The Great Telescopes of the Future.[1]

FOR some ten years past visitors to the Observatory of Paris have found Dr. Ritchey installed on the top floor, working out his optical ideas. These ideas are the fruit of his long experience in the use and construction of telescopes, first at Yerkes and later at Mount Wilson. They are thus very mature, and unless we are to discard experience altogether, they deserve the most careful consideration.

The publication before us has been distributed by the great glass-making firm of St. Gobain. M. Delloye, the manager, to whom Dr. Ritchey pays many grateful acknowledgments, states that it arose from the wide interest excited by a presentation in Paris, by the Company, of Dr. Ritchey's celestial photographs. Accordingly, to make the presentation permanent, the company has issued half-tone reproductions of nineteen of the finest photographs, together with several others illustrating Dr. Ritchey's experience and projects. Most of the pictures are included in the excellent series of astronomical photographs which are available through the Royal Astronomical Society, and one gets the impression that they are familiar by their incorporation in various popular books. A careful scrutiny, however, shows that the present publication leaves far behind the best that has been produced before; and in that connexion it is germane to recall that *all* the best photographs of stellar and nebular fields were made by Ritchey, and the most sensational of them were made by telescopes the chief parts of which, both optical and mechanical, he had made, and in many cases had devised also. On revision of that sentence one may add Barnard's name, but no other. This should not be forgotten in considering the outlook for the future.

The text of this brochure has been written in English, and translated into French, somewhat carelessly. Both versions appear side by side. In no case is the French an improvement upon the author's careful wording. In one case the French text achieves the exact opposite of the English, as when " Nous avancerous ainsi lentement, mais sûrement " does duty for " We shall thus advance by *long*, *sure* steps ". What is of interest, in addition to these epoch-making photographs, is an outline of Ritchey's view of the right construction for the great telescopes of the future. Those who wish for a fuller account of the same will find it in the *Transactions of the Optical Society*, **29**, p. 197 (1928)—the Thomas Young Oration—where details, numbers, and references, here lacking, are given.

It is evident from this publication that Ritchey is still ardent and unwearied in the pursuit of more, and still more, perfect and powerful optical means. That may seem an obvious thing to say. But improvements of means demand an ever stricter discipline in their use, and there is a good deal to be advanced for getting full service out of the instruments we possess. It is possible to spend so much time in preparation that nothing is left for achievement. But let that be the consolation of those who must be content with something less than the best. It is evident that if we are to penetrate further into space—and the remote, small objects are at least as significant as those we happen to be near—we must have greater power. Now few look for a greater refractor than about 40 inches. Even the 100-inch reflector is not likely to be surpassed without change of plan. But as readers of NATURE know from an article in the issue of Dec. 21, 1929, the California Institute of Technology has been furnished with the funds for a reflector of 200 inches, and the plans are already energetically advanced, by Dr. G. E. Hale, assisted by investigators of every type. In the conduct of these investigations no door has been closed in advance, and any location and any type of telescope may be adopted. But so far as they go, they seem to point to a repetition of the 100-inch as to mounting, and as to the mirror, a solid disc of fused silica, faced with fused quartz. The total weight of the moving parts is estimated at 500 tons. To intensify the light-gathering the focal ratio is to be unusually short, 3·3, and is to be shortened still further by an interposed lens which is also to correct the field for coma.

Everything depends upon a right choice, but it is scarcely the place of those outside the scheme to follow the decisions that must be made with anything except hearty good wishes for their success.

The design of a super-telescope to which Dr. Ritchey has been led, and which he has gradually developed, but varied very little, in a lifetime of study, is quite different, and in many ways it is bolder in its novelties. First of all he would not have a solid mirror, which for the 200-inch size must weigh 30 tons. He could build it up of a back- and a face-plate, separated by a honeycomb structure, also built of thin plates of the same composition. Weight could be reduced to one quarter, support could be made by flotation, or at the centre of gravity; air could be circulated throughout. A reduction in the weight of the mirror permits a proportionate reduction elsewhere. Intensification of light-gathering and correction for coma would be produced by 'figuring' from a Cassegrain model, on a plan devised by Prof. Chrétién and himself. The telescope building would be in the form of a tower, at the top of which would be a dome containing two flat mirrors of which one only rotated in the ideally simple cœlostat manner, and sent a vertical beam through the centre of the tower to the great mirror which lay fixed in a horizontal position. This construction permits immediate change of the secondary mirrors, thus multiplying the uses of the telescope. Not unimportant, the observer would also be in an easy position. There are many other details of technical interest, but they must be passed over here.

It is again scarcely useful to express or to form an opinion upon these proposals. What is impracticable to one pair of hands, may be perfectly successful in another. Most seems to depend upon the

[1] L'Evolution de l'astrophotographie et les grands télescopes de l'avenir (The Development of Astro-photography and the Great Telescopes of the Future). Par G. W. Ritchey. Publié sous les auspices de la Société Astronomique de France. Pp. 36+34 planches. (Paris.)

success of the built-up mirror. Cemented glass is usually reckoned a tricky construction, with a horrible aptitude for flying and tearing flakes off the face it is cemented to. As against this, Dr. Ritchey in 1911 and 1912 made two flats in this way, 20 inches in diameter, and they have since behaved beyond reproach. He figures in these publications the honeycomb part of a 60-inch mirror, and also a more advanced stage, but it does not appear to have ever been completed. If it is a question of funds, I submit that it would be well worth the while of those interested in the major problem, to see that that experiment, which has been carried so far, is tried out and not left inconclusive. R. A. S.

Denudation in the Punjab Hills.

THE denudation of mountain slopes, as a result of the ignorant clearance of forest under the combined activities of the lumberman, fire, and excessive grazing, and the resultant damage is not a new problem and has been previously referred to in NATURE. For centuries the Alps have furnished examples of the difficulties which governments have to contend with in combating the ignorance of the local population on the subject of the actual causes from which the trouble arises. Throughout the Mediterranean, large areas of bare hills form an object lesson of the same kind, whilst America provides the most recent examples of the inevitable results following wholesale destruction of the vegetation in hill and mountain areas through excessive logging, often followed by extensive fires, and over-grazing. A recent paper on "Denudation of the Punjab Hills" (*Ind. For. Records, Sylv. Series*, vol. 14, pt. 2; 1929), by Mr. B. O. Coventry, traces the history of denudation and its results in the province. Mr. Coventry is a conservator of forests and has been in the province since 1895. His treatment of this important matter and the conclusions he has arrived at merit careful attention.

The monograph commences with a consideration of the forest vegetation and evidence of denudation. The main topographical tracts are distinguished as (1) The Himalayan tract; (2) The Sub-Himalayan tract, comprising the lower hills up to about 3000 ft. and including the Salt Range on the west and the Siwaliks on the east, two outlying ranges of hills rising from the plains to about 3000 ft.; (3) The Plains.

The climate in these regions varies considerably, the rainfall being about 30 in. per annum near the foot of the hills to 5 in. or less in the south of the Plains. Mr. Coventry, in considering the denudation problem, divides the climatic or forest zones as follows: (1) *Plains*—Tropical zone (below 1000 ft.), zone of *Prosopis spicigera*. (2) *Sub-Himalaya*—Sub-Tropical Zone (1000 ft. to 3500 ft.), zone of *Acacia modesta* (forests in east differ from those in west). (3) *Himalaya*—(a) Sub-Temperate Zone (3500 ft. to 5500 ft.), zone of *Pinus longifolia*; (b) Lower Temperate Zone (5500 ft. to 7500 ft.), zone of *Pinus excelsa*; Upper Temperate Zone (7500 ft. to 9500 ft.), zone of *Abies Pindrow*; Sub-Alpine Zone (9500 ft. to 12,000 ft.), zone of *Betula utilis*; Alpine Zone (above 12,000 ft.), no tree growth.

It will be understood, as is invariably the case in mountainous regions, that aspect, exposure, and latitude modify the appearance of a species in a locality; and there is no clearly marked line of demarcation between two adjacent climatic zones though these are separated by what may be regarded as a 'neutral zone' where species of the two zones flourish equally well. Moreover, each of the above forest zones is not occupied by one type of forest alone, but different kinds of forest occur in the same zone, and the factors determining the distribution of the types are edaphic or soil factors. The species which will regenerate on dry soils are termed 'xerophytes', and those which require moist soils 'mesophytes'. These terms become important when it is considered that whereas a seedling may find the requisite soil conditions to enable it to become a well-established tree, its root system then going deep down in the soil, subsequent denudation may remove all the surface soil, thus preventing further seedlings developing on the area. Owing to this fact, as the author points out, and to the great age to which some species live, "it is not uncommon to find a forest of a particular species growing on a soil" or even on bare rock "which is quite different from the kind of soil it requires for its natural regeneration or upon which its distribution is dependent". A change from a xerophytes type of vegetation to a mesophytes type in the series is regarded as a case of 'progression', whilst the contrary is looked upon as a case of 'retrogression'. One part of Mr. Coventry's observations has been devoted to a study of the 'retrogressive' changes in the vegetation of the Punjab Hills. After discussing the forest vegetation in the different forest zones (for which the reader is referred to the monograph) the retrogressive changes in the different zones are summarised as follows:

The forests in each zone are generally undergoing retrogression. In the Sub-Tropical zone the climax formations of olive (*Olea cuspidata*) forests and other mesophytic types are changing to brushwood forests of *sanatha* (*Dodonaea viscosa*). In the Sub-Temperate zone the mesophytic and climax formations of oak are changing to *chir* pine (*P. longifolia*), and the *chir* pine forests are generally deteriorating in quality. In the Temperate zone climax formations of oak or other broad-leaved species are changing to blue pine (*P. excelsa*). In other words there is a general tendency for the climax and mesophytic types to change to more xerophytic types indicating a general change from moist to drier soil conditions. Although these conclusions have been arrived at from observations with regard to the vegetation chiefly on the Murree and Kahuta hills, they apply