Seeley would ascribe to ancestral, fundamental impressions, and not to adaptation. The present writer believes that the elongation of the wing finger, the progressive weakening of the middle fingers and the peculiar shape of the first finger are all purely adaptive, together with the shape of the humerus, the peculiar form of the sternum, the anchylosis of bones, the shortening of tail and concomitant increase in length of the sacrum, the diminution and loss of the fibula, the loss of teeth, retreat of the nostrils, etc. The bone in the lizard commonly called the squamosal extends to, or nearly to, the brain surface in the mosasaurs. If the determination of the bone be right, this character loses its value as an avian index in the pterodactyls; if wrong, there is the same possibility in the pterodactyls. *Dimorphodon* had the fifth toe peculiarly modified for the sustentation of the patagial membrane. What good reason then has Professor Seeley for supposing that this specialization was lost in later forms; that the membrane was restricted to the sides of the body only? The rudimentary fifth toe in *Ornithostoma* was divergent. What use had it unless that of *Dimorphodon?* In bats the membrane extends to the ankle and over the tail. It is reasonable to suppose that such were its relations in all the pterodactyls, the later as well as the earlier.

Especially does the writer disagree with Professor Seeley in his opinion that the quadrupedal position of the body in ambulation was a normal one. He doubts very much whether the peculiar articulation of the humerus would permit such a position of the bones in some of the pterodactyls. And what use were the loosely attached middle fingers of some pterodactyls as ambulatory organs? In a specimen of *Ornithostoma* recently acquired by the University of Kansas, the small fingers are in position, from which it is evident that they could not have been brought to the surface of the ground in a state of pronation. Nor does it seem reasonable that the animals walked upon the knuckles of the fifth fingers. In those animals in which the body is carried more or less erect, as in birds and dinosaurs, there occurs elongation of both sacrum and ilium. In the early pterodactyls there were three or four sacral vertebræ; in *Nyctodactylus,* one of the latest, there were six true sacral vertebræ and one coossified lumbar. It thus would seem that some or all pterodactyls walked erect when upon the ground, with the knees probably much flexed. The pelvis of *Nyctodactylus,* with an expanse of outstretched wings of fully eight feet was less than seven eighths of an inch in diameter at the brim, and not three fourths of an inch at the outlet. The heads of the femora in the largest species measuring twenty feet in expanse were less than two and a half inches apart. If the legs were knock-kneed, as seems probable, both of the feet in such animals would have rested upon a space smaller than one's hand. In the posture I have indicated, with the body erect, the wing metacarpal bones would have rested upon the ground at the sides.

The eggs of *Nyctodactylus* could not have been three fourths of an inch in diameter, and of *Ornithostoma* not over two inches. How big would the young have been recently hatched from such eggs? Were they cared for by their parents after birth? Did the pterodactyls build nests?

S. W. WILLISTON.

PAPERS ON ENGINEERING.

The *Proceedings* of the Royal Society, just issued (Vol. XVI., Part II., Lond., Nov., 1901), contain a number of papers of peculiar interest in the field of applied science and engineering.

The opening article is by Lord Rayleigh, on 'Flight.' In this paper it is stated that the main problem in flight is that of the aeroplane, as in the case of the kite. But the kite is anchored and at rest relatively to the earth; while the aeronaut, the aviator, whether human or other, is adrift. No bird can maintain itself in motion in a uniform wind-current without active exertion, any more than in an atmosphere at rest. Soaring is thus evidently the outcome of utilization of internal movements of the atmosphere surrounding the bird. The albatross presumably takes advantage of such movements where strata move in proximity with differing motions. Langley has shown the possibility of taking advantage of the gustiness of the wind when soaring. Attention is called to the fact that the horizontal motion of an aeroplane greatly increases the pressure beneath it when falling, tending thus to sustain it effectively. On this fact depends the possibility of flight. The sustaining pressure is also reinforced by an important complementary suction above, with similar effect in supporting the falling mass. Artificial flight is a question of speed of horizontal motion; no man can raise himself from the ground by any mechanism operated by muscular power except with preliminary acceleration in the horizontal direction. Lord Rayleigh is inclined to agree with Sir Hiram Maxim that the problem of artificial flight is mainly one of time and money. It would presumably be mainly a military problem. He does not think it will prove a safe method of conveyance; but, as Maxim has remarked, we have not even yet succeeded in making war quite safe.

The Hon. Charles A. Parsons, in the second paper, discusses motive power and the steam turbine. He commences with a paraphrase of a page in the introductory section of Thurston's 'History of the Steam Engine,' in which the account of the steam turbine in Hero's 'Spiritalia' is presented, and goes on to say that an experiment made years ago in the production of a redesigned Hero engine enabled him to obtain twenty horse-power on a consumption of but forty pounds of steam per horse-power-hour, which is a very fair performance for engines of the simpler modern forms and of similar power. A later model illustrated his system of compounding, but without commensurate advantage. Branca's turbine of 1629, similar in principle and general construction to the impact waterwheel, had been reproduced successfully by Dr. La Val and is in extensive use in a form illustrating modern scientific construction. In 1884, Mr. Parsons began his work on his now familiar form of compound turbine, adopting the type of wheel known in hydraulics as the impact turbine. This proved practically successful, ultimately, and is now made in large numbers for electric 'plants.' It has been proved to be capable of as high economy as the reciprocating engines of the best modern constructors.

In 1894, the same plan was adopted for engines supplied to the *Turbinia*. The outcome was the redesigning of the screw-propeller and its method of application and the attainment of a higher speed than had ever before been recorded, 32¾ knots, 38 miles, an hour. The steam consumption was 14½ pounds per horse-power-hour, a result better than was usually obtained in similar craft with even triple-expansion engines and under similar conditions of steam supply. About 28 pounds of steam were vaporized per square foot of heating surface of boilers.

The *Viper* and the *Cobra* have been later built on the same general plan and the former became the récord-breaking vessel for the world, attaining above forty miles an hour (37,118 knots, 43 miles) on the dimensions of the regular 30-knot torpedo boat destroyer, a length of 210 feet, a beam of 21 feet and with 350 tons displacement. Water-tube, safety-boilers were fitted and the engines were of the compound turbine type.

A design for a war-vessel is hypothetically proposed on this plan and Mr. Parsons considers it possible to build a ship of 420 feet length, 42 feet beam and 14 feet draught, having 2,800 tons displacement, which should develop *eighty thousand* horse-power and a speed of 44 knots (over 51 miles) an hour. This represents a concentration of power never before dreamed of by the engineer, far less attempted or approximated, although an American designer, Mr. Mosher, has rivalled the work of Parsons in smaller craft.

Papers by Professor Ewing on the 'Structure of Metals' and by Sig. Marconi on wireless telegraphy fall into the same general category of work in applied science, and those of Lord Kelvin, Professor Dewar and others are in the field of pure science and have special interest through their promise of later utilization. Sir Andrew Noble presents a remarkable and illuminating discussion of the modern explosives.

R. H. THURSTON.