CORRELATION OF THE KINDERHOOK FORMATIONS OF SOUTHWESTERN MISSOURI.

In a recent geological report on Greene county, Missouri,[1] by Professor Edward M. Shepard, the stratigraphy of a portion of the southwestern part of the state surrounding the city of Springfield, has been described in detail. Some of the correlations proposed for the Kinderhook formations, however, are erroneous because of the almost entire disregard of paleontological evidence. The Kinderhook formations in the area are not abundantly fossiliferous, and unless careful search be made for fossils they may be easily overlooked. All the principal formations, however, contain distinctive faunas which furnish the data for a definite correlation of the beds.

The formations described by Shepard that must be included in the Kinderhook, are as follows, beginning with the lowermost, the names being those used in the report:

1.	Eureka or black shale	0 to 4 feet
2.	King limestone	1 to 15 feet
3.	Sac limestone	1 to 18 feet
4.	Phelps sandstone	0 to 4 feet
5.	Louisiana limestone	0 to 8 feet
6.	Hannibal sandstone and shale	10 to 90 feet
7.	Chouteau limestone	3 to 30 feet

The most conspicuous of these formations in the region covered by the report are the Sac limestone, the so-called Hannibal sandstone and shale and the so-called Chouteau limestone. In his geological map Shepard has recognized only three divisions in the series which correspond in general with the three formations just named. The Eureka shale and the Phelps sandstone are also formations which are apparently worthy of separate definition, but the King limestone and the so-called Louisiana limestone may prove, upon sufficient investigation, to be nothing but

[1] A Report on Greene county, by Edward M. Shepard, Geol. Survey of Missouri, Vol. XII, pp. 12–245 (December 1898).

lithologic facies of the Sac limestone. The strict correlation of the formations called Louisiana limestone, Hannibal sandstone and shale, and Chouteau limestone with the formations recognized under these names in the central and northeastern portion of the state cannot be sustained, as will be shown in the following pages, and in the present paper the names Northview sandstone and shale and Pierson limestone will be substituted for Hannibal sandstone and shale and Chouteau limestone.

The four lowermost of the formations in the preceding list, were referred by Shepard to the Devonian, but in view of the well defined Kinderhook faunas that are present in the Eureka shale and the Sac limestone, such a correlation cannot be sustained.

Eureka shale.—This formation has been recognized by Shepard in but few localities in the area covered by his map, and is restricted, for the most part, to the southwestern portion of the region where it attains its maximum thickness. Outside of this portion of the area, a few inches of shale have been recognized at several localities lying above the magnesian limestones, which are referred to this formation. Near Frazer's, at the chief locality for the Eureka shale cited by Shepard, the following fossils were collected by the writer:

1. *Lingula* sp. cf. L. *subspatulata* M. & W.
2. *Orbiculoidea* sp. undet.
3. *Chonetes* sp. cf. *C. logani* N. & P. or *C. ornatus* Shum.
4. *Ambocoelia parva* Weller.
5. Phyllocarid crustacean.
6. Fish scales?

The most common fossils in the fauna are the Lingulas, in this respect simulating the Eureka shale fauna of northern Arkansas which has been described by Williams.[1] *Orbiculoidea* is not recorded from Arkansas by Williams, although there is no reason why the genus should not be present in the Eureka shale of that state. The *Chonetes* found at Frazer's is evidently identical with one of the species of this genus recorded by Williams,

[1] Am. Jour. Sci. (4), Vol. VIII, pp. 139–152.

and is probably identical with one of the common Chouteau species of the genus. *Ambocoelia parva* was first described from the Northview sandstone, and the specimens from the shale seem to be indistinguishable from the types of the species except that they are more or less crushed. No crustaceans are recorded by Williams, but Phyllocarid crustaceans similar to those noticed in the fauna are not of uncommon occurrence in similar shale formations. Fish remains were detected by Williams in the Arkansas beds. No specimens of the *Leiorhynchus subspatula* noticed by Shepard[1] from this locality were detected by the writer.

Notwithstanding the presence of some forms in this fauna at Frazer's which have not yet been recognized in the Eureka shale of Arkansas, and the absence of others which are known to occur there, when we consider the poorly preserved nature of the fossils in all the localities and the stratigraphic relations of the beds containing them, the similarity between the faunas of the two regions is sufficient to establish the correlation, in a general way, of the beds containing them.

In regard to the age of the Eureka shale fauna in Arkansas Williams[2] says:

> The fauna of these fine shales in Arkansas, terminating and following the black shales, is unmistakably much higher than the Genesee black shale of New York. Faunally it is the correlative of the Louisiana or lithographic limestone, and is thus as late as the Kinderhook stage of the Eocarboniferous.

The beds indicated in the quotation are the fine green shales which always follow without any break in the sedimentation, the typical black Eureka shale when the two members are both present. Usually the black shales, in Arkansas, contain almost no fossils save *Lingulus*, but at one locality on War Eagle Creek a fauna from the black shales is noted which does not differ essentially from that in the greener beds.

Recent careful studies among the Kinderhook faunas of the Mississippi valley have given a basis for a more definite

[1] Loc. cit., p. 67. [2] Loc. cit., p. 149.

correlation of the Eureka shale fauna than Williams was able to make.[1] As will be shown, the fauna may be correlated definitely with that of the upper Kinderhook, that portion of the series which lies above the Chonopectus sandstone in the Burlington section.

The specimens referred to *Cyrtina acutirostris* by Williams are probably not representatives of the typical form of this species, but of a variation which may prove to be an undescribed form which is present in the Sac limestone and in the typical Chouteau limestone. *Spirifer marionensis* is a common species in the upper Kinderhook. The species recorded as *S. ? compactus* Meek is certainly *S. peculiaris* Shum., a common and variable species in the upper Kinderhook which possibly runs up into the lower portion of the Burlington limestone. *Athyris hannibalensis* is only a small form of *A. lamellosa*, and the two are not specifically distinct. It is common in the upper Kinderhook of southwestern and southeastern Missouri, but has not been recognized in the Burlington section. The three forms of *Chonetes* recorded by Williams are probably all present in the upper Kinderhook. The species of *Productus* referred to *P. hallanus* Walc. is not that species, but the specimens so identified are identical with a common species in the Sac limestone which has also been recognized in the typical Chouteau of central Missouri and in the upper beds of the Kinderhook in southeastern Missouri. The pedicle valve resembles *P. hallanus*, but the brachial valve does not have the concentric markings of that species. The orthids recorded by William are like those in the upper Kinderhook faunas elsewhere. *Leptaena rhomboidalis* is present in almost every upper Kinderhook fauna but has not been recognized in the Chonopectus fauna, nor in that of the Louisiana limestone. The additional species recorded by Williams afford little evidence as to the age of the fauna.

[1] Many of the Arkansas collections studied by Williams were made by the writer as an assistant to Professor Williams under the auspices of the United States Geological Survey. These collections were also carefully studied by the writer in Professor Williams' laboratory during the winter of 1894–5.

The paleontological evidence, as shown above, points conclusively to the Kinderhook age of the Eureka shale of Arkansas, and not merely may the fauna be correlated with the Kinderhook in general, but with that portion of the Kinderhook which is represented by the Chouteau limestone of central Missouri. The fauna is younger than the Chonopectus fauna of the Burlington section, and is also younger than the fauna of the Louisiana limestone if the generally accepted view as to the stratigraphic position of this formation, at the extreme base of the Kinderhook, be the correct one.

The Eureka shale in Missouri, as described by Shepard, is doubtless a stratigraphic continuation of the Arkansas formation, though the actual time of its deposition may have been a little earlier. The Kinderhook sea, in southwestern Missouri and northern Arkansas, is believed to have been transgressing upon the land to the southward. The Eureka shale facies of sedimentation is believed to have been a transgressing formation associated with the trangression of the sea to the southward, it being the initial sedimentation upon the newly submerged land surface. This formation, therefore, in the region covered by the Greene county report, was probably deposited a little earlier in time than its stratigraphic equivalent in northern Arkansas, as it is followed by the Sac, Northview, and Pierson formations. In northern Arkansas this same stratigraphic unit represents the final stages of the Kinderhook, it being immediately followed by the St. Joe marble whose fauna indicates the Burlington age of the formation. The black Eureka shale in Arkansas, with its associated greenish shale beds and the equivalent Sylamore sandstone, may be considered as the sole representatives of the Kinderhook in that state, the time of their deposition being the final stages of the Kinderhook epoch.

Sac limestone.—The King limestone, described by Shepard, has not been studied by the writer. It is said to be[1] "rarely over a foot or two in thickness except outside and south of the area." A further statement is made in regard to the formation[2]

[1] Loc. cit., p. 71. [2] Loc. cit., p. 72.

to the effect that "to the south . . . . it underlies, directly, the Phelps sandstone, the Sac limestone being absent." This manner of occurrence would seem to indicate that the formation was but a facies of the Sac limestone, it being thin or almost absent where the typical facies of that formation is well developed, becoming thicker and replacing the lithologic facies described as the Sac limestone, to the south. A careful search for fossils should be made in the limestone in order to determine whether or not its fauna is the same as that in the Sac limestone.

The typical facies of the Sac limestone is well exposed in numerous outcrops along the Sac River and its branches in the northern portion of Greene county, the name of the formation being selected by Shepard[1] because of this occurrence. It is a hard, bluish gray, compact limestone with a maximum thickness of eighteen feet, usually deposited in beds of from six to ten inches thick with thin greenish shaley partings between the beds. The rock has been quarried somewhat extensively at several points and shipped to Springfield to be used as curbing. Shepard referred the formation with those beneath it, to the Devonian, considering it to be of Hamilton age. No fossils were secured by him in the formation itself by means of which such a correlation could be established, but in the overlying Phelps sandstone, numerous waterworn fragments of fish-teeth were secured, some of which were identified as *Ptyctodus calceolus*. This genus of fishes is usually considered to be limited to the Devonian, and its presence in beds overlying the Sac limestone was considered to be sufficient evidence to justify the reference of the underlying beds to the Devonian. A study of the invertebrate fauna of the Sac limestone, however, serves to definitely correlate the formation with the lower portion of the Chouteau limestone of central Missouri, and leads to the conclusion that either the waterworn fragments of fish-teeth have been wrongly identified, or that the genus *Ptyctodus* has a higher geological range than has hitherto been supposed.

Although no fossil fauna was secured from this formation

[1] Loc. cit., p. 74.

by Shepard, the Sac limestone is really fossiliferous in most localities where it is exposed, and frequently affords beautifully preserved specimens. One of the best fossil localities in the formation known to the writer, is at an old quarry about eight miles northeast of Springfield, east of the Fair Grove road where it crosses the north branch of the Little Sac. The species collected at this locality will be enumerated, with notes on their occurrence elsewhere.

1. *Platycrinus ollicula* S. A. M.
2. *Platycrinus annosus* S. A. M.
3. *Platycrinus absentivus* S. A. M.

   All three of these species of Platycrinus were originally described from the Chouteau limestone of Pettis county, Missouri.
4. *Dichocrinus* sp. undet. A single specimen of this crinoid has been observed. It is too imperfect for specific identification, but it resembles *D. inornatus* from the upper Kinderhook beds at Le Grand, Iowa.
5. *Schizoblastus roemeri* Shum. This species originally described from the Chouteau limestone at Providence, Missouri, is one of the commonest species in the Sac limestone at the locality under discussion.
6. *Leptaena rhomboidalis* Wilck. This species is entirely absent from the lower Kinderhook beds at Burlington, Iowa, making its first appearance in the upper "Yellow Sandstone," bed No. 5.[1] The species is also absent from the Louisiana limestone fauna of the lower Kinderhook, but is universally present in the upper Kinderhook.
7. *Chonetes logani* N. & P. This little species is particularly characteristic of the oolite bed No. 6[2] of the Burlington section. It is also possible that *C. ornatus* Shum., from the typical Chouteau limestone, is not specifically distinct.
8. *Productus blairi* S. A. M. This species was originally described from the Chouteau limestone of Pettis county, Missouri.
9. *Productella concentrica* H. This species occurs abundantly in the Chouteau limestone of central Missouri, and is also a member of the oolitic limestone (bed No. 6) fauna at Burlington, Iowa.
10. *Schizophoria swallovi* H. The specimens referred to this species are smaller than the normal form of the species in the Burlington limestone. Specimens agreeing in all respects with those from the Sac limestone, are also present in the typical Chouteau limestone.

[1] Iowa Geol. Survey, Vol. X, p. 76. [2] Loc. cit., p. 77.

11. *Rhipidomella burlingtonensis* H. A small form of this species is present in the fauna, which agrees in all respects with specimens from the Chouteau limestone.
12. *Pugnax missouriensis* Shum. The Sac limestone specimens of this species are indistinguishable from specimens of the same species from the Chouteau limestone at Chouteau Springs, Missouri.
13. *Athyris prouti* Swall. This species has not been seen from the Chouteau limestone of central Missouri, but is a common species in the upper portion of the Kinderhook near Sulphur Springs, Missouri.
14. *Athyris* sp. undet. A small species somewhat resembling the Devonian *A. fultonensis* occurs in the Sac limestone fauna, and the same form is present in the Chouteau limestone at Providence, Missouri.
15. *Cleiothyris* sp. undet. Specimens of a small lenticular species resembling *C. hirsuta* are present in the fauna, and the same species occurs in the Chouteau limestone at Providence, Missouri.
16. *Spirifer peculiaris* Shum. This is one of the commonest species of the Sac limestone fauna, as it is also of the Chouteau limestone of central Missouri. The same or a closely allied species occurs in bed No. 5 at Burlington.
17. *Spirifer latior* Swall.? This species was originally described from the Chouteau limestone of Cooper county, Missouri, but no illustrations of it have ever been published. The Sac limestone specimens are identified thus with some doubt, but in any event a species identical with them occurs in the Chouteau limestone of Pettis county.
18. *Spirifer striatiformis* Meek? This identification is only provisional, but specimens of the same species occur in the Chouteau limestone in Pettis county.
19. *Syringothyris missouri* H. & C. This species is only known elsewhere from the Chouteau limestone at Chouteau Springs, Missouri.
20. *Cyrtina* sp. undet. The same species has been recognized from the typical Chouteau limestone.
21. *Dielasma* sp. undet. A rather large, smooth species of this genus is present in the fauna, which is apparently identical with specimens from the Chouteau limestone of Pettis connty.
22. *Capulus* sp. undet. Several forms of this genus are present in the fauna which may belong to several distinct species.
23. Corals and Bryozoa. Several undetermined species of corals and bryozoa of little diagnostic value, occur in the fauna.
24. Fish teeth. Fragments of fish teeth are not uncommon in the fauna.

From the list of fossils just given it will be seen that the fauna of the Sac limestone corresponds closely with that of the typical Chouteau limestone of central Missouri, and more especially with the lower division of the Chouteau limestone as described by Swallow.[1] There is no foundation whatever for correlating it with the Hamilton formation of the Devonian, but several of the species are also present in beds 5 and 6 of the Kinderhook at Burlington, Iowa.

The formation referred by Shepard to the Louisiana limestone, is described as follows by that author:[2]

> The lowest member of the Carboniferous is not so variable in composition and texture as the other two. It frequently, however, possesses such lithologic characters as to make it difficult to distinguish it from the associated Devonian rocks. As only a few obscure fossils have been found in this region, its identification is dependent entirely upon position and lithologic characters.

The Devonian formation referred to in the above quotation is the Sac limestone. The difficulty in separating the so-called Louisiana limestone from the Sac limestone is frequently indicated by Shepard by such statements as the following:

> P. 85: . . . . an outcropping of what seems to be some eight or ten feet of Louisiana, though it may prove to be a somewhat modified form of Sac limestone; p. 76: it is barely possible that this particular rock may be Louisiana, and not the Sac limestone; p. 77: there is frequent difficulty, on account of lithologic characters, in separating it [the Sac limestone] from the Louisiana when the Phelps sandstone is absent; p. 77: it is a noticeable fact that, when the Devonian [the Sac limestone] is present, the Louisiana limestone is usually, though not always, absent.

Among the localities mentioned for the Louisiana limestone, the best exposure where both this formation and the Sac limestone are present, is said to be at the Newton mound,[3] and the description of its stratigraphic position at this locality is as follows: "Immediately underlying the Hannibal shales and overlying the Phelps sandstone, are ten feet of this limestone." The Phelps sandstone at this same locality is described in another

[1] Geol. Surv. Mo., Rep. I and II (1855), p. 102.

[2] Loc. cit., p. 84. [3] Loc. cit., p. 84.

place[1] as follows: "a number of fragments of the typical sandstone with fish teeth were found on the slope. A hurried search did not discover this sandstone uncovered." If this last statement be correct, it is difficult to see how the fact stated in the first of the above quotations can be demonstrated. Another locality mentioned where the Louisiana limestone is said to be "associated with the Devonian" is on the Cochran farm. The so-called Devonian described at this locality is the Sac limestone and "loose fragments" of Phelps sandstone in which "no fish teeth were found." In neither of these localities is it demonstrated that the so-called Louisiana limestone and the Sac limestone are distinct formations separated by the Phelps sandstone. The loose fragments supposed to belong to this sandstone can be of no value in elucidating the stratigraphy. In none of the other localities given for the Louisiana limestone is there any evidence given to show that the formation is distinct from the Sac limestone, and the careful reader of the Greene county report is forced to the conclusion that its author mistook mere lithologic variations of a single stratigraphic unit as two distinct formations. A careful search for fossils, however, should be made in the outcrops of so-called Louisiana limestone, for the purpose of demonstrating its identity with the Sac limestone.

Phelps sandstone.—This formation has been examined by the writer only at its typical locality in the neighborhood of the Phelps mines. It has been recognized by Shepard, however, as a more or less continuous formation throughout the area covered by his report, and is frequently characterized by the waterworn fragments of fish teeth. At the Phelps mines these teeth are somewhat abundant, but are so waterworn that in every specimen observed the original form has been destroyed. Some of these specimens have been identified by Shepard as *Ptyctodus calceolus*, and it was chiefly from the evidence of this identification, with no knowledge of the invertebrate fauna of the Sac limestone, that the Phelps sandstone was referred to the Devonian, such a reference carrying with it, of necessity, all the

[1] Loc. cit., p. 81.

underlying beds down to and including the Eureka shale. This sandstone resembles, lithologically, the Sylamore sandstone of Arkansas; both formations carry fish remains and also numerous black phosphatic nodules.

Northview sandstone and shale. — In the older geological reports these beds have been known as the Vermicular sandstone and shales from the abundance of worm burrows which occur in the sandstones. Shepard[1] has considered these beds to be the equivalent of the Hannibal shales of the Mississippi River section which are supposed to lie beneath the Chouteau limestone, and he has so designated them in his report. These beds in southwestern Missouri, however, are certainly not the equivalent of the typical Hannibal shales, if the relationship of that formation to the remainder of the Kinderhook series be properly understood, and as they possess a characteristic individuality of their own throughout a considerable geographic area, it seems advisable to designate the formation by a special name. The sandstones of the formation are abundantly fossiliferous near Northview, in the western edge of Webster county, and therefore this name is suggested for the formation.

Shepard's investigations have shown that the formation has a thickness ranging from ten to ninety feet. It is typically made up of two members, a lower bluish shale and an upper fine-grained yellowish sandstone. The two members of the formation grade from one into the other with no sharp line of separation, and one member is frequently thickened at the expense of the other, the lower shale member being the most peristent.

The fauna of this sandstone at Northview has been described in detail in another place,[2] and contains the following species.

1. *Zaphrentis* sp. undet. A few fragments of specimens of this genus have been observed.
2. *Scalarituba missouriensis* Weller. This is the name which has been applied to the worm borings which penetrate the sandstone in all directions.

[1] Loc. cit., p. 86.

[2] Kinderhook Faunal Studies. I. Fauna of the Vermicular Sandstone at Northview, Webster county, Missouri. Trans. St. Louis Acad. Sci., Vol. IX, pp. 9–51.

3. *Orthothetes inaequalis* Hall? In the paper cited above, this shell was identified as *O. chemungensis*. It is probably identical with one of the species in the upper Kinderhook beds at Burlington, but may not be the *O. inaequalis*.
4. *Schizophoria swallovi* Hall. The specimens of this species resemble those from the subjacent Sac limestone, and also those from the superjacent Pierson limestone, but are usually larger than the Sac limestone specimens.
5. *Rhipidomella burlingtonensis* Hall. The specimens of this species are not unlike those from the other Kinderhook formations of the region, but are usually larger than the Sac limestone specimens.
6. *Chonetes illinoisensis* Worthen? The specimens so identified should perhaps rather be referred to *C. multicosta* Win., described from the "yellow sandstone" at Burlington, Iowa.
7. *Productella concentrica* Hall. A single individual of this species resembles specimens of the same species from Burlington, Iowa.
8. *Spirifer marionensis* Shum. This is one of the most abundant species in the fauna of the Louisiana limestone at its typical exposures. It is also a common species in the oolite bed at Burlington and occurs in the subjacent "yellow sandstone" at the same place, as well as being more or less common in most of the upper Kinderhook faunas.
9. *Spirifer striatiformis* Meek? This species is probably identical with the one so identified from the Sac limestone.
10. *Syringothyris carteri* Hall. Several specimens from Northview have been referred to this species, although the characteristic syrinx and punctate shell structure of the genus have not been observed.
11. *Ambocoelia parva* Weller. This species has only been observed in this fauna and in the Eureka shale.
12. *Athyris lamellosa* Lev. This species is a common one in the superjacent Pierson limestone, and is also a member of the typical Chouteau limestone fauna.
13. *Cleiothyris* sp. undet. These specimens are possibly identical with those in the Sac limestone.
14. *Dielasma* sp. undet. This shell is perhaps the same as that described by Winchell as *Centronella allei* from the upper "yellow sandstone" at Burlington.
15. *Crenipecten winchelli* Meek? This is a species which was originally described from the Waverly sandstones of Ohio.
16. *Crenipecten laevis* Weller. This species was described from Northview, and is not known elsewhere.

17. *Pernopecten cooperensis* Shum. This is one of the commonest species in the Northview sandstone, and is also one of the most characteristic species of beds 5 and 6 of the Burlington section. It was originally described from the Chouteau limestone of Cooper county, Missouri, and is a common shell in some beds of the Chouteau limestone.
18. *Modimorpha northviewensis* Weller. This species has only been recognized at Northview.
19. *Macroden* sp. undet. This species has not been identified, but the genus is represented in the upper "yellow sandstone" fauna at Burlington by a very common species. The genus is also represented in the typical Chouteau limestone.
20. *Cardiopis radiata* M. and W. This species originally described from the goniatite limestone at Rockford, Indiana, also occurs in the Chouteau limestone in Pettis county, Missouri.
21. *Cardiopsis erectus* Weller. This species was first described from Northview, and has not been recognized elsewhere.
22. *Palaeoneilo* sp. undet. This species was formerly identified with a query as *P. constricta* Con., but it is probably distinct. It is closely allied to *P. microdonta* Win. of the upper "yellow sandstone" at Burlington, but is usually larger.
23. *Palaeoneilo truncata* H. This species, originally described from the Waverly sandstones of Ohio, is represented in the upper "yellow sandstone" at Burlington by *P. barrisi* W. & W. a similar but smaller species. The genus *Palaeoneilo* does not occur in the Chonopectus fauna at Burlington, and has not been recognized in any of the lower Kinderhook faunas.
24. *Schizodus aequalis* Hall. This is a Waverly sandstone species, and has not been recognized elsewhere in the Kinderhook.
25. *Elymella missouriensis* M. & G. This species was originally described from the Chouteau limestone of Pettis county, Missouri.
26. *Promacrus websterensis* Weller. This was described as a new species from Northview.
27. *Promacrus cuneatus* Hall. In the description of the fauna of the Chonopectus sandstone,[1] this species was provisionally included. Since that time, however, through the courtesy of Dr. E. O. Hovey, of the American Museum of Natural History, the type specimen of *P. cuneatus* has been examined by the writer, and it proves to have come from the upper "yellow sandstone," bed No. 5, at Burlington. The genus *Promacrus* is represented by several species in the

[1] Kinderhook Fauna Studies. II. Fauna of the Chonopectus Sandstone at Burlington, Iowa. Trans. St. Louis Acad. Sci., Vol. X, pp. 57–129.

typical Chouteau limestones of central Missouri. It is not known anywhere in the lower Kinderhook beds, and is probably a characteristic form of the upper Kinderhook faunas.

28. *Sanguinolites websterensis* Weller. This species was described as new from Northview, but probably occurs also in the Waverly sandstones of Ohio.
29. *Edmondia* sp. undet. This species was originally identified as *E. burlingtonensis* W. & W., but an examination of the types of that species from the Chonopectus sandstone have led to the conclusion that the two shells are not specifically identical.
30. *Edmondia missouriensis* Weller. This species was described as new from Northview.
31. *Tropidodiscus cyrtolites* Hall. This species, originally described from the goniatite limestone at Rockford, Indiana, is also recorded from the Waverly sandstones of Ohio.
32. *Euphemus?* sp. undet.
33. *Bucania?* sp. undet.
34. *Bellerophon* sp. undet.
35. *Mourlonia northviewensis* Weller. This was described as a new species from Northview.
36. *Pleurotomaria* sp. undet.
37. *Platyschisma missouriensis* Weller. This was described as a new species from Northview.
38. *Straparollus* sp. undet.
39. *Phanerotinus paradoxus* Winch. This species, first described from Burlington, is probably a member of the upper "yellow sandstone" fauna at that locality.
40. *Capulus* sp. undet.
41. *Porcellia rectinoda* Win. (?) The correct horizon of the original types of this species at Burlington is not known. Two other members of the genus, however, occur in the Chonopectus sandstone. The genus is also known to occur higher up in the Burlington limestone.
42. *Loxonema* sp. undet. This species is of the general form of specimens which are not uncommon in the Chouteau limestone in Central Missouri.
43. *Orthoceras indianense* Hall. These specimens, formerly identified as *O. Chemmigense* Swall., are probably identical with a form common in the oolitic limestone (bed No. 6) at Burlington, which may probably be identified with *O. indianense* of the goniatite limestone at Rockford, Indiana.
44. *Triboloceras digonum* M. & W. This species is a common one in some portions of the Chouteau limestone of central Missouri.

45. *Proetus* sp. undet.
46. *Spirophyton* sp. undet. These fucoid markings are abundant everywhere in the sandstone, and with the worm borings are the only fossils which are always recognizable in this formation.

When the description of the Northview fauna was published no differentiation of the faunas of the "yellow sandstone" at Burlington was possible. Since that time, however, a study of the type collections from that locality has shown that two quite distinct yellow sandstone faunas occur.[1] The lower is characterized by *Chonopectus fischeri* N. & P., and the bed containing it, bed No. 2, has been called the Chonopectus sandstone. The upper yellow sandstone is characterized by the presence of *Pernopecten*, *Promacrus*, and *Palaeoneilo*, genera which are wanting from the Chonopectus fauna. These same genera, however, are among the most characteristic forms of the Northview sandstone, and all of them are also present in the fauna of the typical Chouteau limestone of central Missouri. The faunas of the Northview sandstone and of the upper yellow sandstone at Burlington may be considered as analagous, and they may without hesitation be considered as one facies of the upper Kinderhook or Chouteau fauna.

The Northview shales are usually quite barren of fossils, but at a few localities they are abundant. They are mostly brachiopods and corals, but no complete list of species can be given in this place. The collections in Walker Museum contain only a few specimens from this bed near Bolivar in Polk county, the species represented being *Athyris lamellosa*, *Reticularia cooperensis*, and *Rhipidomella burlingtonensis*. These species are all present in the fauna of the typical Chouteau limestone elsewhere.

Pierson limestone.—This is a fine-grained, buff colored, gritty limestone having a maximum thickness, according to Shepard,[2] of thirty feet, being the formation designated by him as the Chouteau limestone. In view of what has already been written in regard to the faunas of the Sac limestone and the Northview sandstone, it will be recognized that the formation is by no

[1] Iowa Geol. Surv., Vol. X, p. 79. [2] Loc. cit., p. 83.

means an exact equivalent of the Chouteau limestone of central Missouri, but represents merely the upper portion of that formation. The formation is well exposed along Pierson Creek near the zinc mines, and since it possesses an individuality of its own as a formation, over a rather extensive area, it may be designated as the Pierson limestone. The formation is frequently non-fossiliferous, but fossils often occur and are usually well preserved. One of the best fossil localities is on the south branch of the Little Sac Creek, about two miles north of Lyman station on the St. Louis and San Francisco railroad. At this locality the following fauna was collected which may be taken as a typical representation of the fauna of the whole formation.

1. *Zaphrentis* sp. undet. A single imperfect specimen of this genus is the only coral of the fauna.
2. *Leptaena rhomboidalis* Wilck. This species is of frequent occurrence in the fauna.
3. *Orthothetes* cf. *O. inflatus* W. & W. A species similar to *O. inflatus*, but much flatter, is rather common in the fauna. The same shell is associated with *O. inflatus* in oolitic bed No. 6 of the Burlington section.
4. *Chonetes* sp. undet. A large species frequently having a width of more than twenty mm is not uncommon in the fauna. It resembles *C. illinoisensis* Worthern, but is much larger and should perhaps be identified as *C. shumardianus* DeKon.
5. *Chonetes logani* N. & P. ? A species having the general form of *C. Logani* is not uncommon in the fauna, but the preservation is not such as to exhibit the characteristic surface markings of that species.
6. *Productus arcuatus* Hall. This species is particularly abundant in the oolite bed at Burlington, and the Pierson limestone specimens are of the typical form.
7. *Productus burlingtonensis* Hall. Specimens of this species indistinguishable from those in Burlington limestone, occur in the Pierson limestone.
8. *Productus laevicostus* White. This species makes its first appearance in the Chonopectus sandstone of the Burlington section, and ranges up into the base of the Burlington limestone.
9. *Productus punctatus* Martin. Specimens of this species are not uncommon in the Pierson limestone. In the Burlington section it makes its first appearance in bed No. 7, the topmost bed of the Kinderhook at that locality.

10. *Schizophoria swallovi* Hall. Specimens of this species identical with those in the Burlington limestone are present in this fauna.
11. *Rhipidomella burlingtonensis* Hall. Individuals of this species from the Pierson limestone resemble those from the Northview sandstone, and are more nearly like typical representatives of the species from the Burlington limestone than are the Sac limestone specimens.
12. *Camarophoria* sp. undet. This species is of the general form of *C. caput-testudinis* White, the types of which are from the base of the Burlington limestone, and bed No 7 of the Kinderhook at Burlington. The Pierson limestone species, however, differs from *C. caput-testudinis* in being a much smaller and flatter shell.
13. *Rhynchonella cooperensis* Shum. This species was originally described from the Chouteau limestone of Cooper county, Missouri.
14. *Athyris lamellosa* Lev. This is one of the commonest species of the fauna, and specimens from the Pierson limestone are indistinguishable from those in the Burlington limestone.
15. *Spirifer marionensis* Shum. This is the same species that occurs in the Northview sandstone. It is one of the commonest members of the Pierson limestone fauna and also of the oolitic limestone fauna at Burlington.
16. *Spirifer latior* Swall.? The specimens identified as this species are not different from those in the fauna of the Sac limestone.
17. *Spirifer peculiaris* Shum. The Pierson limestone representatives of this species are not unlike those from the Sac limestone.
18. *Spirifer grimesi* Hall. This Burlington limestone species is represented by typical individuals in the Pierson limestone.
19. *Spirifer* sp. undet. This species has the high area of Syringothyris, but lacks the syrinx, and is apparently not punctate.
20. *Reticularia cooperensis* Swall. This species rarely occurs in the fauna. It is a common form in the typical Chouteau limestone and also occurs in the upper "yellow sandstone" at Burlington.
21. *Dielasma* sp. undet. These specimens have the general form and size of those recorded from the Sac limestone, but usually have more conspicuous lines of growth.
22. *Macrodon* sp. undet. A single imperfect specimen of this genus is the only pelecypod recognized in the fauna.
23. *Orthoceras* sp. undet. Fragmentary specimens of a species of Orthoceras are not uncommon in the fauna.

In the Pierson limestone fauna we find a disappearance of the pelecypod element which is so characteristic of the Northview sandstone, and a return of the brachiopods. Some of these

brachiopods are common to the Sac limestone, but there are introduced several species, such as *Spirifer grimesi*, *Productus burlingtonensis*, *Productus punctatus*, and *Athyris lamellosus* (which was also present in the Northview sandstone), which pass upward and connect the fauna with that of the Burlington limestone above.

Conclusions.—A critical examination of the Kinderhook faunas of southwestern Missouri, shows that the entire series of strata in that region referable to this division of the Mississipian series are to be correlated with the upper division of the Kinderhook, or the Chouteau limestone of central Missouri. This Chouteau fauna is not one uniform fauna throughout, but exhibits at least two rather well-defined facies, one brachiopod fancies generally characteristic of the limestones and another pelecypod facies characteristic of the more clastic sediments. In Greene county, Missouri, the brachiopod facies is present in the Sac limestone and the Pierson limestone, while the pelecypod facies is present in the Northview sandstone.

In the Burlington section, beds 5, 6, and 7 are apparently to be correlated with the Greene county formations, and in the faunas of these three beds the same brachiopod and pelecypod facies are exhibited, but in a different order, the pelecypod facies occupying bed 5, and the brachiopod facies beds 6 and 7.

In central Missouri, the region of the typical Chouteau limestone, opportunity has not been offered to study these faunas in situ. Among the material received from that region, however, the same two faunal facies may be recognized, though it is impossible to work out their interrelations without careful field investigation.

These two faunal facies apparently lived contemporaneously throughout the area covered by the upper Kinderhook sea, each one occupying those portions of the region where the local conditions were best adapted to its development, shifting about with local changes in the environment, and each one going on with its developmental changes with the progress of time. The faunas of the Northview sandstone and of bed No. 5 at Burlington,

have so much in common that they may be considered as representatives of a single fauna, yet they may not have been and probably were not strictly contemporaneous. They simply indicate that at some stage during the limited time period in which they both belong, there were present in each of these widely separated regions, conditions suitable for the existence of the same general assemblage of species.

The Chonopectus fauna, which underlies these faunas in the Burlington section, is not represented in southwestern Missouri; neither is the typical Louisiana limestone fauna present in the region.

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