

I am sure that it only needs a trial of the form indicated to prove its superiority in every respect for astronomical purposes. All objectors on the score of accuracy, &c., should refer to the *Annals* of the Harvard College Observatory, vol. i., part ii., pp. xxxiv., where they will find what seems a sufficient answer.

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THE LIMIT OF THE LIQUID STATE OF MATTER

THE conditions under which an investigation is carried out often predetermine the conclusions to be drawn from the observations made. That this has been the case with the observations made upon the upper confines of the liquid state, there is now ample evidence to show. When Cagniard de Latour, on heating liquids in sealed tubes, noticed the disappearance of the liquid surface, he came to the conclusion that the liquid state had ceased to be possible, and that the substance had passed into the gaseous state. But Latour had no means of varying the volume of his liquid to observe whether or not increase of pressure might again induce liquefaction. This defect was removed by Dr. Andrews, who constructed the well-known apparatus for varying the volume by means of a screw. And it is to the work performed with this apparatus that the above remark is applied. By two modes of observation Dr. Andrews arrived at the conclusion that the liquid and gaseous states of matter were continuous. The experiments being conducted in transparent glass tubes, the appearance of the contained fluid constituted one mode, and the registration of the pressure constituted the other. *Neither of these methods could by the necessities of the case give any aid in determining the state of matter.* Dr. Andrews's method of demonstrating the continuity, by passing from a lower to a higher temperature under a pressure which prevented the formation of vapour, ensured the homogeneity of the fluid under examination, and precluded the existence of a visible liquid surface; and as liquid and gas are equally transparent, no tidings of the state of the fluid under examination could come to him by observations of its appearance. How did Dr. Andrews tell when his tubes contained liquid? By lowering the pressure till a meniscus was seen. *Then the formation of a meniscus is the only test of the liquid state.* Dr. Andrews then obliterated the only ocular test of the fluid's condition by increasing the pressure, and raised the temperature till on again reducing the pressure no meniscus was formed, showing the fluid to be gaseous, and he then declared that no sudden change of state had occurred—that is to say, that it was impossible to say that the fluid was either liquid or gaseous, but that it had probably passed through an intermediate state. Of course a change of state had taken place, and if we only reflect that the change from cohesion to repulsion is caused by the thermal velocity of the molecules, and not by the number of them in a space, the change should depend upon temperature and not upon pressure.

The characteristic property of the liquid state is then the possession of cohesion sufficient to form a surface, or simply surface tension; and could this property be retained in a visible form at all pressures, the existence of the continuity enunciated by Andrews could be put to a crucial test. By compressing hydrogen over various liquids in which it is insoluble, I was enabled to carry the above proposition into effect, and after several hundreds of experiments, detailed in a paper read before the Royal Society, the conclusion was arrived at that the two states are not more continuous than are the solid and liquid states, but are separated by an isothermal passing through the critical point. In fact by Latour's or Andrews's method, where the liquid was in contact with its own

vapour, the critical point is the only place where the direct passage from liquid to gas is visible, but the employment of hydrogen for retaining a free surface enables us to observe the passage at any pressure, and it takes place as suddenly at 200 atmospheres pressure as at the critical pressure. Thus the critical point is the termination of an isothermal line, which is the limit of the liquid state.

As to the other mode employed by Andrews—namely, pressure—continuity of pressure does not prove continuity of state. If it did the continuity of the solid and liquid states could easily be proven. In fact, the irregularities observed by Andrews in the vicinity of the critical point rather lend support to the views that a change of state takes place there.

We may state the change thus:—The cohesion of the liquid state is weakened as the thermal motion increases, till the repulsion is in excess of the attraction, and the gaseous state ensues. The evidence I have collected from capillary phenomenon in the paper above referred to proves this to be the case, and shows that pressure has no effect in altering the occurrence of the phenomenon. Thus we are led to the conclusion, that so far from the liquid and gaseous states of matter being continuous and indistinguishable, the liquid limit or "absolute boiling point" is the only fixed point among the properties of matter. The freezing point can be altered by pressure, and besides, many bodies like ethyl alcohol may have no freezing point, probably becoming more and more viscous till absolute zero is reached. But all substances may be made to pass into the gaseous state, and even delicate compounds may be rendered gaseous without decomposition when under sufficient pressure. We see then that this important change of state, for which I propose the name Cohesion Limit, and which till lately was supposed to have no existence, is in reality the only fixed point in the relations of the states of matter, being determined by temperature alone.

J. B. HANNAY

INTERNATIONAL METEOROLOGY

THE second meeting of the International Meteorological Committee took place at Copenhagen, August 1-5 inclusive. All the Members were present, except Prof. Cantoni, who had resigned his seat on the Committee on account of health. Prof. Tacchini was unanimously elected in his place. The following brief account of the more important of their proceedings is in the numerical order in which the respective subjects were discussed:—

It was resolved—

(a) To organise an exhibition, in connection with the International Fisheries Exhibition, London, of the methods and apparatus used in different countries for giving weather intelligence and storm warnings to the coasts, and of the instruments, &c., used in the study of ocean meteorology.

(b) To issue a circular to all existing organisations, requesting them to supply data as to their condition and operations up to the end of the current year.

(c) To request the several institutions to be more precise in the information published by them as to the hour of occurrence of rain and other phenomena.

(d) To request all institutions to append to their Daily Bulletins, Monthly Sheets giving the mean results for the month, in the same way as the London Office has done since 1880.

(e) To request all institutions to furnish particulars of any stations which may exist in distant localities, especially in the Torrid Zone, South America, and the Islands of the Pacific, at least during the period of the International Polar Observations, and to publish the names of such stations in the Polar Bulletin issued by Prof. Wild.

(f) To express approval of the plan proposed by Capt. Hoffmeyer and Dr. Neumayer to publish daily synoptic

charts of the Atlantic Ocean, with an explanatory text, at the cost of the respective institutions of Copenhagen and Hamburg, and to recommend other institutions to contribute materials for the work, if they can.

(g) M. Tietgens, Chairman of the Great Northern Telegraph Company, submitted to the Committee a plan for a cable to connect Iceland and the Faroes with Europe, the expense to be met by the receipts from meteorological telegrams. The Committee, while recognizing the very great importance which information coming from Iceland and the Faroes must possess in relation to the issue of storm warnings and forecasts in Europe, felt that they were not in a position to express an opinion on the practical execution of the project.

(h) The Sub-Committee nominated at Berne (MM. Mascart and Wild) submitted specimens of their proposed International Reduction Tables. It was resolved to print a full page of each of these tables, with explanations, and submit them to meteorologists for their opinion, with the view of subsequently publishing the tables by means of subscriptions from the different institutes.

(i) M. van Rysselberghe's proposal to communicate by wire the indications of his instruments at out stations to central offices was considered, and that gentleman was requested to draw up and publish a detailed scheme for its execution.

(j) A Committee was nominated, consisting of M. de Brito Capello, Rev. Clement Ley, and Prof. Hildebrandsson, to draw up a scheme of instructions for the observations of "cirrus" clouds.

(k) It was resolved that the prospects of the preparation of a general catalogue of Meteorological Bibliography were not favourable to its execution, and that the only action for the Committee to take was to invite the heads of the different institutes to prepare catalogues of the meteorological literature of their respective countries.

The Members of the Committee were most hospitably entertained during their stay in Copenhagen. They were honoured with an invitation to dine with the King on the 5th inst., and on the following day an excursion was organised for them by the Marine Ministry to Friederichsborg and Elsinore, which was fortunately favoured with fine weather.

THE SMOKE ABATEMENT INSTITUTE

AT a meeting held at Grosvenor House, under the presidency of His Grace the Duke of Westminster, K.G., on July 14, at which the Reports of the recent Exhibitions in London and Manchester were presented, and the medals distributed to successful exhibitors, the following resolution was moved by Prof. Abel, C.B., F.R.S., seconded by Mr. J. Norman Lockyer, F.R.S., and carried unanimously:—

"That it is desirable that the work thus far carried on by the Smoke Abatement Committee be continued, and for that purpose a Smoke Abatement Institute be formed."

The chief objects of the proposed Association will be:—

(a) To promote the abatement of coal smoke and other noxious products of combustion in cities and other places, in order to render the atmosphere as pure and as pervious to sunlight as practicable.

(b) To check the present serious waste of coal, and the direct and indirect loss and damage accompanying the over-production of smoke and noxious products of combustion.

Extended powers will be taken for carrying out the objects of the Association by the following, among other means, viz. :—

1. By promoting and encouraging the better and more economical use of coal and coal products, the selection of suitable fuel, and the general improvement in producing, applying, and using heat and light for domestic and industrial purposes.

2. By conducting tests of smoke-preventing apparatus and fuels in manufacturing towns as well as in London.

3. By reporting on tests, granting awards for approved fuels, methods, or apparatus; by lectures, printing, publishing, and circulating statistics and other information for the guidance of local authorities, inventors, manufacturers, and others; and by giving instruction to workmen, servants and others in the use of new appliances, &c.

The terms of membership are one guinea per annum, or such larger sum as members may voluntarily choose to contribute. No liability will be incurred by becoming a member beyond a guarantee of one guinea, payable, if required, in the event of the termination of the Association; and any member can withdraw from the Association by giving notice of his wish to do so.

THE COLOURS OF FLOWERS, AS ILLUSTRATED BY THE BRITISH FLORA¹

IV.—Degeneration

THE cases already detailed lead us gradually up to the consideration of those very degenerate flowers whose structure has become completely debased, and especially of those which have green perianths instead of coloured corollas. As a rule, evolutionists have taken it for granted that green flowers were the earliest of any, and that from them the coloured types have been derived by insect selection. But if the principles laid down so far be correct, then it is obvious that, since all petals were originally yellow, green petals must be degraded, or at least altered types. Of course, the flowers of gymnosperms (in their blossoming stage) are mostly composed of green scales or leaves; and so it no doubt remains true that all flowers are ultimately descended from green, or greenish, ancestors. But if petals are by origin modified stamens, it will follow that all corollas at least were once coloured; and we shall probably see reason in the sequel to extend the principle to all perianths whatsoever. Without insisting upon the rule too dogmatically, so as to embrace every kind of angiosperm, we may, with some confidence, assert that wherever a flower possesses a rudiment of a perianth in any form, it is descended from coloured and entomophilous ancestors.

The Composites are, perhaps, in some respects, the very highest family of entomophilous flowers now existing on the earth. Their very structure implies the long and active co-operation of insect fertilisers. They could not otherwise have acquired the tubular form, the united corolla, the sheathed anthers, the compound heads of many-clustered florets. That originally green flowers could attain to this stage of development, and yet remain green, is simply inconceivable. But the Composites contain also some of the most degraded flower types in all nature. Beginning with such forms as the common groundsel (*Senecio vulgaris*), which has an inconspicuous yellow rayless head, specially adapted to self-fertilisation, we go on to plants like the *Artemisias*, with small greenish florets, which have taken, or are taking, to wind-fertilisation. Still more degraded are the *Antennarias*, *Gnaphaliums*, and *Filagos*, whose mode of fertilisation is problematical. And at the very bottom of the scale we get the little green *Xanthium*; so degenerate a form that its connection with the other Composites can only be traced by means of several intermediate exotics, in every stage of progressive degradation. Such conclusive examples clearly show us that green flowers may occur as products of degradation even in the most advanced families.

Adoxa moschatellina is another excellent specimen of a green corollifloral blossom. This pretty little plant is closely allied to the honeysuckles and ivies; but it has somehow acquired a light green corolla, in place of a white or pink one. It is still entomophilous, and scantily secretes honey, so that the reason of the change cannot be

¹ Continued from p. 350.