House-flies in the Philippines.

I remember, years ago, seeing a dried specimen of the house-fly sent to Boston in a letter as a great rarity there, — the only one the sender had seen in a year's residence in Manila. As this is one of the constant accompaniments of man, and a sure sign of his presence or vicinity, I was at a loss to account for its absence. It is not even found in the sugar-yards in any great numbers. I now see why it should be so rare; viz., because it could not of itself pass over the six hundred miles of the windy China sea; and the few which might be transported on vessels, if they got ashore from their distant anchorage, would be prevented from multiplying by their numerous enemies, — bats, spiders, birds, lizards, and other reptiles. Some days I would not see one, and rarely more than two, around the table. Were they common, with the other insect-pests, life would be almost unendurable in these islands. S. KNEELAND.

Solar corona.

Various reasons have been assigned for the very conflicting representations of the corona made by observers who have simultaneously sketched it. It seems to me that the principal cause of the very puzzling differences observed lies in the fact that the light of the corona falls so near the limit of visibility at the violet end of the spectrum as to excite the retina in different observers unequally.

I would have each observer tested for color-blindness in the part of the spectrum between G and H; and no doubt as great differences would be found in the sensitiveness of different eyes near the upper limits of visibility as is known to exist in different ears in perceiving sounds near the upper limit of audibility. Only those sketches of the corona could be properly compared with each other which were made by observers to whom the relative intensity of the various parts of the spectrum appeared approximately the same. H. T. EDDY.

Badly crystallized wrought iron.

An iron contractor told me, the other day, that he was called as an expert in a case where the wrought-iron strap of the walking-beam of a steamboat broke, and injured some one. The broken strap (about four by eight inches in section, I think) was shown, and the interior found to be very badly crystallized, — the worst case, my friend said, he ever saw. The exterior was of fair, ordinary texture. Afterwards, a part of the strap was cut off, sawn lengthwise into bars, and tested for tensile strength. All portions were rather weak, the highest resistance being but 36,000 pounds; but the inner sections, where the iron was worst crystallized, were the strongest of all.

Does any one know more about this case or any similar one? T. M. CLARK.

178 Devonshire Street, Boston, March 2.

WHITNEY'S CLIMATIC CHANGES.[1]

II.

IN the first part of this article the contents of the volume were described: the author's principal conclusions will now be discussed.

THE CAUSE OF THE GLACIAL EPOCH.

Professor Whitney's fundamental postulate, that the general temperature of the atmosphere is due to heat from the sun, is beyond controversy. His hypothesis that the intensity of solar radiation is gradually lessening, by reason of the dissipation of solar energy, and that the paleontologic record in arctic and temperate regions is in close sympathy with this lessening, will be admitted by most students. But when he asserts that the degradation of terrestrial climate has been continuous and uninterrupted, the glacial epoch notwithstanding, assent will not so readily be yielded. The idea that the glacial epoch was characterized by exceptional cold is all but universally entertained, and is so plausible on its face that it can be displaced only by cogent reasoning.

He advances two lines of argument, — first, that the phenomena of the glacial epoch were produced entirely by local causes, such as the elevation of mountains and the submergence of plains; second, that they belonged in the natural order of things to a warmer stage of the earth's climate, and have disappeared by reason of the secular degradation of climate. These two explanations are not clearly recognized as distinct, but are appealed to indiscriminately in the course of a somewhat desultory discussion; the one being more commonly called upon to account for the appearance of glaciers, and the other for their disappearance. If temporary local changes are competent to produce local glaciation, they would seem to be equally competent to terminate it; and a secular cause need not be appealed to. If, on the other hand, the glaciation of quaternary time has been actually abated by a secular change of temperature, it would seem logical to refer its inauguration also to a secular change.

The first line of argument is developed chiefly in a discussion of the distribution of glaciers, modern and ancient, with reference to local conditions. This is full of profitable suggestion; and it is hard to see how any one who has weighed the considerations therein adduced can entertain the hypothesis of a polar ice-cap. It appears beyond question, that the only work accomplished by the introduction of any conditions of a general nature favorable to glaciation would be the enlargement of existing glaciers, and the institution of limited ice-sheets in favorable localities. This, however, is a question of *a priori* possibilities: it is quite another matter to determine whether local conditions can be made to account for the ancient magnitude of glaciers. Whitney tells us that they can; but the only ancient ice-sheet he seriously undertakes to ex-

[1] Continued from No. 5.

plain in that way is the Scandinavian. So far as local conditions are concerned, he practically leaves the phenomena of England, Spain, Switzerland, India, New Zealand, and the Atlantic and Pacific coasts of North America, without a plausible suggestion. His analysis of the subject is, moreover, conspicuously incomplete in that it omits all but the most casual mention of ocean-currents. These great distributers of climate are in continual conflict with the elements dependent on latitude; and any remodelling of coast-lines or sea-bottoms which facilitates or impedes their circulation must influence the local distribution and local magnitude of glacial ice. While, therefore, his presentation of the subject is interesting and valuable, it is unsatisfactory. It suggests a line of inquiry of great promise, but it falls far short of a solution of the problem.

The idea that a general elevation of atmospheric temperature is more favorable to glaciation than a general lowering, is one which arises from an exaggerated appreciation of the importance of precipitation as a condition of glacier-formation. The existence of a glacier shows that the local precipitation in the form of snow exceeds the local ability of the processes of evaporation and melting to dissipate that snow in the course of the year: it shows an excess of solid precipitation over dissipation. All will admit, that, if the local temperature be lowered without a concomitant change in other conditions, the ice will increase; and *vice versa*. All will admit, too, that, if the local precipitation be increased without modification of the other conditions, the ice will be augmented; and *vice versa*. That is to say, the amount of the ice depends on local temperature and local precipitation. If the general temperature of the atmosphere be elevated by a change in solar radiation, the local effect is twofold: on one hand the local temperature is raised, and on the other the local precipitation is increased. The first change tends to diminish the volume of ice; the second, to increase it. Whitney's proposition is, that the latter tendency outweighs the former, and the glacier grows: the majority of investigators assume that the change of local temperature is the more important, and that the glacier shrinks. Considering the importance of this question to his discussion, and the all but universal prejudice against his view, it is surprising that he suffered the matter to rest with a mere declaration of opinion, without attempting a quantitative comparison. Let us endeavor to supply his omission.

There is no comprehensive knowledge of the climate of any point where glacial ice now actually accumulates; but we fortunately have an excellent meteorologic record of a station high in the Alps, where the conditions are presumably on the verge of glacier-formation, and where the climate cannot be far different from that of the surrounding ice-fields. Moreover, the observations at St. Bernard have been so thoroughly discussed by Plantamour, Wolf, and others, that the material is in the most available shape. Having for data a mathematically deduced annual curve of temperature, and an annual curve of precipitation, each based on the record for a long series of years, it is not difficult to introduce the hypothesis of a variation in general temperature, and obtain an approximate quantitative indication of the effect of this variation on glaciation. The mean temperature at St. Bernard is —1.76° (C.). Let us first assume that through a variation in solar radiation this temperature is raised 3°, and again that it is raised 6°; then that it is lowered 3°, and again 6°; and let us inquire what effect these variations will have upon the snowfall. Evidently there are two ways in which the snowfall is affected by a general rise of temperature: first, the fraction of the year during which precipitation takes the solid form is diminished, so that the snow forms a smaller percentage of the total precipitation; second, the change in temperature being general and not local, the power of the atmosphere to receive and transport moisture is increased, and the local precipitation is therefore increased. If we note the day in the spring when the curve of the annual oscillation of temperature passes upward through the freezing-point, and again the day in the fall when it passes the same point in descending, we have the limits of the portion of the year during which all the precipitation is theoretically fluid. (We are, of course, speaking of the ideal average year: in any individual year there is a time of transition, with more or less alternation of rain and snow.) Let us call this period 'summer,' and the remainder of the year, when precipitation takes the form of snow, 'winter.' Assuming that the form and amplitude of the temperature curve remain unchanged, while the mean temperature is varied as by hypothesis, we can readily ascertain the lengths of 'winter' and 'summer' for each of the assumed cases. These have been computed, and will be found in the subjoined table, lines IV. and XII. We next ascertain, by the aid of the precipitation curve, the amount of precipitation during each of these periods (V).

Computation of the relations of snowfall to melting and evaporation at St. Bernard, Switzerland.

I.	ASSUMED GENERAL RISE OF TEMPERATURE, IN CENTIGRADE DEGR.	−6	−3	0	+3	+6
II.	'Winter' begins	Aug. 17.6	Sept. 20.2	Oct. 11.1	Oct. 30.9	Nov. 23.8
III.	'Winter' ends	July 12.3	June 3.9	May 11.1	Apr. 19.9	Mar. 27.4
IV.	Length of 'winter' in days	327.7	255.7	211.0	170.0	123 6
V.	Precipitation during this period at the present time, in metres	1.1576	.9260	.7491	.5658	.3982
VI.	Mean temperature of 'winter'	−8.68	−7.74	−6.06	−4.14	−2.10
VII.	Corresponding mean temperature over Atlantic ocean, near France	+5.2	+7.9	+10.0	+12.0	+14.5
VIII.	Tension of saturation for temperatures VII. (millim.)	6.625	7.964	9.165	10.457	12.298
IX.	Tension of saturation for temperatures VI. (millim.)	2.322	2.512	2.876	3.351	3.925
X.	Ratios of precipitation (VIII. — IX.)	4.303	5.452	6.289	7.106	8.373
XI.	Relative snowfall (V. × X. × .2122)	1.057	1.071	1.000	.853	.708
XII.	Length of 'summer' in days	37.3	109.3	154.0	195.0	241.4
XIII.	Mean temperature of 'summer'	+0.26	+2.22	+4.13	+5.93	+7.48
XIV.	Relative melting-power (XII. × XIII. × .001572)	.015	.381	1.000	1.818	2.839
XV.	Mean annual temperature	−7.76	−4.76	−1.76	+1.24	+4.24
XVI.	Corresponding tension of saturation, in mm. of barometric pressure	2.506	3.191	4.028	5.025	6.200
XVII.	Comparative rate of evaporation (XVI. ÷ 4.028)	.622	.792	1.000	1.247	1.539
XVIII.	Comparative rate of dissipation ($\frac{1}{3}$ XIV. + $\frac{2}{3}$ XVII.)	.420	.655	1.000	1.437	1.974
XIX.	Ratio of snowfall to snow dissipation (XI ÷ XVIII.)	2.518	1.635	1.000	.593	.359

The air-currents which cross the Alps, and from which the precipitation at St. Bernard is derived, acquire their moisture chiefly from the Atlantic ocean. The temperature over the Atlantic being higher than on the Alps, the air is there able to receive a larger portion of moisture than it can retain in the Alps; and in a general way the precipitation on the Alps may be said to be due to this cause. It is true that the air-currents traversing the Atlantic do not become perfectly saturated, and that on the way to the Alps they sometimes increase their aqueous contents by absorption from the Mediterranean or from the land, and sometimes diminish it by precipitation; but the only measure of Alpine precipitation available for the present purpose is obtained by deducting the co-efficient of saturation corresponding to the temperature on the Alps from the co-efficient of saturation corresponding to the temperature over the Atlantic. By ascertaining this difference for the existing temperatures, and again for the temperatures assumed in the hypothetic cases, we are able to make a comparison between the actual rate of precipitation and that which would obtain if the general temperature of the atmosphere were raised or lowered. The annual procession of temperature over the Atlantic ocean is not accurately known; but the tract of most importance for the present purpose is that partially surrounded by England, France, and Spain: and its temperature conditions are sufficiently well determined by the observations in these countries. By the aid of the isotherms plotted for each month by the French bureau of meteorology, the temperature of a definite portion of this region has been deduced for each month of the year. Line VI. of the table gives the mean temperature of 'winter' at St. Bernard for each of the five cases. Line VII. gives the mean temperature over the indicated portion of the Atlantic for the same periods and on the same assumptions. In lines VIII. and IX. the maximum tension of aqueous vapor in the atmosphere, expressed in millimetres of barometric pressure, is given for each of these temperatures; and the differences between these (X.) are taken as measures of the relative rates of precipitation under the various assumptions. Multiplying these rates by the corresponding numbers of line V., we obtain a series of numbers which measure the relative snowfall under the several assumptions. (For convenience these numbers have been multiplied by an arbitrary constant, so as to express them in terms of the present precipitation as unity.) For example: in the assumed case of a general temperature 6° lower than the present, the length of 'winter' is 327.7 days. At the present time the total precipitation in rain and snow during that period is 1.1576 metres; and in the assumed case the whole of this precipitation would be in the form of snow. This is notably greater than the present snowfall, .7491 metres: but the general rate of precipitation, affecting the whole year alike, would be less than the present in the ratio of 4.303 to 6.289; and these two factors, tending in opposite directions, so nearly neutralize each other that the total snowfall (XI.) in the assumed case differs by only 6 per cent from the actual.

The figures of line XI. show, for a thermometric range of 12° (C.), a variation of only 35 per cent in the snowfall, and indicate, that, if the formation of glaciers depended exclusively on precipitation, it would not be greatly influenced by a general change of temperature. The actual influence is exerted chiefly through the agencies of dissipation; to the consideration of which we now pass.

The dissipation of the snow is accomplished partly by evaporation and partly by melting. Whether one process or the other preponderates, depends upon circumstances; and in the case under consideration we do not know their relative importance. We have therefore made separate computation of the ratios of melting and evaporation. Melting takes place only during the period we have designated 'summer'; and its rate during that period is measured by the mean temperature, expressed in centigrade degrees. If, therefore, we multiply the length of the 'summer' in each case by its mean temperature, we obtain a number indicative of its relative power to melt snow and ice. These numbers are given in line XIV., and exhibit a wide range; the rate of melting with a general temperature 6° higher than the present being nearly three times as great as the present, and the rate with a general temperature 6° lower than the present being less than the sixtieth part of the present rate.

Evaporation is not restricted, like melting, to the 'summer' period, but goes on during the entire year whenever the atmosphere is not saturated with vapor. Strictly speaking, its rate is measured by the difference between the amount of moisture actually in the air and the amount necessary to produce saturation. We have no direct means of ascertaining this rate for our assumed cases; but it seems reasonable to suppose that the relative humidity, or the ratio of mean actual vapor-tension to the tension due to saturation, would be the same in all the cases; and upon this postulate the rate of evaporation for each case is measured by the tension of saturation due to the mean annual temperature. These tensions are given in line XVI., and the deduced rates of evaporation in line XVII. These numbers do not increase so rapidly as those expressing the melting-power; but they indicate that the rate of dissipation by evaporation is doubled by a general rise in temperature of 9°.

Since, then, a rise of general temperature diminishes slightly the solid precipitation, and at the same time increases greatly both the rate of melting and the rate of evaporation, it is evident that it is not favorable to the formation of glaciers; and we shall obtain the same qualitative result, whatever we assume to be the relative importance of melting and evaporation. For the sake of reaching a definite quantitative result, we will make the arbitrary assumption that the snow now precipitated at St. Bernard loses two-thirds of its volume by evaporation and only one-third by melting. This gives for the ratios of dissipation the numbers contained in line XVIII. Dividing the relative snowfall (XI.) by the relative dissipation (XVIII.), we obtain the ratio of snowfall to snow-dissipation (XIX.) which may be taken to express the tendency to the formation of glaciers. This tendency appears to be increased two and one-half times by 6° lowering of general temperature, and diminished nearly two-thirds by a corresponding advance of temperature. Considering the entire range of temperature indicated by the hypotheses, each increment of $4\frac{1}{2}°$ doubles the conjoint power of evaporation and melting to remove the precipitated snow.

It is, of course, not imagined that this analysis takes account of all the climatic factors affecting the problem; but it is believed that no omitted factor can modify the qualitative result. One of the most important of the ignored considerations is that of the influence of rain upon the rate of melting. There is no way in which the heat of a warm current of air is communicated so rapidly to a bed of snow or ice as by means of the precipitation of rain; and, since rainfall is necessarily increased by rise of temperature, our results would be somewhat strengthened if this factor were taken into account.

Another factor of possible importance is connected with the velocity of air-currents. The circulation of the atmosphere is caused by differences of temperature, and these differences arise from solar heating; so that an augmentation of solar heat tends to accelerate the aërial currents. This acceleration would probably not be great for the range of temperatures here considered; nevertheless, it would be worthy of consideration if we were able to give a quantitative expression to its effects. One of these effects would be an increase of precipitation, including an increase of snowfall; another would be an increase of the rate of melting; and a third would be an increase in the rate of evaporation. In their relation to our results, these effects might perhaps neutralize one another.

The problem we have thus examined is by no means simple, and it is not impossible that some meteorologic fallacy lurks behind our figures; but, until it shall be pointed out, we are constrained to believe that one of Professor Whitney's chief postulates is untenable.

Another postulate, and the one most essential to his general theory, is equally at variance with the ordinary belief of men, and is, in our opinion, equally erroneous. It will be considered in the third and final part of this article.

AMERICAN PALEOZOIC FOSSILS.

MILLER, S. A. *The American paleozoic fossils: a catalogue of the genera and species* (etc). Cincinnati, *the author*, 1877, 1883. 16+334 p. 8°.

THIS second edition of Miller's catalogue of American paleozoic fossils consists of the original list issued in 1877, with a consecutively paged supplement of some ninety pages. The work is essentially a catalogue of genera and species, with names of authors, dates, places of publication, groups of rocks in which the species are found, and the etymology and signification of the names applied to them. There is also an introduction to the stratigraphical geology of the paleozoic rocks, a chapter on the construction and application of names in paleontology (contributed by Prof. E. W. Claypole), and an explanatory preface to the original, and to the supplementary part. It is needless to dilate on the usefulness of a work of this kind, which commends itself at once to the notice of working naturalists, even those not especially devoted to paleontological studies. Catalogues and bibliographies, even when of inferior execution, are always welcome to the student as labor-saving tools, and when well done are invaluable. The testimony of experts in this case is to the effect that the work has been done with care and completeness; though, as in all such catalogues, it would be strange if there were not some omissions. In the way of criticism, we should say that the addition of the number of the page to that of the volume, or to its abbreviated title, would have been little additional labor to the industrious compiler, and would save much time to the person using the work as a means of reference, especially to old works which are often destitute of an index. Furthermore, except in the case of confessedly absolute synonyms, we believe it is better to express the compiler's view, that a certain generic or specific name is merely the equivalent of another, by a mark of interrogation preceding the sign of equality and the supposed prior name. In this way there is less liability to error in matters about which authors are not universally agreed, than when a positive statement is made on one or the other side. It would also be well if a bibliography of the works cited in the list, often by titles so condensed as to be difficult of recognition by those unfamiliar with paleontological literature, were to be added to the volume. These, however, are suggestions rather than criticisms; and we may supplement them by further suggesting that naturalists would be under still greater obligations to Mr. Miller, should his time and inclinations lead him to prepare similar catalogues for the later geological formations.

AUSTRALIAN CRUSTACEA.

Catalogue of the Australian stalk and sessile-eyed Crustacea. By WILLIAM A. HASWELL. Sydney, 1882. 24+324 p., 3 pl. 8°.

THE Australian museum has recently issued a list of Australian crustacea, much after the pattern of the list of New-Zealand crustacea, published six years ago. The present work is largely a compilation; the author for some reason usually preferring to copy the descriptions of authors, even when specimens were at hand, while the synonymy exhibits many proofs of a like treatment. There occur to us several species which should have been inserted in the list, but which appear to have escaped Mr. Haswell: these are,—

Paramicippa affinis Miers.
Halimus auritus Edwards.—(Pt. Philip, Kinahan, *Proc. roy. Dublin soc.*, i. 117, 1858.)
Lambrus latirostris Miers.
Leitocheira bispinosa Kinahan.
Pilumnopeus crassimanus A. Milne-Edwards.
Pilumnus deflexus A. Milne-Edwards.
Neptunus rugosus A. Milne-Edwards.
Thelphusa angustifrons A. Milne-Edwards.
Thelphusa crassa A. Milne-Edwards.
Gelasimus longidigitum Kingsley.
Gelasimus annulipes Edwards.
Ocypoda fabricii Edwards.
Ocypoda convexus Quoy et Gaimard.
Pachygrapsus transversus Gibbes (P. levimanus Stimps.).
Heterograpsus crenulatus Edwards.
Cyclograpsus tasmanicus Jacquinot et Lucas.
Macrophthalmus dilitatus Edwards.
Macrophthalmus definitus White.
Calcinus latens.
Alpheus bidens Edwards.
(Alpheus thetis White is merely mentioned, but not in such a manner as to imply that it belonged to the Australian fauna, as in reality it does.)

Still, leaving these deficiencies, the work will probably have a certain value for the students of Australia, as it brings together in a compact form descriptions of a large proportion of the crustacea of the antipodean continent.

J. S. KINGSLEY.