On the whole the observations here reported confirm the conclusion that environmental conditions play an important part in the determination of the bodily form of the adult. It is obvious, therefore, that explanations that take into account only hereditary causes cannot satisfactorily account for the observed phenomena. This is particularly true of stature and weight, which appear extremely variable in the same lines of descent, according to the environmental conditions in which the individuals live.

THE POSSIBILITIES OF THE ROCKET IN WEATHER FORECASTING

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Most Desirable Conditions for Obtaining High Altitude Data for Weather Forecasting.—It is well understood that the pressure, temperature, wind velocity, and moisture content, which obtain at the top of the troposphere, i.e., at the 10 km. level, would be of much importance in weather forecasting; making possible the prediction of surface conditions many miles distant from the place of observation.

The data would obviously be of greatest value if obtained simultaneously at a number of separated stations. If this were done, an accurate weather map, representing conditions at a definite high elevation could be made, and compared with that representing surface conditions. Such a high altitude weather map would also be of obvious importance in aviation.

It is evident that the time of ascent should be as short as possible, not only in order that the data for the various stations should be obtained simultaneously, but also in order that drifting by the wind, and the consequent difficulty of recovery of the apparatus, be reduced to a minimum. The descent should also be as rapid as possible, for the same reasons, with proper arrangements to prevent damage on landing.

It would also be desirable, although not essential, that the instruments remain at, or near, the 10 km. level for from one to five minutes.

In short, then, the most desirable method of obtaining high altitude data for weather forecasting, would consist in the sending of instruments to the 10 km. level daily, from a number of stations, the ascent and descent being as rapid as practicable; provision further being made, if desirable, for maintaining the instruments at this level during an appreciable interval of time.

The Rocket Method as a Means of Realizing These Ideal Conditions.—Although the ordinary rocket has a vertical range of but a few hundred feet, the rocket should, in principle, be capable of reaching much greater altitudes.

A theory, together with estimates as to what should be attainable under realizable conditions, is given in *Smithsonian Miscellaneous Collections*, Vol. 71, No. 2. It is intuitively evident, however, that a great elevation must be obtainable provided a large part of the heat energy of the propellant is converted into kinetic energy of the ejected gases, and also provided the proportion of mass of propellant to total mass is high.

It should be understood that although theory indicates the possibility of reaching great altitudes, the application discussed in the present paper is solely the raising of recording instruments to a moderate height.

As regards the conditions to be satisfied by the most desirable method above outlined, other than the mere attainment of the altitude, the rocket method is ideally suited to the raising of apparatus rapidly and without jar, inasmuch as the propulsive force is sensibly constant, and, therefore, the apparatus, starting from rest, will rapidly attain a high velocity. After the propellant has been completely expelled, the apparatus will gradually be brought to rest by gravity. A parachute device, carried by the rocket, could permit of any desired speed of descent; the details of construction and operation being, of course, well understood.

Concerning the maintenance of high level for an appreciable interval of time, the rocket apparatus can contain, besides instruments and parachute, a rubber balloon of the usual size, compactly folded, together with a steel sphere containing compressed hydrogen, to be released into the balloon when the upper limit of flight has been reached, as suggested in principle by Dr. Abbot. The parachute would be brought into action, and the balloon released, a predetermined interval of time after the balloon had been inflated.

Extent to Which the Conditions Necessary for a Satisfactory Rocket Method have been Realized.—The first condition for increasing the range of the rocket apparatus is the ejection of the powder gases with as high a velocity as possible. This feature has already been developed to a satisfactory degree. The velocity of the ejected gases has been increased from 1000 ft./sec. to over 7,500 ft./sec.; or, expressed differently, the fraction of the heat energy of the powder that is transformed into energy of motion of the ejected gases has been increased from one-fiftieth to over a half; the propellant being a dense smokeless powder. It is important that the velocity of ejection be large, as it enters exponentially in the expression for the initial mass necessary to propel a rocket to any given height.

Regarding the second condition for a great range, namely, the employment of a large proportion of weight of propellant to total weight, it should be understood that this proportion need not be large for a range as low as 10 km. It is necessary to employ the principle of multiple charges, as explained in the above Smithsonian publication, if the proportion is to exceed the value for ordinary rockets, which is about $^1/_5$. This action consists in the loading and firing of a number of charges successively in the same combustion chamber.

The results of work upon this feature, to date, have been the development and experimental demonstration of a simple and light multiple charge apparatus, firing a few cartridges and travelling straight. In order to complete the development, it is necessary to adapt the apparatus to fire a large number of cartridges, and to make the parts, exclusive of propellant, sufficiently light. Work on increasing the number of cartridges is in progress.

In order to complete the development with a minimum of expense, the perfecting of details should be carried out only insofar as is necessary in order to produce an inexpensive apparatus. The only expense of maintenance will be a new magazine for each ascent.

In any case, the time required to reach the 10 km. level should be of the order of 20 seconds, if the retardation due to air resistance and gravity is minimized.

As an illustration of what should be possible with an apparatus developed in this way, it may be said that, using as a basis for the estimate a velocity of ejection of 5,500 ft./sec., which is easily obtained, a rocket weighing of the order of 11 lbs. initially and 6 lbs. at the highest point would be needed in order to send instruments weighing one pound to the 10 km. level.

NOTE ON A PNEUMATIC METHOD OF MEASURING VARIATIONS OF THE ACCELERATION OF GRAVITY[1]

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1. *Introductory.*—Some years ago I made an extended series of experiments[2] on the diffusion of gases through water; the gas in this work was imprisoned in a cartesian diver, and the very sensitive conditions under which the diver floats at a given level were made the criterion of measurement.

Inasmuch as such experiments consist virtually of a comparison of weights with the forces derived from air pressures, it must, therefore, be possible to obtain the acceleration of gravity in terms of these pressures, just as in another place I shall describe interferometer experiments made to evaluate the changes of g in terms of torsion. It will not, of course, be possible to determine g absolutely in this way because so little air is used; but it was hoped that the changes of g, in a proper environment would be determinable with some precision. Quite apart from this specific purpose, however, the long range experimental data are of varied interest.