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point approximately $\frac{1}{2}$ of the distance along the mantle edge from the anterior end, where the edge is produced into a triangular process, directed somewhat anteriorly, and which is in the line with the anterior edge of the post-adductor muscle. Above, this process is spotted with a medium brown color, and its edge is produced into papillae which become finer towards the nearer ones of the branchial and anal regions. Below, the coloration appears confined to a strip widest near the vertex of the process described, and is succeeded posteriorly by the papillae previously mentioned.

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THE ANATOMY OF CERTAIN MUSSELS FROM THE UPPER TENNESSEE.

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In the Proc. Americ. Philos. Soc. 57, 1918, pp. 521-526, the present writer has published a Synopsis of the Naiades, or fresh-water mussels of the upper Tennessee drainage, assigning each species its proper place in the system. But in some of them the observations on the anatomy forming the basis for the taxonomic arrangement have not been given. It is the purpose of the present paper to furnish these data, together with additional remarks on species treated previously.

I am sorry that I am compelled to introduce again nomenclatorial changes without fully supporting them; but this will be done in another paper.

PROCONIA PILARIS (LEA), *F. PILARIS LESUEURIANA* (LEA), *F. PILARIS BURSA-PASTORIS* (WRIGHT). (See Ortmann, l. c., pp. 527-529.)

Anatomy: *F. bursa-pastoris* (Wr.) in NAUTIL. 27, 1918, p. 90 (incomplete, no gravid females at hand).

Gravid females have been found subsequently on the following dates: May 11, 13, 14, '13; May 20, 22, 23, '14; July 7, 8, 13, '14. They belong in part to the var. *bursa-pastoris*, in part to the var. *lesueuriana*, but none have been found belonging to

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typical *pilaris*. *Glochidia* have been observed from the earliest to the latest date, so that the breeding season begins probably very early in May, and lasts to about the middle of July (tachytictic).

In all three forms the anatomy is the same, that is to say, that of the genus *Fusconia*, and agrees essentially with that of *F. subrotunda* (Lea). Also the placentae are of the same characteristic subcylindrical (not compressed or lanceolate) shape. *Glochidia* of the shape and size of those of *F. subrotunda*: sub-elliptical, higher than long, L. 0.13, H. 0.15 mm.

In the upper Clinch form of *bursa-pastoris*, the orange color of the soft parts and red color of the placentae prevail, whitish specimens being rare. The same is the case in Powell River, at least in its upper parts. Farther down in the Powell (Clairborne Co., Tenn.), specimens with whitish soft parts outnumber those with orange parts. In the lower Clinch, the specimens (*lesueuriana*-type) are nearly all whitish, and only a few with orange color have been found. In French Broad and Holston Rivers, in all three varieties, white soft parts and white placentae are the rule all the way up to the forks of the Holston and the Watauga River. Orange soft parts and red placentae are extremely rare. I have only one specimen from Grainger Co., Tenn. (*lesueuriana*-type), and one from Sullivan Co. (*bursa-pastoris*-type).

* FUSCONIA CUNEOLUS (LEA), F. CUNEOLUS APPRESSA (LEA).
(See: l. c., pp. 530, 531.)

Gravid females: May 16, '15; May 22, '14; May 25, '15; July 5, 7, 8, 13, '13. *Glochidia* in specimens collected July 7 and 8. Thus tachytictic, breeding from May to July.

These two forms have the same anatomy, and belong to *Fusconia*. They agree very well with the account given of *F. rubiginosa* (Lea) (= *flava* Raf.). (See: Ann. Carnegie Mus. 3, '12, p. 241.) Of nine specimens preserved, seven have a short mantle connection between anal and supraanal, while in two this is missing, but probably torn.

* All four gills are marsupial, but in young specimens, the marsupial part of the inner gill is often restricted to the middle

of the gill. The ova form distinct, subcylindrical placentae. The *glochidia* are subelliptical, nearly semielliptical, about as high as long, L. and H. 0.16 mm. They are much like those of *F. flava*, but slightly larger.

* Color of soft parts of the orange type, chiefly evident on the foot, mantle-margin, and adductor muscles. However, this color is not very intense, often very pale orange, and in young specimens the soft parts are sometimes whitish. The gonads are red, and so are the eggs and placentae, from pink to bright crimson; in some cases they are pinkish-orange.

This group undoubtedly represents, in the upper Tennessee, the *flava*-group of the interior basin.

FUSCONAIA EDGARIANA (LEA), F. EDGARIANA ANALOGA (ORTM.).

(See: *F. cor* and *cor analoga*, Ortmann, l. c., pp. 532-533).

Most of the specimens preserved in alcohol represent the flat headwaters-form (*analoga*), but I have a sterile female (Anderson Co., Tenn.), which is the swollen typical form.

* Gravid females: May 13, 14, '13; July 5, 7, 8, '13. Of those preserved none happened to have glochidia.

Soft parts identical with those of *F. cuneolus*, and with those of the *flava*-group in general. Color in most cases deep orange, chiefly so foot and adductors. I never found specimens with whitish soft parts, and only a few are marked: pale orange. Gonads, eggs and placentae rarely pink, mostly intensely crimson.

FUSCONAIA BARNESIANA (LEA) and varieties. (See: l. c., p. 534 ff.).

The anatomy of this group has been described previously. (See: NAUTIL. 31, '17, pp. 61, 62.)

LEXINGTONIA DOLABELLOIDES (LEA), L. DOLABELLOIDES CONRADI (VANATTA). (See: l. c., pp. 545, 546.)

Gravid females: May 11, 13, '13; July 5, 7, 9, 10, 13, '13.

Glochidia: May 13 and July 5 (tachytictic).

All gravid specimens belong to the compressed headwaters-form (*conradi*), but I have examined the soft part of males and

May 13 - July

sterile females of the swollen form (*dolabelloides*) of the lower Clinch and the French Broad Rivers.

The structure of the soft parts is identical with that of *Lexingtonia subplana* (Conr.). (See: Ortmann, NAUTIL. 28, '14, p. 28.) It differs from that of the genus *Pleurobema* chiefly in the cylindrical placentae of deep red color.

Anal and supraanal openings separated by a short mantle connection, which is sometimes absent (torn?). Branchial opening with papillae, anal with crenulations. Posterior margins of palpi connected at base. Gills broad, the inner somewhat broader than the outer. Inner lamina of inner gills free from abdominal sac except at anterior end. Outer gills marsupial; when charged very little swollen. Placentae well developed, of subcylindrical shape.

Glochidia, in the specimens preserved, all unripe, but in one of them, collected on July 5, they were sufficiently formed so as to permit examination of shape and measurements. They are subelliptical in outline, higher than long, L. 0.16, H. 0.13 mm.

Color of soft parts orange, in most cases very intensely so, chiefly the foot, adductor muscles, and mantle-margin. Rarely the soft parts are paler, and occasionally they are whitish in young specimens. Among the larger gravid females in one only the shell is marked; "pale, marsupium cream;" but the specimen clearly belongs here, as is shown by the subcylindrical placentae. Gonads, eggs and placentae generally deep red, but in a few cases, the gonads have been marked as "orange," and in a few other cases the marsupium has been marked as "pink" or "cream color." However, in two males of the swollen form from French Broad River, the soft parts were pale. This is a remarkable exception, and quite interesting in so far as also other Naïades which the normally tinted tend to assume paler color of the soft parts in French Broad River.

According to the soft parts this species is a *Lexingtonia*. I have (l. c.) mentioned the beak-sculpture of *L. subplana* as a possible additional character of this genus. In the present species this consists of a number (six to eight) of fine, rather crowded, irregular, and wavy bars, distinct only anteriorly,

becoming indistinct and effaced in the middle part. Posteriorly, upon the posterior ridge, there are a few (two to three) low, indistinct tubercles, which show no connection with the anterior bars. Thus, anteriorly, the beak-sculpture resembles that of *L. subplana*, but posteriorly it is different in the development of low tubercles.

The description of the shell, as given l. c. for the genus, should be slightly modified so as to include this species. This refers chiefly to general shape and color pattern of the shell (rays breaking up into blotches).

PLEUROBEMA OVIFORME (CONRAD), *P. OVIFORME ARGENTEUM* (LEA), *P. OVIFORME HOLSTONENSE* (LEA). (See: Ortmann, l. c., '18, pp. 550 ff.)

I have described the anatomy of the flat headwater-form (*argenteum*) under the incorrect name of *P. fassinans*. (See: NAUTIL. 28, '14, p. 31.) Gravid females belonging to this have been collected on the following dates: May 11, '13; May 12, '15; May 13, 14, 15, 16, 20, '13; May 20, '15; July 5, 7, 8, 9, 10, 13, 14, '13. Glochidia have been secured on May 11, 15, 20, and July 8 and 9. This is a tachytictic form, breeding from May to July.

Soft parts of the typical *Pleurobema*-structure, much like that of *P. clava* (Ortmann, Ann. Carn. Mus. 8, '18, p. 234). Mantle-connection between anal and supraanal openings short, sometimes absent. Anal with very fine papillae, branchial with larger papillae. Posterior margins of palpi connected for $\frac{1}{2}$ to $\frac{1}{3}$ of their length. Inner lamina of inner gills free from abdominal sac, except at anterior end. In the female, the outer gills alone are marsupial. When charged, the placentae are rather distinct, but less so when glochidia are present. They always are lanceolate and compressed, never subcylindrical. Glochidia subelliptical, almost subcircular, about as high as long, L. and H. 0.16 mm. (much like those of *P. clava*). Sometimes they are slightly higher than long, L. 0.15, H. 0.17 mm. (So in specimens from Chickamauga Creek, Ringgold, Ga.)

Color of soft parts whitish, often with the foot yellowish, pale brown, or pale orange, rarely also mantle-margin and adductors

pale orange or orange-brown. The eggs and placentae are whitish, cream color, pale yellow, but in most cases of a peculiar and characteristic pale orange, and also the gonads of the female often have the same color. These colors agree with those of *P. clava*, but incline more frequently to the pale orange type. It should be remarked, however, that all specimens from Little River, Blount Co., Tenn. (about a dozen) represent a peculiar color variety. The structure of the soft parts is entirely normal, but the color is of the orange type, and the placentae are bright red (in over half a dozen gravid females). The shells of these specimens do not at all differ from those of the form *argenteum* as found in Virginia, except that the color markings of the epidermis are absent, and that the latter is comparatively dark (brown to black-brown). However, all of my specimens of this form are rather large. One of my females from Chickamauga Creek had pink placentae, the others had them cream color, as is normal.

Of the typical *P. oviforme* (form of the rivers of medium size), gravid females have been found on May 11, 13, '13; May 20, 25, '14; July 5, 7, 9, 10, 13, '13. Glochidia are at hand from July 5.

The anatomy is exactly like that of *P. oviforme argenteum*, as described above, and the glochidia have the same shape and size (0.16 mm.).

Color of the soft parts whitish, inclining on foot and mantle often to yellowish-brown or pale orange. Ova and placentae white, more rarely cream color or pale orange. Thus, in color, this form more closely resembles *P. clava*.

Of the swollen type, *P. oviforme holstonense*, I have found only few specimens. No gravid females have been secured, but sterile females and males. The anatomy is exactly as in typical *oviforme*.

* Note. *Lexingtonia dolabelloides conradi*, chiefly in young specimens, often resembles the typical *P. oviforme* in the shell. But in the color of the soft parts they are quite distinct, and the intensely orange tints seen in the former have never been observed in the latter. Gravid females of *P. oviforme* are recognized also by the light-colored placentae, which are not quite so solid a

in *Lexingtonia*, and have a lanceolate, compressed shape, so that the charged marsupial gills, even in young specimens, are considerably more swollen. The two species also differ in the beak-sculpture, which, in *P. oviforme*, consists of about four subconcentric, rather indistinct bars, which are slightly angular and nodulous upon the region of the posterior ridge; but there is no trace of the fine, wavy, and crowded bars seen on the anterior side of the beaks in *Lexingtonia*.

LASTENA LATA (RAFINESQUE). (Ortmann, l. c., p. 556.)

The description of the anatomy will be found in NAUTIL. 28, '15, p. 106.

LASMIGONA (ALABMINOTA) *HOLSTONIA* (LEA). (See: *Lasm. (Sulcularia) badia* (Raf.) (Ortmann, l. c., p. 557.)

The anatomy has been described in NAUTIL. 28, '14, p. 431.

Additional specimens have been obtained subsequently, confirming the previous account, and furnishing more complete records for the breeding season. *Gravid females* have been collected on Sept. 6, 7, '13; Sept. 8, 12, '15; Sept. 20, '12; and in spring on May 12, '14; May 18, '15. *Glochidia* have been found as early as Sept. 20; and on the two dates in May, discharge of glochidia was observed. Thus this species is bradytictic, breeding from September to May.

ALASMIDONTA (PRESSODONTA) *MINOR* (LEA). (See: l. c., p. 580.)

Anatomy, see Ann. Carn. Mus. 8, '12, p. 295, and NAUTIL. 28, '14, p. 46.

Also here additional material has been secured throwing more light on the beginning of the breeding season. Dates for *gravid females* are as follows: Sept. 2, 4, 5, '14; Sept. 6, '18; Sept. 9, 11, '15; Sept. 17, 20, '12. *Glochidia* have been observed on the last two dates. This places the beginning of the season in September.

ALASMIDONTA (DECURAMBIS) *RAVENELIANA* (LEA). (Ortmann, l. c., p. 561.)

I have collected a number of specimens of this species in Pigeon River, at Canton, Haywood Co., N. Car., on May 14,

'14. Of three males and four gravid females, all with glochidia, two of them discharging, the soft parts have been preserved. The breeding season thus ends in May.

The anatomy is the same as that of the genus *Alusmidonta*, as described previously (Ann. Carn. Mus. 8, '12, p. 297), also with regard to color (inclining to yellowish and orange tints). It should be mentioned that the inner lamina of the inner gills is, in two males and two females, entirely connected with the abdominal sac (as is the case in *A. marginata*); but in one male and two females, it is free in the posterior half or one-third of the abdominal sac. The specimens with the inner lamina partly free are the smaller ones.

Glochidia as usual, triangular, with hooks, about as high as long, L. and H. from 0.29 to 0.32 mm. Thus they are smaller than those of *A. marginata*, where the L. is 0.33, the H. 0.36 mm.

PAGIAS FABULA (LEA). (Ortmann, l. c., p. 562.)

Anatomy described in NAUTIL. 28, '14, p. 65. *Gravid females*, with *glochidia*, were at hand, collected on Sept. 17, '12. An additional gravid female, with eggs, has been found on Sept. 7, '13. This indicates the beginning of the breeding season in September.

PTYCHOBANCHUS SUBTENTUM (SAY). (See: *Ellipsaria subt.*, Ortmann, l. c., p. 564.)

The soft parts have been described in Ann. Carn. Mus. 8, '12, p. 308, fig. 5. Many specimens have been secured subsequently, confirming this account. It should be added that large females show that the folds of the marsupium are more numerous, and occupy nearly the whole outer gill.

Gravid females have been found frequently from Sept. 5 to Sept. 21, but with eggs only, indicating the beginning of the season; on May 20, '13, females discharging placentae with glochidia have been observed, indicating the end of the season.

DROMUS DROMAS (LEA), D. DROMAS CAPERATUS (LEA). (l. c., p. 566.)

Anatomy: Ann. Carn. Mus. 8, '12, p. 315, figs. 18, 18a, 18b. The soft parts of the var. *caperatus* are absolutely identical

with those of the main species. The color of the marsupium is mostly red, more rarely white.

Gravid females of the variety have been found on Sept. 7, 8, '14; Sept. 16, 17, 21, '15, mostly with eggs, but already on the earliest date a specimen with *glochidia* was seen. The latter have the same shape as those of the main species, L. 0.18, H. 0.09 mm.

ACTINONAIAS PECTOROSA (CONRAD). (l. c., p. 569.)

Anatomy: Ann. Carn. Mus. 8, '12, p. 325 (as *Nephronaias perdix*).

Gravid females have been found on Sept. 11, 15, '13; Sept. 15, '15; Sept. 17, '12; Sept. 17, '13, all with eggs. *Glochidia* have been found on May 12, '13, and May 20, '14, being discharged on the last date. Thus the breeding season is from September to May.

CARUNCULINA MOESTA (LEA). (See: *Toxolasma lividum* (Raf.) Ortman, l. c., p. 578.)

This form is the upper Tennessee representative of *C. glans*, but I have a set of an absolutely identical form from the Ozark region (James River, Galena, Stone Co., Mo., collected by A. A. Hinkley), recorded by Hinkley (Proc. U. S. Mus. 49, '15, p. 588) as *Lampsilis glans*, and I shall include these specimens in the following report.

I have described (NAUTIL. 28, '15, p. 142) the anatomy of a sterile female of *C. glans*. Among the specimens of *C. moesta* from the Ozarks, there are males, sterile females, and one gravid female with *glochidia*, collected July 30, '14. From the upper Tennessee region, I also have males and sterile females, and a gravid female with *glochidia*, the latter collected on May 16, 15.

Thus the breeding season of this form is rather obscure. We should expect it to be bradyctictic, and the specimen collected in May would agree with this. However, the presence of *glochidia* at the end of July appears strange; this specimen was discharging, and it might be a case of belated discharge. On the other hand, the beginning of the preceding season can not fall very early in autumn, for among a considerable number of

females found by myself on Aug. 31, '14, not a single gravid one turned up. Wilson and Clark (Bur. Fisher. Doc. 758, '12, p. 48) report glochidia in July for *C. glans*.

All specimens examined have the same anatomical structure agreeing with that of *C. glans*. The caruncle of the mantle-margin generally is brown, lighter or darker, varying to white or blackish. Its shape is short subcylindrical or hemispherical. The edge of the marsupium has black-brown pigment. The *glochidia* are subovate, higher than long, L. 0.17 to 0.18, H. 0.19 to 0.20 mm., thus agreeing with those of *C. parva*, as described previously (NAUTIL. 28, '15, p. 181).

CONRADILLA CAELATA (CONRAD). (See: *Lemiox rimosus* (Raf.) Ortmann, l. c., p. 574.)

Anatomy: see NAUTIL. 30, '16, p. 39. The nomenclature will be discussed elsewhere. The new generic name *Conradilla* takes the place of *Lemiox* Raf., used in the publications referred to.

* MEDIONIDUS CONRADICUS (LEA). (See: *Medionid. plateolus* (Raf.) Ortmann, l. c., p. 575.)

Anatomy: see Ann. Carn. Mus. 8, '12, p. 335, fig. 22, and NAUTIL. 28, '15, p. 142. A misprint in the latter paper should be corrected; the L. of the glochidium is 0.22 mm., not 0.28.

The breeding season is now rather well known; gravid females are found from the beginning of September (earliest date Sept. 6), and glochidia as early as Sept. 13; discharge of glochidia has been observed in numerous cases from May 11 to May 20.

EURYNIA (MICROMYA) PERPURPUREA (LEA). (Ortmann, l. c., p. 576.)

Anatomy: see NAUTIL. 29, '15, p. 68.

Immature glochidia have been found on Sept. 5, '18, mature ones on Sept. 21, '12.

EURYNIA (MICROMYA) NEBULOSA (CONRAD). (Ortmann, l. c., p. 577.)

Anatomy: see NAUTIL. 29, '15, p. 64.

Investigation of additional specimens has confirmed the char-

acters given previously. I have collected *gravid females* as early as Aug. 31. *Glochidia* were observed first on Sept. 2, so that the breeding probably begins toward the end of August. Discharge of glochidia has been seen from May 11 to May 24, and a single discharging female was found on July 5, probably exceptionally belated. My extreme measurements of the *glochidia* are: L. 0.21 to 0.23, H. 0.27 to 0.30 mm.

EURYNIA (MICROMYA) VANUXEMENSIS (LEA). Ortmann, l. c., p. 530.)

Anatomy: see Ann. Carn. Mus. 8, '12, p. 342, and NAUTIL. 29, '15, p. 65.

Earliest date for gravid females Sept. 2; for glochidia Sept. 17. Discharge from May 15 to May 25.

(The species of the genus *Truncilla* will be treated in a separate paper.)

MODIOLUS DEMISSUS DILLWIN, IN SAN FRANCISCO BAY.

BY G. DALLAS HANNA.

One of the supposedly accidental introductions of animal life from the east to the west coast of North America with the extensive attempts to transplant the oyster was the plicated mussel, *Modiolus demissus*. It was first recorded from the new location by Stearns in 1899 (NAUTILUS, XIII, p. 86) from specimens collected by R. N. Drake in 1894 at a point "3 miles north of Stanford University," that is, the southern part of San Francisco Bay. The record was repeated by the same author in April, 1900 (*Science*, n. s., XI, p. 658).

"Fine specimens" were again collected, apparently from the same colony, by Doe and Gifford, and recorded by Keep in April, 1901 (NAUTILUS, XIV, p. 115). In his "West Coast Shells," Revised edition, p. 37, 1911, the same author states, "It doubtless came to California with seed oysters which were planted in San Francisco Bay, where it may now be found in considerable numbers."