Thus, by the end of the tenth day, the reptilian type or fore foot has been attained, and the amphibian type lost, whilst the limb as a whole is now a fore-leg no longer, but a wing, thoroughly specialised by evolutional transformation.

The fore-limb has not simply become modified into a wing by the shortening of the pollex and third ray, the enlargement of the second, and the abortion of the fourth and fifth of a fore-paw, like that of the lizard; but we have now the historical representatives of three more rays which have cropped up since the end of the eighth day.

I have repeatedly noticed that aborted parts, like over-shadowed plants, are late to appear, and soon wither, or are arrested in their growth. This is the case here, for the new rays are late, small, and scarcely functional in the fullest development. They are not lost, however, but, like certain larval structures to be found in the skulls of the highest types of birds, they are built up into the finished wing, although they form an unimportant part of it as far as function goes.

The first of these additional rays is the "pre-pollex"; this is a lunate tract of fibro-cartilage attached to the inner face of the first metacarpal. The other two are composed of true hyaline cartilage, and appear, one on the ulnar side of the second, and the other on the ulnar side of the third developed metacarpal.

I have described them as intercalary metacarpals, for they seem to be the starved twins of the second and third large rays; each distal carpal, very probably, in the archaic forms carried two rays. Thus there is supposed, for such a fore-limb, a digit inside the pollex of the modern bird, and then two pairs of rays, of which only the inner in each case has been retained.

The paddle of Ichthyosaurus shows this kind of primitive cheiropterygium admirably.

Thus we can account for seven carpals and six digits in the wing of the modern bird; in the legs the specialisation is not so intense, but is very great; the study of the embryonic stages shows in it many parts that the adult bird gives no signs of whatever.

Instead of there being even two tarsals, free and functional, there is only one, and that has merely the function of a "sesamoid," and has been mistaken continually for a bone of that sort, that nucleus answers to our naviculare, morphologically termed the "centrale."

Notwithstanding the extreme diversity in the habits of existing birds, and the great difference seen in their shank bone, this part is always single, although composed of three metatarsals. As in reptiles, the joint at this part is not between the astragalus and tibia, as in mammals, but through the tarsal series; no sign of this structure is seen in the adult bird. That which appears to be the condyloid end of the tibia is a row of tarsal bones, the tibiale, fibulare, and intermedium: these have long been known as separate bones in young birds, but their distinctness in the early embryo as cartilaginous nuclei has only lately been made out.

I have been able, however, to demonstrate this repeatedly in different kinds of birds. The centrale also, although seen in the embryo as one of the tarsal series, was not properly identified; it is a constant element, but becomes degraded.

The distal series of tarsals exists as a single tract of cartilage, and then as a single plate of bone. But it is related to three metatarsals, and the middle or thick part is the first to chondrify in the embryo, and to ossify in the chicken or young bird; there are here three connate nuclei, with very slight signs of distinctness. The whole mass answers to our middle and external "cuneiform bones," and to the inner half of the "os magnum." Thus five tarsals can be always made out clearly, and two more accounted for.

The first metatarsal, which has been known, for some time, through the valuable researches of Morse, to have occasionally a proximal as well as a distal rudiment, has, I find, always a proximal rudiment as well.

Then, as Dr. G. Baur and Miss A. Johnson have shown, there is a fifth metatarsal; it is a small pisiform cartilage, which soon coalesces with the fourth, and with the great distal tarsal. I can only find a "pre-hallux" by turning to teratology, and this is not the lawful method.

There may, however, be some "reversion" or "atavism" in the polydactyle foot of the Dorking fowl, which has a well-developed "pre-hallux" and a double "hallux"; the twin digits of that part have a very ichthyosaurian appearance.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, xxix., No. 11.—B. Dessau, on metal films arising from the disruption of a kathode. Discusses the production of mirror-like films such as obtained by Plücker, Crookes, and Wright from the disgregation of the metal kathode in Geissler-tubes. With a pointed kathode and a flat glass surface as recipient, the film forms a flat conical deposit, showing interference-rings in reflected light, and proving also the presence of optical dispersive power in the metal. The dispersion in films of platinum, iron, nickel, and silver. It is anomalous in the case of gold and copper. The films are double-refracting, and, in the case of oxidisable metals, disappear on oxidation.—Ed. Hagenbach, propagation of electricity in telegraph-wires. Experiments made with chronographic apparatus on Swiss lines, together with a discussion of the results of Wheatstone, Walker, Guillemin, and others. Arguing from theory, the author compares, not the apparent speed, but the ratio of the time to the square of the length of circuit.—B. von Kolenko, reply concerning the pyro-electricity of quartz. Maintains, against Prof. Hankel, that the poles of a warmed quartz crystal are not altered during cooling by passing through a flame.—E. Edlund, remarks on H. Hoppe's communication on the theory of unipolar induction.—S. von Wroblewski, on the representation of the rotation between the gaseous and liquid states of matter by isopyknal lines. The transition of state is represented by curves drawn on a diagram having, for given definite densities, pressures as ordinates and temperatures as abscissæ; such curves being termed *isopykns* or isopyknal lines. The result of examination of these curves shows that, though there is no such thing as an absolutely definite critical temperature or critical pressure *per se*, there is a critical density for every liquid.—K. Schmidt, on reflection at the surface of crystalline elliptically-polarising media. Experiments made with a crystal of cinnabar, and results compared with the formulæ of Voigt and that of Ketteler. The latter leads to closer correspondence than the former with the facts of observation.—H. Muraoka, on the deformation of metal plates by grinding. The radius of the curvature produced by grinding metal disks set in a bed of fusible alloy is proportional to the cube of their thickness.—K. Exner, validity of lens formulæ for non-homogeneous lenses.—E. Budde, a means of deciding between the electro-dynamic point-laws of Weber, Riemann, and Clausius. This gives the elementary theory of an experiment not yet made.—J. Kollert, on a new galvanometer. This is practically identical with Gray's form.

No. 12, 1886.—C. Fromme, on the galvanic polarisation evoked by small electromotive forces. This gives a first series of results with platinum electrodes in dilute sulphuric acid.—Edm. Hoppe, on the theory of unipolar induction; with a reply to Prof. Edlund.—F. Himstedt, on a determination of the quantity "*v*." The method was that of comparison of the two capacities of a condenser; the result $v = 3{\cdot}0074 \times 10^{10}$ cm./sec.—R. Lamprecht, on the action of the magnet upon electric discharges in rarefied gases, concludes that the law of Biot and Savart holds good as the calculated trajectories agree with curves observed by Hittorf in 1869.—A. Foeppl, the spread of the electric charge in conductors.—L. Boltzmann, remarks on the opinion of Herr Lorberg on a point in electro-dynamics.—W. Voigt, on the torsion of a rectangular prism of homogeneous crystalline substance; a mathematical investigation.—J. Kiewiet, on the elasticity of bending of pure zinc, copper, tin, and their alloys. The moduli of elasticity of alloys is not constant, but depends on the mode of preparation of the alloy as well as on its composition. Wertheim's rule for calculating the moduli of alloys from those of their components, according simply to the proportion of the constituents, appears to be inexact. The change of moduli of alloys with temperature is a simple linear function.—J. Stefan, on the relation between the theories of capillarity and evaporation.—A. Heritsch, on radiophony. The author combats Graham Bell's view that the condensed gases of a smoke deposit or carbon strip have something to do with its radiophonic properties. He finds that a coke plate heated to redness and then instantly placed in a tube and exposed to intermittent illumination from sunlight or electric light, emits tones. He further constructed a sort of flat glow-lamp, which, even when raised to brilliant incandescence, emitted tones when exposed to intermittent sunlight. No other source than sunlight was sufficient for this experiment.—G. Kobb, on the spectrum of germanium.—Greiner and Friedrichs, on a new mercury air-

pump; a modification of Geissler's form.—A. Grosse, a wire-tape rheostat. Fine german-silver wires are spiralled around cotton threads, which are then woven into a sort of tape, the warps being thereby insulated from one another. A piece 2 cm. wide and 4 metres long has 1000 ohms resistance.—W. Holtz, a Wheatstone's bridge for air and water flow. An illustrative apparatus of tubes such as has often been used.

IN the *Scottish Geographical Magazine* for January there is an excellent bathy-orographical chart of the Clyde sea-area, constructed for Dr. H. R. Mill by Mr. J. G. Bartholomew. The colouring of the map is designed to show with special effect the area and depths of the Firth of Clyde and its inlets. For this purpose the land and sea have been treated separately, and coloured in strong contrast to each other. The system of colouring is, however, uniform, and in both cases the lowest or deepest areas are distinguished by the darkest tints, and graduated up to the lighter tints of the higher or shallower portions. The same number contains a paper on the configuration of the Clyde sea-area, which was read by Dr. Mill at the last meeting of the British Association.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 16 — "Note on Specific Inductive Capacity." By John Hopkinson, M.A., D.Sc., F.R.S.

Consider a condenser formed of two parallel plates at distance x from each other, their area A being so great, or the distance x so small, that the whole of the lines of force may be considered to be uniformly distributed perpendicular to the plates. The space between the plates is occupied by air, or by any insulating fluid. Let e be the charge of the condenser and V the difference of potential between the plates. If the dielectric be air, there is every reason to believe that $V \propto e$, that is, there is for air a constant of specific inductive capacity. My own experiments ([1880] Phil. Trans., vol. clxxii. p. 355) show that in the case of flint-glass the ratio of V to e is sensibly constant over a range of values of V from 200 volts per cm. to 50,000 volts per cm. From experiments in which the dielectric is one or other of a number of fluids and values of V upwards of 30,000 volts per cm. are used, Prof. Quincke concludes (Wiedemann, *Annalen*, vol. xxviii., 1886, p. 549) that the value of e/V is somewhat less for great electric forces than for small. From the experiments described in that paper, and from his previous experiments (Wiedemann, *Annalen*, vol. xix., 1883, p. 705, *et seq.*) he also concludes that the specific inductive capacity determined from the mechanical force resisting separation of the plates is 10 per cent. to 50 per cent. greater than that determined by the actual charge of the condenser. The purpose of the present note is to examine the relations of these important conclusions, making as few assumptions as possible.

In words, the specific inductive capacity as determined by charge or discharge of a condenser at any given potential and distance between the plates is the arithmetic mean of the inductive capacities determined by the force resisting separation of the plates and that determined by lateral pressure, the potential and distance being the same. This is true whatever be the relation between charge and potential difference, but it is at variance with the experimental result that K_p and K_s are both greater than K.

The results obtained by Prof. Quincke are not easy to reconcile. For that reason it is the more desirable that their full significance should be ascertained. Full information is given of all the details of his experiments except on one point. It is not stated whether, in the experiments for determining K by direct discharge of the condenser, the capacity of the connection and key was ascertained. It would in most ordinary arrangements of key be very appreciable in comparison with the capacity of the condenser itself. If neglected, the effect would be to a certain extent to give too low a value of K, the effect being most marked when K is large.

The property of double refraction in liquids caused by electrification is sometimes cited as showing that electrification is not proportional to electromotive force. The fact that the double refraction in a liquid under powerful electromotive forces is very small would further show that there is a close approximation to proportionality, and that the deviation from proportionality would be insensible to any electro-static test. Such conclusions, however, cannot be safely drawn in the case of bodies such as castor-oil, in which $K \pm \mu^2$. In such bodies, assuming the electro-magnetic theory of light, the yielding to electromotive force is much greater if the force be applied for such time as 10^{-4} second than when applied for 10^{-14} second, and it is quite possible that the law of proportionality might be untrue in the former case, but very nearly or quite true in the latter.

"On the Dielectric Constants of Fluids." (Addendum to Dr. Hopkinson's "Note on Specific Inductive Capacity.") By Prof. G. Quincke, For. Mem. R.S.

In investigating the properties of dielectric fluids (*Wiedemann's Annalen*, vol. xix. 1883, p. 707; vol. xxviii., 1836, p. 529), I found the dielectric constants with the electric balance or by the hydrostatically measured pressure of an air-bladder greater than when measured by the capacity of a condenser surrounded by air or the insulating fluid, and discharged by turning a key through a ballistic galvanometer.

The capacity of the key and of the short thin junction-wire connecting the key with the condenser was, however, in that calculation left out of account as being evanescently small.

In consequence of a written communication from Dr. John Hopkinson, I quite recently compared the capacity of the key and the junction-wire with the capacity C of the condenser by observations with the ballistic galvanometer with the same difference of potential between the surfaces, and thereby found the relation—

$$\frac{x}{C} = 0{\cdot}1762;$$

greater, therefore, than I had conjectured.

Let there be subtracted from the observed galvanometer readings s_1 and s_{11} for the condenser in air and in the dielectric fluid, the deflection calculated for the electricity on the key and junction-wire, then there will actually be obtained from the ratio of the readings thus corrected (s_1) and (s_{11}) values of the dielectric constants (K) of the fluid almost exactly coinciding with the measurements of the electric balance. The agreement is indeed as perfect as might be expected, considering the difference in the methods of observation employed.

Thus, for example, it was found:

	Dielectric constants with Ballistic galvanometer (K)	Weighing K_p
Ether	4·211	4·394
Carbon disulphide ...	2·508	2·623
,, ,, ...	2·640	2·541
Benzole	2·359	2·360
Petroleum	2·025	2·073

[Note added by Dr. Hopkinson.—Prof. Quincke's explanation sets the questions I have raised at rest. There can be little doubt that K, K_s, and K_p are sensibly equal and sensibly constant. The question what will happen to K_p and K_s if K is not constant has for the present a purely hypothetical interest.

Physical Society, January 22.—Prof. McLeod, Vice-President, in the chair.—Dr. F. Wormack was elected a Member of the Society.—The following papers were then read:—The permanent and temporary effects on some of the physical properties of iron produced by raising the temperature to 100° C., by Mr. Herbert Tomlinson, B.A.—On some new measuring-instruments used in testing materials, by Prof. W. C. Unwin, F.R.S. In most measuring-instruments previously used, it has been considered sufficient to make the measurement of elongation from one side of the bar, but this, the Professor showed, was liable to serious errors owing to the fact that test-bars are not always perfectly straight, and to the possibility of originally straight bars being bent by improper fixing in the testing-machine. In such cases the modulus of elasticity calculated from the apparent elongations are subject to considerable error. In endeavouring to overcome these difficulties the author has devised several new forms of measuring-apparatus, which are attached to two sides of the bar by steel points, and the mean elongation of the two sides determined. The first apparatus described consists essentially of sliding calipers read by microscopes to 1/10,000 of an inch. Another form has two clamps provided with sensitive levels. Each is attached to the bar by two steel points, the line joining which is