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## NEW DATA ON THE UPPER DEVONIAN OF IOWA

S. W. STOEKEY

A recently discovered exposure of fossiliferous beds of Upper Devonian age in Iowa County, Iowa, containing a rich and well-preserved fauna, is believed to be of unusual interest and significance. These beds were uncovered by the road grader and extend along the north side of the road across Section 29, Amana Township, for a distance of about a mile. The exposure begins a few rods west of the limits of Middle Amana and with exception of two or three interruptions by ravines, is continuous to the point where it disappears under the Hohe Amana outlier of Des Moines sandstone. The beds are overlain by glacial till and their base is nowhere exposed. The maximum thickness of the exposure is about eight feet.

Iowa County lies in the southern part of the East Central division of Iowa. The southeast corner of the county is about forty-five miles from the nearest point on Mississippi River at Muscatine. It is about fifty miles east and twenty-five miles south of the geographic center of the state. The Iowa River enters near the northwest corner of the county, meanders through a wide flood plain in an east-southeast direction and leaves the county about five miles south of the northeast corner. It is in the loess and drift-covered bluffs of the Iowa River valley that the beds in question are exposed. Aside from Pleistocene and recent deposits, the only natural rock exposures in the county are those of the Des Moines outliers and a small outcrop of Kinderhook limestone and chert overlying beds of Sheffield Shales in the bank of Price Creek in the village of Amana. Indeed it was with the idea of tracing this Kinderhook terrane westward by means of the newly exposed beds that I began their examination. The results were very different from those anticipated and quite surprising.

The beds referred to are calcareous shales and argillaceous limestones. The lower part of the exposure consists of three or four feet of fossiliferous calcareous shales, weathering and breaking down rapidly on exposure, varying from buff to gray in color. Running through this zone are discontinuous layers of unfossiliferous, brown, sugary limestone or dolomite. In places are found

fragments or slabs of crinoidal limestone not certainly in place. The upper three or four feet consist of rather light gray shales, readily weathering into plastic clay and containing many hollow calcite nodules. No fossils were collected from this zone.

From the lower calcareous shales have been collected a fauna chiefly of Brachiopods, but including also fucoids, corals, Bryozoa, crinoidal fragments and Gastropods.

The following Species have been identified:

	INDEPENDENCE	LIME CREEK
1. <i>Atrypa rockfordensis</i> F. & F.-----	1	1
2. <i>Atrypa devoniana</i> Webster-----	2	2
3. <i>Atrypa planosulcata minor</i> F. & F.-----		3
4. <i>Cyrtina iowaensis</i> F. & F.-----	3	4
5. <i>Pugnoides subacuminata</i> Webster-----	4	5
6. <i>Pugnoides? ambigua</i> Calvin-----	5	?
7. <i>Schizophoria iowaensis</i> Hall-----	6	6
8. <i>Dowvillina arcuata</i> H. and W.-----	7	7
9. <i>Dowvillina variabilis</i> Calvin-----	8	8
10. <i>Crania famelica</i> H. & W.-----	9	9
11. <i>Cranaena Calvini</i> H. & W. ( <i>Cranaenella</i> <i>Calvini</i> F. & F.)-----	10	10
12. <i>Macgeea parva</i> Webster-----	11	
13. <i>Aulopora saxivadum?</i> H. & W.-----		11

In addition unidentified species of gastropods, Fenestella, and fuicoidal and crinoidal remains have been collected.

This is an Upper Devonian fauna. Of the thirteen species named in the list, nine are common to the Lime Creek Shales of Cerro Gordo and adjacent counties in northern Iowa, and the fossiliferous Independence shales of Buchanan County. Two, *Pugnoides ambigua* Calvin and *Macgeea parva* Webster, have not been reported from the Lime Creek, but are found in the Independence. *Atrypa planosulcata minor* F. & F. and *Aulopora saxivadum* are found in the Lime Creek but not in the Independence.

Dr. M. A. Stainbrook of Lubbock, Texas, who has made a special study of the Buchanan County Independence fauna, has very kindly examined the collection from Iowa County and is of the opinion that the varietal differences as compared with the Lime Creek and the Buchanan County faunas are decidedly toward the Independence. Indeed, he regards the two faunas as equivalent. He says in a recent letter, "I am sure that the fauna is the same as the Independence found in the exposures at Independence and Brandon. My present attitude is to assume that it (the Independence) is not Lime Creek. By that I mean that the differences between the two faunas are rather large and as yet unexplained. It must be acknowledged that the similarities between them are great also.

Which facts have the greater significance seems now largely a matter of opinion." Dr. Stainbrook here simply restates the orthodox view of Iowa Geologists held for many years.

Dr. Calvin, who first described the Independence shales in 1878, later definitely assigned them to the Wapsipinicon stage of Norton. In his *Geology of Buchanan County* he gives an account of the circumstances of their discovery. They were penetrated to a depth of twenty feet by workmen in search of coal in an old quarry east of Independence. He describes them as very dark and carbonaceous, containing vegetable remains, some parts of which had been transformed into true coal. He notes some other exposures of the shales in the county but adds: "In general the natural exposures are few and unsatisfactory, the position of the beds being such that the outcropping edges are either covered with talus or are sodded over." He then gives a list of eighteen species of fossils comprising the fauna, of which fourteen, all but four, are found also in the Lime Creek. In spite of the remarkable similarity of the two faunas, he says: "The Independence shales belong to the Wapsipinicon stage of Norton." In his report on the *Geology of Linn County*, Norton had described the body of argillaceous limestones lying between the Otis beds below and the Lower Davenport above in the Wapsipinicon stage of the Devonian in that county and had correlated them with the Independence shales as described by Calvin. "It is true," he says, "that the evidence in favor of the identity of the Kenwood beds with the shales of the shaft at Independence might be stronger. The former are destitute of fossils and carry no trace of carbonaceous matter. But the position of both beneath the Gyroceras beds and their argillaceous nature we must accept as proof that they occupy the same geological horizon."

The same author in his "The Wapsipinicon Breccias of Iowa" published in 1916 in Vol. XXVII of the *Iowa Geological Survey* gives a thorough description of all the outcrops of the "fossiliferous Independence shales" known at that time (including one at Linn Junction, a few miles north of Cedar Rapids in Linn County, the first natural exposure observed). He builds up an elaborate **argument for their** correlation with the Wapsipinicon beds of Linn and Cedar Counties to the south. After reviewing Calvin's work, he describes the natural exposures of these shales near the town of Brandon in the southwestern part of Buchanan County. There are three of these exposures originally brought to the attention of the late Dr. A. O. Thomas by M. A. Stainbrook, one of his students, to whom reference has already been made. Dr. Thomas had asked

Dr. Norton to study the terrane and collaborate with him in their description and interpretation. Two of these exposures outcrop along Lime Creek in Buchanan County and one faces the Cedar River in Benton County.

Without going into details it is sufficient to say that the beds are typical both lithologically and faunally of the Independence shales as described by Calvin. Moreover, their position and relations are similar to one another. In each case the exposed shales are flanked at either end by beds of Cedar Valley limestone against which they abut. In no case does any indurated terrane overlie the shales nor is their lower contact with an older formation anywhere exposed. Dr. Norton suggests three possible hypotheses for the explanation of the anomalous position of these shales. I quote:

1. "The close alliance of the fauna of the Independence with that of the Lime Creek shales suggests that the two may be identical and that the exposures of the fossiliferous Independence are in reality sections of the Lime Creek shales where they fill unconformably old erosion channels cut in the earlier Devonian terranes.

2. "We may also entertain the hypothesis that the fossiliferous Independence is unconformable with the Wapsipinicon and Cedar Valley limestones but represents a formation, distinct from the Lime Creek shales, nowhere found conformably in place in the Iowa section.

3. "The contacts of the fossiliferous Independence with the Wapsipinicon and Cedar Valley limestones may be explained by deformation. On this hypothesis the horizon of the Independence is to be looked for below and not above the beds with which it is in contact. Under the stresses which have caused extensive brecciation over the area of outcrop of the Wapsipinicon the plastic fossiliferous shales have been squeezed up into the midst of higher Devonian terranes."

Of these hypotheses Dr. Norton adopts the last and again correlates the fossiliferous Independence shales with the unfossiliferous Kenwood beds of the Wapsipinicon stage.

In his paper before this body at its session here in Cedar Falls in 1919, Dr. Thomas discussed the problem under the title "The Independence Shale near Brandon, Iowa." He reviewed the circumstances connected with the discovery and interpretation of the shales by Dr. Calvin. "Thus it will be seen," he says, "that the earliest knowledge of this terrane and its fossils was gathered from artificial exposures which in a few years were completely covered up. From these exposures and supported by evidence acquired by a little digging, Calvin constructed a section of the Devonian rocks of Buchanan County, placing the Independence shale below the *Gyroceras* beds. The failure of the shales with their easily recognized fossils to appear in many places at this horizon in other

counties along the eastern border of the Iowa Devonian belt has led workers — and correctly — to refer stratigraphically equivalent terranes even though barren and lithologically different, to the Independence. A well-known example is the Kenwood beds of Norton in Linn County.”

You are familiar with Dr. Thomas's strong argument from both the physical and the biological point of view for the equivalence of the Independence and the Kenwood beds. He adopts the view that the Independence shales “have been forced up into their present position at the Brandon exposures by the forces that produced the brecciation.” He stated it as his opinion, based upon his studies of the two faunas, “that the Lime Creek is a greatly expanded and recurrent descendant of the Independence rather than a contemporary.”

It must be evident from this brief review that the whole question of the relationship of the Independence to the Upper Devonian in Iowa and especially to the Lime Creek is and has been from the time of Calvin an open one. Dr. Calvin made perfectly clear his realization of the incomplete and unsatisfactory data from which he constructed his stratigraphical column for Buchanan County. In their discussion both Norton and Thomas suggested other hypotheses than the one adopted by them that might explain the facts. They ably stated the argument in favor of the view that the fossiliferous Independence shales of Buchanan County belong stratigraphically in the lower stage of the Iowa Devonian and that the Lime Creek fauna is a descendant and not a contemporary of the Independence, but it is clear that neither of them regarded the question as closed or their explanation as more than the strongest hypothesis for the explanation of the known facts.

The fortunate uncovering of a body of shale carrying the Independence fauna over one hundred miles to the southeast of where the Lime Creek disappears beneath the drift mantle in north central Iowa, gives a new aspect to the problem and suggests a re-examination of the whole question.

The matter seems to resolve itself into the question whether or not the Iowa County shales represent the continuation southeastward of the Lime Creek shales of Cerro Gordo County. If they do, and if it can be shown that they carry the Independence fauna, the only logical conclusion is that the shales of Buchanan County, carrying the Independence fauna, must be correlated with the Lime Creek. It becomes a simple syllogism: Iowa County shales are equivalent to Lime Creek shales; Iowa County shales are equiva-

lent to Independence; therefore Independence is equivalent to Lime Creek. But geological problems of this sort are not solved mathematically. We must fall back upon the law of probabilities. Let us examine the case for the major premise that the Iowa County shales are Lime Creek.

In quite the typical way of the geological terranes in Iowa, the Lime Creek shales have been traced and mapped as an elongated zone of varying width extending in a northwest-southeast direction from the southeast corner of Winnebago County, through Cerro Gordo, northeastern Franklin and western Butler, a distance of about fifty miles, with a known width varying from a mile to over twenty miles. In the southern part of Butler County they disappear beneath the thick mantle of drift. No one of course supposes that they end with their disappearance from view. In Grundy County to the south of Butler, Arey reports well logs, indicating the presence of the typical Owen limestones and below them shales answering the description "both in character and position of the Hackberry beds." "There can be no doubt," he remarks, "that the Lime Creek shales have a southeastward extension into Grundy County."

In northeastern Tama and western Benton very little data bearing upon the question are at hand further than the fact that well records show the presence of shale beneath the drift. These have generally been referred to the Kinderhook but it is entirely reasonable to suppose that in part at least they represent the extension southeastward of the Lime Creek and that the terrane is continuous in a zone along the eastern border of the Kinderhook.

A glance at the geological map of Iowa shows why the contact of the Kinderhook with the Lime Creek is nowhere revealed from Butler and Franklin Counties at the north to Iowa County at the south. This zone occupies the interplain between the Cedar and Iowa Rivers. Nowhere does a master stream cut athwart this drift covered plain until we come to Iowa County. The tributaries of the Iowa and the Cedar head in this interplain but do not cut deeply into the heavy mantle of drift. The wonderful exposures of the Lime Creek shale in the Cerro Gordo and contiguous area are due to the fact that Lime Creek, itself now a minor waterway, occupies the pre-glacial valley of the Master Stream of northern Iowa during pre-glacial and inter-glacial times. This great pre-glacial river had cut deeply into the Paleozoic terranes and perhaps was never entirely obliterated during Glacial time. At *any rate* it doubtless accounts for the extensive Lime Creek exposures in

northern Iowa. In Iowa County the Iowa River makes a remarkable bend almost due east and cuts directly across the eastern border of the Kinderhook and the underlying Devonian. If it were not for overlying loess and till and wash there would doubtless be revealed in the walls and valley slopes a splendid section of the Des Moines, the Kinderhook and the Devonian formations at least insofar as they have been spared by the ruthless forces of erosion. As it is, only here and there do we get a glimpse. It required the power of the road machinery to uncover the part of the section under discussion.

Lithologically the Iowa County beds correspond well with number three of Calvin's general section of the Lime Creek shales, viz., "twenty feet of yellowish, very calcareous shales, with bands of shaly limestone; weathering partly into clay and partly into small chips or nodules; very rich in beautifully preserved fossils, particularly brachiopods and corals, a number of interesting species of stromatoporoids being included with the corals."

I have previously stated the essential facts regarding the fossil content of these beds. About eighty percent of the species are common to the Iowa and Cerro Gordo faunas. It is probably not putting the matter too strongly to say that apart from the Independence problem there would be no hesitation on the part of any geologist to correlate these Iowa County beds with the Lime Creek shales.

Is the minor premise that the fauna of the Iowa County beds is equivalent to the Independence fauna valid? I know of no man better able to render a decision on that question than Dr. Stainbrook. As an undergraduate student of geology under Dr. Thomas, he was the original discoverer of the Brandon exposures and made a collection of the fossils. He is thoroughly familiar with the facies of the Independence fauna. He has examined the Iowa County fossils and unequivocally states that the Iowa County fauna is Independence. If the Iowa County beds are Lime Creek and also Independence then all are Lime Creek.

There remains something to be said concerning the relation of the Independence to the Lime Creek. Dr. Calvin apparently believed that the law of superposition compelled him to place the Independence shales in the lower stage of the Iowa Devonian. This forced him to account for the similarity of its fauna to that of an horizon separated from it by several zones of Upper Wapsipicon, and all the Cedar Valley, together with a time interval sufficient to produce a very highly eroded surface; for the Upper De-

vonian series wherever the contact is known lies disconformably upon the eroded surface of the Cedar Valley. Dr. Calvin's explanation follows: "During the time represented by the shales and limestones which lie between the Independence shales and the Lime Creek shales the peculiar fauna of the lower shale horizon, adapted to life on a muddy sea bottom, persisted in some congenial localities at present unknown, suffering in the meantime only a very slight amount of modification, and again appeared, reinforced by a number of other species, when the sea bottom offered conditions favorable to its success." In 1908 before the A.A.A.S. at Baltimore Stuart Weller said: "The Lime Creek fauna includes a number of forms which are recurrent from the Independence shales near the base of the Wapsipinicon, a distribution which suggests the unity of the entire Devonian fauna of Iowa, and further, that the Lime Creek is not far removed from the subjacent beds although there is apparently an unconformity between them." I have already quoted the statements of Thomas and Stainbrook on the matter. In the case of all these authorities the question was, can the Lime Creek fauna be explained as a descendant of the Independence, a closely similar fauna with a time interval of considerable extent? Their unanimously affirmative answer was entirely justified under the presuppositions of the case.

With the new data now at hand the form of the question may well be changed thus: Assuming the essential contemporaneity of the Lime Creek and the Independence beds can the differences in their respective faunas be explained on geographic, environmental, or other grounds? Or, better still, dismissing all presuppositions, should the Independence shale be correlated with the Lime Creek on the basis of the two faunas?

Without attempting any full discussion of the question it may be stated that the differences rather than the similarities of the two faunas have been most emphasized. Of the eighteen Independence species originally listed by Calvin fourteen or about eighty percent — are found in the Lime Creek. That is also about the percentage for the Iowa County species.

It has been urged that there are many species in the Lime Creek not found in the Independence. That is true. It should not be forgotten, however, that the Independence exposures are nowhere complete, indeed even when added together must be very incomplete. It would be unreasonable to expect the whole Lime Creek fauna to be found in a more or less restricted part of the series, such as we have in Buchanan and Iowa counties.

Another objection is that the varietal differences in the same species as represented in the two areas are marked. That is also true, but not more so than might be expected from the geographic and environmental differences involved. The Iowa County species run smaller than the Lime Creek, and I am informed that this is also true of the Independence species. Such varietal differences as size, surface markings, even shape, are found in far more restricted areas. This would be illustrated within the limits of almost any county in Iowa where there are exposures of the fossiliferous Devonian. In short, in my opinion, the differences of the faunas can be very naturally and easily explained on the basis of the essential contemporaneity of the terranes.

#### SUMMARY

1. The calcareous shales recently discovered in Iowa County are geographically located where they would be expected if they represented the southeastward extension of the Lime Creek shales. They are drift-covered from Butler County to Iowa County where they are found in the erosion slopes of the Iowa River Valley.

2. Lithologically the Iowa County shales answer well to the description of Calvin's number 3 of the Lime Creek section.

3. They contain a fauna about eighty percent. of whose species are found in the Lime Creek.

4. On the basis of location as well as similarity of rock materials and fossils to those of the Lime Creek, the Iowa County shales must be correlated with the Lime Creek.

5. In comparing the Iowa County fauna with that of the Independence shales of Buchanan County it is found that they are equivalent. On the basis of this equivalence the Iowa County shales must be correlated with the Independence.

6. If propositions 4 and 5 are valid the Independence must be correlated with the Lime Creek.

7. The differences between the fauna of the shales in Cerro Gordo County and that of the shales in Buchanan County are no greater than might be expected from the geographical considerations and from the restricted nature of the latter.

COE COLLEGE,  
CEDAR RAPIDS, IOWA.