

Hymenoptera, leading directly to the horn-tails and sawflies, while Permohymen (Fig. 3) and Asthenohymen must be regarded as specialised side branches.

The fossil evidence is now fairly strong that there were three distinct groups of holometabolous insects which evolved a pupal stage independently of one another early in the Permian period. These are (a) the Mecopteroid orders, namely, Mecoptera, Neuroptera, Paramecoptera, Paratrichoptera, Diptera, Trichoptera, Lepidoptera, and Siphonaptera; (b) the Hymenopteroid orders, Protohymenoptera and Hymenoptera; and (c) the Coleopteroid orders, Protocoleoptera, Coleoptera and their parasitic offshoot Strepsiptera. The only possible explanation of this appears to have been the marked change of climate which ushered in the Lower Permian. We must conceive that the pupal stage was a response to a new environment, the larva going underground and shortening the later nymphal instars into a single more complex change or metamorphosis.

In concluding this article, we must point out that the evidence as it stands at present points to a long history

for winged insects before the Upper Carboniferous, though no fossils have yet been found in the Pterygota older than these. For the Apterygota, or primitive wingless insects (orders Thysanura, Protura and Collembola), an even longer geological history must be demanded, probably taking them back to the Lower Devonian. We know nothing as yet of the most primitive type of insect wing, whether it evolved from a gill or from a paranotal expansion, nor do we know anything at all about the original type of wing-venation except that it was probably a very simple one, not complex as in the highly specialised Upper Carboniferous groups. The problematical remains recently described as jaws and palpi of insects from the Rhynie Beds (Old Red Sandstone of Scotland) may well have belonged to Thysanura, but only careful study of definitely well preserved specimens could finally determine this point.

REFERENCES.—“Mesozoic Insects of Queensland,” R. J. Tillyard, *Proceedings Linnean Soc. N.S.W.*, 1916-1924, 10 parts; various papers on fossils from the Belmont Beds by same author, *l.c.*, 1916-1926; Kansas Permian Insects, *American Journal of Science*, 9 parts, C. O. Dunbar and R. J. Tillyard, 1923-1926.

Obituary.

DR. J. T. BOTTOMLEY, F.R.S.

JAMES THOMSON BOTTOMLEY, who died in Glasgow on May 18, was born in Belfast on January 10, 1845. His father was William Bottomley, of Belfast, and his mother a sister of the late Lord Kelvin. He was educated at Queen's College, Belfast, and Trinity College, Dublin, where he had a distinguished career and was gold medallist at the degrees of B.A. and M.A. He started his scientific career by becoming assistant to Prof. Andrews at Belfast, afterwards a demonstrator of chemistry and physics in King's College, London, and in 1870 he came to the University of Glasgow to act as Arnott and Thomson demonstrator in the Department of Natural Philosophy, at the head of which was his uncle, Sir William Thomson. He held this position until 1899, when Lord Kelvin resigned from his professorship.

During these twenty-nine years Dr. Bottomley was continuously engaged in research work, and his researches covered a very extensive field, including liquefaction of gases, the use of liquid air for experiments on radiation at very low temperatures, the air thermometer, the bolometer, emissivity and conductivity of wires in vacuum, radiation from bright and black bodies, vacuum pumps, thermo-couples, modulus of elasticity, and the electrical properties of platinoid, etc. These papers were contributed mostly to the *Proceedings of the Royal Society*, and the Reports of the British Association. He published a book on theoretical mechanics in two parts, vol. 1 on dynamics, and vol. 2 on hydrostatics. But in this line he is best known as the author of “Four-Figure Mathematical Tables: Comprising Logarithmic and Trigonometric Tables, and Tables of Squares, Square Roots, and Reciprocals.”

As time went on, Sir William Thomson delegated a good deal of the lecturing to students to Mr. Bottomley. He belonged to a type not uncommon in our universities, of distinguished scholars and amiable gentle-

men, enthusiastic in their own department of study, and with every good desire in the world to help their students, but largely unable to impart their knowledge in the class-room. Uncle and nephew were both deficient in this respect, one being too advanced and abstruse for the average student, the other in being too ridiculously simple. He elaborated the obvious, sometimes painfully though unconsciously, wasting time striving to elucidate minor points which all understood. He did not seem able to state the salient points and pass on. Hence when he was getting on very well with his audience, often they would lose all patience with his meticulous niceties. When an emergency arose it appeared how difficult it is for the cloistered man of science to deal with a practical situation. Physics and psychology seemed to have no common ground. A sense of humour or power of repartee would heal the breach in a moment, but Dr. Bottomley was too serious for that and could not retaliate or change his mode of lecturing. Kelvin might bore the hilarious dawdlers quite as much, but they did not dare to take liberties with him.

As consulting engineer, Dr. Bottomley acted for the Scottish Asylums Board and for Nobels, Ltd. He had a regular electrical engineering consulting practice mostly concerned with lighting installations, such as Skibo Castle, Roxburgh Castle, etc. He joined the Institution of Electrical Engineers as an Associate in 1872 and was elected a member in 1889.

Dr. Bottomley became associated with the business of Kelvin, Bottomley and Baird when the firm was floated as a private limited company in 1900, and on the death of Lord Kelvin in 1907 he was appointed chairman, a position which he continued to fill until his death. In recognition of his distinction as a scientific worker and of his long and honourable connexion with the University of Glasgow, the degree of Doctor of Laws was conferred upon him in November 1904.

M. M.