not thoroughly equipped great caution in publication." (3) *The Construction of a Natural System.*—The speaker spoke of the necessity of constructing a natural system with easy advance in the knowledge of affinities, as a convenient summary of information, a sort of mile-post, to tell of progress and to direct future effort. The concluding summary was as follows :—"The points presented in this consideration of the third phase of systematic botany are that the last and highest expression of systematic work is the construction of a natural system, based upon the accumulations of those who collect and describe, and those who study life-histories ; that this work involves the completest command of literature and the highest powers of generalization ; that it is essential to progress for a natural system to be attempted with every advance in knowledge ; and that all the known facts of affinity, thus brought within reach, should be expressed in all systematic literature."

This Section, as usual, was the most crowded of all, forty-seven papers having been read before the Section itself, and many more before its two offshoots, the Botanical and the Entomological Club. This was another of the Sections which its Secretary considered to have had the most successful meeting on record. A feature now at every annual session is the report of members appointed the year before to study certain assigned questions. This year four such reports were presented :—Transpiration, or the loss of water in plants, was treated by Chas. E. Bessey and Albert F. Woods. "Movements of fluids in plants" was read by Prof. Wm. J. Beal, of Michigan. Dr. J. C. Arthur, of Purdue University, Lafayette, Ind., read a paper entitled "Gases in Plants." A paper was read by Prof. L. H. Pammel, of Ames, Iowa, on the absorption of fluids by plants.

SECTION H—*Anthropology.*

The youngest Vice-President at this session, if not the youngest man who ever held a Vice-Presidential office in the American Association, is Prof. Joseph Jastrow, whose age is 28 years. His address was entitled "The Natural History of Analogy."

Major J. W. Powell, Chief of the U.S. Geological Survey, exhibited and explained his linguistic map of North America, on which he showed the classification of languages of the aborigines.

Mr. Cushing read a paper on the Zuñi Indians, and danced the Messiah dance, which a few months ago was so much talked about, and almost involved a war with the Government.

SECTION I—*Economic Science and Statistics..*

Of all the Vice-Presidential addresses, that of Prof. Edmund J. James, of Philadelphia, before this Section, aroused the most widespread popular interest and attention, on account of the vital practical importance of the theme presented, which was "The American Farmer: his present economic condition and future prospects."

The silver question was carefully considered, and all who took part in the discussion agreed in opposing the free coinage schemes which are now so vehemently urged upon Congress.

The general business of the Association included a change in the constitution, so as to admit fifty foreign honorary members, and many recommendations to Congress as to forestry, water supply and management, and other topics. Preliminary arangements were made to participate in the Columbian World's Fair in 1893. A Committee was appointed to solicit donations for the endowment of the Association with a fund of at least $100,000. Three hundred and seventy-one new members were elected, bringing the total membership up to about 2300, which is high-water mark in the history of the Association.

Prof. Joseph Le Conte, of California, was elected President ; and the Association adjourned, to meet at Rochester, N.Y., on the third Wednesday of August 1892.

RAIN-MAKING IN TEXAS.

THE announcement in the *Standard* about a fortnight since, that rain had been artificially produced in Texas by exploding oxyhydrogen balloons and dynamite, was probably received by most scientific men with a suspension of judgment. The somewhat sensational form of the report, the emphasis with which it dwelt on the unfavourable antecedent conditions, and the omission of all details that might enable us to form some rough estimate of the forces employed and of the resulting effects, seemed calculated to appeal to the barren emotions of astonishment and love of the marvellous rather than to the sober judgment of well-balanced minds ; and but for the fact that the experiments were stated to have been made by the officers of the U.S. Signal Service, which, on the hypothesis of a hoax, would have been a needless challenge to speedy denial, one might have been disposed to regard the story as only an additional instance of a kind of produce for which the Western States are somewhat notorious. The further accounts that have now reached us prove, however, that this is not one of Jonathan's amusing attempts to play off on the credulity of his simple-minded cousins across the Atlantic. Not only have experiments of the kind described been actually made, but they have been apparently successful, and they seem to have been repeated sufficiently often to render it at least improbable that this success has been entirely fortuitous. The improbable features of the *Standard's* report are, indeed, somewhat toned down ; the dryness of the local atmosphere was by no means so great as was to be inferred from the vague language of the *Standard's* informant ; but, as far as can be judged from the notices now before us, it seems unlikely that the rain which followed General Dyrenfurth's experiments would have occurred in the undisturbed course of natural events.

The experiments were made at a place known as Ranch C. One writer states that an intermittent series of experiments had been carried out for three weeks, and that "not in a single instance has rain failed to fall within ten or twelve hours after the explosion." But the number of trials is not stated—an omission the more to be regretted, because the improbability that the results are fortuitous increases in a certain geometric ratio of the number of successful repetitions. We have definite accounts of those made on August 18, 26, and apparently the morning of the 27th, and it is by no means clear that the evidence is not limited to these, although the expression quoted above would seem to imply otherwise. The first, that of August 18, was made about 3 p.m. There were at the time a few scattered clouds, but no indication of rain. The reading of the barometer is not reported, but the relative humidity of the air immediately before the experiments (presumably at the earth's surface) was not more than 60 per cent. of saturation. An oxyhydrogen balloon, the capacity of which is not stated, was exploded by electricity at an altitude of a mile and a quarter. Several kites, with packets of dynamite attached, were sent up immediately after the balloon, and the charges exploded by similar means, and "rendrock powder was distributed for a distance of two and three-quarter miles from head-quarters, and fired by igniting dynamos." These explosions "sent up great volumes of white smoke, which rose only a short distance, and was then beaten down by heavy rain, which at once began falling and continued for four hours and twenty minutes." Prof. Curtis, the meteorologist of the expedition, estimates that the rain covered an area of not less than 1000 miles.

On August 26 it is stated that "balloons containing several thousand feet of oxyhydrogen gas were sent up and exploded at heights varying from 1000 to 10,000 feet, and at sundown batteries on the ground began their work, and until 10.30 p.m. a constant cannonade was carried on under a sky of perfect clearness, lit by countless stars of a brilliancy seldom seen in the north. The barometer promised fair, and the hygrometer stood between dry and very dry," whatever these expressions may mean. The account continues :—"At 11 p.m. General Dyrenfurth withdrew his forces, and all retired for the night. Sleep, however, was soon interrupted, for at 3 a.m. the first return fire flashed from the heavens, when

the rain-makers were roused by a crashing peal of thunder, and the rain was soon beating on the roof. At sunrise a magnificent double bow arched the heavens, and the downfall of rain did not cease till 8 o'clock a.m. A number of heavy charges of dynamite were then made, and after every one the drops again poured down, till at last the clouds were entirely expended."

In these quotations is given all that is essential in the newspaper reports now before us. Although deficient in many details that it would be desirable to know, they are written by one who witnessed what he described, and there seems no reason whatever to doubt their genuineness and good faith; we may therefore, discuss the information they afford, without misgivings of its substantial trustworthiness.

It is not antecedently improbable that, in certain states of the atmosphere, the liberation of a large amount of heated gas consisting wholly or in great part of water vapour, at an elevation where aërial movements are but little retarded by terrestrial friction, may suffice to generate an ascending current; and elementary physical considerations teach us that a mass of air that would be called relatively dry at the lower level, will in ascending speedily become saturated and condense its surplus vapour, first as cloud, and eventually as rain, not indeed by acquiring more vapour, but in virtue of dynamic cooling as it progressively expands under the diminished pressure of greater altitudes. But unless the atmospheric strata thus immediately affected be already in a condition of unstable equilibrium, unless the vertical decrease of temperature in these strata is already somewhat greater than the adiabatic rate of decrement, so that the ascending movement once started can be maintained by the store of energy already present in the form of sensible temperature and the latent heat of the included vapour, the effect must of necessity be temporary and local—more of the nature of a small thunder-storm, or cloud-burst, than of the widely extended or sporadic rainfall that accompanies a barometric depression.

In fact, the possibility of rainfall production depends on the possibility of producing and maintaining an upward movement in the atmosphere. There is always some vapour present in the air, generally sufficient to form clouds when dynamically cooled by an ascent through two or three thousand feet; although such air, while resting on the ground and warmed by its contact, may be very dry as judged by our feelings and by the evidence of the hygrometer. The amount of energy yielded by any moderate provision of oxyhydrogen balloons and dynamite is but infinitesimal in comparison with that already locked up in the atmosphere and its vapour, and which, under the circumstances above specified, viz. a vertical decrease of temperature exceeding a certain fixed rate, is available for maintaining a movement once set up; and the part played by the heated gases of such experiments as those now described can be little more than that of a trigger that releases a detent.

It seems highly probable that on August 18 the atmosphere was in this unstable condition. Even in the warm stratum resting on the ground, the humidity was 60 per cent. of saturation, clouds (indicating saturation) existed at some height, and rain began to fall almost immediately on the conclusion of the explosions. It may be noticed, too, that the time of day was that at which the barometer is lowest and the humidity highest in the cloud-forming stratum, although, in fine weather, lowest at the ground surface. In the absence, then, of any observations of the temperature and humidity of the strata primarily stirred up by the exploding balloons and dynamite, it seems likely that they were in a condition to maintain ascending currents once started, and even to communicate the disturbance to regions around.

On the 26th, the atmosphere was evidently in a much more inert condition, and four hours elapsed before rain fell, the disturbance being then apparently more local, and of the nature of a thunder-storm. However, with the meagre data as yet before us, it would be premature to attempt any critical discussion of the processes in operation.

It is needless to say that popular theorizing, on this as on most other physical phenomena, concerns itself chiefly with the things that are most obvious to the senses, but often have little or nothing to do with the process. Thus we find that attention has been fixed on the explosion; and we are told that the idea of breaking clouds by producing a motion in the air, and so destroying the equilibrium of the suspended globules of moisture, which in coalescence form rain, is not a new one; that it was the custom to keep a cannon in French villages, with which to fire at passing clouds and thus hasten the downpour; that at the battles of Dresden and Waterloo the concussion of the air by the cannonade led to the descent of torrential showers; and we are reminded that "in the same way" rain follows a peal of thunder caused by the passage of a lightning-flash through a moisture-laden atmosphere, &c. Now, all this noise and disturbance have no more to do with the production of rainfall than has the thrashing which the village rain-maker of Central India receives from his fellow villagers to stimulate him to fresh exertions when he is thought to have neglected the performance of his official duties, or the London street-boy's whistle, with which Sir Samuel Baker startled a rain-making king in the Southern Soudan, and which was followed by such a deluge that even the rain-making potentate implored him to arrest the working of the spell.[1] The effect of a concussion, as such, is to produce an instantaneous compression of the air, and a momentary heating in a wave which travels away at the rate of about 1000 feet per second, and is incapable of generating any translational movement of the atmosphere, and certainly of promoting condensation. Nor do we know of any recorded observations in support of the idea that it can cause the coalescence of cloud corpuscles into raindrops. Neither does the concussion of the air by a thunder-clap stand to the downpour that follows it in the physical relation of cause to effect. In this case Sir John Herschel adopts the opinion originally put forward by Eeles, that the order of succession is the reverse of that here assumed, that the formation of the rain-drop is the antecedent phenomenon, and the lightning-flash (and *ergo* the thunder) the consequent; the electrical discharge being determined by the sudden concentration of the electricity of (say) one thousand corpuscles on the surface of the single resulting rain-drop, in which case its intensity would be increased ten-fold. What causes the coalescence is still a matter of much obscurity, though some light has been thrown upon it by the ingenious experiment exhibited by Mr. Shelford Bidwell at the Royal Society's *conversazione* on May 14, 1890, and described in vol. xlii. (p. 91) of this journal. When the shadow of a small (condensing) steam jet was thrown upon a white screen, under ordinary conditions, it was of feeble intensity and of a neutral tint; but when the jet was electrified, the density of the shadow was at once greatly increased, and it assumed a peculiar orange-brown tint. It appeared that electrification promoted the coalescence of the exceedingly minute particles of water contained in the jet, thus forming drops large enough to obstruct the more refrangible rays of light. On this view, then, electrification would appear to be the cause of coalescence, and the electrical discharge the ulterior result; but as yet we know too little of the

[1] This story has probably been told by Sir Samuel in one of his well-known works on Africa, and is too good to be spoilt by condensation. It is, at all events, authentic, the present writer having heard it from his own lips at a Simla dinner-table.

molecular processes concerned in the formation of a raindrop to attempt anything like a complete theory.

In conclusion, while we cannot but recognize the high interest of General Dyrenfurth's results, with the imperfect information at present before us we cannot regard them as conclusive. It is the characteristic weakness of all experiments of the kind that many of the essential circumstances are scarcely ever recorded, or perhaps even capable of being brought within the limits of observation: and thus the logical conditions of a proved conclusion cannot be fulfilled. For instance, it is very unlikely that anything is known of the state of the atmosphere in respect of its humidity and its vertical temperature decrement at the elevation at which the balloons were exploded, and yet, as we have seen, these data lie at the very root of the whole matter. However, arrangements are being made for further operations at El Paso and in Western Kansas, so that it will not be long before the highly interesting and practically important problem of stimulating the precipitation of rain will receive a more satisfactory solution.

H. F. B.

NOTES.

THE Permanent Committee of the International Committee of Weights and Measures is now holding its meeting at Sèvres, near Paris. The Committee includes: Dr. Foerster (Germany); M. J. Bertrand (France); Dr. Benoît, Director of the Bureau at Sèvres; Mr. H. J. Chaney (Great Britain); Prof. Govi (Italy); Prof. Krusper (Hungary); Prof. Lang (Austria); Mr. H. de Macedo (Portugal); M. Stas (Belgium); Prof. Thalen (Sweden); Dr. Wild (Russia). The Committee has recently lost its President (General Ibañez); and one of the objects of the present meeting is to elect a new President; an election which will doubtless fall on the senior member of the Committee, Dr. Foerster.

THE members of the Heilprin Expedition, who have lately returned from the west coast of Greenland, give an extremely unfavourable account of the position in which they were obliged to leave Lieutenant Peary. His leg was broken in Melville Bay on July 11. Dr. Hughes, who has recorded in the Philadelphia *Press* the adventures of the Expedition, describes how the accident happened. "While we were going astern for the last time," he says, "to make the butt that forced us through a barrier of ice into comparatively clear water, Lieutenant Peary stepped behind the wheel-house to see how things were going. With a crash the rudder struck a piece of ice, and the next instant his leg was crushed between the rudder gearing and the side of the wheel-house. He was carried below into the cabin, when an examination showed that his right leg was broken square across just above the knee. Everything possible was done for him." When he had recovered from the shock, and had thought the matter over, he decided to go on to Whale Sound, trusting that by next spring his leg would be so far mended that he would be able to accomplish the object of his expedition. His friends thought it would be better for him to return, but they could not help admiring his spirit, and resolved to do everything in their power to further his aim. The shores of Whale Sound proved to be completely blocked with ice, so the *Kite* steamed north to McCormick Bay, on the northern shore of Murchison Sound, which they reached on July 25. Here a space of about two miles was comparatively clear; and Lieutenant Peary's men went ashore, and reported that the place was well suited for their head-quarters. A site was selected on the south shore of McCormick Bay, in latitude 77° 43′, and a wooden house erected, which Lieutenant Peary declared to be "substantial and warm enough." On July 30 the Heilprin party had to leave him, which they did with sad forebodings. Mrs. Peary bravely insisted on remaining with her husband, and they have six companions. The Lieutenant hopes to start in the spring for the unexplored interior of Greenland, but Dr. Hughes says: "It is the deliberate opinion of all our party—and this opinion is indorsed fully by all the officers of the *Kite*—that unless a relief expedition be sent to Lieutenant Peary next summer, he and his party will never be seen again alive." It is doubtful whether the food supply is sufficient; and it is thought most improbable that whalers will take them away next summer. In that case their only resource would be the whale boats, in which they would have to traverse 500 miles of ocean "filled with floes and bergs, and often shrouded with fog or swept by terrible storms."

AN earthquake of great violence caused immense damage in the Republic of San Salvador on September 9. According to reports sent from the capital of the country to the *New York Herald*, there had been indications for several days that a seismic disturbance of more than usual power might be expected. The volcanoes of San Salvador, San Miguel, and Izalco had been unusually active, and deep subterranean rumblings with slight earth tremors had been felt. At 1.55 a.m., on September 9, the earthquake began in the city of San Salvador with a slight tremor, which gradually augmented. The duration of the first shock was ten seconds, during which time a frightful subterranean noise was audible in every part of the city. While the shock lasted, the earth rose and fell in long waves, and even strong men were unable to keep their feet. The walls of houses cracked, and then tottered and fell. In the capital alone 40 persons were killed, and 50 or 60 seriously injured. The experience of towns in the country seems to have been still worse. Of 320 houses at Comasagua only eight remain standing, and the loss of life there was great. Analquito has also been almost completely destroyed, and Cojutepeque, Santa Tecla, San Pedro, and Masahuet were so badly shaken as to be practically ruined. It is feared that the earthquake has been even more disastrous than those of 1854 and 1873.

IN the Isle of Fayal, among the Azores, several shocks of earthquake were felt on August 27 and 28.

MR. TUCKWELL writes to us from Loughrigg, Ambleside, that an aurora was seen there on Friday night, September 11. The arch spanned the heavens from south-west to north-east, passing nearly through the zenith. It was white, with slight coruscations at its south-west base. It was first seen at 9 p.m.: it had faded by 10 o'clock.

A NEW department of physics and electrical engineering will be begun this session at the new branch of the Manchester Technical School in Whitworth Street, where a large well-lighted warehouse is being fitted up for the purpose. The building will be lighted by electricity, the installation being fitted up with especial regard to instruction. For the latter purpose, the electric light installation in the Central School in Princess Street will also be available.

THE Library Association is holding its annual meeting this week at Nottingham. Mr. Robert Harrison, of the London Library, presides. The meeting began yesterday in the large theatre of the Nottingham University College.

THE Industrial Society of Mulhouse has issued a programme of prizes which it proposes to give for work done in the year 1891–92. A copy will be sent to anyone who applies for it to the Secretary of the Society. The prizes are very numerous,