

THE BREEDING SEASON OF UNIONIDÆ IN PENNSYLVANIA.

BY DR. A. E. ORTMANN.

Since C. T. Simpson published his new system of the *Unionidæ* (Proc. U. S. Nat. Mus. 22, 1900), which is founded, in a large part, upon the "marsupium" of the female, this latter organ must be regarded as one of the most important features of the soft parts of the mussels, and should be known in every species. Yet there is a large number of species, in which it has never been seen by anybody. That certain species are very rarely found with the marsupium developed, is, in my opinion, chiefly due to the fact that they are not easily obtained at the period when they are gravid. As Sterki has first suggested (NAUTILUS, 9, 1895, p. 91), there are *two groups* among our mussels with regard to the period of gravidity¹): *summer breeders* and *winter breeders*. In the summer breeders the short "breeding season" falls into the early summer months (May, June, July); now since many of the species which belong or may belong here are characteristic for the larger rivers, avoiding smaller streams, and since just at this time the rivers very generally are swollen and muddy by copious summer-rains, it is practically impossible to collect them in the gravid condition.

During the summer of 1908 we had exceptionally dry weather in our region; the stage of the rivers in Pennsylvania was already in the beginning of July very low, and thus the writer succeeded in finding several species in a gravid condition, which generally at that season are out of reach. In addition, he has collected other species in the smaller streams at various seasons, and has found gravid females, both of summer and winter breeders. The following is a list of them, which also intends to give the previous records for those species which are found in Pennsylvania:²

¹ In order to avoid misunderstanding, I want to state expressly that by "period of gravidity" or "breeding season" I mean the time when the gills, or part of the gills, which forms the "marsupium," are filled with eggs or embryos.

² See: Lea, I; Observations, II, 1838, p. 51 ff.; III, 1842, p. 231; VII, 1860, p. 221; X, 1863, p. 412, etc.; Sterki, V, NAUTILUS, 9, 1895, p. 91; 12, 1898, p. 18; Amer. Natural., 37, 1903, p. 103; Baker, F. C., Bull. Chicago Ac., 3, 1898 (passim); Conner, C. H., NAUTILUS, 21, 1907, p. 87.

GROUP A. WINTER BREEDERS.

Truncilla triquetra Raf. Found gravid by the writer repeatedly in the months of September and October.

Truncilla perplexa rongiana Lea. Winter breeder (Sterki, '35). Found gravid in September.

Micromya fabalis Lea. July-August (Lea, III, '42).

Lampsilis ventricosa Barn. Winter breeder (Sterki, '95); autumn (Lea, III, '42); March, October (Lea, *ibid.*). Found gravid by the writer in all months from May to October. Marsupium partly empty (ovisacs extruded) on May 11; marsupium just beginning to be filled, July 30. (Breeds apparently "all the year round." See below.)

Lampsilis ovata Say. Autumn (Lea, III, '42); November (Lea X, '63). Found gravid in August, September, October. (This is merely a variety of *L. ventricosa*.)

Lampsilis cariosa Say. October (Lea, II, '38). Found gravid in August.

Lampsilis ochracea Say. June and November (Lea, II, '38).

Lampsilis multiradiata Lea. Autumn (Lea, III, '42); July, August (Lea, *ibid.*). Found gravid in May, June, August, September, October. Only few specimens being found in June and July, it is uncertain whether there is an "interim" in the summer.

Lampsilis luteola Lam. March, July-August, October (Lea, III '42); July (Baker, '98). I found gravid specimens in April, May, June, July, August, September, October. The species is a typical winter breeder, only the end of one season and the beginning of the next partly overlap in summer. In June, and chiefly in the beginning of July, sterile females (with the marsupium not charged) are much more frequent than in other seasons, while gravid females are very rare at the same time.

Lampsilis radiata Gmel. "All the year round" (Conner, '07; November (Lea, II, '38); May (Lea, X, '63). Discharge of ovisacs observed from November to March (Lea, X, '63).

Lampsilis ligamentina Lam. Winter breeder (Sterki, '95); autumn (Lea, III, '42). Found gravid by the writer in August, September, October, but not in July. Among numerous specimens collected, July 8, '07, July 3, 10 and 13, '08, not a single gravid female was discovered. The earliest date for the latter is August; but from that time on they were found regularly. This species pro

fers the larger rivers, and thus no dates could be secured for the spring months, yet the "interim" in July is very sharply marked.

Lampsilis orbiculata Hldr. Autumn (Lea, III, '42). Found gravid in August and September.

Lampsilis recta Lam. Winter breeder (Sterki, '95); autumn (Lea, '42). Found gravid in July, August, September, October. No records at hand for the early summer.

Lampsilis nasuta Say. "All the year round" (Conner, '07); winter breeder (Sterki, '95); November (Lea, II, '38). I found this species gravid in September (Delaware River), and on June 2 and 3 (in Lake Erie), when numerous gravid females were found.

Lampsilis iris Lea. I found three gravid females on May 11.

Lampsilis parva Barn. Winter breeder (Sterki, '95); May and November (Lea, VII, '60). Extrusion of ovisacs observed by Lea (*ibid.*) in May.

Lampsilis (Proptera) alata Say. Winter breeder (Sterki, '95); autumn (Lea, III, '42). Found gravid end of August, September, October.

Lampsilis (Proptera) gracilis Barn. Winter breeder (Sterki, '95); autumn (Lea, II, '42). Found gravid in September.

Obovaria retusa Lam. Autumn (Lea, III, '42). I found a gravid female of this species on August 29, '08.

Obovaria circulus Lea. Winter breeder (Sterki, '95); autumn (Lea, III, '42); March, July-August (Lea, *ibid.*). I found gravid females on May 27, '08. Both forms *O. circulus* and *lens* are included here: they pass into each other.)

Obovaria ellipsis Lea. Winter breeder (Sterki, '95); autumn (Lea, III, '42).

Plagiola securis Lea. Autumn (Lea, III, '42). Gravid females not rare in September and October.

All species mentioned so far possess the "Lampsilis-type" of marsupium, *i. e.*, the posterior part of the outer gills is charged, at the period of gravidity, with eggs or embryos contained in distinct ovisacs. When not gravid, this part of the gills differs in structure from the rest, and females are always recognizable.

Cryptogenia irrorata Lea. Winter breeder (Sterki, '95); autumn (Lea, III, '42).

Marsupium very peculiar, but allied to the Lampsilis-type.

Ptychobranthus phaseolus Hldr. Winter breeder (Sterki, '95);

autumn (Lea, III, '42). Found gravid in August, September, October. A specimen found on May 11, '07, had most of the ovisacs discharged. None of the numerous specimens collected by the writer in June and July were gravid.

The peculiar shape of the marsupium of this species is well known.

In the following species, belonging to Group A, the marsupium occupies the whole of the outer gills, and while in *Strophitus* distinct "placentæ" (Sterki) are developed, such structures or ovisacs are not present in the rest.

Strophitus undulatus Say. Autumn (Lea, III, '42); March, October (Lea, *ibid.*); September, December (Lea, II, '38); discharge of placenta observed in January and February (Lea, X, '63). I found this species gravid in the months of July, August, September, October; also in May. The latest date is May 22, '08 (one out of eleven individuals). Among numerous specimens collected on May 14 and May 27, '08, no gravid females were present, and during the month of June such were never found, although a good number of specimens were collected. The earliest date again is July 11. This gives an "interim" from the end of May to about the middle of July.

The eastern *S. undulatus* Say is absolutely undistinguishable from the so-called *S. edentulus* Say of the western waters.

Anodonta cataracta Say. Breeding season, eight months during the year; the interim May to October (Conner, '07); gravid in October and November (Lea, II, '38). I have seen gravid specimens collected on July 23, '08, and August 21, '08. The first date, no doubt, represents an exceptional case: there was only a single gravid individual among forty to fifty specimens. The other date (also a single individual, but only one found at that date) possibly marks the beginning of the season. At any rate it is very probable that the breeding season occasionally lasts longer than indicated by Conner, and may be extended in individual cases beyond May and may begin earlier than October, as is the case in other winter breeders.

Anodonta imbecillis Say. Autumn (Lea, III, '42); March (Lea, *ibid.*). Found gravid May 21, '08 (outlet of Lake Leboeuf, Erie county), and June 2, '08 (Lake Erie). This species is hermaphroditic, according to Sterki (NAUTILUS, 12, '98, p. 87).

Anodonta grandis Say. Autumn (Lea, III, '42); July, August (*ibid.*); October (Baker, '98). In Pennsylvania gravid females are frequent in August, September, October. I have found a single

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gravid female on May 22, '08, out of a large number collected. Among numerous specimens collected on April 24, June 23, July 17 none were gravid. Thus the "interim" appears to extend over the month of May to July, with occasional individual exceptions.

Anodontoïdes ferussacianus Lea. Autumn (Lea, III, '42); October (*ibid.*). Found gravid in May, August and October. Among a dozen specimens, collected June 5, '08, in Little Shenango River, and among numerous specimens of the var. *subcylindraceus* Lea, collected on June 2, '08, in Lake Erie, not a single one was gravid. This would establish an interim at least in June. No dates are at hand for July.

Symphynota compressa Lea. Autumn (Lea, III, '42); March, September (Lea, *ibid.*). Gravid in May and beginning of June (June 2 in Lake Erie; only part of the outer gills charged). No gravid females taken during the rest of June, and during July, but only a small number of specimens was secured during this time. Beginning August 6, all through the month, and during September and October, gravid females were abundant. The color of the marsupium is very variable in this species: whitish, pink, orange, brown, and probably depends on the stage of development of eggs and embryos.

(To be continued.)

NOTES.

SHELLS NEW TO THE NEW ENGLAND FAUNA.—In a very small portion of shell-sand gathered by Mr. John Robinson at Hampton Beach, New Hampshire, I discovered a genus new to America, namely *Homalogyra atomus* Phil. A subsequent visit to this place enabled me to add a number of forms new to the New England Coast north of Cape Cod. Among those thus far determined is a *Scissurella*, probably *crispata* Flem., and *Cœcum pulchellum* Stimp. A few years ago Miss Marjorie C. Newell discovered specimens of *Tagelus devisus* Spengl. on Coffin's Beach, and Miss M. W. Brooks has detected a specimen of this species at Hampton Beach.

Later I hope to make an extended paper with illustrations of these and other new additions to our molluscan fauna.—EDWARD S. MORSE.

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(Concluded from page 95.)

Symphynota viridis Contr. August 24, '08, four gravid females were found among a dozen specimens; of 35 specimens collected by Dr. D. A. Atkinson on July 11, '08, not a single one was gravid.

Symphynota costata Raf. Autumn (Lea, III, '42); March, October (Lea, *ibid.*). I found gravid specimens in April, May (latest date, May 26), and then again in August (earliest date, August 9), September, October. Numerous specimens were collected in June and July, but none of them was gravid.

Symphynota complanata Barn. Autumn (Lea, III, '42); March (Lea, *ibid.*). Gravid females found on May 14, '08.

Alasmidonta undulata Say. September and October (Lea, II, '38). Gravid females on July 18 and August 12.

Alasmidonta heterodon Lea. August, September (Lea, II, '38); May (Lea, X, '63).

Alasmidonta marginata Say. October and December (Lea, II, '38). The western form was found gravid in August, September, October. Out of a number of specimens collected on June 5, 8 and 22 none was gravid. No dates at hand for July. The eastern form was found gravid on August 13. The western form (= *truncata* Wright = typical *marginata* Say) is hardly distinguishable from the eastern (= var. *varicosa* Lam.), see Pilsbry and Fox, NAUTILUS, '01, pp. 16 and 17).

GROUP B. SUMMER BREEDERS.

Some of the summer breeders (*Unio*, *Pleurobema*) have the outer gills only serving as marsupium, in others (*Quadrula*) all four gills are supposed to assume this function in the breeding season. Yet in many *Quadrulas* this condition is unknown, and, as we shall see below, the arrangement of the species into genera will need revision and correction. I enumerate the species here according to Simpson's Synopsis.

Unio gibbosus Barn. Summer breeder (Sterki, '95); July, August (Lea, III, '42). I found gravid females of this common species in June and July, and a single belated one on August 13. Hun-

dreds of individuals were collected in April, May, August, September, October, but no gravid females were among them.

Unio crassidens Lam. Summer breeder (Sterki, '95). I collected numerous specimens in July, August, September, October, but never found a gravid female. I never had a chance to get this species earlier in the season.

Unio complanatus Dillw. "But once annually, from April-May to July-August" (Conner, '07); May (Lea, X, '63). I collected this species only in the month of August, and consequently never found it gravid.

Pleurobema clava Lam. July-August (Lea, III, '42). Found gravid on June 18 and July 10. Specimens collected on May 14 and in August, September and October were not gravid.

Pleurobema aesopus Green. Summer breeder (Sterki, '95). Gravid on July 3 and 13, '08. Never found in the gravid state during August, September, October, when many were collected.

Sterki ('95) places this with the species, in which all four gills are charged, and (Pr. Ohio Ac., 4, '97, p. 391) with the genus *Quadrula*. Yet according to my observations only the outer gills serve as marsupium, and are distinguished at that time by a very peculiar red color; already Lea (X, '63, p. 432) enumerates this species among those which have red eggs, but he saw them only in the ovarium. Yet this "red" of the gills is entirely different from that of certain gravid species of *Quadrula*, being rather of a "lilac" hue.

Quadrula undulata Barn. Summer breeder (Sterki, '95). I collected many specimens in August, September, October, but did not find gravid females. The only one was found on July 3, '08; it had all four gills charged, which were whitish (not red).

Lea (X, '63, p. 417) says that only the outer branchiæ serve as marsupium, while Sterki ('95) puts it in group B, where all four branchiæ are said to be charged.

Curiously enough, Sterki ('95, p. 93) places the closely allied *U. multiplicatus* Lea (= *Q. heros* Say) with his group A (winter breeders), giving the date November 1, and says that also the marsupium is of the type A (*Lampsilis* type). Since the latter has been described and figured by Lea (VII, '60, p. 122, pl. 30, f. 105), and is distinctly of the *Quadrula* type, with all four gills charged, I believe that we have to deal with a *lapsus calami* for *U. multiradiatus* Lea.

Quadrula lachrymosa Lea. May (Lea, III, '42).

Quadrula pustulosa Lea. Summer breeder (Sterki, '95).

Quadrula rubiginosa Lea. July-August (Lea, III, '42); June (Baker, '98). I found this species gravid on May 27, June 30, July 3 and July 8. The marsupium corresponds to the account given of it by various writers; it is formed by all four gills, which are at that time deep red.

Quadrula subrotunda Lea. Summer breeder (Sterki, '95). Found gravid July 3 and July 13. During late summer and fall no gravid females were found, although many specimens were collected. All four gills are charged and of deep red color.

Quadrula kirtlandiana Lea. One gravid female was found on August 2, '07, among hundreds of specimens collected; all four gills were charged, and red. Later in the season, in August, September, October, no gravid females were seen. *by the writer*

Quadrula coccinea Conr. Found gravid on June 18, '08 (Neshannock Creek, McKean Co., collected by Mr. Dennis Dally on June 22, '08. There were, altogether, about a dozen of them, and in every case the marsupium did not agree with the type of the genus *Quadrula*, for only the outer gills were charged in their whole extent, and were whitish. This would remove this species from the genus *Quadrula*, and would place it with *Pleurobema*. (Baker, '98, p. 80, gives a description of the soft parts, and says "four gills used as marsupium," but this may not be founded upon personal observation, but may have been inferred from the systematic position of the species.)

Tritogonia tuberculata Barn. Gravid, according to Sterki (NAUTILUS, 21, '07, p. 48) on June 10, '07, and marsupium formed by all four gills. This would place the species with the genus *Quadrula*, where it would group with *Q. trapezoides* Lea. Since the specific name is preoccupied in this genus, and since none of the synonyms are available, a new name should be found, and I propose here: *Quadrula tritogonia* nov. nom. (I have discussed this point with Dr. Sterki, and he is of the same opinion.)

Of the other species of *Quadrula* found in Western Pennsylvania, *Q. hippopæa* Lea, *cylindrica* Say, *metanevra* Raf., *cooperiana* Lea, *obliqua* Lea, *pyramidata* Lea, *tuberculata* Raf., I have never seen gravid females, and nothing is known about their marsupium and breeding season.

The above observations on the breeding seasons of Pennsylvanian

and received gravid from the Allegheny River, McKean Co.,

Unionidæ fully bear out Sterki's division into two groups: summer and winter breeders. The breeding season of the summer breeders is short (maximum hardly four months), while in the winter breeders this season is prolonged, extending from late summer, through the winter into spring. Yet it must be borne in mind that probably in the single individual the breeding season does not fully occupy the whole length of the term, since it has been repeatedly observed that the embryos and ovisacs are discharged at various times, even in the beginning of the winter.

In some species belonging to the group of winter breeders the period of gravidity may be extremely long, so that the end of one breeding season (in May, June, July) may overlap with the beginning of the next (June, July, August), and such species may appear to breed "all the year round." This has been hinted at already by Sterki, and Conner gives the following instances: *Lampsilis radiata* and *Lampsilis nosuta*. My own observations make this condition probable in *Lampsilis ventricosa* and *Lampsilis luteola*. Yet in others an "interim" is very distinct in the early summer. This is the normal condition, according to Sterki, and has been found to be true for *Anodonta cataraeta* by Conner, and by my observations it is made more or less probable for *Lampsilis ligamentina*, *Ptychobranhus phaseolus*, *Strophitus undulatus*, *Anodonta grandis*, *Anodontoides ferrussacianus*, *Symphynota compressa*, *Symphynota viridis*, *Symphynota costata*, *Alasmidonta marginata*.

These peculiar conditions may be explained by the following assumption: *Quadrula*, with the four gills serving as marsupium, is, in my opinion, the most primitive type of our *Unionidæ*. Next to it stand *Pleurobema* and *Unio*, with only the outer gills serving as marsupium, but with the shell more or less resembling that of *Quadrula*. These forms represent also the most primitive type of the breeding season, which is short, and falls into the warm season. These forms existed already at a time when a uniform warm climate prevailed. At that time, possibly, the breeding season was not so restricted, but at the present time it has become so, since only during a short period of the year these old, primitive conditions prevail (in summer). Forms like *Unio* and *Quadrula* actually go back to mesozoic times.

All other genera are more advanced. The group *Alasmidonta*, *Symphynota*, *Anodontoides*, *Anodonta*, *Strophitus* (which is, according to Sterki, characterized by a peculiar glochidium) resembles in

the marsupium the *Pleurobema-Unio* type, but with a tendency to reduce the hinge teeth. Another group consists of the specialized genera, in which the marsupium becomes more or less restricted to a part of the shell where true ovisacs are developed. All these more advanced forms originated probably at a time when seasonal climates existed already in our continent—in the tertiary—beginning of the warm period in summer possibly induced the breeding season, that is to say, to postpone the discharge of the embryos to a more favorable time, namely, till the beginning of the next (known only in one of the specialized genera, *Lampsilis*), while in less specialized genera, *Alasmidonta*, *Symphynota*, *Anodonta*, also in *Ptychobranhus*, some species of *Lampsilis*, an "interim" in midsummer.

I think this is a reasonable interpretation of the breeding season and their development, yet it is primarily a mere theory, which should be substantiated by further research on the marsupium and the breeding seasons of our *Unionidæ*.

MOLLUSKS FROM AROUND ALBUQUERQUE, NEW MEXICO.

BY H. A. PILSBRY AND J. H. FERRIS.

A considerable amount of work has been done on the mollusks, and the numerous local lists published were showing for the Territory if compiled into one catalogue. The recent lists were based upon material collected by Pilsbry, Cockerell and his pupils, and by Messrs. Joshua L. Ferris and Pilsbry. The records are to be found in p. 116; x, p. 42; xi, p. 69; xii, pp. 76, 131; xiii, p. 144; xiv, pp. 9, 47, 72, 82, 85; xvi, pp. 57, 69, Mollusks of the western States, I, II, etc.

the marsupium the *Pleurobema-Unio* type, but differs by a general tendency to reduce the hinge teeth. Another group is formed by the rest of the genera, in which the marsupium becomes very highly specialized, more or less restricted to a part of the outer gills, and where true ovisacs are developed. All these more advanced genera originated probably at a time when seasonal changes of climate existed already in our continent—in the tertiary—and the shortening of the warm period in summer possibly induced them to prolong the breeding season, that is to say, to postpone the discharge of the embryos to a more favorable time, namely, till the next spring. This made necessary special adaptations for the carrying of the embryos through the winter, and probably the ovisacs of the most highly developed genera belong to these special adaptations. In certain genera, ovisacs are not at all developed, and in *Strophitus* an independent form (placentæ). This lengthening of the breeding season finally led to the merging of the end of the one of them into the beginning of the next (known only in one of the most highly specialized genera, *Lampsilis*), while in less specialized genera, in *Alasmidonta*, *Symphynota*, *Anodonta*, also in *Ptychobranhus* and some species of *Lampsilis*, an "interim" in midsummer still exists.

I think this is a reasonable interpretation of the different types of breeding season and their development, yet it is proposed here as a mere theory, which should be substantiated by further investigations on the marsupium and the breeding seasons of our *Unionide*.

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