

13612
T.

A

THE
INTERNATIONAL SCIENTIFIC SERIES.

Each Book Complete in One Volume. Crown 8vo. cloth.



- I. **FORMS of WATER: a Familiar Exposition of the Origin and Phenomena of GLACIERS.** By J. TYNDALL, LL.D., F.R.S. With 25 Illustrations. Eighth Edition. 5s.
- II. **PHYSICS and POLITICS;** or, Thoughts on the Application of the Principles of 'Natural Selection' and 'Inheritance' to Political Society. By WALTER BAGEHOT. Seventh Edition. 4s.
- III. **FOODS.** By EDWARD SMITH, M.D., LL.B., F.R.S. With numerous Illustrations. Eighth Edition. 5s.
- IV. **MIND and BODY: the Theories of their Relation.** By ALEXANDER BAIN, LL.D. With Four Illustrations. Seventh Edition. 4s.
- V. **The STUDY of SOCIOLOGY.** By HERBERT SPENCER. Eleventh Edition. 5s.
- VI. **On the CONSERVATION of ENERGY.** By BALFOUR STEWART, M.A., LL.D., F.R.S. With 14 Illustrations. Sixth Edition. 5s.
- VII. **ANIMAL LOCOMOTION;** or, Walking, Swimming, and Flying. By J. B. PETTIGREW, M.D., F.R.S., &c. With 130 Illustrations. Third Edition. 5s.
- VIII. **RESPONSIBILITY in MENTAL DISEASE.** By HENRY MAUDSLEY, M.D. Fourth Edition. 5s.
- IX. **The NEW CHEMISTRY.** By Professor J. P. COOKE, of the Harvard University. With 21 Illustrations. Eighth Edition, remodelled and enlarged. 5s.
- X. **The SCIENCE of LAW.** By Professor SHELDON AMOS. Sixth Edition. 5s.
- XI. **ANIMAL MECHANISM: a Treatise on Terrestrial and Aërial Locomotion.** By Professor E. J. MAREY. With 117 Illustrations. Third Edition. 5s.

London: KEGAN PAUL, TRENCH, & CO., 1 Paternoster Square.

A

The International Scientific Series—continued.

- XII. **The DOCTRINE of DESCENT and DARWINISM.** By Professor OSCAR SCHMIDT (Strasburg University). With 26 Illustrations. Sixth Edition. 5s.
- XIII. **The HISTORY of the CONFLICT between RELIGION and SCIENCE.** By J. W. DRAPER, M.D., LL.D. Eighteenth Edition. 5s.
- XIV. **FUNGI: their Nature, Influences, Uses, &c.** By M. C. COOKE, M.A., LL.D. Edited by the Rev. M. J. BERKELEY, M.A., F.L.S. With numerous Illustrations. Third Edition. 5s.
- XV. **The CHEMICAL EFFECTS of LIGHT and PHOTOGRAPHY.** By Dr. HERMANN VOGEL (Polytechnic Academy of Berlin). Translation thoroughly revised. With 100 Illustrations. Fourth Edition. 5s.
- XVI. **The LIFE and GROWTH of LANGUAGE.** By WILLIAM DWIGHT WHITNEY. Fourth Edition. 5s.
- XVII. **MONEY and the MECHANISM of EXCHANGE.** By W. STANLEY JEVONS, M.A., F.R.S. Sixth Edition. 5s.
- XVIII. **The NATURE of LIGHT, with a General Account of PHYSICAL OPTICS.** By Dr. EUGENE LOMMEL. With 188 Illustrations and a Table of Spectra in Chromo-lithography. Third Edition. 5s.
- XIX. **ANIMAL PARASITES and MESSMATES.** By Monsieur VAN BENEDEN. With 88 Illustrations. Third Edition. 5s.
- XX. **FERMENTATION.** By Professor SCHÜTZENBERGER. With 28 Illustrations. Fourth Edition. 5s.
- XXI. **The FIVE SENSES of MAN.** By Professor BERNSTEIN. With 91 Illustrations. Fourth Edition. 5s.
- XXII. **The THEORY of SOUND in its RELATION to MUSIC.** By Professor PIETRO BLASERNA. With numerous Illustrations. Third Edition. 5s.
- XXIII. **STUDIES in SPECTRUM ANALYSIS.** By J. NORMAN LOCKYER, F.R.S. With Six Photographic Illustrations of Spectra, and numerous Engravings on Wood. Third Edition. 6s. 6d.

London: KEGAN PAUL, TRENCH, & CO., 1 Paternoster Square.

The International Scientific Series—continued.

- XXIV. **A HISTORY of the GROWTH of the STEAM ENGINE.** By Professor R. H. THURSTON. With numerous Illustrations. Third Edition. 6s. 6d.
- XXV. **EDUCATION as a SCIENCE.** By ALEXANDER BAIN, LL.D. Fifth Edition. 5s.
- XXVI. **The HUMAN SPECIES.** By Professor A. DE QUATREFAGES, Membre de l'Institut. Third Edition. 5s.
- XXVII. **MODERN CHROMATICS.** With Application to Art and Industry. By OGDEN N. ROOD. Second Edition. With 130 original Illustrations. 5s.
- XXVIII. **The CRAYFISH: an Introduction to the Study of Zoology.** By T. H. HUXLEY, F.R.S. Fourth Edition. With 82 Illustrations. 5s.
- XXIX. **The BRAIN as an ORGAN of MIND.** By H. CHARLTON BASTIAN, M.D. Third Edition. With 184 Illustrations. 5s.
- XXX. **The ATOMIC THEORY.** By Professor A. WURTZ. Translated by E. CLEMINSHAW, F.C.S. Fourth Edition. 5s.
- XXXI. **The NATURAL CONDITIONS of EXISTENCE as they affect Animal Life.** By KARL SEMPER. Third Edition. With 2 Maps and 106 Woodcuts. 5s.
- XXXII. **GENERAL PHYSIOLOGY of MUSCLES and NERVES.** By Prof. J. ROSENTHAL. Third Edition. With Illustrations. 5s.
- XXXIII. **SIGHT: an Exposition of the Principles of Monocular and Binocular Vision.** By JOSEPH LE CONTE, LL.D. Second Edition. With 132 Illustrations. 5s.
- XXXIV. **ILLUSIONS: a Psychological Study.** By JAMES SULLY. Second Edition. 5s.
- XXXV. **VOLCANOES: what they are and what they teach.** By JOHN W. JUDD, F.R.S. Third Edition. With 92 Illustrations. 5s.
- XXXVI. **SUICIDE: an Essay on Comparative Moral Statistics.** By Professor H. MORSELLI. Second Edition. 5s.
- XXXVII. **THE BRAIN AND ITS FUNCTIONS.** By J. LUYK, Physician to the Hospice de la Salpêtrière. With numerous Illustrations. Second Edition. 5s.

London: KEGAN PAUL, TRENCH, & CO., 1 Paternoster Square.

The International Scientific Series—continued.

- XXXVIII. **MYTH AND SCIENCE: an Essay.** By TITO VIGNOLI.
Second Edition. 5s.
- XXXIX. **THE SUN.** By C. A. YOUNG, Ph.D., LL.D. Second Edition.
With numerous Illustrations. 5s.
- XL. **ANTS, BEES, and WASPS.** A Record of Observations
on the Habits of the Social Hymenoptera. By Sir JOHN LUBBOCK,
Bart., M.P. Seventh Edition. With 5 Chromo-lithographic Plates, 5s.
- XLI. **ANIMAL INTELLIGENCE.** By GEORGE J. ROMANES,
LL.D., F.R.S. Third Edition. 5s.
- XLII. **The CONCEPTS and THEORIES of MODERN
PHYSICS.** By J. B. STALLO. Third Edition. 5s.
- XLIII. **DISEASES of MEMORY.** An Essay in the Positive
Psychology. By TH. RIBOT. Second Edition. 5s.
- XLIV. **MAN BEFORE METALS.** By N. JOLY, Correspondent
de l'Institut de France. Third Edition. 5s.
- XLV. **THE SCIENCE of POLITICS.** By Prof. SHELDON
AMOS. Third Edition. 5s.
- XLVI. **ELEMENTARY METEOROLOGY.** By ROBERT H.
SCOTT. Third Edition. 5s.
- XLVII. **THE ORGANS of SPEECH.** By GEORG HERMANN
VON MEYER. 5s.
- XLVIII. **FALLACIES.** A View of Logic from the Practical Side.
By ALFRED SIDGWICK. 5s.
- XLIX. **THE ORIGIN OF CULTIVATED PLANTS.** By
ALPHONSE DE CANDOLLE. 5s.
- L. **JELLY FISH, STAR FISH, AND SEA URCHINS.**
Being a Research on Primitive Nervous Systems. By G. J. ROMANES,
LL.D., F.R.S. 5s.
- LI. **THE COMMON SENSE OF THE EXACT
SCIENCES.** By the late WILLIAM KINGDON CLIFFORD. With 100
Figures. 5s.
- LII. **PHYSICAL EXPRESSION: its Modes and Principles.**
By FRANCIS WARNER, M.D., F.R.C.P. With 50 Illustrations. 5s.

THE
INTERNATIONAL SCIENTIFIC SERIES.

VOL. XXXIII.

London: KEGAN PAUL, TRENCH, & CO., 1 Paternoster Square.

152
278

SIGHT:

AN EXPOSITION OF THE PRINCIPLES
OF
MONOCULAR AND BINOCULAR VISION.

BY

JOSEPH LE CONTE, LL.D.

AUTHOR OF "ELEMENTS OF GEOLOGY," "RELIGION AND SCIENCE," AND PROFESSOR OF
GEOLOGY AND NATURAL HISTORY IN THE UNIVERSITY OF CALIFORNIA.

WITH NUMEROUS ILLUSTRATIONS.

SECOND EDITION.

LONDON:

KEGAN PAUL, TRENCH, & CO., 1 PATERNOSTER SQUARE.

1883.

P R E F A C E.

IN writing this treatise I have tried to make a book that would be intelligible and interesting to the thoughtful general reader, and at the same time profitable to even the most advanced specialist in this department. I find justification for the attempt in the fact that there is not, to my knowledge, any work covering the same ground in the English language. Vision has been treated either as a branch of optics or else as a branch of physiology of the nervous system. Helmholtz's great work on "Physiological Optics," of which there exist both a German and a French edition, is doubtless accessible to scientists, but this work is so technical that it is practically closed to all but the specialist. I believe, therefore, that the work which I now offer meets a real want, and fills a real gap in scientific literature.

The form in which the subject is here presented has been developed entirely independently, and as the result of a conscientious endeavor to make it clear to students under my instruction. As evidence of this, I would draw attention to the fact that, out of one hundred and thirty illustrations, only about twelve have