the fact and the importance of that waste by cylinder-condensation which is only to-day becoming recognized as an essential element in the theory of the 'real' steam-engine of the engineer, as distinguished from the 'ideal' engine of the authors of the theory of thermodynamics, and which is recognized as imperatively demanding consideration, if that theory is to be made of practical use in engineering. Watt's discovery of this 'cylinder-condensation' led him to the invention of his separate condenser, and of the long-neglected but now familiar steam-jacket, — an attachment which was, for many years, only seen upon the Watt or Cornish engine, and was almost never used elsewhere. It has now come in with the compound engine, and is familiar to every engineer. Watt also found that this action placed an early limit to the gain derivable by expansion.

The work of Watt in the systematic experimental study of the steam-engine was not taken up by his successors in the profession until about the beginning of the present half-century, or a little later, when Hirn in France, and Isherwood and the navy department in this country, began the work which has now become classic. Defective as some of this earlier work may be by some regarded, it was of inestimable value; and Hirn, and his assistant and colleague, Hallauer, will never be forgotten as prominent among the pioneers in this all-important line of research. Mr. D. K. Clarke of Great Britain, one of the first of the new race of engineers, interested alike in theory and in experiment, familiar alike with the science and the practice of engineering, must be placed beside these investigators as having persistently called attention to the loss of energy revealed by them, and by his own investigation of the wastes occurring in the steam-cylinder of the locomotive. This work began, in his case, as long ago as 1855.

Hallauer was one of the first to recognize, and frankly to admit, the defects of the 'ideal' treatment of the theory of the steam-engine, and was as prompt in his acceptance of the inevitable as was his preceptor. As Hirn says, breaking away from the old system, his progress was rapid and satisfactory. Seizing with avidity experimentally determined facts, he held fast to the knowledge thus acquired, and demanded that theory should precisely conform to fact. His work upon the compound engine was especially fruitful; and his knowledge of theory, and his skill in its application, rendered his work at once available. He studied also the data given him by Widmann, relative to the performance of marine engines, and deduced, from his examination of the phenomena here revealed, the proper methods of increasing their efficiency. Uniting, in a rare degree, the practical sense with the intellectual cast of mind of the scientific man, he was able to make his work immediately and most effectively useful.

Referring to his personal character, Hirn describes him as possessing the most admirable qualities. Kindly, affectionate, modest, and yet intellectually great, Hallauer united with these prepossessing characteristics the most irrepressible energy and mental force. The last words in the eulogy by his friend Hirn are those of personal regard and of deepest affection.

Hallauer wrote many papers,[1] the first being an account of the method adopted by Hirn for determining the quality of steam by means of the calorimeter. The greater number were descriptive of his experimental investigations. He was an honorary member of the Société industrielle de Mulhouse, and of the American society of mechanical engineers, and was a member of the Société des ingénieurs civils de Paris. The writer wishes to add to the eulogy of Hirn, if it be possible to so add to it, this tribute of kind remembrance of one who, even were he not so distinguished a colleague in the professional fraternities, would none the less demand the most earnest expression of admiration, esteem, and respect.

Robert H. Thurston.

THE SYNOPTICAL FLORA OF NORTH AMERICA.

The second portion of Professor Gray's 'Synoptical flora of North America' has appeared, six years after the publication of the first part, which contained the gamopetalous orders following Compositae. The present instalment of this important work — the most important contribution (with the exception, perhaps, of the Genera plantarum of Bentham and Hooker) made in late years to systematic botany — treats of the plants of North America (exclusive of Mexico) belonging to the families which precede those elaborated in the previous volume, which took up the 'Flora' where it was left more than forty years ago, at the end of the second volume of Torrey and Gray's 'Flora.' The present publication is devoted to an elaboration of the families (Caprifoliaceae to Compositae) embraced in the second volume

[1] Published by Gauthier-Villars, Paris.

of the old 'Flora,' and is therefore in a certain sense a new edition of that work, although entirely recast and rewritten.

The present volume is of special importance and value. Its publication has long been looked for with impatience, and its pages will be examined with the deepest interest by all students of American botany. It contains the mature views of the most acute and profound student of the great and difficult order of Compositae, to which not less than one-eighth of all the flowering plants of North America must be referred, — an order, as represented on this continent, to the comprehension of which he has given his best efforts and unflagging industry for more than half a century, and which, it is safe to predict, no other botanist would ever have been able to so elucidate. The plants, belonging to 5 families, 274 genera, and 1,767 species, are characterized in this volume, which contains, exclusive of its very full index, 446 pages, of which all but about 50 are devoted to Compositae, with 237 genera and 1,610 species.

A brief and necessarily imperfect comparison of the families here elaborated, as represented in this country at the present time, with what was known of them when the second volume of Torrey and Gray's 'Flora' appeared, between 1841 and 1843, will show the extent and character of the work which has occupied Professor Gray of late years, and the importance of the service which he has performed, as well as the zeal and industry of the botanical travellers and explorers who have long been busy, under his general direction, in all parts of the country.

Adoxa, transferred from Araliaceae, now appears, represented by its single widely distributed species, among Caprifoliaceae. Additions to Sambucus are S. melanocarpa (of the northern Rocky Mountains) and S. Mexicana (a Mexican species of the boundary and of southern California). The Texas station, near San Antonio, of this tree, is not given. In Viburnum, V. densiflorum — a southern species, as Professor Gray remarks, too near V. aurifolium — is admitted. Symphoricarpus, a North-American genus, is increased by a new, long-flowered section with three species, of the south-western mountains: Lonicera conjugialis of the Sierra forests of California, and L. Utahensis of the northern Rocky Mountains and Utah, are additions to that genus which shows besides many important changes in the rank and position of various species. Important changes appear in Rubiaceae. Loganieae, which appeared in the old 'Flora' as a tribe of this order, is now placed as a family between Asclepiadaceae and Gentianaceae, in the preceding volume. Borreria is reduced to Spermacoce; and Hedyotis is split up among Houstonia, Oldenlandia, and Pentodon. Besides these changes, eight genera not in the old 'Flora' are represented by plants, mostly of West-Indian or Mexican origin, which recent explorations have brought to light in southern Florida and along the Mexican boundary. Kelloggia, a monotypical genus of the Pacific slope, commemorates the botanical labors and zeal of Dr. Albert Kellogg, one of the early explorers of California botany. The large genus Galium is increased from eighteen to thirty-seven species.

In Valerianaceae, Plectritis and Fedia are merged in Valerianella, while the species of Valeriana are increased from six to eight.

The extension and changes in Compositae during the last forty years, as was to have been expected in a family so largely represented in our flora, and of such wide and general distribution, far exceed, in number and importance, the changes in the smaller orders alluded to above.

This order, as represented in North America at the time of the publication of the old 'Flora,' was grouped in eight tribes: in the new elaboration, representatives of eleven tribes appear. It now contains representatives of 237 genera and 1,610 species; while forty years ago there were, within the limits of the region embraced by Torrey and Gray's publication, only 199 genera and 1,011 species. Of the large genera, Aster, which Dr. Gray remarks "is far the most difficult of our genera, both from the settlement of the names of the species and from their limitation, in respect to which little satisfaction has been obtained as the result of long and repeated studies," heads the list with 124 species, — seven less than the author's elaboration of this genus for the old 'Flora.'

This diminution of species is due to the fact that several of the Linnaean species have been dropped, from one cause or another, and because Aster, largely a genus of eastern America, has not received many additions through western explorations. The same remarks are true, too, of Solidago, our second largest genus of Compositae, now represented in our flora by 74 species, although not less than 94 were admitted in the old 'Flora.' Some species have been dropped entirely, and others reduced to varieties; while few new additions to the genus have been made. Erigeron, on the contrary, has been nearly doubled, increasing from

40 to 71 species. Bigelovia, which fifty years ago had a single representative in the Atlantic states, now, as extended, contains 19 species, with its centre of distribution beyond the Rocky Mountains; whence, of late years, have come, of course, the principal additions to our flora. Similar comparisons might be made indefinitely between the composition of our flora as now understood and that of the earlier part of the century, were such comparisons necessary to illustrate the importance of the work under consideration, or to impress upon our readers the sense of our obligations to its author. Were it necessary or proper to say any thing at this time in regard to the part played by Professor Gray in the development of botanical science in this country, it would only be necessary to point to the fact, that, of the North-American Compositae as enumerated in this volume, more than 600 species and 30 genera have been characterized and enrolled by him since the publication of his previous study of the order. Twenty-eight species are first described in this volume.

The present volume, like its predecessor, will be found a model of comprehensive arrangement, and neat, concise, and clear expression. Unlike its predecessor, it bears upon the titlepage, in addition to the names of Professor Gray's New-York, London, and Leipzig publishers, "Published by the Smithsonian institution, Washington," where copies, no doubt, can be obtained, as well as from the author at Cambridge.

THE LANGUAGES OF AFRICA.

A sketch of the modern languages of Africa; accompanied by a language-map. By ROBERT NEEDHAM CUST. London, *Trübner*, 1883. 2 vols. 16+566 p. 8°.

THE Caucasus is styled in the east, from the variety of idioms spoken by the many tribes that are harbored in its recesses, the 'Mountain of languages.' This variety, remarkable as it is, becomes insignificant when compared with that which exists in Africa, which might well be called the 'Continent of languages.' In these volumes of Mr. Cust, we read of no less than five hundred and ninety-one distinct idioms, of which four hundred and thirty-eight are classed as languages, and a hundred and fifty-three as dialects. And even this does not complete the list; for there are several unexplored regions, of whose tribes and languages nothing certain is known.

A closer scrutiny, however, lessens the marvel materially. Of the idioms enumerated, no less than two hundred and forty-eight belong to that portion of the continent which lies south of the equator. All these idioms, as is well known, compose only two linguistic stocks, — the great Bantu family, which occupies the whole of the wide territory explored by Livingstone and Stanley; and the Hottentot-Bushman family, comprising the tribes of dwarfish people who seem to have been the aboriginal inhabitants of South Africa. The Bantu nations now speak, according to Mr. Cust, two hundred and twenty-three languages and dialects. But as philologists have no doubt that all the idioms of the Indo-European stock are the offspring of a primitive mother-tongue, which was at one time spoken by a single tribe, and earlier still by a single household, so we may feel assured that all the languages of the Bantu family have their origin in the speech of a single clan.

There was reason to hope that in Mr. Cust's elaborate work we should find this process of reduction continued, and the vast variety of African tongues brought into the manageable compass of a comparatively few linguistic stocks. This expectation, unfortunately, is not fulfilled. Mr. Cust has chosen to adopt the classification of the eminent ethnologist, Prof. F. Müller, who arranges the languages (or, more properly speaking, the tribes) of Africa in six main divisions, — Semitic, Hamitic, Nuba-Fulah, Negro, Bantu, and Hottentot-Bushman. This arrangement, however, was proposed by the distinguished Viennese professor, not for linguistic, but mainly for ethnological, or rather anthropological, reasons. Only three of these divisions — the Semitic, the Bantu, and the Hottentot-Bushman — are true families. The other three divisions are styled by Mr. Cust, 'groups,' — a word which in comparative philology has, at least as here employed, no scientific meaning whatever. The connection of the tribes composing these groups is not even geographical: it depends merely upon some physical resemblances; and these, it may be affirmed, are not nearly so strong as those which exist between the Hungarians, the Germans, and the Basques, whom no philologist would think of classing together. In fact, the word 'group' in this case is simply, as Mr. Cust frankly admits, a confession of ignorance.

The ignorance which is thus confessed is, on the author's part, to a large extent voluntary. With the immense mass of linguistic materials which he has collected, and which far surpasses all that earlier inquirers have been able to accumulate, nothing would have been more easy