

tended discussion of problems in hydraulics (flow in pipes and channels) is given (in which references to quite recent work are made). Then follows a good account of the Prandtl boundary layer theory and a discussion of resistance (Stokes' theory, Karman vortices, etc.). The theory of airfoils is amply treated (it being pleasant to see the credit given to Lanchester's pioneer work). The book closes with a chapter on experimental methods and apparatus and an appendix containing some sixty-eight photographs made by the author of various types of flow.

We strongly recommend this work to any student of practical hydrodynamics. As in the case of the companion volume, one interested mainly in the mathematical theory will have to look elsewhere.

F. D. MURNAGHAN

Les Calculs Formels des Séries de Factorielles. By J. Ser. Paris, Gauthier-Villars, 1933. vii+98 pp.

This book has to do with series, such as

$$f_0 - \sum_{n=1}^{\infty} f_n \frac{x(1-x) \cdots (n-1-x)}{1 \cdot 2 \cdots n},$$

arising in connection with the table of successive differences of the values of a function $f(x)$ for equally spaced values of x . A large number of transformations of these series, and of expansions of particular functions in the series, are given. The treatment is entirely formal, there being only a few passing remarks about questions of convergence. Nothing in the way of a theory is developed; the contents consist chiefly of a collection of special calculations.

Even when due allowance is made for the restrictions that have been imposed intentionally on the subject matter, the book remains rather unsatisfactory. As there is no index, and as the subdivisions of the chapters have no titles, it is difficult to use the book for reference purposes. In many places, because of the lack of full explanations, the meaning is obscure. There are no references to the literature, and there are many typographical errors.

L. A. MACCOLL

Le Mystère et le Paradoxe du Vol Animal. By Émile Batault. Paris, Gauthier-Villars, 1933. 14+236 pp.

Sur l'Excédent de Puissance des Oiseaux. By A. Magnan and A. Planiol. Paris, Hermann, 1933. 25 pp.

Sur l'Excédent de Puissance des Insectes. By A. Magnan and A. Planiol. Paris, Hermann, 1933. 26 pp.

It must have been from the flight of birds that man first conceived the ambition to fly. And it was natural to believe that the solution of the problem lay in the study and imitation of animal flight. The student of the history of science is familiar with the drawings that Leonardo da Vinci made of wing-like appliances for man's use. The difficulty in the problem was that of power. The perfection of the gasoline motor and the screw propeller gave an entirely new approach to the question. As a result the flight of airplanes and the flight of birds differ in fundamental ways, and in consequence the latter has lost some of its interest. As a natural phenomenon, however, the flight of birds is still

worthy of study, and there are many perplexing questions connected with it. The interest in the problem is not only mechanical, but also physiological.

The writer of the first book was a physician who for years was interested in the problem of animal flight. A mechanical aptitude, shown by various inventions, gave him the qualifications for appreciating both the mechanical and physiological aspect of the question he was studying. The author died before the appearance of the work, and the final proofs of the book were handled by his friend Henri Tripiier.

The first book starts with a historical account of the problem, beginning with Leonardo da Vinci, he being the first to have worked in a scientific manner. The author then proceeds to anatomical and physiological considerations. A first question is that of the relative muscular equipment of birds and men. Dr. Batault does not agree with the high estimates that some writers have placed on the power that birds develop. He believes that errors have been made by an inadmissible use of the quantity KSV^2 for calculating the resistance overcome. He believes that the muscles that man uses in walking are relatively as powerful as those a bird uses in flight. But he does find that the muscular systems of creatures that fly differ from those of other animals by the rapidity with which they act.

The author of the first book puts questions in a very definite way. For instance, in Chapter 4 we find the heading, "Que fait l'oiseau dans l'air pour s'y soutenir?" Here certainly is the kernel of the problem. Dr. Batault's view of the question is this. The rapid movement of the wing impounds a certain amount of air, which for a moment becomes a part of the flying mass considered. Then the downward movement of the wing being arrested, the air is expelled. The system loses part of its mass, and the reaction on the bird gives necessary sustentation. The sequence of actions described continues. "Comme partout où va l'oiseau, il est entouré d'air, il trouvera sur sa route un projectile gazeux à utiliser." The writer summarizes his description with the statement, "Et je crois toujours vrai que dans le vol: *tout se passe comme si l'oiseau perdait à chaque battement une partie de sa masse*, ce que je considérerais comme le clef du problème." But one can well ask how much this contributes after all to an understanding of the problem. Such a statement as, ". . . le vol animal depende d'impulsions musculaires, fréquentes, courtes et relativement très fortes," leaves one wondering how far the author thought the solution of the problem could be carried.

Different types of flight are considered in the first book, and in connection with each there is a critical analysis of the views of other writers. The work therefore gives far more than the author's own judgment. There is only a page or two of formal mathematics in the book, but there is a little use here and there of some of the basic formulas of air resistance. The later chapters give considerable numerical data concerning aerodynamic properties of the wings of different birds.

The last two books, which are small monographs, give the results, mainly by curves, of experiments made to determine the velocities and power developed by birds and insects. The apparatus employed, as shown by the photographs, is rather elaborate.

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