

Johann Kepler, 1571-1630.

THE great German astronomer and mathematician Johann Kepler, the tercentenary of whose death is being commemorated this year, was born at the little town of Wiel or Wielderstadt, not far from Stuttgart in Württemberg, on Dec. 27, 1571, and died at Ratisbon in Bavaria on Nov. 15, 1630, in his fifty-ninth year. A cenotaph to his memory was erected at Ratisbon in 1803, and commemoration celebrations will commence on Sept. 24 with an address before the memorial by Dr. von Dyck, of the Munich Technical High School.

Born at a time when his country was already torn by religious dissensions, Kepler lived to see it drenched with blood by one of the most disastrous of all wars. Altogether he lived under four Emperors, Maximilian II., Rudolph II., whose lack of capacity for government was in no way compensated for by his love of alchemy and astrology, Matthias II., anxious but unable to prevent the coming storm, and Ferdinand II., whose ingrained hatred of Protestantism led to a reign filled with persecution and strife. The Thirty Years' War had been in progress twelve years before Kepler died, but ere it had run its course the land had become a wilderness and in Kepler's native district of Württemberg it is said 58,000 families had disappeared, while the population had shrunk to one-sixth of its former numbers.

Save, however, that Kepler was a Protestant; that he once had to quit his chair on account of his religious views; that he became imperial mathematician to Rudolph; that he compiled the Rudolphine Tables, and that for many years he was dependent on the royal favour for his income, his life's work was little connected with the doings of Church or State. While princes and ecclesiastics schemed, quarrelled, and fought, Kepler steadily pursued his own course and by the exercise of his matchless intellect solved some of the problems which had baffled the greatest minds. Kepler's true contemporaries were such as Gilbert, Napier, Bacon, and Galileo rather than emperors and kings, and though students will long read of Wallenstein and of Gustavus Adolphus and pore over Schiller's famous history, Kepler's name is destined to be handed down to the remotest posterity.

If there was little in the character of the times favourable to scientific studies, neither was there in Kepler's parentage and environment anything conducive to the upbringing of a scholar. His parents, it is true, were of noble descent, but they were also in impoverished circumstances, a condition which perhaps had much to do with the unfortunate family differences. Kepler himself was a sickly seven-months' child and his boyhood was marked by serious illnesses. Yet for all that he was able to attend school at Adelberg and Maulbronn, and at the University of Tübingen in 1591 he gained his master's degree in theology. It was at Tübingen he also heard the German astronomer, Michael Maestlin (1550-1631), lecture on the theories of Copernicus. Theology by then had become of secondary importance to Kepler, and,

at the age of twenty-three, through the tolerance of the Archduke of Austria, although a Protestant, he was made professor of mathematics at Gratz in catholic Styria, and it was there he began brooding "with the whole energy of his mind on the subject, inquiring pertinaciously why the number, the size and the motion of the planetary orbits were not other than they are". How he published his hastily conceived explanations; how he was advised by Tycho Brahe to obtain a solid foundation for his views from actual observations; how he met Tycho at Prague and through him was made imperial mathematician, has often been told.

Tycho only lived a year after meeting Kepler, but their association has left its mark on the history of astronomy, and it was Tycho's observations which provided the material for Kepler's researches. Of the thirty or more works published by Kepler, two stand out as epoch-making, his "Astronomia Nova", published in Prague in 1609, and his "Harmonia Mundi", published at Linz in 1619. It was in the former—published, it may be remarked, the year that Galileo first used the telescope—that Kepler enunciated his first two laws, that the planets describe ellipses round the sun with the sun at a focus of each ellipse and that a line drawn from a planet to the sun sweeps over equal areas in equal times, while it was in the second work he gave the world his third law, that the squares of the periodic times are proportional to the cubes of the mean distances of the planets from the sun.

On Kepler's many other works, his commentary on Vitellus, his book on Dioptrics, a copy of which Newton used as an undergraduate, his writings on logarithms and his Rudolphine Tables it is unnecessary to dwell. Neither is it necessary to follow him to Linz, to Sagen, to Rostock, or to recall the domestic afflictions which befell him or the miserable tale of his constant impecuniosity due to emperors whose performances did not keep pace with their promises. Through foul weather and fair alike, Kepler continued constant to the one aim, the advancement of natural knowledge, and in so doing left a great heritage to the world.

In personal appearance Kepler, as we know from his own words, was lank, lean, and spare, and that "for observations his eye was dull and for mechanical operations his hand was awkward". His delicacy of constitution, no less than his weak eyes, was sufficient to prevent him becoming a great observer. He was as remarkable for the exuberance of his imagination as for his powers of thought and his untiring industry. With these he joined an open-mindedness and candour that led him not only to record his wildest fancies but also to emblazon his greatest errors. A staunch Protestant, pinning his faith to the Confession of Augsburg, he was sincerely religious, but averse to controversies. In other directions he declared himself as "troublesome and choleric in politics and domestic matters", yet with all his frankness he was probably an easy

man to live with. His singular action when after the death of his first wife he sought another is one of the most humorous of matrimonial adventures. At his request his friends sought for a suitable companion. Eleven ladies with strangely diverse qualifications were passed in review, and of them, after much vacillation, Kepler chose Susannah Reutlinger, the daughter of a cabinetmaker. Of her he wrote that she had an education worth the largest dowry. "Her person and manners are suitable to mine—no pride, no extravagance. She can bear to work; she has a tolerable knowledge how to manage a family; middle aged, and of a disposition and capability to acquire what she still wants." For fifteen years Susannah shared Kepler's joys and sorrows and difficulties, and she bore him seven children.

In his work Kepler found the fullest satisfaction, and a discovery elated him as much as it did Davy. In Kepler there was none of the cold, passionless calm we associate with Cavendish. Like a Luther, he regarded himself as an instrument of the Almighty, and his studies were interspersed with prayer. He had once written a small treatise on the Divine Wisdom as shown in the Creation, and

his subsequent works contain many passages of exaltation. When after seventeen years of searching he discovered the third of his laws his delight knew no bounds. "Nothing holds me", he said, "I will indulge in my sacred fury; I will triumph over mankind by the honest confession, that I have stolen the golden vases of the Egyptians, to build up a tabernacle for my God, far away from the confines of Egypt. If you forgive me, I rejoice; if you are angry, I can bear it. The die is cast; the book is written, to be read either now or by posterity—I care not which. It may well wait a century for a reader as God has waited six thousand years for an observer." Kepler's work, however, was appreciated immediately by his contemporaries, while of his discoveries the famous French physicist Arago once wrote: "Les lois de Kepler sont le fondement solide et inébranlable de l'astronomie moderne, la règle immuable et éternelle du déplacement des astres dans l'espace. La gloire de Kepler est écrite dans le ciel; les progrès de la science ne peuvent ni la diminuer ni l'obscurcir, et les planètes, par la succession toujours constante de leurs mouvements réguliers, la raconteront de siècle en siècle."

The Taxonomic Outlook in Zoology.*

By Dr. W. T. CALMAN, F.R.S.

THE anatomist, the physiologist, the field naturalist, the student of one or other of the innumerable specialisations of biological science, has always been inclined to regard with distaste, if not with contempt, the work of those whose business it is to denominate, classify, and catalogue the infinite variety of living things. The systematist is generally supposed to be a narrow specialist, concerned with the trivial and superficial distinctions between the members of some narrow group of organisms which he studies in the spirit of a stamp collector; happy when he can describe a new species, triumphant if he can find an excuse for giving a fresh name to an old one.

It would be idle to deny the truth that there is in these criticisms, just as it would be easy, although unprofitable, to point out that the substance of them might be directed against the practice of most other branches of research. The specialist, of whatever kind, has a tendency to mistake the means for the end, to become fascinated by technique, and to suffer from a myopia that blurs his vision of other fields than his own.

I think, however, that there are some signs of an increasing appreciation of the usefulness and even of the scientific value of taxonomy among the younger generation of zoologists. More particularly, those who are concerned with the applications of zoology to practical affairs are, for the most part, although not invariably, aware of the need for exact identification of the animals they deal with. They do not always realise the difficulties that may stand in the way of this identifica-

tion. It is a common experience with us at the Natural History Museum to have some mangled fragments of an animal brought in by a practical man, who expects to be supplied with the name of it while he waits. I am afraid that he often goes away with a low opinion of our competence.

It may not be without interest, therefore, if I attempt, in the first place, to give some idea of how matters stand with this part of the systematist's task, the identification and description of the species of living animals.

When Linnæus published in 1758 the first volume of the tenth edition of his "Systema Naturæ", he named and described about 4370 species of animals. If we ask how many are known to-day, the diversity of answers we get is some indication of the confusion that exists. Some years ago, at the request of the late Sir Arthur Shipley, I endeavoured to get from my colleagues at the Museum estimates of the numbers of species in the various groups with which they were specially conversant. Some of the answers obtained were very interesting. With regard to mammals I was told "anything from 3000 to 20,000, according to the view you take as to what constitutes a species". For the most part, however, the authorities consulted were unwilling to suggest even an approximate figure, for a very different reason. They told me that great sections of the groups with which they were concerned were so imperfectly surveyed that it was quite impossible even to guess how many of the supposed species that had been described would survive reconsideration.

It may be worth while to consider for a little the

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