. Thus this species evidently is a summer breeder (tachytictic).

The soft parts are those of the genus *Fusconaia*: the *supraanal* is separated from the *anal* by a very short mantle-connection, which is absent (or torn?) in rare cases. Inner lamina of inner gills free from abdominal sac. All four gills are marsupial. * Placentae well developed and subcylindrical.

Branchial opening with well developed papillae, *anal* with distinct, but small papillae. *Palpi* subfalciform, posterior margins connected at base only.

While thus the *Fusconaia* structure is typically developed, this species is quite unique in its color. This concerns chiefly the color of the gonads, eggs, and placentae.

The soft parts are often uniformly pale, whitish, but may shade to orange, and the orange is most prominent on foot, adductors, and mantle-margin; but the paler tints prevail, and often the orange is replaced by yellowish or brown. The gills

¹ In NAUTILUS, 28, 1914, p. 31, I have described the anatomy of "*Pleurobema fassinans*." This is a mistake: the shells examined belong to *Pleurobema* all right, but are the form known as *U. argenteus* Lea, which belongs to the *oviforme*-group, and should be called: *Pleurobema oviforme argenteum* (Lea). These will be treated more fully elsewhere.

FIGS.
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 Estabrookianus.
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are pale, but are generally suffused with blackish. The gonads are brown to red, mostly of a peculiar dull lavender color in the female, and the latter color, or purplish brown, is the prevailing color of the eggs and placentae. The charged gills become thus rather dark purple, or purple-brown, shading sometimes to dull red or blackish, in other cases to brownish, brownish pink, brick-red, or even pale brown. These are very peculiar tints, by which this species is easily recognized in the field: four marsupial gills of this blackish-purple color are not known in any other Naiad.

Glochidia have been found only in specimens belonging to the headwaters variety (*barnesiana bigbyensis*). They are subelliptical, slightly higher than long, L. 0.15, H. 0.16 mm.

Although a true *Fusconaia*, this species (or group of forms) stands isolated within the genus, in characters of the shell as well as in the soft parts. It differs from the species of the *subrotunda*-group (incl. *ebena*, *pilaris* etc.) very markedly by its smaller size and by the very shallow beak cavities. The forms of the *undulata*-group (incl. *flava*, and the *cuneobus*- and *corniformis*-forms) have generally also somewhat deeper beak cavities, and the shell has a more or less distinct posterior ridge, with a flattening or a shallow groove in front of it, characters which are missing in the *barnesiana*-group. As has been pointed out, in the latter group, the color of eggs and placentae is remarkable: in all other forms of *Fusconaia*, this varies from white to bright red.

I introduce here another species, in order to show that the *barnesiana*-type is also represented outside of the Cumberland-Tennessee drainage, namely in the Ozarks.

FUSCONAIA OZARKENSIS (Call) 1887.

F. ozarkensis Call, Pr. U. S. Mus. 10, '87, p. 499, pl. 27. Tr. St. Louis Ac. 7, '95, p. 33, pl. 18. *Lampsilis ozarkensis* Meek & Clark, Bur. Fisher. Doc. no. 759, '12, p. 18. *Pleurobema utterbacki* Frierson, in: Utterback, Naiad. Missouri (Amer. Midland Natural 4, 1916, p. 86, pl. 5, pl. 20, f. 63).

I have specimens from James River, Galena Stone Co., Mo., and White River, Cotter and Norfolk, Baxter Co., Ark., do-

nated by L. S. Frierson, July 30 and Aug. 2, 1914. They were preserved in alcohol. They were gravid females, and the markings probably the same as in *F. ozarkensis*. It is tachytictic.

There is some confusion in the first description of *F. ozarkensis* except by Meek and Clark. These authors (supported by other authors) have it, and, for instance, regarded as varieties of *F. ozarkensis* (and *F. ozarkensis* itself) are also this. My specimens were from

Walker, Frierson, *Pleurobema*, and not *F. ozarkensis* (p. 131), and it is the most plausible of the shell alone. *Quadrula coccinea*, a synonym of *Pleurobema*, are synonyms) must keep in mind that the shell, while his does not belong here, represent the female.

The investigation of *F. ozarkensis* is a *Fusconaia*. Compared with the *barnesiana*-type of *F. ozarkensis* differs from *barnesiana* in the outline of the shell, the development of the rays, and the absence of the suture. A few specimens from White River, those from James River, and those from Frierson (p. 87, f. 63) show differences in obesity

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nated by L. S. Frierson and collected by A. A. Hinkley on
 July 30 and Aug. 2 and 5, '14. A number of specimens (8)
 were preserved in alcohol, coll. July 30 and Aug 2, which all
 were gravid females, and one of each date had glochidia. This
 marks probably the end of the breeding season, and the species
 is tachytictic.

There is some confusion with regard to this species. After
 the first description by Call, it has not again been recorded, ex-
 cept by Meek and Clark, and I believe, the identification of
 these authors (supported by B. Walker) is correct. But I think
 that other authors have seen this form, but have not recognized
 it, and, for instance, Simpson's *pannosus* and *subellipticus* (re-
 garded as varieties of *Pleurobema argenteum* and *breve* respec-
 tively) are also this. Frierson's *utterbacki* is surely this, since
 my specimens were thus labeled by Frierson.

Walker, Frierson, and Simpson (in part) believe this to be a
Pleurobema, and not a *Lampsilis* (see also Simpson, '00, p. 557,
 and '14, p. 131), and this comes nearest to the truth, in fact,
 it is the most plausible assumption to be made from the study
 of the shell alone. The shell "resembles a very elongated
Quadrula coccinea," according to Meek and Clark, and the com-
 parison with *Pleurobema argenteum* and *breve* (which, by the
 way, are synonyms), made by Simpson, is significant. We
 must keep in mind that Call's fig. 4 represents the normal shape
 of the shell, while his fig. 1 is rather abnormal, and possibly
 does not belong here at all. These two figures by no means
 represent the female and male, as Call believes.

The investigation of the soft parts has shown that this actually
 is a *Fusconia*. Corresponding, both in soft parts and shell, to
 the *barnesiana*-type of the upper Tennessee region. *F. ozarkensis*
 differs from *barnesiana* by the more elongated (subtrapezoidal)
 outline of the shell, more anterior beaks, and the weak devel-
 opment of the rays, which are faint at the best, and often en-
 tirely absent. A swollen form of it is not known to me, but
 specimens from White River are slightly more convex than
 those from James River (farther up). Also Utterback's quota-
 of Frierson (p. 87, footnote) make it probable that there are
 differences in obesity.

ANATOMY.

Supraanal opening probably separated from the *anal* by a short mantle-connection, but in all my specimens this is torn by rough handling. Inner lamina of inner gills free from abdominal sac. All four gills marsupial in the female. *Placentae* well developed and *subcylindrical*.

Anal opening with small papillae, branchial opening with well developed papillae. *Palpi* as usual, their posterior margins connected for about one third of their length or less.

As to the color of the soft parts, which is so characteristic in *barnesiana*, not much can be said, since my material has been too long in alcohol. But in most of my specimens the gills are yet distinctly suffused with black. The placentae have been rendered whitish, but here and there traces of a dark stain are preserved (which is disappearing gradually). It is quite possible that the color of the placentae originally was similar to that of *barnesiana*.

The *glochidia* are subelliptical, slightly higher than long; L. O. 15, B. O. 18, thus agreeing with those of *F. barnesiana*.

NOTE ON THE RELATION OF SNAIL FAUNA TO FLOODS.

BY A. RICHARDS.

During the years 1911 to 1916, while the writer was a member of the faculty of the University of Texas, a series of incidental observations on the snail fauna of Waller Creek was made. These observations have now come to an end due to the change of residence of the observer. It seems not unwise, therefore, to publish a short note on the subject in the hope that the facts recorded, although fragmentary, may have a bearing on the work of some other follower of snail life.

Waller Creek is a small stream near the University of Texas at Austin. It is some four miles in length and empties into the Colorado River at a distance of perhaps two miles below the University. That portion of the stream close to the University between Fifteenth and Twenty-seventh Streets, was most closely observed, but data was also collected from the region below.

During the hot usually, the stream occasional pool; a depth of a few (Austin Chalk) bottom. The slope. In time rises very rapid; water rushes down be heard for a distance considerable, between seventh Street to the shape of the tremendous force.

During the first snail population. There were in place *Planorbis lentus*; one could in a few of either kind.

collected were many heads pointing in were also to be obtained especially which in that last snails of course!

It is to be noted had become so a sufficient important occurred in March 1905, March July and November creek in April when my observation considerable time had opportunity to reinspect had suffered in the

In the fall of