The flora from Potosi is extensive and not yet fully elaborated. It includes about sixty species and the following genera are represented: Acacia, Acrostichum, Amicia, Caesalpinia, Calliandra, Capparis, Cassia, Copaifera, Cuphea, Dalbergia, Desmodium, Drepanocarpus, Enterolobium, Escallonia, Euphorbia (?), Festuca, Gaylussacia, Gymnogramme, (?), Hedysarum, Inga, Lomariopsis, Lonchocarpus, Machaerium, Mimosa, Mimosites, Myrica, Myrteola, Passiflora (?), Peltophorum, Pithecolobium, Platipodium, Poacites, Podocarpus, Polystichum, Porliera, Ruprechtia, Sweetia, Terminalia, and Weinmannia.

A perusal of these genera, already recognized, is sufficient to convince any botanist or indeed any visitor to the region, that this flora is very different from that now found in the Potosi region. While the botanical exploration of the present Bolivian flora leaves much to the future it is obvious that if we seek for representatives of this fossil flora in the recent flora of Bolivia, nearly all the genera are to be found represented in the more or less well watered country east of the present eastern range, and particularly on the lower eastern slopes. Moreover most of the fossil species are very close to still existing species of the latter region and this resemblance is so close that I cannot conceive of this flora being older than Pliocene.

There is then definite evidence that parts of the high plateau and of the eastern Cordillera stood at sea level in the late Tertiary.

In the Eden and in parts of the Richmond Group (Upper Ordovician) large ripples, measuring 50 to 150 cm. from crest to crest, are rather common throughout the region of the Cincinnati Anticline, in Kentucky, Indiana, and Ohio. From a careful study of very numerous rippled layers of these formations in southwestern Ohio and north-central Kentucky, of 13 rippled layers in the Brassfield formation of east-central Kentucky and of one in the Blackhand formation (Mississippian) of eastern Ohio, the following data were obtained:
1. The crests of all large ripples are broadly rounded like the troughs. More than half of all seen in limestones of the Ordovician and Silurian of the Cincinnati Anticline were more or less symmetrical; the others are distinctly asymmetrical.

2. Not one showed any sign of assortment. Shells of Rafinesquina, over 5 cm. long and wide, Bryozoans 8 to 10 cm. long and over 1 cm. thick, and, in the Richmond, calices of Streptelasma, over 10 cm. long and over 3 cm. wide are found scattered equally over crests, sides and troughs of the ripples, mixed in a most any proportion with finer shell fragments down to the finest matrix filling the interstices. The same broadly rounded, symmetrical crests with complete absence of assortment of any kind were observed in ripples measuring 145 cm. from crest to crest in the conglomeratic Berne member of the Black-hand formation. Here, pebbles of \( \pm 0.5 \) cm. diameter are uniformly mixed with coarse and fine sand.

In the growth of oscillation ripples, the to and fro motion of the oscillating current produced by waves on the bottom of a water body involves a constant tossing of the grains. This results in a sifting and complete assorting of the grains. Its absence in the large ripples in question proves that they have not formed by the action of waves, but of some current. Clues to its nature are found in the following observations.

3. In Kentucky the Brassfield formation of the Silurian east of the Cincinnati Anticline shows one or two rippled layers within its 18 feet of thickness. West of it no traces of ripples were found according to Foerste. The ferruginous oolitic facies of the same formation is also limited to the east side of the anticline, extending over a distance of nearly 120 miles from Madison County, Kentucky, to Clinton County, Ohio, in a belt running roughly north-south (perhaps slightly east of north). On the west side of the Anticline nothing but a salmon brown color of the limestone betrays the (relative) neighborhood of ferruginous deposits. From this the inference appears justified that the shore-line of the Brassfield sea was somewhere to the east with a general north-south trend.

Of the 13 measured exposures of rippled layers in the Brassfield, ranging over a distance of nearly 50 miles, 12 showed directions of strike between N 50 W and N 110 W, averaging N 76 W, i.e., at right angles to the direction of the assumed shore-line. The current, therefore, must have run parallel to this shore-line. This excludes the undertow and similar currents from discussion.

4. Large current-ripples are found only on rocks of relatively coarse
grain, as conglomeratic sands (Blackhand formation) or fragmental limestones, never on fine-grained sediments, e.g., on dense blue argillaceous limestones. These are, however, frequently covered with small current-ripples, ranging in wave-length from 1 to 30 cm., and are often interstratified with fragmental limestones of coarse grain covered with large ripples and separated from them only by thin layers of shale. The calcareous layers show delicate tracks of gastropods or trilobites well preserved which practically exclude any current action.

This seems to indicate that the current in question varied in intensity from a maximum to nil, in relatively short intervals. The finer sediments could record only the weaker movements, as stronger currents would have thrown them into suspension.

5. In the Ordovician, I have repeatedly found large asymmetrical ripples on two successive limestones, not more than a foot apart, with nearly the same strike, but with their lee sides facing in opposite directions. The current, therefore, reversed its direction in relatively short intervals.

Observations 4 and 5 exclude ocean currents of larger dimensions, while they point consistently to tidal currents. These, too, are the only marine currents, flowing parallel to the shore-line, in which velocities of at least 1 m/sec., which seem necessary to produce the effects observed, are found over large areas.

In 1901 Cornish\(^7\) described from the English Coast large current-ripples corresponding closely to those observed in the fossil state. On open shores, such as at Mundsley (Norfolk, p. 183), above the mouth of Barmouth Estuary (p. 173), or especially on the Goodwin Sands (p. 189), about six miles off the shore of Kent, these tidal ripples invariably trend at right angles to the shore, often at right angles to the waves. On the open shore, too, their wave-length is the same as that of most large Paleozoic ripples, while those observed in estuaries, where the velocity of the tidal current is greatly increased, have a greater wave-length.

I therefore infer that the large current-ripples described were produced by tidal currents. Those of the Brassfield formation in Kentucky offer a direct analogy to those of the English Coast.

The ripples of the Lorraine and Richmond Formations, however, offer an additional problem.

1. They are not limited to a relatively narrow zone in the neighborhood of the shore, but formed (probably more or less synchronously) throughout the area of the Cincinnati Anticline, that is, over an area of at least 15,000 square miles and probably much more.
2. They trend in all directions, although a north-south trend is more common than an east-west trend.

At first sight this seems to offer a serious objection to my interpretation, since in open waters the direction of the current passes through all the points of the compass in the course of twelve hours, which would render the formation of permanent ripples impossible. The following observations, however, offer a clue to this problem.

In 1881 Hunt\textsuperscript{9} visited the broad open gulf of Torbay on the south shore of Devonshire two weeks after a heavy storm. In Midbay, at a depth of over 12 meters, where the bottom usually is a soft muddy sand that clogs the dredge in a few minutes, he found the ground hard, producing “not a single shell or a particle of the usual muddy sand.” Four weeks after the storm “the ground was still very hard, both the dredge and a fishing-lead tied to a line \textit{bumping along as though over ridges}.” Over six weeks after the gale the same spot had returned to its normal state.

Similarly, Cornish\textsuperscript{9} found Pegwell Bay (Kent), in which ordinarily the tide never produces anything but small current ripples, covered with large tidal ripples after a heavy gale blowing into the bay.

These observations indicate that the drift produced by periods of storms may so strengthen the tidal current as to produce large current ripples. This I suggest as the probable origin of our large Eden and Richmond ripples.

The ripples observed by Hunt formed at a depth of over 12 meters with a tide of over 2 meters. In open waters the range of the tides and the velocity of the resulting currents would be much smaller than in the channel. With gales of similar strength, therefore, the same mechanical effect of the currents would be possible only at a much smaller depth of water. Allowing, however, for extreme conditions, we may safely say that it is probable that our Ordovician ripples formed in water less than 25 meters deep rather than more. The Persian Gulf offers an interesting analogy. With an area of about 90,000 square miles, it has a mean depth of but 25 meters.\textsuperscript{10} The tidal range along all its shores is 3 to 3.75 meters.\textsuperscript{11}

The fact that at least three independent factors must combine for the production of these ripples, namely sufficiently strong tidal action, storms, and small depth of the water, explains why such large current ripples are not found in other seas, the sedimentary record of which is otherwise almost identical; e.g., certain parts of the Middle Triassic Muschelkalk of Western Europe.
A fourth factor of no less importance is brought out by consideration of the following facts:

1. The formations of the Upper Ordovician consist essentially of the following sedimentary units, interstratified in irregular order: (a) Calcareous shale, varying from highly fossiliferous to barren. (b) Dense, blue, argillaceous limestones, mostly barren (except in many cases the surfaces of the layers). (c) Fragmental limestones, varying from fine-grained to regular shell breccias.

2. None of these units have a great horizontal extent, i.e. all formed simultaneously on different parts of the sea bottom.

3. The shale may have any thickness, while the limestones are seldom over one foot thick.

4. Single valves of brachiopods and isolated joints of Crinoids are common in the shales.

5. The dense argillaceous limestones almost always show delicate cross-bedding.

6. Current-rippled fragmental limestones are always overlain by shale.

7. In fragmental limestones thin and delicate shells and skeletons are commonly found broken, but the fossils in general show little wear.

8. Large current-ripples are found in such formations as show a predominance of shale over limestones, e.g., the Eden and parts of the Richmond formations. They are absent, however, where limestones predominate, especially in the Fairview and McMillan formations.

9. Fragmental limestones dominate in the Fairview and McMillan formations and show ample evidence of a stirring of the sediment, often of violent character, as e.g., the Rafinesquina breccias of the Bellevue horizon.

From these data I conclude that the typical sediment of the Upper Ordovician seas in the region which now forms the Cincinnati Anticline was a clay with an abundant animal population, varying in density from place to place. The almost constant agitation of the sea bottom (obs. 4 and 5) furnished the fine shell powder which mixed with the clay, gives it its calcareous character. Densely populated areas supplied it, especially after periods of storms, to adjoining areas of scarce population in sufficient quantity to form argillaceous limestones. This areal relation explains why argillaceous limestones are generally poor in fossils if not entirely barren.

During exceptional periods of storm many feet of the muddy sediments were thrown into suspension. In order to cloud water 20 to 50 meters deep with sediment, as has been observed repeatedly in the
channel and on the banks of Newfoundland\textsuperscript{1}; a considerable thickness of sediment must be stirred up. The heavier particles, shells and skeletons, however, are concentrated on the bottom, drifting with the current and eventually thrown into large current ripples. The relatively short duration of this current action explains observation 7. The suspended clay settled later, forming the layer of shale overlying the rippled limestone layers (observation 6). Since the thickness of sediment which could be thrown into suspension during such storm periods is limited, the thickness of the resulting fragmental limestone is limited, while shale on shale could accumulate indefinitely as long as no abundant animal population settled on it (observation 3). The rippled layers were preserved if sufficient shale was added between two exceptional storm periods to prevent the stirring of the sediment from reaching down to it. A decrease of the clay supply, however, would reduce the rate of sedimentation and allow ordinary storm waves to expose the fragmental layer, which, under the action of the shifting normal tidal current, would suffer a surficial redistribution of material, resulting in complete leveling of the surface. A sufficient rate of sedimentation must, therefore, be considered as a fourth factor determining the formation of large current ripples (observation 8).

From the above it follows that the rough rhythm of sedimentation, shown by the recurrence of fragmental limestones between shales and argillaceous limestones, is due to the interference of two, probably not strictly periodic processes: the shifting of the centers of animal population on the sea bottom and the occurrence of storm periods of exceptional violence.

If the interpretation presented above is correct, the geographic conditions indicated by the large current ripples of the Upper Ordovician of the Cincinnati Anticline may be summarized as follows:

1. A sea having sufficient connection with the open ocean to allow relatively high tides.

2. Sufficient area to permit the formation of strong winddrifts in most directions during periods of storms.

3. A depth small enough to admit of a strong action on the bottom sediments by winddrift and tidal current combined, probably 25 meters or less on the average.

4. Atmospheric conditions providing for the occurrence of storms, blowing from all points of the compass, such as tropical cyclones or those of intermediate latitudes.

\textsuperscript{1}Linney, W. M., \textit{Rep. Geol. Garrard Co.}, 1882, (16); \textit{Washington Co.}, 1882, (10-11); \textit{Lincoln Co.}, 1882, (13); \textit{Mason Co.}, 1885, (8); \textit{Bath and Fleming Cos.}, 1886, (10, 62–69); \textit{Shelby Co.}, 1885, (8).
THE BEARING OF SELECTION EXPERIMENTS WITH DROSOPHILA UPON THE FREQUENCY OF GERMINAL CHANGES

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Biologists generally agree that changes in the germ plasm do occur. On the other hand, there appears to be considerable disagreement regarding the frequency of these spontaneous changes. Some experiments, as illustrated by the work of Pearl, Hj. Nilsson, De Vries, Tower, and Johannsen,⁵ are more easily analyzed by supposing that changes in the germ plasm occur very rarely in comparison with the number of generations of individuals studied, so that the origination of new races by selection is not generally possible. Other experiments, notably those of Castle, Smith, Middleton, and Jennings (on Diffugia),² have been interpreted as showing that such changes are occurring so frequently that they may be found in each generation, and so afford a basis for selection to make continuous progress. As long as different experiments lead their authors to such different conclusions, no broad generalizations as to the scope of the evolutionary significance of selection may be drawn without the most intimate and critical consideration of all other related investigations, and, accordingly, all additional evidence that may be secured has an important bearing.

The familiar Mendelian units are currently conceded to arise sud-