seventeen days in the opossum,[1] and thirty-eight days in the kangaroo.[2] My fortunate discovery of the early opossum embryos, and the subsequent examination of the two other marsupials, seem to throw a great deal of light upon this question, if they do not actually solve it. The principal facts which have been brought out may be briefly stated.

1. In the opossum the yolk-sac spreads out over about one-third of the inner area of the subzonal membranes, and forms a highly vascular disk, the *false chorion* of the placental mammals. This disk is ventral to the embryo; and among the numerous embryos which were examined *in situ*, these disks were found to be *invariably placed in a long uterine furrow*, while the remainder of the enveloping membrane floated free in the cavity of the uterus. The use of the word 'attachment' would be misleading in this connection, as a slight touch with the needle was sufficient to remove the embryos from their position. The outer surface of the subzonal membrane, all over the area to which the yolk-sac was adherent, was found to be covered with minute villi, which were just visible to the naked eye. These villi are simple upgrowths of the subzonal epithelium, shaped like little hillocks, and confined to this area. At this early stage they are hollow.

2. In Professor Wilder's specimen,[3] villi were found to be scattered over the same area of subzonal membrane; but in this case their development had proceeded much farther, and, although they were extremely minute, each was found to be provided with a solid papilla, which arose from the epithelium of the yolk-sac. A closer examination showed that the cap of subzonal epithelium was composed of flattened cells, and that the papilla was provided with capillary branches derived from the vessels of the yolk-sac. These villi conform, therefore, to what Professor Turner has described as the simplest type of allantoic villi, the nearest approach to which, among the placental mammals, is found in the pig.

3. In the kangaroo foetus the villi could be seen without a lens. They were, however, so minute, that it is not at all surprising that they have been overlooked hitherto. They were spread over the highly vascular portion of the yolk-sac, which is loosely attached to the subzonal membrane. A close examination into their structure has not yet been made.

[1] See Bachman, Proc. acad. nat. sciences Philad., 1848, 44.
[2] See Owen, Comp. anat. and phys. of the vertebrates, iii. §400.
[3] The genus cannot be ascertained, owing to a misplaced label. The foetus undoubtedly belonged to one of the smaller Australian genera.

4. The allantois in the opossum embryos was found in various stages of growth, but in none was it attached to the subzonal membrane. In Professor Wilder's specimen it was highly vascular, and appeared to show a *disk-like area of attachment to the subzonal membrane*. This area showed no traces of villi. The subzonal epithelium consisted of flattened cells. In the kangaroo it was an extremely small vascular sac.

5. Owing to an accident, one horn of the uterus in which the embryos were preserved *in situ* was destroyed, so that no satisfactory study of the uterine wall could be made.

The presence of villi over that portion of the subzonal membrane which is in contact with the uterine wall renders it highly probable from analogy that minute crypts are present upon the latter. At all events, we now have data sufficient to establish the following facts: that the so-called *false chorion* of some of the lower orders of placental mammals, formed by the spreading of the yolk-sac over the inner surface of the subzonal membrane, in the marsupials functions as a *true chorion*, developing simple villi, by which the maternal and foetal blood-vessels establish a feeble interchange: in other words, the functions of the allantois in the placental mammals are, in a rudimentary way, performed by the yolk-sac in the marsupials. Finally, some genera of the marsupials probably show the attachment of the allantois to the subzonal membrane, which is the first step towards the establishment of an allantoic placenta.

These facts naturally give rise to a number of interesting questions, which will be discussed in a paper to be published in the *Quarterly journal of microscopical science* for July.

I wish to express my indebtedness to Professors Wilder and Chapman, without whose aid these observations would have been very incomplete. HENRY F. OSBORN.

Morphological laboratory,
Princeton, May 11, 1883.

RAINFALL AT PANAMA.

IN the *Comptes rendus* for Feb. 26, M. de Lesseps publishes some interesting observations of rainfall for four years (1879-82) at the Isthmus of Panama. The accompanying table gives these observations, together with like observations at stations along the Pacific coast, which are added for the purpose of comparison.

M. de Lesseps remarks that the rainy season lasts about six months, from May to November, with an interruption at the end of June and beginning of July. He assigns as a cause for these peculiarities the advance of the (overhanging) sheet of rising air which

Table of rainfall at Panama and other stations.

	PANAMA, lat. 9° N., long. 80° W.					SAN JOSÉ, lat. 10° N., long. 84° W.	MAZATLAN, lat. 23° N., long. 107° W.	SAN DIEGO, lat. 33° N., long. 117° W.	S. FRANCISCO, lat. 38° N., long. 122° W.	PORTLAND, lat. 46° N., long. 123° W.
	1879.	1880.	1881.	1882.	Mean, 4 years.	Mean, 2 yrs.	Mean, 2 yrs.	Mean, 7 yrs.	Mean, 7 yrs.	Mean, 7 yrs.
	"	"	"	"	"	"	"	"	"	"
January	0.04	1.89	0.16	0.00	0.52	0.22	1.74	1.72	6.61	4.98
February	2.52	.12	.16	.12	.73	.00	.00	1.55	4.34	8.78
March	5.71	.16	.35	.00	1.56	1.00	.00	1.21	3.45	7.87
April	5.55	1.61	3.23	.98	2.84	4.20	.00	.95	2.38	2.91
May	10.28	4.45	10.35	5.24	7.58	7.44	.00	.19	.64	2.90
June	6.46	5.00	13.78	6.18	7.86	6.23	2.12	.06	.26	1.81
July	7.91	9.88	7.20	5.35	7.58	10.30	10.16	.03	.01	.74
August	7.24	11 46	4.49	4.06	6.81	5.16	9.14	.08	.00	.91
September	9.02	7.91	8.94	4.06	7.48	9.14	15.96	.07	.14	1.99
October	9.80	11.81	9 69	6.69	9.50	10.02	3.26	.46	1.29	4.51
November	19.21	6.46	9.72	10.91	11.58	2.87	.80	.90	3.08	8.83
December	.98	5.51	2.48	2.01	2.74	.88	3.06	2.43	3.50	7.46
Year	84.72	66.26	70.55	45.60	66.78	57.46	46.24	9.65	25.70	53.69

accompanies the curve of maximum daily temperature due to the annual oscillatory movement of the thermal equator. The movement of this curve is closely connected with the annual movement of the sun across the geographical equator. The sun passes the zenith of the isthmus at mid-day twice in the year, on April 13 and Aug. 29. The sheet covers the isthmus from the beginning of May to the end of June, and from the end of July to the beginning of December. These two intervals occurring between the first of May and the first of December constitute the rainy seasons. The first is generally interrupted by the short 'summer of St. John.' During the remainder of the year is the dry season. At this time the sheet is entirely to the south of the isthmus, while during the 'summer of St. John' it is entirely to the north.

On the north side of this sheet the trade-winds of the northern hemisphere prevail, which, at the isthmus, have in general a direction from the north-east. On the south side the trades of the southern hemisphere prevail, which have a direction from the south. In the interior of the sheet, at the earth's surface, the wind is feeble and uncertain. This, then, for the isthmus, is the period of calms, the time of gentle breezes; now from the land, now from the sea, according to the hour of the day.

Percentage of precipitation in each month.

	Panama.	San José.	Mazatlan.	San Diego.	San Fran'co.	Portland.
January	1	0	4	18	26	9
February	1	0	0	16	17	16
March	2	2	0	12	13	15
April	4	7	0	10	9	6
May	11	13	0	2	2	5
June	13	11	5	1	1	3
July	12	18	22	0	0	1
August	10	9	20	1	0	2
September	11	16	34	1	1	4
October	14	17	7	5	5	8
November	17	5	2	9	12	17
December	4	2	6	25	14	14
Total	100	100	100	100	100	100

M. de Lesseps further remarks, that one can see, that, in the time during which the (overhanging) sheet of ascending air is over the isthmus, the season of rain prevails, because the trade-winds, blowing along the ocean's surface, accumulate in this sheet a mass of vapor, which rises up, comes to the higher regions of the atmosphere into lower and lower temperatures, and is condensed; producing, thus, a vault of perpetual cloud, which generally surrounds the earth in a dark ring, — called, by the French sailors, '*pol au noir;*' by the Americans and English, 'cloud ring,' — and continually precipitates during the rainy season the showers of the tropical regions.

The waters of the gulf-stream which come from the equator are charged with a great quantity of vapor; and this is condensed and precipitated by the Cordilleras. This accounts for the abundant rains of the Atlantic watershed. This cause does not exist on the Pacific watershed. The general current along the coast of the isthmus is just the reverse of that in the sea of the Antilles. On the contrary, the tide comes from the north; and in consequence these waters are cooler, and furnish less vapor to the air flowing along the surface. This explains why it rains more at Colon than at Panama, and why, in proportion as one removes from the Atlantic coast, the rain diminishes. So upon the island of Naos, situated in the Bay of Panama; and, where the canal company has established a meteorological station, the rain gathered is less than at Panama.

The existence of winter and summer rains in belts approximately parallel to the equator has been long recognized. A glance at the table above will show that the rains all along the Pacific coast are markedly periodic, and occur later in the year as we go north; and the heavier rainfall occurs at the time the sun is the farthest south of the equator.

H. A. HAZEN.

THE COPPER-BEARING SERIES OF LAKE SUPERIOR.

IT may not be unprofitable, at this presumably the closing stage of the present discussion of the Keweenawan series, to state summarily the main grounds on which its pre-Potsdam age is maintained. It is obvious that such a statement can but imperfectly indicate the nature of the evidence relied upon; for the significant data are derived from numerous localities, and from diverse phenomena which cannot be adequately, and at the same time briefly, described. The formation involves an area of upwards of forty thousand square miles; and only a wide survey of it, a critical elaboration of trustworthy observations, and a judicial treatment of the evidence, can command complete deference, and that is a thing of the future. No