

INTERNAL CHARACTERS OF SOME MISSISSIPPIAN
RHYNCHONELLIFORM SHELLS¹

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INTRODUCTION

Among all the Paleozoic brachiopods no type of shell configuration has greater range, greater distribution, or greater representation than the rhynchonelliform shells, and previous to the appearance of the great work on the Genera of Paleozoic Brachiopoda, by Hall and Clarke,² the more common custom was to refer all these shells to the genus *Rhynchonella*. It was pointed out by these authors, however, that the genotype of *Rhynchonella*, *R. loxia* Fischer, from the Upper Jurassic fauna of Russia, was, in its assemblage of external and internal characters, clearly distinct, generically, from any of our Paleozoic forms. They recognized, furthermore, no less than sixteen generic or subgeneric groups of rhynchonelliform shells in the Paleozoic faunas, to which either new names were given or for which previously published names were revived. No attempt was made by these authors to distribute all the species of Paleozoic Rhynchonelloids in their proper genera, but in his "Synopsis of American Fossil Brachiopoda" Schuchert³ has attempted to so distribute the species so far as was possible. More than a hundred species, however, were allowed by Schuchert to remain in the genus *Rhynchonella*, because their internal characters had never been investigated and it was impossible to place them properly without such an investigation.

The present study is an attempt to determine the essential generic characters of some of the rhynchonelliform shells of the Mississippian faunas of the Mississippi Valley basin. The method of study has been to grind down the shells from the beak toward the front, on a carborundum wheel, the surface being polished and careful cross-section drawings being made at frequent intervals. From the drawings of these serial sections the internal arrangement of the septa and other lamelliform plates, the hinge-plate, crura, spondylia, and cruralia can be interpreted with ease. The investigation has been extended to include certain rhynchonelliform shells which have been referred to the Pentamerid genus *Camarophoria* by Hall and Clarke and by Schuchert, all of which were originally described as members of the genus *Rhynchonella*.

CAMAROPHORIA KING⁴*CAMAROPHORIA SCHLOTHEIMI (VON BUCH)*

At the outset of the investigation it is important to determine the essential differences between *Rhynchonella*, used in its broad sense, and

² Paleontology of New York, vol. viii, parts 1 and 2 (1891-1894).

³ Bulletin of the U. S. Geological Survey, No. 87 (1897).

⁴ Superfamily Pentameracea Schuchert.

Camarophoria. Hall and Clarke have referred all those rhynchoneli-form shells possessing a median septum in each valve, a ventral spondylium, and a dorsal cruralium to *Camarophoria*, and their diagnosis of that genus is clearly made, at least in part, from such rhynchonelliform shells as *R. subcuneata* and *R. subtrigona*, which are illustrated by them as typical of the genus. For the present study the essential characters of the genus *Camarophoria* have been determined by grinding specimens of *C. schlotheimi* from the Permian of Germany. Drawings of a series of eleven cross-sections of this shell are here presented in figure 1. The most diagnostic characters of the genus are found in the brachial valve where the hinge-plate is undivided and is supported by a strong median septum. From the lateral faces of the median septum a pair of horizontal processes arise close to the posterior extremity of the shell (figures 1c, d, e), which at first slope broadly and then curve more narrowly

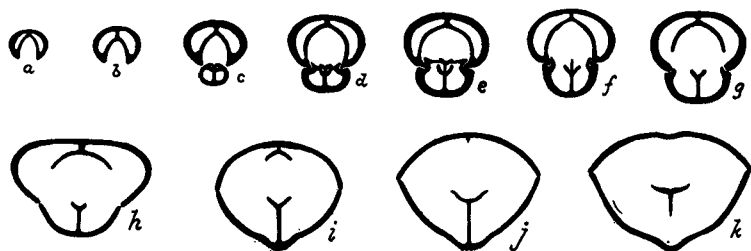


FIGURE 1.—Cross-sections of the rostral Portion of *Camarophoria schlotheimi* (von Buch)

This series of eleven cross-sections ($\times 2\frac{1}{2}$) is from a specimen from the Permian of Pössneck, Germany

toward the hinge-plate with which the distal portions of the processes are joined posteriorly. Before the articulation of the valves is passed, however, the distal margins of the processes become free from the hinge-plate (figure 1e), and they constitute the two sides of a concave cruralium supported by a median septum from the floor of the valve, and in turn bearing a continuation of this septum along the middle line of its concave side which supports the undivided hinge-plate. The hinge-plate terminates abruptly in front, and is doubtless continued anteriorly in the crura, although these processes were not preserved in any of the examples sectioned. The cruralium continues anteriorly beyond the termination of the hinge-plate, and for a short distance the continuation of the median septum upon the concave side of the cruralium persists (figure 1f), although it becomes rapidly reduced and soon disappears. The cruralium continues with increasing elevation from the floor of the valve and in-

creasing width to near the middle of the shell, and is even extended somewhat beyond the anterior limit of the median septum upon the floor of the valve.

In the pedicle valve the hinge-teeth are supported by strong dental lamellæ which are joined to form a broad spondylium supported by a median septum from the floor of the valve. Beyond the articulation of the valves the inner margins of the lamellæ become free. The spondylium is much broader and deeper than the cruralium of the opposite valve and is attached to the floor of the valve by a much lower median septum; it rapidly becomes shallower and narrower anteriorly, terminating before the cruralium of the brachial valve has reached its maximum expansion. The median septum continues a short distance beyond the extremity of the spondylium, but quickly disappears. Hall and Clarke⁵ mention "two accessory supporting lamellæ abutting on one side against the outer surface of the converging dental plates, and on the other against the interior cardinal surface of the valve," but these have not been observed in any of the specimens sectioned, although they are present in at least two of the species referred to the genus *Camarophoria* by the same authors, *C. subcuneata* and *C. subtrigona*, neither of which species possess the true cruralium of the brachial valve which is so conspicuously developed in *C. schlotheimi*.

CAMAROPHORIA HAMBURGENSIS N. SP.

Among the Mississippian species which have been investigated, only two possess the essential characters of *Camarophoria* as exhibited by the genotype, and neither of these were referred to the genus by Hall and Clarke. The first is an undescribed species which may be designated as *C. hamburgensis*. It occurs commonly in the thin Hamburg oolite bed near the base of the Kinderhook at Hamburg, Calhoun County, Illinois.⁶ The species occurs for the most part as detached valves, and a series of sections of both the pedicle and brachial valves is shown in figure 2. In the brachial valve this species is essentially like *C. schlotheimi* except that the lateral processes of the median septum, which are produced into the cruralium, arise nearer the floor of the valve, and their distal margins do not curve up sufficiently to become attached to the under surface of the hinge-plate, but always remain free (figures 2*k*, *l*). As in *C. schlotheimi* the median septum appears to pass through the cruralium in the apical portion of the valve as a support to the hinge-plate, and after it has ceased to render this support it is continued as a gradually disappearing

⁵ Paleontology of New York, vol. viii, part 2, p. 213.

⁶ Transactions of the Academy of Science of Saint Louis, vol. xvi, p. 465.

median ridge along the concave side of the cruralium (figures 2*m, n, o*), the cruralium itself gradually increases in elevation and in width, finally becoming narrower and terminating abruptly. In the pedicle valve the

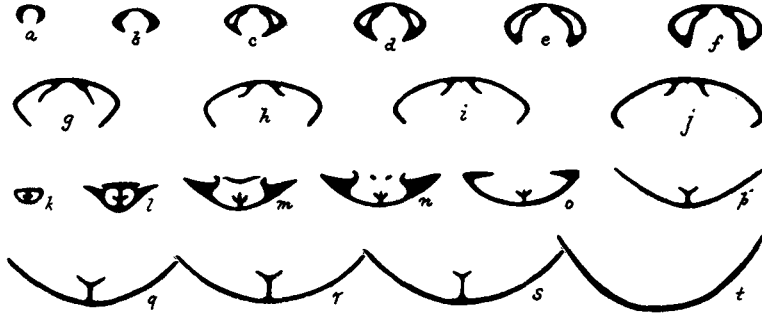


FIGURE 2.—Cross-sections of the rostral Portion of the Pedicle Valve, and a Like Series of the Brachial Valve, of *Camarophoria hamburgensis* n. sp.

This series of ten cross-sections ($\times 2\frac{1}{2}$) is from specimens from the Kinderhook oolite at Hamburg, Calhoun County, Illinois

dental lamellæ are not joined to form a true spondylium, supported by a median septum from the floor of the valve, but they do form a spondylium-like process which rests directly upon the floor of the valve.

CAMAROPHORIA EXPLANATA (McCHESNEY)

A second species which is apparently a typical member of the genus *Camarophoria* is *C. explanata* (McChesney), which was referred to the genus *Pugnax* by Hall and Clarke. Externally this species closely resembles certain rhynchonelliform shells which have commonly been referred to *Pugnax*. The example illustrated by Hall and Clarke was a very perfect sulphur cast of McChesney's type specimen, which of course gave no indication of median septa in either valve and was naturally referred to *Pugnax*, but these characters were observed by Schuchert, who correctly referred it to *Camarophoria*.⁷ In figure 3 a carefully prepared series of sections of this species is shown. The lateral processes from the sides of the median septum of the brachial valve are short and are situated high above the floor of the valve (figures 3*c, d, e*). In the section nearest the apex of the brachial valve these cruralium processes are apparently consolidated with the beginning of the hinge-plate (figure 3*b*), but the separation is complete from its origin, the distal margins of the processes not being joined to the under side of the hinge-plate for a short distance, as in *C. schlotheimi*. The median septum rising from the concave floor

⁷ Bull. of the U. S. Geological Survey, No. 87, p. 162.

of the cruralium continues to the anterior margin of the hinge-plate, and even beyond, where it supports the bases of the crura (figure 3*f*), but beyond this point it is rapidly reduced and soon disappears. The cruralium is narrow, never attaining the width of that in the other two species which have been described, but becomes gradually wider toward the front; it becomes highly elevated above the floor of the valve anteriorly and is produced beyond the base of the median septum. The crura are strongly curved toward the opposite valve soon after the disappearance of the supporting median septum (figure 3*g*). In the pedicle valve the dental plates are curved toward the median line of the valve and form a spondylium which rests directly upon the floor of the valve posteriorly, but is supported by a low median septum anteriorly; it is not continued so far toward the front of the shell as is that of the brachial valve.

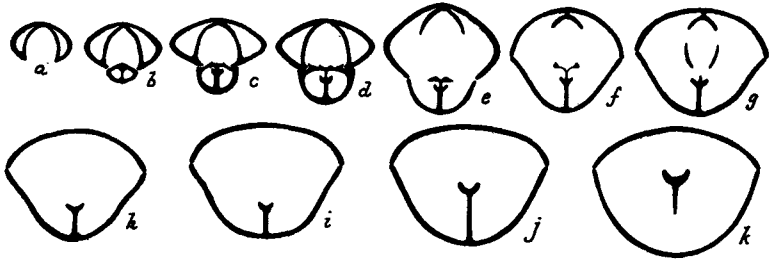


FIGURE 3.—Cross-sections of the rostral portion of *Camarophoria explanata* (McChes.) This series of eleven cross-sections ($\times 2\frac{1}{2}$) is from a specimen from the Chester Limestone of Illinois

The development of a true cruralium in the brachial valve is considered as the essential generic character of the three species just described. This cruralium is fundamentally different from the cruralium-like crural cavity between the lateral portions of the divided or undivided hinge-plate of many of the rhyntonelloid shells, which does not continue anteriorly beyond the hinge-plate and which does not support, along the median line of its concave surface, a continuation of the median septum. The criterion which has come to be used during late years for the placing of a rhyntonelloid shell in the genus *Camarophoria*—that is, the presence of a median septum in each valve—must give way to the character of the cruralium of the brachial valve. Many rhyntonelloid shells possess a distinct median septum in the brachial valve, and the fact that the dental lamellæ of the pedicle valve converge somewhat more rapidly in some examples and become joined as they reach the floor of the valve, or even before they reach it, and thus give rise to a median septum, is not sufficient basis for placing them in a different family, and even in a differ-

ent order, as has been done by some students of the brachiopods. The presence or absence of the pedicle median septum in the true Rhynchonelloids is dependent solely upon the modification of certain elements, the dental lamellæ, which are present in all of the shells. The cruralium of the brachial valve, on the other hand, as developed in the species of *Camarophoria*, is a totally distinct morphologic element in the structure of the shell, and its presence is well worthy of recognition as of more than generic importance.

TETRACAMERA N. GEN.⁸

TETRACAMERA SUBCUNEATA (HALL)

Among the rhynchonelliform shells possessing a pedicle median septum, and referred for the first time to the genus *Camarophoria* by Hall and Clarke, is *Rhynchonella subcuneata* Hall. A series of cross-sections

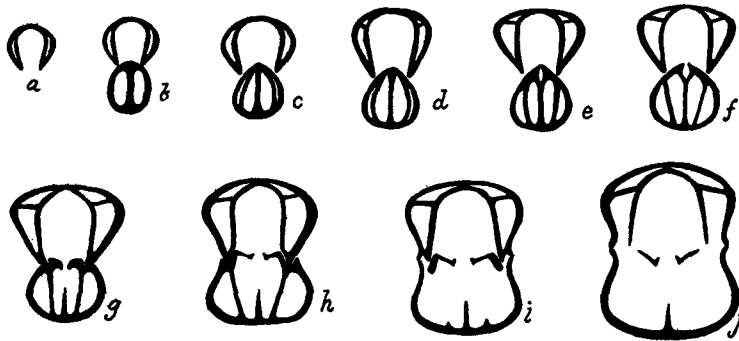


FIGURE 4.—Cross-sections of the rostral Portion of *Tetracamera subcuneata* (Hall)

This series of ten cross-sections ($\times 2\frac{1}{2}$) is from a specimen from the Salem limestone of Indiana

of this common species of the Salem limestone is shown in figure 4. The median septum of the brachial valve is undivided at the apex of the valve (figures 4*b*, *c*, *d*), but before the articulation of the shell is reached a median incision is formed internally which is at first arched over (figure 4*e*), but soon becomes open on the cardinal side by the incision between the lateral divisions of the hinge-plate (figure 4*f*). This cruralium-like or crural cavity⁹ is very short, not even extending anteriorly to the articulation of the valves, although the median septum continues with gradually decreasing height, sometimes to near the middle of the valve.

⁸ Superfamily Rhynchonellacea Schuchert.

⁹ This cavity is morphologically different from the cruralium of *Camarophoria*, and will hereafter be referred to as the crural cavity.

This structure is totally different from that of *Camarophoria*, in which a true cruralium is developed between the level of the hinge-plate and the floor of the valve, and continues as far anteriorly or even beyond the base of the median septum. The character of the median septum and crural cavity in this species is essentially identical with that of *Camarotæchia* and of several other undisputed rhynchonelloid genera. The species possesses, in addition to the median septum, two lateral lamellæ in the brachial valve which originate on the floor of the valve on either side of the base of the median septum and abut against the inner cardinal surface of the valve at their opposite extremity (figures 4c, d, e, f, g, h), these lamellæ, with the median septum, dividing the apical portion of the valve into four compartments. Anteriorly these lateral septa support the two lateral divisions of the hinge-plate directly opposite the hinge-sockets, to a point beyond where the inner margins of the divisions of the hinge-plate are supported by the divided median septum. These lateral lamellæ terminate abruptly, beyond the line of articulation of the hinge, and disappear entirely while the median septum is still considerably elevated.

In the pedicle valve the dental lamellæ are strongly developed and curve toward the median line as they approach the floor of the valve, forming a spondylium which rests directly upon the inner surface of the valve posteriorly, but which is raised upon a low median septum anteriorly. From the outer surface of each dental lamella a nearly horizontal plate passes across each lateral rostral cavity, joining with the inner surface of the outer shell wall. These lateral buttress plates have been observed in only one other rhynchonelloid shell, *R. subtrigona* M. & W., and they are the two accessory supporting lamellæ mentioned by Hall and Clarke in their diagnosis of *Camarophoria*, but which are wholly wanting, as has been shown, in the genotype of that genus, and are not known to be associated with the characteristic brachial cruralium of that genus. The peculiar association of characters in this species is believed to be sufficiently distinct from other rhynchonelloid shells to be worthy of recognition as a distinct and as yet undefined generic type, for which the name *Tetracamera* is herewith proposed. The genotype of this new genus is *T. subcuneata* (Hall), and the only other species which can as yet be included in it is *T. subtrigona* (M. & W.), which is next to be described.

TETRACAMERA SUBTRIGONA (M. & W.)

Tetracamera subtrigona is another rhynchonelliform shell which was placed in the genus *Camarophoria* by Hall and Clarke. This species is much larger than *T. subcuneata* and is proportionally much broader. Its

geologic horizon is the Keokuk limestone. The internal characters of the shell are exhibited in the series of cross-sections shown in figure 5. The rostral cavity of the brachial valve is divided by a median septum which is at first solid (figure 5*e*), but is soon excavated on the median line near the cardinal side of the valve. This median excavation is completely arched over to the line of articulation of the valves (figures 5*f*, *g*, *h*, *i*), beyond which it is open on the cardinal side by a narrow, median, slit-like incision (figures 5*j*, *k*, *l*), thus forming a crural cavity which differs from that of *T. subcuneata* in having a much greater anterior extension and in having the median incision on the cardinal side much narrower;

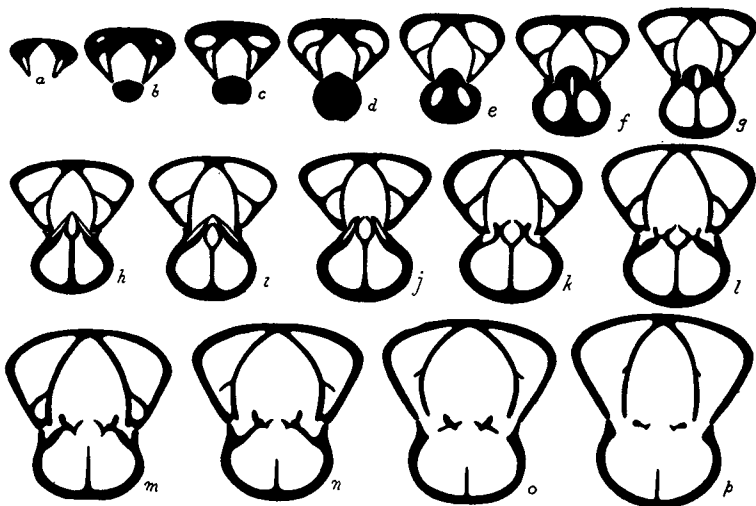


FIGURE 5.—Cross-sections of the rostral portion of *Tetracamera subtrigona* (M. & W.) This series of sixteen cross-sections ($\times 1\frac{1}{4}$) is from a specimen from the Keokuk limestone of Keokuk, Iowa

this structure, however, is totally different from that of the true cruralium of *Camarophoria*. At the line of articulation of the valves a shallow, broad, oblique cavity originates on each side of the central crural cavity (figures 5*h*, *i*, *j*), whose bounding wall on the cardinal side is much thinner than the inner wall. The inner walls may perhaps be compared with the two lateral septa of the rostral portion of the brachial valve of *T. subcuneata*, although their position is very different, their inner extremities abutting against the outer surface of the walls of the crural cavity and their outer extremity against the inner surface of the sides of the valve. Shortly after the origin of these lateral, oblique cavities, the crural cavity is differentiated into two portions (figure 5*i*) by the outgrowth from its inner surface of a pair of lateral processes which nearly

meet in the median line; the two portions of the cavity thus formed are of unequal size; the one toward the cardinal side is smaller, subcrescentic in form, and is completely arched over, as was the undivided cavity posteriorly. The arched covering of the smaller crescentic cavity quickly disappears and the slitlike, median, cardinal incision of the crural cavity opens freely toward the interior of the shell (figures 5*j*, *k*, *l*). The lateral, oblique cavities on each side of the central crural are inclosed upon the cardinal side but for a short distance (figures 5*h*, *i*, *j*), but the inner walls continue as supporting plates abutting against the outer surface of the walls of the crural cavity internally and against the inner surface of the lateral walls of the valve externally (figures 5*k*, *l*), and they continue beyond the anterior extremity of the crural cavity, giving support to the crural bases (figures 5*m*, *n*). The median septum continues well toward the anterior extremity of the valve with gradually decreasing height.

In the pedicle valve of this species the dental lamellæ unite to form a spondylium which rests directly on the floor of the valve, and each plate is supported by a lateral buttress plate connecting the outer surfaces of the dental lamellæ with the inner surfaces of the lateral walls of the valve, these structures being essentially as in *T. subcuneata*, although the buttress plates are situated nearer the cardinal margins of the valves, and they slope toward the cardinal margin in passing from the inner to their outer extremities. Shortly before the inner margins of the dental lamellæ become free from the cardinal margins of the valves these buttress plates cease to reach to the inner surfaces of the lateral walls of the valve, and continue as gradually decreasing processes on the outer surfaces of the dental lamellæ (figures 5*n*, *o*, *p*).

In the internal structure of its pedicle valve this species is essentially like *T. subcuneata*, and it is therefore placed with it in the genus *Tetracamera*, but the structure of the brachial valve is unique among all the species examined, and it is possible that these characters should be considered as of sufficient importance to justify the establishment of a distinct genus for the species.

RHYNCHOTETRA N. GEN.

RHYNCHOTETRA CAPUT-TESTUDINIS (WHITE)

Another rhyntonelliform shell referred to the genus *Camarophoria* by Hall and Clarke, apparently because of the presence of a median septum in each valve, is *Rhynchonella caput-testudinis* White. This species has a peculiar external configuration, differing markedly from all other rhyntonelliform shells of the Mississippian faunas in its elongate, trian-

gularly subovate form, its coarse plications, the great depth of the valves toward the beak, and the broad, concave lateral surfaces of the shell toward the beak. Material for the proper examination of the internal characters of a typical member of this species has not been available, but specimens of at least a closely allied form, which may perhaps be a distinct species, differing only in the arrangement of the coarse plications of the shell, have been investigated, and the series of cross-sections observed is shown in figure 6. In this shell the cross-section of the apical portion of the brachial valve is subtriangular in outline, and is divided by a median septum with a crural cavity internally, this cavity being arched over on its cardinal side (figure 6a). This condition persists to the be-

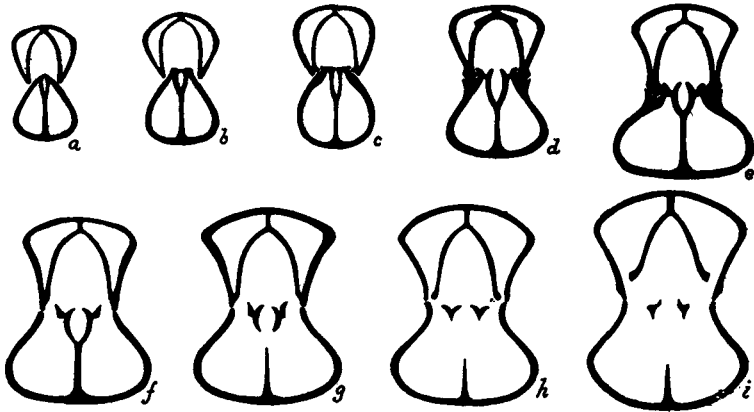


FIGURE 6.—Cross-sections of the rostral Portion of *Rhynchotetra caput-testudinis* (White).¹

This series of nine cross-sections ($\times 2\frac{1}{2}$) is from a specimen from the Burlington limestone of Missouri!

ginning of the articulation of the valves, with the cardinal surface becoming broader and flatter (figures 6b, c), but beyond this point the cardinal surface is open and the divided portion of the median septum forms an open crural cavity (figures 6d, e). The outer surfaces of the processes forming this cavity are at first connected laterally with the two portions of the divided hinge-plate, but anteriorly this connection with the lateral margins of the valves ceases (figure 6f), and shortly thereafter the connection with the median septum is broken (figure 6g), the lateral walls of the crural cavity passing into the bases of the crura. The median septum continues well toward the front with gradually diminishing height. In this valve there is no structure comparable with the crurallium as seen in the typical representatives of *Camarophoria*, the crural

cavity being identical in all essentials with the similar structure in many undisputed rhynchonelloid species.

In the pedicle valve the dental lamellæ are strongly developed and meet near the floor of the valve to form a spondylium which is supported by a median septum. Anteriorly the spondylium is progressively more elevated above the floor of the valve by the median septum. For a short distance, opposite the articulation of the valves, a pair of slight, lateral processes are present upon the outer surfaces of the dental lamellæ near their attachment to the median septum, which are possibly incipient lateral buttress plates such as are present in the genus *Tetracamera*.

PUGNAX HALL AND CLARKE

PUGNAX PUGNUS (MARTIN)

The remaining species which will be considered here have never been removed from the family Rhynchonellidæ, although they have been distributed among several different genera, and in some cases their generic

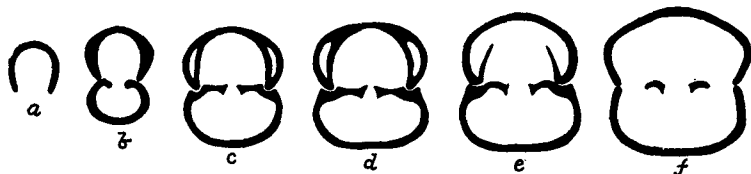


FIGURE 7.—Cross-sections of the rostral portion of *Pugnax pugnus* (Martin)

This series of six cross-sections ($\times 2\frac{1}{2}$) is from a specimen from the Mountain limestone of Ireland

reference has clearly been incorrect. Hall and Clarke have referred no less than five Mississippian species to the genus *Pugnax*, and Schuchert has placed the same species in the genus, the generic characters most commonly depended upon being the external configuration of the shell, most especially the obsolescence of the plications except toward the anterior margin of the shell. In order to have a standard for the comparison of the American species referred to this genus, one of the typical species of the genus, *Pugnax pugnus*, from the Mountain limestone fauna of Ireland, has been investigated, and the cross-sections secured are shown in figure 7. The structure of this shell is exceedingly simple. No median septum is present in either valve; the hinge-plate of the brachial valve is divided to the apex, and the dental lamellæ of the pedicle valve are short. None of the Mississippian species referred to the genus *Pugnax* by Hall and Clarke or by Schuchert possesses this simple structure, and in fact no species possessing the combination of this arrangement of

internal characters, with its peculiar external configuration, have been observed among those studied, and only two of the species which have been examined exhibit an entire absence of the median septum in the brachial valve.

ALLORHYNCHUS N. GEN.

ALLORHYNCHUS HETEROPSIS (WINCHELL)

One of the species in which an entire absence of the brachial median septum has been observed is *Rhynchonella heteropsis* Winchell, but in its external configuration it departs so widely from the typical form of *Pugnax* that no one has ever suggested that it be considered as a member of that genus. In figure 8 a series of cross-sections of this species is



FIGURE 8.—Cross-sections of the rostral Portion of *Allorhynchus heteropsis* (Winchell)
This series of six cross-sections ($\times 2\frac{1}{2}$) is from a specimen from the Kinderhook bed No. 4, at Burlington, Iowa

shown. The species can not be legitimately considered as a member of the genus *Pugnax* because of its external form, and on the other hand it can not be included in any of the recognized rhynchonelloid genera which it resembles externally, because of its internal features; it is therefore taken as the type of a new genus which may be called *Allorhynchus*. The species is marked by strong and angular plications which continue to the beaks of both valves, and in the umbonal portion of the brachial valve there is a distinct, median, longitudinal depression.

ALLORHYNCHUS MACRA (HALL)

Another species having the internal features of *A. heteropsis*, and lacking the external form of *Pugnax*, is *Rhynchonella macra* Hall, from the Salem limestone. A series of cross-sections of this species are shown in



FIGURE 9.—Cross-sections of the rostral Portion of *Allorhynchus macra* (Hall)
This series of four cross-sections ($\times 2\frac{1}{2}$) is from a specimen from Salem limestone near Alton, Illinois

figure 9. The species differs from *A. heteropsis* in its much smaller size, its much more compressed form, its much shallower and more obscure fold and sinus, and in the obsolescence of the plications toward the beak.

It agrees with that species in the absence of a brachial median septum, in the short dental lamellæ of the pedicle valve, and in the presence of a median, longitudinal depression in the umbonal portion of the brachial valve.

CAMAROTÆCHIA HALL AND CLARKE

GENERAL CHARACTERISTICS

In the Devonian faunas of North America the genus *Camarotæchia* has an abundant representation. The members of the genus are characterized by the presence of a median septum in the brachial valve which is divided internally to form a short crural cavity between the two sides of the divided hinge-plate. The crural cavity is commonly very short, sometimes terminating posterior to the articulation of the valves, but the simple, unattached median septum sometimes continues with gradually diminishing height, well toward the center of the valve. In the pedicle valve members of this genus are supplied with well developed dental lamellæ which join the floor of the valve independently. In their external configuration members of the genus *Camarotæchia* are strongly and more or less angularly plicated, the plications continuing to the beak, and they possess a well defined fold and sinus.

CAMAROTÆCHIA CHOUTEAUENSIS N. SP.

In the Mississippian faunas a single well defined but undescribed species of *Camarotæchia* has been observed. It is a common form in the



FIGURE 10.—Cross-sections of the rostral portion of *Camarotæchia chouteauensis* n. sp. This series of eight cross-sections ($\times 2\frac{1}{2}$) is from a specimen from the Chouteau limestone of central Missouri

Chouteau limestone and may be called *C. chouteauensis*. A series of cross-sections of the species is shown in figure 10.

WILSONIA KAYSER

WILSONIA GROSVENORI (HALL)

A species which was referred to the genus *Pugnax* by Hall and Clarke and by Schuchert is *Rhynchonella grosvenori* Hall. Internally this species possesses all the essential characters of *Camarotæchia*, as is shown in

the series of cross-sections given in figure 11. Externally it is more or less subcubical in form, with comparatively fine plications and slightly depressed median sinus in the pedicle valve, which is greatly produced anteriorly at nearly a right angle to the plane of the valve. These char-



FIGURE 11.—Cross-sections of the rostral Portion of *Wilsonia grosvenori* (Hall)

This series of five cross-sections ($\times 2\frac{1}{2}$) is from a specimen from the Salem limestone of Illinois

acters give the species much the aspect of members of the genus *Wilsonia*, to which genus it is here provisionally referred. The internal characters of typical members of the genus *Wilsonia* differ in no essential respect from *Camarotoechia*, and if the genus is worthy of recognition it must be distinguished by its external form.

LEIORHYNCHUS HALL

LEIORHYNCHUS GREENEANUM (ULRICH)

Another rhynchonelloid genus recognized by Hall and Clarke, which has the essential internal characters of *Camarotoechia*, is *Leiorhynchus*. This genus is established primarily upon its external form, it being but

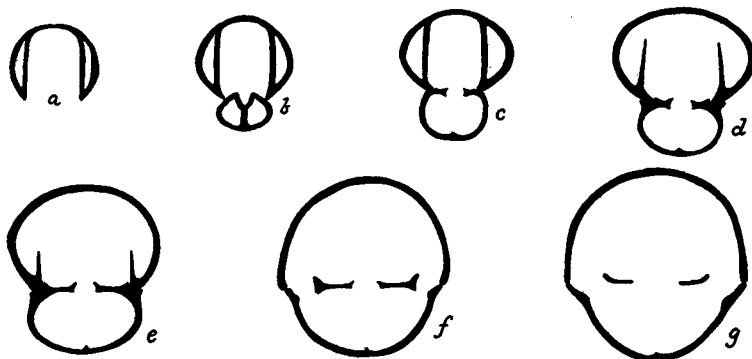


FIGURE 12.—Cross-sections of the rostral Portion of *Leiorhynchus greeneanum* (Ulrich)

This series of seven cross-sections ($\times 2\frac{1}{2}$) is from a specimen from the Knobstone formation of southern Indiana

obscurely plicated, with its plications commonly better developed on the fold and sinus than upon the sides of the shell. A good example of this genus is *L. greeneanum* (Ulrich), from the basal Mississippian of southern Indiana, a series of cross-sections of which is shown in figure 12.

PUGNOIDES N. GEN.

PUGNOIDES OTTUMWA (WHITE)

One of the rhynchonelloid shells which has been commonly referred by recent authors to the genus *Pugnax* is *Rhynchonella ottumwa* White. A series of cross-sections of this species is reproduced in figure 13, in which it is shown to possess all the essential internal characters of *Camarotoechia*. If, however, it is legitimate to recognize such genera as *Wilsonia* and *Leiorhynchus*, genera possessing essentially the same internal structure as

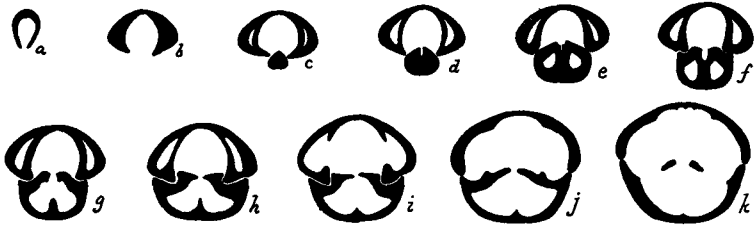


FIGURE 13.—Cross-sections of the rostral portion of *Pugnoides ottumwa* (White)

This series of eleven cross-sections ($\times 2\frac{1}{2}$) is from a specimen from the Pella beds of Iowa

Camarotoechia, and based primarily upon the external form and ornamentation of the shell, then *R. ottumwa*, with its external aspect of *Pugnax*, must also be excluded from *Camarotoechia*, and as there is no genus in which it can be placed, it becomes necessary to establish a new one for its reception. This genus may be called *Pugnoides*, with *P. ottumwa* as genotype.

SHUMARDELLA N. GEN.

SHUMARDELLA MISSOURIENSIS (SHUMARD)

A species of rhynchonelliform shell from the Chouteau limestone was described by Shumard in 1855 as *Rhynchonella missouriensis*. The contour and ornamentation of the shell is peculiar, and it has commonly been referred to the genus *Pugnax* by recent authors, evidently because of its coarse plications, which become more or less obsolescent toward the beak. The presence of a strong median septum in the brachial valve, however, must exclude the species from that genus, and the internal characters of the shell are so different from other species that, associated as they are with the peculiar external form, the species may be taken as the type of a new genus, *Shumardella*. A series of cross-sections of the shell is shown in figure 14. In this genus the median septum of the brachial valve is divided internally by a narrow median incision, which, however, is not open cardinally to form an open crural cavity as in *Camarotoechia*, but is arched over, as is shown in figure 14d. The me-

dian septum is soon disconnected from the cardinal side of the valve (figure 14e), and continues with gradually decreasing height well toward the middle of the valve. With the disconnection of the median septum cardinally, the two plates forming the sides of the inclosed crural cavity continue as free plates extending into the cavity of the valve (figure 14e),

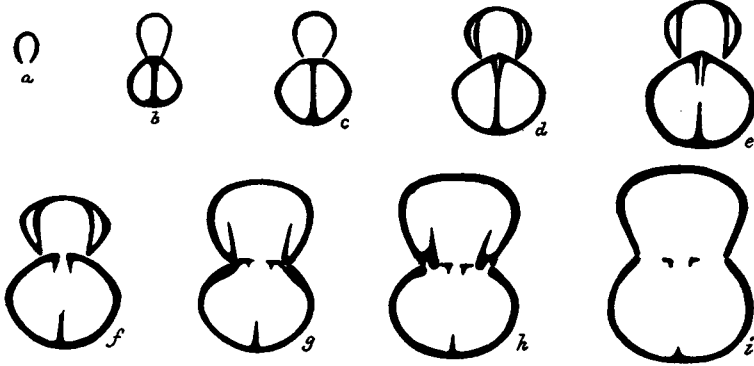


FIGURE 14.—Cross-sections of the rostral Portion of *Shumardella missouriensis* (Shum.) This series of nine cross-sections ($\times 2\frac{1}{2}$) is from a specimen from the Chouteau Limestone of Missouri

the space between the plates is arched over cardinally for a time, but with the reduction of the width of these vertical plates the hinge-plate becomes divided just posterior to the articulation of the valves (figure 14f). Beyond the articulation of the valves the inner margins of the divided hinge-plate are produced anteriorly into the bases of the crura.

SHUMARDELLA OBSOLESCENS (HALL)

Associated with *S. missouriensis* in the Chouteau limestone is a smaller, more subglobular shell, with nearly obsolete plications, which has com-

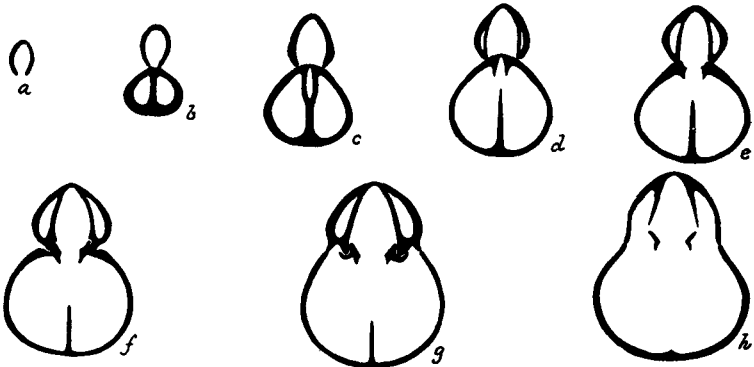


FIGURE 15.—Cross-sections of the rostral Portion of *Shumardella obsolescens* (Hall) This series of eight cross-sections ($\times 2\frac{1}{2}$) is from a specimen from the Chouteau limestone of Missouri

monly been considered as a variety of *S. missouriensis*. This shell is perhaps identical with *Rhynchonella obsolescens* Hall, from the Rockford limestone of Indiana; at least the external form is essentially the same, and it may be designated as *S. obsolescens* until the internal characters of the Rockford shells are investigated. A series of cross-sections of this shell is shown in figure 15, which shows that in its essential features it agrees with *S. missouriensis* and may be included in the same genus.

RHYNCHOPORA KING

GENERAL CHARACTERISTICS

The genus *Rhynchopora* has been established to include several rhynchonelloid shells which are known to possess a punctate shell structure, this shell structure being the essential character upon which the genus has been based. The internal structure of the shell has never been described, but on investigation several species seem to exhibit additional characters of generic importance. No opportunity has been afforded to examine the genotype of the genus.

RHYNCHOPORA PUSTULOSA (WHITE)

This species occurs in one of the Kinderhook formations at Burlington, Iowa, and a series of cross-sections of a typical representative of the species is shown in figure 16. After the second section the pedicle valve is

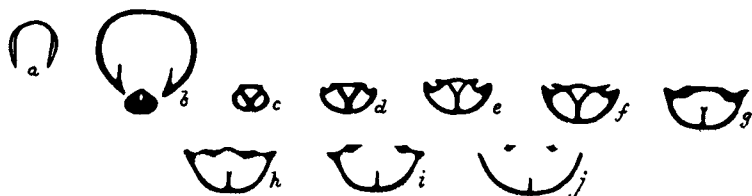


FIGURE 16.—Cross-sections of the rostral portion of *Rhynchopora pustulosa* (White). This series of ten cross-sections ($\times 2\frac{1}{2}$) is from a specimen from the Kinderhook bed No. 4, at Burlington, Iowa.

not shown in these figures, as it possesses no features of diagnostic value. In the brachial valve a well defined median septum is present which is divided to form a crural cavity as it approaches the cardinal side of the valve (figures 16c, d, e, f), but, unlike *Camarotoechia*, this crural cavity is roofed over by the undivided hinge-plate. Even after the median septum has become disconnected cardinally the undivided hinge-plate persists nearly to the point where the crural bases become free (figures 16g, h, i). This character of the undivided hinge-plate is entirely different from any other generic group of Mississippian rhynchonelloids

which has been investigated in these studies, and seems to be an additional character of generic value in *Rhynchopora*.

RHYNCHOPORA HAMBURGENSIS N. SP.

In the thin oolite limestone of the Kinderhook at Hamburg, Illinois,¹⁰ a small rhynchonelloid shell occurs in great profusion. The shell structure is distinctly punctate and a series of cross-sections, reproduced in

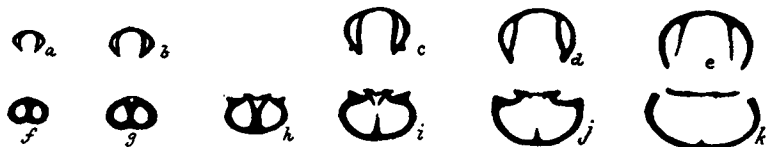


FIGURE 17.—Five Cross-sections of the rostral Portion of the Pedicle Valve and Six of the Brachial Valve of *Rhynchopora hamburgensis* n. sp.

These two series of cross-sections ($\times 2\frac{1}{2}$) are from specimens from the Kinderhook oolite of Hamburg, Illinois

figure 17, shows that it has the same type of undivided hinge-plate as is present in *R. pustulosa*.

RHYNCHOPORA BEECHERI GREGER

Cross-sections of this shell have not been made, but a series of very excellent internal casts in chert exhibit not only its strongly punctate shell structure, but also the presence of an undivided hinge-plate similar to that in other members of the genus.

RHYNCHOPORA PERSINUATA (WINCHELL)

This species has not previously been referred to the genus *Rhynchopora*, but study of an excellent example of an internal cast of the species from the typical locality shows that the hinge-plate is undivided as in members of the genus, but the specimen is not preserved in such a manner as to exhibit either the presence or absence of the characteristic punctate shell structure. On examining all available examples of the species, however, one was observed in which the shell structure is distinctly punctate, so that the two essential characteristics of the genus *Rhynchopora* are known to be present.

RHYNCHOPORA ? COOPERENSIS (SHUMARD)

This species occurs somewhat commonly in the Chouteau limestone, but a diligent examination of all the examples which have been available for study has failed to demonstrate that the punctate structure of the

¹⁰ Transactions of the Academy of Science of Saint Louis, vol. xvi, p. 465.

shell is present; but in its external features the shell is so like *R. persinuata* that the two species can scarcely be distinguished. A series of cross-sections showing the internal features of the species is reproduced in figure 18, and these show the characteristic undivided hinge-plate of

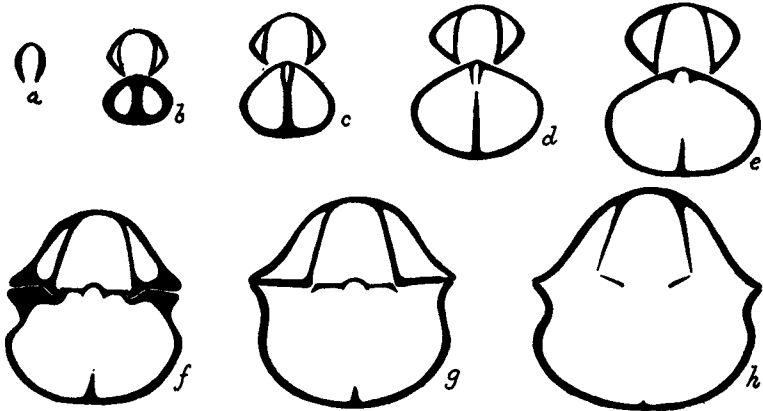


FIGURE 18.—Cross-sections of the rostral Portion of *Rhynchopora ? cooperensis* (Shumard)

This series of eight cross-sections is from a specimen from the Chouteau limestone of Missouri

Rhynchopora. Under these circumstances it seems to be safe to refer the species to that genus, although until the punctate shell structure has been observed the reference may be made with a query.