time at all. So that our curve must sooner or later become a straight line, and ultimately concave upwards. Drawing a straight line which shall agree as nearly as possible with our observations, we shall find from it, that the speed of the trotting-horse is increasing at a nearly uniform rate of $4\frac{1}{3}$ seconds in ten years; so that, on this supposition, it would cross the two-minute line in 1907, and the one-minute line in 2045. It is highly probable that the curve will have become concave before the latter period; but it does not seem too rash to predict that a horse will be born before 1907 that can trot a mile in two minutes.

II. — Total number of horses capable of trotting in 2.30 or better.

Date.	No.	Date.	No.	Date.	No.
1843	1	1859	32	1871	233
1844	2	1860	40	1872	323
–	–	1861	48	1873	376
1849	7	1862	54	1874	506
–	–	1863	59	1875	–
1852	10	1864	66	1876	794
1853	14	1865	84	1877	836
1854	16	1866	101	1878	1,025
1855	19	1867	124	1879	1,142
1856	24	1868	146	1880	1,210
1857	26	1869	171	1881	1,532
1858	30	1870	194	1882	1,684

Table II. shows the enormous rate of increase of this new breed of animals, amounting to about twenty per cent a year. Treating the observations by the logarithmic method, we find, that, since 1864, the increase may, with a reasonable degree of accuracy, be represented by the formula $y = .0016\,x^4$, where y represents the number of horses, and x the number of years since 1850. Thus, for 1882, we have $y = .0016 \times 32^4 = 1678$. Applying this formula, we find, that, if the present rate of breeding is continued, the trotting-horses of America in 1900, that can travel a mile in 2.30 or better, will number not far from 10,000.

WM. H. PICKERING.

THE ORIGIN OF CROSS-VALLEYS.[1]

II.

RETURNING now to Virginia and Pennsylvania, we have to consider not only why the rivers there cross the mountains, but also why they flow to the south-east instead of to the north-west. Taking the last question first, we are forced to suppose that the north-westerly slope, which must have existed at least up to the end of the carboniferous, was then or soon after reversed in the slow writhing of the surface. This is demanded by the lay of the land, and by the now small area of what must have been, in paleozoic time, a large crystalline land-mass. The slope being changed early in the growth of the folds, or before their beginning, the streams tried to make their way to the eastward; and the Hudson, Delaware, Susquehanna, Potomac, and James are the descendants of those that succeeded. Their rectangular courses, alternately longitudinal and transverse, bear witness to their defeats and victories. Lakes must have been numerous here once, though they are now all drained. It is known that rivers often chose cross-faults of small throw as points of attack in cutting their way through the growing ridges; and it is very probable that they made use of pre-existent valleys when they advanced over the old sinking land.

In considering the applicability of backward-cutting lateral streams to the production of our cross-valleys, we should test the past by the present, and examine such ridges as Kittatinny or Bald Eagle mountains in Pennsylvania, or Clinch mountain in Tennessee, rising between parallel longitudinal valleys, to see if they show embryonic cross-valleys in the more advanced stages of development. They do not. The continuity of their crest-line is most characteristic and remarkable: it very rarely departs from its line of almost uniform height. The exceptions are, first, the finished water-gaps, or transverse valleys, whose origin is in discussion; second, the occasional wind-gaps, or notches, which sometimes cut the ridge a third or half way to its base, and which are, we believe, always determined by small transverse faults; third, the less conspicuous serrations of small value. It is difficult to assign any reason why lateral streams should not now, as well as in former times, show us the later stages of breaking down the ridge on which they rise; and yet these almost-formed cross-valleys between adjoining longitudinal valleys are practically unknown in our Appalachian topography. The reason of their absence can hardly be, that there are now enough completed water-gaps for all practical purposes, and hence the lateral streams stop making any more; for this would imply a consciousness of the end that plays no part in geological operations, and we are therefore constrained to think that Löwl's explanation cannot apply to the Appalachians in any general way.

But it has a certain limited application in

[1] Concluded from No. 12.

the making of 'coves,' as may be perceived by the following considerations. The backward-cutting of a lateral stream can form a water-gap only where the longitudinal valley into which the lateral stream flows is decidedly lower than the longitudinal valley on the other side of the dividing-ridge; for, if there is no such difference of level, the pass through the ridge between the two will be eroded more and more slowly as it is lowered, and finally it will remain at practically a constant altitude above the valleys on either side. It can never form a drainage channel joining them: but, if the longitudinal valleys are of different heights, the result as described by Löwl may be produced; or, if a broad plateau-fold is bordered by a deep valley, its lateral streams may finally head up in coves or circular valleys, like those south of the west branch of the Susquehanna, and at many other points in the Appalachians. The geological map of Pennsylvania (1858) shows these admirably.

Now it may be asked, Are not the upper valleys of the Susquehanna, and of the other rivers that break through the Blue mountain, merely large examples of 'coves'? There are two objections to this explanation. First, what became of the head waters of these rivers before they had a south-easterly outlet? It seems most probable, that the many pre-existent streams in each river-basin concentrated their waters in a single channel of overflow, and that this one channel survives, — a fine example of natural selection. Second, how does it happen — notably in the case of the Susquehanna just above Harrisburg — that several deep water-gaps have been formed one behind the other? Such an arrangement might naturally result if the valley were antecedent; but it is difficult to account for if the several gaps result from the backward erosion of accidental lateral streams.

Löwl thinks that faults are greater obstacles to rivers than folds. He says, that even if river erosion could, under certain favorable conditions, keep pace with mountain folding, it does not follow that it could control a fault: for that would imply that the fault was formed gradually, and that its throw increased at a constant though imperceptible rate; and this he considers entirely unwarranted (408). It is certainly a difficult matter to understand the mechanics of such faults; and yet our ideas concerning them must conform to the facts as they occur in nature. In spite, therefore, of a natural preference for an active growth of faults, we are compelled, when we see streams running across them from the downthrow to the upthrow side, to accord them a slow growth. Tennessee shows many examples of this paradoxical nature; and some of the faults thus disregarded, or, we might say, corrected, have a throw of several thousand feet. On the other hand, it cannot be denied that many faults have had a controlling influence on stream-courses; and we must therefore admit here, as above, the possibility of valley-cutting being stronger or weaker than orographic movements. The variety that is to be seen in the physical features of the earth, and that is consequently to be looked for in the conditions which determined them, is so great that it demands almost equal variety in the theories for their explanation.

W. M. DAVIS.

Cambridge, Jan. 12, 1883.

THE ORIGIN, AFTER BIRTH, OF ASPIRATION OF THE THORAX.

THE negative pressure in the pleural cavities, which plays such an important part in the respiratory mechanism of the adult mammal, and also exerts a marked influence upon the flow of blood and lymph, is known not to exist in unborn or stillborn mammals which have never breathed. It has hitherto been assumed, however, that it was established with the first inspiration; and all theories as to its mode of production have been controlled by this belief. Hermann, in an interesting paper (*Pflüg. archiv*, xxx. 276), shows that this assumption is incorrect. In infants which have lived and breathed after birth for periods of from one hour to eight days, there is found on experiment to be no negative pressure in the pleural cavity when the chest-walls are in their death position. This fact leads, necessarily, to important results in regard to the respiration of young mammals. Their lungs in expiration can contain hardly any of what in the adult is known as 'residual' air: they contain still some air imprisoned in the air-cells, and causing them to float in water. But this 'minimal' air is practically no more than what remains in a piece of adult lung squeezed between thumb and finger. Except this minute quantity, there is in the new-born mammal no stationary air. At each inspiration, air direct from outside enters the alveoli of the lungs; and, at each expiration, air from the alveoli is expelled, leaving the lungs practically empty. Hence the renewal of the air in the lungs is much more efficient than in adults. The high percentage of oxygen which the alveolar air must contain is probably correlated with the more active oxidations known to occur in the young animal. The question naturally arises, What is the object of the residual air in the lungs, and the negative pressure in the thorax, which we find established later? Hermann suggests three possible objects: 1°. Aspiration on the veins, promoting bloodflow to the heart; 2°. More uniform composition of air in the alveoli [and, we may add, more uniform temperature]; 3°. The presence of a certain store of air in the lungs in the case of a temporary stoppage of the breathing-movements. It remains to be seen at what age and rate the negative pressure in the thorax is developed. It is obviously brought about by a more rapid growth of the thorax than of the lungs.

H. NEWELL MARTIN.