MATHEMATICS IN AUSTRALIA.

The Teaching of Mathematics in Australia. Report presented to the International Commission on the Teaching of Mathematics. By H. S. CARSLAW. Sydney, Angus and Robertson, 1914. (Agents: Oxford University Press, London and New York.) 8vo. 79 pp.

DURING the deliberations of the International Congress of Mathematicians at Rome in 1908, the necessary steps were taken to organize an International Commission on the Teaching of Mathematics, the members of which were to prepare or procure reports on the teaching of mathematics in different countries. Many of these reports were ready for the Cambridge Congress in 1912, but since then several more have appeared. At this writing, 18 countries have published 172 reports with a grand total of 11,186 pages. Germany has already issued 46 reports with nearly 4,000 pages; the tale is told in about a fifth of this space, each, by Austria with 13 reports, Great Britain with 34 reports, Switzerland with 9 reports, and Japan with 2 volumes. The reports of France and the United States each cover some 700 pages. Of more modest dimensions are, in order of size, the reports from Belgium, Russia (including Finland), Italy, Sweden, Spain, Holland, Hungary, Denmark; then we have the present report from Australia and the 16-page report from Roumania.

Professor Carslaw's name is already a familiar one to many readers of the BULLETIN, from his elementary texts,* his notable work on the theory of Fourier series and integrals† and his translation of Bonola's Non-Euclidean Geometry.‡

* Plane Trigonometry, an elementary text-book for the higher classes of secondary schools and for colleges. London, 1909. New edition, London, 1915. Key, London, 1914. An Introduction to the Infinitesimal Calculus. Notes for the use of science and engineering students. London, 1905. Second edition, 1912. Reviewed by A. M. Kenyon in this BULLETIN, January, 1914, vol. 20, pp. 204–206.

† Introduction to the Theory of Fourier's Series and Integrals and the Mathematical Theory of the Conduction of Heat. London, 1906. Reviewed by J. E. Wright, in this BULLETIN, January, 1909, vol. 15, pp. 196–197.

‡ Non-Euclidean Geometry. A critical and historical study of its development by Robert Bonola. Authorized English translation with additional appendices by H. S. Carslaw with Introduction by F. Enriques. Chicago, 1912. Reviewed by A. Ranum in this BULLETIN, October, 1912, vol. 19, pp. 22–23.

Now we have from his pen a clear cut and interesting statement concerning the teaching of mathematics in Australia: in the secondary schools, the technical colleges and schools of mines, the government colleges for the training of teachers, the royal military and naval colleges, and the universities.*

Australia is politically divided into five states (New South Wales, Victoria, Queensland, South Australia, Western Australia) which with the Island of Tasmania form what has been known since 1901 as the commonwealth of Australia. At each of the six capitals, Sydney, Melbourne, Brisbane, Adelaide, Perth, and Hobart, a university supported in part by public funds and in part by private endowments and fees paid by students is established. And while the educational conditions vary greatly in the different states, and not a little in the same state, the universities whatever their status are the "crown of the educational system of which they form a part." The conditions in New South Wales and Victoria, states each with a population of more than one and one half millions and universities founded well over half a century ago, are greatly superior to those in the enormous state of Western Australia with its scattered population of less than 300,000 people and a university which has been in operation little more than a year.

A marked peculiarity of Australian education is that the state "not only controls, but completely and absolutely supports and regulates the system of public education without support from or interference by the localities in which the schools may lie. Australian education tends therefore to be centralized, systematic, and homogeneous; but since local interest is naturally fitful, the external equipment of the schools is usually of an inferior character, while the qualifications of the teachers are distinctly superior. Primary education throughout Australia is free, but secondary is not. The state secondary schools are fewer and somewhat less important than those of a semi-public, endowed, or denominational character."

The organization of secondary education in Australia is passing through a period of active development. But until

* Two other recent publications contain a good deal of information about Australian universities: (1) Universities in the Overseas Dominions. Board of Education, Special Reports on Educational Subjects, vol. 25. London, 1912, pp. 116–171, 196–198, 238–269; (2) Congress of the Universities of the British Empire, 1912. Report of Proceedings, London, 1912; also the Year Books for 1914 and 1915.

very recently the chief influence upon the work of the secondary schools has been exerted by the universities, not only through their requirements of matriculation, but also by a system of public examinations taken by pupils of the schools whether they proposed to enter the universities or not. These examinations are similar to the Cambridge and Oxford local examinations. For definiteness let us consider mathematics in New South Wales.

In New South Wales an "intermediate certificate" is given after the successful completion of two years' work (when the pupil is about 16) in the high school. The mathematical course includes arithmetic, mensuration of plane and solid figures, simple numerical trigonometry of the right angled triangle, algebra through simultaneous quadratics, graphs, and Euclid's Elements, Books 1–3.

The third and fourth years' work in the high schools are divided into pass and honor sections and lead to the "leaving certificate." Practically all pupils have to do some mathematical work in these two years, but only those who have shown special aptitude for this study attempt the full course. Indeed, some take only part of the pass course, but all who desire leaving certificates to count as equivalent to university matriculation have to satisfy the examiners in one of the two pass mathematical papers, and thus have to reach a certain standard in algebra, geometry, and trigonometry. There are three higher papers yet, in mathematics: one devoted to geometry and trigonometry; another to algebra, coordinate geometry, and the elements of the differential calculus; and the third to mechanics.

The pass work in algebra includes the following subjects: Logarithms, interest and annuities, graphical illustrations of maxima and minima, binomial theorem for a positive integral index; the additional work for honors includes such subjects as convergence of series, binomial theorem for fractional and negative index, the exponential and logarithmic series, coordinate geometry of the straight line and circle, and a short introduction to the differential calculus.

In geometry the pass work includes the equivalent of Euclid's Elements, Books 4–6; for honors the additional subjects are: Modern geometry, including transversals, nine-point circle, harmonic ranges and pencils, pole and polar, similitude and inversion; solid geometry as in Euclid's Elements, Book 11, together with theorems relating to the surfaces and volumes of the simpler solid bodies; geometrical conics, including the more important properties of the parabola and ellipse.

Pass trigonometry takes the pupil through the solution of triangles; the honor work includes a fuller treatment, as well as a discussion of DeMoivre's theorem and certain types of series.

Mechanics comes only as one of the higher papers in mathematics. It is intended to be preceded and accompanied by experimental work. The subjects treated are the elements of statics and dynamics, with elementary hydrostatics and atmospheric pressure.

For teachers in secondary schools, public or private, a university degree is an almost indispensable qualification; and not only this, but also special training in the theory and practice of education.

The Teachers' College in Sydney was founded in 1906, mainly for the training of state school teachers. It offers a variety of courses of training varying in length from six months to four years. An ordinary college course—to enter upon which the student must have the leaving certificate or its equivalent— is a two years' course, which qualifies for teaching in the classes of the primary schools. For graduates of the university who wish to prepare as secondary school teachers a one-year course in practical and theoretical education is provided.

Of university mathematical courses which are open to our prospective high school teacher there are three classes, Mathematics I, II, III. Each is divided into three sections: Class A, Class B, and Class C. Candidates for the degree of B.A. or B.Sc. with honors attend the honors' section (Class A) in each year, although it is possible to reach the lowest grade of honors by specially good work in the second section (Class B) in the three years. Here are the programmes for Class A:

Mathematics I (first year): Algebra, geometry, trigonometry, statics and dynamics, analytical geometry of two dimensions, and the elements of the calculus. Those who enter this class are supposed to have honor leaving certificates.

Mathematics II (second year): Infinitesimal calculus, differential equations, spherical trigonometry, analytical statics, particle dynamics, and elementary rigid dynamics.

Mathematics III (third year): Analytical geometry of three dimensions, rigid dynamics, higher analysis, and some applied mathematical subject, e. g., hydrodynamics, sound, the theory of electricity and magnetism.

In addition to these courses a two-year course has recently been instituted in insurance mathematics.

Similar courses are offered in the University of Melbourne and the general educational conditions are very like those in New South Wales. As already remarked, the organization in other states is less advanced. The universities of Australia are staffed by British professors, and thus the mathematical work of the country is fashioned in conformity with much the same ideals as those held by the mother land. Professor Carslaw is at the University of Sydney. Professors Horace Lamb and W. H. Bragg were for many years teachers in the University of Adelaide.

There are several technical colleges in New South Wales, but the work in all of them is, to a great extent, of an elementary character. Higher technical education is available only in the engineering school and mining school of the university. It is hoped that effective cooperation between these schools and colleges may soon be brought about. Schools of mines flourish in Victoria and South Australia. At Victoria mathematical instruction is given in arithmetic, algebra, geometry, plane and spherical trigonometry, analytical geometry of conic sections, differential and integral calculus, and applied mechanics.

There are two institutions in Australia for the early training of the officers of the military and naval forces of the commonwealth, the Royal Australian Military College and the Royal Australian Naval College.

The former is modelled somewhat upon the lines of the United States Military Academy at West Point. Cadets enter at the age of sixteen to nineteen, and receive a training in both military and civil subjects. Mathematics is compulsory for entrance and occupies a prominent position in the first three of the four years of the college course. In the first year 216 hours are given to mathematical lectures and the subjects studied are algebra, geometry, trigonometry, elementary differential and integral calculus, elementary statics and dynamics. In the programme for each subject there is an obligatory and a voluntary section. For example, while a knowledge of the theory and practical use of logarithms and the use of the slide rule is obligatory, discussion of the exponential theorem of logarithmic series and the calculation of logarithms is optional.

In the second year the hours of instruction in mathematics are the same as in the first year. The subjects of study are: algebra (partial fractions, convergence and divergence of series, simple theorems in probability, etc.); geometry (solid; analytic discussion of straight line and circle; while the voluntary part includes parabola, ellipse and hyperbola); plane and spherical trigonometry (small angles, inverse functions, solution of trigonometrical equations, effect of small errors in surveying and on the trajectory of a bullet, solution of spherical triangles and applications to surveying and astronomy, etc.); astronomy (time, determination of latitude and longitude, correction of instrumental errors, Kepler's laws, etc.); calculus (the voluntary part includes maxima and minima of functions of two variables, approximate numerical evaluation of integrals); dynamics (the voluntary part includes application of the calculus to motion of a particle in a straight line and plane curve, effect of air resistance on a bullet, elementary cases of motion of a rigid body in one plane); statics (center of mass, numerical and graphical calculations relating to tackle, shears, derricks, etc., stresses in frameworks, stresses in a gun, forces in three dimensions, etc.); elementary hydrostatics and hydrodynamics.

In the third year 72 hours of instruction are given in mathematics. The subjects of study are infinitesimal calculus (approximate numerical evaluation of integrals, mean values, etc.); theory of errors; differential equations (ordinary equations of the first order and degree, linear equations, etc.); dynamics; statics.

After satisfactorily completing the four years' course in the college the cadets receive the rank of lieutenant and spend one year in England or India attached to British regiments. They then return to Australia to occupy positions in the permanent military forces. The number of cadets admitted each year is about 40, including 6 who come from New Zealand.

The Naval College was founded for the training of cadet midshipmen who should later join the Australian navy. The training is similar to that at Osborne or Dartmouth in England. Candidates must be thirteen years of age in the year in which they are examined for entrance. The full course lasts for four years and instruction is given in the following mathematical subjects:—arithmetic, algebra, geometry, plane and spherical trigonometry, analytical geometry, differential and integral calculus.

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A CORRECTION.

IN my paper on "Problem Collections in Calculus" in this BULLETIN, June, 1914, volume 20, page 488, line 13, delete "about a dozen signs are wrong and." An unusual form of the equations of an epicycloid led me to consider that in the derivation a slip had been made in sign which required several changes in later work. Since Professor Dingeldey has requested me to rectify my review in this particular, I gladly comply with his wish.

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SHORTER NOTICE.

Per la biografia di Giovanni Ceva. By GINO LORIA. Reprint from the *Rendiconti* of the Reale Istituto Lombardo di Scienze e Lettere. Pavia, 1915. 3 pp.

STUDENTS of geometry who may have looked into the history of the subject will be interested to know that Professor Gino Loria, of the University of Genoa, has recently been able to fix the date of birth and death of Giovanni Ceva, whose "De lineis rectis se invicem secantibus" appeared at Milan in 1678. Poggendorf gives no dates under the biography of Ceva, but Professor G. Vivanti in the second edition of "Il concetto d'infinitesimo e la sua applicazione alla matematica," in the *Giornale di matematiche,* volumes 38 and 39, quotes M. Pantaleoni as stating that Ceva died in 1734. As a matter of fact, Professor Loria shows, Ceva was born in December, 1647, and died in Mantua on May 13, 1734. It is also interesting to note that Ceva is described in the archives of Mantua as Matematico Cesareo e Commessario Generale dell' Acque di tutto lo Stato, and that he was buried in the Church of Santa Teresa de' Carmelitani Scalzi.

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