quence, unable to obtain its position except by estimation.

At twenty minutes past seven I estimated it to have been in about R. A. 22 h. 57 m., Dec. + 29° 50′, as determined by comparison with Argelander's charts, no allowance for precession being made. It was 2° 37′ almost exactly north of Beta Pegasi, as roughly determined by the size of the field of my comet eye-piece. Its motion is slowly eastward, probably north-east; but its altitude was so low, and the hour being so near moonrise, I could not determine its exact direction.

It presented a beautiful appearance through my 4½-inch achromatic. LEWIS SWIFT.

Warner observatory, Rochester, Feb. 24.

Movement of the arms in walking.

In SCIENCE, Feb. 9, Mr. F. W. True recognizes the 'movement of the arms in walking' as a functional relic of quadrupedal locomotion; urging thereby a modification of the expression of Professor Dana, sanctioned by Dr. Gill, that "man stands alone among mammals in having the fore-limbs not only prehensile, but out of the inferior series, the posterior pair being the *sole* locomotive organs." And the questions are asked, "Have we not at least a ghost of a pre-existing function? Does man walk by means of his feet and legs alone?" Viewing the question from the developmental standpoint, it seems to me that the strongest evidence appears in the first locomotor-acts of the child. Before bipedal progression is learned, *the child goes on all-fours, and is an actual mammalian quadruped.* At the beginning of this the prehensile power of the fingers is very imperfect. Men have been known to educate their toes to do more than the fingers can at that stage of functional development. At that time the palms are of more value as soles than for holding things. In the beginning, also, the arms in some children are better legs than are the hind-limbs, being more easily used. For example, it is more common for children to creep on the knees than on the elbows; but some learn remarkably early to elevate both knees and elbows, to creep on the soles and palms. My own boy walked on his soles and palms from the start, and never upon his knees. The speed with which he finally learned to run in this way was remarkable. After learning to move somewhat on his hind-legs, when he got in such haste as to make bipedal balancement difficult or uncertain, he would take to all-fours, thereby making better speed with less danger of a fall.

U.S. dept. of agric., Washington, Feb. 13, 1883. W. S. BARNARD.

The heart as a locomotive organ.

Every one has observed that the tendency of the heart to beat while walking 'is a most natural one.' 'The action is rhythmical,' the number and force of the pulsations varying with the velocity of the walk. 'It is also involuntary;' but, although proper locomotive movements are usually in a high degree *voluntary*, this consideration need cause us no uneasiness, if we reflect, that, when its action is from any cause suspended, 'an air of stiffness' is soon imparted to the whole body.

In view of these facts, does it not seem that the statement (SCIENCE, p. 11) that "man stands alone among mammals in having the fore-limbs not only prehensile, but out of the inferior series, the posterior pair being the *sole locomotive organs*," should be further modified, and the heart assigned its proper place between the swinging arms as a *true* locomotive organ? O. HARGER.

New Haven, Feb. 28.

The copper-bearing rocks of Lake Superior

There are one or two statements in Mr. Selwyn's remarks on the age of the rocks on the northern shore of Lake Superior, in the number of your journal for Feb. 9, which I cannot suffer to pass unchallenged.

I cannot enter here into a general discussion of the much-vexed question of the age of the Lake Superior copper rocks, — I have discussed it at length elsewhere,[1] — but I must take issue with the statement that there is "no evidence whatever of their holding any other place in the geological series" than that which "includes the Potsdam and Primordial Silurian." My own conclusions in this connection, after an examination of most of the circuit of Lake Superior, are: —

1°. That the copper-bearing rocks underlie unconformably — and with an immense unconformity — a series of sandstones holding Cambrian fossils. These fossils may not correspond to the oldest Cambrian fossils known elsewhere, as argued by N. H. Winchell in the report quoted, but they are distinctly Cambrian; and if the copper-bearing strata are to be called Cambrian, then we must stretch that term over a most immense unconformity, in order to include a rock-series holding no fossil evidence of its Cambrian age, — a thing which appears to me very unreasonable to do. This unconformity is best seen in the St. Croix river region of western Wisconsin, and thence north-eastward. Although attention was drawn some years since by Sweet, Chamberlin, and myself,[2] to the strikingly conclusive occurrences of this region, our evidence has been ignored by others who have never examined the region, and who continue to approach the question from the eastward, or, in other words, from the same direction as a succession of geologists, from Houghton to Selwyn, all of whom have felt baffled. It is interesting to note in this connection that N. H. Winchell, the only geologist who has gone to the St. Croix since our report was issued, confesses to the unconformity,[3] although he had strenuously refused to believe in it before visiting the region. It does not seem to me that any geologist can honestly deny this unconformity until he has done as we have done; viz., followed the copper-bearing strata, with all their characters preserved, mile by mile, from the typical region of Keweenaw Point, to their junction with the fossiliferous Cambrian sandstone of the St. Croix valley.

2°. That the copper-bearing strata also underlie unconformably the 'eastern sandstone' of the south shore of the eastern half of Lake Superior. Winchell has argued a difference of age between this sandstone and that of the St. Croix valley. However this may be, — and I have myself seen no evidence that the one of these sandstones is not merely the direct downward continuation of the other, — the work done by myself and assistants along the contact line of the copper-bearing rocks, and the eastern sandstone from Bête Grise Bay westward to the vicinity of Lake Agogebic, has served to convince me that there is here also an unconformity as great as the other.

3°. That the time-gap between the copper-bearing series and the Huronian was too long to allow of our classing them together, — for it certainly covered a considerable amount of denudation and alteration, — but it is still doubtful if this gap was long enough to cover the folding of the folded Huronian. The greatest confusion prevails as to the use of the term Hu-

[1] The copper-bearing rocks of Lake Superior, — vol. v., monographic publications of the U. S. geol. survey; also Third annual report of the same survey. Both of these publications are still under press.

[2] Geology of Wisconsin, vol. iii. [3] Loc. cit., p. 134.

ronian. The Canadian geologists have fallen into the custom of calling every thing Huronian that is schistose, and yet it is evident that much of the schists called by them Huronian are but dependencies of the older gneiss. I may say in this connection, that the 'Animikie group' of Thunder Bay, which Selwyn, following Logan, refers to the copper-bearing series, is, beyond question, the exact equivalent of the unfolded iron-bearing rocks of the Penokee region of Wisconsin, and these again of the folded iron-bearing schists of the Marquette and Menominee regions; and that there can be little doubt that all of these are the equivalents of the original Huronian of the north shore of Lake Huron. This reference of the Animikie rocks to the Huronian is, I know, a novel position, although Logan long since for a time held the same view; but I feel confident that it is a correct one. Indeed, I speak confidently as to all of the conclusions here mentioned, because I have had unusual opportunities for observation, having studied both the Cambrian sandstones and the copper-bearing rocks, as well as the Huronian from Keweenaw Point across Wisconsin, into Minnesota, and thence north-eastward to Thunder, Black, and Nipigon Bays. Having made this wide sweep, I can see quite well how others, examining only portions of the district, should be puzzled or reach different conclusions.

There is one other statement in Mr. Selwyn's letter that I cannot concur in; and that is as to the occurrence of tuffs, or volcanic detrital matter, among the copper-bearing rocks. I know such materials should be expected to occur in a series largely composed of volcanic flows; but after a careful search for them in the field, and the study of a large number of thin sections, I can find no fragmental rocks which are not either certainly ordinary sediments or at least much more probably so than of direct volcanic origin.

Madison, Wis., Feb. 16, 1883. R. D. IRVING.

WHITNEY'S CLIMATIC CHANGES.

The climatic changes of later geological times: a discussion based on observations made in the Cordilleras of North America. By J. D. WHITNEY. Cambridge, 1882. 14+394 p. 4°.

I.

THIS volume is one of a series, by the same author, based on the work of the California geological survey, but published under the auspices of the Museum of comparative zoölogy. The preceding volume treated of the auriferous gravels of California, and this one is in some sense a sequel to it. Although the treatise is an outgrowth of the Californian work, its material includes observations by the author in eastern America and in Europe, as well as data gathered by others from all regions. It is of interest, not only by reason of its contribution of original matter, but because it develops at length a theory that has heretofore been stated but briefly, and which has been almost ignored by the advocates of its rivals. The book comprises four hundred quarto pages, but is without index, — an omission only imperfectly supplied by an analytic table of contents.

In the volume on the Auriferous gravels, our author states that the Sierra Nevada has had substantially the same height and dimensions from cretaceous time. The streams which flowed down its western flank during the tertiary did not excavate gorges, but, on the contrary, spread great bodies of detritus. The modern rivers, following essentially the same courses, have cut deep V-shaped cañons, which were partially filled with ice during the glacial epoch. The tertiary climate was relatively moist, as is shown by the broad channels of the tertiary rivers, and by the fact that they filled their valleys with gravel instead of cutting cañons.

In the present volume, the idea of a diminution of precipitation from pliocene to present time is expanded into a theory of general, continuous, secular desiccation, and is developed at length. Evidence is adduced to show, that within historic time there has been a shrinking of lakes and rivers in South America, in the interior basin of Asia, and about the shores of the Mediterranean; and that, in late geological time, large areas in northeastern and northwestern Asia and northern Africa were covered with water, while the Great Basin of North America contained a system of fresh-water lakes. The ancient glaciers of the Sierra Nevada, and of the Cordilleras generally, are described; and their disappearance is referred to the same desiccation. An account is given of the tertiary lakes of western North America, and it is pointed out that their extent gradually diminished. The popular theory that modern desiccation is due to the destruction of forests, and the theory of some geologists that the great lakes and rivers of the immediate past were connected with the melting of the ice of the glacial epoch, are controverted; and it is argued that all the phenomena pertain to a general, secular diminution of precipitation.

To account for this diminution, the following considerations are adduced: The amount of moisture precipitated to the earth depends on evaporation. The amount of evaporation depends on temperature and on the extent of water-surface. If, therefore, it can be shown that the continents of the earth have gradually increased in area, while the oceans have gradually diminished, or if it can be shown that the temperature of the atmosphere has gradually lowered, then an explanation will be afforded of the change in precipitation. After a review of the facts, Professor Whitney concludes that an expansion of continents has actually taken place, but that it is inadequate to account for the observed recent desiccation. He therefore bases his theory chiefly upon a loss of heat,